2016 Heard Island Expedition Project Description

Definition

TITLE

DIVERSITY: 1. SEARCH FOR XANTHOPHYCEAE IN CULTURES OF SOIL SAMPLES AT HEARD ISLAND

Abstract

Samples of soil will be brought into culture in order to isolate specimens of the algal class Xanthophyceae. The specimens will be analyzed for critical molecular markers for distinguishing cryptic species.

Principal Investigator	Robert A Anderson	Friday Harbor Laboratories, University of Washington
Co-Investigator	Thomas Friedl	Albrecht-von-Haller-Institut für Pflanzenwissenschaften
Co-Investigator	Nataliya Rybalka	Georg-August-Universitaet Goettingen
Co-Investigator	Robert van Syoc	California Academy of Sciences
Co-Investigator	Gordon Hendler	Los Angeles County Museum of Natural History
Co-Investigator	Jody Martin	Los Angeles County Museum of Natural History
Co-Investigator	Harold Heatwole	North Carolina State University
Co-Investigator	William Miller	Baker University
Co-Investigator	Onsite team members	Cordell Expeditions
Co-Investigators	Additional collaborators to be named	

Context

NOTE:

This project is one of a group of similar projects, the goal of which is to extend the known species biodiversity of Heard Island. The group seeks to identify species, whether already documented or new, to extend the known biodiversity of Heard Island. This and the other projects in this group require collecting a set of specimens, typically of soil and sediment, that could contain micro- or macro-fauna, algae, fungi, or similar organisms that cannot be recognized in the field, but nevertheless comprise a significant part of the ecosystem. All projects in this group can make use of essentially the same collection of samples, hence it is not proposed to make separate collections for each specific investigator, but rather to make a single collection that will be divided among the members of the group.

This document describes one of the investigations in this group, namely the study by Robert A. Anderson. Other investigations in this group make essentially the same request, namely a limited number of voucher specimens from which to make laboratory identifications and to accession the specimens into permanent archival collections for future research.

Background

I am primarily interested in the algal class Xanthophyceae, which has a number of genera that commonly occur in soils, especially cold soils like Antarctica and the Alps Mountains. I have collaborated with Prof. Dr. Thomas Friedl and his wife N. Rybalka in studies on xanthophycean algae (see below). The collaboration began from my earlier work on the Xanthophyceae where I was able to demonstrate critical molecular markers for distinguishing cryptic species. This is a significant point for studying soil algae because many of their morphological traits have been reduced and lost during their adaptation to the harsh soil environment.

Motivation and goals

My goal would be to isolate the Xanthophyceae into pure culture; once in culture, I would ask collaborators such as Thomas Friedl to carry out the molecular studies. There are also a number of other algal taxa that inhabit soils, and I would attempt to isolate those species into culture as well. Many green algae grow in soils, and in addition groups such as the Chrysophyceae, cyanobacteria, diatoms, Eustigmatophyceae and unicellular red algae can be

found growing on or in soils.

Description

Onsite

Equipment	Camera, GPS, clean soil sampler and containers
Location(s)	Any location with reasonably rich soil. In addition, I would also be willing to attempt isolating algae from the coastal waters of these islands. It is likely that many planktonic species will die because of sampling protocols, but I am unaware of any phytoplankton cultures from the islands. Therefore, even unlikely survivors may be of interest to the scientific community.
Procedure	My requirements would be soil samples that were collected near the air-soil interface (i.e. collected in the top 1-2 cm of soil). Samples may be placed in a plastic bag (e.g. Zip-Lock bag; Whirlpac bag) and sent to me without additional concerns for temperature or handling.

Records

Photo-documentation	Each item will be documented by GPS location, photographs of the local environment, and a close-up image of the item as found.
Logging	The samples will be labeled with regard to collection site (latitude-longitude coordinates), date, and other relevant information.
Nonliving specimens	Any object that could be considered a potential threat to any species, particularly megafauna such as seabirds, will be defined as debris, and documented and collected.
Live specimens	All samples for culturing must be live, i.e., unfixed and protected from extreme environmental stress.

Post-expedition procedure

Destination(s) of records	Principal Investigator, University of Washington. The cultures will be deposited in public culture collections (e.g. USA and Australian culture collections).
Processing of records	Upon receipt of the samples, I will establish enrichment cultures to grow the algae, and then I will begin the process of isolating the algae into culture. For example, soil algae grow very well on agar, so streaking enrichment cultures often leads to single-cell isolations and eventually to axenic cultures. Alternatively, cells can be isolated by micropipette.
Publication(s) expected	Paper in the Heard Island monograph. Journal notes as appropriate.
Definition of success	Identification of Xanthophyceae in culture and determination of molecular markers.

