



***Program and Abstracts***  
***Combined Annual Meeting***

***21 - 27 June 1997***

***Radisson Hotel***  
***Santa Barbara***



## ***Program and Abstracts***

*63rd Annual Meeting  
American Malacological Union*

*and the*

*30th Annual Meeting  
Western Society of Malacologists*

*21 - 27 June 1997*

# *American Malacological Union*

## **COUNCIL and COMMITTEES, 1996-1997**

### **Voting Members (current term)**

#### **PRESIDENT**

Eugene Coan (96-97)

#### **PRESIDENT-ELECT**

Robert Hershler (96-97)

#### **VICE-PRESIDENT**

Robert S. Prezant (96-97)

#### **SECRETARY**

Roland C. Anderson (97, by presid. appt.)

#### **TREASURER**

Eugene P. Keferl (96-00)

#### **BULLETIN EDITOR**

Ronald B. Toll (94-99)

#### **COUNCILLORS-AT-LARGE**

Kevin S. Cummings (95-97)

Gary Rosenberg (95-97)

Matt James (96-98)

Laura Adamkewicz (96-98)

#### **IMMEDIATE PAST PRESIDENTS**

Rüdiger Bieler

E. Alison Kay

Constance E. Boone

#### **PAST PRESIDENTS (4-10 YEARS)**

James H. McLean (95-97)

Fred G. Thompson (96-98)

#### **PAST PRESIDENTS (10+ YEARS)**

Dorothea Franzen (95-97)

Harold D. Murray (96-98)

### **Non-voting Council Participants**

#### **NEWSLETTER EDITOR**

Donna D. Turgeon

#### **BULLETIN MANAGING EDITOR**

Paula M. Mikkelsen

#### **NEWSLETTER ASSISTANT EDITOR**

Dawn Hard

### **Honorary Officers**

Honorary President    vacant

Honorary Life Members

William K. Emerson

Ruth D. Turner

J. Z. Young

### **1996-1997 AMU Committees**

#### **NOMINATING**

Terrence M. Gosliner, Chair

Rüdiger Bieler

James H. McLean

Kevin S. Cummings

#### **AUDITING**

Robert Hershler, Chair

Fred Thompson

Matt James

**PUBLICATIONS**

Ronald B. Toll, Chair  
 Gene Coan  
 Gene Keferl  
 Rüdiger Bieler  
 Roland C. Anderson  
 Robert Prezant  
 Fred Thompson  
 Also attending: Paula Mikkelsen  
 Donna Turgeon

**ENDOWMENT REVIEW/FINANCE**

George M. Davis  
 James Nybakken  
 Roger Hanlon

**CONSTITUTION & BLAWS**

Harold Murray, Chair  
 Donna Turgeon  
 Robert Prezant  
 Constance Boone

**AMU WEBSITE**

Deborah Wills, Chair

**STUDENT AWARDS**

Robert S. Prezant, Chair  
 Laura Adamkewicz  
 Paula Mikkelsen  
 James Nybakken  
 Gary Rosenberg  
 Ron Toll

**MEMBERSHIP**

John Wise, Chair

**CONSERVATION**

Robert H. Cowie, Chair  
 Kevin S. Cummings  
 K. Elaine Hoagland  
 E. Alison Kay  
 Matthew James  
 Barry Roth

**ARCHIVES**

George M. Davis, Chair

**AMU Living Past Presidents**

|                       |      |                        |      |
|-----------------------|------|------------------------|------|
| Ruth D. Turner        | 1957 | Harold S. Murray       | 1974 |
| Alan J. Kohn          | 1983 | Roger T. Hanlon        | 1990 |
| William K. Emerson    | 1962 | Donald R. Moore        | 1975 |
| Robert Robertson      | 1984 | Carole S. Hickman      | 1991 |
| Albert R. Mead        | 1963 | Dorothea S. Franzen    | 1976 |
| Melbourne R. Carriker | 1985 | Robert C. Bullock      | 1992 |
| Juan José Parodiz     | 1965 | George M. Davis        | 1977 |
| James Nybakken        | 1986 | Fred G. Thompson       | 1993 |
| Arthur H. Clarke      | 1968 | Carol B. Stein         | 1978 |
| William G. Lyons      | 1987 | Constance E. Boone     | 1994 |
| David H. Stansbery    | 1971 | Clyde F. E. Roper      | 1980 |
| Richard E. Petit      | 1988 | E. Alison Kay          | 1995 |
| Arthur S. Merrill     | 1972 | Louise Russert-Kraemer | 1982 |
| James H. McLean       | 1989 | Rüdiger Bieler         | 1996 |

[see membership list for contact information]

# *Western Society of Malacologists*

## **Executive Board, 1996-1997**

### **PRESIDENT**

Henry W. Chaney

### **FIRST VICE-PRESIDENT**

Sandra Millen

### **SECOND VICE-PRESIDENT**

Roger Seapy

### **TREASURER**

George Metz

### **SECRETARY**

Terry S. Arnold

### **MEMBERS-AT-LARGE**

Saxon Sharpe  
Paula Mikkelsen

### **IMMEDIATE PAST PRESIDENTS**

Hugh Bradner  
Nora Foster  
Kirstie Kaiser

## **Committees for 1996-1997**

### **EDITORIAL**

George Kennedy  
Kim Hutsell

### **HISTORIAN**

Jody Woolsey

### **NOMINATING**

Hugh Bradner, Chair

### **AUDIT**

Hal Lindahl  
David Mulliner  
Hal Norrid

### **STUDENT GRANT**

Henry W. Chaney  
Lindsey T. Groves  
James Nybakken  
William K. Emerson  
F. G. Hochberg

## **STUDENT GRANT AWARD**

The WSM student grant is given annually in competition open to graduate students working on Mollusca. The student grant fund is maintained through donations and the annual auction proceeds. Send requests for information to: Department of Invertebrate Zoology, Santa Barbara Museum of Natural History, 2559 Puesta del Sol, Santa Barbara, CA 93105, USA. Email: [inverts@sbnature.org](mailto:inverts@sbnature.org) (Attention: Henry Chaney)

## WSM Past Presidents

|                    |      |                      |      |
|--------------------|------|----------------------|------|
| David K. Mulliner  | 1968 | Donald R. Shasky     | 1982 |
| William K. Emerson | 1969 | David R. Lindberg    | 1983 |
| A. Myra Keen       | 1970 | George L. Kennedy    | 1984 |
| Eugene V. Coan     | 1971 | William D. Pitt      | 1985 |
| Beatrice L. Burch  | 1972 | Terrence M. Gosliner | 1986 |
| Twila Bratcher     | 1973 | Carole M. Hertz      | 1987 |
| James H. McLean    | 1974 | Matthew J. James     | 1988 |
| George E. Radwin   | 1975 | Hans Bertsch         | 1989 |
| James W. Nybakken  | 1976 | Roland Anderson      | 1990 |
| Helen DuShane      | 1977 | Paul H. Scott        | 1991 |
| Peter D'Eliscu     | 1978 | David K. Mulliner    | 1992 |
| Barry Roth         | 1979 | Douglas Eernisse     | 1993 |
| Vida C. Kenk       | 1980 | Kirstie L. Kaiser    | 1994 |
| Carol C. Skoglund  | 1981 | Nora R. Foster       | 1995 |
|                    |      | Hugh Bradner         | 1996 |

## 1997 Combined Meeting Committees

### WSM PRESIDENT/MEETING

#### REGISTRAR

Henry Chaney

### SYMPOSIA/SPECIAL SESSION CHAIRS

#### Deep-Sea Mollusca

Jerry Harasewych

#### Phylogenetic Systematics

Gary Rosenberg

#### North Pacific Cephalopods

Eric Hochberg

### PALEONTOLOGY FIELD TRIP

Lindsey Groves

### AUCTION [AMU/WSM]

Richard E. Petit

Henry Chaney

### REPRINT SALE [WSM]

George L. Kennedy

### ORGANIZATION

Barbara Chaney

Eric Hochberg

Anne Joffe

Marie Murphy

Barbara Prince

Sue Stephens

## GENERAL INFORMATION

### MEETING VENUES

All meeting presentations will be given at the Radisson Hotel, either in the "El Cabrillo Room" on the second floor or the "La Cantina Room" on the ground floor. These rooms are in close proximity to each other by a stairway and elevator. All session breaks will be held in the El Cabrillo Room.

### POSTERS

Posters will be displayed in the El Cabrillo Room and the adjoining Gazebo Room. Posters can be set-up from 3:00-4:00 PM on Sunday and during program breaks on Monday. They will be grouped as shown in the program schedule. The formal Poster Session will be on Tuesday at 4:10 PM. Posters can remain on display until Thursday.

### GROUP PHOTOGRAPH

The group photograph will be taken at creek side on the grounds of the Santa Barbara Museum of Natural History just prior to the closing reception and banquet, approximately 6:45 PM on Thursday. The wine will be poured and the hor d'oeuvres served once you are photographed.

### T-SHIRTS

T-shirt sales will be at the registration desk, located in the anteroom of the El Cabrillo Room. Shop early because supplies are limited.

### STUDENT PAPER COMPETITION

The AMU will be presenting awards for the best paper delivered by a student at this joint meeting. This year there are 15 such productions to be considered. Judges will evaluate presentations based on scientific content, adequacy of research approach, organization and quality of visual aids and the manner in which the student handles questions and answers. An asterisk in the program after the presenter's name designates eligible papers for this competition.

### BUSINESS MEETINGS

The business meetings for both Societies will be held Thursday afternoon in the El Cabrillo Room. Note the schedule for the correct time. All members are urged to attend.

### EVENING EVENTS

**SUNDAY:** The Presidents' Reception will be held at the Cabrillo Pavilion Arts Center, directly across Cabrillo Blvd. from the Radisson Hotel, and situated on Santa Barbara's East Beach. Wines and beers from the local region will be featured with a variety of hor d'oeuvres. The festivities begin at 7:00 PM. Come and enjoy this traditional opening night event.

**MONDAY:** Gary Rosenberg will be conducting a workshop on cladistics. This session is intended to give those unfamiliar with cladistics an introduction to its terminology, methods and philosophy. The presentation will be low-tech, giving you the opportunity to work through some examples with pencil and paper. Those so inclined can then try running some phylogenetics

programs on lap-top computers. Scheduled to begin at 7:30 PM in the Gazebo Room, adjoining the El Cabrillo Room.

Meanwhile, the traditional WSM slide night will be held in the El Cabrillo Room. All interested persons are invited to bring their photographic slides for use in short, very informal presentations.

**TUESDAY:** At 5:45 PM buses will be departing from the Radisson for the Santa Ynez Valley and the Gainey Vineyard. Included in this trip will be a tour of the facilities, a tasting of the current varietals and a barbecue tri-tip steak dinner as the midsummer sun sets over the vineyard. Return should be by 11:00 PM. Late afternoons in the valley are usually warm, but a sweater is suggested as temperatures often cool abruptly in the evening.

**WEDNESDAY:** The annual WSM reprint sale, followed by the AMU/WSM auction will be held in the El Cabrillo Room. The reprint sale will begin at 7:00 PM as will the auction preview. The actual auction commences at 8:00 PM. A selection of mollusk books and other shell paraphernalia are featured with the redoubtable Dick Petit presiding. A cash bar with light snacks will be available.

**THURSDAY:** The final night of the meeting will include a reception and banquet at the Santa Barbara Museum of Natural History. Prior to dinner, participants can tour the public galleries of the museum including two special exhibitions: "Pacific Currents," underwater photographs of life along the coastline of western North America from Mexico to Canada, and "Delights for the Eye and Mind: Images of Mollusks during the Age of Enlightenment." There are also numerous shell exhibits that are supporting the Museum's summer programs. Transportation between the museum and the Radisson Hotel is available, buses depart at 6:15 PM.

#### **FIELD TRIPS**

Announcements will be made during the meeting about final arrangements for the field trips on Friday, 27 June. The boat for the Channel Island Cruise will be departing the Santa Barbara Harbor at about 8:00 AM. The Paleontology Trip will depart the Radisson Hotel at 9:00 AM.

#### **VISIT TO SBMNH**

On Friday, 27 June the Department of Invertebrate Zoology at the Museum will be holding an Open House for all those interested in visiting the mollusk collections. The open house will begin at 9:00 AM and will last until 4:00 PM. There will be no organized transportation from the Hotel so private arrangements should be made by those without cars.



## *AMU/WSM Meeting Schedule*

|                          | <b>Morning</b>  | <b>Afternoon</b>  | <b>Evening</b>  |
|--------------------------|---|---|---|
| <i>Saturday, June 21</i> |   | - AMU Council meeting,<br>2:30 - 6:30 PM,<br>El Monte Room  | Free  |
| <i>Sunday, June 22</i>   | - AMU Council Meeting,<br>committee, 8:30 - 1:00,<br>El Monte Room  | - Check-in, Registration,<br>2:00 - 5:30 PM, Lobby<br>- WSM Board meeting,<br>3:00 - 4:00 PM, Pool-side<br>- CSM meeting, 4:00 - 5:30 PM<br>El Cabrillo Room                    | - Presidents' Reception,<br>Cabrillo Pavilion,<br>7:00 - 9:30 PM  |
| <i>Monday, June 23</i>   | - <b>Plenary: Deep-Sea<br/>Symposium</b><br>8:15 - 12:10,<br>El Cabrillo Room<br>- AMU Editorial Board,<br>lunch, Restaurant                  | - <b>(1) Deep-Sea Symposium,</b><br>continued, 1:50 - 4:50<br>El Cabrillo Rm.<br>- <b>(2) Contributed papers:</b><br><b>Biology and Ecology</b><br>1:30 - 4:30, La Cantina Room | - Cladistics Workshop,<br>7:30 - 8:30,<br>Gazebo Room<br>- Informal Slide Show,<br>7:30 - 8:30,<br>El Cabrillo Room |
| <i>Tuesday, June 24</i>  | - <b>Contributed Papers:</b><br><b>Taxonomy and Evolution</b><br>8:30 - 12:10,<br>El Cabrillo Room<br>- AMU Publ. Comm.,<br>lunch, Restaurant | - <b>Contributed Papers:</b><br><b>Taxonomy and Evolution</b><br>1:30 - 4:10,<br>El Cabrillo Room<br>- Poster Session<br>4:10 - 5:00,<br>El Cabrillo Room                       | - Santa Ynez Valley<br>Winery evening; meet<br>buses in front of hotel<br>at 5:30 PM                                |

|                           | <b>Morning</b>   | <b>Afternoon</b>   | <b>Evening</b>   |
|---------------------------|--|--|--|
| <b>Wednesday, June 25</b> | <p>- <b>(1) Phylogenetic Systematics Symposium</b><br/>8:30 - 12:00,<br/>El Cabrillo Room</p> <p>- <b>(2) Contributed Papers: Cephalopods,</b><br/>8:30 - 10:10<br/>La Cantina Room</p>                                  | <p>- <b>(1) Phylogenetics,</b><br/>continued<br/>1:30 - 5:10,<br/>El Cabrillo Room</p> <p>- <b>(2) Special Session: Cephalopods of the North Pacific</b><br/>1:30 - 5:20,<br/>La Cantina Room</p>  | <p>- CMS [Veliger]<br/>Board Meeting<br/>5:30-7:00PM,<br/>Hotel Restaurant</p> <p>- Reprint sale [WSM]<br/>and Auction Preview,<br/>7:00 PM,<br/>El Cabrillo Room</p> <p>- Auction of literature, art<br/>[AMU-WSM]<br/>8:00 - 10:00 PM<br/>El Cabrillo Room</p> |
| <b>Thursday, June 26</b>  | <p>- <b>(1) Special Session: Cephalopods of the North Pacific,</b> continued<br/>8:30 - 12:10,<br/>El Cabrillo Room</p> <p>- <b>(2) Contributed Paper: Biology and Ecology</b><br/>8:30 - 11:50,<br/>La Cantina Room</p> | <p>- <b>Special Session: Cephalopods of the North Pacific,</b> continued<br/>1:30 - 2:50,<br/>El Cabrillo Room</p> <p>- AMU Membership Meeting,<br/>3:00 - 4:00 PM,<br/>El Cabrillo Room</p> <p>- WSM Membership Meeting,<br/>4:00 - 5:00 PM,<br/>El Cabrillo Room</p> | <p>- Banquet, SBMNH,<br/>meet buses in front<br/>of hotel at 6 PM</p> <p>- Group Photograph<br/>creekside at Museum<br/>6:30 PM</p>  |
| <b>Friday, June 27</b>    | <p>- Field Trips:<br/>Meet buses in front of<br/>hotel at 8:00 AM:<br/>(1) Fossil Tour;<br/>(2) Channel Island Cruise;<br/>(3) Tour of SBMNH<br/>to 4:00 PM</p>  |  |  |

# AMU/WSM Program

## Monday Morning

**8:15-8:30**

Opening Remarks

### Deep-Sea Symposium

El Cabrillo Room  
Chair: M. G. Harasewych

**8:30-8:40**

Introduction: M. G. Harasewych

**8:40-9:00**

The Aplacophora as a deep-sea taxon

Amelie H. Scheltema

**9:00-9:20**

A review of the family Simrothiellidae: the systematic status of the genera and their importance as a model for biogeography

Pamela Arnofsky

**9:20-9:40**

Preliminary data on the distribution of the family Prochaetodermatidae (Mollusca: Caudofoveata)

Dmitry L. Ivanov

**9:40-10:10**

News on monoplacophoran anatomy and phylogeny

Gerhard Haszprunar

**10:10-10:30 – Break**

**10:30-10:50**

Studies of hydrothermal vent fauna, especially gastropods

Janet R. Voight

**10:50-11:10**

Evolutionary origins of endemic hydrothermal vent neomphalinid gastropods: 28S rRNA investigations

Andrew G. McArthur, Ben F. Koop and Verena Tunnicliffe

**11:10-11:30**

Evolution in deep-sea molluscs: a molecular genetic approach

R. J. Etter, M. R. Chase, Michael A. Rex and J. Quattro

**11:30-11:50**

The anatomy of a new hadal, cocculinid limpet (Gastropoda: Cocculinoidea), with a preliminary phylogenetic analysis of the family Cocculinidae

Ellen E. Strong, M. G. Harasewych and Gerhard Haszprunar

**11:50-12:10**

Phylogeny and zoogeography of the bathyal family Pleurotomariidae (Mollusca: Gastropoda: Orthogastropoda)

M. G. Harasewych, Andrew G. McArthur, Rei Ueshima, Atsushi Kurabayashi, S. Laura Adamkewicz, Matthew Plassmire and Patrick Gillevett

## Monday Afternoon

### 1 - Deep-Sea Symposium

El Cabrillo Room  
Chair: Andrew G. McArthur

**1:50-2:10**

Reproduction among protobranch bivalves from sublittoral, bathyal and abyssal depths off the New England coast (USA)

Rudolf S. Scheltema and Isabelle P. Williams

**2:10-2:30**

A molecular survey of eogastropod phylogeny

M. G. Harasewych and Andrew G. McArthur

**2:30-2:50**

The Ptychactractinae: an endemic deep-sea clade of the Turbinellidae?

Yuri I. Kantor and Philippe Bouchet

**2:50-3:10**

Origin and distribution of deep-sea fauna of conoidean gastropods

Alexander V. Sysoev

**3:10-3:30 – Break**

**3:30-3:50**

On the vertical distribution of morpho-functional types of Conoidea

Alexandra I. Medinskaya

**3:50-4:10**

Taxonomic status of deep-sea gastropods of the northeastern Pacific

James H. McLean

**4:10-4:30**

Invertebrate megafauna, community structure and molluscan associates at three deep-sea sites off central California

James Nybakken, Guillermo Moreno, Lisa Smith Beasley, Anne Summers and Lisa Weetman

**4:30-4:50**

Discussion: M. G. Harasewych

**2 - Contributed Papers:  
Biology and Ecology**

La Cantina Room  
Chair: Tim Pearce

**1:30-1:50**

*Dreissena polymorpha*: macrocosm, microcosm and the organism interface

Louise Russert-Kraemer

**1:50-2:10**

Land snails of the lower Salmon River drainage, Idaho

Terrence J. Frest and E. J. Johannes

**2:10-2:30**

Leaf litter land gastropods from a tropical rain forest, southern Veracruz, Mexico

Edna Naranjo-García

**2:30-2:50**

Land snail ecology on northern Kuril Islands, Far Eastern Russia: habitat versus isolation

Timothy A. Pearce

**2:50-3:10**

Some chromosomic and electrophoretic characteristics of the genus *Pomacea* (Gastropoda: Pilsidae) from the southeastern Mexico

Maria E. Diupotex, Nora Foster and Sofia A. Rubio

**3:10-3:30 – Break**

**3:30-3:50**

Patterns of introduction of non-indigenous non-marine snails and slugs in the Hawaiian Islands

Robert H. Cowie

**3:50-4:10**

A review of the sea hare *Aplysia donca* (Gastropoda: Opisthobranchia) from Mustang Island, Texas

Ned E. Strenth and John D. Beatty

**4:10-4:30**

Introduction of a new molluscan shell pest: not just another “boring” organism

Carolynn S. Culver and Armand M. Kuris

**Tuesday Morning**

*Conservation of same as Poster Session*

**Contributed Papers:  
Taxonomy and Evolution**

El Cabrillo Room  
Chair: Barry Roth

**8:30-8:50**

Early Paleozoic stem group chitons from Utah and Missouri: no Problematica!

Bruce Runnegar and Michael J. Vendrasco

**8:50-9:10**

Molluscan paleontology of middle Eocene brackish-marine rocks near Ojai, Ventura County, southern California

Richard L. Squires and Gian Carlo Shammis

**9:10-9:30**

Abalone in the fossil record: a review (Gastropoda: Prosobranchia: Haliotidae)

Daniel L. Geiger and Lindsey T. Groves

**9:30-9:50**

Molecular phylogeny of giant clams  
(Cardiidae: Tridacninae)

Jay A. Schneider and Diarmaid Ó Foighil

**9:50-10:10**

Form, function and diversity of epithelial sensory  
structures in trochoidean gastropods

Carole S. Hickman

**10:10-10:30 – Break**

**10:30-10:50**

The utility of the gastric chamber of Caenogastropod  
stomachs in higher and lower level systematic  
studies

Ellen E. Strong\*

**10:50-11:10**

Nacre is homoplastic - then what?

