PHOTOESSAY

Biophoton Images of Plants: Revealing the Light Within

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Top: Chlorophyll fluorescence image of cut geranium leaf in complete darkness (1-minute exposure). Bottom: Biophoton image begun after 5 hours in complete darkness (120-minute exposure).

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Everything glows. Photons are continuously emitted and absorbed by all matter. Light emissions can reveal the state of being of all living systems. Highly sensitive optical instruments are able to detect and measure what our eyes cannot see.

Biofields are energy fields that surround and penetrate all living organisms (Hintz et al., 2003; Rubik, 2002). These fields provide information about a living system. Imaging these fields with highly sensitive cameras, it is possible to reveal biofields by measuring the photon emission (biophotons). Utilizing charge-coupled device (CCD) camera technology originally developed for astronomical imaging capable of looking back to the beginning of the universe, we can make the seemingly invisible, visible. Highly sensitive low-light level imaging systems can aid in our understanding of how living systems function and communicate with light.

Biophoton emission is a type of biologic chemiluminescence in which photons are emitted as part of chemical reactions occurring during metabolic processes. This radiation is not stimulated by chemical or optical markers. It exists in all living organisms and persists at a steady-state level as part of living metabolic processes and has been measured in all types of plant, animal, and human cells. This radiation is strongly correlated with cellular function (as first noted by Gurwitsch in 1925) and state of health (Van Wijk et al., 1992). Unhealthy, stressed, and injured cells emit more photons than healthy cells.

Much of the research on biophoton emission has utilized plants. When a plant is placed in darkness, the chlorophyll fluoresces for a few minutes. After this fluorescence decays, there is an ultraweak emission present. Published studies indicate that biologic processes increasing oxidative metabolism producing singlet oxygen and other oxygen-related free radicals correlate with measured biophoton emission (Hideg, 1993; Salin and Bridges, 1981). Some recent theories consider the possibility that this radiation helps regulate bio-

**FIG. 1.** Left: White light image (10 millisecond exposure). Middle: Chlorophyll fluorescence image in darkness (1-minute exposure). Right: Biophoton image in darkness (10-minute exposure). Clockwise from left in photo on right: Boston fern, coleus, geranium, cabbage, purple sage.

**FIG. 2.** Left: Chlorophyll fluorescence image in darkness (1-minute exposure). Middle: Long exposure biophoton images begun after 4 1/2 hours in darkness, and (right): 22 hours in darkness.
logic and biochemical functions within and between cells (Van Wijk, 2001). Other researchers postulate that biophoton emission may be a potential mechanism responsible for intra- and intercellular communication (Popp, 1999).

Research on biophoton phenomena has primarily utilized very sensitive single-point detectors called photomultiplier tubes (PMTs). These detectors are capable of counting individual photons but they do not provide an image. A few studies have utilized low-resolution, low-noise imaging sensors. Now the technology is available to make images in which each picture element (pixel) captures only a few photons. These highly sensitive cameras require that the sensor be cooled to on the order of $-80^\circ\text{C}$ or colder. Cooling a sensor reduces the dark current—a noise inherent to the detection process—thereby increasing the signal-to-noise ratio.

The camera we used to take the images in this paper is a Princeton Instruments VersArray 1300B made by Roper Scientific (Tucson, AZ). The images were taken with the sensor cryogenically cooled to temperatures between $-90^\circ\text{C}$ and $-130^\circ\text{C}$. The array has $1300 \times 1340$ pixels. Pixels can be grouped together (binned) to provide larger, more-sensitive pixels.

The camera is mounted on a light tight chamber keeping the contents in total darkness. A standard Nikon 35-mm lens (Melville, NY) was used to image the leaves onto the sensor. The camera measures radiation in the visible and near-infrared range from approximately 350 nm to 1050 nm. Each biophoton image requires an exposure time lasting minutes.

The image at the beginning of this paper shows images of a cut geranium leaf. To the naked eye this leaf was green with yellow areas and brown edges. The top black-and-white image is a 1-minute exposure taken right after the leaf was placed in total darkness. The edges of the leaf were brown and did not fluoresce. The bottom image shows a 2-hour exposure taken after the leaves had been in darkness for 5 hours. The bright spots are the result of stray high-frequency radiation in the range of gamma and cosmic rays. The longer the exposure, the more stray radiation is present. This image shows that, even after many hours in the dark, plants continue to glow. Note how much detail can be seen in the leaves and around the edges. The brown edges glow less (i.e., are darker) than the yellow and green areas (shown here in black and white). The brightest areas of the leaf correspond to yellow areas (shown in black and white).

Multiple different kinds of leaves produce this effect as can be seen in Figure 1. Five different kinds of leaves are shown. The Boston fern fluoresces the most (brightest in the black-and-white image here), while the geranium has the most biophoton emission of this group. To the naked eye the coleus is green with red veins. Note that the green areas (shown here in black and white) emit more biophotons (i.e., are brighter) than the red veins (shown in black and white).

Much information about a patient’s state of health and response to injury can be gleaned by monitoring biophoton emission over time (Creath and Schwartz, 2003a,b). Figure 2 shows a number of geranium leaves. From the fluorescence image damaged areas of the leaves are obvious. The gray scales of the right image have been scaled to be approximately twice those of the middle image. Note the shift in areas where the relative biophoton activity is greatest. Areas along the edges of the lower leaves where there was more activity produce fewer photons as the leaves dry out.

Research in biophoton phenomena pulls together multiple disciplines. There are many opportunities for researchers to understand the nature and function of this radiation better. The potential applications in energy medicine research range from basic science experiments measuring the effectiveness of healers on biological systems such as plants to measuring the light emitted from healers’ hands to measuring therapeutic effects in patients. Light holds an important key in our understanding of biofields and the dynamics of energy within a biosystem. Images like these give us a window into a seemingly invisible part of the mystery of light and life. We are only beginning to see the light within.

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**REFERENCES**


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