

Gulf of Mexico Origin, Waters, and Biota

Volume 1: Biodiversity

Edited by Darryl L. Felder and David K. Camp

Cairns, S. D. and D. G. Fautin. 2009. Cnidaria: Introduction, Pp. 315–319 in Felder, D.L. and D.K. Camp (eds.), Gulf of Mexico-Origins, Waters, and Biota. Biodiversity. Texas A&M University Press, College Station, Texas.

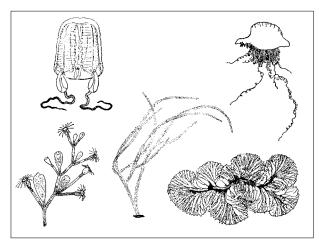
±12

Cnidaria: Introduction

Stephen D. Cairns and Daphne Gail Fautin

Cnidarians are ubiquitous in the marine environment, occurring from the Arctic to Antarctic and from the intertidal to 10,710 m, the depth record held by the hadal tubeforming sea anemone *Galatheanthemum* (see Belyaev and Sololova 1960). The cnidarian component of the marine gelatinous zooplankton contributes to one of the largest food webs on the planet (Robison 2004). A few species of hydroids occur in fresh-water lakes and streams, including *Hydra*, the animal used in most textbooks to illustrate the phylum. The only place cnidarians are not found is on land and in the air.

These are the animals that possess cnidae, the microscopic eversible capsules that give the phylum the name we use for it. There is continued and understandable confusion about the phylum's proper name. The name Coelenterata was proposed by Frey and Leuckart in 1847. But in 1888, Hatschek, realizing that Frey and Leuckart's Coelenterata consisted of 3 phyla, renamed those groups Spongiaria, Cnidaria, and Ctenophora. Hatschek could as easily have retained the name Coelenterata for the nonsponge, nonctenophore phylum instead of creating the name Cnidaria for it, which would be more consistent with modern concepts of nomenclature, a position that Williams (1999) still strongly supports. But the International Code of Nomenclature did not exist in 1888 nor does it apply to superfamilial taxa; thus the naming of higher taxa becomes a matter of usage and preference. In her famous invertebrate textbook, Hyman (1940) advocated the term Cnidaria, as did Dunn (1982) in the Synopsis and Classification of Living Organisms, but the original Gulf of Mex-



Cnidaria, various classes. After Pratt 1916.

ico Bulletin (Galtsoff 1954), as well as the highly influential *Treatise on Invertebrate Paleontology* (Moore 1956) and the current *Zoological Record*, use the term Coelenterata. Nonetheless, over the years the name Cnidaria has replaced the name Coelenterata. Although these names were in equal usage as late as 1984, Cnidaria was used in 90% of publications by 2002 (van der Land 2003). Thus, whereas there is logic based on priority to use the term Coelenterata, we have opted for Cnidaria, based on modern usage.

Most textbooks have asserted for decades that there are 9000–10,000 species of cnidarians. However, the first compilation based on an actual count of species (van der Land, pers. comm. 2005) indicates a number closer to 13,000. Thus, the 792 Gulf of Mexico cnidarians repre-

sent about 6% of the world total, an increase of 352 species (~80%) over the 1954 list (Galtsoff 1954). All cnidarian groups are included in the current report, whereas in 1954 the Zoanthidea and Antipatharia were omitted (see taxon summary table). It appears that almost every deep-sea expedition to the Gulf of Mexico produces new cnidarian records, so the total listing of Gulf cnidarians is probably far from complete.

Although many cnidarians are small, are inconspicuous or cryptic, and live at considerable depth, some are large and have direct relevance to humans. For instance, some antipatharians and octocorals are fashioned into jewelry; various scleractinians are sold as curios; some actiniarians and scleractinians are important in the aquarium trade; the larger scleractinians and octocorals form the foundation of coral reefs that afford protection to coastlines and nurseries for larval fish and invertebrates; many cubozoans and scyphozoans (= jellyfish) are a menace to recreational swimming and diving; large populations of scyphozoans have adversely affected fisheries in some places; and a variety of bioactive compounds, including some of potential medical importance, have been extracted from cnidarians, mostly octocorals and actiniarians (Kinzie 1974).

