TERN SOCIETY OF MALACOLOGISTS

ANNUAL REPORT

VOLUME 43

ABSTRACTS AND PROCEEDINGS
of the 43rd Annual Meeting of the
WESTERN SOCIETY OF MALACOLOGISTS
held jointly with the AMERICAN MALACOLOGICAL SOCIETY
SAN DIEGO STATE UNIVERSITY, SAN DIEGO, CALIFORNIA
June 26 – June 30, 2010

Issued December 30, 2011

THE

WESTERN SOCIETY OF MALACOLOGISTS

ANNUAL REPORT

VOLUME 43

Being the

ABSTRACTS AND PROCEEDINGS
of the 43rd Annual Meeting of the
WESTERN SOCIETY OF MALACOLOGISTS
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AMERICAN MALACOLOGICAL SOCIETY
at
SAN DIEGO STATE UNIVERSITY
SAN DIEGO, CALIFORNIA
June 26 – June 30, 2010

Issued December 30, 2011

In Memoriam

Warren O. Addicott, Ph.D.
17 February 1930 – 11 July 2009

John D. Jackson, Jr., J.D.
10 December 1941 – 24 November 2009

Joseph R. (José) Johnson
2 February 1933 – 28 April 2009

Margaret (Peg) Mulliner
20 January 1926 – 13 February 2010

James W. Nybakken, Ph.D.
1936 – 20 June 2009

William T. Schneider
6 May 1930 – 8 February 2011

CONTENTS

The WESTERN SOCIETY OF MALACOLOGISTS

Founded 1968

Officers, 2009-2010 (2010 meeting year):

President: George L. Kennedy

First Vice President: Esteban F. Félix Pico

Second Vice President: Janet L. Leonard

Sectretary: Charles L. Powell, II

Treasurer: Kelvin L. Barwick

Members-at-Large: Hans Bertsch and Nora R. Foster

Committees and Appointments:

Nominating Committee (previous three past presidents):
Michael J. Vendrasco (Chair), Charles L. Powell, II, and Carlos Cáceres Martínez

Editor: George L. Kennedy (2010 meeting volume)

Editorial Board: Hans Bertsch, Charles L. Powell, II, and Nora R. Foster

Student Grant Committee: Hans Bertsch and Nora R. Foster

Webmaster: Douglas J. Eernisse

Historian: George L. Kennedy

International Liason: Hans Bertsch and Rosa del Carmen Campay

Society Publications:

Western Society of Malacologists, Annual Report (containing the abstracts and proceedings of its Annual Meeting); ISSN 0361-1175

Western Society of Malacologists, Occasional Papers

Student Grant Awardees for 2010:

Robyn Mieko Dahl, University of California at Riverside

Maria Meza-Lopez, Rice University, Houston, Texas

Best Student Paper presentations for 2010:

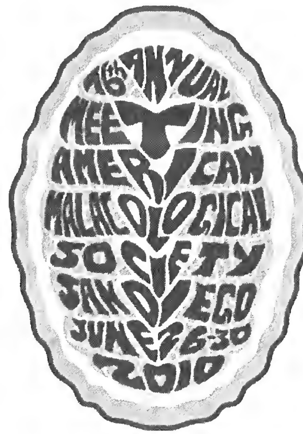
Logan D. Froman, "Is a newly discovered chiton brooder on Santa Catalina Island an undescribed species?" (by L. D. Froman & D. J. Eernisse), and

Roland C. Zepeta, "Morphometric analysis and diversity of chitons from the Oaxacan coast" (by R. C. Zepeta & A. Reyes Gómez)

PROGRAM AND ABSTRACTS

for the 2010

Western Society of Malacologists and American Malacological Society Joint Annual Meeting



AZTEC CONFERENCE CENTER
SAN DIEGO STATE UNIVERSITY
SAN DIEGO, CALIFORNIA
26 June – 30 June 2010

SAN DIEGO STATE UNIVERSITY

Meeting Acknowledgements

The combined joint Annual Meeting of the Western Society of Malacologists (43rd) and the American Malacological Society (76th) could not have been accomplished without the aid and assistance of many persons and institutions. The WSM and AMS Presidents particularly want to thank Brian Gollands, AMS Webmaster; Kelvin Barwick, WSM Treasurer; and Hans Bertsch, WSM, for his heroic efforts in all matters international. This is the core group that made this meeting happen.

Institutional support generously provided by:

Brian F. Smith and Associates, Inc., Environmental Consultants, Poway and San Diego
Department of Biological Science, California State University, Fullerton
San Diego City Ocean Monitoring Program, San Diego
Scripps Institution of Oceanography, La Jolla

For the graphic design of the chiton logos for the meeting, we thank Paige Elizabeth Wallis of Soothed by Rainfall Studios (http://soothedbyrainfall.net/). This work was privately funded by Peter Marko. For graphics design and assistance on the program, badges and certificates, we thank Adrián S. Moreno of BFSA. Isaura Zamora López designed the web poster.

We especially appreciate the time and effort put into organizing the program of speakers for the AMS Symposium on Pacific Biogeography (Peter Marko and Alan Kohn), as well as the special sessions on Invasive Molluscs (Jennifer Burnaford) and Molluscan Paleontology (Lindsey Groves), and workshops on Genomics (Eric Gonzales) and Internet Literature (Pat LaFollette).

Others who have assisted us in the production of this meeting in one way or another, but in no particular order, include: Wendy Enright, Dawn Olson, Rosa Campay, Brian Smith, Karen Deese, Brittany Phillips, Cynthia Trowbridge, Christine Parent, Amanda Lawless, Dawn Dittman, Paula Mikkelsen, Janet Voight, Chuck Powell, Danielle Zacherl, Chrystal Johnson, Lori Padelford, Michelle Adams, Alyssa Dolata-Goodrich, and Cory Immele and the Aztec Center staff. Meeting volunteers include Paul Tuskes, Nancy Schneider, Carole Hertz, Rosa Campay, Rebecca Kowallis, Chrystal Johnson, and Candice Aguirre. And lastly, but certainly not least, we thank LeAnn Eernisse and Lana Kennedy for putting up with us in those last few hectic months; it will be over soon. To those of you who we may have missed, please accept our apologies.

Notable donations to the WSM-AMS Reprint Sale include items from WSM, AMS, George Metz, Chris Meyer and the Smithsonian Institution, the San Diego Shell Club, and several generous individuals.

Donations to the Auction event include items from AMS, the San Diego Shell Club, Alan Kohn, Nora Foster, George Kennedy, Carole and Jules Hertz, and others.

Notable donations for the Student Grant Fund were made by the Southwestern Malacological Society, the Pacific Conchological Club, the San Diego Shell Club, and by WSM members.

Summary Highlights of WSM-AMS Meeting Schedule

June 26, 2010 — Saturday

Registration. 12 noon until 5:00 P.M., Cuicacalli Hall, front foyer, continued in Cuicacalli Hall, Seminar Room A, until 9:00 P.M.

Welcoming reception. ~ 5:30 P.M. until 9:00 (?) P.M. Cuicacalli Hall, outside patio area next to the pool, NE corner of Cuicacalli Hall.

June 27, 2010 — Sunday

Registration. 8 A.M. – 5:00 P.M. "Casa Real" meeting room, upper level of Aztec Center.

Welcome, Introductory Remarks, and Annoucements. 9:00 A.M. "Backdoor" lecture hall, lower level of Aztec Center.

Special session on Invasive Molluscs. 9:15 – 4:00 P.M. "Backdoor" lecture hall.

Contributed papers on marine mollusks. 10:20 – 5:00 P.M. "Casa Real" meeting room.

WSM Executive Board Meeting. 6:00 P.M. "Aztlan" meeting room.

Special Workshop: ***Malacological Literature and Resources on the Internet*** by Pat LaFollette. 6:30 – 9:00 P.M. Cuicacalli Hall, Seminar Rooms A+B.

June 28, 2010 — Monday

Registration. 8 A.M. – 5:00 P.M. "Casa Real" meeting room, upper level of Aztec Center.

Special session on Molluscan Paleontology 2010: Contributed papers in honor of LouElla R. Saul. 9:00 – 2:30. "Backdoor" lecture hall. Session to be followed by Contributed Papers.

Contributed papers on terrestrial and freshwater mollusks. 8:40 – 12 noon. "Casa Real" meeting room. Session to be followed by Contributed Papers.

Special Workshop: ***Molluscan Genomics Workshop: Seq-based Genomics for Organismal Biology*** by Eric Gonzales. 6:30 – 9:00 P.M. Cuicacalli Hall, Seminar Rooms A+B.

June 29, 2010 — Tuesday

Registration. 8 A.M. – 5:00 P.M. "Casa Real" meeting room, upper level of Aztec Center.

AMS Symposium: Molluscan Biogeography: Perspectives from the Pacific Ocean. 8:20 A.M. – 3:00 P.M. "Backdoor" lecture hall.

Group photograph. 3:00 P.M.. Aztec Center stairway

AMS-WSM Auction and Reprint Sale. 6:30 – 9:00 P.M. Cuicacalli Hall, Seminar Rooms A+B.

June 30, 2010 — Wednesday

Contributed papers Chitons and others. 9:00 A.M. – 12 noon. "Casa Real" meeting room.

Contributed papers on tropical Eastern Pacific. 9:00 – 12 noon. "Backdoor" lecture hall.

Poster Session. 1:30 – 3:30 P.M. "Casa Real" meeting room. Authors to be by their posters.

General business meeting. 3:30 – 4:30 P.M. "Casa Real" meeting room.

Farewell Dinner, Casa Guadalajara Restaurant in Old Town. ~ 6:30 P.M. – 9:00 P.M.

July 1, 2010 — Thursday

Field trip. Scripps Institution of Oceanography and Scripps Birch Aquarium.

Evening and Other Activities

Saturday, June 26, 2010

Registration and check in for on-campus residents and early arrivals. 12 noon until 5:00 P.M, front desk of Cuicacalli Hall; continued at following reception event.

Welcoming reception and pizza party. ~ 5:30 P.M. to 9:00 P.M. (?). Cuicacalli Hall, outside on patio area around pool, NE corner of building.

Sunday, June 27, 2010

WSM Executive Board meeting. 6:00 P.M. Aztlan meeting room.

Workshop: Malacological Literature and Resources on the Internet by Pat LaFollette of LACMNH. ~ 6:30 P.M. Bring your laptop computer to follow along. Cuicacalli Seminar Rooms A+B

Monday, June 28, 2010

Workshop: Molluscan Genomics Workshop: Seq-based Genomics for Organismal Biology by Eric Gonzales of UC Berkeley. ~ 6:30 P.M. Bring your laptop computer to follow along. Cuicacalli Seminar Rooms A+B

Tuesday, June 29, 2010

Auction and Reprint Sale. Mainly books, but other things too. Lots of new reprints and maps. ~ 6:30 P.M. Cuicacalli Seminar Rooms A+B

Wednesday, June 30, 2010

WSM General Business meeting. 3:30 – 4:30 P.M. "Casa Real" meeting room.

Final farewell Dinner at Casa Guadalajara Restaurant in Old Town San Diego. ~ 6:30 p.m., dinner service starts at 7:00 P.M. Happy hour begins ***after*** society business meetings (3:30 P.M. in meeting rooms)

Thursday, July 1, 2010

Field trip to Scripps Institution of Oceanography and Scripps Birch Acquarium.

TECHNICAL SESSIONS PROGRAM:
WSM-AMS 2010 JOINT ANNUAL MEETING
SDSU AZTEC CONFERENCE CENTER

SUNDAY	27 JUNE 2010	BACKDOOR

9:00 A.M. ***Welcome, Introductory Remarks and Announcements***
Douglas J. Eernisse, George L. Kennedy and Esteban F. Félix Pico

9:10 A.M. **SPECIAL SESSION ON INVASIVE MOLLUSCS**

9:10 – 9:15 Jennifer L. Burnaford
Opening remarks and introduction

9:15 – 10:00 Andrew N. Cohen
Quagga and Zebra Mussels in the Western U.S.: Invasion and response 2007-2010

10:00 – 10:20 Break

10:20 – 10:40 Dawn E. Dittman
Dreissena bugensis ***in Lake Ontario and the Finger Lakes of New York***

10:40 – 11:00 Henry S. Carson, M. Paola López-Duarte and Lisa A. Levin
Population connectivity of *Mytilus galloprovincialis* ***in southern California***

11:00 – 11:20 Jeffrey A. Crooks
Temporal dynamics of biological invasions and the lag effect

11:20 – 11:40 Andrew L. Chang, April M. H. Blakeslee, A. Whitman Miller and Gregory M. Ruiz
Where is it from and how did it get here? Investigating invasions of the North Atlantic gastropod *Littorina littorea* ***in California***

11:40 – 12:00 Heidi W. Weiskel, J. E. Byers, T. C. Huspeni, C. J. Zabin, C. M. Bowles, C. Brown, and E. D. Grosholz
Demographics and eradication of two new invasive populations of *Batillaria attramentaria* ***in California***

12:00 – 1:30 P.M. Lunch break

1:30 – 1:50 Danuta M. Bennett, Tom D. Dudley, and Scott Cooper
Experimental and monitoring studies of the invasive snail *Potamopyrgus antipodarum* ***in southern California streams***

1:50 – 2:10 Marion E. Wittmann, John E. Reuter, Sudeep Chandra, S. Geoffrey Schladow and Brant C. Allen
Asian clam (*Corbicula fluminea****) invasion in Lake Tahoe: The ecology and management of an invasive bivalve in an oligotrophic lake***

2:10 – 2:30 Jennifer L. Burnaford, Scottie Y. Henderson and Bruno Pernet
Assemblage shift following population collapse of invasive *Mercenaria mercenaria* ***in an urban southern California lagoon***

2:30 – 2:50 Elizabeth C. Davis-Berg
Mucous trail following in the rosy wolf snail *Euglandina rosea*

2:50 – 3:10 Break

3:10 – 3:30 Megan E. Paustian, Pedro Barbosa and Timothy A. Pearce
Evaluating competition between the invasive slug *Arion subfuscus* ***(Draparnaud) and the native slug*** *Philomycus carolinianus* ***(Bosc)***

3:30 – 3:50 Wallace M. Meyer III and Robert H. Cowie
Rapoport's rule as a tool for assessing the potential distribution and conservation implications of non-native species on tropical islands

3:50 – 3:55 Jennifer L. Burnaford
Closing remarks

4:00 – 4:20 Andrew N. Cohen
The history of native oysters in San Francisco Bay: Implications for restoration

4:20 – 4:40 Maria Rosa, J. Evan Ward, Sandra E. Shumway, Emmanuelle Pales Espinosa, Bassem Allam, Gary H. Wikfors and Bridget A. Holohan
The role of particle surface properties on selection by the Eastern Oyster *Crassostrea virginica* ***and the Blue Mussel*** *Mytilus edulis*

4:40 – 5:00 Kenneth M. Brown, Barry Aronhime and Xueying Wang
Crab predation causes size-specific inducible response in Hooked Mussels

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6:30 – 9:00 Patrick I. LaFollette
Evening workshop: ***Malacological Literature and Resources on the Internet***
Cuicacalli Hall, Seminar Rooms A+B

SUNDAY	27 JUNE 2010	CASA REAL

10:20 A.M. **CONTRIBUTED PAPERS ON MARINE MOLLUSKS**

10:20 – 10:40 André F. Sartori
Anomalous by nature: A fresh look at Anomalodesmatan systematics

10:40 – 11:00 Jingchun Li
Host races or ecomorphs? Testing host-mediated speciation in two marine commensal bivalve species

11:00 – 11:20 Jann E. Vendetti
Predation at a snail's pace: Time-lapse photography in neogastropod whelks

11:20 – 11:40 Paul M. Tuskes and Jennifer A. Kelly
Observations on the biology of *Neosimnia barbarensis* ***and predator-pray interaction with the sea pen host,*** *Acanthoptilum* ***sp.***

11:40 – 12:00 James H. McLean
Revision of recent and fossil Liotiidae (Gastropoda: Vetigastropoda)

12:00 – 1:30 P.M. Lunch break

1:30 – 1:50 Emilio Michel Morfín, Luis M. Bautista and Oscar E. Holguin
Purple dye snail *Plicopurpura pansa* ***(Gould, 1853) from Isla Socorro, Revillagigedo Archipelago, México (1997 & 2010 surveys)***

1:50 – 2:10 Rebecca M. Price
Elevated temperatures have a minimal effect on growth in *Nucella lamellosa*

2:10 – 2:30 Z. Graciela Castillo Rodríguez and Felipe Amezcua
Stramonita biserialis ***(de Blainville, 1832) (Gastropoda: Muricidae) on the Pacific Coast of Mexico***

2:30 – 2:50 Fabio Moretzsohn
Interspecific variation of odontophores in the Cypraeidae (Mollusca: Gastropoda) suggest they are taxonomically informative

2:50 – 3:10 Break

3:10 – 3:30 Ángel A. Valdés and Elysse Gatdula
Systematics, evolution, and cryptic diversity of tropical Atlantic *Chelidonura* ***(Opisthobranchia: Cephalaspidea)***

3:30 – 3:50 Ulysses Gatdula
Phylogeny of *Cyerce* ***(Opisthobranchia) with the description of a new species from Guam***

3:50 – 4:10 Luis E. Gonzalez Jr. and Ángel A. Valdés
Molecular and morphological phylogeny of the genus *Dondice*

