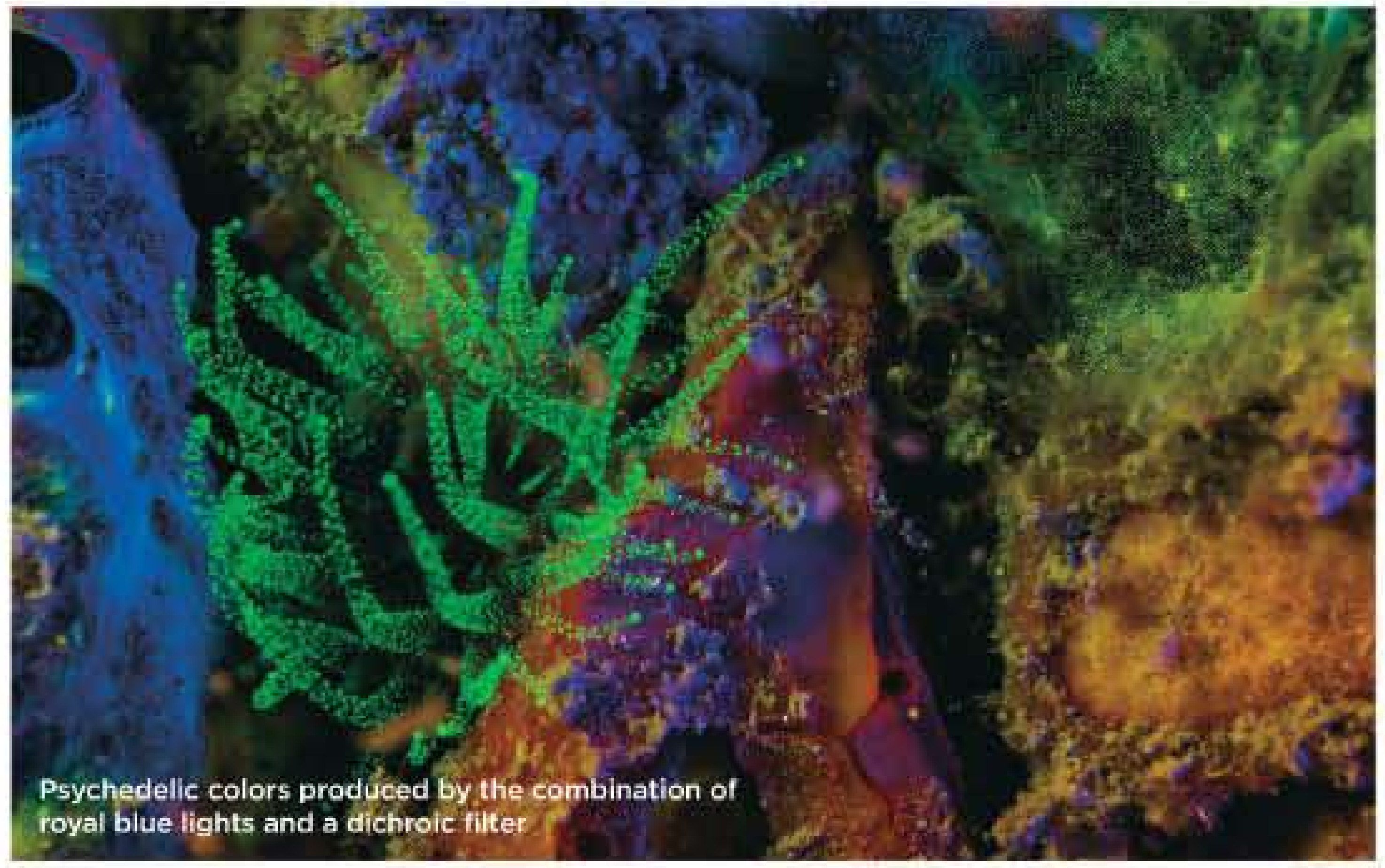