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15. Congruence of chloroplast- and nuclear-encoded DNA sequence variations used to assess species boundaries in the soil microalga Heterococcus (Stramenopiles, Xanthophyceae), Nataliya Rybalka · Matthias Wolf · Robert A Andersen · Thomas Friedl
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Supplementary material

Suppl. 1 Introduction to the Xanthophyta: Yellow-green Algae

The Xanthophyta include more than 600 species. Members of this group are photosynthetic organisms which live primarily in freshwater, though some are found in marine waters, in damp soil, or on tree trunks. They generally are not abundant when they are found at all, and many species have only been found once. Despite this, they are the dominant producers in some salt marshes, and some, like Tribonema, are cosmopolitan in their distribution.

Unlike the other Chromista, Xanthophyta completely lack the brown pigment fucoxanthin. Like these other chromists however, they lack chlorophyll b, and instead have chlorophyll c. This gives them a characteristic yellowish-green color, as opposed to the golden color or their relatives, which may make them difficult to recognize as chromists.

Many xanthophytes produce a cell wall, though it is not composed of cellulose (as in plants) or of chitin (as in fungi). In fact, the cell wall composition of these protists is still completely unknown, though it is known that cysts in this group will often contain silica in their walls. The walls are often, but not always, composed of two overlapping cylindrical halves which fit together, one slightly inside the other.

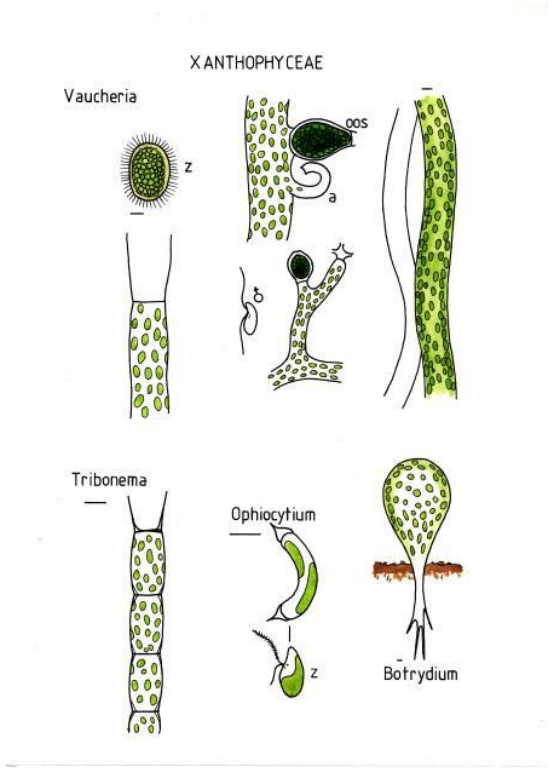
Xanthophytes may be sessile or free-living. Most are flagellated unicells, but many are colonial, living as naked cells in a gelatinous envelope. There are also filamentous forms, which produce long chains of cells, and there are coenocyticforms, such as the water-felt Vaucheria. These coenocytes are tubular multinucleated filaments with no internal partitioning into cells. Some orders may live as an amoeboid stage, living on or within plants; in ways similar to another chromist group, the slime nets. However, it is currently thought that the Xanthophyta are more closely related to the brown algae than to any other group.

Sexual reproduction is known only in two genera: Botrydium, in which the sex cells are isogamous, and Vaucheria, in which the cells are oogamous. Most reproduction is asexual, and this is accomplished by a wide variety of means, including fragmentation of filaments, but often involving the production of some kind of spore. Spores may be flagellated and free-swimming (zoospores), or they may be non-flagellated (aplanospores). Spores are formed internally, being released by rupture of the old cell wall.

There are no positively known fossils of the Xanthophyta, though spores and rock deposits of the Miocene and Pleistocene have been attributed to this group. It is likely that the lack of a fossil record results more from the fact that their cyst morphology is poorly studied, rather than from a lack of preservation, since the silicified cysts of this group ought to be found.

[Source: http://www.ucmp.berkeley.edu/chromista/xanthophyta.html]

Suppl. 2 Images of Xanthophyceae



(Above) Xanthophyceae [Source: http://www.freshwaterlife.org/]

(Above left) Xanthonema sp. [Source: http://protist.i.hosei.ac.jp/pdb/images/Heterokontophyta/Xanthonema/sp_1c.html]

(Above right) Goniochloris [Source: http://protist.i.hosei.ac.jp/pdb/images/Heterokontophyta/Bumilleriopsis/sp_3.html]

Evaluation

HIMI Management Plan

The present project is sanctioned by Items **A2, A3, A5, A6,** and **C3** of **Table 2, Section 5.5** of the HIMI MP:

> A2) Surveys of indigenous species to obtain baseline information to copare against non-native species.
>
> A3) Surveys to determine the presence and extent of possible non-native species.
>
> A5) Long-term monitoring of climate, glaciers, and fauna and flora colonization of newly deglaciated areas.
>
> A6) Surveys to improve understanding of the Reserve's biodiversity and its response to climate change.

