American Malacological Society

65th Annual Meeting

Worthenia tabulata *Brian Jacobson*

Program and Abstracts

4-9 July 1999

Sheraton Station Square

Pittsburgh, Pennsylvania, U.S.A.

American Malacological Society

65th Annual Meeting

Program and Abstracts
4-9 July 1999
Pittsburgh, Pennsylvania, U.S.A.

AMERICAN MALACOLOGICAL SOCIETY
COUNCIL AND COMMITTEES, 1998 – 1999

VOTING MEMBERS (current term)

PRESIDENT
Robert S. Prezant (98-99)

PRESIDENT-ELECT
Terrence M. Gosliner (98-99)

VICE PRESIDENT
Janice Voltzow (98-99)

SECRETARY
Roland C. Anderson (97-02)

TREASURER
Eugene P. Keferl (96-00)

***BULLETIN* EDITOR**
Ronald B. Toll (94-99)

COUNCILLORS-AT-LARGE
Paula M. Mikkelsen (98-00)
Robert H. Cowie (98-00)
Diarmaid O Foighil (99-01)
Jose H. Leal (99-01)

IMMEDIATE PAST PRESIDENTS
Robert Hershler
Eugene Coan
Rüdiger Bieler

PAST PRESIDENTS (5-10 YEARS)
Carole Hickman
Robert C. Bullock

PAST PRESIDENTS (10+ YEARS)
James Nybakken
George M. Davis

NON-VOTING COUNCIL PARTICIPANTS

NEWSLETTER EDITOR
Donna D. Turgeon

NEWSLETTER ASSISTANT EDITOR
Dawn Hard

***BULLETIN* MANAGING EDITOR**
Timothy Pearce

HONORARY LIFE PRESIDENT
Ruth D. Turner 1997

HONORARY LIFE MEMBERS
Melbourne R. Carriker 1997
William K. Emerson 1987
Richard E. Petit 1997
Robert Robertson 1997
J.Z. Young 1990

1998-99 *AMS* COMMITTEES

NOMINATING
Rüdiger Bieler, Chair
Robert Hershler
Robert Bullock
Harold Murray
Jose Leal

SYSTEMATICS
Gary Rosenberg

AUDITING
Terry Gosliner, Chair
Robert Bullock
Janice Voltzow

PUBLICATIONS
Ronald B. Toll, Chair
Paula Mikkelsen
Roland Anderson
Debbie Wills
Eugene Keferl
Robert S. Prezant, *ex officio*

STUDENT AWARDS
Laura Adamkewicz, Chair
Roland Anderson
David Lindberg

ENDOWMENT & FINANCE
George M. Davis, Chair

AMS WEBSITE
Deborah Wills

MEMBERSHIP
John Wise, Chair
Heather Bennett

CONSERVATION
Robert Cowie, Chair
Kevin Cummings
Terry Frest
Matt James
E. Alison Kay
Chuck Lydeard
Barry Roth

CONSTITUTION & BY-LAWS
Harold Murray
Eugene Coan

AMS 1999 ORGANIZATIONAL ASSISTANCE

REGISTRATION COORDINATOR
Fei-Wen Cheng

AUCTION & ART
Richard Petit
Charles Sturm

NEW LOOKS SYMPOSIUM
Harold Rollins
Ellis Yochelson

MOLLUSCAN GENETICS
Laura Adamkewicz

MOLLUSCS AND EDUCATION
Patricia M. Morse

BIOMINERALIZATION
Joseph Carter

WOMEN/MALACOLOGY
Louise Russert-Kraemer
Constace Boone
Heather Bennett

1999 *AMS* T-SHIRT ART
Stuart Yellin

1999 *AMS* LOGO
Brian Jacobson

***AMS* HISTORY/CLENCH TAPES**
Harold Murray

FOSSIL FIELD TRIP
Albert Kollar

FRESHWATER TRIP
Art Bogan

CARNEGIE MUSEUM
John Rawlins
Charles Sturm

REGISTRATION
Anne Joffee
Mary Lou Pojeta

***AMS* CONSERVATION BROCHURE**
Chuck Lydeard

REGISTRATION DESK
Anne Joffee
Mary Lou Pojeta

GENERAL ASSISTANCE
Uma Narayan
Jennifer Prezant

STUDENT TRAVEL AWARDS
Bernice Barbour Foundation
Eve Lloyd Thompson

CURATION WORKSHOP
Charles Sturm

PAST PRESIDENTS

Henry A. Pislbry 1932
Paul Bartsch 1933
Junius Hendersen 1934
William C. Clench 1935
Calvin Goodrich 1936
Joshua L. Bailey, Jr. 1937
Carlos del a Torre 1938
Maxwell Smith 1939
H. B. Baker 1940
Harald A. Rehder 1941
Henry van der Schalie 1946-47
A. Myra Keen 1948
Elmer Berry 1949
Fritz Haas 1950
J. P. E. Morrison 1951
Jeanne Schwengel 1952
A. Byron Leonard 1953
Joceph C. Bequaert 1954
Morris K. Jacobson 1955
Allyn G. Smith 1956
Ruth D. Turner 1957
Aurele La Roque 1958
R. Tucker Abbott 1959
Katherine V. W. Palmer 1960
Thomas E. Pulley 1961
William K. Emerson 1962
Albert R. Meade 1963
John Q Burch 1965
Juan J. Parodiz 1965
Ralph W. Dexter 1966
Leo G. Hertlein 1967
Arthur H. Clarke 1968
Joseph Rosewater 1969
Alan Solem 1970
David H. Stansbery 1971
Arthur S. Merrill 1972
Dee S. Dundee 1973
Harold D. Murray 1974
Donald R. Moore 1975
Dorothea S. Franzen 1976
George M. Davis 1977
Carol B. Stein 1978
William E. Old, Jr. 1979
Clyder F. E. Roper 1980
Richard S. Houbrick 1981
Louise Russert-Kraemer 1982
Alan J. Kohn 1983
Robert Robertson 1984
Melbourne R. Carriker 1985
James Nybakken 1986
William G Lyons 1987
Richard E. Petit 1988
James H. McLean 1989
Rogert T. Hanlon 1990
Carole S. Hickman 1991
Robert C. Bullock 1992
Fred G. Thompson 1993
Constaance E. Boone 1994
E. Alison Kaye 1995
Rüdiger Bieler 1996
Eugene Coan 1997
Robert Hershler 1998

MEETING INFORMATION

Hotel Venue: All papers and posters, as well as Registration, *AMS* Student Reception, the President's and Symposium Reception, Coffee Breaks, Keynote Address and Wine and Cheese Reception, Auction, Book, T-shirt, and Art Sales, and the General Business Meeting, will all be held in the *Sheraton Station Square*. See below or the Schedule Matrix on a following page for the exact times, rooms and locations. Special announcements will be posted in the hotel lobby and on the scrolling monitors.

Registration: The registration desk is located in the inside hotel foyer, just outside the meeting rooms. Your registration packets will hold this program as well as your name tag (needed to get into sessions), banquet ticket(s), updated meeting information, and information about the Pittsburgh area.

Parking: For those of you with cars, valet parking is available with the hotel or merely park in the hotel parking lot or adjacent lot (less expensive). Ask at the front desk for details.

Coffee Breaks: Morning and afternoon session coffee breaks will be held adjacent to the registration desk.

Student Paper Awards: The *AMS* will again present awards for outstanding paper/poster presentation. Students participating in this are indicated with an asterisk in the program.

Station Square: This area of Pittsburgh is across the River from downtown but offers a full array of restaurants and bars, shops, and small entertainment centers, all within very short walking distance of the hotel. The Sheraton Station Square also offers restaurant, bar, a small shop, pool and exercise room. You can take a subway under the river to get downtown or ask the hotel about their shuttle service.

NON-SESSION EVENTS

Saturday 3 July 7:30-9:30pm

***AMS* Student Reception**: A reception for *AMS* students only will be held in the Coach Room. Students: don't eat dinner before this reception!

Sunday 4 July 11:50am

Annual *AMS* group photograph. Location to be announced.

Sunday 4 July 7:30pm

President's and Symposium Reception: This sumptuous repast will be held in the Fountainview Room. The balcony location offers an excellent view over the river of the July 4th Three Rivers Stadium Fireworks.

Monday 5 July 7:30pm

Keynote Address: Dr. Richard Lutz will offer the keynote address on "Deep-Sea Hydrothermal Vents: Exciting New Discoveries". This will be followed by a wine and cheese reception. Both will be held in the P & LE Room.

Monday 5 July – Wednesday 7 July

Book sales: Both Don Dan and Donald Hahn will display relevant books for sale or order.

Wednesday 7 July 7:30pm

Auction: Specially prepared art work, books, reprints, malacomusic and more!! The auction and special art exhibit and will take place in the Admiral Room. Early looks start at 7:30pm – auction proper will begin around 8:00pm.

Thursday 8 July, 3:15pm

General Business Meeting: Be sure to attend the annual business meeting of the *AMS* to be held in the Topeka/Santa Fe Room. Reminder, while the 65th meeting of our society, this will be the first official meeting of the *American Malacological SOCIETY*.

Thursday 8 July, 6:30pm

Banquet Cruise: The cruise liners are located behind the hotel. Please proceed to the ship no later than 6:30pm and be sure to get on the right ship (as indicated on your ticket).

Friday 9 July

Field Trips: Both fossil and freshwater field trip participants should meet in the hotel lobby at announced time in the morning for van pick-up. Information on pre-field trip meetings will be announced.

Carnegie Museum of Natural History Collection: Individuals who have arranged to visit the mollusc collection at the Carnegie should meet at the morning announced time in the hotel lobby. For those of you who have not signed up for this visit, the collection will be open to all. Those who wish to continue to use the collection on Saturday, please notify Charlie Sturm sometime during the meeting.

SPECIAL PRESENTATION SESSIONS AND WORKSHOPS

Sunday 4 July 8:45 – 5:30 The B&O Room.

New Looks at Old Molluscs Symposium: Recent Perspectives of Molluscan Evolution. Organized by Harold (Bud) Rollins and Ellis Yochelson, this symposium will concentrate upon class level controversies with the Mollusca.

Monday 5 July 1:30 – 5:00 The Topeka/Santa Fe Room.

Molluscs and Education: New Ideas from Museums to the Classroom. Organized by M. Patricia Morse, this session will examine the use of molluscs in current principles of science education, including K-12 and undergraduate education using interactive programs, Science as Inquiry, new resources for teaching, and molluscs as tools for engaging students.

Tuesday 6 July 8:30 – 12:00 The Topeka/Santa Fe Room.

Molluscan Genetics. Organized by Laura Adamkewicz, this session will focus on allozyme and population genetics of molluscs.

Tuesday 6 July 8:30-4:30 The Atchinson Room.

Posters. Authors will be present at their posters from 3:00-5:30 but posters can be viewed anytime during the day.

Tuesday 6 July 1:30 – 5:00 The B&O Room.

Biomineralization in Molluscs. A session on shell microstructure and biomineralization organized by Joseph Carter. The session will offer presentations on biochemistry and physiology of shell formation as well as importance of growth lines and shell microstructure in understanding molluscan biology. A separate workshop will be held on Wednesday.

Tuesday 6 July 4:45-5:45 The Topeka/Santa Fe Room.

Open meeting of the **Systematics and Collections Committee**.

Wednesday 7 July 9:00-3:30 The Topeka/Santa Fe Room.

Malacology Curation Workshop. Charles Sturm has organized a workshop for amateurs and interested professionals on the “how to” of curation, including looks at curation techniques, resources, and interactions of amateurs and professionals.

Wednesday 7 July 1:30-4:50 The B&O Room.

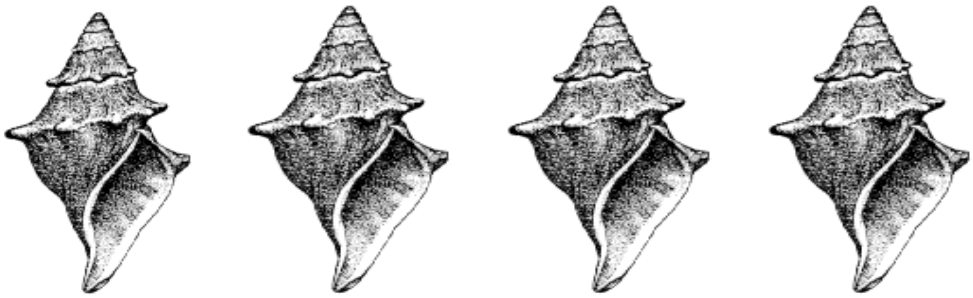
Biomineralization & Biomineralization Workshop. A continuation of the Biomineralization Session plus demonstration and discussion of specific techniques. Bring specimens, slides, peels and micrographs for exchange and discussion.

Thursday 8 July 9:00-12:00 The Topeka/Santa Fe Room.

Women in Malacology. Louise Kraemer, Connie Boone and Heather Bennett have put together an overview and roundtable session on contributions of women to Malacology, past and present. A panel discussion will be followed by open discussion, with an invitation to share points of view, reminiscence, reprints, pictures, etc. The hope is for a shared and growing database. ALL *AMS* attendees are invited to attend.

Thursday 8 July 1:30-3:00 The Topeka/Santa Fe Room.

History of AMS and the Clench Tapes. Organized by Harold Murray who will offer insight into our societal history along with the first release of his extensive taped interview with Bill Clench. Juan Jose Parodiz, President of *AMU* in 1965 will offer his interpretation of our early, and sometimes controversial history as well.



AMERICAN MALACOLOGICAL SOCIETY 1999
65TH ANNUAL MEETING

	Saturday 3 July	Sunday 4 July	Monday 5 July	Tuesday 6 July	Wednesday 7 July	Thursday 8 July	Friday 9 July
		Registration (8:30-12:00)					
a.m.		Opening Remarks (8:45)	Contributed I 9:00-12:00	Genetics (8:30-12:00)	Contributed III (9:00-12:00)	Contributed IV (9:00-12:00)	Field Trips (van pick-ups) 8:30
		New Looks Symposium I (9:00-11:50)			Curation Workshop I (9:00-12:00)	Women In Malacology Round Table (9:00-12:00)	Carnegie Collection 8:30
		AMS Group Photo 11:50-12:00		Posters (9:00-12:00)			
p.m.	Council Meeting (2:30-5:30)	Registration (1:30-5:30)	Contributed II (2:00-5:00)	Biomineralization I (1:30-4:40)	Biomineralization II & Workshop (1:30-4:50)		
	registration (2:00-7:30)	New Looks Symposium II (2:00-5:30)	Molluscs & Education (1:30-5:00)	Posters (1:30-5:30) Authors present: (3:00-5:30)	Curation Workshop II (1:30-3:30)	Clench Tapes & History of AMU/AMS (1:30-3:00)	
						General Business Meeting (3:15-4:30) Open	
		Books Sales	Posters (set up)	Book Sales			
				Open Session (4:45-5:45) Systematics			
	Council Meeting (as needed) (7:30-9:00) Student Reception (7:30-9:30)	President's and Symposium Reception (7:30-10:30)	Keynote & Wine & Cheese Reception (7:30-9:30)		Art Display & Auction Art & Book Sales (7:30 -10:30)	Banquet Cruise (6:30-10:00)	

SUNDAY 4 JULY 1999

8:45-9:00 Opening Remarks: R. S. Prezant
Welcome: J. J. Parodiz

NEW LOOKS AT OLD MOLLUSKS SYMPOSIUM I

B&O Room
Harold Rollins & Ellis Yochelson, Conveners
Audio/Visual Aides: Leslie Brooker & Daniel Geiger

9:00-9:10 Symposium Introduction. E. Yochelson

9:10-9:30 The bellerophont controversy revisited. H. B. Rollins and J. A. Harper

9:30-9:50 Multiple lines of evidence supporting the existence of Paragastropoda. K. Bandel

9:50-10:10 A higher-order phylogeny of Gastropoda. P. J. Morris

10:10-10:30 On the achieving of limpetdom in the history of gastropod molluscs: the ultimate high or low. D. Lindberg

10:30-10:50 Break

10:50-11:10 Is the Aplacophora monophyletic? A cladistic point of view. G. Haszprunar

11:10-11:30 Why the Middle Cambrian *Wiwaxia* may be ancestral to the Mollusca. A. H. Scheltema and C. Schander

11:30-11:50 Problems in constructing a phylogeny for Paleozoic polyplacophorans. R.E. Hoare

11:50-12:00 ***AMS* ANNUAL GROUP PHOTOGRAPH**

12:00-2:00 Break

NEW LOOKS AT OLD MOLLUSKS SYMPOSIUM II

Harold Rollins and Ellis Yochelson, Conveners
Audio/Visual Aides: Leslie Brooker & Daniel Geiger

2:00-2:20 Cambrian and Ordovician diasome mollusks. J. Pojeta, Jr.

2:20-2:40 Some aspects of the diversification of the Bivalvia from the Ordovician to the Devonian. C. Babin

2:40-3:00 DNA evidence on the evolution of the Bivalvia. D.C. Campbell*

3:00-3:20 Break

3:20-3:40 Reconstruction of ancestral character states for coleoid cephalopods. M. Vecchione, R.E. Young and D. Carlini

3:40-4:00 Re-examination of the history of living and fossil nautilid cephalopods. W. B. Saunders and P.D. Ward

4:00-4:20 Through the mud darkly, a neontologist looks at scaphopod evolution. R. L. Shimek

4:20-4:40 Monoplacophoran evolution in the Cambrian. J.S. Peel and A. Gubanov

4:40-5:00 The issue of extinct classes of Mollusca: or what is and what isn't a class of mollusks. E. L. Yochelson

5:00-5:30 Symposium Summary and Discussion

MONDAY MORNING

CONTRIBUTED SESSION I

B&O Room

Ronald Toll, Convener

Audio/Visual Aide: Heather Bennett

9:00-9:20 Mollusc-sediment relationships at Assateague Island National Seashore, Maryland. Fei-Wen Cheng*

9:20-9:40 Gastropods as prey of octopuses of the deep-sea genus *Graneledone*. J. R. Voight

9:40-10:00 Feeding ecology of the bivalve *Rangia cuneata* (Sowerby, 1831): incurrent siphoning in and above the benthic-boundary layer. C. M. Cleveland*

10:00-10:20 Feeding preferences of invasive and native turban snail predators. S. Lonhart*

10:20-10:40 Break

10:40-11:00 Age and size of *Mercenaria mercenaria* in a South Carolina tidal creek. A. G. Eversole

11:00-11:20 Four year trend in the molluscan community of Hillsborough Bay, Florida. D. J. Karlen

11:20-11:40 Molluscan diversity and sediment toxicity in Biscayne Bay, Florida. D. D. Turgeon

11:40-12:00 Allometric shell growth, sexual dimorphism and canonical discriminate analysis of the Asian viviparids. Yuh-Wen Chiu, Hon-Chen Chen, Sin-Che Lee and C. A. Chen

MONDAY AFTERNOON

CONTRIBUTED SESSION II
B&O Room
Donna D. Turgeon Convener
Audio/Visual Aides: Sarah Watson

2:00-2:20 Plio-Pleistocene faunal patterns in the western Atlantic: I. Bivalvia. M. Cambell

2:20-2:40 Predation on bellerophontiform molluscs with special reference to shell morphology. A. Lindström, J. O. R. Ebbestad and J. S. Peel

2:40-3:00 *Cochlespira* (Turridae, Gastropoda) in the Cenozoic of the Southeastern United States. M. Campbell, S. Campbell, L. Campbell and D. Campbell

3:00-3:20 A comparison of living and dead molluscs on coral reef associated hard substrata in the northern Red Sea. M. Zuschin, J. Hohenegger and F. F. Steininger

3:20-3:40 Break

3:40-4:00 Do juvenile unionids like sand? A unionid translocation and follow-up at a site with a moderate *Dreissena polymorpha* (Pallas 1771) infestation, Mississippi River Mile 725.8, T.H. 43 bridge, Winona, Minnesota/Wisconsin, U.S.A. M. E. Havlik

4:00-4:20 Distributional differences in the freshwater pulmonate snails *Physa gyrina* and *Physa heterostropha*: competitive exclusion or habitat choice? A. R. Wethington*

4:20-4:40 The habitat and distribution of Thiara granifera in Kuan-Du wetland, northern Taiwan. Nan-Hsiung Wang, Yuh-Wen Chiu, Da-Ji Huang, M. D. Barnes and Liang-Hsien Chen

4:40-5:00 Progress on the taxonomic manual: Shell-bearing Gastropoda of the

Northeastern Pacific. J. H. McLean

MOLLUSCS & EDUCATION: NEW IDEAS
Topeka/Santa Fe Room
M. Patricia Morse, Convener
1:30-5:00pm

A panel of molluscan science educators will present short scenarios and projects that are based on the following principles:

- Effective science education includes interactive, hands-on activities that mirrors the way scientists do science
- Talks and activities presented will reflect the National Science Education Standards (URL) that call for all students to understand Science as Inquiry and recognize that students actively asking questions, constructing their own testable hypotheses, gathering and analyzing data, and communicating the results among peers leads to student learning
- Databases, up-to-date research tools, new ideas that work, new resources for information and an understanding of what teaching inquiry means helps teachers to be more effective in their classrooms
- Molluscs offer a terrific subject to engage students and the larger public, and serve as a basis to connect students with new ways of learning about the biology of the molluscan organisms and the environments in which they live
- New tools, such as computers, databases, research tools, new forms of software for data analysis and telecommunications allow new classroom activities

TUESDAY MORNING

GENETICS
Topeka/Santa Fe Room
Laura Adamkewicz, Convener
Audio/Visual Aides: Renee Avery

9:00-9:20 Molecular phylgeography of the eastern Pacific and Caribbean Patellogastropoda. W. B. Simison

9:20-9:40 Molluscan aquaculture genetics and molecular breeding: Mapping the way? P. Gaffney

9:40-10:00 Origin of polyploidization in the North American Sphaeriidae (Mollusca: Bivalvia). T. Lee

10:00-10:20 Conservation genetic study of the freshwater mussel, *Cumberlandia monodonta*. Hsiu-Ping Liu

10:20-10:40 Break

10:40-11:00 Clonal persistence in *Lasaea* – inferences from single-copy nuclear gene trees. D. O'Foighil

11:00-11:20 The molecular phylogeny of Bivalvia is highly dependent on the alignment of Helix E-10. S. L. Adamkewicz

11:20-11:40 Speciation, gene flow and hybridization of hydrothermal vent endemic mussels from the mid-Atlantic ridge. G. O'Mullan

11:40-12:00 Wood, whales and hydrothermal vents: unexpected connections among little known mussels of the deep. D. L. Distel

TUESDAY AFTERNOON

BIOMINERALIZATION SESSION I

B&O Room
Joseph Carter, Convener
Audio/Visual Aide: Daniel Geiger

1:30-1:40 Greeting. J. G. Carter

1:40-2:00 Biomineralization in the radula teeth of the chiton genus *Acanthopleura* (Mollusca: Polyplacophora) and its significance to systematics within the group. L. Brooker*

2:00-2:20 Gastropod larval shell mineralization. C. S. Hickman

2:20-2:40 Conellate biomineralization in belemnoid rostra. A. Seilacher and J. S. Pignatti

2:40-3:00 The composition of the mollusc shell as a proxy for molluscan physiology. G. D. Rosenberg

3:00-3:20 Discussion and break

3:20-3:40 Organic matrix preparations as tools for understanding stress-related variations in bivalve shells. G. R. Clark II

3:40-4:00 Climatic variations recorded in the shell of the freshwater pearl mussel *Margaritifera margaritifera*. E. Dunca.