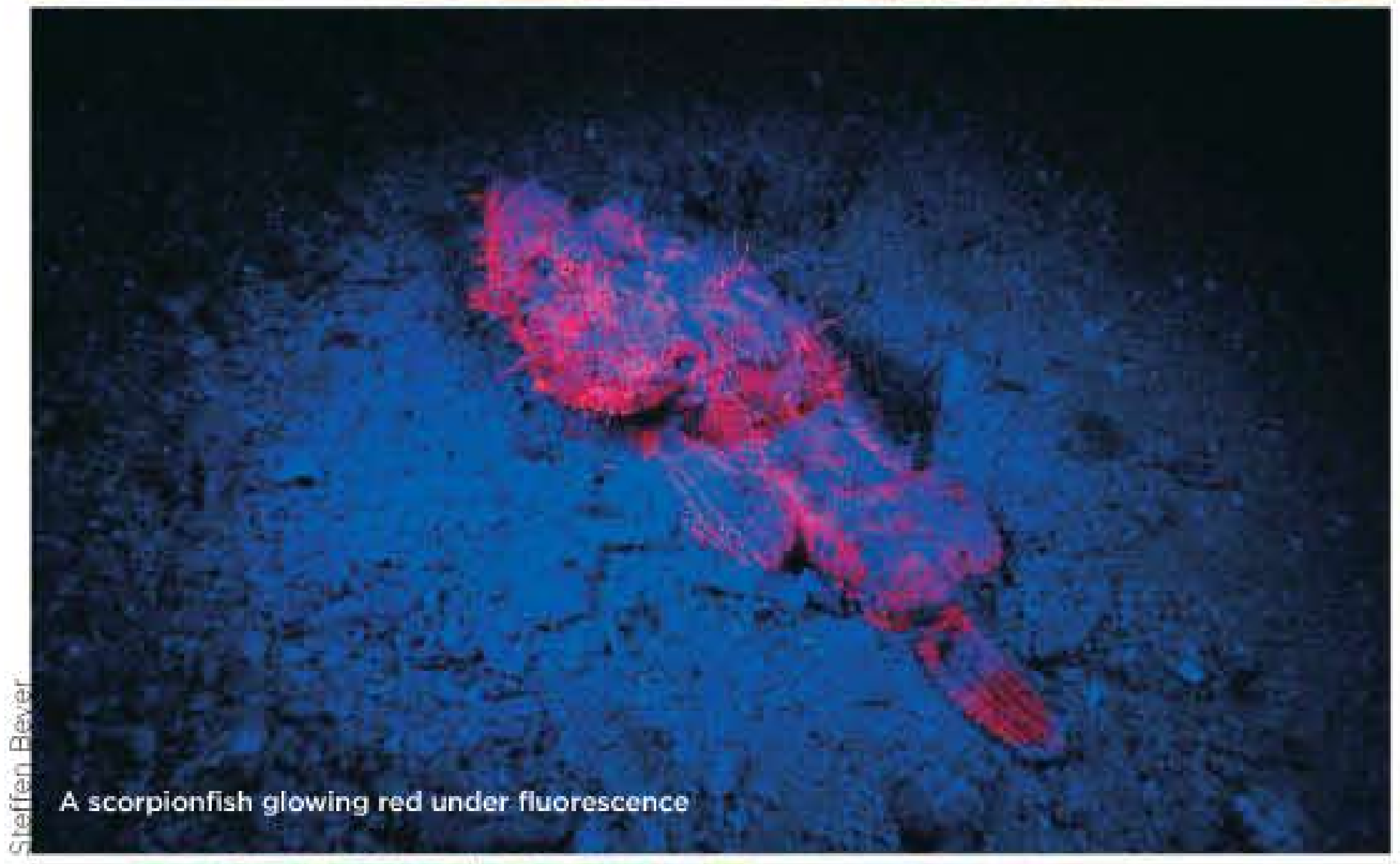
Finding the glow with "fluo"

