

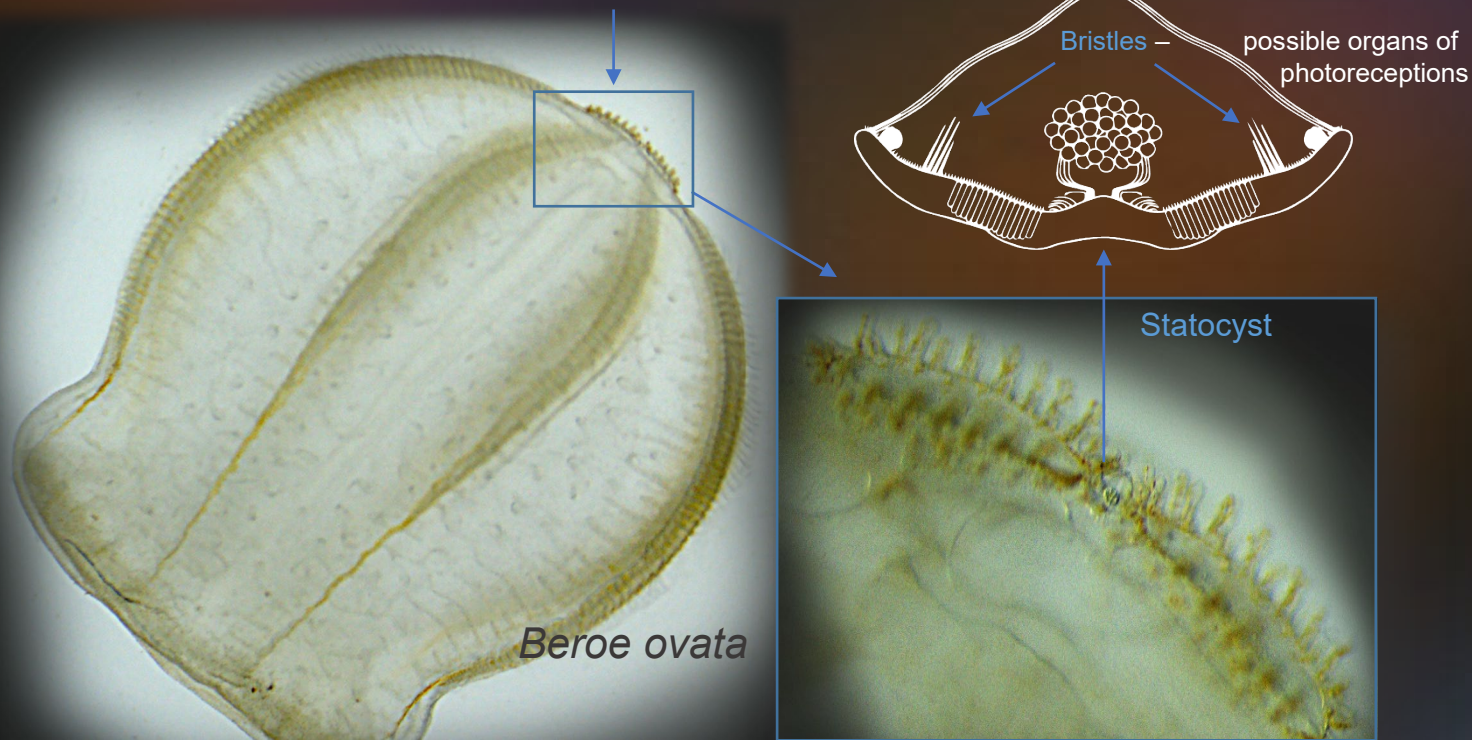
Light perception in **Beroidea** ctenophores: evidence from laboratory experiments and genomics data