Section 5.5 of the HIMI Management Plan provides the following:

> Research within the Reserve is required for the integrated and ecologically sustainable management of the broader HIMI region. … Scientifically robust evidence is needed to make effective conservation management decisions. … Research and monitoring activities must be undertaken in accordance with the research and monitoring priorities identified in Table 2 and the Australian Antarctic Science Strategic Plan. … Research also facilitates the fulfilment of public reporting requirements.

In combination with the remarks about Table 2 (above), we interpret this statement to mean that the research described in this document is consistent with the AAD mission for management of the HIMI.

The HIMI Management Plan further provides

> … the policies … require … that: any biological resources taken are not intended to be used for commercial purposes; … that samples will not be given to other people … without permission … [Parts of this excerpt are omitted solely for space requirements in this document, and are not meant to be omitted in the agreement.]

We do affirm that this project has no commercial interest or activity, and that Cordell Expeditions guarantees conformance with the above statement, both in words and meaning.

Priority

Given the high-quality of this investigation and the high likelihood of yielding new information, this project has the top priority for the 2016 Expedition. It will be given priority in time and manpower.

Specimens

This project is predicated on obtaining viable living samples of soil that can be cultured into samples viable for molecular typing and determining phylogenetic relationships within the Class. No Xanthophyceae are known from Heard Island, according to the species list in Woehler and Green, *Southern Ocean Sentinel* (2006).

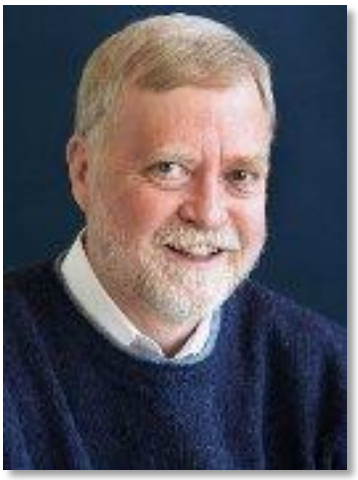
In addition, the collection of a relatively large number of soil samples is indicated as the correct strategy for obtaining statistically meaningful data. Conversely, it would make no sense to collect a very small number of samples and attempt

analysis onsite. Indeed, individuals of the Class cannot be recognized in the field, and must be put into culture to observe, identify, and analyze them.

Risks

There are no inherent risks in the work of this project, other than the risks associated with human access to the collection sites, which are covered in the Risk Management Plan for the expedition.

Dr. Robert A. Anderson



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Biography

My primary interest is in the systematic biology (nomenclature, phylogeny, taxonomy) of golden algae (heterokont and haptophyte algae). I am also interested in growing both freshwater and marine species in culture. I collect algae from bogs, ponds, lakes and streams in the Keweenaw, including the open regions of Lake Superior.

Research Interests

- Chrysophyte algae
- Algal Systematics
- Algal Culturing

Recent Publications

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Dr. Robert van Syoc

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Senior Collection Manager of Invertebrates at the California Academy of Sciences in San Francisco, has been a CAS staff member since his student days at San Francisco State University in 1979. During his academic career Bob has studied various topics in marine ecology and invertebrate zoology, from San Francisco Bay to the South Pacific. Bob earned his Ph.D. at the Scripps Institution of Oceanography, where he used DNA analysis to study genetic relationships and speciation among barnacles at the molecular level.

Publications

A Phylogenetic Overview of Sponge-inhabiting Barnacles and Their Host Specificity (Crustacea, Cirripedia), Robert J. Van Syoc · Rob W. M. Van Soest · Joana R. Xavier ·John N. A. Hooper

Barnacle symbionts of gorgonian sea fans, description of seven new species (Archaeobalanidae Cirripedia) from the Philippines, Including a Key to the Western Pacific species of Conopea. R. J. Van Syoc · D. Carrison-Stone · L. Madrona · Gary C. Williams

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Dr. Rich Mooi

California Academy of Sciences, Curator of Invertebrate Zoology and Geology, Echinoid systematics and evolution

When I was about 8 years old, I sat at the kitchen table and used a blue ballpoint pen to draw the "blueprints" for the research vessel I would be using when I became a marine biologist. Things don't always go the way you plan--even when you start early. But I can say that my life as a field biologist and phylogeneticist of marine organisms has never wavered from the exciting endeavor represented by those childhood sketches. My parents introduced me to the wonders of the natural world, and I discovered very soon that there was nothing I would like to do more than devote my life to uncovering, drawing, and writing about those wonders.

