

MACROPHOTOGRAPHY



**Tools, Tips & Techniques
for Digital Photographers**

Robert Berdan
2012 ©

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Because of the dynamic nature of the Internet, any web addresses or links contained in this book may have changed since publication and may no longer be valid.

If you would like to use this e-book as part of a workshop or course on macrophotography please contact Robert Berdan to discuss a discount for orders of 4 or more e-books.

Edited by Karen-Maria Tratt - www.strictlywords.ca

Cover photo: Robert Berdan inside a drop of water on a pine needle, digital composite, and photo of Robert by Donna Berdan.

Choosing a Camera for Macrophotography

Macrophotography refers to taking pictures that magnify the specimen between about 0.5X and 10X with most of the photographs being taken at 0.5X to 2.0X. Macrophotography can be accomplished using a variety of camera lens combinations. The two most common camera types today are compact digital cameras and digital single lens reflex cameras (DSLR). Other cameras including medium format and large format cameras can also be used for macrophotography, but they are less common and will not be covered here. Instead I will concentrate on DSLR cameras because they offer the most flexibility and versatility. Most of the techniques covered will also apply to film based cameras, but film is now getting scarce and digital cameras offer many advantages over film.

Compact digital cameras for macrophotography

Compact digital cameras are capable of taking excellent macrophotographs and because they have relatively small sensors some of these cameras can be held as close as 1 cm from the subject. Some (e.g., the Pentax Optio) even include LED lights for ultra closeups and are also waterproof. The quality of the images from most compact cameras is not as good as images from most DSLR cameras because the sensors are smaller resulting in more picture noise or grain. Only a few compact cameras offer higher quality RAW files and interchangeable lenses. For many folks these limitations are only minor inconveniences and compact cameras can produce great photos. If you are new to photography and want to explore the macro world compact cameras are very capable. Some compact cameras permit manual focus and control over the aperture, others have zoom lenses and most offer screw mounts for a tripod. Most of the text in this e-book, however will concentrate on how to use a DSLR camera because they offer even greater flexibility and produce higher quality images.

Advantages of compact cameras:

1. They are small, compact and can fit in your pocket.
2. In macro mode most compact cameras can be positioned very close to the subject.
3. Compact cameras are usually lower in cost ranging from about \$200 to about \$1200.
4. Some compact cameras are completely waterproof and can be used to photograph in ponds, lakes, tide pools and in harsh weather conditions.
5. Compact cameras have smaller sensors resulting in a large depth of field even up close.

Disadvantages of compact cameras

1. Only a few offer interchangeable lenses.
2. Few have a depth-of-field preview button.
3. Few allow you to attach a cable release, though most offer self-timers and some have remotes.
4. Viewfinders, if present, tend to be small and LCD screens are difficult to view in bright sunlight.

5. Due to their smaller sensors and pixels, image quality is poorer than those produced by DSLRs.
6. Very few models offer the ability to shoot RAW files, which are better quality files and allow more flexibility in post processing.
7. Very few compact cameras permit the use of filters or an electronic cable release.



Compact digital camera being used to photograph Lady's slipper orchids.

If you use a compact digital camera, your biggest challenge will be holding the camera steady (use a tripod where possible). In some instances, you might not want to get too close to your subject (think about bees, wasps and hornets). Also, some insects that can fly, like butterflies, usually won't tolerate a close approach and are likely to fly away. The working distance in macrophotography with a compact camera is usually quite small, consisting of a few centimetres.

If you are considering the purchase of a digital compact camera for shooting macro photographs, here are some features to look for.

1. Zoom lens with ability to focus in close: i.e., should have macro mode option.
2. Ability to shoot RAW files for higher quality images (only a few offer this).
3. Ability to use a self-timer to reduce camera shake, or accepts a remote control to fire the shutter.
4. Look for a camera with lights around the lens to light up the subject when you are in very close.
5. Determine whether the camera allows you to focus manually and also select the focus point.
6. All good digital cameras should offer exposure compensation.

7. Live view is a nice feature where you can see the image through the back LCD screen to avoid parallax error associated with small viewfinders and most compact cameras.
8. A tilting LCD screen makes it easier to view when your subjects are positioned low to the ground.
9. Consider a waterproof camera for shooting in rain, tide pools and other bodies of water.
10. Choose a camera that offers 24-30 frames per second high definition (HD) video.
11. The camera should include a tripod screw mount to attach the camera to a tripod.
12. Choose a camera with a minimum of 10 megapixels to allow 8 x 10 enlargements or greater.
13. Camera should not be too slippery in your hands some offer rubber grips to prevent the camera from slipping out of your hands.
14. Ideally the camera should have some means to protect the front of the lens – glass or cover.
15. Select cameras with vibration reduction to reduce camera shake in low light.

Other factors in choosing a compact camera include: styling, size and cost. In general, I recommend staying with one of the main camera brands for quality and support. There are so many compact cameras with new models coming out almost weekly that it's difficult to recommend specific models. One that I have used with good macrophotography results and is completely waterproof is the Pentax Optio WG-II. Unfortunately the camera does not offer RAW files, but at about \$330 is one of the best compacts I have used. It includes an intervalometer for time-lapse photography and shoots HD video.



Pentax Optio WG-2 Compact Camera costs about \$330 and is waterproof to about 40 feet. Includes LED lights around the lens and has plastic grips around the edge. Includes a lens zoom with equivalent 28-140 mm focal length, 16 MP and full HD video at 30 frames per second and the camera can focus as

close as 1 cm. ISO sensitivity 125-6400, f/3.5 to f/5.5 and shoots at 1.0 frame per second (fps). If you buy this camera be sure to buy a spare battery and a remote control release.



Water lens technique, photo taken with a compact Pentax Optio camera in macro mode.

Digital single lens reflex cameras, aka DSLRs

DSLR cameras are the most popular cameras among serious photographers and professional nature photographers because they offer a wide range of features, interchangeable lenses and the ability to see the image clearly through the lens. There are many brands to choose from, so my advice is to stick with one of the major brands. Canon and Nikon are the two most popular brands and offer the widest selection of lenses and accessories. Other brands, such as Pentax (Ricoh), Olympus, Sony, Leica, Samsung, Fuji and Samsung, offer good quality camera equipment but often only a limited number of lenses and accessories. Regardless of the brand of camera you choose, the most important factor in producing high quality images is the photographer. Before purchasing a camera, consider renting it to try before purchasing, and certainly read reviews on web sites such as www.dpreview.com. Sometimes what we want and what we can afford are two different things. If you start making money with your photographs, then it's easier to justify spending more money on camera equipment. If you already own some camera equipment, start with what you own and add lenses and accessories as your interest increases.

The most economical way to get into macrophotography is to have: 1) a reverse lens adapter, 2) closeup filters and 3) extension tubes. After that, you are looking at buying a macro lens and possibly other

accessories. The good news is that you won't have to spend your money on film and film processing; the bad news is that you will also need a computer and image editing software to view and process the images.

Things to consider when purchasing a DSLR camera for macrophotography

1. Price and warranty.
2. How does the camera feel in your hands?
3. Does the brand offer a wide range of accessories?
4. Does the brand offer a wide range of lenses?
5. Camera should offer a wide range of ISO speeds, 200-1600 minimum.
6. Camera should offer a depth of field preview button.
7. Camera should offer autofocus with ability to switch to manual focus.
8. Camera should offer the ability to shoot RAW files.
9. Megapixels – look for a camera with more than 8-10 megapixels.
10. Camera includes HD video 1920 x 1080 pixels 24 or 30 fps
11. Tilting LCD screen for work down low - nice to have but not essential.
12. Camera should offer exposure compensation minimum of +/- 1 f-stop minimum)

Camera brands

When I started in 1972, I choose an Olympus OM-1 SLR camera because it was half the price of the Nikon equivalent, and Olympus had some of the best macro and photomicrography accessories of any manufacturer at that time. Unfortunately, Olympus did not keep pace with the competition, so many years later I switched to Nikon for better autofocus and a wider selection of lenses. I think every photographer that shoots with Nikon wonders if Canon equipment is better, and vice versa. Today, I shoot with Nikon, Canon and Pentax cameras. I prefer Nikon's ergonomics on the DSLR cameras and its autofocus features over Canon; however, Canon seems to be ahead of Nikon in having lower image noise, and Canon put out a full frame camera with HD video 30 fps almost two years before Nikon. To be fair, Nikon offers what I think is better autofocusing options and bigger on camera buttons which I like. Using both Nikon and Canon gear allows me to compare them and this also helps me be a better teacher as these are the two most popular brands that students use in my workshops.

The bottom line is you should research what you like and can afford, then learn everything you can about your camera equipment. That way, when you get down to shooting, you are not thinking about your camera but rather about seeing and making great pictures. Just because a certain photographer uses a particular brand-name camera, does not mean he/she will take better pictures than someone with a cheaper model – skill and vision are and always will be the most important elements in good photography. Ultimately, buy what you like, can afford, and consider camera systems that offer the features and ergonomics that suit your needs.

The choice between a compact digital camera and SLR camera usually comes down to how much weight you are willing to carry around and how much flexibility you want with your photography. For some people, a cell-phone camera may be all they need; whereas for others nothing short of a camera bag filled with lenses will satisfy them. I fit in the latter category because photography is a big part of my life and it's my passion. To me, photography is also about options and I want all the options I can afford.

What photographers should already know

1. Lens focal length determines the field of view: wide angle (10-35 mm), normal (40-70 mm) and telephoto (100-1000 mm).
2. Photographers should understand the different camera modes: A, T, M, P, B.
3. How camera ISO speed affects sensitivity of the sensor to light and also the amount of "noise".
4. When to use the cameras different colour modes: sRGB for JPG vs. AdobeRGB for RAW files.
5. Digital photographers should understand the advantages and disadvantages of JPG vs RAW files.
6. Digital photographers should know how to set the camera white balance.
7. Photographers should understand different metering modes: average, spot, center weight, evaluative or matrix and when to use each.
8. How F-stops affect depth of field and the amount of light entering the lens.
9. How to find information about your camera and its' controls in your camera manual.

Before embarking on macrophotography techniques, it is recommended that photographers have a basic knowledge of their camera controls or have taken a basic course on photography. Alternatively, I recommend that if the reader uses a DSLR type camera that he\she should spend a bit of time reviewing the basic camera controls before proceeding. On my web site I have a number of articles and slide shows available that cover camera basics.

Getting started in macrophotography

If you use a compact camera, then the main control you need to find and learn how to activate is the macro shooting mode. It usually will appear as a flower symbol on one of your camera buttons.



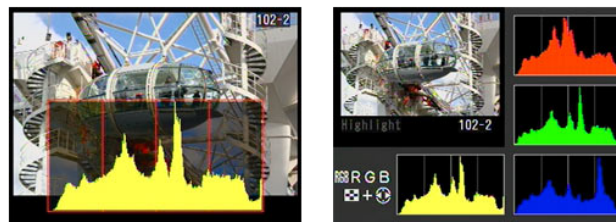
Interestingly, some SLR cameras also have such a button or camera setting (e.g. Nikon 5100), however on a DSLR camera, it doesn't affect how close you can focus; it may only pop up the on camera flash.

With a compact camera in macro mode, press the shutter button half way, and move your camera closer to your subject and view the image on the LCD view screen. Your main obstacle will be to hold the camera steady. If your camera has vibration reduction feature turn it on, or use a tripod or other support, then take the picture.

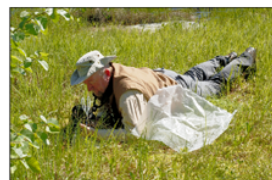
Once you take the picture you can evaluate it on the LCD screen. Check the exposure histogram to see if the exposure is good and, if not consider using exposure compensation to lighten or darken the image. The exposure compensation button usually has a +/- symbol on it; you press it while increasing or decreasing the exposure to darken or lighten the image. Retake the photograph and examine the exposure again. Some compact cameras may permit you to alter the depth of field by changing the F-stop usually from f/2.8 to f/8. The higher the F-stop number, the greater the depth of field you can achieve.

You may also be able to choose the focus point, which can be important when you move very close to a subject. If so, turn on this feature and place the focal point, which is usually a box appearing in your LCD screen, over the region you want in sharp focus. In general, because compact cameras are limited in their ability to precisely control the depth of field and focal points, most serious photographers will opt for an SLR-type camera for macrophotography.

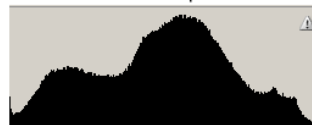
Use the Histogram Function to Determine Exposure with Digital Cameras



Under Exposed



Correct Exposure



Over Exposed



Exposure histograms represent the number of pixels (height, y-axis) in the image that are dark, middle tone or white (tonal range, x-axis). If the histogram is skewed to the left it means that you have a lot of black or dark tones in the image or the image is underexposed. If the histogram is skewed to the right it

means you either have a lot of light tones in the picture or it is overexposed. Some cameras also have a “blink feature” that causes those areas of the image to blink if overexposed. You can adjust exposure by using the camera's exposure compensation button to darken or lighten the image; this will also cause the histogram to shift left or right. The most important thing to avoid is over-exposure.

Using a DSLR in macrophotography

Single lens reflex cameras are referred to as such because they have a mirror inside the camera body that reflects the light directly from the lens to a prism at the top of the camera and into the viewfinder. The photographer sees exactly what the camera sees. When the photographer takes a picture, the mirror is quickly pulled up out of the way so that light falls on the camera's film or digital sensor, which is why these cameras are referred to as reflex cameras. The main advantage of SLR cameras is that they can be relatively small yet permit the attachment of a wide range of lenses for different purposes. Also, the photographer sees exactly what the camera sees with no parallax error. The relatively compact nature of SLR cameras and the ability to attach a wide range of lenses is what makes them so popular.



Various SLR cameras including a film based camera on the left and two popular Digital SLR cameras

Digital SLR cameras come in two basic forms, depending on their sensor size. A full frame digital camera has a larger sensor that is the same size as 35 mm film. When you attach a lens to this camera with a specific focal length e.g. , 100 mm, then that is the true focal length of the lens. There are also SLR cameras with slightly smaller sensors, sometime referred to as APS (Advanced Photo System). When you attach a lens on these cameras, the focal length is usually multiplied by about 1.5X such that a 100 mm lens becomes a 150 mm lens. The result is a slightly different angle of view and in the case of telephoto lenses, the result is greater magnification.

I like to own both a full frame and APS camera body as it essentially doubles the focal length of the lenses I have in my camera bag. I gain magnification with smaller chip cameras, and these cameras usually offer faster shooting speeds because the smaller sensor processes less information. The full frame digital cameras have a larger viewfinder that makes it easier to view the subject and focus, and these sensors tend to have lower digital noise than smaller sensor cameras. Full frame cameras, however usually cost more and have slower high speed frame rates.

Some lenses are manufactured for use only with cameras with smaller sensors (Nikon calls them DX lenses, Canon calls them EF-S, Pentax DA, Sony DT, Sigma DC, Samsung NX, Tamron Di II and Tokina DX). Lenses designed for use with the smaller SLR sensors are usually cheaper, but cannot be used on a full frame SLR camera without some vignetting or image cropping. Lenses designed for full size sensor SLR cameras can be used on both types of digital camera; however the apparent focal length of the lens will be different e.g., 100 mm macro lens will become a 150 mm macro lens on an APS camera (some APS cameras multiply focal length by 1.3, 1.5 or 1.6X). The ideal solution, if you can afford it, is to own two camera bodies, one with the smaller APS sensor and another with the full frame sensor.

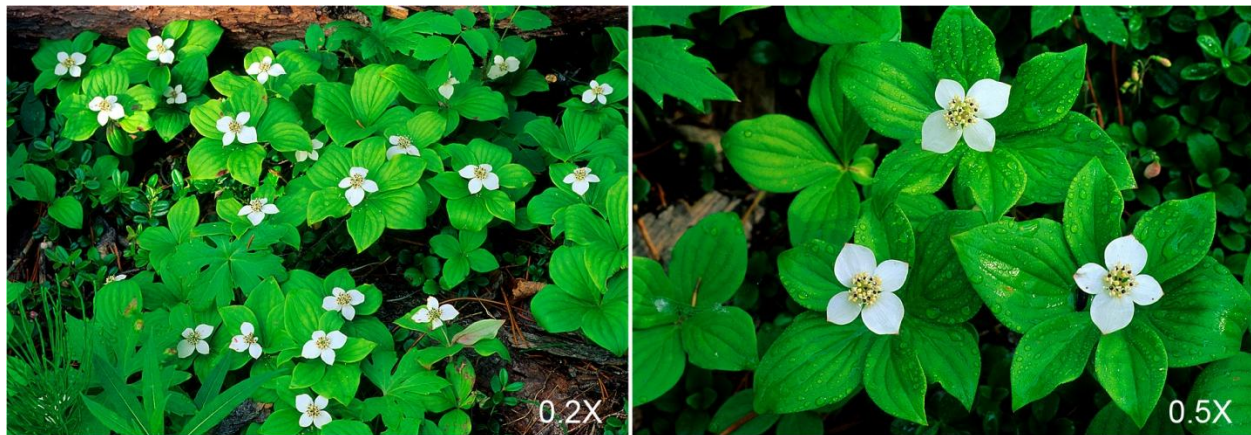
Not only is the number of pixels in a sensor important, but so is the size of the sensor and the size of the sensor pixels in determining picture quality. A large sensor with the same number of megapixels as a smaller sensor will result in better quality images because the individual pixels are bigger and more sensitive to light. Similarly in the past high ISO speed film e.g., 1600, was more sensitive to light because the silver halide crystals were bigger; however, this also resulted in images with more graininess. For this same reason, an SLR camera with the same number of megapixels as a compact camera will always have better quality images, as the sensor in compact cameras is usually smaller. Bigger pixels mean they have a larger area to capture photons of light, and the result is better signal to noise ratio, which simply means less grain and smoother tones, especially when using higher ISO speeds.

