Program and Abstracts

77th Annual Meeting
American Malacological Society

23-27 July 2011
Pittsburgh, PA

Sponsored by:
American Malacological Society
Section of Mollusks, Carnegie Museum of Natural History

Forbes Family Medicine Residency Program

With support from
Dolores H. Lee

Edited by:
Charles F. Sturmf, Timothy A. Pearce, and Amanda Zimmerman
Pittsburgh, 2011
The American Malacological Union, now the American Malacological Society, was founded in 1931 chiefly through the organizing efforts of Norman W. Lermond, a New England farmer, utopian community founder, Socialist Party politician, and amateur naturalist. Although a national organization of malacologists had long been discussed, Lermond undertook correspondence with amateur and professional malacologists throughout the country, and eventually gathered the names of 192 persons interested in forming an organization. Its first meeting was held on April 30-May 2, 1931, in Philadelphia, Pennsylvania, with 29 attendees from 12 states. Its first president was Henry A. Pilsbry of Philadelphia’s Academy of Natural Sciences.
Juan José Parodiz –
A Dedication

21 December 1911 - 4 September 2007

Juan José Parodiz was born in Argentina in 1911. This year, 2011, marks the 77th meeting of the American Malacological Society and the 100th anniversary of José’s birth. José started working at the Museo Argentino de Ciencias Naturales “B. Rivadavia” (MACN) in 1927. He was 16 years old. In 1950 he came to the United States as a Guggenheim fellow. While in Washington, D.C. he met his future wife, Esther Sells. José returned to Argentina and continued working at the MACN. In 1951, José immigrated to the United States, married Esther, and started his career at the Carnegie Museum of Natural History in Pittsburgh, PA. José was the curator of invertebrate zoology (all non- insect and non-arachnid invertebrates), a position from which he retired in 1981. From 1981 until 2007, when he passed away, he served as curator emeritus. During José’s career at MACN and the Carnegie Museum, he authored more than 100 papers and described 77 molluscan taxa. His last publication was with colleagues from South America and appeared in 2002. Ten taxa, nine species and one genus, have been named in his honor.

I last saw José in May of 2007, shortly before he moved from Pittsburgh to Allentown, PA. At the age of 95 he was slowing down and decided to move closer to other members of his family. He was looking forward to the move and was hoping to celebrate his 100th birthday in 2011. Five months after relocating to Allentown, José suffered a life-ending cardiac event and quietly passed away.

Let us remember him on the 100th anniversary of his birth. His career spanned two continents. He worked on fossil and Recent faunas. He studied material from terrestrial, freshwater, and marine environments. While we are in Pittsburgh, I hope we all raise a glass and toast the accomplishments of this unique individual; a supporter and former president of the American Malacological Society (1964-1965).
James H. Lee –
A Dedication

22 October 1922 - 31 August 2005

James H. Lee was born in Kokomo, Indiana. He moved to Pittsburgh at the age of 3. Other than a period of time when he served in the US Army during the China-Burma-India Campaign of World War II, he spent the rest of life in southwestern Pennsylvania. Jim was not a naturalist by nature or training. Jim earned a degree in business from the University of Pittsburgh. He then went to work for Blue Cross of Western Pennsylvania. Upon his retirement from Blue Cross of Western Pennsylvania he started to enjoy getting out into the woods. He would occasionally meet with his buddies and take off for a day in the woods.

I met Jim in 1987 when I married Pat, his daughter. He took note of my interest in paleomalacology and started to join me on field trips. Jim accompanied me on trips in Pennsylvania, Maryland, North Carolina, and Florida. Jim also took an interest in malacology at the Carnegie Museum and made donations to purchase books for the library.

Jim was very involved in the updating of the AMS book “How to Collect and Study Shells”. In 1999 when AMS undertook the revision of this book, I was appointed to accomplish this task. Jim served as one of my amateur reviewers and he read and commented on much of the book.

If Jim were alive, I have no doubt that he would be involved in this meeting. In lieu of this involvement, Jim’s widow, Dolores, has made a donation to sponsor this meeting. It is in his memory that the keynote symposium, Mollusks: The Great Unanswered Questions is dedicated.
Welcome to Pittsburgh

I would like to welcome everyone to the 77th Annual Meeting of the American Malacological Society. This is the third time that the meeting is to be held in Pittsburgh, one of America’s most livable cities and home to many universities and museums. In addition, Pittsburgh is home to a number of major sports teams including the Steelers (football), the Penguins (hockey), and the Pirates (baseball).

In 2008 I was asked to serve as vice-president. I’m not sure what my qualifications were for this position as I am a physician, not a professional malacologist. For better of worse (I hope the former) I agreed and now am writing the introduction to the Program and Abstracts.

The main venue for the meeting is the Richard King Mellon Hall of Science on the campus of Duquesne University. The University sits on a bluff and overlooks downtown Pittsburgh and the Monongahela River. Duquesne was founded on Oct. 1, 1878. It opened as the Pittsburgh Catholic College with 40 students and six faculty members. Duquesne expanded to its current campus on the bluff and built the original “Old Main” building in 1885. This five-story red brick landmark was, for years, the highest point on the Pittsburgh skyline. It is still actively used as the administrative building on campus. The University opened its first new schools in 50 years, including the Rangos School of Health Sciences (1990) and the Bayer School of Natural and Environmental Sciences (1994).

A number of symposia will be held here including Mollusks: The Great Unanswered Questions (James H. Lee Memorial Symposium) sponsored by the AMS Symposium Fund and a gift from Dolores H. Lee. This and other symposia and activities are described in “Symposia and Special Events” on the following pages.

Additional venues include the Marriott Pittsburgh City Center (for the Presidential reception and the Auction), the Rivers Casino (banquet), and a post banquet cruise on a Gateway Clipper Fleet ship.

There are a number of activities taking place after the meeting ends. These include a field trip to collect land snails, a workshop on identifying freshwater mussels, and the use of the mollusk collection at the Carnegie Museum of Natural History. These activities are described in greater detail in “Symposia and Special Events”.

Once again, welcome to Pittsburgh and enjoy the Meeting.

Charlie Sturm
President AMS, 2010-2011
SYMPOSIA AND SPECIAL EVENTS

Presidential Reception
Saturday, 23 July 6:30-8:30 PM

This event will take place at the Marriott Pittsburgh City Center, a few blocks from the meeting location on the Duquesne University campus. Meet new friends and reconnect with old friends. Light refreshments (hors d’oeuvres, beer, wine) will be served. This will be a low key kick off to the 77th Annual American Malacological Society Meeting. If you were not able to register for the meeting earlier in the day, you will be able to register at the Reception.

Mollusks: The Great Unanswered Questions
The James H. Lee Memorial Symposium
Sunday, 24 July 8:30 AM-4:30 PM

This symposium, sponsored by funds from the American Malacological Society and a donation from Dolores Lee, will look at the Mollusca in the broadest sense. Experts from North America and Europe will look at various groups of mollusks. They will discuss recent developments in these groups as well as known unknowns that are ripe for future exploration. This symposium was organized by Timothy A. Pearce.

Gastropoda: Biology, Behavior, and Ecology
Monday, 25 July 8:00 AM-11:50 AM and Wednesday, 27 July 8:00 AM-11:30 AM

Amy Wethington and Beth Davis-Berg organized this symposium that explores aspects of gastropod biology and ecology. This session will explore these areas in the marine, freshwater, and terrestrial habitats. The Symposium’s first part will be on Monday, 25 July and it will conclude with the second session on Wednesday, 27 July.

Open Session
Monday, 25 July 1:30 PM-5:20 PM

Presentations, not submitted for a specific symposium, are the basis of the Open Session. Presentations cover a broad spectrum of malacology including taxa in various classes of marine, freshwater, and terrestrial mollusks.

Annual Auction
Monday, 25 July 6:30 PM-9:00 PM

One of the events many people look forward to is the Annual Auction. This activity generates funds to help support student-related activities. Books, apparel, and mollusk related brick-a-brac will be auctioned in a lively setting. Bring items for the auction and bring your wallet! Refreshments will be served. The Annual Auction will be held at the Marriott Pittsburgh City Center, a few blocks from the Duquesne University campus.
Cretaceous and Cenozoic Molluscan Paleontology Symposium
Tuesday, 26 July 8:00 AM-12:10 PM

There are great exposures of Cretaceous Period and Cenozoic Era formations in the eastern United States. This symposium will deal with some of the exciting research being undertaken in these areas. Some of the earliest molluscan fossils described in the United States were from these locations. See why early scientists like Thomas Say and Timothy Conrad found these formations so fascinating. John Pojeta has organized this exciting symposium.

History of Malacology Symposium
Tuesday, 26 July 1:30 PM-5:40 PM

This symposium, organized by Jay Cordeiro, looks at two aspects regarding the history of malacology: people and institutions. There will be several presentations on malacologists both well known and obscure. Other presentations will deal with institutions that have malacological collections and are centers of research. Come and learn about some of the interesting roots of our field.

Publications Workshop
Tuesday 26 July 6:35 PM-9:00 PM

If you have contemplated writing a scientific publication or seek hints to improve your existing publishing skills, this workshop is for you. We will explore different types of publications: journals, monographs, and books. We will explore different methods of publishing: academic and commercial presses and print on demand. We will discuss how to work effectively with editors, managing editors, and artist/illustrators. After several short presentations, the workshop will be open for discussion and we expect lively audience participation.

Poster Presentations
Wednesday, 27 July 8:00 AM-2:00 PM

Posters will be on display in the lobby of the Richard Mellon Hall. Posters will be displayed Wednesday from 8:30 AM until 3 PM. Presenters will be available to discuss their posters from 1:00-2:00 PM.

Business Meeting
Wednesday, 27 July 2:00-3:00 PM

The business meeting is the time when AMS members can address their concerns to the President and AMS Council. You will have the opportunity to vote on the officers for the coming year. At this meeting, you will hear about the locations and plans for upcoming meetings.
AMS Banquet and River Cruise  
Wednesday, 27 July 6:00-9:00 PM

At this activity we bring the meeting to an end. A bus will pick us up at the Duquesne University campus and at the Marriott Pittsburgh City Center. We will proceed to the Rivers Casino where we will have a buffet dinner. Several types of food include Italian, Asian, Barbeque menus, a large salad bar, vegetarian options, and a dessert bar. After dinner, we will proceed to the dock and board a ship from the Gateway Clipper Fleet. We will then undertake a 1 hour trip on Pittsburgh’s famous “Three Rivers”: the Ohio, Allegheny, and Monongahela Rivers. There will be a cash bar on the ship. After experiencing Pittsburgh from river level, we will return to the dock, head back to the bus, and return to the hotel or campus. If you want to stay at the Rivers Casino and try your luck feel free to do so. Be sure to keep cab fare in your pocket so you will be able to get back to the hotel or campus; it is only a 2 mile trip.

Optional Post Meeting Activities  
Thursday, 28 July

Terrestrial Gastropod Field Trip: 8: 30 AM-3: 30 PM
This field trip will be led by Timothy Pearce. You will board a van and leave from the Duquesne University campus and travel to Powermill Reserve, the field station of Carnegie Museum of Natural History. Powdermill Reserve is located in the western foothills of the Appalachian Mountains near Ligonier, PA. You will have the opportunity to learn about the region and collect mollusks while at Powdermill. A bag lunch will be provided.

Unionidae Identification Workshop: 9:00 AM-3:00 PM
This workshop on how to identify freshwater mussels, will be held at the Carnegie Museum of Natural History. It will be conducted by Art Bogan, a well known unionid researcher and author of several books on Unionidae. Art will discuss techniques for identifying unionids in general and specifically, how to identify those from the eastern United States.

Section of Mollusks Research Collection, Carnegie Museum of Natural History 8:30 AM-5:00 PM
The Section of Mollusks Research Collection will be available for those who would like to utilize the collection and/or library. Please contact Tim Pearce or Megan Paustian prior to or while at the meeting and let them know about your interest. The Section of Mollusks is particularly strong in Sphaeriidae, Unionoida, and terrestrial Gastropoda, especially of the eastern United States, with sizeable holdings of freshwater and marine Mollusca as well. The collection will be available during other limited times this week.
The ultimate responsibility for the success or failure of any endeavor, such as an annual meeting of the American Malacological Society, rests with the office of the president of the organization. However, it would be presumptuous and erroneous to think that a single person would be able to organize and execute such an endeavor. In planning for and executing the 77th Annual Meeting of the American Malacological Society, I have been fortunate to have had the assistance of a number of dedicated and enthusiastic individuals. Here is a list of those who gave graciously and selflessly of their time and talents to help make this meeting a reality.

**ACKNOWLEDGEMENTS**

**Organizing Committee**
Louise Corpora  
Amanda Lawless  
Timothy A. Pearce  
Patricia Sturm  
Joseph Reznik  

**Program and Abstracts**
Timothy A. Pearce  
Amanda Zimmerman  

**Web Page**
Marla Coppolino  

**Art Director and Logo Design**
Amanda Zimmerman  

**Mollusks: The Great Unanswered Questions**
Timothy A. Pearce  

**The James H. Lee Memorial Symposium**
Timothy A. Pearce  

**Cretaceous and Cenozoic Molluscan Paleontology**
John Pojeta  

**Gastropoda: Biology, Behavior, and Ecology**
Elizabeth Davis-Berg  
Amy Wethington  

**History of Malacology**
Jay Cordeiro  

**Auction**
Paula Mikkelsen  
Mary Pojeta  

**Advice**
Frank “Andy” Anderson  
Robert Dillon  
Doug Eernisse  
Paula Mikkelsen  
Timothy A. Pearce  
Robert Prezant  

**Registration Desk**
Louise Corpora  
Anita Graff  
Jerry Graff  
Mary Pojeta  
Patricia Sturm  

**Student Awards**
Timothy A. Pearce  
Megan Paustian  
Robert Prezant  

**Post Meeting Activities**
Art Bogan  
Tim J. Dolan  
Megan Paustian  
Timothy A. Pearce  
Joseph Reznik  
Paul Rob
## Mollusks: The Great Unanswered Questions
### The James H. Lee Memorial Symposium

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<tr>
<th>Time</th>
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<th>Speaker(s)</th>
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<td>8:30-9:00</td>
<td>Introductions and Overview</td>
<td>Charles F. Sturm and Timothy A. Pearce</td>
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<tr>
<td>9:00-9:30</td>
<td>Marine Bivalvia – a Discussion of Known Unknowns</td>
<td>Rüdiger Bieler and Paula Mikkelsen</td>
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<tr>
<td>9:30-10:00</td>
<td>Global Freshwater Bivalve Diversity</td>
<td>Dan Graf</td>
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<td>10:00-10:30</td>
<td>Phylogeny within Polyplacophora: Chitonida reflects geographic isolation</td>
<td>Doug Eernisseee</td>
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<tr>
<td>10:30-11:00</td>
<td>Break/Socialize</td>
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<tr>
<td>11:00-11:30</td>
<td>New developments in aplacophoran research</td>
<td>Christiane Todt</td>
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<tr>
<td>11:30-12:00</td>
<td>News and Thoughts on Monoplacophora: Their Role in Molluscan Phylogeny</td>
<td>Gerhard Haszprunar* and Bernhard Ruthensteiner</td>
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<td>12:00-1:30</td>
<td>Lunch</td>
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<tr>
<td>1:30-2:00</td>
<td>The Diversity of Land Molluscs – questions unanswered and questions unasked.</td>
<td>Robert Cameron</td>
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<td>2:00-2:30</td>
<td>Interacting constraints and the problem of similarity in gastropod structure and function</td>
<td>Carole Hickman</td>
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<td>2:30-3:00</td>
<td>When Cometh Our Reformation? Molecular typology meets population genetics in the pleurocerid gastropod fauna of east Tennessee.</td>
<td>Robert T. Dillon, Jr.* and John D. Robinson</td>
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<td>3:00-3:30</td>
<td>Break/Socialize</td>
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<tr>
<td>3:30-4:00</td>
<td>Hundreds of species and thousands of questions: what we still don’t know about the coleoid cephalopods.</td>
<td>Clyde F.E. Roper and Elizabeth K. Shea*</td>
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<tr>
<td>4:00-4:30</td>
<td>The Great Unknown Scaphopod</td>
<td>Gerhard Steiner</td>
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<tr>
<td>4:30-5:00</td>
<td>Phylogenomics reveals deep molluscan evolutionary relationships</td>
<td>Kevin M. Kocot*, Johanna T. Cannon, Christiane Todt, Andrea B. Kohn, Mathew R. Citarella, Achim Meyer, Christoffer Schander, Scott R. Santos, Leonid L. Moroz, Bernhard Lieb, and Kenneth M. Halanych</td>
</tr>
</tbody>
</table>
Gastropoda: Biology, Behavior, and Ecology Symposium I

8:00-8:10  Introductory remarks.
A. Wethington and E.C. Davis-Berg.