Claus Hedegaard

**11:10-11:30**

Phylogenetics and classification of the *Philine aperta*  
clade: traditional versus cladistic approaches

Terrence M. Gosliner and Rebecca Price

**11:30-11:50**

From the bottom up or the intertidal down? Patterns  
of movement based on phylogenetic inferences in the  
Patellogastropoda

Robert P. Guralnick

**11:50-12:10**

The Eastern Pacific members of the bivalve family  
Sportellidae

Eugene V. Coan

## Tuesday Afternoon

### Contributed Papers: Taxonomy and Evolution

El Cabrillo Room  
Chair: John Wise

**1:30-1:50**

A phylogeny of pleurocerid snails  
(Caenogastropoda: Cerithioidea) based on molecular  
and morphological data

Wallace E. Holznagel\*

**1:50-2:10**

Phylogenies of the *Columbella* and *Conella* groups  
(Neogastropoda: Columbelloidea), and implications  
for the evolution of Neogene tropical American  
marine faunas

Marta J. deMaintenon

**2:10-2:30**

Taxonomic problems with tropical members of the  
family Haliotidae (Gastropoda: Prosobranchia)

Daniel L. Geiger\*

**2:30-2:50**

Shells, anatomy, and the phylogeny of the  
Nassariinae (Prosobranchia: Nassariidae)

David M. Haasl

**2:50-3:10**

Shell pedomorphosis in *Prunum* (Neogastropoda:  
Marginellidae): a multilineage microstructural  
analysis

Ross H. Nehm and Claus Hedegaard

**3:10-3:30 – Break**

**3:30-3:50**

Molecular phylogenetic relationships of brooding  
oysters

Diarmaid Ó Foighil, Derek Taylor and Christopher  
Jozefowicz

**3:30-4:10**

A preliminary assessment of the generic relationships  
of the Lampsilini (Bivalvia: Unionidae) based on a  
portion of the 16S rRNA gene

Kevin J. Roe

**4:10-5:00**

### Poster Session

El Cabrillo Room  
Chair: S. Laura Adamkewicz

### 1 - Deep-Sea Symposium

- Finned octopuses (Cirrata) in the seas of Russia  
K. N. Nesis
- Molecular systematics of Aplacophora based on  
EF1a nuclear gene sequences  
Akiko Okusu

## 2 - North Pacific Cephalopods

- Preliminary results on fecundity of the common squid, *Todarodes pacificus* (Cephalopoda, Ommastrephidae), in the Japan Sea  
Natalya B. Bessmertnaya and Yaroslav A. Reznik
- Seasonal distribution of the gonatid squid *Berryteuthis magister* (Berry, 1913) in the Okhotsk Sea  
Vasili D. Didenko, Yuri A. Fedorets and Petr P. Railko
- Remains of the prey — recognizing the midden piles of *Octopus dofleini*  
Rebecca Dodge and David Scheel
- Host specificity patterns of dicyemid mesozoans found in eight species of cephalopods of Japan  
Hidetaka Furuya
- Species composition and distribution of octopuses of the genus *Octopus* on the northwestern Japan Sea Shelf  
Alexi V. Golenkevich
- Peculiarities of giant protists infecting the gills of some squids in the Bering Sea  
F. G. Hochberg and Chingis M. Nigmatullin
- First record of the “*Octopus aegina* genus group” in the Hawaiian Islands Archipelago  
Christine L. Huffard and F. G. Hochberg
- Young cephalopods collected by a mid-water trawl in the Bering Sea in summer  
Tsunemi Kubodera and Keiichi Mito
- Age determination of the gonatid squid *Berryteuthis magister* (Berry, 1913) based on morphometric characters  
Petr P. Railko
- Distribution and abundance of pelagic cephalopods in the central North Pacific: information from large-scale high-seas driftnet fisheries  
Michael P. Seki
- Distribution and biology of *Rossia pacifica* (Cephalopoda, Sepiolidae) in the Russian Exclusive Zone of the Japan Sea  
Gennadi A. Shevtsov and Nikolai M. Mokrin

- Discovery of an egg mass with embryos of *Rossia pacifica* (Cephalopoda, Sepiolidae) in the Okhotsk Sea

Gennadi A. Shevtsov and Vladimir I. Radchenko

## 2 - Contributed Papers

- How to build an herbivore: the evolution of herbivory in columbellid gastropods (Neogastropoda: Columbellidae)  
Marta J. deMaintenon
- Lack of significant esterase and myoglobin differentiation in the planktonic developing periwinkle, *Littorina striata* (Gastropoda, Prosobranchia)  
Hans De Wolf, Thierry Backeljau, Kurt Jordaens and Ron Verhagen
- The coccidian parasite *Aggregata* (Apicomplexa: Aggregatidae) in Cephalopods from European waters  
Camino Gestal, F. G. Hochberg, Paola Belcari, Christina Arias and Santiago Pascual
- Gill filament differentiation and experimental colonization by symbiotic bacteria in the tropical lucinid clam *Codakia orbicularis*  
Olivier Gros, Liliane Frenkiel and Marcel Mouëza
- Allozyme homozygosity and phally polymorphism in the land snail *Zonitoides nitidus* (Gastropoda, Pulmonata)  
Kurt Jordaens, Thierry Backeljau, Hans De Wolf, Paz Ondina, Heike Reise and Ron Verhagen
- Molecular phylogeny of marginelliform gastropods: a progress report  
Ross H. Nehm and Chinh N. Tran
- Phylogenetic relationships of flabellinid nudibranchs based on mitochondrial DNA sequences  
Katharina Noack\*
- Highest known land snail diversity: 66 species from one site in Jamaica  
Gary Rosenberg and Igor V. Muratov

- Multiple paternity within broods of a squid, *Loligo forbesi*, demonstrated with microsatellite DNA markers

Paul Shaw and Peter R. Boyle

- Evidence for four species of *Brachioteuthis* (Oegopsida: Brachioteuthidae) in the eastern North Atlantic

Elizabeth K. Shea\*

- Distribution and transport of *Illex argentinus* paralarvae (Cephalopoda: Ommastrephidae) across the western boundary of the Brazil/Malvinas Confluence Front off southern Brazil

Erica A. G. Vidal and Manuel Haimovici

- The phylogenetic relationships of some littorinid species assessed by small subunit ribosomal DNA sequences and morphology

Birgitta Winnepenninckx and Thierry Backeljau

#### 10:10-10:30 – Break

Chair: Paula Mikkelsen

#### 10:30-11:00

Molecular phylogeny of hydrobiid gastropods

Hsiu-Ping Liu, Robert Hershler, M. Mulvey and Winston Ponder

#### 11:00-11:30

The challenge of resolving high-level molluscan phylogeny with separate or combined data sets

Douglas J. Eernisse

#### 11:30-12:00

Popular delusions, phantom taxa, and the weirdness of ranks

Barry Roth

## Wednesday Morning

### 1 - Phylogenetic Systematics

El Cabrillo Room  
Chair: Gary Rosenberg

#### 8:30-8:40

Introduction: Gary Rosenberg

#### 8:40-9:10

Homology analysis and parsimony algorithms — enemies or friend?

Gerhard Haszprunar

#### 9:10-9:40

Problems and pitfalls in phylogeny inference as illustrated by molluscs

Thierry Backeljau, Hans De Wolf, Kurt Jordaens, Patrick Van Riel and Birgitta Winnepenninckx

#### 9:40-10:10

A review and critique of the single-organ system approach: lessons from freshwater mollusks

Charles Lydeard

### 2 - Contributed Papers:

#### Cephalopods

La Cantina Room  
Chair: Kir Nesis

#### 8:30-8:50

Rendezvous in the dark: coevolution between sepiolids and their luminous bacterial symbionts

Michele Kiyoko Nishiguchi, E. G. Ruby and Margaret J. McFall-Ngai

#### 8:50-9:10

Locomotory adaptations of pelagic cephalopods to habitat depth

Brad A. Seibel\*

#### 9:10-9:30

Squid (*Lolliguncula brevis*) distribution within the Chesapeake Bay: locomotive reasons for its ecological success

Ian K. Bartol\*

#### 9:30-9:50

Feeding behavior and chemoreception in cephalopods

F. Paul DiMarco and Phillip G. Lee

**9:50-10:10**

The effects of laboratory prepared diets on survival, growth and condition of the cuttlefish, *Sepia officinalis*

Pedro M. Domingues, F. Paul DiMarco, Jose P. Andrade and Phillip G. Lee

**9:50-10:10 – Break**

## Wednesday Afternoon

### 1 - Phylogenetic Systematics

El Cabrillo Room  
Chair: Gary Rosenberg

**1:30-2:00**

Coding what we can't see: the negative gain and parallelism of shell loss in cladistics

Paula M. Mikkelsen

**2:00-2:30**

Unordered vs. ordered multistate characters: explication and implication

John B. Wise and Ellen E. Strong

**2:30-2:50**

Traditional versus phylogenetic characters: the art of the state in molluscan systematics

Robert Guralnick\*

**2:50-3:10**

The morphospacial "whorled" of strombid snails

Jon R. Stone\*

**3:10-3:30 – Break**

Chair: John Wise

**3:30-4:00**

Calibrating phylogenies with the fossil record

Helena Fortunato

**4:00-4:30**

The role of stratigraphic data in phylogenetic analyses of extinct molluscs

Peter Wagner

**4:30-4:50**

Reproducibility and explicit hypotheses in molluscan phylogeny

Gary Rosenberg

**4:50-5:10**

Concluding Discussion and Remarks: Rosenberg

### 2 - Cephalopods of the North Pacific

La Cantina Room  
Chair: F. G. Hochberg

**1:30-1:40**

Introduction: F. G. Hochberg

**1:40-2:00**

Post-spawning egg care in *Gonatus* (Cephalopoda: Teuthoidea): life history and energetics

Brad A. Seibel, F. G. Hochberg, James J. Childress and David B. Carlini

**2:00-2:20**

Gonatid squids in the subarctic North Pacific: ecology, biogeography, niche diversity, and role in the ecosystem

Kir N. Nesis

**2:20-2:40**

Two unusual *Gonatopsis* species (Gonatidae: Cephalopoda) from the bathyal waters off Sanriku, northeastern Japan

Tsunemi Kubodera

**2:40-3:00**

The California market squid fishery

Marija Vojkovich

**3:00-3:20 – Break**

**3:20-3:40**

In search of *Rossia pacifica diegensis*

Katharina M. Mangold, Richard E. Young and Craig R. Smith

**3:40-4:00**

In situ observations of nesting *Octopus dofleini*, the giant pacific octopus

James A. Cosgrove



**4:00-4:20**

Intertidal ecology of *Octopus dofleini*

David Scheel, Tania L. S. Vincent and Rebecca Dodge

**4:20-4:40**

Deep-water octopods (Opisthoteuthidae, Bathypolypodinae, Graneledoninae) from the Okhotsk and western Bering seas

Kir N. Nesis and Chingis M. Nigmatullin

**4:40-5:00**

Do octopuses play?

Roland C. Anderson and Jennifer A. Mather

## Thursday Morning

### 1 - Cephalopods of the North Pacific

El Cabrillo Room  
Chair: Takashi Okutani

**8:30-8:50**

Distribution and assemblage patterns of micronektonic squids at large-scale fronts in the central North Pacific Ocean

Michael P. Seki

**8:50-9:10**

Cephalopods eaten by swordfish, *Xiphias gladius* Linnaeus, caught off western Baja California Peninsula

Unai Markaida\*

**9:10-9:30**

Species composition of cephalopods found in the diet of the Hawaiian monk seal, *Monachus schauinslandi*

Gwen Goodman-Lowe\*

**9:30-9:50**

Life history and population structure of the neon flying squid, *Ommastrephes bartrami*, in the North Pacific Ocean

Akihiko Yatsu, Junta Mori, Hiroyuki Tanaka, Hiroshi Okamura and Kazuya Nagasawa

**9:50-10:10**

Statolith shape and microstructure in studies of systematics, age, and growth in planktonic paralarvae of gonatid squids (Cephalopoda, Oegopsida) from the western Bering Sea

Alexander I. Arkhipkin and Vyacheslav A. Bizikov

**10:10-10:30 – Break**

**10:30-10:50**

The gonatid squid *Berryteuthis magister* in the western Bering Sea: distribution, stock structure, recruitment, and ontogenetic migrations

Vyacheslav A. Bizikov and Alexander I. Arkhipkin

**10:50-11:10**

A new subspecies of the schoolmaster gonate squid *Berryteuthis magister* (Berry, 1913): genetic and morphologic evidence

Oleg N. Katugin

**11:10-11:30**

Egg size, fecundity, vitelline oocyte resorption, and spawning in the gonatid squid, *Berryteuthis magister* (Gonatidae)

Chingis M. Nigmatullin

**11:30-11:50**

Population structure and life history of the gonatid squid *Berryteuthis magister* (Berry, 1913) in the North Pacific

Yuri A. Fedorets, Vladimir A. Luchin, Vasili D. Didenko and Petr P. Railko

### 2-Contributed Papers: Biology and Ecology

La Cantina Room  
Chair: Doug Eernisse

**8:30-8:50**

Early development of *Crucibulum auricula* and *Crepidula convexa* (Gastropoda, Prosobranchia, Calyptraeidae) from the Venezuelan Caribbean

Patricia Miloslavich and Pablo Penchaszadeh

**8:50-9:10**

The spawn in the genus *Adelomelon* (Prosobranchia: Volutidae) from the Atlantic coast of South America

Pablo E. Penchaszadeh, P. M. S. Costa, M. Lasta and Patricia Miloslavich

**9:10-9:30**

Dynamics of adult and juvenile bivalve dispersal: a shifting paradigm

Robert S. Prezant, Harold B. Rollins and Ronald B. Toll

**9:30-9:50**

Shell polymorphism in the neogastropod *Alia carinata* (Hinds)

Jeff Tupen

**9:50-10:10**

The diel vertical migration of Norris' top snail (*Norrisia norrisi*) on giant kelp (*Macrocystis pyrifera*)

Steve I. Lonhart\*

**10:10-10:30 - Break**

**10:30-10:50**

Diet and temperature on growth and biogeographic distribution of the herbivorous kelp snail *Norrisia norrisi*

Michelle Priest\*

**10:50-11:10**

How aqueous geochemistry affects lacustrine mollusks

Saxon E. Sharpe\*

**11:10-11:30**

Latitudinal variation in radular morphology in the Atlantic plate limpet, *Tectura testudinalis*

Eric J. Chapman\*

**11:30-11:50**

Size structured competitive interactions between a native and introduced estuarine mud snail: implications for a species invasion

James E. Byers\*

## Thursday Afternoon

### Cephalopods of the North Pacific

El Cabrillo Room

Chair: Tsunemi Kubodera

**1:30-1:50**

Fecundity of the ommastrephid squid *Dosidicus gigas* in the eastern Pacific

Chingis M. Nigmatullin, Vladimir Laptikhovsky and Nikolay Mokrin

**1:50-2:10**

Occurrence of the adult form of *Neoteuthis* sp. from the Hawaiian Islands

Kotaro Tsuchiya

**2:10-2:30**

Light-polarization and color sensitivity in the common octopus and firefly squid of Japan

Ian G. Gleadall, Yoshio Hayasaki and Yasuo Tsukahara

**2:30-3:00 - Break**

**3:00-4:00**

AMU Membership Meeting

**4:00-5:00**

WSM Membership Meeting

# *Abstracts of Papers and Posters*

## **Do octopuses play? [NPC]**

Roland C. Anderson and Jennifer A. Mather

The Seattle Aquarium, 1483 Alaskan Way, Seattle, Washington 98101-2059; roland.anderson@ci.seattle.wa.us

Play behavior is likely a sign of intelligence, and is an important activity of vertebrates, including mammals, birds and perhaps reptiles. As cephalopods are known for their intelligence, it seems appropriate to look for play in this group. Small *Octopus dofleini* were held separately at The Seattle Aquarium and presented with a novel floating "toy." Presentations were made twice a day for five days, during which texture and brightness of the toy varied. Each octopus was observed during each presentation until it made no contact with the object for 30 min. We then compared the sequences of actions in the first and last days' observations, looking for different, prolonged or truncated sequences of behavior between them. Some actions and sequences were different, a necessary condition for the designation of "play." In addition, several octopuses showed a repeated behavior, "blowing" the toy away with a jet of water from the funnel only to have the toy circle the tank and return to the animal; this behavior continued for an extended period of time. The blowing behavior will be discussed as possible "play."

## **Statolith shape and microstructure in studies of systematics, age, and growth in planktonic paralarvae of gonatid squids (Cephalopoda, Oegopsida) from the western Bering Sea [NPC]**

Alexander I. Arkhipkin and Vyacheslav A. Bizikov

Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO); 5 Dm. Donskoy Street, Kaliningrad 236000 Russia; janet@meitre.koenig.su

Microstructure, morphology and ontogenetic development of statoliths, and age and growth of 405 planktonic paralarvae and 117 juveniles belonging to ten species of gonatid squids (Cephalopoda, Oegopsida) were studied over and off the continental slope in the western part of the Bering Sea (57°00'-61°30'N, 163°00'E-179°20'W). Statolith microstructure of all species was characterized by the presence of a large droplet-shaped nucleus and bipartite post-nuclear zone divided in two by the first stress check, excluding *Berryteuthis magister*, which had only one stress check and the post-nuclear zone was not subdivided. In *Gonatus* spp., completion of development of the post-nuclear zone coincided with full development of the central hook on the tentacular club. Daily nature of statolith growth increments was validated by maintenance of 13 paralarvae belonging to the four most abundant species captured. Based on statolith microstructure, all species can be subdivided into two groups: (1) species with the nucleus in a central position in the first-check statolith (*Gonatopsis* spp., *Eugonatus tinro* and *B. magister*); and (2) species with the nucleus shifted to the inner side of the first-check statolith (*Gonatus* spp.). Comparative analysis of statolith morphology showed that paralarval statoliths have species-specific characters that allowed us to construct keys to species identification of gonatid paralarvae using their statoliths. Study of paralarval growth using statoliths revealed that cold-water planktonic gonatid paralarvae have rather fast growth rates in length, attaining 7-10 mm ML at early ages (15-20 days). Early juvenile sizes (20-25 mm ML) are attained at ages of 35-70 days.

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## NOTES

\* = eligible for Best Student Paper/Poster Award

[PS] = Phylogenetics Symposium

[DS] = Deep-Sea Symposium

[NPC] = North Pacific Cephalopoda Special Sessions

[poster] = poster area; all other titles are oral presentations

Address listed is the primary address of the first author

## **A review of the family Simrothiellidae: the systematic status of the genera and their importance as a model for biogeography [DS]**

Pamela Arnofsky

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543; parnofsky@whoi.edu

The family Simrothiellidae (Aplacophora; Neomeniomorpha) has a world-wide distribution at ocean depths between 75-4300 meters. Six genera are placed in this family based on radula morphology, specifically possession of distichous bars with many denticles at some point during ontogeny and paired anteroventral radular pockets. The placement of *Uncimenia* in this family is somewhat dubious. This family may have important implications for understanding pre-Pangean biogeography. The genus *Helicoradomenia*, a vent species, is important because it possesses many of the plesiomorphic characters which are useful for defining and describing the primitive type Neomeniomorpha. The overview of this family will include a new genus and species collected from off the coast of Ireland and Scotland. (Supported by NSF DEB-PEET 95-21930)

## **Problems and pitfalls in phylogeny inference as illustrated by molluscs [PS]**

Thierry Backeljau, Hans De Wolf, Kurt Jordaens, Patrick Van Riel and Birgitta Winnepeninckx

Royal Belgian Institute of Natural Sciences, Vautierstraat 29, B-1000 Brussels, Belgium; tbackeljau@kbinirsnb.be

Phylogeny inference is a field of biological research in which the results and conclusions of particular studies may heavily depend on the performance, accuracy and applicability of the methods and computer software used to analyze the data. In the present contribution we illustrate and discuss some controversial problems in phylogenetic data treatment. We particularly focus on (1) the differential performance of distance matrix programs applied to molecular data, (2) the use of bootstrapping, and (3) the effects of character choice and interpretation in parsimony analyses. These issues will be explored at different phylogenetic levels (from intraspecific taxa to phyla) using mainly, though not exclusively, molluscan examples based on both molecular (DNA sequences, RFLP, RAPD, allozymes) and morphological data.

## **Squid (*Lolliguncula brevis*) distribution within the Chesapeake Bay: locomotive reasons for its ecological success**

Ian K. Bartol\*

The College of William and Mary, Virginia Institute of Marine Science, School of Marine Science, Gloucester Point, Virginia 23062; ibartol@vims.edu

The suggestion that squids evolved in environments where competitive interactions with fishes are minimized presumes that squid are inferior to fish with respect to swimming efficiency, endocrine functioning, and oxygen carrying capacity. However, one unique cephalopod, the brief squid *Lolliguncula brevis*, is frequently captured in the euryhaline waters of the Chesapeake Bay where it is often in direct competition with hundreds of species of fishes. The extent to which *L. brevis* utilizes the bay and reasons for its successful invasion are not entirely known. To determine the number, size gradient, and spatial distribution of squid found within the bay throughout the year, monthly trawl surveys were conducted. Furthermore, to provide insight in to how this organism has managed to coexist with mobile communities of nekton, one aspect of its lifestyle, locomotion, was examined by videotaping squid of various sizes in a flume and analyzing the footage using a Peak Motion Measurement System. Results suggest that *L. brevis* utilizes the bay both as juveniles and adults and is capable of making extensive excursions into the bay where it can withstand a predictable range of environmental conditions. The success of *L. brevis* in estuaries may in part be a result of locomotive adaptations that make it more competitive with fishes in highly variable environments.