Getting close with a DSLR

How close you can approach your subject and how much magnification you can achieve depends on the type of lens and its focal length. A normal 50 mm lens allows you to achieve about 0.25X magnification, which is fine for taking pictures of some flowers and groundscapes. To get even closer and higher magnifications there are a number of options that I will describe:

1. Attach closeup filters to a lens (also called supplementary filters in some books).
2. Attach extension tubes between the lens and the camera.
3. Attach variable extension tube or bellows for high magnification work .
4. Use a reverse lens adapter or stack two lenses together, with the smaller front lens reversed.
5. Purchase a macro lens.
6. Attach your camera to a stereo microscope or light microscope – see my web site.
7. Attach your camera to a Scanning electron microscope (costs start at \$60,000 – yikes!)

Closeup Filters



Normal 35-50 mm lens



Close-up Filters

Closeup filters (also called supplementary filters) are an economical way to get started in macro-photography. The standard lens that comes with some new cameras has a focal length of about 50 mm and close focus range of about 0.45 meters (about 18 inches). This limits objects in your viewfinder to approximately 0.1- 0.2X or less in magnification. To achieve greater magnification you can attach a closeup filter. Closeup filters screw onto the front of your camera lens just like other filters. They are light in weight and easy to carry with you, and do not reduce the amount of light entering your lens.

Closeup lenses come in different strengths or diopters (+1, +2, +3 and +4). The higher the diopter, the closer you can bring your camera to your subject. You can also combine several filters for added magnification, although I suggest you do not use more than two closeup filters at one time. If you are going to combine closeup filters you will get better results if you attach the largest diopter filter first. The filter numbers are additive, that is, a +1 and a +2 filter = +3 filter. If you have a +3 closeup filter, you will get better results by using it rather than using two lower power filters, as each glass interface you add in front of your lens increases glare and will reduce image contrast and sharpness. A set of 3 basic closeup filters +1, +2 and +4, can be purchased for around \$100-\$150 (e.g., Hoya 52 mm thread).

Closeup filters come in two forms: single lens element filters and dual element closeup filters. Dual element closeup filters are produced by Nikon and Canon and can cost \$100 to \$200 each. Dual element filters are more highly corrected than single element lenses and produce better quality images. For those new to macrophotography, I recommend starting with a set of 3 single element closeup filters. One disadvantage of using a closeup filter is that it is not as sharp as a macro lens, most notably at the edge of the images. For this reason, closeup filters are not suitable for copying art, stamps or anything

that requires edge sharpness. For flowers and most subjects in nature, they work very well, and this is how I got started in macrophotography. Also, once you attach a closeup filter to your camera, you can no longer focus the lens to infinity without removing the filter. Higher quality two-element closeup filters do an excellent job. You can attach them to a telephoto lens, normal lens or even a macro lens, so long as they have the correct filter thread size.

Closeup filters look like regular filters and come in different diameters and strengths (diopters). They screw onto the front of your lens and permit your camera to be positioned closer to your subject – you can attach them to any of your lenses.

Technical information on closeup filters

The magnifying power of a closeup filter is measured in diopters, although some companies (e.g., Olympus) indicate the focal length of the closeup filter. Here is how you can convert one to the other and determine how close you can get to your subject with different closeup filters and lenses.

Diopter = $\frac{1000 \text{ mm}}{\text{Focal length of filter in mm}}$

E.g. +2 Diopter = $\frac{1000 \text{ mm}}{500 \text{ mm}}$ +4 = $\frac{1000 \text{ mm}}{250 \text{ mm}}$

A +2 Diopter closeup filter will permit you to focus on objects 500 mm from the front of the lens, and a +4 Diopter closeup filter will permit you to focus on objects 250 mm from the lens.

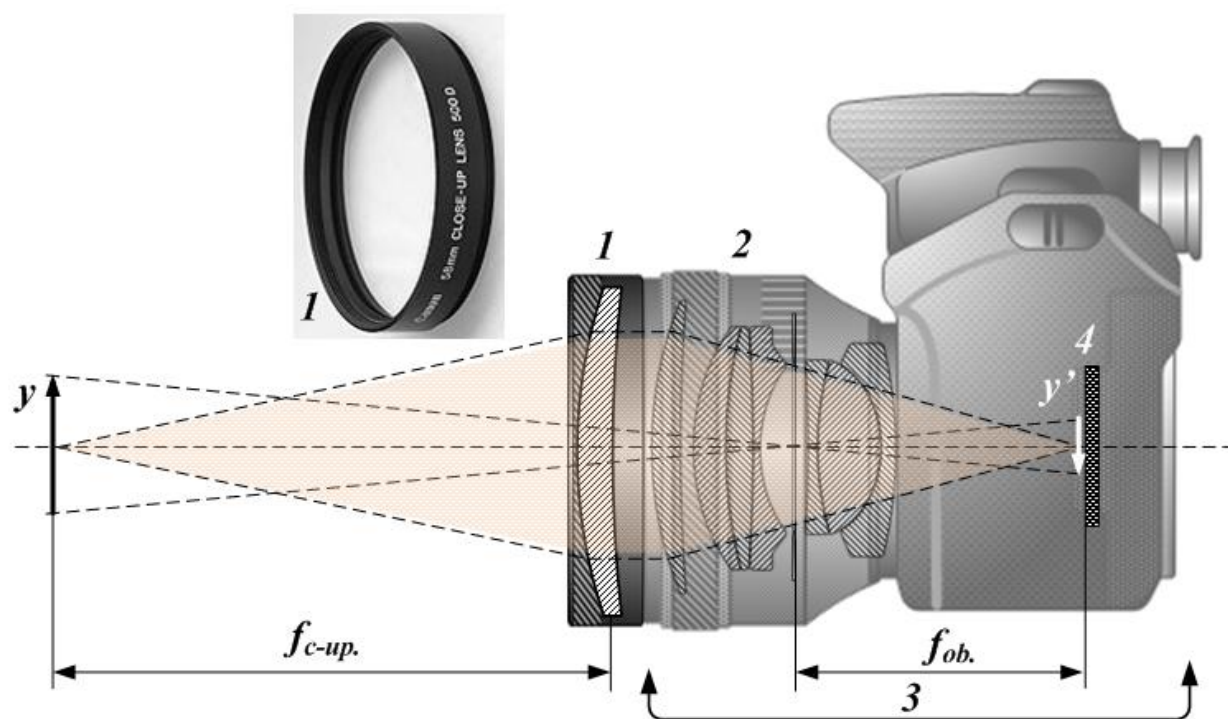


Above are four closeup filters. On the left is a Nikon 2 element closeup filter, followed by three Hoya single lens closeup filters. The three 52 mm closeup filters cost me around \$50, while the dual element closeup filter was over \$150.

To Determine the Magnification you can achieve with closeup filters you use the following formula:

$$\text{Magnification} = \frac{\text{Focal length of camera lens}}{\text{Focal length of closeup lens}}$$

e.g. $\frac{50 \text{ mm Normal lens}}{250 \text{ mm (+4 closeup)}} = 0.25 \times$ $\frac{200 \text{ mm Telephoto lens}}{500 \text{ mm (+2 closeup)}} = 0.4 \times$



$$\text{Magnification} = \beta = \frac{y'}{y} = \frac{f_{ob.}}{f_{c-up.}} = \frac{f_{ob.} \cdot D_{(\text{diopter of c-up lens})}}{1000} \quad f_{c-up.} = \frac{f_{ob.}}{\beta}$$

Diagram courtesy of Wikipedia

Extension Tubes



On the left is an Olympus variable length extension tube, and on the right a set of three Kenko auto extension tubes.

Another way you can move your camera closer to your subject is to place an extension tube between your camera and lens. Extension tubes are hollow and do not contain any glass elements; therefore, they do not degrade the image produced by your primary lens. The amount of magnification you can achieve will depend on the amount of extension and the focal length of the lens you use them with. Longer focal length lenses require more extension to achieve the same amount of magnification.

Extension tubes come in fixed lengths (e.g., 7, 15, and 25 mm are common sizes). You can combine two or more tubes for greater extension. Generally, the greater the extension the greater the magnification achieved. Olympus makes an auto extension tube that varies in length like a set of bellows, and it is great for working in the field. Extension tubes reduce the amount of light entering the lens but result in no appreciable loss of sharpness. In this respect, extension tubes are superior to closeup filters.

Another advantage extension tubes entail is that they can be used with any lens you own to make it focus more closely including your telephoto lenses. A set of three extension tubes costs about \$200 new, \$100 to \$150 used. Because they contain no glass elements, brand names are not important, so long as they fit on your camera and permit the metering system to work. Auto extension tubes are preferred – these allow you to view your image with the aperture wide open. I recommend testing them in the store with your lens before you buy a set. You can also buy just a single tube. The great thing is you can attach them to a wide angle lens, normal lens, macro lens and even a telephoto lens, and they will permit your lens to focus more closely. They are a great way to get started in macrophotography.

Technical Information on Extension Tubes

Magnification = $\frac{\text{Extension tube distance in mm}}{\text{focal length of lens}}$

E.g. $\frac{50 \text{ mm lens}}{50 \text{ mm extension}} = 1.0 \times$

$\frac{200 \text{ mm lens}}{50 \text{ mm extension}} = 0.25 \times$

In general the greater the extension the greater the magnification, however longer focal length lenses will produce less magnification with the same amount of extension.

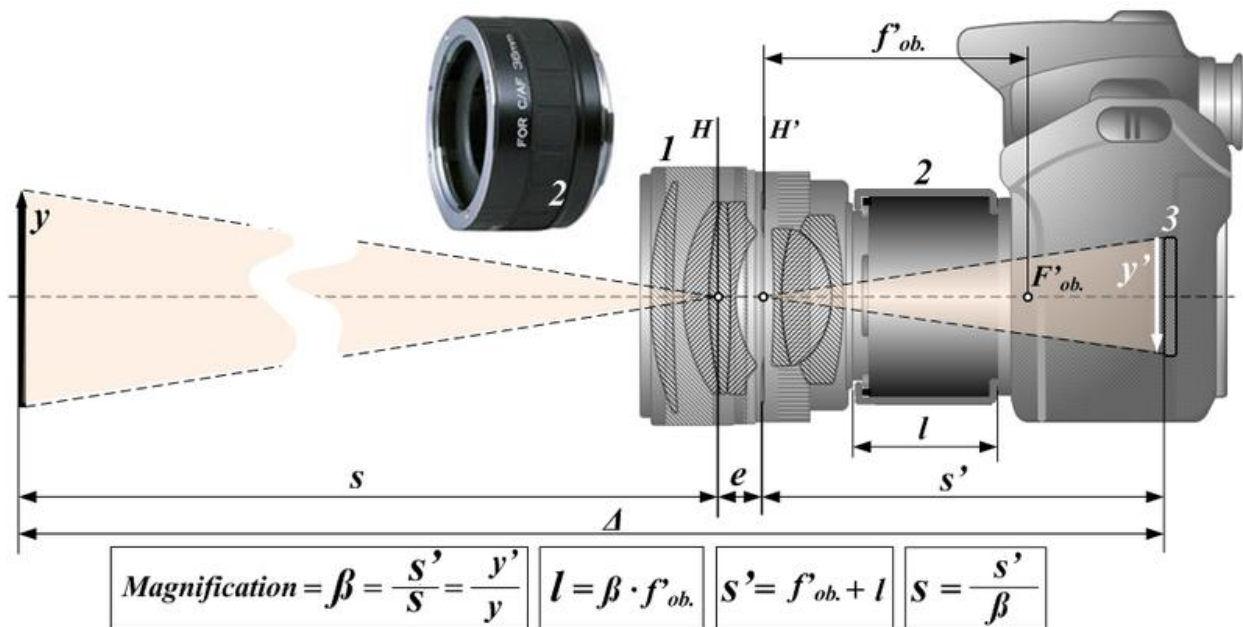


Diagram courtesy Wikipedia

TIP: If you own a telephoto lens such as 70-200, 70-300, 200 or 300 mm focal length lens, by attaching an extension tube you will be able to use this lens for photographing flowers, butterflies and enjoy a large working distance of several feet or more. Also some telephoto lenses already have a macro or close focusing capability built in.



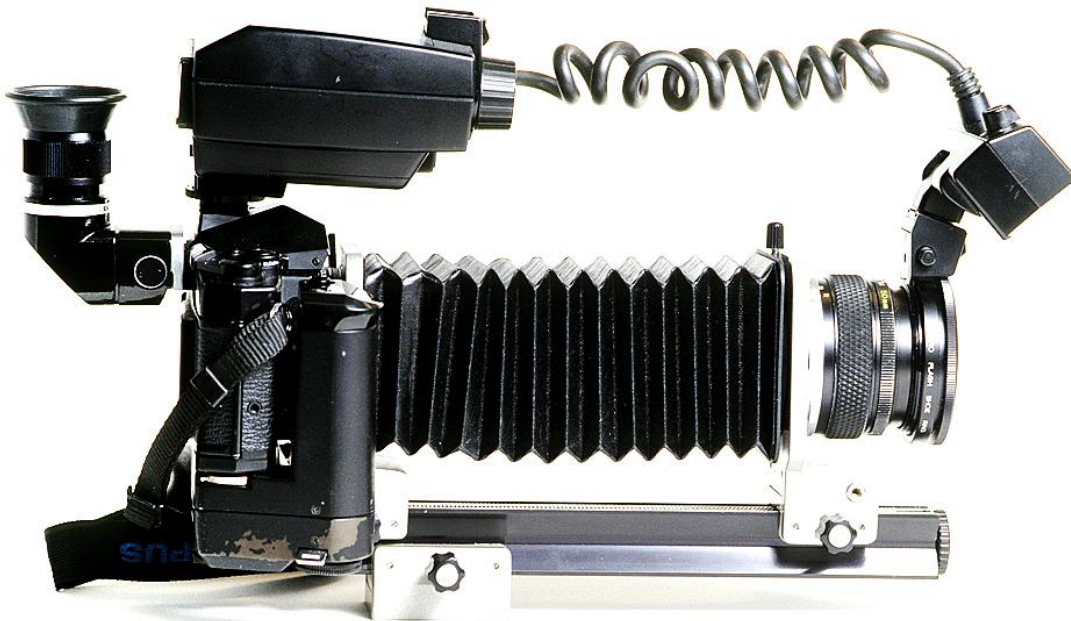
Variable length extension tube attached to 75-150 zoom lens on a 35 mm Olympus OM-4 film camera.

Bellows for High Magnification and Studio Work

Bellows are "flexible" extension tubes. Their main advantage is that they permit even greater extension than tubes, and the amount of extension can be controlled precisely. Bellows can be used in the field with a tripod, but they are cumbersome to carry around and their accordion-like leather is easily damaged. A set of bellows is also expensive, costing from \$300 to over \$1000. Some bellows also include a reversing lens adapter.

Good bellows units include a focusing rail because at high magnification, focusing is achieved by moving the bellows and lens forward or backward. Many bellows units operate in manual mode, which means that you will have to set and close the lens aperture just before shooting. Automatic bellows usually come with a double cable release that closes the aperture before you expose. An automatic set of bellows allows you to focus with the lens aperture wide open.

The magnification achieved with bellows depends on the lens that you place in front of the unit, but magnifications from 1X to 20X are possible. Bellows are for advanced photographers that want to achieve high magnification. They are best suited for working indoors in a studio. At magnifications of more than 3X or 4X even the slightest breeze can move your subjects in and out of focus. Focusing is done by moving the camera on the rail and this requires a very steady tripod and usually a flash due to light fall off with the added extension. Don't forget you also need a cooperative subject that will hold absolutely still; at magnifications over 5X, an ant will walk out of your field of view in less than a second!



Set of Bellows with electronic flash connected to the front macro lens. A varimagnifier is attached to the camera viewfinder to assist focusing. Bellows permit a variable amount of extension and magnification.

Macro Lenses

Macro lenses are the most highly corrected lenses you can buy and have very high resolving powers. A macro lens may cost between \$400 to \$2000. If you find you are using your extension tubes or closeup filters frequently, or you become serious about macrophotography, then it is time to consider purchasing a macro lens. If you already invested in extension tubes or closeup filters you can continue to use them with your macro lens to achieve even greater magnification. My recommendation is that if your budget can stand it, consider purchasing your camera manufacturers macro lenses before you begin to looking at an independent lens manufacturer. If you can't afford a macro lens from your camera manufacturer, Tamron makes an excellent 90 mm Macro lens to fit most major camera brands (Nikon, Canon, Sony, Pentax). I have not had an opportunity to work with macro lenses from other companies. Always check out several reviews on web sites by professional photographers – they tend to be more critical than most photography magazines which are afraid to lose potential advertisers.

TIP: Before purchasing a lens some camera stores will rent you the same lens and then if you decide to purchase it they will refund the rental price. If you have a trusting friend who owns a macro lens you might be able to borrow and try it for a short period of time. Just remember: if you borrow a lens and drop it, you bought it.

Macro lenses are generally available in three common focal lengths: 50-60 mm, 90-110mm and 200 mm. The greater the focal length of the lens, the longer the working distance you will have between your camera and the subject. Longer focal length lenses also have a narrower field of view, allowing you to isolate a subject against the background more easily. The downside of a long focal length macro lens is sometimes you need to be too far away to focus. For photographing the ground, including lichens and mushrooms, often a shorter focal length macro lens works the best.

