LITERATURE SUMMARY FOR OCTOCORALS

SPECIES IDENTIFICATION

Sanchez, J. A. and H. W. Wirshing . 2005. **A field key to the identification of tropical Western Atlantic zooxanthellate octocorals (Octocorallia: Cnidaria)**. Caribbean Journal of Science 41(3): 508-522.

ABSTRACT.— Despite their abundance and ecological importance, octocorals have received relatively little taxonomic attention compared to scleractinian (stony) corals. Identification of octocoral species is often difficult and ambiguous, and requires thorough microscopic examination of skeletal components (sclerites). Here, we provide a key for field identification—no microscope required—of 51 zooxanthellate (harboring photosynthetic dinoflagellate symbionts) octocoral species (3 soft and 48 gorgonian octocorals) from the tropical western Atlantic. The key is based on characters from colony branching pattern, surface morphology and texture, extended polyp size, and colony color. Although species confirmation by microscopic examination is still recommended, it is hoped that tools, such as this key, and approaches for fast octocoral identification will ease the difficulty of carrying out surveys and monitoring programs.

Key points:

- Most tropical western Atlantic zooxanthellate gorgonian octocorals are closely related phylogenetically and comprise a highly endemic fauna.
- Most taxa have sister species with similar morphological characters, which makes it, in some cases, extremely difficult to differentiate species without thorough microscopic examination.
- It is possible, however, after familiarization with the organisms, to identify tropical western Atlantic gorgonians macroscopically.
- **Provides flow chart diagram for fast visual identification of Caribbean symbiotic gorgonian corals.**
- The chart follows a simple dichotomous pattern based on the presence or absence of a character, and ends with a cluster of individual species each differentiated by a brief diagnostic description.
- Although it may be an oversimplification, the flow chart can be used as a rapid underwater guide.

POPULATION STRUCTURE

Lasker , H. R. 1990. **Clonal Propagation and Population Dynamics of a Gorgonian Coral.** Ecology 71(4): 1578-1589.

Key points:

- vegetative propagation can lead to high population growth rates.

- A simple model of colony growth indicates that, due to their initial size, fragment formed colonies have up to a 25-fold greater chance of reaching reproductive size than do larval recruits.
- No evidence of a trade-off between larval reproduction and vegetative propagation in Plexaura A, and it may be more accurate to characterize vegetative propagation as a strategy of clonal growth than as reproductive strategy.

Gotelli, N. J. 1991. **Demographic Models for *Leptogorgia virgulata*, a shallow-water gorgonian.** Ecology: 72(2): 457-467.

ABSTRACT. -- I used time—invariant and time—varying matrix models to analyze the demography of *Leptogorgia virgulata*, a shallow—water gorgonian. For a local population in the northeastern Gulf of Mexico, I estimated monthly rates of recruitment, colony growth, and mortality in a mapped 24—m^2 plot for 2 yr. In a time-invariant model, average mortality and recruitment rates were nearly balanced, so the population growth rate, ln (@l), was close to 0.0. An elasticity analysis showed recruitment contributed <5% to the measured rate of population growth. The most important component of population growth rate was survivorship, particularly of the large size classes. Results were similar for a patch model that incorporated spatial variation in recruitment and colony growth rates. Several published transition matrices of forest trees, which have a similar life history, were also characterized by low elasticities for recruitment. Fluctuations in population size of *L. virgulata* were analyzed with a time-varying matrix model. I randomized certain elements in the 23 monthly projection matrices and simulated the population track. For models with random temporal variation in survivorship, standard deviations (and coefficients of variation) of population size were consistently larger than observed. This result suggests that temporal variation in mortality rates tended to damp population fluctuations. The damping occurred at low population sizes: models with random variation in survivorship generated significantly smaller minimum population sizes than observed. In contrast, population tracks with random temporal variation in recruitment were not consistently different from observed. Although recruitment is widely regarded as an important factor structuring marine communities, its contribution to the temporal (but not spatial) dynamics of *L. virgulata* was minimal. This finding may be typical of long-lived organisms with delayed reproduction and indeterminate growth, such as forest trees and many sessile marine invertebrates.

Coffroth, M. A. and H. R. Lasker. 1998. **Population Structure of a Clonal Gorgonian Coral: The Interplay Between Clonal Reproduction and Disturbance**. Evolution 52(2): 379-393.

- Clonality is influenced by the way the local habitats promote propagule production and survival.
- Disturbance promotes the dispersal of the corals that have cloned cells spread across habitats.

Yoshioka, P.M. 1996. **Variable recruitment and its effects on the population and community structure of shallow-water gorgonians.** Bulletin of Marine Science 59(2):433-443.

- Recruitment varied between 5 and 10 colonies/m^2 for most of the study but reached episodic proportions (up to 45 col/m^2).
- Gorgonian populations can be termed "recruitment limited".
- "stock recruitment" relationships indicated that the species composition of recruit colonies largely follows the relative abundances of adult (large) colonies.

GROWTH

Brazeau, D. A. and H. R. Lasker. 1992. **Growth Rates and Growth Strategy in a Clonal Marine Invertebrate, the Caribbean Octocoral *Briareum asbestinum***. Biological Bulletin 183(2): 269-277.