## **Preliminary results on fecundity of the common squid, *Todarodes pacificus* (Cephalopoda, Ommastrephidae), in the Japan Sea [NPC, poster]**

Natalya B. Bessmertnaya and Yaroslav A. Reznik

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The reproductive systems of 30 mature female *Todarodes pacificus* Steenstrup, 1880, with mantle lengths of 179-285 mm from different regions of the Japan Sea were investigated to determine fecundity and egg diameter. Individual absolute fecundity (IAF) was calculated as the sum of total oocyte number in the gonad plus egg number in the oviducts. For the more particular characteristic of reproductive system condition an index of spawning readiness (ISR) reflecting the weight ratio between oviducts and ovary was used. IAF (calculated from 30 mature females) varied from 116,000 to 1,069,000 with an average of  $506,000 \pm 37,000$  oocytes. IAF does not depend on seasons and regions. The number of eggs in paired oviducts (OF) varied from 140-79,000. This value is 0.12-11% of IAF. The diameters of eggs ranged from 0.69-0.88 mm with a mean value of  $0.82 \pm 0.01$  mm. In view of the high correlation between egg diameter and mantle length, these parameters were compared by seasons and by regions.

## **The gonatid squid *Berryteuthis magister* in the western Bering Sea: distribution, stock structure, recruitment, and ontogenetic migrations [NPC]**

Vyacheslav A. Bizikov and Alexander I. Arkhipkin

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A 4-year series of observations (1993-1996) on distribution, abundance and length-at-age structure of *Berryteuthis magister* in the western Bering Sea revealed high fluctuations of the squid stock both in seasonal and inter-annual aspects. Two seasonal groups of squids were distinguished in the region using statoliths ageing techniques: spring-summer-hatched and autumn-winter-hatched squids. Squids of both groups showed similar patterns of ontogenetic migrations through the region, with minor differences from year to year. Juveniles of mantle length (ML) 14-19 cm entered the region from the southeast with the Eastern Bering Slope Current (EBSC) in May-June (autumn-hatched) and November-December (spring-hatched). They accumulated on the feeding grounds over the continental slope off eastern Siberia where they grew and matured during the next 4-5 months. Squids of both groups became mature at age 10-11 months at ML 24-26 cm (females) and 20-21 cm (males). Maturing squids gathered in dense concentrations in near-bottom layers above the slope, in locations with the highest near-bottom temperatures (between 350 and 450 m). As it was shown on the autumn-hatched group, functionally mature squids (males and mated females) in October started to migrate to the south-west until they left the region of study, with the Kamchatka Current. Only 5-10% of autumn-hatched squids spawned on the Siberian slope.

Our data indicated that *B. magister* migrated counterclockwise between the western and eastern parts of the Bering Sea following the general scheme of water circulation. Abundance of mature squids in pre-spawning concentrations in the western part depends largely on abundance of juveniles brought to the region by the EBSC from supposed spawning grounds located in the south-eastern part. Thus, the general scheme of the life cycle and population structure of *B. magister* can not be understood without data from both the western and eastern parts of the Bering Sea.

## Size structured competitive interactions between a native and introduced estuarine mud snail: implications for a species invasion

James E. Byers\*

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Populations of the native mud snail, *Cerithidea californica*, have been decreasing over past decades in several northern California salt marshes. The presence of the introduced mud snail, *Batillaria attramentaria*, is often cited as a potential cause for *Cerithidea*'s decline. The goals of the present study are to document whether or not *Cerithidea*'s displacement is in fact due to replacement by *Batillaria*, whether the replacement is occurring through the suspected mechanism of exploitative competition for the snails' shared food resource — epibenthic diatoms, and to what degree competitive strengths vary with the sizes and densities of the snails. I conducted experiments to generate consumer-resource interaction curves for two size classes of each snail species and their diatom food source. I then used these relationships to make predictions of the interspecific effects of each snail species on the other. The predictions were tested in the field and proved to describe accurately the outcomes of interspecific interactions between the snails. The predictions and tests indicate that *Batillaria* is the more efficient competitor and strongly suggest that *Cerithidea*'s decline in these marshes could be due to replacement by *Batillaria*.

## Latitudinal variation in radular morphology in the Atlantic plate limpet, *Tectura testudinalis*

Eric J. Chapman\*

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*Tectura testudinalis* is a limpet (Archeogastropoda: Lottiidae) that inhabits the rocky shores of the northwestern Atlantic. I examined differences in radula morphology that could be due to a direct correlation between shell height and radula length. Limpets were collected from six latitudinally separated populations in the New England area. *Tectura testudinalis* has a docoglossan radula that is long and stout with four blunt teeth per row, two central and two lateral. This limpet feeds on various red coralline algae in the genus *Clathromorphum*. Radulae were removed from the soft body tissue using sodium hypochlorite and examined with light and scanning electron microscopy. The radulae were measured from tooth row seven through thirty seven. Preliminary results indicate that this methodology could be effective in determining latitudinal variation in *T. testudinalis*.

## The Eastern Pacific members of the bivalve family Sportellidae

Eugene V. Coan

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The taxonomy of the eastern Pacific species that have been allocated to the bivalve family Sportellidae are reviewed. All taxa are members of the tropical fauna. The genus *Basterotia* is represented by five species: *B. californica* Durham, 1950, here reported from the Recent fauna for the first time; *B. #1* and *B. #2*, two new species, the latter the most common species in the genus and here reported to brood its young; *B. peninsularis* (Jordan, 1936) [of which *B. hertleini* Durham, 1950, and *B. ecuadoriana* Olsson, 1961, are synonyms]; and *B. quadrata* (Hanley, 1834) [of which *Poromya granatina* Dall, 1881, is a synonym]. A new genus is described, with a new species as its type. *Anisodonta americana* Dall, 1900 from the PlioPleistocene of Florida is also a member of this genus. *Ensitellops* is represented by *E. hertleini* Emerson and Puffer, 1957 [of which *E. pacifica* Olsson, 1961, is a synonym]. *Fabella* is represented by *F. stearnsii* (Dall, 1899) [of which *Sportella duhemi* Jordan, 1936, is a synonym]. *Sportella californica* Dall, 1899, proves to be an *Orobitella* (Galeommatoidea: Lasaeidae), and *Anisodonta pellucida* Dall, 1916, is based on a juvenile mactrid, probably *Simomactra falcata* (Gould, 1850).

## **In situ observations of nesting *Octopus dofleini*, the giant pacific octopus [NPC]**

James A. Cosgrove

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Much of our information regarding the nesting behavior of *Octopus dofleini* has come from aquarium observations. This paper reports on the “in situ” observations of seven nesting *O. dofleini* females from discovery until their deaths or disappearance. All nesting dens were in 17 to 24 meters of water and were walled off. No midden heap was observed. Early in nesting the females were a pale gray color over the body with typical reddish arms. Later, the arms became a pale gray also. As death approached, the skin on the suckers and arms turned a pale yellow color and began to slough off. Three of six dead females were found outside their dens, one was partially out of the den and two died in their dens. At death the females had lost an estimated 50% - 93% of their body weight. An average of 330 strings with an average of 172 eggs in each string resulted in an average nest size of 56,760 eggs. Hatching occurred at night and finished in less than a week. Juveniles averaged 0.029 grams at hatching.

## **Patterns of introduction of non-indigenous non-marine snails and slugs in the Hawaiian Islands**

Robert H. Cowie

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The native snails of the Hawaiian Islands are disappearing. One cause is predation by introduced carnivorous snails. Habitat destruction/modification is also important, facilitating the spread of other non-indigenous snails and slugs. Eighty-one species of snails and slugs are recorded as having been introduced. Thirty-three are established: 12 fresh-water, 21 terrestrial. Two or three species arrived before western discovery of the islands (1778). During the 19th century about one species per decade, on average, was introduced. The rate rose to about four per decade during the 20th Century, with the exception of an especially large number introduced in the 1950s as putative biocontrol agents against the giant African snail, *Achatina fulica*. The geographical origins of these introductions reflect changing patterns of commerce and travel. Early arrivals were generally Pacific or Pacific Rim species. Increasing trade and tourism with the USA, following its annexation of Hawaii, led to an increasing proportion of American species. More general facilitation of travel and commerce later in the 20th Century led to a significant number of European species being introduced. African species dominated the 1950s biological control introductions. The process continues and is just part of the homogenization of the unique faunas of tropical Pacific islands.

## **Introduction of a new molluscan shell pest: not just another “boring” organism**

Carolynn S. Culver and Armand M. Kuris

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In 1993, a new polychaete pest was found inhabiting the shell of California cultured abalone. The worm is being described as a new genus in the family Sabellidae. It is a nonindigenous species; apparently introduced through importation of South African abalone for commercial research purposes. Although the sabellid infestations do not impact abalone tissues, shell growth can become greatly altered. Interestingly, boring by these worms in the shell is not the mechanism responsible for the abnormal growth. Instead, this parasite is apparently able to interfere with the anti-fouling mechanisms of the mantle and then guide shell deposition of the host. Direct impacts include a decrease or virtual cessation in shell growth and a weakening of the shell structure. We have determined that host specificity of this sabellid is rather broad and many native California gastropod species may be at risk of infestation. It is possible that the

altered shell structure may have indirect impacts (e.g., increased susceptibility to predation). With the recent finding of an established sabellid population in an intertidal habitat in California, further examination is needed to determine the potential environmental risks associated with the sabellids and which native species are most at risk. Without this information, management efforts to minimize the spread of the sabellid and protect native gastropod species is now, and will continue to be, seriously hindered.

### **Phylogenies of the *Columbella* and *Conella* groups (Neogastropoda: Columbellidae), and implications for the evolution of Neogene tropical American marine faunas**

Marta J. deMaintenon

Department of Integrative Biology, University of California, Berkeley, California 94720-3140;  
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The closure of the Isthmus of Panama in the mid-Pliocene is one of the most accessible model systems for assessing evolutionary responses to a vicariant event followed by large scale environmental change. The patterns of evolution of tropical American marine faunas have been the subject of many studies, but preservational and sampling biases have hampered their identification. This paper documents the patterns of diversification and extinction in two groups of shallow marine molluscs of the Neogene American tropics. The members of the *Columbella* and *Conella* groups of the neogastropod taxon Columbellidae were assessed through the corroboration of cladistic phylogenies and the fossil record.

The three major clades of the *Columbella* and *Conella* groups show different patterns of evolution through the Neogene in the American tropics, but also share some common trends. All three clades experienced increased extinction in the Caribbean after Isthmian closure, which was not balanced by increased origination; however no major clade went entirely extinct in the Caribbean. One eastern Pacific group underwent an episode of diversification, but the timing of this diversification is uncertain.

### **How to build an herbivore: the evolution of herbivory in columbellid gastropods (Neogastropoda: Columbellidae) [poster]**

Marta J. deMaintenon

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The phylogeny of the neogastropod family Columbellidae, based on anatomical and morphological data, is used to address the evolutionary relationship between alimentary anatomy and feeding habits. Columbellids are opportunistic feeders and generally carnivorous; some species, however, include plant matter in their diets. Several studies have suggested a correlation between columbellid diet and alimentary anatomy, but the evolutionary basis of these observations has not been explored.

Comparison of a phylogenetic hypothesis with anatomy and diet suggests that facultative herbivory has evolved more than once in columbellids, and the transition from carnivory to herbivory is accompanied by changes in several features of alimentary anatomy. Most columbellids have gastric shields, but those of herbivores tend to be larger than those of carnivores. In addition, herbivores tend to have wider radular surfaces, with flat, blade-like cusps that may be more efficient for scraping, and odontophores with more cell layers in thickness than those of carnivores.



## **Lack of significant esterase and myoglobin differentiation in the planktonic developing periwinkle, *Littorina striata* (Gastropoda, Prosobranchia) [poster]**

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The relationship between gene flow and the maintenance of geographic or morphology-related variation in the polymorphic Macaronesian periwinkle, *Littorina striata*, was investigated by means of isoelectric focusing of esterases (EST) and myoglobin (Mb). This revealed that: (1) individual EST variation is very high, (2) there is no EST differentiation between sexes, shell morphotypes or wave-exposure regimes, (3) there is no clear macrogeographic patterning of EST variability, although there is a (non-significant) trend of decreasing EST variability with increasing latitude (i.e., from the Cape Verde Islands in the south to the Azores in the north), and (4) there is no Mb variation, even not between islands separated by more than 2000 km. These results indicate that *L. striata* shows a high degree of genetic homogeneity among geographic populations and that the morphological patterning in this species persists in the presence of intense gene flow.

## **Seasonal distribution of the gonatid squid *Berryteuthis magister* (Berry, 1913) in the Okhotsk Sea [NPC, poster]**

Vasili D. Didenko, Yuri A. Fedorets and Petr P. Railko

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Estimations of cephalopod biomass in the Okhotsk Sea during 1989-1991 showed that *Berryteuthis magister* is a dominant species. Juvenile and immature squids forage and grow in the epi-, meso-, and upper bathypelagic zone. Young squid are concentrated in the pelagic zone over the continental slope of the northern Okhotsk Sea and the slope off the eastern Sakhalin in the central deep sector of the sea. In this region concentrations of squid during summer and autumn-winter periods are low whereas during the winter-spring season they significantly increased. In the southern deep sector of the sea concentrations of squid in summer are somewhat lower than near the northern slope. During the winter-spring season young squids occur only in the bathypelagic zone.

On the whole throughout the Okhotsk Sea the biomass of *B. magister* is low during the winter-spring season, considerably increased in summer, and reduced to a minimum during the autumn-winter period. Horizontal and vertical distributions of juvenile and young squids are correlated with the hydrologic regime and cooling-down the upper layers that causes them to migrate to warm areas where water temperatures are greater than 2.0°C and the depths greater than 500 m.

## **Feeding behavior and chemoreception in cephalopods**

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The feeding behavior of animals follows the sequence of perception, orientation, locomotion and finally ingestion of the food. Thus, the success or failure of test diets can be attributed to (1) the visual and/or chemical stimuli from the diet, (2) the texture and palatability of the diet, (3) the diet's nutritional quality, and (4) the post-ingestive feedback from the diet. Experiments that focused on chemical perception (using a Y-maze to test solutions such as extracts, nucleotides, amino acids) and acceptance of test diets (such as supplemented pellets and surimi; various shapes; whole animal diets; behavioral conditioning) indicated differences in the feeding responses among different groups of cephalopods. Data from *Nautilus*, octopus, cuttlefish and squid chemoattraction and feeding

experiments suggest both a hierarchy of feeding responses within each group as well as a continuum along which each group displays a dominant mode of hunting. We present results in support of these models and then comment on the physiological and behavioral adaptations that also lend them support. Preliminary results indicate that *Nautilus* appears more sensitive to chemical stimuli, octopus to contact chemical and tactile stimuli, and squids to visual stimuli. Cuttlefish may utilize vision as well as contact chemical and tactile stimuli. Our ultimate goal is to understand more about the nutritional physiology and feeding behavior of cephalopods through the development of prepared diets.

### **Some chromosomic and electrophoretic characteristics of the genus *Pomacea* (Gastropoda: Pilidae ) from the southeastern Mexico**

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Karyotypic and electrophoretic characteristics of freshwater snails of the genus *Pomacea* were compared. Organisms from provinces of the states of Veracruz, Tabasco and Campeche, southeast Mexico, were used. The polymorphism found in the organisms originating in different provinces showed great similarity to that shown by organisms originating in Lake Catemaco, where this endemic species is classified as *Pomacea patula catamacensis*. Karyotypes of the two species *P.p. catamacensis* and *P. flagellata* showed similar numbers  $2n = 26$  and  $n = 13$  and morphology, and lacked a differentiated sexual chromosome. There were slight differences between metacentric and mediocentric chromosomes. Electrophoretic studies also showed a marked similarity between the organisms collected in the different provinces and those of Lake Catemaco. However, there are variations in the magnitude of the band pattern and a differential band in the Catemaco samples, revealed both in the isoelectric running and in molecular weight. This band was only detected in the organisms with their origin in Catemaco. Results of this study determined both the variations in the populations analyzed, and a method for determining the source and diversity of clones.

### **Remains of the prey — recognizing the midden piles of *Octopus dofleini* [NPC, poster]**

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Octopuses use dens for shelter, and discard meal remains outside the den in midden piles. Contents of middens are important data for describing octopus diets, yet field signs for distinguishing octopus midden piles from remains left by other processes can be subtle. We describe contents and field signs of 50 midden piles of *Octopus dofleini* from Prince William Sound, Alaska. Midden piles were recognized as discards from octopuses based on one of two criteria: either midden piles were found at the mouth of a den containing an octopus ( $N = 36$ ) or midden piles contained at least one remain drilled by an octopus ( $N = 35$ ; 21 samples met both criteria). The crabs *Telmessus cheiragonus*, *Cancer oregonensis*, *Pugettia gracilis*, and *Lophopanopeus bellus* together comprised 68% of the remains. Drills were found on the carapace and chelipeds of 8 (35%) of 23 species found in middens. The drill mark is distinguishable from other molluscs by its shape: drills of *O. dofleini* on crabs were oblong (2–6 by 1–2.5 mm), and came to a point at one or both ends. Drill marks tapered toward the inside of the shell; the final perforation of the inner surface was no more than a pinpoint.

## **The effects of laboratory prepared diets on survival, growth and condition of the cuttlefish, *Sepia officinalis***

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Laboratory prepared, supplemented surimi diets (fish myofibrillar protein concentrate) were fed during four separate 30-day experiments. Four essential amino acids (methionine, lysine, leucine and proline) were tested for their effects on the feeding rate, food conversion, survival, growth and condition of the cuttlefish, *Sepia officinalis*. The first experiment tested methionine. Two of the four test diets had no added methionine but different amounts of protein (62.1% and 93.5%). The remaining two diets had 93.5% protein with increasing concentrations of methionine, so that one diet was fully supplemented with amino acids. During the remaining experiments, similar diets were fed to test the effects of lysine, leucine and proline. Only diets with full supplementation produced significant growth ( $p < 0.05$ ) while none of the remaining three diets in each experiment produced significant growth ( $p > 0.05$ ). After the lysine experiment, cuttlefish fed the fully supplemented diet laid viable eggs while cuttlefish fed the other diets laid no eggs. This work was supported by a Ph.D. scholarship grant (BD 3210/95) from the J.N.I.C.T., Program PRAXIS XXI from the Portuguese government and by NIH National Center for Research Resources (Grant # RR01024 and RR04226), the Texas Institute of Oceanography and the Marine Biomedical Institute, University of Texas Medical Branch at Galveston.

## **The challenge of resolving high-level molluscan phylogeny with separate or combined data sets [PS]**

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Major questions of higher-level molluscan phylogeny remain unsettled despite recent efforts to test hypotheses with explicit cladistic methodology. Even if "morphologists" generally agree that molluscs are, indeed, a monophyletic group, they disagree about the basal divergence within molluscs and are even more divided about which other phyla are closest relatives of molluscs. The aplacophoran molluscs are especially problematic. Are they mono- or paraphyletic? Are they sister taxon to a clade, Testaria, comprised of polyplacophorans plus conchiferans, i.e., all other molluscs, or are they sister taxon of polyplacophorans, together comprising Aculifera, the sister taxon of Conchifera? Some have even suggested that one or both aplacophoran lineages are conchiferans whose shell-less non-metameric body reflect secondary reductions, not plesiomorphic simplicities. With little consensus concerning the closest sister taxa, and with no surviving outgroup that is morphologically similar to molluscs, it is exceedingly difficult to polarize morphological character variation within molluscs. An example is metamerism. Was the ancestral mollusc metameric like a chiton or not like an aplacophoran? Molecular sequence comparisons could provide such a resolution, but the most extensive ones published to date, a 1996 study based on 18S ribosomal RNA by B. Winnepenninckx and coauthors, were discouraging because they did not even support molluscan monophyly. My own parsimony analysis of these molluscan sequences include additional outgroup sequences and was based on my own sequence alignment. The minimum-length trees found differed from those previously reported by supporting molluscan monophyly and by including a caudofoveate aplacophoran within a clade of conchiferan molluscs as sister taxon to polyplacophorans. The nearest outgroup to molluscs was resolved as not a single taxon but as clade of several eutrochozoan phyla. Addition of morphological data to the analyses did not substantially alter the topology.

## **Evolution in deep-sea molluscs: a molecular genetic approach [DS]**

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The origin of the extraordinarily diverse deep-sea benthic fauna is poorly understood and represents an enormous gap in our understanding of basic evolutionary phenomena. The main obstacle to studying evolutionary patterns in the deep sea has been the technical difficulty of measuring genetic variation in species that are typically minute, must be recovered from extreme depths and are fixed in formalin. We developed molecular genetic techniques to work with formalin-fixed macrofauna. Population genetic structure of several species of bivalves and gastropods revealed strong differentiation along a depth gradient from 500 to 4800m despite the lack of any obvious topographic or oceanographic features that would impede gene flow. Our findings indicate that the deep-sea macrofauna can have strong population structure over small spatial scales, similar to that observed in shallow-water and terrestrial organisms, with important implications for evolution in the deep sea. Our new genetic methods make it possible for the first time to use extensive available collections of deep-sea species to explore the evolutionary-historical basis of deep-sea biodiversity on global scales, and add a new dimension to the use of museum collections in general for spatial and temporal analyses of population structure.

## **Population structure and life history of the gonatid squid *Berryteuthis magister* (Berry, 1913) in the North Pacific [NPC]**

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Population structure of the Commander squid in the North Pacific is proposed based on an analysis of data on spatial, temporal, and size-sexual structure of this squid in the most areas of its wide range. Four spatially distinct populations are distinguished with their own spawning and foraging areas, as well as probably with exchanges of individuals to varying degrees: (1) Bering Sea population with the main spawning area along the Komandor-Aleutian islands, Bowers Ridge and a minor spawning area (based on biomass and abundance) on the slope of the western Bering Sea. A joint, overlapping foraging area occurs in the Bering Sea and partially near the northern Kurile Islands; (2) Okhotsk Sea population with the main spawning area near the Kurile Islands and a minor spawning area in the southwestern Okhotsk Sea. The foraging area occurs almost throughout the Okhotsk Sea and insignificantly in subarctic zone of the western North Pacific; (3) Japan Sea population, the most isolated, with weakly divided seasonal spawnings in the northeastern Japan Sea. The foraging area occurs almost throughout the Japan Sea; (4) American population (presumed) with a spawning area in the Pacific off the west coast of North America. The foraging area extends to the eastern Aleutian Islands and partially in the boreal zone of the Northern Pacific.