4:10 – 4:30 Hans Bertsch and Cathy Marlett
The Seri, the sun and the slug: Cultural and natural history of *Berthellina ilisima* ***(Opisthobranchia) from the central Sea of Cortez***

4:30 – 4:50 Jazmín D. Ortigosa Gutiérrez, Laura Sanvicente Añorve, Elia Lemus Santana, Juan Lucas Cervera, Vivianne Solís Weiss and Nuno Simões
Opisthobranch assemblages in Alacranes coral reef, Yucatan Peninsula, México: A preliminary aproach

4:50 – 5:00 Patrick I. LaFollette
Introduction to evening workshop on: ***Malacological literature and resources on the Internet,*** followed by Evening workshop: ***Malacological Literature and Resources on the Internet*** in Cuicacalli Hall, Seminar Rooms A+B

MONDAY	28 JUNE 2010	BACKDOOR

9:00 A.M. **MOLLUSCAN PALEONTOLOGY 2010: CONTRIBUTED PAPERS IN HONOR OF LOUELLA R. SAUL**

9:00 – 9:20 Lindsey T. Groves
Opening remarks and tribute to LouElla R. Saul

9:20 – 9:40 Richard L. Squires and LouElla R. Saul
Groups of Northeast Pacific Cretaceous gastropods and bivalves

9:40 – 10:00 LouElla R. Saul and Richard L. Squires
The curious posture of the Cretaceous aporrhaid gastropod *Tessarolax*

10:00 – 10:20 Break

10:20 – 10:40 Bernard M. Landau and Lindsey T. Groves
Cypraeidae (Mollusca: Gastropoda) from the lower Miocene Cantaure Formation of northern Venezuela

10:40 – 11:00 Edward J. Petuch
A bernayine cowrie species radiation from the Plio-Pleistocene Everglades Pseudoatoll

11:00 – 11:20 John M. Alderson and Robert J. Stanton, Jr.
A Miocene marine fauna from the Conejo Volcanics, Los Angeles County, California

11:20 – 11:40 Carole S. Hickman
Biogeographic patterns in Cenozoic microgastropod assemblages

11:40 – 11:45 George L. Kennedy
Presentation of the Western Society of Malacologists 2010 Award of Honor to LouElla R. Saul

11:45 – 12:00 Group Photograph for Paleontology session presenters

12:00 – 1:30 P.M. Lunch break

1:30 – 1:50 Christy C. Visaggi and Patricia H. Kelley
Geographic variation in predatory drilling on bivalves across four ecoregions in Brazil: Implications for the fossil record

1:50 – 2:10 Lindsey T. Groves
New species of Paleogene cypraeoideans (Mollusca: Gastropoda) from the Pacific Slope of western North America

2:10 – 2:30 Lindsey T. Groves, Harry F. Filkorn and John M. Alderson
A new species of Late Cretaceous cypraeid from the Santa Ana Mountains, Orange County, California

CONTRIBUTED PAPERS

2:30 – 2:50 Joshua P. Lord
Redefining size: Impact of allometric relationships on modeling indeterminate growth, with a focus on chitons

2:50 – 3:20 Break

3:20 – 3:40 Stephanie L. Schroeder
Fight or flight: *Lottia gigantea* ***agonistic encounters***

3:40 – 4:00 Laney M. Whitlow and Douglas J. Eernisse
Shell geometry and plasticity in the surfgrass limpet, *Lottia paleacea,* ***and their effects on reproductive life history traits***

MONDAY	28 JUNE 2010	CASA REAL

8:40 A.M. **CONTRIBUTED PAPERS ON TERRESTRIAL AND FRESHWATER MOLLUSKS**

8:40 – 9:00 G. Thomas Watters
Why are freshwater mussels so big? Size, reproduction, and the evolution of the Unioniformes

9:00 – 9:20 Daniel L. Graf and Anthony Geneva
Coelatura ***and the monophyly of the Unionidae (Bivalvia: Unionoida)***

9:20 – 9:40 Marian E. Havlik
Effects of the August 2007 flood on translocated mussels, South Fork of the Zumbro River, Rochester, Minnesota, August 2008

9:40 – 10:00 Nathan V. Whelan
Life history of *Leptoxis* ***(Gastropoda: Pleuroceridae)***

10:00 – 10:20 Break

10:20 – 10:40 Edna Naranjo García
New records of land mollusks from southeastern Selva Lacandona, Chiapas, México

10:40 – 11:00 Gary Rosenberg and Makiri Sei
Phylogenetic analysis of Jamaican Annulariidae (Mollusca: Gastropoda)

11:00 – 11:20 Timothy A. Pearce and Marvin C. Fields
Carnivore bites the dust: Land snail *Ancotrema hybridum* ***is*** *A. sportella*

11:20 – 11:40 John B. Burch, Taehwan Lee and John L. Keebaugh
Comparative morphology of *Physa (Haitia) natricina* ***Taylor 1988, an endangered freshwater snail***

11:40 –12:00 Janet L. Leonard, John S. Pearse, Sanne Helsen, Natalie Van Houtte, Karin Breugelmans, Kurt Jordaens and Thierry Backeljau
Evidence for rapid evolution with diversification of sexual behavior in the genus *Ariolimax* ***(Gastropoda: Stylommatophora)***

12:00 – 1:30 P.M. Lunch break

CONTRIBUTED PAPERS

1:30 – 1:50 Ana K. Celis Hernández, Carlos Figueroa Beltrán and Miguel A. Téllez Duarte
Importance and vulnerability of archaeological shell middens in Baja California: The cases of San Quintin and the Upper Gulf

1:50 – 2:10 Deborah V. Roman
Case studies in the confounding factors involved in appropriate shell identifications from cultural middens: Recommendations for future amelioration of such problems

2:10 – 2:30 Eric E. Gonzales and Daniel S. Rokhsar
Introduction to evening workshop on: ***Molluscan Genomics Workshop: Seq-based genomics for organismal biology***

2:50 – 3:20 Break

3:20 – 5:00 Posters available for study; continuing papers in Backdoor

5:00 – 6:00 Dinner break

6:30 – 9:00 Eric E. Gonzales and Daniel S. Rokhsar
Evening workshop: ***Molluscan Genomics Workshop: Seq-based genomics for organismal biology***
Cuicacalli Halll, Seminar Rooms A+B

TUESDAY	29 JUNE 2010	BACKDOOR

8:20 A.M.

AMS SYMPOSIUM:
MOLLUSCAN BIOGEOGRAPHY: PERSPECTIVES FROM THE PACIFIC OCEAN

8:20 – 8:30 Peter B. Marko
Opening remarks and introduction

8:30 – 9:00 Suzanne Williams
Effect of geography, tectonics, ecology and glacio-eustatic processes on speciation of marine intertidal gastropods

9:00 – 9:30 Alan J. Kohn
Life history and tropical marine biogeography in the light of phylogeny

9:30 – 10:00 Peter B. Marko
Pleistocene glaciation, biogeographic dynamics, and evolutionary responses of Eastern Pacific molluscan assemblages

10:00 – 10:30 Break

10:30 – 11:00 David K. Jacobs
***When to infer flight in molluscs? – Cryptic taxa in the trematode** Parorchis, **the gastropod** Cerithidea **and the bivalve** "Transennella"*

11:00 – 11:30 Cynthia D. Trowbridge, Y. M. Hirano and Y. J. Hirano
Biogeography of North Pacific sacoglossan opisthobranchs

11:30 – 12:00 Christine E. Parent
Ecological and evolutionary determinants of island biogeography of land snails

12:00 – 1:30 P.M. Lunch break

1:30 – 2:00 Thomas F. Duda, Jr., Marielle Terbio, Gang Cheng, Semoya Phillips, Dan Chang and David W. Morris
***Patterns of population structure and demography in** Conus*

2:00 – 2:30 Hans Bertsch
Provincial-level relationships and feeding biogeography of Northeast Pacific opisthobranchs: Taxonomic vs. network biodiversity analyses

2:30 – 3:00 Douglas J. Eernisse
Parapatric sibling species pairs in chitons and limpets: Do they help explain impressive diversification along the shores of western North America?

3:00 – 3:05 Alan J. Kohn
Closing remarks

3:05 – 3:30 Break and GROUP PHOTOGRAPH

3:30 – 5:00 Posters available for study

5:00 – 6:00 Dinner break

6:30 – 9:00 AMS & WSM AUCTION and Reprint Sale
Cuicacalli Hall, Seminar Rooms A+B

WEDNESDAY	30 JUNE 2010	CASA REAL

9:00 A.M. **CONTRIBUTED PAPERS ON CHITONS AND OTHERS**

9:00 – 9:20 Iker Irisarri, Douglas J. Eernisse and Rafael Zardoya
Major branch swapping in the placement of *Cryptochiton* ***and*** *Plaxiphora* ***within Acanthochitonina (Mollusca: Polyplacophora)***

9:20 – 9:40 Ronald Cesar Zepeta Vilchis and Adriana Reyes Gómez
Morphometric analysis and diversity of chitons from the Oaxacan Coast

9:40 – 10:00 Lizeth Galeana Rebolledo, Rafael Flores Garza, Sergio García Ibáñez, Pedro Flores Rodríguez, Carmina Torreblanca Ramírez, Salvador Ramírez Salazar, Arcadio Valdés González, and Domingo G. Arana Salvador
Polyplacophora community in the rocky middle-intertidal zone of Acapulco, Guerrero, México

10:00 – 10:20 Break

10:20 – 10:40 Sergio García Ibáñez, Rafael Flores Garza, Pedro Flores Rodríguez, Arcadio Valdés González, Francis G. Olea de la Cruz, Francisco Javier Valencia Santana and Domingo G. Arana Salvador
Chitons: Acapulco's gourmet delight

10:40 – 11:00 Rebeca Vásquez Yeomans and Jorge Cáceres Martínez
Parasites of the clam *Chione fluctifraga* ***cultured in Bahía San Jorge, Sonora, Mexico***

11:00 – 11:20 Jorge Cáceres Martínez and Rebeca Vásquez Yeomans
Histopathological alterations of the Pacific oyster *Crassostrea gigas* ***associated with algal blooms in Northwest Mexico***

12:00 – 1:30 Lunch break

WEDNESDAY	30 JUNE 2010	BACKDOOR

9:00 A.M. **CONTRIBUTED PAPERS: THE TROPICAL EASTERN PACIFIC**

9:00 – 9:40 Hans Bertsch and Rosa del Carmen Campay
Biodiversity 2010 Millennium goals: Marine resources and conservation issues in Northwest México

9:40 – 10:00 Meredith R. Raith, Danielle C. Zacherl and Douglas J. Eernisse
Phylogenetic relationships among *Ostrea* ***species in the Gulf of California***

10:00 – 10:20 Break

10:20 – 10:40 Jennifer K. Hofmeister, Richard E. Ross and Roy L. Caldwell
Observations of mating behavior in the lesser Pacific striped octopus, *Octopus chierchiae* ***(Jatta, 1889)***

10:40 – 11:00 Jean S. Alupay, Richard E. Ross and Roy L. Caldwell
Growth and development in the lesser Pacific striped octopus, *Octopus chierchiae* ***(Jatta, 1889)***

11:00 – 11:20 Scott Cassell, Tom Loomis, and Christopher Kitting
Feeding and other behavior of Humbolt Squid in Bahía de Los Angeles, Sea of Cortez, Baja California

11:20 – 11:40 Esteban Fernando Félix Pico, Mauricio Ramírez Rodríguez, Martín Hernández Rivas and Jorge López Rocha
Population structure, growth and production of the mangrove black ark *Anadara tuberculosa* ***(Bivalvia: Arcidae) from Ensenada de La Paz, Baja California, México***

11:40 – 12:00 Carmina Torreblanca Ramírez, Rafael Flores Garza, Pedro Flores Rodríguez, Sergio García Ibáñez, Arcadio Valdés González, Lizeth Galeana Rebolledo and Domingo G. Arana Salvador
Gastropod and bivalve community diversity in the rocky middle-intertidal zone of Acapulco, Guerrero, México

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12:00 – 1:30 Lunch break

1:30 – 3:00 Poster session; presenters available for discussion.

3:00 – 3:30 Refreshments

3:30 – 4:30 WSM General business meeting (Casa Real)

4:30 – 6:00 Happy Hour in Old Town San Diego

6:30 – 9:00 Farewell Dinner at Casa Guadalajara Restaurant, Old Town San Diego

POSTER PRESENTATIONS

Orso Angulo and Gerado Aceves Medina
Holoplanktonic Mollusca in the Gulf of California, a model applied to biogeography

Rüdiger Bieler, Paula M. Mikkelsen, David I. Jablonski, Scott J. Steppan, John P. Huelsenbeck, André F. Sartori, Rafael Robles, Adam Tomašových, Jan Johan ter Poorten, Nathanael Herrera and Nick Matzke
Bivalves in time and space (BiTS): Testing macroevolutionary methods against the bivalve fossil record

Jorge Cáceres Martínez and Rebeca Vásquez Yeomans
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ABSTRACTS

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A Miocene marine fauna from the Conejo Volcanics, Los Angeles County, California

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The lower to middle Miocene Conejo Volcanics of the Topanga Group is a major component of the Santa Monica Mountains, cropping out over an area of 600 km^2. It underlies much of the western part of the range, where it attains a thickness of at least 1,800 m. In the study area, near Malibu Canyon and near the eastern edge of major volcanic deposition, it is about 1,100 m thick and consists of basaltic / andesitic flows and hyaloclastic breccias of submarine origin.

A newly discovered shallow-marine fauna from the upper 550 m of the formation consists of about 70 taxa, with barnacles, oysters, serpulids, and regular echinoids numerically predominant, although small gastropods, pectinids and brachiopods are locally abundant. Bryozoans, crabs, foraminifers, calcareous algae, fish bones, shark teeth, and plant fragments are also present but are rare overall.

The mainly fragmentary fossils occur in limy lenses between flows or on the tops of flows that are overlain by breccia. They also occur as smaller pods, stringers, and dikes in the same flow rocks. Individual lenses are up to 2 m thick and 100 m long and are present along horizons that may reach 1,800 m in lateral extent. At a few localities, vertical to subvertical dikes are connected to an overlying limestone lens; they extend as much as 8 m into the underlying flow rocks.

Fossiliferous horizons are characterized by distinctive assemblages. For example, several of the horizons, in ascending order, and with characteristic taxa noted, are the Basal Horizon with pectinids, terebratulid brachiopods, and foraminifers, the Operculum Horizon with locally abundant gastropods (*Turbo*, *Tegula*, and the opercula of *Turbo*), the Oyster Horizon with oysters and the inarticulate brachiopod *Discinisca*, and the Top Conejo Horizon with a mixture of oysters and pectens as in lower horizons along with infaunal bivalves. These differences are interpreted to reflect different habitats from which the fossils and enclosing sediment were derived.

The Conejo fauna contains a large proportion of epifaunal species. In this regard, it contrasts sharply with the faunas of typical Neogene terrigenous strata in California, which are characterized by diverse infaunal bivalves, clypeasteroid echinoids, and a diverse and different assemblage of gastropods, including particularly turritellids and naticids.

The fauna is essentially neritic but sedimentologic evidence indicates that it was transported into deeper water. The present distribution of many of the taxa, such as *Spondylus scotti* is to the south of the study site. Oxygen isotope analysis confirms that the climate was warmer and indicates a modern equivalent location off northern Baja California.

At several locations, the epifaunal assemblage in the limestone grades into an infaunal assemblage in the basal 1 m of overlying volcanic sediment. Terrigenous sediment is present only in the uppermost horizons; infaunal species are only common at the Top Conejo horizon.

Growth and development in the lesser Pacific striped octopus, *Octopus chierchiae* (Jatta, 1889)

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Relatively few octopus species have been described to exhibit direct development compared to the predominant paralarval strategy. The lesser Pacific striped octopus, *Octopus chierchiae*, is an intertidal species extending from the Gulf of California to Columbia and has not been observed since the 1980's. This pygmy octopus lays few large eggs that develop directly into the juvenile form. Females are uniquely iteroparous producing multiple clutches. An aquarium supplier collected seven individuals in 2008. We obtained three adult males and one adult female. The female was mated and produced three viable clutches. Observations were made on growth and development of 20 to 30 offspring in each clutch. The female laid individual eggs for each batch over the period of one month and the eggs took roughly four weeks to hatch. Males and females follow the same growth trajectory early in development, but start to diverge in weight at about 150 days (five months). The resulting sexual size dimorphism coincides with the development of secondary sex characteristics in males. Feeding and hunting behaviors for juveniles were recorded for the first time. The ontogeny of characteristic transverse body striping was also studied and revealed unique patterns on the head and dorsal mantle for each individual that remained constant throughout their development. Observations were made for one year, the lifespan of the oldest offspring raised in the laboratory. These observations augment what limited information we have about this unusual and rare iteroparous octopus.

Holoplanktonic Mollusca in the Gulf of California, a model applied to biogeography

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Molluscan biogeography patterns have been based on boundaries delimited by physical factors (*e.g.*, mangroves, mud flats, rocky shores, etc.), never the less this approach cannot be applied to planktonic and nektonic species, in this case neither to holoplanktonic molluscs due that their distribution and abundance is affected by currents, temperature and water masses. In this work we analyzed the holoplanktonic molluscs from zooplankton samples collected in seven oceanographic surveys (2005-2007), in order to obtain their general distribution and abundance patterns and to look for a general bio-regionalization of the Gulf of California. Our results demostrate the presence of two main species assemblages: a cold of temperate affinity distributed in the northern part of the Gulf, and a warm assemblage of tropical and sub-tropical affinity distributed

in the south, and a third that is referred as a transitional, were both meet. We suggest a general model of the Gulf of California consisting of three main bio-regions, with borders that are dynamic in time and space in response to the water mass movementes in the Gulf of California.

