UNDERSTANDING EXPOSURE

Proper exposure is the biggest problem for all photographers, whether amateur or professional. Your technique can be perfect, your lenses the best available, your film the finest, the location the most exotic; but if your exposure is off, your photographs will be throwaways. And no matter how sophisticated your camera's exposure system is, you cannot depend on it to handle every situation. If you want to become a good nature photographer, it is vital to always keep in mind the basics of exposure.

Exposure determination depends on two basic camera controls: shutter speed and aperture. *Shutter speed* is the length of time that your camera's shutter stays open when you take a picture. *Aperture*, or *f*-stop, is the size of the lens opening through which light passes to the film. Together they control the total amount of light reaching the film. Both of these values are set up to work in what are called *stops*. A stop represents the doubling or halving of the amount of light that reaches the film. Cameras are much easier to use if you learn to think in terms of stops.

The standard shutter speed sequence on most cameras is marked in seconds and fractions of a second: 1, 1/2, 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/500, and 1/1000 sec. Each speed is half the preceding speed but double the following speed; for example, 1/60 sec. is half as long as 1/30 sec., but twice as long as 1/125 sec. Shutter speeds control motion. A moving subject is blurred by slow speeds and frozen by fast speeds.

The *f*-stops marked on a lens also work in doubles and halves. The usual series of numbers is *f*/1.4, *f*/2, *f*/2.8, *f*/4, *f*/5.6, *f*/8, *f*/11, *f*/16, and *f*/22. Each number indicates the size of the lens opening. And the important thing to remember is that as the numbers get larger, the lens opening gets smaller. For example, *f*/1.4 represents a very large lens opening while *f*/22 is a very small one. Not all lenses have all these numbers, and some have even more, but all *f*-stop numbers work the same way. Each number represents an opening in the lens that is half the size of the preceding number and double the size of the number that follows. For example, *f*/8 is an opening that has twice the area of *f*/11, but it has only half the area of *f*/5.6.

Fortified with an understanding of exposure values, the photographer can capture even the most delicate subjects on film. Here, the details of frost were perfectly exposed, with allowance for adequate depth of field.

The *f*-stops control depth of field, which refers to the portion of a photograph, from near to far, that is in sharp focus. The smaller the lens opening, the greater the range that is in sharp focus; the larger the opening, the more limited the area that is sharp (page 53).

Stopping down is the traditional term used to describe cutting the amount of light reaching the film by going to a smaller *f*-stop. *Opening up* is just the opposite: going to a larger aperture. By extension, you should also think of shutter speeds in the same terms. Using a faster shutter speed is, in effect, stopping down since it also cuts the amount of light reaching the film. Using a slower shutter speed, which lets more light get to the film, is in effect opening up.

Since both shutter speed and *f*-stop control how much light reaches the film, and since both work in doubles and halves, we can establish a relationship between them. A stop change in shutter speed is the equivalent of an *f*-stop change. Thus the two are interchangeable. Basically, this means that to get the same amount of light to the film you can use a small lens opening and a slow shutter speed or a large opening with a fast shutter speed. It's similar to drawing a gallon of water: you can turn the tap on full for a short period of time, or have just a trickle for a long time. Either way you end up with a gallon of water. The lens opening and the amount of time it is open work together in a reciprocal relationship.

What this means is that when you need a smaller aperture for increased depth of field or a faster shutter speed to stop action, you are free to exchange shutter speeds for *f*-stops, and vice versa, and still get proper exposure. Assume, for example, that 1/125 sec. at *f*/8 is the proper exposure. The same amount of light hits the film when you double the time to 1/60 sec. and half the opening to *f*/11. The exact same amount of light is also produced by half the time, 1/250 sec., at double the opening, *f*/5.6. In practice this is simple to do: Just count the number of stops you change on one scale and change the other scale this same number of stops, but in the opposite direction. Again let's start with a proper exposure of 1/125 sec. at *f*/8. A two-stop change in shutter speed to 1/30 sec. (more time) needs a two-stop change in *f*-value to *f*/16 (smaller opening) to get the same amount of light to the film.