We distinguish temporal seasonal spawning groups of squids isolated in a varying degree within the Bering Sea and Okhotsk Sea populations and we consider the groups to be seasonal subpopulations (spring-summer and autumn-winter). Each subpopulation consists of early and late spawning individuals that differ slightly in size, but are significantly different in sexual maturity. We propose probable tracks of transportation of larvae and juvenile squids of every subpopulation of the Bering Sea and Okhotsk Sea populations with currents depending on flows in the epi-, meso-, and upper bathypelagic zones of the Bering and Okhotsk seas, and the North Pacific. A hypothetical scheme for the life history of *B. magister* in the North Pacific is proposed.

## Calibrating phylogenies with the fossil record [PS]

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Cladistic analyses of well sampled groups with a good fossil record commonly yield phylogenies of species that conflict strongly with stratigraphic data, even to the extent of hypothesizing phylogenies that turn the stratigraphy upside down. This is almost certainly due to the convergent evolution of similar morphologies (i.e., homoplasy), rather than the inadequacy of the fossil record. This problem can be dealt with either through the use of stratigraphic information as a character (i.e., stratocladistics), or by constructing separate phylogenies for different stratigraphic intervals that can then be assembled into a composite phylogeny. Snails of the genus *Strombina* were used to test the second approach. Strombinids originated and diversified in the Caribbean during the Miocene and Pliocene, when they became nearly extinct in the Caribbean, but diversified greatly in the Eastern Pacific. Phylogenies of 42 species based only on morphology (49 shell characters, 186 states) yield trees with high stratigraphic inconsistency and ghost lineages that postulate the presence of descendants 10 million years or more before the first appearance of their ancestors. Removal of species that originated after the Pliocene resolved all these stratigraphic inconsistencies although some ghost lineages remained. This Miocene/Pliocene tree was then used to root the Pleistocene and Recent species. This final composite tree is highly consistent with the known fossil record for this group.

## Land snails of the lower Salmon River drainage, Idaho

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The rich Lower Salmon River area, Idaho, endemic land snail fauna has been known since the 1860s. Six taxa have been federal listing candidates since the inception of the Endangered Species Act. We conducted a comprehensive terrestrial mollusk survey of the lower 100 km in 1992-1994, visiting over 210 sites. 60+ land snail taxa were encountered, of which 18+ are new. Site diversity is comparatively low (3); but over 50% of the taxa are Lower Salmon/regional endemics. Endemism is most noted in *Oreohelix* and *Cryptomastix*. Many taxa are limited to single drainages or accreted terrain blocks with regionally unusual lithologies, such as limestone or marble. Endemics can occur at any elevation or in any moisture regime, but are most frequent in semi-arid settings at lower elevations. This small area has at least five discrete species assemblages, only one of which extends beyond the region. Adjacent Hells Canyon seems to show similar patterns of speciation, endemism, and substrate localism. At least 36 Lower Salmon taxa are in some danger of extinction. Grazing, recreation, and human settlement are the main threats to lower elevation sites; logging also at higher elevations. Many taxa are limited to one or a few sites. Site numbers and population reductions have been noted for such listing candidates as *Oreohelix idahoensis idahoensis* and *O. waltoni* since 1988.

## Host specificity patterns of dicyemid mesozoans found in eight species of cephalopods of Japan [NPC, poster]

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Dicyemid mesozoans are parasites that live in the renal sacs of benthic cephalopods. Eight species of cephalopods caught off the coast of Japan were examined for the presence of dicyemids. To date we have recovered a total of 21 dicyemid species from these cephalopods: *Octopus dofleini* (2 species); *O. fangsiao* (5); *O. hongkongensis* (3); *O. minor* (3); *O. vulgaris* (3); *Sepia esculenta* (6); *S. lycidas* (2); and *Sepioteuthis lessoniana* (1). Four genera of dicyemids were encountered: *Dicyema* (12 species); *Pseudicyema* (1); *Dicyemeneea* (7); and *Dicyemodeca* (1).

The largest cephalopod host species, namely , *O. dofleini*, *O. hongkongensis*, and *Sepioteuthis lessoniana*, harbored the largest dicyemid species. Typically 2-3 species of dicyemids occur in each host species. However, in *O. fangsiao* and *S. esculenta* 5 or 6 species of dicyemids were detected. In both cases all species of dicyemids were never observed together in a single host. In contrast, only one species of dicyemid has ever been found in *Sepioteuthis lessoniana*.

Most species of dicyemids examined are host specific. In a few instances, the same species of dicyemid was detected in two different cephalopod hosts, which belong to the same genus. Three dicyemids, namely, *Dicyema acuticephalum*, *D. japonicum*, and *D. misakiense*, each infects two host species in the genus *Octopus*. *Pseudicyema truncatum* infects two cuttlefishes in the genus *Sepia*. In summary, a high degree of host specificity appears to be characteristic of dicyemid-cephalopod relationships.

### **Taxonomic problems with tropical members of the family Haliotidae (Gastropoda: Prosobranchia)**

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Most commercial species in the family Haliotidae are well known and present no taxonomic problems. However, many of the small, tropical species are little known and their taxonomy has been confusing. Here three recent cases are presented. (1) From Geiger (1996): The purported but replaced "type" specimen of *Haliotis unilateralis* Lamarck, 1822, is identified as a *H. varia* Linné, 1758. This species does not occur in the East African faunal province from which *H. unilateralis* is exclusively known. A neotype has been designated, and the radula and epipodium have been described for the first time. In the Red Sea, only *H. pustulata* Reeve, 1846, occurs sympatically with *H. unilateralis*. (2) From Geiger and Stewart (submitted) and Stewart and Geiger (submitted): *H. crebisculpta* Sowerby, 1914, is represented by three syntype specimens belonging to two species. The identity of both species is discussed, including their soft part characters and their geographic distributions. (3) From Geiger and Coleman (in prep.): a still unnamed species from the tropical western Pacific is discussed.

### **Abalone in the fossil record: a review (Gastropoda: Prosobranchia: Haliotidae)**

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Fossil abalone are rare and poorly known, in contrast to their Recent counterparts. The taxonomy is problematic, because most of the 35 fossil species have been described from single specimens, and because the shell of Recent species is extremely plastic. The use of fossil species in phylogeny is questionable. Abalone first appear in the Upper Cretaceous with two species, are unknown in the Lower Paleocene, appear again the late Eocene and Oligocene of New Zealand and Europe, and are regularly found from the Miocene onwards worldwide. Most records are from intensively studied areas: West America, Caribbean, Europe, South Africa, Japan and Australia. The scarcity of Indo-Pacific records is remarkable, because their highest present-day diversity is found there. Three hypotheses for the origin of the family are discussed: Central Indo-Pacific, Pacific Rim and Tethys. Fossil and Recent abalone both seem to have lived in the shallow, rocky sublittoral in tropical and temperate climate. No onshore-offshore pattern could be detected.

## **The coccidian parasite *Aggregata* (Apicomplexa: Aggregatidae) in Cephalopods from European waters [poster]**

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Coccidians of the genus *Aggregata* are host-specific intracellular parasites found in the digestive tracts of a large number of cephalopod hosts. Transmitted via the host diet, the infection is initiated when cephalopods feed on crabs, shrimps and other crustaceans. Most studies on this group of protozoan parasites in European waters date from the beginning of this century. Based on this early work several species of *Aggregata* are recognized, namely: (1) *A. eberthi*, found in *Sepia officinalis* (Linnaeus, 1758), is widely distributed throughout the Mediterranean (Italy, Monaco, France, Spain, Tunisia), English Channel (France, England), and North Sea (Germany); (2) *A. octopiana*, found in *Octopus vulgaris* (Cuvier, 1797), has been reported from the Mediterranean (Italy, Monaco and France), and English Channel (France); and (3) *A. spinosa*, also found in *O. vulgaris*, previously has been recorded only from the English Channel (France). In order to review host range, geographic distribution, and incidence of the coccidians in European populations of cephalopods we initiated a large sampling program to survey a diversity of host species from the Mediterranean and the northwestern Iberian Peninsula. *Aggregata octopiana* in *O. vulgaris* and *A. eberthi* in *S. officinalis* were the most abundant coccidians encountered. An undescribed species of *Aggregata*, was found in the oceanic ommastrephid squid *Todarodes sagittatus* (Lamarck, 1798) off the NW coast of Spain. Sample localities, levels of infections, and comparative data on morphology and morphometry of sporocysts and sporozoites are reported in this work.

## **Light-polarization and color sensitivity in the common octopus and firefly squid of Japan [NPC]**

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Color vision (hue discrimination) is a contrast-enhancing mechanism involving complex interactions among several different types of cell, such as the blue, green and red cones and various interneurons in the primate retina. It is, however, based on a relatively simple principle: lateral inhibition. Here, the same principle is demonstrated in the contrast-deriving properties of the octopus retina: a color-blind but polarization-sensitive system greatly simplified by the presence of only two types of visual cell. This model system demonstrates a digital enhancement principle applicable to any parameter of visual contrast. In the eye of most color-blind animals, the only possible parameter of contrast is brightness; while in vertebrates with color vision, the contrast parameters used (in photopic conditions) are differences in both brightness and hue. The ventral retina of the firefly squid appears to use three different parameters: brightness, hue and polarization. However, to say that Japanese firefly squids have color vision is probably a misconception. The purpose of the second half of this talk will be to explain how the firefly squids probably use their system and why they have color sensitivity but not "color vision."

## **Species composition and distribution of octopuses of the genus *Octopus* on the northwestern Japan Sea Shelf [NPC, poster]**

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Bottom octopuses were collected in the north-western Japan Sea shelf over the past 10 years by different types of sampling gear. Species composition of octopuses is relatively poor. Three highly abundant species are present, and two

of them are of commercial value: *Octopus dofleini* and *O. conispadiceus*. The third species, which is smaller in size and less numerous, could not be identified with any known species, probably due to the lack of reliable taxonomic guides. *Octopus dofleini* is found between 42°-46°N, though commercial concentrations were present only in the southern part of the surveyed area. Vertical distribution is susceptible to seasonal fluctuations, and is highly influenced by hydrological conditions. Octopuses of this species are extremely rare in the depth range 20-150 m in the winter-spring period. Commercial stocks are found at depths of 20-50 m in the summer-autumn period when temperatures range from 8-18°C. *Octopus conispadiceus* is found between 42°-48°N, and commercial stocks are located mainly in the northern part of the region. Unlike *O. dofleini*, the distribution of *O. conispadiceus* is restricted to waters with low temperatures that range between 0-5°C. The species lives at depths from 30-400 m in the winter-spring period, and moves towards the shelf edge in summer and fall. *Octopus* sp. (description will be presented; identification may correspond to *O. fujitai* or *O. yendoi*). The species occurs between 42°-48°N in the depths that range from 50-260 m. Its distribution is restricted to cold waters.

### **Species composition of cephalopods found in the diet of the Hawaiian monk seal, *Monachus schauinslandi* [NPC]**

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The diet of the Hawaiian monk seal, *Monachus schauinslandi*, was determined through examination of fecal material collected from seals in the northwestern Hawaiian Islands during the years 1991-1994. Cephalopods were found in the feces as undigested beaks and comprised approximately 25% of the diet. Of the 940 fecal samples examined, 228 contained a total of 630 octopus beaks while 43 contained a total of 338 squid beaks. Cephalopod species were identified using both upper and lower beaks obtained from known specimens of octopus and squid. Five benthic species and two pelagic species of octopus were identified, representing a mix of diurnally and nocturnally active species. In addition, 19 species of squid were found in the samples, representing a mix of coastal, pelagic and mesopelagic species. Length and weight of squid species were determined using length/weight regressions of lower rostral lengths. These findings indicate that cephalopods are an important component in the diet of Hawaiian monk seals, which forage both inshore and offshore, and both diurnally and nocturnally.

### **Phylogenetics and classification of the *Philine aperta* clade: traditional versus cladistic approaches**

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The Philinidae are a group of highly derived cephalaspidean opisthobranchs, in which the shell is reduced and internal. A preliminary phylogeny of the Philinidae is presented. Many traditional characters, such as shell sculpture and shape, have been modified within several lineages and are therefore less informative in characterizing major clades. Species phylogenetically closely related to *Philine aperta* Linnaeus, 1758, the type species of the genus, have been the subject of considerable systematic discord and instability. Re-examination of the anatomy of members of this clade suggests that several taxa that have been united under the name *P. aperta*, are in fact distinct. *Philine aperta* from southern Africa is distinct from the European *P. quadripartita* Ascanius, 1777, on the basis of consistent differences in gizzard plate and penial morphology. The anatomy of *P. elegans* Bergh, 1905, and *P. orientalis* A. Adams, 1854, is described together with that of three undescribed species. Cladistic analysis indicates that penial morphology, gizzard plate shape and microstructure and ornamentation provide valuable new characters for elucidating relationships among members of the *Philine aperta* clade and to other closely allied outgroups. Members of the *Philine aperta* clade are among the most highly derived members of the Philinidae.



## **Gill filament differentiation and experimental colonization by symbiotic bacteria in the tropical lucinid clam *Codakia orbicularis* [poster]**

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A previous study, using PCR analysis, has demonstrated that the transmission mode of sulfur-oxidizing bacteria, located in gill-bacteriocytes of *Codakia orbicularis* is environmental. Aposymbiotic juveniles differentiate gill-filaments as usual in most bivalves, when sterile sand is added. Mucocytes, granule cells, and intercalary cells differentiate progressively, whereas bacteriocytes are lacking. Therefore, the differentiation of these three cell-types does not appear as a consequence of symbiosis, but may be a prerequisite.

Experimental colonization of aposymbiotic juveniles have been obtained by addition of crude sand collected in the natural habitat of *C. orbicularis*. A free-living form of the bacterial endosymbionts associated to sea-grass bed sand appears to be endocytosed at the apical pole of undifferentiated cells which become bacteriocytes. The association between the symbiont and its bivalve host is not necessary for metamorphosis. However, it must occur at some post-metamorphic stage. Undifferentiated cells of the gill-filaments remain receptive to bacteria, several months after metamorphosis, and become bacteriocytes when aposymbiotic juveniles are put in contact with the symbiont free-living form. In *C. orbicularis*, the environmental transmission of symbionts does not appear to be restrained to a definite period of the post-larval development.

## **Traditional versus phylogenetic characters: the art of the state in molluscan systematics [PS]**

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Correct assessment of morphological similarity and difference is essential for either traditional or phylogenetic frameworks. However, in traditional frameworks, assessments of putative homology are not rigorously tested by congruence. By contrast, in phylogenetic methodologies initial assessment of homology must pass the test of congruence before we can adequately assess true homologies from homoplasies. Our assumptions of homology based on similarity may prove to be false.

Not only has homology assessment of characters undergone theoretical remodelling within a phylogenetic framework, but the notion of the character itself has changed. Characters have often been thought of as the endpoints of developmental processes. However, systematists have rightly pointed out that the character is the ontogeny instead. I will show that by focusing on morphological endpoints of developmental processes as opposed to the full ontogeny of characters, a tremendous amount of phylogenetic information is misinterpreted and therefore miscoded or missing in datasets. I use case studies from the gastropod radula to show the importance of ontogenetic information in character definition.

## **From the bottom up or the intertidal down? Patterns of movement based on phylogenetic inferences in the Patellogastropoda**

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Morphological and molecular work supports the position of the Patellogastropoda, the true limpets, as the most basal gastropod clade. Although the clade is composed mostly of species that live intertidally, some members live in the deep

sea and can be associated with hot vents and cold seeps. We ask whether these deep sea taxa have originated onshore and migrated offshore or vice versa. Previous workers have shown that the prevailing trend based on the fossil record is onshore origination and offshore migration over the course of evolution of a monophyletic lineage. We take a different approach using a phylogenetic hypothesis among living forms to determine the polarity of movement.

I have gathered a dataset of morphological characters and taxa in order to assess the phylogeny of the patellogastropods. This analysis includes eighteen taxa, seven of which are from the deep sea, and four outgroups. I have scored eighty five characters for each of these taxa based on histological sections, dissection, shell microstructure and external anatomy. The phylogenetic hypothesis I generated does not support the onshore-offshore model, but instead the pattern of speciation suggests that taxa have migrated from the offshore to the onshore. Stratigraphic distribution of the the patellogastropod lineages indicated that anoxic events may be correlated with recolonization of on-shore habitats during the Cretaceous.

## **Shells, anatomy, and the phylogeny of the Nassariinae (Prosobranchia: Nassariidae)**

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How does the inclusion of shell characters affect phylogenetic analyses? Shell characters are often ignored or granted a relatively minor role due to perceived high levels of homoplasy. I report on preliminary phylogenetic analyses of the bucciniform gastropod subfamily Nassariinae using shell and anatomical characters. Our current understanding of nassariine phylogeny is extremely poor. Shell characters could provide valuable information for the following reasons: subfamilial taxonomy among nassariids is based largely on shell characters; some nonshell characters (e.g., radular dentition) could exhibit higher levels of homoplasy than has been acknowledged; and there are a number of fossil taxa that could represent sister taxa or plesiomorphic representatives to the extant forms.

A data matrix of 42 taxa and 44 characters was constructed. Because relationships between nassariines and possible outgroups are unknown, 14 taxa were used as outgroups. Of the 44 characters, 13 were anatomical and 31 were shell characters. Characters were experimentally weighted to examine their relative effect on tree topologies. The combined analysis supported the monophyly of the Nassariinae plus a few additional taxa. With few exceptions, the anatomical characters exhibited less homoplasy than shell characters. Weighting each character by 1000 times their rescaled C.I. produced similar results. In these analyses, anatomical characters seem to be structuring basal clades, while shell characters structure relationships among derived clades.

## **A molecular survey of eogastropod phylogeny**

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A preliminary survey of partial 18S sequences of representatives of all living families of Eogastropoda revealed that all shallow-water (shelf) patellogastropods comprise a highly robust clade with high bootstrap support and characterized by the presence of several unique inserts. Bathyal and abyssal limpets (Neolepetopsidae and Pectinodontinae), from vents, seeps, and submerged wood, emerge as a separate clade that could not be confidently joined to the shelf patellogastropods, and lack the inserts characteristic of the shelf limpets. These profound differences suggest that the deep-sea limpets comprise an ancient divergence within Eogastropoda.

## Phylogeny and zoogeography of the bathyal family Pleurotomariidae (Mollusca: Gastropoda: Orthogastropoda) [DS]

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The relationships of the family Pleurotomariidae, and ten of its 24 known Recent species were investigated using an iterative, three gene [18S rDNA, cytochrome c oxidase I (CO I), 16S rDNA] approach to phylogeny reconstruction. A broad survey of the Gastropoda using partial 18S rDNA sequences (450 bp) was used to orient the Pleurotomariidae within the class and to determine suitable outgroups. The 18S data strongly support the monophyly of Pleurotomariidae, which are the sister group to a clade comprising the remaining superfamilies assigned to Vetigastropoda (Lepetodrilloidea + Scissurelloidea + Fissurelloidea + Haliotoidea + Trochoidea). Sequences from the CO I gene (579 bp) confirm the sister group relationship between the Pleurotomariidae and the remaining Vetigastropoda. Data from the 18S, COI, and 16S genes (475), analyzed separately and together, clearly distinguish *Entemnotrochus* from *Perotrochus* s.l. Resolution of taxa within *Perotrochus* s.l. is less robust, with species generally assigned to *Mikadotrochus* invariably the most basal, the large, thin-shelled *Perotrochus* referred to “*Perotrochus* Group B” intermediate, and *Perotrochus* s.s. the most derived. The data suggest that the western Atlantic *Perotrochus* s.l. are derived from western Pacific *Perotrochus* s.l., a contention that is supported by newly discovered Antarctic Cretaceous and Paleocene fossils, and that *Perotrochus* s.s. represents a monophyletic, western Atlantic radiation.

## Homology analysis and parsimony algorithms — enemies or friend? [PS]

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“Pattern Cladism” regards homology as a deductive concept after applying a parsimony analysis of character distributions. Contrary to various statements, “non-weighting” of characters is not possible. If characters are equally weighted (as usually done), character selection is the most powerful way of relative weighting (0 versus 1). However, as in molecular analysis, selection of “good” characters is always done on a basis of an (often subconscious) a priori homology analysis. Modifying Orwell’s law, “all characters are equal, but some are more equal than others”. Moreover, the classic distribution criterion of homology-”homologous characters have identical or hierarchical distribution”-is the theoretical basis of parsimony analysis. Accordingly, application of the parsimony principle is a kind of homology analysis based on inductive character selection.

A synthetic way of “Hennigian patterning” is proposed for phenotypic (and in principle also for molecular) analysis with application of a priori criteria of homology. The resulting, preliminary a priori probabilities of homology serve as criteria for selection and weighting (very low = not selected / low / medium / high / Dollo characters) of characters. After application of a parsimony algorithm, the final cladogram decides homology estimations.

## News on monoplacophoran anatomy and phylogeny [DS]

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The interpretation of the monoplacophoran bauplan has been controversially debated in the past. The anatomy and fine structure of recently discovered species (*Laevipilina antarctica*, *Micropilina minuta*, *M. arntzi*) was examined to clear up this matter. *Laevipilina antarctica* (shell length: 3 mm) resembles the previously described larger species: it lacks any

connection between the pericardium and nephridia and is also devoid of connections between nephridia themselves. The tiny (about 1 mm shell length) *Micropilina minuta* and *M. arntzi* lack a heart and are partly paedomorphic in showing only four and three ctenidial and nephridial pairs, respectively. The latter species is a simultaneous hermaphrodite and a brooder. Comparative analysis reveals a differentiation of ctenidia and possibly also gonads from posterior to anterior. Nephridial conditions clearly contradict all ideas on annelid affinities. It is shown that the extant monoplacophorans cannot be regarded as "living fossils," but form a considerably modified early offshoot of conchiferan mollusks. The autapomorphic serial repetition of various organ systems is one aspect of their modification.