Cnidaria may be the most basal phylum with tissuelevel organization, but, unlike nearly all other animals, cnidarians are diploblastic, having only two basic cell layers, the ectoderm and the endoderm. (Hyman [1940] termed these the epidermis and gastrodermis, but later repudiated that usage [Hyman 1967; see Fautin and Mariscal 1991].) Between these cell layers is the mesoglea (British spelling is mesogloea), a gelatinous connective sheet that includes only a few cells (in organisms such as hydrozoan polyps) to many cells (in sea anemones), and may be extremely thin or constitute the bulk of the organism (it is the "jelly" of jellyfish). The tissues of cnidarians are not organized into organs, so excretion or respiration, for example, is done through the general body surface, and the nervous system is a simple nerve net. Digestion, like respiration and excretion, occurs in the single body cavity, the coelenteron (or gastrovascular cavity), which has one opening that serves as both mouth and anus. This opening is surrounded by tentacles.

Aside from the diploblastic body structure and single body cavity opening to the outside, cnidarians are distinguished by the possession of nematocysts. Functioning mainly in defense and food capture, nematocysts are typically densest in the tentacles. Only cnidarians form nematocysts and all cnidarians possess them. Nematocysts are

one of three categories of cnidae, which are intracellular secretory products. The other two are confined to only some cnidarians (spirocysts to hexacorallians and ptychocysts to cerianthids).

The cnidarian body is said to be radial in symmetry, and the body axis is oral-aboral. Members of class Anthozoa, however, are actually biradial. The class is distinguished in part by its members having an actinopharynx (stomodeum or "throat") that extends from the mouth some distance into the coelenteron, and the coelenteron is divided by sheets of tissue radiating from the body wall (mesenteries), some or all of which connect to the actinopharynx. A bilaterality in symmetry is due to the actinopharynx typically being ovoid rather than circular in cross-section, and the mesenteries of an individual not being all identical. Some cnidarians ("corals") have developed an external or internal supporting skeleton composed of calcium carbonate (Scleractinia, Octocorallia, Stylasteridae) or a proteinaceous substance (Antipatharia). Thus, cnidarians are morphologically complex relative to sponges (because they have a tissue grade organization) but less so than flatworms (because they lack a complete digestive tract and mesoderm).

Several orders of hydrozoans have complex life cycles, sometimes referred to as an "alternation of generations" or metagenesis, consisting of alternating periods as an attached asexual polyp (hydroid stage), then as a vagile sexual medusa (or variations on this general theme). Many species have been described twice, once based on the polyp and once on the medusoid stage, so different species and even generic names have been assigned to the same species (Cairns 2002). As a result, a dual nomenclature has developed and even a dual classification of the higher taxa. The taxonomy is slowly being resolved through the patient rearing of species through complete life cycles and the more expedient method of DNA sequencing of target genes. Even in this book, the hydromedusae (see Segura-Puertas, Celis, and Chiaverano, this volume) are treated separately from the hydroids (Calder and Cairns, this volume), with 3 species common to both lists.