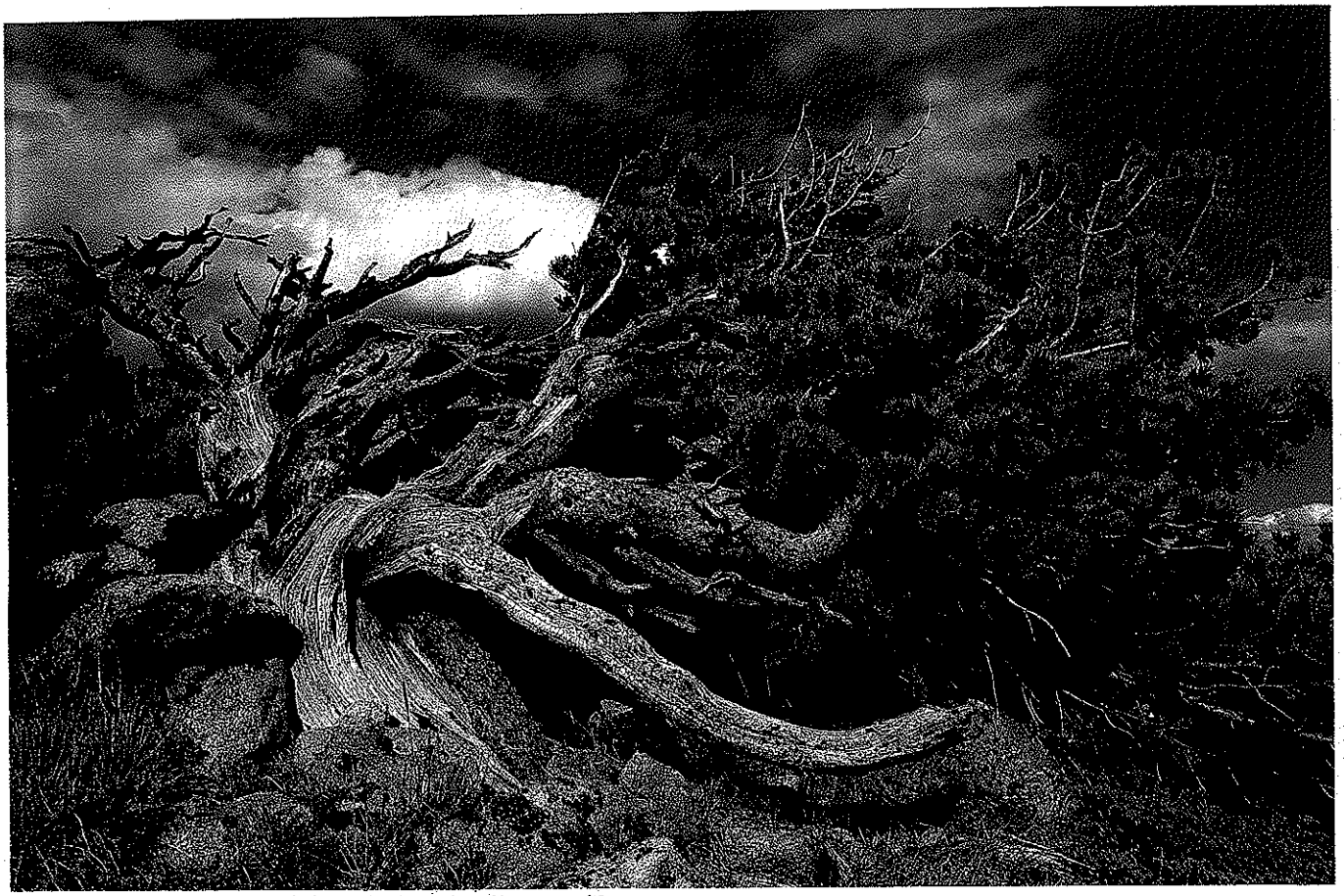
Of course, the shutter speeds and *f*-stops you choose will depend on the film you are using. Different films vary in their sensitivity to light, and this variation is expressed in their speed ratings, or ISO numbers (previously called ASA numbers). The smaller the ISO number, the less sensitive the film—that is, it needs more light for proper exposure. Hence films with small ISO numbers like Kodachrome 25 at ISO 25 are called low-speed or slow film while those larger ISO numbers, like Ektachrome 400 at ISO 400 are called high-speed or fast films. ISO numbers can also be thought of as working in stops. Although ISO ratings or various films do not always progress uniformly like shutter speeds and apertures, a doubling or halving of an ISO number represents a doubling or halving in the film's sensitivity to light. From ISO 25 to ISO 50 is a one-stop change; from ISO 50 to ISO 100 is one more stop; from ISO 100 to ISO 200 is another stop. Thus Ektachrome 400 is four stops faster (more sensitive to light) than Kodachrome 25.

Knowing the proper exposure for one film in a given lighting situation means that you know the proper exposure for all films, if you work in stops. If Kodachrome 25 is properly exposed at 1/15 sec. at *f*/8, what is the proper exposure for Ektachrome 200 film? ISO 200 is three stops faster than ISO 25, so the exposure for Ektachrome 200 is 1/125 sec. at *f*/8, or 1/60 sec. at *f*/11, or 1/30 sec. at *f*/16, or 1/15 sec. at *f*/22, and so on. How about Kodachrome 64 at ISO 64? Technically, it is one and one-third stops faster than Kodachrome 25. ISO 25 to ISO 50 is one stop; ISO 50 to ISO 100 would be another whole stop. ISO 50 to ISO 64 is one-third stop. A third of a stop is a smidge—plenty close enough! So Kodachrome 64 would be exposed at 1/15 sec. at *f*/11+ or the equivalent. To get an *f*/11+ aperture on your camera, you simply set your aperture ring between *f*/11 and *f*/16, about a quarter to a third of the way beyond *f*/11.

Learning to calculate proper exposure by working in stops is the starting point for all good photography. It's a simple system, and it's easy to learn. More importantly, it puts you in control of your images, rather than being dependent on your camera's meter.