8:10-8:30  Comparing soil attributes to molluscan biodiversity: does the soil type matter?
Elizabeth C. Davis-Berg

8:30-8:50  Molecular and morphological analysis of the Hawaiian Achatinellidae
Norine W. Yeung*, Brenden S. Holland, and Robert H. Cowie

8:50-9:10  Conservation of native Hawaiian land snails requires understanding the complex
interactions among non-native and native species
Wallace M. Meyer, III

9:10-9:30  Report on the Terrestrial Mollusks of the Sierra de la Madera (Opusura), Sonora,
Mexico – The Caracoleros
Amy S. Van Devender*, Robert W. Van Devender, Arzu Rivera García, and
Martha N. Van Devender

9:30-9:50  Analysis of Anguispira diversity on the Southern Cumberland Plateau.
Jia W. Pan and David G. Haskell*

9:50-10:10  Break

10:10-10:30  Natural History of the Slug Family Philomyctidae
Megan Paustian

10:30-10:50  The protoconchs and larval ecology of some Pyramidellidae (Opisthobranchia)
Robert Robertson

10:50-11:10  Ontogenetic shifts in dietary specialization of a vermivorous marine snail,
Conus ebraeus
Dan Chang

11:10-11:30  Geographic variation in diets of three broadly distributed Conus species in the
Indo-West Pacific
Thomas F. Duda, Jr.*, Dan Chang, and Jordan Lafave

11:30-11:50  Females floated first in bubble-rafting snails (Janthinidae)
Celia K. C. Churchill
# Open Session

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<th>Authors</th>
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<tr>
<td>1:30-1:40</td>
<td>Introductory remarks</td>
<td>Gary Motz</td>
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<td>1:40-2:00</td>
<td>Egg deposition by <em>Rossia palpebrosa</em> (Cephalopoda: Rossiinae) in a marine sponge (<em>Porifera: Mycale lingua</em>) on the Newfoundland Shelf</td>
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<td>Susanna Fuller, Vonda Wareham, and Elizabeth Shea*</td>
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<td>2:00-2:20</td>
<td>Movement patterns of giant Pacific octopuses.</td>
<td>D. Scheel* and L. Bisson</td>
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<td>John A. Wilk</td>
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<tr>
<td>2:40-3:00</td>
<td>Large <em>Cerithium</em> vs. small <em>Bittium</em>: too simple?</td>
<td>Ellen E. Strong</td>
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<td>3:00-3:20</td>
<td>The Philippine Mollusk Symbiont International Cooperative Biodiversity Group</td>
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<td>Gary Rosenberg</td>
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<td>3:20-3:40</td>
<td>Systematics of <em>Leptoxis</em> (Gastropoda: Pleuroceridae)</td>
<td>Nathan V. Whelan</td>
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<td>3:40-4:00</td>
<td>Break</td>
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<tr>
<td>4:00-4:20</td>
<td>Comparing Apples to Apples: Clarifying the Identities of Two New World Ampullariids, <em>Pomacea canaliculata</em> and <em>Pomacea insularum</em></td>
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<td>Kenneth A. Hayes*, Ellen E. Strong, and Robert H. Cowie</td>
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<td>4:40-5:00</td>
<td>Influence of Weather on Land Snail Movement Distances</td>
<td>Timothy A. Pearce*, Benjamin P. Robinson, and Matthew T. Klepacz</td>
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<td>5:00-5:20</td>
<td>Preliminary report on terrestrial mollusks and other invertebrates associated with cave ecosystems in Maine</td>
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<td>Joseph Reznik* and Timothy A. Pearce</td>
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# Cretaceous and Cenozoic Molluscan Paleontology Symposium

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<td>8:00-8:10</td>
<td>Introduction to the Symposium</td>
<td>John Pojeta</td>
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<tr>
<td>8:10-8:30</td>
<td>Thinking through the evolution of study of Late Cretaceous and Paleogene continental mussels and snails: Against all odds a brighter future</td>
<td>Joseph H. Hartman</td>
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<td>8:30-8:50</td>
<td>Fossil Coleoids from the Turonian-Masstrichtian (Late Cretaceous) of the Western Interior</td>
<td>Neal L. Larson</td>
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<td>8:50-9:10</td>
<td>Mode of life and habitat of baculites from the Upper Cretaceous of the U.S. Western Interior</td>
<td>Neal L. Larson* and Neil H. Landman</td>
</tr>
<tr>
<td>9:10-9:30</td>
<td>Molluscan paleontology of the Chesapeake Bay Area---the classic standards for the Atlantic Coastal Plain</td>
<td>Lauck Ward</td>
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<td>9:30-9:50</td>
<td>Biodiversity of the basal Yorktown Formation at Kings Mill, James City County, Virginia, USA</td>
<td>Lyle D. Campbell*, Sarah C. Campbell, and Matthew R. Campbell</td>
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<tr>
<td>9:50-10:10</td>
<td>Provinciality of the Chesapeake Group Mollusks: Plio-Pleistocene of Virginia and northern North Carolina, USA</td>
<td>Sarah C. Campbell*, Lyle D. Campbell, and Matthew R. Campbell</td>
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<tr>
<td>10:10-10:30</td>
<td>Break</td>
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<tr>
<td>10:30-10:50</td>
<td>Rapid short-lived excursion in variability of Late Pliocene populations of an evolutionary conservative Neogene lineage, <em>Glycymeris americana</em> and its antecedents (Arcoidea: Bivalvia), in the western North Atlantic</td>
<td>R.D.K. Thomas</td>
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<td>10:50-11:10</td>
<td>The Cenozoic micromolluscan fossil record is a major reservoir of undocumented marine biodiversity</td>
<td>Carole S. Hickman</td>
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<td>11:10-11:30</td>
<td>Evolution of the ligament in pterioidean bivalves: the significance of Cretaceous and Cenozoic Fossils</td>
<td>Ilya Tёмkin</td>
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<tr>
<td>11:30-11:50</td>
<td>Evolution of the alimentary system in heterodont bivalves</td>
<td>Ilya Tёмkin* and Ellen E. Strong</td>
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<td>11:50-12:10</td>
<td>Preview of a new phylogenetic/Linnean classification of the Bivalvia</td>
<td>Joseph G. Carter</td>
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</table>
| 1:30-1:40| Introduction to the Symposium  
Jay Cordeiro                  |
| 1:40-2:00| Reorganization of the non-type systematic mollusk collection of the  
Paleontological Research Institution: A progress report  
Greg Dietl, Warren Allmon, Judith Nagel-Myers, and David Campbell* |
| 2:00-2:20| History of Malacology at the Museum of Comparative Zoology, Harvard  
University  
Adam J. Baldinger             |
| 2:20-2:40| The Illinois Natural History Survey / University of Illinois Museum of Natural  
History Mollusk Collection  
Kevin S. Cummings* and Jeremy S. Tiemann |
| 2:40-3:00| Museum Collections and the Role of Amateur Collectors: An Example from the  
Carnegie Museum  
Charles F. Sturm*, Timothy A. Pearce, and Fabio Moretzsohn |
| 3:00-3:20| A collection of photos of world malacologists  
Robert Robertson               |
| 3:20-3:40| Malacological Collections in Maine’s Aroostook County  
Scott Martin            |
| 3:40-4:00| Break                                                                          |
| 4:00-4:20| *Conus* from Chemnitz to Cryptic Species at the Zoological Museum of the  
University of Copenhagen (ZMUC)  
Alan J. Kohn            |
| 4:20-4:40| “Jay on Jay”– Conchological Contributions of John C. Jay  
Jay Cordeiro               |
| 4:40-5:00| Reverend Lowe’s snails: a mosaic on the beach  
Aydin Örstan               |
| 5:00-5:20| Who Was Barthélemy de Basterot – And Does It Matter?  
Scott Martin              |
| 5:20-5:40| The Nautilus: 125 Years of Malacology  
José H. Leal              |
26 JULY 2011 (6:35PM TO 9:00PM)

Publications Workshop

6:35-6:45  Introduction
          C. Sturm

6:45-7:00  Publishing on demand: the pros and cons
          Charles F. Sturm* and Timothy A. Pearce

7:00-7:15  The Malacological Monograph
          Paula M. Mikkelsen

7:15-7:30  Publishing through an university press versus a commercial publisher
          Fabio Moretzsohn

7:30-7:45  A Picture is Worth a Thousand Words: A Step by Step Guide to Working
          with an Illustrator.
          Amanda Zimmerman

7:45-8:00  Researching dates of publication in the Internet age
          Gary Rosenberg

8:00-9:00  Open forum for questions, answers, and comments
Gastropoda: Biology, Behavior, and Ecology Symposium II

8:00-8:10 Introductory Remarks
A. Wethington and E. Davis-Berg

8:10-8:30 Assessing danger, how leeches affect physid life history and behavior
Amy R. Wethington

8:30-8:50 From behavior to ecosystems and back: linking levels of ecological organization with pulmonate snails as a model system
Andrew M. Turner

8:50-9:10 The evolution of reproductive isolation in a simultaneous hermaphrodite, the freshwater snail Physa
Robert T. Dillon, Jr.*, Amy R. Wethington, and Charles Lydeard

9:10-9:30 Conservation Genetics of a Critically Endangered Freshwater Limpet Genus and Rediscovery of an Extinct Species
Diarmaid Ó Foighil*, Jingchun Li, Taehwan Lee, Paul Johnson, Ryan Evans, and John B. Burch

9:30-9:50 Hormones and hermaphrodites: influences of anthropogenic and environmental stressors on pulmonate snail endocrine systems
Thomas McCarthy*, Terri Provost, Bryant Buchanan, and Sharon Wise

9:50-10:10 Break

10:10-10:30 Acclimatory and short-term respiratory responses to temperature by Lithasia obovata, and its relation to differences in the physiological adaptations of freshwater pulmonates and prosobranchs.

10:30-10:50 Evaluation of spatial and temporal variability in population sex ratios of pleurocerid snails and their relationships with estrogenic compounds and other environmental variables
Serena Ciparis

10:50-11:10 Stuck between a rock and a hot place: Assiminea succinea at the seashore
Aydin Örstan

11:10-11:30 Feedings rates of the neogastropod Nucella lamellosa subjected to different amount of tidal emersion, as simulated in the lab
Rebecca M. Price
27 JULY 2011 (8:00AM TO 2:30PM)

**Poster Presentations**

*Presenters will be with their posters from 1PM to 2PM.*

Differential Survival among Tahitian Tree Snails During a Mass Extinction Event: Testing the Demographic Refuge Hypothesis
Cindy Bick

Molluscan Diversity and Temporal Changes in an Urban Pond in Northern New Jersey
Eric J. Chapman, Robert S. Prezant*, and Rebecca Shell*

A Scientifically Valuable Worldwide Land Snail Collection at Paleontological Research Institution, Ithaca, New York
Marla Coppolino

Micromollusc sampling: evaluating field survey techniques in Hawaii’s tropical forests

The occurrence of two nudibranchs and their invasive prey item, *Membranipora membranacea*
Megan McCuller* and Larry Harris

The Herbert D. Atheard Sphaeriidae Collection of the North Carolina State Museum of Natural Sciences
J.M. Smith and A.E. Bogan*

*Leptoxis* (Gastropoda: Pleuroceridae): more than just shells
Thomas Tarpley, Nathan V. Whelan*, and Paul D. Johnson

Effects of soil freezing on the biodiversity of terrestrial gastropods in northern hardwood forests
Helen Yurchenco
Acclimatory and short-term respiratory responses to temperature by *Lithasia obovata*, and its relation to differences in the physiological adaptations of freshwater pulmonates and prosobranchs.

James E. Alexander, Jr.* and Kelly C. Thayer

Department of Biology, University of Louisville, Louisville, KY 40292, USA

The Shawnee rocksnail, *Lithasia obovata* (Say, 1829), is a pleurocerid snail commonly found along the shoreline of the middle reach of the Ohio River. We examined the effects of temperature acclimation and acute temperature variation on the rocksnail’s respiratory rate. Two groups of snails (of similar body size) were acclimated to a constant temperature of either 15°C or 25°C (± 1°C, 12:12 L: D) for at least six weeks. Following acclimation, oxygen uptake rate (VO$_2$, in mg O$_2$ L$^{-1}$ hr$^{-1}$) was measured for each animal at both 15°C and 25°C. The VO$_2$ rates measured at 15°C did not differ; likewise, the VO$_2$ rates at 25°C were identical. We examined if *L. obovata* shows any degree of metabolic temperature compensation, as determined by acclimation Q$_{10}$ (Q$_{10\text{acc}}$). If Q$_{10\text{acc}}$ is near 1.0, there is a perfect metabolic compensation; metabolic rates vary little between the two temperatures. If Q$_{10\text{acc}}$ is between 1 and 2, there is partial acclimation, and if Q$_{10\text{acc}}$ is similar to the acute Q$_{10}$ values (which typically range from 2 to 3 for most ectotherms), there is no metabolic compensation to temperature. Q$_{10\text{acc}}$ was 3.16, suggesting *L. obovata* exhibits little temperature acclimation. These results are similar to that of most prosobranchs. Because of the thermal inertia of the relatively large volume of water in the Ohio River (which does not shift in temperature more than 1°C day$^{-1}$), *L. obovata* never is exposed to rapid changes in water temperature and thus has little need for acute temperature acclimation. In contrast to responses of most prosobranchs, many pulmonate snails found in smaller streams (and in littoral zones of lentic habitats) commonly experience shifts of 6 to 10 °C day$^{-1}$; many pulmonates use temperature acclimation and exhibit lower Q$_{10}$ and Q$_{10\text{acc}}$ values.
History of Malacology at the Museum of Comparative Zoology, Harvard University

Adam J. Baldinger

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In 1859, L. Agassiz founded the Museum of Comparative Zoology (MCZ) at Harvard University. From the works of past curators, namely J.G. Anthony, W.J. Clench, R.D. Turner, and K.J. Boss, and other Associates (i.e. R.I. Johnson, R.W. Foster), the Department of Malacology at the MCZ has become one the largest and most diverse collections in the world. The collection includes over 358,000 cataloged lots and at least 150,000 more. The collection includes specimens from many 19th century malacologists and 27,000 lots from the Boston Society of Natural History. Other strengths include western Atlantic species, North American Unionidae and Pleuroceridae, deep-sea mollusks, Teredinidae, Achatinellidae, and other pulmonate groups. Since the 1930s the collection has been stored in wooden drawers and cabinets. The systematic arrangement of the collection at the time was considered far advanced over any other collection. Renovations that facilitate collections storage and collections-based research have recently taken place at the MCZ. In 2006, renovations began in the Department of Malacology and included the installation of new storage efficient collections cabinetry. The specimens were reorganized alphabetically by family, genus, and species. The year 2010 marked the 150th anniversary of the opening of the MCZ. A brief history and summary of recent and current activities within the Department of Malacology are provided.
Differential Survival Among Tahitian Tree Snails During A Mass Extinction Event: Testing The Demographic Refuge Hypothesis

Cindy Bick

Department of Ecology and Evolutionary Biology, University of Michigan Museum of Zoology, Ann Arbor, MI 48109, USA. bickci@umich.edu

The introduction of the carnivorous Rosy Wolf Snail (*Euglandinarosea*) to French Polynesia heavily impacted the endemic snail fauna and directly caused the mass extinction of all but 5 of 61 endemic Society Island partulids in the wild; approximately half of all species in this Pacific Island land snail family. On Tahiti, the largest island in French Polynesia, ongoing field surveys have encountered remnant micro-populations of two nominal species, Partula clara and/or Partula hyalina, in more than 30 valleys. DNA analyses have shown that P. clara and P. hyalina are two color morphs of a single Tahitian founder lineage. I’m interested in understanding why this particular lineage has differentially survived almost 40 years of *E. rosea* predation pressure in Tahitian valleys. Was it simply the most abundant lineage, or is there some other aspect of its biology that allows it to persist? H. E. Crampton’s 1916 survey contains some intriguing clues: P. clara and P. hyalina were rare compared to the co-occurring congeners that were extirpated, but they had higher mean clutch sizes, respectively 3-4 versus 2-3 per female reproductive tract, in wet Tahitian valleys. I hypothesize that P. clara and P. hyalina may have a demographic refuge from extirpation that has allowed them to differentially survive. A number of Tahitian partulids, including P. clara and P. hyalina, are being maintained in captive breeding populations where environmental differences are minimized and endogenous differences in demography are tractable. I plan on extracting demographic data from the captive populations to test if P. clara and P. hyalina also exhibit enhanced fecundities in captivity. If so, estimates of species-specific reproductive rates will be entered into an *E. rosea* predation model to test if this reproductive rate difference can explain their differential survival in the valleys of Tahiti.
Marine Bivalvia – a Discussion of Known Unknowns

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Bivalves share many of the “deeper” unresolved questions with the other molluscan groups – issues such as their origin and sister-group relationships within the Mollusca, or their suitability to explore molecular data in a "known" fossil framework. Others are more specific to this group that radiated so successfully and nowadays predominantly specializes as infaunal and sessile epifaunal suspension feeders. This paper highlights and explores unanswered questions, from the seemingly trivial and mundane (how many species are actually out there?), to addressing enigmatic clades about which we know extremely little besides their shells, to macroevolutionary questions that could best be addressed by bivalve-based data. Fast-developing molecular approaches, a resurgence of detailed morphological and soft-anatomical research, and a renewed focus on Bivalvia by biological and paleontological workers provide us with an opportunity to address such questions. Coordination of efforts – and reciprocal illumination – across traditional disciplinary boundaries will be key in such endeavors. Supported by NSF DEB-0732854/0732903/0732860 and DEB-0918982.
Biodiversity of the basal Yorktown Formation at Kings Mill, James City County, Virginia, USA

Lyle D. Campbell*, Sarah C. Campbell¹, and Matthew R. Campbell²

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Yorktown Formation (Pliocene) samples yielded a rich assemblage of vertebrates, ostracodes, molluscs, and other invertebrate phyla from samples collected along the James River at Kings Mill, Virginia. This section, now rip-rapped, contains four faunal breaks: Eastover-Sunken Meadow; Sunken Meadow-Leptopecten leonensis bed; Leptopecten bed-Chama reef; and Yorktown-Pleistocene. Most Sunken Meadow and Leptopecten outcrops show leaching of aragonite, but at Kings Mill aragonitic taxa including micro-mollusks are well preserved, possibly due to buffering by the overlying, carbonate-rich, Chama reef.

