Summary

When the tiny side of nature is too big for photography through a microscope, you can use an ordinary camera and inexpensive attachments. Brian R. Page describes three of these economical close-up photography methods.

There is a little-known world of nature rich in varied detail. Life underfoot, the tiny side of nature, is a place of intense competition, stalking animals and sudden death. Nature on this scale is wide open for exploration by the amateur naturalist. To go on safari, just get down on your hands and knees.

Close-up photography is often essential to document your discoveries and observations there. Fortunately, if you already own a 35-mm single-lens reflex camera it can be adapted for close-up work without great trouble or expense.

A single-lens reflex camera allows you to compose a picture while viewing through the actual lens used to expose the film. By contrast, many popular cameras use a separate view finder or range finder. These cameras are not suitable for

CLOSE-UP PHOTOGRAPHY ON A BUDGET

Story and Photographs by Brian R. Page

Study insects and plants, or simple beauty with one of the best tools of science — a camera.

Left: Praying mantis (family Mantidae). **Below**: Kathy Page records floral details.

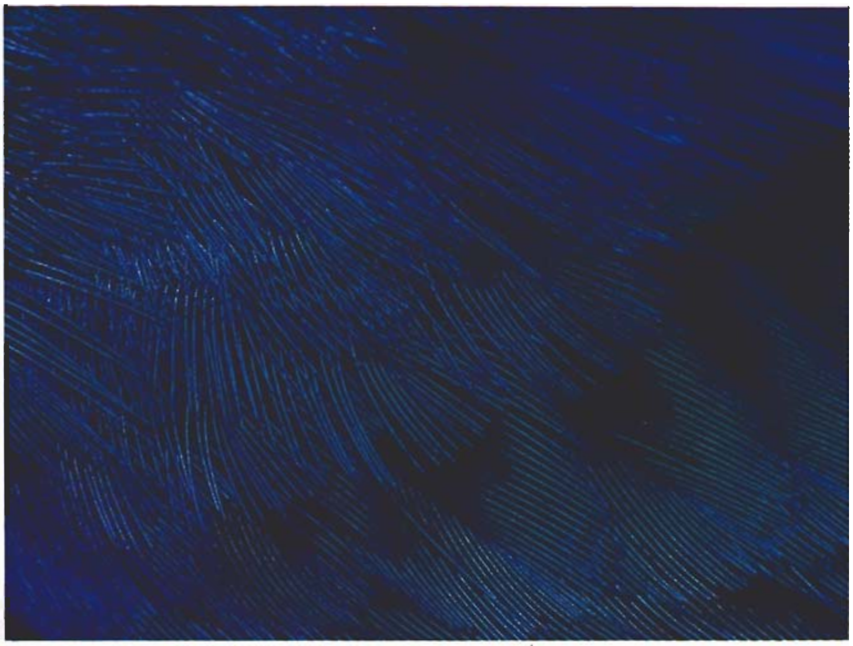
Table 1: Supplementary Lens Subject Area

50 mm Camera Lens

Diopter	Infinity	0.6 m (2 ft)
+1	71 x 48 cm	23 x 15 cm
+2	36 x 23	17 x 11
+3	24 x 16	13 x 9
+4	17 x 11	11 x 8

105 mm Camera Lens

Diopter	Infinity	1 m (3.3 ft)
+1	34 x 23 cm	14 x 10 cm
+2	17 x 11	10 x 7
+3	11 x 8	8 x 5
+4	8 x 6	6 x 4



Right: Feathers from an Indigo bunting (*Passerina cyanea*) photographed at 2.5x life size with a 55-mm lens on bellows and Kodachrome 64 film.

close-up work because, at close range, the view finder does not allow you to see exactly what is in front of the camera lens.

Professional photographers often use a special *macro* lens to get close to their subjects. Unfortunately, macro lenses can be quite expensive. Similar results can be obtained by an amateur without laying out a lot of cash for new equipment. In this article I describe three ways of making close-up photographs — to within a few inches of your subject.

Supplementary Lenses

The easiest way to get started in close-up photography is with a set of supplementary lenses. Supplementary lenses are simply low-power magnifying glasses mounted in a threaded ring (like a lens filter), which screws on to the front of your camera lens. A set usually consists of three lenses. The magnification power of these lenses is measured in *diopters*. The three lenses in a set are +1, +2 and +4 diopters. Using a supplementary lens is like fitting your camera with corrective eyeglasses. The purpose is to make a "far sighted" lens "nearsighted."

