

Reevaluating the distribution of apical flaps in nematocysts of the Anthozoa

Abigail Reft,
Department of Ecology and Evolutionary Biology, University of Kansas
ajreft@ku.edu

What are nematocysts?

Nematocysts (Figures B, C and D) are intracellular capsules of the phylum Cnidaria (e.g. jellyfish, sea anemones, corals) used in capture of prey, defense against predators, and intraspecific aggression. They have a double-walled capsule and an inverted tubule. Because all cnidarians have them, nematocysts are a source of characters to investigate the phylogeny of the phylum.

Apical structure of nematocysts

One nematocyst character assumed to be phylogenetically informative is the structure at the apex where the capsule opens. Two apical structures are known in nematocysts:

- an operculum (Figure A)
- three flaps (Figure B)

Existing Hypothesis

Opercula are found only in nematocysts of classes Hydrozoa, Scyphozoa, and Cubozoa (Westfall 1965, Rifken and Eidean 1983)

Apical flaps are found only in class Anthozoa (Westfall 1965)

Hydrozoa, Scyphozoa and Cubozoa are more closely related to each other than each is to Anthozoa (Bridge et al. 1995); therefore apical structure reflects phylogeny (Figure A).

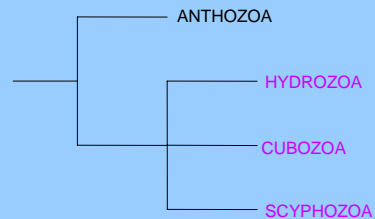


Figure A. Relationships among the classes of Cnidaria. Based on Bridge et al. 1995

Purple – nematocysts have an operculum

Black – nematocysts have apical flaps

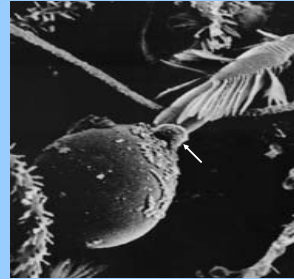


Figure B. Operculum of nematocyst in tentacle of the jellyfish *Cassiopea* sp. (Scyphozoa) ~2000x.

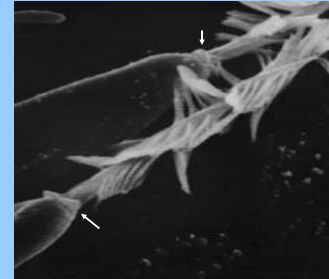


Figure C. Apical flaps of nematocyst in tentacle of the sea anemone *Anemonia krebsi* (Anthozoa, Hexacorallia, Actiniaria) ~2600x.

Problems

Apical flaps are assumed to be wide-spread in Anthozoa. However

- They have been documented only in the order Actiniaria (sea anemones) of subclass Hexacorallia
- order Corallimorpharia (subclass Hexacorallia) does not have apical flaps (den Hartog 1980)
- Renilla* (subclass Octocorallia) has an “operculum-like” structure (Ivester 1977)
- The nematocyst of the coral (subclass Hexacorallia, order Scleractinia) in Figure D has an operculum structure



Figure D. Operculum structure in tentacle of the coral *Astrangia solitaria* (Anthozoa, Hexacorallia, Scleractinia) ~3400x

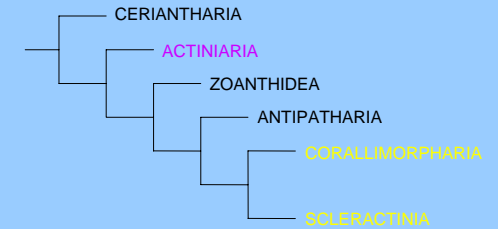


Figure E. Apical structure of nematocysts mapped onto Daly et al. 2003 tree of orders of the anthozoan subclass Hexacorallia.

Purple – Order in which nematocysts have apical flaps

Yellow – Orders in which nematocysts are known not to have apical flaps

Black – Orders in which nothing is known about the apical structure

Implications and further research

Figure E suggests at least three possible interpretations of the evolution of apical flaps in the subclass Hexacorallia.

1. Apical flaps evolved in the ancestor of Hexacorallia. Flaps were lost in the ancestor of Corallimorpharia and Scleractinia
2. Apical flaps evolved only in the ancestor to Actiniaria
3. Apical structure does not reflect phylogeny

However, to determine if any of these hypotheses are true the following studies are necessary.

Priority 1: Nematocysts of the orders Ceriantharia, Zoanthidea, and Antipatharia need to be surveyed to determine apical structure

Priority 2: Nematocysts of the subclass Octocorallia need to be more carefully surveyed (apical structure known from only 1 genera)

References

- Bridge D, Cunningham CW, DeSalle R, Buss LW. 1995. Class-level relationships in the phylum Cnidaria: molecular and morphological evidence. *Mol. Biol. Evol.* 12: 679-689.
- Daly M, Fautin DG, Cappola VA. 2003. Systematics of the Hexacorallia. *Zool. J. Linn. Soc.* 139: 419-437.
- den Hartog JC. 1980. Caribbean shallow water Corallimorpharia. *Zool. Verh. Leiden* 176: 3-83.
- Ivester MS. 1977. Nematocyst differentiation in the anthozoan *Renilla reniformis* (Pallas). *Trans. Amer. Micros. Soc.* 96: 238-247.
- Rifkin J, Eidean R. 1983. The structure and function of the nematocysts of *Chironex fleckeri* Southcott, 1956. *Cell Tiss. Res.* 233: 563-577.
- Westfall J. 1965. Nematocysts of the sea anemone *Metridium*. *Am. Zool.* 5: 377-393.

Acknowledgments

Photos courtesy of Dr. Richard Mariscal. Thanks to Daphne Fautin and her NSF grant 9978106 in the program Partnerships to Enhance Expertise in Taxonomy (PEET).