The Sunken Meadow molluscan fauna contains 220 species, of which 208 are found at Kings Mill. Continuing curation of overlying Leptopecten bed samples increased the documented fauna by 102 molluscan taxa. Abundant Cyclocardia and diverse Astarte species in both units plus abundant Placopecten in the Sunken Meadow had indicated a boreal faunal province, but more complete assemblages indicate warm temperate affinities. At Kings Mill, Sunken Meadow molluscs include 4 genera presently found only north of Cape Hatteras, NC, 63 genera found both north and south, and 47 found only south of the cape. Similarly, the Leptopecten bed contains 3 genera from north of the cape, 66 from both north and south, and 47 found only to the south. Otolith assemblages suggest water depths greater than 80 meters.

The Leptopecten bed does not conform to prevailing Yorktown stratigraphic models. The bed has three stratigraphically overlapping species, Chesapecten jeffersonius, C. septenarius, and C. madisonius (10 to 14 rib morphology), the same co-occurrence reported by Gibson (1987) from Yorktown Unit 3 (Lee Creek mine, Aurora, NC). We propose that the Leptopecten leonensis bed is an important Early Pliocene stratigraphic unit traceable from the Rappahannock River through Kings Mill and the Lee Creek section to Lower Goose Creek Limestone of South Carolina and in Tamiami Limestone and lower Jackson Bluff Formation of Florida.
Provinciality of the Chesapeake Group Molluscs: Plio-Pleistocene of Virginia and northern North Carolina, USA

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Faunal surveys of Chesapeake Group stratigraphic units provide new evidence for provincial-level interpretations of biogeographic affinities. These units in stratigraphic order from oldest to youngest are: Yorktown Formation (Zone 1 [Sunken Meadow Member], Leptopecten-Chionopsis bed, type Rushmere Member, Rice’s Pit-Yadkin-Moore House Member, Chuckatuck Shoal-Mogarts Beach Member, and Upper-Chuckatuck-Rock Wharf strata); Chowan River Formation; Plio-Pleistocene strata at Aurora, and type James City Formation.

Species-level comparisons with Recent Western Atlantic provinces and sub-provinces are restricted by high levels of extinction, typically exceeding 80%. Surviving species, such as Nucula proxima and Neverita duplicata, with broad latitudinal ranges obscure biogeographic affinities. A final challenge for provincial comparisons is the array of proposed demarcations defining Northwestern Atlantic shelf zoogeography.

Genus-level comparisons are more inclusive, as 85 to 95% of the fossil species belong to Recent genera. However, strict genus-level presence-absence analysis ignores species richness. We developed a quantified approach, with Recent Western Atlantic generic distribution multiplied by the number of species in that genus from the fossil assemblage. Recent Arctic, Boreal, Virginian (incrementally divided into four sub-assemblages by latitude), and Carolinian molluscan faunas were similarly quantified as standards for comparison.

All Chesapeake Group units show highest affinity for Recent fauna living between Cape Hatteras and Kitty Hawk, North Carolina, the overlap or transition zone between Carolinian and Virginian provinces. Internally, there is a warming trend through time from Sunken Meadow through uppermost Yorktown, and another from Chowan River up through Aurora faunas, but these trends are not large enough to indicate a provincial shift. We conclude that warm-temperate provincial conditions presently exist in the Northwestern Atlantic only in the narrow, 100 km band between Cape Hatteras and Kitty Hawk, but during milder Pliocene and early Pleistocene climates, warm-temperate conditions prevailed throughout the region, as indicated in Chesapeake Group faunas.
The Diversity of Land Molluscs – questions unanswered and questions unasked.

Robert A. D. Cameron

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Land molluscs do not feature prominently in the general discourse on patterns of diversity at larger scales (Macroecology), yet we may well know more about them than about many other invertebrate groups. The theme of my presentation relates to one big question: when we assess diversity at any scale, are we using “comparable taxonomic entities”? What seem at first to be housekeeping questions (how many species of land mollusc are there at all scales up to global?) turn out to involve conceptual issues that are unresolved. At the most basic level different taxonomic practices make comparisons across regions problematic, and, at least at the lower levels (subspecies, species, genera) prevent us drawing general conclusions.

Beyond this basic difficulty, the huge range of size, of life histories, of powers of dispersal, of ways of life combine to challenge the assumption that each species can be reduced to equivalent digits in large scale analyses. We should contest this standard macroecological simplification, and are in a strong position to do so. Hence, while pointing out the gaps in our knowledge, I will use examples to show that we can use both higher taxonomic categories and data on ecology to construct hypotheses and test their generality. I will examine the extent to which such subdivision gives us fruitful insights, and, in particular, to start to answer the most difficult questions: what are the assembly rules (if any) for local molluscan faunas? What role, if any, does competition play in structuring faunas and how does environmental history as distinct from present constraints affect them?
Preview of a new phylogenetic/Linnean classification of the Bivalvia

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A multi-year collaboration among 51 biologists and paleontologists, representing 19 countries, has resulted in a comprehensive reclassification of the Bivalvia. This classification is cladistic in its identification of synapomorphies and in its incorporation of some unranked clade names, but it is evolutionary in its indication of hypothesized ancestor-descendant relationships, acceptance of some paraphyletic taxa, and predominantly Linnean nomenclature. The classification is based on an integration of molecular and morphologic phylogenetic evidence, comparative anatomy, paleontology, and stratigraphy. Molecular phylogenetics was found to be essential for suggesting relationships not apparent from morphological evidence. Morphological phylogenetics was found to be equally essential for suggesting evolutionary relationships among ancient, extinct clades, and for indicating ancestor-descendant relationships hidden by limited molecular data (as in the Trigoniida-Unionida and Arcticoidea-Veneroidea ancestor-descendant pairings). Unlike previous classifications of the Bivalvia, the present one more consistently gives preference to typified names over descriptive names for suprafamilial taxa, extends the ICZN principle of coordination to suprafamilial names, and bases their priority on publication date independently of family-group names.

Noteworthy aspects of this classification include: 1) division of the Pectinoidea into two superfamilies, possibly derived from different ancestors; 2) actinodont ancestry for the clade of Carditoidea-Crassatelloidea, but not for other Heterodonta; 3) separation of the remaining Heterodonta into the major clades Lucinidia (derived from the Babinkoidea) and Cardiidia (derived from the Grammysioidea); 4) division of the Cardiidia into the megaorders Poromyata, Solenata, and Cardiata, with each megaorder deriving from different “anomalodesmatan” ancestors (i.e., the superfamilies Pholadomyoidea, Orthonotoidea, and Pleuromyoidea-Modiomorphoidea, respectively); 5) derivation of the Myoidea-Pholadoidea clade from the superfamily Pleuromoidea; 6) derivation of the remaining Heterodonta, including the orders Megalodontida and Hippiuritida, and the superfamilies Kalenteroidea, Gastrochaenoidea, Anthracosioida, Cyamioidea, Galeommatoidea, Cardioidea, Tellinoidea, Arcticoidea, Glossoidea, Sphaeroidea, Ungulinoidea, Gaimardioida, Dreissenoida, Cyrenoidea, Hemidonacoidea, and Veneroidea, from the superfamily Modiomorphoidea.

Cretaceous and Cenozoic Molluscan Paleontology Symposium
Ontogenetic shifts in dietary specialization of a vermivorous marine snail, *Conus ebraeus*

Dan Chang

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Shifts of characters over developmental processes involve transitions of environmental, ecological, behavioral and genetic factors. Ontogenetic shifts of diets have been observed in many organisms and consist of changes in size, composition and diversity of prey. Studies of dietary shifts are important for understanding patterns of resource utilization within a single population. *Conus ebraeus* is a vermivorous gastropod species that is broadly distributed in the Indo-West Pacific region. To investigate the dietary ontogeny of this species after settlement, I collected 250 fecal samples from 246 *C. ebraeus* individuals with shell lengths ranging from 6.8 to 30 mm. These specimens were collected in Guam in 2010. I used microscopic examinations and DNA barcoding to identify prey species from fecal materials. More than 10 species groups of 7 genera of polychaetes represent the prey of these specimens. Contrary to previous studies of this species, juveniles tend to be generalists while subadults and adults exhibit more specialized diets, with at least two dietary shifts occurring after settlement. These patterns of shifts may be affected by size, availability and nutritional values of prey as well as the foraging efficacy of cone snails at different life stages. This study provides essential information for studies of ecological adaptations of *Conus* species and their role in antagonistic coevolution.
Molluscan Diversity and Temporal Changes in an Urban Pond in Northern New Jersey

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Chronic urban growth without regard to sustainability carries long term concerns about water quality and the related ecological health of aquatic habitats as reflected in biotic diversity and community structure. Barbour’s Pond is a small lentic system located in Garrett Mountain Reservation, Passaic County in northern New Jersey, one of the most densely populated and industrialized regions in the United States. The park proper is heavily used for recreation, including fishing, horseback riding, and numerous cross country meets. Despite its small size and surrounding urban sprawl, including a dense network of highways, the shallow waters of this pond hold 18 species of molluscs, including one nonindigenous species of viviparid snail and a single species of unionid bivalve. Monthly samples over a two year period found the highest diversities in December 2004, and January, June, and July 2005. Total molluscan relative abundance was greatest in July and November 2004, possibly reflecting new cohorts produced in the late spring and autumn. Univariante statistics, however, demonstrate that this pond has a diverse as well as a temporally stable malacofauna. This report represents limited results as little information is available about possible in-situ migratory behavior of these molluscs during winter months or during particularly warm summers or drought conditions plus the deeper parts of the pond were not accessible for sampling. There was no anomalous loss of any given species nor any apparent die off of any species during this sampling period. Analysis of basic environmental parameters that fluctuated over the years showed little correlation with molluscan diversity, underscoring the relative stability of the molluscan community within the environmental complexity of at least this small urban pond.
Females floated first in bubble-rafting snails (Janthinidae)

Celia K. C. Churchill

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Ever since Mivart asked Darwin to explain a bird’s use for half a wing, biologists have been challenged to explain extraordinary evolutionary change mechanistically. Reconstructing improbable evolutionary events is complicated by their nonreplicable historical nature, but indirect lines of evidence have revealed how early bird and whale lineages adapted to radically different modes of life through sequential modification of ancestral traits. Here, I use a phylogenetic approach to reconstruct the enigmatic evolutionary origins of Janthinidae, a family of marine snails with one of the most implausible ecologies of any mollusk. Janthinids raft passively in the neuston, a vast oceanic surface habitat, by constructing floats composed of mucus bubbles. I present the first molecular phylogeny including Janthinidae, which confirms that janthinids are derived from Epitoniidae (wentletraps)—benthic predators and parasites of sea anemones and corals. Based on the life histories of both families, I test two hypotheses for the origin of floats and rafting: juvenile droguing or modified egg masses. The phylogenetic reconstruction supports the modified egg mass hypothesis. In the plesiomorphic condition, exhibited by Recluzia cf. jehennei, only adult females build floats, upon which they deposit egg capsules. Two subsequent inferred evolutionary changes in float formation and function involved autonomous juvenile rafting in the derived genus Janthina, and the loss of float function as a substrate for egg capsules in the ovoviviparous J. janthina. These changes appear to be sequential adaptations to a neustonic existence, a conclusion supported by the positive association of apomorphic janthinid traits with ecological prevalence.
Evaluation of spatial and temporal variability in population sex ratios of pleurocerid snails and their relationships with estrogenic compounds and other environmental variables

Serena Ciparis

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When present in aquatic environments, steroidal estrogens and synthetic estrogenic compounds can interact with the endocrine system of aquatic organisms. Disruption of endocrine processes involved in sexual differentiation can ultimately lead to female-biased sex ratios in exposed populations. For freshwater snails in the family Pleuroceridae, little is known about the spatial and temporal variation in population sex ratios or potential relationships between sex ratios and exposure to estrogenic compounds. The variability in population sex ratios of Leptoxis spp. was evaluated within the Shenandoah River watershed (Virginia, USA), where agricultural operations are a source of estrogenic compounds to streams, and in other rivers in Virginia. Proportions of females in populations of Leptoxis carinata varied among streams within the Shenandoah River watershed, ranging from 0.46-0.87, and these proportions reflected consistent female bias at nine of 15 study sites. There was little within-site variation across generations of snails or when the same generation was examined in two different seasons. Proportions of females were not directly related to in-stream estrogenic activity or landscape sources of estrogenic compounds, but were negatively related to mean summer temperature at the tributary sampling sites. Population sex ratios of Leptoxis spp. were female-biased at two of six sites in the Shenandoah River and one of five sites outside the basin. At the river sampling sites, proportions of females were positively related to specific conductivity. Overall, results suggest that site-specific factors can affect population sex ratios of pleurocerid snails. However, until more is known regarding mechanisms of sex determination and sexual differentiation in gastropods, population sex ratios should not be used as indicators of potential biological effects of estrogenic compounds.
A Scientifically Valuable Worldwide Land Snail Collection at Paleontological Research Institution, Ithaca, New York

Marla Coppolino

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From the 1950s through the early 1990s, Dr. Julian Smith, a Cornell University professor of chemical engineering and serious amateur malacologist, collected mostly land snail and some freshwater snail specimens in Tompkins County in central New York, USA, as well as in other states and countries. He donated his collection and accompanying data to Cornell University in 1995, which was later transferred to the collections of Paleontological Research Institution of Ithaca, New York. Most of the 371 lots were collected by Dr. Smith, and some received as gifts, and together they comprise more than 200 species in 34 families. Overall, specimens were collected from more than 100 different localities worldwide. Among the highlights of this collection are Partula species that were collected by Henry Crampton between 1906 and 1909, many of which are now threatened, critically endangered, or extinct in their native habitats. The process to confirm identifications and catalogue the lots has recently begun. I plan to use this valuable collection to help form a baseline list of land snails for a survey in central New York State.