The 50-60 mm macro lens can also serve as a normal lens for taking landscapes or anything else you might like to photograph. Macro lenses often have additional f-stops, such as f/22 or f/32 to add even greater depth, though the increased depth is often accompanied by a reduction in sharpness due to the diffraction (bending) of light around the small lens diaphragm. Most lenses tend to be their sharpest in the middle range of their focal length, such as f/8 or f/11. Opening the lens wider than this or closing it down usually results in a slight loss in sharpness. Rather than carry around a normal 50 mm lens I usually use a 60 mm macro lens as my “normal lens” and use it for macrophotography and landscapes.

A 90-110 mm macro lens is ideal for photographing insects or any subject where you need more working distance. When attached to a camera with an APS-sized sensor it results in about a 150 mm macro lens which has even greater working distance. This 100 mm macro lens also serves as an excellent short telephoto or portrait lens though you may find it “too sharp” for some people’s portraits.

When purchasing a macro lens look for one that has an f/2.8 wide aperture. Lenses with a maximum aperture of f/4 or f/5.6 will allow less light in and, therefore, the subject will be darker and harder to focus.

The 200 mm f/4 macro lens produced by Nikon is a beautiful lens and I would love to own one, but can’t justify buying it now that I can put my 100 mm lens on an APS body. The main advantage it offers is greater working distance for skittish animals and dangerous insects, such as hornets. Still, I find I can achieve similar working distance by attaching extension tubes to one of my telephoto lenses (e.g., 70-200 or 300 mm f/4 lens). Canon also offers a 180 mm macro lens.

Some of the newer macro lenses have vibration reduction, and while this feature is very useful for hand holding telephoto lenses, I find that most of the time I use my macro lenses with a tripod. Vibration reduction would certainly be helpful if you are chasing butterflies and have a flash attached to your camera, but I don’t think it’s as important on a macrolens as it is to have on a telephoto lens. It doesn’t hurt to have it, but even having autofocus features isn’t critical with a macro lens. I find that I usually switch my lens to manual focus most of the time.

TIP: Generally, I don’t use a UV or skylight filter in front of my lenses unless there is a real danger of getting something on them like salt water spray or sand, because the UV filter will decrease the sharpness of your lens slightly. A polarizing filter is sometimes useful in order to reduce reflections off plant leaves or water surfaces, but this filter will also reduce the light entering the lens by about 2 f-stops or shutter speeds. I recommend you use a lens hood to protect the lens when possible.

Macro Lenses



There are a few macro-zoom lenses (e.g. 70~180mm f/4.5~5.6s ED), the longer the focal length the greater working distance you have from your subject. Also keep in mind the actual focal length will vary depending on whether you are using a full frame camera or digital camera with 1.5-1.6X sensor.

Some zoom lenses offer a macro mode, and if you would rather not carry around several lenses, you might consider buying one of those lenses. An 18-200 mm zoom lens is an ideal first camera lens and it's capable of focusing close to achieve about 0.4X magnification. It's not as sharp as a true macro lens, but it may be sharp enough and you can even get closer by attaching a closeup filter to the front. Consider that most flower photographs don't require sharpness at the edge of the picture frame.

There are a few high magnification macro lenses. Canon offers the MP-E 65 mm lens with built-in extension that permits between 1-5X magnification. This lens is challenging to use because the view gets darker as you extend the lens and your depth of field and angle of view is very small making finding your subjects challenging, especially if they are moving. To properly focus this lens, the photographer needs to move the lens backward and forward so a focusing rail is almost a requirement at magnifications of 2X or larger. This lens is capable of amazing photographs; however, I would not recommend it as a first macro lens because photographers will find a 60 or 100 mm macro lens much more versatile and easier to work with.

TIP: Nikon calls their macro lenses "micro lenses" or "micro Nikkor" lenses for some strange reason, but they are really macro lenses.

Canon MP-E 65 mm 1-5X Macro Lens



Canon Macro Twin Lite
MT-24 EX Flash

Primarily for Studio work - requires flash or very bright lights
also requires macro focusing stage to move the lens back and forth.

Teleconverters

Teleconverters, also called tele-extendors, magnify the image produced by your lens, but maintain the same working distance. They also increase the apparent focal length of your lens when placed between your camera and your primary lens. Unlike extension tubes, teleconverters contain glass elements. They are available in several magnifications 1.4X, 1.7X, 2X and 3X.

There are two main disadvantages of using teleconverters. The first is that they reduce the amount of light reaching your film. A 1.4X teleconverter reduces light entering the camera by one f-stop, a 2X converter reduces the light by 2 f-stops and the 3X by 3 f-stops. If you use your camera on automatic mode it will adjust the exposure, but the darker it gets the harder it is to focus and autofocus may not be possible when the combined lens and teleconverter results in f/5.6 or greater.

Second, teleconverters degrade the quality of the image in proportion to their magnification. In my experience 3X teleconverters are generally unacceptable. With teleconverters you really get what you pay for. The lens used in front of the teleconverter will also affect the quality of your image; the better the lens the better the quality of image. The good news is that if you use teleconverters with a macro lens, you will usually achieve good results because macro lenses are highly corrected and have higher resolving powers than most other lenses. Even good teleconverters may produce poor images when used with some cheaper zoom lenses or poor quality telephoto lenses. Some teleconverters are matched to a particular lens, while others are designed to work with specific focal length lenses. Camera manufacturer's teleconverters tend to be much more expensive than those by other companies and are often design for use with specific lenses.

Also beware that some teleconverters designed for specific telephoto lenses may have protruding glass elements that prevent them from being used with macro lenses. Off-brand name teleconverters usually don't have the protruding glass and can be used with a wider variety of lenses, though their performance is usually not as good as more expensive brand name teleconverters. Sometimes you can use a teleconverter with protruding glass elements if you combine it with a suitably long extension tube.

Teleconverters are relatively small and easy to carry around compared to carrying additional lenses. They are worthy accessories to have.



Brand name teleconverters like those above from Nikon and Canon are designed for use with specific telephoto lenses and cost around \$450 each. For macrophotography you may want to consider a teleconverter from Tamron, Kenko or other manufacturer. They will be cheaper and many can be used on a wider variety of lenses because they don't have protruding glass. Be sure to test the teleconverter with your lens in the store if possible to be sure it works.

The good news is that the quality of the image is dependent on both the quality of the teleconverter and macro lens, but since macro lenses are the mostly highly corrected lenses available I have found that even the more economical teleconverters provide excellent results. While it's possible to combine teleconverters or purchase a 3X teleconverter in my experience most of the time the image quality is poor except perhaps if you are taking a photograph of the sun. Also note that when you add a teleconverter to a lens it reduces the light input and when the total lens f-stop exceeds F5.6, the lens can no longer autofocus. With macro this isn't an important issue because, most of the time you will likely focus manually.

TIP: For even greater magnification you can combine a teleconverter with an extension tube.

Reverse Lens Adapter and Lens Stacking

The most economical way to get into macrophotography is to purchase a reverse lens adapter for approximately \$10-\$20. The adapter screws into the front of the lens where your filter would normally go, and it also attaches to your camera body. Many of the camera's automated lens features will not function this way. You get more magnification if you use a wide angle lens or add extension tubes.

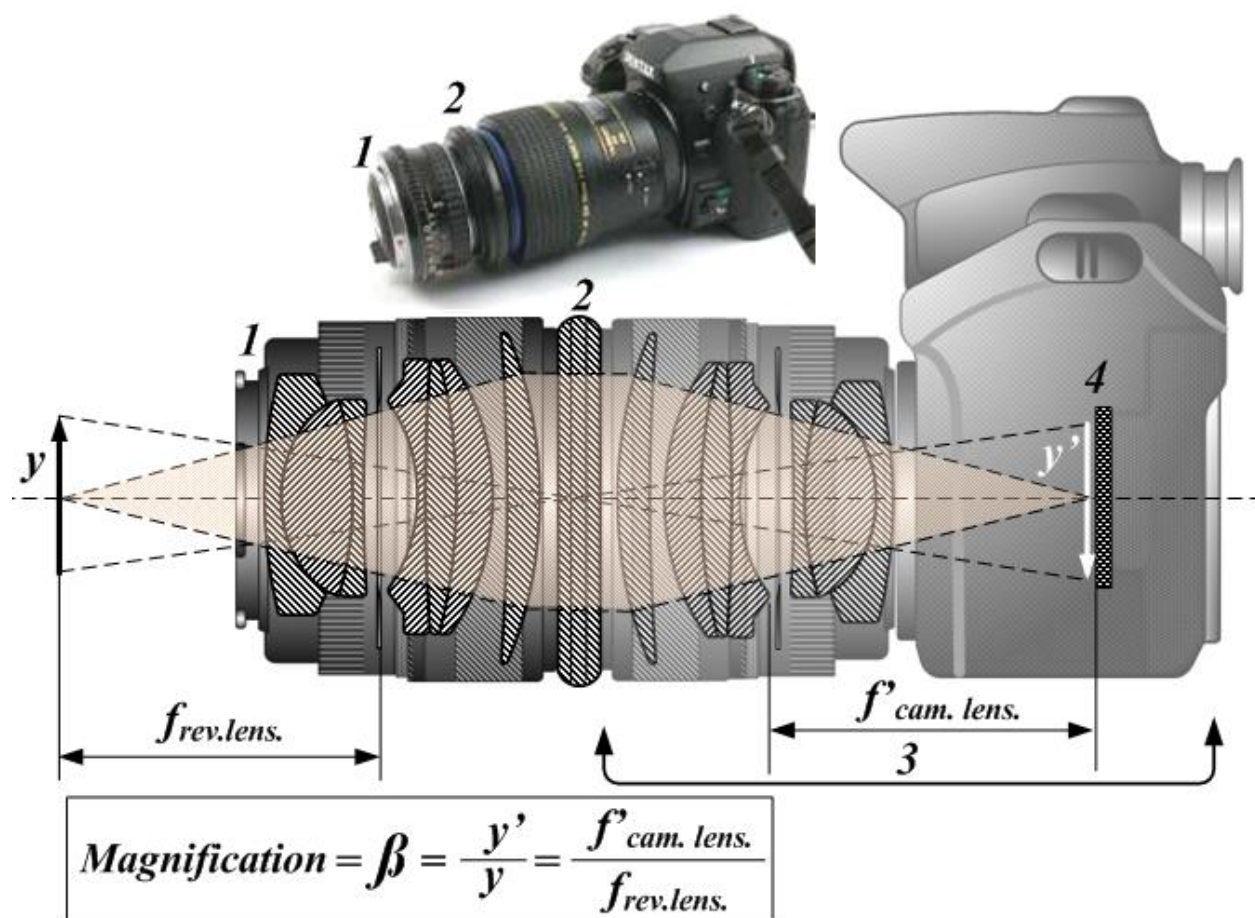
Normal lenses are designed to focus an image optimally when the distance between the front of the lens and the subject is greater than the distance between the front of the lens and the film plane. In macrophotography, objects are often closer to the front of the lens than the distance between the front of the lens and the film plane. For this reason, if you reverse a normal or wide angle lens and attach it to your camera you can achieve good results and high magnification. Wide angle lenses between 20-35 mm in focal length are particularly suitable and can achieve magnifications of between 1.0X to 2.0X. The disadvantage of this technique is that the lens must be stopped down manually, and to focus you will have to move the camera back and forth!

I have tried using reversed lenses I have found them awkward to work with. One photographer whose pictures of spiders I admire is Thomas Shahan (thomasshahan.com) – he uses a reversed lens attached to extension tubes on his Pentax DSLR camera to achieve beautiful high magnification pictures of spiders and other arthropods.



Reverse lens adapters are available for about \$20.

Another method to achieve magnification is to reverse one lens and attach it to another lens. To do this I took two cheap UV filters, removed the glass and taped the rings together using electrician tape so that the threads faced out on both sides. This adapter then allowed me to attach two lenses together as shown below. The shorter focal length lens (e.g., 35-50 mm) is reversed and attached to the front of a compact zoom lens (e.g., 70-300 mm). Both lenses need to have the same filter thread size. The front lens aperture should be set to wide open. This method can achieve high magnification; however, the main problems I found with this is that the front of the lens is exposed to the elements. Additionally, the working distance is often very small and the front lens aperture needs to be set manually or left wide open.



Above a 50 mm lens is attached to 90 mm macro lens via a double threaded filter adapter. These type of setups do work, and if you already own the lenses, then I believe they are worth trying, especially if you only occasionally shoot macrophotographs, otherwise, I recommend using either closeup filters, extension tubes, teleconverters and lenses with true macro-capability (diagram courtesy of Wikipedia).

Camera Supports

It is certainly possible to take macrophotographs by hand holding your camera and lens, and sometimes it may be necessary, but most of the time you will want to support your camera to get the sharpest pictures possible. One exception is when you are chasing butterflies or other subjects that move quickly. In those circumstances, you can attach a flash to your camera and the flash will permit you to freeze the action and capture skittish animals even when hand holding your macro lens and camera.

For flowers and other small specimens, a tripod is a necessity for sharp pictures. If your subjects are small flowers or any type of specimens found on the ground, then a tripod that will lay completely flat is preferred. You can use a bean bag in some circumstances, but a tripod whose legs splay out flat to the ground is the best accessory you can own. Choosing a tripod depends on many factors, including your budget and how much you are willing to carry around with you.

The sturdiest and lightest weight tripods are made of carbon. Tripods can vary in cost from \$25 to over \$1000. In addition to choosing a tripod, you also need to decide what kind of head to attach to it. Nature photographers often prefer a ball head that allows quick set up with variable tension so the subject if moving can be followed. For macrophotography one rarely needs to move the camera quickly so a tripod head with three axis handles also works well.

If you are considering purchasing a tripod for macrophotography select one that does not have a center post so that the tripod can lie flat on the ground. Sometimes I simply hacksaw the center post off. Some tripods provide center posts which allow you to attach the camera to the bottom of the post. Anyone that has tried to do this soon realizes how uncomfortable and inconvenient this is. If you are in the market for a new tripod, I have written an overview of tripods and their features on my web site at: www.canadiannaturephotographer.com/tripod.html.

Avoid cheap tripods they have limited use unless you want something disposable. Beanbags are useful for shooting from the ground or your car window, but can't replace a good tripod.



Left: home-made bean bag Right: photographer supporting his camera on a bean bag.



Sunpak 620-060 Tripod Cost \$30



Joby Gorillapod starting at \$19.95

Cheap tripods: The one on the left can't be positioned low to the ground; the one of the right is only stable enough for small compact cameras and has limited maneuverability.



Above: Gitzo tripod with legs splayed out so the photographer can photograph small calypso orchids close to the ground. The legs are covered in pipe insulation, which makes them more comfortable to carry.



The main elements of a good nature tripod: Carbon fiber, legs can splay out flat, two legs have foam for more comfortable grip, a ball head with Arca Swiss-style quick release clamp that allows the camera to be attached or remove quickly. Rubber twist leg locks that work in water are also desirable.

Focusing Rails

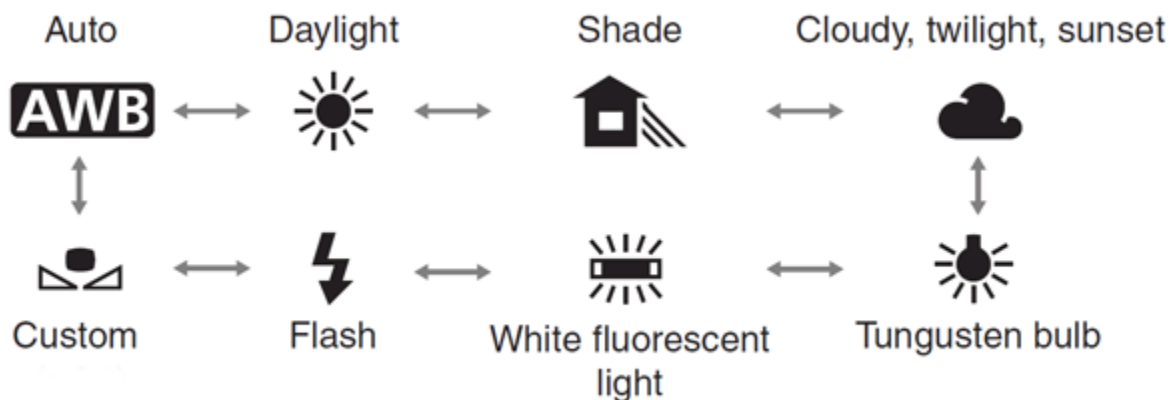


Focusing rails are useful for high magnification macrophotography, 1.0X and up, the reason being that, at high magnifications, focus is achieved by moving the camera and lens forward and backward. Shown above and below is the [Velbon Super Mag Slider](#) (about \$125) – most focusing rails cost more than this.



Lighting for Macrophotography

Good light is essential to all forms of photography. In macrophotography, the two main forms of light are natural and artificial light. Natural light that originates with the sun can vary in color, quality and direction. The colour of the light refers to how warm (yellow) or cool (blue) it is. The camera white balance should be set to match the color of the light falling on the subject if you are capturing your images in .JPG mode. If you set your camera to record RAW files, you can leave it set to auto white balance (AWB), then adjust the white balance later when you process the images in software such as Adobe Photoshop. I almost always shoot RAW files and post process them in Adobe Photoshop.



Typical camera white balance settings – for the most accurate colour rendering, you should set the camera white balance to match the type of light you are photographing under if using .jpg files.

