Notes on Macro Photography

What is it?

- 1x to 10x life size on the sensor plane, by formal definition. But really anything close-up (Say > 1/5 life size) is what most people call macro photography.
- **Macro or close-up photography opens up new worlds of subject matter that include: plants, animals, insects, man-made and natural objects.**
- **It can be done outside with the photographer going to the subject or inside with more controlled conditions and setups.**

Equipment

To achieve close-up photographs, specialized equipment is usually needed.

Macro Lenses.

- Available from about 35mm to 200 mm focal lengths for 35 mm cameras. Longer focal length means heavier and more expensive lenses. They also require bigger flash rigs if use flash. They, however, have a narrow field of view so you get less unwanted background and they allow greater working distance for a given magnification (image size / object size) which helps when photographing things that can be scared away, e.g. insects.
- Macro Lenses are optically corrected for closeups. They focus to life size, typically or 1/2 life size.
- They are also “flat field” meaning that a piece of flat artwork is all in focus at the same time.
- There are some exotic versions of macro lenses that allow tilt and shift movements, like a view camera does. The tilting can change the plane of sharpest focus to put the depth of field where you want it to be.

Close up lens attachments

- They usually screw on the front of a lens just as a filter does. These come in single or two elements filter varieties standardly.
- The two element ones (made by Canon and Raynox) are excellent and cost around $100 each. The Canon versions

come as D250 (+4 diopter) and D500 (+2 diopter) The Raynox are three element/ 2 groups and are called the DCR-150 (+4.8 diopter) and the DCR-250 (+8 diopter) Note also that the Raynox screws into an adopter that is mounted around the lens.
- The single element ones are much less expensive,(3 filter sets for under $100), but don't do nearly as good a job, (image distortion and sharpness) particularly if the lens you attach them to isn't stopped down quite a bit.

Extension Tubes

- These are (usually) open tubes that are placed between the camera and the lens and therefore extend the lens optical elements further from the camera. This allows for closer focusing and therefore greater magnification than the lens by itself.
- They come in various fixed lengths, adjustable lengths, and both autofocus and non-autofocus versions.
- They can be used with regular or macro lenses. You will not be able to focus at long distances with the extension tube in place.

Bellows

- These are like extension tubes except that they are made of pleated material and are always adjustable.
- A few allow "movements" like a tilt shift lens that can increase the depth of field.
- They are usually longer than extension tubes and can be used with "short mount" lenses such as enlarging lenses. Some maintain automatic lens control (Aperture). Most don't. So far as I know none allow for autofocus.

Lens reversing rings

- These allow any lens to be mounted backward on a camera and are good for extreme close ups.
- The tricky part is that the lens is so close to the subject that it is often difficult to get light on the subject and not simultaneously shine a lot of light on the rear lens element.

Lens mating rings

- Two lenses are mounted front to front with the ring in between them.
- These are also used for extreme closeups.
- If one mounts a 200mm lens on the camera and a 50mm lens facing it one gets a good rig for going at about 4x life size. (200mm/50mm = 4). The 50mm lens, would in this case be kept wide open. This arrangement is much like a close-up filter only using a higher quality lens.
- These are more commonly called macro couplers or macro coupling rings or macro reverse double coupling rings.

Macro rails

- These are rack and pinion arrangements that attach to the bottom of the camera.
- They enable the camera to move back and forth to focus accurately. The camera is set to manual focus. Some also allow left to right movement.
- They are very handy for focus stacking in that one can move the focus point just a little and take the next shot in the stack.
- A few extremely elaborate ones are available that are motorized with an extremely fine thread. This are for people who do focus stacking with literally hundreds of frames and need to automate the process.

Tele-extenders

Converting a lens using, say, a doubler keeps the same minimum focusing distance, thus doubling its magnification. This can profitably be used with diopters for close up work. There is, of course, a two stop penalty for using a doubler and a one stop penalty for using a 1.4x extender.