- Colonies grew at a net rate of 16.6 cm/yr and added 1.2 branches/year.

Castanaro, J. and H. R. Lasker. 2003. **Colony growth responses of the Caribbean octocoral, *Pseudopterogorgia elisabethae*, to harvesting**. Invertebrate Biology 122(4): 299-307.

ABSTRACT. -- Colonies of the branching Caribbean gorgonian *Pseudopterogorgia elisabethae* were subjected to partial mortality at 2 sites in the Bahamas to study how colony growth responds to disturbances such as harvesting, grazing, and storm damage. Colonies were clipped so that either 4 branches or 10 branches remained. Growth rates of branches were then monitored over 1 year and compared with nearby unclipped colonies. No significant differences were found between branch extension rates among the 3 treatments. Extension rates of newly formed branches were significantly greater in all treatments than among branches present at the start of the experiment. Per capita branching rates were greater on the more severely clipped colonies and were smallest on control colonies. The absolute number of branches that became mother branches did not differ among treatments. Colonies clipped so that 4 and 10 branches remained had the same average number of mother branches per colony, and there was no significant difference between treatments in the average number of new branches formed on the colonies. Per capita branching rates were significantly different among treatments only because the relative proportion of branches that became mother branches was higher in colonies with four branches than in treatments with more initial branches. Total growth (cumulative growth on all branches) was not significantly different between the 2 clipped treatments. Many of the control colonies suffered extensive damage, which may have obscured the comparison of clipped and unclipped treatments; however, within the range of these clipping treatments, differing levels of partial mortality did not lead to different recovery rates. The lack of treatment effects is particularly relevant to assessing the effects of harvest techniques on the recovery and productivity of harvested, naturally occurring, colonies.

Sanchez, J. A. and H. Lasker. 2004. **Do multi-branched colonial organisms exceed normal growth after partial mortality?** Proceedings of the Royal Society of London 271: 117-120.

ABSTRACT. One of the advantages of modular colonial growth is the capability to recover after partial mortality. Tolerance to partial mortality is a known property of some resistant species of plants that respond to mortality with vigorous regrowth or overcompensation. It is not clear whether modular marine invertebrates such as octocorals overcompensate. This study provides evidence that following

injury to colonies (by breaking apical dominance), new growth exceeds normal rates of branching, as observed in some plants, in a degree correlated to the original multi-branched network setting (e.g. the number of original branches connected to main stem), in colonies of the Caribbean gorgonian octocoral *Pseudopterogorgia bipinnata*. This can be explained by the network of communicating vessels and canals inside octocoral colonies, which provide the structure for effective allocation of resources to regenerating parts.

Key points:

- Octocorals such as *P. bipinnata* exceed normal growth or overcompensate after partial mortality and/or breaking the apical dominance.

Goffredo, S. and H. R. Lasker. 2006. **Modular growth of a gorgonian coral can generate predictable patterns of colony growth.** Journal of Experimental Marine Biology and Ecology 336(2): 221-229.

ABSTRACT. The modular construction of colonial organisms can generate complex growth patterns that incorporate both growth and partial mortality. These patterns often confound simple age based descriptions of growth but, in some cases, modularity can generate predictable patterns of colony growth that are amenable to modeling approaches more commonly used in unitary organisms. Colonies of the Caribbean gorgonian *Pseudopterogorgia elisabethae* from a 20 m deep population in the Bahamas exhibit such characteristics. Mass was highly predictable from colony height, following a power function with an exponent of 2.1. Age, as determined from counts of annual growth rings was a good predictor of height and mass. The relationship between age and height was modeled using a Von Bertalanffy growth curve. Growth models from both the age:height relationship and from extrapolations of colony growth rates from another Bahamian population yielded similar but more variable results. Based on those data and previously published observations of spawning and survivorship, colonies reach sexual maturity at 5–7 y and can live to over 40 y. Using the Von Bertalanffy function to estimate ages from height facilitates interpretation of size frequency distributions and suggested enhanced recruitment on San Salvador Island following the passage of Hurricane Andrew in 1992. Although simple growth models do not characterize the variance inherent in modular growth, these models can provide useful tools for the interpretation of population data.

REPRODUCTION

Lasker, H.R. 2006. **High Fertilization Success in a Surface-Brooding Caribbean Gorgonian**. Biological Bulletin 210(1): 10-17.

ABSTRACT. -- Colonies of the Caribbean gorgonian *Pseudopterogorgia elisabethae* release eggs that are retained on the colony surface where they are fertilized and then develop. In December 2001, spawning on San Salvador Island, Bahamas, occurred over 6 d, with spawning by any one colony limited to 1–3 d. With the exception of the first and last days of the spawning period, fertilization success was high, often greater than 90%. Eggs collected in December 2001 had an overall fertilization success of more than 66%. At one site, the increase in fertilization after the first day of spawning correlated with male spawning, but male gonad index was a poor predictor of fertilization success. The number of male

colonies close to a female was not correlated with fertilization success. Surface brooding is an efficient mechanism for "harvesting" sperm released upstream of female colonies. By maintaining their eggs at a single location, surface-brooding species can extend the period over which eggs are likely to encounter sperm. As a result, fertilization success is summed across the temporal variance in sperm availability, and the need for very high densities of sperm, with its concomitant risk of polyspermy, may be reduced.

