Fluorescent Diving

by Lynn Miner

Fluo night diving is diving with a blue light torch and mask barrier filter for viewing bio-fluorescence. It has been on the scene for a few years now but it's not just for night dives any longer. This article discusses fluo diving science and also covers how to do it in daylight conditions.

Fluorescence is the property of some marine life to emit light of a longer wavelength (of visible light) when illuminated with shorter wavelength blue light. Not all marine creatures exhibit this effect but in those that do, the sight can be stunning.

This is NOT reflected light such as when you take your white light torch on a night dive. That "white light" is reflected off the reef and bounces back to your eyes/ camera. Emission light, is light the organism is creating and "emitting" back to you.

The visible spectrum of light is the thin slice of the electromagnetic spectrum visible to the eye. It lies between the low energy, low frequency, extremely long wavelength radio waves and the high energy, high frequency, extremely short wavelength X-Rays. The "bandwidth" of light wavelengths the average person can see covers from approximately 400 nanometers (nm) which is deep purple to about 750 nm dark red.

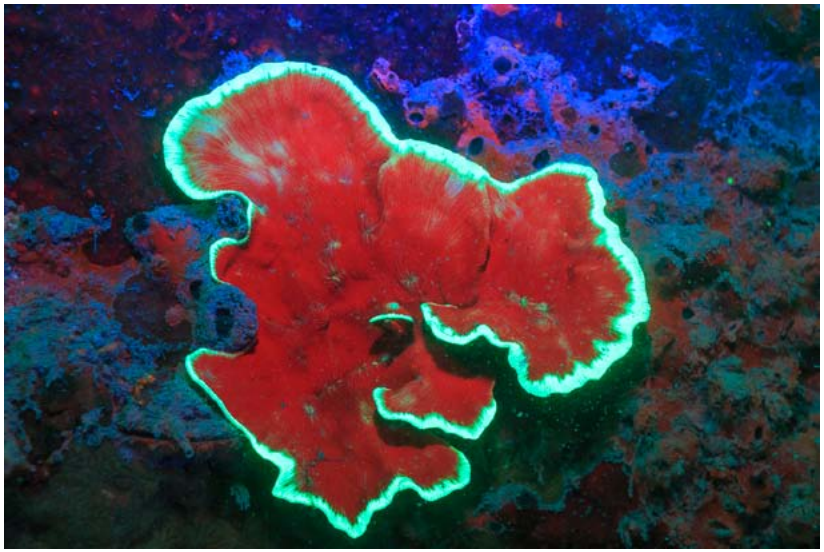
When a high energy, short wavelength photon of light (blue in our case) strikes a protein (referred to generically as a Green Fluorescent Protein - GFP), it absorbs that light energy. This causes the electrons of its constituent atoms to make a quantum jump from one electron shell to a higher shell. Then this change of energy state "decays" (effectively instantly) back to its quiescent resting state or shell.

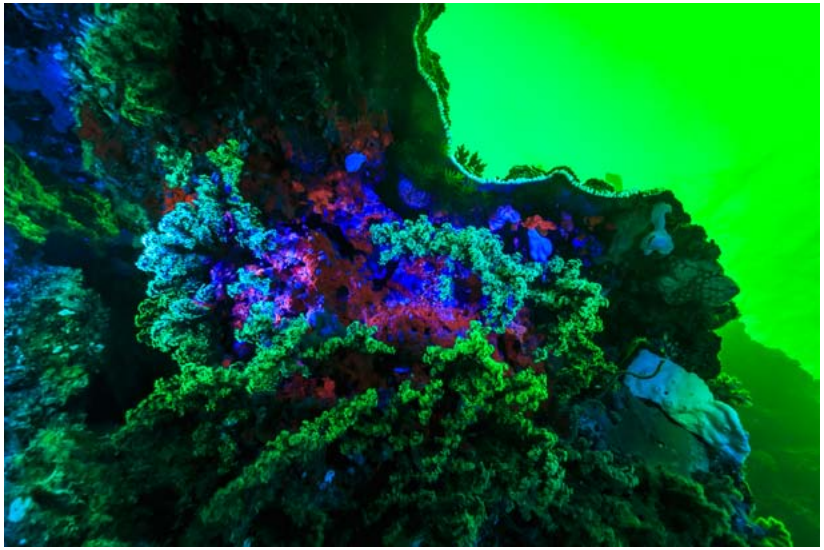
When this decay occurs, the electron gives up "emits" a photon of light but at a lower energy and longer wavelength. It also emits a minuscule amount of heat, hence the lower energy state of the photon. It's called conservation of energy – it must all balance out. This change in wavelength is referred to as the Stokes Shift named after the Geo. Stokes, the Irish Physicist who discovered it in the 1830's. This concept is shown again in the figure below. We are actually talking about quantum mechanics here.