Experimental and monitoring studies of the invasive snail *Potamopyrgus antipodarum* in southern California streams

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The New Zealand Mud Snail (*Potamopyrgus antipodarum*) is invading streams across the western United States, including Malibu Creek and its tributaries and Piru Creek in the Santa Clara River watershed in southern California. Because little is known about the population dynamics and ecological impacts of *P. antipodarum* in our region, we collected data on the growth and development of these snails in the field, as well as conducted experiments to determine how this invasive snail affects algal resources, native invertebrates, particularly native snails from the same family (Hyrdobiidae), and native amphibians and fish, such as the endangered arroyo toad and southern California steelhead trout. These data will help evaluate the costs and risks of introducing snail biocontrol agents, such as snail parasites, into the ecosystem ecological and economic benefits of snail control.

Based on monthly samples taken from Piru Creek In 2009-2010, we found that snail densities fluctuated between very low (less than 10 individuals / m^2) following winter high flow events, to relatively high (more than 1,500 individuals / m^2) during spring and summer months. Juvenile forms of the snail dominated snail age classes (>50%) between March and June, but snail reproduction occurred year round. Field and laboratory experiments allowed us to examine the effects of abiotic factors on *P. antipodarum* and the effects of *P. antipodarum* on stream algal assemblages, invertebrates (native mayflies (*Centroptilum* sp.), caddisflies (*Gumaga*), and snails (*Physella* and *Pyrgulospsis* sp. *cf. P. stearnsiana*)), and Western Toad tadpoles. The New Zealand Mud Snail reduced the growth and survival of native taxa by changing the abundance and composition of their shared food resource, benthic algae.

Provincial-level relationships and feeding biogeography of Northeast Pacific opisthobranchs: Taxonomic vs. network biodiversity analyses

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Provincial-level biogeography has usually been compared from a taxonomic perspective (presence or absence of genera or species). However, this minimalist approach does not address two major biodiversity issues: abundance and function. A list of species does not reflect their ecological contribution. "A network approach provides a powerful representation of the ecological interactions among species and highlights their global interdependence" (Bascompte, 2009).

I analyzed the species composition and extra-provincial relationships of the four marine faunal zones (*sensu* Briggs 1974) in the northeast Pacific between Point Conception, California, USA (34° 27' N; 120° 28' W), and Punta Aguja, Piura, Perú (5° 47' S): Californian (CA), Sea of Cortez (SofC), Mexican (MX) and Panamic (PA).

There is a total of 399 opisthobranch species (including 82 undescribed) reported from these zones: CA, 214; SofC, 183; MX, 158; and PA, 217 (Bertsch, 2010). Percentages of species by orders vary among regions. Although the majority of shared species are with the NE Pacific faunal zones to the north and south (37.7–79.9%), there is a small amount (4.9–7.1%) shared with regions east (Atlantic) and west (Indo-Pacific and Japan). Barriers to dispersal appear more significant than does temperature.

Endemism and groups of sister species reveal further phylogeographic relationships. Low levels of opisthobranch endemism in MX and SofC (~5.6%) indicate they are regions within part of the Panamic province (*sensu* Keen, 1971); the higher level of endemism (23%) in the Panamic southern region (*sensu* Briggs) reflects both a lack of collecting data and numerous unnamed species, especially from the Galápagos Islands. Opisthobranch endemism in Atlantic provinces ranges from 6.5 to 47.6% (García and Bertsch, 2009). Other Sea of Cortez invertebrates (*e.g.*, echinoderms and platyhelminthes) have reported endemism levels of 6.2–40.9%; however these estimates do not include the probable large number of unknown species present (Hendrickx *et al.*, 2005)

Feeding biogeography (=*biogeografía alimenticia*; see Bertsch and Hermosillo, 2007) compares the numbers of specimens and ecosystem/trophic relationships across multiple faunal regions or provinces. Using long-term records of 2-10 years (including mine and those of J. Nybakken, J. Goddard, S. Johnson, and A. Hermosillo), from 12 sites in the central and northeast Pacific (averaging 60 species and 4521 specimens reported at each location), I examined the occurrences of bryozoan, cnidarian and sponge-feeding nudibranchs. The absolute percent of species present and their relative abundance can vary independently (and differently) between provinces. The actual contribution of species to community ecosystems differs between faunal provinces, variously shaped by trophic patterns acting on random dispersal and vicariance events.

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Biodiversity 2010 Millennium goals: Marine resources and conservation issues in northwest México

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In 1992 the Convention on Biological Diversity established a target goal "to achieve by 2010 a significant reduction of the current rate of biodiversity loss" (Sachs *et al.*, 2009). Lack of progress in meeting and exceeding this objective will have significant negative socio-economic, health and cultural effects on the entire intertwined global biogeochemical ecosystem of which humans are an over-contributing part. Human overpopulation has wrought a cascading rupture of the global bioeconomy: *e.g.*, climate change, ocean acidification, habitat and species loss, and poverty and disease.

Events in the waters of northwest México (Sea of Cortez and the Pacific coast of the Baja California peninsula) provide an excellent example of the multi-faceted impacts of the human footprint.

The incredible biodiversity of the Sea of Cortez includes almost 4,900 named invertebrate species; it is unknown how many more await discovery. However, due to human activities, this biota is in extreme danger. "Pollution from agriculture and urban areas, coastal habitat destruction, inadequate fisheries regulation and historical over-fishing, lack of reliable scientific data, and uncontrolled eco-unfriendly tourism ... have resulted in the near extinction of highly visible species ..., and substantial reductions in the Gulf's important commercial shrimp populations and their associated benthic fauna" (Brusca and Findley, 2005). This is also true for the Pacific coast of the Baja California peninsula.

Multiple synergistic events have caused the range expansion of *Dosidicus gigas* (Humboldt squid) into the Sea of Cortez and along the coasts of California and the Pacific Northwest during the past 35 years: global warming, rising sea temperatures, and the squid occupying niches left vacant by overfishing of their normal predators.

Octopuses, clams, snails, sea stars, sea cucumbers and urchins have all suffered population declines from over-collecting.

The ill-planned Escalera Náutica at Santa Rosaliita destroyed not only natural habitats, but also the physico-biological resources of the very communities it purported that it would benefit. Today the constructed marina is merely a sandlot.

In contrast, the ten Mexican fishing cooperatives between Punta Abreojos and Isla Cedros maintain a sustainable harvest of spiny lobster (*Panulirus interruptus*).

Mariculture is used to provide supplies of such over-exploited commercial species as abalones, mano de león (*Nodipecten subnodosus*), Catarina scallop (*Argopecten ventricosus*), and pearl oysters, while scientific population studies are re-evaluating resource uses.

Environmental and community groups and individuals, the Mexican government, and the United Nations have successfully established national parks, Reservas de la Biósfera (Islas del Golfo de California, Bahía de los Ángeles y Canales de Ballenas y Salsipuedes, and El Vizcaino) and Areas Naturales Protegidas (Valle de los Cirios). Significant portions of the Sea of Cortez were declared a Natural World Heritage Site by UNESCO (2005). At Reserva de la Biósfera Vizcaíno, the benign cohabitation of salt processing and whale and bird watching in Laguna Ojo de Liebre mutually benefits all organisms (including humans and their needs, pleasures and economy).

The goals of scientific investigation—discovery, dissemination and application—involve ethical imperatives. Our right to do science depends upon our responsibility of doing it well, benefitting the interrelationships of all our planet's ecosystems (Bertsch and Campay, 2010).

Fulfilling biodiversity conservation goals requires doing science, and all its consequences, well. Science progresses from observation to the communication of knowledge, leading to a "use for" (or relationship among) living beings, with resultant actions. "Countervailing efforts to maintain biodiversity must be sensitive to human needs if they are to retain public support" (Sachs *et al.*, 2009). There is an urgency before us.

Our actions must be done with care and reverence for all ecosystems and their inhabitants, resulting in the preservation, conservation and protection of biodiversity. We are a part of, not apart from, Global Life.

It behooves us to appropriate a simple Conservation Ethic: "To develop and use a sustainable management plan for life, which conserves, protects and manages Earth's biodiversity for the health and well-being of all members of the Global Ecosystem."

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The Seri, the sun and the slug: Cultural and natural history of *Berthellina ilisima* (Opisthobranchia) from the central Sea of Cortez

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The Seri people of western Sonora have a rich and profound relationship with molluscs. In addition to multiple sustainable uses (for food, utensils, tools, etc.), molluscs form an important component of their folklore, history and linguistics. Over 100 mollusc species are identified by Seri names.

Two species of opisthobranch molluscs are known by common names in their language: *Bulla gouldiana* Pilsbry, 1893, and *Berthellina ilisima* (Marcus and Marcus, 1967). The only other known species of opisthobranch from the entire Pacific coast of the Americas with an indigenous common name is the huge (up to 30 cm in length) nudibranch *Tochuina tetraquetra* (Pallas, 1788), which is eaten by the inhabitants of the Kuril Islands.

Berthellina ilisima has a bright yellow to orange-red color, reaching 60 mm in total length. The Seris named this species *xepenozaah*, "sun in the ocean." However, this species is not eaten nor used by the Seri. Its brilliant color and commonness called their attention to this slug.

This species ranges throughout the Sea of Cortez and south along the Mexican and Central

American coastline to Panamá. It also occurs in the Galápagos Islands, and northerly in southern California during warm water El Niño events.

At Bahía de los Ángeles, Baja California (an area known to and probably visited by the Seri people for centuries), *Berthellina ilisima* was the fourth most common opisthobranch observed during a long-term ecological study from January 1992 to December 2009. Reasons for variation in its annual densities are being researched. This species showed a distinct annual August–June life cycle. Over 90% of egg masses were seen from May to July; copulating pairs were seen in May and June. Examination of fecal material suggests it eats haplosclerid sponge.

Bivalves in time and space (BiTS): Testing macroevolutionary methods against the bivalve fossil record

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Most large-scale evolutionary questions require an understanding of history, but analyses based exclusively on extant taxa require inferences whose uncertainties are broad or poorly understood. One of the few groups where methods can be developed and tested directly against historical data are bivalves, which are abundant today, rich in diversity, and have a long history documented by an excellent fossil record. The goal of this project is to develop bivalves as a preeminent model for macroevolutionary studies. The project will address species-level evolution over time in Bivalvia. More importantly, we will test and develop generally applicable methods for comparative analysis of organisms. All studies will be conducted on two not-closely related clades, to estimate the generality of the results. This research will provide four primary contributions to evolutionary biology. (1) Estimate phylogenies for two diverse family-level clades (Cardiidae and the pitarine group in Veneridae) using a combination of multiple genes and morphological characters. Focus in each clade will be on 100 extant species, ca. 60 morphological characters, and five genes (both mitochondrial and nuclear). (2) Integrate the extensive fossil records for the two clades by estimating combined-data phylogenies, adding 50-100 extinct species to each extant combined-data set. (3) Reconstruct temporal and geographic diversification patterns using the tree from (2) to assign all fossil occurrences to clades. The fossil occurrence data set will consist of thousands of entries, with new data supplementing our existing database. The dense fossil sampling in the combined-data phylogenies will provide the framework for step (4), which will test the accuracy of three principal macroevolutionary methods: molecular clock dating, ancestral state reconstruction, and historical biogeographic reconstruction. Simulations under different models of character/range evolution will estimate expected performance. We will cross-validate and rarefy the combined-data sets, subsampling fossils down to levels typical of macroevolutionary studies, to compare to the "known" dates/traits/ranges from the integration (2) and (3). Only the exceptional fossil record of bivalves makes it possible to treat the combined-data estimate of ancestral values as "known." The full integration of these three data sets (molecular, extant and extinct morphological, fossil occurrence) with macroevolutionary diversification models and parallel tests of the three primary macroevolutionary methods will yield significant insights on the spatial and temporal dynamics of a major marine group, and establish bivalves as a key model system for macroevolution.

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Crab predation causes size-specific inducible response in Hooked Mussels

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Blue crabs (*Callinectes sapidus*) are voracious predators on hooked mussels (*Ischadium recurvum*) that grow epizoically on oyster clumps along the Louisiana coast. We have shown that blue crabs prefer small mussels (< 30 mm shell length) because larger mussels are difficult to crush without injuring the crab's chelae. In this study, we were interested in whether mussels survived better when attached in "clumps" by byssal threads, whether clumps provide a refuge for small mussels, whether small mussels produce more byssal threads, and whether there is an inducible response in byssus production. We exposed mussels to crab predators alone or in clumps on oysters in the lab, and found mortality decreased by 56 % when mussels were in clumps. Crabs were strongly size selective when offered solitary mussels, but no size selection occurred when they were offered mussels in clumps, since smaller mussels were able to hide in crevices between larger mussels. When we exposed mussels to control sea water, water with the scent of crabs, and water with the scent of consumed mussels, an inducible increase in byssal thread production occurred in all mussels ($F = 5.9$, $P = 0.007$), and at a significantly higher rate for small mussels ($F = 8.9$, $P = 0.006$). We conclude that increased predation risk for small mussels has resulted in higher weight specific production of byssal threads, and that clumping behavior reduces mortality.

Comparative morphology of *Physa* (*Haitia*) *natricina* Taylor 1988, an endangered freshwater snail

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A comparison of the endangered freshwater snail *Physa* (*Haitia*) *natricina* Taylor 1988 with the European invasive snail, *Physa acuta* Draparnaud 1805, now includes a study of anatomical characters that have been considered significant in the systematics of the two species. The relationships of these two species are important because *Physa natricina* was reported previously (Rogers and Wethington, 2007) to be synonymous with *Physa acuta*, which would remove *Physa natricina* from protective consideration should there be any significant modification of its habitat that would threaten the snail's existence. The previous anatomical study of *Physa natricina* was by Taylor when he named and described the species as new to science. An attempt by us to obtain comparative topotypic material of *Physa acuta* has not yet been successful, but there are two pertinent anatomical studies of *Physa acuta* already available, one by Taylor (2003) and the other by Paraense and Pointier (2003). Taylor's reference is pertinent because his monograph is the only comparative systematic study to date of the Physidae on a world-wide geographic scale, and Paraense and Pointier's is especially important because it was done on topotypic specimens of *Physa acuta*. The morphology of *Physa acuta* as described and illustrated by these three authors is basically in agreement, so we have used their descriptions as a comparative base for our anatomical study of *Physa natricina*. Our anatomical observations confirm our previous conclusions based on conchological and DNA data. *Physa natricina* and *Physa acuta* are clearly separate and distinct species, and *Physa natricina* should remain on the Federal list of endangered and threatened species.

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Assemblage shift following population collapse of invasive *Mercenaria mercenaria* in an urban southern California lagoon

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The quahog *Mercenaria mercenaria* has been introduced repeatedly to the Pacific coast of North America since 1870, but only one population is known to have become established in California, at Colorado Lagoon, in Long Beach in Los Angeles County. In the 1970s and 1980s this small urban body of water (low-tide perimeter ~1700m) hosted a large, reproductively active population of *M. mercenaria*, with reported densities as high as 18 clams/m^2 in the intertidal and exceeding 500 clams/m^2 in the subtidal. In order to determine the current status of the *M. mercenaria* population at Colorado Lagoon, we sampled 57 intertidal plots (each 0.25 m^2 in area and 0.20 m deep) and 20 shallow subtidal locations (each ~0.5 m^2 in area and 0.15 m deep). Our data show major changes in the bivalve assemblage at Colorado Lagoon over the past 30 years. Although we found two living *M. mercenaria* in searches of the intertidal zone outside of our plots, no *M. mercenaria* were found among the 2,490 live clams in our sample plots. Therefore, *M. mercenaria* is not extinct at the site, but the population has declined dramatically in number since the 1980s. The non-native Manila clam *Venerupis philippinarum*, which was not recorded in the lagoon in the

1970s and 1980s, made up 88% of the individuals collected in our survey. The *V. philippinarum* population appears to be self-sustaining, as individuals from 6 mm to 71 mm in length were present in the intertidal zone. Overall, four of the eleven species of living bivalves we encountered were non-native. Thus despite the population crash of the invasive quahog, this small urban lagoon remains heavily dominated by non-native bivalves.

Crystal formation in the connective tissue between the inner and outer gonad walls of the red abalone *Haliotis rufescens*

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The red abalone *Haliotis rufescens* is cultured in Baja California, Mexico and histopathological analyses for determining its health status are carried out periodically. During a study of six organisms (72 mm mean shell length) from an aquaculture facility, we observed crystals formation in the connective tissue between the inner and outer gonad walls of one of the abalones. Crystals varied in size and shape from 50 to 300 µm and from irregular to polygonal, respectively, and they were acidophilic to the hematoxilin-eosin stain. A hemocyte and fibrilar reaction around crystals was observed and there was not any development of reproductive follicles. Additionally, the affected abalone was infected by the prokaryote *Xenohaliotis californiensis* and it presented hemocyte infiltration in the gills. Externally, the abalone showed weak adherence to the substrate and an extension of the foot muscle towards the shell. This is the first record for crystal formation in the connective tissue matrix of the gonad in mollusks. The significance of this interesting finding is discussed.