EXPOSURE

IN BRIGHT SUNLIGHT, IGNORE YOUR CAMERA'S METER



WHITEBARK PINE AT TIMBERLINE, Kodachrome 25, 24mm lens, 1/125 sec. at *f*/8

You can determine correct exposure two ways: you can rely on a meter, like the one in your camera, to measure the light level, or you can estimate the level of light yourself. No matter how technically advanced your camera's exposure system is, there is one situation—bright sunlight—when I strongly recommend that you go with an estimated exposure. On a bright, clear day, it is fairly easy for a meter's appraisal of the settings needed for correct exposure to be thrown off by a subject that is light colored or shiny or by a subject that is more than normally dark in tone. Yet correct exposure in bright sunlight anywhere in the world, when photographing a frontlit subject bigger than a backpack, can always be quickly calculated using what is known as the "sunny *f*/16 rule." When the camera is set at *f*/16, the correct shutter speed is the one with the number closest to the film's ISO rating. This can be expressed as correct exposure equals one/ISO at *f*/16. For example, for a film that has an ISO rating of 64, the proper bright sunlight exposure at *f*/16 is 1/60 sec., the shutter speed closest to 64. The sunny *f*/16 rule works—memorize it! If your camera's meter doesn't give you the same values, ignore the meter. I have shot thousands of photographs this way.

Of course, once you know the correct shutter speed for *f*/16, you can use any equivalent combination of settings. You do not have to shoot Kodachrome 64 at 1/60 sec. and *f*/16. The same amount of light reaches the film when you use 1/125 sec. at *f*/11, 1/250 sec. at *f*/8, or 1/500 sec. at *f*/5.6. Pick the *f*-stop you need for depth of field, or the shutter speed that you need to stop subject or camera motion.

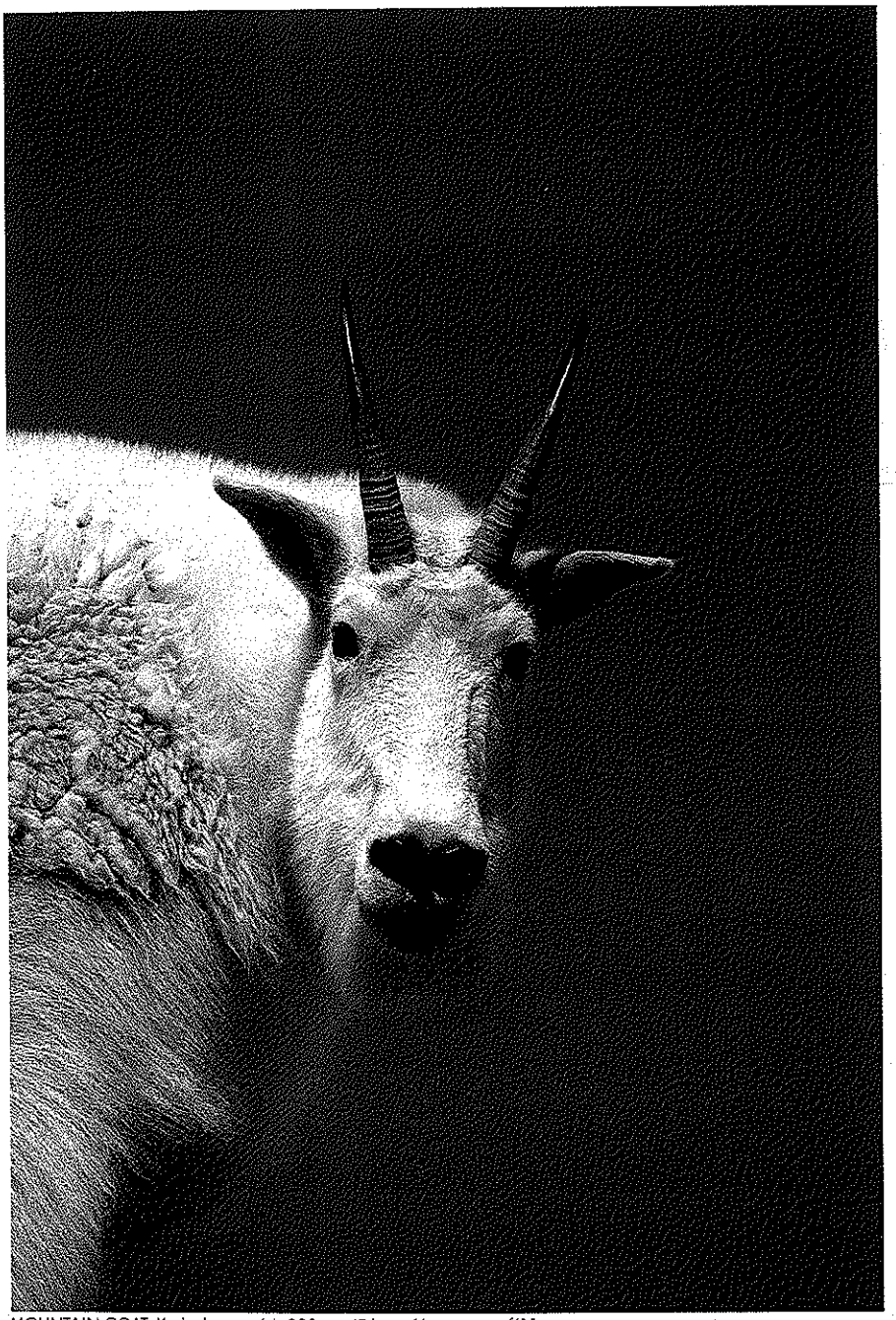
Fighting a constant wind at the timberline, I quickly composed this shot and then waited for a lull. Even so, I was forced into a compromise between shutter speed and depth of field. I chose a medium shutter speed (as slow as I dared to go with the wind) and a medium f-stop.