Each step, represents a quantum leap from one shell to the next. There are no intermediate steps or jumps. The further the jump, the greater energy required and the great the difference in wavelength when the electron decays. These differences in energy manifest as different colors.

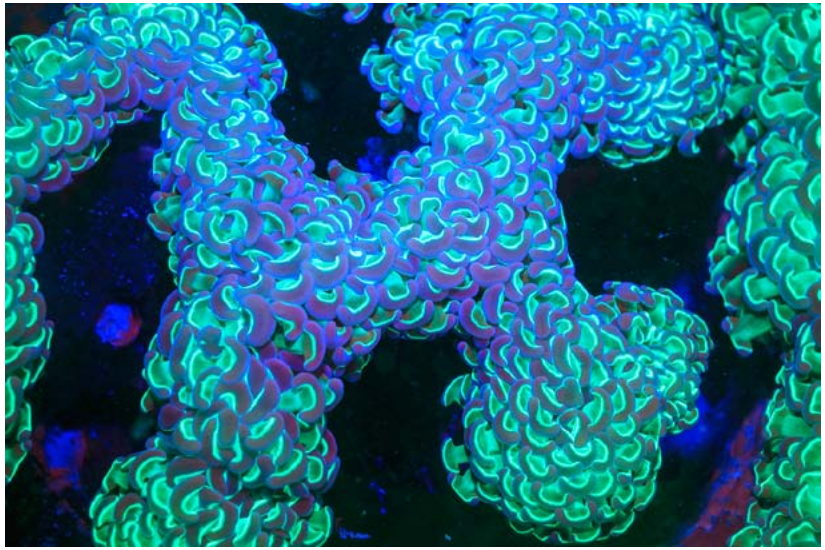
The wavelength of light used in most fluo torches is a narrow band in the blue, somewhere (manufacturer specific) from 440-480nm. It has been discovered that blue

All Day Fluorescing Sheet Coral macro detail, New Dropoff, Palau – FireDiveGear (FDG) TL Azur Focus light with a single S&S YS-D1 strobe with FDG excitation filter and FDG camera barrier filter. Canon EOS Rebel T4i, Sea and Sea Housing. ©Lynn Miner2015 Tokina AT-X M35 Pro DX 35mm f2.8 Macro lens, ISO 800, f/7.1 1/100





All Day Fluorescing, encrusting corals and sponges among soft corals, under a ledge New Dropoff – FireDiveGear (FDG) TL Azur Focus light, 2 Ikelite 161 substrobes with FDG excitation filter and FDG lens barrier filter, Canon EOS 5D Mk III camera body, Ikelite Housing. ©Stuart Westmorland2015 Canon EF 17-40mm f4L zoom lens at 17mm, ISO 1600, 1/45 at f/11



Soft Coral (Eupyllia ancora) macro detail, New Dropoff, Palau. FireDiveGear (FDG) TL Azur Focus light with a single S&S YS-D1 strobe with FDG excitation filter and FDG camera barrier filter. Canon EOS Rebel T4i, Sea and Sea Housing. ©Lynn Miner2015 Tokina AT-X M35 Pro DX 35mm f2.8 Macro lens, ISO 800, f/7.1 1/100

light is much more efficient in stimulating fluorescence of Green Fluorescent Protein (GFP) and it's mutations than ultraviolet light. The reason is that (as we all know from our Beginner Open Water Course), the only light available at depths beyond about 10 meters / 30 feet is blue. This is the light organisms such as coral have evolved in over the eons.

It is not well understood why some corals and other sea creatures evolved to fluoresce. What is known is that some marine organisms (such as corals, tunicates, barnacles, sponges, anemones, jellyfish, clams, nudibranchs, cephalopods, shrimp, crabs, worms, fish) produce GFP and mutations of GFP (other colors than green) which react to blue light causing this effect.

Many theories abound as to why marine fluorescence evolved and is a very active area of scientific research. Perhaps the most obvious answer to this question is that they simply do because they are made up of elements that display the fluorescence effect. This may seem confusing but consider this: human teeth fluoresce as do the teeth of nearly all animals. What possible evolutionary pressure could be at work here? The answer is that teeth are made up of elements that fluoresce. It may be just that simple.