Histopathological analysis of the Pacific oyster *Crassostrea gigas* collected during an episode of mollusk mortality in Sinaloa

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The culture of the Pacific oyster *Crassostrea gigas* in northwest Mexico is a growing activity in coastal lagoons. Since its introduction to Baja California, Mexico from Marietta, Washington USA, around 1973, this economic activity has spread to Baja California Sur, Sonora and Sinaloa. Culture techniques varied from the use of floating rafts to the use of oyster bags on trays and it is carried out as a family business or as an enterprise for exporting. Currently oyster production in the region, including the native oyster *Crassostrea corteziensis*, contribute with almost 20% of the national oyster production estimated in about 40,000 metric tons. While environmental culture conditions in Baja California and Baja California Sur are considered as pristine, in the continental zone (Sonora

and Sinaloa) the impact of costal communities and industries in the quality of the environment is important. In September 2009, unusual mortality records of the Pacific oyster and other mollusks, in Bahía de Altata, Sinaloa, called the attention of authorities. The live and histopathological analysis of samples taken from this lagoon showed organisms with a reddish coloration and weak appearance. The reddish coloration also affects the coloration of the inner shell face. At tissue level, there was an increase in the number of brown cells in the connective tissue of all organisms. Brown cells contained reddish granules coinciding with the external coloration of affected animals. In moribund animals, bacterial growth was evident. The presence of abundant brown cells indicates a generalized activation of the defense mechanisms of the oysters. An increase in the number of these cells has been associated with pollution (heavy metals, phenols) and the presence of bacteria is a common step in moribund animals exposed to poor environmental conditions. Further information revealed the occurrence of dredging for navigation in the Bay, which could be associated with a release of contaminants from the bottom; however, mortality events also were detected in other lagoons in the zone. After few weeks, the oyster's conditions became normal and mortality ended. This information alerts on the necessity of continuous monitoring programs and actions for preventing environmental contamination in oyster production areas to guarantee the quality of the product for human consumption. Additionally, this information supports the fact that oyster mortalities in the region are not caused by a single factor.

Histopathological alterations of the Pacific oyster *Crassostrea gigas* associated with algal blooms in northwest Mexico

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The culture of the Pacific oyster *Crassostrea gigas* in Northwest Mexico began in the early 1970s. Nowadays, its production reaches more than 10,000 metric tons per year. Recurrent episodes of unusual mortalities have been affecting production since 1997. Initially, it was believed that those events were associated to one single specific factor such as a particular pathogen. In fact, some of these episodes have been directly associated with the presence of oyster herpes-virus, especially in seed and in juvenile oysters. However, other factors may act to produce high mortality events in culture areas in the presence or absence of specific pathogens. Among them, the occurrence of algae blooms (ABs). This study shows histopathological evidence of tissue disruptions associated with abundant presence of microalgae in the digestive tract and gills of oysters collected during ABs in three different localities and times in Northwest Mexico associated with high mortality rates. These microalgae include *Rhizosolenia* sp., *Prorocentrum* sp. and dinoflagellates belonging to the Gonyaucales. The most important alteration of host tissues are destruction of the normal architecture of the columnar epithelia of the stomach and intestine, hemocyte infiltrations in the connective tissue surrounding the stomach and intestine, and in some cases hemocyte infiltration and rupture of gill tissues.

Population connectivity of *Mytilus galloprovincialis* in southern California

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Mytilus galloprovincialis is a long-established invasive mussel on the Pacific Coast of the United States, abundant on hard substrata in the mouths of bays. We used a six-year time series of population connectivity through trace-elemental fingerprinting of the larval shell to examine the seasonal and interannual variability of larval exchange for this species and its native congener *M. californianus.* We revealed consistent Autumn poleward movement and Spring equatorward movement for both species in San Diego County, coincident with nearshore surface currents. However, because the major reproductive seasons differ, the dominant source-sink dynamics of these two species were nearly opposite. *Mytilus galloprovincialis* had higher self-recruitment at the regional level (42%) than *M. californianus* (28%) as hypothesized for a bay-dwelling species, although mean dispersal distance was similar for both species (35-37 km). Production of successful recruits from each site was positively related to estimates of adult cover for *M. galloprovincialis*, with two sites in the north, Oceanside and Agua Hedionda, producing the majority of recruits to the county. These sites, including an aquaculture operation for this species, are positioned "upstream" of the rest of the county during this species' major reproductive season. Demographic modeling of the entire *M. galloprovincialis* life cycle demonstrated that subpopulations depend on both local and distant sources of recruits for persistence, suggesting that the metapopulation concept is a useful framework for this species. The models also identified key life stages for persistence, such as off-season juvenile survival. This knowledge, along with the information about key source populations, could be used in enhancement or eradication efforts for native or invasive bivalves.

Feeding and other behavior of Humbolt Squid in Bahía de Los Angeles, Sea of Cortez, Baja California

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Geographic ranges of Humbolt squid, *Dosidicus gigas*, expanded within the past couple decades, into Sea of Cortez, and recently northward up the Pacific Coast.

In March, 2010, our team from Undersea Voyager Project studied these large squid in situ from vessels off the Sea of Cortez fishing village of Bahia de Los Angeles, Baja California. Study excursions were made day and night, virtually daily throughout two weeks. The first authors' additional, previous observations also were extensive.

Many Panga (small outboard boat) fishermen with hand lines and glowing jigs (hooked lures) fished numerous of these squid each night, typically above seamounts, rising to ~50 m of the surface at the edge of the large bay. Most squid had bodies ~0.8 m in length, plus tentacles ~0.5 m long.

Local squid are reported to reach >1.5 m in body length, and >50 kg total weight. Initial catches appeared to be near the bottom, but as squid starting attacking the lures, often at dusk, squid appeared to follow others within ~10 m of the surface, where water temperatures were ~15 degrees C. Sometimes dead squid parts were used as bait on the jig. Squid jet propulsion and fins provided >10 kg of thrust (much more than their weight in air), as these squid were hauled in. As squid were eviscerated throughout the panga fleet, all but the mantle was jettisoned, probably functioning as chum for other squid, although essentially no other animals were caught on the jigs, nor detected visually in the shallower water column then.

Initial diving with the squid met with limited observations of squid behaviors, with bright white lights. But adding red filters, without white light, then yielded much contact with the squid, often in groups of squid, simultaneously. A 50-cm previously frozen salmon was used as bait, in front of manned then remote underwater video cameras. White light yielded no contact with squid, but use of entirely red lights yielded multiple attacks on the salmon, being consumed completely within a few minutes, recorded remotely. Foregut contents of other Humboldt squid yielded a distinctive, fresh, tough, 1-cm piece of a gill raker from a fish > ~0.3 m in length. Previously, such large Humbolt squid were reported (in white lights, in deeper water) to eat tiny fishes, only.

These ~1.5 m (total length) squid had sharp hooks up to ~1mm long, reminiscent of giant radular teeth, on their numerous suckers. Resulting gripping was painful and effective even on tough human skin. Their strong beak was ~4 cm tall, with a gape of ~2 cm, and very dense, muscular buccal mass 6 cm in diameter. Their morphology seems adapted to tearing sizable prey. They also attacked and consumed each other, during these human fishing activities.

National Geographic TV coverage on their Hooked series will air in the fall. Analogous comparisons are planned for multidisciplinary submarine and other dives at Catalina Island around September, 2010, recruiting other scientists who have modest individual funding.

Stramonita biserialis (de Blainville, 1832) (Gastropoda: Muricidae) on the Pacific Coast of Mexico

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Stramonita biserialis (de Blainville) is a thaidid gastropod and, like muricids, consumes hard-shelled invertebrate (mollusks and barnacles) prey by drilling through their shells. The distribution is Cedros Island, Baja California, through the Gulf of California and south to Chile, as well as the Galapagos Islands (Keen, 1971).

In according with Vermeij (2001), it is possible to distinguish a northern and a southern form of *Stramonita biserialis* based on their appearance, such as crenulations on the outer lip, slenderness of the shell, a broader aperture and a red haematura color on the aperture. Our study was designed to examine differences between individuals of *Stramonita biserialis* along the Pacific coast of Mexico, based on observations of the characters of the shell, digestive tract and radula. Seventy specimens of *Stramonita biserialis* was collected at various sites along of the coast Pacific of Mexico from La Paz, Baja California, to Oaxaca. Based on morphological differences we found two types of *Stramonita biserialis*: type 1, with 58 individuals, show a high degree of interindividual variability, which are distributed from La Paz, Baja California to Oaxaca, and type 2, with 12 individuals with a lesser degree of interindividual variability in which the aperture always was haematura red, and distributed between La Paz, Baja California to Mazatlán.

Based on their digestive tract and radulae, the type 1 form showed diffcrences from the type 2 form by the lesser size of salivary glands. The type 2 form has a wider central cusp on the rachidian tooth, and the lateral teeth are strongly curved and thin. The type 1 form of *Stramonita biserialis* has a wider distribution than that of the type 2 form and a highly complex variability in the shell form.

The food supply, salinity, oxygen content, turbity, agitation, temperature, and density could be causes correlated with shape, as has been reported among individuals of *Thais lamellosa* by Spight (1973), however this study considers to two species in according with the two forms of Vermeij (2001).

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Importance and vulnerability of archaeological shell middens in Baja California: The cases of San Quintin and the upper Gulf

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Worldwide, the pressure of the development over the coastal zone has grown drastically, impacting and altering drastically its fragile ecosystem s and destroying the natural and cultural heritage. In Baja California, shell middens are the most noticeable archaeological feature. They are the rcsult of the prehistoric human occupation that over millennia exploited the marine resources as a means of subsistence. On both coasts, the Pacific and the Gulf of California, archaeological mollusks arc an important source of historic and paleoenvironmental information, providing data on: the preference of resources, the geographical areas of exploitation, trading routes, the physical-chemical conditions of waters where they grew, and the impact of man on biodiversity and environment. In spite of the importance of shell middens as historical and environmental memory, they are in risk of disappearance due to their high vulnerability to the effects of development, especially of tourism infrastructure along the coast of Baja California. This paper presents the preliminary results of a comparativc analysis on archaeological mollusks from two sites located on both coast: San Quintin Bay on the Pacific and El Faro on the Upper Gulf of California; emphasis is given to thcir importance as objects of scientific and cultural research and to their vulnerability as non-monumental heritage. The abundance of shell middens as well as the historical-cultural context from which thcy were formed, suggests the need to understand: a) the nature of the cultural and cnvironmental information recorded during millennia since the first human settlement in Baja California, and b) the vulnerability sctting of both coasts of the Peninsula. Wc conclude on the need to cncouragc efforts for integral coastal conservation with the aim of recognition for shell middens as part of the cultural and natural landscapes, in order to prevent them from getting covered by road asphalt or simply destroyed.

Where is it from and how did it get here? Investigating invasions of the North Atlantic gastropod *Littorina littorea* in California

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Understanding the early stages of biological invasions can provide significant insight into the invasion process as well as the influence vectors have on subsequent invasion success or failure. We characterized three newly discovered populations of an introduced gastropod, *Littorina littorea* (Linné, 1758) in California, USA, comparing them to potential source populations in Europe and the East Coast of North America. Demographic surveys were used to assess spatial distribution and sizes of *Littorina littorea* in San Francisco and Anaheim Bays. Mitochondrial DNA was sequenced and compared among the nascent California populations and various populations from the East Coast of the US and Europe to characterize the California populations and ascertain their likely source. Demographic and genetic data were considered together to deduce likely vectors for the California populations.

The three large California populations of *L. littorea* contained only adult snails and had unexpectedly high genetic diversity rather than a bottleneck as typically expected in introduced populations. Overall haplotype diversity in Californian populations was significantly reduced compared to European populations, but not compared to East Coast populations. Genetic analyses clearly suggested the East Coast as the source region for the California introductions, although *L. littorea's* homogeneous genetic structure on the East Coast complicated identification of more specific source populations. The California *L. littorea* populations were at an early, pre-establishment phase of invasion with no evidence of recruitment, partly explaining the absence of a genetic bottleneck. The live seafood trade is the most likely invasion vector for these populations, as it preferentially transports large numbers of adult *L. littorea*, matching the demographic structure of the introduced California *L. littorea* populations. These introductions highlight continued operation of live seafood trade vectors and the influence of vectors on the demographic and genetic structure of the resulting populations.

The history of native oysters in San Francisco Bay: Implications for restoration

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Federal- and state-funded efforts to restore native oysters (*Ostrea lurida*) in San Francisco Bay started in 1999, and plans and goals are now being developed for the large-scale creation of oyster beds on 400 acres of the bay (Zabin *et al.,* 2009). These efforts have been premised on the well known local history of the native oyster: it was hugely abundant in the bay at the time of European contact, providing an important food resource for the region's Native American population as shown by the large number of shells in numerous shell mounds on the bay's shores; the native oyster declined rapidly during the early colonial period due to a combination of overharvesting, pollution, and smothering by sediment produced by hydraulic gold mining in the Sierra Nevada; the oyster was then apparently absent from the bay for many decades, until it was rediscovered in the late 1990s, initiating the current restoration efforts (Skinner, 1962; NOAA, 2004; Kirby, 2004; Grosholz *et al.*, 2007).

However, a recent review of the historical, archaeological and geological evidence indicates that this common understanding of the history of the native oyster in San Francisco Bay is deeply in error in many critical elements. These findings suggest that both the rationale and the biological potential for restoring native oysters in San Francisco Bay are poorly supported by the facts, and the existing restoration projects and the restoration plans and goals now in development should be reconsidered.

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Quagga and Zebra Mussels in the Western U.S.: Invasion and response 2007-2010

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Quagga and Zebra mussels, native to Europe, were discovered in the Great Lakes in the 1980s, with zebra mussels spreading widely in eastern North America. Impacts on some ecosystems have been large and various, including alterations of food webs, light penetration and water chemistry, and large reductions in native bivalve populations. Economic impacts are typically estimated in the hundreds of millions or billions of dollars, and include impacts on water supplies, commercial and recreational fishing and other water-based recreation, navigation, and property values. Both mussels were discovered in the western U.S. in 2007/2008. This presentation will describe their western distribution; monitoring efforts; the controversy over reports of larval detection; interception, containment and eradication efforts to date; and will present a strategy for more effective containment.

"Aging improvement": *Spondylus calcifer*

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The spiny rock scallop (*Spondylus calcifer*) is the largest species of the Spondylidae in America. Many of the individuals of the spiny rock scallop are damaged by burrowing animals and his growth marks are eroded, so the age estimation is not accurate and it´s subestimate. Age estimates of bivalves are normally made by getting a section of the shell from the umbo to the ventral region with a low-speed saw or through the printing of the growth marks on acetate films. In this project we evaluate three regions (the axis of maximum growth, the umbo and the teeth of the hinge) for age estimation, using an economic method for preparation. The growth marks were evident in three regions, but the axis of the maximum growth showed the greatest amount of damage, followed by the umbo, the teeth of the hinge showed no signs of burrowing animals and marks of growth were clearly apparent. The ease, low cost of preparation and clarity of the marks obtained from the sections made in the teeth of the hinge, suggesting that this area can provide valuable information for ecological and biological studies. This methodology will be used to estimate the age and growth of the spiny rock scallop rock as part of the first author's Master degree project.

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Temporal dynamics of biological invasions and the lag effect

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One of the fundamental goals of invasion biology is to better understand the temporal nature of invasions – to answer the question of "when?" In some instances, the initial invasion event appears to represent an ecological release, where the invader appears to rapidly dominate new territory. Conspicuous molluscan examples of this phenomenon include the zebra / quagga mussels and the New Zealand mud snail. However, in many cases an ecological explosion appears to come only after the burning of a long fuse. For example, the Pacific oyster (*Crassostrea gigas*) only now appears to be successfully invading southern California, despite its presence on the West Coast for many decades.

Time lags such as these are often associated with population-level dynamics such as increases in the number of invaders or their geographic range, but lags occur throughout all aspects of invasions, including human responses to them. Although lags provide an opportunity to examine basic ecological and evolutionary dynamics, a primary interest in lags relates to their tendency to cause "ecological surprises." An important principle regarding lags is that they, in and of themselves, do not necessarily decrease predictive ability. Some lags are inherent and expected, but a startling array of unexpected lags have also been documented and a variety of evidence suggests that invasion dynamics can take decades, centuries, or even millennia to play out. Given that scientific activities and management actions typically take place over far more compressed timescales, it is necessary to incorporate longer-term perspectives to effectively understand and manage invasions.

Reevaluation of the taxonomic status of the spring snails *Pyrgulopsis gilae* and *Pyrgulopsis thermalis* based on molecular and morphological data

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Two mitochondrial DNA (mtDNA) and a nuclear DNA marker were used to investigate genetic variation amongst populations of two state-listed (and federal candidate) springsnails in the upper Gila River watershed of New Mexico (*Pyrgulopsis gilae* and *Pyrgulopsis thermalis*). This investigation was prompted by a prior study, which delineated substantial intraspecific haplotype variation within both of these species (Hurt, 2004). We will combine our results with a morphological analysis to re-assess the taxonomy of these two snails. This study will assist ongoing efforts to manage and conserve springsnails in the upper Gila River basin.

