Ultrastructure and cytological changes of the kitefin shark, *Dalatias licha*, photophores during light emission

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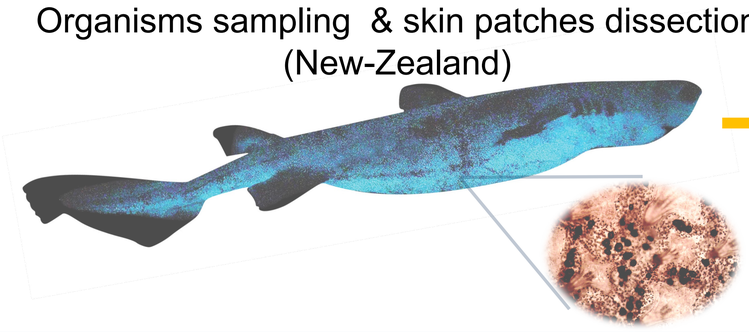
INTRODUCTION

Within shark families, only the Etmopteridae, Dalatiidae and Somniosidae are able to emit light [1]. The kitefin shark, *Dalatias licha* (Bonnaterre, 1788), is a deep-sea shark from the Dalatiidae family recognized as being the biggest luminous vertebrate known to date [2]. This study investigates the ultrastructure and hormonal control of the light organ (photophore) of *D. licha*. The study was driven by the comparison with the available data for the other species *Etmopterus spinax* [3,4], an etmopterid shark, to give a better understanding of the light emission process and its evolutive conservation within shark families. We attempt to describe the ultrastructure of its photophores and the cytological changes occurring after a hormonal stimulation through melatonin, known to trigger light emission, and α-MSH, a light emission inhibitor. Light and transmission electron microscopy were used for that purpose.

MATERIALS & METHODS

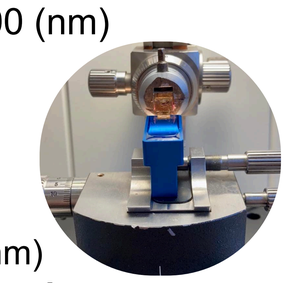
Organisms sampling & skin patches dissection (New-Zealand)



Hormonal treatment (melatonin, α-MSH) & tissue fixation

Post-fixation & embedding in Spurr resin

Semi-thin sections 500 (nm)
Light microscopy



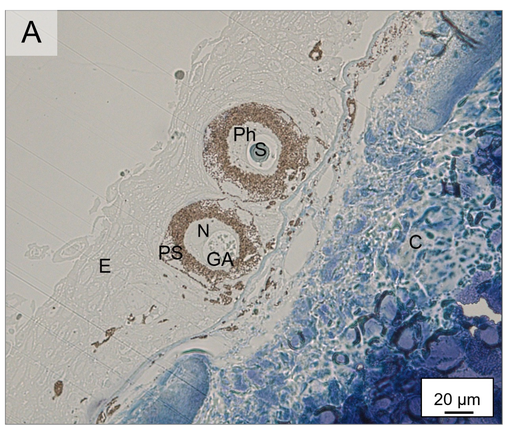
Ultra-thin sections (90 nm)
Transmission electron microscopy