But it was not until my second year at the University of Toronto that I came up against what are arguably some of the most enigmatic of marine organisms: the echinoderms. This group, which includes the sea urchins, sea stars, brittlestars, sea cucumbers, and sea lilies, displays some of the most bizarre morphologies of any marine organism. The origins of certain peculiar evolutionary novelties are poorly known, and the echinoderms are a perfect laboratory in which to study the far-reaching effects of some of these, especially small changes in rates of development. In particular, I was drawn to the aesthetically and scientifically pleasing sand dollars. Under the tutelage of Malcolm Telford, who taught me that there were no satisfying answers to poorly formulated questions, and Rick Winterbottom, who taught me that the best questions were about the relationships of organisms, I discovered my calling as a phylogenetic systematist.

Using phylogenetics as a tool, I have studied everything from abyssal sea urchins to linguistics. My most satisfying systematic works still deal with the sand dollars, which continue to lay the ground work for my ideas on the relationship between development and phylogeny. Recently, with colleagues in France, I have begun work on skeletal systems of all echinoderm groups, both fossil and extant. This theory of skeletal homologies provides keys to determining how these strange animals evolved. In the same way that knowing homologies in vertebrate skeletons has helped us to understand their evolution, our hope is that this theory of echinoderm homologies should be helpful in explaining the origins of even the most bizarre echinoderm groups.

Biodiversity Outreach

In 2014, Mooi embarked on an ambitious project a little closer to home. He joined an Academy effort to produce an extensive digital learning course on the not-so-small topic of biodiversity. The course, simply titled “Biodiversity,” is available for free via iTunes U and Khan Academy and has garnered over one million views since its launch. It covers topics as diverse as ocean acidification, invasive species, and gene flow, and for all of these topics, Mooi acts as scientist, illustrator, and narrator. Using Mooi’s finely honed drawing skills and clever animation techniques, the course helps make the important topic of biodiversity accessible to the general public.

This sort of scientific outreach—bringing science to a wider and more diverse audience—is near and dear to Mooi. He's been involved in running the Summer Systematics Institute for 20 years, inviting high school students to work on research projects with Academy scientists for a summer crash course in natural history museum-based work.

The biodiversity course is easily accessible online, but the outreach doesn’t stop there. During a 2015 expedition to the Philippines, a place where the Academy is invested in research and collaborating with the local community, Academy staff brought USB drives loaded with the course translated into the local language of Tagalog. They shared the course with colleagues in Manila, who brought it to classrooms and peers in the outer provinces of the Philippines. “Our colleagues are so overwhelmed by the challenges of their day-to-day work that they don’t have time to think about the bigger picture,” Mooi says.

When coming up with the curriculum for the online course there was never any question as to whether or not

biodiversity would be the topic. “Biodiversity study and preservation are in our wheelhouse. They're what we can do, and what we should do,” says Mooi. “The common thread running through the videos is an attempt to inject the idea that all this biodiversity is not going to be here forever if we don’t do something now.”

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Dr. Gordon Hendler, Curator, Echinoderms

Los Angeles County Museum of Natural History

Dr. Hendler is author of a popular book on "Sea Stars, Sea Urchins and Allies: Echinoderms of Florida and the Caribbean," published by the Smithsonian Institution Press. He has been Curator of Echinoderms since 1985, and served as head of the museum's Department of Invertebrate Zoology. In addition, he is a Research Associate at the Smithsonian Institution, and Adjunct Professor at the University of Southern California. Gordon received a B.A. from Rutgers University in 1968, and a Ph.D. from the University of Connecticut in 1973. After completing postdoctoral fellowships at Woods Hole Oceanographic Institution and the Smithsonian Tropical Research Institute, he directed the Smithsonian's Galeta Marine Laboratory, and was a supervisor at the Smithsonian Oceanographic Sorting Center. Gordon has conducted field work around the world, from the Aleutian Islands to the Antarctic, extensively in the tropics, and off both coasts of the United States, using scuba, submersibles, and ROVs. His research, primarily on brittle stars, has resulted in many publications on their morphology, ecology, systematics, behavior, reproduction and larval development.