For most type of flower photography, a soft, even light source often provides the best results. This type of lighting occurs on overcast days, but you can also find even lighting in the shade, which you can create yourself using an umbrella, towel, cardboard or simply have someone stand over the flowers. The problem with direct sunlight is that the dynamic range, or the ability to capture dark and light tones, is often greater than the camera can record resulting in too much contrast. There is usually a loss of detail in the shadows as they block up and the highlights are overexposed and contain no detail. Some macrophotographers use large sheets of translucent plastic to diffuse the light. They cover the flowers and then crawl underneath the plastic to photograph the flowers. The best way to appreciate the importance of soft, diffused light is to take some photos of flowers in bright sunlight and some in the shade, then compare the results as shown below.

TIP: Set your digital SLR camera to shoot RAW files and use Auto White Balance for the best quality images. If you don't own a program to process RAW files set your camera to shoot both RAW and JPG files, just in case you purchase an image editing program in the future and want to be able to use the higher quality RAW files.



Left in bright sunlight, the shadows often block up with no detail apparent, and highlights can also burn out due to over exposure. Photographing the same flowers in shade produces more even tones and a much better image.



One way to reduce the contrast on a sunny day is to create your own shade using an umbrella or diffuser; anything that creates shade will work. A black or white umbrella is best as it won't introduce a colour cast.

TIP: Photographing on or near the ground can be hard on your knees. I bring along soft knee pads that I purchase from a hardware store sometimes called "Gardner's kneepads". I strap the kneepads on so I can comfortably kneel down on rocky surfaces or surfaces with small stones. The knee pads cost only a few dollars, are light weight and easy to fit in my camera pack.



A portable compact diffuser used to create soft light over the flowers on sunny days.



Queen's cup lily photographed under the soft light of cloud cover.

Direction of Light

Soft, diffused light often works well for photographing flowers, but sometimes a strong backlight or side light can enhance the texture of a specimen. The more aware you are of light, its color, direction and quality, the better photographer you will become.



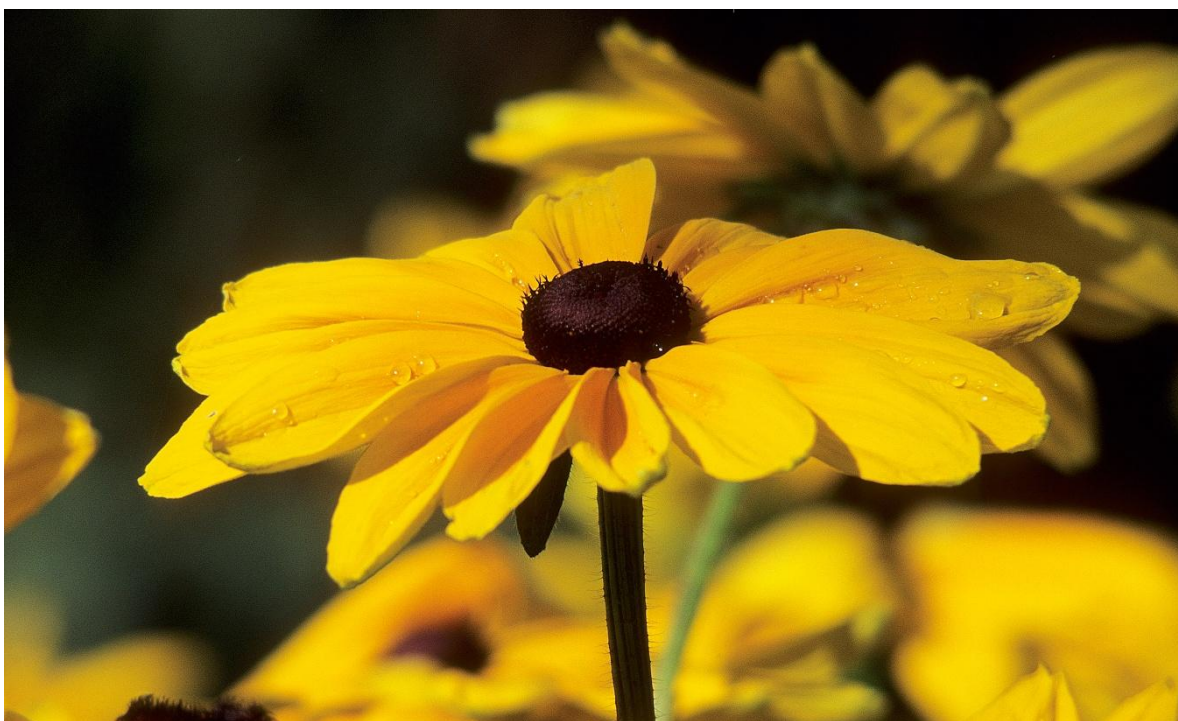
Soft Overcast Light



Backlight



Electronic Flash



Flower photographed in bright sunlight with a close focusing telephoto lens.



Arbutus Bark is thin, smooth, and reddish-brown, peeling in thin flakes or strips to expose younger, smooth, and green to cinnamon-red bark. The bark was photographed in a strong sidelight which enhanced the 3D texture. 60 mm Macro lens, f/11 on Vancouver Island, B.C.



1 f-stop Under Exposure



Normal Exposure



1 f-stop Over Exposure

Keep in mind that how you expose the image also affects the tonality – your meter is only a guide.

On the next page are two photographs of prairie crocus flowers that bloom in early spring in Calgary, Alberta. The setting sun created the backlight which highlights the small hairs on the flowers, and the light had a warm tone. In both cases, I had to lie on my stomach to take these photographs (60 mm Macro lens on Nikon D2X digital camera at f/11 ISO 200). The third photograph of prairie crocus was taken after a spring snowfall under cloud cover which created soft diffused light.





Prairie crocus in snow. Note the snow has melted around the flowers; this is because the flowers created an exothermic chemical reaction (heat) that melted the snow. Note the S shaped curve in this composition. 100 mm Macro lens, f/11, ISO 200. Nikon D2X digital camera.

Electronic Flash

Artificial light can consist of flood lamps, tungsten bulbs or one or more flash units. In the field, artificial lighting is usually provided by electronic flash. Depending on the lens, sometimes the on camera flash works well (e.g. 60 mm macro lens), but if the lens is too long it can produce a shadow on the subject. For this reason, I either use a flash with the light source positioned up above the camera or to the side of the camera. Some flash units offer adapters that allow the flash units to be attached to the front of the camera lens.

A flash offers certain advantages in that it produces a strong, but brief pulse of light that can be used to stop movement, such as an insect in flight, or whenever one needs to hand-hold their camera. However, flash also tends to produce a harsh directional light source and may result in black backgrounds, as the light falls off quickly and can result in over-exposed foregrounds. The best way to learn how to use your flash with macrophotography is to experiment with it and compare the results you get with natural light. In general, light from an electronic flash tends to be harsh and cooler in colour, which can enhance sharpness. You can soften the light by taping Kleenex tissues over the light source or adding a plastic diffuse; for even softer light, you can attach a small, portable soft box.



Above: Postman butterfly photographed with 100 mm macro lens, camera hand-held and a portable electronic flash attached to the camera. This butterfly was photographed in a butterfly room at the Calgary zoo. Due to high humidity in butterfly rooms I recommend you bring extra lens cleaning tissue.



Above: Caterpillar photographed using available light and a tripod



Above: Caterpillar photographed with an electronic flash; note the increase in contrast, dark background and fine plant hairs. The caterpillar appears sharper. 100 mm macro lens.

Using an electronic flash often requires some testing to get good results. First, read your flash and camera manual to determine the shutter speed settings your camera needs to be set to. Many cameras only permit a shutter synch speed of up to $1/250$ sec. Some cameras permit high speed sync flash at any shutter speed (e.g. Nikon D300). Generally, you want to set your flash to **Through The Lens** metering, or TTL, then adjust the exposure compensation if the subject turns out too dark or too light. The big advantage of digital cameras over film cameras is that you get an instant preview and can make adjustments and corrections to the exposure in the field.

Flash diffusers

A direct flash creates a very harsh light that emphasizes texture. In portrait photography, a straight flash often reveals imperfections in the skin and is not flattering to the subject. Likewise in macrophotography, sometimes a straight flash can be too harsh and photographers often choose to soften the light source. Portrait photographers use umbrellas or bounce the light from the flash off a wall or ceiling, but these are not options usually available to macrophotographers in the field. A simple device to soften the flash is a small, white plastic diffuser placed over the flash, or you can attach Kleenex tissue to the front of the flash using elastic bands. Another way is to attach a specially made flash diffuser (shown below).



[Lastolite Micro Apollo Flash MKII](#) flash diffuser attached to a Nikon SP800 Flash and below it a smaller plastic flash diffuser attached to a Nikon SB-28DX flash unit, both diffusers soften the light.

Specialized flash units for macrophotography

There are a variety of flash devices designed just for macrophotography. Some include one or two smaller flash lights that attach to the front of the lens. Ring light flash units are used frequently by dentists to photograph their customers' teeth, or by photographers who want to create a flat light with no shadows. Canon offers a special macro flash unit with two small lights on the front, and it's even possible to adjust the lighting ratio so that one flash is stronger than the other. It's also possible to use just a single flash with the unit.



Human eye photographed at 1X using Canon MP-E 65 mm Macro lens and Twin Lite MT-24EX flash unit. You can see the highlights from the two flash lights reflected near the pupil.

Most modern flash units use TTL or through the lens metering technology, which greatly simplifies using flash; however the camera meter can still be fooled by the background tones. Photographers should take some test shots, then adjust the exposure using the camera exposure compensation feature, or adjust the flash light output.

Canon Macro Twin Lite 24 EX provides 2 Flash units that fit on the front of the macro lens.



Nikon TTL camera flash cord allows the flash to be positioned off the camera and can be handheld or attached to another support, such as the small tripod shown above.

Controlling the Background

In any photograph, the background can enhance or detract from the image. One of the most common errors is a background that is too busy or distracting. This can happen in macrophotography because the image in the view finder that the photographer sees is with the lens wide open, and it often doesn't reveal out-of-focus highlights caused by grass or sticks. All automatic lenses allow the viewer to focus with the aperture wide open to allow as much light in as possible for the photographer to focus.

When taking the picture, however, the aperture closes down to the f- value set by the photographer. If the aperture is at any other setting other than wide open, it gets smaller. The result is an increase in the depth of field which reveals elements that can cause distractions. Better DSLR cameras include a depth of field preview button, usually on the front of the camera near the lens mount, that allows the photographer to press it and view the depth of field at any specific aperture. If the lens is set to a smaller aperture e.g., f/16, the aperture gets smaller, the viewfinder gets darker and there is also an apparent increase in the depth of field.

Before taking closeup pictures, photographers should use the depth of field preview button if they have it on their camera or lens. Quite often, an element that is not visible, such as bright piece of grass becomes noticeable only after stopping down. If you don't have this feature, you can see the actual depth of field of the final image by viewing it on the LCD screen on the back of your camera.



Assistant holding a green-coloured piece of cloth behind the flower to simplify the background.



Top: Yellow Lady's slipper with a distracting background. Bottom: The same image with a black card placed behind the flowers creates a simpler background and brings out the flower's colour.

Depth of Field in a Photograph

The depth of field in a photograph represents the region that appears to be in focus, and it depends on two factors: 1) How close you are to the subject and 2) The f-stop setting. In general, the closer you come to any subject, the smaller the depth of field becomes. In macrophotography, depth of field can become very small as you get close and magnify the specimen. In some cases, it can be measured in millimeters or microns (fractions of a millimeter).

To compensate, the photographer can do one of two things. First, use a smaller aperture (higher f-stop) e.g., f/11 to f/32. Second, take a series of photographs at different focus points and then stack them together. In both of these instances at high magnification, the depth of field will still be very limited. As the aperture becomes smaller, the amount of light coming in through the lens is reduced, necessitating longer exposures or higher intensity light sources. The other thing that happens is that, as the aperture gets smaller than f/11 (e.g., f/16 to f/45), light waves begin to bend as they pass through the small opening. This causes light interference and the image appears softer.



When using a wide aperture (e.g., f/2.8-4), or when the camera and lens is positioned very close to the subject, the depth of field becomes smaller and smaller (diagram courtesy of Wikipedia).

Depth of field in a photograph can be used creatively to focus attention on specific elements of the picture. Some photographs are better suited to a large depth of field, e.g., a landscape, while some photographs are better suited to a shallow depth of field. In macrophotography, the best depth of field depends on the subject matter and the intent of the photographer. In some cases, a shallow depth of field can be effective, while in other instances, the photographer may want all or most of the subject in focus. When you are very close to subjects at magnifications of 1.0X or more, the depth of field will become very small, even if you use the smallest aperture available on your lens (e.g., f/16-f/22). In these instances the photographer must also pay close attention to how the camera and lens is oriented with respect to the subject. If you are photographing a butterfly the camera should be oriented perpendicular to the wings to get most of the subject in focus. To learn how depth of field photograph affects the photograph, the best thing to do is to vary the f-stop settings (e.g., f/2.8, f/8, f/16) and compare the results.



Top: Rose photographed at f/22. Bottom: A closer view of the rose photographed at f/2.8. Note the out-of-focus specular highlights “circles” created by using a shallow depth of field.

Focus stacking to increase the apparent depth of field

Focus stacking is a technique becoming more popular with the advent of digital photography. It involves taking multiple pictures of a specimen or scene while changing the focus point. In macrophotography, this is done by moving the camera and lens forward or backward on a focusing rail. The pictures are then stacked on top of each other using software (e.g., Adobe Photoshop), then blended together to create a single image with the combined depth of field of all of the images. The main challenge is that the subject must not move during the time the photographer takes the series of photographs!



House fly showing two photographs one focused on the head the other on the back of the fly. The third photograph is the combined or stacked image (image courtesy Wikipedia).

To create a focus stack you need to find a subject willing to pose while you take a series of shots. Start by focusing on the front of the specimen – take a shot, then move your lens a little bit closer using a focus rail and take another shot. The number of shots will depend on how cooperative your subject is and the depth of field that exists in a single shot. Generally, if you are really close, you may need to take five to 10 shots. A suggested starting point is to stack 2-3 images, then increase the number with higher magnification images.

How to focus stack images using Adobe Photoshop Extended CS4, CS5 or CS6

1. Start Adobe Photoshop CS4, CS5 or CS6 and start Adobe Bridge. Open the first RAW image in the series and adjust the exposure, white balance etc. Then click on Done. This creates an xmp file which stores the Camera RAW image settings which we will copy to the other files. If you shot .jpg files, skip this step.
2. Back in Adobe Bridge, select the image you just adjusted in Camera Raw. It will have a small circle above and the top right indicating it has an xmp file. Select the image, and at the top of

Bridge, select Edit>Develop settings>Copy Camera RAW settings.

3. In Bridge, shift-click to select all the images in the focus stack series, and Select Edit>Develop settings>Paste Camera RAW settings. When the popup box comes up, all the checkboxes should be selected > click OK. This copies the xmp settings to the rest of the RAW images.
4. In Bridge, shift click to select the images you want to stack then Select >Tools> Photoshop >Load files into Photoshop Layers
5. Once the images have loaded, open the layers palette. Shift click to select all the layers > Edit > Auto-align layers – Select Auto >OK. This aligns the specimen in each layer.
6. Once the images have been processed, select Edit>Auto Blend Layers>check stack and make sure the checkbox Seamless Tones and colors is selected >OK.
7. In the layers palette, flatten all layers. You can process the stacked image further by cropping, burning, dodging and adding text; when finished save the image as a .jpg or .tif file.



Image stack performed on a damselfly. This preserved insect was part of an insect collection, so it couldn't move. I used it only to demonstrate the stacking technique using Photoshop. Photographs were taken using a Canon MP-E 65 Macro lens at about 3X magnification and with an electronic flash. The image is a composite of seven images stacked together, resulting in a greater depth of field.



High magnification image of a moth taken using a Stereo microscope without stacking – note the limited depth of field in this image 10X.

Other software & hardware for focus stacking

To focus stack images, there are several other programs available you may want to check out, including:

HeliconSoft (www.heliconsoft.com) for Mac and Win.

Zerene Stacker (www.zereneystems.com/cms/stacker/softwaredownloads) Mac, Win, Linux.

Combine ZP (www.hadleyweb.pwp.blueyonder.co.uk/CZP/Installation.htm) Windows - free.

StackShot an electronically controlled macro-rail that coordinates the movement of the rail and the triggering of the camera (www.cognisys-inc.com/stackshot/stackshot.php).

TIP: for best results using focus stacking, it helps to have a focusing rail to move the camera forward and backward.

Summary of macrophotography techniques

- Most compact digital cameras with a macro mode can be used for closeup photography.
- A DSLR camera offers the most flexibility and control in macrophotography.
- Closeup filters (+1 to +4 diopters) screw onto the front of the lens to achieve magnification.
- Closeup filters are available as single element or dual glass elements.
- Extension tubes permit any lens to focus more closely and do not degrade the image quality.
- Macro lenses come in three basic focal lengths: 50-60, 100-110 and 200 mm. The longer the focal length the greater the working distance between the camera lens and subject.
- Bellows permit magnifications up to about 10X and are best suited for studio work.
- Teleconverters (1.4, 1.5, 1.7, 2.0 and 3X) can be used with some lenses to magnify the image size, but they reduce the light coming into the camera and degrade the image quality.
- A reverse lens adapter permits you to attach a lens to the camera backwards to achieve high magnification, but the lens loses its automated aperture controls.
- Reversing and stacking lenses can be used to achieve high magnification.
- When shooting with your camera, be sure to set the appropriate white balance or use auto white balance (AWB) if shooting RAW files.
- Natural light varies in color, direction, and quality; often the best results are achieved with soft, even lighting that is available in the shade.
- Side lighting and backlighting can enhance texture and provide a sense of depth to an image.
- One advantage of using a flash is that the brief pulse of light permits photographers to hand hold their cameras when pursuing subjects such as butterflies that move about quickly.
- When using flash, be sure to check the camera exposure histogram and modify exposure compensation as required.
- Flash diffusers can be used to soften the light from compact flash units.
- If a background is too busy, it can be simplified by holding a piece of coloured paper or cloth behind it.
- Depth of field decreases as you get closer to a subject, and the depth of field in an image is dependent on the f-stop used, with larger f-stops (smaller apertures) providing the greatest depth of field.
- To achieve greater depth of field, it is possible to take several photographs with different focal points then stack and blend the photographs using software such as Adobe Photoshop.