4:00-4:20 Influence of thermal environment on shell microstructure. R. S. Prezant, A. Tan and E. Chapman

4:20-4:40 Constructional morphology of microscopic features in bivalve shells. T. Ubukata

4:40-5:00 How shells are formed, and how they are not. C. Hedegaard

POSTERS

1:30-5:30 [Authors Present 3:00-5:30]
Atchinson Room

1. Climatic variations recorded in the shell of the freshwater pear mussel *Margaritifera margaritifera* (L.). U. Nordlund. E. Dunca, J. Sorelius and H. Mutvei.

2. Evaluation of the geochemical and physical properties of molluscan material used for AAR analysis. K. L. Davis, J. F. Wehmiller, T. H. O'Donnell and S. A. Macko.

3. Allochthonous shell concentrations in a thyasirid facies from the early Middle Miocene (Badenium) of Austria. M. Harzhauser, O. Mandic, M. Zuschin, P. Pervesler and R. Roetzel.

4. Gastropod torsion – new data on an old problem in malacology. A. Wanninger, B. Ruthensteiner, B. Josffe and G. Haszprunar.

5. The early evolution of the Cirroidea (Gastropoda) still remains mysterious. Jiri Fryda, R. B. Blodgett and A. C. Lenz.

6. *Progoscutula* – oldest caenogastropod limpet. J. Fryda.

7. Suggestions for polyphyletism of Paleozoic bellerophontiform molluscs inferred from their protoconch morphology. J. Fryda.

8. Taxonomic revision and zoogeography of Magellanic Nudibranchia (Gastropoda: Opisthobranchia). M. Schrödl.

9. Rediscovery of *Phyllidiopsis sinaiensis* (Nudibranchia: Doridoidea) with a brief review of the Red Sea Phyllidiidae. A. Fahrner and M. Schrödl.

10. Microstructure of the periostracum of *Solemya velum* (Bivalvia: Cryptodonta). H. Bennett.*

11. Comparison of aesthete canal morphology in several chiton species. C. Fernandez, M. Vendrasco and B. Runnegar.

12. Not just another dingy dee-sea limpet: a new *Copulabyssia* (Gastropoda: "Cocculiniformia": Pseudococculinidae) from off eastern Brazil. J. Leal and L. R. Lopes de Simone.

13. Anatomy of *Seguenzia mirabilis* Okutani with phylogenetic reevaluation of Seguenziidae (Vetigastropoda: Seguenzioidea). T. Sasaki, E. Tsuchida and T. Okutani.

14. Rare legacy: freshwater mollusks from the Charles M. Wheatley collection at the Milwaukee Public Museum. J. Jass and J. Glenn.

15. Phylogeny of *Lyratoherpia* (Ampineura, Dondersiidae) and problems concerning types. C. Schander and A. H. Scheltema.

16. Effects of latitude and zonation on shell parameters in the limpet, *Tectura testudinalis*. E. Chapman*

WENESDAY MORNING

CONTRIBUTED SESSION III

B&O Room
Marian Havlik, Convener
Audio/Visual Aide: Steve Lonhart

9:00-9:20 Effects of a digenetic trematode parasite on feeding and physiology of the snail *Elimia flava* (Lea). K. K. Lenertz*

9:20-9:40 Morphology and metabolism of the enigmatic *Xenoturbella* (Bivalvia, Protobranchia; formerly phylum unknown). O. Israelsson*

9:40-10:00 Radula and shell morphometry of Thai micro-snails. S. Panha and P. Tongkerd

10:00-10:20 Crossed-lamellar structure and its connection to shell strength in *Nucella lapillus*. R. Avery*

10:20-10:40 Break

10:40-11:00 Tapping the unexplored: midgut morphology of cerithioidean gastropods (Caenogastropoda) – Preliminary results and implications for homology and phylogeny. E. E. Strong and M. Glaubrecht

11:00-11:20 Development of the reproductive system in *Nassarius vibex* (Neogastropoda: Buccinidae: Nassariinae). M. J. deMaintenon

11:20-11:40 What do squid signal with a Zebra display? I. The formal challenge. J. Mather

CURATION WORKSHOP I

Topeka/Santa Fe Room
Charles F. Sturm, Jr., Convener
Audio/Visual Aide: Renee Avery

9:00-9:15 Introduction to Session. C. S. Sturm, Jr.

9:15-9:45 Archival and curatorial practices for the amateur malacologist. C. S. Sturm

945-10:45 Database design for mollusk collections. G. Rosenberg

10:45-11:00 Break

11:00-11:30 Donating amateur collections to museums. T. A. Pearce

11:30-12:00 Non-professional assistance in scientific collections: prospects and payoffs. J. H. Leal

WEDNESDAY AFTERNOON

BIOMINERALIZATION II

B&O Room
Joseph Carter, Convener
Audio/Visual Aide: Kristin Lenertz

1:30-1:40 Greeting, J. Carter

1:40-2:00 Shell microstructure analysis of eight vesicomyid clams: evolutionary implications. M. Tieger

2:00-2:20 Structure and growth of the ventral hinge system of *Pandora wardiana* A. Adams, 1859. A. M. Bush*

2:20-2:40 Phylogenetic significance of cardioidean shell microstructure. J. A. Schneider and J.G. Carter

2:40-3:00 Evolutionary trends in bivalve shell and ligament microstructure. J. G. Carter

3:00-3:20 Break

BIOMINERALIZATION WORKSHOP

B&O Room
3:20-4:50

3:20-3:30 Introduction. J. G. Carter

3:30-4:50 Displays, demonstrations, discussions, drinks

Microscopes, petrographic & biological, will be provided.
Microstructure reference sets and glossaries will be distributed.
All attendees are invited to bring specimens, slides, acetate peels,
And photographs for exchange and/or discussion.

CURATION WORKSHOP II

Topeka/Santa Fe Room
Charles S. Sturm, Jr., Convener
Audio/Visual Aide: Ellen Strong

1:30-2:00 Collecting, identifying, and curating freshwater mollusks. K. S. Cummings

2:00-2:30 The molluscan literature: its usage and limitations. R. E. Petit

2:30-3:15 Panel Discussion

THURSDAY MORNING

WOMEN IN MALACOLOGY

Topeka/Santa Fe Room
Louise Kraemer, Convener

9:00- 12:00 Overviews from Louise Kraemer, Constance Boone and Heather Bennett followed by round-table/panel discussion.

CONTRIBUTED SESSION IV

B&O Room
Jennifer Mather, Convener
Audio/Visual Aide: Carol Cleveland

9:00-9:20 Experimentation in the early chitons and the building of a body plan. M. Vendrasco and B. Runnegar

9:20-9:40 Muteloidea Schmuteloidea: a re-evaluation of the relationships of the Hyriidae (Bivalvia: Unionoida). D. L. Graf*

9:40-10:00 Phylogenetic relationships of the introduced freshwater clam *Corbicula*. S. Siripattrawan

10:00-10:20 Molecular systematics, hidden diversity, and forgotten species: a case study of the genus *Potamilus* Rafinesque 1818. J. M. Serb, K. J. Roe and C. Lydeard

10:20-10:40 Break

10:40-11:00 Phylogenetic utility of mitochondrial gene order in gastropods. W. E. Holznagel and C. Lydeard

11:00-11:20 A phylogenetic overview of *Tryonia* springsnails: molecular and morphological perspectives. R. Hershler, Hsiu-Ping Liu and M. Mulvey

11:20-11:40 An insight into the biogeography, speciation, and evolution of some of the freshwater snail *Elimia* species within the southeastern U.S. river drainages [Pleuroceridae: Gastropoda]. E. L. Mihalcik

11:40-12:00 *Puperita tristis* (D'Orbrigny, 1842) is an ecotype of *Puperita pupa* (Linnaeus, 1767). R. Minton and R. Gundersen

THURSDAY AFTERNOON

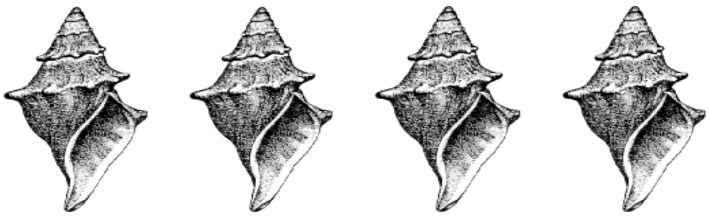
HISTORY AMU/AMS-CLENCH TAPES

Topeka/Santa Fe Room
Harold Murray, Convener
Audio/Visual Aide: Steve Lonhart

1:30-2:00 Reminiscences on Malacology in the Twentieth Century. J. J. Parodiz

2:00-3:00 William J. Clench on tape. H. D. Murray

3:15-4:30 *AMS* General Membership Open Business Meeting



The molecular phylogeny of Bivalvia is highly dependent on the alignment of Helix E-10

Laura Adamkewicz [ladamkew@gmu.edu]
Department of Biology, George Mason University, Fairfax, Virginia 22030

Earlier molecular phylogenies of the bivalve mollusks based on sequences of the 18S rDNA gene have usually not recovered bivalves as a clade separate from the gastropods nor recovered all the subclasses of bivalves as separate clades. Taxon-specific effects have been identified as an important cause, but the inclusion of 55 species of bivalves is sufficient to eliminate most distortions from this source. Alignment in regions of variable length and uncertain homology, the most important of which is Helix E-10, between bases 204 and 258 of *Placopecten*, also has a profound effect on the phylogeny. This region is particularly variable in the Heterodonta and Anomalodesmata, which appear to be sister groups. Total length in these two subclasses ranges from 52 to 112 bases. Non-homologous inserts appear to cause some of this variation, particularly in the Mactroidea. With optimal alignment of three variable regions, gastropods do form a separate clade that is a sister group of the bivalves, but within Bivalvia, not all subclasses are monophyletic. Because excluding these regions from consideration has an effect as large as any from alterations in alignment, efforts to improve the data matrix should continue.

Crossed lamellar structure and its connection to shell strength in *Nucelia lapillus*

Renee Avery [ravery@hopper.unh.edu]
Biology Department, University of Massachusetts Boston, Boston, Massachusetts 02128

Shell morphological variation among conspecific intertidal gastropods has been widely recorded. Specific types of molluscan microstructure have been suggested to correlate with certain behaviors and environments. Yet, how microstructure varies between conspecific morphs that live under different environmental pressures and exhibit different behaviors has not been examined. The dogwhelk *Nucella lapillus* (Gastropoda: Murucidae) exhibits a thick- and thin-shell morph along shores differentially exposed to wave action. The shell of *N. lapillus* has two types of microstructure. The inner shell layer is crossed lamellar structure, a relatively strong and energetically expensive material. The outer layer is homogeneous structure, a weaker and cheaper material.

N. lapillus was collected from three wave-exposed and three wave-protected sites along the rocky New England coast. Thick-shell morphs average 1103 μm in thickness of which 7% is crossed lamellar structure and requires 288 N of force for shell failure. Conversely thin-shell morphs average 666 μm in thickness of which 16% is crossed lamellar structure and requires a 106 N force. Snails living on wave-protected shores are under extreme predation pressure and require the ability to grow quickly and to produce strong shells in order to survive predatorial crab attacks. Since crossed lamellar structure is costly to produce and may hinder quick growih, increasing the thickness of the shell with homogeneous microstructure may be more economical.

Some aspects of the diversification of the Bivalvia from the Ordovician to the Devonian

Claude Babin [gayet@univ-lyon1.fr]
UFR Sciences de la Terre, Université Claude Bernard - Lyon 1, 27-43 boulevard du 11 novembre 1918, 69622 Villeurbanne cedex, France

Studies of the Paleozoic Bivalvia have accelerated in the last three decades and we have numerous new data dealing with the diversification of this class of mollusks. After the extreme scarcity of the Cambrian data, the abruptness of the diversity of the bivalve faunas in the fossil record during the Early Ordovician is an outstanding event. It is also noteworthy that both this first explosion and the succeeding diversification during the Middle Ordovician were located primarily on the Gondwanan and Avalonian shelves in shallow clastic facies. By contrast, from the Late Ordovician, Baltica and Laurentia were more propitious for the

further diversifications of bivalves, notably epibenthic ones. Thus before the close of the Period, all the subclasses of bivalves were established and the Class was dispersed throughout the world oceans. After the uppermost Ordovician extinctions, an important replacement at familial and generic levels occurred during the Silurian. The Pteriomorphia, many of them adapted to an epibyssate mode of life, underwent an explosive evolution, particularly during the Ludlow, while many free-burrowing suspension-feeding genera were adapted to the broad expanses of soft muds. During the Devonian, bivalves continued their diversification at both familial and generic levels, and for the first time, some of them colonized fresh-water. The continuing paleogeographic chances favored faunal exchanges, for example between Appalachian and western European areas, and led to the establishment of cosmopolitan faunas.

Multiple lines of evidence supporting the existence of Paragastropoda

Klaus Bandel [bandel@geowiss.uni-hamburg.de]
Geological-Paleontological Institute, Universität Hamburg, D-20146 Hamburg, Germany

In fossil gastropods only the shell can be consulted for information, and anatomical details are lost. Even the imprints of the muscles on the inner shell surface provide few useful data regarding phylogenetic position, but more regarding behaviour connected to substrate preference of the animal in question. Teleoconch morphology has been extensively used to include those up to 500 million years old gastropods in the phylogenetic system that can safely be recognized to belong to the class. It has become apparent that the only way to avoid misinterpretation due to the many convergences in this shell is by analysis of the early ontogenetic shell, and here especially in such cases where it has been formed with little yolk consumption. According to the protoconch morphology four subclasses can be differentiated among modern gastropods, Archaeogastropoda, Neritimorpha, Caenogastropoda, and Heterostropha. Thus, these units can be recognized in fossil material. They agree with systematic units that are in use and frequent change in the classification of living gastropods when only a few adaptions are supplied. All classification schemes based on the construction of the nervous system, the features of the pallial cavity, the morphology and construction of the radula, composition of the DNA, cleavage patterns, or sperm morphology are in accordance with this classification that is based on shell morphology. From this it can be deduced that some units of the gastropods have become extinct, such as the Amphigastropoda (bellerophontids), the Euomphalomorpha, and the Mimospirida. If we accept torsion of the soft body and, thus, the place of the pallial cavity over or next to the head as the autapomorphy of the class Gastropoda, Amphigastropoda, either have no reflection of body torsion in their shell or are not Gastropoda. Their gastropod nature assumed they had during their ontogeny a planktotrophic larval stage, and they produced a coiled shell. They may have twisted their body at 180° after metamorphosis when taking up benthic life. Other gastropods with veliger shells like the Cyrtoneritimorpha and Peruneloidea that lived predominantly during Ordovician to Devonian time had an openly coiled larval shell that was usually succeeded by a trochospiral teleoconch. They probably represent the stem groups of the Caenogastropoda, Cycloneritimorpha, and Heterostropha which appeared during Devonian time. Archaeogastropoda may have developed from the ancestal Late Cambrian stock with planktotrophic larvae by telescoping early ontogeny and mechanically deforming the embryonic shell before mineralization. Due to this they may have lost the potential of forming a larval shell, but gained the ability to tort the shell during early embryogenesis. Within the Archaeogastropoda the most primitive anatomy has been preserved in the Docoglossa, even though their teleoconch is specialized to limpet shape.

Microstructure of the periostracum of *Solemya velum* (Bivalvia: Cryptodonta)

Heather Bennett [WaHeather@aol.com]
Department of Biological Sciences, University of Rhode Island, Kingston, Rhode Island 02881

The periostracum of the bivalve genus *Solemya* is notable since it considerably overhangs the calcified margins of the shell. This extension is quite flexible and is folded toward the mantle margin during

burrowing. This ability to fold the periostracum inward is correlated with the deep-burrowing habits of these bivalves. Using histochemical techniques, Beedham and Owen (1965) found that the periostracum of *Solemya parkinsonii* is composed of four chemically distinct lavers. I used scanning electron microscopy to examine the periostracum of the common Atlantic awning clam *Solemya velum* to determine whether these periostracal layers are also structurally distinct. The results show four discrete layers, each with a different microstructure. I propose functions for each of the layers, and offer suggestions for future research on the microstructure of the bivalve periostracum.

Biomineralization in the radula teeth of the chiton genus *Acanthopleura* (Mollusca: Polyplacophora) and its significance to systematics within this group

Lesley Brooker [lbrooker@central.murdoch.edu.au]
Division of Science and Engineering, School of Biology and Biotechnology, Murdoch University, Murdoch, Western Australia 6150

Chitons obtain their food by rasping the rocks on which they live and extracting the embedded microorganisms. As such they possess teeth that are harder than the substrate, and the possession of a radula hardened by the incorporation of various iron and calcium biominerals is ubiquitous to this class.

The genus *Acanthopleura* currently consists of 15 species (Ferreira 1986) all of which possess discoid, unicuspid major lateral teeth, that exhibit limited interspecific variation. The mechanisms of biomineralization in these teeth have been elucidated with the aid of the Scanning Electron Microscope and Energy Dispersive Spectroscopy. This has enabled the determination of elemental percentages along the length of the radulae and thus the sequence of deposition of the iron, phosphorous and calcium that are the primary elements found in the major lateral teeth of *Acanthopleura*. These elements occur in the form of magnetite, lepidocrocite, ferrihydrite and apatite, which are found in architecturally discrete regions of the tooth. The elements are initially deposited in a band between the tooth cusp and its base (the function zone), and this region is of paramount importance in the subsequent multi-frontal biomineralization process.

The process of biomineralization in this genus is described in detail and the differences encountered at the species level are discussed with regard to the usefulness of biomineralization in the major lateral teeth as a taxonomic character.