By STEFFEN BEYER & SOLOMON BAKSH



Psychedelic colors produced by the combination of royal blue lights and a dichroic filter



A scorpionfish glowing red under fluorescence

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An example of green, yellow and red fluorescence from these zoanthids

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Many marine organisms (for instance corals, tunicates, barnacles, sponges, anemones, jellyfish, clams, nudibranchs, cephalopods, shrimp, crabs, worms, fish) produce proteins that have the property to react to certain wavelengths of light; a phenomenon called fluorescence.

According to expert, Dr. Charles Mazel, from the physics point of view, fluorescence is the process by which light of one wavelength (color) is absorbed in a substance and transformed into another color. On the biology side, fluorescence comes from a few sources. The intense greens, yellows and oranges in corals and anemones, come from fluorescent proteins in the host tissue; a deep red fluorescence also originates from chlorophyll in algae, including the symbiotic algae in the invert tissues.

You get an orange fluorescence from phycoerythrin, a photosynthetic accessory pigment found in red algae and cyanobacteria. There is also fluorescence in many other reef animals, including fish, shrimp, crabs, mantis shrimp, bristle worms and more. In many cases there is no idea what is doing the fluorescing.

Simply put, fluorescence is the term used to describe the absorption of light at one wavelength and its emission at another wavelength. In the case of marine life, the exciting light can have wavelengths in a wide range between (invisible) ultraviolet and (visible) blue, and the wavelengths of the emitted light are usually blue, green, orange and red, depending on the specific protein the organism produces.

When an organism is being "hit" with higher energy light (relatively) in the 450–470 nm (dark blue) wavelength range, lower energy light (relatively) in the green, yellow and red portion of the spectrum is being emitted.

Note that fluorescence is different from phosphorescence (after excitation, light is emitted over a longer period of time) and luminescence (some marine organisms actively produce their own light using certain enzymes or symbiotic bacteria).

Modern scientific research shows that many fish, even deep-sea fish, can actually see red light. One wonders why, since there is no red light at these depths. It has been found that underwater organisms actually use fluorescence to transform the only light available to them, namely ultraviolet (black light) and blue light, into visible light of longer wavelengths, such as red, among others, for a number of purposes.

Besides protecting themselves from the harmful effects of ultraviolet radiation, as a kind of sunscreen, corals seem to do this in order to feed their symbiotic algae, which live inside their tissues. This allows the corals to dwell at greater depths, where corals without this capability are unable to thrive.

Recent discoveries seem to suggest that fish also use fluorescence, in order not to be easily discernible from the background of fluorescing corals, which otherwise would make them easy prey, and in order to communicate between each other (within the same species), at least at short distances.

Fluorescence diving (or snorkeling) is not an exclusive or highly expensive way to see marine life in a new light, literally. All that is required is some specialized equipment if night diving is going to be an activity. Some dive centers have also started offering equipment for rental and PADI now offers the Fluorescence Night Diver Specialty course written by Lynn Miner, a pioneer in the development of manufactured fluorescence gear.

