第七屆海洋無脊椎動物研習會

造礁珊瑚
的
分類、鑑定及保育

時間：1993年5月13～15日

地點：國立中山大學海洋科學學院

主辦單位：行政院國科會生命科學研究推動中心

贊助單位：國立海洋生物博物館籌備處、
臺灣電力公司

協辦單位：國立中山大學海洋生物研究所

Non-Invasive Research and Monitoring Techniques for Coral Reefs

Judith C. Lang

Texas Memorial Museum
University of Texas, Austin, Texas

Most reef corals and other organisms that contain zooxanthellae (photosynthetic dinoflagellates) can tolerate only narrow range of physical and chemical environments. Increasingly, coral reefs near human habitation are stressed by anthropogenic perturbations, and reef ecosystems are , perhaps, a harbinger of global climate change. Long-term information on the dynamics of reef organisms and communities is needed to distinguish human-induced changes from those which occur naturally.

Baseline data to rigorously assess the status of most reefs are few. Reef resources must be catalogued at nested scales to include levels of resolution from centimeters to square kilometers. indicator species that are usually successful or display heightened sensitivity to a locally-important perturbation can provide critical insight into the health and functioning of an ecosystem. Data on a subannual scale are required when condition of stress, and susceptibility to infections or bleaching (loss of algae and/or of photosynthetic pigments from zooxanthellate organisms) vary seasonally.

High-resolution color photographs and videotapes, calibrated with a gray scale, are potentially a valuable source of information concerning many aspects of reef health, structure and function-including recruitment, mortality, and relationships with adjacent topographic information is used for non-destructive measurements of colony shape, size and three-dimensional growth. Nonetheless, certain classes of information are most readily visible to the eye underwater and best recorded in-situ.

Illustrations of new approaches to ecological monitoring/research will include:

1. Seasonal indices of color change in randomly-chosen colonies of *Porites astreoides* and *Montastraea* spp. (both excellent indicators of bleaching in certain habitats), based on quantitative analyses of digitized photographic images.
2. Benthic cover and "apparent health" indices for reef corals, using a combination of manually-recorded chain intercepts, marked chain points visible in high resolution videotapes, a geographic information systems analysis of aerial photographs, and customized software.

Multicharacter Approaches to the Taxonomy of Reef Corals (*Montastraea* and *Porites*).

Dr. Judith C. Lang
Texas Memorial Museum, Austin, Texas, USA

Species boundaries are best defined by the use of multiple independent methods. One strength of the multicharacter approach is that controversies over the adequacy of any particular trait lose some of their potency if a consistent pattern emerges when all characters are considered together.

Species designations in the genus *Porites* have been controversial for the last 100 years. It is commonly asserted that species of *Porites* show a gradual continuum in morphological character, and do not form discrete morphological units. Weil (in press) used electrophoretic and morphological techniques on a large number of specimens to reassess the taxonomy, and to explore the evolutionary relationships, of the extant *Porites* in the Caribbean (Venezuela, Curacao, Panama) and Eastern Pacific (Panama, Galapagos). Both methods produced results in support of the specific distinctiveness of the three ramose (*P. divaricata*, *P. furcata*, *P. Porites*) and three massive (*P. astreoides*, *P. "branneri"*, *P. colonansis*) species in the Caribbean and of two massive (*P. lobata*, *P. panamensis*) species in the Eastern Pacific. The presence of diagnostic skeletal characters that reliably separate these species is evidence for an important genetic component to morphology in this genus. Another multicharacter, taxonomic study and phylogenetic analysis of *Porites* is based on specimens collect in St. Croix, Florida and Belize by Potts *et al.*(in prep.), who express skepticism that current data are sufficiently robust to reliably characterize some species within this genus.

Behavioral, electrophoretic, micromorphological, and other criteria were employed in the somewhat controversial description of three cryptic species within *Montastraea annularis* (Knowlton *et al.*, 1992; Weil and Knowlton, in press), widely distributed scleractinian that structurally dominates many western Atlantic reef communities. At the heart of this ongoing of the newly-recognized species in the field. Meantime, Holland *et al.* (1992) have applied mitochondrial DNA sequencing to this taxon, which should facilitate studies of its taxonomy and phylogeny.

← line missing here

"Zooxanthellae"--an outsider's review

At least 20 species of photosynthetic dinoflagellates, distributed in seven genera and four orders of the Dinophyceae, are currently known to be symbiotic with marine invertebrates. Symbiotic algae are classified on the basis of morphology, chromosomes, biochemistry, physiology and genetics (originally isoenzymes, now also small subunit ribosomal DNA sequences). At present, some aspects of "classical" dinoflagellate phylogeny and molecular phylogeny are not in agreement (*e.g., Amphidinium* does not group with *Symbiodinium* in any of the phylogenetic trees constructed by McNally *et al.*, in review, although both these genera are in the order Gymnodiniales.)

Phylogenetic similarity among the symbiotic dinoflagellates may--or may not--correlate with the phylogenetic similarity of their respective animal hosts. Many dinoflagellate-invertebrate symbioses are highly specific (*e.g., Symbiodinium meandrites* inhabits *Meandrina meandrites f. meandrites* whereas *Meandrina meandrites f. danae* has an undescribed species of *Symbiodinium*). Some animal hosts presently treated as conspecifics have different symbionts (*e.g.*, the algal symbionts in *Velella velella* are *Scrippsiella chattonii* in the Mediterranean and *S. velella* off California; the "light" morph of *Millepora dichotoma* in Eilat contains a species. of *Symbiodinium*, the "dark" morph contains *Gloeodinium viscum*). Perhaps we need to reconsider the taxonomy of these animal hosts--or reinstate some previously described host species. However, these are also individual animals that host more than one symbiont (*e.g.*, individuals of the flatworm *Haplodiscus* sp. contain both *Amphidinium belauense* and a *Symbiodinium*-like alga), and some algal symbionts inhabit more than one animal host (*e.g., Symbiodinium microadriaticum* is found in both *Cassiopeia xamachana* and *C. frondosa.*). Clearly we still have lots to learn about the "Zoophyta".