Composition Basics

Composition refers to the placement of elements in a photograph. A good composition is one where the elements in a picture provide a sense of unity or belonging, and each element in the picture supports the main subject. To achieve this, photographers attempt to organize the elements in the viewfinder so the final picture is seen as a whole.

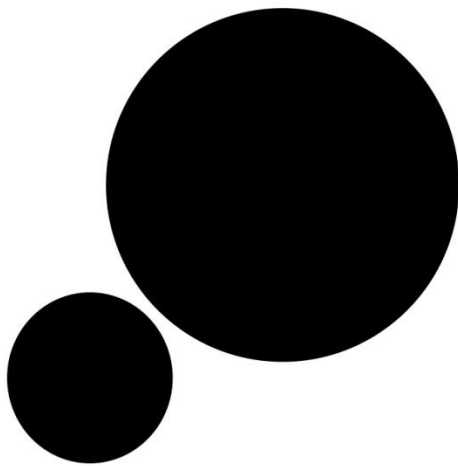
The following is only intended as an introduction to composition to help guide the new photographer in making better pictures. The most common error new photographers do is always place the subject in the middle. While this is sometimes the best spot, very often it is not. A simple guideline for more effective composition is to position the main subject so that it is an unequal distance from each side of the frame. The other decision each photographer has to make is to whether to frame the subject horizontally or vertically. When learning, it's a good idea to take both horizontal and vertical framed shots of your subject and evaluate the images later.



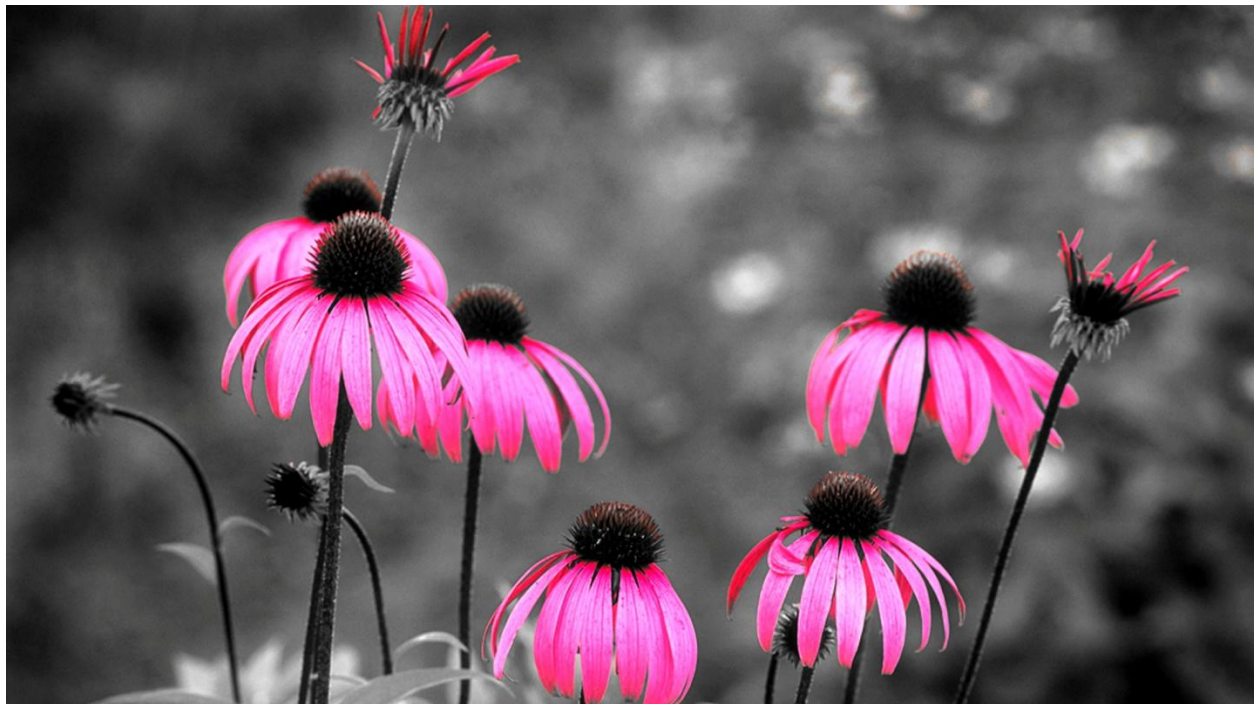
In each of the photographs above a vertical orientation worked best. Left: Shooting stars, Middle: Skunk cabbage, Right: closeup of a Tiger Lilly.

How to achieve unity or a sense of belonging

1. Through dominance and subordination.
2. Dominance can be achieved by differences in size, color, location, focal point, convergence and through the effective use of light.
3. A good photographer tries to control the amount of attention an element receives and the sequence in which the elements are observed.



Dominance through size and focal point. Dominance of the first or top flower in this picture is achieved through both its larger size and because it is in focus, while the smaller flower is soft and out of focus.



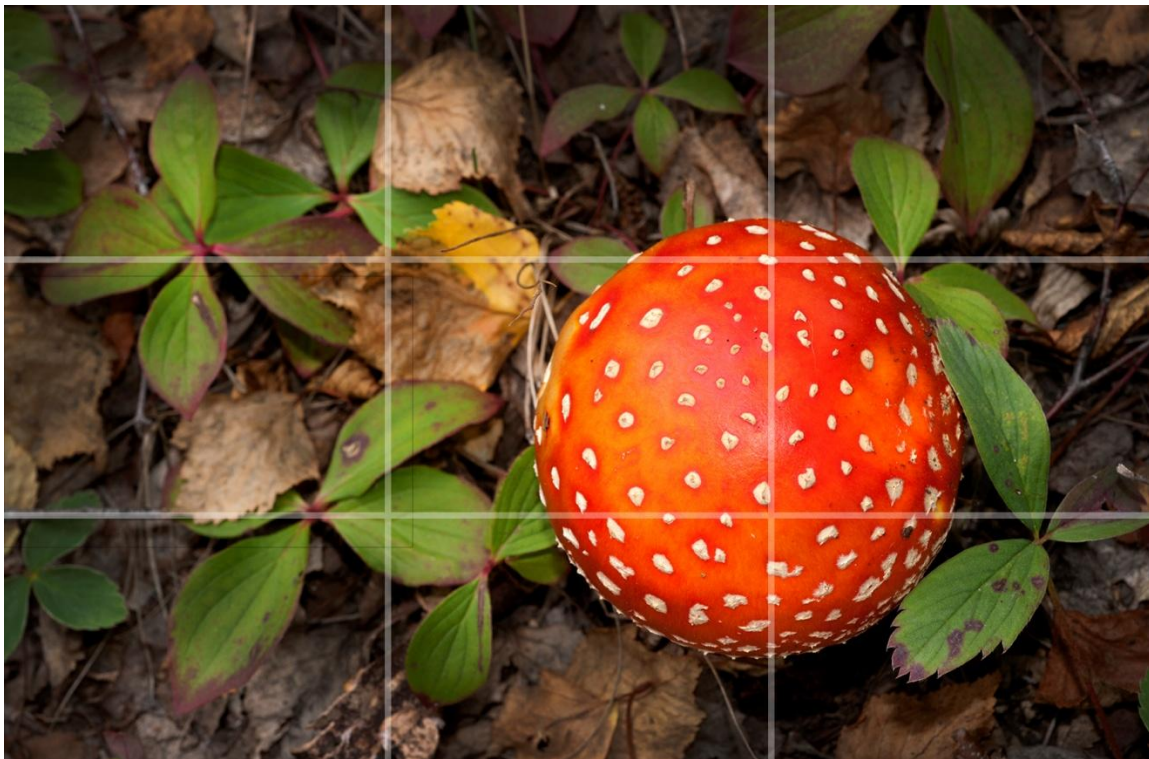
Dominance in this image is achieved through color. In this photograph of cone flowers, the image was converted to black and white and then the original colour of the petals was returned using the history paint brush in Adobe Photoshop. The original photo's background was too colorful, resulting in a distracting background that didn't allow the beautiful colors of the cone flowers to stand out.



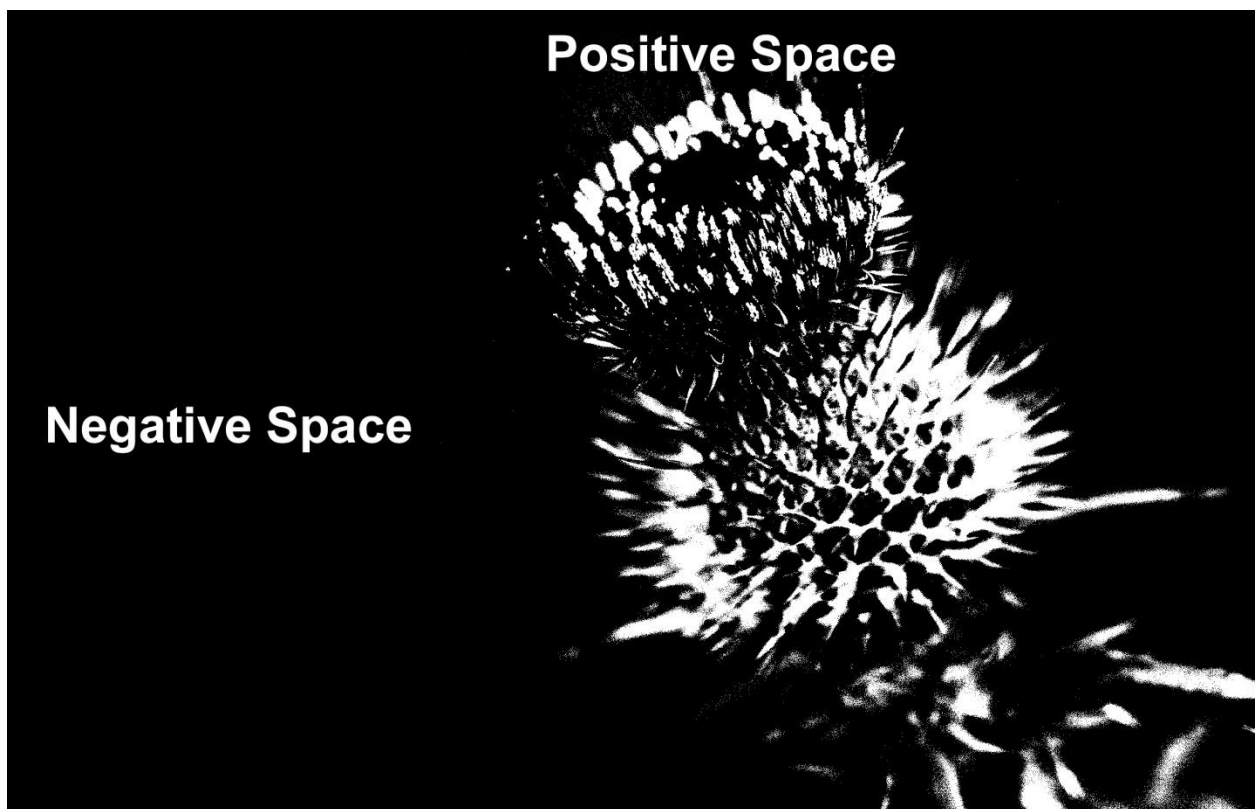
Lady's slipper the flower in front is dominant because it is big, brilliantly coloured and in focus.



In some images the center works well for positioning the main elements, as shown in the top image and below in this image of the interior of a poppy. 100 mm macro lens f/16.



Rule of thirds. Compare the images above – the mushroom off to the right appears more interesting. The grid represents the rule of thirds, and the lines and intersection points tend to be good places to place your subject or whatever forms the center of interest.

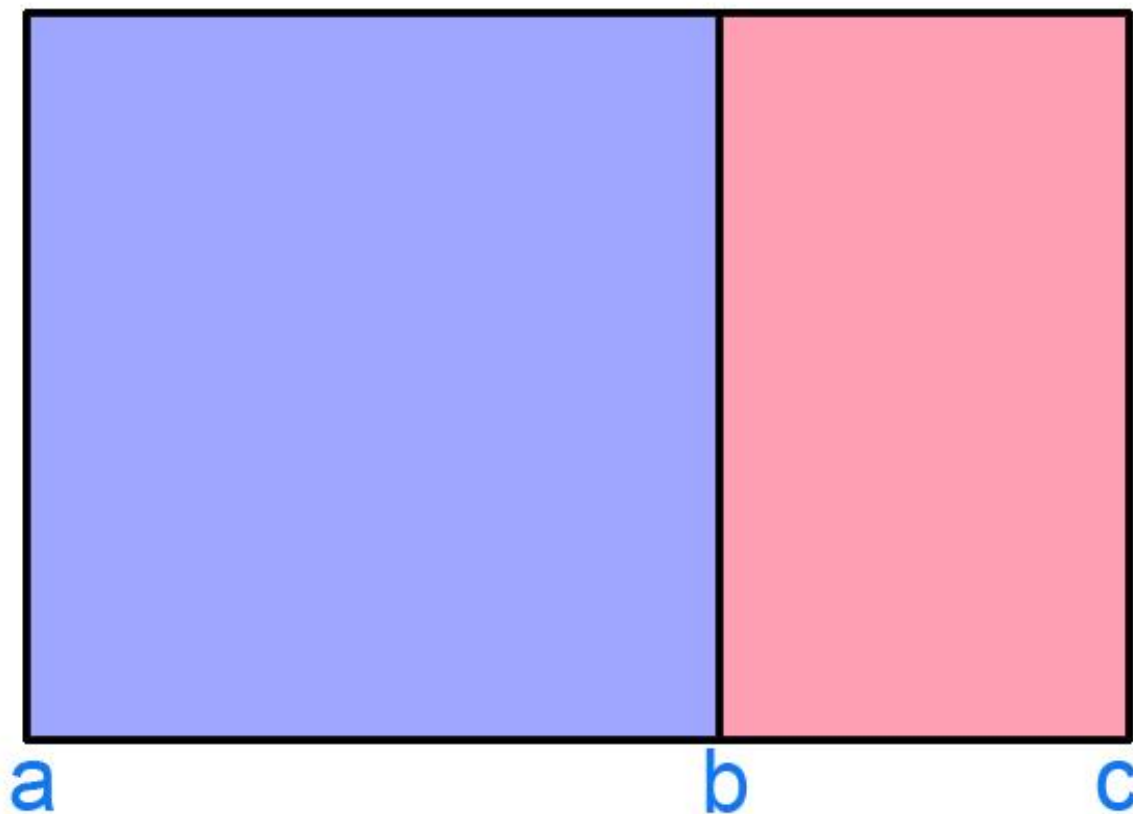


Positive and negative space can also play an important role in composition.

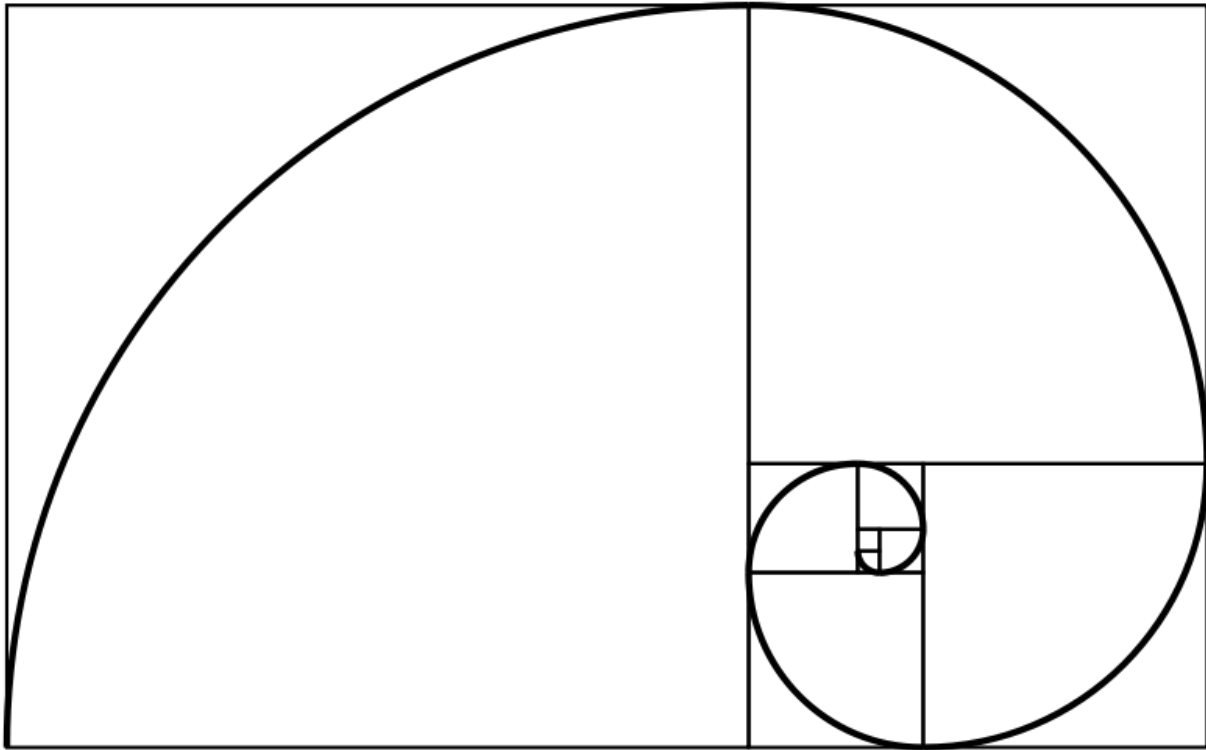
Artists often refer to parts of an image as positive space – the region occupied by the main subject and negative space, the region of the image where there is mainly open space. These two compartments need to balance each other. There is no formula for this as it has to feel right. Some subjects, for example, a person or anything that is red, or very bright in an image tends to command a lot of attention and may need more negative space to balance the picture. It's valuable to think of some images in this way and it can sometimes help make for better compositions.