Key points:

- Fertilization success was high, often greater than 90%.

Kapela, W.L., H. R. 1999. **Size-dependent reproduction in the Caribbean gorgonian *Pseudoplexaura porosa***. Marine Biology 135: 107-114.

- For *Pseudoplexaura porosa* determined the colony size at first reproduction, size-dependent polyp fecundities, and whole gonad production, and follow the gametogenic cycle.
- Of 120 colonies ranging in height from 20-250cm, only colonies taller than 50 cm were reproductive.

ZONATION / DISTRIBUTION

Wheaton, J. L. 1987. **Observations on the octocoral fauna of Southeast Florida's outer slope and fore reef zones**. Caribbean Journal of Science 23(2): 306-312.

- *Iciligorgia shrammi* – common, greatest biomass.
- *Plexaura flexuosa* – most abundant.

Goldberg, W.M. 1973. **The ecology of the coral-octocoral communities off the Southeast Florida coast: geomorphology, species composition, and zonation**. Bulletin of Marine Science 23(3): 465-488.

- 39 species of gorgonians are found here and define a typical coral reef community.
- Gorgonian diversity is maximal at a depth of 15-20 m.
- Mean diversity of 25.1 col/m^2

MISCELLANEOUS

Dr. Howard Lasker
Graduate Program in Evolution, Ecology and Behavior
876 Natural Sciences Complex
State University of New York at Buffalo
Buffalo, NY 14260

Research Summary:

Population ecology of *Pseudopterogorgia elisabethae*. - *Pseudopterogorgia elisabethae* is a common gorgonian of coral reefs throughout the Caribbean. Colonies are harvested for a pseudopterosin, a natural product that has anti-inflammatory properties and which is used as a topical agent in cosmetics. We are studying and modeling the population ecology of *P. elisabethae* focusing on those parameters crucial to the development of a management plan. The project encompasses studies of the species recruitment, growth and survivorship. We are also studying *P. elisabethae* population genetics as well as developing methods for colony propagation that can be used in mariculture. A larger and more general goal of the project is to identify the parameters that must be incorporated in analyses of coral populations and determine whether there are ''ecologic profiles'' that can be used to differentiate species that should be highly protected from those for which managed harvesting is ecologically sound.

Fertilization success among broadcast spawning benthic invertebrates. - Analyses of marine invertebrate life history strategies have generally ignored fertilization rates as a factor in the organism's life history, and most studies have implicitly assumed high fertilization rates. Our data (Lasker et al. 1996) on Caribbean gorgonians are among the few data on in situ fertilization rates for a broadcast spawning species. Fertilization rates of eggs vary from 0 to near 100% on different nights and different spawning events. The variance between sites and times is enormous, but much of the time many eggs go unfertilized. This result has now been verified in four different species in reefs in both Panama and the Florida Keys. The presence of sperm limitation among broadcast spawning species suggests a variety of reproductive strategies that may be pursued by colonies and also suggests dichotomies between male and female colonies. We are examining fertilization strategies among gorgonians using a combination of fertilization success models, data on in situ fertilization and genetically determined paternity of larvae produced in natural spawning events.

Gutierrez-Rodriguez, C., M. S. Barbeitos, J. A. Sanchez and H. R. Lasker. 2009. **Phylogeography and morphological variation of the branching octocoral *Pseudopterogorgia elisabethae.*** Molecular Phylogenetics and Evolution 50(1):1-15.

ABSTRACT. -- Coral reef anthozoans exhibit extensive morphological variation across and within environmental clines making it difficult to define species boundaries. The relative contributions of genetic variation and ecophenotypic plasticity to the observed phenotypic variation are unknown in most cases. The branching octocoral *Pseudopterogorgia elisabethae* is widely distributed throughout the Caribbean and colonies vary in appearance within and among populations. We performed genetic and morphological analyses of *P. elisabethae* from multiple locations within the Bahamas, as well as a Florida Keys and a distant western Caribbean location to determine the levels of genetic and morphological variation (colony form and sclerites characteristics) across populations from different sites, and assessed whether there was congruence between the genetic and morphological variation. Based on sequences of the internal transcribed spacer region of the ribosomal DNA, four groups were found that generally correspond to the geography of the Bahamas. Morphometric analysis of branch and branchlet characteristics indicated that colonies from two of the sites differed from the rest, but there was no clear correspondence between genetic and morphological variation. In general, there were

no qualitative differences in the sclerites from the different populations. However, there were some differences in the dimensions of scaphoids and rods of colonies from different sites. This study has shown that *P. elisabethae* displays genetic and morphologic variation among some populations of the Bahamas, Florida and San Andres, Colombia. ***P. elisabethae is harvested in the Bahamas and these findings should be considered in management plans and conservation efforts for the species.***