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Mucous trail following in the rosy wolf snail *Euglandina rosea*

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A variety of predatory gastropods, including *Euglandina rosea* were introduced to Hawaii and other Pacific islands in a failed attempt to limit the spread of the giant African land snail, *Achatina fulica*. Instead of consuming *Achatina fulica, E. rosea* has been implicated in the decimation of many species of endemic island snails. *Euglandina rosea* is native to the southeastern United States, and follows mucous trails of its prey. Although experiments have examined food choice, it is unknown if the ability of *E. rosea* to follow mucous trails differs with prey snail species. I compared the ability of *E. rosea* to follow trails and associated behaviors of two groups of gastropods: those found within its local habitat (southeastern USA) and those found outside its native range (Kansas). Each predator ($n = 10$) was tested against a total of 24 individuals from eight species of gastropods (four species from each area) and three individuals of each species. In contrast to the results from previous studies, I found that *E. rosea* followed trails in the direction that they were laid. The data indicate that prey gastropods from Florida and Kansas were followed at almost identical frequency by all ten predators tested. In addition, I observed significant differences in the predator's inter-tentacle angle and velocity when following or not following a trail.

Dreissena bugensis in Lake Ontario and the Finger Lakes of New York

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Dreissenid mussels, *Dreissena bugensis* and *D. polymorpha*, invaded Lake Ontario before 1990. The U.S. Geological Survey (USGS) samples standard offshore transects in southern Lake Ontario for food-web analysis. Sampling was done in some of the Finger Lakes to compare the benthic invertebrate community patterns in these large deep lakes. The benthic invertebrate index station depths sampled were 35 m, 55 m, 95 m and 130 m at three sites from 1992 to 2008. Similar depths were sampled in the Finger Lakes after 1999. As of 1992, along the southern shore of Lake Ontario, dreissenid numbers were low, 0 to 200 m^{-2} with the species in nearly equal proportions. The trends in southern Lake Ontario from 1993 to 2005 showed a progressive spatial invasion and increasing numbers of *D. bugensis* from west to east and from shallow water to the deepest depths of the lake. When present, the proportion of zebra mussels is small, < 2 / 1000 quagga mussels. The quagga densities at the 55 m sites peaked in 2001, 18 thousand m^{-2}, and have declined since. A pattern consistent with trends of density patterns over time often seen in invading species. The first decline in densities observed in 2006 at the 95 m depth and in 2008 at the 130 m depth. The invasion pattern in the Finger Lakes has been similar in some of the lakes. *Dreissena polymorpha* arriving first and then *D. bugensis* replacing it (Seneca Lake, Cayuga Lake). Interestingly, as of 2007-2008 others of the Finger Lakes had primarily *D. polymorpha* with few or no *D. bugensis* (Owasco Lake, Skaneateles). These lakes may still be early in the invasion process. Variation in dreissenid numbers and local size-frequencies reflect the likely invasion history and seasonal / depth correlated patterns of settlement, growth, and turnover. Knowledge of basic life history, spatial distribution, density, and local mussel size-frequency is essential for understanding the profound effects these invaders are having on the function of the ecosystems of large deep lakes.

Methods for the cytogenetic study in shellfish *

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The proposal of some methods for obtaining chromosomes for cytological and cytogenetic analysis, which are of valuable importance in the understanding of intra- and intergeneric specific biological behavior; the aim is that these methods will aid the standardization and establishment of cytogenetic techniques; focused on the dot identification architecture chromosome of cells with high mitotic index from invertebrates organisms, for example such as in mollusks, with the aim to be used as a tool for the study and preservation of these organisms.

* *[See full paper following abstracts. Ed.]*

Patterns of population structure and demography in *Conus*

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Based on analyses of mitochondrial (cytochrome oxidase I) and, in some cases, nuclear (calmodulin intron and partial exons) gene sequences, we compared patterns of population structure and historical demography of four *Conus* species that have similar though not completely overlapping distributions. Two of these species, *Conus miliaris* and *C. lividus/C. sanguinolentus*, are fairly distantly related to each other and occur throughout most parts of the Indo-West Pacific. The other two, *C. chaldaeus* and *C. ebraeus*, are recently separated and closely related to *C. miliaris*; they have nearly completely overlapping distributions throughout the Indo-West Pacific and parts of the eastern Pacific. Although the four target species exhibit similar life histories with planktonic larval durations of 3-4 weeks, they do not show similar population structures. Some of these differences are likely a result of low levels of gene flow to isolated locations in the eastern Pacific (*C. ebraeus*) and at Easter Island (*C. miliaris*). Nonetheless, *C. chaldaeus* exhibits slight differentiation at American Samoa and *C. lividus/C. sanguinolentus* shows more extensive differences in haplotype frequencies at Hawaii, while other species show no signals of differentiation at these locations. Analyses of mismatch distributions of haplotypes suggest recent population expansion for most species. In general, the four *Conus* species we examined exhibit haplotype distributions that suggest complete panmixia or recent population expansion in most parts of the Indo-West Pacific and genetic differentiation occurs mostly at isolated locations or across large expanses of open ocean. These patterns imply that population divergence and speciation occur allopatrically and that gene flow tends to homogenize populations at broad geographic scales.

Parapatric sibling species pairs in chitons and limpets: Do they help explain impressive diversification along the shores of western North America?

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My lab has been studying DNA sequence patterns of often-cryptic pairs of West Coast chiton and limpet sibling species whose ranges are mostly separated by latitude except for a more limited transition zone where their ranges partly overlap. Such cases probably reflect a single species splitting into a northern and southern species pair, but it is still uncertain how much gene flow and ecological interaction might have occurred during speciation. In particular, speciation might have been strictly allopatric, the result of either vicariance or long-distance dispersal events. Alternatively, there might have been more or less limited gene flow across biogeographic boundaries, with selection emphasizing the contrasting genetic adaptations on either side of such boundaries and perhaps leading to pre-zygotic reproductive isolation mechanisms. If it were known whether allopatric or parapatric speciation might predominate for such parapatric species pairs then this could also help address the remaining speciation events that must have occurred, given the high diversity of species endemic to this region. These are evident from mapping biogeographic distribution onto our phylogenetic estimates. The history of North Pacific cooling since the Late Miocene and the lack of fossils older than the Pliocene for currently dominant West Coast chiton and limpet genera imply that these impressive diversification episodes have been generated in a relatively short geological interval with seemingly few barriers to dispersal or sharp environmental gradients. However, parapatric sibling species pairs actually represent a minority of all present species diversity. In fact, many closely related species have approximately sympatric range distributions. Does this mean that sympatric speciation is even more frequent than allopatric or parapatric speciation along the West Coast? Would support for parapatric, not allopatric, speciation suggest that sympatric speciation might also be common? There are obstacles to answering such questions. Identified chiton and limpet parapatric sibling species pairs typically have somewhat less sequence divergence than inferred splits between any sympatric species pairs, or unresolved species groups, but the extent of sequence divergence between the parapatric sibling species is still substantial enough to suggest that typical speciation events could be more ancient than the Pleistocene ice age fluctuations known to have strongly affected the latitudinal species ranges along western North America. This presents problems for testing between contrasting models for explaining speciation events that occurred perhaps back in the Pliocene because there has likely been ample time for secondary range expansion leading to range overlap, after speciation was more or less complete. Likewise, contemporary ecological interaction that is apparent within the transition zone of at least some of the parapatric sibling species might either reflect a secondary specialization of species that were already reproductively isolated or else might be central to the reproductive, and genetic, divergence leading to speciation. Detailed consideration of contemporary cases of latitudinal clines of selection within species might be one way to tease apart the complex patterns of diversification in western North America.

Population structure, growth and production of the mangrove black ark *Anadara tuberculosa* (Bivalvia: Arcidae) from the Ensenada de La Paz, Baja California, México

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Anadara tuberculosa (Sowerby 1833) (Bivalvia: Arcidae) dominates muddy mangrove communities of the lagoon of Ensenada de La Paz. Mangrove ecosystems are critical habitat for many species. The productivity of mangroves is important due to their contribution in the form of organic detritus and secondary production. The objective of the study was to identify indicators of secondary productivity of mangrove systems to establish a baseline for measuring changes in the mangrove system due to potential natural or anthropogenic disturbances. The population biology of this intertidal ark was studied by determining population structure, growth and production at the two locations in the sandy barrier El Mogote from August 2007 to July 2009. Von Bertalanffy growth function was estimated through length-based methods (ELEFAN I and Battacharya; by software Fisat II) and using an asymptotic length (L_∞) of 93.2 mm and the growth constant (K) of 0.56 y^{-1}. Longevity is estimated to be approximately seven years. Abundance and secondary production were estimated based on biomass increase. Estimation of weight increase was performed by determining individual growth rates through an analysis of length frequency distributions. The average abundance was 1.27 org./m^2 of arks and yielded an estimated growth rate of 4.91 mm/month (3.67 g/month). Average secondary production of the black ark was 4.51 g/m^2 per month and was higher during the Spring. The obtained results as a quality index of the benthos are suitable for measuring changes to the mangrove system in the lagoon of Ensenada de La Paz. However, the variability of the biomass of the black ark seems to be principally related to human activities.

Is a newly discovered chiton brooder on Santa Catalina Island an undescribed species?

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In the 1980s, one of us (DJE) documented the taxonomy, reproduction, and population genetics of chitons currently assigned to the genus *Cyanoplax*, including three species that brood their embryos with crawl-away larva. One of these, *Cyanoplax caverna* (Eernisse, 1986) from the vicinity of Monterey Bay, was found to be one of the rare marine species that is both hermaphroditic and self-fertilizing. Recently, more southern brooder populations resembling *C. caverna* were discovered near Pismo Beach and on Santa Catalina Island. The Catalina populations, common under intertidal rockweeds, are more variable in color than *C. caverna.* In this study, mitochondrial

16S ribosomal RNA (16S) sequences of *C. caverna* and the more southern brooders resembling *C. caverna* were determined and compared. Results group all sampled Catalina populations together with high bootstrap support relative to more northern populations. These results are consistent with the Catalina brooders belonging to a separate, still undescribed, southern species. Pismo Beach brooders group only weakly (without strong bootstrap support) with the Monterey Bay *C. caverna*, and not with the Catalina brooders. Pismo Beach and Catalina populations are known to brood but we are still investigating whether one or both of these populations have separate sexes or are hermaphroditic and self-fertilizing as is known for the Monterey Bay *C. caverna*. The color variation and considerable 16S haplotype variation observed for the Catalina brooders might suggest that these are cross-fertilizing, not self-fertilizing, which would have interesting implications for inferring the evolution of self-fertilization from a more southern cross-fertilizing and brooding ancestor.

Bivalves from Acapulco Bay, Guerrero, México

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The benthic bivalves, inhabitants of sandy and rocky substrates in Acapulco Bay, Mexico, were studied in order to determine their species richness and abundance. Samples were collected in September 2008, from 11 localities, using a 45 x 45 cm quadrant. A total of 5,155 individuals were identified based on characteristics of the shell, resulting in 144 species, 67 genera and 33 families. The families with the greatest number of species were Veneridae and Mytilidae. The dominant species, in terms of abundance and frequency in the study area, were *Crassinella ecuadoriana, Carditamera radiata, Neolepton subtrigona, Chione squamosa, Septifer zeteki, Brachidontes adamsianus, Bernardina margarita, Kellia suborbicularis* and *Lithophaga spatiosa*. The greatest richness (62 species) and abundance (790 individuals) were associated with sandy substrates.

Chitons: Acapulco's gourmet delight

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The city and port of Acapulco, Guerrero, Mexico, are internationally recognized tourist destination because of their natural beauty, historical legacy, gastronomic traditions and other attractions. Ingredients used for its culinary delights include bivalve, cephalopod, gastropod, and polyplacophoran molluscs. The exotic dish prepared from chitons is locally known as "Cucaracha del Mar a la Mexicana" (Mexican Style Sea Roach).

Mexico has neither rules nor regulations about the amount and sizes that can be captured for this resource, much less a closed season to allow successful reproduction and sustainability. Therefore, to establish strategies that will allow ecological balance and social development, it is necessary to collect information about this natural resource and the human use of it. The present study about the consumption of polyplacophorans in Acapulco was financed by Fondos Mixtos from CONACyT-Guerrero State.

During 2009, 74 restaurants were questioned about their sale of seafood, and 35 answered positively for the occasional or frequent offering of Mexican Style Sea Roach in their menus. Seven of these were chosen for study because they always have chitons for sale. Those seven places were visited on April, July and December 2009, and one dish of Mexican Style Sea Roach was bought each time to measure their shells. The numbers of foot or meat pieces were counted, taking note of their length (mm) and weight (g). Out of 21 dishes bought, 1,204 meat pieces were counted in total. On average, each plate consisted of 57.33 pieces (standard deviation = 19.2), varying between 25 to 107 per plate. Prices fluctuated from $50.00 to $280.00 Mexican pesos ($4.00 to $23.00 USD) per serving, averaging $70.00 pesos ($5.75 USD). *Chiton articulatus* Sowerby in Broderip & Sowerby, 1832, was the only polyplacophoran species served. Other mollusks used to complement the dish were *Plicopurpura pansa* (Gould, 1853) and *Fissurella gemmata* Menke, 1847. Over time, the number of pieces varied significantly, with July being the greater and December with the lowest amount of pieces per service. The average length of the polyplacophoran foot observed was 32.7 mm (standard deviation = 6.9 mm). The sizes fluctuated from 13.2 to 61.6 mm in July and December, respectively. One-way analysis of variance showed significant differences for the average foot length through time (F-Fisher= 75.45, P= 0.0; Kolmogorov-Smirnov, X^2= 134.83, P= 0.0). The correlation between the amount of foot meat and average length was significant (Pearson= -0.84, P= 0.0; Spearman= -0.89, P= 0.0). A greater number of meat pieces and lower foot length was observed in July during the middle of the rainy season, while in December, the start of the drought season, a lower number of pieces and largest average length were served.

Gastropods from Acapulco Bay and La Roqueta Island, Guerrero, Mexico (Preliminary results)

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This study contributed to knowledge on the gastropods of the state of Guerrero, Mexico, specifically Acapulco Bay and La Roqueta Island. Biological material was collected from 11 sampling stations distributed across the bay and the island, during September 2008. For each sampling station, two samples were obtained from sand and two from rocks, from 45 cm per side quadrants. For the sand samples, 3.8 kg per station were obtained. The depth varied from 5.4 to 24 m. A total of 9440 individuals were collected, from which 184 species were identified, representing 51 families and 105 genera. Outstanding were the Littorinidae, Rissoidae, Barleeidae, Caecidae, Turritellidae, Calyptraeidae, Cerithiopsidae, Columbellidae and Cysticidae families for the wide distribution in the study area, the Columbellidae, Pyramidelliidae and Caecidae families for the greatest species richness and the Caecidae, Rissoidae, Calyptraeidae families for the greatest density.

The gastropod species, living in the sandy habitat, that display the largest abundance were *Caecum* (*Caecum*) *quadratum*, *Caecum* (*C.*) *bahiahondaense*, *Crepidula aculeata* and *Gibberula* sp. In contrast the species *Vermicularia frisbeyae*, *Rissoina* (*Rissoina*) *stricta* and *Fartulum* (*Fartulum*) cf. *laeve* characterize the rocky habitat with their abundance values.

Phylogeny of *Cyerce* (Opisthobranchia) with the description of a new species from Guam

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Cyerce is a group of marine opisthobranch mollusks (sea slugs) characterized by possession of flat, leaf-like appendages on the dorsal side of the animal. These appendages maintain living, active chloroplasts obtained from their algal prey, which provide the animal with sugars. There are eight known species of *Cyerce* found throughout tropical and subtropical regions; each species contains a unique combination of characters. This study reconstructs the phylogeny of species of *Cyerce* using a combination of mitochondrial and nuclear DNA data. DNA sequence data indicate significant differences between previously known species and have revealed the existence of a new species recently collected from Guam.

Molluscan Genomics Workshop: Seq-based genomics for organismal biology

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Until recently, large-scale animal sequencing projects were limited to major research initiatives taken on by private, national or international laboratories and consortiums in biomedicine and bioenergy. This situation arose due in part to the inhibitory costs of Sanger sequencing large genomes, and due to the computational expertise required for algorithm development in data analysis. However, increasingly fast, cheap, and accurate, next- and third-generation sequencing technologies (Seq-based), combined with increasingly powerful and accessible informatic tools, have made large-scale sequencing projects by smaller research communities and individual laboratories an exciting new reality. These technologies have opened the door to Seq-based organismal research in molluscan biology, and more molluscs are now being sequenced with increasing regularity. This workshop, "Molluscan Genomics Workshop: Seq-based genomics for organismal biology", seeks to foster the integration and use of Seq-based tools and strategies across the varied disciplines of organismal biology. The workshop includes five tutorials on both Sanger- and Seq-based genomics research, including: (1) Sequencing: Advances and implications of Seq-based technologies, (2) Genomes: Genome sequencing and the *Lottia gigantea* (Mollusca :

Gastropoda) genome project, (3) Workflows: Phylogenomic workflows in systematics, deep sequencing, and resequencing, (4) Databases: Sequence database and bioinformatic research tools, and (5) Applications: The future of Seq-based research tools in organismal and molluscan biology. In addition, the workshop highlights the need for a community-driven, phylogenetically informed knowledgebase of descriptive biology. In the end, if you are going to do PCR, you should sequence a genome. Maybe not today, but soon.