## **Nacre is homoplastic - then what ?**

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When molluscan shell structures are mapped on a composite phylogeny, it is most parsimonious to interpret nacre as homoplastic and crossed lamellar structures as plesiomorphic. This refutes the traditional assumption that the "ancestral mollusc" had a nacreous (mother-of-pearl) shell. The interpretations are invariant under different assumptions of accelerated or delayed character transformation, and whether crossed lamellar structure is an unordered or a Dollo character (evolved once, reduced several times). The properties of nacre from gastropods, bivalves, cephalopods, and monoplacophorans differ between the groups, but not within. Consequently, nacre should not be considered homoplastic, but rather as four different characters of mistaken identity. The distribution of nacre in mollusks is not an evolutionary oddity, but the result of an inadequate character analysis. The take-home message is not "nacre is apomorphic, crossed lamellar plesiomorphic." The point is, classic assumptions should be tested repeatedly, and also that putative homoplasies should be re-investigated. Inferred homoplasy may be due to a flawed character analysis.

## **Form, function and diversity of epithelial sensory structures in trochoidean gastropods**

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Among the major branches of the gastropod evolutionary tree, elaboration of epithelial sensory structures is the hallmark of trochoidean vetigastropods. The epithelium of the head and foot is a richly microvillar surface containing an extraordinary density and diversity of putative sensory structures. Previous knowledge of these structures resides primarily in verbal descriptions and scanning electron micrographs of inadequately fixed and poorly preserved material. The minute cantharidine trochid *Alcyona ocellata* A. Adams, 1861, provides new data from a combination of scanning and transmission electron microscopy of carefully relaxed and fixed material.

Seven different kinds of cilia project from the epithelium: (1) single short cilia, (2) clusters of 5 to 7 short cilia emerging from a shallow pit, (3) clusters of multiple cilia at the tip of a short stalk, (4) single cilia at the tip of a short stalk, (5) clusters or tufts of longer cilia, (6) tracts of longer cilia, and (7) regions of longer cilia associated with discrete epithelial structures. The most complex structural arrangements occur on the cephalic and epipodial tentacles, where a single cell with microvillae wraps around six to eight flattened and concentrically packed columnar sensory cells, each with a basal nucleus and as many as 12 distal cilia projecting into the environment. Trochoideans appear to have specialized in epithelial detection of a diversity of close range stimuli, both mechanical and chemical, in contrast to caenogastropod osphradial specialization in discriminating more distant cues.

## Peculiarities of giant protists infecting the gills of some squids from the Bering Sea

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*Hochbergia*, a genus of giant protist of unknown affinities, is found on the gills of a diversity of oceanic cephalopods in the North Pacific Ocean. Squid examined for this parasite were collected in August to December, 1995-1996, on the slope of the northwest Bering Sea. A total of 14 specimens of *Moroteuthis robusta* (970-1350 mm ML) were 100% infected with *H. moroteuthensis*. Intensities of infection varied from 12-750 specimens host<sup>-1</sup> (average 220). The minimum intensity was observed in a mature male of 970 mm ML. The remainder of the *M. robusta* examined were immature females with minimum intensities of 53-60 specimens host<sup>-1</sup>. Two distinct morphs or stages of protists were present: (1) small white protists - 0.4-1.2 mm in length, with a smooth cyst wall; (2) larger yellow protists - 1.1-1.9 mm in length, with a complexly sculptured cyst wall. The ratio between white and yellow forms ranged from 0-100% of the total number in any given host (average 65% white and 35% yellow).

Several undescribed species of *Hochbergia* were present in squids of the genus *Gonatus*. In *G. onyx* (12 specimens; 70-180 mm ML), the incidence of infection was 80% with intensities ranging from 4-100 specimens host<sup>-1</sup>. Only yellow forms were present. A single specimen of *G. middendorffi* (425 mm ML) had hundreds of the large yellow morphs. In contrast, both *Gonatopsis borealis* (15 specimens; 85-140 mm ML) and *Berryteuthis magister* (20,300 specimens; 30-380 mm ML) were not infested with *Hochbergia*. Several possible reasons for the observed differences in parasite distribution will be discussed.

## A phylogeny of pleurocerid snails (Caenogastropoda: Cerithioidea) based on molecular and morphological data

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Phylogenetic hypotheses for North American pleurocerid snails remain in their infancy. I was interested in estimating relationships of pleurocerid snails using both morphological and molecular data. For the molecular data set, a portion of the mitochondrial 16S rRNA gene was sequenced for representative species of the family. For the morphological data set, I constructed a data matrix based on variation observed in the radula from the same representative taxa that were sequenced. Phylogenies were constructed for the morphological and molecular data sets both separately and combined. Taxonomic and character congruence is discussed.

## First record of the “*Octopus aegina* genus group” in the Hawaiian Islands Archipelago [NPC, poster]

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A new species of the “*Octopus aegina* group” sensu Robson (1929) has been discovered in shallow, coastal, subtropical waters of the Hawaiian Islands Archipelago. This species is characterized as medium sized (ML to 100 mm) with moderate sucker counts (160-210 on normal arms of males and females; about 100 on hectocotylyzed arms of males). Gill counts range from 9-11 per demibranch; copulatory organs are small, 2.5-3.5% of the length of the hectocotylyzed arm; eggs are small and hatchlings planktonic. This species shares several characteristics with the non-ocellate members of the “*aegina* group,” namely: *O. aegina* Gray, 1849; *O. marginatus* Taki, 1964; and *O. sp. 3* (Norman, 1992). It differs

primarily in its geographic distribution, body size, sucker counts, and spermatophore size and number. The species occupies sandy substrates in depths ranging from 1-80 m and appears to be crepuscular. Distribution, morphology (including illustrations), and delineation from other members of the "*O. aegina* group" are presented.

### **Preliminary data on the distribution of the family Prochaetodermatidae (Mollusca Caudofoveata) [DS]**

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At present the family Prochaetodermatidae includes 13 species in 5 genera. Based on literature and collection data, it is possible to make the following preliminary conclusions: (1) Presently we probably know no more than half of species diversity of the family world-wide. (2) Representatives of the family live in all oceans, excluding the Arctic, Subarctic, and continental seas (except for the Mediterranean and the Sea of Marmara). (3) The distribution has a near-continental amphioceanic pattern. (4) All known species inhabit the continental slope, except two species of *Chevroderma*, which also occur on the East Pacific and Atlantic abyssal plains. (5) Generally, the family is bathyal-hadal in its vertical distribution. Species have been recorded on slopes of the following trenches: Aleutian, Kurile-Kamchatka, Japan, Izu-Bonin, Philippine, Sunda, and Peruvian. The depth range is 539 to 7500 m in the Pacific, 1050 to 7060 m in the Indian Ocean, and 457 to 5208 m in the Atlantic (except *Prochaetoderma raduliferum*, occurring at 54-2415 m). (6) The distribution pattern and the levels of monotypy and endemism suggest a Pangean-tropical origin of the group. (Partial support from NSF DEB-PEET grant 95-21930).

### **Allozyme homozygosity and phally polymorphism in the land snail *Zonitoides nitidus* (Gastropoda, Pulmonata) [poster]**

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Genetic variation in the pulmonate land snail *Zonitoides nitidus* was examined by means of vertical polyacrylamide gel electrophoresis in 17 European populations (4 Swedish, 4 German, 7 Belgian, 1 British and 1 Spanish). No heterozygotes were observed. Hence, *Z. nitidus* consists of a number of fixed homozygous multilocus genotypes (strains). Nine strains were detected and in most populations >2 strains co-occurred. Strains were unevenly distributed between the localities. One strain was remarkably differentiated from the others, which is suggestive of a taxonomic differentiation. Anatomically, two phally types were distinguished: euphallics, with well-developed male reproductive organs, and hemiphallics, in which the male reproductive organs are weakly developed. Both phally types occurred together, but euphally ratios were very low (0-19%). This, together with the absence of heterozygotes suggests that selfing may be the prevailing breeding system in this species. There was no relation between phally type and alleles or genotypes, but euphally ratios differed between geographical regions. On average, hemiphallic individuals were smaller, but no intermediate phally types were found. Yet, it remains to be decided whether hemiphally is a juvenile character.

### **The Ptychactractinae: an endemic deep-sea clade of the Turbinellidae? [DS]**

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Due to the scarcity of its representatives, the composition and relationships of the subfamily Ptychactractinae remains little known. Based on new, rich material from recent expeditions, mainly in the Indo-Pacific, it has been possible to study the anatomy of a number of ptychactractine taxa and the generic composition of the subfamily, hitherto much confused

and debated, is being revised. As understood here, the subfamily is essentially a deep-water taxon, inhabiting shallower waters only in the boreal and Arctic zones, and includes five genera [*Ptychactractus* Stimpson, 1865, 45-900 m; *Ceratoxancus* Kuroda, 1952, 360-1000 m; *Latiromitra* Locard, 1897 (= *Cyomesus* Quinn, 1981), 200-1900 m; *Benthovoluta* Kuroda and Habe, 1950 (= *Chatamidia* Dell, 1956, and probably *Surculina* Dall, 1908), 50-1750 m; and *Metzgeria* Norman, 1879, 110-900 m] and 39 species (17 new). The fossil record of the subfamily is extremely scanty, but the family Graphidulidae, from the Cretaceous of Texas, may be closely related. Ptychactractinae are widely distributed in the World Ocean, with the greatest diversity in the tropics, essentially the Indo-Pacific. Some of the species of *Benthovoluta* and *Latiromitra* have very broad distributions. Their biology remains unknown, but species of *Ceratoxancus* may have spectacular labral teeth, the function of which is speculative. The Ptychactractinae do not appear to be closely related to the rest of the turbinellids, with which they do not share apomorphic characters. The group should probably be elevated to full family rank.

### **A new subspecies of the schoolmaster gonate squid *Berryteuthis magister* (Berry, 1913): genetic and morphologic evidence [NPC]**

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The gonatid squid *Berryteuthis magister* is considered to be a polytypic species with two subspecies: *B. m. magister* (Berry, 1913); and *B. m. nipponensis* Okutani and Kubodera, 1988. The nominal subspecies ranges in distribution over a vast area of the North Pacific, including marginal basins, such as the geographically and hydrologically semi-isolated Japan Sea.

Morphologic and genetic variation of *B. m. magister* from the Japan Sea and northwestern Pacific were analyzed. Two sources of information unequivocally suggested, that specimens from the Japan Sea constitute a third taxon of the subspecific rank. When compared to the nominal subspecies, specimens of the new subspecies are considerably smaller, have relatively larger fins, and less pronounced size differences of club suckers. The radula of the new subspecies has dicuspid lateral (L(2)) teeth while specimens of *B. m. magister* usually have three cusps on L(2).

Based on information from 26 putative genetic loci, revealed by protein electrophoresis, standard genetic distance D(N) between the new and the nominal subspecies of *B. magister* was 0.044. Intersubspecific distance estimate is almost forty times higher, than D(N) between geographically separated populations of *B. m. magister* from the north-western Pacific. D(N) values between the two subspecies suggests that the Japan Sea population was separated from the ancestral population almost 220 thousand years ago. Seven out of 12 polymorphic genetic loci showed significant differences between the two subspecies. Genetic differentiation F(ST) between taxa was 0.12, which corresponds to a negligibly small theoretical migration rate of two animals per generation.

### **Two unusual *Gonatopsis* species (Gonatidae: Cephalopoda) from the bathyal waters off Sanriku, northeastern Japan [NPC]**

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Five specimens of unusual *Gonatopsis* squid were collected from the bathyal waters off Sanriku, northeastern Japan, during an investigation of cephalopod fauna. They were classified into two species, both of which are different from hitherto known *Gonatopsis* species. One species resembles *G. borealis*, but has a much more muscular, tightened and proportionally longer mantle than *G. borealis*. Four specimens, including a mature male and a female, of this species were collected by an oblique tow of a mid-water trawl from 1200-1300m depth and by a bottom trawl at about 1500m depth. The other species also resembles *G. borealis*, but is easily distinguished from the known *Gonatopsis* species by having a

large photogenic tissue on the ventral surface of the eyes. Only one specimen of this species was collected by a bottom trawl at about 1500m depth. Detailed systematic comparison of the present two species and the other *Gonatopsis* species is given.

### **Young cephalopods collected by a mid-water trawl in the Bering Sea in summer [NPC, poster]**

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Cephalopods collected with a large mid-water trawl during August to October in 1988 and 1989 in the eastern Bering Sea were examined. Samples were provided by the U. S.-Japan joint research project on Resources of Walleye Pollack in the Bering Sea conducted by the National Research Institute of Far Seas Fisheries. The trawl used for the research had a mouth opening of about 43m x 34m and had two otter boards. Tows sampled near 25-70 m depth at about 4.0 knots for 30 minutes within several hours after sunset. In total, 79 tows were conducted and more than 4400 young cephalopods, mostly 10-100 mm DML, were collected. A total of 15 species were identified; 12 species were from the family Gonatidae. The most abundant species was *Gonatopsis borealis*, followed by *Berryteuthis anonychus* and *Gonatus middendorffi*. These 3 species comprised 66% of the total catch. Annual fluctuations were recognized in the abundance, horizontal distribution and size-frequency distribution of the dominant species.

### **Molecular phylogeny of hydrobiid gastropods [PS]**

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Hydrobiids are the largest group of freshwater mollusks, comprising more than 400 recent and fossil genera and several thousand extant species. These snails are ideal subjects for studies of evolution and vicariance biogeography because of their diversity, antiquity, and linkage with drainage system. Despite the unique and compelling features of the group, absence of a rigorously proposed phylogenetic hypothesis has prevented use of these animals in evolutionary and biogeographic studies. Many of morphological and anatomical characters exhibit homoplasy. Thus, the resulting trees are poorly resolved. The purpose of our study was to generate a cladistically based phylogenetic hypothesis of hydrobiid gastropods using DNA sequences. We selected 50+ taxa which represent most of the currently recognized subfamilies of hydrobiids, provide a broad spectrum of areas of endemism around the world, and include brackish-coastal and freshwater inland snails from three continents. We sequenced portions of three genes; mitochondrial 16S rRNA and cytochrome c subunit I and nuclear 18S rRNA. The phylogenetic hypothesis inferred from DNA data was used to address the following questions: (1) are hydrobiid snails monophyletic? (2) has invasion of the freshwater environment occurred more than once during hydrobiid adaptive radiation? and (3) does the phylogenetic topology fit a biogeographic model? We also seek to determine whether the molecular phylogenies are congruent among themselves, and with the existing morphology-based classification.

### **The diel vertical migration of Norris' top snail (*Norrisia norrisi*) on giant kelp (*Macrocystis pyrifera*)**

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Norris' top snail, *Norrisia norrisi*, has been reported to undergo a diel vertical migration on giant kelp, *Macrocystis pyrifera*, at Santa Catalina Island, climbing up the kelp at dusk and descending at dawn. The influence of irradiance and snail size on the diel behavior and vertical distribution of *Norrisia* on *Macrocystis* has not been studied previously. On Santa Catalina Island at Pumpnickel Reef, I made 1,602 observations of snail height and irradiance over a 10-mo. period.



Mean height above the holdfast was always highest at night for all snail sizes. However, only snails 17 mm showed a consistent and significant negative response to irradiance, decreasing their height above the holdfast with increasing irradiance. Snails >17 mm were distributed throughout the kelp during the day (high irradiance). A 25% increase in the mean number of snails observed at night was due to snails 17 mm emerging from the holdfast. During the day, snails of all sizes were relatively inactive, either hiding in or on the holdfast or clinging to stipes and the base of blades. At night, snails were more active, moving onto distal portions of the blades and feeding more frequently. The diel vertical migration of snails 17 mm may be an adaptive behavior to avoid diurnal predators and diminishes as snails grow.

## **A review and critique of the single-organ system approach: lessons from freshwater mollusks [PS]**

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The use of a single-character or single-organ system for systematic studies of molluscs has a very long history. Nearly every organ system has been studied by one investigator or another over the years. One interesting by-product of the single-organ system approach has been the tendency for some investigators to claim that the organ-system they studied provides the most accurate reflection of phylogeny. Most investigators today recognize the value of single-organ system approaches particularly for the wealth of comparative material obtained, but realize that the data need to be examined in a phylogenetic context with other characters (a holistic or total evidence approach). Freshwater molluscs have been studied using both single-organ system and holistic approaches. I compare and contrast the single-organ approach and holistic approach in case studies of unionid mussels and pleurocerid snails. The study strongly supports an integrative approach using all available data to infer accurate phylogenies.

## **In search of *Rossia pacifica diegensis* [NPC]**

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In 1912 S. S. Berry presented a full description of his species *Rossia pacifica* and noted that some specimens from off southern California differed somewhat. To the latter he gave the subspecific name *R. p. diegensis*. Since this time, this subspecies has been virtually ignored. We present evidence based on the retrieval of *Rossia* eggs from a depth of 1000 m off southern California that *R. p. diegensis* is a valid taxon and discuss the zoogeographical implications.

## **Cephalopods eaten by swordfish, *Xiphias gladius* Linnaeus, caught off western Baja California Peninsula [NPC]**

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Lower beaks of 994 cephalopods from the stomach contents of 138 swordfish, *Xiphias gladius*, caught off western Baja California Peninsula coast were analyzed. They belonged to 15 species of teuthoids, four octopods and one vampyromorph. Weight and mantle length of cephalopods were estimated from the beak rostral lengths. The ommastrephid squids *Sihenoteuthis oualaniensis* and *Dosidicus gigas* comprised 62 % by number and 79 % by estimated weight. Three species of Gonatidae represented 19 % by number, and *Argonauta* sp. was the most abundant octopod comprising 7.5 % by number. *Ancistrocheirus lesueurii* is recorded for the first time in the California Current. Discussion on the distribution of most important cephalopods is done. Swordfish showed a preference for powerful, medium to large sized squid that are probably feed at surface at night.

## **Evolutionary origins of endemic hydrothermal vent neomphalinid gastropods: 28S rRNA investigations [DS]**

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A molecular systematic investigation of gastropod phylogeny was performed to examine the antiquity of the hydrothermal vent endemic *Neomphalina* (Neomphaloidea + Peltospiroidea). Twenty-three new D1 domain and thirty new D6 domain DNA sequences of the 28S ribosomal RNA gene were obtained from fresh-frozen and formalin-ethanol preserved gastropod specimens. These were combined with previously published molluscan 28S ribosomal RNA sequences for a total of 159 sequences. Alone, either domain exhibited poor resolution of gastropod phylogeny but together (32 genera only) monophyly of the Neritimorpha, *Neomphalina* (Peltospiridae + Cyathermiidae), Vetigastropoda, Patellogastropoda, Caenogastropoda (including *Viviparus*, *Ampullaria*, and *Campanile*), and Heterobranchia (Euthyneura plus Valvata) was supported by bootstrap values. Relationships among these groups could not be resolved, possibly due to rapid early-Paleozoic radiations. Elevated evolutionary rates in the Patellogastropoda conformed to previous studies and confounded analyses. Exclusion of overly-distant taxa yielded bootstrap support of the sister relationship between Caenogastropoda and Heterobranchia. The hydrothermal vent *Neomphalina* exhibited divergence values and phylogenetic novelty equivalent to the other early Paleozoic radiations, supporting its consideration as a vent refugial phylogenetic relic. Sequences of 28S ribosomal RNA are best used to examine within-order gastropod relationships due to saturation of substitutions at higher levels and among-order evolutionary rate variation.

## **Taxonomic status of deep-sea gastropods of the northeastern Pacific [DS]**

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Deep-sea gastropods of the northeastern Pacific have been poorly sampled compared to Japan and the northeastern Atlantic. Few new taxa from the northeastern Pacific have been described in the last six decades except for those associated with hydrothermal vents and seeps. Based on my compilation of taxa for inclusion in an illustrated manual on the northeastern Pacific gastropods ranging from the Bering Sea to central Baja California, I have assembled a list of 140 species of shelled gastropods with depth records of 800 m and deeper. Of these, 45 species are undescribed and intended for description in the book, if not described in advance of the book. Taxonomic composition is similar to that known from the lower continental slope and abyssal plains worldwide, with 36 families represented, of which there are 16 archaeogastropod, 10 mesogastropod, 8 neogastropod and 2 opisthobranch families. Highest species diversity is known for the families Buccinidae (28), Turridae (18) and the turriiform Conidae (13). There are four main sources of material: (1) Material from the R/V *Albatross* surveys, of which 55 species were described by Dall between 1889 and 1919. (2) Material from Andrew Carey's University of Oregon surveys in the 1970s, containing many new species from the lower slope and the Cascadia and Tufts abyssal plains off Oregon. (3) Material from Scripps cruises to the deep slope of the San Diego Trough and other southern California basins, containing a number of new species. (4) Recently described limpets, other archaeogastropods and provannids from hydrothermal vents of the Juan de Fuca and Gorda ridges.

## **On the vertical distribution of morpho-functional types of Conoidea [DS]**

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The superfamily Conoidea is one of most characteristic components of deep-sea gastropod fauna. Its evolution was strongly associated with alterations in the foregut anatomy and specialization of feeding mechanisms. The following analysis has been based on numerous published data on the anatomy and radulae, as well as the original

data. Six main types of morpho-functional organization and respective feeding mechanisms are presently known for the Conoidea (Taylor et al., 1993, Kantor and Sysoev, 1996). They are primarily determined by the function of the radula and the presence of a venom gland. The most typical situation is the use of individual teeth of the membrane-less radula at the proboscis tip for envenomation of prey. The evolution of feeding mechanisms leads finally to a complete reduction and loss of the radula. The most primitive feeding mechanisms, in which the radula functions only as a whole, is found only in shallow-water species (Pseudomelatominae and some Clavatulinae). The use of marginal teeth at the proboscis tip, at the presence of radular membrane, is characteristic of shelf, many bathyal, and a few abyssal species (Drilliinae, Cochlesspirinae, Crassispirinae, Turrinae, some Terebridae). The majority of abyssal species belong to the feeding type, in which the radula does not function as a whole, and individual hollow teeth are used at the proboscis tip (Turridae, Terebridae, all Conidae). Two feeding mechanisms include species without a venom gland: some shallow-water species do not use teeth at the proboscis tip and possess a well-developed radular membrane (Strictispirinae), and some are highly specialized radula-less forms, mostly inhabiting deep waters (Daphnellinae, Taraninae, some Terebridae). One more type of foregut organization also included radula-less deep-sea species with a venom gland (some Conidae). All morpho-functional types are recorded in the shelf faunas, though the most specialized radula-less forms are rare. The bathyal fauna is characterized by almost complete spectrum of feeding mechanisms, except for most primitive ones. It includes many primitive forms with radular membrane. Basically, the abyssal is inhabited by representatives of four feeding mechanisms, but vast majority of species belong to advanced groups (membrane-less forms with hollow teeth, or the radula is absent). The share of advanced species increases with the depth increase. The tendency to reduction of radula, up to the complete loss, is also characteristic of abyssal species. Thus, the deep waters were colonized by evolutionarily young taxa with advanced feeding mechanisms, and only the most specialized species are able to live at greatest depths of the ocean.

