SPEX Fluorescence Group

APPLICATION NOTES

F-17

Fluorescent Pigments in Living Coral

Introduction

The brightly-colored coral reefs that make scuba-diving and snorkeling so enjoyable when vacationers stay in the Caribbean or South Pacific are essential to the survival of many species of fish and underwater life. Not only do the reefs offer a haven for smaller fish to hide from the larger predators, but also some fish actually survive by eating the reefs themselves. Reefs offer protection to plants and animals from the ravages of waves and ocean currents. Thus, when the reefs die, so do many other living creatures.

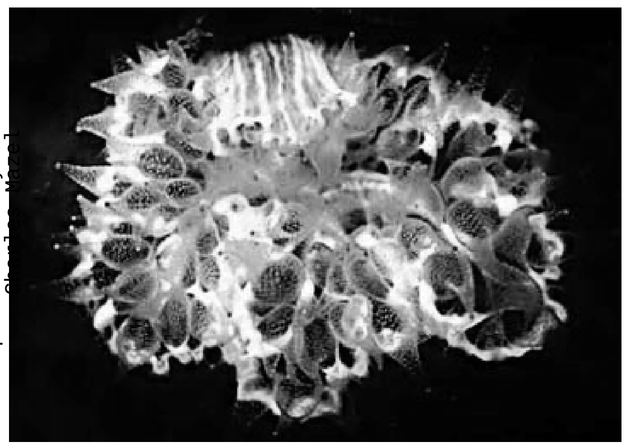

photo courtesy of Dr. Charles Mazel

When Dr. Charles Mazel of Physical Sciences (Andover, Massachusetts) decided that his research required him to make fluorescence measurements in the field, he began searching for the right instrument. Because his field was the ocean and his specimens were live coral, the instrument would have to be transportable and capable of withstanding the pitch and yaw unavoidable aboard a ship, for Dr. Mazel did not need seasick instruments. Furthermore, his samples had special requirements in order to produce usable results:

- The samples might be sensitive to photodamage, and so could not be subjected to prolonged exposure to excitation radiation.
- The samples were scattered over many different sites, so the instrument would be required to endure prolonged periods without service. Set-up of the system had to be easy.
- The fluorescence of the coral could be dependent upon environmental factors such as seawater composition and temperature, so the perturbation of the corals' surroundings had to be kept to a minimum.

Dr. Mazel found the instrument he needed when he contacted JY Horiba. The fast scan-rate of the SPEX® FLUOROMAX® spectrofluorometer, as well as its unmatched sensitivity, allows samples to be measured faster than any other instrument without degrading data quality. Not only was the FLUOROMAX® rugged enough to endure shipboard life and operate as long as 1200 hours between lamp replacements, but we agreed to fit it with custom tie-downs to protect it from damage from rogue waves. Finally, a fiber-optic probe accessory let Dr. Mazel measure the corals' fluorescence while they sat comfortable in a familiar bath of warm, flowing seawater.

Dr. Mazel is interested in the phenomenon of coral fluorescence: not just from chlorophyll in symbiotic algae, but also the intense, multi-hued glow from pigments in the animals' tissues themselves. How many pigments are there? What are their spectral characteristics? What role do they play in coral physiology? Is the fluorescence an indicator of coral health?

To this end, Dr. Mazel assembled a library of spectral signatures, characterizing the excitation and emission spectra of different corals in vivo and non-destructively. His FLUOROMAX® has traveled to ship- and shore-based sites to study fragile corals in the Bahamas and Dry Tortugas.

Experimental

Dr. Mazel, a scuba-diver, collected specimens and maintained them in a tank of flowing seawater. Through a fiber-optic probe 2 m long, the resultant fluorescence spectra were collected. For the excitation spectra, emission wavelengths of 490, 530, 590, and 690 nm were used, the bandpass = 2 nm, and integration time = 0.2 s; for the emission spectra, excitation wavelengths of 365, 450, and 488 nm were used, the bandpass = 2 nm, and the integration time = 0.5 s.

