

CONTROL OF BIOLUMINESCENCE

OPERATING THE LIGHT SWITCH IN PHOTOPHORES FROM MARINE ANIMALS

AKADEMISK AVHANDLING

för filosofie doktorsexamen i zoofysiologi som enligt naturvetenskapliga fakultetens beslut kommer att försvaras offentligt fredagen den 20 februari 2009, kl. 10.00 i föreläsningssalen, Zoologiska institutionen, Medicinaregatan 18, Göteborg

av

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DISSERTATION ABSTRACT

Jenny Krönström (2009) **Control of bioluminescence - operating the light switch in photophores from marine animals** Department of Zoology/Zoophysiology, University of Gothenburg, Box 463, 405 30 Göteborg

Physiologically controlled photocytes, capable of producing bioluminescence, are a common feature in the ocean among animals ranging from cnidarians to fish. The aim of this thesis was to study and compare the nature of this control, in both distantly and closely related species from the groups Teleostei Crustacea, and Cnidaria.

This was done using histochemistry and electron microscopy to reveal the internal morphology of the different photophores and to identify the location of nerves and signalling substances inside these organs. Moreover, luminescence responses of isolated photocytes, photophores or live animals, exposed to drugs with effects on adrenergic, noradrenergic, 5-hydroxytryptaminergic and nitric oxide signalling mechanisms, were measured.

Nitric oxide donors had modulating, primarily quenching, effects on the luminescence from the fish species *Argyropelecus hemigymnus* and *Porichthys notatus* and the krill *Meganyctiphanes norvegica*. However, a few of the *A. hemigymnus* photophores, and a part of the *P. notatus* response were potentiated when using nitric oxide donors. The variety in nitric oxide responses was reflected by the presence of nitric oxide synthase-like material in different cell types, including neurons, photocytes and lens/filter cells, in the photophores from the studied fish species and *Meganyctiphanes norvegica*.

Capillary sphincter cells and capillary endothelia contained nitric oxide synthase-like material in *Meganyctiphanes norvegica* photophores. Moreover, varicose nerve fibres, containing 5-hydroxytryptamine, followed the capillaries and reached the sphincter cells, suggesting that nitric oxide and 5-hydroxytryptamine may interact and control the resistance for haemolymph flow in the photophores, but other mechanisms are also discussed in the thesis. Contractile properties of the sphincter structures, and possibly the endothelial cells, were supported by the presence of muscle-like filaments in the sphincter structures and filamentous actin in both sphincter and endothelial cells. Relaxation of sphincters and capillaries may increase the flow of oxygenated haemolymph to the light-producing cells, thus stimulating or facilitating luminescence. Further indications for this scenario were a stimulation of luminescence by muscle relaxing substances and a quenching of the 5-hydroxytryptamine stimulated luminescence by a muscle contracting substance. Attempts to study an adrenergic mechanism in cnidarians failed for unknown reasons.

In conclusion, it was shown that a nitric oxide signalling system is present in the photophores from several luminescent species. The variety of nitric oxide responses, as well as the variety of morphological arrangements and patterns of innervation in the studied photophores emphasise the biodiversity of bioluminescence.