Poster Presentation
“Jay on Jay” - Conchological Contributions of John C. Jay

Jay Cordeiro

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John Clarkson Jay was born in 1808 and grew up in Rye, NY; one of a long line of influential family members throughout U.S. history including New York assemblyman Peter Augustus Jay and Supreme Court Chief Justice John Jay. Although a prominent banker and physician, Dr. Jay would make his impact on natural history in conchology. He was founder of the NY Lyceum of Natural History, Trustee of the American Museum of Natural History (AMNH), and member of the Boston Society of Natural History and Academy of Natural Sciences of Philadelphia (ANSP). Jay was an avid shell collector accumulating over 50,000 specimens comprising 14,000 species (~7000 by today’s standards) - the second largest in the U.S.; and a 1000-volumes mollusk library- one of the largest worldwide; costing him over $35,000. Through trade with eminent conchologists (Adams, Anthony, Baker, Cailliaud, Cuming, Gundlach, Lea, Linsley, Mighels, Prime, Sowerby, Wheatley), Jay acquired several type specimens (57 described species) and described 46 Recent mollusks from around the world; most relocated and documented. Jay self-published four editions and one supplement of his collection catalogue from 1835-1852. He was asked to publish a listing of specimens collected by Commodore Matthew C. Perry’s U.S. Naval Expedition to Japan in 1852-1854, which opened Japan to the West. The shell collection and library were purchased by Catherine L. Wolfe in 1873-4 for $10,000 and donated to the AMNH as a memorial to her father, John D. Wolfe, the museum’s first president. The shell collection was cataloged by Sanderson Smith, a Staten Island collector, and exhibited in its entirety from 1874-1911. John C. Jay’s legacy, and that of his family, is maintained by the Jay Heritage Center at Jay’s boyhood home in Rye, NY; set on 23 acres of the original 400-acre Jay Family Estate; the oldest National Historic Landmark structure in New York.
The Illinois Natural History Survey / University of Illinois Museum of Natural History Mollusk Collection

Kevin S. Cummings* and Jeremy S. Tiemann

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The University of Illinois Museum of Natural History (UIMNH) was “decommissioned” in 2005, and the Illinois Natural History Survey (INHS) obtained the orphaned UIMNH Mollusk collection on 1 May 2008. The UIMNH Mollusk Collection comprised about 45,000 lots of freshwater, terrestrial, and marine mollusks. The UIMNH Collection was assembled by Frank Collins Baker with a large portion of the collection coming from a donation by Anson A. Hinkley. The collection also includes specimens deposited by other early naturalists, including Richard Ellsworth Call, Phillip P. Carpenter, William Clench, Lorenzo E. Daniels, James H. Ferriss, Junius Henderson, Olof O. Nylander, Henry Pilsbry, John Wesley Powell, William S. Strode, Albert G. Wetherby, and James Zetek. It is a relatively old collection with specimens dating back to the mid-1800s. Over 135 countries are represented, but the collection is especially strong in freshwater mollusks in the Midwest and Southeastern United States and land snails from Southwestern U.S. and Central America. The INHS portion of the collection contains over 40,000 lots, most of which are freshwater bivalves and gastropods. In the past 25 years the INHS has been a repository of specimens from surveys conducted throughout the U.S. by state and federal agencies, non-governmental organizations, and private consultants. When combined, the INHS-UIMNH Mollusk Collection is one of the 20 largest mollusk collections in North America and contains over 320,000 catalogued specimens in over 70,000 lots, including approximately 600 lots containing type specimens. The combined collection has over 35,000 catalogued lots of freshwater mussels, approximately 15,000 lots of freshwater snails, nearly 15,000 lots of terrestrial snails, and about 5,000 lots of marine bivalves and gastropods. Over 40,000 soft parts of more than 200 species have been preserved (approximately half in ethanol) and are available for study. Information on the INHS Mollusk Collection can be found at http://www.inhs.illinois.edu/animals_plants/mollusk/.
Comparing soil attributes to molluscan biodiversity: does the soil type matter?

Elizabeth C. Davis-Berg

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To understand the ecological impact of factors such as habitat destruction and introductions of invasive species, it is useful to establish baseline levels of biodiversity for the region studied. To this end, we sampled invertebrates, focusing on mollusks, at localities in both Kansas and Michigan, assessing baseline biodiversity. We will compare those baseline survey data to historical and land use data and use known biological indicator species to estimate the level of habitat degradation.

Surveys of the mollusks in two localities in Kansas, The Nature Conservancy’s Welda Prairie and the University of Kansas’ Fitch Natural History Reservation, were conducted. We sampled at two terrestrial sites and one aquatic site using sampling grids and we also conducted a general survey for larger gastropods around the sites. In Michigan, 3 areas were sampled: in and around Fish Lake in Lapeer County (East), near Eastern Michigan University in Washtenaw County (Southeast), and around Bellows Lake in Benzie County (Northeast). We used the same techniques to sample terrestrial gastropods in both Kansas and Michigan. Dip-net sampling was conducted at the aquatic sites.

The results of the mollusk study found large differences in species abundance and biodiversity between the two regions. We tested the soil for N, P, and K and compared the results to previous results on molluscan biodiversity.
Reorganization of the non-type systematic mollusk collection of the Paleontological Research Institution: A progress report

Greg Dietl, Warren Allmon, Judith Nagel-Myers, and David Campbell*

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The collection of the Paleontological Research Institution (PRI) includes more than 2.5 million specimens, one of the largest and most scientifically important fossil collections in the United States. Allowed to deteriorate, it was largely inaccessible for many years. Since 1992, it has been in large part rejuvenated through a major program of reorganization, re-housing, curation, and databasing. As part of a 2-year NSF-funded project, the backbone of the collection—its non-type systematic mollusk collection (estimated at about 1.5 million specimens)—has been re-housed in modern facilities in compactorized drawers. This portion of the collection emphasizes Cenozoic marine taxa from eastern North America, but includes worldwide material from the Cambrian to the present. The collections are now sorted by family; alphabetizing genera within families is progressing (complete for fossil cephalopods). The project significantly upgrades the physical condition and conservation status of PRI’s fossil and recent mollusk collection by creating space for expansion within each section and facilitating the curation of large amounts of previously uncurated material. The original G.D. Harris and K.V.W. Palmer study collections used to compile their fundamental monographs on the Paleocene and Eocene of the U.S. Gulf Coastal Plain have been fully curated, stratigraphically organized, and databased. These scientifically valuable collections, which form the nucleus of PRI’s non-type systematic collection, contain about 4800 specimen lots. The easy availability of information on the Harris and Palmer collection on the PRI collections online database (www.pricollectionsdatabase.org) will ensure that this collection is made more widely known and available to the research community than it has been heretofore.
The evolution of reproductive isolation in a simultaneous hermaphrodite, the freshwater snail *Physa*

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The cosmopolitan freshwater snail *Physa acuta* has found widespread use as a model organism for the study of mating systems and reproductive allocation. Mitochondrial DNA phylogenies suggest that *Physa carolinae*, recently described from the American southeast, is a sister species of *P. acuta*. The divergence of the *P. acuta/carolinae* ancestor from the more widespread *P. pomilia* appears to be somewhat older, and the split between a hypothetical *P. acuta/carolinae/pomilia* ancestor and *P. gyrina* appears older still. Here we report the results of no-choice mating experiments yielding no evidence of hybridization between *P. gyrina* and any of four other populations (*P. pomilia*, *P. carolinae*, Philadelphia *P. acuta*, or Charleston *P. acuta*), nor between *P. pomilia* and *P. carolinae*. Crosses between *P. pomilia* and both *P. acuta* populations yielded sterile F1 progeny with reduced viability, while crosses between *P. carolinae* and both *P. acuta* populations yielded sterile F1 hybrids of normal viability. A set of mate choice tests also revealed significant sexual isolation between *P. gyrina* and all four of our other *Physa* populations, between *P. pomilia* and *P. carolinae*, and between *P. pomilia* and Charleston *P. acuta*, but not between *P. pomilia* and the *P. acuta* population from Philadelphia, nor between *P. carolinae* and either *P. acuta* population. These observations are consistent with the origin of hybrid sterility prior to hybrid inviability, and a hypothesis that speciation between *P. pomilia* and *P. acuta* may have been reinforced by selection for prezygotic reproductive isolation in sympathy. We propose a two-factor model for the evolution of postzygotic reproductive incompatibility in this set of five *Physa* populations consistent with the Dobzhansky-Muller model of speciation, and a second two-factor model for the evolution of sexual incompatibility. Under these models, species trees may be said to correspond with gene trees in American populations of the freshwater snail *Physa*.
When Cometh Our Reformation? Molecular typology meets population genetics in the pleurocerid gastropod fauna of east Tennessee.

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Evolutionary science was born with Charles Darwin’s simple but profound insight that populations vary. In the phylum Mollusca, perhaps nowhere is Darwin’s insight better demonstrated than in the freshwater gastropods, where geographic isolation, environmental variability, and great expanses of time have combined to yield high levels of genetic variation both within and among large sets of easily sampled populations. In the twentieth century, as the architects of the Modern Synthesis replaced typological thinking with populational thinking and developed the biological species concept, such researchers as Calvin Goodrich (1874-1954) used an appreciation of the variation in freshwater gastropod populations to make significant contributions to our understanding of molluscan evolution.

In recent years, however, a flood of DNA sequence data and the ease by which such data can be analyzed using cladistic techniques have promoted forms of molecular typology no more objective or repeatable than the morphological typology prevailing before Darwin.

We have recently published a large-scale survey of genetic variation at ten allozyme-encoding loci across 15 populations of pleurocerid snails sampled from east Tennessee, with 30 individuals sampled per population. In the present research we resample these same 15 populations, sequence but a single mitochondrial gene from a single individual from each population, and demonstrate how molecular typology as widely practiced today can confound the reconstruction of evolutionary relationships. We then re-expand our sample of individuals and genetic loci, demonstrating the power of analysis of variance to uncover a cryptic pleurocerid species in east Tennessee, previously invisible both to the morphological typology of the nineteenth century and to the molecular typology of the twenty-first. We call for a reformation in the practice of biological systematics, a turning back from typology, and a return to the populational understanding that has always informed the best evolutionary science.

Science is a self-correcting process. The great unanswered question is not whether such a reformation will come, but when.
Geographic variation in diets of three broadly distributed *Conus* species in the Indo-West Pacific

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Knowledge of the organization and structure of species interactions is crucial to bolster our understanding of the impact of species interactions on organismal evolution. To examine the extent of geographic variation in predator-prey relationships among three widely distributed, vermivorous, Indo-West Pacific cone snail species, *Conus chaldaeus*, *Conus ebraeus*, and *Conus miliaris*, we obtained sequences of a region of the mitochondrial 16S gene from fecal materials of snails sampled from multiple locations. Our results showed that these three *Conus* species exhibit significant differences in diet and only very little overlap in the prey species that are utilized among locations. The large degree of geographic variation in diet highlights the complex taxonomy of the polychaete prey of *Conus* that appear to involve several species complexes. In addition, we postulate that the patterns of variation in diets result from a heterogeneous distribution, location-specific preferences, or location-specific availability of prey.
**Micromollusc sampling: evaluating field survey techniques in Hawaii’s tropical forests**

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Terrestrial micromolluscs (snails ≤ 5 mm) constitute a considerable proportion of the snail fauna in many habitats. Due to their small size and soil-leaf litter habitat, micromolluscs are often overlooked or underestimated in biological surveys. Two methods are commonly used for sampling land snails: visual/hand picking in the field and sieving of soil-leaf litter. The Hawaiian Islands harbor diverse land snail communities with >750 species and 99% endemicity. Unfortunately, snail extinctions in the archipelago are estimated at 50-90% despite a lack of empirical data needed to accurately assess the extent of snail biodiversity loss. Historically, surveys in Hawaii have primarily employed visual/hand picking alone. Visual/hand picking is far less labor intensive than sieving and permits covering much greater areas with limited resources, but may underestimate biodiversity. To better estimate the distributions and conservation status of Hawaiian land snails, we are developing a combined protocol that more accurately assesses land snail biodiversity in Hawaii. Three areas on Oahu, Hawaii, that harbor native snails in diverse habitats were used as experimental sites for surveying micromolluscs. Sampling involved a 30-minute visual search in a 100 m² area followed by sieving of leaf litter and topsoil from 4 quadrats. Preliminary data indicate that species richness may be underestimated with the visual/handpicking method alone. Using the most effective sampling approach during surveys is crucial for understanding land snail distributions and life histories and for developing conservation management plans. A combined visual/hand picking and sieving approach is needed to accurately document the remaining species in Hawaii.

Poster Presentation
Phylogeny within Polyplacophora: Chitonida reflects geographic isolation

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Neoloricata corresponds to crown group chitons, including the last common ancestor of extant chitons and all of its descendants. Two divergent neoloricate sublineages are each likely monophyletic: Lepidopleurida and Chitonida. The phylogeny of the mostly deep-water lepidopleurids was recently investigated by Julia Sigwart and colleagues [2011; Invert. Syst. 24 (2010): 560–572], but significant phylogenetic questions also remain for the more species-rich and morphologically diverse chitonids. Recent studies have supported two distinct lineages within Chitonida: Chitonina and Acanthochitonina. Their composition conflicts with classifications used in recent chiton monographs. In particular, a different concept of Acanthochitona has emerged, supported by a likely derived abanal gill arrangement and cup- or cone-shaped egg hulls of its members. Despite this progress, multiple questions remain. My own ongoing analyses of mitochondrial 16S ribosomal DNA (16S) across 40+ chitonid genera have provided some additional resolution beyond what was feasible in previous taxonomically-sparse molecular studies of Chitonida. The 16S results are a preliminary step toward an eventual taxonomically dense combined analysis of morphology and molecules. Some familiar taxa are not supported, implying that their morphological basis is prone to convergence. For example, a slit posterior valve is inferred as polyphyletic and is more likely associated with size-related respiratory adaptations. The alternative groupings supported often coincide instead with biogeographically restricted radiations. A reformulated North Pacific Mopaliidae excludes the mostly southern hemisphere Plaxiphora (formerly Mopaliidae) and includes several morphologically disparate and provisionally reassigned North Pacific genera: Cryptochiton, Tonicella, Dendrochiton, and Juvenichiton. Another North Pacific clade, Cyanoplax + Schizoplax, is closer phylogenetically to the North Pacific Nuttallina than to the more similar appearing members of Lepidochitona from Europe. Within Chitonina, the 120+ species of “Ischnochiton” are polyphyletic, again reflecting geographic patterns. Finally, the monophyly of Chitonidae is challenged, its parts also unconventionally split into New World versus Old World subclades.
Egg deposition by *Rossia palpebrosa* (Cephalopoda: Rossiinae) in a marine sponge (*Porifera: Mycale lingua*) on the Newfoundland Shelf

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Marine sponges collected from the Newfoundland shelf (Northwest Atlantic) in Canadian fisheries research trawl survey contents during the fall survey in 2008, 2009, and 2010 were examined for associated fauna. Approximately 25% of all specimens of *Mycale lingua* (Demospongiae) contained eggs belonging to the sepiolid cephalopod *Rossia palpebrosa*. Specimens were collected from stations from 150-462 m deep, and eggs were present in densities up to 15 eggs per sponge. Embryos were collected from a large range of developmental stages, which suggests continuous spawning. We report for the first time the species of sponge containing *R. palpebrosa* eggs, as well as contribute to the knowledge of the role of sponges in marine benthic habitats in the Northwest Atlantic and the spawning behaviour of *R. palpebrosa*. With the exception of evidence of sponge reproduction, no other eggs were found in > 1500 samples of sponge collected.

Open Session
Global Freshwater Bivalve Diversity

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Given the ecological calamity facing fresh waters, the pressing questions facing malacologists include: How many species of freshwater bivalves are there? How are they distributed? And, what are the evolutionary processes that created these patterns? The answers are fundamental to understanding the biology of the colonization of fresh waters and for setting informed conservation priorities that can mitigate the 6th mass extinction.

Opinion varies over which bivalves should be regarded as “freshwater.” For marine biologists, mere occurrence in hypoosmotic habitats has been sufficient to merit that label. It is more informative to make a distinction between those taxa that have radiated in in-land fresh waters (i.e., < 0.5 ppt) from those that are actively (or passively) colonizing upstream from estuaries. Among extant lineages, there have been (at least) three extensive radiations in fresh water: the Unionida (six families, ca. 850 spp.), the Sphaeriidae (Venerida, > 200 spp.), and the Cyrenidae (= Corbiculidae, Venerida; ca. 100 spp.). Other typically marine/brackish families have made limited excursions above sea level, including the Mytilidae, Arcidae, Donacidae, Corbulidae, Pholadidae, and Pharidae. Most of these “peripheral” freshwater species are endemic to monsoonal Asia. In addition, two euryhaline families, Dreissenidae and Cardiidae, have radiated in the “freshened” Black and Caspian seas, but few species thrive in rivers and lakes.

My talk will focus on the three major radiations of freshwater lineages. I will discuss the results of recent phylogenetic and biogeographic investigations of the Unionida, Sphaeriidae, and Cyrenidae, with an emphasis on areas of ambiguity/controversy or where research is lacking. In general, the tropical freshwater species/clades are poorly understood and among the most imperiled. Hopefully, this review will stimulate further inquiry into global “non-marine” bivalve phylogeny and ecology. This research was funded by the National Science Foundation.
Thinking through the evolution of study of Late Cretaceous and Paleogene continental mussels and snails: Against all odds to a brighter future

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After years of collecting fossil continental mollusks, studying museum specimens, dissecting and upgrading the geography and stratigraphy literature-base of thousands of molluscan localities, and working with others on Late Cretaceous and Paleogene geochronology, sequence stratigraphy, paleogeography, and paleoenvironments, I have come to one inescapable conclusion: freshwater bivalves and freshwater and terrestrial snails are more valuable research tools than I ever envisaged. The negativity associated with their use stems from misconceptions resulting from inadequate publications reflecting their utility and the necessary reliance, in some cases, on outdated nomenclature and taxonomy, leading to limited or no useful evolutionary, biostratigraphic, or enhanced paleoecological information. Studies have been published that acknowledge some of this potential: 1) pre-K/Pg boundary extinction model in North America; 2) lack of a reduction in diversity through intertrappean flows in Deccan Traps, India; 3) identification of North American land-mammal ages by continental molluscan assemblages; 4) use in paleolandscape reconstruction, placing near K/Pg shorelines and other geomorphic features; 5) biostratigraphic recognition of many relatively short-lived taxa; and 6) understanding that many supposed long-lived Lazarus genera went extinct in the Cretaceous that were convergent on modern shell morphologies, the genera of which have limited fossil records. The basis of continental molluscan studies is on generally inadequately delimited types. A Web project currently under way aims to identify what is known about the types and steps to best establish a foundation for further study. Part of this process is to make high-resolution images of type specimens available for download. Where access to data is becoming more restricted, an important avenue for using continental mollusks effectively is to provide the framework for their use. The esoteric citations of yore can be fit into a modern context and the making of valuable topotypic collections upon which all can proceed through a virtual Web repository.
News and Thoughts on Monoplacophora: Their Role in Molluscan Phylogeny

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Since their discovery in 1957 extant monoplacophorans (Tryblidiida: Neopilinidae and Micropilinidae) have always played a central role in considerations on molluscan phylogeny. Most attention is still given to the expressed seriality of several organ systems (shell muscles, gills, auricles, nephridia and gonads, lateropedal connectives), which has been interpreted either as a reduced annelid-like segmentation or as an independent multiplication among the early Mollusca. Most recently, molecular data suggest sister-group relationships with the Polyplacophora and thus challenge the Conchifera-concept (Polyplacophora and Conchifera as sister groups).