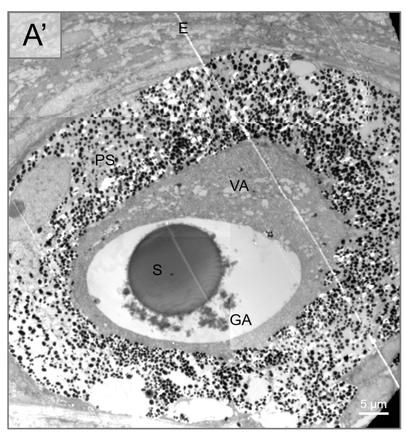
RESULTS & DISCUSSION

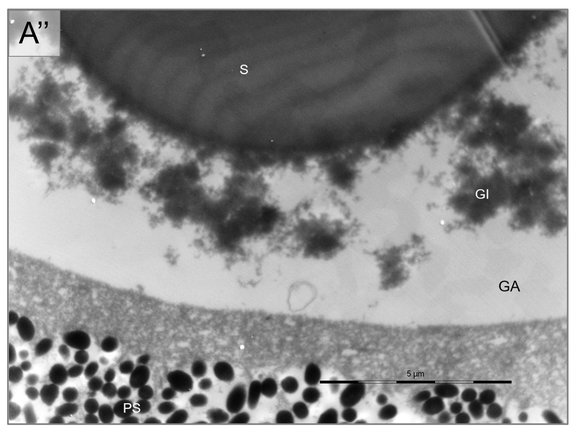
Semi-thin

Ultra-thin

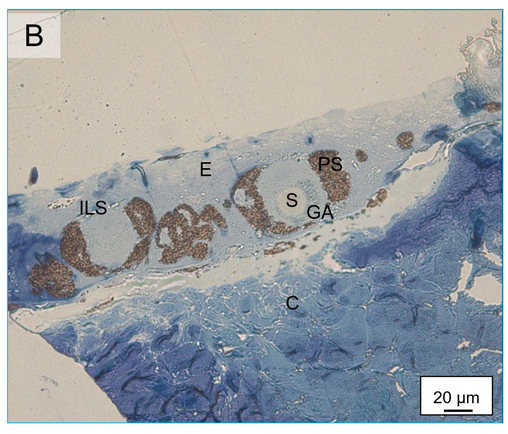
CONTROL

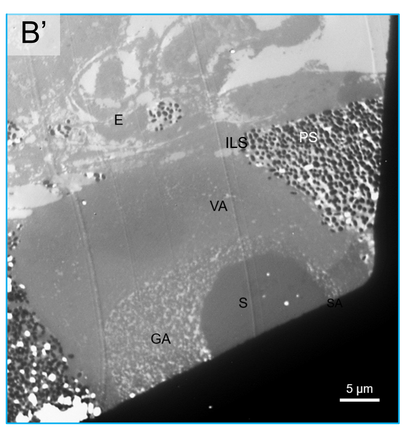


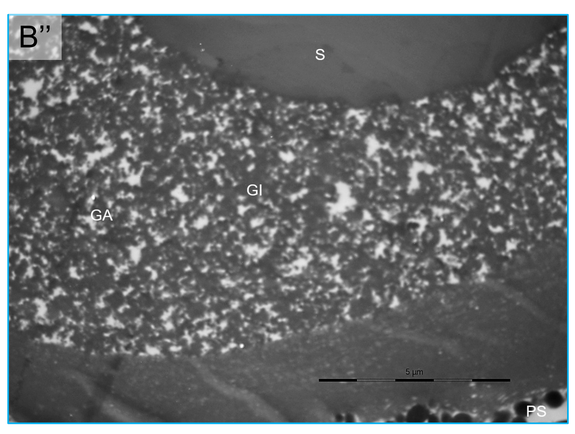




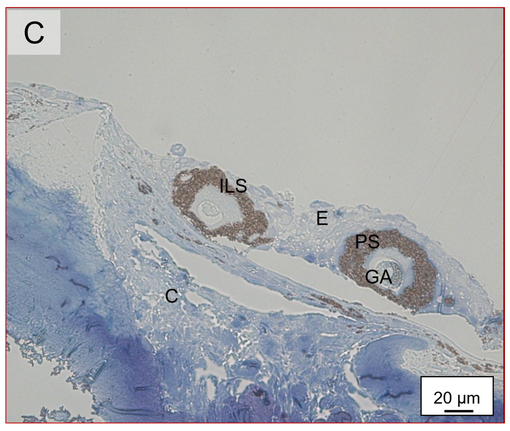
MELATONIN

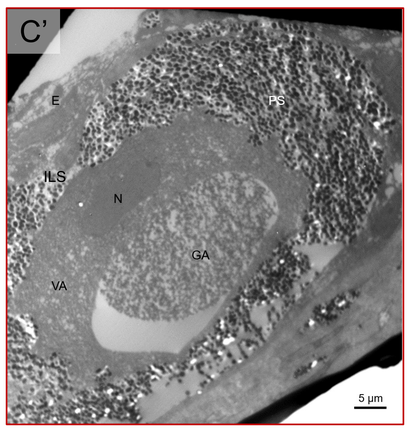


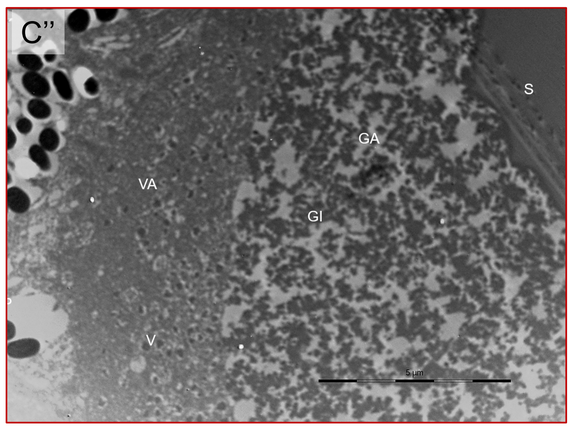




α-MSH







Semi-thin and ultra-thin sections of *Dalatias licha* photophores.

A) Semi-thin section of a control photophore (without hormonal treatment), **A')** Ultra-thin section of a control photophore and **A'')** zoom within the granular area.

The regionalized photocyte and a large secretion were discovered.

B) Semi-thin section of a photophore under melatonin treatment (light emission trigger), **B')** Ultra-thin section of a photophore under melatonin treatment and **B'')** zoom within the granular area.

The ILS is retracted to open the top of the photophore and allows light emission. Changes are observed within the granular area.

C) Semi-thin of a photophore under α-MSH treatment (light emission inhibitor), **C')** Ultra-thin section a photophore under α-MSH treatment and **C'')** zoom within the granular area.