(Opposite page, top) *Since I knew the basic exposure for bright sunlight, I did not bother to take a meter reading. In order to get both foreground and background in focus I used a small f-stop. A tripod enabled me to study the composition carefully and allowed for a slow shutter speed.*

(Opposite page, bottom) *A fast shutter speed was absolutely essential in order to arrest the goose in motion. To compensate for the shutter speed, I shot with the lens wide open—but this meant critical focusing. A 500mm lens allowed me to isolate the subject. When using the "sunny f/16" exposure with Kodachrome 64, I often find it best to rate the film a little faster. Try shooting at a base exposure of 1/60 sec. at between f/16 and f/22 to richen the exposure.*

EXPOSURE

KEEPING THE WHITE SUNLIT SUBJECT FROM WASHING OUT



MOUNTAIN GOAT. Kodachrome 64, 300mm IF lens, 1/250 sec. at *f*/11

I strove for detail in the white fur of this mountain goat and for a brilliant blue sky. Mine was a tall order, but satisfactorily filled: my exposure kept the goat properly exposed, and also increased the color saturation in the sky.

When you are working in bright sunlight, photographing white subjects that fill a good part of the frame, the basic sunny *f*/16 exposure rule does not work. Highlights and details on the white surface become washed out, and the resulting slide is overexposed. Compare, for example, the two photographs of the swan on the opposite page. In the smaller photograph, the sunny *f*/16 rule was used, and you can see how all the detail in the swan's feathers is lost. A similar problem occurs when you shoot in bright sun and include such highly reflective surfaces as sand and snow in the frame. With transparency film, it is especially important to keep details in the highlights. Once they are lost, there is no way you can recover them.

Taking a meter reading is not the solution to this problem, however; a meter can also be misled by the situation. The answer is to base your exposure on the sunny *f*/16 rule, but cut your light by one stop. This will give you the correct exposure for keeping all the details of your white subject intact. Under these conditions then, the correct non-metered exposure becomes "sunny *f*/22." Let's assume, for example, that you are using Kodachrome 64. Your proper bright sunlight exposure time is still 1/60 sec., the shutter speed closest to ISO 64 in number. But your proper *f*/stop is now *f*/22. As always, you can pick any equivalent combination of shutter speed and *f*-stop that you need for your subject. In this example you could use 1/125 sec. at *f*/16, 1/250 sec. at *f*/11, 1/500 sec. at *f*/8, or 1/1000 sec. at *f*/5.6.

EXPOSURE

FIRST, FINE-TUNE YOUR CAMERA'S METER

When you are not shooting in bright sunlight, your camera's meter is an invaluable aid. But far too many photographers are slaves to their meters, assuming that the meter will make the *right* decision, or that their expensive, auto-exposure camera will automatically make good exposures.

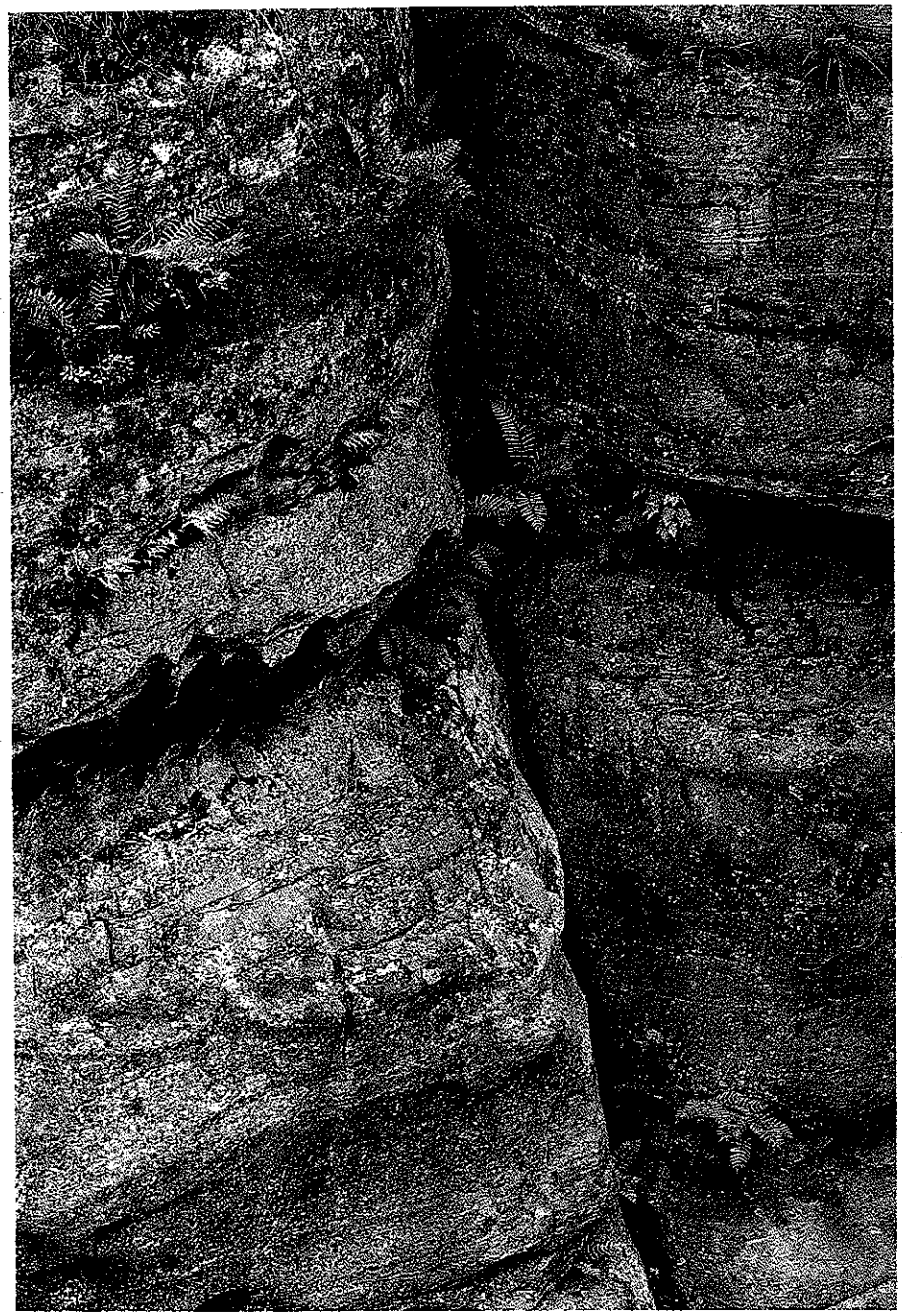
The first thing to do with any meter is to make sure it is calibrated properly. Calibration is exactly what you do when you buy a car and learn what the gas gauge means. Is the tank really empty when the gauge is on the "E" mark? Probably not. You learn what it means; you calibrate the gauge by experience. You can do the same with your exposure meter.