Structure and growth of the ventral hinge system of *Pandora wardiana* A. Adams, 1859

Andrew Milton Bush [anbush@vt.edu]
4044 Derring Hall, Department of Geological Sciences, VPI&SU, Blacksburg, Virginia 24061-0420

Pandora wardiana A. Adams, 1859 (Anomalodesmata), an Eastern Pacific bivalve, has a planar right valve and a convex left valve. The ventral margin of its right valve flexes to the right when the shell closes. The flexible margin is composed of many discrete plates of the outer calcified shell layer connected by flexible organic hinges. The plates are roughly rectangular, with the long edge parallel to the shell's edge. The arrangement of the hinges on the flat valve margin allows it to deform into a curved configuration when the shell closes. Three types of hinges allow this deformation: comarginal, simple radial, and complex radial. The left valve lacks the flexible margin and the hinges. The calcareous plates of the margin form by the fusion of smaller crystals. This fusion is controlled by the deformational stresses experienced by the margin when the shell closes. The normal stresses generated by shell closure produce a regular pattern of hinges, but shell damage produces unusual stress patterns that result in random hinge arrangement. As the shell grows, the old margin is underlain by the stiff inner shell layer as new margin is formed. The

configuration of the hinges through an individual's ontogeny is recorded as a network of crack-like lineations on the outer shell layer of the right valve.

DNA evidence on the evolution of the Bivalvia

David C. Campbell [bivalve@email.unc.edu]
Department of Geology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27599-3315

Although the anatomy and skeletal morphology of modern and fossil bivalves provide extensive evidence about their evolution, several disagreements about their classification remain. Molecular data help resolve some of these issues. Newly obtained and published 18S gene sequences represent most extant bivalve superfamilies, as well as various other molluscan classes. Analyses of these data support the validity of many traditional taxa, but not others.

Three major clades can be recognized within the Bivalvia: Pteriomorphia, Protobranchia, and Heteroconchia *(sensu* Cox, 1960 and Waller, 1998). Within the Heteroconchia, three major clades exist: Paleoheterodonta, Anomalodesmata, and Heterodonta (includes Myoida). Heterodonta is divided into two subclades, one including Cardioidea and Tellinoidea; the other, Mactroidea, Myoidea, Pholadoidea, and Veneridae. Contrary to some current classifications, Myoida and Veneroidea appear polyphyletic, *Septifer* places within the Mytilidae rather than in a separate family, and the Ostreoidea do not place within Pectinoida.

Plio-Pleistocene faunal patterns in the western Atlantic: 1. Bivalvia

Matthew Campbell [ecphora@indiana.edu]
Department of Geological Sciences, Indiana University, Bloomington, Indiana 47405

The present study analyzed the Plio-Pleistocene distribution of bivalve faunas from Iceland and arctic Canada to the Gulf Coast of the United States. Stratigraphic and geographic ranges for 860 species were determined from available literature, museum and private collections. The Pliocene and Pleistocene epochs were divided into nine time-stratigraphic intervals based on nannofossil zonation. The region from Iceland west to the Canadian arctic and south to Florida and Texas was divided into five geographic units.

By Recent standards, endemism appeared to be much higher in the Pliocene and Pleistocene faunas, with over fifty percent of the species present being restricted to a single zoogeographic region. Preliminary data showed 73% endemism in the arctic-boreal region, 23 % endemism in the Virginian region, 12 % endemism in Carolinian region, 34 % endemism in the Floridian region, and 24 % endemism in the Gulf Coast region. By contrast, the modern bivalve faunas in these zoogeographic regions have less than five- percent endemism.

The Virginian and Carolinian faunas contained more species shared with adjoining regions, while the Floridian species were less likely to be found elsewhere. Distinctive features of the Recent Floridian environment were compared with species distribution data. Other possible factors contributing to this contrasting pattern were explored in the context of an apparent reduction in the total number of distinct faunal provinces through time. The proposed model considered recruitment, migration, barriers and speciation against the impact of three major glaciation-extinction events.

Cochlespira (Turridae, Gastropoda) in the Cenozoic of the Southeastern United States

Matthew Campbell, Sarah Campbell, Lyle Campbell, and David Campbell [ecphora@indiana.edu / scampbell gw.uscs.edu / lcampbell@gw.uscs.edu / bivalve@pop.unc.edu]
Department of Geological Sciences, Indiana University, Bloomington, Indiana 47405;
Natural Science Division, University of South Carolina, Spartanburg, South Carolina 29307;
Department of Geology, University of North Carolina, Chapel Hill, North Carolina 27599

The genus *Cochlespira* contains a strikingly sculptured group of small to medium sized, sharply keeled, fusiform turrids. The genus arose during the Paleocene of Europe and the North American Gulf Coast. *Cochlespira* was well represented in the Eocene to Miocene of Europe, Australia, Eastern North America, and the Indo-Pacific. This study recorded first time records of the genus from the Miocene age Chipola and Shoal River formations of Western Florida, and from the Pliocene Duplin Formation of South Carolina and the Jackson Bluff Formation of Florida.

Although Recent species are found throughout tropical and subtropical waters of the IndoPacific, the eastern Pacific, and the western Atlantic, individual specimens are rare in the field and rare to uncommon in museum collections. This review of the Neogene and Recent species of the Southeastern Coastal Plain suggested that five undescribed species were represented in the Neogene material. Two new species are proposed from the Pliocene collections. Detailed descriptions are provided for the Recent taxa. *C. radiata* was previously recognized from juvenile material, and in the original illustration the very rare *C. elegans* appeared distorted, perhaps from artistic license by the illustrator.

Evolutionary trends in bivalve shell and ligament microstructure

Joseph G. Carter [clams@email.unc.edu]
Department of Geology, University of North Carolina at Chapel Hill, North Carolina 27599-3315

New discoveries of original and relic shell and ligament microstructure in Silurian through Triassic bivalves have shed new light on general evolutionary trends in this class. The primitive nature of nacreous structure in middle and inner shell layers is now confirmed, and the timing of its replacement by porcelaneous structure has been identified for many lineages. Porcelaneous structures commonly first evolved within the pallial myostracum and then increased their area of deposition at the expense of nacreous middle and inner shell layers. Parivincular ligaments evolved independently not only in palaeotaxodonts and autobranchs, but also independently several times in the Autobranchia, in the Actinodontoida, Lucinoida, Veneroida, and perhaps also in the Pholadomyoida. The discovery of excellent relic ligament and shell microstructure in Upper Silurian bivalves from Gotland increases the probability that virtually complete shell microstructural information will soon be available for many bivalve genera originating in the early Paleozoic.

Effects of latitude and zonation on shell parameters in the limpet, *Tectura testudinalis*

Eric J. Chapman [eric_j_c@hotmail.com]
Biology Department, Queens College, City University of New York, Flushing, New York 11367-1597

Specimens of the limpet, *Tectura testudinalis* were collected from five separate latitudinal sites ranging from Pocologan, Nova Scotia, in the north, to the Cape Cod Canal in Massachusetts. Length, width and height of all individuals were measured. The numbers of individuals in each of the 50 cm x 50cm quadrats was also recorded to quantify populations in each of the low, mid and high zones at each of the sampling sites. Three replicates were taken at each of the shore positions at each of the five sites in an attempt to ensure an unbiased sampling protocol. Data were analyzed using Microsoft Excel, MIMTAB, and SPSS. I found a very strong correlation between shore position and number of individuals, R^2 = .998. There are significant correlations among all of the shell parameters measured. ANOVA shows all

of the means for all of the shell parameters are significant at the 95% CI. These data suggest that the limpets of this region are effected by the difference in physical parameters, mainly water temperature and geographic location.

Mollusc - sediment relationships at Assateague Island National Seashore, Maryland

Fei-Wen Cheng [j11qc@qcunix1.acc.qc.edu]
Biology Department, Queens College, City University of New York, Flushing, New York, 11367-1597

Benthic diversity at Assateague Island was poorly known until a comprehensive macrofauna inventory was conducted by Counts and Prezant (1996). To further examine the molluscan distribution and abundance on the island, faunal core samples were taken at two sandy, ocean sites and at two marshy, bay sites. To investigate vertical zonation patterns, I sampled stations that ran from shoreline down to 1.5 m water depth. Sediment cores accompanied each faunal sample for plotting possible correlation of molluscan presence to grain size and organic content, two important features of their living environment. Preliminary results show that *Gemma gemma*, followed by *Solemya velum* and *Mulinea lateralis*, abounded in bay sites with fine sediments; *Donax variabilis*, if present, dominated ocean sites with coarse grains. Organic content, however, did not appear to significantly contrast between marshes and beaches in this study.

Allometric shell growth, sexual dimorphism, and canonical discriminate analysis of the Asian viviparids

Yuh-Wen Chiu (1), Hon-Chen Chen (2) , Sin -Che Lee (1), and Chaolun Allen Chen (1)
[chiuyw@ccvax.sinica.edu.tw]
(1) Institute of Zoology, Academia Sinica, Nankang 115, Taipei, Taiwan;
(2) Department of Zoology, National Taiwan University, 10764, Taipei, Taiwan

Viviparids are an archaic gastropod group in the Eurasia. Traditionally, descriptive morphology, such as shell shape, color, and sculpture, are utilized to differentiate the viviparid species, however, confusion is found in these traditional approaches. In this study, we examined the allometric shell growth and sexual dimorphism in three species of Asian viviparid, and the results indicated these two ontogenetic effects contribute significantly to the inter- and intraspecific variations of shell morphology. We then applied multivariate method, canonical discriminate analysis (CDA) to examine the 13 morphometric measurements taken from 6 Asian viviparid species. CDA analysis indicates that 94% of variation among genera can be explained by the first two canonical variables. 3 of the 4 genera, *Chipangopaludina, Idiopoma, and Sinotaia* can be clearly identified. At species level, 81.6% of variation can be explained by the first 2 canonical variables for the two species in genus *Chipangopaludina.* However, CDA fails to differentiate the two species in the genus *Sinotaia*; even though 82.1 % of variation could be explained by the first two canonical variables. The interactions among allometric shell growth, sexual dimorphism and morphometric variation of the Asian viviparids are highlighted.

Organic matrix preparations as tools for understanding stress-related variations in bivalve shells

George R. Clark II [grc@ksu.edu]
Department of Geology, Kansas State University, Manhattan, Kansas 66506-3201

The growth of bivalves can be very sensitive to environmental stress, as demonstrated by the great variety of growth lines described from this class of mollusks. When examined closely, most growth lines prove to involve variations in shell microstructure, variations in organic content, or both. Because a major part of the organic matrix occurs as sheaths around individual carbonate crystallites, a carefully decalcified shell section can preserve the size, shape, and orientation of the crystal microstructure, often in a superior

manner than thin sections or fracture sections. The same preparations can also demonstrate any variations in organic content, as when matrix sheaths become packed together when anoxic conditions cause shell resorption, or when the rate of accumulation of intracrystalline matrix varies from the rate of precipitation of the carbonate.

At least four types of stress-related variations occur in the shell of *Mercenaria mercenaria,* all of which can readily be examined using scanning electron microscopy of critical-point dried organic matrix preparations. Some other species, such as *Mytilus edulis,* show less complexity but equal suitability to study with the same techniques.

Feeding ecology of the bivalve, *Rangia cuneata* (Sowerby, 1831): incurrent siphoning in and above the benthic-boundary layer

Carol M. Cleveland [bycmc@olemiss.eduj
Department of Biology, The University of Mississippi, University, Mississippi 38677

Suspension-feeding bivalves often facilitate benthic-pelagic coupling in estuarine environments although that impact is difficult to quantify. The hypothesis for this study is that northern Gulf of Mexico estuaries have few suspension feeders that are large enough to significantly affect primary productivity. To test this hypothesis, feeding in one species *Rangia cuneata* that occurs commonly in estuaries and dominates in Lake Pontchartrain, LA, is being analyzed. Clams were placed in a re-circulating flume, particles added, and siphoning videotaped from two angles. Incurrent, excurrent, and pseudofeces rejection velocities were calculated, and vector diagrams constructed for clams in low (<0.05m/s), medium (0.05m/s), and high (0.1m/s) flows. The height of the benthic-boundary layer, presumably an area high in detritus and low in live phytoplankton, was calculated at each velocity in order to determine whether the clams were feeding in it or above it. Although the benthic-boundary layer at the flows used is relatively thick (>5mm), the clams appear to extend their siphons above it. This suggests that *R. cuneata* are able to feed on the living phytoplankton in the water column.

Collecting, identifying, and curating freshwater mollusks

Kevin S. Cummings [ksc@inhs.uiuc.edu]
Center for Biodiversity, Illinois Natural History Survey, 607 E. Peabody Dr., Champaign, Illinois 61820

Freshwater mollusks are perhaps the most endangered group of animals in North America. Accurate data on distribution and status are essential to freshwater mollusk conservation. Museums and private collections play an important role as repositories for specimens and associated data to document species occurrences historic and present. Without these collections it would be impossible to ascertain or assign conservation status to species-at-risk. Amateur collectors have provided important specimens and information throughout the years to aid in this effort. Many states have recently initiated citizen stream monitoring networks to help state and federal agencies properly protect and manage areas of high biodiversity or endemism. Carefully collected and documented collections are essential to these efforts. Topics to be addressed in this workshop will include collecting methods (obtaining permits, selection of field equipment, qualitative vs. quantitative surveys, types of data to collect in the field, site selection, and temporal considerations), identification (curator contacts, relevant literature, and on-line resources), and curation techniques (specimen preparation and maintenance, curatorial supplies, and database considerations).

Evaluation of the geochemical and physical properties of molluscan material used for AAR analysis

Katherine L. Davis (1), John F. Wehmiller (1), Thomas H. O'Donnell (2), and Stephen A. Macko (2) [daviskl@udel.edu / jwehm@udel.edu / tho4b @.virginia.edu / sam8f @ virginia.edu]
(1) Department of Geology, University of Delaware, Newark, Delaware 19716;
(2) Department of Environmental Sciences, University of Virginia, Charlottesville, Virginia 22903

As part of an ongoing study of US Atlantic coastal plain (ACP) Quaternary molluscs, the geochemical and physical properties of modern and fossil molluscan material (10^5 to 10^6 years old) used for AAR analysis is being examined to evaluate sample suitability. The results presented here include total organic carbon (TOC) and isotopic composition from *Mercenaria campechiensis* from five sites along the ACP having varying ages, preservation states and diagenetic alteration histories. Differences in the patterns of transparency observed in reflected light for different shell structures was documented and subsamples were analyzed to determine if a correlation existed between transparency, shell structure, TOC and isotopic composition.

Preliminary results indicate that for TOC, transparent and opaque samples have overlapping ranges in concentration. However, the highest concentrations (0.032-0.073 weight percent) were all observed in opaque subsamples from modern shells. No clear relationship between TOC and shell structure was observed. We have also examined age relationships between the middle shell layer and carbon, nitrogen, and 13C concentrations. TOC values are typically higher and 13C values (-15 to -16 per mil) are more enriched in modem shells than in fossil shells (<.03 weight percent and -14 to -26 per mil). Fossil shells with high TOC levels also have very high C/N, characteristic of nonproteinaceous material. Shells with high C/N also have more depleted 13C suggesting that carbon from other sources has penetrated and elevated levels within the shell matrix.

Development of the reproductive system in *Nassarius vibex* (Neogastropoda: Buccinidae: Nassariinae)

Marta J. deMaintenon [martajm@amnh.org]
Department of Invertebrates, American Museum of Natural History, Central Park West at 79th Street, New York, New York, 10024-5192.

The reproductive tract is one of the most complex and variable of organ systems in gastropod mollusks, and it is one of the few internal organ systems without hard parts that has been valuable for systematic research at relatively low taxonomic levels. For the frequency with which it is used in systematics, however, the ontogeny of reproductive structures and their homologies in different taxa are not well established. The objective of this project was to describe the mosaic development of the reproductive system in *Nassarius vibex*, to establish the number of separate pieces that develop in each sex, their relative developmental timing and contributions to the adult system. The results of this project contribute to a survey of gastropod reproductive system development, to determine the evolutionary trends in ontogeny of the reproductive system, and to develop and refine systematic characters for resolving gastropod phylogeny.

The reproductive system in *N. vibex* develops in four parts in the male and three in the female. In both sexes, the system starts to differentiate in late juveniles, with the anterior ducts; medial and posterior ducts develop after. Accessory reproductive structures and gonads develop after the ducts are differentiated, and glandular tissues do not appear until near maturity. Both sexes reach functional maturity before the gonoduct and shell are completely developed.

Wood, whales and hydrothermal vents: unexpected connections among little known mussels of the deep

Daniel L. Distel [distel@maine.edu]
Department of Biochemistry, Microbiology, and Molecular Biology, The University of Maine, Orono, Maine 04474

The evolutionary history of chemosynthetic mussels at deep-sea hydrothermal vent and cold-water seeps has been a subject of long standing debate. Although vent communities have been proposed as extinction-resistant refugia for descendants of extremely ancient taxa, data for vent and seep bivalves have been ambiguous in this regard. Mytilid fossils at vents and seeps are unknown before the late Jurassic. Furthermore, phylogenetic relationships between fossil and modern vent mytilids are unclear and relationships between extant vent- and non-vent mussels are largely unexplored. Hence it has remained uncertain whether modern chemosynthetic mussel communities derive from relatively recent invasion(s) of vent and seep environments or from continuous habitation of these environments by more ancient indigenous vent taxa. Phylogenetic analyses of small subunit rRNA sequences 1) provide molecular evidence supporting the recent invasion of vents and seeps by modern mytilid taxa, 2) identify close relatives of these taxa among several genera of minute wood- and bone-associated deep-sea mussels, and 3) show that the vent-, seep-, wood-, and bone-associated mussels form a monophyletic lineage, deeply divergent from traditionally described mytilid subfamilies. Identification of chemosynthetic symbionts in at least one of the wood- and bone-associated mussels suggests that anaerobic decay of wood, like bone, may produce sufficient hydrogen sulfide to support chemosynthetic bivalve communities, and that chemosynthetic symbioses may be common or perhaps ancestral in this ancient lineage.

Comparison of microgrowth pattern in *Margaritifera margaritifera* shells from north and south Sweden

Elena Dunca and Harry Mutvei [Elena.Dunca@pal.uu.se / pz-harry@nrm.se]
Department of Earth Sciences, Historical Geology and Palaeontology, Uppsala University, Norbyvägen 22, 75236 Uppsala, Sweden;
Department of Palaeozoology, Swedish Museum of Natural History, Box 50007, 10405 Stockholm, Sweden

Shells of the pearl mussel *Margaritifera margaritifera* were collected from two Swedish unpolluted rivers: the Vramsån River, situated in the southernmost part of Sweden, Scania, and the Välijoki River, situated in the northernmost part of Sweden, 100 km above the Polar Circle. In southern Sweden the climate is mostly maritime and the mean annual temperature is about $+8^0$C, whereas in the northernmost Sweden the climate is mostly continental and the mean armual temperature is about -1^0C.

The annual growth rate and microgrowth pattern in the shells from these mussels, living in climatologically very different environments, were analyzed and compared. The microgrowth pattern, with growth acceleration and retardation zones, is the same within each population and specific for each year, but different between the two populations in study. The shells from the Vramsån River population have 160±20 microlamellae, whereas the shells from the Välijoki River population have 100±20 microlamellae. The number of lamellae corresponds to the number of days with water temperatures higher than 4^0C in each locality suggesting diurnal growth periodicity of the shells. The growth rate is higher and the deposited microlamellae are thicker in younger individuals, being about 2-5μm. By aging, the mussel deposits thinner microlamellae of 170-400nm or even thinner. This makes it difficult to compare young individuals with old ones.

Despite of the differences in the length of the growth period and the number of microlamellae the mean shell growth is almost the same in mussels from the two localities separated by a distance of ca 1700km.

Age and size of *Mercenaria mercenaria* in a South Carolina tidal creek

Arnold G. Eversole, Nathalie Devillers, and William D. Anderson [aevrsl@clemson edu]
Department of Aquaculture, Fisheries and Wildlife, Clemson University, Clemson, South Carolina 29634-0362; South Carolina Department of Natural Resources, Charleston, South Carolina 29422-2559

Mercenaria mercenaria (L.) were sampled from four sites in Two Sisters Creek, South Carolina, which had not been commercially exploited since the early 1970s. Shell lengths (SL) were measured and ages

estimated from increments in shell sections. Mean SL of individuals collected at the two sites near the mouth of the creek were significantly larger than those collected in the upper reaches of the tidal creek. The back-calculated mean SL, however, was similar among sites for most ages. Analysis of ages revealed that individuals near the mouth were significantly older than those from the upper reaches. Differences in age structure were also observed among sites. Differential recruitment hypothesis is proposed to explain the upstream pattern of decreasing SL, and ages of hard clams in Two Sisters Creek.

