

WORKSHOP SUMMARY

Workshop Achievements

The goals and objectives set for the Workshop were met and exceeded. The following areas capture achievements from this workshop:

Nomenclature for Microscopic Anatomy of Corals

The first formalized group effort to describe the histopathology of coral lesions was undertaken at this workshop. During the deliberations several of the participants expressed concern about the lack of adequate terminology for histopathologists to precisely describe the locations of lesions in hexacorals and octacorals. Several new terms were suggested that were thought to better identify tissues by function, recognizing that different etiologic agents can affect different functional tissues and have very different effects on the animal. As a result, the drafting of a white paper has been recommended that outlines the coral histopathology terminology dilemma, offers suggested terminology and definitions, and seeks critical review from the invertebrate zoology, histology, cell biology and pathology communities.

Coral Lesion Description and Diagnostic Criteria

Over 40 different coral ‘diseases and syndromes’ have been reported worldwide (Green and Bruckner 2000). Participants at this workshop conducted a histopathology review of 15 lesions from 9 presumed disease conditions based on gross observations (aspergillosis, black band, dark spots, growth anomaly, yellow blotch, white band, white patch, white plague II and an unknown disease characterized by tissue sloughing) and one presumed physical damage (snail predation). These lesions were collected from 8 scleractinian coral species (*Acropora cytherea*, *Acropora palmata*, *Acropora prolifera*, *Dichocoenia stokesii*, *Montastraea annularis*, *Montastraea faveolata*, *Siderastrea siderea*) and one gorgonian species (*Gorgonia ventalina*).

This review provided a consensus of microscopic findings associated with each of these lesions and consistent findings were noted for some of the field diagnosed diseases. These did not provide, however, definitive differential diagnostic characters for any of the diseases except gorgonian mycosis. The descriptions for all of the lesions though will provide benchmarks for future studies.

Obviously these efforts were only the beginning of an in-depth, critical comparative review of coral lesions to confirm field diagnoses. There remain a number of disease lesions that were not reviewed. Many more descriptions of normal tissue and the histopathology associated with the lesions of recognized coral diseases will have to be added to these first attempts. It was also recognized that it is imperative for collection and processing techniques to be optimized with the goal of eliminating all autolysis, collection and processing artifacts.

Advanced Training

This workshop provided one of the first opportunities for board-certified medical and veterinary pathologists and invertebrate histopathologists to come together to exchange

information, identify gaps in our knowledge of, and gain experience with, coral histopathology. This workshop served as a form of continuing education or cross-training for all of the participants. As more individuals with experience in reading coral histology slides are trained to conduct coral histopathology, the field of coral pathology will grow. Their contributions along with the integration of information from marine biologists, microbiologists, virologists, toxicologists, and molecular biologists will provide more parameters to enhance the accuracy of differential diagnosis and elucidation of the pathogenesis and etiology of coral diseases. Bringing together the diversity of specialists needed to develop coral pathology is difficult, but their interest drives their involvement. We recognize that new means of facilitating these valuable interactions must be identified. One means to facilitate interactions and bring together specialists from remote locales is a new technology, introduced at this workshop, Virtual Slides. The Virtual Slide Technology allows connection among investigators via web conferencing to explore and develop coral microscopic anatomy and pathology. The participants recommended pursuing access to this technology to meet the needs of coral researchers, especially those in remote locations, interested in histology and histopathology for both education and consultation pursuits.

Overall, the following were achieved at this workshop:

- a) A standardized approach for describing microscopic morphology.
- b) A standardized format for describing histology.
- c) The initiation of standardized nomenclature for microscopic anatomy of corals.
- d) Descriptions of 15 lesions using the above formats for corals from the Atlantic and Pacific.
- e) Consensus on a standardized format for histopathology reports, nomenclature for microscopic anatomy and pathology, and recommendations to improve histological features reached during this workshop will enable development of instructional materials and distance learning tools for coral histopathology.

Coral pathologists must adopt strict standards for their field to become recognized by the medical and diagnostic communities. To take advantage of the depth and breadth of experience in those communities, standards must be adopted for (1) descriptors based on accepted medical terminology, (2) consistent and concise descriptions of lesions in the field, as well as (3) clinical morphological diagnoses in the laboratory and review of diagnostic criteria for new and emerging diseases among the coral pathology community.

RECOMMENDATIONS:

- Record the normal range of histological characteristics for the priority species of healthy corals in the Pacific and the Western Atlantic. This would include developing standardized methods to collect corals on a spatial and temporal basis and conduct histology using light and electron microscopy on selected specimens.
- Develop a web-based virtual archive of coral histology and histopathology to facilitate contributions by new scientists to the field of coral health and to enhance the capabilities of existing scientists.
- Disseminate the report via the Coral Reef Information System and other appropriate outlets.
- Develop a white paper to justify the rationale for an internationally recognized systematic terminology for coral histopathology in consultation with experts in scientific nomenclature.
- Conduct monthly reviews of coral lesions, using Virtual Slide technology and teleconferencing, to continue adding to the body of knowledge of coral histopathology.
- Recommend the kinds of data necessary for epizootiological studies. These data need to be gathered during sample collections as they will not be available later.
- Develop a standard protocol that identifies the type of samples and analyses needed based on known pathology and etiology of a disease from gross observations.
- Develop GIS expertise within the consortium for mapping disease distribution, trends and environmental factors.