### **Coding what we can't see: the negative gain and parallelism of shell loss in cladistics [PS]**

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The use of traditional characters in phylogenetic analysis helps us directly contrast taxonomic value in a conventional classification with that suggested by a cladogram. While most cladistic characters are structurally complex, highly derived groups such as opisthobranchs offer numerous cases of character loss — in shell, operculum, streptoneury, etc. — some as presumed synapomorphies for higher-level taxa. These can be complete (absence) or partial (reduction), and have been called “negative gains.” To describe and code such characters, we are forced to assess morphology which is no longer present. How we do so determines the shape of the tree, and thus the relationships it infers. These points are illustrated by a real dataset of 37 sacoglossan opisthobranchs (shelled and unshelled) coded for 52 characters. By manipulating only two shell characters through different a priori assumptions and coding options (binary, multistate, ordered, unordered), substantial changes in the final cladogram(s) ensue. If the cladogram is translated into a hierarchical classification, these choices mean the difference between two or eight equal-rank clades, and confirmation or rejection of traditional taxa. Modern phylogenetic methods are improving our basis for molluscan systematics and our understanding of evolutionary processes. Including negative gain characters, even if initially presumed homoplastic, can document the extent of parallelism or presumed trends. Still, subjective decisions play a strong role and have profound effects. Garbage in, garbage out.

## **Early development of *Crucibulum auricula* and *Crepidula convexa* (Gastropoda, Prosobranchia, Calyptraeidae) from the Venezuelan Caribbean**

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A population of *Crucibulum auricula* was found in Chacopata, living attached to rocky substrates at about 1 m depth. Each female broods between 4 and 20 egg capsules in the mantle cavity, and these are attached to the substrate by a short stalk. The capsules contain between 55 and 305 eggs measuring around 200 µm. Between 3 and 15 embryos develop and ingest the nurse eggs, and later cannibalism among siblings was observed. Only 1 to 11 hatch as crawling juveniles measuring between 600 and 840 µm.

The population of *Crepidula convexa* was found in Morrocoy, living attached to live *Modulus modiolus* gastropods at about 10 to 50 cm depth. Each female broods between 5 and 15 egg capsules also attached to the substrate by a stalk. The egg capsules contain between 1 and 6 eggs measuring around 350 µm. All eggs develop and hatch as non-swimming pediveligers measuring between 550 and 1170 µm. No adelophagy or cannibalism were observed.

## **Leaf litter land gastropods from a tropical rain forest, southern Veracruz, Mexico**

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Studies on leaf litter land mollusks from a tropical rain forest are presented. Samples were collected monthly from April 1990 to June 1991 from two contrasting types of ground leaf litter: one where *Ficus yoponensis* was present and had a rapid rate of decay, and other where *Nectandra ambigens* had a slow rate. These sites were situated in a secondary forest with *Ficus* only and in a tropical rain forest with both *Ficus* and *Nectandra*. Live snails were uncommon (27 alive/15 months). Additional samples were taken from canopy leaf litter from October 1991 to April 1992 to determine which species, if any, lived there. Accumulated leaf litter was sampled from the tops of all shrubs and small trees between 50 cm to about 2 m in height in 5 m<sup>2</sup> area. Forty species of 17 families were recovered from ground leaf litter; nine species were found only in the canopy; 14 in both. Shells were more common in secondary forest (*Ficus*), perhaps because of a denser understory. In the tropical rain forest, shells were especially common for a short period of time under *Ficus*; while under *Nectandra* shell numbers were lower, but found over a longer period during the 15 months. Live snails seem to prefer canopy leaf litter (47 alive/6 months) rather than ground leaf litter; high annual rainfall (ca. 5,000 mm) is a possible explanation.

## **Shell pedomorphosis in *Prunum* (Neogastropoda: Marginellidae): a multilineage microstructural analysis**

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Living and fossil gastropods have figured prominently in research on the evolution of development through phylogeny (e.g., heterochrony). Here we examine: (1) spatial, temporal, and microstructural patterns of shell deposition through ontogeny; (2) changes in these depositional patterns through phylogeny; and (3) the relationship between microstructure depositional patterns and the assembly and evolution of shell features in three clades of pedomorphic *Prunum* (Neogastropoda: Marginellidae) from the western Atlantic. Ontogenetic patterns of microstructure deposition are mapped on phylogenies for each *Prunum* clade to determine if pedomorphic shells exhibit global or dissociated heterochrony and if pedomorphic shells in different clades are a product of similar microstructure deposition patterns.

Our microstructural analyses focus on shell layering, the external varix, the inner lip, dorsal lip callus, the anterior aperture margin callus, and the posterior aperture margin callus. Ontogenetic studies of these shell characters in all three clades indicate that paedomorphic shells are formed by similar microstructure deposition patterns. However, paedomorphic shell characters do not evolve in concert: the direction and magnitude of character evolution is different among characters. In addition, the evolution of paedomorphs is not due to a simple truncation of ancestral adult ontogeny: the loss or reduction of shell features and microstructural layers in paedomorphs is not the reverse order of character appearances in the outgroup.

## **Molecular phylogeny of marginelliform gastropods: a progress report [poster]**

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Maximum-parsimony phylogenetic analyses of marginelliform gastropods (Neogastropoda: Families Marginellidae and Cystiscidae) using multiple character sets (shell, radula, and soft-part morphology) have produced robust estimates of the relationships of marginelliforms to other neogastropod families (Olividae, Volutidae, Volutomitridae) and the interrelationships among marginellid tribes (Nehm, 1996). However, resolution of within-tribe phylogeny is currently poor, and the results of morphological analyses have yet to be corroborated with molecular data.

DNA sequences from 16S RNA are used to: (1) test the Covert hypothesis of marginellid polyphyly (that cystiscids are most closely related to olives rather than marginellids); (2) determine the phylogenetic position of *Hyalina* within the Marginellidae, thus establishing if radular loss was a single or multiple event; and (3) test the monophyly of *Prunum* and *Volvarina*.

Fifteen species from nine marginelliform genera (*Prunum*, *Dentimargo*, *Marginella*, *Hyalina*, *Volvarina*, *Rivomarginella*, *Bullata*, *Persicula*, and *Gibberula*) and one outgroup (*Olivella*) are available for molecular analyses. Successful DNA extraction has been completed for *Prunum*, *Dentimargo*, *Persicula*, *Gibberula*, and *Olivella*, and is currently in progress for the remaining taxa. PCR and DNA sequencing have been completed for *Dentimargo*, and are in progress for the other genera.

## **Finned octopuses (Cirrata) in the seas of Russia [DS, poster]**

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Finned octopuses, long considered rare exotic animals, have, in the last few decades, been found to be common and usual inhabitants of the near-bottom layer on continental slopes and abyssal plains throughout the World Ocean. Three species, representing a peculiar reproductive strategy and belonging to two different life forms, are recorded in the Russian seas. *Cirroteuthis muelleri* Eschricht (fam. Cirroteuthidae) belongs to the campanula-like forms and inhabits the northern seas, *Opisthoteuthis californiana* Berry and *O. "albatrossi"* (Sasaki) (fam. Opisthoteuthidae) belong to the flapjack-like forms and inhabit the Far Eastern seas. All three feed on small epibenthic and suprabenthic animals, mostly crustaceans, have large (length 10-11 mm) eggs, produced continuously during the whole adult life and laid individually on the bottom. The individual period of maturity is extended, and feeding and growth continue during spawning. Fecundity is rather low (according to Ch. M. Nigmatullin and V. V. Laptikhovskiy, some 1-4 thousand), development direct, juveniles are less connected with bottom than adults. *Cirroteuthis muelleri* may reach 35 cm in total length and is distributed through the whole Arctic Basin, Scandic Basin and Baffin Sea. It is benthopelagic, recorded in near-bottom layer at approx. 500-3,800 m, but was repeatedly caught in midwater and once even at the surface. It is a common and characteristic animal of the lower slope under the Atlantic Water Mass and on the abyssal plains.

*Opisthoteuthis* are predominantly benthic animals, occurring mainly on the upper slope and very common locally. *Opisthoteuthis californiana* is widely distributed from the northern Bering Sea to off eastern Honshu and California at depths ranging from 125 to approximately 1100 m. In the Okhotsk Sea it is common at 400-900 m, in the Western Bering Sea at 300-650 m. Maximal arm ring diameter in males is 72 cm, in females 64 cm. *O. "albatrossi"* is a larger (females to 80 cm) and deeper water species (780-3400 m), known from the Aleutian Islands to eastern Honshu, including the Okhotsk Sea. Males of both species of *Opisthoteuthis* are larger than females. The sex ratio is equal or females predominate.

## **Gonatid squids in the subarctic North Pacific: ecology, biogeography, niche diversity, and role in the ecosystem [NPC]**

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All available ecological and biogeographical data are gathered on the northern North Pacific gonatid squids: *Berryteuthis* (2 species), *Gonatopsis* (3) and *Gonatus* (7). The species are compared according to their size, horizontal and vertical distribution, spawning habitats, diurnal vertical migrations, and gelatinous degeneration associated with maturation. "Ecological individuality" of each species is evaluated. Each species occupies its own ecological niche but these niches overlap to varying degrees. The history of niche divergence in North Pacific gonatids during Neogene-Pleistocene is characterized. Common features are described of horizontal and vertical distribution of relative abundance and biomass of North Pacific gonatids. Their roles in the ecosystem are analyzed as predators, prey, competitors, and hosts of parasites. In addition, the biomass, production, and food consumption of gonatids are evaluated.

Total biomass of gonatids in the subarctic North Pacific and Russia's Far Eastern seas is roughly estimated in 15-20 mln tons, their yearly production in 50-80 mln tons (some 10-15% of the world total production of mesopelagic cephalopods) and yearly food consumption in 100-200 mln tons. The life cycle of gonatids is much shorter and their P/B-coefficient much higher than in subarctic mesopelagic fishes. Squid biomass in the Okhotsk Sea is less than 10% that of fish but their production is assessed in 58-67% of total fish production. This emphasizes the very important role of gonatid squids in subarctic oceanic ecosystems.

## **Deep-water octopods (Opisthoteuthidae, Bathypolypodinae, Graneledoninae) from the Okhotsk and western Bering seas [NPC]**

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Based on data collected in the Okhotsk Sea (OS), in 1984, at depths of 55-2000 m, eight deep-water benthic octopuses inhabit this region, namely: *Opisthoteuthis californiana* (400-900 m); *O. "albatrossi"* (780-1500 m); *Benthooctopus* sp. 1 (145-800, ?850 m); *Benthooctopus* sp. 2 (280-1375, ?2000 m); *Benthooctopus* sp. 3 (750-1375, ?2000 m); *Benthooctopus* sp. 4 (n. sp., 1800-1840 m); *Bathypolypus salebrosus* (300-750 m); and *Graneledone boreopacifica* (1040-2000 m). *Opisthoteuthis californiana*, *B. salebrosus*, *G. boreopacifica* and at least 3 *Benthooctopus* spp. were present off NE Japan and oceanward from Kurile Islands; three more species of *Benthooctopus* are known off NE Japan. In the western Bering Sea (WBS), in 1993-1995, at depths of 100-750 m, three species were recorded: *O. californiana* (328-578 m), *B. salebrosus* (350-578 m), *Benthooctopus* n. sp. aff. *abruptus* (260-750 m). All species have large eggs, 10-11 mm in *Opisthoteuthis* spp., 16-20 mm in *B. salebrosus*, 22-27 mm in *B. aff. abruptus*, 20-28 to 35-37 mm in *Benthooctopus* spp. Fecundity in Bathypolypodinae is some dozen of eggs.

*Benthoctopus* aff. *abruptus* is known to occur off NE Japan but not in the OS and none of the four OS *Benthoctopus* are found in the WBS. Morphologically and biogeographically *B.* aff. *abruptus* is an intermediate link between rather deep- and warm-water *B. abruptus* (southern and eastern Japan, 300-1000 m) and *B. sibiricus* from the eastern Arctic, the most cold- and shallow-water (38-220 m) species of *Benthoctopus*. The migration of *Benthoctopus* spp. into the High Arctic is thought to have proceeded in two ways: (1) from the North Atlantic in the post-glacial time (*B. piscatorum*); and (2) from the North Pacific through the Bering Strait probably in mid-Pliocene (*B.* aff. *abruptus* - *B. sibiricus*).

### **Egg Size, Fecundity, Vitelline Oocyte Resorption, and Spawning in the Gonatid Squid, *Beryteuthis magister* (Gonatidae)**

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This is the first study of reproduction in a species of "large egg" squid. The reproductive systems of a total of 165 females (160-345 mm ML) were investigated. Specimens examined in this study were collected in the western part of Bering Sea during 1994-1996. All stages of maturity were represented. Fresh ripe eggs ranged in size from 3.5-4.1 x 3.4-3.7 mm. During the process of spawning the size of the eggs decreased significantly. Potential fecundity (PF) in pre-spawning females varied between 30,000-115,000 and increased as ML's increased:  $PF = \exp(2.629 + 0.00432 ML)$ . Relative fecundity ranged between 50-102 oocyte g<sup>-1</sup> (average 75). Large-scale resorption of vitelline oocytes began in pre-spawning females and intensified during the course of spawning. The spawning type is defined as intermittent and descending with a gradual decrease in the number of eggs per egg mass coupled with a gradual degeneration of liver and mantle tissue. The reproductive balance (evolution PF in ontogeny) is as follows: values for average actual (realized) fecundity were 42% PF and for residual fecundity they were 58% PF. The residual stock of oocytes, on average, consisted of 10% PF protoplasmatic, 2.5% PF normal vitelline, and 45.5% vitelline resorpted oocytes. The process of vitellogenesis during ontogenesis involved an average of 90% PF (=VF). From this figure 46% VF is realized, 51% VF is involved in the process of resorption, and 3% VF remained as residual normal oocytes. The energy of resorpted vitelline oocytes probably is one of the main sources for metabolism in non-feeding, spawning females.

### **Fecundity of the Ommastrephid Squid, *Dosidicus gigas*, in the Eastern Pacific [NPC]**

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The female reproductive systems of a total of 76 *Dosidicus gigas*, collected in 1980-1989 from off southern Peru to Nicaragua (150-720 mm ML), were investigated. The average diameter of ripe eggs was 0.78-1.07 mm and the egg weight was 0.22-0.47 mg. These features are significantly higher ( $t = 8.129$  and  $t = 6.321$ ) in female squid caught off Nicaragua compared to squid caught off Peru. Potential fecundity (PF = total oocyte stock in pre-spawning females) varied between 300,000 and 13,000,000 and increased in direct proportion to increases in mantle length (ML) and body weight (BW):  $PF = \exp(5.110 + 0.00589 ML)$   $r=0.89$  and  $PF = \exp(6.775 + 0.000215 BW)$   $r=0.82$ . Relative fecundity of mature females (588-3768 oocyte/g; mean 1632) did not differ in different parts of the species' range (Peruvian waters, equatorial zone, and Nicaragua region). Intra-specific variations in PF was extremely high even among animals of the same size and in the same physiological condition. Thus in maturing females (380-395 mm ML) the PF varied from 2.5 to 6.0 million oocytes. Variations presumably are caused by different individual growth rates during the foraging period, when PF levels are already established. The Index of Potential Reproduc-

tive Investment is 0.19-1.32 (0.56). Mature females accumulate from 10,000 (ML 150 mm) to 1,000,000 (ML>500 mm) oocytes in the oviducts. During a single spawning event each female spawns more than 30% of the initial oocyte stock. Spawning is intermittent as is typical in other ommastrephids.

## **Rendezvous in the dark: coevolution between sepiolids and their luminous bacterial symbionts**

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It has long been noted that the partners of an animal-bacterial symbiosis express phenotypic traits that reflect adaptation to their relationship. We have studied the coevolutionary patterns of the independently culturable partners in the sepiolid squid-luminous bacteria symbioses. Molecular phylogenies for the host squid were derived from sequences of the nuclear internal transcribed spacer region and the mitochondrial cytochrome oxidase subunit I; the glyceraldehyde phosphate dehydrogenase gene was used for phylogenetic determinations of the bacterial symbionts. A combined tree for all three loci indicated a parallel phylogeny between the sepiolids and their respective symbionts. These phylogenetic analyses were coupled with experiments examining the ability of the different symbiont strains to compete and colonize a particular sepiolid host. Our results indicated an enhanced specificity for native strains of symbionts over non-native strains, and provided a hierarchy of symbiont competency that completely complemented the phylogenetic relationships. This combination of molecular systematics and symbiont colonization provides both molecular and biological evidence for mechanisms of coevolution among animal-bacterial associations, and specifically the evolutionary events that may provide insights for the origin and divergence of this group of sepiolids.

## **Phylogenetic relationships of flabellinid nudibranchs based on mitochondrial DNA sequences [poster]**

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Opisthobranch mollusks in general show a high incidence of convergent evolution in anatomical structures that are used in their classification. This might have serious implications for establishing phylogenetic relationships based on morphology within these groups as homoplasy would hinder the recovery of correct phylogenies.

The large and morphologically diverse nudibranch family Flabellinidae has recently received much attention, and phylogenetic relationships within this family based on morphological characters have been published (Gosliner and Kuzirian, 1990; Gosliner and Willan, 1991). Both studies, however, show large amounts of homoplasy in their datasets. To investigate the extent of convergent evolution of anatomical structures within this family, I have established a preliminary phylogeny of flabellinid nudibranchs based on DNA sequences of the mitochondrial genes 16S and cytochrome oxidase I. This molecular phylogeny provides an independent phylogenetic framework for this family on which the evolution of anatomical structures can be traced.

## **Invertebrate megafauna, community structure and molluscan associates at three deep-sea sites off central California [DS]**

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Invertebrate megafaunal community structure at three sites at the base of the continental slope at 3,000 m was investigated by beam trawls and camera sleds. The sedimentary environment was dominated by holothurians, ophiurans, pennatulids and one species of sea star and one species of corallomorpharian. There was considerable variation in rank



order of abundance of the dominant invertebrates among the sites and between years at one of the sites. Comparisons between camera sleds and trawls indicated no differences in rank order of abundance, but the densities estimated from the camera sleds were about four times those of the trawls. The molluscan fauna was sparse in relation to the other invertebrates, only 15 species were found, and the two most abundant species were the large scaphopod, *Fissidentalium megathyris*, and the turrid, *Steiraxis aulaca*.

## **Molecular phylogenetic relationships of brooding oysters**

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Molluscan systematists have traditionally regarded the Ostreacea as a notoriously difficult taxon, due in large part to their xenomorphic growth patterns. In some cases, systematic relationships have been further obscured by undocumented anthropogenic transfers. Molecular characterization of oyster taxa, however, promises to significantly increase our understanding of phylogenetic relationships among these intriguing organisms. We are focusing on the brooding oysters: the Lophinae and the Ostreinae. Their phylogenetic relationships to other members of the Ostreacea are being delineated using 28S nuclear ribosomal gene sequences. A fragment of the mitochondrial 16S ribosomal gene is being used to investigate relationships among the brooders. Preliminary results indicate that: (1) parental care may have been secondarily lost in ancestral lineages of cupped oysters; (2) the Lophinae and the Ostreinae may both be paraphyletic; (3) Harry's (1985) interpretation of systematic relationships among Southern Hemisphere Ostreinae is not supported; (4) the "non-ostreid" larval development of *Tiostrea chilensis* is secondarily derived.

## **Molecular systematics of Aplacophora based on EF1a nuclear gene sequences [DS, poster]**

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Aplacophora are shell-less, vermiform, deep-sea mollusks in which the external cuticle is covered by numerous aragonite spicules. Little is known about aplacophoran phylogeny, and its analysis has been based mostly on morphological characters. The only published molecular data, which utilized 18S rRNA sequences, did not resolve the phylogeny of the Aplacophora. The phylogenetic questions are whether the two aplacophoran taxa, Neomeniomorpha and Chaetodermomorpha, are monophyletic and whether they are basal to all extant mollusks. To resolve conflicting hypotheses, the highly conserved nuclear coding gene elongation factor-1 alpha (EF1a) was analyzed for *Epimenia australis* and *Chaetoderma canadense*. The analysis of a 1200 bp fragment of the EF1a gene from the two aplacophoran species and from species representing Polyplacophora, Bivalvia, Gastropoda, and Cephalopoda represents the first aplacophoran phylogeny based on EF1a molecular data. (Supported in part by NSF DEB-PEET 95-21930)

## **Land snail ecology on northern Kuril Islands, Far Eastern Russia: habitat versus isolation**

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Boreal islands in the northern Kuril Island Archipelago in Far Eastern Russia have relatively few vegetation assemblages, and represent an excellent situation in which to examine the influences of habitat and isolation on the composition of terrestrial gastropod assemblages. In 1996, I collected 6,250 gastropods of 13 species from 61 leaf litter samples taken from meadow, alder (*Alnus maximawiczii*), and pine (*Pinus pumila*) habitats on eight of the northern Kuril Islands. In contrast to temperate North American gastropod faunas, meadow samples averaged more species than alder forest samples, although abundances were slightly lower in meadows. Pine forests had very few species and extremely low

abundances of individuals. Consistent with island biogeography theory, larger islands tended to have a greater total number of species, however, gastropod abundances tended to be lower on larger islands. Five species occurred on all or all but one island suggesting that isolation does not limit their distribution, but five other species occurred on four or fewer of the islands, consistent with the hypothesis that isolation influences the distribution of some species. All or all but one of the 13 species occurred in the meadow and alder habitats, respectively, but only four species occurred in pine forest litter, indicating that habitats are not equally suitable. Thus, both habitat and isolation appear to influence gastropod species assemblages on the northern Kuril Islands.

