

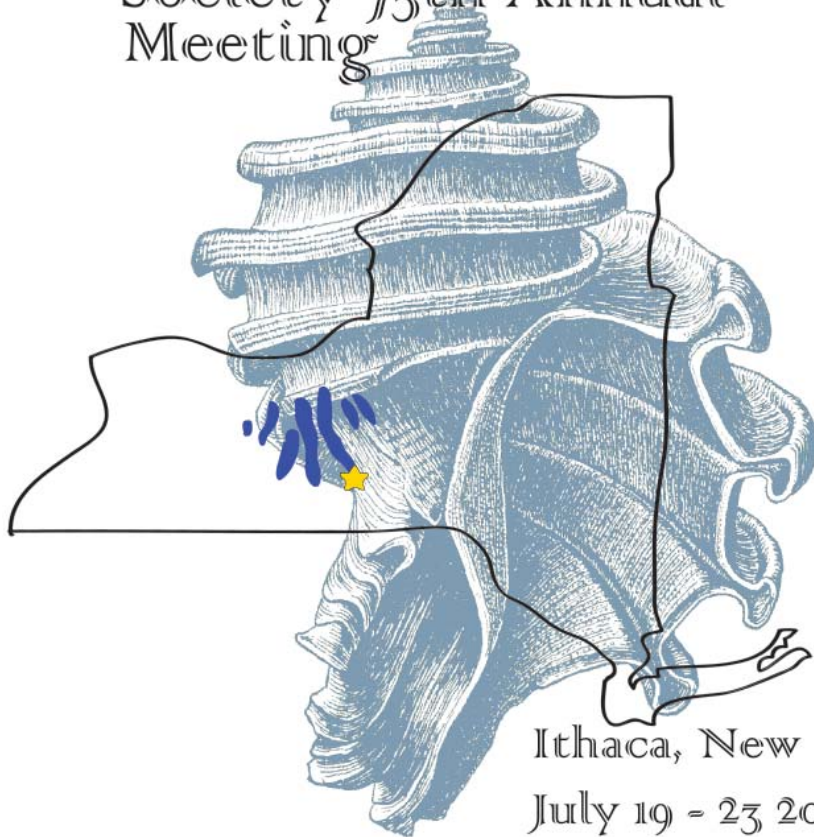
Special Publication no. 37 of the

**Paleontological Research Institution**

Ithaca, New York

# Program and Abstracts

American Malacological  
Society 75th Annual  
Meeting



Ithaca, New York

July 19 - 23 2009

*Edited by*

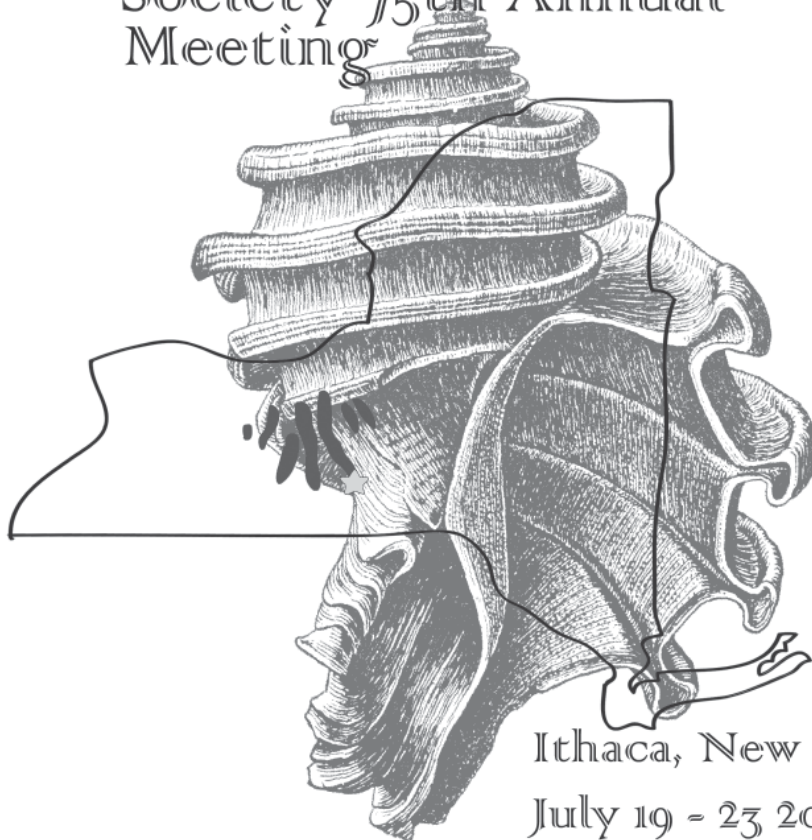
Warren D. Allmon, Paula M. Mikkelsen, and Kelly Cronin

SUMMARY OF EVENTS

<b>Sunday, 7/19</b>	
2:00-6:00 pm	Registration, Snee Atrium
2:00-5:00 pm	AMS Council Meeting (closed), Snee 4th floor conference room
2:00-5:00 pm	Geometric Morphometrics Mini-Workshop, Snee 2146
6:00-8:00 pm	President's Reception, Museum of the Earth
<b>Monday, 7/20</b>	
8:00 am-5:00 pm	Registration & Reprint Sales, Snee Atrium
8:45 am	Welcome and Keynote Address, Hollister Auditorium
9:30 am	Speciation Symposium, Hollister Auditorium
noon	Group photo
noon	Lunch
noon	Publications/Editorial Committee meeting (closed), Snee 1146
1:40 pm	Speciation Symposium (cont.), Hollister Auditorium
1:30 pm	Contributed Papers I - Fossils, Snee 1146
6:00 pm	Auction, Holiday Inn Ballroom
<b>Tuesday, 7/21</b>	
8:00 am-5:00 pm	Poster Session, Snee Atrium
8:40 am	Contributed Papers II - Land & FW, Snee 2146
11:40 am	Lunch
11:40 am	Conservation Committee meeting (open), Snee 2146
1:40 pm	Discussion - Teaching Malacology, Snee 2146
3:20 pm	Contributed Papers III - Bivalves, Snee 2146
4:30 pm	Institute of Malacology meeting (closed), Holiday Inn Boardroom
6:30 pm	Dinner Cruise on Cayuga Lake
<b>Wednesday, 7/22</b>	
8:40 am	Contributed Papers IV - Gastropod Phylogeny, Hollister Lecture Room
noon	Lunch
noon	Systematics Committee meeting (open), Snee 1146
1:40 pm	Contributed Papers V - General Topics, Snee 1146
1:40 pm	Contributed Papers VI - General Topics, Snee 2146
4:00 pm	AMS Business Meeting (open), Snee 1146
6:00 pm	Annual Banquet, Moosewood Restaurant
<b>Thursday, 7/23</b>	Field Trips

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Warren D. Allmon, Paula M. Mikkelsen, and Kelly Cronin



Department of Earth and  
Atmospheric Sciences



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Produced on behalf of AMS by the Paleontological Research Institution  
1259 Trumansburg Road, Ithaca, NY 14850  
PRI Special Publication no. 37, ISBN 978-0-87710-489-6

### About Our Logos

The logo of the American Malacological Society (center this page and back cover) is the Spiny River Snail, *Io fluvialis* (Say, 1825) (Pleuroceridae). It is endemic to the United States.

The shell in this meeting's logo is the Miocene muricid snail *Ecphora gardnerae* Wilson, 1987. It is the state fossil of Maryland, and the main component of the original logo of Paleontological Research Institution. *E. gardnerae* is only found in the sediments of the Atlantic Coastal Plain and was one of the first American fossils to be illustrated in the literature. Its first illustration appeared in the third edition of Martin Lister's *Historia Conchyliorum*, published in London in 1770 by William Huddesford (Lister died in 1712).

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# Welcome to Ithaca !

Welcome to Ithaca and the Finger Lakes Region of Central New York State, at one of its (many) most beautiful times of year. In addition to the AMS meeting, there is much to do and see here, and you might just have to come back again.

Like many small college towns, Ithaca loves to think of itself as different. Our two most popular local bumper stickers — “Ithaca is Gorges” and “Ithaca: 10 square miles surrounded by reality” — proclaim this proudly. And Ithaca (and surrounding Tompkins County) *is* different. Regularly rated as one of the best-to-live-in small communities in America, it is home to the youngest and best-educated population — and lowest unemployment — of any county in New York State. Education is the number one industry: the county is home to Cornell University, Ithaca College, and Tompkins-Cortland Community College, and of the county’s 100,000 residents, more than a quarter are students. Ithaca is also the North American seat of the Dalai Lama, and the ice cream sundae was invented here (in 1892). In June 2008, more than 6,000 Ithaca residents set the unofficial record for the world’s largest human peace sign. It is also an area of striking geology and scenery. The two largest of the Finger Lakes — Seneca and Cayuga — are among the deepest in the world, and there are more than 150 waterfalls within 10 miles of Ithaca, including the highest single-vertical-drop waterfall east of the Mississippi (Taughannock Falls). Ithaca has a wealth of performing and visual arts, museums, and restaurants that would be the envy of many much larger cities, and one of the highest per capita levels of library card ownership in the nation.

This year’s AMS meeting is jointly sponsored and hosted by the Paleontological Research Institution (PRI) and Cornell University’s Department of Earth and Atmospheric Sciences. This is not the first direct connection between PRI and AMS. PRI’s second Director, Katherine Palmer, served as President of what was then called AMU in 1959-1960, but held her meeting at McGill University in Montreal. PRI has a long and distinguished history in malacology; it holds one of the largest and best collections of Cenozoic fossil mollusks in the U.S. and its flagship journal, *Bulletins of American Paleontology*, has published many contributions to the study of fossil and Recent mollusks.

Thank you for coming to this 75th annual AMS meeting. Please don’t hesitate to ask us if there is anything we can do to make the meeting, and your stay in Ithaca, more enjoyable.

- Warren D. Allmon  
AMS President, 2008-2009

## *Your Hosts* **Paleontological Research Institution**

The Paleontological Research Institution (PRI) is a natural history museum located in Ithaca, New York. The Institution was founded in 1932 by Gilbert D. Harris (1864-1952), a professor at Cornell University from 1895 to 1934, to care for his collections and library. PRI today has outstanding programs in research, collections, publications, and public outreach. The Institution cares for a collection of 2-3 million specimens (one of the 10 largest in the US), and publishes the oldest paleontological journal in the Americas (*Bulletins of American Paleontology*, begun in 1895).

In 2003, PRI opened the Museum of the Earth on its campus on Ithaca's West Hill, overlooking Cayuga Lake. The Museum is an 18,000-square-foot education and exhibit facility whose exhibits and programs cover the entire spectrum of the history of the Earth and its life, with a particular focus on the northeastern United States.

PRI is a national leader in development of informal (*i.e.*, outside the classroom) Earth Science education resources for educators and the general public. PRI is separate from but formally affiliated with nearby Cornell University, and interacts closely with numerous units of the University in research, teaching, and public outreach.

## **Cornell University**

Cornell University was founded in 1865 as a coeducational, non-sectarian institution offering studies from the classics to the sciences and from the theoretical to the applied. These ideals, unconventional for the time, are captured in the school's motto, a quote from founder Ezra Cornell: "I would found an institution where any person can find instruction in any study."

Once called "the first American university," Cornell is a uniquely-structured institution with a distinctive mix of scholarship and ideals. It is both New York State's land grant university and a private university — the most educationally diverse member of the Ivy League. It is considered one of the top research universities in the world, with 28 Rhodes Scholars and 40 Nobel laureates currently affiliated with the university. It produces the nation's largest number of graduates in the life sciences who go on to PhD degrees, and is ranked fourth in the world in the number of graduates who pursue PhDs at American institutions.

Cornell is organized into seven undergraduate colleges and seven graduate divisions. On the Ithaca campus, 13,000 undergraduate and 6,000 graduate students from all 50 states and 122 countries choose from among 4,000 courses. The University also operates Weill Cornell Medical College in New York City and a campus in Qatar.

## 75 Years of AMS - A Few Dates to Remember

(excerpts from a forthcoming compilation by Paula Mikkelsen)

- 1931—American Malacological Union is founded by Norman Lermond of Thomaston, Maine. The need for a national society of persons interested in mollusks had been persistent since the late 1890s. Following an encouraging conversation with William J. Clench of Harvard University, Lermond sent letters to every person that he knew was interested in mollusks or their shells. 169 persons paid their 25-cent dues to be enrolled as charter members. 29 members from 12 states attended the first meeting hosted by Henry Pilsbry at the Academy of Natural Sciences in Philadelphia, in April-May 1931. A constitution was adopted, the name American Malacological Union proposed and accepted, and Pilsbry elected president. Although the word “union” in the society’s original name now might sound odd, the choice was appropriate in 1931 because the organization was conceived as a union of professionals, amateurs, and shell clubs.
- 1941—The first symposium on record at a meeting was in Rockland, Maine. “Methods of Collecting and Preserving Mollusca,” organized by Blenn R. Bales and published in the *AMU Bulletin for 1941*, became handy reference source. In 1955, the papers were incorporated into the first printing of the popular booklet, *How to Collect Shells*. The booklet was revised three times, and lately has evolved into the more comprehensive revision, *The Mollusks: A Guide to their Study, Collection, and Preservation* (Sturm et al., 2006). Since 1969, symposia and special topic sessions have been regularly offered at annual meetings to highlight key issues in malacology and to attract participants who might not otherwise attend. In 1985, a Symposium Endowment Fund was established to provide annual funding to support travel for symposium speakers and other associated costs of these special sessions. AMS-funded symposia are mandated to be of “world-class” caliber (by a Council motion in 1996), and are required to publish proceedings in the AMB.
- 1942-1945—The AMS has traditionally met in the summer every year since its founding. The series was broken only by the four years of World War II. During this hiatus, by carrying on voluminous correspondence, Secretary-Treasurer Imogene Robertson compiled annual reports; in the last (1945) was reported the death of founder Norman Lermond at age 83. The 1946 meeting (the twelfth) in Washington, DC, was recorded as an especially joyous occasion, as old friends and new gathered to exchange news and experiences after so long an absence. Subsequent meetings (a full list is available on the AMS website) have taken place throughout the US, as well as once in Havana, Cuba (1938),



twice in Canada (Montreal in 1960 and Ottawa in 1967), and once officially in the Bahamas (although actually aboard the cruise ship Nordic Empress, out of Miami in 1993).



- 1948—The Pacific Division of AMU was organized and held separate meetings on the west coast in years when the main body met on the east coast. Still the Pacific Division felt in many respects like a poor step-child to the main organization. In 1968, PD members met in California to form the Western Society of Malacologists as an independent organization. The PD was formally dissolved in 1972. WSM frequently meets jointly with the AMS at western sites.
- 1983—*American Malacological Bulletin* is created as a biannual peer-reviewed scientific journal. This was preceded from 1931-1933 as reports of the annual meeting in *The Nautilus*, then from 1934-1970, as an *Annual Report* that included meeting abstracts, some extended papers, reports on the business meeting, and a membership list. In 1971, the annual was renamed *Bulletin of the American Malacological Union*, with contributed papers occupying a more substantial fraction of the content. In 2009, AMB joined the e-generation by becoming part of BioOne ([www.bioone.org](http://www.bioone.org)), the electronic aggregation of bioscience research journals.
- 1996—In the interest of molluscan conservation, Council passed the following motion: “The American Malacological Union does not allow selling, buying, or trading of shells or shell products at its annual meetings.” This policy remains in place today, and most strongly affects the annual AMS Auction, the proceeds of which support student programs offered by the society. Still one of the most enjoyable events at the annual meeting, the auction offers a wide variety of books and “shell paraphernalia” (T-shirts, toys, ceramics, quilts, etc.) auctioned by some of our most vibrant personalities.
- 1998—AMU is renamed the American Malacological Society. The name change brought the organization more in line with comparable societies with a better understanding of its focus, goals, and activities.
- 1998—AMS met jointly for the first time with the international society *Unitas Malacologica* in Washington, DC, , forming the first World Congress of Malacology. AMS has met at World Congresses in Vienna, Austria (2001), and Antwerp, Belgium (2007).