Rediscovery of *Phyllidiopsis sinaiensis* (Nudibranchia: Doridoidea), with a brief review of the Red Sea Phyllidiidae

Alexander Fahrner and Michael Schrödl
[kldl130@mail.lrz-muenchen.de / schroedl@zi.biologie.uni-muenchen.de]
Zoologische Staatssammlung München, Münchhausenstraße 21, 81247 München, Germany;
Zoologisches Institut der Ludwig Maximilians-Universität München, Abteilung Prof. Haszprunar, Karlstr. 23, 80333 München, Germany

Phyllidiopsis sinaiensis (Yonow, 1988), of which only a single specimen had been known, was rediscovered in the northern Red Sea. Colour photographs of living specimens, presented for the first time, show the dorsal colour-pattern which has been unknown so far. The anatomy of *Phyllidiopsis sinaiensis* is redescribed in detail. Major features of the holotype used to characterize the species, such as very low tubercles and predominantly yellow viscera, are shown to be artifacts. *Phyllidiopsis sinaiensis* appears to be among the most common nudibranchs in the Gulf of Aqaba. The fact that it has not been reported since its original collection in 1980 can be explained by its confusion with the externally similar, common species *Phyllidiella pustulosa* (Cuvier, 1804). The phyllidiid fauna of the Red Sea, including nine valid, one undescribed, and an additional, unidentified species, is briefly reviewed.

Comparison of aesthete canal morphology in several chiton species

Christine Fernandez, Michael Vendrasco and Bruce Runnegar
[chriiszf@ucla.edu / mikev@ess.ucla.edu / runnegar@ess.ucla.edu]
Department of Earth and Space Sciences, University of California, Los Angeles, California 90095-1567

Epoxy casts of aesthete canal systems in chiton valves were created from a variety of species. Scanning electron microscope images taken of the casts show the entire three-dimensional pattern of the aesthete canal complex in these chitons. This methodology allows for a more thorough morphologic comparison of aesthete canal systems across species. Results show complex canal morphologies and a large variation between species in aesthete size and shape. One purpose of this comparative study is to better assess the physiological, ecological, and taxonomic significance of aesthete canal morphology.

Specimens were collected along the Pacific coastline of California; others, from localities worldwide, were obtained from the Natural History Museum of Los Angeles County. Isolated valves were cleaned, embedded under vacuum in epoxy, decalcified, and imaged using a scanning electron microscope. The epoxy preserved the canals in life position, making it possible to directly observe the location and orientation of canals and aesthetes relative to each other. This technique has been applied to the study of endolithic algal borings in fossil shells, but had not previously been used much to document primary shell porosity.

***Pragoscutula* - oldest caenogastropod limpet**

Jiří Frýda [fryda@cgu.cz]
Czech Geological Survey, Klárov 3, 11821, Czech Republic

The unusual Early Devonian limpet, *Pragoscutula wareni* Frýda, 1998, with its well preserved protoconch was recently discovered among gastropods of the *Plectollotus (Boucotonotus) - Palaeozygopleura* Community of the Prague Basin. Limpet-like morphology was independently evolved among numerous living and fossil groups of Gastropoda, as well as in the Monoplacophora. In fossil limpets only such shell characters as shell microstructure and protoconch type may help in the determination of their higher taxonomic position. Until now, the oldest known limpet belonging to an extant gastropod megataxon is the Triassic *Patella* (Patellogastropoda; Hedegaard *et al.* 1997). Amongst Paleozoic gastropods, we hitherto know only of limpets belonging to the extinct order Cyrtoneritimorpha (Neritimorpha), which had a typical fish-hook like protoconch. The higher taxonomic position of the remaining majority of Paleozoic limpets is still uncertain. The shells of the recently discovered *Pragoscutula wareni* bear a close, dextrally coiled protoconch consisting of about 1.5 whorls. This protoconch morphology indicates that *Pragoscutula wareni* belonged undoubtedly to the class Gastropoda. In addition, gastropod megataxa like the Amphigastropoda, Archaeogastropoda, Heterostropha, Mimospirina, Euomphalomorpha, Cyrtoneritimorpha, and Perunelomorpha can be excluded as possible higher taxa for *Pragoscutula.* On the other hand, the protoconch morphology of *Pragoscutula wareni* fits well with that in the Caenogastropoda. Thus, this limpet is the oldest hitherto known member of the subclass Caenogastropoda. In addition, *Pragoscutula wareni* represents the oldest (and first Devonian) evidence for a closely coiled, non-archaeogastropod and non-amphigastropod protoconch type.

Suggestions for polyphyletism of Paleozoic bellerophontiform molluscs inferred from their protoconch morphology

Jiří Frýda [fryda@cgu.cz]
Czech Geological Survey, Klárov 3, 11821, Czech Republic

Paleozoic bellerophontiform molluscs have been interpreted as untorted, exogastrically oriented monoplacophorans, or torted, endogastrically oriented archaeogastropods, or a polyphyletic combination of both. Our limited knowledge of the soft-part morphology of these molluscs is based mainly on interpretations of such shell characters as their muscle scar pattern, the presence of a dorsal slit, and the shape of their aperture. Recent studies of their protoconchs suggest that the bellerophontiform molluscs unite several groups with differing early shell ontoaenies. The nature of the early shells in the core genus *Bellerophon* indicates that it does not belong to the subclass Archaeogastropoda. A sharp peak in the size-frequency distribution for species of *Bellerophon and Kokenospira,* each with about three whorls, has been interpreted as an effect of an increase in mortality during their change from a larval into a benthic mode of life (Dzik 1978; Frýda 1998). On the other hand, Ordovician sinuate bellerophontiform molluscs *(Sinuitopsis and Wodestospira)* have relatively large (up to 0.4 mm), smooth, symmetrical protoconchs which are formed by only the first half of the whorl (Dzik 1981). The Early Devonian cyrtonellid mollusc *Cyclocyrtonella advena* (Perner, 1903) developed a true larval shell (Horný, 1993). A bowl-shaped protoconch similar to that in modern neopilinids was recently found in the Early Devonian *Ladamarekia miranda* (Frýda 1998). All these facts suggest that Paleozoic bellerophontiform molluscs represent a polyphyletic group.

The early evolution of the Cirroidea (Gastropoda) still remains mysterious

Jiří Frýda (1), Robert B. Blodgett (2), and Alfred C. Lenz (3)
[fryda@cgu.cz / blodgetr@bcc.orst.edu / aclenz@julian.uwo.ca]
(1) Czech Geological Survey, Klárov 3, 11821, Czech Republic;

(2) Department of Zoology, Oregon State University, Corvallis 97331, Oregon, U.S.A.;
(3) Department of Earth Sciences, University of Western Ontario, London, ON N6A 5B7, Canada

On-going revision of Siluro-Devonian gastropods shows that the Paleozoic Porceillidae, including the Porceillinae with discus-like teleoconchs and Agnesiinae with sinistrally coiled teleoconchs, represents a relatively highly diversified group. The unusual change in shell coiling (from dextral to sinistral) during their early shell ontogeny is a character which is known only in two groups of Archaeogastropoda: the Paleozoic Porcelliidae and Mesozoic Cirridae. Porcelliidae having a selenizone or row, of tremata (Frýda, Blodgett and Lenz, in prep.) have been suggested to give rise during the Triassic to the slit-less Cirridae (Bandel 1993). Recent discoveries of the Early Devonian high-spired, sinistrally coiled shell of *Alaskacirrus* Frýda and Blodgett, 1998 and discus-like shell of *Pavlodiscus* Frýda, 1998 (both lacking a selenizone) suggest that the family Cirridae was separate from the family Porcelliidae since at least Early Devonian time. However, both genera may also represent dead-end branches of the Paleozoic Porceillidae. The long stratigraphic ranges of both the Porcelliidae (Silurian-Triassic) and Cirridae (Triassic-Cretaceous) demonstrate that the Cirroidea represents a quite independently evolving group of Archaeogastropoda which had a duration of about 350 million years.

Muteloidea Schmuteloidea: a re-evaluation of the relationships of the Hyriidae (Bivalvia: Unionoida)

Daniel L. Graf [dgraf@umich.edu]
Department of Biology and Museum of Zoology, University of Michigan, Ann Arbor, Michigan 48109-1079

There has been an increased awareness of the phylogenetic paradox created by disparity among evolutionary hypotheses derived from different life history stages, especially among marine invertebrates. The same is the case among freshwater mussels (Unionoida). These globally-distributed bivalves have been divided into two superfamilies diagnosed by their parasitic larval type: the Unionoidea, which have glochidia, and the Muteloidea, possessing lasidium-type larvae. This taxonomy, however, conflicts with earlier systems based upon adult characters (e.g. degree of posterior mantle fusion, arrangement of the marsupial demibranchs). the objective of my study was to phylogenetically test the affinities of the Hyriidae, a family of glochidium-bearing freshwater mussels with adult morphology similar to mussels with lasidia.

A morphological data set compiled from both larval and adult life history stages was analyzed phylogenetically using parsimony (18 genera, including *Neotrigonia* as the outgroup; 38 characters). A single tree 62 steps long was recovered. Its topology suggests that hyriids, despite their development including a parasitic glochidium, share a more recent common ancestor among the lasidium-bearing mussels (e.g. *Iridina, Acostea, Mycetopoda, etc.)* than with any unionoidean. Based upon this analysis, recent molecular studies, as well as certain nomenclatural revelations, a new classification system is proposed for Gondwanaland freshwater mussels -- Unionoidea (= Margaritiferidae + Unionidae) and Etherioidea (= Hyriidae + (Iridinidae + Etheriidae)).

Allochthonous shell concentrations in a Thyasirid Facies from the early Middle Miocene (Badenium) of Austria

Mathias Harzhauser (1), Oleg Mandic (2), Martin Zuschin (3), Peter Pervesler (2), and Reinhard Roetzel (4) [mathias.harzhauser@nhm-wien.ac.at]
(1) Museum of Natural History Vienna, Burgring 7, 1014, Vienna, Austria;
(2) Institute of Paleontology, Althanstrasse 14, A-1090, Vienna, Austria;
(3) Department of Geology, Texas A & M University, College Station, Texas;
(4) Geological Survey of Austria, Rasumofskygasse 23, A-1031 Vienna, Austria

The early Middle Miocene (Lower Badenian) marine transgression resulted in a marked change of molluscan palaeocommunities throughout the Central Paratethys, reflected by a strikingly diverse fauna.

During summer 1998 five artificial outcrops were investigated at the village Grund (Lower Austria) with special emphasis on the paleoecology and taphonomy of molluscan concentrations.

The section Grund is characterised by a rapid change of allochthonous psammitic and autochthonous pelitic sedimentation. The psammitic deposits are produced by high energy, short-time events with abundant channel-structures and thick coquinas. The latter consist mainly of gastropods and bivalves typically occurring in shallow marine sublittoral settings, such as small sized Veneridae, Cardiidae, Lucinidae, Nassariidae und Turritellidae. Ecologically the fauna is domianted by infaunal suspension feeders.

The intercalated pelitic layers in contrast represent the autochthonous sedimentation and are colonized monospecifically by *Conchocele michelottii* (R. Hörnes, 1875), the only mollusc species of the diverse fauna at Grund occurring in life position.

The life position is documented by valve articulation, dorsal margin up position and preservation of the inhalant and ventral tunnel network tube. Its abundance, as well as its monospecific occurrence indicate special chemical and physical conditions of the sediment preferred by this thyasirid species, causing an environment which was not suitable for the colonization by other molluscs.

The pelitic sediments and the monospecific occurrence of *Conchocele* indicate reducing conditions during deposition. The thick sand layers and skeletal concentrations are interpreted as results of high energy events, which transported these sediments into the Thyasirid facies.

Is the Aplacophora monophyletic? A cladistic point of view

Gerhard Haszprunar [haszi@zi.biologie.uni-muenchen.de]
Zoologische Staatssammlung München, Münchhausenstraße 21, D-81247 München, Germany

The systematic position and monophyly (versus paraphyly) of the two aplacophoran taxa, Solenogastres (also called Neomeniomorpha or Ventroplicita) and Caudofoveata (or Chaetodermomorpha) has been a subject of long-lasting debate. Also the plesiomorphic versus apomorphic (paedomorphic) condition of several aplacophoran features has been heavily discussed for over a century. A cladistic analysis has been undertaken to solve these questions or at least to point out more clearly the specific lack of knowledge and necessary future studies. Outgroup comparison of character states is generally limited, because many relevant organ systems (e.g. buccal apparatus, mantle cavity, gonopericardial system, osphradia) do not exist in any possible molluscan outgroup. Based on current knowledge the result is not fully conclusive, but the arrangement {Solenogastres [Caudofoveata (Polyplacophora & Conchifera)]} is the most probable. In contrast, the monophyly of Testaria (Polyplacophora & Conchifera) is well supported by several characters and contradicts recent ideas about a monophyly of Aculifera (Polyplacophora & Aplacophora). In particular ontogenetic data revealed by modern technologies (e.g. fine-structure, antibody staining) are badly needed to improve the understanding of aplacophoran relationships and of the ancestral features of the Mollusca as a whole.

Do juvenile unionids like sand? A unionid translocation and follow-up at a site with a moderate *Dreissena polymorpha* (Pallas 1771) infestation, Mississippi River Mile 725.8, T.H. 43 Bridge, Winona, Minnesota/Wisconsin, USA

Marian E. Havlik [havlikme@aol.com]
Malacological Consultants, 1603 Mississippi Street, La Crosse, Wisconsin 54601-4969

A September 1996 unionid translocation, prior to alterations on 9 bridge piers, yielded 6199 unionids in a mostly sand substrata (23 species, density 1.88/m^2, 50% <3 yrs of age). The large number of juveniles

resulted from careful searching in sand. Numbered state special status unionids (2%) were planted nearby on a longitudinal transect; hash-marked common unionids were distributed from the surface. Overall, just moderate numbers of *Dreissena polymorpha* were present because this side channel only has indirect commercial navigation impacts. Six of 7 special status species were at Pier 1 (6 m deep), but *D. polymorpha* carpeted riprap and mud substrata complicating recovery of 1371 unionids at this site. Over 300 *D. polymorpha* were attached to many unionids, but few were fresh-dead. Up to 60 *D. polymorpha*, 1-5 mm long, nearly covered many juveniles.

All visible *D. polymorpha* were removed before translocation. Follow-up 18 September 1997 showed an overall survival of 93.8%, with a 94.7% survival of special status unionids. The mean density of marked unionids was 4.25/m^2, resident unionid density was 17.25/m^2. Many *Obovaria olivaria* (Rafinesque 1820) showed growth, both after translocation (interruption rings), and in 1997 (5 mm growth). 1997 spring high-water changed the substrata; 50-75 mm of packed sand accumulated over many unionids but they still showed growth. *Liguma recta* was adversely affected by translocation (50% mortality); this species might do better if just placed on the substrata. *Alasmidonta marginata* Say 1818, the first from the Minnesota portion of the Mississippi River since 1930, was found at the translocation site.

How shells are formed - and how they are not

Claus Hedegaard [claus.hedegaard@biology.aau.dk]
Institute of Biology, Department of Population Biology, University of Aarhus, Ny Munkegade, Bldg. 550, 8000 Aarhus C, Denmark

Summary of my recent research on texture analysis of mollusc shells, followed by questions on shell formation. I hope this will be a discussion, rather than a monologue; I encourage the listeners to suggests ways to solve problems.

Texture analysis - the distribution of crystallographic orientations - prove mollusc shells are highly textured; the shells are predominantly composed of elements with aligned crystallographic axes. A small piece of a shell acts as it has only one orientation, but due to curvature and coiling the axes are unaligned over large distances (e.g., a whorl). That is, during growth the crystallographic axes of shells are continuously and systematically shifted. Please consider, whether this shift of axes is a chance result of physiology, or actually the controlling mechanism of shell morphology ? How can we test one or the other hypothesis ? Do shells 'get off to a lucky start' and then morphology is predetermined by growth of the crystals or is alignment of crystals a consequence of the growth ? Crystals are less aligned at the outside than the inside of shells. Is this an effect of the environment, a consequence of ontogeny, or 'just so' ? Deposition of calcium carbonate in shells forms acid. Acid dissolves shells. If the mollusc does not do 'something' shell formation ceases. The literature contains a number of suggestions what that 'something' may be. Generally, they are wrong, obscure or both. Given adequate time, I should like to discuss techniques to test modes of shell formation, particularly measuring components of the extrapallial fluid in live organisms.

A phylogenctic overview of *Tryonia* springsnails: molecular and morphological perspectives

Robert Hershler (1), Hsiu-Ping Liu (2), and Margaret Mulvey (3) [hershler.robert@nmnh.si.edu]
(1) Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560;
(2) Department of Biology, Southwest Missouri State University, Springfield, Missouri 65804-0095;
(3) Department of Environmental Science, Virginia, Institute of Marine Science, Gloucester Point, Virginia 23062-1346

The aquatic snail genus *Tryonia* is one of the more diverse groups of North American hydrobiid snails and includes species living in brackish habitats along the California coast, thermal springs in the West, and springs and lakes in the Florida Panhandle. The genus has received attention from the conservation standpoint (one species is federally listed as endangered and three others currently are candidates for federal listing), and also has figured prominently in the development of provocative, albeit non-phylogenetic, scenarios for historical biogeography of western North America. For this study we use mitochondrial DNA sequences to investigate the phylogenetic relationships of these snails, together with other representatives of the subfamily Cochliopinae and outgroups. Partial sequences of mtCOI permitted generation of well-resolved trees which indicated that *Tryonia,* as currently constituted, is polyphyletic. Anatomical studies revealed heterogeneity in genitalia congruent with the molecular data. Implications of these results for systematics of hydrobiid snails and previously proposed hypotheses for North American biogeography are briefly discussed.

Gastropod larval shell mineralization

Carole S. Hickman [caroleh@ucmpl.berkeley.edu]
Department of Integrative Biology and Museum of Paleontology, University of California, Berkeley, California 94720-3140

Standard models of gastropod shell formation are based on the post-metamorphic secretion of the juvenile and adult shell. This shell is built primarily by accretionary growth along the apertural margin, where cells at the mantle edge engage in various combinations of continuous and periodic secretion. Different combinations explain the observed arrays of spiral, axial, and discordant "ornamentation" of the shell exterior as well as features such as spines and tubercles. Accretionary growth is basically a process of ***marginal progradation.*** A second model explaining much of shell growth in cypraeids, builds the shell by ***surficial aggradation*** on the shell exterior in contact with the mantle surface. Surficial aggradation also may occur on interior shell surfaces.

Three additional mechanisms are observed in the construction of gastropod larval shells, and all three are poorly understood. The earliest "shell" is an organic sheath that forms during the trochophore stage. Calcification of the organic sheath may occur rapidly, appearing as a wave that originates at the shell field invagination and spreads to the rest of the shell. In gastropods that feed and grow in the plankton, marginal progradation defines basic shell form, but many delicate patterns of ornamentation of the shell surface appear to result from ***remote biomineralization.*** Some patterns are indistinguishable from those generated in experimental studies of self-assembly processes. A third pattern of mineralization, ***imbricate thickening,*** occurs in many caenogastropod larvae at metamorphosis. It is a complex process that transforms apertural configuration by filling velar notches and eliminating sinusigeral beaks.

Problems in constructing a phylogeny for Paleozoic polyplacophorans

Richard D. Hoare
Department of Geology, Bowling Green State University, Bowling Green, Ohio 43403

The classification of the Polyplacophora is in a state of flux including that of Paleozoic taxa. Several attempts at revised classification have been made since publication of the Treatise volume in 1961. Numerous taxa have been described since that time and other undescribed taxa are known which will affect the classification. Major gaps in our knowledge cause many relationships to be questionable. Further collections and study of microstructure (including aesthetes), ontogeny, and relationships of various characters such as structral laminae and insertion plates are necessary to construct a more comprehensive classification and a feasible phylogenetic lineage. A comparison of several important characters is made with known specimens of the hercolepadids and multiplacophorans. Although it is reasonable to assume

that the polyplacophorans arose from a segmented ancestral form, it is unlikely that this group led to other classes of Mollusca.

Phylogenetic utility of mitochondrial gene order in gastropods

Wallace E. Holznagel and Chades Lydeard [wholzna3@biology.as.ua.edu]
Department of Biological Sciences, Biodiversity, and Systematics, University of Alabama, Tuscaloosa, Alabama, 35487-0345

The mitochondrial (mt) genome is a closed circular molecule, comprised of 37 genes. Alteration in the order of mt genes has been observed across a variety of vertebrate and invertebrate taxa. While doing a gastropod survey using nucleotide sequence data from a portion of the mt genome we noticed variability of gene order. Seeing this we decided to investigate the phylogenetic utility of mt gene order for inferring relationships within Gastropoda. Specifically we investigated the utility of a portion of the genome encoding the large ribosomal subunit and the preceding flanking region for 44 Prosobranch and heterobranch species. Preliminary analysis indicates that gene order in this region will be useful for resolving relationships at various hierarchical levels within Gastropoda.