Publications

Hendler, G. 2013. Recent mass mortality of *Strongylocentrotus purpuratus* (Echinodermata: Echinoidea) at Malibu and a review of purple sea urchin kills elsewhere in California. Bulletin of the Southern California Academy of Sciences 112:19-37. PDF

Hendler, G and S.J. Brugneaux (2013) New records of brittle stars from French Guiana: *Ophiactis savi*gnyi and the alien species *Ophiothela mirabilis* (Echinodermata: Ophiuroidea). Marine Biodiversity Records 6 (e113): 1-5. PDF

Hendler, G. and S.J. Brugneaux (2013) New records of brittle stars from French Guiana: *Ophiactis savignyi* and the alien species *Ophiothela mirabilis* (Echinodermata: Ophiuroidea) -- ERRATUM. Marine Biodiversity Records 6 (e122): 1. PDF

Hendler, G., A.E. Migotto, C.R.R. Ventura, and L. Wilk (2012) Epizoic Ophiothela brittle stars have invaded the Atlantic. Coral Reefs. DOI 10.1007/s00338-012-0936-6. PDF

Hendler, G. (2011) New light on the nomenclature, taxonomy, and biology of Hemipholis species (Echinodermata: Ophiuroidea: Ophiactidae). Zootaxa 3048: 44-52.

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Hendler, G. and M. Dojiri (2009) The contrariwise life of a parasitic, pedomorphic copepod with a non-feeding adult: ontogenesis, ecology, and evolution. Invertebrate Biology 128: 65-82.

Dojiri, M., G. Hendler, and I.-H Kim (2008) Larval development of *Caribeopsyllus amphiodiae* (Thaumatopsyllidae, Copepoda), an enterozoic parasite of the brittle star Amphiodia urtica. Journal of Crustacean Biology 28: 281-305.

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Aizenberg, J. and G. Hendler (2004) Designing efficient microlens arrays: lessons from nature.

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Ho, J.-S., M. Dojiri, G. Hendler, and G.B. Deets (2003) A new species of Copepoda (Thaumatopsyllidae) associated with a brittle star from California, USA, and designation of a new Order Thaumatopsylloida. Journal of Crustacean Biology 23: 582-594.
Hendler, G. (2002) Ophiuroidea. Pp. 414-416. In: J.W. Nybakken, W.W. Broenkow, T.L. Vallier (eds.) Interdisciplinary Encyclopedia of Marine Sciences. Grolier Academic Reference, Danbury, Connecticut.
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Hendler, G., M.J. Grygier, E. Maldonado, and J. Denton (1999) Babysitting brittle stars: Heterospecific symbiosis between ophiuroids (Echinodermata). Invertebrate Biology 118: 190-201.
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Hendler, G. and J. E. Miller (1991) Swimming ophiuroids real and imagined. Pp. 179 190. In: Yanagisawa, T., I. Yasumasu, C. Oguro, N. Suzuki, and T. Motokawa (eds.) Biology of Echinodermata. A.A. Balkema, Rotterdam, Netherlands.
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Cobb, J.L.S. and G. Hendler (1990) Neurophysiological characterization of the photoreceptor system in a brittlestar, *Ophiocoma wendtii* (Echinodermata: Ophiuroidea). Comparative Biochemistry and Physiology. 97A: 329 333.
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Hendler, G. and R.W. Peck (1988) Ophiuroids off the deep end: Fauna of the Belizean fore reef slope. Pp. 411 419. In: Burke, R.D., P.V. Mladenov, P. Lambert, and R.L. Parsley (eds.) Echinoderm Biology. A.A. Balkema, Rotterdam, Netherlands.
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Hendler, G. and J. E. Miller (1984) Feeding behavior of *Asteroporpa annulata*, a gorgonocephalid brittlestar with unbranched arms. Bulletin of Marine Science 34: 449 460.
Hendler, G. (1984) The association of *Ophiothrix lineata* and *Callyspongia vaginalis*: A brittlestar sponge cleaning symbiosis? P.S.Z.N.I. Marine Ecology 5: 9 27.
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Hendler, G. (1979) Sex reversal and viviparity in Ophiolepis kieri n.sp. with notes on viviparous brittlestars from the Caribbean (Echinodermata: Ophiuroidea). Proceedings of the Biological Society of Washington 9: 783 795.
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Hendler, G. (1978) Development of *Amphioplus abditus* (Verrill) (Echinodermata: Ophiuroidea). II. Description and discussion of ophiuroid skeletal ontogeny and homologies. Biological Bulletin 154: 79 95.
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Worley, E.K., D.R. Franz and G. Hendler (1977) Seasonal patterns of gametogenesis in a North Atlantic brooding asteroid, *Leptasterias tenera*. Biological Bulletin 153: 237 253.
Hendler, G. (1977) Development of *Amphioplus abditus* (Verrill) (Echinodermata: Ophiuroidea). I. Larval biology. Biological Bulletin 152: 51 63.
Hendler, G. (1975) Adaptational significance of the patterns of ophiuroid development. American Zoologist 15: 691 715.
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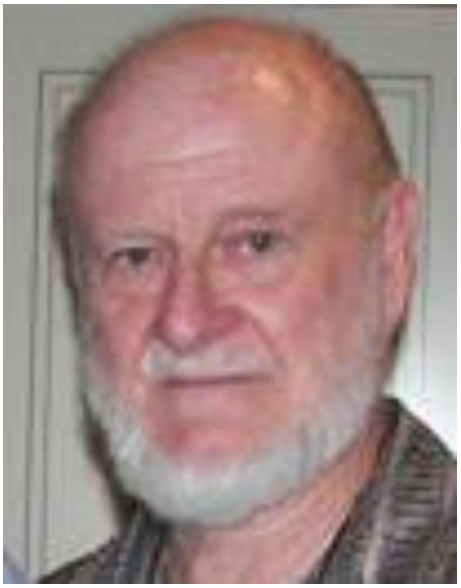
Humes, A.G. and G. Hendler (1972) New cyclopoid copepods associated with the ophiuroid genus *Amphioplus* on the eastern coast of the United States. Transactions of the American Microscopical Society 91: 539 555.
Hendler, G. and D. R. Franz (1971) Population dynamics and life history of *Crepidula convexa* Say (Gastropoda: Prosobranchia) in Delaware Bay. Biological Bulletin 141: 514 526.
Franz, D.R. and G. Hendler (1970) Substrate diversity and taxonomy of *Crepidula convexa*(Say) (Gastropoda: Prosobranchia). Occasional Papers of the University of Connecticut (Biology) 1: 289 291.
Loveland, R.E., G. Hendler, and G. Newkirk (1969) New records of nudibranchs from New Jersey. Veliger 11: 418 420.