**MEETING PROGRAM**  
**Sunday, 19 July 2009**

2:00-6:00 pm	Registration, Snee Atrium
2:00-5:00 pm	AMS Council Meeting (closed) Snee 4th floor conference room
2:00-5:00 pm	<p><b>Geometric Morphometrics Mini-Workshop</b>  Leader: John Wilk  Snee 2146</p> <p>This three-hour mini-workshop will cover some of the basic techniques for geometric analysis of 2D images. We will be concentrating on issues related to landmarking, thin-plate spline, data visualization, group differentiation, and (if time permits) basic regression analysis. A CD containing some of the more commonly used analysis software will be provided, however participants will need their own laptops. Participants should also bring 10-30 images of an organism of interest that were taken at approximately the same angle. Additional categorical and/or continuous data about these images (population, taxonomic ID, temperature, size, or latitude, for example) will be used in the example analyses mentioned above. Space is limited, contact John Wilk, <a href="mailto:jwilk@uic.edu">jwilk@uic.edu</a>.</p>
6:00-8:00 pm	<p><b>President's Reception</b>  PRI's Museum of the Earth</p> <p>Please join us for an enjoyable evening at PRI's Museum of the Earth, which features a walk through geological and paleontological history of the Earth as well as thousands of fossils and other specimens on display. We are celebrating AMS' 75th annual meeting this year! Several of our society scrapbooks will be available for perusal, and we will hear an entertaining talk about our founder, Norman Lermond, by his biographer Scott Martin (see abstract on page 60). Tours of the PRI Research Collections will also be offered. We will carpool from Cornell and the Holiday Inn to MotE on the western side of Cayuga Lake; check the Registration Desk if you need a ride. Your registration packet includes a map and driving directions.</p>

## Monday Morning, 20 July 2009

8:00-5:00 pm	Registration continues, Snee Atrium
8:00-5:00 pm	<p><b>Reprint Sales</b>, Snee Atrium</p> <p>Throughout the meeting, we will be offering a selection of reprints that have been donated to AMS as part of the annual auction (the auction event will be held on Tuesday evening at the Holiday Inn). These are being offered at 10 cents or 25 cents a piece, depending on size. Many of these were originally part of the library of Dr. Melbourne R. Carriker (University of Delaware), a Past President and staunch supporter of AMS, especially its student members. Proceeds of sales of his donated books and reprints become part of the Melbourne R. Carriker Student Research Grant, awarded each year by AMS. Please stop by, browse, and contribute!</p>

### Opening Session and Keynote Speaker Hollister Auditorium

8:45 am	Welcome AMS President Warren Allmon, PRI Dr. Lawrence Brown, Provost, Cornell University
9:00 am	Keynote Speaker: Gonzalo Giribet <b>Past, present, and future of molluscan phylogenetics — or, will we ever know the molluscan Tree of Life?</b>

### Symposium: Speciation in Mollusks Organizer and Session Chair: Warren D. Allmon Hollister Auditorium

9:30 am	Warren D. Allmon Introduction
9:40 am	Douglas J. Eernisse <b>Revisiting Test's 1946 views on speciation in California limpets</b>
10:00 am	Paula M. Mikkelsen <b>Speciation in marine bivalves: an overview</b>
10:20 am	P. B. Marko*, and A. L. Moran <b>Larval developmental mode and speciation in transisthmian marine bivalves</b>

10:40 am	Matthias Glaubrecht <b>Toward solving Darwin's "mystery": speciation and radiation in freshwater gastropods</b>
11:00 am	Robert T. Dillon, Jr.*, and John D. Robinson <b>The opposite of speciation: genetic relationships among the populations of <i>Goniobasis</i> ("<i>Elimia</i>") in central Georgia</b>
11:20 am	Rebecca J. Rundell <b>Diversification of ecologically similar species on Pacific islands</b>
11:40 am	Ellinor Michel*, Peter B. McIntyre, Catherine Wagner, and Jonathan Todd <b>Diversification and life history variation: an experimental isotopic demonstration of viviparity in a Tanganyikan gastropod radiation</b>

12:00 noon

Group Photo

Lunch

Publications Committee/AMB Editorial Board meeting (closed)  
Snee 1146

### Monday Afternoon, 20 July 2009

**Symposium: Speciation in Mollusks (continued)**  
**Session Chair: Warren D. Allmon**  
**Hollister Auditorium**

1:40 pm	Ursula Smith <b>Speciation in the turritellid gastropods of New Zealand</b>
2:00 pm	Warren D. Allmon <b>What, if anything, can we learn about speciation from fossil marine gastropods?</b>

**Contributed Paper Session I—Fossil Mollusks**  
**Session Chair: Gregory P. Dietl**  
**Snee 1146**

1:40 pm	Mary Kosloski*, and Gregory P. Dietl <b>Anatomy of a geographic cline in shell morphology of the predatory gastropod <i>Busycon carica</i> (Gmelin, 1791) along the US Atlantic Coast</b>
2:00 pm	Judith Nagel-Myers*, Gregory P. Dietl, and Carl E. Brett <b>Predation scars on Middle Devonian pterineids from the Hamilton Fauna of New York</b>
2:20 pm	Greg Burzynski*, Patricia H. Kelley, and Craig Tobias <b>Bivalve survival selectivity during the Late Pliocene: was high metabolism a detriment?</b>
2:40 pm	Lyle Campbell*, and Sarah Campbell <b>Lower Pliocene turrids from the Eagle Point Pit, Darlington County, South Carolina</b>
3:00 pm	Break
3:20 pm	Stephen R. Durham*, and Gregory P. Dietl <b>Prey preference hierarchies for the Tulip Snail <i>Fasciolaria liliun hunteria</i> (G. Perry, 1811): a re-evaluation</b>
3:40 pm	Christy C. Visaggi <b>Latitudinal variation in Recent <i>Hemimactra</i> from the U.S. east coast: drilling predation, shell thickness, and proportional thickness of microstructural layers</b>
4:00 pm	Warren D. Allmon <b>Cretaceous-Recent diversity of turritelline gastropods: a status report</b>
4:20 pm	Austin J. W. Hendy, Ursula E. Smith*, Mary E. Kosloski, Carlie Pietsch, Francis J. Mulcahy, and Gregory P. Dietl <b>Exploring geographic gradients in the body size of western Atlantic mollusks: a specimen-based approach</b>
4:40 pm	Michelle M. Casey*, and David M. Post <b>Baseline issues in the stable isotopic trophic level discrimination of drilling gastropods: examples from a modern eutrophication gradient</b>

## Monday Evening, 20 July 2009

### Annual AMS Auction Holiday Inn Ballroom

6:00 pm                      Reprint sales and auction preview  
6:30 pm                      Live auction begins

We are, as usual, hosting our annual Auction of molluscan books and paraphernalia (no specimens) for all meeting participants. This event raises the necessary funds for our student programs, and provides a fun-filled evening for all involved, even if you don't buy a thing! Paul Callomon will return as our auctioneer – this is something you don't want to miss! We have a great selection of books, some beautiful hand-crafted items, and a few silly things too. Please attend, and dig deeply and generously. It's for the students, and you never know what treasures might appear.

## Tuesday Morning, 21 July 2009

### Poster Session Snee Atrium

**Posters** will be available for viewing all day on Tuesday. Presenters should be at their posters to discuss and field questions during the two coffee breaks, at 10:00 am and 3:00 pm. Posters should be put up on Tuesday before 10:00 am, and removed between 3:20 and 5:00 pm. For assistance, see the Registration Desk.

- Rüdiger Bieler, Gonzalo Giribet, and Paula M. Mikkelsen  
**BivAToL – a new initiative for bivalve phylogeny**
- David Campbell  
**Preliminary molecular phylogenetics of Alabama Viviparidae**
- Marla L. Coppolino  
**Do snails live where we think they do? The influence of soil chemistry and habitat complexity on land snail abundance and diversity**
- Larisa A. Curta, Amira D. Davis, Robin Elahi, and Rebecca M. Price  
**Exposure to air and reduced food supply limit short-term growth rates in *Nucella lamellosa***

- Joseph H. Hartman and Arthur E. Bogan  
**Deep time, geologic events, and paleobiogeographic distance: when is the application of extant genera to fossil continental molluscan species pointless?**
- Adrienne Jochum, Claudia Nesselhauf, Alexander M. Weigand, and Annette Klussmann-Kolb  
**Limelight shines on the troglobitic Cave Thorn: a comprehensive study focuses on America's only subterranean ellobiid snail, *Carychium stygium* (Pulmonata, Ellobioidea, Carychiidae)**
- Caitlin Keating-Bitonti, Dustin R. Wing, and Jonathan A. Todd  
**Does increased sedimentation adversely affect Lake Tanganyika's soft substratum-dwelling gastropod assemblages?**
- Jaynee R. Kim  
**Invasive veronicellid slugs in the main Hawaiian Islands**
- Jessica G. Lambert, Gregory P. Dietl, Patricia H. Kelley, Troy D. Alphin, and Christy C. Visaggi  
**Anthropogenic influence on the health of oyster reef ecosystems: a comparison of live and dead assemblages**
- Lauren Maistros and Warren D. Allmon  
**Spherical snails: extreme parietal callus as a widespread but underappreciated gastropod morphology**
- C. G. Norton, B. Nelson, and A. F. Johnson  
**Albinism in *Helisoma trivolvis*: genetics and practical applications of pigmentation differences**
- Robert S. Prezant & Rebecca Shell  
**Functional morphology of *Lissarca notorcadensis* (Bivalvia: Philobryidae)**
- Brian W. Steffen  
**Biodiversity through the ages — molluscan paleoecology of Kansas**
- Norine W. Yeung, Kenneth A. Hayes, Chuong T. Tran, Jaynee R. Kim, Travis J. Skelton, Wallace M. Meyer, and Robert H. Cowie  
**Introduction, spread and impacts of alien snails and slugs in Hawai'i**

**Contributed Paper Session II—Land and Freshwater Mollusks**  
**Session Chair: Wallace M. Meyer III**  
**Snee 2146**

8:40 am	Steven P. Campbell*, Jacqueline L. Frair, and James P. Gibbs <b>Population size and habitat use of the federally-threatened Chittenango Ovate Amber Snail (<i>Novisuccinea chittenangoensis</i>) and its competitive interactions with a non-native snail (<i>Succinea</i> spp. B)</b>
9:00 am	Catherine E. Wagner*, Ellinor Michel, and Jonathan Todd <b>Evidence for strongly contrasting rates of diversification</b>
9:20 am	Hsiu-Ping Liu, and Robert Hershler* <b>Genetic diversity and population structure of the threatened Bliss Rapids snail (<i>Taylorconcha serpenticola</i>)</b>
9:40 am	John B. Burch*, John Keebaugh, and Taehwan Lee <b><i>Physa natricina</i> – invasive nuisance or endangered endemic?</b>
10:00 am	Break and Poster Session
10:20 am	Alexander M. Weigand*, Adrienne Jochum, Claudia Nesselhauf, Markus Pfenninger, and Annette Klussmann-Kolb <b>Globetrotter ellobiid hitchhikes across the Atlantic – phylogeography of <i>Carychium minimum</i> (Pulmonata, Ellobioidea, Carychiidae)</b>
10:40 am	Timothy A. Pearce <b>Is the Tiger Snail <i>Anguispira alternata</i> declining?</b>
11:00 am	Jayne R. Kim <b>The Prevalence of <i>Angiostrongylus cantonensis</i> in the main Hawaiian Islands</b>
11:20 am	Wallace M. Meyer III <b>The importance of land snails in litter decomposition in a Hawaiian rain forest</b>

11:40 am

Lunch

Conservation Committee meeting (open)  
Snee 2146



## Tuesday Afternoon, 21 July 2009

1:40 pm                    **Discussion: Teaching Molluscan Classification in a Rapidly Changing Climate**  
**Discussion Chairs: Warren Allmon and Paula Mikkelsen**  
**Snee 2146**

Five classes of mollusks. Archaeogastropoda-Mesogastropoda-Neogastropoda. Protobranchia-Lamellibranchia-Septibranchia. Despite several decades of systematic revision, invertebrate zoology and paleontology textbooks and instructors continue to perpetuate Thiele's (1935) classic system of molluscan classification because it's "easier to teach" even though it is clearly incorrect according to recent phylogenetic results. Please participate in this pedagogical discussion on how to organize and teach our new hypotheses to biology and paleontology undergraduates. We hope to gather our collective thoughts into a condensed report that in some format will influence the next wave of textbook authors.

3:00 pm                    Break and Poster Session

### **Contributed Paper Session III—Bivalves** **Session Chair: Jay Cordeiro** **Snee 2146**

3:20 pm	John Wilk <b>Ontogenetic examination of convergence between mangrove "oysters" (Isognomoniidae: Bivalvia)</b>
3:40 pm	Jay Cordeiro <b>Digital range mapping North America's freshwater mussel fauna</b>
4:00 pm	A. E. Bogan*, M. E. Raley, Y. Huang, T. L. King, and J. F. Levine <b>Phylogeny and distribution of the North American <i>Alasmidonta</i> (Bivalvia: Unionidae)</b>
4:20 pm	Francisco J. Borrero*, and Stephen F. Matter <b>Turnover in the freshwater mussel community at Ohio Brush Creek: evidence from taphonomy and mark-recapture studies</b>

## Tuesday Evening, 21 July 2009

- 4:30-630 pm      Institute of Malacology meeting (closed)  
Holiday Inn Boardroom
- 6:30 pm            **Dinner Cruise** on beautiful Cayuga Lake, included  
with your registration fee.  
Bus transportation will be provided

## Wednesday Morning, 22 July 2009

### Contributed Paper Session IV—Gastropod Phylogeny Session Chair: Tracy White Hollister Auditorium

8:40 am	Gina Meletakos and Colleen Sinclair* <b>A molecular phylogeny of polygyrid land snails — monophyly or not?</b>
9:00 am	Norine W. Yeung <b>Phylogenetics of the non-achatinelline Achatinellidae: the other “handsomely colored” tree snails of Hawaii</b>
9:20 am	Angela Dinapoli* and Annette Klussmann-Kolb <b>Inferring the phylogeny of the Heterobranchia (Mollusca, Gastropoda) using phylogenetic tools that are dependent as well as independent of tree reconstruction</b>
9:40 am	Tracy R. White <b>Mitochondrial phylogenomics and macroevolution of pulmonate gastropods</b>
10:00 am	Break
10:20 am	Katrin Goebbler* and Annette Klussmann-Kolb <b>Out of Antarctica? New insights into the phylogeny and biogeography of the Pleurobranchomorpha (Mollusca, Gastropoda)</b>
10:40 am	M. G. Harasewych,* Patrick Gillevett, and Masoumeh Sikaroodi <b>The Delray Beach, Florida, colony of <i>Cerion (Paracerion) tridentata costellata</i> Pilsbry, 1946 (Gastropoda: Pulmonata: Cerionidae): indirect Cuban origins</b>

11:00 am	Bernhard Lieb* and M. G. Harasewych <b>The phylogeny and biogeography of Pleurotomariidae: new evidence from hemocyanin sequences</b>
11:20 am	Alan J. Kohn <b>Practical species-level gastropod taxonomy and phylogeny in the molecular era</b>
11:40 am	Gary Rosenberg*, Natalie Blake, and Anthony Geneva <b>Phylogenetic analysis of Jamaican Pleurodontidae (Mollusca: Gastropoda)</b>

**12:00 noon**

**Lunch**

**Systematics Committee meeting (open)  
Snee 1146**

**Wednesday Afternoon, 22 July 2009**

**Contributed Paper Session V—General Topics  
Session Chair: Ellen Strong  
Snee 1146**

1:40 pm	Hsiu-Ping Liu and Robert Hershler* <b>Microsatellite evidence of invasion and rapid spread of divergent New Zealand mudsnail (<i>Potamopyrgus antipodarum</i>) clones in the Snake River basin, Idaho, USA</b>
2:00 pm	Carole S. Hickman <b>Relict deep-water gastropods in a disappearing seaway</b>
2:20 pm	Erika V. Iyengar* and Emily Petchler <b>Stuck on you: specialization of epibiotic <i>Crepidula adunca</i> (Gastropoda) on the host <i>Calliostoma ligatum</i> (Gastropoda)</b>
2:40 pm	Janice Voltzow*, Erika V. Iyengar, and Karolyn Holody <b>Convergence in feeding structures and behavior in suspension-feeding snails</b>
3:00 pm	Break

3:20 pm	Ellen E. Strong <b><i>Abyssochrysos</i> revisited (Caenogastropoda: Abyssochrysidae)</b>
3:40 pm	Brian K. Penney*, Lori H. LaPlante, Jason R. Friedman, and Maria Ocasio Torres <b>The relative role of nematocysts in defense of <i>Flabellina verrucosa</i></b>

**Contributed Paper Session VI—General Topics**  
**Session Chair: David Scheel**  
**Snee 2146**

1:40 pm	James H. McLean <b>Revision of world Liotiidae, Recent and fossil (Gastropoda: Vetigastropoda)</b>
2:00 pm	Aydin Örstan and Megan Paustian* <b>A dip in the pool: how the slug <i>Megapallifera mutabilis</i> maintains its water balance</b>
2:20 pm	Megan Paustian <b>Evaluating the presence of competition between native and invasive slugs in central Maryland</b>
2:40 pm	Ralph W. Taylor <b>William I. Utterback, of "<i>Utterbackia fame</i>": a short biographical sketch with emphasis on his life after malacology!</b>
3:00 pm	Break
3:20 pm	David Scheel* and D. Frohbeiter <b>Octopus habitat selection for nearshore kelp stands in Prince William Sound, Alaska</b>
3:40 pm	Elizabeth K. Shea*, Michael Vecchione, Rob Wilson, Annie Lindgren, and Ellen Kenchington <b>Sexual dimorphism in <i>Brachioteuthis beanii</i> (Cephalopoda: Brachioteuthidae) in the northwestern Atlantic</b>

4:00 pm                      **AMS Business Meeting, Snee 1146**

## Wednesday Evening, 22 July 2009

6:00 pm                      **Annual Meeting Banquet**  
Moosewood Restaurant

Moosewood Restaurant is a world-famous vegetarian restaurant in downtown Ithaca. We are delighted to show you this establishment for our end-of-meeting banquet and awards ceremony. Carnivores, don't be put off by the "green stuff" — Moosewood's cozy atmosphere and superbly imaginative menu (which also includes fish) are not to be missed by any visitor to the Finger Lakes Region. With an emphasis on healthful natural foods, Moosewood has operated successfully for 33 years and has been acclaimed as a driving force in the world of creative vegetarian cooking. It was named one of the 13 "Most Influential Restaurants of the Twentieth Century" by *Bon Appetit* magazine. Moosewood also boasts its own cookbooks, soups, salad dressings, and main-course entrees, now on retail shelves.

## Thursday, 23 July 2009 Field Trips (preregistration required)

All day                      Devonian Fossil Field Trip  
Leader: Warren Allmon

Explore and collect Devonian marine fossils of the Ithaca Region. We will carpool; listen for an announcement of a pre-trip meeting to coordinate our efforts. Details for pre-registrants are in your registration packet, or see the Registration Desk during the meeting.

All day                      Land and Freshwater Field Trip  
Leaders: Marla Coppolino, Art Bogan, and  
Stephanie Clark

Explore and collect the freshwater and land mollusks of the Cayuga Lake Basin. We will carpool; listen for an announcement of pre-trip meeting to coordinate our efforts. Details for pre-registrants are in your registration packet, or see the Registration Desk during the meeting.

# Abstracts

*Presenter of multi-author papers indicated by asterisk (\*).*

**What, if anything, can we learn about speciation  
from fossil marine gastropods?**

**Warren D. Allmon**

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Gastropoda is one of the most diverse clades of animals, with at least 60,000 described living species, and >13,000 Recent and fossil genera. Although modern land and freshwater snails have figured prominently in studies of speciation, we know relatively little about overall patterns and drivers of this diversity in the marine realm. Many authors have noted a paradox: marine species often have pelagic larvae and extensive geographic ranges; this would seem to suppress geographic speciation, yet speciation in the sea is certainly not rare. Molecular phylogeographic analyses are shedding some light on this paradox, but are limited to Recent taxa. Although its contribution to speciation is much maligned, the fossil record offers important insights, from two principal sources: (1) analyses of biogeographic ranges within faunas, and (2) studies of diversification in individual clades in the context of environmental change. Because of their diversity and abundance, especially since the mid-Mesozoic, marine gastropods are playing an increasing role in such studies. Recent studies of geographic range at the faunal level suggest that taxa with narrower ranges have higher rates of speciation, perhaps because those attributes that contribute to wide geographic range also suppress allopatry. Several clade-by-clade studies also show the negative relation between geographic range and speciation rate. They also often show strong correlation between first appearance of species and significant environmental change. Although interpretations of incomplete stratigraphic ranges are always problematic, these studies point to the importance of environmental change – and therefore perhaps vicariance – in marine gastropod speciation. Together with studies of modern species, these results suggest a potential solution to the “paradox of marine speciation”: at least in gastropods, a combination of temporal environmental change and environmental heterogeneity could create opportunities for small-scale allopatry. Environmental changes could fragment large ranges and reduce local population sizes. Under these conditions, environmental heterogeneity can provide barriers for sufficient time to allow genetic differentiation. This potential synthesis highlights the value of the fossil record, appropriately interpreted, for studies of speciation.