Morphology and metabolism of the enigmatic *Xenoturbella* (Bivalvia, Protobranchia; formerly phylum uncertain)

Olle Israelsson [olle.israelsson@nrm.se]
Department of Invertebrate Zoology, Swedish Museum of Natural History, Box 50007, S-104 05 Stockholm, Sweden

The enigmatic *Xenoturbella* Westblad, 1949 is one of the strangest animals known, but it has been neglected by most textbooks. It is virtually nothing but a ciliated vermiform bag with ventral mouth (but no anus) but without any defined organs except an anterior internal sense organ ('statocyst') containing motile flagellated cells. It has until recently been interpreted as a flatworm, an enteropneust, a holothurian, a sister group to bryozoans, or a unique representative of a separate plesiomorphic group. However, it possesses a pericalymma larva and is actually a highly modified protobranch bivalve (Israelsson, *Proc. Roy. Soc. (Lond.)* B, in press). The feeding and metabolism, and virtually all aspects of the ecology, physiology, and biochemistry of *Xenoturbella* are unknown. It is not even known whether it feeds from the exterior via the epidermis or from the interior via the intestinal cavity. Recent studies of the biochemistry and physiology have brought light on the feeding and the metabolic pathways in *Xenoturbella,* and will result in a reinterpretation of the body organisation of *Xenoturbella.*

Rare legacy: freshwater mollusks from the Charles M. Wheatley collection at the Milwaukee Public Museum

Joan Jass and Jeanette Glenn [jass@mpm.edul
Zoology Section, Milwaukee Public Museum, 800 West Wells, Milwaukee Wisconsin 53233

Charles M. Wheatley was an amateur Pennsylvania conchologist who built a large personal collection of freshwater mollusks, especially from the eastern United States. He was active at the Academy of Natural Sciences of Philadelphia and, via associations made through the Academy (for example, with Isaac Lea), acquired much type lot material. After his death in 1882, Wheatley's widow sold his collections and in 1888 the Milwaukee Public Museum (MPM) acquired approximately 50,000 of his specimens. Gastropods were loaned to Henry A. Pilsbry of the Academy of Natural Sciences at Philadelphia in 1903 and unionids to Richard I. Johnson of the Harvard Museum of Comparative Zoology in 1977-78, both of whom returned the loans to MPM with determinations.

A recent program of collection computerization has enabled MPM to produce a complete inventory of its Wheatley holdings. The 55,000+ specimens include 732 unionid and 675 pleurocerid lots. The geographic breakdown of the MPM Wheatley collection is (state/number of lots): Tennessee/613, Alabama/213, North Carolina/186, Michigan/95, New York/88, Ohio/73, all other/210.

Of the MPM Wheatley unionid lots, roughly 20% are assigned a conservation status of Threatened or Endangered / possibly Extinct, and another 25% are Species of Special Concern. Even those species with a Currently Stable status are often represented by specimens from 1800's collecting sites in the Southeast which no longer exist today due to habitat change.

Amphi-Atlantic phylogeography of direct-developing *Lasaea* lineages

Robert Jennings, Joong-Ki Park, and Diarmaid Ó Foighil
[robmjenn@umich.edu / Parkjk@umich.edu / diarmaid@umich.edu]
Museum of Zoology and Department of Biology, University of Michigan, Ann Arbor, Michigan 48109-1079

Direct-developing intertidal *Lasaea* lineages occur in the North Atlantic as both continental margin and oceanic island populations. We conducted molecular phylogenetic analyses of representative populations in order to test colonization hypotheses for North Atlantic oceanic islands. Individuals were collected from continental putative source populations (Florida, Iberia) and two oceanic island groups (Bermuda, Azores). Mitochondrial gene sequence data sets were generated from these samples and analyzed phylogenetically. No amphi-Atlantic genotypes were detected: Bermudan lineages co-clustered exclusively with Floridian congeners and Azorean samples formed an exclusive clade with Iberian haplotypes. Our data indicate that geographical proximity to continental source populations is a better predictor of North Atlantic *Lasaea* phylogenetic relationships than present-day oceanic surface circulation patterns. The phylogenetic trees generated are not consistent with colonization of oceanic islands by indirect-developing ancestral lineages or by truly trans-oceanic rafting events. However, they are consistent with predicted topologies resulting from limited (¾2,000 km) long-distance colonization by rafting (against present-day circulation patterns in the case of the Azores) and from anthropogenic introductions.

Four year trend in the molluscan community of Hillsborough Bay, Florida

David J. Karlen [karlen@epcjanus.epchc.org]
Environmental Protection Commission of Hillsborough County, Tampa, Florida 33605

Since 1993, a bay-wide benthic monitoring program has been conducted in Tampa Bay by the Environmental Protection Commission of Hillsborough County in conjunction with the Tampa Bay Estuary Program. Young-modified Van Veen grab samples (area=0.04m^2) were collected annually at randomly generated sampling sites, utilizing a modified Environmental Monitoring and Assessment Program (EMAP) hexagonal grid system. Samples were collected during September - October of each year. The Hillsborough Bay molluscan community data are presented for the first four years of the program (1993-1996). No significant differences were observed among the four years for molluscan diversity (H'), evenness (J'), or abundance (ind/m^2). The numbers of species present were significantly lower in 1995 ($p = 0.03$). This observed drop in species richness in 1995 may have been the result of lower salinity due to higher precipitation in August 1995. The most abundant species for the 1993, 1994, and 1996 sampling periods was the bivalve *Mysella planulata* (Stimpson, 1851) which accounted for 59%, 50%, and 64% of the total abundance respectively. For the 1995 sampling period, the most abundant mollusk was the mussel *Amygdalum papyrium* (Conrad, 1846) which made up 42% of the overall abundance. The distributions of molluscan taxa were also considered in relation to habitat parameters and sediment contaminants.

Non-professional assistance in scientific collections: prospects and payoffs

José H. Leal [leal@water.net]
The Bailey-Matthews Shell Museum, P.O. Box 1580, Sanibel, Florida 33957

The pros and cons of the use of non-professional, non-remunerated personnel (curatorial assistants, collection volunteers) in institutional collections are outlined. The discussion is based on the author's experience with collection volunteers in several American and foreign natural history museums and, more recently, as director of the Shell Museum on Sanibel Island, Florida, an organization that relies heavily on volunteer help. Although help from collection volunteers can at first be costly from the standpoint of training, time, adaptation to suitable management style, and to the dynamics of volunteer work, the long-term rewards to the organization may far surpass these initial investments. This becomes evident when the organization lacks the resources needed to hire auxiliary professional staff. Non-professional assistance can be especially valuable in the performance of ancillary collection tasks such as data entry, development of electronic dictionaries, translation of foreign-language texts, sorting newly arrived collections and, in some cases, of more taxonomically oriented activities. The author offers a selection of chores that can realistically be performed by collection volunteers and makes recommendations about their recruitment, selection, training, and day-to-day management.

Not just another dingy deep-sea limpet: a new *Copulabyssia* (Gastropoda: "Cocculiniformia": Pseudococculinidae) from off eastern Brazil

José H. Leal and Luiz Ricardo Lopes de Simone [leal@water.net / lrsimone@usp.br]
The Bailey-Matthews Shell Museum, P.O. Box 1580, Sanibel, Florida 33957;
Museu de Zoologia da Universidade de São Paulo, Caixa Postal 42694, 04299-970 São Paulo, Brazil

Bathyal samples collected off the Abrolhos Reef Complex (eastern Brazil) during the Cruise MD55 of the French R/V *Marion-Dufresne* (1987) yielded specimens of an unnamed species of the genus *Copulabyssia.* These limpets, dredged between 960-1320 m, constitute the first record of the family Pseudococculinidae in the southern Atlantic. Shell sculpture in the new species shows a similar arrangement to those of its 4 recognized congeners, with concentric ribs and fine radial elements in interspaces. Ribs are several times more tightly packed in the new species. Right cephalic tentacle (copulatory organ) is about 4 times as broad as the left one, with opened sperm groove. Mantle edge is covered by small translucent papillae. Organs of subpallial cavity are typical of the genus: right gill is composed of 14 leaflets, but left side of subpallial cavity differs by presence of a small, yellowish "bump", which could represent a vestigial gill leaflet (left gill in congeners consists of a single leaflet). Radular teeth in the new species are similar to those of the eastern Atlantic *Copulabyssia corrugate* (Jeffreys, 1883), with broad rachidian tooth, massive bicuspid 5th lateral tooth, and pluricuspid marginal teeth with 2nd one being the largest. Descriptions of internal morphology based on microdissections are provided, including characterizations of the digestive system and the complex muscular apparatus of the odontophore.

Origin of polyploidization in the North American Sphaeriidae (Mollusca: Bivalvia)

Taehwan Lee [taehwanl@umich.edu]
Museum of Zoology, University of Michigan, 1109 Geddes Avenue, Ann Arbor, Michigan 48109-1079

Sphaeriid clams are prominent and ubiquitous members of freshwater ecosystems. Their reproductive biology is complex; they are hermaphroditic and ovoviviparous, and apparently have the ability to self-fertilize. Cytogenetic studies of the North American Sphaeriidae have uncovered very large and variable chromosome complements suggesting that pronounced polyploidization may have played a major role in their evolution. Preliminary phylogenetic analyses, using mitochondrial gene sequence data, have yielded valuable insights into the evolution of this group. However, if sphaeriid polyploidization stems from

reticulation events, organellar gene trees will be insufficient, and perhaps misleading, in reconstructing sphaeriid phylogenies.

I am constructing single-copy nuclear gene trees of the North American Sphaeriidae to complement the mitochondrial data set and to test for hybrid origins of polyplold genomes. A target fragment (530 nt) of 6-Phosphogluconate-Dehydrogenase (PGD) gene has been amplified by RT-PCR for 4 species of sphaeriids. PCR products were cloned into a plasmid vector in order to obtain individual allele sequences. Sphaeriid species display pronounced intra-individual heterozygosity, e.g. the PGD alleles expressed by a single clam may exhibit >10% sequence divergence. This genetic diversity resolves into two major clades. The allelic repertoire of some species contains genotypes of both PGD clades, a result consistent with reticulation. A more comprehensive sampling of the Sphaeriidae is ongoing to flesh out the putative role of reticulate processes in this family.

Effects of a digenetic trematode parasite on feeding and physiology of the snail *Elimia flava* (Lea)

Kristin K. Lenertz [klenertz@acesag.auburn.edu]
Department of Zoology and Wildlife Science, Auburn University, Auburn, Alabama 36849-5414

Snails in the genus *Elimia* (Gastropoda: Prosobranchia) have shown a highly variable capacity to control stream periphyton. *Elimia* is an intermediate host for several species of digenetic trematodes (flukes). This study was conducted to assess the effects of parasitism on grazing and related physiology of this snail. Individuals of *Elimia flava* were collected from Choctafaula Creek, SE Alabama, from a population naturally infected with a cotylomicrocercous trematode. Snails (n=34) were allowed to graze for 10 d on tiles colonized by periphyton in recirculating laboratory streams. Grazing, oxygen consumption, and ammonia excretion were measured for each snail, and individuals were then dissected to quantify parasites. In this population, infections ranged from 0 (no parasites found) to >500 sporocysts/snail, with about 40% of the population infected. Non-parasitized snails consumed more periphyton than parasitized snails, and showed a correspondingly higher level of ammonia excretion. However, unlike ammonia, rates of oxygen uptake did not differ between groups. These data suggest that infection by trematode parasites may account for some of the often-high degree of variation in grazing observed within and among populations of this snail.

On the achieving of limpetdom in the history of gastropod molluscs: The ultimate high or low

David R. Lindberg [davidl@ucmpl.Berkeley.Edu]
Department of Integrative Biology & Museum of Paleontology, University of California, Berkeley, California 94720-4780

From the Cambrian to the Recent limpet shell forms are common in the history of the Gastropoda. Surprisingly, they are relatively rare in the outgroups with the exception of the Monoplacophora. Within the Gastropoda limpet shell forms are demonstrably homoplastic in every major clade. These are often thought to be associated with major adaptive changes, however, similar shell morphologies do not necessarily indicate similar habits or habitats. Limpets occur in a wide variety of habitats, and caution is therefore necessary before linking shape to a mode of life and explaining it in terms of simplistic adaptive innovations and scenarios.

Unlike coiled gastropods, limpet morphospace can be defined in two dimensions by assuming a standard oval aperture. The x-axis then becomes apex position ranging from fully anterior to fully posterior, while the y-axis represents shell height. Adult forms of fossil and living limpet taxa are then placed on this morphospace and the morphospace divided into clade-specific regions. While some limpets within the Monoplacophora, Vetigastropoda, Cocculina, Pseudococculinaidae and Hipponacea occupy small areas of limpet morphospace, other clades such a s the Patellogastropoda have groups that broadly distributed

within the morphospace. Paleontological, phylogenetic and ontogenetic trends with clade-specific areas of the morphospace are also discussed.

Predation on bellerophontiform molluscs with special reference to shelf morphology

Anna Lindström, Jan Ova R. Ebbestad, and John S. Peel
[anna.lindstrom@pal.uu.se / jon-ove,ebbestad@pal.uu.se / john.peel@pal.uu.se]
Department of Earth Sciences, Historical Geology and Palaeontology, Uppsala University, Norbyvägen 22, 752 36 Uppsala, Sweden

Predator-prey relationships in the Palaeozoic were more significant than earlier believed and repaired injuries exist in a number of groups with hard shells. This study concerns five species of presumed isostrophic exogastric tergomyans and seven species of isostrophic endogastric gastropods, chosen because of their distinct, uniform morphology. Five of the twelve bellerophontiform molluscs with shell repair are small (less than 1 cm in length) and show single breaks extending more or less straight across the shell from suture to suture. Three of the smaller species are narrowly lenticular, while the last two have more rounded shells. Of the larger tergomyan and gastropod species, more than 2 cm in length, all but two show multiple injuries. None of the species have any particular strengthening features of the shell and both narrow and wide umbilici are found.

The available material suggests a positive correlation between shell morphology and distribution of injuries. All breaks occur at the apertural margin, and it is probably the nature of the margin and its emarginations that renders the observed pattern. The consistent distribution of the injuries may also show behaviour traits of the predators, seeking out their prey by smell, and directing their attacks after the exhalant current.

Conservation genetic study of the freshwater mussel, *Cumberlandia monodonta*

Hsiu-Ping Liu [hsiu-pingliu@mail.smsu.edu]
Department of Biology, Southwest Missouri State University, Springfield, Missouri 65804

Freshwater mussels are the second most endangered group in North America. Unfortunately, threats from habitat degradation and loss continue. The ultimate goal for freshwater mussel conservation is to preserve mussel diversity, more specifically to ensure the survival of the species and to maintain natural evolutionary processes (such as hybridization and speciation). Both goals require preservation of genetic diversity.

The spectaclecase, *Cumberlandia monodonta,* is a prime species for conservation and management effort. The spectaclecase has experienced a decline in abundance and a reduction in range -- characteristic of other endangered mussel species. Yet, they remain abundant in some isolated habitats and sufficient numbers can be obtained for reintroduction efforts if necessary. Mitochondrial and nuclear DNA sequence data was used to characterize genetic diversity of the spectaclecase within a population, among populations within a single drainage, and among populations between drainages.

Implications of the results for conservation and management strategy of spectaclecase are discussed.

Comparing size-frequency distributions of a subtidal whelk in native and invaded habitats

Steve Lonhart [lonhart@biology.ucsc.edu]
Department of Biology, University of California, Santa Cruz, California 95064

Invasive species often experience an ecological release in non-native habitats due to the absence of coevolved natural enemies. This release can lead to invader population explosions and significant changes in life history characteristics. The recent expansion of Kellet's whelk *(Kelletia kelletii)* into central California is an opportunity to study differences in population structure in native and invaded habitats. I compared size-frequency distributions for whelks in southern and central California over a 5 yr period. In the native habitats, whelk size ranges were greatest, densities were highest, and distribution was nearly continuous. In central California, whelks were primarily small adults, densities were low, and populations were patchy. Whelks in Monterey Bay potentially consist of several closely overlapping cohorts with some evidence of weak, episodic recruitment. This recruitment pattern may be the result of planktonic larvae carried northward during ENSO events, making central California populations larval sinks of southern California source populations. In addition, whelk populations in central California are severely impacted by local predators that are either absent or uncommon in southern California.

Feeding preferences of invasive and native turban snail predators

Steve Lonhart [lonhart@biology.ucsc.edu]
Department of Biology, University of California, Santa Cruz, California 95064

Novel ecological function may be a mechanism contributing to the successful establishment of invasive species. The recent expansion of Kellet's whelk *(Kelletia kelletii)* from south of Point Conception into central California added a novel functional feeding mode to the guild of invertebrate predators that consume turban snails. Whelks feed with a proboscis while sea stars, common predators of subtidal turban snails, feed with an eversible stomach. In laboratory experiments, I compared consumption rates and feeding preferences of a buccinid whelk *(Kelletia kelletii)* and three sea stars *(Pisaster giganteus, Astrometis sertulifera and Orthasterias koehleri)* for up to five *Tegula* species from southern and central California. If the novel feeding mode of the whelk is advantageous, feeding rates should be relatively higher. To explore local adaptation among predators and prey, I compared whelks and sea stars from southern and central California. If predators are well adapted to local prey, consumption rates should be high for sympatric prey and lower for allopatric prey. Except for *Orthasterias,* sea stars and whelks had identical preferences among *Tegula* species irrespective of the geographic origin of prey. There was no evidence of local adaptation; *Orthasterias* from central California preferred southern California *Tegula* to sympatric prey species. The novel feeding mode of the whelk did not contribute significantly to higher feeding rates of central California *Tegula,* and it apparently has not enhanced the successful establishment of the whelk.

What do squid signal with a Zebra display? I. The Formal Challenge

Jennifer Mather [mather@uleth.ca]
Department of Psychology & Neuroscience, University of Lethbridge, Lethbridge AB, Canada T1K 6K8

Sepioleuthis sepiodea squid produce a variation of the Cephalopod skin display described as a Zebra and present in many true squid and sepiolids. Instances of the Formal Zebra challenge between two adult males were observed (n=21) and filmed (n=5) in Bonaire for description. Formal Zebras were approximately 1 minute in duration, and the exchange consisted of display, position and movement components. Zebra display intensity was described to a maximum of 10, ranging from an average of 9.3 for the squid positioned under and 5.4 for over. Some position jockeying was seen but the contest rarely led to conflict. Physical contact of the posterior mantle led to pressure, apparently more by the lower male (which won

15/21 times). The Formal Zebra appears to be an honest communication about male competence, with some fitness assessment during the exchange yet a ritualized outcome.

Progress on the taxonomic manual: shell-bearing Gastropoda of the Northeastern Pacific

James H. McLean [jmclean@nhm.org]
Natural History Museum of Los Angeles County, 900 Exposition Blvd., Los Angeles, California 90007

Work is in progress on a taxonomic reference manual treating approximately 1360 species ranging from Alaska to the outer coast of Baja California. Although this fauna had been considered well known, alpha taxonomy for marine gastropod families remains unfinished. Approximately 25 new genera and 265 new species will be described separately in advance of the book or described within the book. Taxa are diagnosed and discussed at all levels of classification. Generic treatments include references to type species and citation of recent authors using a similar generic concept. Species treatments include single-line synonymies for all taxa and synonyms, consisting of original combinations, pagination and figures, and in brackets, references to subsequent type figures, catalog numbers of primary types and abbreviated type localities. The general bibliography includes references to all generic and species-level taxa, including synonyms. Each family has a separate bibliography of recent work on systematics and phylogeny. Illustrations are black and white photographs of shells with composite plates prepared in PhotoShop. Half of the text is now in draft and the remaining part of the text is in detailed outline form, including revisions of the turrids and pyramidellids, the two most ignored families for the Northeastern Pacific. Taxonomic problems most in need of further investigation are noted. The format provides the essentials of a formal monograph and also serves as an identification manual for the long neglected eastern Pacific marine gastropod fauna. Timely completion of the project is contingent upon receiving grant support for a skilled collaborator.

An insight into the biogeography, speciation, and evolution of some of the freshwater snail *Elimia* species within the southeastern US river drainages [Pleuroceridae: Gastropoda]

Elizabeth L. Mihalcik [elm@cc.usu.edu]
Florida Museum of Natural History, Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida 32611-7800

This study documented the biogeography of the smooth *Elimia* forms within the southern Atlantic and Gulf Coastal river drainages. Genetic studies indicated that speciation probably occurred sometime prior to the Pliocene. The movement of the freshwater fauna within the region has been attributed to the rise and fall of sea level and stream capture between headwater streams of the major river basins. Phylogenetic analyses indicated that *Elimia limida of* the southern Atlantic coastal Altamaha River is more closely related to *E. densicostata and E. dickinsoni* of the Gulf coastal Apalachicola and lower Choctawhatchee River systems. This analysis also revealed that the Escambia and upper Choctawhatchee River *Elimia* are more closely related to the Alabama River species, *E. olivula.* Speciation probably occurred after the ancestral stocks colonized their respective river basins because of the high number of endemic species occupying these different drainages. The greatest number of endemic *Elimia* species occur in the Apalachicola River drainage system. The fewest number of endemic *Elimia* species occur in the Yellow and Escambia River systems. According to the distributional accounts of the pleurocerid and hydrobiid snails and other invertebrate taxa, colonization of the southeastern rivers may have reached this area from four possible sources; Tennessee River system, Alabama and Coosa River systems, Santee and Edisto River systems, and possibly the Hiwassee River system. Each of these possible routes will be discussed with evidence from the freshwater gastropods as well as other freshwater invertebrate and vertebrate groups.