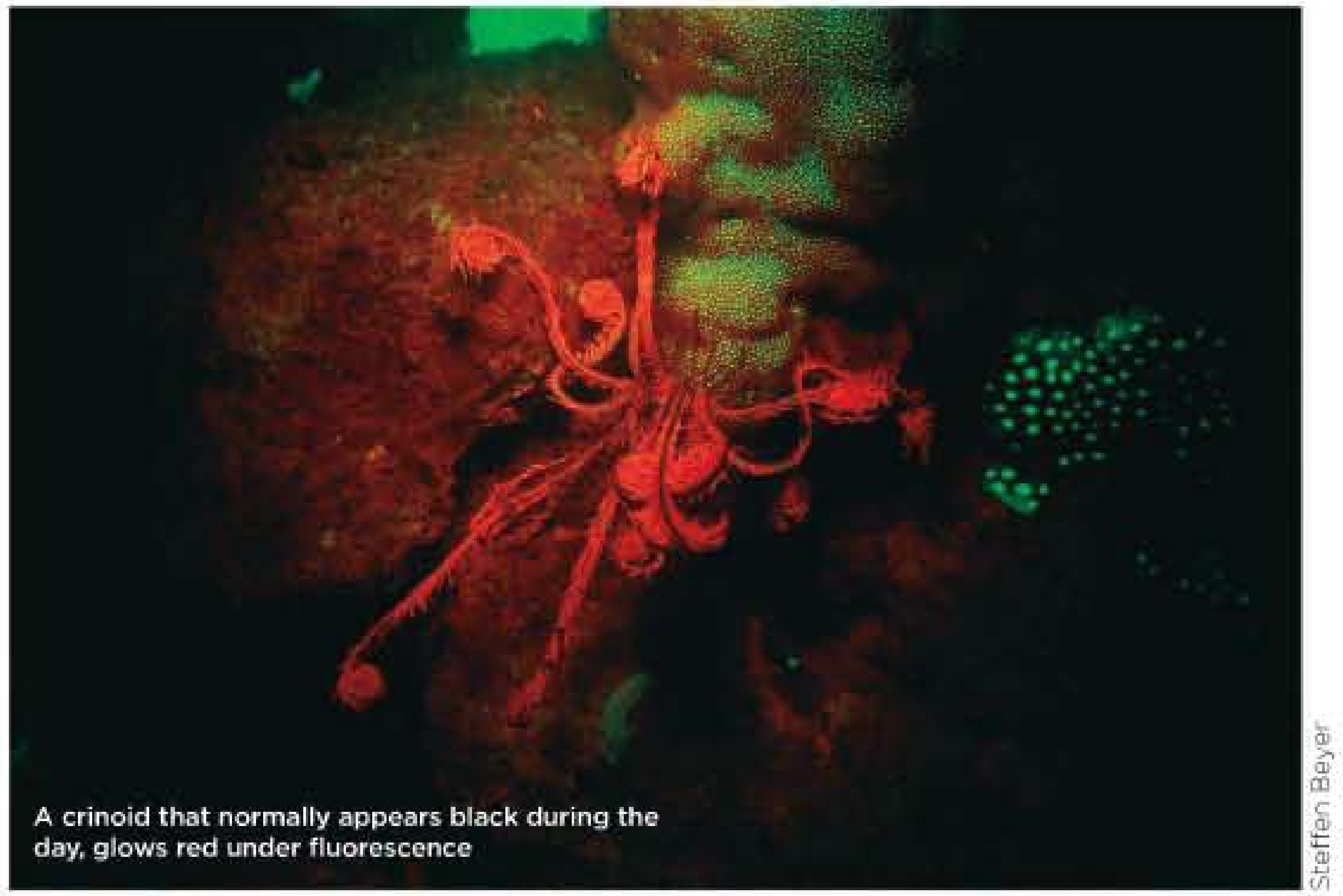
What are some of the types of equipment used? Firstly, it's important to have a torch or flashlight with an LED that emits light in the 450-470nm wavelength range. This is usually referred to as royal blue or actinic light, which aquarists will already be familiar with. Additionally, some fluo flashlights include a dichroic filter (excitation filter)to further enhance the imaging experience.

A dichroic filter, or interference filter, is a very accurate color filter used to selectively pass light of a small range of colors, while reflecting all other colors and is a vital part of the equipment.

As Dr. Mazel explains, "You can certainly see fluorescence under actinics. but with actinics you don't get the full effect. The problem is that when you look at your aquarium with just the actinics on, you are observing both the fluorescence and the reflected light from the actinics. Reflection is a completely different process than fluorescence, and it is the reflection mixing with the fluorescence that hides the true fluorescent effect."