ACKNOWLEDGEMENTS

The generous contribution of time, effort and expertise from a number of individuals made the *Coral Disease and Health Workshop: Coral Histopathology II* and this publication possible. We offer a sincere thank you to all of you.

We would like to recognize the Organizing Team, Drs. Lou Sileo, Shawn McLaughlin, Sylvia Galloway and Cheryl Woodley, who set the vision for the workshop, developed the agenda and identified expertise in key facets of pathology, histopathology and coral histopathology to establish a common nomenclature for the microscopic study of coral disease. Drs. Lou Sileo and Cheryl Woodley both deserve a special note of appreciation: Lou for his efforts and time prior to the meeting to devise a process to effectively generate a morphologic diagnosis and then his hard work to shepherd the group discussions to a productive end; and Cheryl for her leadership, working with those from disciplines other than her own, which has proven crucial in moving this coral histopathology effort forward.

Particular thanks go to Ms. Julie Higgins (NOAA NOS CCEHBR) who jumped in to help with the final preparations for the workshop on her first day on the job and to Ms. Samantha Ryan for helping to transport workshop participants.

We are especially grateful to NOAA's International Registry of Coral Pathology and Dr. Shawn McLaughlin and Ms. Kathy Price for the many long hours they spent prior to the meeting preparing the histological slides and slide sets to allow individual and collective deliberations of representative coral lesions. Without these materials and this valuable resource (i.e., IRCP), this workshop just would not have happened.

We would like to express sincere appreciation to the Department of Pathology and Laboratory Medicine at the Medical University of South Carolina who hosted the workshop. The assistance and accommodations provided by the Department were incredible. In particular, we appreciate the time Dr. Debra Hazen-Martin spent helping logistically and in various other critical matters to the workshop. We also appreciate the expertise in human pathology and wisdom that Dr. Russell Harley brought to the discussions. We are most grateful to Mr. James Nicholson who truly went beyond the call of duty in helping us in almost every facet of the meeting from setting up a webpage with frequent updates prior to the meeting to lending his expertise in all of the technology involved in this conference. Mr. Nicholson made arrangements to have high quality microscopes, cameras and going the extra-mile in digitizing slides to allow us to have access to the most current technology available in histology – virtual slides –for our deliberations. He also challenged confocal microscopy with coral tissue – live and fixed! And added such special touches as a group photo and a DVD of the images obtained during the meeting for each participant to take home. It is unlikely we would have accomplished as much as we did without his expert assistance, patience and dedication. Jim, we thank you.

We would like to thank Dr. Robert Ogilvie, MUSC Department of Cell Biology and Anatomy, for introducing us to a new digital technology that is revolutionizing histology and histopathology in the medical field. His presentation and the use of the virtual microscope opened a lot of eyes during the meeting, revealing just how powerful and useful this tool can be to share knowledge among pathologists and a significant enhancement to coral histopathology and its communications globally.

We also thank Dr. Ogilvie and Aperio Technologies for bringing the ScanScope slide digitizer for demonstration at the workshop. Access to the Aperio System allowed us to exceed our expectations for the meeting.

Dr. Sylvia Galloway deserves special recognition for the role she has played in producing this report. Her role began by serving as recorder during the four days of deliberation, where she so aptly synthesized the discussions for each participant to review and then facilitated bringing them to consensus on each pathology opinion that is offered in this report. Sylvia didn't stop there, but has spearheaded the editing, layout and design of this publication.

We must acknowledge Dr. Thierry Work for his contributions to the workshop and the generation of this publication. Thierry constantly kept us focused on the need for this workshop to have a useful product. During the meeting his initiative, drive and just plain energy, got us over some humps and propelled us into having a draft report before everyone left the meeting and well on the way to a finalized product within three weeks. Thierry we are exceedingly grateful for your leadership in this endeavor.

We are especially grateful for the advice provided by four outside experts in anthozoan and coral anatomy and histology: Stephen Cairns, National Museum of Natural History, Smithsonian Institution; Daphne Fautin, University of Kansas; Walter Goldberg, Florida International University; and Jaroslaw Stolarski, Intytut Paleobiologii PAN. Their combined wisdom enabled us to provide strong definitions for several terms that were troubling to the workshop participants and thus will further good communication amongst coral biologists and histopathologists.

We are particularly indebted to Dr. Esther Peters, a pioneer in the field of coral histology and histopathology for freely giving of her time and expertise both during the workshop and afterwards. Her detailed review/editing of this report insured that it is of high quality. In particular, we appreciate the refinement of the glossary that she and Dr. Esti Winter worked on together calling upon the expertise within the coral community to provide the most authoritative definitions.

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