Calibrate your meter to give a proper reading when pointed at a middle-toned subject. A middle tone is defined as average; neither light nor dark, neither white nor black, but halfway in between. It is the tonality of wheat bread lightly toasted. Technically, a middle-toned subject reflects 18 percent of the light. To meter for this, you can buy a Kodak 18-percent gray card, but luckily in nature there are lots of middle-toned, average subjects that will work just as well. Among them are green grass, most foliage, and dry tree trunks.

Calibrating a meter is easy. You know one correct non-metered exposure, the sunny *f*/16 one. Simply go outside and meter something middle-toned in bright sunlight. The easiest subject to use is the clear north sky on a sunny day. Choose an area about 45 degrees above the horizon in the middle of the day. Use a normal or longer lens, set on the infinity focusing mark.

Let's assume you want to calibrate your meter and you're using Kodachrome 25 film. Proper bright sunlight exposure is 1/30 sec. at *f*/16. Set your camera for this exposure. Then meter the sky, making sure there is no smog or haze, and simply change the ISO setting on the camera's film speed dial until the meter indicates that this setting is correct. It doesn't matter what number you end up with on the dial. After all, they are just reference marks. You know already what the meter should say is the correct exposure; you just have to get the meter to tell you this answer. Whatever number you come up with is now the setting you use whenever you're shooting that film with that meter. On the camera body that I use for Kodachrome 25 film, for example, I keep the meter set at ISO 50. And on the body I use for Kodachrome 64, I set the meter at 120. In both cases, this reduces the exposure by one stop. Cameras vary, however. Be sure to test your meter.

This calibration has nothing to do with pushing film or changing development times, you are simply correcting your camera's film speed dial. Once you've set the meter at its correct mark, just go outside and photograph as usual. You can calibrate other meters by comparing them against the first one.



CINNAMON FERNS ON SANDSTONE WALL. Kodachrome 25, 200mm lens, 1/15 sec. at *f*/11

(Above) *Many of nature's subjects are of "average" tonality. Since I have calibrated my camera's meter to obtain a proper reading of a middle tone, I was able simply to point my camera and shoot at the reading that my meter indicated.*

(Opposite page) *By metering the entire scene as a middle tone, the flower, the grass, as well as the droplets of dew were perfectly exposed.*