Results and Conclusions

The research to date indicated that just four autofluorescent pigments contributed to the observed fluorescence from coral. The four pigments fluoresced with peak wavelengths near 486, 515, 575, and 685 nm, respectively (Figures 1 through 4). Chlorophyll (λ_{max} = 685 nm) was found in all specimens.[1]

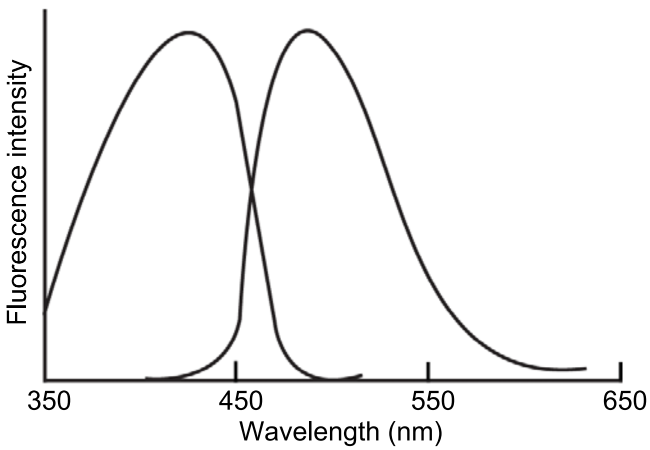

Figure 1. Excitation and emission spectra for *Agaricia* coral (λ_{max} = 486 nm).

Besides providing insight into the mechanisms of photosynthesis and a possible monitor of reef stability through bleaching, these spectra also serve as a catalog of coral identity to help distinguish between specific types of coral.

Acknowledgement

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[1] Mazel, C.H. In *Ocean Optics XIII*; Ackleson, S.G., Frouin, R., Eds; Proc. SPIE 2963, 1997, pp 240–245.

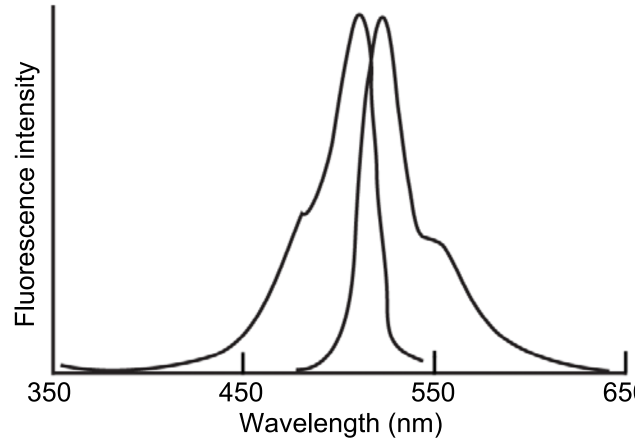

Figure 2. Excitation and emission spectra for *Mycetophyllia lamarckiana* coral (λ_{max} = 515 nm).

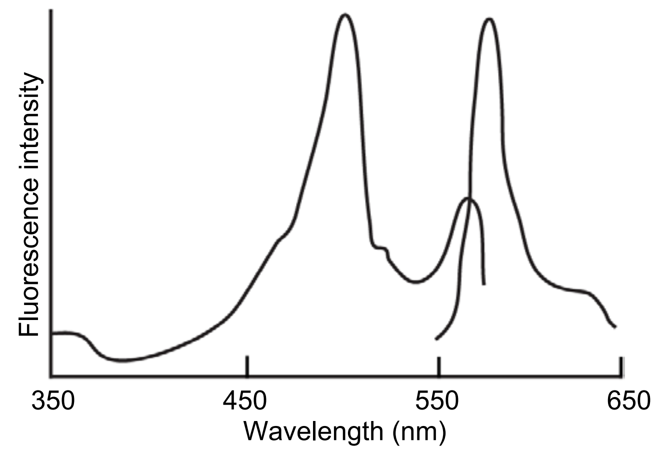

Figure 3. Excitation and emission spectra for *Montastrea cavernosa* coral (λ_{max} = 575 nm).

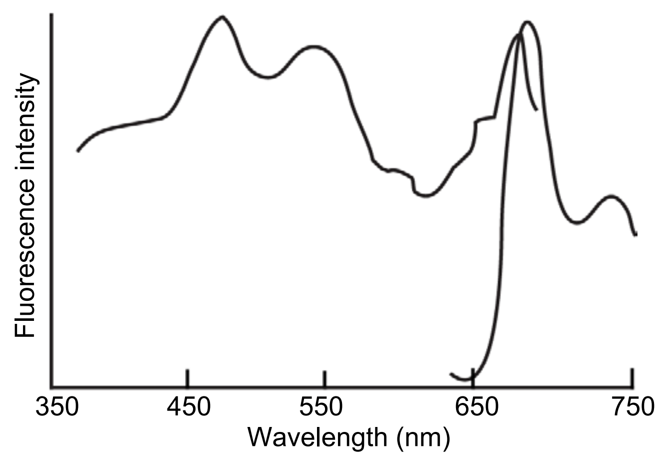

Figure 4. Excitation and emission spectra for *Montastrea annualaris* coral (λ_{max} = 685 nm).