The ILS covers the top of the photophore during luminescence inhibition. Changes are observed within the granular area.

C : conjonctive tissue, E : epidermis, GA : granular area, GI : granular inclusions, ILS : iris-like structure, N : nucleus, PS : pigmented sheath, S : secretion, V : vesicles, VA : vesicular area.

CONCLUSION

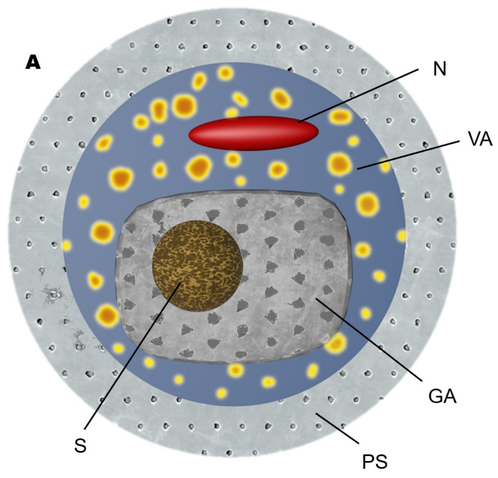
Ultrastructure

- Regionalized photocyte : granular and vesicular area
- Large spherical secretion within the granular area
- No lens cell nor reticular layer in *Dalatias licha* photophore compared to *Etmopterus spinax*

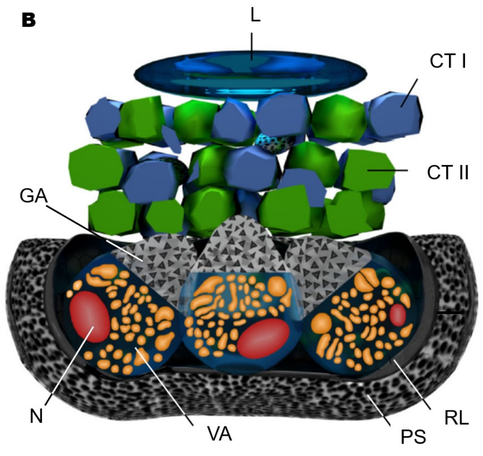
Hormonal control

- Cytological changes occur during light emission (melatonin) and its inhibition (α-MSH) at the photocyte and ILS level

D. licha



E. spinax



3D modeling of a cross-section in Dalatiidae and Etmopteridae photophores.

A) *D. licha*. **B)** *Etmopterus spinax* [3]. CT I : cellular type I, CT II : cellular type II, GA : granular area, N : nucleus, PS : pigmented sheath, RL : reticular layer, S : secretion, VA : vesicular area.

References : [1] Duchatelet *et al*. (2021) *Oceans*; [2] Mallefet J. *et al*. (2021) *Front. Mar. Sci.* ; [3] Renwart M. *et al*. (2014) *Zoomorphology*; [4] Renwart M. *et al*. (2015) *Zoomorphology*