Prof. Harold Heatwole



Education/Training
B. A. (Botany), 1955, Goshen College, Goshen Indiana
M. S. (Zoology), 1958, University of Michigan, Ann Arbor
Ph.D. (Zoology), 1960, University of Michigan, Ann Arbor
Ph.D. (Botany), 1987, University of Queensland, St. Lucia, Qld. (Australia)
D. Sc 1981, University of New England, Armidale, NSW (Australia)

Positions and Employment
University of Michigan, Ann Arbor, Michigan, Instructor, 1959-60
University of Puerto Rico, Rio Piedras, P. R.; Assistant Professor, 1960-63; Associate Professor, 1963-66
University of New England, Armidale, NSW, Australia; Senior Lecturer, l966-71, Assoc. Prof., 1972-1991
NC State University, Raleigh, NC; Head of Zoology Dept. 1991- 1996; Professor, 1991-present

Other Relevant Experiences and Professional Memberships
Standing Committee on Island Ecosystems, Pacific Science Association, 1970-72
President Australian Coral Reef Society, 1982, 1983
President Australian Society of Herpetologists, 1977-78
Council Member: Association for Tropical Biology, 1967-68, 1989-90; Great Barrier Reef Committee, 1971-82; Australian Coral Reef Society, 1983-86, 1990; Ecological Society of Australia, 1985-87

Editorial Experience
Editorial Board, Journal of Herpetology, 1967-69
Editorial Board, Australian Journal of Herpetology, 1981-1983
Editorial Board, Biotropica, 1993-1996Editorial Board, Journal of Arid Environments, 1995-present
Editorial Board, Systematics and Biodiversity, 2002-present
Series Editor for series "Ecology in Australia" (8 volumes)
Editor of Australian Journal of Ecology, 1985-87
Fauna Editorial Committee, Australian Dept. of the Arts, Sport, the Environment, tourism and Territories, 1988-92
Series Editor for Amphibian Biology, 6 volumes (3 more in preparation)
Editor of Integrative and Comparative Biology, 2006-

Administrative Experience
Director of El Yunque Biological Research Station, University of Puerto Rico, 1962-66
Heron Island Research Station Board,1979-80; Deputy Chairman, 1980
Heron Island Research Station Advisory Board, 1981-83
Lizard Island Research Station Committee of Trustees, 1980-83
Consortium of Island Research Stations, 1980-83
Acting Head, Dept. of Zoology, University of New England, 1981-1983
Head, Dept. of Zoology, NC State University, 1991-1996
Organization of Tropical Studies, Board of Directors, 1993-1996
La Selva Research Station Board of Directors, 1993-1996

Selected publications (partial list)

Micro-organisms

207. Heatwole, H., P. Saenger, A. Spain, E. Kerry and J. Donelan. 1989. Biotic and chemical characteristics of some soils from Wilkes Land, Antarctica. Antarctic Science 1: 225-234.