You will also need a barrier (yellow) filter to go over your facemask. This is an essential piece of equipment that serves two purposes: it blocks the intense blue light that causes the fluorescence effects in the marine creature from entering into your eyes. This blue light can cause your eyes to burn and become irritated after a short period of time making the dive very unpleasant.

The blue light is also much brighter than the emitted fluorescence given off by the organism, so the colors you are looking to observe are overwhelmed and washed out by it.



A crinoid that normally appears black during the day, glows red under fluorescence

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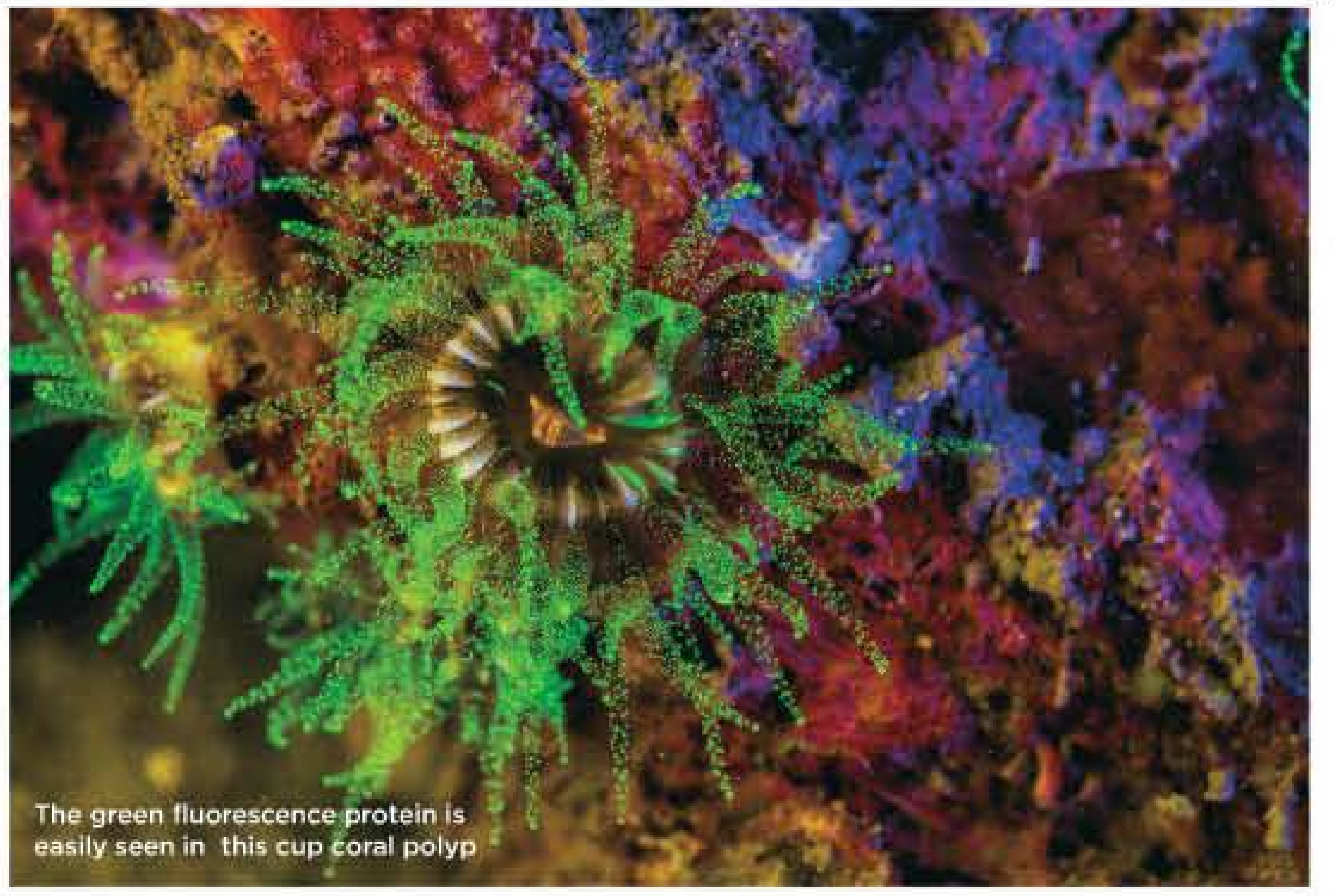