Recent investigations on Micropilina minuta (with four pairs of gills and nephridia but lacking a heart) by means of 3D-analysis of serial sections have confirmed and elaborated the concept of progenesis among the Micropilinidae. Seriality of gills and (partly) of nephridia and gonads is established during tryblidian ontogeny from posterior to anterior and thus independent from true metamerism in annelids and arthropods. Comparative investigations on nephridiogenesis in basic molluscs suggest that molluscan nephridia are formed like those of annelids and that the most anterior nephridium in adult tryblidians is the retained larval (proto-) nephridium.

We also question the phylogenetic significance of the widely applied Tergomya-Cyclomya-concept. This is contradicted by the condition of mantle retractors and the high variability of shell shape in molluscs exemplified in the case of closely related patellogastropods.

The proposed sister-group-relationship between Polyplacophora and Tryblidiida (Serialia-concept) is at least a misnomer, since seriality in both taxa has been established independently. From the morphological point of view the traditional Conchifera-concept remains as a valid hypothesis for early molluscan evolution.

Mollusks: The Great Unanswered Questions
The James H. Lee Memorial Symposium
Comparing Apples to Apples: Clarifying the Identities of Two New World Ampullariids, *Pomacea canaliculata* and *Pomacea insularum*

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The Ampullariidae (apple snails) are freshwater gastropods and a key group of basal caenogastropods. They play important ecosystem, disease vector, and agricultural pest roles and have great potential as models in evolutionary biology. The family is composed of two reciprocally monophyletic lineages, one of Old World taxa, and the other consisting of the more diverse New World ampullariids. The family has never been revised and knowledge of levels of species diversity remains confused, particularly among New World taxa with >250 available species-group names. Few types of the more than 150 possibly valid species have been adequately illustrated or described, with most descriptions based only on general shell features. The taxonomic confusion that is rampant within this group is amply illustrated by two species that have been introduced widely and are difficult to differentiate conchologically, *Pomacea insularum* (d’Orbigny, 1835) and *P. canaliculata* (Lamarck, 1822). Until recently, studies of these invasive snails and their impacts mistakenly referred to both as *P. canaliculata*, which is listed as one of the World’s 100 worst invasive species. Difficulty in accurately identifying these species has hampered efforts to prevent their spread and to precisely assess their immense environmental and agricultural impacts. Furthermore, this confusion has made it difficult to evaluate the true range of life-history variation and biogeographic distribution of either species. Molecular phylogenetic data have only recently confirmed the distinctiveness of these two species and closely related congeneric lineages. A robust phylogenetic framework has facilitated a deeper understanding of ampullariid systematics and evolution. Preliminary data support previous work, affirming the large degree of overall morphological similarity between these two species. However, our comparative analyses have revealed differences in adult shell morphology, reproductive anatomy, life history, and biogeographic distributions, corroborating our molecular results and confirming the distinctiveness of these two species.

Open Session
The Cenozoic micromolluscan fossil record is a major reservoir of undocumented marine biodiversity

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Knowledge of fossil marine molluscan diversity is generally considered less mature than knowledge of living biodiversity. The task of sampling living taxa is significantly easier because it is restricted to a single time plane, whereas the paleontologist must sample all of stratigraphic history. The task is important because it is the only way to progress from inferences of relationship to testing hypotheses of evolutionary history. There is increasing recognition of the need to integrate molecular and morphological approaches in systematics of living molluscs. There is less recognition of the imperative of integrating neontological and paleontological data. A strong anatomical imperative for naming and classifying in some molluscan groups effectively divorces these groups from their fossil record. It further reinforces a dichotomy of treatment of shells and animals that dates back to the 18th century.

In actual practice, the naming and identification of living conchiferan molluscs continues to be based primarily on empty shells. Nomenclature of both living and fossil taxa is anchored primarily by names with no corresponding anatomy or molecular sequence. A 21st century focus on biodiversity urges molluscan systematists to the same position: smarter sampling and better characterization. Examples of progress in understanding Cenozoic molluscan diversity result from recognition of (1) an immense global diversity of micromolluscs (<5 mm), (2) sedimentary and ecological facies that have been poorly sampled, (3) taphofacies in which micromolluscs are especially well preserved.

Two examples from the Cenozoic micromollusc record tap rich legacies of life in extreme environments, unusual habitats. Micromolluscs in ancient chemosymbiotic communities, fueled by chemoautotrophic bacteria, provide a larger geobiological perspective when taxonomic characterization is coupled with insights from petrography, geochemistry, biomarkers, biofilms, and biofabrics. The study of interstitial molluscs requires sampling for sub-millimeter shells, and is revealing preservation of minute detail that is commonly lacking in macromolluscs.
Interacting constraints and the problem of similarity in gastropod structure and function

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The most challenging unsolved problem in evolutionary biology is the explanation of structural similarity. Similarities occur from the atomic and molecular levels to the adult phenotype and may be dramatically expressed in larval forms in taxa with biphasic life histories. Gastropods serve as an ideal system for exploring the alternative constraints of (1) common ancestry, (2) evolutionary convergence on optimal functional solutions, and (3) the architectural constraints of building materials and assembly rules. Systematic malacologists traditionally have been most interested in distinguishing similarity due to common ancestry (homology) and similarity due to convergence (homoplasy). Although architectural constraints have been largely ignored, the bioinorganic materials of the gastropod shell and mineralized radula are ideally suited to studying the boundary between strong biological control over the phenotype and weaker control over structure generated by remote biomineralization and self-assembly of inorganic materials. The basic themes and variations of gastropod shell form that have so justly excited the human imagination now can be pursued at finer structure all the way to the atomic level of substructure. Some of the most exciting discoveries have been made outside of malacology by scientists who recognize the gastropod shell and radula as ideal models for exploring big questions.

Morphology, as a search for structural principles, has been eclipsed in malacology by the power of molecular data in resolving relationships. The molecular imperative has been driven by several centuries of morphological description of many thousands of gastropod species without rigorous phylogenetic assessment. A new morphological imperative has arisen through recent discovery that many thousands more species are yet to be described. For many malacologists, biodiversity exploration is the new primary challenge. Return to a morphological imperative is strong in the comparative anatomical study of microgastroid taxa, where new techniques are identifying novel differences in structures previously considered “identical.”
Phylogenomics reveals deep molluscan evolutionary relationships


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Despite their diversity and importance, little is known about the evolutionary relationships among the major lineages, or classes, of Mollusca. Morphological disparity among these lineages has prompted numerous conflicting phylogenetic hypotheses. Unfortunately, because of varying interpretations of features as derived or plesiomorphic, a lack of clear synapomorphies, and often unclear character homology, the ability of morphology to resolve such an ancient radiation is limited. To date, molecular investigations of molluscan phylogeny have relied primarily on nuclear ribosomal gene sequences (18S and 28S), but have also offered little resolution. However, several recent phylogenomic studies employing large amounts of sequence data from genomes and expressed sequence tag (EST) libraries have shown great promise in advancing our understanding of metazoan evolution. In order to investigate molluscan phylogeny using such an approach, we sequenced ESTs from 18 diverse molluscs using 454 pyrosequencing. These, plus publicly available data, resulted in a total of 42 molluscs plus outgroups. At least two members of every major lineage (except Monoplacophora) were included in this study. Building on existing bioinformatics tools, we developed a pipeline to trim, assemble, translate, and parse sequences into putative orthologous groups (OGs). A final supermatrix consisting of 308 OGs and 84,614 amino acids was analyzed using maximum likelihood and Bayesian inference. Our results strongly support the monophyly of Aplacophora as well as a sister-taxon relationship between Aplacophora and Polyplacophora (Aculifera). Within Conchifera, a sister-taxon relationship between Gastropoda and Bivalvia is supported with Scaphopoda sister to that clade and cephalopods sister to all other (sampled) conchiferans. In light of these results, we performed ancestral state reconstruction analyses based on a modified version of the morphological character matrix of Haszprunar (2000). Hypotheses regarding the evolution of several important characters will be evaluated in light of these results.

Mollusks: The Great Unanswered Questions
The James H. Lee Memorial Symposium
Conus from Chemnitz to Cryptic Species at the Zoological Museum of the University of Copenhagen (ZMUC)

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Two independent lines of 18th century collections established by Count Adam Moltke in 1759 and Peter C. Abildgard about 1789 merged in the 19th century to become the Zoological Museum of the University of Copenhagen (ZMUC). With subsequent additions they joined in 1862, and were in a new building in 1867. In 1963, the Museum moved into its present quarters on the new University campus. The ZMUC collection currently contains 20 type specimens of Conus. Most of these were described and illustrated by Martini and Chemnitz in the Neues Systematisches Conchylien-Cabinet in 1773-1795. Despite it having extensive, accurate descriptions and individually recognizable illustrations, the ICZN rejected this work because of its incompletely binominal nomenclature. The earliest available described species with a ZMUC holotype is the well-known C. gloriamaris, by Chemnitz in a separate paper in 1777. Later, 17 other Martini-Chemnitz species whose name-bearing types are in the ZMUC were given available names. And in his 1895 monograph, Rudolph Bergh described one new species, C. judaeus, based on a ZMUC specimen that unfortunately no longer exists. After breaking the shell presumably to extract the preserved animal, Bergh characterized it as identical to C. ebraeus except for its markedly different radular teeth. In a study of genetic connectivity in the widespread C. ebraeus, Thomas Duda discovered an Okinawa population with shells indistinguishable from other, including sympatric, populations but whose 16S mtDNA differed 4-7%, indicating interspecific difference and a cryptic species hidden within C. ebraeus. Subsequent investigation revealed teeth that differed from C. ebraeus and were identical to Bergh’s description for C. judaeus. Our results revealed molecular genetic, radular tooth, and ecological differences, vindicating Bergh’s emphasis of radular over shell characters and his basing a new species on one thoroughly studied specimen, and connecting the historic ZMUC collection with the modern molecular age.
Fossil Coleoids from the Turonian-Maastrichtian (Late Cretaceous) of the Western Interior

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A large seaway invaded the central portion of North America from the end of the Albian Stage to the end of the Maastrichtian Stage (nearly 35 million years) leaving behind abundant marine fossils. These marine fossils give us clues and insights to the fauna, environment, and deposition of this ancient ocean. Molluscs make up the majority of the fossils preserved in the sediments and are commonly used by geologists, biostratigraphers, and paleontologists to map and better understand this ancient ocean and its fauna.

Coleoid cephalopods (squid and octopus) have been reported from marine deposits in the Turonian through Maastrichtian stages of the Late Cretaceous Western Interior for more than 150 years, yet they are rarely recognized and are only scantily represented in a few museum collections. While exterior shelled cephalopods such as nautilids and ammonites are abundant, coleoids, with only interior gladii or pens, are not. Predation and diagenesis play a big role in the preservation of cephalopods. Little remains of these coleoid fossils and rarely are gladii or jaws (the only hard parts composed of chitin or calcite) ever found. As a result, few fossil coleoids are ever preserved, fewer yet are even recognized, and most are never collected because the collector has not been educated or trained to recognize them.

Recent studies show that coleoids were more varied and diverse near the end of the Cretaceous in North America than had been suspected. The known families, genera, and species of fossil coleoids from the North American Cretaceous (90 to 66 MYA) are investigated and inferences are drawn as to their mode of life and abundance.
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Mode of life and habitat of baculites from the Upper Cretaceous of the U.S. Western Interior

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Investigations of exceptionally well-preserved specimens of Baculites sp. (smooth species) from the Upper Cretaceous of the U.S. Western Interior reveal clues into the paleobiology of these ammonites. Large concentrations of tens of thousands of specimens are present in the lower Campanian Pierre Shale near Belle Fourche, South Dakota. The specimens occur as steinkerns, although in many instances, they retain their original shell. These well preserved specimens provide insights into ammonite growth, predation, dimorphism, breeding, and spawning.

The baculites are distributed in several stratigraphic horizons (approximately 8 m thick) over 13 km². The sheer abundance of these specimens suggests that, like modern cephalopods, baculites returned to the same grounds year after year to mate, spawn, and die. A high percentage of the baculites preserve beautiful muscle scars, allowing a reconstruction of their musculature. Jaws and radulae are present inside the body chambers of some specimens, giving insight into their diet. Healed pathologies have been observed in less than 1% of the sample. However we have not yet observed any evidence of lethal predation in any mature baculite specimens inferring this was a safe breeding ground for the ammonites. A large number of small crustaceans are present, which probably fed on baculite eggs and hatchlings.

Small spots of approximately 1 mm in diameter are occasionally preserved on the surface of the steinkern of the body chamber. These spots are shallow, circular to elliptical, and especially abundant close to the aperture. The spots may represent attachment sites of egg masses. We speculate that adults may have attached their eggs inside the empty shells of dead baculites to protect the eggs during incubation.

Cretaceous and Cenozoic Molluscan Paleontology Symposium
The Nautilus: 125 Years of Malacology

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The Nautilus started in Philadelphia in July, 1886, as The Conchologists’ Exchange, a newsletter edited by William Averell, a shell trader from Chestnut Hill, Philadelphia. The publication aimed to promote communication among shell collectors and sale of shells and shell collections. In 1888, Henry A. Pilsbry from the Academy of Natural Sciences in Philadelphia assumed editorship of the publication. Pilsbry changed the name to The Nautilus and reorganized the journal to give it more scientific underpinnings. Given the age of the journal, its influence, and the role it played in American malacology, the history of The Nautilus is almost fully congruent with the history of 20th Century American malacology. Based on his experience as its editor since 1998, the author presents a brief historical account, with special reference to the distinct editors and editorial styles that influenced the journal. In addition, the transformations, trends, and fluctuations experienced by The Nautilus will be discussed, including facts and examples demonstrating the importance and scope of that traditional American malacological journal.
Malacological Collections in Maine’s Aroostook County

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There are two institutions in northern Maine’s Aroostook County that house shell collections. The collections are of immense value and could benefit from curation by current experts. The Nylander Museum of Natural History in Caribou, ME was completed in 1939 to house the collections and papers of local amateur naturalist Olof Nylander. Nylander tramped the Maine North Woods by railroad, canoe, and foot to acquire significant expertise in (1) field geology, (2) paleontology, (3) malacology, (4) ferns, and (5) orchids. His uninventoryed shell collection contains (1) freshwater and terrestrial mollusks found by Olof in the North Country, (2) marine shells that he collected along the Atlantic coast and Florida or acquired through trade and gifts, (3) Midwestern unionids donated by Arnold Ortman of the Carnegie Museum, (4) color variants of *Cepaea hortensis* that Olof collected on a trip to Sweden, (5) *Liguus* tree snails from Florida, (6) Hawaii land snails, and (7) *Polymitra* land snails from Cuba. The University of Maine-Presque Isle is home to the Northern Maine Museum of Science. This museum’s beginnings extend to the early 1970s when it received two substantial donations of natural history material: (1) portions of the Portland Museum of Natural History; and (2) the collection of Leroy Norton. Norton was an amateur naturalist from Presque Isle, ME whose natural history holdings included marine, freshwater, and terrestrial shells, among other items. While Norton’s shells included Maine forms, most of the freshwater (unionid, snail) and terrestrial specimens are from widespread United States locales; his marine shells were worldwide in provenance. The shell specimens, which include some rare items, are fortunately documented in research notebooks maintained by Norton. Other recent acquisitions will also be discussed.

History of Malacology Session
Who Was Barthélemy de Basterot – And Does It Matter?