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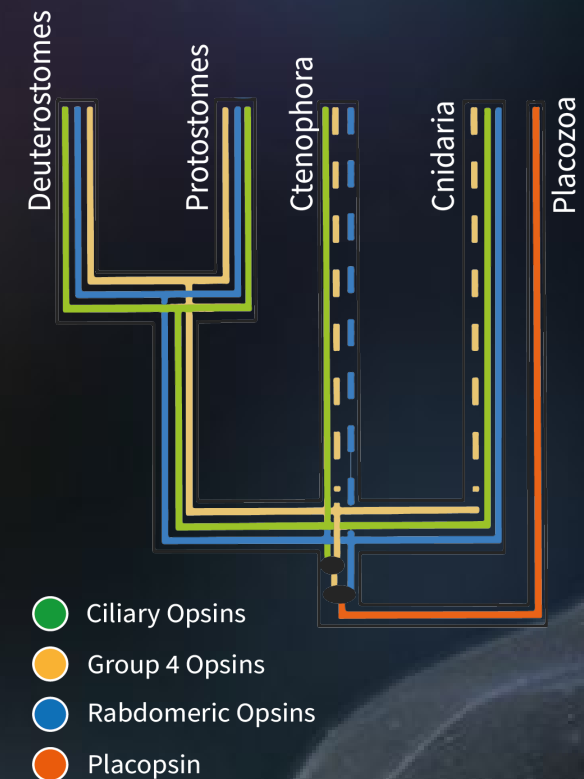
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Ctenophores are the basal Metazoa branch in which evolution the animals common ancestral vision mechanisms could be realized for the first time. There are a little bit evidence about any aspects of photosensitivity in ctenophores. Photoreceptor structures were found in the aboral organ of various ctenophores species.

The anatomy of the **aboral organ**



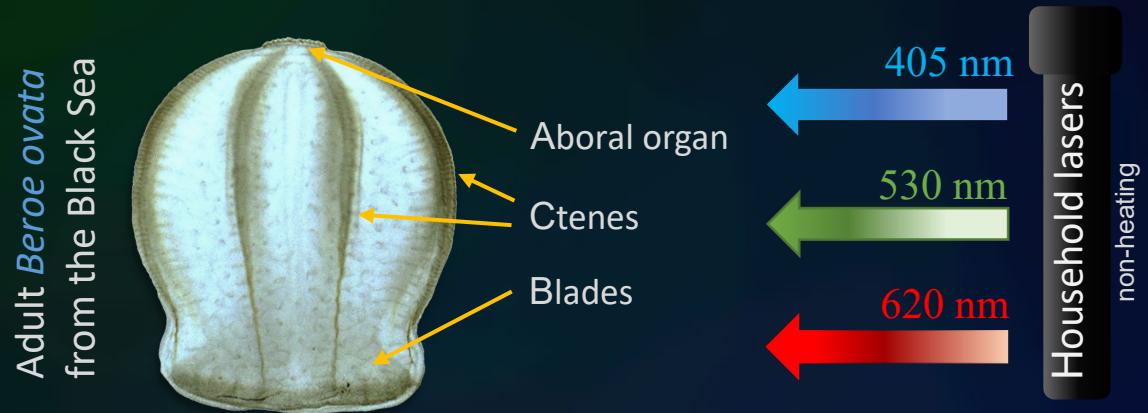
Three opsins have been discovered in the genome of lobate ctenophore *Mnemiopsis leidyi*



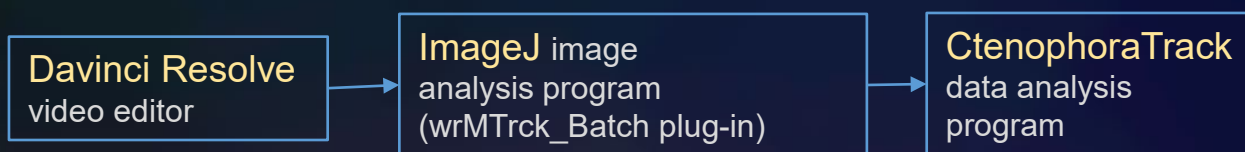
Aim:

- To provide the first experimental results on the reaction of *Beroe ovata* to high-intensity light exposure
- To identify genes relevant for light sensing in Beroidae

Methods and Algorithms:



Video recording and analysis



The search for protein sequences that may relate to photoreception at NCBI

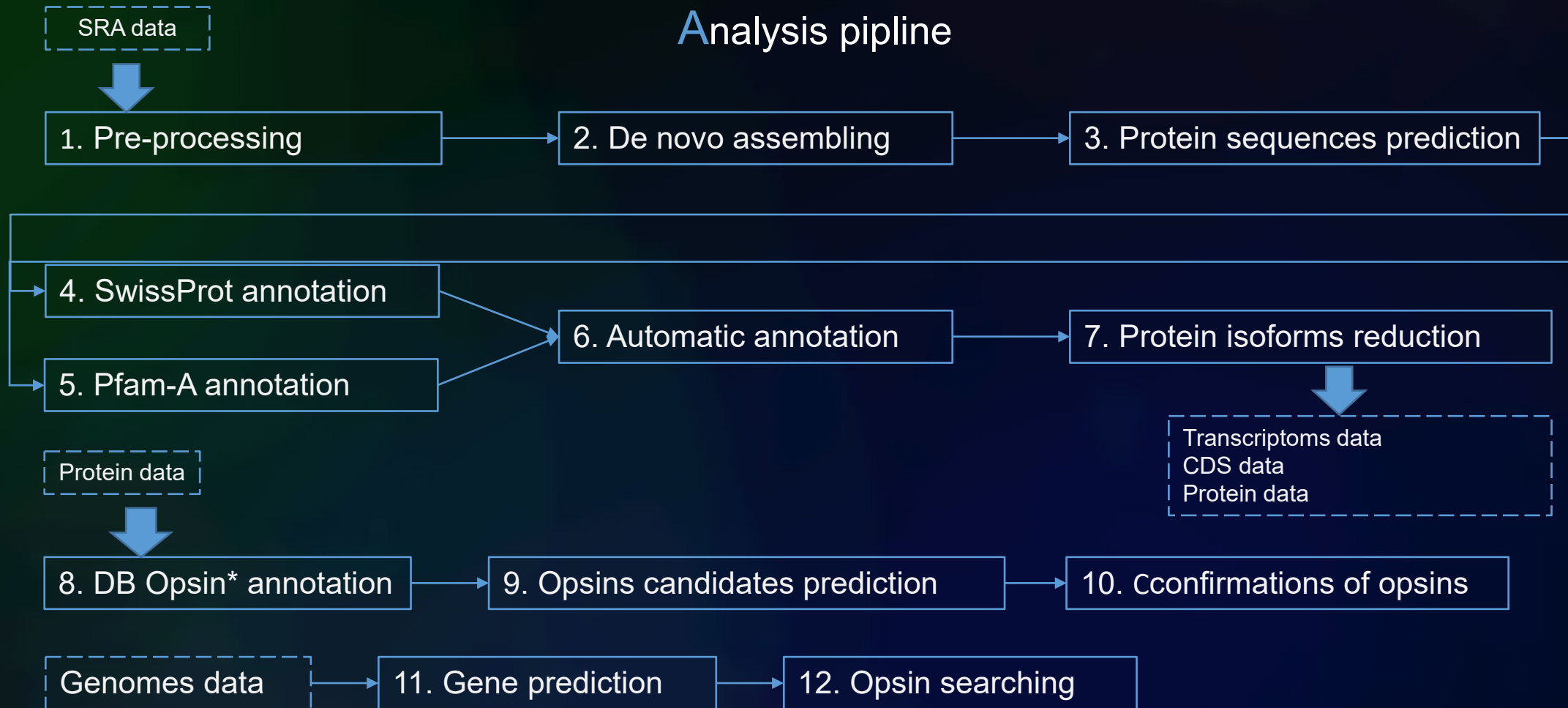
Transcriptome

Name	BioSample	SRA	
<i>Beroe forskalii</i>	SAMN07658075	SRR6074515	
<i>Beroe ovata</i>	SAMN07658076	SRR6074516	
<i>Beroe</i> sp. UF-2017 (Australia)	SAMN07426145	SRR5892577	
<i>Beroe</i> sp. UF-2017 (Antartica)	SAMN07426140	SRR5892576	
Name	Total Sequences	Sequence length	%GC
<i>Beroe ovata</i> (Black Sea)	11712387	35-151	45