## **The spawn in the genus *Adelomelon* (Prosobranchia: Volutidae) from the Atlantic coast of South America**

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Since the early descriptions of egg capsules of South American volutes in the past century, very few additions have been made, many of them unfortunately proved to be wrong. We describe here the egg capsule of the largest South American volute, *Adelomelon becki* (Broderip, 1836), and redescribe the often confused spawn of *A. ancilla* (Lightfoot, 1786). The spawn of *A. becki* is a single, conspicuous, large, globose and hemispheric egg capsule attached to pectinid shells, measuring 50 mm in basal diameter and 35 mm in height. The base is round and has a narrow (3 mm) margin. The number of embryos ranges from 7 to 10. The size at hatching was 16.0 to 18.6 mm in shell length. The internal volume of the egg capsule was 30 to 35 ml. No nurse eggs were observed. All the studied material was at a pre-hatching crawling stage.

The egg capsule of *A. ancilla* is oval and flat, with a diameter ranging from 37 to 45 mm, never covered by a calcareous layer. They are generally attached to pectinid shells. The number of eggs per capsule is 5-8, and so is the number of developing embryos; no nurse eggs are present. The eggs are 150 microns in diameter and are surrounded by a very dense liquid. The internal volume of the egg capsule ranged from 2.5 to 4.0 ml. Hatching takes place as crawling juveniles, the shell measuring between 11.7 and 12.7 mm.

We discuss the affinities within the volutids, including *Adelomelon brasiliiana* free egg capsules

## **Dynamics of adult and juvenile bivalve dispersal: a shifting paradigm**

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There has been a growing literature base that has attempted to, at least in part, refocus our attention on recruitment and dispersal mechanisms, away from planktonic and larval propagules, towards small and juvenile forms. In bivalve molluscs, it is now well known that short to medium range dispersal in juvenile (post-larval) tellinids, mytilids, venerids, solenids, myids, and arcids is possible via byssal or stochastic drift. We believe we must add to this list dispersal of some adult bivalves as well. Evidence of dispersal in some adult venerid, mactrid, and corbiculid bivalves is substantial. Brooding *Corbicula fluminea* can disperse as adults using mucoid drogue lines. Large, sexually mature *Mercenaria mercenaria* can be entrained from sandy sediments and are thus capable of passively migrating to new sites.

The relative importance of adult bivalve dispersal in founding new demes or patch dynamics is unknown. We suggest that repetitive findings of small populations of adult bivalves in sites where larval recruitment is not evident could represent viable founding populations that have their origins in adult phases. Discrepancies in fisheries surveys as well as anomalies in predicted trends of population heterozygosities, could reflect dispersal by adult bivalves.

## **Diet and temperature on growth and biogeographic distribution of the herbivorous kelp snail *Norrisia norrisi***

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*Norrisia norrisi* (Family Trochidae), a herbivorous snail that commonly lives and feeds on kelps, is largely confined to the warmer waters of the Southern California Bight from Point Conception to Isla Asuncion, Baja California, Mexico. Previous experimental research has shown that *N. norrisi* prefers kelps over all other algal foods. Here, we test the hypothesis that *N. norrisi* not only shows strong preferences for kelps but also grows best on its preferred seaweed food. In addition, we test the hypotheses that colder seawater temperatures result in reduced consumption and assimilation of algal foods and reduced growth (shell and body mass). To test these hypotheses, individual snails were held in feeding arenas in the laboratory and fed algal diets ad-libitum for a minimum of 6 weeks. Diets consisted of fresh thalli of either the green alga *Ulva lobata* or the kelp *Eisenia arborea* which were provided every four days. Snail shell size and biomass were measured bimonthly to determine growth. Additionally, the amount of seaweed food consumed and the quantity of fecal matter produced were determined for both algal diets. Our results suggest that when fed a unialgal diet, *N. norrisi* grows best on kelp and that its feeding biology is strongly influenced by seawater temperature (Sponsored by CSU Fullerton Biology Department and CSU Fullerton DAC)

## **Age determination of the gonatid squid *Berryteuthis magister* (Berry, 1913) based on morphometric characters [NPC, poster]**

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There are 2, 3 or 4 different age groups present in harvested populations of *Berryteuthis magister*. Size distributions of these groups overlap considerably, which makes it difficult to determine precisely the modal size classes. We worked out a method of discrimination between groups of the squid based on cluster analyses of morphometric traits. We obtained data on number, maturity, and size-weight character of each age group. Modal size classes of these groups were time approximated on the multiplicative model ( $Y = aX^b$ ). Theoretical growth curves for *B. magister* from the western Bering Sea and from the Kurile region also were obtained. These curves were based on data for each sex for a several-year period.

## **A preliminary assessment of the generic relationships of the Lampsilini (Bivalvia: Unionidae) based on a portion of the 16S rRNA gene**

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The Lampsilini contains approximately 1/3 of all North American unionid taxa. Members of this tribe display an astonishing variety of conchological and reproductive adaptations not found in other freshwater bivalves in North America.

A phylogenetic analysis of Lampsilini relationships constructed upon a preliminary molecular data set of mitochondrial 16S rRNA sequences provides an opportunity to test the monophyly of the Lampsilini as well as explore relationships among the genera in that tribe. In addition, the classification allows examination of the evolution of reproductive structures found in the various informally recognized groups within the Lampsilini. The data set generated will also provide the basis for future research aimed at generating much needed classifications within the various generic groups, and research into the evolution of reproductive strategies in the Lampsilini.

## **Reproducibility and explicit hypotheses in molluscan phylogeny [PS]**

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One of the advantages of phylogenetic systematics over traditional methods of expressing relationships among taxa is that methods and data used to reach conclusions can be explicitly stated, allowing other workers to verify the results and test the effects of various methodological assumptions. Some workers however, continue to proceed in a narrative mode, loosely guided by phylogenetic principles. They present neither explicit methods nor explicit data. Others present data matrices, but their stated methods do not reproduce their results. In some cases it is possible to reconstruct the methodological errors that lead to the erroneous results. Malacologists have generally shied away from debates about phylogenetic methods, but such debates can have salutary effects for the field if conducted in a collegial fashion. In the hopes of stimulating debate, I draw examples from phylogenies recently published by Taylor, Kantor & Sysoev (1993), Bandel & Reidel (1994), and Coovert & Coovert (1995).

## **Highest known land snail diversity: 66 species from one site in Jamaica [poster]**

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Four person hours of collecting at a small (circa 4 hectare) karstic, partially disturbed site near Auchtembeddie, Jamaica in September 1996 yielded 57 species of land snails and 2 species of slugs. A subsequent visit in February 1997 yielded 50 snail species in six person hours, including 7 species not collected earlier. Of the total, 21 species were found alive, 9 fresh dead, and 30 with sufficient gloss, color or periostracum remaining to indicate that they probably still exist at the site. Six species were represented only by long dead shells. Of 21 species collected alive, 20 are Jamaican endemics Jamaica. At least 43 genera are represented. Family distribution is as follows: Helicinidae, 13 species; Poteriidae, 2; Annulariidae, 3; Truncatellidae, 2; Succineidae, 1; Pupillidae, 1; Valloniidae, 1; Euconulidae, 1; Subulinidae, 2; Oleacinidae, 9; Orthalicidae, 1; Bulimulidae, 2; Urocoptidae, 6; Systrophiiidae, 1; Sagdididae, 13; Camaenidae, 5; Helminthoglyptidae, 1; Veronicellidae, 2.

Highest diversities previously reported are 60 species at Waipipi Reserve, New Zealand (56 native snails, 1 native slug and 3 introduced snails) and 52 native snails at Manombo, Madagascar. Of the 66 Jamaican species, 58 are native, including two slugs, 4 are introduced, and 4, all micromollusks, are of uncertain status. The sites in New Zealand and Madagascar have been searched more intensively than the Jamaican site, where no arboreal, leaf litter, or soil sampling has been done. Only 11 (17%) of the Jamaican species sampled reach maturity at under 5 mm. Thus, further work at the site should push known diversity considerably higher than 66 species.

## **Popular delusions, phantom taxa, and the weirdness of ranks [PS]**

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Biological classifications shape the way we think about the organisms of interest to us. Aspects of traditional ("canonical") systematics are examined for some less-than-salutary effects on scientific thinking. Rank-free classification, incorporating phylogeny-based taxonomy, while not free of problems of its own, can help us avoid some of the pitfalls of canonical classification.

## Early Paleozoic stem group chitons from Utah and Missouri: no Problematica!

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Conical sclerites from the North American Cambrian were placed in an extinct molluscan class, *Mathevia*, by Yochelson (1966). In 1979, Runnegar and others suggested that *Mathevia* Walcott is the oldest known chiton and a close relative of Early Paleozoic chiton genera such as *Chelodes* Davidson and King and *Hemithecella* Ulrich and Bridge. However, a counter proposal by Stinchcomb & Darrough (1995) moved *Mathevia* and *Hemithecella* back to the "molluscan Problematica."

Large numbers of silicified fossils from latest Cambrian (Sunwaptan) strata in Utah show that *Mathevia* had at least two types of sclerites (valves) that are repeatably found in ratios of 4 or 5:1. These ratios are not those expected from undisturbed chiton graveyards (6:1) but they do falsify the notion that *Mathevia* had only two valves (Yochelson) or as many as 15 (Stinchcomb & Darrough). As one of the median faces of the more numerous kind of valve is distinctively concave, apparently to receive the leading face of an adjacent valve, this new species of *Mathevia* helps bridge the morphological gap between *M. variabilis* and *Hemithecella*. Their relationship to unequivocal stem group chitons is now supported by additional characters and partially articulated specimens. With regard to the broader picture, it is likely that all Paleozoic chitons are stem group polyplacophorans and that early disparity was reduced by a series of mass extinction events.

## *Dreissena polymorpha*: macrocosm, microcosm and the organism interface

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Ernst Mayer reminded biologists years ago that there is never a time in the life of a sexually reproduced organism when it does not have both a genome and an environment, and that it is the dynamic relation between the two that eludes understanding, and yet that demands it. The anxious call went out in 1989 as one of the first symposia was being organized to confront the sudden and massive appearance of *Dreissena polymorpha* in the Great Lakes: "Let's not reinvent the wheel!" The accompanying plea to participants was an exhortation to use what we knew, in order to proceed in a more more deliberate and creative way than in the past, with other introduced organisms.

In this paper, I carefully review what has been done, what has been found, where research seems to be going, and where research ought to be going on *D. polymorpha*. My particular concern will be for the organism, and for Mayr's prophetic injunction.

## Intertidal ecology of *Octopus dofleini* [NPC]

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The ecology of the giant octopus, *Octopus dofleini*, is largely known from SCUBA diving studies around Vancouver Island, B.C. Here, we present new data on the habitat use of this species from Prince William Sound, Alaska. We searched for octopuses on foot in the intertidal during minus tides, and to depths of 30 m (100 ft) by SCUBA diving. Octopuses were found in habitat characterized by low slope, cobble or rock outcrops, and dense vegetation cover; and typically were not found on steep slopes, bedrock, gravel, or mud, areas of low vegetation, nor on boulder piles. Intertidal prey middens were composed primarily of crab remains; as depth increased, scallops became common in middens and largely replaced crabs below -10 m. Seventy-five percent of octopuses were found in the intertidal zone between +2 and -1.3 m MLLW. During SCUBA surveys, octopuses were more abundant on shallow dives (to -5 m) than on deep dives. Three octopuses from the intertidal, tracked using sonic transponders, remained in or returned to shallow

water. This pattern of intertidal habitat use contrasts with studies by others in B.C. that reported on subtidal octopuses between -5 and -20 m. Sea otters are regular predators on octopuses; and we suspect that intertidal habitats provide a refuge from otter predation for juvenile octopuses. Otters were prevalent in the Sound and absent at the B.C. study sites.

### **The Aplacophora as a deep-sea taxon [DS]**

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The ocean depths are not such an unvarying, constant environment as they once were thought to be. Differences among aplacophoran faunas reflect the physical, chemical, and biological environments at hydrothermal vents, on the bottom beneath regions of high and low organic flux from the surface, in trenches, on continental slopes and abyssal plains, on sea mounts, in oxygen rich and poor areas, and in polar and tropical regions. Prochaetodermatidae numerically dominate upper continental slopes and neomenioids are dominant on sea mounts. (Supported by NSF DEB-PEET 95-21930)

### **Reproduction among protobranch bivalves from sublittoral, bathyal and abyssal depths off the New England coast (USA) [DS]**

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An examination of seven species of protobranch bivalves reveals that the "apparent fecundity" (i.e., the number of ova produced by a single female at the time of reproduction) is consistently greater among sublittoral than among bathyal and abyssal species. Such a relationship exists both among forms with lecithotrophic planktonic larvae and those lacking a planktonic stage. The apparent fecundity of a species increases with increasing size (i.e., shell length) in both shoal-water and deep-sea species. Accordingly, the apparent fecundity of older individuals exceeds that of smaller, younger ones. From examination of gonads at different seasons, spawning in sublittoral species is inferred to be periodic and occurs only during the summer months. Contrariwise among deep-sea species, evidence suggests continuous gametogenesis in those species examined. It is therefore not possible to estimate the rate that ova are produced nor the lifetime fecundity of such deep-sea forms. Populations of sublittoral species are dominated by juvenile individuals, whereas in deep-sea species at their optimum depth (i.e., the depth at which they occur in greatest numbers), populations consist largely of sexually mature individuals, suggesting relative stability in such populations. Deep-sea species near the limits of their depth distributions are composed of populations that more nearly resemble those of sublittoral forms and are made up mostly of juvenile individuals. Species with a development lacking a planktonic stage have larger and fewer ova and, among those populations examined, were dominated at both sublittoral and abyssal depths by juvenile individuals.

### **Molecular phylogeny of giant clams (Cardiidae: Tridacninae)**

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Giant clams have been shown to be a morphologically highly derived clade of cardiid bivalves. A phylogenetic hypothesis of giant clams is constructed with the mitochondrial ribosomal 16S gene. As the sister taxon to the Tridacninae is the Lymnocardiinae, a basal lymnocardiinae, the edible cockle *Cerastoderma*, is used as the outgroup. This molecular phylogenetic hypothesis is compared to results previous obtained from morphological analysis and the fossil record. Giant clams, like cardiids in general, have numerous morphological characters and an

excellent fossil record. This situation, unusual among bivalves, allows assessment of the 16S gene as a tool for phylogenetic reconstruction of clades that have diverged during the Cenezoic.

### **Flight of the Vampire: Scaling of metabolism and aquatic “flight” in *Vampyroteuthis infernalis* (Vampyromorpha: Cephalopoda) [NPC]**

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*Vampyroteuthis infernalis* is a cosmopolitan cephalopod that lives in the heart of the oxygen minimum layer below 600 m depth. Morphometric and physiological studies have indicated that *V. infernalis* has little capacity for jet propulsion and has the lowest metabolic rate ever measured for a cephalopod. Because fin swimming is inherently more efficient than jet propulsion, some of the reduction in energy usage relative to other cephalopods may result from the use of fins as the primary means of propulsion. *Vampyroteuthis infernalis* undergoes a rapid metamorphosis which consists of changes in the position, size, and shape of the fins. This suggests that there are changes in the selective factors affecting locomotion through ontogeny. The present study describes these changes in *V. infernalis* in relation to models for underwater “flight”. Citrate synthase (CS) and Octopine dehydrogenase (ODH) activities, indicative of aerobic and anaerobic metabolism respectively, were measured across four orders of magnitude size range. Results indicate that fin swimming is the primary means of propulsion at all post-metamorphic sizes. Negative allometry of CS activity in mantle and arm muscle is consistent with scaling of aerobic metabolism observed in most animals. The unusual positive allometry of fin muscle suggests that fin swimming is more costly at larger sizes. Positive scaling of ODH activity in fin, mantle and arm tissue suggests that fin propulsion, jet propulsion and medusoid “bell-swimming” are all important for burst escape responses. The observed scaling patterns and morphological changes at metamorphosis appear to function as an ontogenetic “gait-transition”.

### **Post-spawning egg care in *Gonatus* (Cephalopoda: Teuthoidea): life history and energetics [NPC]**

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A novel reproductive strategy of deep-water spawning and egg-care was observed for the mesopelagic squid, *Gonatus onyx*. Brooding females and associated eggs and hatchlings, captured between 1250 and 1750 m off southern California are described. Brooding females appear to be senescent and are lacking tentacles. The loss of tentacles in gonatid species is discussed in relation to this unusual life-history characteristic previously unreported for squids. Metabolic estimators and chemical composition of *G. onyx* and *G. pyros* also are reported and discussed in relation to buoyancy and energy reserves which may support a non-feeding, post-spawning brood period of up to 9 months.

### **Distribution and assemblage patterns of micronektonic squids at large-scale fronts in the central North Pacific Ocean [NPC]**

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Large-scale oceanic fronts associated with water masses form the primary biogeographic boundaries in the open ocean. In the North Pacific, the Subarctic and Subtropical Fronts form boundaries that divide some of the large, core pelagic biogeographic provinces. Historically, biogeographic ranges of many micronektonic species including euphausiids,

pteropods, heteropods, and chaetognaths as well as some commercial fish species have been shown to correspond with regions delimited by these large scale features. Recent trawl surveys that sampled across these fronts and frontal zones support previous suppositions that the distribution, abundance and assemblage patterns of pelagic cephalopods are also strongly influenced by these physical features.

During August 1991, >3000 cephalopods representing 25 species were collected at sites across the Subarctic Boundary along the 174.5° and 179.5° W meridians between the 37° and 46° N latitudes. Another 637 individuals representing 34 species were taken in the Subtropical Frontal region (between 21° and 31° N latitudes) during March-April 1992. The oegopsid squid families Onychoteuthidae, Enoploteuthidae, Gonatidae, Pyroteuthidae, Cranchiidae, and Chiroteuthidae were the most extensively sampled and provided the best insight into how cephalopods respond to variations in oceanographic conditions. Patterns of distribution, abundance, and interspecific associations of the cephalopod fauna are described with respect to the local frontal environment and discussed within the context of large scale northern transitional and central biogeographic provinces. Taxonomic advances and concerns are highlighted.

### **Distribution and abundance of pelagic cephalopods in the central North Pacific: information from large-scale high-seas driftnet fisheries [NPC, poster]**

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During the late 1970s through to 1992, high-seas drift gillnet fisheries targeting flying squid, *Ommastrephes bartramii*, and tuna and billfishes operated in waters of the North Pacific transition zone (NPTZ) and its associated subtropical and subarctic boundaries. These large-scale fishing operations generally involved deploying numerous panels of rectangular nets 30-50 m long by about 10 m deep strung together to form a curtain of webbing stretching several kilometers across the oceans' surface capturing animals by entanglement. At the height of the fisheries in the late 1980s, more than 700 vessels operated in the multinational fisheries, each fishing about 30-60 km of nets per day. During the 1990-91 fishing seasons, observer programs were administered over the fisheries, monitoring catch and effort in up to 10% of the fishing fleets. Information collected by the observers have provided an unprecedented near-basinwide characterization of pelagic nekton species composition, distribution, abundance, and interspecific relationships on a relatively short time scale.

Overall, more than 25 million cephalopods were observed captured during the 22-month monitoring program, of which >99% were *O. bartramii*. Regions of high catch rates and observed size frequency distributions are consistent with life history and ecological movement patterns reported for the species. For other commonly taken species, *Onychoteuthis borealijaponica* were most abundant in the subarctic western Pacific east of Hokkaido, Japan where catch rates exceeded 2,000 squid/50 km of net in several 1° latitude x 1° longitude statistical areas. The highest catch rates of *Gonatopsis borealis* (>200 squid/50 km net) were all found in areas west of the dateline in the vicinity of the Subarctic Boundary, while the pelagic octopus, *Ocythoe tuberculata*, were taken in limited numbers throughout the NPTZ during all seasons but was nowhere abundant. Capture of *Thysanoteuthis rhombus* was basically restricted to subtropical waters fished during the winter months with large mesh (ca. 170-180 mm stretched measure) nets.

### **How aqueous geochemistry affects lacustrine mollusks**

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Changes in climate and hydrology through time affect the solute composition and the stable isotopic content of lake water. These changes may be reflected in both the presence (occurrence patterns) and the isotopic composition of shell



aragonite of lacustrine mollusks. Interpretation of preliminary data suggests that modern molluscan occurrences are restricted by solute composition, rather than just pH or salinity as is commonly believed. All mollusks are found in waters with (bi)carbonate and calcium ( $\text{CaCO}_3$ ) forming the dominant-to-important components of the solute composition. Additionally, the bicarbonate-to-calcium ratio within this solute type appears to limit certain genera. Linkage of species occurrences to solute chemistry provides a new way of viewing biogeographical ecology and, from that, a new methodology for reconstructing past hydrology and climate. A related study compares the stable oxygen isotopic content of modern gastropod shells with that of the water at the time of shell growth. Results show that the  $\text{D}^{18}\text{O}$  content of lacustrine gastropod shells covaries with that of the host water, although the variability and offset from the value of the water differ among genera. Understanding the relationship between water and shell isotope values provides a basis for interpreting shell stable isotope geochemistry and the isotopic values of the waters in which the mollusks lived. Both studies will contribute to our understanding of mollusk ecology and biology, and paleoenvironments.

### **Multiple paternity within broods of a squid, *Loligo forbesi*, demonstrated with microsatellite DNA markers [poster]**

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For some time, observations on spawning aggregations of squid have suggested the possibility that females may mate with more than one male before spawning. Due to the difficulties of catching, then maintaining these animals under controlled conditions, confirmation of multiple paternity within broods has been impossible. The adoption of multiple matings, whether solicited or not (i.e. “sneaker males”), and their effectiveness in producing multiply sired broods, has many important implications for the study of behaviour, genetic population structure and evolution in these species.