**Cretaceous-Recent diversity of turritelline gastropods:  
a status report**

**Warren D. Allmon**

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Turritelline gastropods (family Turritellidae, subfamily Turritellinae) are one of the most diverse, abundant, widespread, and easily recognized gastropod groups of the Cretaceous and Cenozoic, yet little is known about their overall diversity history. A database of every species and subspecies name ever assigned to the group currently has 1,683 entries. Based on an ongoing analysis of nomenclature, critical systematic revision, and subjective judgement, approximately 900 of these names represent valid species. The oldest known, generally accepted representative of the group occurs in the Lower Cretaceous (Valanginian) of Poland. Absolute global species numbers are highest in the Cretaceous, Middle Eocene, and Lower Miocene. Species/million years, however, are relatively low in the Cretaceous, with a pre-Pleistocene peak in the Lower Eocene; large values also occur in the Lower Paleocene, Upper Eocene, and Lower Miocene. Prior to the Pleistocene, overall diversity per million years has been declining since the Lower Eocene. A comprehensive species-level approach to turritellines appears to be useful, however, for two main reasons. (1) Turritellines are relatively easily recognized and frequently reported, suggesting that knowledge of them is more complete than for many other gastropod groups. (2) Although turritellines have clearly been the victims of occasionally exuberant over-splitting, most of which has yet to be cleaned up by modern revision, total diversity of the group might nevertheless not be seriously overestimated, as evidenced by the fact that in almost all faunas that have been studied recently (*i.e.*, during the last 25 years), new species continue to be described at roughly the rate that others are synonymized. Thus, although dataset used in this analysis is very preliminary and imperfect, it is the best currently available, and might still be useful for identifying major features of the history of this important group.



**BivAToL – a new initiative for bivalve phylogeny**

**Rüdiger Bieler<sup>1</sup>, Gonzalo Giribet<sup>2</sup>, and Paula M. Mikkelsen<sup>3</sup>**

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As part of NSF's Assembling the Tree of Life (AToL) program, a project is underway, bringing together an international, multi-institutional team to reconstruct bivalve phylogeny. Now into our second year of the grant project, we have completed our major collecting expeditions and are generating morphological and molecular data. Here we present an overview of the project, its participants, its intended products, and a plea to the malacological community for help with obtaining some of the taxa that have eluded us so far (see also [www.bivatol.org](http://www.bivatol.org)). Supported by NSF DEB-0732854-0732903-0732860.

**Phylogeny and distribution of the North American *Alasmidonta*  
(Bivalvia: Unionidae)**

**A. E. Bogan\*<sup>1</sup>, M. E. Raley<sup>1</sup>, Y. Huang<sup>2</sup>, T. L. King<sup>3</sup>,  
and J. F. Levine<sup>4</sup>**

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*Alasmidonta* currently contains 12 species including 3 species presumed extinct. Six species of *Alasmidonta* occur in North Carolina, including the presumed extinct *A. robusta*. Tissue samples from all extant species of *Alasmidonta* were included in a test of the monophyly of the genus. Systematic relationships of the recognized species were examined using mitochondrial DNA sequences from cytochrome oxidase c subunit 1 (COI) and NADH dehydrogenase subunit (ND1). *Alasmidonta* (*Prolasmidonta*) *heterodon* and *A. (Pressodonta) viridis* are recovered as significantly different from other members of the genus, and we recommend the two subgenera be elevated to generic level. *Alasmidonta varicosa* is split into two separate taxa. *Alasmidonta raveneliana* is represented by two separate conservation units corresponding to the French Broad and Little Tennessee River basins. Further work is needed to understand the variation in *A. marginata* between the upper Mississippi River and the Ohio River drainage populations.

**Turnover in the freshwater mussel community at Ohio Brush Creek: evidence from taphonomy and mark-recapture studies**

**Francisco J. Borrero\*<sup>1,2</sup> and Stephen F. Matter<sup>3</sup>**

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Ongoing mark-recapture studies at two localities in Ohio Brush Creek have shown year-to-year changes in abundance, diversity and micro-distribution of freshwater mussels. Stochastic events that result in shifts from faster running water and riffle habitats to more lentic conditions are interpreted as potential determinants of habitat quality for freshwater mussels at these localities. Effects from such events have variable duration, ranging from short term (*i.e.*, part of a season) to multiyear. At a locality that has had comparatively high mussel abundance and diversity, we found taphonomic evidence of a mussel assemblage that is dramatically different from the current mussel community at this site. Over 100 specimens of adult threeridge mussels (*Amblema plicata*) of a narrow size range were found dead *in situ* and in living position within a clay ledge, occupying a very small area at the site. A very conservative estimate suggests a density of >15 individual/m<sup>2</sup>, which is extremely high when compared to 30 other locations at Ohio Brush Creek. We routinely find living *A. plicata* at densities much below 1 individual/m<sup>2</sup>. The dead specimens were complete (*i.e.*, both valves) and with nearly intact periostracum and ligament. However, the carbonate shell material was quite "chalky," suggesting chemical alteration since death, over an undetermined length of time of probably several years. Most strikingly, all specimens show a similar level of alteration, suggesting that death of the whole group might have occurred within a relatively short time span. We interpret these observations as evidence that mussel communities can show considerable turnover within sites. We will discuss our views of various potential factors responsible for such changes.

***Physa natricina* — invasive nuisance or endangered endemic?**

**John B. Burch<sup>\*1</sup>, John Keebaugh<sup>2</sup>, and Taehwan Lee<sup>2</sup>**

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The endangered species act of 1973 was enacted to protect biodiversity (part of our national natural heritage) and to slow — and to hopefully mitigate — the accelerating disappearance of native animals and plants. Various species of freshwater mollusks have been designated as “Endangered and Threatened.” For a species to be listed as “endangered and threatened,” it is imperative that their taxonomic credentials are accurate — that they are valid species, they have been adequately described, and they are not synonyms of previously named *species*. One of the most speciose, common, and widely distributed families of freshwater snails in continental North America is the Physidae. The great majority of physids are found in lentic habitats — ponds, lakes, roadside ditches, swales, sluggish backwater areas of streams, etc. A physid species adapted to the benthic portions of a major river is rather unusual. *Physa (Physella) natricina* Taylor, 1988, is such a riverine species. Its known Recent distribution is the Snake River, Idaho, one of the major tributaries of the Columbia River the northwestern United States and southwestern Canada. *Physa natricina* has another distinction — it is the only member of the family Physidae to be Redbook-listed. Physid snails are food organisms for fish and birds, and perhaps other animals as well. But any aquatic organism living in a major river in North America is faced with another danger — the manipulation of its habitat water for production of hydroelectric power and for supplying irrigation water for agriculture. Many of the nominal species of Physidae were named largely on geographic location and shell characteristics. Within the family, there is not a significant amount of variation in the purported diagnostic shell characteristics, which can make species identification challenging. Because of *P. natricina*’s “endangered and threatened” listing, its status as a species is critically important.

**Bivalve survival selectivity during the Late Pliocene:  
was high metabolism a detriment?**

**Greg Burzynski\*, Patricia H. Kelley, and Craig Tobias**

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Survival of species across mass extinction events is of special interest in evolutionary study. Cenozoic molluscan faunas suffered several mass extinctions that offer insight into biological factors influencing survivorship. Previous studies have examined effects of morphological escalation on molluscan survivorship across extinction boundaries and generally found no relationship; few have focused on behavioral escalation, which includes anti-predatory burrowing or swimming. This behavioral escalation would lead to increased metabolism, which has a useful proxy in the fossil record. Using novel biogeochemical techniques, metabolic rates of fossil bivalves can be studied. Ratios of stable oxygen isotopes vary seasonally in marine environments;  $^{18}\text{O}$  enrichment occurs during cooler periods and  $^{16}\text{O}$  in warmer periods. As bivalves secrete their shells outward, the isotopic ratios are recorded. Stable isotope analysis of representative shells from selected taxa can be performed serially from umbo to commissure to produce sinusoidal growth curves. With these, annual growth rate can be determined, which is intimately linked to metabolic rate. A major extinction of marine bivalves occurred during the upper Pliocene, straddling the Moore House Member of the Yorktown Formation and the Chowan River Formation. Bulk samples of bivalves from the upper Pliocene of Virginia and North Carolina were collected from these formations, and picked and sorted, where possible, to the species level. Several taxa, including *Glycymeris*, *Mercenaria*, and Pectinidae, have been identified as potential groups for isotope analysis. Comparison of relative abundance of each species at each stratigraphic level will demonstrate which was better able to endure the extinction. It is predicted that species with a higher metabolic rate will, due to their higher nutrient demands, be preferentially decimated during times of lower food source abundance. This study demonstrates the feasibility of the stable isotope method in evolutionary paleoecological studies, and sheds new light on how biotic factors influence macroevolution.

## Preliminary molecular phylogenetics of Alabama Viviparidae

David Campbell

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Viviparidae is a conspicuous, moderately diverse component of freshwater gastropod communities. Currently, four genera are recognized in eastern North America, but the number of species is very uncertain. Three species are Federally endangered, all endemic to Alabama. Discovery of a new, morphologically distinctive population of the endangered *Campeloma decampi* prompted investigation of the family. *Campeloma* forms polyploid hybrid lineages, so mitochondrial data provide only a partial picture of phylogeny. Calmodulin intron has been used in *Campeloma*, but might not provide a consistent marker either. Nevertheless, some patterns are emerging. North American *Viviparus* appears more closely related to *Tulotoma* than to European *Viviparus* s.s. As previously suspected based on allozymes and morphology, *V. georgianus* is probably a species complex. Multiple alleles of calmodulin intron could be present. *Lioplax* shows a straightforward geographic pattern of relationships. *Campeloma* has several distinct mitochondrial lineages, but some of these are geographically anomalous. Specimens from the Mobile Basin group with upper Mississippi and Great Lakes drainages, but are very different from Tennessee River sequences. Mitochondrial sequences show little difference between ordinary *C. decisum*-like specimens from the mainstem Tennessee River and morphologically distinctive *C. decampi* from tributary creeks, but the new population is moderately distinctive genetically. Calmodulin intron and mitochondrial markers give different patterns of relationship. A full understanding of the regional species will require thorough sampling throughout their ranges and the development of additional nuclear markers, as well as additional life history and morphological data.

**Lower Pliocene turrids from the Eagle Point Pit, Darlington  
County, South Carolina**

**Lyle Campbell\* and Sarah Campbell**

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Eagle Point pit, Darlington County, South Carolina (USA), has yielded over 330 species of Lower Pliocene mollusks. Among these, turrids are exceptionally diverse, with 49 species documented from three families, seven subfamilies, and 23 genera. In contrast, warm-temperate Yorktown Zone 2 faunas of Virginia yielded 28 turrid species (three families, six subfamilies, 20 genera). Work in progress also documents 51 turrid species from the subtropical, Middle-Pliocene Duplin Formation of the Carolinas (three families, six subfamilies, 25 genera). The proportion of species within each subfamily is similar among Eagle Point, Yorktown, and Duplin faunas, with approximately 50% of the species in Drillidae and 25% in Mangeliinae. However, 19 of the Eagle Point turrids are new to the Pliocene of the Carolinas. Eagle Point provided a variety of unusual habitats including *Chama* bioherm reefs, which supported unique microniches and recruited a rich and unusual fauna. Two Eagle Point taxa resolve turrid mysteries. The Tuomey Collection at the University of Alabama contains a single specimen of *Polystira* labeled "Darlington, SC." This tropical genus, not otherwise known north of Florida, raised doubt concerning the locality. A matching specimen, from Eagle Point, confirmed the genus in the Carolinas and established its stratigraphic position. Similarly, "*Drillia*" *arctata*, a unique specimen and Conrad manuscript name from the "Virginia Miocene" appears conspecific with an Eagle Point turrid. The Eagle Point fauna is some 400,000 years older than the better known Duplin. It is uncertain whether the high richness and endemism of the turrid fauna is a function of time, of environmental factors, or of some combination.

**Population size and habitat use of the federally-threatened Chittenango Ovate Amber Snail (*Novisuccinea chittenangoensis*) and its competitive interactions with a non-native snail (*Succinea* spp. B)**

**Steven P. Campbell\*, Jacqueline L. Frair, and James P. Gibbs**

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The Chittenango Ovate Amber Snail (*Novisuccinea chittenangoensis*) (COAS) is a globally endemic, federally threatened, terrestrial snail. Little is known of the species' ecology, which is critical for informing recovery actions. Our goal was to understand the population ecology and habitat use of COAS and its competitive interactions with a closely related invasive snail, *Succinea* spp. B. (Spp. B). From 2002-2008, we conducted 10-16 mark-recapture surveys each year to estimate population size, demographic rates, and size-frequency distributions of COAS. In 2008, we conducted a competition experiment in which we placed individual COAS in enclosures with varying densities of Spp. B for a two-week period and recorded snail growth and mortality. We also performed *in situ* habitat use surveys to compare the spatial distribution of the two species and their use of available plants and substrata. Population size of COAS increased since monitoring began in 2002, peaked at 858 in 2005, and decreased to 326 in 2008. The competition experiment indicated negative effects of Spp. B on COAS growth and survival. Over the two-week experiment, COAS grew an average of 0.85 mm at the lowest density of Spp. B and 0.15 mm at the highest density. Similarly, percent mortality was 15% lower at the lowest Spp. B density compared to the highest density. Each species showed coincident spatial distributions and overlapping use of plant species and substrata, suggesting a high probability of interaction and competition under natural conditions with the following exceptions: Spp. B was more prevalent on *Nasturtium officinale* and COAS used wood, detritus, and *Eupatorium purpureum* more than did Spp. B. These preliminary results suggest that the COAS population is fluctuating but not declining and that habitat management could be a viable option for increasing population size, but the feasibility and necessity of removal of Spp. B require further study.



**Baseline issues in the stable isotopic trophic level  
discrimination of drilling gastropods: examples from a modern  
eutrophication gradient**

**Michelle M. Casey\*<sup>1</sup> and David M. Post<sup>2</sup>**

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The distribution of stable isotopic signatures within organic and inorganic materials shows marked variation that sets an isotopic baseline that can be used to trace the dietary sources of organisms. The relatively small biological fractionation of carbon (< 1‰) makes  $\delta^{13}\text{C}$  useful for tracing the relative contribution of these sources, or end-members, whereas the relatively large biological fractionation of nitrogen (~ 3.4‰) makes  $\delta^{15}\text{N}$  useful for calculating trophic position. Both aquatic and terrestrial organisms commonly obtain nutrients from at least two distinct sources (*e.g.*, littoral and pelagic primary producers in aquatic systems;  $\text{C}_3$  and  $\text{C}_4$  plants in terrestrial systems) which have distinct  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  signatures. These isotopic signatures are known to exhibit great heterogeneity in modern mollusks and they shift with lateral changes along shore, onshore-offshore gradients, water depth, rates of primary productivity, latitude, season, etc. In contrast, very little is known about the interannual variation of isotopic signatures, which is crucial for adequately addressing issues of isotopic baseline in time-averaged fossil assemblages. This study documents the variation in isotopic signatures of mollusks from Long Island Sound interannually and along a steep eutrophication gradient and uses that information to provide a cautionary tale for applying stable isotopic methods to the trophic ecology of Recent and fossil drilling gastropods.

**Do snails live where we think they do?  
The influence of soil chemistry and habitat complexity on  
land snail abundance and diversity**

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Various ecological parameters, including soil pH, calcium, and habitat complexity have been suggested in the literature as having influence on land snail abundance and diversity. But how reliable are these parameters to use as predictors, and what combinations of factors support snail populations? In this study, I compared relationships between snail abundance and diversity and 15 ecological parameters (habitat complexity, measured as combined values assigned to different levels of vegetation, topography and exposed rock, and soil moisture; organic matter; cation exchange capacity; pH; and levels of calcium, magnesium, zinc, potassium, phosphorus, sulfur, boron, manganese, iron, and copper) with snail abundance and diversity in six counties in southwestern Illinois. Statistical analyses were run using these soil factors plus the habitat complexity index. Bayesian Information Criteria (BIC) analysis was run for abundance and diversity. The resulting best-fitted BIC model for abundance contained three parameters (pH, sulfur, and habitat complexity;  $R^2 = 0.47$ ), all of which were positively associated with abundance in a multiple regression analysis. For diversity, the best-fitted BIC model also contained three parameters (calcium, iron, and habitat complexity;  $R^2 = 0.54$ ). Calcium and habitat complexity showed a positive association in the multiple regression analysis, but iron was inversely associated with diversity, suggesting that it could restrict snail diversity in otherwise supportive habitat. The regression model equations have potential value in that they can be used to predict snail abundance and diversity in areas that have not been assessed.

**Digital range mapping North America's  
freshwater mussel fauna**

**Jay Cordeiro**

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The global center of freshwater mussel diversity is located in the United States with 40% of the world's freshwater mussels — approximately 300 species. Research and data analysis by NatureServe and others shows that freshwater mussels are among the most imperiled species in North America. Land and water managers, wildlife personnel, and other conservationists have an urgent need for ready access to information about conservation status, habitats, ecology, and distribution of these remarkable animals. NatureServe has already led the effort to put this information into an accessible, searchable format on the Internet through its popular *Explorer* website (<http://www.natureserve.org/explorer>). At NatureServe, we have finalized completion of the first available digital range maps for all freshwater mussel species of the United States and Canada. These were built upon digital maps showing distribution by eight-digit and six-digit USGS cataloging units (HUCS) created for US freshwater fish species. Users of NatureServe's conservation status data and range maps are a diverse group that includes conservation planners, reserve managers, and technicians at governmental and nongovernmental organizations. However, because the data are available over the Internet, many other users also access this information. On a typical day, *Explorer* receives over 2,000 unique visits. To obtain review and corrections to existing maps, we will solicit comments from researchers in the molluscan community. Once the data have been updated, we will upload all changes to NatureServe's website made available through XML files for use in future products. ArcView shapefiles of the maps will be available for download in the Get Data section. As part of an effort to develop an Atlas of Freshwater Mussels of the United States by the Freshwater Mollusk Conservation Society (FMCS), this project is offered as a data storage model for geo-referenced locality information available free-of-charge to the general public that can be continually modified and updated as necessary.