Genome

<i>Beroe forskalii</i>	GCA_011033025.1
<i>Beroe ovata</i>	GCA_900239995.1

Analysis pipeline

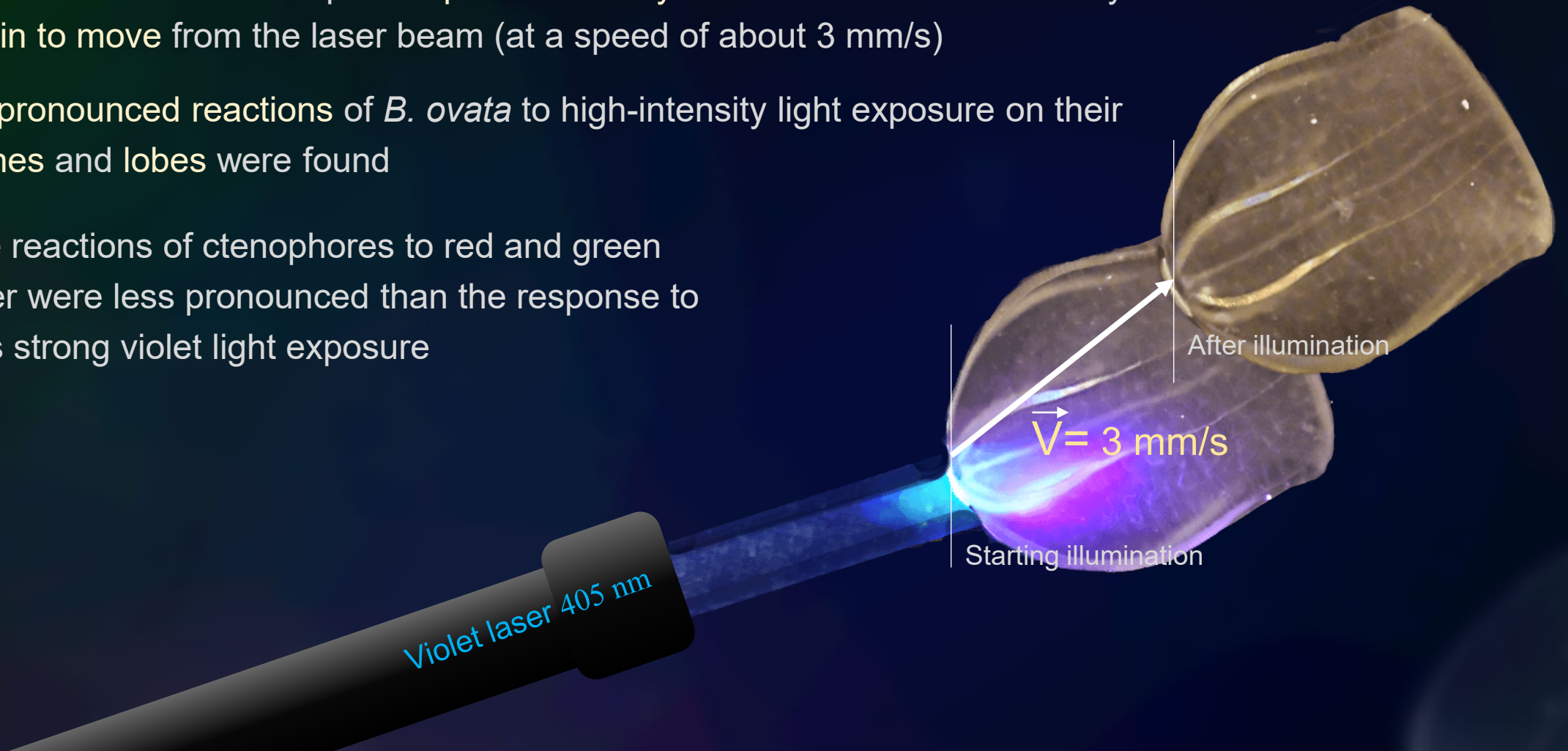


1. fastP v0.23.2
2. Trinity v2.13.2
3. TransDecoder v5.5.0
4. BLAST v2.12.0 – SwisProt (11/17/2021)
5. HMMER v3.2.1 – Pfam-A (11/15/2021)
6. TransDecoder v5.5.0
7. Usearch v11.0.667 (identity 95%)

8. BLAST v2.12.0 (balstp) –Opsin database formed on the basis of SwisProt and TrEMBL
9. Selection of sequences with the best identity to the opsins
10. Web BLASTP – nr protein db; SMART
11. Augustus v. 3.4.0
12. BLAST v2.12.0 (blastp)

Results:

- After 1–5 sec of starting illumination of the *B. ovata* aboral organ with a violet spectrum laser the ctenophores press the body and entrails near the statocyst and begin to move from the laser beam (at a speed of about 3 mm/s)
- No pronounced reactions of *B. ovata* to high-intensity light exposure on their ctenes and lobes were found
- The reactions of ctenophores to red and green laser were less pronounced than the response to less strong violet light exposure