EXPOSURE

COMPENSATING FOR VERY LIGHT AND DARK SUBJECTS

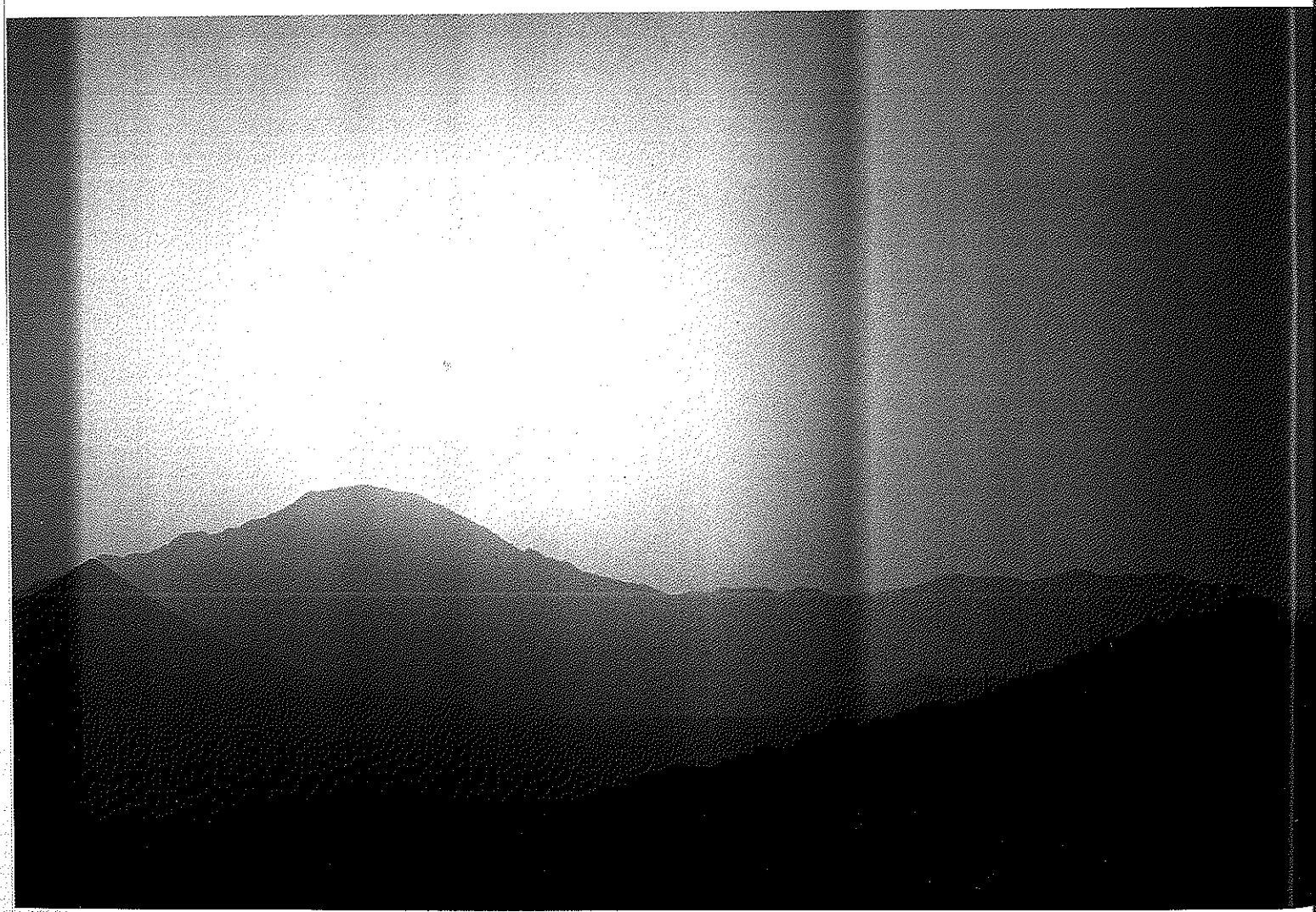
Once you have calibrated your camera's meter to read a middle-tone value, you should have no problem getting a correctly exposed photograph of a middle-toned subject. You just meter the middle-toned area, and shoot at what the meter says. But you don't always shoot middle-toned subjects. How do you meter subjects that are very light or very dark?

When you point the camera at a scene that contains a lot more light or dark tones than usual, the camera will expose it as if it were middle toned. In effect, the camera wants to make every scene it sees the equivalent in tone of a neutral gray. If you shoot as the camera's meter indicates, a predominantly dark scene will be made lighter overall and a pristine white subject like the milkweed seeds (right) will be recorded as dull and grayish. A similar problem occurs when your scene includes the sun, or any other strong light source, such as sparkling reflections on water.

The camera, in its quest for middle tones, grossly underexposes light subjects and overexposes dark ones. Thus, with a light subject you need to open the lens one, two, or even more stops to give the subject more exposure. With dark subjects, you need to stop down a similar amount to give the subject less exposure. In most cases there is an easy way to determine how much to change the exposure, and surprisingly, it is the same for both light and dark subjects. Find an area in the same light as your subject that has mostly middle tones. Take a reading of that area with your camera and then use the settings suggested by that reading to take the picture. Keep in mind those readily available middle-toned subjects you already know like green grass, most foliage, or dry bark.

For the picture of the milkweed seeds, for example, I focused on the milkweed. Then, swinging the camera to the side, I metered the green background, a middle-toned area in the same diffused light as the milkweed. I was careful not to change focus, since that would change the length of the lens, altering the amount light reaching the camera's meter. Once the meter reading was taken, I brought the milkweed back into the frame, recomposed the scene, and shot, using the settings indicated by the reading. Similarly for the sunset, I swung the camera to the side, eliminating the sun from the frame, and metered an area of the sky that I wanted to be middle toned.

There is really no one correct exposure when you're shooting a sunset because the exposure can be varied depending on the mood you wish to establish. The bright sunlight, however, misleads the camera into underexposing the scene. For the most natural looking results, take a reading of the area of the sky that you wish to be middle-toned in the photograph. Here, I selected a rich orange area (like that in the upper left of the frame) and took a reading of it, excluding the sun from the frame.