**Exposure to air and reduced food supply limit short-term growth rates in *Nucella lamellosa***

**Larisa A. Curta\*<sup>1</sup>, Amira D. Davis\*<sup>1</sup>, Robin Elahi<sup>2</sup>, and Rebecca M. Price\*<sup>1</sup>**

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The rate at which marine invertebrates grow is affected by many environmental factors, including temperature, diet, wave action, and exposure to air, but the way that these factors interact in the field remains poorly understood. For example, tidal emersion can limit the size of intertidal invertebrates, but it is unclear whether this pattern results from decreased feeding time or a more direct consequence of exposure to air. We used mesocosm experiments to isolate the effects of these two factors on the growth rates of the whelk *Nucella lamellosa*. Two exposure treatments subjected the snails to air for two hours and for 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 treatment were kept submerged and fed *ad libitum*. We measured the change in height, shell weight, tissue weight, and the total degrees of new growth after 24 days. Snails in control mesocosms grew significantly faster than snails from all four treatments with respect to all four measures of growth ( $P \ll 0.001$ , ANOVA). However, there was no significant difference in growth among snails from the two-hour exposure treatment and the two- and five-hour food-removal treatments ( $P > 0.3$ , ANOVA). These results suggest that exposing *N. lamellosa* to air retards growth directly by limiting the physiological processes of shell deposition and indirectly by limiting food intake. Exposure to air could explain why some intertidal marine invertebrates with calcium carbonate shells are smaller than subtidal conspecifics.

**The opposite of speciation: genetic relationships among the populations of *Goniobasis* ("*Elimia*") in central Georgia**

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The ranges of *Goniobasis catenaria* (Say, 1822) and *G. proxima* (Say, 1825) extend from Virginia south through the Carolinas into the Piedmont and upper Coastal Plain of Georgia, where they intersect with populations of *G. floridensis* (Reeve, 1860) ranging up from the north. But in contrast to the situation in surrounding states, Georgia populations of *G. catenaria* and *G. floridensis* have been taxonomically subdivided and redescribed under at least 20 additional specific nomina, including *G. boykiniana* (Lea, 1840), *G. suturalis* (Haldeman, 1840), *G. caelatura* (Conrad, 1849), *G. postelli* (Lea, 1858), *G. induta* (Lea, 1862), *G. mutabilis* (Lea, 1862), *G. viennaensis* (Lea, 1862), *G. timida* (Goodrich, 1942), and *G. darwini* (Mihalcik & Thompson, 2002). To see if this increased nomenclatural diversity might signal higher levels of population divergence, we compared gene frequencies at 11 polymorphic allozyme-encoding loci among eight Georgia populations of *G. catenaria* and three populations of *G. floridensis* to three populations of *G. proxima*, which have never been taxonomically split. Genetic variation was generally low within our 14 populations, and high among them, as has been reported in numerous prior surveys of pleurocerid allozyme divergence conducted elsewhere. The ranges of pairwise genetic identity observed among populations within all three species were similar, from 0.989 to 0.776 among the seven *G. catenaria*, 1.00 to 0.753 among the three *G. floridensis*, and 0.917 to 0.585 among the three *G. proxima*. These values are quite comparable to those reported from previous studies of genetic divergence among populations of *G. proxima* and *G. catenaria* in Virginia and the Carolinas. We attribute the proliferation of nomina in the *Goniobasis* populations of Georgia to qualitatively higher levels of shell morphological variation, possibly ecophenotypic in origin, and explore the influence of cultural factors within the nineteenth and twentieth-century taxonomic community.

**Inferring the phylogeny of the Heterobranchia (Mollusca, Gastropoda) using phylogenetic tools that are dependent as well as independent of tree reconstruction**

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Many questions regarding gastropod phylogeny have not yet been answered, such as the molecular confirmation of the Heterobranchia concept based on morphological studies from Haszprunar (1985, 1988). This taxon comprises the "Lower Heterobranchia" (with several "primitive" or "basal" members) and the Euthyneura (with the Opisthobranchia and Pulmonata). In the present study we inferred a phylogenetic hypothesis by using a multigene dataset including nuclear (28S rDNA + 18S rDNA) and mitochondrial (16S rDNA + COI) sequences of the Heterobranchia. The taxon sampling includes representatives of many important "basal" heterobranch families with uncertain systematic affinities (*e.g.*, *Larochella*, *Graphis*), and additional members of several groups that have been poorly represented in earlier molecular investigations (*e.g.*, Architectonicidae, Rissoellidae, Omalogyridae, Cimidae, Orbitestellidae, Valvatidae, Cornirostridae, Murchisonellidae, Glacidorbidae). Our results support a monophyletic Heterobranchia, the gradual evolution of basal lineages and reveal paraphyly of Euthyneura and Pulmonata, as well as polyphyly of Opisthobranchia. Molecular data of Gastropoda could show a high degree of homoplasy. Therefore, it is important to improve the information value of molecular data using tools that are independent from tree reconstruction. The most promising *a priori* approach to evaluate data quality is the examination of bipartitions (splits) that are present in an alignment. To visualize variations in signal distinctness in the present study, network analyses were used based on split decomposition and split support spectra. Our recent molecular phylogenetic work provides the most comprehensive molecular study of Heterobranchia relationships to date and supplies new insights into the evolution and phylogeny of this enigmatic taxon. Moreover, using network analyses approaches, valuable supplemental information could be obtained to improve the current phylogenetic hypothesis. In addition, various possible evolutionary hypotheses could be visualized by network analyses rather than only one evolutionary pathway as does a tree topology.

**Prey preference hierarchies for the Tulip Snail *Fasciolaria liliium hunteria* (G. Perry, 1811): a re-evaluation**

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When attacking bivalves, the Tulip Snail, *Fasciolaria liliium hunteria*, wedges the prey's valves apart using its apertural lip, sometimes breaking its own shell and resulting in repair scars. Wedging behavior is not used when feeding on gastropods. The frequency of repair scars on *Fasciolaria* is thus a useful proxy in the fossil record for assessing the relative proportion of bivalve to non-bivalve prey in *Fasciolaria*'s diet in space and time. Wells (1958) observed a preference hierarchy (gastropod prey over oysters), which complicates simple extrapolation analyses of the frequency of feeding scars to estimate relative abundances of prey types available to *Fasciolaria*. In this study, we re-evaluate the robustness of Wells' preference hierarchy for *Fasciolaria* in light of biomass differences between prey types. We collected nine *F. liliium hunteria* from a shelly, sandy mudflat with patchily distributed oyster clumps in Masonboro Sound, North Carolina. One snail, between 70 and 86 mm, was placed in each of nine 38-liter aquaria. Observations were conducted throughout April 2009. An oyster-only treatment containing five *Crassostrea virginica*, a gastropod prey-only treatment containing five *Urosalpinx cinerea*, and a mixed treatment containing five *Crassostrea* and five *Urosalpinx* were used. Consumed prey were replaced daily. Seven *Crassostrea* and 60 *Urosalpinx* were eaten by all nine *Fasciolaria* over the 25-day observation period. Consumed prey biomass was estimated by regressing ash free dry mass (AFDM) on shell size for both prey species. Whereas the average number of *Urosalpinx* consumed (2.4/day) was greater than the number of oysters consumed (0.28/day), in terms of biomass this pattern was reversed (1.09g AFDM/day for *Urosalpinx* and 3.57g AFDM for oysters). These results do not support Wells' prey preference hierarchy, suggesting that variation in scarring frequencies in space and time reflect variation in the relative abundances of bivalve and non-bivalve prey available to *F. liliium hunteria*.

## Revisiting Test's 1946 views on speciation in California limpets

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Avery Ransome (Grant) Test completed groundbreaking research on the ecology, evolution, and taxonomy of California limpets after her earlier extensive fieldwork in California. Her 1946 article, "Speciation in limpets of the genus *Acmaea*" (*Contributions from the Laboratory of Vertebrate Biology*, 31: 1-24) was influenced by contemporary "Modern Synthesis" views. She had insightful views of geographic and ecological speciation processes and phenotypic plasticity in California's diverse and co-occurring limpet species. Here, I compare her intriguing conclusions with subsequent discoveries and my own collaborative research of the western North American limpet fauna combining molecular and morphological analyses. She recognized 17 California *Acmaea* species, including *A. mitra* and 15 other species still considered valid but now assigned to the genus *Lottia*. She considered their shells as mostly unreliable and emphasized instead the radular ribbon *sans* teeth for both species diagnoses and apparently as the basis for recognizing affinities between species. Some portions of her three proposed species groupings are congruent with molecular results but other parts are not. She had a quite modern view of geographic (*i.e.*, allopatric) speciation processes and gave examples that alternatively agree or conflict with current molecular-based estimates. Perhaps because she assumed that the speciation events leading to this high diversity must have been very recent, she did not believe that geographic speciation was a sufficient speciation process. Instead, she postulated ecological (*i.e.*, sympatric) segregation processes as more common, with a recurring trend of polytypic species giving rise to more specialized descendent species. Subsequent discoveries have capsized her assumption that limpets in distinct microhabitats might be reproductively isolated due to limited lifetime movements and possible internal fertilization. The diversity of California limpets is more likely due to a much more ancient history of allopatric speciation followed by subsequent ecological divergence, but how this remarkable specialization occurs is still poorly known.



**Past, present, and future of molluscan phylogenetics — or, will we ever know the molluscan Tree of Life?**

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Among the most vexing questions in animal phylogenetics is the resolution of the molluscan interclass relationships. Traditional systematics, often founded on cladistic principles (numerical or not), seemed to agree on just a few points, but pretty much all converged on the monophyly of the shell-bearing mollusks or Conchifera. The incorporation of molecular data from a few markers has questioned even this commonly accepted idea, or even the notion of molluscan monophyly. Disputes on the paraphyly or monophyly of Aplacophora and Aculifera, or the Diasoma and Cyrtosoma concepts, are also common in the phylogenetic literature. But is the lack of resolution in molecular and morphological data a defect of methodologies, or is it caused by a dearth of understanding of their disparate anatomies, or an inherent lack of phylogenetic signal for the early diversification of mollusks? Here I will revise some notions about molluscan relationships, the data utilized to study such phylogenies, and hopefully define a roadmap for achieving a resolution for the internal tree of life of the group of animals with the largest disparity in body plans.

**Toward solving Darwin's "mystery": speciation and radiation  
in freshwater gastropods**

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As much as the century-long debate on what species are has created confusion and controversy, not less has speciation been discussed, *i.e.*, the process of how new species evolve, ultimately resulting in the multiplication of species. Most appropriately for a year celebrating Darwin twice, his "mystery of the mysteries" (*i.e.*, the origin of species and, as a consequence, of biological diversity in general) remains at the forefront of current evolutionary biology studies. Although allopatric speciation *sensu* Ernst Mayr is still considered an important mechanism in many cases, over the last two decades, it became evident (as a slow and quiet revolution, though) that alternative explanations could account for how new species come into being. Among the most prominent factors currently discussed, particularly in the context of adaptive radiation, is ecology in concert with specialization. However, with respect to freshwater gastropods, we are still far away from really understanding speciation processes that lead to the array of radiations described recently for many taxa and cases. With an increasing armamentarium of molecular genetic techniques for exploring the genetic structure of populations, species, and higher level taxa, the mystery has become many and solutions multiplied, as we uncover further complexities in what we mean by a species. Contrasting riverine and lacustrine settings, I will discuss these issues exemplified by my own studies on pantropically distributed Cerithioidean gastropods, for taxa ranging from the New World and the Mediterranean region to lakes and rivers in East Africa and Southeast Asia to Australia.

**Out of Antarctica? New insights into the phylogeny and biogeography of the Pleurobranchomorpha (Mollusca, Gastropoda)**

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The present study provides first insights into the molecular phylogeny and the historical biogeography of a neglected clade of opisthobranch gastropods – the Pleurobranchomorpha or side-gilled sea slugs. The primary focus is to verify the hypothesis of an Antarctic origin of this clade. For this purpose, the combination of four gene markers (18S rDNA, 28S rDNA, 16S rDNA, CO1) was used to infer a phylogenetic hypothesis of the Pleurobranchomorpha employing Maximum Likelihood and Bayesian inference methods. This hypothesis was subsequently utilized to reconstruct the historical biogeographic distribution by applying four sophisticated methodologically distinct approaches. These included two parsimony-based methods, a Bayesian inference estimation, and a newly developed Maximum Likelihood approach. Relaxed molecular clock analysis was used to calibrate the tree. Phylogenetic analyses supported the monophyly of the Pleurobranchomorpha and their sister-group relationship to the Nudibranchia. Monophyly of the main subgroups Pleurobranchaeinae and Pleurobranchinae could not be revealed. Reconstruction of the ancestral area of the Pleurobranchomorpha yielded different possibilities in the diverse analyses. However, the Pleurobranchinae most probably derived from an Antarctic origin. Estimation of divergence times revealed a long, credible interval for the Pleurobranchomorpha, whereas the Pleurobranchinae diverged in Early Oligocene and underwent rapid radiation during Oligocene and Early Miocene. Divergence of the Pleurobranchinae into the Antarctic *Tomthompsonia* and the remaining species in Early Oligocene coincides with two major palaeogeographical events, namely the onset of glaciation in Antarctica and the opening of the Drake Passage in correlation with formation of the Antarctic Circumpolar Current (ACC). These sudden and dramatic climate changes probably led to subsequent migration of the last common ancestor of the remaining Pleurobranchinae into warmer regions, whereas the ACC could have accounted for larval dispersal to the eastern Atlantic.

**The Delray Beach, Florida, colony of  
*Cerion (Paracerion) tridentata costellata* Pilsbry, 1946  
(Gastropoda: Pulmonata: Cerionidae): indirect Cuban origins**

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Despite the long fossil history of the genus *Cerion* in Florida, the Recent fauna is limited to a single native species with four varieties, and to survivors of a series of experimental introductions during the early twentieth century. At least nine species of *Cerion* from Cuba, the Bahamas, Puerto Rico, and Curacao were introduced in substantial quantities to various of the Florida Keys between 1912 and 1924 by Paul Bartsch. Relatively few of these original propagules survive today either as pure colonies or as hybrids with the native *C. incanum*. A large colony of *Cerion* has recently been reported from Delray Beach, Florida, far north of the reported ranges of native and introduced species. Although long range dispersal of *Cerion* has generally been attributed to hurricanes, this population is morphologically distinct from proximal populations in the Bahamas. Partial cytochrome c oxidase I sequences reveal the Delray population to be monophyletic, and to differ substantially from *Cerion* inhabiting various islands of the Bahamas, Puerto Rico, or the Dutch West Indies. The Delray COI sequences cluster into two groups. The dominant group matches sequences obtained from two specimens of *C. tridentatum* collected by Bartsch in Rincon de Guanaba, Cuba, in 1924, the source of his introduction of this species to Fort Jefferson in the Dry Tortugas, as well as the sequence from a single specimen collected at Fort Jefferson in 1947. The remaining group matches a sequence derived from a specimen resembling *C. chrysalis* collected at Fort Jefferson in 1947. Our data indicate that the source of the Delray population of *Cerion* is Fort Jefferson in the Dry Tortugas. The taxon *C. tridentatum costellata* Pilsbry (type locality Fort Jefferson) is likely a hybrid of *C. tridentatum* and one or more of the other Cuban species introduced by Bartsch to Fort Jefferson.

**Deep time, geologic events, and paleobiogeographic distance:  
when is the application of extant genera to fossil continental  
molluscan species pointless?**

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Is novelty and extreme morphological difference a necessary requirement for the naming of extinct genera during, say, the Cretaceous or Paleogene (K/Pg) (or older)? There are a number of taxa that are currently under study that have been in "holding" genera since the 1800s. Genera, such as the bivalve *Unio* and the snail *Hydrobia*, are not valid in the fossil record of western North America. As examples, their use has been retained over the years because they possess simple, undistinguished morphologies. A different sort of problem is represented by genera that can include species very similar to modern taxa, but are so as the result of convergence. Fossil snail examples include *Viviparus* and *Campeloma*. *Bellamyia*, with a very limited fossil record in the eastern hemisphere, was assigned to the fossils of *Viviparus* deposited during the end-Cretaceous and Paleogene Laramide Orogeny by D. W. Taylor, a comparison not without merit. The biogeographic and evolutionary consequences of this reassignment, however, were not addressed and pose some interesting problems. Fossil species of *Campeloma* are similar to extant forms, but with some added variation in features. *Campeloma* is known for its variability. Should this survivor of the K/Pg event expand to the morphological variation found in modern species, or should a new genus be established, thus providing an age range for the Laramide genus-level taxon of about 20 million years (instead of 75 Ma range for the genus *Campeloma*)? Following this type of examination, there seems little doubt that mussel species and associated "genera" that were lost at the end of the Cretaceous have not undergone a 66 million year, multiple Lazarus awakening. Being on the other side of an ocean or major inland sea, separated by an extinction event, and a geologic era could be sufficient reason to consider convergence is at work and not taxon longevity.

**Exploring geographic gradients in the body size of western Atlantic mollusks: a specimen-based approach**

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Considerable attention has focused on investigation of large-scale spatial variations in the body size of mollusks, with particular interest in variations of body size across biogeographic boundaries and along latitudinal gradients. All previous studies, however, have utilized relatively coarse levels of comparison and debate still exists about both the generality of observed trends and the underlying processes that drive them (*e.g.*, food availability, competition, or life-history traits). In particular, the mechanisms that control modern body-size distributions at the scale of local communities and regional faunas still require testing. In addition, it is difficult to interpret temporal or geographic patterns in fossil body size without understanding modern trends and mechanisms. We present a new database of body-size data for selected gastropods and bivalves of the western Atlantic, focusing particularly on those taxa that exhibit a circum-Caribbean biogeographic distribution. At present the database includes data for 147 species (*ca.* 7,200 specimens; 2,100 specimen lots) that represent a range of trophic lifestyles taken from adult specimens repositied in malacological collections. This database will allow a wide range of questions about modern body-size distribution to be addressed as well as acting as a baseline for comparison with fossil data.

**Relict deep-water gastropods in a disappearing seaway**

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Undescribed bathyal marine gastropods in a remnant Indonesian seaway suggest an intriguing link between plate tectonics and historical biogeography in the famous biogeographic region of Wallacea. New genera and species in three bathyal prosobranch families are associated with active volcanic arcs and subduction zones in the Molucca Sea adjacent to Sulawesi and Halmahera. Although the taxa are undescribed, some of the specimens were collected 100 years ago during the *Albatross* Philippines expedition. The discovery is significant in terms of the complex tectonic history of the remnant deep marine basins of Wallacea and the complex series of Cenozoic collisions that brought Gondwanaland into contact with Laurasia. Sulawesi is, itself, a fusion of Gondwanan and Laurasian elements. Although the lines that have been drawn and redrawn to define Wallacea as a biodiversity hotspot are the work of terrestrial biogeographers, there is increasing evidence of patterns of marine biodiversity that are linked to the geology and geophysics of the region. The Molucca Sea is the only known example of a seaway that is disappearing in a zone of collision between two facing volcanic arcs. It is the relict of what was once a substantially larger deep marine basin. Striking features of the new taxa include high incidences of shell breakage and repair, several kinds of determinate growth features (rare in basal gastropods), and anatomical structures associated with sperm transfer and/or storage (also atypical of basal gastropods). Deep forearc settings merit further exploration because they frequently are characterized geologically by diffuse seepage of methane, sulphide, and geochemically interesting fluids that support chemosymbiotic taxa.