When you are down on your hands and knees, it is handy to know how much subject area is covered when using each lens. For that information, I refer to a table that I carry along in my camera bag. (See Table 1.) I usually use supplementary lenses with either my 50-mm "normal" lens or a 105-mm short telephoto. The table lists the size ranges of the subject area for +1, +2, +3, and +4 diopters when the camera lens is focused at infinity and also the size of the subject area when the camera is focused at the its closest focusing range.

Using my 50-mm lens focused at infinity with a +2 supplementary lens, I can photograph an area of 36 by 23 centimeters (14 by 9.75 inches). Without changing the supplementary lens, I can adjust the focusing ring on the 50-mm camera lens to its point of closest focus and photograph an area 17 by 11 cm (6.75 by 4.5 in).

When using supplementary lenses, the normal focusing adjustment is used to vary the dimensions of the subject area. Real focusing of the image is done by moving the camera. As you watch through the finder, move the camera back and forth until the subject is properly focused.

Because depth of field decreases as magnification increases, even the slightest movement causes blur. Therefore, it pays to use the smallest aperture possible. (A small aperture is indicated by a large *f* number.)

This will usually be a number such as *f*/16 or *f*/22. However, use of a small aperture means that plenty of light must be available. You need either bright sunlight, a high-speed film, or flash.

Figure 1 on the next page shows a bracket I use to hold my camera and a small electronic flash unit. The flash is permanently pointed to the area 5 cm (2 in) in front of the camera lens. This is where the subject appears in proper focus. To calculate the aperture setting, I use the *guide number* of my electronic flash. The guide number, divided by the distance between the flash and the subject, gives the aperture or *f*/stop. In our case, we already know the *f*/stop. We want to use *f*/16. So we can divide the guide number by 16 to produce the flash distance.

My small electronic flash has a metric guide number of 6 when used with Kodachrome 25, a slow, fine-grain color slide film. The guide number 6 divided by 16 gives a quotient of 0.375 meter. Thus, using Kodachrome 25 and an aperture of *f*/16, I must position the flash 37.5 cm from the subject. That's the job of the bracket.

The camera attaches to the bracket via its tripod socket. The flash is held on with rubber bands. An extension cord runs between the PC socket on my camera and the cord of the electronic flash. Finally, a +4 diopters supplementary lens goes on the front of the camera lens, and I set the aperture to *f*/16. Now I am ready to go hunting.

If your electronic flash has an automatic mode, it is a good idea to disable it. In automatic mode, the flash senses the brightness of its light during the flash and makes corrections based on the reflectivity of the subject. Be sure your flash is switched to manual mode.

If you do not have an electronic flash, use a higher speed film with an ISO rating of 64 for slides or an ISO of 100 for color negatives. Bright sunshine easily permits an aperture of *f*/16 in most cases. You

CREATING A TABLE OF FLASH DISTANCES

This BASIC program may be used to create a table of flash distances depending on the degree of enlargement.

If you have extension tubes rather than a bellows, you may wish to modify the program. The FOR-NEXT loop between lines 90 and 130 varies the magnification. Because the magnification is fixed for a given extension tube, you may wish to replace variable M with F to vary the aperture from 1 to 22.

Execution of the BASIC program results in Table 2. Flash distance is listed both in centimeters and inches. With this table, I can routinely set my camera lens to *f*/16 (for greatest depth of field) and vary the magnification as required to suit my subject.