***Puperita tristis* (D'Orbigny, 1842) is an ecotype of *Puperita pupa* (Linnaeus, 1767)**

Russell Minton and Ross Gundersen [rminton@biology.as.ua.edu / gundersr@uwp.edu]
Biovidersity and Systematics, University of Alabama, Box 870345, Tuscaloosa, Alabama 35487;
Department of Biological Sciences, University of Wisconsin-Parkside, Kenosha, Wisconsin 53141

Puperita pupa and *Puperita tristis* occur sympatrically in the West Indies. In his 1941 review of western Atlantic Neritidae, Russell kept the two species separate based on shell color differences: *P. pupa* is characterized by a white shell with black lines, *P. tristis* by a black shell with small white spots. Russell also included radular differences, but noted that both species exhibit plasticity for both characters. Authors have suggested that *P. tristis* is a variety or color form of *P. pupa.* We tested the relationship of *P. pupa* and *P. tristis* through examinations of shell and radular characters, reciprocal translocations, and random amplified polymorphic DNA (RAPD).

P. pupa and *P. tristis* do not differ significantly in shell shape and proportion, as measured by principal component analysis. Translocations showed that the pupa and tristis phenotypes could be expressed by either species. Radular differences, although highly plastic, could be induced in a similar fashion. Statistical analysis of RAPD band sharing indicated that interspecific variation did not differ significantly from intraspecific variation. Based on our findings, we believe *P. pupa* and *P. tristis* to be conspecific, with *P. tristis* an ecotype of *P. pupa.* Shell color pattern and radular characteristics are highly plastic and appear to be responding to environmental conditions. An unusual feature of this plasticity is the sudden and dramatic change in shell phenotypes in response to a change in habitat.

A higher-order phylogeny of Gastropoda

Paul J. Morris [mole@morris.net]
Malacology Department, The Academy of Natural Sciences, 1900 Ben Franklin Parkway, Philadelphia, Pennsylvania 19103

The molluscan class Paragastropoda Linsley and Kier, 1984 is a group of anisostrophically coiled Paleozoic snail-like molluscs, which are inferred to have been not torted. This group was erected on the basis of a functional analysis of the motile Onychochilidae. The angle of apertural elongation (a correlate of shell balancing and locomotion) in onychochilids is intelligible only if the soft parts are reconstructed as untorted. However, most of the taxa placed in the Paragastropoda were nearly planispiral sessile organisms. The presence or absence of torsion in these taxa cannot be assessed by the original argument of Linsley and Kier. In this paper I present a functional analysis of two of these sessile putative paragastropods: *Maclurites* and *Hypomphalocirrus*. In this analysis I first derive the expected anatomy of these taxa as sessile descendants of untorted onychochilid ancestors. This results in the prediction that the water incurrent in an untorted *Maclurites* was at the top of the aperture, but; at the bottom in *Hypomphalocirrus*. I then expand these derivations to include a wide variety of possible anatomies and ancestries. By examining the behavior of clay models in a flow tank, I demonstrate that these nearly-planispiral shell forms generate a passive water flow that enters at the base of the aperture and exits at the top. At reasonable flow velocities for shallow marine conditions, this passive flow is biologically significant, being an order of magnitude greater than the pumping ability of extant gastropods. A macluritid reconstructed as a paragastropod would have had to pump against this passive flow gradient, likewise for an onychochilid reconstructed as a gastropod. I therefore conclude that *Maclurites* was torted and should be returned to the Gastropoda, while *Hypomphalocirrus* and the other omphalocirrids are true untorted members of the Paragastropoda.

New approaches in the classrooms - where are the molluscs?

M. Patricia Morse [mpmorse@u.washington.edu]
Zoology Department, University of Washington, Seattle, Washington 98195

The Active Learning Approach with Undergraduates has replaced the "sale on the stage" learning of years past. Students in both the secondary schools and colleges now engage in research experiences and conservation efforts that offer new avenues of learning during these earlier years. How has this come about? What is the role of the computers and the age of information? What does it mean for students to be engaged in inquiry science, and how can we, as malacologists, help to increase the flow of knowledge to support such activities? Based on numerous national reports, we now recognize that science is for all students. It is our responsibility to provide new opportunities for young children to share the joys of discovery and beauty about molluscan organisms so that they will become stewards in the future to help preserve these molluscs that we have been so privileged to study. In this presentation, I will discuss some of the trends in student leaming and how we might embrace them as we teach molluscan biology.

William J. Clench on tape

Harold D. Murray [hmurray@trinity.edu]
Department of Biology, Trinity University, San Antonio, Texas 78212-7200

For eight days from June 4 to 11, 1979, 1 recorded whatever Bill Clench (72 years old) wished to say on tape. The approximately 810 minutes of recording occurred in his kitchen at 26 Rowena Street, Dorchester, Massachusetts primarily in the mornings and afternoons.

The first tape was started without preparation and resulted in Bill forgetting dates, places, people, and experiences. Thereafter, he and I spent the evenings going over his field notes and identifying items to be discussed the next day.

Bill made numerous trips to Cuba and repeatedly visited sites in most of the southeastern states. He reflected on changing habitats, what was collected, collecting colleagues, and trials and tribulations of early collecting. The last tapes reflect on some personalities in malacology, but he had no harsh word for anyone. Finally on the last tape, he told a couple of his favorite jokes, and those who knew Bill will remember that gift best.

An attempt will be made to play a few selected parts of the tapes. This will be the first public airing of the tapes.

Climatic variations recorded in the shell of the freshwater pearl mussel *Margaritifera margaritifera* (L)

Ulf Nordlund (1), Elena Dunca (1), Joakim Sorelius (2), and Harry Mutvei (3)
[Ulf.Nordlund @ pal.uu.se / Elena.Dunca @ pal.uu.se / Joakim.Sorelius @ syscon.uu.se / pz-harry @ nrm.se]
(1) Department of Earth Sciences, Historical Geology and Palaeontology, Uppsala University, Norbyvägen 22, 75236 Uppsala, Sweden;
(2) Dept of Systems and Control, Uppsala University, Lägerhyddsv 2, Box 27, 751 03 Uppsala, Sweden;
(3) Department of Palaeozoology, Swedish Museum of Natural History, Box 50007, 10405 Stockholm, Sweden

Variations in the annual growth of freshwater bivalve shells are primarily controlled by changes in the environment. In shells from localities with minimal human influence, the temperature may be a main factor influencing the growth. In this study, a high correlation with temperature is demonstrated using shells of the pearl mussel *Margaritifera margaritifera* (L.) from the River Pärlälven in northernmost Sweden, and the River Vramsån in south Sweden. Through mathematical analysis of annual growth rates

and monthly mean temperatures it is furthermore possible to establish the seasonality of shell growth. It can be shown that the bivalves from northern Sweden have a simple unimodal growth curve with a maximum in the summer months June-August, while further south the picture becomes more complex, as exemplified by the shells from Vrams6n. It is suggested that this increased complexity is due to influence of human activities (pollution, fertilizer use), but also that factors other than temperature become relatively more important as temperature no longer is a main constraint for growth. A specially designed method based on linear regression was developed for dating of the shells and for analysis of seasonality of growth. The method eliminates any periodicity that may occur in the temperature data since this may make the dating ambiguous. Also, some constraints regarding negative growth were added to increase the accuracy and efficiency of the analyses. The method has been successfully used for dating of shells with uncertain collection date.

Clonal persistence in *Lasaea* - inferences from single-copy nuclear gene trees

Diarmaid Ó Foighil and Joong-Ki Park [diarmaid@umich.edu / Parkjk@umich.edu]
Museum of Zoology and Department of Biology, University of Michigan, Ann Arbor, Michigan 48109-1079

The cosmopolitan intertidal clam genus *Lasaea* is one of a few animal groups which contain asexual lineages that may have persisted for an evolutionary significant timespan. This reasoning is based on the finding of exceptional mitochondrial genetic divergence levels between clonal and sexual lineages and the presence of regional clades of genetically diverse clones. However, mitochondrial gene divergence data merely yield a maximal estimate of clonal persistence and may considerably overstate their actual longevity as asexual entities. We tested the hypothesis of clonal longevity in polyploid *Lasaea* lineages by constructing single-copy nuclear gene trees for regionally monophyletic clades. Tree topologies were largely consistent with that predicted for long-lived clones: divergent within-individual allelic sets that resolve into reciprocally monophyletic clades, each clade containing alleles from a variety of genetically distinct clonal lineages. A small minority of alleles show evidence of recombination. Although they do appear to be long-lived, polyploid *Lasaea* clones may have not been strictly amictic since their genesis.

Speciation, gene flow and hybridization of hydrothermal vent endemic mussels from the mid-Atlantic ridge

Gregory O'Mullan
Center For Theoretical and Applied Genetics, Room 318C, Marine and Coastal Sciences Bldg., Dudley Road, Cook College, Rutgers University

Two species of vent endemic mussels (Bivalvia: Mytilidae) were identified from the mid-Atlantic Ridge. These mussels inhabit the ridge system in patchy populations dependent upon chemosynthetic bacteria, which thrive on chemically enriched hydrothermal effluents. Prior studies confirmed the identity of these two species with molecular and morphological techniques. Our genetic analyses, using allozymes and mitochondrial ND4 sequences, clearly demonstrated that the two species are separated on a north/south gradient. Furthermore, they revealed hybridization at one mid-range, mid-depth hydrothermal field. An analysis of gene flow suggested that this pattern of differentiation between species is not a consequence of isolation-by-distance; instead it suggests some degree of genetic incompatibility between the species.

Radula and shell morphometry of Thai micro-snails

Somsak Panha [somsakp@sc.chula.ac.th] and Piyoros Tongkerd
Department of Biology, Faculty of Science, Chulalongkorn University, Bangkok, 10330 Thailand

The classification of micro-snails at present is still very confusing, because it has been based mostly on the characteristic of the shells. In this work, we examined the morphology of the radulae and shells of snails in 5 families: Cyclophoridae, Diplommatinidae, and Hydrocenidae, in Subclass Prosobranchia; Cyrychiidae, Urocoptidae and Vertiginidae, in Subclass Pulmonata. An examination of the relationship between the average radula sheet width and average shell parameters (shell height, shell width, vertical aperture, and horizontal aperture) for each type of snail, in term of correlations, show that the radula sheet width is significantly related to shell width ($p<0.01$), vertical aperture ($p<0.05$) and horizontal aperture ($p<0.05$). The results of the shell morphology study indicated a statistically significant relationship between the shell width and shell height, as revealed by regression analysis. An ANOVA analysis of the ratios between shell width / shell height, vertical aperture / shell height, and horizontal aperture / shell height also indicates a significant difference. (Supported by grants from The TRF/Biotec Special Program for Biodiversity Research and Training grant BRT 139035 and in part of The Hitachi Scholarship Foundation).

Reminiscences on malacology in the twentieth century

Juan Jose Parodiz
Curator Emeritus, Section of Invertebrate Zoology, Carnegie Museum of Natural History, Pittsburgh, Pennsylvania 5213-4080

The *American Malacological Society*, formerly, the *American Malacological Union*, was founded in this century to further the interests of American malacologists. The first meeting of the *AMU* that I attended was in 1950. It was at this time that I had the pleasure of meeting Dr. Fritz Haas. The 1952 meeting was held in Kansas City and was attended by only 14 people. In 1965, while I served as President of *AMU*, the meeting was held in New York City. This was a critical time for the organization.

Aside from historical anecdotes of the *AMU* history, I would like to dwell on some of the personalities of 20th century malacologists. I met Dr. Henry Pilsbry of the Academy of Natural Sciences (Philadelphia) in the 1940. 1 would like to recount some of his dealings in the South American fauna, as well as my visits to him in Philadelphia and his work habits. I met Dr. W. J. Clench in 1950. 1 will say a few words about him as curator of the Museum of Comparative Zoology (Harvard) and about his sense of humor. I will conclude with a few thoughts on a lovable team of old timers, Morris Karl Jacobson and A. d'Attilio.

Donating amateur collections to museums

Timothy A. Pearce [tpearce@delmnh.org]
Delaware Museum of Natural History, Box 397, Wilmington, Delaware 19807-0937

Amateur collectors continue to make valuable contributions to science by donating their collections to museums. Donors benefit through tax deductions, gaining 'immortality' by being recorded as collector or donor on specimens to be kept indefinitely, and knowing that the specimens they spent (enjoyable) hours assembling will have lasting scientific value. Museums benefit by increasing the size and scientific value of their collections.

Museums are the libraries where scientists find specimens to study, so museums accept and curate specimens that future scientists may need. Two considerations are information, and preservation method. First, specimens most valuable scientifically have locality data describing where they were collected. Additional scientific value comes from other information that cannot be determined from study of the specimen itself. Such extrinsic information might include date collected, habitat, behavior, and collector's name. Secondly, besides dry shells, scientists have traditionally relied heavily on study of soft parts. Most museums accept donations of specimens with preserved soft parts, the most common preservative being ethyl alcohol.

Collectors can improve the speed and likelihood that their donation will be incorporated into a museum. Communicate with museum staff early, when you are building your collection. Arrange for your collection and data to be donated in case you become incapacitated. Include locality data as part of the donation and assure that data are understandable and unambiguously associated with the specimens. Include with the donation copies of documents showing that protected species were obtained legally. Consider also a financial donation or volunteering time toward curating the specimens.

Monoplacophoran evolution in the Cambrian

John S. Peel and Alexander Gubanov [john.peel@pal.uu.se]
Department of Earth Sciences (Historical Geology and Palaeontology), Uppsala University, Norbyvägen 22, S-752 36 Uppsala, Sweden

Cambrian monoplacophoran molluscs show considerable variation in shell form, ranging from limpets to tightly coiled shells which may be bilaterally symmetrical, dextral or sinistrally coiled. This diversity has provided fertile ground for speculation about early molluscan evolution. While almost all extant molluscan classes are known from the late Cambrian, the relationship of these, including the Tergomya, to late Vendian-early Cambrian micro-molluscan faunas dominated by heicionelloids is highly problematic. Yet these heicionelloids, appearing in the earliest stages of the 'Cambrian Explosion' display surprising ecological diversification. In exploring this diversity we will review the question of small size, distribution of asymmetry and the stratigraphic and palaeo-geographic records of helcionelloids to better understand this first great radiation of the Mollusca.

The molluscan literature: its usage and limitations

Richard E. Petit [repetit@compuserve.com]
P.O. Box 30, North Myrtle Beach, South Carolina 29597

The difficulty in determining the type species of genera is a matter of concern and some overlooked sources are discussed, including the *Review Critique de Paleozoologie*.

The listings in the "References Cited" section of a paper reveal much more than just which works have been consulted. Incorrect or incomplete citations demonstrate a lack of familiarity with works being cited. Reliance on other authors for these data can result in unnecessary errors making it difficult for others to locate the cited works.

Reliance on the completeness and accuracy of the publications of workers whom we hold in high regard is often misplaced. Published lists of taxa, whether of an area or of a supraspecific group, should not be taken as complete. Even lists compiled by many authors over a period of years contain errors and omissions. Such lists will become more of a problem as certain workers insist that a name included on such a list be considered the valid name of a taxon regardless of priority.

It should now be possible to establish two web sites. One to list taxa, including other pertinent data such as type species for genera and type repository for species, and another to list all molluscan literature. This would be a long-term project but could have a significant impact. Ideally, this site would also list location of reviews, repositories of rare works, and other esoterica.

Cambrian and Ordovician Diasome mollusk

John Pojeta, Jr. [pojeta.john@nmnh.si.edu]
U.S. Geological Survey, National Museum of Natural History, MRC 137, Smithsonian institution, Washingtont DC 20560

Diasoma is a systematic category used to show the presumed phylogenteic relatioship of the molluscan classes Rostroconchia, Pelecypoda, and Scaphopoda, separate from other conchiferan mollusks. Rostroconchs have an origin in Lower Cambrian rocks, have a poorly documented Middle Cambrian record, and the heyday of their evolution is in Late Cambrian and Early Ordovician time when they were most diverse, occurred in both carbonate and clastic rock facies, and had a worldwide distribution. In the later Ordovician, their morphological and species-level diversities declined. Undoubted pelecypods first occur in Lower Cambrian rocks. There is considerable disagreement about Middle and Late Cambrian taxa that are considered to be pelecopods by some authors. However, beginning in Lower Ordovician rocks, and continuing throughout Ordovician time, pelecypods underwent a dramatic diversification at all taxonomic levels, are found in both clastic and carbonate facies, and explored many of the life styles that they show in younger rocks, although shallow burrowing and byssally attached modes of life predominate. The oldest known scaphopod occurs in upper Middle Ordovician rocks, and a second species may occur in Upper Ordovician rocks; they are never diverse in the fossil record.

Influence of thermal environment on shell microstructure

Robert S. Prezant (1), Antonieto Tan (2), and Eric Chapman (1)
[rprezant@qc.edu / atan@worc.mass.edu / eric_j_c@hotmail.com]
(1) Biology Department, Queens College, City University of New York, Flushing, NY 11367;
(2) Department of Biology, Wooster College, Wooster, Massachusetts 01602

Macrostructural changes in molluscan shell induced by the environment have been well documented. Changes in shell form of the three-ridge mussel *Amblema plicata,* for instance, and those of oysters grown in different current regimes are well known. Less well known are changes in shell microstructure induced by environmental change. Such microscopic variations could reveal subtle shifts in environment over short or long periods of time.

We have recorded microstructural changes in shell of several species of marine and freshwater molluscs maintained in different thermal regimes. Some of these structures, such as so-named crossed-acicular lamels in *Corbicula fluminea*, could reflect a loss of organization of the more highly structured crossed lamellar layers. Thermally induced changes in the *in utero* shell thickness of the crossed lamellar layer of brooded *Campeloma decisum* could reflect rate of calcification. Other modifications signify redirection or alteration in crystallization patterns. Some spiral features could be correlated with environment. These changes likely reveal a shift in shell deposition milieu, possibly from changes in enzyme dynamics, carbonic acid load and/or site and path of nucleation during exposure.

The Bellerophont controversy revisited

Harold B. Rollins and John A. Harper [snail@vms.cis.pitt.edu]
Department of Geology, University of Pittsburgh, Pittsburgh, Pennsylvania 15260;
Pennsylvania Geological Survey, Pittsburgh, Pennsylvania 15222

During the 1970s and early 1980s, a controversy concerning the systematic placement of the Bellerophontida - a group of planispirally coiled marine molluscs typically considered to be primitive gastropods, Including the Heicionelloidea and Bellerophontoidea ("bellerophonts") - emerged in the paleontologic literature. This was not a new controversy as many of the points of contention; had been raised in the 1940s. The primary issue of the 1970/80s was this: certain Bellerophontoidea have multiple,

symmetrical muscle scars preserved on internal molds (steinkerns). One camp, headed by Bruce Runnegar and John Pojeta, insisted that, because multiple, symmetrical muscles suggest metamery, the Bellerophoniida must have been untorted and, therefore, were monoplacophorans rather than gastropods. Another camp, headed primarily by John Peel and Robert Linsley, argued that single pairs of muscles and various gastropod-like features of some "bellerophonts" indicate that many of these animals were gastropods. They conceded that other Bellerophontida were monoplacophorans. Although distinguishing between the separate lineages would be difficult, it could be done by analyzing all the shell features and not just the muscle scars (which were notoriously rare). Yet a third camp, headed by us and Ellis Yochelson, insisted that "bellerophonts" were gastropods. In 1982 we presented evidence that the various arguments for "bellerophonts-as-monoplacophorans" were specious and concluded that all "bellerophonts" were gastropods. We weren't sure what the systematic placement of the Helcionelloidea was, but subsequent research by John Peel has resulted in their attaining their own new molluscan class, the Heicionellida. In this presentation, we revisit the "bellerophont controversy", show its impact on the taxonomy of these enigmatic molluscs through the literature of the 1980s and 1990s, and suggest further avenues of research for solving their systematic placement.

Database design for mollusk collections

Gary Rosenberg [rosenberg@acnatsci.org]
Academy of Natural Sciences, Philadelphia, Pennsylvania 19103

The malacology department at the Academy of Natural Sciences has used computerized databases for collection management since 1976. The database system has evolved from a flat file system in Selgem, through Focus, to a relational, multitable structure in Paradox, and now is being migrated to a fully normalized, multitable structure in Access. The successes, challenges and problems that we have encountered over the years allow me to offer some thoughts on optimal database design for mollusks collections, be they two hundred specimen amateur collections, or half million lot museum collections.