A universally accepted classification of Cnidaria does not currently exist; the classification we use (summary table) follows Marques and Collins (2004). Revelations produced by molecular data (e.g., Collins 2002) and reevaluations of morphology (e.g., Bouillon 1985, Bouillon and Boero 2000, Marques and Collins 2004) are gradually bringing stability to cnidarian classification. They are also contributing to a phylogenetic understanding of

cnidarian groups. Of particular interest in this regard is the discovery that the mitochondrial gene in the Medusozoa (Scyphozoa, Cubozoa, and Hydrozoa) is linear, not circular as it is in the rest of the animal kingdom, which supports the monophyly of that taxon as the sister group of Anthozoa (Bridge et al. 1992). We also follow Berntson et al. (1999) in placing Ceriantharia in the Hexacorallia as a sister group to the Zoanthidea. We treat Corallimorpharia as a separate order, but corallimorpharians may actually be skeletonless scleractinians (e.g., Daly, Fautin, and Cappola 2003). Other significant papers having a bearing on the higher classification of Cnidaria include Bridge et al. (1995), Song and Won (1997), Collins (2000), and Bouillon et al. (2004).

Significant review papers, books, or web pages on the following cnidarian groups include: Cnidaria (Dunn 1982; http://beta.tolweb.org/tree); Anthozoa (Fautin and Mariscal 1991); Octocorallia (Bayer 1981; http://www.calacademy.org.research/izg); Helioporacea (Bayer 1992); Pennatulacea (Williams 1995, 1999); Actiniaria (http://hercules.kgs.ku.edu/hexacoral/anemone2/index); Cubozoa (Kramp 1961); Scyphozoa (Kramp 1961; Arai 1997); and Hydrozoa (Petersen 1990).

References

- Arai, M. N. 1997. A Functional Biology of Scyphozoa. Chapman and Hall, London.
- Bayer, F. M. 1981. Key to the genera of Octocorallia exclusive of the Pennatulacea (Coelenterata: Anthozoa), with diagnoses of new taxa. Proceedings of the Biological Society of Washington 94(3): 902–947.
- 3. Bayer, F. M. 1992. The helioporacean octocoral *Epiphaxum*, Recent and fossil: a monographic iconography. Studies in Tropical Oceanography 15. 76 pp., 62 pls.
- 4. Belyaev, G. M., and M. N. Sokolova. 1960. Zoobenthos of the Marianas Trench. Trudy Instituta Okeanologii AN SSR 41: 123–127.
- Berntsen, E. A., S. C. France, and L. S. Mullineaux. 1999.
 Phylogenetic relationships within the class Anthozoa (Phylum Cnidaria) based on nuclear 18S rDNA sequences.
 Molecular Phylogenetics and Evolution 23(2): 417–433.
- Bouillon, J. 1985. Essai de classification des Hydropolypes-Hydroméduses (Hydrozoa- Cnidaria). Indo-Malayan Zoology 1: 29–243.
- 7. Bouillon, J., and F. Boero. 2000. Synopsis of the families and genera of the Hydromedusae of the world, with a list of the worldwide species. Thalassia Salentina 24: 47–296.
- 8. Bouillon, J., M. D. Medel, F. Pages, J. M. Gili, F. Boero, and