Here we confirm, using sensitive microsatellite DNA markers specifically developed for this species, that multiple males do contribute to the fertilisation of single broods of a loliginid squid, *Loligo forbesi*. To achieve this result pre-hatching embryos from single egg strings collected from the wild were genotyped using 6 independent microsatellite loci, and prospective maternal and paternal genotypes reconstructed from the allelic combinations observed. We also genetically confirm that females may lay their egg strings within existing bunches laid by other females. The wider applications of microsatellite DNA markers to behavioural and evolutionary studies in cephalopods are discussed.

### **Evidence for four species of *Brachioteuthis* (Oegopsida: Brachioteuthidae) in the eastern North Atlantic [poster]**

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As currently recognized, the family Brachioteuthidae contains one genus (*Brachioteuthis*) and five species (*beanii*, *riisei*, *behni*, *bowmanii*, and *picta*), but is greatly in need of revision. Taxonomic confusion within the family can be attributed in part to poor original descriptions, and in part to the paucity of available mature specimens in good condition. Traditionally, the eastern Atlantic has been thought to have only one species, *B. riisei* (Steenstrup, 1882); however, a detailed examination of newly-hatched and juvenile specimens collected during the Amsterdam Mid North Atlantic Plankton Expeditions of 1980-1983 ( $n = 259$ ) revealed that four morphotypes were consistently distinguishable based on the shape of the head, the mantle chromatophore patterns, and the shape of the tentacle. Only two of these four morphotypes can be tentatively assigned to currently recognized species. *Brachioteuthis* sp. 3 is described similarly to *B. picta*, and *Brachioteuthis* sp. 4 has many of the same characters as *B. bowmanii*. Confident identifications are hampered by the lack of original descriptions of hard parts, such as beak morphology, as well as the potential allometric differences between adults and juvenile or newly-hatched cephalopods.

## **Distribution and biology of *Rossia pacifica* (Cephalopoda, Sepiolidae) in the Russian Exclusive Zone of the Japan Sea [NPC, poster]**

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*Rossia pacifica* Berry, 1911, is a common species in coastal waters of Japan Sea. In the Russian Exclusive Zone it is found south to 51°N in the summer-autumn period. It occurs both near the bottom (15-310 m) and in the pelagic layers (0-490 m). The sepiolid ranges in size from 12-82 mm ML; female mantle lengths are 41-82 mm (mean 51 mm) and male mantle lengths are 27-42 mm (mean 32 mm). Egg masses of *R. pacifica* have been found in Peter the Great Bay (42°33'N, 131°13'E) from October-November in depths ranging from 100-300 m; in the region 42°40'N, 133°02'E to 42°51'N, 133°37'E - from July-November in depths of 30-50 m; and in the region 43°02'N, 13410'E - from July-September in depths of 15-20 m. Egg masses typically are attached to rocks and to the underside of various objects (trap boxes, etc.).

In the winter-spring period *R. pacifica* is distributed south to 49°N. Of the total population 94% occurred in epipelagic depths, 5.3% in mesopelagic, and 0.7% in the bathypelagic zone. Maximum abundance of the species (200 specimens per hour trawling) was observed on the South Sakhalin shelf. Small specimens (less than 20 mm) dominate in pelagic catches, while large specimens (more than 50 mm) dominate in bottom catches. Sizes in winter-spring range from 9-85 mm ML; female mantle lengths are 43-85 mm (mean 65 mm) and male mantle lengths are 33-56 mm (mean 45 mm). Females mature at 62 mm ML, and males at 38 mm.

In summary, juveniles of *R. pacifica* live mainly in epipelagic layers (0-200 m) whereas adults are demersal. The species spawns throughout the year with a peak in autumn.

## **Discovery of an egg mass with embryos of *Rossia pacifica* (Cephalopoda, Sepiolidae) in the Okhotsk Sea [NPC, poster]**

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A total of 27 tows were conducted at depths ranging from 100-300 m during the Okhotsk Sea bottom trawl survey off southwestern Kamchatka between 51°- 54°N in July 1996. In 14 samples (52%), 144 specimens of *Rossia pacifica* and an egg mass fragment were collected. The frequency of occurrence of *R. pacifica* increased from 17% at the 100 m contour to 80% at the 250 and 300 m contours. Mean catch was 8.1 specimens per half-hour tow. Maximum abundance was observed at 250 m depth: mean catch was 15 specimens, or 1615 g. Mature female mantle lengths ranged from 84-100 mm (mean 88.3 mm); lengths of nidamental glands - 45-55 mm (mean 50.8 mm); body weights - 165-235 g (mean 192.5 g). Male mantle lengths varied from 54-58 mm (mean 56.0 mm); body weights - 60-95 g (mean 75 g).

An egg mass fragment with 36 eggs was collected in 250 m on a sand bottom. The water temperature near-bottom at this location was 1.58°C. Each egg (12 mm in diameter) contains 3 capsules. The external capsule is oval in shape, white in color, and ranges in size from 13.8-17.8 mm. The egg is filled with a yolk mass and embryo lies on it with its mouth plunged deeply into the yolk. The dorsal mantle length of the embryo is 1.6 mm. All arms and tentacles are well developed with suckers in 2-3 unarranged rows. The embryos body form, head, fins, and armature of the arms corresponds to those of *R. pacifica*.

The presence of mature males and females, ready to spawn, plus an egg mass fragment caught at a depth of 250 m indicates the presence of a *R. pacifica* spawning ground.

## **Molluscan paleontology of middle Eocene brackish-marine rocks near Ojai, Ventura County, southern California**

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Within-habitat, brackish-marine mollusks are rare in lower Tertiary rocks of California. Lagoonal mudstones in a localized, 50 m-thick section in the lower middle Eocene ("Transition Stage") upper part of the Matilija Sandstone at Matilija Hot Springs near Ojai, contain low-diversity assemblages of gastropods and bivalves. Although the number of specimens is highly variable, the gastropods *Potamides* and *Loxotrema*, and the bivalves *Acutostrea*, *Cuneocorbula*, *Pelecypora*, *Tellina*, and *Trapezium* are in the majority of the assemblages. Less widely distributed are the gastropods *Crepidula*, *Tympanotonus*, *Melanatria?*, *Pygrulifera*, *Crommium*, and *Neverita*, and the bivalves *Barbatia* and *Corbicula*. This is the first confirmed record of *Tympanotonus* in North America and the first record of *Trapezium* on the Pacific coast of North America. The assemblages are of two types: those that are nearly in situ and those that have undergone only short-distance post-mortem transport. The former consists of up to 12 species of mollusks, all of which are unabraded and many are complete. The latter consists of coquinas of either *Pelecypora* or *Cuneocorbula*, both of which are made up of tightly packed, unabraded single valves.

Through time, the quiet-water lagoon environment fluctuated repeatedly with coastal-sabkha evaporites, as well as with barrier-bar/sandy beaches. The latter contains only fragments of the oyster *Acutostrea*.

## **The morphospacial "whorled" of strombid snails [PS]**

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Phylogenetic systematic analyses provide more objective, reproducible, and falsifiable means of classifying taxa than do traditional systematic techniques. In addition, branching patterns (cladograms) obtained from phylogenetic systematic analyses may be interpreted as reconstructions of evolutionary processes.

Mollusk shells are ideally suited for mathematical modeling and analyses using morphological space (morphospace). Records of ontogenetic history are recoverable from specimens, and this developmental information (in the form of mathematical parameters) can be used as complementary data in cladogram construction.

By combining mathematical models, morphospacial analyses, and cladograms, therefore, falsifiable scenarios of morphological evolution of mollusks can be hypothesized. This type of synthetic approach is exemplified with species of Strombidae. A cladogram is mapped into a three-dimensional morphospace, using a geometric algorithm to position nodes (interpretable as ancestors). During evolution of members within a clade containing all species traditionally classified in *Lambis* and some in *Strombus*, morphological change consisted predominantly of an increase in vertical dimensions of whorls. The change was greatest early in the history of the group and diminished thereafter. In the development of the synthesis, ancestral forms are reconstructed and traditional subgeneric classification within *Lambis* is shown to be untenable.

## **A review of the sea hare *Aplysia donca* (Gastropoda: Opisthobranchia) from Mustang Island, Texas**

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*Aplysia donca* was described from a single specimen collected in March of 1947 from a tide pool along the coast of Mustang Island, Texas. This species is known only from this one small and probably immature specimen. Despite

extensive field work conducted on sea hares along the Texas coast, this species has never again been reported nor collected. Taxonomic characters which constituted the basis of the original description of *A. donca* were examined in a juvenile series of *A. morio* from South Padre Island, Texas. Similarities of these characters in combination with the lack of a single non-variable character support the premise that the original description of *A. donca* was based upon an immature specimen of *A. morio*.

## **The utility of the gastric chamber of Caenogastropod stomachs in higher and lower level systematic studies**

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Features of the caenogastropod midgut, indeed of gastropods in general, have been regarded as potentially misleading in phylogeny reconstruction due to functional constraints. Thus, these characters have been assumed to be homoplasious and have remained underexplored as a potential source of characters in phylogeny reconstruction at lower and higher systematic levels. Revealed here are previously undescribed features of the midgut that are useful at a variety of taxonomic levels.

At higher systematic levels, one such character is the direction of ciliary currents on the left gastric chamber wall. Commonly associated with a sorting area in this region, the direction of ciliary action has been shown to reverse at the base of the neogastropod radiation. This suggests a fundamental shift in the circulation and digestion of food within the neogastropod stomach. In addition, comparative studies within families have been undertaken to assess the conservatism of features within the gastric chamber, revealing a number of features that may be useful at lower systematic levels. For example, several species of freshwater cerithiaceans have been shown to possess a similar modification of the glandular pad on the gastric chamber floor. Finally, the presence of a ciliated ridge associated with the sorting area within the gastric chamber of some littorinids, has potential significance at both higher and lower systematic levels.

## **The anatomy of a new hadal, cocculinid limpet (Gastropoda: Cocculinoidea), with a preliminary phylogenetic analysis of the family Cocculinidae [DS]**

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Ever since their discovery and first description by Dall in 1882, cocculinid species have intrigued their investigators with unique combinations of features. The anatomy of a new species of cocculinid limpet, is no exception. The only cocculinid, apart from *Fedikovella caymanensis*, known to inhabit hadal depths, this species possesses a number of features characteristic of cocculinids including the presence of broad oral lappets, epipodial tentacles, a hemal gland with associated aortic arch, and vestigial eyes modified into the so-called basitentacular gland. The hermaphroditic reproductive system includes a modified right cephalic tentacle inferred to function as a copulatory organ and a single receptaculum seminis. No evidence of a seminal groove could be found. However, this species is unique within the family in several aspects of both external and internal anatomy. These unique features include a prominent internal transverse septum within the shell, a closed receptaculum duct and the presence of several small statocones in some individuals. In addition, this species displays a unique combination of features heretofore undocumented among cocculinids, the most significant being the configuration of the nervous system. Preliminary phylogenetic analysis of the Cocculinidae includes fourteen taxa and twenty nine characters. Results indicate a basal placement of the species within the family and supports monophyly of the genera *Cocculina* and *Coccopigya*.

## Origin and distribution of deep-sea fauna of conoidean gastropods [DS]

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Conoidean gastropods, and especially the part formerly known as the family Turridae, are among the dominant molluscan groups in deep-sea faunas. These gastropods are very diverse, particularly as concerns their anatomy and feeding mechanisms. The evolution of the group was probably targeted at improvement of feeding, and advanced taxa possess highly specialized and efficient feeding mechanisms. Conoidean origin and initial stages of evolution were associated with shallow waters of tropical areas. The most primitive taxa (families and subfamilies) are still either restricted to, or most diverse in, warm, shallow-water habitats. Bathyal and, especially, abyssal faunas consist mainly of advanced representatives, and the share of higher taxa increases with depth. However, there are no taxa of the family group, that are characteristic only for the deep water fauna. This may indicate that the deep-water faunas are evolutionarily rather young and, at the same time, that colonization of deep waters reflected the adaptive radiation of conoideans rather than a major step in their evolution. A specific bathyal fauna of conoideans is known from as early as Oligocene deposits, and while Mio-Pliocene faunas were very similar to Recent ones from respective regions. The bathyal zone is characterized by an increased percentage of primitive taxa as compared to the shelf. Abyssal and hadal conoideans are represented by relatively few genera and families and subfamilies. An increase in diversity is recorded in near-continental regions, often inhabited by endemic genera, whereas the fauna of oligotrophic oceanic areas mostly consists of representatives of few widely spread genera belonging to advanced groups. The distribution pattern of deep-sea conoideans is characterized by the presence of a number of species with very limited ranges. At the same time, there are species with very wide ranges (e.g., amphioceanic). The mode of larval development seems not to strictly correlate with the area of species range.

## Occurrence of the adult form of *Neoteuthis* sp. from the Hawaiian Islands [NPC]

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During the surveys on the diet of *Alepisaurus ferox*, two adult form specimens of *Neoteuthis* sp. were discovered in the Hawaiian waters. The predator fish were collected in 1982 from 11°23.0'N, 177°58.5'E, 180m in fishing depth, and 11°24.0'N, 169°4.5'E, 230m, by longline. The squid specimens are both females, 62.5 mm and 61.5 mm in DML, respectively. The body is weakly muscular and its surface bears distinct iridescence.

Two species of the genus *Neoteuthis* has hitherto been known (Nesis, 1982), such as, *N. thielei* Naef, 1921, the type species of the genus, from the Atlantic, and unnamed species (from Hawaiian waters by Young, 1972). *Neoteuthis thielei* attains to 17 cm DML in adult (Nesis, 1982), while the adult male specimens of the Pacific unnamed species (Young, 1972) does 83 mm DML. The present specimens is almost conspecific, but yet different from Young's (1972) specimen in several indices and features. In the present study, the taxonomic status of this species, and some ecological information are discussed.

## Shell polymorphism in the neogastropod *Alia carinata* (Hinds)

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I analyzed *Alia carinata* from four different habitats to investigate the presence of literature-alleged shell pattern and shell form polymorphism. Using univariate and multivariate statistics, I demonstrated that *Alia* from *Gastroclonium subarticulatum* (Rhodophyta), *Zostera marina*, and benthic hard bottom habitats displayed measurably and identifi-

ably distinct forms. Individuals from *Macrocystis pyrifera* (Phaeophyta) canopies showed considerable form overlap with benthic specimens. Interhabitat polymorphism was related to differences in both size and shape, while observed sexual dimorphism was strictly size-related, with males larger than females. *Alia* from *Zostera* were mostly non-patterned and dark in color, while those from the other three habitats were generally patterned and variably colored. Planktonic dispersal of juveniles suggests that intraspecific polymorphism is a result of phenotypic plasticity, and not natural selection. Allometric growth, wave exposure, and predation differences among sampled habitats may be important controlling factors in observed intraspecific polymorphism.

### **Distribution and transport of *Illex argentinus* paralarvae (Cephalopoda: Ommastrephidae) across the western boundary of the Brazil/Malvinas Confluence Front off southern Brazil [poster]**

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This study discusses the transport and the influence of different water masses, phytoplankton and zooplankton biomass on the distribution and abundance of *Illex argentinus* paralarvae off southern Brazil (28°09' S-34°20' S). During four surveys carried out from 1987 to 1991, a total of 428 paralarvae were collected with a bongo net (0.33 mm mesh size) in 203 tows. Paralarvae were found from autumn to spring, but were absent in summer and in regions of major influence of coastal and subantarctic waters. The greatest relative abundance (41 paralarvae 100 m<sup>3</sup>) was found in spring of 1987. Paralarvae were mainly distributed along a shelf-break front formed between tropical waters of the Brazil Current and subantarctic waters of the Malvinas/Falklands Current where partial upwelling processes and planktonic enrichment were found. From the slope to the coast, there was a clear progression of paralarval sizes. Hatchling occurred at the outer shelf and slope in tropical and/or subtropical waters. The largest paralarvae and small juveniles were found at the inner shelf under the influence of subantarctic waters, where high concentrations of chlorophyll-a and zooplankton biomass were measured.

### **Studies of hydrothermal vent fauna, especially gastropods [DS]**

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Extreme and highly variable temperatures, exposure to chemically reducing fluids, such as hydrogen sulfide, and heavy metals and temporally unstable habitats, limit the number of animals that dwell at hydrothermal vents. Studies of diversity have virtually ignored vent habitats due to the limited number of species they support and the difficulties in adequately sampling abyssal habitats. Animal diversity at volcano-hosted vents on Juan de Fuca and Explorer ridges in the northeast Pacific is significantly lower than the East Pacific Rise (EPR) at 9°-21°N. Although individually, EPR vents are smaller and shorter-lived than are North Pacific vents, EPR vents appear to occur in greater diversity; they thus may offer more total area than do the larger, comparatively long-lived, but well-spaced North Pacific vents. The increased proximity of individual EPR vents may also allow large, apparently endemic predators to forage at multiple vents and therefore to survive, despite the ephemeral nature of the individual habitats. Such predators are virtually absent from northeast Pacific vents. The proximity of EPR vents may directly enhance the effective dispersal of the large larvae of vent-dwelling gastropods, which are likely to have limited individual dispersal capacity.

## **The California market squid fishery [NPC]**

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Market squid (*Loligo opalescens*) is presumed to be one of the most abundant marine resources in California waters. Squid range from southeastern Alaska to Bahia Asuncion, Baja California, Mexico. Catches have traditionally come from two fishing areas within California: Monterey Bay and the islands off southern California. Squid become vulnerable to commercial fishing gear when they concentrate near shore to spawn and are typically taken at night. Harvest and demand are primarily controlled by international market conditions. The demand for squid has increased dramatically in recent years. Prior to 1987, California landings averaged 10,000 tons. Beginning in 1988, commercial landings began to increase and have grown from approximately 40,000 tons to over 83,000 tons in 1996.

Little is known about the present size, structure or status of the population, but historical evidence from research cruises, as well as catch data, indicates the biomass is large. It is believed that squid can be more intensively harvested than other marine animals because they are short lived. They also appear to be heavily influenced by environmental conditions.

## **The role of stratigraphic data in phylogenetic analyses of extinct molluscs [PS]**

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Both biotic factors (rates and models of morphologic change, rates of extinction, numbers of applicable characters and speciation models) and abiotic factors (rates of sampling) affect the accuracy of parsimony. The molluscan fossil record provides workers with a high proportion of the widely distributed species, which increases the accuracy of parsimony in simulations. However, high rates of morphologic change (well within the ranges inferred by cladistic analyses of molluscs) seriously undermine the accuracy of parsimony in the same simulations, even with no patterned homoplasy present. Stratigraphic data offer tests of whether congruent characters represent phylogenetic signal or convergence. Existing phylogenetic methods utilize stratigraphic data based on congruence and total evidence logic and on probability theory. These methods provide more exact estimates of phylogeny than does parsimony by making explicit ancestor-descendant estimates and implying particular patterns of speciation and routes of morphologic change. Evaluation of these methods is very important when contrasting the evolutionary scenarios implied by alternate estimates of phylogeny. Simulations using preservation and evolutionary rates typical of molluscs find that all methods incorporating stratigraphy perform better than does parsimony. Methods currently in development evaluate the likelihood of a phylogeny implying both particular amounts of stratigraphic gaps and particular amounts of morphologic change. Ultimately, likelihood approaches probably will provide workers with the most robust phylogenetic estimates of phylogeny for extinct molluscs.

## **The phylogenetic relationships of some littorinid species assessed by small subunit ribosomal DNA sequences and morphology [poster]**

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Small subunit ribosomal DNA (18S rDNA) is usually considered to be a slowly evolving molecule with very limited, if any, phylogenetic resolving power for divergences that took place in less than 40 MY. We evaluated this issue by a congruence and total evidence analysis of morphological data and complete 18S rDNA sequences of nine littorinid species from the genera *Melarhappe*, *Littoraria*, *Nodilittorina* and *Littorina*. We particularly focused on the still somewhat controversial position of the Macaronesian periwinkle *Littorina (Liralittorina) striata*, a species that has been variously assigned to *Melarhappe*, *Nodilittorina*, and currently *Littorina*. These analyses suggested (1) that 18S rDNA provided a much stronger phylogenetic signal to recover the well-known, young *Littorina-Neritrema* radiations (divergence time < 10 MY), whereas the topology of the older, *Littoraria-Nodilittorina-Liralittorina* branches was much less supported, and (2) that the current morphological and molecular data are insufficient to unambiguously resolve the relationships of *L. striata*. Anyway, although current practice suggests the contrary, 18S rDNA may be not so unsuitable to reconstruct relatively young radiations.

## **Unordered vs. ordered multistate characters: explication and implication [PS]**

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Characters with three or more states are typically treated as ordered or unordered in multistate character coding methods. Although both treatments hypothesize which character states directly evolve into which other states (= character transformation series or character state trees), the proposed suppositions are very different. What are these differences? Does unordered really provide a logical approach based on similarity, the first criterion of testing homology? These questions are addressed in an effort to establish how these issues affect the reconstruction of the evolutionary history of the Phylum Mollusca, or for that matter any attempt at phylogenetic systematics.

## **Life history and population structure of the neon flying squid, *Ommastrephes bartrami*, in the North Pacific Ocean [NPC]**

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The neon flying squid consists of an autumn cohort (formally known as LL group) and a winter-spring cohort (L, S, SS groups combined) as based on age estimation with statolith microstructure, mantle length compositions, distribution of both mature individuals and paralarvae. Both cohorts are estimated to have one-year life span. They undergo seasonal north-south migrations between the spawning grounds in the subtropical waters and feeding grounds in the Subarctic waters. The winter-spring cohort can be further separated into a western stock and a central-eastern stock on the basis of intensity of infection with larval nematode and cestode parasites. The autumn cohort was abundant in the central and eastern North Pacific but rare west of 170°E which coincides with the location of the Emperor Sea Mount Chain north of 35°N. The autumn cohort also is separable into central and eastern stocks on the basis of parasite infection intensity.