Protozoans

277. Heatwole, H., D. Alter, J. Charley, N. C. N. Stephenson, J. Bedford, P. O'Donoghue, W. R. Miller and F. Reay. 1999. From bedrock to biota: weathering, physico-chemical properties, protozoans and micrometazoans of some soils of East Antarctica. ANARE Reports, No. 140: 1-91.

Invertebrates

277. Heatwole, H., D. Alter, J. Charley, N. C. N. Stephenson, J. Bedford, P. O'Donoghue, W. R. Miller and F. Reay. 1999. From bedrock to biota: weathering, physico-chemical properties, protozoans and micrometazoans of some soils of East Antarctica. ANARE Reports, No. 140: 1-91.

Tardigrades

254. Miller, W. R. and Heatwole, H. 1995. Tardigrades of the Australian Antarctic Territories: the Mawson Coast, East Antarctica. Invertebrate Biology 114:27-38.

260. Miller, W.R., J. D. Miller and H. Heatwole. 1996. Tardigrades of the Australian Antarctic Territories: the Windmill Islands, East Antarctica. Zoological Journal of the Linnean Society 116: 175-184.

261. Miller, W. R. and H. Heatwole 1996. Tardigrades of the Australian Antarctic Territories: the northern Prince Charles Mountains, East Antarctica. Proceedings of the Linnean Society of New South Wales 116: 245-260.

277. Heatwole, H., D. Alter, J. Charley, N. C. N. Stephenson, J. Bedford, P. O'Donoghue, W. R. Miller and F. Reay. 1999. From bedrock to biota: weathering, physico-chemical properties, protozoans and micrometazoans of some soils of East Antarctica. ANARE Reports, No. 140: 1-91.

280. Miller, W. R., S. K. Claxon and H. F. Heatwole 1999. Tardigrades of the Australian Antarctic Territories: Males in the genus*Echinsicus* (Tardigrada: Heterotardigrada). Zoologischer Anzeiger 238: 303-309.

287, Miller, W. R., D. S. Horning and H. F. Heatwole Tardigrades of the Australian Antarctic: Macquarie Island, sub-Antarctica. Zoologischer Anzeiger 240: 475-491.

Fish

88. Heatwole, H., E. Heatwole and C. R. Johnson. 1974. Shark predation on sea snakes. Copeia 1974: 780-781.

217. Zimmerman, K. D., G. R. Gates and H. Heatwole. 1990. Effects of venom of the Olive Sea Snake, *Aipysurus laevis* , on the behaviour and ventilation of three species of prey fish. Toxicon 28: 1469-1478.

228. Zimmerman, K. D., H. Heatwole and H. I. Davies. 1992. Survival times and resistance to sea snake *(Aipysurus laevis)* venom by five species of prey fish. Toxicon 30: 259-264.

229. Zimmerman, K. D. and H. Heatwole. 1992. Ventilation rates in three prey fish species treated with venom of the Olive Sea Snake,*Aipysurus laevis*. Comparative Biochemistry and Physiology 102C: 421-425.

241. Zimmerman, K. D., Watters, D. J., Hawkins, C. J., Heatwole, H. 1993. Effects of fractions isolated from venom of the Olive Sea Snake, *Aipysurus laevis*, on the behavior and ventilation of a prey species of fish. Journal of Natural Toxins 2: 175-186.

252. Heatwole, H. and N. Poran. 1995. Resistances of sympatric and allopatric eels to sea snake venoms. Copeia 1995: 136-147.

Fungi/Lichens

44. Heatwole, H. 1966. Moisture exchange between the atmosphere and some lichens of the genus Cladonia. Mycologia 58: 148-156.

57. Heatwole, H. and A. Heatwole. 1968. Movements, host-fungus preferences and longevity of Bolitotherus cornutus (Coleoptera: Tenebrionidae). Annals of the Entomological Society of America 61: 18-23.

Bryophytes/Feins

235. Heatwole, H. 1993. Distribution of epiphytes on trunks of the arborescent fern, *Blechnum palmiforme*, at Gough Island, South Atlantic. Selbyana 14: 12-24.

Birds

38. Heatwole, H. 1965. Some aspects of the association of cattle egrets with cattle. Animal Behaviour 13: 79-83.

64. Heatwole, H. 1968. Two records of Australian land-birds at sea. The Emu 68: 132.

156. Heatwole, H. and R. Muir. 1982. Population densities, biomass and trophic relations of birds in the pre-Saharan steppe of Tunisia. Journal of Arid Environments 5: 145-167.

