Living light quest: 40 years of research…what did I learn?

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I work since 1981 in the laboratory of animal physiology of Prof Baguet at the Catholic University of Louvain where I studied the oxygen consumption and control mechanism of bioluminescence in isolated luminous organs of fish during my master and my Ph.D. degree. After a post-doc stay at the University of Montreal in Canada (Prof. M. Anctil Laboratory), I started a research program to study the possible conservation of bioluminescence control mechanisms through evolution: the study of luminous echinoderms was initiated as the first step in this new program. Comparison of control mechanisms in fishes and echinoderms as well as within other marine invertebrates phyla (such as Cnidarians, Ctenophora, Worms, Crustaceans, Molluscs...) highlighted possible evolutionary convergences in the wide diversity of the phenomenon.

During my research formation (master and PhD) I studied the oxygen consumption of isolated photophores of the epipelagic fish (*Porichthys notatus* and *P. myriaster*) then make a comparison with mesopelagic fishes from the strait of Messina in Sicily (*Argyropelecus hemigymnus, Maurolicus muelleri, Chauliodus sloani,…*). I was able to demonstrate that oxidative metabolism of the light organ did change during adrenergic-induced light emission: while the light organ of epipelagic fishes showed an increase of O2 consumption those of mesopelagic ones decreased by 20% in average. Recent works on mesopelagic fishes highlighted the importance of nitric oxide (NO) modulation in luminous teleost fish. Works on biochemistry allowed to demonstrate the widespread of coelenterazine in luminous mesopelagic fish during a research stain Dr O? shimomura's laboratory in Woods Hole.

Since 1990, a pluridisciplinary study of a small cosmopolitan echinoderm, the ophiuroid *Amphipholis squamata*, allowed describing the morphological, physiological, and ecological basis of the luminous phenomenon in this species. This work was achieved through national and international collaborations (Italy, France, UK, USA). A comparative study of bioluminescence control, developed in other ophiuroid species, revealed differences in mechanisms within this echinoderm class, calcium requirement might represent a common key point in all photogenesis studied so far in ophiuroids. This research program was possible through national and international collaborations (Italy, France, UK, Sweden, USA, Australia, New Zealand). Access to deep-sea cruises boosted our knowledge of echinoderms luminescence, more than 50 new luminous species of ophiuroids, while 11 seastars, 9 holothuroids, and 4 deep-sea crinoids must be added to the list of bioluminescent organisms.

Amphiura filiformis was the second main ophiuroid species model we investigated and results obtained in pharmacology, morphology but also in transcriptomic analysis revealed not only the diversity of control but open ways to new research into origin of luminous system in this species. With Dr. O Shimomura we found the presence of coelenterazine and tried to isolated a specific luciferase without purification success. One of my PhD student found in the A filiformis transcriptome multiple copy of a Renilla-like luciferase gene what suggested that luciferase are not species-specific as originally thought.

No doubt other species are still unknown and effort will be done to better understand control, function, biochemistry as well as geographical and phylogenetical distribution of bioluminescence in the Echinoderm phylum.

In 2007, a new research program on luminous sharks, using *Etmopterus spinax*, as model species, has been developed with the discovery of a hormonal control mechanism. Numerous modulations have been discovered. Comparative studies of other luminous shark species and researches using immunohistochemistry, western blot, molecular approaches led to a new control mechanism of shark's luminescence relying on light emission and extraocular perception. These researches were possible through national and international collaborations (Norway, Australia, Taiwan, Japan, and New Zealand). Light emission in sharks seems to be mainly used for camouflage by countershading (isolume follower hypothesis) but also for defense by aposematic signaling, reproduction as well as schooling. Recently a third luminous family of squaliform shark was documented. The development of new experiments in physiology , ethology and molecular domain will highlight the mystery of the elusive deep-sea luminous sharks. After 14 years of study, we have made breakthroughs in the origin and evolution of shark bioluminescence. We continue our research.

During those years I had the chance to observe luminous species from other phyla and some of them attracted my attention among which *(i)* pelagic worms from the genus *Tomopteris; (ii)* the krill, *Meganictiphanes norvegica*, but also some octocorals from the Mediterranean sea and Northern Skaggerack.

Key results will be presented to be followed by an open general discussion. The current crisis, we are going through, is pushing us towards less contact but I am convinced that science is rich of collaboration and not of competition. Learn to communicate, to trust the experts who want to help you have a glowing future. Always look at the bright side of life.

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