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Barthélemy de Basterot (1800-1887) was described as “Irish but with French parents” who had a “fine comprehension of geology and conchology.” Born in Dublin, he was raised in County Galway on an estate inherited from his Irish forebears. Basterot matriculated to France as a youth, first to study, and afterwards to live as a French baron upon “marrying well.” He built a small castle outside Paris that serves as a hotel today. Basterot’s paleontological opus was hisDescription géologique du basin tertiaire du sud-ouest de la France(1825). It contained seven superbly drawn plates of shells. Basterot described and cataloged 330 species of fossil mollusks (86 were new species) that he discovered in the Aquitaine Basin of southwestern France, especially the region around Bordeaux. He analyzed his data in relation to (1) extant species currently in the oceans (only 66), and (2) other Tertiary fossil mollusks. Ninety-one of his 330 species were also reported from Italy’s Subapennine region, 66 from the Paris Basin, 24 from England’s London and Hampshire Basins, and only 18 from the Vienna Basin. While Basterot ascribed these dissimilarities to biogeography, Charles Lyell came to recognize them as differences ingeological age. Lyell subsequently devised a molluscan chronometer, based on the proportion of living to fossil species, for differentiating the Tertiary Period into what came to be known as Epochs. While the molluscan chronometer ultimately fell into disuse, Lyell’s Tertiary Epochs are still with us, partly because of Basterot and his Bordeaux fossils. Basterot parlayed his 1825 monograph into a lifetime membership in London’s Geological Society. Other aspects of Basterot’s life will be discussed, including his broader role in natural history.
Hormones and hermaphrodites: influences of anthropogenic and environmental stressors on pulmonate snail endocrine systems

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Hermaphroditic, pulmonate snails are widespread and important members of aquatic ecosystems, and may serve as indicator-species when assessing levels of environmental stress. In addition to natural biological (mating interactions, predation risk) and environmental (thermal fluctuations) stressors, as benthic organisms living in shallow waters, pulmonates are at risk of exposure to anthropogenic pollutants, including chemicals in bottom sediments or dissolved in the water, and light pollution from above. As hermaphrodites, individuals may act in both / either the female role or the male role during reproduction. This flexibility suggests that the maintenance of the endocrine system generally, and estrogen and testosterone concentrations specifically, is vitally important for successful reproduction. Given that mating interactions may occur under environmentally stressful conditions, the endocrine system’s response to and/or management of stress (e.g. corticosterone) is likely to be important. We are examining disruptions to the endocrine system in various snail species resulting from exposure to light pollution (artificial light in normally dark nocturnal habitats) and polychlorinated biphenyls (PCBs) as anthropogenic stressors, and thermal environment as a natural stressor. We found significant differences in growth rates, timing of the onset of reproduction, and hormone concentrations in physid snails exposed to different light levels. Exposure to PCBs significantly increased mortality, reduced reproduction, and altered hormone concentrations in planorbid snails. We are beginning to document the natural hormone levels in local and lab populations, determine the site of production for estrogen and testosterone within the hermaphrodite body, and examine how both natural and anthropogenic factors influence relative hormone concentrations. Given the abundance and importance of hermaphroditic molluscs in aquatic ecosystems, it is important to understand how disruptions to the physiology, life-history characteristics, and mating systems affect these species and the communities in which they live.
The occurrence of two nudibranchs and their invasive prey item, *Membranipora membranacea*

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The presence of *Corambe obscura*, a small, cryptic, dorid nudibranch, in the Gulf of Maine, has only recently been observed in the fall of 2009 at docks located in Portsmouth, NH, where it has expanded from its natural habitat south of Cape Cod, MA. Very little work has been done on this species in its natural habitat, and no work has yet been done on this species in its new environment or its feeding habits on the prey *Membranipora membranacea*, an invasive bryozoan. Though previously observed in 1977 feeding on *Electra crustulenta* in New Jersey, in the Gulf of Maine (GOM) it feeds exclusively on *M. membranacea*. *C. obscura* is also often present on kelps containing *Onchidoris muricata*, another dorid nudibranch, found feeding on *M. membranacea*. I have proposed a study to determine how prevalent both nudibranchs are in the southern GOM by recording number and size of slugs, amount of egg masses present, percent cover of bryozoan, kelp size, temperature, and current intensity. Three sites were chosen in the GOM: Spring Point Marina in Portland, ME; Wentworth Marina in New Castle, NH; and Beverly Point Marina in Beverly, MA. Each floating dock in the marina had kelp blades randomly sampled for aforementioned parameters and kelps sampled are of the species *Saccharina latissima*. Preliminary work done in summer and fall of 2010 show that both slugs increase in abundance along with *M. membranacea*; however, they prefer different floats, possibly due to current intensity. Now that there is overlap in habitat between these two nudibranchs, the effect of reducing amounts of the invasive bryozoan is a rich field for study, as these slugs seem to be the most voracious *M. membranacea* predators.
Conservation of native Hawaiian land snails requires understanding the complex interactions among non-native and native species

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Conservation of biodiversity often requires reducing or controlling the impact of non-native plant and animal species. Unfortunately, an insufficient understanding of the complex interactions among species (native and non-native) makes it difficult for conservation practitioners to develop effective strategies to protect native biodiversity. I will show that effective restoration of native biodiversity, particularly native snails, may not be realized following efforts to remove two non-native taxa, the black rat, *Rattus rattus*, and several non-native ginger species, *Hedychium* spp., in Hawaiian forest ecosystems as a consequence of the complex interactions that currently exist among non-native plants and animals, native snails, and the remaining food web. Black rat removal is seen as a positive conservation strategy to limit predation levels on native birds, snails, and plants. However, black rats also readily consume two of the most destructive non-native snail species in Hawaii, the giant African snail, *Achatina fulica*, and the predatory snail, *Euglandina rosea*. Therefore, reduction/eradication of *R. rattus* populations may cause an ecological release of these non-native snail species, and effective restoration for native snails and plants may not be realized. Efforts to control non-native ginger species in Hawaii are a conservation priority because they restrict regeneration of native plant species and facilitate the formation of an exotic forest type. However, native succineid land snails preferred non-native ginger species to native plants suggesting that native succineid populations could be negatively affected by ginger removal efforts. Both examples reveal that: (1) managers should proceed cautiously with control efforts that involve these species, (2) concurrent invertebrate and plant monitoring should be established prior to and following control efforts, and (3) malacologists need to focus more efforts on the ecology of the extant land snails, so conservation practitioners can make informed decisions and prevent further population declines and species loss.

Gastropoda: Biology, Behavior, and Ecology Symposium
The Malacological Monograph

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Despite more than 225 malacological serials being published today, there are few outlets for papers longer than ca. 100 printed pages. Most of these qualify as scholarly “monographs,” or works upon a single subject, usually comprehensive systematic revisions of a single taxon or original research on a single topic, most often by a single author. Because they are of a highly technical nature and have a relatively limited audience, monographs are generally unattractive to book publishers, even though they are of “book length” and are usually cataloged as single volumes (rather than as serial issues) by libraries. Monographs present a unique set of challenges – for the author (lengthy writing time vs. faculty appointment expectations, finding a publisher, funding the research and expensive author charges) and for the publisher (finding willing reviewers, lengthy production time, securing and maintaining funding for high-cost volumes). A 1997 conference by the Association of Research Libraries discussed the future of the monograph across all disciplines, and ways in which it could be revitalized, including electronic publishing. Thus far, malacological monography has not extensively explored such alternatives. Available outlets for the malacological monograph today include Malacologia (up to 200 pp.), Monographs of Marine Mollusca, Bulletins of American Paleontology, and Palaeontographica Americana.
Publishing through an university press versus a commercial publisher

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Academic and university presses operate very differently from commercial publishers and each has its advantages. For example, the former publishes scholarly works, including some that are unprofitable but offer more editorial control and peer review. The latter puts more emphasis on marketability and faster timelines, which can translate into more sales. In the past few years, I have contributed as an author to two book projects published by Texas A&M University Press, *Gulf of Mexico–Origin, Waters, and Biota. Vol. 1. Biodiversity*, and *Encyclopedia of Texas Seashells*. Another book project, *The Book of Shells. A Life-Size Guide to Identifying and Classifying Six Hundred Seashells*, was published by the University of Chicago Press but designed and produced by a small commercial publisher, Ivy Press. I will draw from my experience with both types of publishers to compare and contrast the two.
Conservation Genetics of a Critically Endangered Freshwater Limpet Genus and Rediscovery of an Extinct Species

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A third of all known freshwater mollusk extinctions worldwide have occurred within a single medium-sized American drainage. The Mobile River Basin (MRB) of Alabama, a global hotspot of temperate freshwater biodiversity, was intensively industrialized during the 20th century, driving 47 of its 139 endemic mollusk species to extinction. These include the ancylinine limpet *Rhodacmea filosa*, currently classified as extinct (IUCN Red List), a member of a critically endangered southeastern North American genus reduced to a single known extant population (of *R. elatior*) in the MRB. We document here the tripling of known extant populations of this North American limpet genus with the re-discovery of persistent *R. filosa* in a MRB tributary and of *R. elatior* in its Ohio River Basin (ORB) Green River type locality. *Rhodacmea* species are diagnosed using untested conchological traits and we reassessed their systematic and conservation status across both basins using morphometric and genetic characters. Our data corroborated the taxonomic validity of *R. filosa* and we inferred a within-MRB cladogenic origin from a common ancestor bearing the *R. elatior* shell phenotype. The geographically-isolated MRB and ORB *R. elatior* populations formed a cryptic species complex: although overlapping morphometrically, they exhibited a pronounced phylogenetic disjunction that greatly exceeded that of within-MRB *R. elatior* and *R. filosa* sister species. *R. filosa*, the type species of the genus, is not extinct. It persists in a Coosa River tributary and morphometric and phylogenetic analyses confirm its taxonomic validity. All three surviving populations of the genus *Rhodacmea* merit specific status. They collectively contain all known survivors of a highly distinctive North American endemic genus and therefore represent a concentrated fraction of continental freshwater gastropod biodiversity. We recommend the establishment of a proactive targeted conservation program that may include their captive propagation and reintroduction.
Stuck between a rock and a hot place: *Assiminea succinea* at the seashore

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*Assiminea succinea* (Rissooidea: Assimineidae) is a small (maximum shell length: ~3 mm), intertidal snail. A mosaic of aquatic and terrestrial traits characterizes its anatomy and behavior. Although captive snails tend to climb out of sea water, in their natural habitat they are immersed daily with no chance to escape. Their eyes are at the tips of stubby tentacles kept erect outside of water like those of fully terrestrial gastropods. The mantle cavity has a vestigial gill. However, observations of live snails and photographic evidence suggest that *A. succinea* derives oxygen from an air bubble kept within the mantle cavity. Evidence also indicates that eggs are laid where the adults live and the embryonic development is direct. *Assiminea succinea* is neither aquatic nor terrestrial: it evolved for life in the transition zone between the sea and the land.
Reverend Lowe’s snails: a mosaic on the beach

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British naturalist clergyman Richard T. Lowe (1802-1874) spent his career on the Madeira Islands where he studied plants, fishes, and snails. In a paper published in 1832, Lowe recounted his experiments conducted to determine if the snails in the genera *Melampus*, *Pedipes*, and *Truncatella* were gill- or lung-breathers. The conclusions Lowe derived from his results were indecisive or wrong. I will re-analyze Lowe’s findings in light of current malacological information and evolutionary theory, especially by enlarging on Gavin R. de Beer’s 1954 idea of mosaic evolution. I will also present a framework to develop historical malacology as a “complementary science” in the sense Hasok Chang proposed in 2004. The purpose is to practice historical malacology as a field contributory to the advancement of present day malacology.
Analysis of *Anguispira* diversity on the Southern Cumberland Plateau.

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*Anguispira* is a genus of land snail found in forested habitats throughout the eastern United States. In south-eastern Tennessee and northern Alabama, the genus appears to have radiated into a cluster of taxa that are all range-restricted, carinate, and calciphilic. Some of these species are listed as threatened by federal and state agencies. In this study, we used mitochondrial DNA and macroscopic shell characteristics to assess diversity within the calciphilic species. We collected tissue samples in a non-lethal manner from 139 individuals of 6 different *Anguispira* taxa from 19 different locations across the Southern Cumberland Plateau region, along with a few samples from nearby areas for use as outgroups. We sequenced portions of the cytochrome oxidase b (Cob) and 16S mitochondrial genes. These data support the monophyly of most of the calciphilic taxa. Relationships between these taxa were not fully resolved, but it appears that the carinate taxa may form a monophyletic group. Genetic variation within currently named calciphilic taxa was low, whereas variation among taxa was high, indicating that they may have been diverging independently from one another for a long time. In addition, it appears that a recently discovered new population of *Anguispira* is monophyletic and genetically distinct from other nearby taxa such as *A. picta* and *A. cumberlandiana*. Preliminary analyses of shell morphology indicate that this population may also be diagnosable morphologically.

Open Session
Slugs of the World: A Review of Terrestrial Slug Diversity

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Researchers have traditionally neglected the terrestrial slugs among the landsnails, although slugs are ecologically, economically, and evolutionarily important. In parallel with my “Global Terrestrial Slug Faunas” project for the Encyclopedia of Life (EOL), I will highlight the great morphological, behavioral, and biogeographic diversity in this polyphyletic group. I will define slugs, state the advantages of limacization over shell-bearing, show phylogenetic relationships among the slug taxa, and discuss the general biogeography of the families. The unique characters and identifying features of different families will be shown in brief. I will review the conspicuous agricultural and disease-vector pest species as well as the highly endemic species that should be of conservation concern. I will discuss needed steps to revise and expand our knowledge of slugs, with a focus on poorly studied taxa and regions. Finally, the EOL website will be presented as a platform of interest to malacologists in general to share and publicize biological information.
Natural History of the Slug Family Philomycidae

Megan Paustian

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The Philomycidae are a wide-ranging family of terrestrial slugs of varied range distributions and life history strategies whose basic biology remains poorly known. I will review their natural history, discuss recent contributions from my research, and suggest what topics future research should address. I will discuss the morphology that defines the family and its four genera (*Megapallifera, Meghimatium, Pallifera, Philomycus*) from eastern North America, Central America, and southeast Asia; their known resources (food and shelter) and sources of population regulation (predators, weather); and their life cycle and mating strategies, such as the love dart of *Philomycus*. Some species are highly endemic, while others are wide-ranging or prone to invasiveness. A recent study in Japan suggests that non-invasive and invasive philomycids differ in their habits and life history strategies. I will also address how climate change and habitat loss are likely to affect philomycids in light of their ecology.

Gastropoda: Biology, Behavior, and Ecology Symposium
Influence of Weather on Land Snail Movement Distances

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Land snails are poikilothermic and require water. We predicted farther and faster movement during warmer and moister weather. We determined daily movement distances by attaching spools of thread to shells of three land snail species (Anguispira alternata, Mesodon thyroidus, and Neohelix albolabris) and monitored for 3 months in 1989 at the University of Michigan Biological Station, Pellston, Michigan. We correlated 486 daily movement distances (135 non-movement, 351 movement) with daily weather parameters temperature, humidity, and rainfall.

We examined (1) all movements modeling weather effects that best predicted if a snail would move at all and (2) just the 351 observations in which snails moved to examine the weather effects that best predicted how far a snail would move.

All three weather factors contributed significantly to the model estimating whether snails would move. Humidity showing the greatest significance and increased the odds of movement while greater temperature and more rain decreased the odds of moving. The three species did not differ significantly from each other regarding the effect of weather on whether they moved.

Humidity was the only significant weather factor in the model estimating the effect of weather on distance moved; more humidity was associated with greater distances moved. The distance moved by A. alternata was significantly less than that of the other two species, while M. thyroidus and N. albolabris distances did not differ significantly.

More movement with greater humidity is consistent with our prediction, but we were surprised to find that more rainfall and greater temperatures did not increase odds of moving or distance moved. The less importance of rain might be explained if snails rest in relatively moist areas, making rainfall less relevant, while snails actively crawling are susceptible to evaporative water loss, so high relative humidity would be important.

