

Instructors: Barbara Christie-Pope & Craig Tepper

Course learning objectives:

- To develop an expertise and working knowledge of the literature related to the research topics.
- To develop and conduct a research project focusing on the biology of fire corals (*Millepora*) and their algal protist symbionts (*Symbiodinium*).
- To become familiar with research techniques useful for studying the molecular biology of marine organisms.
- To become familiar with scientific writing, scientific publication, and the peer-review process by critiquing published articles and writing a manuscript outlining a research proposal and the results of your research.
- To meaningfully discuss the chosen research topic with other biologists.

This course supports the Educational Priorities and Outcomes of Cornell College with emphases on knowledge, inquiry, reasoning, communication, and vocation.

Expectations:

The research projects will be a collaborative effort between student researchers and instructors. We expect all of us to gain insight and knowledge as a direct result of our research interactions. Students will take primary responsibility for conducting research and do so with professional attitudes and time commitments. With our guidance, we expect students to produce a manuscript modeled after the peer reviewed literature you are reading in order to write your research paper. The Introduction to your paper will consist of the background for a research proposal that your group designs. This proposal must address either Millepore biology or *Symbiodinium*. Students should understand that producing a publishable manuscript generally requires many drafts, reviews, and revisions.

Evaluation:

Your final course grade will be determined according to the following criteria:

- Effort, attitude, and time invested in the research project including lab safety, attention to detail, ability to troubleshoot research problems, obtaining reproducible results, and participation in paper revisions.
- Organization of lab research results, computer files, and any other documentation that remains in the lab as your research legacy.
- Familiarity with relevant research literature.
- Evidence of original thought regarding the project.
- Quality of **ALL** your **drafts and the final** written research paper.

Daily Schedule:

The daily schedule will be determined by weather conditions and availability of the boat while we are at IZE. On a typical day, we will spend half of our day working in the lab and the other

half working at one of a number of reef sites. Additionally, we (Barbara and Craig) meet with the research groups every evening at 7:00 PM to discuss paper drafts. This schedule will remain the same all week (including weekends).

Required Reading (all readings can be found on Moodle)

- Raven et al. 2011. Phylum Cnidaria. Biology 9th edition Chapter 33.
- Lewis 2006. Biology and ecology of the hydrocoral *Millepora* on coral reefs. Advances in Marine Biology. 50:1-55.
- Tepper et al. 2012. Cryptic Species: A mismatch between genetics and morphology in *Millepora*. *Marine Science* 2:57-65.
- Samayoa et al. 2017. Patterns of Millepore-*Symbiodinium* associations at two Caribbean locations: San Salvador, The Bahamas and South Water Caye, Belize. *Proceedings of the First Joint Natural History and Geology Symposium*. 1: 59-70.
- Jackson 2014 Executive Summary. **In: Status and Trends of Caribbean Coral Reefs: 1970-2012.** pp1-16. Edited by Jeremy Jackson, Mary Donovan, Katie Cramer and Vivian Lam.

Project Specific Reading

Millepore Phylogeny

- Ruiz-Ramos et al. 2014. Morphological and genetic evaluation of the hydrocoral *Millepora* species complex in the Caribbean. *Zoological Studies* 54:4
- Schweinsberg et al. 2016. Inter- and intra-colonial genotypic diversity in hermatypic hydrozoans of the family Milleporidae. *Marine Ecology* 38: e12388.
- Takama et al. 2018. Molecular phylogeny demonstrates the need for taxonomic reconsideration of species diversity of hydrocoral Genus *Millepora* (Cnidaria:Hydrozoa) in the Pacific. *Zoological Science* 35: 123-133.

Symbiodinium

- Buddemeier & Fautin 1993. Coral bleaching as an adaptive mechanism. A testable hypothesis. *BioScience* 43: 320-326.
- Buddemeier et al. 2004. The Adaptive Hypothesis of Bleaching. In **Coral Health and Disease**. Ed Rosenberg & Loya. Ch 24. Pp427-444. Berlin, Germany: Springer
- Weis. 2008. Cellular mechanisms of Cnidarian bleaching: stress causes the collapse of symbiosis. *J of Experimental Biology* 211:3059-3066.
- Fournier, A. 2013. The story of symbiosis with zooxanthellae, or how they enable their host to thrive in a nutrient poor environment. *BioSciences Master Reviews* Nov 2013:1-8.
- Paxton et al. 2013. Stress and death of cnidarian host cells play a role in cnidarian bleaching. *J of Experimental Biology* 216:2813-2820.
- Palumbi et al. 2014. Mechanisms of reef coral resistance to future climate change. *Science* 344:895-898
- Poland & Coffroth 2017. Trans-generational specificity within a cnidarian-algal symbiosis. *Coral Reefs* 36:119-129.

Millepore Nematocysts

- Iguchi et al. 2008. Isolation and characterization of a novel protein toxin from fire coral. *Biochemical and Biophysical Research Communications* 365:107-112.
- García-Arredondo et al. 2011. Effects of bleaching on the pharmacological and toxicological activities elicited by the aqueous extracts prepared from two “fire corals” collected in the Mexican Caribbean. *Journal of Experimental Marine Biology and Ecology* 396:171-176
- García-Arredondo et al. 2012. Structure of nematocysts isolated from fire corals *Millepora alcicornis* and *Millepora complanata* (Cnidaria:Hydrozoa). *The Journal of Venomous Animals and Toxins including Tropical Diseases*. 18:109-115
- Hernández-Matehuala et al. 2015. Cytolytic and systemic toxic effects induced by aqueous extract of the fire coral *Millepora alcicornis* collected in the Mexican Caribbean and detection of two types of cytolisins. *Journal of Venomous Animals and Toxins including Tropical Diseases*. 21:36.

In order to write the research paper required for this course, you will need numerous other references on the topic your group decides to pursue. Craig will compile a list of relevant papers on a flash drive and you may download all of these papers onto your computer after we arrive in Belize.