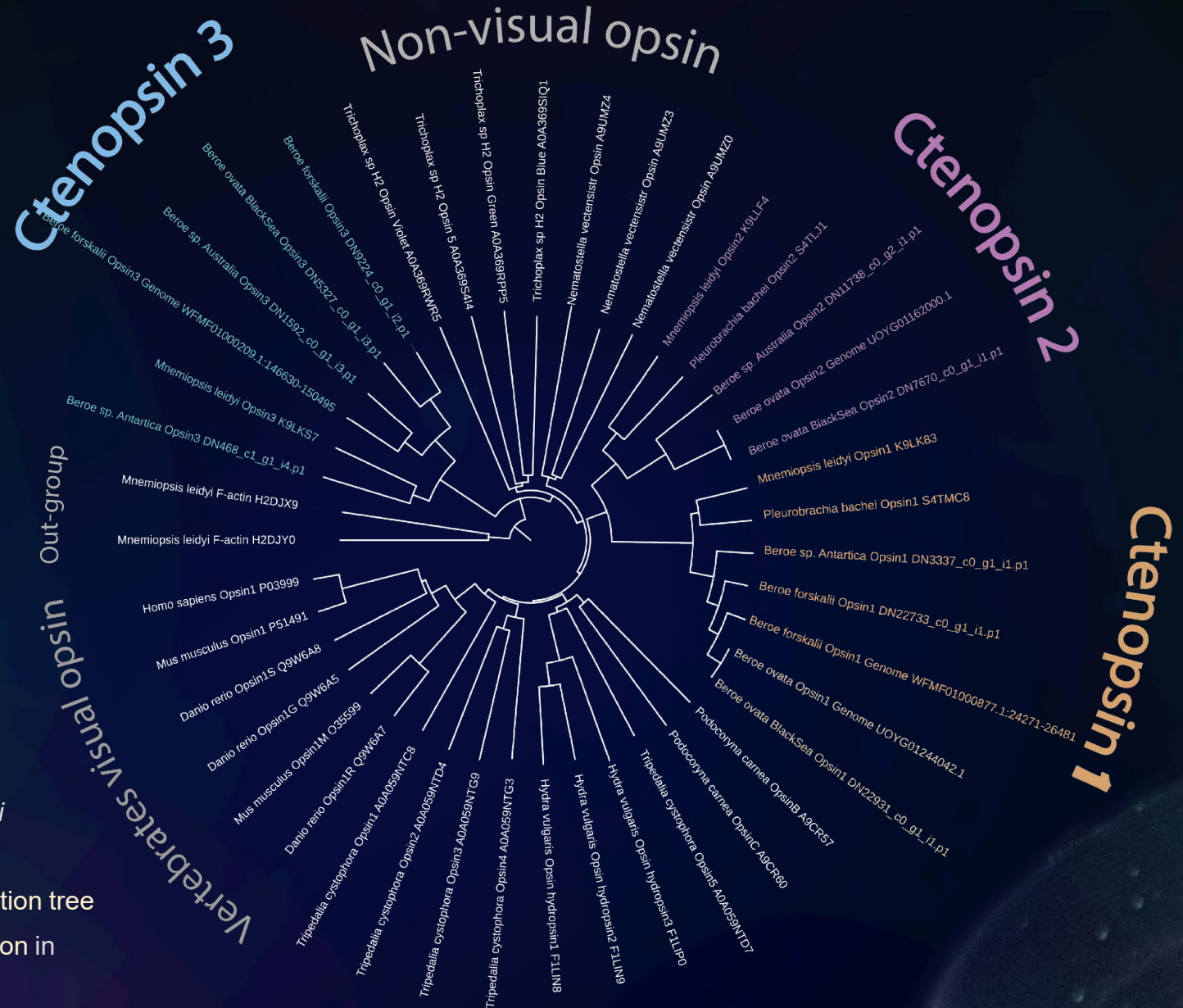


Beroidae vs *Mnemiopsis leidyi* opsins (BLASTP)

	Name	Prot. Len (aa)	Total Score	Query cover	Per. Ident	Acc. Len
<i>Beroe forskalii</i>	Opsin1	121	137	90%	73.39%	345
	Opsin3	107	58.5	42%	54.35%	404
<i>Beroe forskalii</i> (Genome)	Opsin1	179	249	92%	77.11%	345
	Opsin3	391	294	88%	52.86%	404
<i>Beroe ovata</i> (BlackSea)	Opsin1	363	499	86%	78.59%	345
	Opsin3	270	255	98%	57.30%	399
<i>Beroe ovata</i> (Genome)	Opsin1	351	498	89%	78.59%	345
	Opsin2	401	429	97%	60.15%	399
	Opsin3	123	51.2	37%	43.48%	404
<i>Beroe ovata</i>	Opsin3	126	108	99%	52.80%	404
<i>Beroe</i> sp. Antarctica	Opsin1	302	465	100%	76.16%	345
	Opsin3	394	320	96%	57.44%	404
<i>Beroe</i> sp. Australia	Opsin2	141	61.6	43%	70.97%	416
	Opsin3	363	318	83%	54.07%	404

- ✓ Beroidae have three opsin genes like the Lobate ctenophore *M. leidyi*
- ✓ Each ctenopsin forms are separate cluster on the phylogenetic tree
- ✓ Ctenopsins are one of the first branches of the Metazoan opsin evolution tree
- ✓ Ctenopsins 1 and 2 may be in charge of the first step of light perception in ctenophores

Ctenophore opsins phylogenetic tree



Conclusions:

- Ctenophores have the ability to directed photoreception.
- The response of *Beroe ovata* to high-intensity violet spectrum light radiation is observed with a point impact on the aboral organ.
- Other parts of the ctenophore's body are not sensitive to the action of high-intensity light.
- Genes sequences which can response for the photoreception in Beroidae have been obtained. Beroidae has three opsin genes like the Lobate ctenophore *M. leidyi*.
- Ctenopsins are one of the first branches of the Metazoan opsin evolution tree.

Acknowledgements: The study was supported by IBSS GA No. 121030100028-0.