Multicharacter Approaches to the Taxonomy of Reef Corals (*Montastraea* and *Porites*).

Species boundaries are best defined by the use of multiple independent methods. One strength of the multicharacter approach is that controversies over the adequacy of any particular trait lose some of their potency if a consistent pattern emerges when all characters are considered together.

Species designations in the genus *Porites* have been controversial for the last 100 years. It is commonly asserted that species of *Porites* show a gradual continuum in morphological characters, and do not form discrete morphological units. Weil (in press) used electrophorectic and morphometric techniques on a large number of specimens to reassess the taxonomy, and to explore the evolutionary relationships, of the extant *Porites* in the Caribbean (Venezuela, Curacao, Panamá) and Eastern Pacific (Panamá, Galapagos). Both methods produced results in support of the specific distinctiveness of three ramose (*P. divaricata, P. furcata, P. porites*) and three massive (*P. astreoides, P. "branneri", P. colonensis*) species in the Caribbean and of two massive (*P. lobata, P. panamensis*) species in the Eastern Pacific. The presence of diagnostic skeletal characters that reliably separate these species is evidence for an important genetic component to morphology in this genus. Another multicharacter, taxonomic study and phylogenetic analysis of *Porites* is based on specimens collected in St. Croix, Florida and Belize by Potts *et al.* (in prep.), who express scepticism that current data are sufficiently robust to reliably characterize some species within this genus.

Behavioral, electrophoretic, micromorphological, and other criteria were employed in the somewhat controversial description of three cryptic species within *Montastraea annularis* (Knowlton *et al.*, 1992; Weil and Knowlton, in press), a widely distributed scleractinian that structurally dominates many western Atlantic reef communities. At the heart of this ongoing dispute is not the suitability of nonskeletal traits but rather the mormorphological discreteness of the newly-recognized species in the field. Meantime, Holland *et al.* (1992) have applied mitochondrial DNA sequencing techniques to this taxon, which should facilitate future studies of its taxonomy and phylogeny.

"Zooxanthellae"--an outsider's review

At least 20 species of photosynthetic dinoflagellates, distributed in seven genera and four orders of the Dinophyceae, are currently known to be symbiotic with marine invertebrates. Symbiotic algae are classified on the basis of morphology, chromosomes, biochemistry, physiology and genetics (originally isoenzymes, now also small subunit ribosomal DNA sequences). At present, some aspects of "classical" dinoflagellate phylogeny and molecular phylogeny are not in agreement (*e.g., Amphidinium* does not group with *Symbiodinium* in any of the phylogenetic trees constructed by McNally *et al.*, in review, although both these genera are in the order Gymnodiniales).

Phylogenetic similarity among the symbiotic dinoflagellates may--or may not--correlate with the phylogenetic similarity of their respective animal hosts. Many dinoflagellate-invertebrate symbioses are highly specific (*e.g., Symbiodinium meandrites* inhabits *Meandrina meandrites* f. *meandrites* whereas *Meandrina meandrites* f. *danai* has an undescribed species of *Symbiodinium*). Some animal hosts presently treated as conspecifics have different symbionts (*e.g.*, the algal symbionts in *Velella velella* are *Scrippsiella chattonii* in the Mediterranean and *S. velellae* off California; the "light" morph of *Millepora dichotoma* in Eilat contains a species of *Symbiodinium*, the "dark" morph contains *Gloeodinium viscum*). Perhaps we need to reconsider the taxonomy of these animal hosts--or reinstate some previously described host species. However, there are also individual animals that host more than one symbiont (*e.g.*, individuals of the flatworm *Haplodiscus* sp. contain both *Amphidinium belauense* and a *Symbiodinium*-like alga), and some algal symbionts inhabit more than one animal host (*e.g., Symbiodinium microadriaticum* is found in both *Cassiopeia xamachana* and in *C. frondosa*). Clearly we still have lots to learn about the "Zoophyta".

How "Healthy" are Reef Corals?

Dr. Judith C. Lang
Texas Memorial Museum
Austin, Texas, USA

Scleractinian reef corals are now known to be susceptible to a variety of diseases. It appears that environmental factors are important in the mediating the virulence of at least some of these conditions (Peter, 1993). Given increasing levels of concern that numerous tropical coastal ecosystems are deteriorating in many parts of the world, how can we study the "health" of reef corals and the reefs they inhabit?

Standardized point-count techniques are well suited for community-level assessments of "health" in reef corals, especially when rapidity, simplicity, economy and broad applicability are required. "Appearance" or "visible condition" (in terms of coloration, accumulations of sediment or mucus, symptoms of disease, evidence of recent predation, competition, etc.) is quantified more easily at discrete points than along linear intercepts or at the scale of entire colonies. Capturing data as close-up, high-resolution color video images has the further advantages of providing permanent records, that the tapes can be scored by more than one observer (working either independently or together), that organisms can be identified with greater confidence by consulting the relevant literature and that indices of colour change can also be developed (Lang et al. 1992, 1993).

Successive *in-situ* observations, ideally coupled with photographs or videotapes, can provide extremely useful "health" records for individual reef corals over time. Non-invasive, time-series ecological data for "indicator organisms" may help to relate the effects of any given environmental stress to a host of other physical and biological factors that collectively affect their ability to persist in nature. To understand the underlying causal mechanisms for the differential susceptibility of indicators, however, requires sampling and interdisciplinary collaborations.