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10 REM PROGRAM TO DETERMINE FLASH DISTANCE WHEN USING A BELLOWS
20 CLS
30 INPUT "Enter metric guide number for film/flash combination";MGN
40 INPUT "Enter F-stop setting on lens";F
50 CLS
60 PRINT "  FLASH DISTANCE TABLE FOR FLASH GUIDE NUMBER"MGN"AND F-STOP"F
70 PRINT
80 PRINT ,"MAG","CENTIMETERS","  INCHES"
90 FOR M = 1 TO 3.5 STEP .2
100  DISTANCE = MGN / (F * (M + 1 ))
110  CM = DISTANCE * 100:INCH = CM / 2.5
120  PRINT ,M,CM,INCH
130 NEXT M
140 END
```

A 50mm lens mounted backwards on a Nikon F3 using an inexpensive reversal ring.

Table 2

FLASH DISTANCE TABLE FOR FLASH GUIDE NUMBER 12 AND F-STOP 16

MAG	CENTIMETERS	INCHES
1	37.5	15
1.2	34.09091	13.63636
1.4	31.25	12.5
1.6	28.84615	11.53846
1.8	26.78571	10.71429
2	25	9.999999
2.2	23.4375	9.374999
2.4	22.05882	8.823528
2.600001	20.83333	8.333333
2.800001	19.73684	7.894736
3.000001	18.75	7.499999
3.200001	17.85714	7.142856

Printout produced by computer program above.

can even use the built-in exposure capabilities of your camera. The use of supplementary lenses does not change the way your camera adjusts exposure.

Supplementary lenses are a great way to get started in close-up photography. A set should cost around $50. The flash bracket, of course, is optional, but can be easily made with scrap lumber.

Reversal Ring

Like a supplementary lens, the reversal ring attaches to the front of a normal camera lens. It screws in just like a filter. However, unlike a supplementary lens, a reversal ring is simply a ring. It has no glass.

One side of the reversal ring is threaded to fit the front of a camera lens. The other side of the ring is a bayonet mount that mates to the camera. With a reversal ring, the camera lens can be attached backwards on the camera. When attached like this, an ordinary camera lens becomes a close-up lens. A 50-mm lens covers a subject area of about 5-8 cm (2-3 in). This is comparable to the +4 diopter supplementary lens.

Size is the great advantage of reversal rings. When I am hard-pressed for space or weight — like on a back-packing trip for example — and do not expect to make close-up photographs, I leave my supplementary lenses and take just the reversal ring. Then if some irresistible subject crosses my path, I can usually manage.

A significant disadvantage is that when the lens is reversed, the camera cannot keep the aperture wide open (at its smallest *f* number) while I compose a photograph. If I stop down to *f*/8 or *f*/11, the view through the camera grows considerably darker.

A variety of rings designed for most popular cameras is available from Edmund Scientific for less than $20 (101 East Gloucester Pike, Barrington, New Jersey 08007-1380).

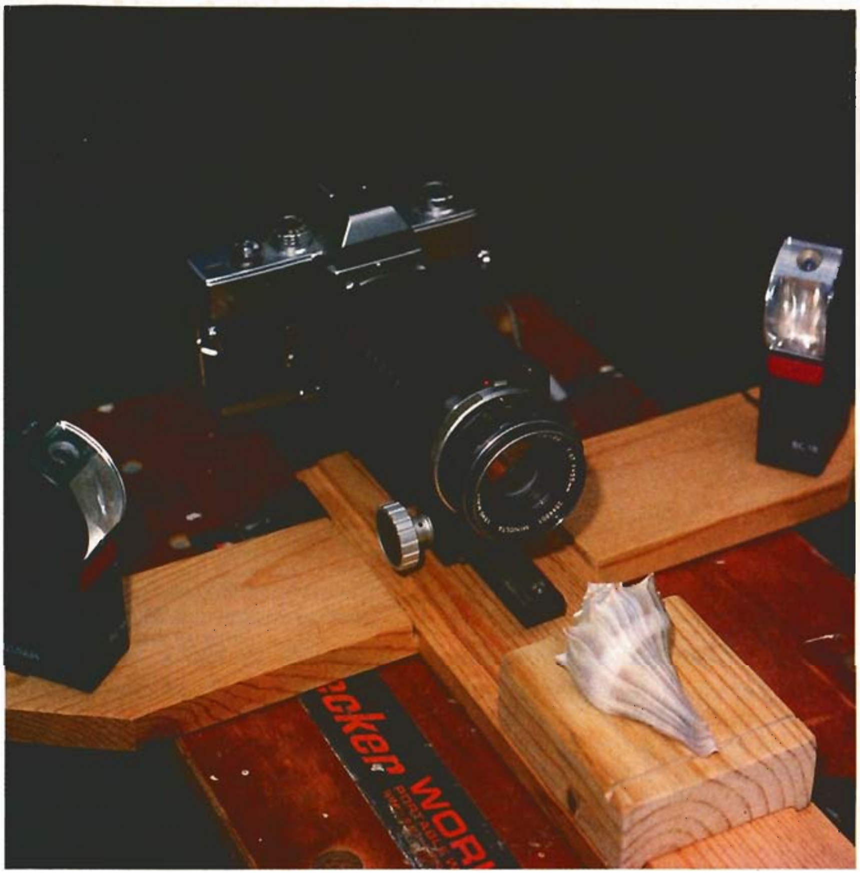
Bellows and Extension Tubes

Neither supplementary lenses nor reversal rings can record an image on film that is larger than life size. To get this close requires some specialized equipment.

An ordinary camera lens may be used to create life size (1:1) images, as well as enlargements two or three times actual size. All you have to do is increase the distance between the camera lens and the film.

Think of a camera lens as a projection device and the film as a theater screen. As the distance between the lens and the screen increases, the projected image size grows larger. There is, however, a price to pay for this growing magnification. First, the distance between the camera lens and the subject sharply declines. Maximum distance becomes something on the order of a few centimeters. Second, the intensity of the projected image dramatically decreases. A given amount of light is spread over a larger area. Finally, just as with supplementary lenses, the depth of field becomes extremely shallow.

Two devices are commonly used to provide the greater separation



The bracket is made from a piece of lumber. The edges have been routed to create a track upon which may ride a subject platform. The bellows is attached with 1/4-inch screws in its two tripod sockets. A subject is placed on the platform. The flash is positioned to point at the subject just in front of the lens.