Open Session
Feedings rates of the neogastropod *Nucella lamellosa* subjected to different amount of tidal emersion, as simulated in the lab

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The largest individuals of the gastropod *Nucella lamellosa* are subtidal, perhaps because intertidal individuals do not forage during low tide. An alternative hypothesis is that tidal emersion is so stressful, that foraging rates remain low even during high tide. I tested between these hypotheses, predicting that snails who undergo daily emersion over a 24-day long mesocosm experiment would eat significantly less than those that were submerged constantly, regardless of the amount of time that food was available. Mesocosms were supplied with running seawater and contained one snail and a rock covered with barnacles (*Balanus glandula*), the preferred prey of *N. lamellosa*. I removed the number of empty barnacle tests on each rock at the start of the experiment, so that the number of empty tests at the end of the experiment reflected the total number of barnacles consumed. Two exposure treatments subjected the snails to air for two and five hours each day. In two other treatments, snails remained underwater but were deprived of their food source for two hours and five hours each day. Snails in a control group were kept submerged and fed *ad libitum*. In another control treatment, barnacles were kept submerged but without snails to provide a baseline number of barnacle deaths. Each treatment was replicated 10 times. Preliminary analyses suggest that, while all of the experimental treatments showed less barnacle consumption than the control (0.0003 < P < 0.04, ANOVA followed by Tukey HSD), they did not differ significantly from each other (P > 0.56, Tukey HSD). Thus, the effects of emersion can be solely explained by the fact that snails stop foraging during low tide.
Preliminary report on terrestrial mollusks and other invertebrates associated with cave ecosystems in Maine

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From 2008-2009, 20 caves in Maine were surveyed for invertebrate fauna. In order to evaluate which species found in caves are actually restricted to caves, we sampled both within caves and from nearby outside the caves. We collected 69 leaf litter and hand samples, 27 of which were from inside caves. At least one snail and 13 arthropod taxa were found inhabiting the caves of Maine. Twenty-two additional land snail species were found nearby outside of caves. Zonitoides arboreus was found within Mt. Megunticook Cave, which contained the most abundant and diverse assemblage of organisms of any of the caves sampled. Glyphyalinia wheatleyi is reported as a new state record and we report 3 new county records for Penobscot Co. and 2 new county records for Waldo Co. The scarcity of invertebrates found to date in Maine’s cave ecosystems might be primarily due to the lack of organic matter within caves, and the scarcity of snails might reflect that none of the caves were in limestone bedrock.
A collection of photos of world malacologists

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Portraits seem a significant component of history. Since the mid-1960s, I have been photographing malacologists (broadly interpreted to include paleontologists). I now have about 470 different individuals, and I will be quickly showing about 40 of these. In my estimation those persons chosen are, for one reason or another, noteworthy scientifically. Many of the choices were difficult if not arbitrary. The collection is far from complete, and I will be adding to it at the meeting. Anyone I expect to see there will not be shown (lest it become a popularity contest). Some of the deceased will be included.
The protoconchs and larval ecology of some Pyramidellidae (Opisthobranchia)

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Although they intergrade, pyramidellid protoconchs can be classified into A-, B-, and C-types. A- and B-types are tilted and heterostrophic (left-handedly coiled but not sinistral), and have 2+ or 1½ to 1¾ whorls, respectively. C-types are not tilted and near planispiral and have about 1 whorl. A-types may be constrained to planktotrophy (Thorson, 1946), but B- and C-types have all three modes of larval development (including lecithotrophy and intracapsular metamorphosis). Boonea species are all B-types and the east American species B. seminuda and B. bisuturalis are planktotrophic (the latter having been reared through metamorphosis in the laboratory). B. impressa has all three developments allopatrically and perhaps intraspecifically. This “species” is planktotrophic at North Carolina, lecithotrophic at Port Aransas, Texas (White, Kitting & Powell, 1985), and it undergoes intracapsular metamorphosis at Galveston, Texas. B. “impressa” may be about three unnamed sibling species. Alternatively, they may be sulfide-modulated ecotypes, or there may be poecilogony (intraspecific variation in mode of reproduction). Regardless, this appears to be the first known exception to Thorson’s (1950) “shell apex theory”, whereby developmental modes can be inferred from protoconch characters. The theory may hold up for prosobranchs. Two east American Fargoa species are C-types and planktotrophic, but some C-type pyramidellids in other genera have other developments elsewhere.
Hundreds of species and thousands of questions: what we still don’t know about the coleoid cephalopods.

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Cephalopod mollusks are a charismatic class of about 700 extant species. Although there are relatively few living species, cephalopods are poorly understood compared to other mollusk classes. This is in part due to the difficulty in collecting Cephalopods and maintaining them alive, and partly because of a research emphasis on commercially important and inshore species. Many fundamental questions remain in systematics and taxonomy, population and community ecology, behavior, growth and development. Elementary school questions (how long do they live? what do they eat? how do you know they are different?) remain difficult to answer for most species. Reliance on generalizations based on the best-studied squids, octopods, and cuttlefishes obscures the diversity and complexity of this class and emphasizes the need for expanded research efforts.

This talk will outline the holes in our knowledge of coleoid cephalopods. Examples will be drawn from all extant orders, but with a special focus on the giant squid Architeuthis sp. as a charismatic example of the oegopsid squids. We will show that it is much simpler to describe what is known about Cephalopods than what is unknown.
The Philippine Mollusk Symbiont International Cooperative Biodiversity Group

Gary Rosenberg

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The Philippine Mollusk Symbiont International Cooperative Biodiversity Group (PMS-ICBG; <www.pms-icbg.org>) is an NIH-funded collaboration that combines research on molluscan diversity with discovery of natural products from bacteria that live symbiotically in mollusks. Targets of the natural product research are compounds of pharmaceutical interest and enzymes that might be used for biofuel production. Pharmaceutical targets are sought mainly in neogastropods, with focus on Muricoidea and Conoidea, but with sampling broadly across the Gastropoda. Cellulase activity is sought primary in the Teredinidae, but also assayed in herbivorous gastropods. On the biodiversity side, project goals include developing a master list of mollusk species known from the Philippines, and merging the Biotic Database of Indo-Pacific Mollusks into the World Register of Marine Species.

Many of the mollusks assayed in the project are caught in lumun-lumun nets, which are bundles of old fishing nets placed on the bottom for several months. This method of fishing, which was developed in the Philippines, is an excellent source of small live gastropods, with more than 100 species and more than 1000 individuals often found in a single haul. The PMS-ICBG has evaluated the lumun-lumun method, finding differences in species composition by depth, season, and geography and also in comparison with the mollusks found in benthic samples taken near the nets. One interesting finding is that the actual depths of the nets as measured by scuba divers are often only 20-30% of the depths stated by fisherman, which means that the depths reported with purchased materials are unreliable.
Researching dates of publication in the Internet age

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Determining priority of scientific names means that it is sometimes necessary to determine as accurately as possible when a new name was published. Dates of publication are usually researched through original wrappers, dates of receipt in libraries, and contemporaneous reviews. Electronic searches often reveal additional sources of information. For digitized works, searching the text can reveal internal dates that otherwise might be overlooked. Searching with author’s or publisher’s name and title words in online resources such as Google Books can find publishers’ catalogues bound with unrelated volumes, and reviews and records of receipt from scholarly societies and libraries with scope beyond the natural sciences. Searching by names of taxa described in a work can find citations that provide a latest possible date of publication. Searching library catalogues through WorldCat can find copies dated differently than usual, which might have been annotated on receipt.

Electronic searches can fail in unexpected ways. Search engines often collapse hits in similar works, or on multiple pages within a work, hiding relevant information. A preview window might show one instance of a key word, but hide the needed one farther down the page. Key words will be missed if OCR fails, so alternate search terms should be used. Even when OCR is correct, searches can fail if there are indexing problems in the underlying database. Different copies of a work may give different results because of different scan quality. Also, not all sources are online at any given time: a search that succeeds one day can fail the next. These factors combined mean that more than half of relevant sources are not found by a cursory search.

New or improved collations are presented for d’Orbigny’s *Voyage dans l’Amérique Méridionale*, Sagra’s *Histoire physique, politique et naturelle de l’île de Cuba*, Kiener’s *Coquilles Vivantes* and *Encyclopaedia Metropolitana*.

Publications Workshop
Movement patterns of giant Pacific octopuses

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We studied movements of giant Pacific octopuses, Enteroctopus dofleini, in south-central Alaska. Animals were captured, outfitted with sonic tags, and released. Position data were obtained for each animal using several tracking methods. Animal movements were affected by diurnal and tidal rhythms, and tracking revealed details of denning behavior. We found limited evidence that octopuses could select habitats based on ecological factors including water depth, availability of kelp cover, or of den shelters. Movement patterns suggested a reliance on local submarine topography for navigation.

Movements appeared to fall into two groups, those having a central-tendency (return to den, presumed foraging) and those lacking such a tendency (presumed to represent relocation). Our analyses suggest that octopuses are responsive to their immediate environment in ways reflected in patterns of movement, but also indicate that area use patterns are a compromise between limited knowledge of the distribution of resources and use of localized information in decision making.
The Herbert D. Atheard Sphaeriidae Collection of the North Carolina State Museum of Natural Sciences

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The Invertebrate Collection of the North Carolina State Museum of Natural Sciences (NCSM) has a growing collection of freshwater mussels and other Mollusks. This collection has expanded primarily through the donation of specimens collected by state agency personnel and the donation of private collections. In June 2007 NCSM received the privately held Herbert D. Athearn, Museum of Fluviatile Mollusks, collection of over 23,000 catalogued lots. We have begun databasing this collection into our MS Access based relational database. The following families are currently being databased: Amnicolidae, Ampullariidae, Bithyniidae, Chilinidae, Cocculinidae, Cochliopidae, Corbiculidae, Hydrobiidae, Hyriidae, Iridinidae, Lithoglyphidae, Margaritiferidae, Mycetopodidae, Neritidae, Pachychilidae, Physidae, Planorbidae, Pleuroceridae, Pomatiopsidae, Semisuclospiridae, Unionidae, Valvatidae, and Viviparidae. This tremendous collection contains approximately 50% freshwater bivalves. The family Sphaeriidae, including specimens in the genera Eupera, Musculium, Pisidium, and Sphaerium (totaling 1,310 lots and 52,074 specimens) has been completely databased. While the majority of the specimens in the family Sphaeriidae are from the United States and Canada, there are also specimens from Albania, England, Mexico, and Poland. This invaluable collection has provided the opportunity for us to document significant gaps and further investigate the historic distribution of multiple genera of aquatic mollusks.

Poster Presentation
Large Cerithium vs. small Bittium: too simple?

Ellen E. Strong

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The marine Cerithiidae is one of 17 families in the Cerithioidea; with ~185 species currently recognized as valid it accounts for ~15% of known cerithioidean diversity. The family is essentially subdivided into two subfamilies: the generally small-sized Bittiinae with a shell characterized by a beaded or cancellate sculpture, a weak anterior canal and an obsolete posterior canal; and the Cerithiinae with typically large, solid shells and well developed anterior and posterior canals. In his generic revision of the Bittium-group, Houbrick emphasized that there is no single conchological feature that unambiguously distinguishes bittiines from cerithiines. However, several anatomical features have been cited as differentiating the two subfamilies, with bittiines characterized by the presence of an epipodial skirt with or without tentacles, an opercular lobe, a metapodial pedal gland, and most significantly a pallial oviduct with two spermatophore bursae and one seminal receptacle. On the other hand, cerithiines typically lack an epipodial skirt, and have a pallial oviduct with one spermatophore bursa and one to two seminal receptacles. Although there are some cerithiines with an epipodial skirt, Houbrick emphasized that it was the unique combination of shell and oviduct features that distinguished bittiines. Reexamination of oviduct morphology in a number of bittiine taxa has revealed that the diagnostic difference in oviduct morphology putatively distinguishing them from cerithiines does not hold up. The monophyly and relationships of cerithiines and bittiines will be explored using new morphological and molecular data to assess if they are reciprocally monophyletic and the morphological basis for their separation.

Open Session
Publishing on demand: the pros and cons

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There are a number of venues for publishing books. There are traditional publishing houses, academic presses, and self-publishing. Publishing on demand (POD) falls within the latter category. When the American Malacological Society was updating How to Collect and Study Shells, all of the above publishing venues were considered. In 2006 this book reappeared as The Mollusks: A guide to their study, collection, and preservation, the final decision was to use POD. This decision was based on a careful evaluation of the pros and cons of each method of publication. Items that were considered were editorial control, retention of copyright, method of distribution, cost of the final product, among others factors. In this presentation, we will discuss this analysis and some of the items one should bear in mind if considering using POD.
Museum Collections and the Role of Amateur Collectors: An Example from the Carnegie Museum

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Museum collections are derived from a number of sources. The curatorial staff often conducts field work and the specimens that they collect become part of the institutional collection. Non-museum researchers, including those not affiliated with a museum, will often donate the specimens from their studies to museums. These vouched specimens become available to other scientists. Amateur malacologists will often donate their collections to museums. In many museum mollusk collections, 80-85% of specimens are donated by amateurs.

This presentation will focus on the donations made to the Carnegie Museum by two amateurs, Jay Tripp and Robert “Makuabob” Dayle. Tripp’s collection, which was strongest in Floridian Plio-Pleistocene fossils, was the basis for the description of four molluscan taxa. Dayle’s collection of Hawaiian Cypraeidae has been used in several publications, and material has been used by researchers in the United States and Israel. In addition to reviewing how these collections were used, we will discuss the positive and negative aspects of accessioning amateur collections.
Leptoxis (Gastropoda: Pleuroceridae): more than just shells

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Current classification of the freshwater gastropod genus \textit{Leptoxis} is almost exclusively defined by gross shell morphology. This classification is based upon a broadly ovate shape, rather than discrete shell characters that can be used to fully diagnose each species, much less the genus. Furthermore, other aspects of \textit{Leptoxis} biology (i.e. the soft body and its behavior) have historically been ignored. In support of a larger phylogenetic and systematic review, we have photographed all extant \textit{Leptoxis} to characterize soft body pigmentation and examine species for diagnosable soft body characters. These photographs portray \textit{Leptoxis} in a manner not captured by countless lots of shells in natural history collections. We document for the first time a wide array of colors and pigmentation patterns in \textit{Leptoxis} and characterize them for each species. Most species of \textit{Leptoxis} have yellow or orange bodies with differing black banding patterns, but \textit{L. arkansensis} and some \textit{L. subglobosa} individuals have bright blue pigmentation. Through analysis of these photographs, the shared presence of an ocular peduncle was found in Tennessee River basin \textit{Leptoxis} species, and a species-specific basal ocular flap was found in \textit{L. dilatata}. We also document the egg laying strategies and the geographical distribution of each species. A greater focus on aspects of \textit{Leptoxis} and pleurocerid biology other than the shell will enhance systematic analyses and improve understanding of a poorly studied but ecologically important group of freshwater gastropods.

Poster Presentation
Evolution of the alimentary system in heterodont bivalves

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In the Mollusca, the stomach evolved the greatest complexity and diversity in the class Bivalvia. The stomach is an extensively ciliated and cuticulated sac equipped with a chitinous gastric shield against which the crystalline style revolves. Its walls are elaborated with a diverse array of ridges and folds, including sorting areas and extensions of the intestinal typhlosoles, and bear the openings to a variety of outpocketings including the dorsal hood, appendices, and ducts of the digestive diverticula. These modifications are a potentially rich resource of characters for assessing evolutionary affinities, yet their utility has yet to be thoroughly explored. Published comparative accounts of bivalve alimentary anatomy thus far have represented this diversity of midgut structure essentially with a single, complex multi-state character, discriminating among several major ground plans corresponding to different feeding types. We tested the usefulness of alimentary system characters for a finer-grained phylogenetic analysis by developing consistent terminology and a standardized perspective on illustrating the features of the stomach’s interior. In this study, focused on select clades of euheterodont bivalves, we reassessed the taxonomic significance of traditional and newly defined stomach and intestinal characters based on original anatomical studies and in light of recent molecular and morphological phylogenetic analyses. The new findings will be discussed against the historical background of the bivalve stomach research (particularly the work of R.D. Purchon), and the potential relationship of stomach characters to diet type and feeding mode will be hypothesized. This project is supported by the NSF-AToL Bivalve Tree of Life (Project 0732854) grant.
Evolution of the ligament in pterioidean bivalves: the Significance of Cretaceous and Cenozoic Fossils

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The hinge ligament is an apomorphic feature of the molluscan class Bivalvia performing a triple function of connecting the valves, keeping them aligned, and forcing them to gape upon the relaxation of the adductor muscles. Structurally, ligaments consist of the organic lamellar and aragonitic/organic fibrous layers, the number and relative orientation of which vary greatly across the class. The diversity in ligament morphology attracted considerable attention of paleontologists and neontologists as a means of inferring phylogeny. In the Pterioidea, the diversity of ligament morphology exceeds that of other bivalves, which makes the superfamily ideally suited for analyzing the evolution of the bivalve ligament. The two most widespread ligament types among the Recent Pterioidea include (1) the alivincular ligament, in which the central fibrous layer is flanked by the anterior and posterior lamellar layers, and (2) the multivincular ligament that consists of alternating, serially repeated lamellar and fibrous layers. In this study, the evolution of the ligamental systems is considered in light of new ontogenetic data for Cretaceous and Cenozoic pterioideans, and a recently proposed phylogenetic hypothesis based on the Recent taxa. The following principal conclusions were reached: (1) the alivincular ligaments in adult forms arose convergently from different precursors; (2) ligament evolution involved different processes (including heterochrony); and (3) there was a trend toward decrease in ligamental sublayers.
Rapid, short-lived excursion in variability of Late Pliocene populations of an evolutionarily conservative Neogene lineage, *Glycymeris americana* and its antecedents (Arcoida: Bivalvia), in the western North Atlantic

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Three glycymerid species, known by Miocene to Pleistocene fossils from the Atlantic Coastal Plain, one still living offshore, constitute a single lineage. The species differ consistently on minor shell characters, and *Glycymeris americana* exhibits considerable ecophenotypic variation, but without any sustained temporal or geographic trend.