**Stuck on you: specialization of epibiotic *Crepidula adunca* (Gastropoda) on the host *Calliostoma ligatum* (Gastropoda)**

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Symbiotic interactions beg the question as to the degree to which the guest has specialized on a particular host and the relative costs and benefits of the association to each participant. On San Juan Island, Washington, the suspension-feeding marine snail *Crepidula adunca* is found almost solely residing in a characteristic, external location on the body whorl of the snail host *Calliostoma ligatum*. Numerous other hosts are available, including *Margarites pupillus*, a sympatric snail in the same taxonomic family as *Calliostoma*. Field transects indicated that individuals of *Crepidula* in the San Juans reside on *Calliostoma* more than on any other host. The incidence of infection across sites ranged to > 80%, with an average epibiont load of up to > 3 individuals per host, representing an addition of > 7% of the body weight of the host. In laboratory choice experiments, individuals of *Crepidula* preferred *Calliostoma* hosts to the other common potential hosts, including hermit crabs in *Calliostoma* shells. *Crepidula* did not show a preference for intact versus sanded *Calliostoma* shells. These results suggest that the cue used by *Crepidula* to identify an appropriate host is likely from living *Calliostoma* tissue or is in *Calliostoma*'s shell and rapidly degrades postmortem. The specialization on *C. ligatum* likely reduces the chance of shared doom for *C. adunca* because this host is less preferred by some predators, moves more quickly than the sympatric potential host *M. pupillus*, and *C. ligatum* effectively deters predators through biting and chemical defenses. This symbiotic interaction is likely parasitic, as the additional weight and surface area from *Crepidula* epibionts likely result in energetic costs for the *Calliostoma* host, and no benefit for the host has been identified.



**Limelight shines on the troglobitic Cave Thorn: a comprehensive study focuses on America's only subterranean ellobiid snail, *Carychium stygium* (Pulmonata, Ellobioidea, Carychiidae)**

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The Carychiidae comprise one of three gastropod groups to have migrated to land independently of the higher pulmonate Stylommatophora. Two genera are currently attributed to this family of the northern hemisphere, *Carychium* and *Zospeum*. *Carychium* Müller, 1773, is widely distributed and, excepting for *C. stygium* (Call, 1897), is ecologically epigean. Its European cousin, *Zospeum* Bourguignat, 1856, is troglobitic and restricted to karst caves in the Pyrenees, the Cantabrian Mountains, and the eastern Dinaric Alps. Members of the genus *Carychium* inhabit mesic forests, talus slopes, wooded swamps, and riparian zones of streambeds. The Cave Thorn, *C. stygium*, is found only in karst caves of central Tennessee and Kentucky. Although its distribution, shell morphology, and ecological niche are sparsely described in the literature, nothing specific about its anatomy or molecular phylogeny has been described. Due to its small size and the biospeleological prowess involved in collecting specimens, this study truly involves more than what meets the eye. *Carychium stygium* was collected in both Kentucky (one molecular study) and Tennessee caves. Tennessee specimens were used for the majority of this study. Our first-time, comprehensive approach considers SEM analysis of shell and radular morphology. Histological serial sections enable a close look at the anatomy of these minute snails. Molecular systematic analyses of mitochondrial gene sequences (CO1) reveal high intraspecific variability and corroborate its systematic designation within the Carychiidae.

**Does increased sedimentation adversely affect Lake Tanganyika's soft substratum-dwelling gastropod assemblages?**

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Recent research on Lake Tanganyika's endemic malacofauna has focused on rocky substrata where SCUBA sampling has provided data on local, regional, and lake-wide diversity and response to anthropogenic sedimentation. In contrast, knowledge of the ecology and distribution of soft-substratum mollusks and their susceptibility to environmental change is poorly known. In 2007, the Nyanza Project sampled small-stream-delta habitats to examine whether human impacts are affecting these extensive soft-substratum environments. Using a paired sampling design, we compared snail faunas within the deltas of two small streams north of Kigoma, Tanzania, which show contrasting levels of anthropogenic impact. Kasekera Stream in Gombe Stream National Park has a relatively pristine watershed protected from habitat degradation. In contrast, Mtanga Stream has a watershed increasingly affected by sediment runoff from agriculture and human pollution. At each delta, we sampled four 1-m<sup>2</sup> quadrats at three sites at 5 m depth, paired for comparability between deltas. Our aims were (1) to provide the first malacological inventory of this habitat, (2) measure species richness (S), abundance, evenness, and Simpson's diversity (D) at a range of spatial scales, to (3) test the prediction that anthropogenic sedimentation negatively impacts species richness and abundance within assemblages, as previously documented for Tanganyika's rock-dwelling snail communities. We recovered 18 species of gastropods, each site having 7-11 species. Our prediction was confirmed: richness and Simpson's diversity were greater for all sites at the reference delta (Kasekera) compared to the impacted delta (Mtanga) and differences between the deltas were highly significant. At the site level, evenness showed no clear patterns between the deltas, though Kasekera Delta showed overall greater evenness. Bray-Curtis cluster analysis for presence/absence and abundance revealed no spatial association of sites at 50 m or greater distance within or between deltas. Assemblages were variable over short distances with one common species (*Syrnolopsis carinifera*) restricted to Kasekera. We conclude that soft-substratum communities are affected by increasing anthropogenic impacts but their degree of vulnerability is unclear.

Poster

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**The prevalence of *Angiostrongylus cantonensis*  
in the main Hawaiian Islands**

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Recently, there has been an outbreak of eosinophilic meningitis on the island of Hawaii, attributed to the nematode parasite, *Angiostrongylus cantonensis*. At present, the symptoms can be treated but there is no known cure. Therefore, it is imperative to gain more knowledge of this parasite's vectors and prevalence throughout the Hawaiian Islands, which will permit their detection, monitoring, and possible eradication. The definitive hosts of *A. cantonensis* are rats and the intermediate hosts are snails and slugs. However, it can infect a wide range of accidental hosts, including humans. Specimens from snail and slug surveys previously undertaken throughout the main Hawaiian Islands were selected for screening for *A. cantonensis*, specifically five snail and slug species known from the literature to be intermediate hosts of *A. cantonensis*: *Achatina fulica*, *Bradybaena similaris*, *Laevicaulis alte*, *Parmarion martensi*, and *Veronicella cubensis*. Specimens were screened from Oahu and Hawaii islands. Following extraction of total DNA from these snails and slugs, *Angiostrongylus*-specific primers were used to detect the presence of the parasite. Digestions of snails and slugs were also done to release nematode larvae and corroborate the genetic results. All species examined except for *B. similaris* tested positive for *A. cantonensis*. Future work will extend the study to all main islands and to additional snail and slug species to obtain a comprehensive picture of the distribution of *A. cantonensis*.

## **Invasive veronicellid slugs in the main Hawaiian Islands**

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The family Veronicellidae includes some of the most damaging and widespread slugs in Hawaii. These invasive slugs are major domestic, agricultural, and environmental pests. The first record of a veronicellid in Hawaii was in 1900. However, the different veronicellid species are difficult to distinguish and correctly identify. The focus of this study was to resolve this problem, which has led to considerable confusion as to the actual species present in Hawaii. According to historical collection data (Bishop Museum) and literature reports, and more recent surveys, three species have been recorded: *Laevicaulis alte*, *Sarasinula plebeia*, and *Veronicella cubensis*. I have re-examined these collections using three approaches. External morphology can distinguish the black slug, *L. alte* from the other two, but it was not possible to distinguish *S. plebeia* and *V. cubensis* reliably by external morphology. Adult specimens of these two species were therefore dissected and distinguished on the basis of key reproductive structures. Juveniles, however, could not be distinguished, so a DNA-sequencing approach involving the 16S mitochondrial marker was used and proved reliable for distinguishing individuals with undeveloped reproductive structures. Using a combination of these three approaches, I am now able to confidently identify these veronicellid species. A number of specimens labeled as *S. plebeia* in the Bishop Museum were sequenced and shown to be *V. cubensis*. It is possible that the brown slug, *S. plebeia*, quite variable in color, might never have been in Hawaii or that it was but is no longer widespread.

**Practical species-level gastropod taxonomy and phylogeny in the molecular era**

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Testing taxonomic hypotheses of species identification and evolutionary hypotheses of phylogenetic reconstruction with molecular genetic data is increasing rapidly. Molecular data are far simpler than morphological, and analytic methods are quite well standardized. Molecular methods can also overcome some other problems and shortcomings of morphology, for example larvae and juveniles that lack adult characters, the necessity for all or most of specimens rather than a small tissue sample, and cases of cryptic species. I examine the relative roles of molecular- and morphology-based taxonomy pertaining to these problems, as exemplified in an ongoing revisionary systematics study of the hyperdiverse, taxonomically challenging gastropod genus *Conus*. Despite the simplicity of DNA molecules and the rapidly decreasing costs of sequencing genes, morphology-based methods remain important, particularly for taxonomy but also for phylogeny. Perhaps the most important reason is that at the present state of the art and science, initial identification of the genetic material to be analyzed is of necessity based on morphology. Although some gene-sequence data exist for about half of the 500+ species of *Conus*, we have not yet reached the point where an unknown tissue sample by itself can be confidently identified to species. Also, acquiring large enough samples for statistically adequate molecular analysis has proven difficult. This is especially true outside of the better known Indo-Pacific region. In the western Atlantic region, the genus, although diverse, is represented by species that are less common and less accessible. I will present a current approach to integrating morphological and morphometric data on shell and radular characters with molecular data in revisionary species-level systematics.

**Anatomy of a geographic cline in shell morphology of the predatory gastropod *Busycon carica* (Gmelin, 1791) along the US Atlantic Coast**

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A conspicuous geographic cline in shell morphology along the Atlantic coast of the United States from the southern shore of Cape Cod, Massachusetts, to Cape Canaveral, Florida, is evident for the whelk *Busycon carica* (Gmelin, 1791). Shell morphology on the southern end of the range is robust, with long spines, a thick shell, and a pronounced tumid ridge on the siphonal canal, as compared to the less spinose, thinner, northern morph, which lacks a tumid ridge. The adaptive ecomorphological significance (if any) of this cline remains untested. Work in progress is investigating the nature of the morphological cline, including the amount of variation present, its geographical partitioning, and its covariation with ecology to test the hypothesis that increased predation pressure from shell-breaking predators in the southern end of the species range maintains the cline. In addition, we are (1) collecting experimental data to test whether intraspecific morphological differences along the cline create performance differences in antipredatory defense, (2) quantifying the frequency of shell repair — a proxy for the selective demands on whelks from shell-breaking predators — along the cline to estimate the covariation between ecology (environmental factors) and observed variation in whelk shell morphology, and (3) tracing the evolutionary history of this complex set of morphological features in the Plio-Pleistocene fossil record of the *B. carica* species complex to establish the origin, strength, and stability of the cline.

**Algal host shifts drive speciation and morphological divergence  
in herbivorous sea slugs**

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Marine taxa were traditionally thought to speciate in allopatry, but recent phylogenetic studies of diverse mollusks reveal that sister species often co-occur along a coastline or within an ocean basin. Identifying ecological mechanisms that promote reproductive isolation and morphological divergence could lead to a new paradigm for speciation in the sea. We are reconstructing the evolutionary history of herbivorous sea slugs in the group Sacoglossa, examining how algal host fidelity has shifted among lineages and contributed to species formation. A molecular phylogeny based on four genes will be presented for the Placobranchacea, comprising the two major lineages of derived sacoglossans. Within this phylogenetic framework, Bayesian methods were used to reconstruct the ancestral host of each clade, and to identify branches on which host shifts occurred. We focus on the Placobranchoidea, a group containing all species that harbor photosynthetically active chloroplasts including the speciose genus *Elysia*. Our analyses reveal a series of progressive host shifts among the major clades of *Elysia*, followed by radiations within basins onto diverse hosts. Allopatric sister species that feed on the same host alga show striking morphological stasis over millions of years, whereas host shifts are correlated with rapid diversification in external morphology and dorsal vessel venation. New hosts likely act as distinct selective environments, favoring novel characteristics as lineages adapt to differences in algal chemistry, chloroplast integrity, and cell wall composition. Ecological associations could thus drive speciation and diversification in the ocean, as in terrestrial taxa such as ectoparasites and phytophagous insects.

**Anthropogenic influence on the health of oyster reef ecosystems: a comparison of live and dead assemblages**

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Over the last half-century, *Crassostrea virginica* oyster reef systems have shown marked decline. Estuaries subject to a high degree of anthropogenic eutrophication have poorer live/dead assemblage fidelity than those less impacted by human influence. The impact of long-term human influence (sedimentation and eutrophication) on the health of *C. virginica* oyster reefs located along the southeastern North Carolina coast is examined. The influence of sedimentation from runoff is modeled using a Dame and patten style model modified to examine the flow of carbon through reef systems. The fidelity of live and dead assemblages is analyzed to test the hypothesis that increased anthropogenic influence (*e.g.*, nutrient deposition, accretion due to sedimentation from runoff) has led to change in rank order abundance, species richness, and diversity in molluscan fauna. I hypothesized that live/dead assemblage data will be more concordant in less disturbed environments than in environments with greater anthropogenic influence. Although *C. virginica* dominates both live and dead assemblages, community field samples from the uppermost centimeters of sediment contained few other molluscan species. Field samples from deeper excavated communities contained greater molluscan species richness and diversity than those found in live assemblages. Use of live/dead agreement as a method of environmental assessment of oyster reefs can be highly imperfect, with impacted sites showing considerable overlap with pristine sites. However, live/dead discordance, specifically in diversity assessments, indicates that further assessment of these communities and the environment that they live in is needed.



**The phylogeny and biogeography of Pleurotomariidae:  
new evidence from hemocyanin sequences**

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Hemocyanins are large, oxygen-binding proteins with evolutionary origins in the Precambrian (*ca.* 700-800 Ma). These molecules, consisting of eight different functional units, have been reported in chitons, gastropods, cephalopods, caudofoveates, and protobranch bivalves, but not in solenogasters, scaphopods, or higher bivalves. Within Vetigastropoda, hemocyanins have been found to occur as two isoforms that probably evolved by gene duplication *ca.* 340 ± 50 Ma. Sequences from a portion of one of the isoforms, spanning parts of exons f2 and g1 as well as the intervening intron, had proven to be phylogenetically informative in a study of haliotid evolution and biogeography. In this study, we explore the utility of this region of the hemocyanin gene in resolving phylogenetic relationships of the family Pleurotomariidae and of its constituent taxa. Preliminary data reveal that this gene contains considerable phylogenetic information, particularly in the intron, which has several taxon-specific indels, and also provides new insights into allelic structures and duplication events during evolution of pleurotomariid hemocyanins.

**Genetic diversity and population structure of the threatened  
Bliss Rapids snail (*Taylorconcha serpenticola*)**

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The Bliss Rapids snail is a federally listed caenogastropod that lives in the Snake River drainage of south-central Idaho. The construction of three large dams along this portion of the Snake River during the twentieth century is thought to have fragmented a single, ancestral population of this species into genetically isolated subunits that are vulnerable to extinction. We assessed variation of 11 microsatellite loci within and among 29 samples (820 snails) from across the entire range of the Bliss Rapids snail to assess genetic structure and test whether habitat fragmentation resulting from dam construction has impacted population connectivity. The overall  $F_{ST}$  (0.15133,  $P < 0.05$ ) and pairwise comparisons among samples (384/406 significant) indicated extensive population subdivision in general. However, we found no evidence of reduced genetic diversity attributable to segmentation of the Snake River, and genetic variation among drainage reaches separated by the dams was not significant. Population structuring in spring-tributaries was considerably greater than in the main stem Snake River as evidenced by differences in  $F_{ST}$  and the number of private alleles detected, and the results of an assignment test and Bayesian genetic clustering algorithm. Our results provide no evidence that dam construction has genetically impacted extant populations of the Bliss Rapids snail. We speculate that the generally weaker genetic structuring of riverine populations of this species is a result of passive dispersal within the water column, which could enable occasional passage through the dams. The somewhat stronger structuring observed in a portion of the river (Shoshone reach) which receives discharge from many springs could be due to local mixing of main stem and (highly differentiated) tributary populations. Our findings parallel recent, genetically based studies of other western North American freshwater gastropods that also demonstrate complex population structures that conflict with traditional concepts of dispersal ability and sensitivity to putative barriers.

**Microsatellite evidence of invasion and rapid spread of divergent New Zealand mudsnail (*Potamopyrgus antipodarum*) clones in the Snake River basin, Idaho, USA**

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We used microsatellites to assess genetic diversity and spatial structuring of the invasive apomictic New Zealand mudsnail (*Potamopyrgus antipodarum*) in the initial focal area of its recent North American invasion, a portion of the upper Snake River basin (Idaho) that is segmented by a series of hydropower dams. Thirty-four samples (812 total snails) from a 368-km reach of this drainage were genotyped for six loci. Sixty-five distinct clones were detected and grouped into four divergent clusters based on chord distances. Genetic structuring of populations was generally low. Our results indicate that the founding population(s) of this invasion was composed of a small number of putative clonal lineages which spread rapidly within this fragmented watershed owing to the enhanced dispersal ability of these parthenogens. The substantial genetic variation documented in this study suggests that caution should be used in the application of biological control measures for this pest species.

**Spherical snails: extreme parietal callus as a widespread but underappreciated gastropod morphology**

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Although the basic mechanisms by which gastropods form their shells are known, we are still largely ignorant of the details, especially of the parietal callus, the layer of secondary shell on the inner lip of the aperture, which is a significant but highly variable structure in many marine gastropods. It is clearly laid down by the mantle, borne by the foot when it is extended from the aperture, but there appear to be no studies of how this occurs or what its function(s) might be. Extreme parietal callus (EPC) is the extension of the parietal callus over more than half of the ventral surface and any of the spire. EPC occurs across a surprising array of marine gastropods, including at least eight families (especially Olividae) and more than 30 genera, Paleocene-Recent. We are exploring EPC in three species from the Paleocene and Eocene of the U.S. Gulf Coastal Plain: *Ancillopsis* [commonly referred to as *Bullia*] *atilis* (Conrad) (Olividae), *Sulcobuccinum* [commonly referred to as *Pseudoliva*] *santander* (Gardner) (Pseudolividae), and *Athleta tuomeyi* (Conrad) (Volutidae). Phylogenetic analysis shows that EPC is homoplasious in these three species. Serial sections and micro-CT scans through these three species suggest that EPC is a homologous feature but with differences in macro- and microstructure. In *A. tuomeyi*, it forms in long layers parallel to the shell surface. In *S. santander* and *A. atilis*, the primary callus is in short thick bands that radiate out from the ventral surface. All three species show a thicker EPC in the Lower Eocene Bashi Formation than in underlying or overlying units. In the Bashi, *A. atilis* displays a novel secondary callus on the left side, deposited prior to the primary callus.