Macro flash arrangements

- When shooting close-ups, an on-camera flash doesn't usually work well because the camera and lens will block much (or all) of the light coming from the flash.
- If one needs to add light, then the lights should be placed to near, or even beyond the front of the lens and to the side. This removes the blockage and gives better modeling. (Shadow placement)

- Sometimes lights are placed behind and/ or above the subject as well. Think of doing a three light portrait of a flower.
- **Flash brackets** that attach to the camera or lens are often used to support a pair of flashes.
- Another arrangement is a **ring light.** This is a ring-shaped light mounted around the front of the lens. It provides a flat, and almost shadowless illumination. Like flash equipment in general, ring lights come in different sizes, power output, and cost.

More Notes on Use:

For general use from say 1/5th life size to life size a macro lens of 90 to 200 mm focal length is the best way to go. If money is an issue one can either use extension tubes or screw on two element diopters to allow any lens to focus more closely. This is about a $100 solution that can get you quite far. The flat field of a macro lens is really for copying "artwork". It is fine in general, but a curved field of a non macro lens might even be better for flowers. (By field I mean the area that is in sharpest focus.) My own preference is screw on diopters over extension tube in this case. There is essentially no light loss as there is with extension tubes and the arrangement is more compact. Further if you use a long lens with diopters, EG a 400 mm f5.6 say with a +4 diopter (You cannot buy a big enough diopter for a faster 400 mm.) you can go well beyond life size. This gives about a 1.6, life size magnification with the lens set on infinity focus. A +4 on a 200mm gives slightly less than life size (0.8x) at infinity. Diopters on lenses shorter than about 100mm are of relatively little help unless they are +4 or larger. Diopters may be stacked. A +2 stacked with a +4 gives the same result as a +6. Note that a reverse lens connected to a macro coupler is, in essence, a well corrected high numerical value diopter. (A reversed . 50 mm lens forms a +20 (1000/50) diopter attachment.) With a 50mm reversed on a 200 mm lens one gets (at infinity focus) approximately 4x life size images. A reversed 20mm lens on a 200mm gets to 10 x life size, though there may be some vignetting of the image.

If the object you are photographing has an much depth and you want the entire depth to be in focus there are three things you can do. Stop down quite a bit. There are

limits here in that stopping down a lot and at high magnification causes a good deal of loss of sharpness due to diffraction. There are two ways around this. One is to tilt the lens downward (A tilt shift lens, or a lens on a tilting bellows is necessary for this.) to change the plane of sharpest focus. The second way is to take multiple pictures each at a different point of focus (usually moving the camera on a focusing rail) and use "focus stacking" software to get the entire frame sharp. One can get amazing results this way on (dead) insects.

If you want very high magnifications a bellows (or lots of extension tubes) and a short focal length (usually reverse mounted) movie camera lens (cheap) or infinity focus microscope objective lens (pricy). is a good way to go. One can get to perhaps 10x life size this way, but lighting is difficult because there is little space between the lens and the subject and because the depth of field is normally well under a millimeter at this level of magnification. An easier way to go is to photograph through a microscope eyepiece at low power using a cell phone camera or a very compact point and shoot. (The taking lens shouldn't be much larger than the eyepiece.) One, of course, needs a microscope and a lighting arrangement for the microscope.

Macro techniques in field use are well described in the last reference.

Helpful References

- Wikipedia, https://en.wikipedia.org/wiki/Macro_photography

- Photography Life,
  - How to Focus in Macro Photography, https://photographylife.com/how-to-focus-in-macro-photography
  - Macro Photography Tutorial, https://photographylife.com/macro-photography-tutorial
  - Macro Photography Lighting Tutorial, https://photographylife.com/macro-photography-lighting-tutorial
  - What Is An Extension Tube, https://photographylife.com/what-is-an-extension-tube
  - Focal Length in Reverse Lens Macro Technique, https://photographylife.com/focal-length-in-reverse-lens-macro-technique

http://www.cambridgeincolour.com/tutorials/macro-extension-tubes-closeup.htm (This has a calculator for extension tubes and diopters that is quite useful.)

John Shaw's Closups in Nature, John Shaw, Amphoto, 1987.