Molecular and morphological phylogeny of the genus *Dondice*

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Dondice is the genus name of three described species of opistobranch mollusk, or more commonly, sea slug: *Dondice banyulensis, Dondice occidentalis,* and *Dondice parguerensis.* These species are found in different localities of marine environments on either side of the Atlantic Ocean. Both *D. occidentalis and D. parguerensis* are Caribbean species populating areas surrounding many if not all of the island intertidal zones within the area. *Dondice banyulensis* represents the eastern most Atlantic localities, finding habitat in areas within and around the Mediterranean. The two species described in the Caribbean are however extremely similar morphologically and seem to only differ in their feeding behavior. The species described as *D. parguerensis* feeds exclusively on the scyphozoan *Cassiopea* (commonly known as the upside down sea jelly) whereas *D. occidentalis* feeds on a type of hydroid known as *Eudendrium racemosum.* The basis of this research has been to determine whether or not these two described organisms are indeed separate species or if they are the same species occupying distinct ecological niches based on their feeding behaviors. Comparing the H3 nuclear histone coding gene, along with fragments of the mitochondrial 16s gene, in conjunction with taxonomically significant morphological characters (reproductive anatomy and radulae shape) we were able to reconstruct the phylogeny of the genus *Dondice.* Our data suggest a genetically distinct clade within the Bahamas as separate from *all* other *Dondice* inhabitants in the rest of the Caribbean; also that this Bahamas clade is the result of an earlier divergence from the eastern Atlantic populations than the Caribbean. Morphological characters also suggest that the species distinction between *D. parguerensis* and *D. occidentalis* based solely on feeding behavior is inconsistent with the relevant data and so a possible synonymization of the two species may be in order.

Coelatura and the monophyly of the Unionidae (Bivalvia: Unionoida)

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The Unionidae is the largest of six freshwater mussel families with over 850 species in 165 genera. The family is well represented on the northern continents, and various lineages have extended southward onto stray Gondwanan fragments. Phylogenetic work on the Unionidae has not yet approached anything resembling comprehensive, within-family sampling. As a result, few solid conclusions can be drawn beyond (1) the fact that topologies recovered to-date have been at odds with the traditional arrangement and (2) most of the morphological characters that we thought were tremendously important for freshwater mussel classification are homoplastic and contradictory.

Since the earliest molecular phylogenetic studies of the Unionidae, the African species *Coelatura aegyptiaca* has been problematic. Analyses of mitochondrial DNA have repeatedly challenged the monophyly of the Unionidae, recovering *Coelatura* as basal to a (Margaritiferidae + Unionidae) clade (= Unionoidea). Moreover, the position of *Coelatura* has led to speculation about a Gondwanan origin for the otherwise northern Unionoidea.

We set out to re-evaluate the position of *Coelatura* with more extensive character and taxon sampling. In addition to 650+ nt of cytochrome oxidase subunit I mtDNA, we also obtained sequences for 480+ nt of 28S nuclear DNA for 39 species representing four freshwater mussel families and two outgroup species. In our analysis, the African Unionidae is represented by 3 species of *Coelatura*, *Nitia*, and *Prisodontopsis*. Preliminary analyses under maximum parsimony and Bayesian inference recover the Unionidae as monophyletic, with *Coelatura* and the other African taxa comprising the basal lineage (of those sampled). We will discuss our results in the context of global freshwater mussel evolution and competing hypotheses of the origin of the African Unionidae.

New species of Paleogene cypraeoideans (Mollusca: Gastropoda) from the Pacific Slope of western North America

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A new species of *Bernaya s.s.* (Cypraeidae) from Eocene rocks of Washington and four new species of *Eocypraea s.s* (Eocypraeidae), one from Paleocene strata of northern California, two from Eocene strata of Washington, and one from Baja California Sur, Mexico are described. The new species of *Bernaya s.s* and the Washington species of *Eocypraea s.s.* represent the northernmost Cenozoic records for their respective genera in western North America. A tentative record of *E.* (*E.*) *inflata* (Lamarck, 1802), previously known only from the Lutetian (middle Eocene) of France, Belgium, and England, is noted from the Domengine Formation of Kings County, California.

A new species of Late Cretaceous cypraeid from the Santa Ana Mountains, Orange County, California

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A new species of Cypraeidae is described from the Upper Cretaceous (Campanian) Schulz Member of the Williams Formation, Santa Ana Mountains, Orange County, California. This is the first cypraeid described from the Williams Formation and only the second species described from the Santa Ana Mountains. The associated fauna includes the bivalve genera *Calva, Coralliochama, Crassatella, Cucullaea, Glycymeris, Indogrammatodon, Opis, Pterotrigonia,* and *Spondylus,* the gastropod genera *Ampullina?, Biplica, Pentzia, Volutoderma,* an unknown cerithiid, and colonial corals.

Effects of the August 2007 flood on translocated mussels, South Fork of the Zumbro River, Rochester, Minnesota, August 2008

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Prior to construction of a sewer trunk line, potential sites were surveyed for state listed mussels in 2005. In 2006, 600 mussels were translocated from four sites, including three state listed mussels: *Alasmidonta marginata* (20.0%), *Lasmigona costata* (2.0%), and *L. compressa* (2.3%). There was modest reproduction of most species. Nearly all state listed mussels were externally aged, measured, and etched with unique numbers on both valves. Common species were hash-marked on both anterior valves. Moved to the Translocation Site were 404 mussels from Site 1 (18.07% state listed); 136 from Site 2 (44.85% listed), while 33 (15.15% listed), and 31 (22.58% listed) were from Sites 3 and 4. In 2007 there was a 95.1% survival of state listed mussels, and 85.3% survival of hash-marked mussels.

During the last follow-up in 2008, mussels recovered from the Translocation Site included 86 numbered mussels (90.7% survival), 56 hash-marked mussels (96.3% survival), and 31 unmarked mussels (including five listed mussels). Of the numbered mussels, 64.1% did not show any change in size, or even a decrease in growth. Only 35.8% of the numbered mussels showed some growth in 2008. We had never seen this phenomenon previously, and concluded that possibly this was a result of the record area flooding shortly after the 2007 follow-up (excessive turbidity and/or acidic conditions from upstream waterfowl). Seventeen numbered mussels not found in 2007 were found in 2008.

Biogeographic patterns in Cenozoic microgastropod assemblages

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Geographic patterning of molluscan biodiversity is best understood in large-shelled lineages in tropical reef-associated habitats. Most of the available data for microgastropods (<5 mm) also are from low latitude assemblages, where there is a paradoxical absence of endemism in taxa that lack a significant planktonic larval stage. Many microgastropod species complexes are widespread in the tropical Indo-Pacific region. The fossil record at low latitudes over the past 100 million years shows a decline in vetigastropod dominance during the Cretaceous and a Maastrichtian shift to assemblages dominated by basal caenogastropods and basal heterobranchs. This is followed by a Cenozoic shift to broader distribution of diversity among superfamilies.

High latitude assemblages from Australasia show a strikingly different pattern. Well preserved microgastropod faunules from fine-grained rocks in New Zealand and the southern coast of Australia are dominated by skeneiform taxa (trochoideans, turbinoideans, seguenzioideans and rissoideans) throughout the Cenozoic. Forty-four skeneiform genera are based on Australasian species, and some of the most diverse lineages are endemic to Australasia. Species of *Crosseola* Iredale, 1924, *Brookula* Iredale, 1912 and *Cirsonella* Angas, 1877 are often represented by many individuals in the 1 mm and 0.5 mm fractions of sieved samples.

Biogeographic explanations of high latitude distributions in the Southern Hemisphere have been shaped by plate tectonic theory and a strong geological bias toward vicariant events, notably the fragmentation of Gondwanaland. However, there is a strong resurgence of dispersalist explanations invoking the dominant influence of the Antarctic Circumpolar Current and rafting of adult fauna on macroalgae. For microgastropods, rafting is not the only (or even the most likely) option for dispersal. Mucus thread kiting, drifting, and flotation at or near the air-water interface occurs in unrelated microastropod taxa as well as in early post-metamorphic juveniles of many marine mollusks (Hickman, 2008). Other micromollusks perform diel migrations between sediment and water column, and some are capable of sustained active swimming: behaviors that expose them directly to currents.

Increasing evidence of hermaphroditism in unrelated microgastropods has strong potential biogeographic implications. Simultaneous hermaphroditism is reported here for the first time in Hawaiian and Australian species of the micro-vetigastropod genus *Alcyna* A. Adams, 1860, based on observations of sperm, eggs, and oocytes in single individuals. Development occurs in a clear capsule, and juveniles hatch directly, without a planktonic phase. In an experimental setting, capsules were deposited on tethered floating plastic squares that could be reached only by mucus thread kiting and by floating upside-down at the air water interface. Observations of basic biology should play a more important role testing hypotheses of dispersal potential.

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Observations of mating behavior in the lesser Pacific striped octopus, *Octopus chierchiae* (Jatta, 1889)

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The lesser Pacific striped octopus, *Octopus chierchiae*, is a rare and unique pygmy species. Because of its colorful striping pattern, ability to spawn multiple egg clutches in its lifetime (iteroparity), and direct developing young, it is a potentially ideal species to culture for both research and the aquarium trade. *Octopus chierchiae* occurs from the low intertidal zone to at least 40 m from the Gulf of California to Columbia. However, it has not been observed since the late 1980s. *Octopus chierchiae*'s iteroparity sets it apart from most other octopods and provides an opportunity to not only study the behavior itself, but to gain insight on the control of reproduction. Four males and two females, which were either collected from the wild or were lab-reared individuals, were mated for a total of eight copulations. Video observations of *O. chierchiae* mating were taken for the first time. Males are smaller than females and possess papillae surrounding their suckers on the tips of all arms except the third right and left. Males were also observed to exhibit a twirling behavior, in which the animal spins the tips of his arms in a circular motion. During copulation, the male pounces on the female, consistent with the behavior of other octopods, but may also exhibit a second mating position: beak to beak. Mating is brief, lasting less than 15 minutes, and observations suggest the female terminates copulation. *Octopus chierchiae* is a highly desirable species both for research and in the aquarium trade. The more that is understood about their mating behavior and habits, the more likely we will be able to culture *O. chierchiae*.

Major branch swapping in the placement of *Cryptochiton* and *Plaxiphora* within Acanthochitonina (Mollusca: Polyplacophora)

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Polyplacophorans are an early offshoot diverging from the rest of mollusks, with the first known fossils dating back to the Late Cambrian. Chiton classifications have been based primarily on valve (shell plate) characters, in some cases even relying completely on them. More recently, new morphological and molecular characters have provided important insight, challenging conventional hypotheses of phylogenetic affinities within Polyplacophora. Our goal is to build a robust phylogeny of chitons employing complete mitochondrial genome sequences, calling attention to particular phylogenetic hypotheses. Previous studies have demonstrated the usefulness of mitochondrial genomes in reconstructing phylogenetic relationships among highly divergent taxa, including, for example, gastropods or cephalopods. Here we emphasize the placement of

Cryptochiton and *Plaxiphora* within Acanthochitonina, a major subclade of extant chitons, recently characterized by sharing abanal placement of gills and cup- or cone-like egg hulls. Our complete mitochondrial genome studies are ongoing but we have already assembled a data set based on three mitochondrial genes (*rrnL*, *cox1*, *cob*) across about 50 selected chiton genera. These genes were selected because their strategic placement, approximately equidistant in the circular mitochondrial genome of the only available genome sequence for chitons, *Katharina tunicata*. Based on the sequences of these three genes, chiton-specific primers were designed for long-PCR amplification of the regions between these genes, in order to completely sequence the whole mitochondrial genome. Meanwhile, we are now able to address certain phylogenetic hypotheses based on our preliminary molecular analyses, in anticipation of our more extensive studies based on complete mitochondrial genomes. Phylogenetic analysis of our three-gene data set has provided evidence that both *Cryptochiton* and *Plaxiphora*, within Acanthochitonina, are presently misclassified at the familial level. *Cryptochiton* has been previously associated with Acanthochitonidae, but instead is resolved within Mopaliidae. *Plaxiphora* has been considered a member of Mopaliidae, but instead is resolved as basal within Acanthochitonina, well apart from Mopaliidae. These unconventional placements are contrary to some proposed phylogenetic hypotheses, but are in agreement with biogeography and some morphological affinities.

When to infer flight in molluscs? Cryptic taxa in the trematode *Parorchis*, the gastropod *Cerithidea* and the bivalve *"Transennella"*

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Suites of alpha taxonomic and phylogeographic divergence patterns on the Pacific Coast show temporal and spatial coherence: the radiation of multiple components of the coastal fauna coincide with late Miocene upwelling, and spatial patterns of cryptic differentiation are evident. Here we report less coherent phylogeographies that suggest avian dispersal.

The trematode *Parorchis acanthus* lives in relatively sessile snails. However, birds act as the final host for the trematode. Thus, dispersal by birds is anticipated. Mitochondrial sequence data generated from *Parorchis* recovered from species of *Cerithidea*, *Acanthonucella,* and *Nucella* on the Atlantic and Pacific coasts reveal a rich cryptic taxonomy correlated with gastropod host, and host life history. Haplotypes are shared in some clades between the Atlantic and Pacific, providing a strong indication of recent and ongoing gene flow via birds. This is true of some, but not all, cryptic clades with bicoastal ranges in the tree. Apparently, the classic taxon *Parorchis acanthus* contains many species-level entities with various bird-mediated dispersal modalities.

New world *Cerithidea* lack planktonic larvae and are strong candidates for avian dispersal - possibly through ingestion or as egg strings adhering to bird feet or feathers. Mitochondrial sequence data suggest 'saltatory' dispersal. Along the Pacific coasts of California and Mexico, local clades are distinguished, but group together without regional coherence and without distinction between the nominal taxa *C. mazatlanica* and *C. californica.* Futhermore the Carribean taxon *C.*

pliculosa nests within this *C. mazatlanica* + *C. californica* clade. In addition, the Carribean *C. costata* falls within a clade of haplotypes of *C. montangei*, a Pacific Coast taxon. These observations raise questions as to the validity of a number of species in the genus and strongly suggest a history of migration between, or founding of, populations via bird dispersal.

"Transennella" (or *Nutricola*), a small brooding venerid bivalve, is often exposed to shore bird predation on Pacific Coast tidal flats where the genus consists of the named species *"T." tantilla* and *"T." confusa*. Mitochondrial clades subdivide these species with some regional coherence, but also show shared haplotypes in distant estuaries, suggesting a broader range of intertidal molluscs may experience avian dispersal.

How the southern shield limpet's rocky journey leads to a mid-life crisis

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Our use of mitochondrial 16S rDNA (16S) comparisons to help distinguish between similar appearing limpet species living and grazing together on the stipe of the feather boa kelp, *Egregia menziesii*, took an unexpected turn. Instead of only two species we found three. One of two species common on feather boa kelp in southern California is itself the more southern of a pair of genetically distinct cryptic species separated by latitude. These two similar-appearing southern and northern shield limpet species have until now been lumped as *Lottia pelta* (Rathke, 1833), already notorious as a master of disguises because of its many distinctive ecomorphs. Our studies of mostly the southern shield limpets confirmed that their growth is extremely plastic, depending on their particular microhabitat. A third species, *Lottia insessa* (Hinds, 1842), is specialized to live only on feather boa kelp. Those southern shield limpets found on feather boa kelp stipes were so similar to *L. insessa* that at first we found it difficult to differentiate them. We also discovered limpets we called "mid-life crisis" morphs on rocks under the canopy of rockweeds, *Silvetia compressa*; these were exactly like those southern shield limpets on feather boa kelp on their older top half and like normal "rock morph" southern shield limpets on their younger bottom half. We hypothesized that these limpets were southern shield limpets that had crawled off feather boa kelp stipes and migrated up the shore on a rocky journey to live the rest of their life on rocks under rockweed. We used 16S to confirm their identity and to confirm a set of diagnostic features for accurate identification of each species, even as tiny juveniles. We found only one northern shield limpet as far south as Pacific Valley, Monterey County, California, where it was greatly outnumbered by its southern counterpart. Phylogenetic results for 16S were robust in supporting each species as distinct and as close relatives of each other, with respect to other *Lottia* species, but we were unable to resolve the interrelationships among these three species. We found that southern shield limpets are most common on feather boa stipes at sites that also have abundant rockweed nearby, whereas sandier sites without abundant rockweed tend to have only *L. insessa* on feather boa kelp stipes. The implication of our study is that southern shield limpets might play an under-appreciated role affecting long-term algal abundance, especially if their habitat shifts might be related to destructive grazing of their associated algal species.

Life history and tropical marine biogeography in the light of phylogeny

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Comparative studies of egg size and larval morphological characteristics coupled with estimates of dispersal abilities enabled Kohn and Perron (1994) to predict attributes of geographic distribution patterns of Indo-West Pacific *Conus* species that vary widely in developmental mode. However, because no species-level phylogenetic hypothesis had ever been proposed for *Conus* at that time, we were constrained to treat each species as an independent entity. During the past decade, however, molecular phylogenetics of *Conus* has progressed to the point where we can use phylogenetic character mapping and the method of independent contrasts to evaluate the importance of phylogenetic relationships to biogeographic patterns. Preliminary analyses suggest that highly significant evolutionary associations exist among developmental traits that affect dispersal ability after accounting for phylogenetic relationships in the one clade of *Conus* analyzed thus far. This comprises the molluscivorous species, and they are also characterized by the tendency toward non-planktonic development with loss of veliger larvae. The extent to which phylogenetic relatedness predicts biogeographic patterns will be examined in additional clades of Indo-West Pacific *Conus*, in geographically structured clades of tropical East Pacific and West Atlantic *Conus*, and in other marine gastropods, as groups in the latter regions are known to have generally higher proportions of species with non-planktonic development than in the Indo-West Pacific.