**Larval developmental mode and speciation in transisthmian marine bivalves**

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The fossil record combined with molecular methods provides malacologists with model systems for studies of biogeography and speciation. We have characterized patterns of speciation among several transisthmian marine lineages of bivalves in the arcid genus *Barbatia* (*Acar*) distributed on both sides of the Isthmus of Panama. A molecular phylogeographic survey of the subgenus *Acar* in the eastern Pacific and western Atlantic shows that high cryptic diversity completely obscures the speciation history in this region. Coalescent-based analyses for two sister-species pairs found on either side of the Isthmus ("geminate" species) indicate that Pacific and Atlantic lineages likely split near the time of final seaway closure, *ca.* 2-4 million years ago. Despite at least two million years of isolation, one geminate pair is not yet phylogenetically distinct (*i.e.*, reciprocally monophyletic), whereas sorting of ancestral variation in the other geminate pair is nearly complete such that Pacific and Atlantic haplotypes form reciprocally monophyletic clades. The pattern is potentially explained by differences in larval developmental mode, given that one geminate has planktotropic larvae and the other has brooded, lecithotrophic larvae; the planktotroph likely has a larger effective population size and a greater potential for gene flow and thus has progressed more slowly to reciprocal monophyly on both sides of the Isthmus. Within-basin differences in clade diversity indicate as many as four post-Isthmian speciation events in the western Atlantic brooded lineage since the time of final seaway closure. The apparent rapid diversification of *Acar* since seaway closure is consistent with the idea that post-Isthmian turnover had a greater impact on diversity than the divisive impacts of the Isthmus. Given that the accumulation of distinct lineages in *Acar* appears to be greatest in a clade whose members lack planktonic larvae, our results also suggest that post-Isthmian faunal turnover was selective with respect to development.

**Norman Wallace Lermond (1861-1944)**

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This 75th annual meeting of the American Malacological Society pays homage to its founder, Norman Wallace Lermond (1861-1944). He actively corresponded with 192 malacologists, both amateur and professional, all over the country to assemble in Philadelphia in April 1921 for the founding meeting. The institution was called the American Malacological Union (AMU) and remained such until a name change in 1998. A native of Maine, Lermond had two great passions in life: politics and natural history, especially plants, birds, and shells. In politics, Lermond was an idealist, a utopian, and a social reformer. He was in the vanguard of the socialism movement in this country. He was a co-founder of the Populist Party in Maine (1891) and ran for Congress (1898) as the Populist Party candidate. He founded (1895) the Brotherhood of the Cooperative Commonwealth, a socialist organization that established *Equality* Colony in Washington State. He was also a co-founder and gubernatorial candidate of the Maine Socialist Party (1900). Many of the social ideals espoused by these groups became part of the American fabric. In 1913, Lermond (called the "John Burroughs of Maine") established the Knox Academy of Arts and Sciences at his property in Maine. The Academy's noble goal was to "build through Nature study a more intelligent, serviceable manhood and womanhood for Maine." There, amateurs and professionals alike could assemble to study the extensive natural history collections in the Academy's museum and the living species in the associated arboretum. The shell collection was worldwide in scope and comprised about 100,000 shells representing nearly 8,000 species. *The Maine Naturalist* was instituted in 1931 as the official journal of the Academy. In 1941, Lermond hosted the 11<sup>th</sup> annual meeting of AMU at Knox Academy and in nearby Rockland, Maine. It was to be his sayonara. When AMU met again in 1946 following the war years, Lermond was deceased and buried in an unmarked grave on the Knox Academy grounds.

**Revision of world Liotiidae, Recent and fossil  
(Gastropoda: Vetigastropoda)**

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The long-neglected but highly diverse family Liotiidae is being revised, based on morphological evidence. Shells of liotiids have interior nacre, are umbilicate, are broader than high, and range in size from 25 mm to 2 mm diameter, with fewer whorls in smaller species. Liotiidae are characterized by a thickened final lip, lamellar microsculpture, and calcified periostracum. The operculum is unique: its inner surface is corneous and shows no volutions; its outer surface has a multispiral pattern formed by a beaded, calcareous ring, which is separated by corneous fringe that projects between the calcareous elements and pinches to hold it in place. Functionally, the liotiid operculum is like that of the trochid operculum. Two subfamilies are recognized, Liotiinae and Areneinae, both first known from the Late Cretaceous. Genera of Liotiinae are characterized by white shells with strong axial and spiral sculpture, and elaborate development of the final lip. Liotiinae are the most speciose and are best represented in the Indo-Pacific (with highest diversity in the Philippines), with lesser occurrence in southern Australia, New Zealand, the eastern Pacific, and the western Atlantic. Many new bathyal species are now known as a result of the Tropical Deep-Sea Benthos program of the Paris Museum. Extinct genera of all sizes are well represented in the Eocene fauna of the Tethys Sea. Genera of Areneinae are characterized by pigmented shells and have the spiral sculpture dominant, thickening of the final lip is preterminal; the opercular beads are smoother than those of Liotiinae; this group is chiefly known from the western Atlantic and eastern Pacific, with lesser representation from the Indo-Pacific, southern Africa, and western Africa. Illustrations and text have been prepared for approximately 410 recognized species, both living and extinct, of which 260 are being described as new. Species are assigned to 95 living and extinct genera, all but 18 of which are also being described as new. Preliminary molecular work by Williams *et al.* (2008) on a limited number of species has suggested that the two groups should not be assigned to the same superfamily, but that hypothesis is not supported by the morphological evidence. Once the taxonomy provided by this revision is in place, further phylogenetic assessment will be possible.

**A molecular phylogeny of polygyrid land snails  
— monophyly or not?**

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We have attempted to clarify the taxonomy of *Stenotrema* spp., a group of polygyrid land snails. Molecular identifications have become increasingly popular, specifically in DNA barcoding, or the use of a short, unique gene sequence as an identification tag. A 648-bp fragment of cytochrome oxidase subunit 1 (COI) from mitochondrial DNA was sequenced. Interspecific as well as intraspecific variation was determined based on Kimura-2-parameter genetic distances. Another goal of this study was to test the monophyly of *Stenotrema* spp. using two independent molecular markers: COI and ITS-1. A 625-bp fragment of internal transcribed spacer (ITS-1) of the nuclear ribosomal DNA was sequenced. A molecular phylogeny of *Stenotrema* was reconstructed through maximum parsimony and Bayesian inference. We were unable to fully resolve relationships or support monophyly, but there is evidence of genetic distinction between several species. This research initiates the compilation of mitochondrial and nuclear sequences for use in future systematic studies of *Stenotrema* spp.



**The importance of land snails in litter decomposition in a  
Hawaiian rain forest**

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The diverse and endemic Hawaiian land snail fauna is disappearing and being replaced by a small number of widespread alien species. Predicting the consequences of this change is difficult because the roles of terrestrial mollusks in many important ecosystem processes are unknown. This study examined the role of the most abundant terrestrial mollusks (native and alien) in litter decomposition in an intact Hawaiian rainforest. It has been suggested that snails/slugs contribute directly (by their own metabolism) and/or indirectly (by habitat modification enhancing micro-arthropod or microbial activity) to the decomposition of leaf litter. Forty-two field microcosms were established at seven sites to examine the role in litter decomposition of five snail/slug species at their mean natural densities: *Succinea* spp. (native snail), *Arion intermedius* (alien slug), *Deroceras leae* (alien slug), *Oxychilus alliarius* (alien snail), and *Limax maximus* (alien slug). Controls had no snails/slugs. Stable isotope analysis of the invertebrate community was also undertaken to determine the trophic position of each snail/slug species. The presence of snails/slugs increased litter decomposition (all treatments except *A. intermedius* had significantly less leaf litter remaining compared to controls). No increases in micro-arthropod abundances were observed, indicating that snails/slugs do not facilitate micro-arthropod recruitment. However, elevated carbon, potassium, and manganese concentrations in the treatments with highest snail/slug biomass (*L. maximus* and *O. alliarius*) potentially influenced microbial composition and biomass. The isotopic signatures indicate that *Succinea* spp. and *A. intermedius* are primary consumers of litter, whereas *D. leae*, *L. maximus*, and *O. alliarius* are higher in the food web. This suggests that snails/slugs when abundant could influence litter decomposition by both direct consumption of leaf litter and facilitation of microbes.

**Diversification and life history variation: an experimental isotopic demonstration of viviparity in a Tanganyikan gastropod radiation**

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Maternal retention and nourishment of young is a fundamental shift in life history strategy observed in many animal groups, and could be associated with increased speciation rates. The physiological basis for such shifts is poorly understood. Here, we document changes in maternal investment strategies in subclades within the *Lavigeria* species flock of gastropods in Lake Tanganyika, a species-rich African rift lake. The observed differences among species reflect a general trade-off between size and number of offspring, indicating constraints on maternal investment in this clade. Using an isotopic tracer, we demonstrate that growing embryos receive nutrients routed both directly from maternal diet and indirectly via maternal tissues. This is the first explicit evidence of matrotrophy in a gastropod, indicating true viviparity, rather than ovoviviparity. Given that *Lavigeria* comprises far more species than its sister group or other Tanganyikan gastropod genera, we conclude that evolving the physiological capacity to retain and nourish young appears to have set the stage for subsequent life history differentiation within *Lavigeria*.

## **Speciation in marine bivalves: an overview**

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The marine environment challenges the study of speciation because the planktonic larvae produced by most marine organisms have the potential for wide dispersal and thus to maintain high levels of gene flow between populations. Marine mollusks – at least those that release planktonic veligers and are not strongly ecologically restricted (*e.g.*, to a host) – are one such case. Whereas species of some groups of mollusks – especially landsnails and freshwater bivalves – are often restricted to one hillside or island or lake, marine bivalves are often more widely distributed, and the mechanisms underlying their radiation are more difficult to examine and comprehend. The fossil record of marine bivalves reveals two great radiation events, one at the Cambrian-Ordovician boundary (488 Ma, predicated by the Cambrian Substrate Revolution, with changes in the gill, foot, and byssus) and the other following the great Permian-Triassic mass extinction (251 Ma, an early part of the Mesozoic Marine Revolution, with the development of siphons and other anti-predator innovations). But what's happening now? What (if anything) can we infer from living marine bivalves to indicate the current scope and processes of speciation? Two bodies of data are available for addressing these questions: (1) the descriptions of new bivalve species from the year 2000 to present, plus the supporting data behind them, and (2) recent bivalve phylogenies at family or superfamily levels, searching for (a) the relative diversity of disparately sized sister clades coupled with the recognized evolutionary innovations of the larger of the two clades, and (b) unresolved polytomies that might indicate rapid ongoing speciation. Species descriptions reveal interesting statistics, but show that we are still actively describing morphologically distinct (*i.e.*, not cryptic), previously undiscovered taxa, with few suggestive of recent speciation trends. Phylogenetic data are insightful but variably informative, depending upon taxon sampling, and show promise for further scrutiny. Supported by NSF DEB-0732854-0732903-0732860.

**Predation scars on Middle Devonian pterineids from the  
Hamilton Fauna of New York**

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We examined the Middle Devonian pterineid bivalve *Ptychopteria* from the Hamilton Fauna of central and western New York for evidence of breakage-induced shell repair. *Ptychopteria* is an excellent candidate for an analysis of predation scars because members of this genus were exclusively epibenthic suspension feeders that dwelled on the surface of the substratum either byssally attached or in pleurothetic (reclining) life position. This mode of life would have made them vulnerable to an array of potential Devonian jawed and clawed shell-crushing epibenthic predators. More than 25% of the 115 individuals that we examined displayed evidence of shell repair (228 had to be excluded from our repair frequency analysis because of poor preservation). This high frequency of repair implies that the shell of *Ptychopteria* was an effective defense against locally prevailing, shell-breaking agents. High repair frequency values also suggest that *Ptychopteria* possessed traits that functioned to withstand shell injury. Specifically, flexible shell margins and a highly retractable mantle enabled *Ptychopteria* to sustain often severe marginal shell damage. The relatively high repair frequency for the Middle Devonian *Ptychopteria* supports a growing body of evidence that suggests predation intensified in the middle Paleozoic.

**Albinism in *Helisoma trivolvis*: genetics and practical applications of pigmentation differences**

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We examined egg production and pigmentation in crosses between albino (A) and pigmented (P) individuals to answer three basic questions about reproduction and development in the freshwater hermaphroditic snail, *Helisoma trivolvis*. (1) Are pigmentation differences between these two groups due to segregation at a single genetic locus? (2) Are there differences between pigmented and albino snails in egg production and survival of offspring? (3) Do these snails ever produce selfed eggs, even when they have been outcrossed? Albino individuals crossed with albino individuals yielded all albino progeny and all crosses containing a pigmented individual yielded pigmented offspring. These initial results support both our hypothesis that albinism is controlled by a single recessive gene and the hypothesis that self-fertilization in *H. trivolvis* is rare; we never saw an albino individual in either AxP or PxA crosses. Additional genetic experiments are underway to verify albinism as the result of a single recessive gene. Crosses between F1 individuals to yield F2 progeny and crosses of F1 back to pure-breeding albinos that yield results consistent with Mendelian inheritance will support this working hypothesis. We also observed differences between strains in fecundity that will influence the expected outcomes of these crosses: albino individuals laid significantly more egg masses than did pigmented individuals, regardless of paternal contribution (A or P) indicating a maternal effect on egg-mass production. Conversely, there was a paternal effect on the average number of eggs per mass with pigmented sperm donors contributing higher average numbers of eggs to egg masses. These results indicate that the number of egg masses laid is determined at least in part by a maternal contribution, and that the number of eggs laid in each mass is limited by the availability of sperm.

**A dip in the pool: how the slug *Megapallifera mutabilis* maintains its water balance**

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The eastern North American native slug *Megapallifera mutabilis* (Hubricht, 1951) (Philomycidae) is primarily an arboreal species. The slugs feed on the green algae growing on tree trunks, often remaining exposed on trees for hours. To understand the behavioral adaptations of this species that enable it to regain the water lost during its arboreal excursions, we have carried out field observations and laboratory experiments. During rest periods, the wild slugs take refuge on damp soil among tree roots or in water-filled tree cavities. Resting slugs observed in the field often huddle with conspecifics and frequently dip their tails or other parts of their bodies in water. In the laboratory, dehydrated slugs exposed to air saturated with water did not absorb water, indicating that physical contact with liquid water is required for rehydration. Captive slugs displayed behaviors similar to those seen in the field. For example, they were often seen partially immersed in the water dishes placed in their containers. Measurements of the weights of slugs before and after immersion in water showed that spending time in water indeed results in water absorption. Huddling among captive slugs was observed even in rehydrated slugs, suggesting that it could have functions in addition to slowing down water loss by reducing exposed surface area and by keeping microhumidity high.

**Evaluating the presence of competition between native and invasive slugs in central Maryland**

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Although many invasive species are recognized as potential competitors of native species, the harm to the native competitor can be difficult to observe in the vast majority of cases. Changes to the individual fitness and population density of native species in the presence of introduced competitors should be evaluated, because these changes suggest an increased risk of eventual extinction. The native slug *Philomycus carolinianus* is likely to compete for resources with the aggressive invasive slug *Arion subfuscus* in Maryland forests. To establish whether competition occurs between these two species, I am testing for the following criteria: the existence of competitive displacement, the sharing of limited resources (shelter and food), and a decline in the fitness of *P. carolinianus* in the presence of *A. subfuscus*. Field surveys showed that displacement between heterospecifics does not apparently occur within mixed natural populations of these species across grids of 5 x 5 m cells. A lab experiment established that low natural levels of food (fungus) can limit the fitness of each slug species, whereas shelter (coarse woody debris) was not limiting, at least under the moist experimental conditions used. When sharing a low-resource lab cage with either *A. subfuscus* or conspecifics, *P. carolinianus* experienced a similar decline in fitness, suggesting that exploitative resource competition was no greater between heterospecifics than between conspecifics. No evidence of heterospecific interference (competition independent of resource levels) was found. Given the limited support for the criteria of competition, *A. subfuscus* was not shown to be an immediate threat to the persistence of *P. carolinianus*.

**Is the Tiger Snail *Anguispira alternata* declining?**

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Declines of some species are difficult to document due to scant or non-quantitative baseline information. Anecdotes suggest declining occurrences of many land snail species, including the Tiger Snail, *Anguispira alternata*. Numerous museum specimens of *A. alternata* from eastern North America probably reflect its large size (up to 25 mm diameter) and commonness (at least formerly). Using information from eight museums, I assembled 439 records of *A. alternata* from Pennsylvania with known collection dates. In a preliminary analysis, I classified dates into 394 samples collected before 1960 and 45 samples collected after 1960. Of Pennsylvania's 67 counties, the species was collected in 48 counties (72%) before 1960 and in 19 counties (28%) after 1960. Could the fewer counties and samples after 1960 simply reflect less search effort or might they reflect increasing difficulty finding the species? To address that question, I examined Pennsylvania land snail samples in the Carnegie Museum collection and compared the proportion of collecting events (collected by one person from one place at one time) that produced *A. alternata* historically versus recently. Of 1,498 collecting events, 57% were before 1960 and 43% after, indicating substantial collecting effort during both periods. Consequently, the fewer modern samples of *A. alternata* suggest modern populations are relatively scarcer now than other species, and likely to be declining. Modern occurrences tend to associate with limestone localities, which might function as buffers against acid precipitation, suggesting a hypothesis about a possible causal factor in the snail's decline.



**The relative role of nematocysts in defense of  
*Flabellina verrucosa***

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Aeolid nudibranchs shell-less yet often brightly colored marine snails can sequester and maintain functional nematocysts from their cnidarian prey. Such kleptocnidae are often described as being a potent defense; however, there is little direct evidence for this function. A major problem in testing the defensive efficacy of kleptocnidae is separating their contribution from that of other potential defenses, especially given that the dorsal structures housing kleptocnidae, the cerata, also host numerous chemical secretory glands that may serve for defense. To circumvent this problem, we found a non-invasive method to strip nudibranchs of their kleptocnidae while keeping cerata attached and intact, and used this method to test the role of kleptocnidae in the defense of *Flabellina verrucosa*. In laboratory assays, a predatory fish rejected whole *Flabellina* regardless of whether they still possessed kleptocnidae, although individuals with kleptocnidae were rejected after fewer samplings. However, the fish were deterred from consuming artificial food treated with *Flabellina* extract, and chemical defense may be more important than kleptocnidae in defense of this nudibranch. If this is true of aeolid nudibranchs in general, the capture and maintenance of kleptocnidae may have initially evolved for a reason other than defense.