At the time of highest Neogene sea level, 3.0-3.5 Ma (Piacenzian), shells with distinctive patterns of oblique, aberrant sculpture appeared, generally together with normal shells of *G. americana*, from Florida to southernmost Virginia. The aberrant morphology has several forms of expression that vary in frequency, regionally and among adjacent localities. Subsequently, these variants disappeared, equally abruptly. They have not been observed in any latest Pliocene or younger populations of *G. americana*.

The aberrant shells bear oblique or irregularly concentric folds or ridges, generally affecting only the outer shell layer. Four variants are recognized. (1) Oblique dorsal rugae occur just posterior or anterior of the umbo. (2) Irregularly concentric rugae extend across the entire shell, which is long relative to its height. (3) Irregularly concentric rugae occur on the juvenile shell, which later reverts toward the normal shape. (4) Anterior and posterior oblique rugae diverge away from a medial area without rugae.

The short-lived emergence of this polymorphism came when habitats preferred by glycymerids, notably shell gravels, were extensive. Sea water temperatures were warmer than at any other time in the Neogene, due to changes in oceanic circulation resulting from final closure of the Isthmus of Panama.

The evolutionary excursion and return to normal shell sculpture of the Cretaceous inoceramid *Actinoceramus* seems to have been adaptive and driven by selection (Crampton and Gale, 2005). In contrast, patterns of development in *G. americana* that were only mildly deleterious, hence subject to weak selection, appear to have emerged and persisted in rapidly growing populations, under unusually favorable conditions.
New developments in aplacophoran research

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In numbers, the aplacophoran mollusks are of subordinate importance amongst the Mollusca, comprising no more than 126 (138) described species for Caudofoveata (Chaetodermomorpha) and 268 described species for Solenogastres (Neomeniomorpha). Even though these numbers represent a severe underestimation of the real diversity, which may be at least ten times as high, aplacophorans remain a somewhat obscure group as compared to gastropods, bivalves, or even chitons. The ongoing confusion when it comes to naming, categorizing, and classifying what is known as either the class Aplacophora with subclasses Chaetodermomorpha and Neomeniomorpha, or the two classes Solenogastres and Caudofoveata, is not helpful in this matter, either. Nevertheless the last decade has brought a number of important results when it comes to aplacophoran biology, biogeography, and currently also aplacophoran phylogeny. This is mostly due to the work done by three researchers, namely Amélie H. Scheltema (US), Luitfried Salvini-Plawen (Austria), and Dmitri I. Ivanov (Russia), as well as their students and former students - including myself - and the next generation we are supervising. For this presentation, I have been in contact with the current major players in aplacophoran research and try to summarize the status quo. This includes new answers on questions of general biology (feeding, reproduction, development), biogeographical distribution and diversity, classification, and phylogenetic relationships. New molecular phylogenetic results point to a monophyletic Aplacophora, sister group to Polyplacophora, thus supporting a clade Aculifera that is sister to Conchifera. What does this mean in terms of evolution of aplacophoran morphological traits? Where are the future challenges? And finally, can we come up with a joint decision: a single class Aplacophora or two classes, Caudofoveata and Solenogastres?
From behavior to ecosystems and back: linking levels of ecological organization with pulmonate snails as a model system

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Ecologists have long predicted that strong linkages exist among disparate levels of ecological organization. For example, shifts in habitat use or diet of a keystone species should, in theory, have strong effects on community and ecosystem level properties. However, there are few demonstrated examples of linkages reaching from individual behavior to ecosystems, in part because of the difficulty of collecting data over the relevant temporal and spatial scales. Here I present the results of studies with pulmonate snails living in pond ecosystems that examine how changes in individual behavior affect community and ecosystem level properties. I have found that shifts in habitat use, induced by the presence of a predator, can have strong effects on the distribution of periphyton. I have also found that predation risk affects the way in which nutrient enrichment enhances secondary productivity.

I have also examined how a change in an important ecosystem property, nutrient loading, affects predator avoidance behavior. Pulmonate snails use chemical cues to detect predators, but chemoreception may be disrupted in systems with elevated pH. Elevated pH in lakes and rivers is often associated with eutrophication. I tested whether elevated pH impairs perception of predation risk by the freshwater snails Physa acuta and Helisoma trivolvis. In one set of experiments, nutrients were added to outdoor mesocosms. Both snail species moved to avoid fish in water with pH up to 9.0 but showed no avoidance at higher pH. In a laboratory study, we used buffers to establish six pH treatments ranging from 7.5 to 10.0. Both species responded to fish cues by moving into safer habitats, but avoidance became impaired in treatments with pH above 9.0. Given the diversity of aquatic organisms that depend on reception of chemical cues and the broad extent of eutrophication, chemosensory impairment is likely a common occurrence in nature.
Report on the Terrestrial Mollusks of the Sierra de la Madera (Opusura), Sonora, Mexico – The Caracoleros

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The Madrean Archipelago Biological Assessment (MABA) organized a bioblitz expedition to the Sierra de la Madera (Opusura) near Moctezuma, Sonora, Mexico from 29 July to 7 August 2010, which included a land snail inventory. The MABA snail team of four people searched five sites in pine-oak woodland (1225 -2080m elevation) for both macro and microsnails and found 347 individuals of 20 species or forms. The only macrosnails were a Sonorella species (n=5) found at four sites, a Succinea species (n=3) from two sites, and one slug. The remaining micromollusks (<6mm) included representatives of seven families. The most diverse group was Gastrocopta with about 10 species/forms; but Vallonia perspectiva was the most abundant single species (n=123). This collection adds six new records to the 61 previously reported for the state and one apparently new species. Ten forms, including Gastrocopta ashmuni group and Sonorella, are indicators for the Southwestern Mollusk Province (SWMP). The Sierra de la Madera is one of the southernmost “sky islands” in the SWMP; but only two species found there are really tropical. Additional conclusions on biogeography of this assemblage would be premature since collecting in Sonora has been sporadic because of the difficult terrain and remote locations. In addition, micromollusks are underrepresented in most collections though they often represent half of the biodiversity.

Open Session
Molluscan Paleontology of the Chesapeake Bay Area-The Classic Standards for the Atlantic Coastal Plain

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The area where the Chesapeake Bay lies today is the site of Paleo-Atlantic transgressions and regressions since the time of the continental break-up in the Late Triassic. Beneath the Bay a series of deltaic sands and fossiliferous marine silty sands records a rich history of climate change; sea level fluctuation, and structural movement.

Today the Atlantic Continental edge is tilted by tectonic forces to the Northeast. The result is that the Coastal Plain north of Massachusetts is tilted below sea level. The shelf is progressively emergent south of that area so that the Chesapeake Bay area is submerged, partially allowing tidal waters to impinge to the Fall Line or Piedmont.

The Salisbury Embayment, the site of the present Chesapeake Bay, has a rich history of Cretaceous and Tertiary sediments. Glacial streams and rivers have cut through these sediments to expose these older beds in the resulting valleys. Subsequent flooding during interglacial periods allowed these rivers to overflow their channels and then be widened by predominately northeast and northwest winds. The result is erosion of the river banks and the construction of wide, flat flood plains. When sea level dropped, broad terrace plains were exposed, with high escarpments to mark where the cliffs were at the edge of the rivers.

The exposures along the Chesapeake Bay and its associated rivers, the Patuxent, Potomac, Rappahannock, York, and James, have created almost continuous sections that extend for kilometers. Within these beds are countless fossils of almost every type from land plants to marine invertebrates. This extensive record has served as a “Type area” to study the stratigraphic succession and the facies within the beds south of the Maryland-Virginia area. The embayment of the rivers in North Carolina, South Carolina, and Georgia continuously decreases. The result is smaller exposures that are farther apart. For this reason much of the stratigraphy south of the Bay area is interpreted on data obtained from the Chesapeake Bay exposure. Unfortunately, these classic sections are being covered by riprap by engineers trying to control “harmful erosion.”

Cretaceous and Cenozoic Molluscan Paleontology Symposium
Assessing danger, how leeches affect physid life history and behavior

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Physa acuta, a prominent member of freshwater ecosystems, is known to have morphological, life history, and behavioral responses to both fish and crayfish predators. However, very little is known about physid response to leech predators. In some habitats, predatory leeches are commonly found in close proximity to P. acuta and their egg masses. This study further explores how leeches can affect the morphology, life history, and changes in mating behavior of P. acuta when they are alerted to the potential danger of leeches.

Twelve snails from three isofemale lines, all hatched on the same day, were evenly assigned to a chemical treatment. The four chemical treatments included in this experiment were: pond water control, crushed snail, snail-fed leeches, and brine shrimp pellet-fed leeches. For the duration of the experiment, the snails were reared separately. The length, width, and length by width ratios of the experimental snails were measured at four weeks (before the water treatments began) and at ten weeks (the sixth week of water treatment). Each week, snails were provided with a water change, depending on treatment, and scored as to whether they had laid egg masses that week and whether egg masses from previous weeks had hatched.

In an additional experiment, mating trials were performed on approximately thirty wild collected snails that were isolated for at least one week prior to the mating trials. Mating trials were conducted on snail pairs in a petri dish in a set amount of water, depending on treatment, for a set period of time. The following data were collected on the mating trials: number of times mated, number and type of rejective mating behaviors observed, and overall activity during each mating trial. Only snails that were of reproductive age and had demonstrated the ability of producing viable egg masses were used.
Systematics of *Leptoxis* (Gastropoda: Pleuroceridae)

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Critically imperiled freshwater gastropods of the genus *Leptoxis* have been traditionally overlooked in many systematic studies. Currently, the taxonomy of *Leptoxis* is based on plastic conchological characters and geographic distribution rather than discrete autapomorphies. This reliance on conchological characters complicates conservation efforts because putative species boundaries, which are the basis for management units, do not always reflect biological reality. Although *Leptoxis* has been resolved as not monophyletic in previous studies, limited taxon sampling and single locus phylogenetic analyses limit confident taxonomic conclusions. As part of a total systematic revision of *Leptoxis*, I am utilizing a multi-locus (16S rRNA and COI mitochondrial genes and 28S rRNA nuclear gene) phylogenetic approach and documenting life history strategies (i.e. egg laying behavior, period of oviposition), and morphological characters to characterize synapomorphic and autapomorphic characters. This is the first phylogenetic study of *Leptoxis* to have complete ingroup and adequate outgroup sampling. Phylogenies inferred in this study resolve *Leptoxis* as not monophyletic with multiple, well-supported, “*Leptoxis*” clades recovered in the phylogeny. These clades are characterized by shared egg laying strategies, which provide more reliable diagnosable characters than shell morphology. A major anomaly of these data, however, is the presence of haplotypes with greater than 15% sequence divergence within populations of *Leptoxis* and other pleurocerid genera. These haplotypes do not appear to be pseudogenes or morphologically cryptic species, but how they are maintained within a population is unclear. The presence of these haplotypes is discussed with regard to how gene trees of this family should be interpreted, and the broader implications these haplotypes have for taxonomic classifications in the Pleuroceridae.
Genera within the Isognomonidae? Family-wide geometric morphometric analysis of ontogenetic patterns and classification schemes

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With the expulsion of the Crenatula from the Isognomonidae, family of tropical, marine bivalves, all species within this morphologically diverse family now reside within a single genus Isognomon. Throughout the taxonomic history of these bivalves, several different classification schemes have been proposed. Some of these incompatible arrangements were the result of intellectual conflict between British and French naturalists during the Napoleonic era. However, many differences in taxonomic arrangements stem from disagreements over the amount of morphological variation within this family, the perceived distinctness of these forms, and how “meaningful” the observed variation was.

The taxonomic arrangement of these bivalves has spanned the entire range of “lumping” and “splitting.” Some authors proposed combining all Isognomonidae, sensu stricto, into a single hyper-variable species. Others embraced arrangements with up to 5 extant genera and separated every regional population into its own species. For this talk, I examine both molecular sequence data and geometric morphometric ontogenetic data for this entire family. I will then compare the findings from examining these data with previously proposed taxonomic arrangements for this family and propose an arrangement that is compatible with my observations.
Molecular and morphological analysis of the Hawaiian Achatinellidae

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Land snail species are decreasing globally and suffer their heaviest losses in the Pacific. The Hawaiian Islands once harbored diverse malacofaunal communities with > 750 species and 99% endemicity. Unfortunately, habitat destruction, invasive species, and other anthropogenic impacts have drastically reduced the number of extant species, with some extinction estimates as high as 90%. The land snail family Achatinellidae contains five subfamilies: Achatinellinae, Auriculellinae, Pacificellinae, Tornatellininae, and Tornatellidinae. Only the Achatinellinae has been extensively studied. Forty-one \textit{Achatinella} species are currently listed under the US Endangered Species Act, and ca. 75% are extinct. The remaining subfamilies are believed to have suffered similar fates, but little to no work has been done since the 1940s. A clear understanding of their systematic relationships is needed to conserve these species but much of the systematics of these subfamilies remains unresolved. To begin addressing this dearth of knowledge, we are using a modern systematic approach combining both morphological and molecular data to analyze both museum and recent materials. Sequences of mitochondrial COI and nuclear 28S genes were obtained from 305 individuals from 20 locations throughout the main Hawaiian Islands. Preliminary analyses provide robust support for monophyly of the family and each subfamily. Subfamilies with the smallest snails have multi-island distributions and a lack of isolation by distance, indicating high levels of dispersal, compared to the larger Achatinellinae (all single island endemics). Preliminary morphological analyses also provide robust resolution among subfamilies. Some of the Hawaiian land snails still cling to scattered habitats and a fuller understanding of their biology is needed to conserve this vanishing fauna.
Effects of soil freezing on the biodiversity of terrestrial gastropods in northern hardwood forests

Helen Yurchenco

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The proposed project will focus on the effects of increased soil freezing from reduced snowpack on the biodiversity of terrestrial gastropods. Gastropod relative abundance, species richness, and allelic diversity (which can address gastropods' resiliency and ability to disperse after disturbance), will be examined in relation to soil temperature, soil/leaf litter calcium content and pH, soil frost depth, and density of vegetative cover (understory vegetation was removed in order to facilitate snow removal at the soil freezing study plots). The study plots, located at Hubbard Brook LTER, are dominated by sugar maple and yellow birch. Gastropods will be measured in four understory vegetation-removal plots, four understory vegetation- and snow-removal plots, and four control plots (each 13 x13m). Gastropods are a useful system for study because they are abundant, have limited dispersal ability, and can show high genetic variability - even across small temporal-spatial scales. Gastropods are also vital faunal components of northern hardwood forests. Understanding the effects of soil freezing on gastropod biodiversity will further our understanding of how climate change affects these forest ecosystems.
A Picture is Worth a Thousand Words: A Step by Step Guide to Working with an Illustrator

Amanda Zimmerman

Section of Mollusks, Carnegie Museum of Natural History, Pittsburgh, PA 15213-4080, USA. Salamandaz42@gmail.com

Working with an illustrator can be intimidating, but a well-executed data chart, specimen line drawing, or full color photo can add impact to a paper’s thesis. Powerful graphics can illustrate a concept the biologist is trying to articulate far better than simple words on paper. From start to finish, there are guidelines and steps to follow to make the experience of exchanging information efficient for both parties and result in an accurate and informative digital or traditional graphic element.
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1) Marriott Pittsburgh City Center
2) Richard King Mellon Science Hall
3) Dormitories
4) 28X Bus to airport
5) 28X Bus dropoff from airport
6) Elevator from Forbes Road to
7) Parking

Solid line: From hotel to
conference venue
Dotted line: From dorms and
cafeteria to conference venue

Pittsburgh Area Map
(Campus area)
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The Great Unknown Scaphopod

Gerhard Steiner

Dept. Evolutionary Biology, University of Vienna, Vienna, Austria

A gap analysis of our knowledge of scaphopods yields ample results. Although there are fewer than 600 Recent species described, and about twice as many fossil taxa, robust and well-founded hypotheses of the position of Scaphopoda among the Conchifera are wanting. One reason for this gap is the absence of unequivocal scaphopod fossils in the early palaeozoic; another is the scarce molecular data on Recent species. A close relation with cephalopods and/or gastropods appears most likely at present, favored by the body axis situation and molecular data. Hardly better is our understanding of relationships within scaphopods. Although the two major subtaxa, Dentaliida and Gadilida are well defined, monophyly of the family- and genus-level taxa and their relations are unresolved in most cases. More informative morphological and a lot more DNA data are required to shed light on these issues. The developmental data are available from a single dentaliid species, but larval and juvenile shell morphology indicates the possibility of different developmental modes in gadilids. Except for a single data point on engrailed, we have no developmental gene expression data. EST studies or genomic approaches are missing. Why do we see such grave gaps in a comparatively small conchiferan taxon? Scaphopods are certainly difficult to observe due to their burrowing life style and hard to culture due to their diet. They are most diverse in sediments below diving depths and, thus, expensive to collect. Since Scaphopoda are the kingpin in our understanding of conchiferan relationships, we need an increased effort to fill the gaps in our scaphopod knowledge.