No single database system will answer the needs of all potential users. Instead databases must be designed to have a core set of standard fields that let them easily perform standard functions and exchange information with other databases. Around this core set of fields, other fields and functions can be added, depending on the size and uses of a collection, and the questions that will routinely be asked. Standard functions are printing labels and catalog pages and running queries and printing reports based on taxonomy and geography. More advanced functions include error-checking capabilities and incorporating images of specimens. All of these functions can be readily performed in widely available commercial packages such as Access 97, Paradox 8, and FileMaker Pro 4.

The composition of the mollusc shell as a proxy for molluscan physiology

Gary D. Rosenberg [Grosenbe@iupui.edu]
Department of Geology, Indiana University-Purdue University, Indianapolis, Indiana 46202

This paper suggests that the composition of the shell of the blue mussel, *Mytilus* sp. is a proxy for its own physiology as well as for the environment in which it lives. If true, then it may be possible to extract important physiological information from the composition of other mollusc shells as well. Digital imaging of the outer shell layer of *Mytilus* sp. shows that magnesium (Mg) and sulfur (S) are concentrated along the margins of calcite prisms, but especially along the terminations of the crystals.

Compositional growth bands of high Mg and S content occur where the terminations of adjacent crystals are aligned in rows. These observations suggest that the organism actively uses Mg and S to control the elongation of the crystals in its shell, hence to determine shell shape along different axes. Regions of the shell with high Mg and S content appear to have been deposited by mantle with a relatively high glucose

metabolic activity, inversely shell with a high calcium (Ca) content. Stable carbon (C) isotope ratios in the mineral of *Mytilus* shell (measured by other researchers), and preliminary nuclear magnetic resonance (NMR) spectroscopy of the mantle (studied by the present researcher), offer independent support for the results of the glucose metabolic studies. Ultimately, it may be possible to develop a comprehensive model of molluscan growth predicting the influence of mantle physiology as well as of environmental determinants on shell chemistry and form over the course of the animal's lifetime.

Anatomy of *Seguenzia mirabilis* Okutani with phylogenetic reevaluation of Seguenziidae (Vetigastropoda: Seguenzioidea)

Takenori Sasaki, Eiji Tsuchida, and Takashi Okutani [takeno@geol.s.u-tokyo.ac.jp / tsuchida@ori.u-tokyo.ac.jp]
(1) Geological Institute, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo I 1 3-0033, Japan;
(2) Ocean Research Institute, University of Tokyo, 1-15-1, Minamidai, Nakano-ku, Tokyo 164-8639, Japan;
(3) College of Bioresource Sciences, Nihon University, 1866, Kameino, Fujisawa 252-8510, Japan

The family Seguenziidae consist of small trochiform gastropods diversified exclusively on deep-sea muddy bottom. Although this group has been variously allocated among higher categories of gastropods, past discussions were founded on limited observation without reliable descriptions, Recently we obtained live material of *Seguenzia mirabilis* Okutani, 1964 from off Miyake-jima, Japan at depths of 2480-2516 m and observed its anatomy by gross dissection, SEM, and serial sections. The results include some significant character states such as: 1) 5 right and 3 left epipodial tentacles of hitherto undocumented type, 2) striking sexual dimorphism in snout and hypobranchial glands, 3) left monopectinate ctenidium lacking true bursicles, 4) right epipodial penis in male, 5) bipartite receptaculum seminis on left side in female, 6) paired kidneys with different histology and distinct openings, 7) unusual type of buccal mass structure, 8) esophagus of vetigastropod type, and 9) concentrated configuration of circumesophageal nerve ring. A cladistic analysis based on a new data set confirmed that *Seguenzia* is the first offshoot within the monophyletic taxon, Vetigastropoda (*Seguenzia* + Lepetodrilidae + Trochoidea + Zeugobranchs). Synapomorphies of vetigastropod subclades were redefined based on this new result.

Reexamination of the history of living and fossil nautilid cephalopods

W. Bruce Saunders and Peter D. Ward [wsaunder @brymawr.edu / argo@u.washington.edu]
Department of Geology, Bryn Mawr College, Bryn Mawr, Pennsylvania 19010;
Department of Geological Sciences, University of Washington, Seattle, Washington 98195

The Nautilida are the only extant group of nautiloid cephalopods. They are represented today by two genera (*Allonautilus* and *Nautilus*) and five or six species, restricted to deep fore-reef habitats in the Indo-Pacific. Fossil nautilids, however, include at least 1,000 post-Triassic (250 Ma) species and scores of genera. Their history and phylogeny have been thought to be well understood, and their systematics have remained relatively unchanged for half a century, during which three tenets have remained unchallenged: 1) nautilids were evolutionarily conservative, showing little morphological change since the end of the Triassic; 2) most genera can be differentiated by just one or two characters; and 3) the last member of the clade, *Nautilus*, evolved in the past 5 million years or so. However, new information about living populations, species variation, and new fossil finds, prompts a re-evaluation of both the phylogenetic interpretation and classification of the group. It now appears that the post-Jurassic taxa were vastly over-split and that the genus *Nautilus* dates back at least to the middle Cretaceous. Cladistic re-evaluation of the group refutes previous phylogenetic hypotheses, and confirms the status of living nautilids as bonafide living fossils.

Phylogeny of *Lyratoherpia* (Amphineura: Dondersiidae) and problems concerning types

Christoffer Schander and Amélie H. Scheltema
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543

Lyratoherpia was instituted by Salvini-Plawen in 1978 with *Lyratoherpia caritiata* as the type species. The original publication also included a second species, *L. bracheata* that was doubtfully included in the genus. An additional species, *L. incali* was published by Scheltema in 1999. A search through already collected material from the deep-sea revealed additional species that is in progress of being described. The characters of these species are coded and analysed cladistically. The type species of *Dondersia, D. festive,* is redescribed and used as outgroup.

The phylogeny of the Dondersiidae Simroth, 1899, is virtually unknown. Presently, it is however, impossible to perform a cladistic analysis due to unavailability of type material. Today the following taxa are referred to Dondersiidae: *Dondersia,* and *Lyratoherpia,* (type species currently reexamined); *Rupertomenia* (no types designated); *Squamatoherpia* and *Helluoherpia* (designated types have not been deposited in museum); *Micromenia* (type material in Monaco Museum - not allowed out on loan); *Stvlomenia* and *Nematonmenia* (type material, as for most Pruvot's species, currently unknown).

Why the Middle Cambrian *Wiwaxia* may he ancestral to the Mollusca

Amélie H. Scheltema and Christoffer Schander [ascheltema@whoi.edu / cschander@whol.edu]
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543

Wiwaxia corrugate (Matthew) was a sclerite-covered, soft-bodied bilaterian preserved in the Middle Cambrian Burgess Shale. There are several reasons for considering that it is closely related to the Mollusca. (1) The form of the eating apparatus appears to be a radula with teeth similar to the plesiomorphic aplacophoran radula. (2) The sclerites of *Wiwaxia* are solid (Butterfield 1990, *Paleobiology* 16:287), the plesiomorphic state for Aplacophora known from ontogeny. The morphologies of wiwaxiid sclerites can be found in aplacophoran spicules, including linear ornamentation and fine lineations, small acuminate distal projections, and attachment "roots" (i.e., a proximal "handle"). Thus, these morphologies are not restricted exclusively to polychacte paleae as indicated by Butterfield. (3) The transformation from the mineralized sclerites as found in *Halkieria* to the nonmineralized sclerites of *Wiwaxia* is paralleled by the spicules of the neomenloid aplacophoran *Notomenia clavigera* Thiele, which are nonmineralized rather than aragonitic as they are in all other known aplacophorans. (4) The repeated sets of dorsal upright wiwaxiid spines are mirrored in the repeated rows of aplacophoran spicules found in an early neomenioid postlarva and reflect dorsal ectodermal segmentation more fully expressed by polyplacophorans. (5) *Wiwaxia* is dorsoventrally flattened with a broad creeping sole as in the more primitive Mollusca. We thus consider that (1) *Wiwaxia* should be included in a clade with the Mollusca, and (2) it should not be considered as part of the stem lineage of the Annelida (Conway Morris & Peel 1995, *Phil. Trans. R. Soc. Lond.* B 347:305). (Funded by National Science Foundation PEET grant DEB-9521930)

Phylogenetic significance of Cardioidean shell microstructure

Jay A. Schneider and Joseph G. Carter [jaschnei@geology.wisc.edu / clams@email.unc.edu]
Department of Geology and Geophysics, University of Wisconsin, 1215 W. Dayton St., Madison Wisconsin 53706;
Department of Geology, University of North Carolina, Chapel Hill, North Carolina 27599

The shell microstructure of Carboniferous and Triassic permophorids, Triassic and Recent carditids, Devonian, Carboniferous, and Triassic crassatelloideans, and Jurassic through Recent cardioideans, viewed in a stratigraphic context, suggests that the Cardioidea evolved from permophorids through early carditid intermediaries, rather than from astartids or myophoricardiids. In the absence of stratigraphic data and

other evidence for phylogenetic relationships, cardiid shell microstructure offers limited potential for subfamily-level phylogenetic analysis because convergences reflecting adaptations for fracture control, abrasion resistance, and metabolic economy of secretion in tropical, oligotrophic habitats. Cretaceous cardiids completely replaced an ancestral laminar, matted structure in their inner shell layer with non-laminar porcellaneous structures, evolved better defined CL structure, evolved stronger reflection of the shell margins, and evolved increased thickness or secondary loss of the ancestral prismatic shell layer. Some Cenozoic cardiids then evolved wider first-order crossed lamellae, non-denticular composite prisms, compound fibrous prisms, ontogenetic submergence of a juvenile non-denticular composite prismatic outer shell layer into the CL middle shell layer or ontogenetic submergence of the inner part of a juvenile fibrous prismatic outer shell layer into the CL middle shell layer.

Taxonomic revision and zoogeogaphy of Magellanic Nudibranchia (Gastropoda: Opisthobranchia)

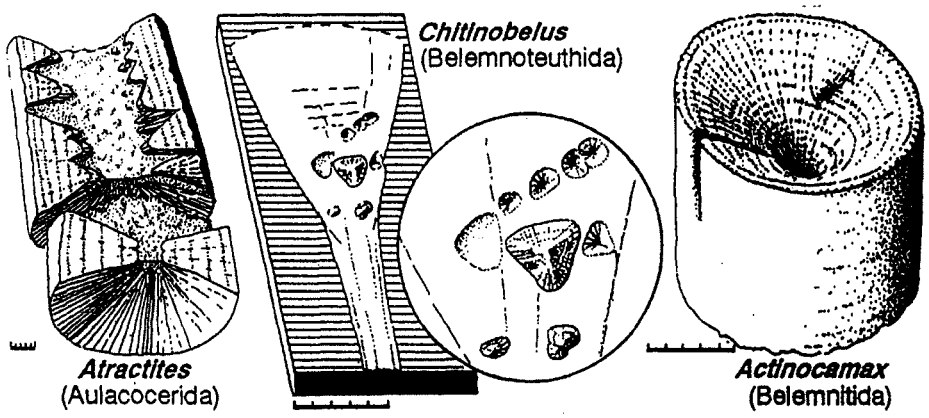
Michael Schrödl [schroedl@zi.biologie.uni-muenchen.de]
Zoologisches Institut der Ludwig Maximilians-Universität, Karlstr. 23, 80333 München, Germany

The nudibranch fauna of the South American shelf south of 41^{0}S, the Magellanic faunal province, was in extreme taxonomic confusion. For a comprehensive revision, more than 2000 specimens were collected from the Chilean and Argentinian coasts. Re-exaniination of types and other museum material of relevance revealed an unexpected number of essential errors in the original descriptions, i.e. regarding the genera *Anisodoris, Cadlina, Tyrinna, Geitodoris, Gargamella, Tritonia,* and *Phidiana.* A main result from extensive morphological and histological studies is the high variability observed in many species. In summary, only 36 of 57 nominal Magellanic nudibranch species are considered to be valid here, others being in synonymy, *nomina dubia* or *nomina nuda.* The Magellanic nudibranch fauna is composed of Doridoidea (20 species), Aeolidoidea (11 species) and Dendronotoidea (5 species). "Arminoidea" seem absent, while being numerously reported from the nearby Antarctic. Considering 36 of 57 nominal Magellanic species, the degree of endemism has been decreased drastically from 70% to 31%. Many species are shown to be widespread within the Magellanic province and to overlap northwards into the Peruvian Province and into northern Argentina. Relationships between the nudibranch faunas of the temperate north- and southeastern Pacific are indicated by bipolar species as well as by twin species pairs separated by the tropics. Towards the south, the antarctic convergence appears to be an effective distributional barrier for nudibrachs since only 3 Magellanic species are shared with Antarctica.

Conellate biomineralization in belemnoid rostra

Adolf Seilacher and Johannes S. Pignatti [cgeodolf@tuebingen.netsurf.de]
Geological Institut, Sigwarstr. 10, D-72076 Tübingen and Kline Geological Laboratory, Yale University, New Haven, Connecticut 06520-8109 CNR, Dipartimento di Scienze della Terra, Università di Roma, P.A. Moro 5, I-00158 Roma

The paradox that Liassic *Atractites* are found only as phragmocone steinkerns in the Mediterranean realm and as massive rostra in other regions (Alps, Chile, Western Canada, Timor) is explained by an incipient mode of calcite mineralization in the form of conellae. It occurred in cooler oceans and affected only sections of the rostrum, while the still aragonitic parts became either recrystallized or diagenetically dissolved. Since conellae are also observed in *Chitonbelus* and in the pseudoalveole of the Cretaceous *Actinocamas*, a Carterian (1998) biomineralizational history applies to all calcitic belemnoid rostra.
[Figures on next page.]



Belemnoid rostra: Seilacher and Pignatti

Molecular systematics, hidden diversity, and forgotten species: a case study of the genus *Potamilus* Rafinesque 1818

Jeanne M. Serb, Kevin J. Roe, and Charles Lydeard [jserb@biology.as.ua.edu]
Biodiversity and Systematics, Department of Biological Science, University of Alabama, Tuscaloosa, Alabama 35487-0345

The majority of freshwater mussel species were described at the turn of the century reflecting the incredible amount of biological diversity of North American unionids. Unfortunately, the plethora of species described during this period has also created a great deal of uncertainty regarding the taxonomic validity of these names. Application of a phylogenetic species concept when questioning the validity of particular taxa can provide researchers with a justification for recognizing putative species, which may have otherwise been overlooked. Recent surveys of the upper Coosa system revealed the presence of a large, alate freshwater mussel which matched the description of *Potamilus poulsoni* Conrad 1834. Once believed to be a distinct species, *P. poulsoni* is currently considered a junior synonym of *P. alatus* (Simpson 1914) and *P. purpuratus* (Frierson 1927). A portion of the cytochrome oxidase c gene was sequenced to determine if the *P. poulsoni*-like specimen from the Coosa system and *P. poulsoni*-type locality specimens from the Black Warrior River basin represented a species distinct from other *Potamilus*. Additionally, we reexamined the monophyly of *Potamilus* and tested the monophyly of *Leptodea* Rafinesque 1820.

Through the mud darkly, a neontologist looks at scaphopod evolution

Ronald L. Shimek [rshimek@imt.net]
RSEI, P.O. Box 4, Wilsall, Montana 59086 and Department of Biology, Montana State University, Bozeman, Montana, 59717

The proposed derivation of the scaphopods from rostroconch ancestors is based primarily on shell morphology and invalid assumptions about the internal morphology and natural history of scaphopods. Such a derivation would have bivalves as the nearest extant relatives of scaphopods.

A rostroconch ancestor is unlikely considering both morphological and behavioral characteristics of the present day scaphopods including their active predatory life style, presence of head structures such as a radula, cerebral ganglia, captacula, and proboscis. The larval shell development and axis of growth indicate development from an ancestor possessing an elongated cap-like shell. Additionally other

morphological features such as their dorso-ventral elongation, pedal retractor muscle orientation, and variation of pedal hemocoel morphology argue for a more distant relationship to bivalves. Recent proposals deriving scaphopods from nonrostroconch ancestors are more reasonable and likely than the rostroconch derivation.

Molecular phylogeography of the eastern Pacific and Caribbean Patellogastropoda

W. Brian Simison, [simey@socrates.berkeley.edu
UC Museum of Paleontology and Integrative Biology, UC Berkeley, Berkeley, California 94720

The eastern Pacific shores present a variety of interesting biogeographical patterns: endemism in the Gulf of California and the Galapagos; trans-equatorial distributions; sibling pairs across the isthmus of Panama; latitudinal diversity gradients and paleontological cycles of provincial compression and expansion, just to name a few. The sources of these patterns may be identified with a historical understanding of the faunas involved. The Patellogastropods or limpets are found throughout the Pacific and Caribbean and have been described as participating in all of the patterns mentioned above. A nearly complete sampling of eastern Pacific and Caribbean limpets have been sequenced for 16s and COI to construct a phylogenetic hypothesis. The result is a robust phylogeny and a foundation for reconstructing the historical events responsible for patterns of limpets distribution. We have examined the phylogenetic source of limpets endemic to the Gulf of California, the phylogenetic relationship of Caribbean and eastern Pacific limpets, trans-equatorial Chilean and Californian limpets, and possible ties between Japanese and California limpets.

Phylogenetic relationships of the introduced freshwater clam *Corbicula*

Sirirat Siripattrawan [siripatr@umich.edu]
Museum of Zoology, University of Michigan, Ann Arbor, Michigan 48109

The taxonomy of *Corbicula* is based largely on shell characters, some of which may have ecophenotypic plasticity. Variability in shell morphology has in the past led to excessive species-naming, so the number of nominal species in the genus is very large. Since the exotic clam *Corbicula* was introduced into North America more than 70 years ago, many studies on North American *Corbicula* have been published. However, until now there is still some controversy whether North American *Corbicula* represent one, two or more species.

I am studying the karyology and molecular phylogeny of North American *Corbicula*. My preliminary results show that North American *Corbicula* may be exclusively triploid. Preliminary CO I gene sequences distinguish two genetic lineages which correspond to white and purple shell morphs. I plan to determine the phylogenetic relationships of these two morphs by incorporation of a variety of Asian *Corbicula* species.

Tapping the unexplored: midgut morphology of cerithioidean gastropods (Caenogastropoda) - preliminary results and implications for homology and phylogeny

Ellen E. Strong and Matthias Glaubrecht [eestrong@gwu.edu / Matthias.Glaubrecht@rz.hu-Berlin.de]
Department of Biological Sciences, The George Washington University, Washington, DC 20052;
Institut für Systematische Zoologie, Museum für Naturkunde, Invalidenstrasse 43, D-10115, Berlin, Germany

The Cerithioidea is a large group of ~200 genera with a pan-tropical and subtropical distribution. Members of the group are predominantly marine, with representatives in fresh and brackish water environments.

Existing descriptions of midgut morphology, although restricted almost entirely to marine and brackish water representatives, nevertheless suggest a high diversity of midgut morphologies within the group. However, these scattered previous descriptions have not been synthesized into a coherent picture with explicit and consistent hypotheses of homology. In order to evaluate the putative homology of the complex and diverse modifications of cerithioidean midguts, we compared classic studies of midgut morphology and integrated them with new data, including representative marine *(Diala, Campanile, Cerithium, Lampanella, Modulus, Planaxis),* brackish *(Telescopium, Terebralia),* and freshwater *(Brotia, Cleopatra, Elimia, Faunus, Lavigeria, Leptoxis, Melanatria, Melanoides, Melanopsis, Pachychilus, Pleurocera, Potadoma, Semisulcospira, Stenomelania, Tarebia, Thiara)* taxa. These investigations have revealed numerous previously unexplored features that are recognizable across otherwise morphologically diverse taxa, including: glandular pad, crescentic ridge, caecum, sorting area fold, crescentic regions of septae within stomach roof, accessory pads, and differential fusion of style sac typhlosoles. This comparative survey indicates that the cerithioidean midgut poses a significant untapped resource of characters suitable for phylogenetic analysis, with a potential to be informative at a variety of taxonomic levels. The implications of these features for the phylogeny of the Cerithioidea will be discussed.

Archival and curatorial practices for the amateur malacologist

Charles F. Sturm, Jr [csturmjr@pitt.edu]
Research Associate, Section of Invertebrate Zoology, Carnegie Museum of Natural History, 4400 Forbes Avenue, Pittsburgh, Pennsylvania 15213-4080

An amateur collection of mollusks will have one of several fates. One is donation to a university or museum for addition to their research collection or for use in exhibitions and education. Another is to be given or bequeathed to a friend. It may be sold for its current monetary value or donated to an organization to be sold to further its goals. Lastly, it may be thrown out with the trash. Except for the last course of action, the recipient of the collection will realize an enhanced value if basic principles of archival practices were followed while the collection was being amassed. Sources of information on archival practices are widely scattered and often poorly known to the amateur. This results in few amateurs taking full advantage of these practices.