- C. Gravili. 2004. Fauna of the Mediterranean Hydrozoa. Scientia Marina 68 (supplement) 449 pp. 68 (2): 5–438.
- Bridge, D., C. W. Cunningham, R. DeSalle, and L. W. Buss. 1995. Class-level relationships in the phylum Cnidaria: molecular and morphological evidence. Molecular Biology and Evolution 12(4): 679–689.
- Bridge, D., C. W. Cunningham, B. Schierwater, R. DeSalle, and L. W. Buss. 1992. Class-level relationships in the phylum Cnidaria: evidence from mitochondrial genome structure. Proceedings of the National Academy of Sciences 89: 8750–8753.
- 11. Cairns, S. D. 1983. A generic revision of the Stylasterina (Coelenterata: Hydrozoa), Part 1. Description of the genera. Bulletin of Marine Science 33(2): 427–508.
- 12. Cairns, S. D., editor. 2002. Common and Scientific Names of Aquatic Invertebrates From the United States and Canada: Cnidaria and Ctenophora. American Fisheries Society Special Publication 28. 115 pp.
- 13. Collins, A. G. 2000. Towards understanding the phylogenetic history of Hydrozoa: hypothesis testing with 18S gene sequence data. Sciencia Marina 64 (supplement): 5–22.
- 14. Collins, A. G. 2002. Phylogeny of Medusozoa and the evolution of cnidarian life cycles. Journal of Evolutionary Biology 15: 418–432.
- Daly, M., D. G. Fautin, and V. A. Cappola. 2003. Systematics of the Hexacorallia (Cnidaria: Anthozoa). Zoological Journal of the Linnean Society 139: 419–437.
- Dunn, D. F. 1982. Cnidaria. Pp. 669–706 in S. P. Parker, ed. Synopsis and Classification of Living Organisms. Volume 1. MacGraw Hill, New York.
- Fautin, D. G., and N. Mariscal. 1991. Cnidaria: Anthozoa. Pp. 267–358 in F. G. Harrison and J. A. Westfall, eds. Microscopical Anatomy of Invertebrates. Volume 2: Placozoa, Porifera, Cnidaria, and Ctenophora. Wiley-Liss, Inc., New York.
- 18. Frey, H., and C. G. F. R. Leuckart. 1847. Beträige zur Kenntniss wirbelloser Thiere mit sesonderer Berücksichtigung der Fauna des Norddeutschen Meeres. Verlag von Friedrich Vieweg und Sohn, Braunschweig. 170 pp.
- Galtsoff, P. S., editor. 1954. Gulf of Mexico: Its Origin Waters, and Marine Life. Fishery Bulletin 89, Fishery Bulletin of the U.S. Fish and Wildlife Service, Volume 55. 604 pp.
- Hatschek, B. 1888. Lehrbuch der Zoologie, eine morphologische Übersicht des Thierreiches zur Einfürhrung in das Stadium dieser Wissenschaft. Gustav Fischer, Jena. 432 pp.
- 21. Hyman, L. H. 1940. The Invertebrates: Protozoa through Ctenophora. McGraw Hill, New York. 726 pp.
- 22. Hyman, L. H. 1967. The Invertebrates: Volume 6: Mollusca I. McGraw Hill, New York. 792 pp.
- 23. Kinzie, R. A. 1974. Plexaura homomalla: the biology and

- ecology of a harvestable marine resource. Studies in Tropical Oceanography 12: 22–38.
- 24. Kramp, P. L. 1961. Synopsis of the medusae of the world. Journal of the Marine Biological Association of the United Kingdom 40: 1–469.
- 25. Land, J. van der. 2003. The demise of the Coelenterata and Madreporaria. Zoologische Verhandelingen 345: 209–213.
- 26. Marques, A. C., and A. G. Collins. 2004. Cladistic analysis of Medusozoa and cnidarian evolution. Invertebrate Biology 123(1): 23–42.
- 27. Moore, R. C., editor. 1956. Treatise on Invertebrate Paleontology. Part F: Coelenterata. University of Kansas Press, Lawrence. 498 pp.
- 28. Petersen, K. W. 1990. Evolution and taxonomy in capitate hydroids and medusae (Cnidaria: Hydrozoa). Zoological Journal of the Linnean Society 100: 101–231.

Submitted: July 2005 Accepted: December 2005

- 29. Robison, B. H. 2004. Deep pelagic biology. Journal of Experimental Marine Biology and Ecology 300: 253–272
- Song, J.-I., and J. H.Won. 1997. Systematic relationship of the anthozoan orders based on the partial nuclear 18S rDNA sequences. Korean Journal of Biological Sciences 1: 43–52.
- 31. Williams, G. C. 1995. Living genera of sea pens (Coelenterata: Octocorallia: Pennatulacea): illustrated key and synopsis. Zoological Journal of the Linnean Society 113: 93–140.
- 32. Williams, G. C. 1999. Index Pennatulacea: annotated bibliography and indexes of the sea pens (Coelenterata: Octocorallia) of the world 1469–1999. Proceedings of the California Academy of Sciences 51(2): 19–103.