between the camera body and the camera lens: extension tubes and bellows. Extension tubes simply snap into place between the camera and lens. One end of the tube has a bayonet mount for the camera. The other end attaches to the back of the normal lens.

An extension tube extends the lens to a single predetermined distance. The degree of image enlargement depends only on the lens used and the length of the tube. A bellows, on the other hand, works like a variable extension tube. This variable distance determines the degree of enlargement.

Each extension tube is labeled with a magnification factor for a normal lens. A bellows has a magnification scale marked on the rack.

Exposure calculation for extension tubes and bellows is somewhat more complicated than that for using supplementary lenses. Most notably, the aperture or *f*/stop setting on the lens is no longer an accurate description of the real aperture.

When a lens is extended with either device, the *effective aperture* of the optical system must be computed according to this formula:

$EA = f * (M + 1)$

where:

EA = Effective Aperture

f = *f*/stop or aperture setting on the camera lens

M = Magnification

For an extension tube, the magnification is a constant. With a bellows, this value depends on how far the lens is extended.

Often the only practical way of illuminating subjects for bellows and extension tubes is through the use of electronic flash units. When calculating flash distance the effective aperture is used, not merely the aperture setting on the lens. This distance is found with the formula:

Distance = Guide Number / Effective Aperture

A 2x enlargement with a lens aperture of *f*/16 and an ISO 64 slide film used with an ordinary electronic flash results in a flash distance of 25 cm (10 in).

Use of a bellows requires careful work. Depth of field is severely limited. Focusing must be done with the camera lens set at its widest aperture. Only then does it pass enough light to see the subject clearly. The wide-open aperture, however, presents a dilemma.

Depth of field is at its shallowest with a wide aperture. If you stop down the lens to *f*/16 to gain some depth of field, you can no longer see the subject clearly. The only solution is to focus with the lens aperture wide open, carefully adjust the aperture to *f*/16, take the photograph, and wait for the film to be processed.

To simplify use of a bellows, I recommend either a standard photographic copy stand or a bracket similar to the photo above. This bracket securely holds the camera and bellows. It also has a sliding base to hold a subject in front of the lens. A removable cross arm holds two electronic flash units. The flash units are positioned to provide the proper illumination for a 2.5x enlargement with my camera lens set to *f*/16. If I use another magnification, I reposition the flash units.

Close-up photography can be addictive. Once you begin to notice the small details in nature, you'll find yourself down on your hands and knees more often. These explorations can even be dangerous, like the time I attempted to photograph hornets in the wild. All I received for my effort was a painful welt and some firsthand experience with swarming social insects. ✳

FURTHER READING

Photographing Nature by the editors of Time-Life Books (Time-Life Books, 1974). This book is one volume of the Time-Life series on photography. It includes a chapter on close-up photography using a variety of techniques.

Life on a Little-known Planet by Howard Ensign Evans (University of Chicago Press, 1984). This is a splendid introduction to entomology, the study of insects — ideal subjects for close-up photography.

ABOUT THE AUTHOR

Brian R. Page was once a newspaper photographer. Now he's a data processing manager enjoying the combination of aesthetics and technology of his leisure time photography.