A basic understanding of archival practices will be presented. The philosophical principles of following archival practices will be discussed. Concepts of archival papers and inks will be covered, as will storage practices. Materials for constructing cabinets will be reviewed as well as environmental storage factors such as temperature, humidity and pests. Bynesian Deterioration of shells and how to prevent it will also be explored. Other archival aspects such as the long-term stability of digital storage methods will be reviewed. To make it easier for people to follow these practices, sources of archival materials will be mentioned as well as the cost of instituting these practices. Lastly, organizations and publications where one can turn to for further information will be presented.

Shell microstructure analysis of 8 vesicomyid clams: evolutionary implications

Matthew Tieger [mtieger@rci.rutgers.edu]
Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, New Jersey 08901

This study represents ongoing research on shell microstructure of deep-sea hydrothermal vent clams of the family Vesicomyidae. Limited collections and conflicting results from morphological and molecular based phylogenies have made the taxonomy of these clams difficult. Studies based on external shell morphology and hinge characteristics have divided the family into 3 genera; *Calyptogena*, *Vesicomya*, and *Ectenagena*, or alternatively with *Ectenagena* as a sub genus of *Calyptogena*. Recent allozyme studies and mitochondrial DNA (Cytochrome Oxidase I) phylogenies, however, do not support the morphological based taxonomy.

This study characterizes the internal shell microstructure of 8 vesicomyid clams using scanning electron microscopy. The clams included in this study are: *Vesicomya gigas*, *V. cordata*, *V. lepta*, *Calyptogena kilmeri*, *C. ponderosa*, *C. elongata*, *C.* sp. aff. *kaikoi*, *Ectenagena extenta*. In an effort to help resolve the controversy of vesicomyid phylogeny, shell microstructure characteristics of these vesicomyids in addition to published data on *C. magnifica*, *C. pacifica* and *C. phaseoliformis* will be compared with existing morphological and molecular taxonomy.

Molluscan diversity and sediment toxicity in Biscayne Bay, Florida

Donna D.Turgeon [dturgeon@ocean.nos.noaa.gov]
Center for Coastal Monitoring and Assessments, National Centers for Coastal Ocean Science, National Ocean Service, National Oceanic and Atmospheric Administration, Building SSMC4 Room 10224, 1305 East-West Highway, Silver Spring, Maryland 20910-3231

NOAA's National Status and Trends (NS&T) Program assesses US coastal benthic communities in relation to contamination. Since 1990, infaunal assemblages and selected environmental parameters (i.e. salinity, dissolved oxygen, conductivity, water temperature, sediment toxicity, and toxic chemicals) have been surveyed in 15 estuaries. At stratified, randomly selected sites, sediments were collected with a Van Veen grab, sieved through 0.5 mm screens, and preserved with a 10% formalin/rose bengal solution. In the laboratory, specimens were sorted, identified to lowest practical taxonomic level, and stored in a 10% alcohol solution. All specimens have been retained; some have been sent to experts for corroboration; all will be archived in a US museum. Data are on electronic databases by density per station and area, species composition, diversity and similarity indices (e.g. Pielou's Index), and cluster analysis.

Sampled 1995-1996, molluscan infaunal biodiversity in Biscayne Bay will be characterized and correlated with selected environmental conditions. Biscayne Bay and nearby benthic assemblages are the most diverse characterized by the NS&T Program to date. An assessment of 1996 infaunal biodiversity, reveals 54,424 individual specimens in 783 invertebrate taxa from 40 stations in Biscayne Bay. In Florida Bay, 20,741 organisms in 642 taxa were identified from 26 stations. The near-shelf western benthos (west of Florida Bay from Naples to Key West) had 43,964 organisms, representing 989 taxa, at 36 stations. Polychaetes comprised from 35-37% of total taxa, and were most numerous, followed in abundance by gastropods (totaling 11 - 15% of taxa with abundances of 27%, 11%, 14%, respectively).

Constructional morphology of microscopic features in bivalve shells

Takao Ubukata [sbtubuk@sci.shizuoka.ac.jp]
Institute of Geosciences, Shizuoka University, 836 Oya, Shizuoka, 422-8529 Japan

Previous studies of hard tissue in molluscs have focused mainly on the physicochemical process of biomineralization and phylogeny of shell microstructures. However, understanding skeletal biomineralization also requires recognition of rule or algorithm forming the geometric pattern of the microstructure. The present paper will discuss morphogenetic aspects of the microscopic features of bivalve shells from the viewpoints of constructional morphology. For recognizing the kinematic process of microstructural construction of bivalve shells, geometric features of aggregated biomineral units in the radial or horizontal shell section were examined both theoretically and empirically. Many of the examined species indicated rectination and curving in the growth directions of microstructural units. In the radial shell section, the rate of crystal growth seems to decrease with the elongation of the structural unit inward, in association with curving the elongation front of the structural units and internal microgrowth increments. The geometric pattern of the feature is reasonably represented by computer simulation when the elongation of the structural units declines at a fixed lateral expansion rate throughout crystal growth and aggregated units curve inward as the result of geometric selection. In the horizontal shell section, microstructural units

tend to be inclined to the growth line near the anterior or posterior shell margin, and the angle between the biomineral unit and microgrowth increment varies among shell mirostructures. The geometric feature of the microstructure is well exhibited by computer simulation when the growth rate of the structural unit in the radial direction is not equal to that in the transverse direction.

Reconstruction of ancestral character states for coleoid cephalopods

Michael Vecchione (1), Richard E. Young (2), and David Carlini (3) [Vecchione.Michael@nmnh.si.edu]
(1) National Marine Fisheries Service, Systematics Laboratory, National Museum of Natural History, Washington, D.C. 20560;
(2) Department of Oceanography, University of Hawaii, Honolulu, Hawaii 96822;
(3) Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Virginia 23062

The coleoids include all living cephalopod species except *Nautilus*, as well as their immediate ancestors plus the belemnoids. Several hypotheses have been published about the morphology of ancestral coleoids. Ancestral states are easily inferred for some characters, such as 10 arms and the presence of an ink sac in basal coleoids or the presence of fins in ancient octopods. Many inferences are less strongly supported, though, and open to debate. We examine this problem using cladograms resulting from analyses of morphology and DNA sequences from samples representing the full diversity of extant species. Ancestral character states are reconstructed using cladistic parsimony. We demonstrate the effect that changes in subclade resolution can exert on inferences about basal nodes. We then compare our reconstructions with those previously published.

Experimentation in the early chitons and the building of a bodyplan

Michael Vendrasco and Bruce Runnegar [mikev@ess.ucla.edu / runnegar@ess.ucla.edu]
Department of Earth and Space Sciences, University of California, Los Angeles, California 90095-1567

A cladistic analysis of primitive modern and fossil chitons was undertaken in order to document how the chiton bodyplan was built; to determine the relationships of some problematic fossils; to establish the time of origin of the chiton crown group; and to assess existing hypotheses for chiton evolution. The characters chosen for the analysis emphasize valve features in order to incorporate as much paleontological data as possible.

Chiton stem taxa are characterized by elongate tail valves with a posterior mucro, a shell made entirely of the outer layer (tegmentum), evenly spaced granules, esthetes that run straight through the valves, internal canals, variable patterns of valve growth, and other features. In fact, the Paleozoic seems to have been a time of experimentation for chitons. This experimentation seems to have tapered off significantly when the chiton lineage was bottlenecked during the Permian-Triassic extinction. It is tempting to exclude aberrant Paleozoic species such as *Strobilepis* from the Polyplacophora, but they share some synapomorphies with other chitons.

The chiton crown group originated in the late Paleozoic, as some of the chitons from sediments of that age belong to the modern family Lepidopleuridae. This chiton family is confirmed as a primitive group in the cladistic analysis and is also shown to be paraphyletic because the origin of the other modern chitons lies within the lepidopleurid clade.

Gastropods as prey of octopuses of the deep-sea genus *Graneledone*

Janet R. Voight [JVoight@fmnh.org]
Department of Zoology, The Field Museum, Roosevelt Road at Lake Shore Dr., Chicago, Illinois 60605

In the absence of data to the contrary, deep-sea octopuses have been assumed to ingest prey much as do shallow-water octopuses. Prey is assumed to be injected with a complex of digestive enzymes, reduced to a slurry which is minced by the actions of the radula and to undergo further digestion in the crop and stomach. The gut contents of deep-sea octopuses that have been reported contain unidentified polychaete bristles with occasional bits of small crustaceans and even ophiuroids, suggestive that deep-sea octopus feed as opportunists. The gut contents of a female specimen of *Graneledone* here reported, however, include shells of two species of gastropods in addition to polychaete bristles and polynoid jaws. Damage to the shells indicates that the octopus physically manipulated the shells prior to ingestion. Preparation of prey in this manner had not been previously demonstrated among octopods. The last issue addressed here is the habitat of the gastropod prey, both species are considered to be restricted to hydrothermal vents in the Northeast Pacific. Although cephalopods had been reported to be absent from hydrothermal vents, these data demonstrate that not only do they occur in the habitat, but that they actively prey on vent fauna.

An inflated view of a pleurotomariid mantle cavity

Janice Voltzow [voltzowj2@uofs.edu]
Department of Biology, University of Scranton, Scranton, Pennsylvania 18510-4625

The paired organs of the mantle cavities of pleurotomariids, or slit shells, are generally viewed as representing the primitive condition for gastropods. Three individuals of the pleurotomariid *Perotrochus maureri* were preserved in their expanded state for dissection and histology, yielding the first views of the histology of these animals since the beginning of this century. A pair of long, bipectinate gills filled the anterior half of the mantle cavity. The gills and their efferent membranes extended up from the corners of the mantle cavity. The afferent and efferent blood vessels were extremely large. In fact, most of the efferent membrane appeared to be a large blood sinus. Given the size of the lamellae and the blood vessels in preserved animals, it is likely that the gills in life are extremely inflated and that the filaments from the left gill meet with the right to separate the mantle cavity into a ventral incurrent chamber and a dorsal excurrent chamber.

The habitat and distribution of *Thiara granifera* in Kuan-Du wetlands northern Taiwan

Nan-Hsiung Wang (1), Yuh-Wen Chiu (3), Da-Ji Huang (1), Mark D. Bames (2) and Liang-Hsien Chen (1)
(1) Department of Biology, Chinese Culture University, Taipei, Taiwan
(2) Department of Natural Resources, Chinese Culture University, Taipei, Taiwan
(3) Institute of Zoology, National Taiwan University, Taipei, Taiwan

The diverse terrain of the Kuan-Du wetland in coastal northern Taiwan includes mangrove swamp and farmland. In order to elucidate the relationships among biotic and abiotic factors, we analyzed the distribution of the mollusk *Thiara granifera* in the wetland by sampling the species and associated environmental variables monthly from July through December 1998 at 17 stations.

The wetland sediment contained a high silt component, and exhibited pH between 7.04 and 12.0, salinity from 1 ~ 14 ‰, and a redox potential (Eh) in reduction state. Twelve species of mollusks were found inside the wetland's embankment and two species of polychaetes and seven species of arthropods outside the embankment. The dominant species was *Thiara granifera.* After dissecting specimens of *T. granifera* and counting, their larvae, we found that the number of larvae was correlated with chlorophyll concentrations in the sediment, suggesting that they may change with environment, with intraspecific competition possibly playing an important role.

Gastropod torsion - new data on an old problem in malacology

Andreas Wanninger, Bernhard Ruthensteiner, Boris Joffe, and Gerhard Haszprunar [kld1129@mail.lrz-muenchen.de / ruthenst@zi.biologie.uni-uenchen.de / bjoffe@lbc.usr.pu.ru / haszi@zi.biologie.uni-muenchen.de]
Zoologische Staatssammlung München, Münchhausenstraße 21, 81247 München, Germany

The ontogeny of torsion, a unique developmental feature that defines the Gastropoda, has been studied for over a century. However, results concerning the timing of torsion vary greatly even among closely related primitive gastropod taxa as do the proposed theories dealing with its ontogenetic mechanisms. Here we present new data on the ontogenetic torsion process in *Patella caerulea* L., a representative of the most basal gastropod clade, the Patellogastropoda.

In contrast to several earlier authors, who described two distinct phases, the whole 180° rotation in *Patella caerulea* is carried out at constant speed. At a rearing temperature of 20-22°C torsion is completed within two hours, while in various haliotid species the total duration has been reported to take from a minimum of three minutes to maximal 200 hours. Thus, we argue that data on the timing of torsion should not be used for phylogenetic interpretations.

Live observations in combination with scanning electron microscopy and fluorescence muscle staining showed that contractions of the larval shell muscles and hydraulic activities of the foot are primarily responsible for the 180° twist in *Patella*. The adult shell muscles arise independently from the larval retractors, thus fossil muscle scars of adults lack significance for ideas on torsion. Neural antibody stainings revealed, that an apical complex precedes the cerebral ganglia and that the visceral loop of the nervous system is formed before torsion and prior to the pedal system, raising doubts on current interpretations of the molluscan tetraneural nervous system.

Distributional differences in the freshwater pulmonate snails *Physo gyrina* and *Physa heterostropha*: competitive exclusion or habitat choice?

Amy R. Wethington [amyw65@juno.com]
Department of Biological Sciences, Biodiversity, and Systematics, University of Alabama, Box 870345 Tuscaloosa, Alabama 35487

Experiments were designed to test the effects of water quality and competition on two congeneric species of freshwater pulmonate snails, *Physa heterostropha pomilia* and *P. gyrina microstoma*, in order to understand their distributional patterns in the Griffy Lake reservoir and surrounding wetland areas. It was my intent to discover what ecological factors restrict the former snail to the reservoir and the latter to an adjacent wetland area (Griffy Pond). I conducted three different snail competition treatments (two intraspecific and one interspecific) and two different water treatments (lake water and pond water), each treatment containing ten cultures of four snails. These results suggest that the superior competitive ability of *P. heterostropha* keeps *P. gyrina* from spreading into the lake and the high tolerance of *P. gyrina* to heat and desiccation keeps *P. heterostropha* from invading and taking over the more productive pond. It appears that these species are not found together in nature (at least not reported in the literature) because *P. heterostropha* would outcompete *P. gyrina* in the more permanent bodies of water and because *P. gyrina* is able to take advantage of rich, temporary habitats that *P. heterostropha* can not invade.

The issue of extinct classes of Mollusca: or what is and what isn't a class of mollusks

Ellis L. Yochelson [yochelson.ellis@nmnh.si.edu]
Research Associate, Department of Paleobiology, National Museum of Natural History, Washington, DC 20560-0121

In the view of several textbook writers there is at least one class of mollusks based entirely on extinct forms. There are two fundamental issues in recognizing extinct classes. One is what criteria should be used to assign a fossil to the phylum Mollusca. The second is what is the degree of difference needed to recognize a fossil as a representative of an extinct class, and conversely what are the morphologic limits of the extant classes. A review of some of the proposals for extinct classes demonstrates that there is no consistency in usage. If one concentrates on morphology of hard parts, there may be several extinct classes if one concentrates on inferred relationships there may be none. The fossil record has been used to support the notion of one extinct class, but equally it may support the notion that there are many classes.

A comparison of living and dead molluscs on coral reef associated hard substrata in the northern Red Sea

Martin Zuschin (1), Johann Hohenegger (2), and Fritz F. Steininger (3) [martin.zuschin@univie.ac.at]
(1) Department of Geology, Texas A & M University, College Station, Texas 77843
(2) Institut für Paläontologie der Universität Wien, Althanstraße 14, A-1090 Vienna
(3) Forschungsinstitut und Naturmuseum Senckenberg, D-60325 Frankfurt, Germany

Different types of subtidal reef-associated hard substrata (reef flats, reef slopes, coral carpets, coral patches, rock grounds), each with different coral associations, were studied in order to determine the agreement of assemblages of living and dead shelled molluscs. A total area of 340.5 m² was investigated and 2846 individuals were counted at 68 sample localities ranging from shallow subtidal to 40m water depth.

Most taxa found dead in the study area were also found live and *vice versa*; differences in this respect can be related to quantitatively unimportant taxa. However, strong differences exist in the proportion of living and dead fauna, dominant taxa, and molluscan distribution patterns. The ratio of live to dead molluscs is high. Living molluscs are strongly dominated by taxa with distinct relations to corals, mainly *Pedum*, *Coralliophila* and *Tridacna*, and the encrusting gastropod *Dendropoma*. In contrast, the death assemblages are always strongly dominated by encrusting bivalves, mainly Chamoidea and Spondylidae, and cerithiid gastropods in varying dominances. Rock grounds are the only bottom type with consistent similarities of living and dead molluscs.

The observed bias is due to the close relationship of molluscan life habits and post mortem history of shells. Molluscs that lived permanently attached to or within living corals (mostly bivalves and encrusting *Dendropoma*) can easily be overgrown after death by the large amounts of living substrata available. Rapid transport of dead molluscs into surrounding sediments or into crevices within corals is typical of gastropods that feed on corals. Molluscs that colonize dead surfaces preferentially accumulate on rock grounds.

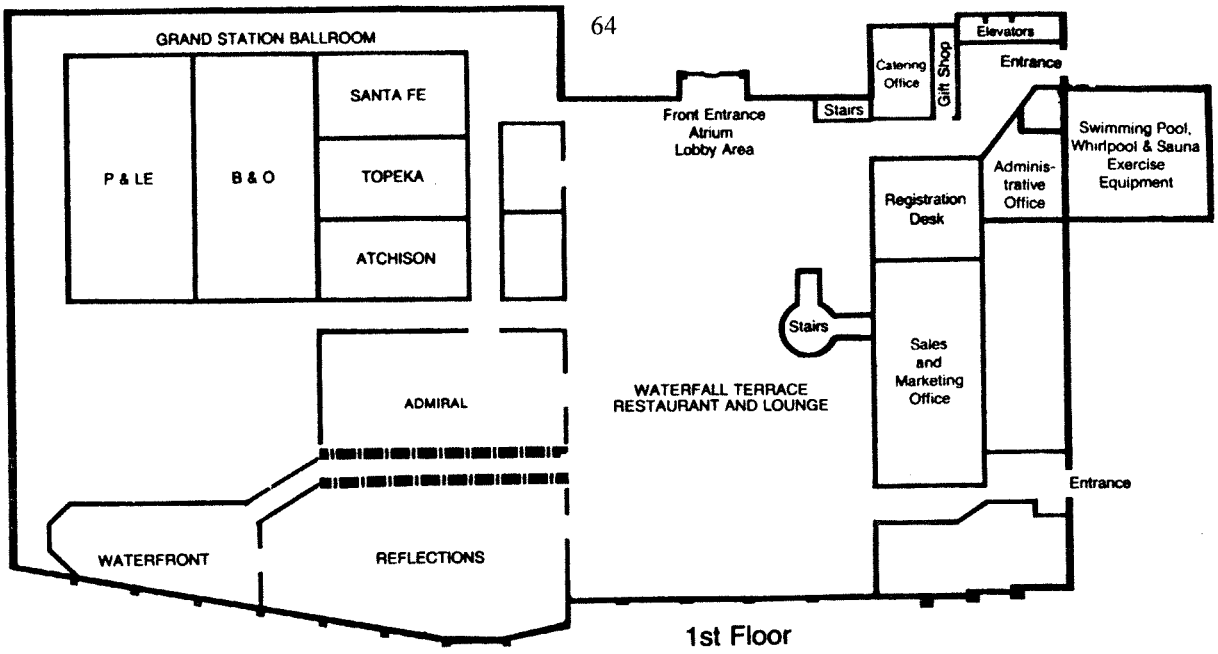
AUTHOR INDEX

(Program listing; abstract listing)

SPECIAL ACKNOWLEDGMENTS

Special thanks are due several individuals and agencies who helped insure the success of this meeting through extensive pre-meeting activities. Appreciated is the time and effort of Registration Coordinator, Ms. Fei-Wen Cheng and the additional secretarial assistance of Ms. Uma Narayan and Evelyn Talcovitz. The Bernice Barbour Foundation provided grants to assist the travel of many student participants. Queens College, City University of New York, through the efforts of Provost David Speidel and President Allen Sessoms, provided significant financial support for our meeting. Dr. Charles Sturm expended a great deal of effort towards the early stages of the *AMS* 1999 auction and art sale and helped with local arrangements. The 1999 *AMS* logo was developed and drawn by Mr. Brian Jacobson; other "t-shirt" art was drawn by Mr. Stuart Yellin. Mr. John Stack and Ms. Myrna Book represented the *Sheraton Station Square* in organizing our meeting venue. Thank you to these individuals and agencies and to the many others who helped with organization, planning and running the meeting. R. S. Prezant, President 1998-99, *American Malacological Society*

Meeting Notes



SHERATON

STATION SQUARE