Proportion – golden ratio

Proportion refers the size relationship of visual elements to each other and to the whole picture. One of the reasons proportion is often considered important in composition is that viewers respond to it emotionally. Proportion in art has been examined for hundreds of years, long before photography was invented. One proportion that is often cited as occurring frequently in biological design is the Golden mean or Golden ratio.

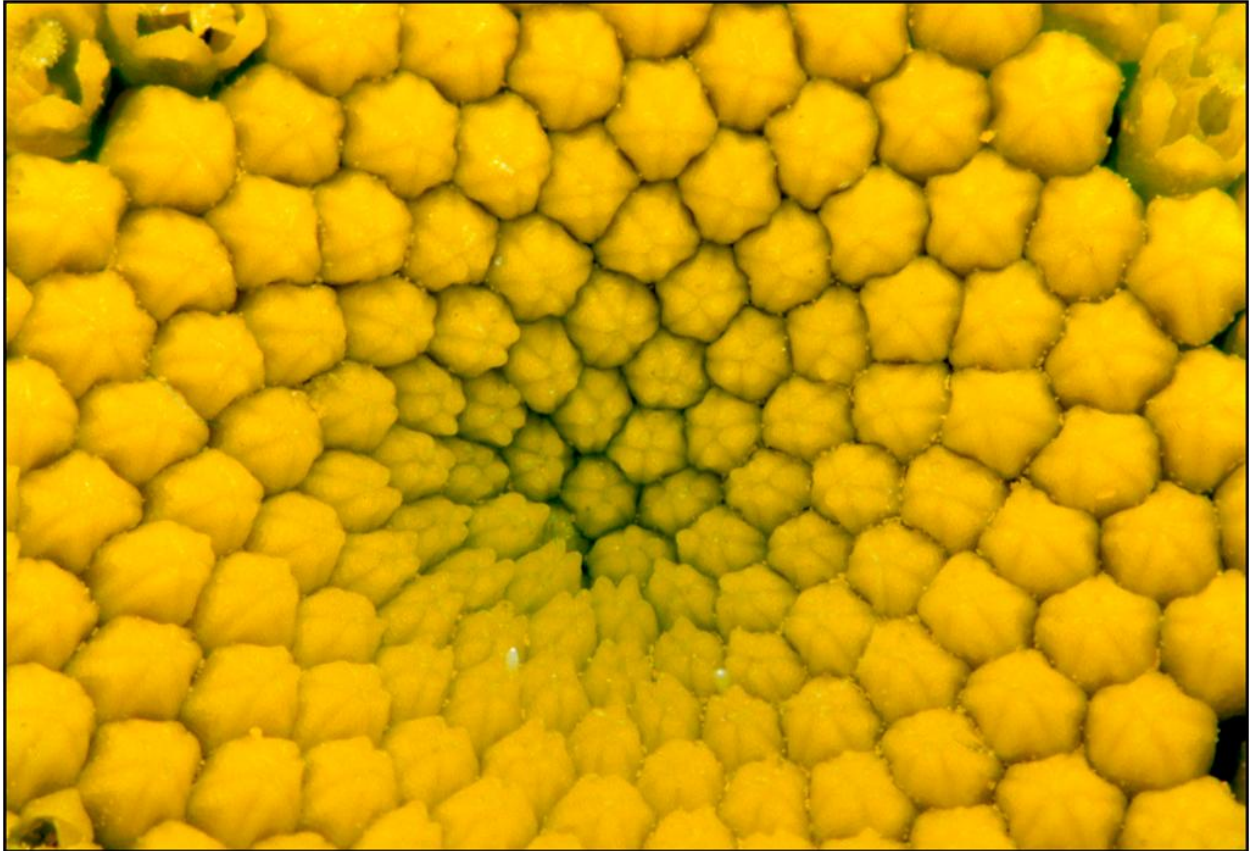


Fibonacci series: 1, 1, 2, 3, 5, 8, 13, 21, 34 etc. Each succeeding number after 1 is equal to the sum of the two preceding numbers. The Ratio formed 1:1.618 is called the golden mean. The ratio of **bc** to **ab** is the same as **ab** to **ac**. If you divide each smaller window again with the same ratio and join their corners you end up with a logarithmic spiral. This ratio and spiral is a motif found frequently throughout nature in skeletons, shells, horns and flowers.



A logarithmic spiral based on the golden ratio or Phi occurs frequently in nature and it may be that humans are genetically programmed to recognize the ratio as being pleasing. Studies of top fashion models revealed that their faces have an abundance of the 1.618 ratio. In Adobe Photoshop CS6 you can now crop your photographs using a logarithmic spiral overlay.

Many photographers and artists are aware of the rule of thirds, where a picture is divided into three sections vertically and horizontally, and lines and points of intersection represent places to position important visual elements. The golden ratio and its application are similar to the rule of thirds, although its points of intersection are closer together. Moving a horizon in a landscape to the position of one third is often more effective than placing it in the middle, but it could also be placed near the bottom one quarter or sixth. There is nothing obligatory about applying the rule of thirds or using the golden mean. In placing visual elements for effective composition, one must assess many factors, including colour, dominance, size and balance together with proportion. Often a certain amount of imbalance or tension can make an image more effective. This is where we come to the artists' intuition and feelings about their subject. Each of us is unique and we should strive to preserve those feelings and impressions about our chosen subject that are different. Adobe Photoshop CS6 offers the ability to use a golden ratio or golden spiral overlay when cropping images, and any image can be made more effective by cropping it afterwards.

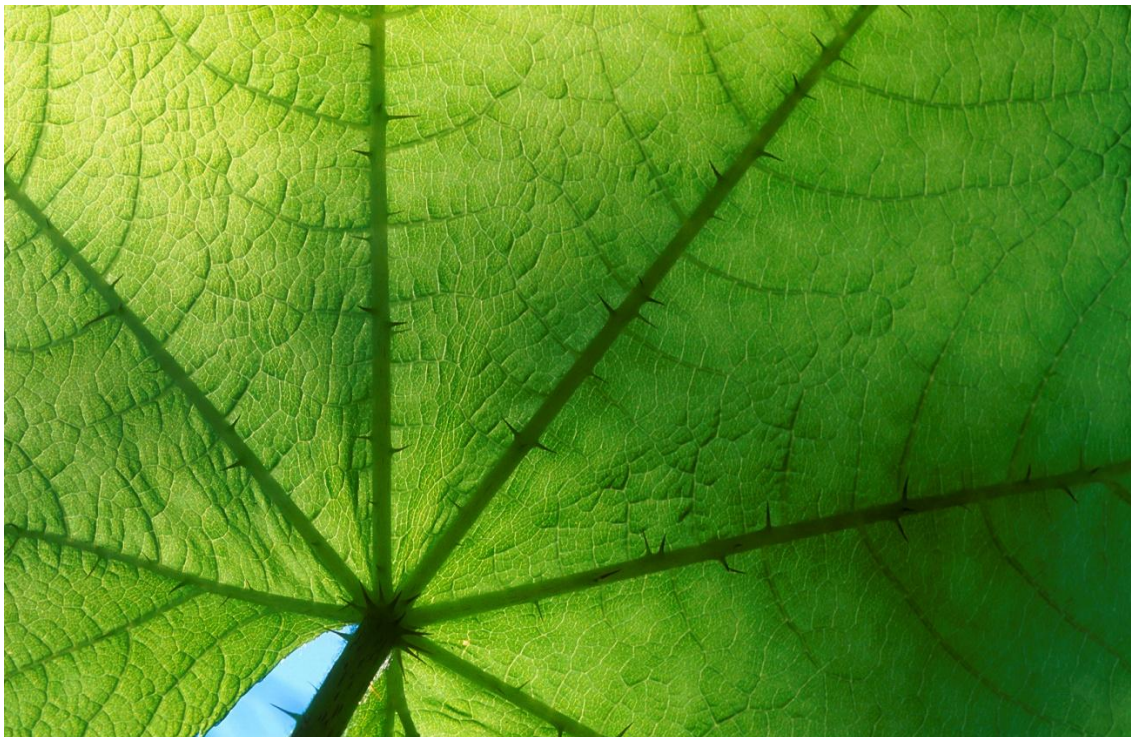


The inside of a daisy reveals logarithmic spiral shapes.

Use of line, shape, form, and rhythm

As photographers, our main task is to organize elements in a picture to create an effective composition. The ability to see lines, shapes and form in a scene before you provides you with tools to help make a photograph more interesting. Lines that run horizontally convey a feeling of rest and tranquility; lines that stand vertical suggest power and support; whereas lines on an angle suggest movement and change. Smooth curving lines or “S” shaped lines convey a sensual feeling and can often be used to draw the viewer into a picture. Lines can also radiate from a point and draw the eye to the focal point or center.

The ability to see lines within an image sometimes requires that you step back and view the scene more objectively. Squinting with your eyes can allow you to see the major forms and lines in the scene before you more easily. Lines in a photograph can lead the eye and provide a sense of depth in two-dimensional photographs.



Underside of Devil's club leaf illustrates radiating lines that form the support for the leaf 1.0X.



Close up of a feather, backlight showing numerous diagonal lines that create a sense of rhythm 10X.

Importance of Colour

Just as bees are attracted to colour, so are human beings. We react to different colours and colour combinations in predictable ways. Red is the most powerful colour and evokes feelings of passion or danger, which is why it's not a surprise that stop signs and stop lights are red. Understanding the psychology of color is valuable to photographers and graphic designers and anyone wishing to take better pictures. Below are just a few elements to be aware of when you take photographs.

White light is made up of a rainbow of colours that vary from warm reds and oranges to cooler greens, blues and violet. When the colours are organized into a colour wheel we recognize certain relationships between the colours.

Complimentary colour

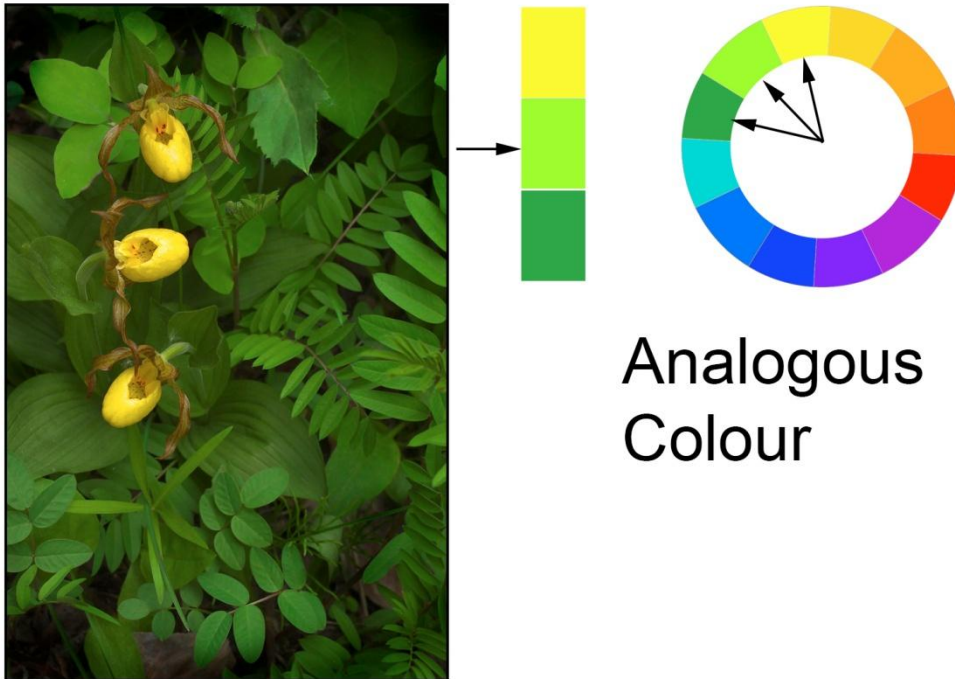


Complimentary Colour

Colours that are on opposite sides of the colour wheel are called complimentary colours and they possess contrast when displayed together. The image of the shooting star flowers appear to come forth in comparison to the yellow Heartleaf Golden Alexanders in the background. When complimentary colours are placed next to each other they make each other appear brighter.

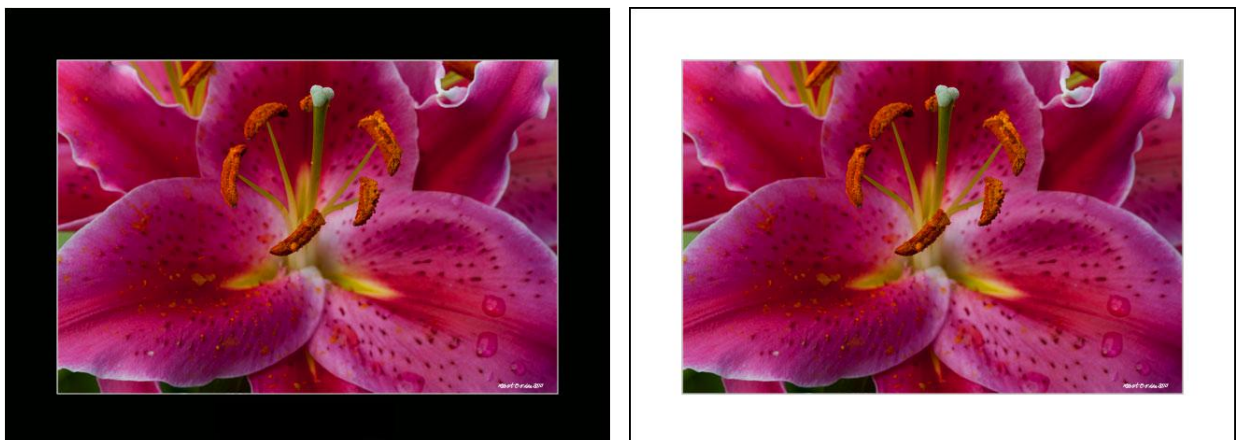
Analogous colour

Analogous colours are those that are adjacent to each other on the colour wheel with one colour being dominant. Analogous colour schemes are often encountered in nature.



Above: Yellow lady's slippers surrounded by shades of green provide a tranquil composition.

Black backgrounds make any colour appear more saturated, which is why images are often shown on black backgrounds. You can create a black background in the field behind a flower with a black card or by getting low and using a flash that is horizontal to the ground - the light will fall off quickly with distance resulting in a black background, best results will be obtained by underexposing the image slightly (-1 f/stop).

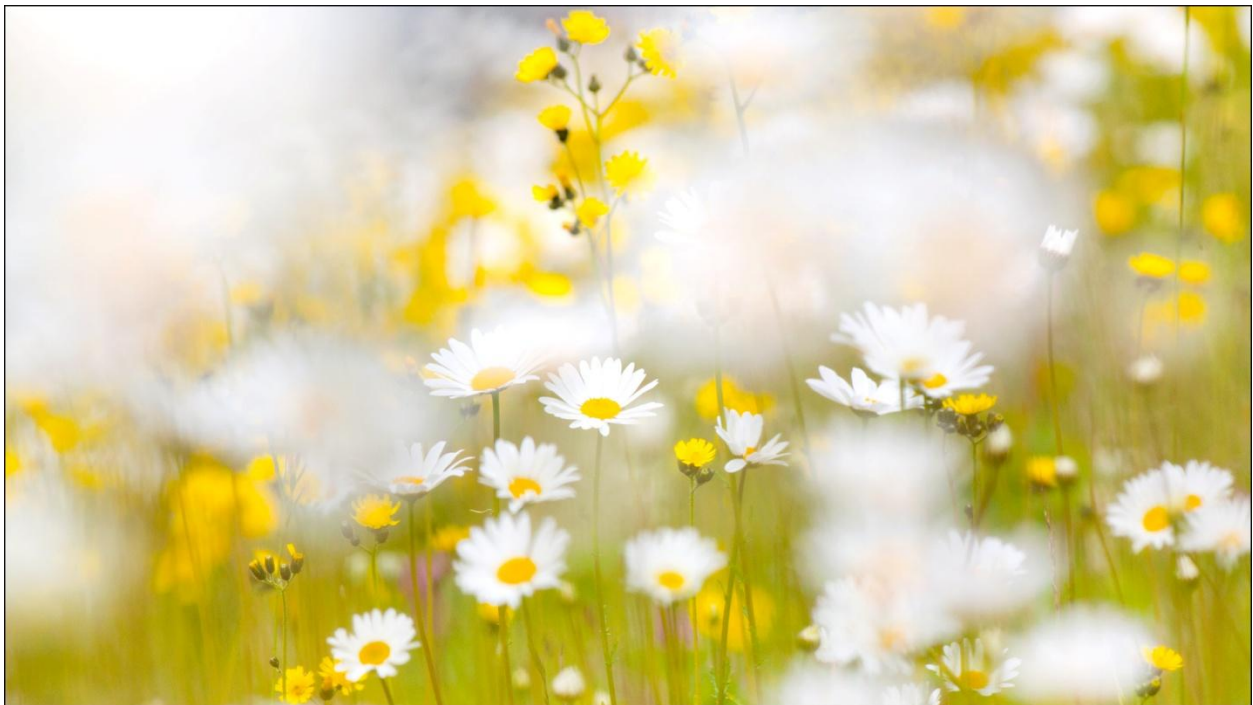


Creative Techniques for Macrophotography

Once you become familiar with the basic tools and equipment used in macrophotography, there are a wide variety of subjects and techniques you can try to make more interesting photographs, including creative vignetting, water drop technique, and multiple exposure swirl photography, to name a few.