170. Heatwole, H. 1985. Brown noddy attacks mouse. Wilson Bulletin 97: 571-572.

178. Heatwole, H. and P. Saenger. 1986. Islands and birds. Oceanus 29: 94-97, 99.

212. Heatwole, H., P. Abbott and M. Jones. 1990. Egg-size and clutch-size of the Brown Booby, *Sula leucogaster* , at Swain Reefs, Great Barrier Reef. Corella 14: 51-51.

225. Heatwole, H., M. Betts, J. Webb and P. 1991. Crosthwaite Birds of the northern Prince Charles Mountains Antarctica. Corella 15: 120-122.

226. Lane, S. G. and H. Heatwole 1991. Seabird islands No. 214 Distant Cay, Great Barrier Reef, Queensland. Corella 15: 117-118

227. Lowman, M. D. and H. Heatwole 1992. Spatial and temporal variability in defoliation of Australian eucalypts. Ecology 73: 129-142.

301. Jones, M., H. Heatwole and P. O'Neill. 2005. Diel changes in numbers of seabirds occupying cays on the Swain Reefs, Great Barrier Reef, Australia. Atoll Research Bulletin No. 540: 217-235.

Mammals

33. Heatwole, H., J. F. Arroyo-Salaman and G. Hernandez. 1964. Albinism in the bat, *Molossus fortis*. Journal of Mammalogy 45: 476.

139. Heatwole, H. and E. P. Finnie. 1980. Seal predation on a sea snake. Herpetofauna 11: 24.

170. Heatwole, H. 1985. Brown noddy attacks mouse. Wilson Bulletin 97: 571-572.

231. Zimmerman, S. E., H. H. [sic.] Heatwole, P. C. Andreopoulos and L. C. J. Yong. 1992. Proliferative glomerulonephritis in mice induced by sea snake *(Aipysurus laevis)* venom. Experimental Toxicology and Pathology 44: 294-300.

Vascular Plants/Canopy/Vegetation

163. Heatwole, H. 1984. Terrestrial vegetation of the coral cays, Capricornia Section, Great Barrier Reef Marine Park. Pp. 87-139 in: The Capricornia Section of the Great Barrier Reef, Past, Present and Future (eds. W. T. Ward and P. Saenger). Royal Society of Queensland and Australian Coral Reef Society Symposium, Brisbane, 181 pp.

171. Heatwole, H. 1985. Survey of the mangroves of Puerto Rico---a benchmark study. Caribbean Journal of Science 21: 85-99.

172. Barson, M. and H. Heatwole. 1985. Seashore vegetation. Chapter 6 (pp. 195-216) in: Seashore Ecology (T. Carefoot and R. D. Simpson), Queensland University Press, St. Lucia, 278 pp.

173. Smith, J. M. B. and H. Heatwole. 1985. Notes on the changing flora of Heron Island and some other coral cays of the Capricornia Group, Great Barrier Reef. Queensland Naturalist 25: 126-133.

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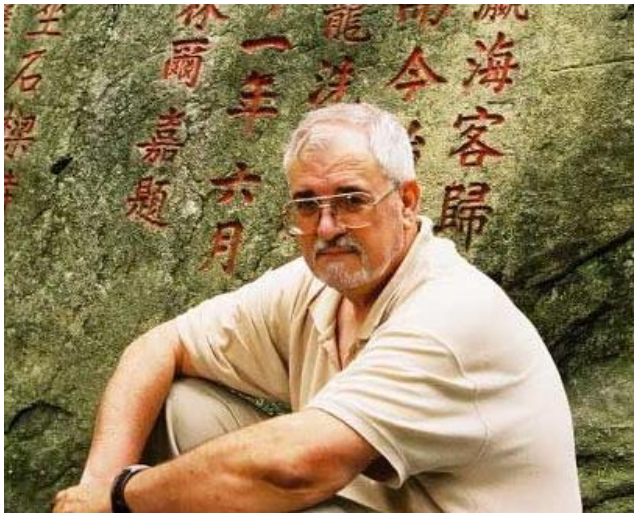

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2007-2011 PI NSF Research Grant, $600,000, RUI: Tardigrades of the LTER sites: A Framework for the Distribution and Phylogeny of North American Tardigrada.
2004-2009 PI NSF Research Grant, $480,000, RUI: Tardigrades of China, $480,000, RUI: A Survey of Moss Dwelling Tardigrades of China.
Master's students supervised: 28

Recent publications:

[62 total, 54 about Tardigrades, 4 in press.]

Miller, W.R. 2011. Tardigrades. American Scientist, **99**:384-391.

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