The green fluorescence protein is easily seen in this cup coral polyp

Some animals emit stronger green fluorescence like this anemone in the Philippines

Ties Lahlali

Coral polyps under white light

The appearance of coral polyps with blue light passing through a dichroic filter

A camera set-up with dichroic filters fitted onto the strobes, a focusing blue light with dichroic filter and a yellow barrier screwed onto the macro lens

A typical set-up for fluorescence diving or snorkeling —yellow barrier over the mask and blue light flashlight

The barrier filter solves both of these problems by "cutting off" the wavelengths (colors) of light just above the blue portion of the visible spectrum. It is important to remember that the mask filter can be "tilted up" or removed to enhance your seeing for orientation, navigation, problem solving, etc.

Underwater photographers can capture fluorescence by adding dichroic filters to their strobes. This produces the blue light necessary for fluorescence excitation. These filters can be easily removed for white light photography. In addition, a yellow barrier filter must go over the lens. There are two options for this—one is to screw the filter onto the lens before putting the camera into the houisng. Unfortunately, with this option, white-light photography is not possible since all resulting images will be yellow.

The other option is to add an external yellow barrier over the macro port. This can be easily removed for regular white-light photography.

Fluorescence can be a fairly weak effect and with the addition of the dichroic filters onto the strobe, this can reduce light output significantly. To overcome this, strobes should be set to full and aperture adjusted for any overexposure.

Edge lighting simply will not work here. Strobes should be pointed toward the subject and as close as possible. An ISO setting of 400 is recommended as a good starting point and can be increased if needed.

Camera focusing can be a major problem because of the lack of white light to assist the camera in locking onto the subject. A focus light, fitted with blue LEDs and dichroic filter is highly recommended.

For land fluorescence photography, a dichroic filter fitted onto a flash head adapter, a safety glasses with yellow lens as the barrier and a blue light flashlight is needed

Glowing polyps of a finger coral

Underwater videography can be achieved with great results by using the Light and Motion Sola NightSea video light. It is fitted with royal blue lights and a dichroic filter, and has a very wide beam angle.

It should be noted that fluorescence photography need not be a nighttime event. Fluorescence photography is conventionally done in the dark because fluorescence emission tends to be weak and is easily overwhelmed by ambient light. But darkness is not necessary—with the right equipment and techniques, you can take fluorescence photographs with moderate levels of ambient light.

According to Dr. Mazel, daytime fluorescene photography can easily be achieved with modern digital cameras. The trick lies in relative exposures. Underexpose for ambient light and properly expose for the fluorescence part of the image. If properly balanced, the result will look as though the ambient light wasn't even there.

Fluorescence photography can also be achieved out of the water. Lots of plants and animals exhibit fluorescence on land. The equipment needed is a yellow barrier filter for the macro lens, a dichroic filter fitted onto a flash head adapter and a safety glasses with yellow lens as the barrier.

I have started offering purchase of fluorescence equipment to anyone who wants a different view of the nighttime world, on land or underwater. You could be a snorkeler, certifed diver who loves to travel or even a photographer, wanting to capture special images—the investment can range from a couple hundred dollars to much more, depending on the set-up.

Please visit: www.fluorodive.com to learn more and I'll guide you accordingly.

Glowing tentacles of open star coral polyps

While green is the typical color for fluorescence, some corals also fluoresce other colors like red, due to different proteins