Creative vignetting

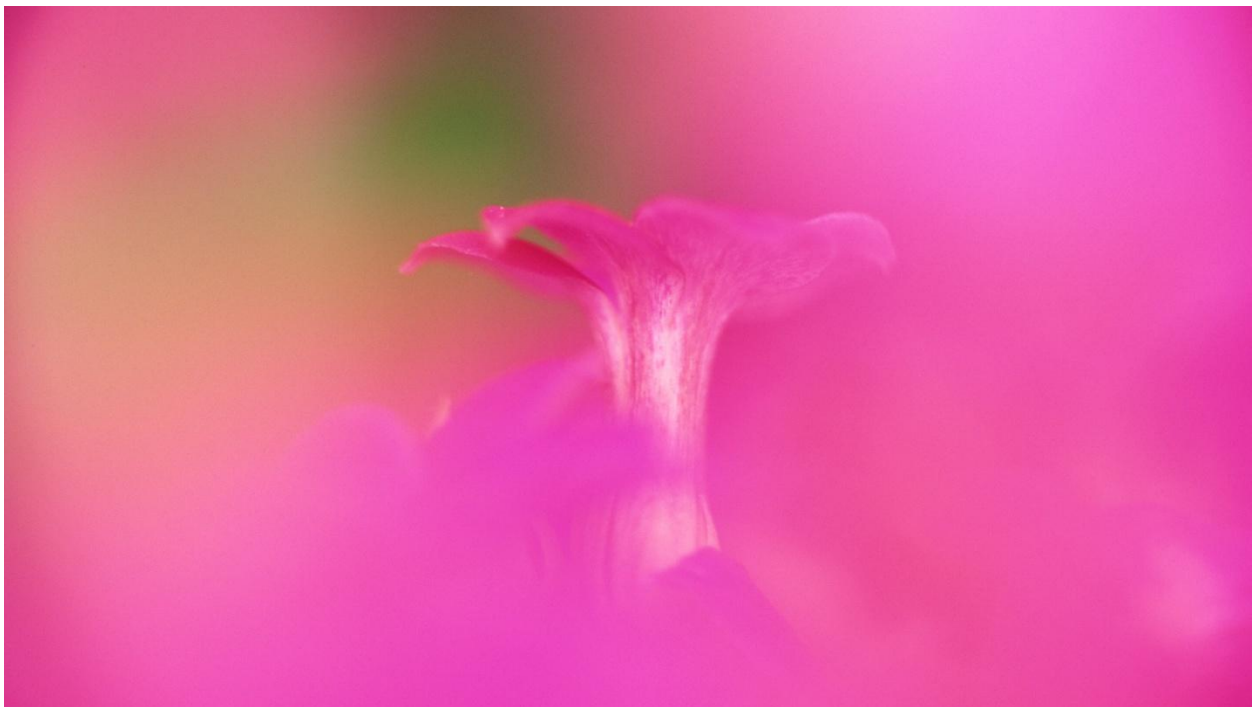
I was first introduced to creative vignetting through articles in Photo Life by Maria Zorn. Vignetting refers to a reduction of an image's brightness or saturation at the periphery compared to the image center. The technique involves placing flowers or leaves very close to the front of the lens, in some cases touching the lens so that they are soft and out of focus. The trick is to surround a subject with this out-of-focus material and attempt to get some part of the image in focus. If you have your camera on a tripod, you can pull some flowers in front or just position your camera lens so you are shooting through the flowers. Any macro lens or even a telephoto lens with close focusing capability can be used.



In the picture above, I used a 300 mm f/4 Canon telephoto lens on a tripod and sat down among the daisies, which in some instances were very close to the front of my lens. I used f/4 aperture so I would have a narrow depth of field, then selected certain flowers to focus on. The out of focus flowers give the image an almost dream-like quality. This technique would also work well if you had a subject such as young child playing in the flowers.



In this picture of tall lungwort flowers, I had green leaves touching the front edge of my lens, which creates the soft out of focus vignettes. The technique is easy to do, but you may have to take a lot of photos to get a few good ones. 100 mm Macro lens f/2.8.



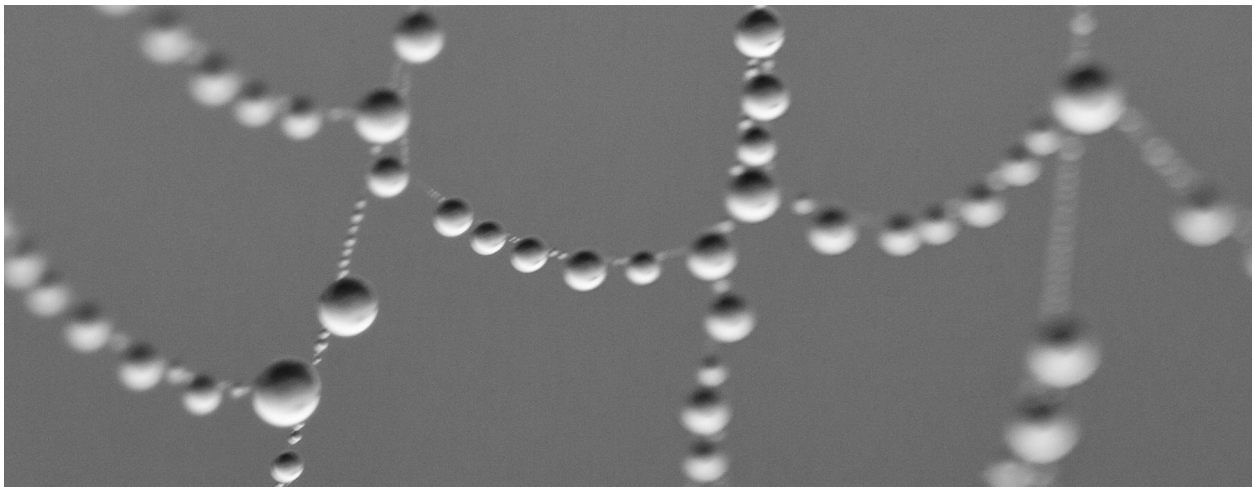
Another example of vignetting where the central flower is surrounded by out of focus flowers.

Using Water to Enhance Your Subject

Water drops in the form of dew often make flowers look more interesting and inviting. In Calgary, it is usually so dry that dew in the mornings is rare – so I help nature along. I often bring a small spray bottle with me filled with water to cover any spider webs or wild flowers I encounter. I also head out to shoot after and during a rainfall– just bring rubber boots and rain gear. I protect my camera from water by covering them in plastic bags, or I use an umbrella. Spider webs are always fascinating and they make interesting photographs, whether you include the whole web or get in close and just focus on some of the smaller elements.



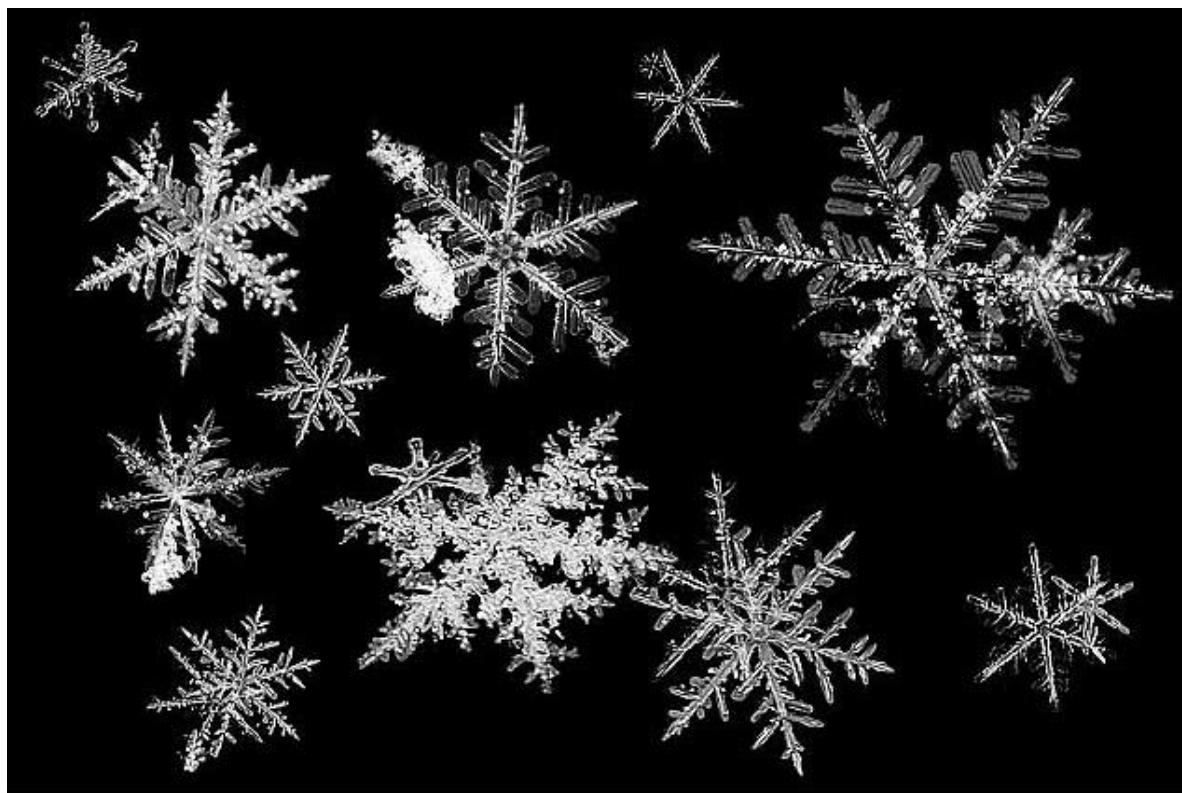
One foggy morning I found thousands of spider webs covered in dew on a mountain road in B.C.



Closeup view of a spider web with natural dew, photographed with a 100 mm macro lens.



Backlit spider web sprayed with water. Without the water drops, the web was almost invisible.



Frost and snowflakes also make great macro subjects in winter. 100 mm Macro lens.

Magnifying Water Drop Technique



One of the most interesting effects you can capture with macrophotography and water drops is by photographing the water drops in such a way that they behave as small lenses with the background subject reflected inside them. In the photo above, the water drops are hanging from a blade of grass.

The tricky part about the magnifying water drop technique is that the drops have to be the right distance from the background and you have to be in pretty close with your macro lens. Getting big drops of water just where you want them doesn't always happen naturally. Here are some of the things that I do to take these types of pictures.

1. Purchase a couple of eyedroppers at the local drug store which you will use to place water drops on a blade of grass or other plant.
2. Getting big drops depends on the humidity; higher humidity favors bigger drops
3. Different plants have different affinities for the water drops; on some plants the water just falls off or runs down the plant.
4. One way to make the drops bigger is to mix the water with glycerin e.g. 50\50 or use glycerin by itself (available in grocery and drug stores as a skin moisturizer).
5. I use a piece of grass stem that I clamp to a small tripod that I can move back and forth in front of some flowers – this way I can focus the water drops on the background.

6. I position the grass or flowers with water drops close to the background and then bring in my camera with a 100 mm macro lens mounted on a tripod and focus on the drops.

You want to try this technique in a sheltered area with little to no wind. You can also try it indoors also, where you have some control. You can even hold a photograph of flowers behind the water drops – I did this initially when experimenting with the technique in the winter time. It works nicely with compact cameras. The biggest challenge is holding the camera still; for best results, use a tripod.



Photo series taken using a blade of grass and water drops – note the blade of grass must be horizontal!



Natural raindrops on pine needles photographed using a 100 mm Macro lens with f/2.8.

Textures and Patterns

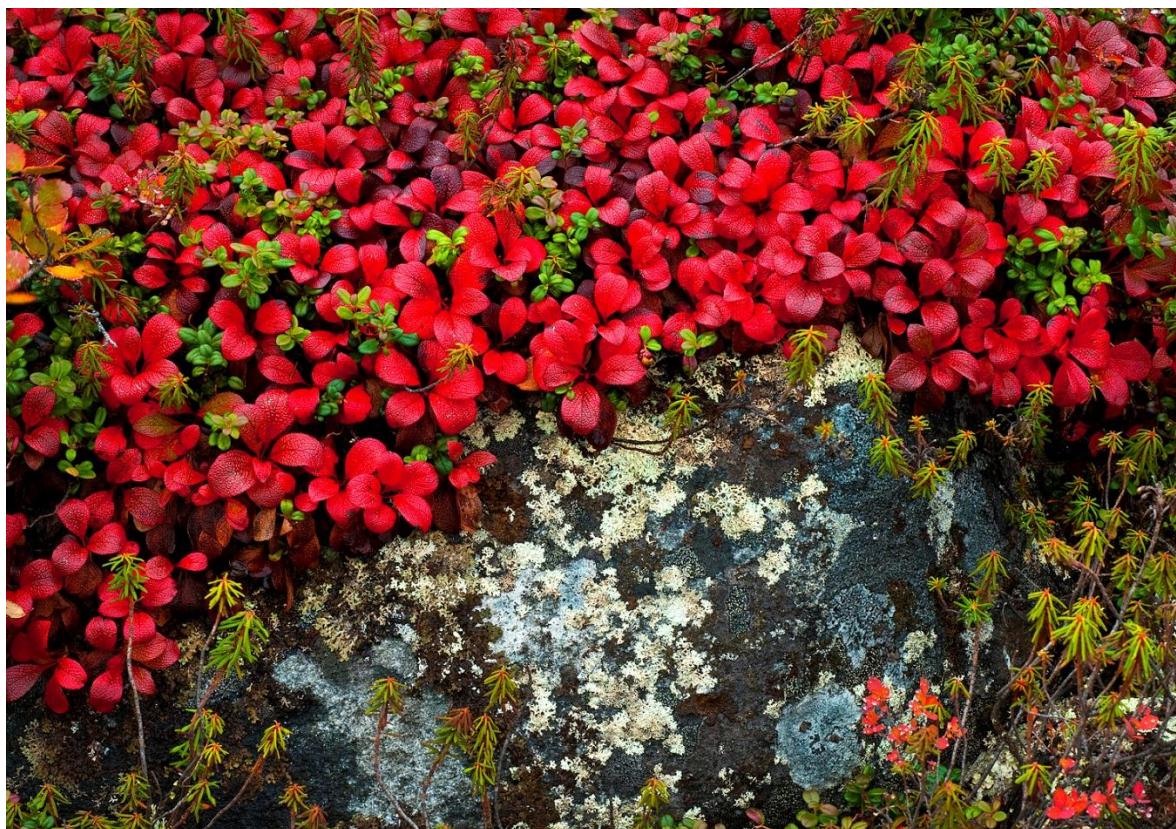
Textures are found all around us - just take a visit to an old scrap yard with your macro lens. Textures also occur in nature; my favorite places to go are the badlands or anywhere where lichen grows on rocks. The main tool you will need is a tripod, your camera and a macro lens or other means to get in close. The best thing is to slow down, take your time and hunt. The more time you take, the more you will begin to see.



Above are a variety of metal textures that I found in an old mining graveyard now being turned into an outdoor museum. Rust, cracked paint, old metal gears, rusted sheet metal can result in an amazing array of textures and patterns.

Visit any forest and you will find a rich selection of textures, from pine needles to lichen growing on rotting logs. One of my favorite locations to photograph lichens is on the Arctic tundra. The plants grow on rocks and close to the ground where they provide feed for the caribou.

On the next page are two photographs of what I like to call groundscapes formed from rock, lichens and moss and other decaying materials. Both images were taken with a 60 mm macro lens at f/11 pointing straight down with the aid of a tripod to hold the camera steady.