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Malacological literature and resources on the internet

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Molluscan literature and other resources available via the internet are expanding at an astonishing rate. Much of the systematic literature in several major university and museum research libraries including USNM/SI, BMNH, MCZ, MBL/WHOI (Woods Hole), ANSP, AMNH, CAS, and the Field Museum is now available in digital format to anyone, anywhere in the world, with Internet access. Many of the malacological journals are also available. These materials are not just available, but indexed to a degree. Additonal books and journals continue to be added at a rapid pace. Taxonomic tools such as Index Animalium and Nomenclator Zoologicus are available as searchable databases. For those with Internet access via an institutional library system, additional resources may be available. I will survey and demonstrate ways of using some of these resources, emphasizing the Biodiversity Heritage Library. Internet resources available for rendering book page images into text (OCR) and translating them into English will also be demonstrated.

Cypraeidae (Mollusca: Gastropoda) from the lower Miocene Cantaure Formation of northern Venezuela

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This is the first account of the rich assemblage of Cypraeidae from the upper lower Miocene (Burdigalian) Cantaure Formation, Paraguaná Peninsula, Falcón Province, Venezuela. Twelve species are recorded from these deposits, ten of which are undescribed. Two species of *Luria*, one species of *Trona*, two species of *Propustularia*, two species of *Zonaria*, and three species of *Pseudozonaria* are described as new. Comparative taxon *Muracypraea "henekeni"* of Groves (1997) from the middle to late Miocene Gatun Formation of Panama and Angostura Formation of Ecuador is also described as new. *Cypraea fossula* (Ingram, 1947) is reassigned as a junior subjective synonym of *Trona trinitatensis* (Mansfield, 1925). The type materials of *Jousseaumea joossi* Schilder, 1939 and *Pustularia mejasensis* Schilder, 1939 are poorly preserved and the taxa are regarded as *nomina dubia*.

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Distribution and abundance of holoplanktonic mollusk assemblages from the southern Gulf of Mexico

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The distribution, abundance and assemblages of holoplanktonic mollusks in the neritic waters of the southern Gulf of Mexico were analyzed during November of 1995. The mollusks were collected with an opening-closing net of 500 µm mesh size in five levels of the water column (0-6 m, 6-12 m, 12-18 m, 45-55 m and 95-105 m). A total of 24,077 organisms were identified, represented in 9 families, 18 genera and 36 species (including forms). The most abundant and diverse family was the Cavoliniidae (52.9%), with 14 species. *Creseis acicula* (with the forms *C. a. acicula* and *C. a. clava*) and *Limacina inflata* represented almost the 77% of the total abundance (39.64% and 36.92%, respectively). Previous studies indicated that Cavolinidae species have a high degree of genetic plasticity resulting in a great number of forms and subspecies. The Bray-Curtis dissimilarity index defined two faunistic assemblages, named 'marine' and 'fluvio-lagoonal influenced' groups. The former was characterized by a higher abundance and higher number of species. These results indicated that only few holoplanktonic mollusk species are able to tolerate freshwaters outflows over the sea.

Evidence for rapid evolution with diversification of sexual behavior in the genus *Ariolimax* (Gastropoda: Stylommatophora)

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On the basis of genital morphology, Pilsbry (1948) identified five species-level taxa in the genus *Ariolimax* and comprising two subgenera. Data from mt DNA loci (cyt b, 16 S rDNA, CO1) show four well supported clades, with the subgenus *Ariolimax* of Pilsbry actually consisting of three clades, *A. columbianus, A. stramineus* (described as a subspecies of *A. columbianus*) and *A. buttoni,* which had been synonymized with *A. columbianus* (Leonard *et al.*, 2007). The fourth clade consists of three taxa included by Pilsbry in the subgenus *Meadarion, A. dolichophallus, A. californicus* and *A. brachyphallus.* Molecular evidence indicates that evolution in the genus has been rapid, since these phylogenetic trees show a pattern of short internal branches and 19 microsatellite loci identified from *A. californicus* consistently amplify in all of the described taxa, suggesting that all these taxa are very closely related. In addition to genital morphology, *Ariolimax* species also show marked differences in sexual behavior. The *Meadarion* taxa are found on the San Francisco Peninsula with *A. brachyphallus* in San Francisco, *A. californicus* in San Mateo County and *A. dolichophallus* in Santa Cruz County. *Ariolimax brachyphallus* is also found in isolated locations in Monterey and San Luis Obispo Counties. Populations in northern San Mateo County show discordance between molecular data, suggesting affinity with *A. brachyphallus,* and behavioral and morphological data, which suggest that the animals are *A. californicus.* The molecular data show no distinction between *A. californicus* and *A. dolichophallus,* although these were described as full species on the basis of morphology and they have very differenct patterns of sexual behavior (Leonard *et al.*, 2002). Preliminary data using microsatellites to identify parentage show no evidence of cross-breeding between adult *A. californicus* and *A. dolichophallus* pairs confined together in the laboratory. The molecular evidence suggests that the observed differences among species in sexual behavior and morphology have evolved very rapidly.

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Host races or ecomorphs? Testing host-mediated speciation in two marine commensal bivalve species

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Host-mediated speciation is one of the explicit models of ecological speciation. For symbiotic organisms, the survival and reproduction of the symbionts are highly associated with host species; host switching alone can potentially cause assortative mating and eventually lead to reproductive isolation. A large number of galeommatoidean bivalves form intimate commensal relationships with marine invertebrate hosts. Some commensal clams have the ability to form associations with multiple (often very different) host species, thereby providing potential opportunities to test mechanisms of host-mediated speciation. I hypothesized that species occupying different host species might form latent host races, characterized by host-specific genetic structuring and morphological traits, both of which are preconditions for host-mediated speciation. Two commensal clam species from the west coast of US were selected to test this hypothesis. *Neaeromya rugifera* has two strikingly different host species: the blue mud shrimp *Upogebia pugettensis* and polychaete sea mouse *Aphrodita* sp. Similarly, *Mysella pedroana* occurs on both the sand crab *Blepharipoda occidentalis* and the hermit crab *Isocheles pilosus*. For each clam species, individuals from different hosts were collected and subjected to morphometric analyses of shell shape in order to detect host specific morphological traits. Samples were also genotyped using a mitochondrial Cytochrome Oxydase I gene (mtCOI) fragment. Haplotype networks were constructed to analyze population level genetic structures. Preliminary results showed that for both *N. rugifera* and *M. pedroana*, individuals possess host-specific morphological traits: populations from different hosts differ significantly in shell morphology. However, based on mitochondrial makers, neither species showed distinct genetic structuring, either based on host species or geographic distribution, indicating the existence of gene flow among populations that occupy different hosts. My preliminary conclusion is that the host-specific morphologies the clams exhibit may reflect ecophenotypic plasticity rather than the existence of host races, but this needs to be corroborated with additional genetic data.

Redefining size: Impact of allometric relationships on modeling indeterminate growth, with a focus on chitons

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An organism's body size has great influence on its ecology, evolution, and reproductive output. Life history models and growth curves are predominantly based on linear measures of body size such as length and diameter, but the use of these measures can misrepresent actual growth patterns. Organisms with indeterminate growth often have their growth modeled with asymptotic growth functions based on body length; these models describe a major energetic shift from growth to reproduction later in life. However, growth curves in this study were based on absolute measures of growth (body weight, body volume), resulting in drastically different growth patterns. Data collected in this study were combined with published data to create volume- and weight-based growth rates for a variety of mollusks, with a focus on the chitons *Cryptochiton stelleri* and *Katharina tunicata*. In all species studied, absolute measures of size such as body weight and body volume display a continuous increase with age and cannot be described by asymptotic growth functions, in sharp contrast to typical asymptotic growth curves. In addition, egg and sperm counts varied exponentially with body length and linearly with body volume and age, indicating that volume is the driving factor behind reproductive output. Growth curves based on volume and weight for several species of limpets, chitons, and other mollusks were shown to display a steady increase in size with age. The use of body length as a proxy for size in growth curves can result in apparently asymptotic growth rates when this is not actually the case. Since growth models are the underpinning of life history theory, accurate energetic and life history models must take into account the absolute size of the organism, not just a linear measure of body size.

Marine bivalves in the Colecciòn Malacológica Dr. Antonio García-Cubas: Taxonomic validation

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The Colección Malacológica "Doctor Antonio García-Cubas" (COMA) houses samples of mollusks collected in Mexico and other countries from the end of the 19^{th} century to the present. The bivalve collection has at least 1300 records, including dry and 70% alcohol-preserved specimens. In 2008, auxiliary to regular curatorial maintenance and adding new specimens to the collection register, we began a process of identifying, correcting and standardizing the taxonomy of the bivalve samples.

The bivalves were identified based on Keen (1971), Abbott (1974), Ríos (1994), Coan *et al.* (2000), Redfern (2001) and the webpage www.bama.ua.edu/~musselp. Taxonomic standardization follows the criteria of Skoglund (2000), Coan *et al.* (2000), Redfern (2001) and the webpages www.itis.gov and www.bama.ua.edu/~musselp.

Today the collection guards 14,500 bivalve specimens of 440 species in the five subclases: Protobranchia, Pteriomorphia, Paleoheterodonta, Heterodonta and Anomalodesmata. The subclass Heterodonta, with 270 species, is the most diverse in the collection.

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Pleistocene glaciation, biogeographic dynamics, and evolutionary responses of Eastern Pacific molluscan assemblages

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The Pleistocene epoch (the last 2 million years) is characterized by frequent alternation between relatively cold glacial and warm interglacial climates, representing one of the most dynamic periods of time in Earth's climate history. Although glacial-interglacial cycling had profound impacts on many species' distributions (particularly those outside the tropics) the evolutionary responses of species during this environmentally dynamic period is unresolved. Overall, the fossil record shows that the biogeographic responses of species to climate change have been highly individualistic, unpredictable, and almost exclusively ecological, with little speciation and extinction having occurred in the last 2 MY. The molluscan fossil record of the eastern Pacific has figured prominently in this debate, and supports the notion that frequent climate change has repeatedly destabilized species interactions, thereby limiting the timeframe for adaptation, co-evolution, and speciation. Despite the paleontological evidence, rocky shore species show good evidence of local adaptation and cryptic or sibling species are not uncommon. One recent outstanding example involves the gastropod *Nucella canaliculata*, which shows a latitudinal pattern of adaptation to spatial variation in relative prey abundances. To better understand this example of adaptive evolution in a historical context, I have re-analyzed genetic data from this species under an isolation-with-migration model that distinguishes the separate influences of ancestral polymorphism and gene flow on patterns of population genetic differentiation. Surprisingly, the analysis shows that most populations (including those differentially adapted to prey) have been separate for ~100,000 years, with very little if any detectable gene flow. The unexpected long history of population isolation within *N. canaliculata* suggests that generalizations about temporal constraints may be unwarranted. At higher latitudes, similar genetic analyses of multiple co-distributed and interacting species agree with paleontological data in the sense that species' responses to past climate change have been individualistic, but some species, such as the important ecological engineer *Mytilus californianus*, show histories of demographic stability and long-term population persistence beyond the last glacial maximum. Together, these analyses suggest that dramatic and frequent climate changes during the Pleistocene (particularly the last glacial maximum) may have had less frequent community-wide impacts on the biogeography of nearshore marine species. Future work in comparative genomics will help to clarify to what extent the apparent variability in demographic histories represents actual demographic variability versus the variability of the coalescent process, as well as provide a way to survey the genome for evidence of local adaptation at the molecular level.

Opisthobranchia (Mollusca, Gastropoda) diversity at Acapulco and Puerto Marquez Bays, Guerrero, México

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The Opisthobranchia represents some of the most gorgeous and good looking marine animals. There are about 6,000 species around the world; they are characterized by their type of reproduction and lack of protective shell. Generally inhabitants of marine rocky or soft bottom, among the algae, and some free duelers, or pelagic associated with floating materials. The fauna of Opistobranchia literature for Mexico is mostly on the description and taxonomy studies for the states of Jalisco, Michoacan, Nayarit and Baja California, such as the work of Berstch (1993), Hermosillo (2003) Hermosillo *et al.* (2006). For the state of Guerrero, Mexico, the knowledge of this group is very scarce, there the importance of the present study where we pretend to describe the diversity of them in two bays and four locations: Acapulco three beaches: Colectores, Parque la Reina and Tlacopanocha; and Puerto Marquez, only Majahua beach; sampling by diving, each visited once every three months at the same place during one year, with the quadrant – transect system, with 10 length and one wide total 10 m^2 ; The Opistobranquia from each quadrant were quantified and identified, collecting only those requiring further study, keeping them in bowls for transfer to the lab for live photo documentation and their further preservation in 95% ethanol after well relaxed. Their identification was made by using the taxonomy key of Keen, 1971; Behrens and Hermosillo (2005) and Hermosillo *et al.* (2006). Density and dominancy analysis were done to better understand some of their ecology and live cycle, seeking for them directly on walls and under rocks at favorable substrates. Collecting in total 37 species under 26 genera, 17 families, five orders, one subclass, one class. The most common species were *Pleurobarnchus aerolatus, Phidiana lanscrucensis, Spurilla neapolitana* and *Aeolidiella alba.* *Pleurobranchus aerolatus* represented 85% of dominancy at "Colectores" beach with 4.7 org./m^2; while at "Parque la Reina" with 11 species, *Spurilla neapolitana* showed 25% dominancy and density of 1 org/m^2 followed by *Pleurobranchus aerolatus* 20% dominancy and 0.8 org/m^2. At "Tlacopanocha" 12 species were recognized, with *Aplysia juliana* had 81.85% dominancy and 22.1 org/m^2. At "Majahua" eight species were found with *Pleurobranchus aerolatus* showing 30.34% dominancy, followed by *Navamax aenigmaticus* with 26%. The greater dominancy was for *P. aerolatus* at two locations, and *A. Juliana* only at one location.

Revision of recent and fossil Liotiidae (Gastropoda: Vetigastropoda)

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The family Liotiidae, with subfamilies Liotiinae and Areneinae, represents a long-neglected basal group of intricately sculptured vetigastropods characterized by a thickened final lip, lamellar microsculpture and a conchiolinous multispiral operculum with a long growing edge; this operculum bears a continuous calcareous coil with pustules; conchiolinous tufts project between the volutions.

Radular, epipodial, and ctenidial characters are plesiomorphic and similar to these structures in other basal trochiform vetigastropods, so uniform that they are uninformative for classification and phylogeny. However, shell morphology provides an abundance of characters useful for generic and specific determination.

The primary objective of this revision is to analyze generic level characters, and to provide a full generic classification of living and fossil genera. The secondary objective is to describe the large number of new species that have been recognized in the major museum collections of the world, or that have been sent to me for determination and descriptions, many of which are from field studies and ongoing expedition programs, particularly that of the Paris Museum. A third objective is to refine the classification by assigning the genera to groups recognized at the level of tribes, based on shared morphological characters.

The Liotiinae and Areneinae are distinguished on differences in shell color, dominance of axial or spiral sculpture, complexity of the final lip, and opercular distinctions. Early records of both subfamilies are first known with certainty from the Late Cretaceous of Europe and the Caribbean. For both subfamilies only a few species are common, most species are geographically restricted, and some are known only from the originally described material.

The subfamily Liotiinae includes a few moderately large species, some that are micro-gastropods as small as 2 mm in diameter, and others representing all intermediate sizes. This is the most speciose subfamily and the one with the best fossil record. Liotiinae are characterized by pointed opercular pustules, absence of color pattern, strong primary sculpture of both axial and spiral elements, and an elaborate development of the compound lip in some genera. This subfamily, which includes nearly all of the Eocene species that had a major radiation in the Paris Basin, is now most diverse and speciose in the Indo-West Pacific, with fewer genera in temperate Australia, the eastern Pacific and western Atlantic. A number of the Indo-Pacific genera are characteristic of bathyal depths, unlike other regions that have little or no bathyal representation of the family. Many Indo-Pacific genera of Liotiinae have a strong periumbilical cord with deep pits on the outer side; another shell form develops a spur, a strong cord emerging from the umbilicus that connects to the outer lip. Genera of the eastern Pacific and western Atlantic do not develop strongly projecting terminal lips, instead usually having a bunching of axial ribs in preterminal stages. Eighteen tribes are recognized.

The subfamily Areneinae includes medium-sized to small-sized species. The Areneinae are less speciose, usually having a color pattern, with spiral sculpture dominant over axial sculpture, the operculum with oblong calcareous elements, and with the final lip less thickened and apertures more tangential than that of Liotiinae. Genera of Areneinae are best represented in the tropical eastern Pacific and western Atlantic, with lesser representation in southern and western Africa and even fewer genera in the Indo-Pacific. Twelve tribes are recognized.

This revision treats ca. 430 species, both living and extinct, of which ca. 280 are described as new. Species are assigned to ca. 110 living and extinct genera, all but 18 of which are also described as new.

Preliminary phylogenetic studies by Williams, *et al.* (2008) provided a sequencing analysis of three genes for a few species in both subfamilies, concluding that the genera of Areneinae were not assignable to the same superfamily as Liotiidae. That result is in contrast to morphological evidence provided by the operculum, which suggests that both subfamilies should be placed in the family Liotiidae.