SUNSET, SONORAN DESERT, ARIZONA. Kodachrome 25, 600mm lens, 1/500 sec. at *f*/5.6

EXPOSURE

WHEN THERE IS NO MIDDLE TONE TO READ

CATTAILS AND REEDS. Kodachrome 25, 105mm lens, 1/8 sec. at *f*/11

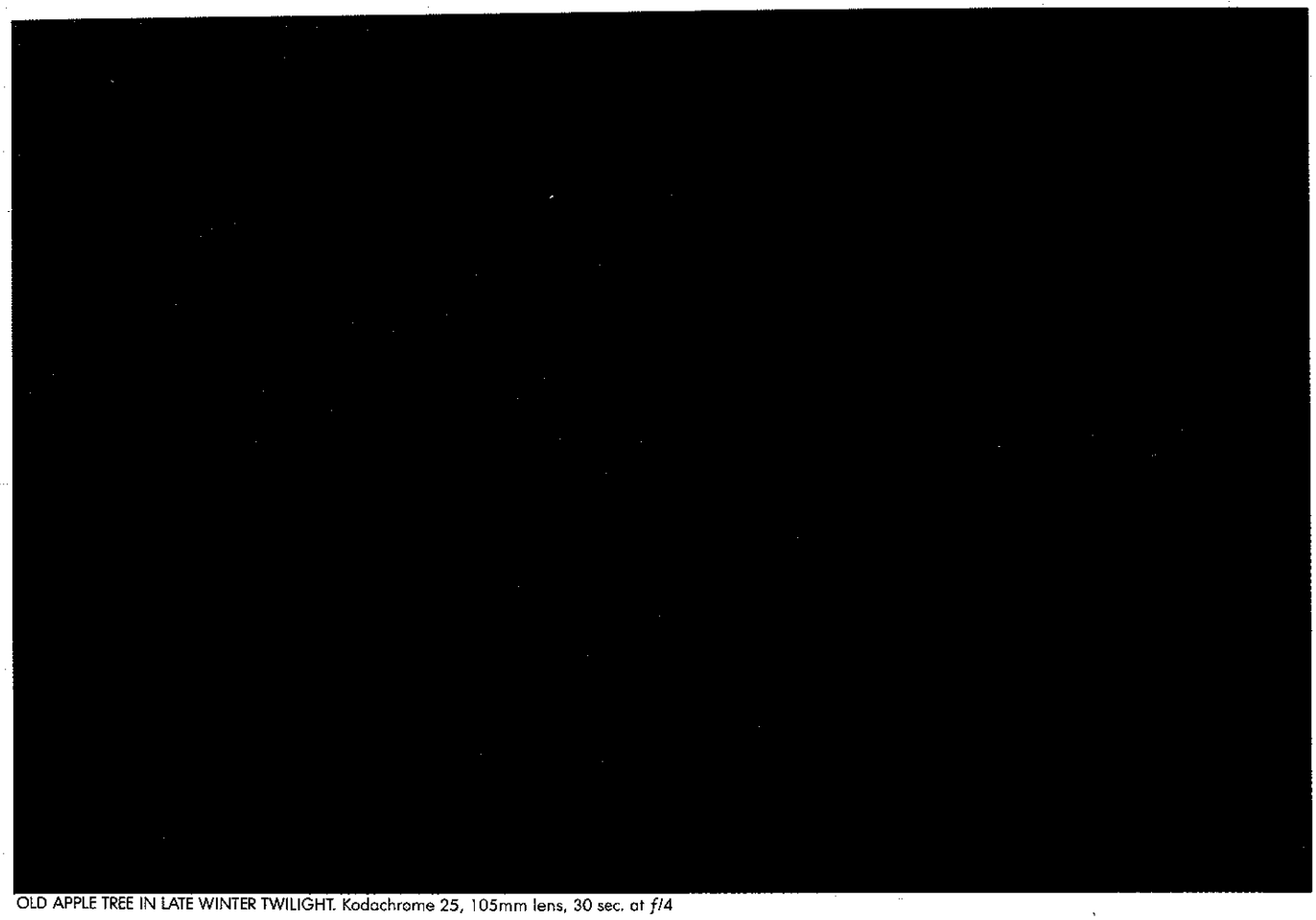
I photographed this scene at sunrise and wanted the water area around the reeds to appear as it actually was—lighter than middle tone. So, I metered for this area and then opened up one stop.

As long as you have a middle-toned area anywhere around you that is in the same light as your subject you will have no problem taking a meter reading. But what do you do when there is no handy middle-toned area?

One solution is to carry a middle-toned area with you in the form of an 18 percent gray card. All you have to do then is meter the card in the same light as your subject. But gray cards, in my estimation, do not work very well outdoors because they have a slight sheen to them and can be too reflective. Find something else that you always have with you. The object does not even have to be middle-toned, as long as you know how many stops off middle-toned it is. One very useful reference is the palm of your hand. With most people, the skin of the palm is one stop brighter than a middle tone. To check the tonal value of your palm, meter it and a known middle-toned subject like green grass; and compare the two readings. Make sure that both are in the same light, and do not refocus while making the two readings since that would affect exposure values. Now, assume your palm is one stop more reflective than a middle tone. To take a picture, first focus on your subject. Then, without refocusing, meter your palm in the same light as your subject. Using the settings the meter indicates, open up one stop. Why open up? Shouldn't you stop down since your palm is brighter than neutral? If you were to shoot at what the meter says, your palm would be middle-toned in the final slide. But it is not; it's lighter. To get it back to the correct value, you must add light.

Another way to handle a scene with no middle tones is to decide how you want the tonal values to appear in the final slide. You can meter any part of your subject, and then decide if you want that part to be middle-toned, or lighter or darker. If you want it to appear as a middle tone, shoot at what the meter says. Otherwise, compensate for the meter reading by working in stops. Color slide film has a very limited range, about six stops, from washed-out white to blocked-up black, so in general you will be metering an area and changing the reading by only a stop or two at the most.

