

Bioluminescence : when the organism is able to make its own light

(ii) **Bioluminescence** : when the light is made by symbiotic bacteria. Bioluminescence is the creation of a spontaneous exergonic chemical reaction involving the oxidation of a Lucifer in catalyzed by a luciferase which produces a transitory excited state that naturally relaxes by producing a photon with oxyluciferin as the final product [2].

Luminous capability is mainly seen in specific types of bacterium, cnidarians, echinoderms, and sponges and often exists in from coastal, shallow waters to the deep abyss. Luminous creatures found in the 200-1000 m depth in mesopelagic zone. Luminous systems have either separate components of luciferase and Lucifer in or a composite molecule called “photo protein” that contains a peroxidase Lucifer in and a luciferase activity. Luciferins are found across a wide range of taxa, whereas luciferases are assumed to be species-specific.

Despite the fact that studies of shark luminescence have been documented for over two centuries shark luminescence research has, with detailed phylogenetical, ecological, and physiological studies now available for numerous species, this article is providing view of shark luminescence [3,4].

Distribution of Bioluminescence in Sharks : In cartilaginous fishes, only sharks have evolved the ability to emit light. Bioluminescence in sharks appears restricted to Squaliformes, for now, only these three families *Dalatiidae*, *Somniosidae*, and *Etmopteridae* have luminescent ability. Indeed, although bioluminescence has once been suggested for the specific supralabial white band of the mega mouth shark, *Megachasma pelagios*, but this is a form of symbiosis relationship and cannot be true bioluminescence.

Fossil studies estimate the *Etmopteridae* are evolved around 90

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Even though, shark photophores are mostly situated on the ventral surface area and produce a light that has a color (wavelength) that is alike to that found in coastal. Even though, shark photophores are mostly situated on the ventral surface area (Figure 1) and produce a light that has a color (wavelength) that is alike to that found in coastal which are blue-green and oceanic blue environments (Table 1).

Some etmopterid species living in the same deep environment have greater swimming speeds and muscular enzymatic processes than their non-luminous cousins, according to studies [10, 11]. *Somniosidae* and *Dalatiidae* produce “simple” luminous patterns on the ventral surface of etmopterid sharks, complex luminous photophore aggregations can be seen, as well as on the snouts, fins, tail, around the eyes, spiracles, gills and the epidermal tissue covering dorsal spines [12-14] (Figure 2).

Because photophores cover male claspers of all species, luminescence could be employed as a mating aid, allowing males to detect females from afar. Visualize their cloaca and pectoral fins (etmopterid’s are brighter) the fourth luminescence function is aposematism, which is a method by which an animal uses warning light patterns to frighten predators away. They trick the predators by the light patterns to make them think they are poisonous thus saving their life.

Etmopterid sharks (contrary to *dalatiid* and *somniosid* species) have large sharp defensive spines connected with their dorsal fins which also have luminous capability (*E. spinax*) it can occur because of the tissue around the spikes which has photophores acting as a warning sign to predators [15]. Etmopterid and dalatiid sharks show a unique set of physical changes (in the eyes) which is not found in non-

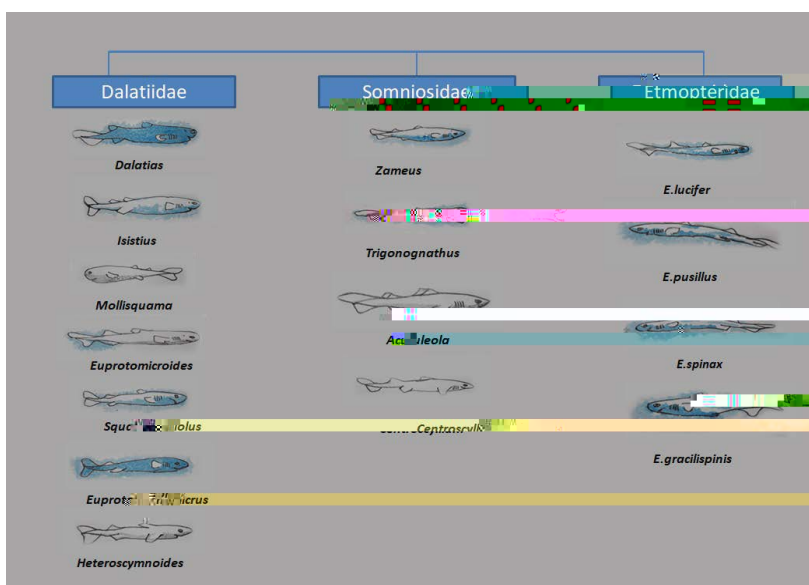


Figure 1: Bioluminescent Shark species list in



luminous species. It seems that when bioluminescence evolved in these sharks that live in the deep, their eyesight coevolved with the ability to produce light. This may help in better vision in the murky depths and may also help in finding prey a mate each other or maybe even potential predators (Table 1) (Figures 1 and 2).

Conclusion

Bioluminescent sharks have interested humans for almost two centuries. Research on these elusive deep sea creatures involving spectrophotometry, luminometry, pharmacology, light/electron microscopy, biochemistry, molecular analyses, and transcriptomics began only 2 decades ago. From a key function of camouflage in *Dalatiidae*, *Somniosidae*, and *Etmopteridae*, shark bioluminescent patterns steadily became an intra- and interspecific communication tool in found etmopterid sharks.

It clearly appears that the future of shark bioluminescence research will also be driven by new molecular data and techniques. These studies paved the way for future transcriptomic, proteomic, and genomic studies on luminous sharks. Among an infinite number of fascinating questions, these studies could focus on the identification of the light-emitting molecular toolkit (luciferase, photoprotein, etc.) in luminous sharks.

Even though recent research allowed us to understand a clear