**Functional morphology of *Lissarca notorcadensis*  
(Bivalvia: Philobryidae)**

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One of the common yet poorly known Antarctic bivalves is the small epifaunal arcoidean *Lissarca notorcadensis*. This philobryid has a circum-Antarctic distribution. The philobryids, including *L. notorcadensis*, are distinguished by retention of a juvenile shell provinculum in adults, epifaunal habits (in this case attachment to the spines of the echinoid *Ctenocidaris* by a few flat byssal threads), filibranch ctenidia, an unfused mantle margin, and brooding through postlarval stages within the infrabranchial chamber. The chalky shell, but not the multilayered periostracum, is pierced by numerous small tubules, common to several arcoids, but still of unknown function. Labial caeca are present and appear secretory as evidenced by the presence of small, elongate mucoid granules also of unknown function. Unlike most philobryids, *L. notorcadensis* has a style sac separate from the midgut and intestine. Absence of an anterior adductor muscle provides volume for brooding and could also reflect the adaptive significance of retention of the provinculum in adults. Paired statocysts, adjacent to the pedal ganglia but, as typical, innervated by the cerebral ganglia, house both numerous statoliths and statoconia. A cerebral photoreceptor is present on the first filament of the inner demibranch of the ctenidium and a variable number of posteriorly located pallial eyes are also present. Pedal ganglia are partially fused dorsally, whereas other ganglia remain separated. Unlike most bivalves, *L. notorcadensis* has gonopores that empty directly into the infrabranchial chamber. Growth series evidence suggests that *L. notorcadensis* is a protandric hermaphrodite. An opisthopodium-like appendage, previously reported only from anomalodesmatans, is present in male and hermaphroditic specimens and could be associated with the reproductive system.

**Phylogenetic analysis of Jamaican Pleurodontidae  
(Mollusca: Gastropoda)**

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Jamaica has approximately 30 endemic species of land snails in the family Pleurodontidae (formerly placed in Camaenidae). They are currently classified in the genera *Pleurodonte*, *Dentellaria*, *Thelidomus*, and *Eurycratera*. DNA sequences from cytochrome oxidase, 16S rRNA, and 28rRNA were obtained for 20 of these species, along with several other Caribbean pleurodontids, and outgroup species including Sagdidae, Hygromiidae, and Cochlicellidae. Phylogenetic analysis showed the Jamaican species to be monophyletic and the genus *Pleurodonte* to be polyphyletic. Jamaican species of *Pleurodonte* did not group with *Pleurodonte* (*sensu stricto*) from the Lesser Antilles, but with *Dentellaria* from Jamaica. These results suggest that a single colonization event with subsequent radiation might have established the Jamaican pleurodontid fauna.

**Diversification of ecologically similar species on Pacific islands**

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Many Pacific island terrestrial snail faunas are known for both species richness and morphological diversity reflecting obvious ecological differentiation. However, some radiations comprise species with little (apparent) ecological differentiation. Such radiations are widespread in nature. I use phylogenetic and biogeographical evidence (based on nuclear and mitochondrial DNA sequences) in combination with ecological data (*i.e.*, rock or leaf litter) and shell morphology (*i.e.*, heavily calcified and spined shells [rock dweller] or ribbed shells [leaf litter dweller]) to understand the evolution of diplommatinid land snails among the many islands of Belau in the western Pacific. I show that Belau diplommatinid land snails have diversified via the accumulation of ecologically similar species within two distinct habitats by repeated colonization across islands, rather than through *in situ* radiation on individual islands. Communities of diplommatinid snail species exhibiting subtle, yet potentially ecologically and therefore evolutionarily meaningful, morphological differences have built up on different islands through dispersal.

**Octopus habitat selection for nearshore kelp stands  
in Prince William Sound, Alaska**

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There remain several unknowns about the movement patterns of *Enteroctopus dofleini* specifically, and octopuses in general. First, do juvenile octopuses actively select habitats, or is local density largely determined by settlement processes? Second, on what scale do octopuses conduct their movements? That small-scale movements (< 100 m) regularly occur is well documented; the extent to which larger-scale movements occur is at best poorly described, especially for *E. dofleini* from the eastern Pacific (in the English-language literature). Third, what is the life history of octopus movements? Do juvenile octopuses alter movement patterns as they become larger and near sexual maturity? This paper presents data on relocation experiments of sonic-tagged giant Pacific octopuses (*E. dofleini*) to address part of the first question: do juvenile octopuses actively select habitats, and on what basis does selection occur? Octopuses were collected from varying depths from the intertidal to 100 m, outfitted with sonic transmitters using varying attachment schemes, and released either where captured (control for artifacts), in novel habitat at a similar depth to their capture location (control for depth), or in novel habitat at a different depth than their capture location (treatment). Released octopuses demonstrated a contrasting-depth preference: those released shallow moved deeper and vice versa. With some exceptions movements generally resulted in octopuses moving into habitats with greater percent cover of broad-leaf Laminariales kelp, indicating that octopuses select habitats based on risk-minimizing strategies.

**Sexual dimorphism in *Brachioteuthis beanii* (Cephalopoda: Brachioteuthidae) in the northwestern Atlantic**

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In the northwestern Atlantic, two different morphotypes of the squid genus *Brachioteuthis* have been reported. Morphotype 1 is characterized by having few chromatophores and clear cartilaginous ornamentation on the mantle; morphotype 2 has dense chromatophores and no ornamentation. Specimens collected from the Gully Marine Protected Area, a deep-sea canyon east of Nova Scotia, Canada, were used to assess whether these two forms are different species or an example of sexual dimorphism. Tissue samples were collected from both morphotypes for barcoding, and reproductive organs were identified and measured in over 50 individuals. No significant differences in CO1 sequences (n = 10) were found, indicating the brachioteuthids from the Gully are all the same species, likely *Brachioteuthis beanii*. In the individuals where reproductive organs could be identified, all of the morphotype 1 specimens were male, all of the morphotype 2 specimens were female. In cephalopods, sexual dimorphism is most commonly represented by hectocotylization of the ventral arms in males. Male/female differences in mantle ornamentation are unknown.

## **Speciation in the turritellid gastropods of New Zealand**

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Evolution in turritelline gastropods (family Turritellidae) over the past 100+ million years is characterized by abundant speciation and ubiquitous heterochrony. More than 1,500 fossil and Recent species have been described and their mode of growth preserves the entirety of their shells from larvae to death, allowing detailed comparison of heterochronic morphological changes within and between species to be made. The turritellines of New Zealand offer a particularly good laboratory for investigation of these themes, as they have an excellent and well known Cenozoic fossil record as well as being represented by modern species around the coast today. In the past, however, it has proved extremely difficult to construct phylogenies for turritelline gastropods using traditional approaches to character description and delimitation. Despite obvious differences in shell shape between species, the group has often been dismissed as being too character-poor to allow for any sort of phylogenetic analysis. However, newer methods incorporating geometric morphometric approaches to defining characters have shown promise in allowing taxa to be incorporated into phylogenetic analyses. Throughout their geological range, the New Zealand turritelline genus *Zeacolpus* appears to display periods of both anagenetic and cladogenetic change. At least one interval in which multiple new species appear occurs at a period of climatic change which could be implicated in the speciation event. Without a phylogeny in place, however, it has been difficult to draw conclusions about the mode of speciation within the lineage. The ability to describe the relationships of fossil species of turritellids using new techniques allows questions of speciation mode and heterochrony to be addressed.

**Biodiversity through the ages  
— molluscan paleoecology of Kansas**

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Twelve late Neogene and one modern molluscan faunas from the Meade Basin of southwestern Kansas were analyzed to examine historical biodiversity trends. Faunas were composed of freshwater and terrestrial taxa and dated from the early Pliocene (*ca.* 4.72 Ma) through the “present” (ADI959). Biodiversity trends were examined at two levels: alpha diversity was assessed as habitat type, species richness, dominance, and evenness; beta diversity was examined as species turnover. Tentative results displayed no clear biodiversity trends through time at both alpha and beta levels, as indicated by low squared correlation coefficient values for species richness ( $R^2 = 0.350$ ), dominance ( $R^2 = 0.071$ ), evenness ( $R^2 = 0.078$ ), and turnover ( $R^2 = 0.097$ ). These results did not suggest that a taxonomic modernization of the molluscan faunas occurred through the past five million years. The results did show variation in alpha and beta diversity among faunas suggestive of random fluctuation across time. The data suggested that the species composition of molluscan faunas was either randomly assembled (open communities), with the species in any fauna governed by chance dispersal events or determined by localized environmental (temperature, precipitation) factors.



***Abyssochrysos* revisited (Caenogastropoda: Abyssochrysidae)**

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The monotypic gastropod family Abyssochrysidae currently contains six described species worldwide, all of which have a turreted shell with dominating axial sculpture and a waxy, olive-green periostracum. All live in tropical regions in deep water, typically between 1,000 and 2,000 m, but can range from *ca.* 500 to *ca.* 3,000 m. Little is known about their ecology, but they are occasionally collected in association with taxa with seep affinities (*e.g.*, vesicomid clams) and some are known since the Mesozoic from inferred fossil-seep assemblages. Due to their deep water occurrence, they were poorly represented in collections, and the first anatomical investigation specifically targeting *Abyssochrysos* was based on rehydrated tissues from a single dried specimen. Additional anatomical information was provided when the Provannidae — a family primarily from vents and seeps — was erected. Based on sperm morphology, Abyssochrysidae was allocated to the Littorinoidea, and affinities suggested with the Provannidae. Paleontologists also highlighted a resemblance to the Paleozoic zygopleuroids, themselves tentatively allied to Ptenoglossa. New investigations have been carried out on material from recent expeditions specifically preserved for anatomical and molecular work. Features of the reproductive (aphallate, open pallial gonoducts), nervous (epiathroid with accessory pedal ganglia) and anterior alimentary systems (mid-esophageal gland) are confirmed to be similar to provannids, but many of these are likely plesiomorphies. However, newly revealed and highly distinctive aspects of the female glandular gonoduct (multiple seminal receptacles, posterior copulatory bursa, expanded renal oviduct) are virtually identical, suggesting a special affinity between the two families. The cuticularized buccal cavity and highly distinctive radula sets *Aybssochrysos* apart, as well as an unusual expanded midgut unknown in any other caenogastropod. These indicate a unique mode of nutrition but gut contents have been uninformative. Abyssochrysidae and Provannidae are thus confirmed to be closely related, but their broader affinities with Paleozoic zygopleuroids remain untested.

**William I. Utterback, of "Utterbackia fame": a short  
biographical sketch with emphasis on his life after malacology!**

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William Irvin Utterback (1872-1949) was born on October 11, 1872, on a farm near Crawfordsville, Indiana. In the fall of 1890, at the age of 18, he began a teaching career that would span 55 years. With a fresh BS degree from Wabash College (1901), Utterback moved to St. Joseph, Missouri, to teach high school biology in 1905. At the direction of the Bishop of the Presbyterian Church of Missouri, William moved his family to Arkansas and established (as the first President) the School of the Ozarks which later became The College of the Ozarks. The years 1908-1917 were spent as a high school instructor again in Missouri. Following his working during summers (1913-1914) with Dr. George Lafevre at the US Fisheries Lab at Freeport, Iowa, the University of Missouri granted him an AM degree. His most important publication came in 1916 when he published the "Naiades of Missouri." Other significant papers in malacology followed. After a stint as a high school biology teacher in Washington State, William finally got a college teaching position in 1919 at Marshall College in Huntington, West Virginia, a position he held until retirement in 1945. During his tenure at Marshall, he worked with noted herpetologists N. Bayard Green, Graham Netting, and Neal Richmond. He continued his research and publishing on mollusks for the early years, but became more and more involved with his work as instructor of biology and coordinator of the "Department of Pre-Medicine." In his later years, he became fascinated with the idea of making his ideas of the natural world blend with his fairly strict concept of the Biblical story of creation. Charles Darwin's work was still a hot-button issue in many circles and he tried to make the two mesh in his own mind. I will present several writings of his that indicate the conflict that he was bearing. Utterback retired in 1945 and lived with his daughter in California until his death in 1949. He is buried in Huntington, West Virginia.

**Latitudinal variation in Recent *Hemimactra* from the U.S. east coast: drilling predation, shell thickness, and proportional thickness of microstructural layers**

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The history of molluscan predation can be examined using the fossil record; evaluating spatial variation is more difficult due to limited fossil deposits. Modern communities offer an opportunity to explore geographic variation in predation and contemporary spatial patterns have implications for paleontological research. This work analyzes latitudinal differences in drilling frequency (DF), shell thickness, and proportional thickness of microstructural layers of *Hemimactra* (formerly *Spisula*) collected from beaches across four biogeographic provinces from Maine to Florida. Thickness, length, and DF were analyzed for 820 shells (10-80 mm in length) from a minimum of four localities and ~200 shells per province. DF peaked in the Carolinian Province (91%) and was lowest in the Gulf Province (4%), both differed significantly from all other provinces ( $p < 0.001$ ). These results are consistent with previous work by Kelley & Hansen (2007) documenting high DF in mid-latitudes and a lack of drilling in lower latitudes. Intermediate levels of drilling predation in the Nova Scotian (39%) and Virginian (35%) provinces did not differ significantly ( $p = 0.533$ ). Thickness was regressed on length for each province and compared among provinces at a mean length of 37.91 mm. Thickness at this standard length was greatest (0.65 mm) in the Nova Scotian Province and lowest (0.43 mm) in the Virginian Province. The more southerly provinces ranged between 0.56-0.57 mm. Thickness and DF did not show an inverse relationship as might be expected. Latitudinal variation was analyzed further at the microstructural level because shell layers differ in their resistance to drilling predation. Acetate peels were constructed for 60 shells (15 per province). Ontogenetic variation was assessed initially by grouping shells into size classes for each province; no pattern was noted. Although latitudinal differences were observed, variation in the preservation of shells between samples from different provinces could be influencing this pattern. Future work using live-collected *Hemimactra* should alleviate taphonomic concerns.

**Convergence in feeding structures and behavior  
in suspension-feeding snails**

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Organisms that suspension feed are frequently successful as invasive species in marine ecosystems, thus the mechanisms of suspension feeding are of great interest for understanding how these invaders spread. Suspension feeding is a comparatively rare feeding mode within aquatic gastropods, although it has evolved independently several times, most notably in the family Calyptraeidae, which includes the invasive species *Crepidula fornicata*. Molluscan gills have bands of cilia that drive water over the gas exchange surface and other cilia that remove particles that become entrained in the mucus covering the gills. The additional energetic cost of using this gill to suspension feed should therefore be minimal. Alterations that permitted gastropod gills to collect food as well as to exchange gases probably involved minor evolutionary modifications of pre-existing ciliated tracts and other structures in the mantle cavity. Therefore, that so few gastropods are suspension feeders is surprising. These snails should only need to divert mucus-entrained food to the mouth rather than to rejection tracts. As a member of the trochid family, *Lirularia succincta* is unusual in that it participates in suspension feeding as well as grazing. To examine suspension feeding in aquatic snails, we used histology, scanning electron microscopy, and video microscopy to compare the functional morphology of gills and other mantle cavity features of *L. succincta* with those of other trochids that do not suspension feed (*Margarites pupillus*, *Calliostoma ligatum*) and other more distantly-related suspension-feeding gastropods, including *C. fornicata*. Unlike its close relatives, individuals of *L. succincta* have gill filaments that are thin and elongated, closely resembling the gills of *C. fornicata*. In addition, the mantle of *L. succincta* has modified ciliary tracts and a specialized, flexible flange on the mantle edge that permits it to form and transport strands of mucus-laden food particles to the mouth in a manner very similar to that of calyptraeids.

**Evidence for strongly contrasting rates of diversification**

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The radiation of cerithioid gastropods in Lake Tanganyika is remarkable both for the morphological disparity among its members and for its species diversity. Eighteen endemic genera comprising a total of more than 70 species are found within this single lake. A notable feature of this diversity is the asymmetry with which it is distributed among genera. Several monotypic genera (*Limnotrochus*, *Stanleya*, *Stormsia*, and others) occur in stark contrast to the diversity of the most species-rich genus, *Lavigeria*, which at current count contains 50+ species. Here, we ask whether this apparent disparity in species richness among these clades is best explained by stochasticity, or by shifts in diversification rate within the radiation. Using a molecular phylogeny, species richness data, and recently developed likelihood-based methods, we show that a two-rate model strongly outperforms a diversification model with a single rate across the Tanganyikan radiation. Furthermore, we localize the increase in diversification rate to the base of the *Lavigeria* clade. This result leads to a key evolutionary question: why does *Lavigeria* contain so many more species than other Tanganyikan cerithioids, despite their shared distribution within Lake Tanganyika?

**Globetrotter ellobiid hitchhikes across the Atlantic –  
phylogeography of *Carychium minimum*  
(Pulmonata, Ellobioidea, Carychiidae)**

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The present-day distribution and genetic variability of species in temperate regions often have significantly been influenced by the effects of the Quaternary ice ages, *e.g.*, large ice sheets, surrounding permafrost, and lower global temperatures. Taxa with low dispersal ability and high humidity dependence are especially prone to these effects. Therefore, we investigated the distribution of a member of the Carychiidae, which is only one of few gastropod lineages to have independently migrated onto land. The minute Herald Thorn, *Carychium minimum* (O. F. Müller, 1774), is primarily a European species inhabiting riparian zones and other permanently moist, terrestrial environments. Besides its distribution on the European mainland, disjunct (trans-) Atlantic populations exist on the Azores and have been reported in North America namely, Ontario and Vancouver Island, Canada, and in the San Francisco Bay area. Phylogeographic analyses using the mtDNA-encoded cytochrome c oxidase subunit 1 gene (CO1) and a dataset of over 20 populations comprising more than 170 individuals reveal four separate phylogenetic units. Long-standing gene-flow barriers during the Quaternary period, such as different ice age refuges, can most likely explain such a pattern of genetically well-isolated haplogroups. Localities with a mixed population structure, *i.e.*, sampling sites possessing haplotypes of the different phylogenetic units, exist in western/southwestern Germany. The population of *C. minimum* on the Azores is most probably a result of passive dispersal showing almost no sequence divergence from one of the four European haplogroups.

**Mitochondrial phylogenomics and macroevolution  
of pulmonate gastropods**

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Transitions between aquatic and terrestrial habitats are a fascinating evolutionary issue for which pulmonate gastropods, being represented on land (Veronicellidae, Stylommatophora, etc.), in the sea (Onchidiidae, Amphibolidae, etc.), and in freshwater (*Hygrophila*), constitute a great model of study. However, due to a high level of homoplasy in morphological characters, availability of few molecular markers, as well as biased taxon sampling in molecular analyses, the higher relationships of pulmonates remain ambiguous, which prevents us from discussing their macroevolutionary history. To help resolve these relationships, we have sequenced the complete mitochondrial genomes of several species. Representatives from each of the higher pulmonate taxa were targeted and, as of May 2009, we were able to obtain eight complete genomes and three nearly complete genomes: one amphibolid (*Salinator ramphidia*), four ellobiids (*Pedipes pedipes*, *Ovatella vulcani*, *Myosotella myosotis*, and *Auriculinella bidentata*), one onchidiid (*Peronia peronii*), two stylommatophorans (*Succinea putris* and *Discus rotundatus*), one siphonariid (*Siphonaria gigas*), one trimusculid (*Trimusculus reticulatus*), and one veronicellid (*Veronicella cubensis*). (For comparison, only seven pulmonate mitochondrial genomes have been published so far.) Phylogenetic trees will be presented and their impact on our understanding of the macroevolutionary history of pulmonates will be discussed, especially the transitions between marine, freshwater, and terrestrial habitats.