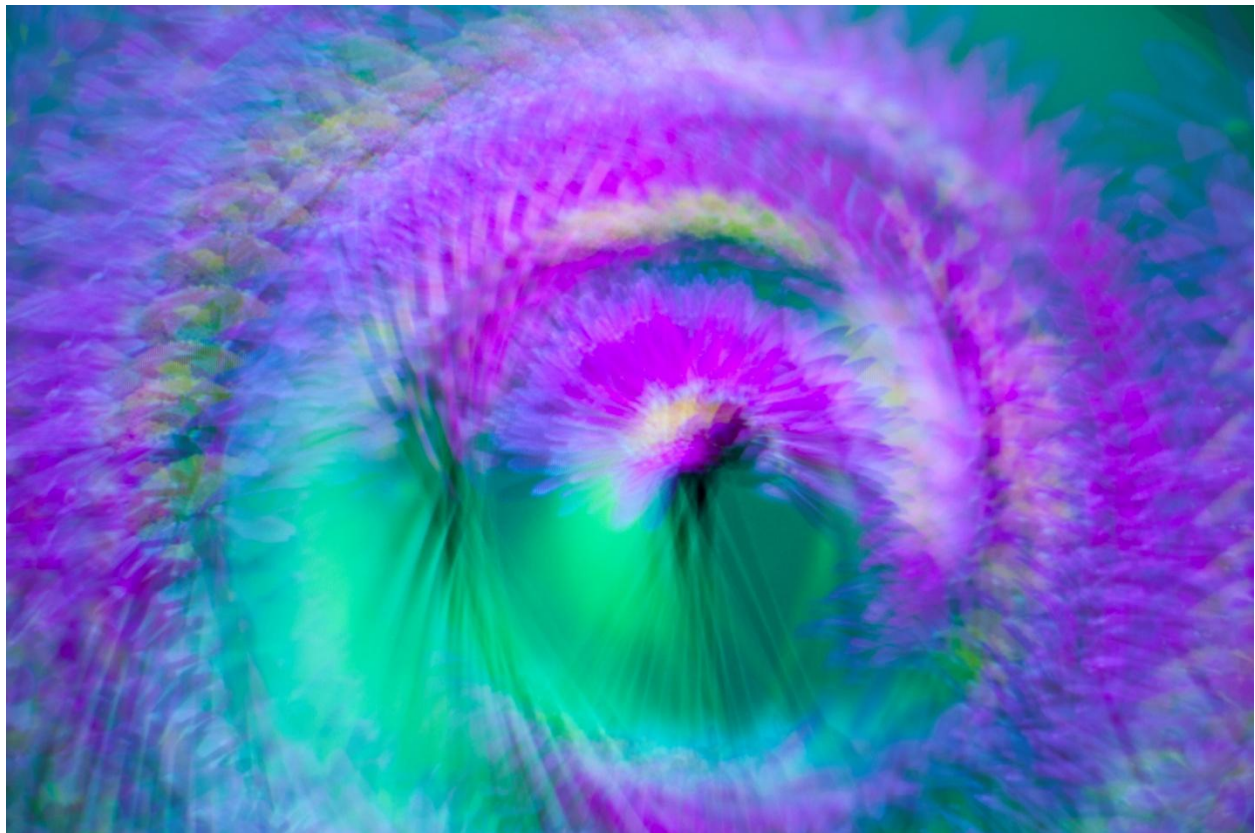
Groundscapes – Top: Bear berry leaves on the tundra. Bbottom: Lichen on the boreal forest floor.

Multiple Exposure Twirl Photography

In this form of photography, the photographer takes multiple exposures of the same view but rotates the image. In the days of film, the exposure for each picture has to be reduced by 1/2 for each additional picture taken. If a single picture has the exposure of f/8 at 1/30 of a second and you took two pictures on the same frame you would set the exposure to 1/60 sec, three pictures 1/125 of a second and so on. The technique can be done with any camera that permits multiple exposures on a single frame.

Nikon Digital cameras are the easiest to work with as they have a multi-exposure feature built in and also combine all the images into one in the camera, which can be previewed after you finish taking the photos. The resultant images are abstracts that resemble flowers. The point of rotation does not have to be about the center but can be around any point in the image. Lenses with rotating collars make the process easier.

Below are the steps for creating these images using a Nikon digital camera. I have not been able to find a method to do this with Canon digital cameras though it is possible to simulate the effect in Photoshop.



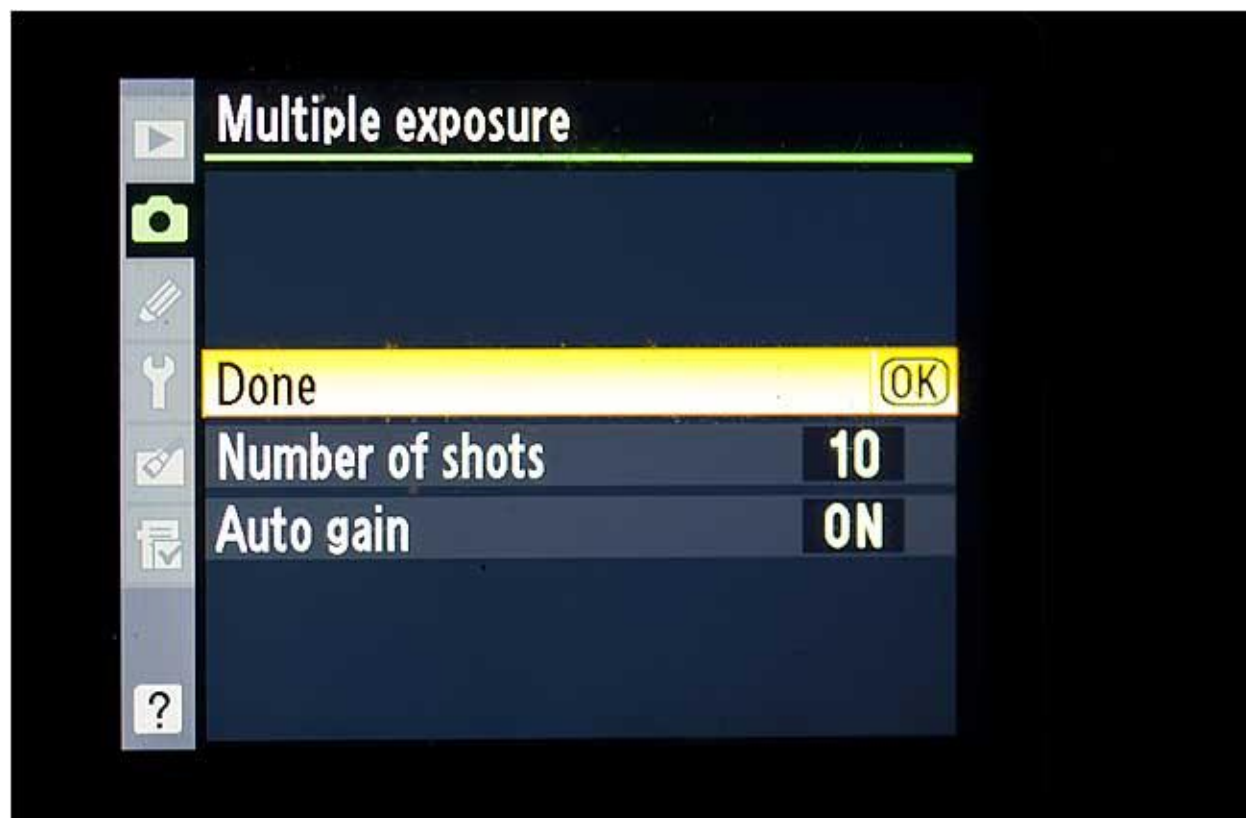
Multi-twirl image of a flower combined from 10 separate exposures.

Multiple exposures with Nikon digital cameras

1. Turn the camera on and press on the Menu button on.
2. Select the Camera icon in the Shooting menu, then select Multiple exposure (Nikon D700 and D300).
3. With Multiple Exposure selected in the menu and turn the feature “ON” with your multi-selector button.
4. When you see the Multiple exposure options, select Number of shots, set it to 10 shots and then to Done – point your camera at a subject take a shot, rotate your camera, take a shot until you have taken all 10 shots. You can then preview the image on the screen.



Photograph the LCD menu on the back of a Nikon Digital Camera (D700)



Your menu, if you shoot with a Nikon DSLR should look like those above. To start taking pictures, just press your shutter button, then rotate the camera and lens slightly by loosening the lens collar and take 9 more shots. When you are done press the preview button to see what your photo looks like. The camera will automatically reset back to single shooting mode, so if you want to shoot another series of multiple exposures, reset the Multiple exposure button and turn it back on. The technique is not limited to rotating the camera, you can simply move the camera up or down as well.

Experiment with 4, 8, 10 or more shots until you get something you like. This technique works well with flowers or anything colourful. This technique may not be for everyone – but it's definitely different and it works with any lens in your camera bag. Check your camera manual if your camera allows multiple exposures.

Insects & Spiders



There are millions of species of insects and spiders and they are readily available in almost any field or backyard. Butterflies are probably most people's favorite because of their showy wings, and they don't bite. There are also butterfly conservatories or zoos where folks can visit and photograph a wide variety of butterflies in an enclosed space. Dragonflies are another favourite subject. Some insects will defend themselves, so be careful if you trying to photograph one of those species. Try to get as much working distance as possible e.g., use a 100-200 mm lens. Sometimes you will discover insects and flower spiders while photographing flowers, such as the flower spider above, photographed with a 60 mm macro lens and flash.



Dragonfly, Sulphur butterflies, cricket and a pesky mosquito.

Some insects, like mosquitos, will come to you; others you will have to hunt down. The best way to photograph dragonflies is to visit a marsh or wetland; however, they won't pose for you very often in the middle of the day. The best time to find and photograph dragonflies is the early morning when they cling to a plant waiting to warm up. If the dragonflies are covered in dew, so much the better. One technique I learned from Maria Zorn is how she visits a wetland in the evening before the sun goes down and finds dragon files that have settled down for the night. When she finds one, she pulls out a piece of tissue paper and leaves it close by so she can return and find the dragonfly early the next morning before it flies away.

Some photographers create terrariums for moths and butterflies, then photograph the insect's life stages. An emerging butterfly would make an excellent subject for time-lapse photography. Aquatic insects are best photographed in the studio in small aquaria. If you can find cooperative insects or spiders that hold still, you might try focus stacking. Most insects don't hold still for long, and although I have tried cooling them in the fridge or freezer, the cooling effects don't seem to last long, as these little critters quickly warm up and are on their way. Some photographers will "bait" insects with sugar water, juice or fresh fruit. I see nothing inherently wrong with doing this. Anyone wanting to photograph insects or spiders would do well to pick up some books on arthropod biology or take a course.

TIP: In Alberta, if you spend time in the grass, check yourself and your hair at the end of the day for ticks. Ticks can crawl from your camera bag to your hair, and if they bite you, can transmit disease.

Mushrooms, Lichens and Moss

Mushrooms, lichens and moss come in a variety of shapes, colors and sizes, and what I like most is that they won't run or fly away. Some species are edible; however you have to be really sure of your identification, as many species of mushroom contain some of the most toxic chemicals on earth. They seem to be especially prevalent in colorful mushrooms. Stick to photographing them and you won't run into any danger. Mushrooms and mosses tend to grow in moist places like forests. Lichens seem to grow in some of the most inhospitable places in the world, such as the tundra and on rocks in the desert where temperatures reach extremes. However, lichens also need clean air, and their growth usually indicates that the air is low in pollutants.

To photograph mushrooms, lichens and moss, any of the closeup techniques described earlier will work fine. A tripod is essential for sharp pictures, and a cable release is recommended. In low light, when the camera is set to exposures between 1/2 to 1/15 of a second, the mirror slap often produces vibration in the camera that can reduce sharpness. To prevent this, use a cable release, your camera self-timer and some DSLR camera bodies also offer the opportunity to lock the mirror up. The time and care you take in the field will result in significantly sharper images when you preview them enlarged on your computer.

A flash can be useful as a fill light; however, I generally try to use natural light as much as possible, which means I am always using a tripod. Sometimes I might use a white card or piece of tinfoil to reflect light under the mushroom.





Turkey-tail Polypore fungus



Veiled mushroom, I had to lie flat on my belly to get the camera really low for this photograph.

Macrophotography at the Sea Shore

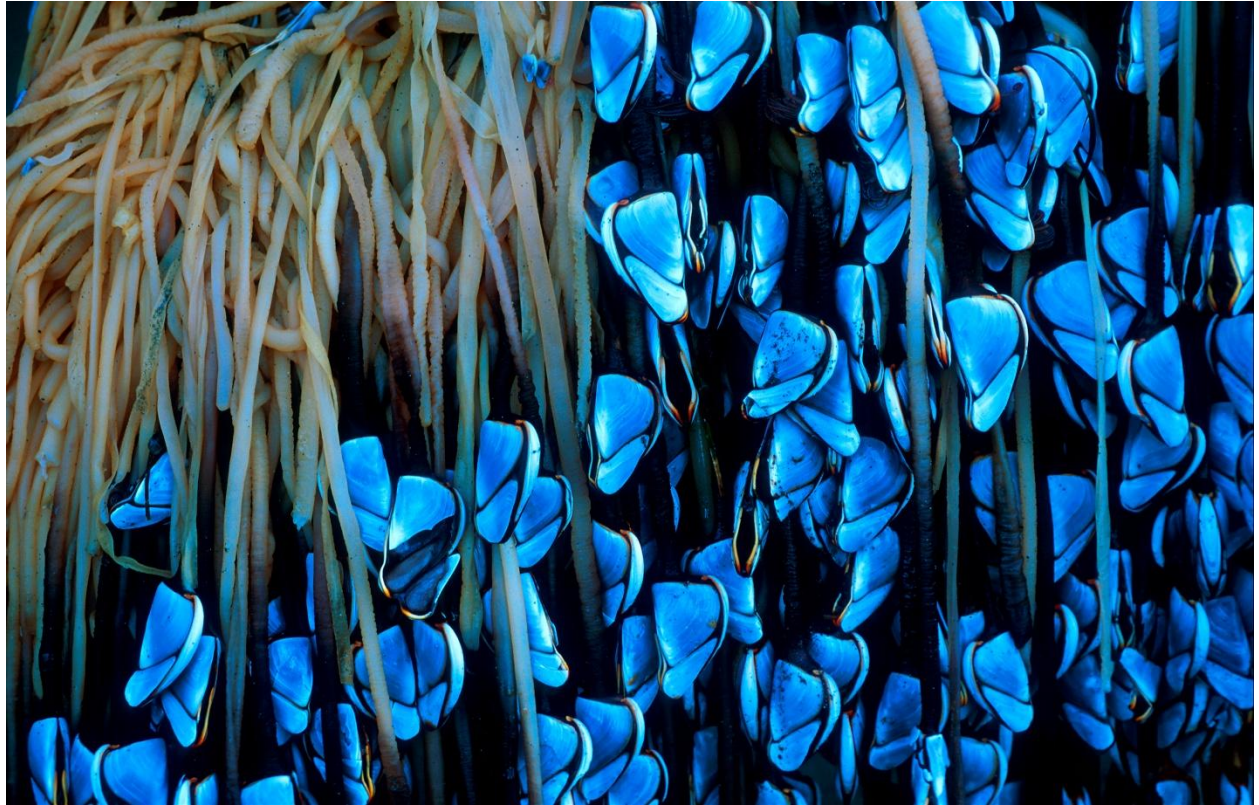
If you are fortunate enough to live near a large body of water, especially the ocean, there are a multitude of things you can photograph on the beach and in tide pools. I have tried taking photographs of organisms in tide pools or the water's edge from a kayak and although it's possible to get a few okay shots, the biggest problem is light reflection off the water. I tried adding a polarizing filter and shading the tide pools with an umbrella with little success. However, using a small waterproof compact camera (Pentax Optio), I was able to stick the camera right into the water and achieve better results. Most of the time I just leave the camera on auto mode and focus by viewing the picture on the LCD screen.



Green Surf Anemone in a tide pool photographed using Macro Mode on a Pentax Optio camera. 1.0X

For other subjects like rock formations, smooth stones or seaweed lying on rocks above the water, I generally use a tripod and a 60 mm or 100 macro lens. Sometimes I will attach a polarizing filter to reduce reflections of the rocks. Armed with a few marine biology books about life on the sea shore, you could spend a lifetime photographing the wide variety of organisms around the ocean's edge.

Next page: Pelagic Goose-neck Barnacles attached to drifting log washed up on shore on the West Coast of Vancouver Island. Ochre starfish bunched together when the tide went out near Bamfield marine station on Vancouver Island. Taken with 60 mm and 100 mm macro lens respectively.



Summary

I have shared with you a wide variety of techniques that you can use to take closeup pictures with either a compact or DSLR type camera. The most important thing a photographer can do once they understand the basic camera features is to learn as much as they can about the subject they want to photograph and then practice. The more you shoot and evaluate your images the better you will get.

The financial cost that was associated with shooting film no longer exists, so shoot a lot and then edit ruthlessly. The ability to preview the image you took immediately afterward is another advantage over film-based photography and will accelerate your learning. While pushing a shutter button is inherently easy, finding and capturing remarkable images is challenging. It can take tremendous amounts of time to find the specimen and set up the picture. Most good photographs do not come easy; they take time, dedication and perseverance. While it is true that anyone can take a closeup picture of a flower, not everyone can take a great picture of a flower. The beauty of macrophotography is that there are great pictures to be found anywhere and you don't need to travel around the world. Start by exploring your backyard or a field or forest near your neighbourhood, and most of all have fun. There is more to our world than most people ever see or realize.

Additional reading

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About Dr. Robert Berdan

Robert started taking pictures in 1972 and has been passionate about Nature photography ever since. Robert received degrees in Zoology and a Master's of Science in Cell Biology at the University of Western Ontario before completing his doctorate in Cell Biology at Baylor College of Medicine in Houston, Texas. Robert then completed a three year postdoctoral study at the University of Calgary in the field of Neuroscience before being hired as an Alberta Heritage Scholar at the University of Alberta in Edmonton. Robert used macrophotography and photomicrography extensively in his research.

In 1990, Robert worked as manager of the Calgary Science Centre in charge of educational programming and was also appointed an adjunct assistant professor in the cell biology department at the University of Calgary. In 1996, he started his own multimedia business called Science & Art, where he offers training and web development.

Robert specializes in outdoor photography. His photographs have been published in a wide variety of magazines, science journals, websites and books, and he has had three gallery showings. His photographs have received awards from Nikon International and National Geographic. Robert has also donated many nature photographs to agencies involved in protecting the environment. Robert makes his home in Calgary, Alberta, Canada.



Photo of Robert Berdan by Peter Dettling.

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