As detailed above, you need a blue light torch. Additionally you need a barrier filter for your mask (and for your camera if you are doing photography). What this barrier filter does is "block" the blue light that is reflected back to you from everything you shine it on. Without the barrier filter, all you will see is very bright blue everywhere. The barrier filters are designed to "cutoff" all or most of the wavelengths in the blue part of the spectrum. The intensity of the emission light from the organism is very diminutive. So dim in fact that it is completely overwhelmed by the blue light. Therefore, when you block the blue, all you will see are the emission colors.

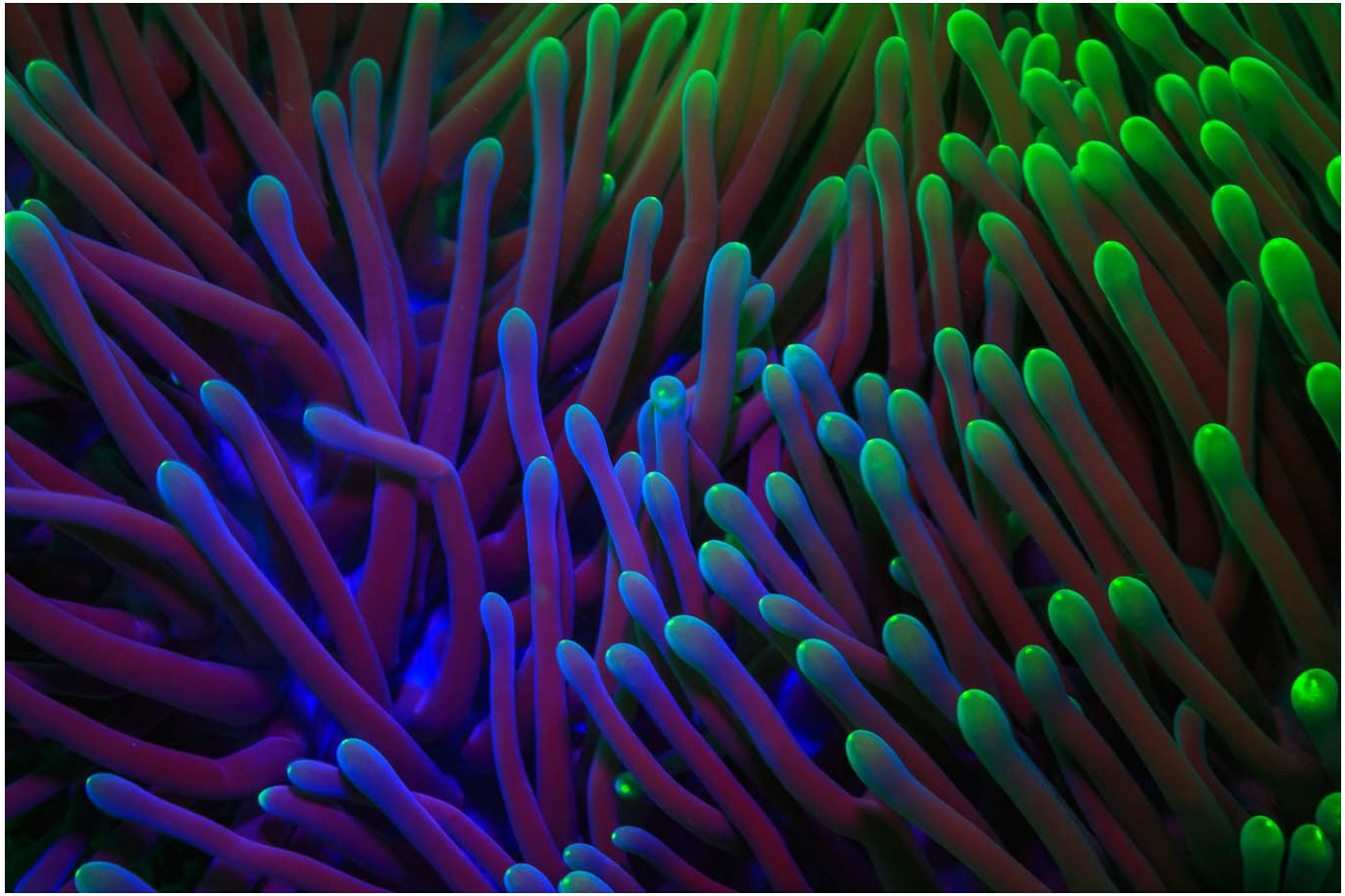
There are many barrier filters available. The most common is a Tiffen # 12. Some use a Tiffen #8. Neither of these will provide the subtle blue backgrounds that are a feature of the custom engineered filters from sources such as FireDiveGear.com. The Tiffen series filters were actually the industry standard Wratten designations from years past and were designed for contrast enhancements for B&W film. This technology dates back to the 1920's. These filters were never intended for color correction/bandpass limiting applications. The proper barrier filter will make all the difference in the world.