**Ontogenetic examination of convergence between mangrove  
"oysters" (Isognomonidae: Bivalvia)**

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Species of flat, tree "oysters" within the genus *Isognomon*, *I. ephippium* (Linnaeus, 1758) and *I. alatus* (Gmelin, 1791), are not closely related and yet develop very similar adult shell morphologies. Species that separate them on the phylogenetic tree do not share their compressed, circular shape and the evolution of convergent shell morphologies is suspected. Previous analyses concentrated only on shells larger than 1 cm in length and only from these two species. This study has been expanded to include shape data from prodissoconchs from the two species in question and adult shell morphology from the majority of species within this genus. Scanning electron micrographs of prodissoconchs were taken from individuals whose adult shells were already imaged. This additional phase of analysis allows for direct comparison of early and late shell shapes and the isolation of those morphological variations that influence adult shell shape. The inclusion of additional species allows the morphological variance within this genus to be directly examined and for the hypothesis of morphological convergence to be tested in a statistically explicit manner.



**Phylogenetics of the non-achatinelline Achatinellidae:  
the other "handsomely colored" tree snails of Hawaii**

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The land snail family Achatinellidae contains five subfamilies: Achatinellinae, Auriculellinae, Pacificellinae, Tornatellinae, and Tornatellidinae. The Achatinellinae and Auriculellinae are Hawaiian endemics, whereas the other three have Pacific wide distributions. The Achatinellinae, which includes the endangered Oahu tree snails (*Achatinella* spp.), have been extensively studied in recent decades, but the remaining subfamilies have not been revised or studied substantially since 1960. These four subfamilies include more than 100 nominal species of small (1-10 mm), often inconspicuously colored snails, which have garnered far less attention than the more colorful achatinelline tree snails. As such, much of the taxonomy and systematics of these highly diverse subfamilies remains confused. Specimens representing these four remaining subfamilies were collected during an ongoing snail and slug survey of the main Hawaiian Islands. Partial sequences of mitochondrial cytochrome c oxidase subunit I were obtained from 305 individuals from 20 locations throughout the six main Hawaiian Islands. Preliminary analyses provide robust support for the monophyly of all subfamilies and clear resolution at the species level within each subfamily. All islands harbor more than one species and there are no single-island endemics. The wide distributions and the lack of isolation by distance pattern suggest high levels of dispersal among the Hawaiian Islands, contrasting with the Achatinellinae. Morphometric analysis and additional molecular markers are currently being developed and preliminary results indicate that these additional data will provide further resolution of the relationships among and within these four subfamilies.

**Introduction, spread and impacts of alien snails  
and slugs in Hawai'i**

**Norine W. Yeung<sup>1</sup>, Kenneth A. Hayes\*<sup>2</sup>, Chuong T. Tran<sup>1</sup>, Jaynee  
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The horticultural trade has been implicated as one of the most important vectors of snails and slugs globally, including in Hawai'i. During 2004-2006, we surveyed nurseries, botanical gardens, and other similar facilities on the six largest main Hawaiian Islands to document the snail and slug species present. In 2006, we began and are continuing to document snail and slug species in non-nursery habitats to determine which species are established outside nurseries. In the nurseries, we recorded 31 terrestrial species, of which all but two were alien and five had previously not been recorded in Hawai'i. There are now 38 established non-native terrestrial snail/slug species recorded in Hawai'i. Whereas many have been established for a long time, the non-nursery surveys indicate that some of the newer introductions are spreading quickly and becoming established. In most cases, it is not known if these aliens have actively replaced native species or occupied modified habitats from which native snails had already vanished. However, as they spread, especially to higher elevations still occupied by native snails, they could be impacting the native snail fauna, perhaps in some cases via competition for certain components of the litter. Predatory snails introduced for biocontrol purposes have impacted native snail species via predation. Alien slugs especially impact forest regeneration by killing native plant seedlings, perhaps thereby modifying native snail habitats. Hawai'i has more established alien terrestrial snail and slug species than any other Pacific island or archipelago and the rate of introduction shows no sign of declining.

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## Helpful Meeting Information

**Meeting venue:** Our presentations and meetings will be held at Snee Hall and adjoining Hollister Hall, part of the Engineering Quad, on College Avenue.

**Accommodations:** most meeting registrants are staying at either:  
Cascadilla Hall, near the intersection of Dryden Road and Eddy Street, just a short walk across Cascadilla Creek from Snee.  
Holiday Inn Ithaca, 222 South Cayuga Street, Ithaca, New York 14850, Tel. (607) 272-1000, Fax (607) 277-1275.

**Name tags** for registrants and guests will be provided with your registration packets. Please wear yours at all AMS functions, especially on campus.

### ATMs:

Holiday Inn: next door in the A-Plus gas station.

On Campus: at the Cornell Store, near Sage Chapel and Olin Hall (but Collegetown's are closer to the dorm and meeting).

Collegetown: inside the Student Agencies door between Rulloff's Restaurant and the Wilson Farms Express.

Downtown:

Bank of America, on the north side of The Commons, about halfway down. A 24-hour drive-up ATM is located right behind it on Seneca Street.

HSBC at the intersection of North Tioga St. and Buffalo St.

### Wireless Internet Access:

Cascadilla Hall: Sign on to "Red Rover Guest" from the second floor main lounge off of the lobby.

Collegetown: Starbucks has free lightlink access.

Snee Hall: Sign into "Red Rover Guest" in Snee Hall.

Holiday Inn: Guests of the Holiday Inn receive free wireless internet access.

### Transportation:

Driving directions and maps are in your registration packets.

Car Pooling (President's Reception, field trips): Many registrants are driving to Ithaca. In an effort to "go green" and keep costs down, we do not have mass transit to and from some of our off-campus events. Busses are few on Sunday especially. Please make friends and car pool, or check the Registration Desk for assistance.

Busses: Ithaca has an extensive and reliable form of public transportation called the TCAT (Tompkins Consolidated Area Transit). Cost is \$1.50 per ride - exact change is required. Maps and schedules are provided in your registration packet,

or visit TCAT on the web at [www.tcat.nextinsight.com](http://www.tcat.nextinsight.com) for routes that will be most useful to you. There are bus stops just down the street from Holiday Inn, and just down the street from Snee Hall.

- Cornell Campus to/from Downtown/Holiday Inn (hotel guests, Auction, banquet): Route 10 runs a continuous loop to the Commons, every 10 minutes from 7:30 am to 7:00 pm. After the auction, there are two 9 pm busses (Route 30 and Route 12) at the Green Street stop; Route 12 picks up again at 10:00, 11:00, 12:00 midnight, and 1:00 am.
- Downtown to/from PRI (Collections Use): Route 21 (Trumansburg) runs from The Commons to Trumansburg, every ½ hour in the morning, every hour in the afternoon, and every ½ hour in the evening (weekday schedule). Get out at the Cayuga Medical Center at the bus stop at the edge of the parking lot, and walk the short path through the woods to PRI.

Taxis: local and regional (including airports)

Ithaca Dispatch (University Taxi, Cayuga Taxi, Yellow Cab):  
(607) 277-TAXI or 277-CABS or 277-7777 or 272-3333  
or Toll Free (888) 321-1149.

On foot: The Holiday Inn and Collegetown are close enough to walk (less than one mile), but the hill is fairly steep. For those so inclined (pun intended), the most direct and shallowest routes will be outlined in the registration packet.

### **Parking:**

On Cornell Campus: In a word, impractical. The guest parking lot is located more than a mile away from Snee Hall, and the garage is both farther away and more expensive than the one in Collegetown. Parking on campus is all permit-restricted, especially during the day. The parking lot behind Snee is also permit-restricted at night. The campus police are *very* strict about ticketing, even during the summer. Park on campus at your own risk.

Collegetown: The Collegetown Parking Garage is accessible from Dryden Road, and charges a maximum of \$24/day. This garage is privately operated, but is located right in front of Cascadilla Hall. There is also metered street parking in Collegetown, free after 6 pm.

Downtown: Two large parking garages bracket The Commons downtown. They are free after 6 pm and on weekends. There is also metered street parking Downtown, also free after 6 pm.

At PRI: Three tiers of free parking! For overflow parking, please use the lot immediately south of us at the Finger Lakes Massage School.



## Restaurant Rundown

**Collegetown:** within a leisurely 7 min. walk from Snee or dormitory.

Asian:

A few Thai and Chinese restaurants uphill from College Ave. on Dryden Road (see map). All pretty tasty, all pretty inexpensive.

Japanese food/sushi at Miyake, Plum Tree, or Café Pacific. All nice, sit-down places with reasonably priced food. But watch out for highschoolers "sake bombing" at Miyake and Plum Tree.

[Dasan-J (Korean BBQ): not recommended.]

Mediterranean:

Sinbad's: really good Mediterranean food.

Aladdin's: nice, all-natural eatery with a variety of pasta, salads, and gyro dishes.

Souvlaki House: like a Mediterranean diner.

Pizza:

Collegetown Pizza, Mama T's, and Sinbad's all sell hot pizza by the slice and are open very, very late.

The Nine's: further down College Ave. and serves deep dish pizza, as well as regular thin crust in a bar/restaurant setting. Go for the live music! (Check the schedule on their website at [www.theninesithacany.com](http://www.theninesithacany.com)).

Misc:

College Town Bagels (CTB): tasty sandwiches and coffee, with outside dining. BEST BET FOR COMMITTEE MEETINGS!

Ruloff's: named after Ithaca's most famous (only?) serial killer. Restaurant by day and evening, bar by night. American with some Mexican and Cajun influences.

GreenMarket: New, and we've heard good things. Also with outside dining.

Stella's: A little fancier, with a great burger. Also a bar by night, with a nice selection of cocktails and scotch.

Subway ... is Subway.

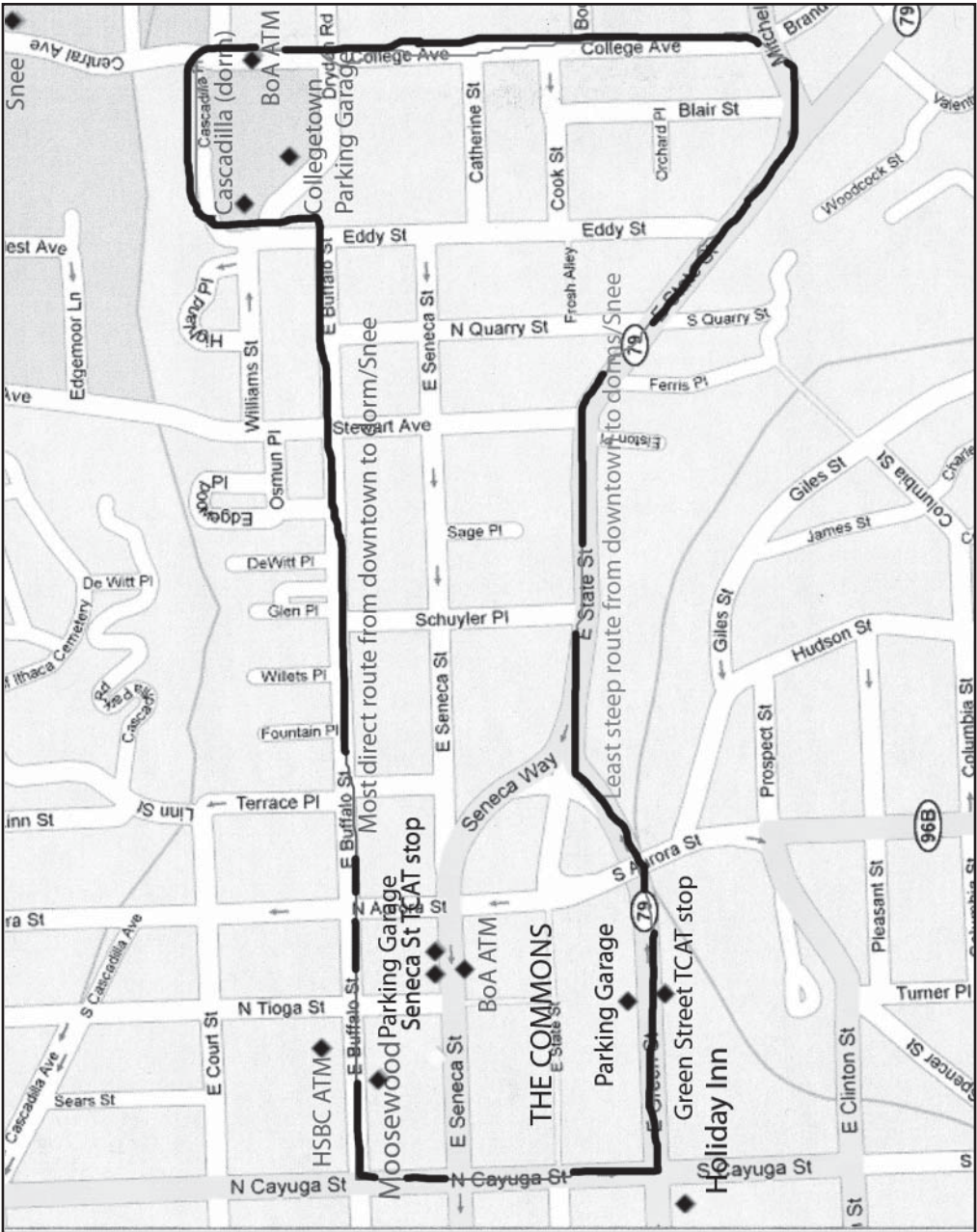
**Downtown:** within a leisurely 5 min. walk from the Holiday Inn.

Around the Commons, check out Ithaca Ale house (great beer and great food), Taste of Thai, Samurai Sushi, Madeline's (for something fancier), and another CTB (same menu as Collegetown). Diamond's (Indian food) and a pizzeria are right around the corner from the Holiday Inn.

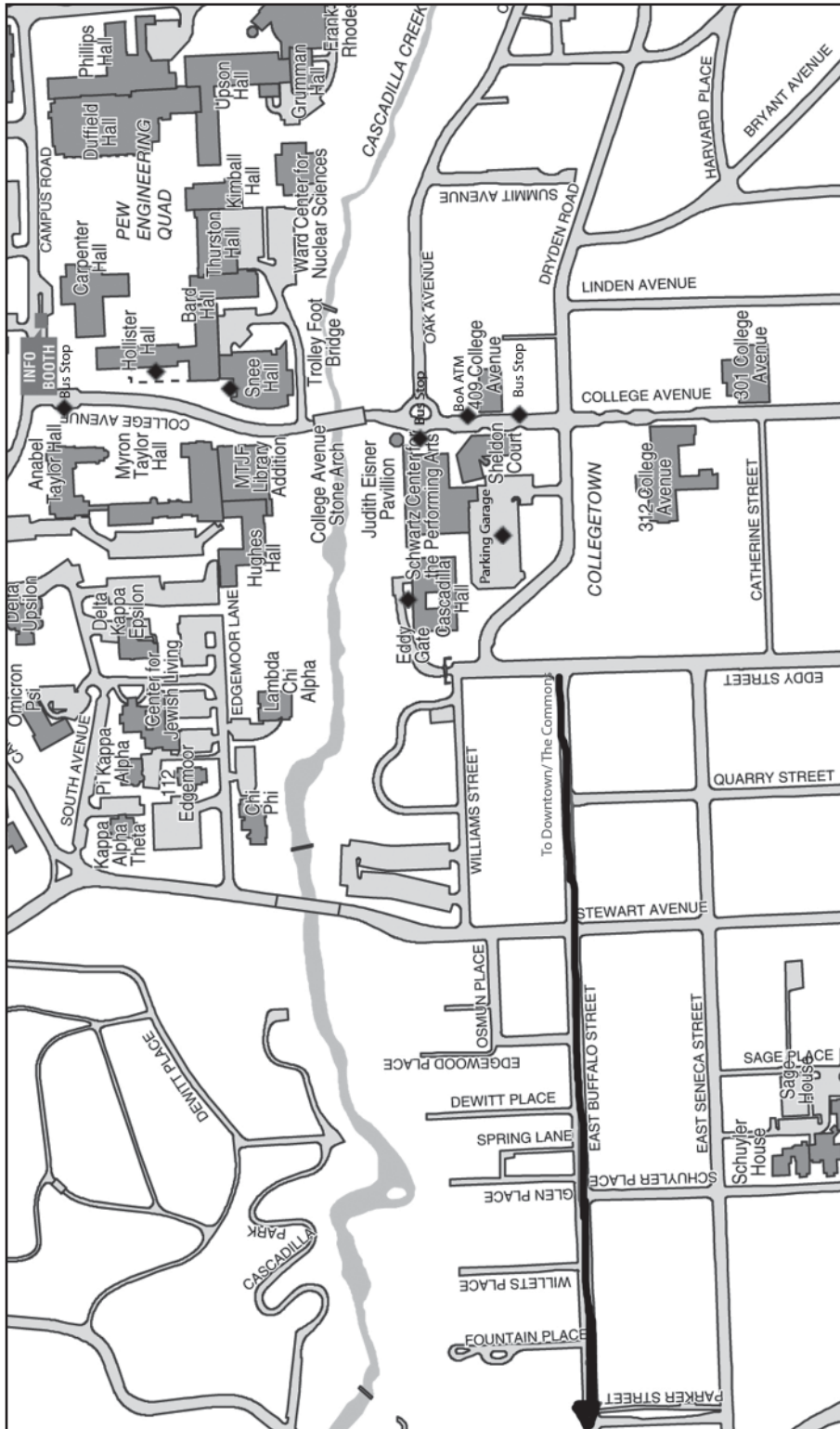
Moosewood Restaurant (215 N Cayuga St), world-famous vegetarian spot, is the venue for our banquet on Wednesday.

Venturing a bit farther, Maxie's Supper Club & Oyster Bar (arguably the best restaurant in Ithaca; 635 W State St) for Cajun-inspired food and oysters, or Joe's Restaurant (602 W Buffalo St) for Italian.

# CORNELL CAMPUS AND DOWNTOWN ITHACA



# CORNELL CAMPUS - MEETING VENUE



To Downtown and Holiday Inn