COPING WITH THE LOW-LIGHT SITUATION



OLD APPLE TREE IN LATE WINTER TWILIGHT. Kodachrome 25, 105mm lens, 30 sec. at *f*/4

When relying on your camera's through-the-lens meter in very dim light and using small *f*-stops, you will often be unable to get a meter reading. But these times of marginal light—the very edge of light—create very beautiful conditions for photography. Suppose you've found a scene you want to photograph. By studying the composition through the viewfinder you decide you need to use *f*/16 for adequate depth of field. But with the lens set at *f*/16, and the shutter speed all the way down to 1 sec., you cannot get a meter reading. Short of buying a sensitive hand-held light meter what can you do?

The answer is to work in stops. You do not have to meter at the *f*-stop you plan on using. Instead, meter with the lens fairly wide open and then figure out what the shutter speed would be at your shooting aperture. Let's say that you meter 1 sec. at *f*/4. What is the correct shutter speed for *f*/16? Remember that stops are doubles and halves; for every one *f*-stop change, shutter speed must double. The progression of changes would be 1 sec. at *f*/4, 2 sec. at *f*/5.6, 4 sec. at *f*/8, 8 sec. at *f*/11, and 16 sec. at *f*/16. In practice, you simply count the shutter speeds off as you change the *f*-stops on the lens.

If you shoot for 16 sec. at *f*/16, though, you will discover that the final slide will be underexposed. For very long exposures you must be concerned with reciprocity failure; the reciprocal, interchangeable relationship between *f*-stops and shutter speeds does not hold. In an earlier analogy, I said that exposure was like drawing a gallon of water; one possibility is turning the tap on just a trickle for a long period of time. Well, if time becomes long enough, some of the water evaporates and you must add a little more to get your gallon. Films at long exposure times act the same way. You must add a little light for correct exposure. Since this is a problem that is compounded by an increase in exposure time, it is best to add light by opening up the aperture, not by increasing the shutter speed time. Some films also shift color balance and must be filtered back to their original balance. Exposure and color corrections are given in the accompanying chart. These are the manufacturers' recommendations; be sure to test them. Most of my long exposures are on Kodachrome 25. And I don't believe it shifts color, even though Kodak says it does. I open up ½ stop at 1, 2, or 4 sec., 1 stop at 8 sec., and 1½ stops at 16 sec. Returning to my original example, I would be shooting at 16 sec. at 1½ stops open from *f*/16, halfway between *f*/8 and *f*/11. The color compensating (CC) filters given in the chart are explained in detail on page 44.

HOW EXPOSURE CAN CONTROL MOOD

DAWN, ROCKY MOUNTAIN NATIONAL PARK, COLORADO. Kodachrome 25, 300mm IF lens, 1 sec. at *f*/8

At dawn and dusk, the quality of light is so delicate that it is difficult to trust your camera's meter to expose for the type of photograph that you want. In the half hour or so before the sun rises and after it sets, the light is not only changing rapidly, but it is also very diffuse. This effect is often heightened by atmospheric haze. In such light the scene perceived by the eye is subtle and usually imparts a definite emotional feeling. Sometimes it may seem light and airy, other times it may seem dark and moody. Yet, when you photograph the scene following your camera's meter, the result is often disappointing. The mood the image conveys is just the opposite of what you felt—or, even worse, the image is emotionally flat.

Your problem is matching your exposure to the feeling that you want in the final image. As the sequence of photographs shown here demonstrates, there is no correct exposure for such times of day. Depending on what mood you want to create, all three exposures work. The center shot was based on the camera's meter, while the other two exposures vary by one stop in either direction. By bracketing in this way you can nearly always ensure that, out of the three, you will have the exposure you really want, even in the most tricky lighting situations.

Overexposing by one stop (above) lightens the tone in the final transparency, accentuating the delicate, misty atmosphere. Underexposing by one stop (opposite, bottom) darkens the scene, silhouetting parts of it and giving it a more somber feeling. Often the least satisfactory shot is the one taken at the exposure recommended by the meter, with all of the tones averaged out to a medium gray.

At twilight and dawn, color is not always the most important consideration. The hues of the landscape are faint and subtle, and the scene is frequently almost monochromatic. Varying exposure plays with the mood.

Here are three photographs that clearly indicate how effectively exposure can be used to control the mood of a scene. In the photograph reproduced above, the scene was overexposed from the metered exposure by one stop, giving the image a delicate, ethereal quality and emphasizing the misty morning atmosphere. In the second photograph (opposite, top), which was taken at the exposure indicated by the meter, the scene is slightly darker and the atmospheric moisture is not as noticeable. In fact, the effect is more neutral in feeling; the photograph could have been taken at dawn or dusk. In the third photograph, a one-stop underexposure deepened the tones of the scene considerably—even the sky is darker. Consequently, the image takes on a much more somber quality.

DAWN, ROCKY MOUNTAIN NATIONAL PARK, COLORADO. Kodachrome 25, 300mm IF lens, 1/2 sec. at *f*/8

DAWN, ROCKY MOUNTAIN NATIONAL PARK, COLORADO. Kodachrome 25, 300mm IF lens, 1/4 sec. at *f*/8