There are safety concerns of fluorescence diving at night. With white

light all the colors of the spectrum are available for you to "see". Remember, in fluo diving the ONLY light you are using is a very narrow band in the blue. Now, put on your blue barrier filter and what's left? Effectively nothing! You just eliminated your light source. You therefore must exercise excellent buoyancy control, be constantly aware of your surroundings and be situationally aware.

Many people think that fluo diving is done just to see the brilliant radiant colors for their "WOW" factor or for a different take on underwater photography. It certainly is all of that and it can indeed be a life changing experience for some people. I've had students surface after their first fluo dive so emotional that they are brought to tears by the overwhelming beauty of the hidden world inside a hidden world. Many people have described it as an underwater version of the motion picture Avatar. But it is much more than that. Fluo diving has become an indispensable tool in coral health research, coral propagation census (polyp bail-out) analysis. If you come upon a polyp or coral "recruit" release with white light, you will see nothing. With the proper fluo diving gear, the individual, nearly-microscopic organisms will shine in the sand like sparkles in the snow on a moonlit night. It is amazing to witness. We at FireDiveGear.com produce torches, strobe filters and barrier filters for some of the most prestigious marine institutes and universities on earth doing climate change work on coral structures.

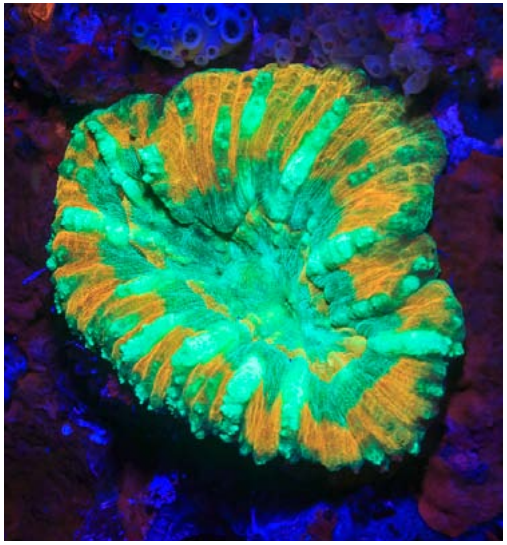
Doing fluo photography in daylight is possible with strong excitation lights and the proper ambient lighting conditions. On a recent trip to Palau, Stuart Westmorland and I did a series of experiments to exploit this. As noted above, there are some safety concerns when doing this at night. During daylight



All Day Fluorescing – FireDiveGear (FDG) TL Azur Focus light with a single S&S YS-D1 strobe with FDG excitation filter and FDG camera barrier filter. Canon EOS Rebel T4i, Sea and Sea Housing. ©Lynn Miner2015 Tokina AT-X M35 Pro DX 35mm f2.8 Macro lens, ISO 800, f/14 1/100

condition, there are no concerns what-so-ever. Doing this work in daylight is much easier and you can get spectacular results.

First it's best to have cloudy skies (but not required). Next look for a wall or overhang structure in the shadows. Obviously it's best to have the sun on the back side of the structure so as not to be directly illuminating the wall. You can work around this also if the target is in a "pocket" or "hole" in the wall or tucked up under an overhang. It's best to use a strong excitation/focus light. This allows you to actually find a subject that fluoresces nicely and allows for plenty of light for the camera to adjust focus whether using manual or auto focus. If your excitation torch is powerful enough, you can get some great shots just using that. However, it often requires relatively slow shutter speeds and near wide open apertures which complicate things



Flower Coral macro detail, Freighter WWII Wreck Iro ©Lynn Miner2015 Tokina AT-X M35 Pro DX 35mm f2.8 Macro lens, ISO 800, f/11 1/100

Set up for macro

with movement and poor depth of field. On the other hand, strobes with the appropriate excitation filters will do very well and solve both of those issues.

PADI has a Fluorescence Night Diver Distinctive Specialty Course that I wrote. There are several dozen certified instructors around the world teaching this course. It covers the science in much greater detail and has a great emphasis on the safety implications unique to fluo diving. A version for SSI is in the works also.

The web is a great resource for more information on this topic. Simply search on the term "fluo dive gear" to find several vendors of equipment, blogs, images and forum discussions on this fascinating subject.

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www.firedivegear.com