Rapoport's rule as a tool for assessing the potential distribution and conservation implications of non-native species on tropical islands

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To protect the remaining biodiversity on tropical islands it is important to predict the elevational ranges of non-native species. Rapoport's Rule – a positive correlation between latitude or elevation and range size – may provide insight into the outcome of introductions of species from various latitudes along an elevational gradient. We evaluated two hypotheses by examining land snail faunas on the eastern (windward) side of the island of Hawaii: (1) the latitude of a species' native region can be used to predict its potential elevational range; (2) non-native temperate species, which experience greater climatic fluctuations in their native range, are more likely to become established at higher elevations and to extend over larger elevational ranges than non-native tropical species. All non-native tropical species were distributed patchily among sites at or below 500 m and occupied small elevational ranges, whereas species introduced from temperate regions occupied wide elevational ranges and formed a distinct fauna spanning elevations from 500 to 2000 m. Most native land snail species and ecosystems occur above 500 m in areas dominated by temperate non-native snail and slug species. Therefore, knowing the native latitudinal region of a non-native species is important for conservation of tropical island ecosystems since it can be translated into potential elevational range if those species are introduced. Since temperate species will survive in tropical locales particularly at high elevation, on many tropical islands the last refuges of the native species, preventing introduction of temperate species should be a conservation priority.

Purple dye snail *Plicopurpura pansa* (Gould, 1853) from Isla Socorro, Revillagigedo Archipelago, México (1997 & 2010 surveys)

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The purple dye snail or purple conch *Plicopurpura pansa*, occurs on rocky shores along the Tropical Eastern Pacific. Snails are strongly attached to wave exposed rocky substrate in the intertidal zone. When disturbed, they exude a secretion that turns to an intense purple color. This dye has been used since ancient times to color ceremonial dresses purple. In contrast with other dye-producing snails, the dye produced by *P. pansa* is easy to extract without sacrificing the snail, so one can obtain multiple milkings. Snail abundance, population structure and dye yield of *P. pansa* collected in the Socorro Island, Revillagigedo Archipelago, México, are shown. Several rocky shores on Socorro Island were sampled

during the 1997 and 2010 surveys. Data from 1997 included for each sampling site density, sexual ratio, size structure and length weight relationship. Moreover, purple conch milkings were made and dye yield are shown. Population density were estimated between 0.58 and 1.2 snails / m^2, near 1:1 male female sex ratio with slight tendency to females. From milked snails, an exponential relationship between size and dye yield was found with an average size of 49.8 mm and average dye yield of 3.59 ml/snail. In 2010, a new survey was done, determining density and size structure. In summary, the purple dye snail population looked healthier on Socorro Island, showing density values and of larger size than those found on rocky shores from Mexican continental coast.

The monitoring of chemical and physical variables affecting *Elimia albanyensis*, a pleurocerid snail endemic to the Flint River in Albany, Georgia

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Elimia albanyensis is a small, sculptured pleurocerid snail used as a bioindicator for water monitoring studies. This endemic is restricted to the Flint River in Georgia. This snail lives primarily on the rocky shoals and is only accessible during low water conditions. Much of the drainage of south Atlanta empties in the Flint River at its headwaters in the north which then flow into the Apalachicola River after merging with the Chattahoochee River where water monitoring stations record basic physical and chemical data. Eventually this water drains into the Gulf of Mexico flowing through Florida. This region has been in much controversy due to the Atlanta region's of hoarding water from the downstream inhabitants of Alabama and Florida. Three sites along the Flint River at Albany Georgia have been chosen for basic chemical and physical analysis. These data were compared with USGS monitoring stations to record the discharge and precipitation within this region. From February through May 2010, water samples were taken from these sites to monitor pH, alkalinity, acidity, and TDS. The results showed that pH values ranged from 6.3-7.58 which are relatively moderate. Total dissolved solids range from 0.002 to 0.014 grams. Alkalinity was measured from 5-11 mg/L of $CaCO_3$ and acidity values ranged from 30 to 42 mg/L of $CaCO_3$. During this time the Flint River had increased discharged rates due to excessive rainfall which produced river gauge heights of greater than 17 feet above normal. The analysis yielded that pH and alkalinity decreased with the river discharge while acidity and total dissolved solids increased with river discharge. Increased values in acidity and total dissolved solids ultimately affect the gastropod shells by pitting and eroding individuals causing eventually mortality. However these pH values ranged from 6.3 to 7.58, which are relatively moderate. This system flows over a limestone substrate that serves as a buffering system to any excessive changes in stream acidity.

Interspecific variation of odontophores in the Cypraeidae (Mollusca: Gastropoda) suggest they are taxonomically informative

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Odontophore "cartilages" or bolsters consist of a mass of chondroid tissue (Leydig cells) that support the radula and connect it to the muscles that move the radula and odontophore. Odontophores have been known for over 160 years but rarely are they mentioned or illustrated. While the radula is widely used for taxonomy, the odontophore has been neglected as taxonomically useful. During a taxonomic review of the *Cribrarula cribraria* complex (Gastropoda: Cypraeidae), museum specimens with dried tissue were digested with a lysing buffer (proteinase K and NET buffer) to obtain the radula. The experiment resulted in clean radulae, in addition to a pair of spongy structures, the odontophore cartilage. The odontophores from congeneric species showed similar texture and overall shape, but size and color varied enough to suggest that the structure might be useful for alpha taxonomy. This led to an effort to study the odontophore diversity in the cowries. To date, a total of 103 species from 31 genera (representing about 43% of species and 69% of genera, respectively) in the Cypraeidae have been studied; most have been photographed in high-resolution under the light microscope, and many also under the scanning electron microscope. There is enough variation in size, shape, color and texture within this anatomically conservative family to consider odontophores as taxonomically useful. Additionally, over 60 specimens of *C. cribraria* (including its several subspecies) have been studied, showing relatively small amounts of interspecific variation. Preliminary sampling of other mollusks suggests that the odontophore varies greatly in size, shape, texture and color, and therefore, may be taxonomically and phylogenetically informative, at least in some taxa. The odontophore is obtained with the radula without difficulty and can be easily imaged under the light microscope; therefore it should not be discarded, but rather studied as a source of additional taxonomic characters.

Gulf of Mexico: Pre-oil spill biotic baseline

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The volume and extent of the Gulf of Mexico (GoMx) oil spill, following the April 20, 2010 explosion and sinking of the Deepwater Horizon offshore rig, 40 miles off Louisiana is still unknown, but it is already larger than the Exxon Valdes spill from 1989. The environmental impacts caused by the surface oil slick, underwater oil plume, and the use of the oil dispersant Corexit, both at the surface and underwater at the 5,000 ft deep leaking well, are expected to be significant. Coastal and marsh wildlife, such as birds, marine mammals and sea turtles typically receive most of the press attention, but thousands of invertebrates in the vicinity of the oil spill are also at risk. There is also the risk of the Loop Current, Florida Current and Gulf Stream currents spreading the oil to Florida and beyond to the U.S. east coast.

The all-species inventory of the marine biodiversity of the GoMx, sponsored by the Harte Research Institute for Gulf of Mexico Studies, Texas A&M University-Corpus Christi, and published in 2009 (Felder and Camp, eds. 2009), was the result of a team of 140 taxonomic experts from 15 countries, and listed a total of 15,419 species from 40 phyla. The mollusks were the second most speciose group, with 2544 species. The extensive checklist from the book was recently turned into a database, the Biodiversity of the Gulf of Mexico (BioGoMx) database (Moretzsohn et al., 2010). Distributional data is currently available at iOBIS (www.iobis.org), but; a more data-rich database will soon be available at GulfBase (http://gulfbase.org).

The BioGoMx database will be crucial as a pre-oil spill biotic baseline for future studies of the environmental impact of the Gulf oil spill. The north-northeast octant of the GoMx, where the Deepwater Horizon well is located and where the oil spill currently exists (as of late May, 2010), has a total of 8,332 species of plants and animals ranging from the shoreline and marshes (4,974 species) to the bottom of the GoMx (913 species); the region between 1,000-3,000 m is home to some 1,718 species, the richest in its depth class in the GoMx. Because of the large volume of the oil spill and extensive underwater use of oil dispersant, the deepwater biota of the GoMx could potentially face great challenges in the near future. Also troubling is the discovery of large underwater oil plumes, whose effects on the biota are unknown.

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New records of land mollusks from southeastern Selva Lacandona, Chiapas, México *

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Records of land mollusks from Eastern Chiapas date from the mid 1800s. Bequaert reported in 1957 that 31 species had been collected by the expedition led by Raymond A. Paynter in 1954 to the northern section of Selva Lacandona. Bequaert mentioned that 41 additional species had been reported from other areas of the state of Chiapas (information gathered from literature). In 2002, Avendaño-Gil and others found 28 taxa in the southwestern corner of Selva Lacandona. Land mollusks were also collected in the southeastern corner of Selva Lacandona during collecting efforts during a freshwater molluscan project. At spare time during various trips, some trails inside the tropical rain forest were visited and shells and humus samples taken. Live mollusks were relaxed with bits of tobacco and water and subsequently preserved in 70% alcohol. Shells were soaked in a weak solution of photo floo®, briefly cleaned with a brush or in an ultrasound cleaner and thoroughly rinse after either treatment before being allowed to dry on paper towel. As identification proceeded species were separated. To date 12 families and 27 species have been recognized. The

Helicinidae appears to be the most diverse with 8 species, then the Subulinidae with four. Seven families are represented by a single species only. The current malacofauna of the region has a close relationship with the fauna of Guatemala, which supports the existence of a Chiapas-Guatemalan Subregion in Central America as proposed by Bequaert (1957).

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** [See also full length paper following abstracts. Ed.]*

Furtive catch of *Chiton articulatus* Sowerby *in* Broderip & Sowerby, 1832 (Polyplacophora) at Acapulco, Guerrero, México: A case study

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At Acapulco, Guerrero, Mexico, mollusks are in great demand in the market for local consumption, besides the tourist demand, providing an excellent source of income for local fishermen. Within that demand, the *Chiton articulatus* Sowerby *in* Broderip & Sowerby, 1832, locally known as "sea roach," is one of the basic ingredients for gastronomy of the coastal areas of the State of Guerrero. An inhabitant of the interidal fringe of rocky shores, the chiton posesses a muscular foot that holds it tightly to the substrate, preventing it from being dislodged dragged and trashed by the strong waves, such muscle is what is used for human consumption. The subject of this study focuses on the activities deployed by a furtive collector (*i.e.*, illegal fisherman) who actively seeks the "sea roach", documenting his activities and registering for the first time the amount and sizes of his daily catch and outstanding fishing activities through time. The study was carried on at Playa "Caletilla" (16° 49' 48.92" N, 99° 54' 21.59" W) from April to July 2009; making frequent and informal visits with him to gain his confidence and trust, documenting his collecting sites, catch or fishing frequency, and approximate profits amongst other data. On four occasions we were able to obtain the length (mm.) and weight (gr.) for each specimen of his catch, the same as the total shells discarded, with these data we developed descriptive statistic and frequency histograms, and with the shell's length a one way ANOVA was used to establish significant differences on the averaged length. The fisherman mentioned he is been fishing for this species during 35 years, nowadays does it at five rocky areas with intense wave action, since at places with soft or mellow waves, there are not enough organisms and time and effort to make a significant catch makes it not worth it. Regarding the weather impact, he mentioned that during the rainy season, right after a heavy rain, the sea is calm which allows him for a better search and greater sizes are obtained. His profit depends on weather, fluctuating from $4.00 to $40.00 US dollars on a productive day. The number of shells obtained on April, May, June and July 2009, totaled 1,067

specimens, with averaged length of 40.79 mm (7.39 std) with range of 17.67 to 65.64 min –max respectively. The ANOVA showed significant difference for shell sizes (F-Fisher = 11.26; P=0.0), and homogeneity for the variance (Levene's = 2.19; P = 0.08). Sheffé comparison for multiple means proved two groups, the first conformed of the smaller sizes obtained during June and July 2009 corresponding with rainy weather; and the second groups constituted by the larger specimens from the catch of April and May, the drought season, therefore biometrics being consistent with the verbal communication with the fisherman.

Opisthobranch assemblages at Alacranes coral reef, Yucatan Peninsula, Mexico: Preliminary results

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The ecology of the opisthobranch fauna from the coral reef ecosystems of the Gulf of Mexico has been scarcely studied, mainly due to the difficulty of sampling this kind of gastropods. This study constitutes a preliminary approach to the knowledge of the assemblages of sea slugs from Yucatan waters. Samples were taken in May 2008, August and December 2009 and April 2010 on different substrates (green algae, red algae, brown algae, *Thalassia* meadows, rocks, and sands) in the National Park "Parque Nacional Arrefice Alacranes". A total of 44 species, belonging to 19 families, were identified. A Multidimensional Scaling analysis based on the Bray-Curtis dissimilarity index was used to define the main opisthobranch assemblages. Results indicated that the algae (including green, red and brown algae) constituted a well defined assemblage. The *Thalassia* meadows and the rocky substrates were more related to the algae habitat, whereas the sandy substrates formed an isolated assemblage. The species characterizing the algae assemblage were mostly herbivorous, such as species from the *Elysia* (*E. crispata*, *E. tuca*, *E. subornata*, and *E. patina*) and *Aplysia* (*A. dactylomela*) genera. The *Thalassia* substrate was mainly characterized by *Phyllaplysia engeli*, the most abundant species in this assemblage. The rocky assemblage was the most diverse group, composed by 16 species with different kinds of feeding guilds (herbivorous, sponge-eaters, cnidarian-eaters, bryozoan-eaters, etc.). Finally, the sandy substrate formed an isolated assemblage due to the exclusive presence of *Aglaja negris*, as well as shells of *Bulla occidentalis* and *Atys* sp.

Opisthobranch fauna of Alacranes coral reef, Yucatan Peninsula, México

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The study of the opisthobranch mollusks is much less developed in the Atlantic coast of Mexico than in the Pacific. Specifically, no surveys aimed solely at the opisthobranch fauna have been made in the National Park "Parque Nacional Arrecife Alacranes" (PNAA), a large reef area 25 km long and 14 km wide located 140 km north of the Yucatan Peninsula, Mexico. For this study, four surveys were carried out in the PNAA using direct and indirect sampling methods (brushing, vacuum pump, and a sledge net) during May 2008, August and December 2009 and March 2010. A list of the opisthobranch fauna is presented here for the first time. A total of 44 species, included in five orders and 19 families, were identified. The most diverse order was the Nudibranchia with 15 species (*Risbecia nyalya*, *Hypselodoris ruthae*, *H. bayeri*, *Aphelodoris antillensi*, *Jorunna spazzola*, *Dendrodoris krebsii*, *Tritonia bayeri*, *T. hamnerorum*, *Scyllaea pelagica*, *Aeolidiella alba*, *Phidiana lynceus*, *Polycera* cf. *herthae*, Nudibranch sp. 1, Nudibranch sp. 2, and Nudibranch sp. 3), followed by the Sacoglossa with 14 species (*Berthelinia caribbea*, *Oxynoe* cf. *azuropunctata*, *Bosellia cf. mimetica*, *Elysia crispata*, *E. ornata*, *E. papillosa*, *E. tuca*, *E. subornata*, *E. flava*, *E. pratensis*, *E. patina*, *Costasiella ocellifera*, *Placida kingstoni*, and *Cyerce* sp.) and the Cephalaspidea with seven species (*Haminoea antillarum*, *Bulla occidentalis*, *Aglaja felis*, *Chelidonura hirundinina*, *Navanax aenigmaticus*, *Haminoea* sp., and *Atys* sp.). The Aplysiomorpha had seven species (*Aplysia parvula*, *A. dactylomela*, *A. brasiliana*, *Stylocheilus striatus*, *Dolabrifera dolabrifera*, *Petalifera petalifera*, and *Phyllaplysia engeli*). The Pleurobranchomorpha was the least diverse group with only one species (*Pleurobranchus crossei*). This study includes 41 new records for the PNAA.

Ecological and evolutionary determinants of island biogeography of land snails

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Among the major components of the natural environment are the number and type of species it contains. But what generates and determines species diversity? One place where researchers have looked for clues is on insular systems: islands are discrete, internally quantifiable, numerous, and varied entities, and so provide us with natural laboratories for developing theories and models to understand the different processes that are involved in generating and maintaining their biodiversity.

The equilibrium theory of island biogeography as originally proposed by R. MacArthur and E.O. Wilson[1,2] (1963, 1967) relied on the ecological processes of colonization and extinction to determine the species diversity of islands. The theory predicted that island diversity would increase with island area because of a lower rate of extinction, and decrease with island insularity because of the lower rate of colonization. The model also assumed that islands would reach species diversity equilibrium relatively quickly after their formation. Although they were well aware of the potential contribution of speciation within island to species diversity, MacArthur and Wilson's equilibrial model was purely ecological and did not incorporate the evolutionary process of diversification. This might seem surprising given that the most well known examples of adaptive radiation, the diversification of a single ancestral species into descendant species occupying a wide variety of ecological niches, are found on island systems. In this evolutionary perspective, island diversity is predicted to increase with island area because of an elevated rate of speciation; in addition, a decreased rate of colonization due to insularity might promote within-island diversification due to decreased competition and ecological opportunity. Island age is expected to positively influence the evolutionary accumulation of species since speciation is a relatively slow process.

Recently, it has become possible to quantify the relative contribution of between-island colonization and within-island speciation to species diversity with the use of molecular phylogenies[3] (Losos and Schluter, 2000). By providing an estimate of the historical relationship among species, phylogenies can be used in combination with information on species' geographical distributions to infer the geographical zone of origin of species. In insular contexts, this means that total island species diversity can be divided into two components of diversity: species resulting from the evolutionary process of within-island speciation and species resulting from the ecological process of between-island colonization. By partitioning species diversity into these two components, it becomes possible to separately evaluate the importance of biogeographical factors (such as island insularity, area, habitat heterogeneity, and age) on within-island speciation and between-island colonization. This is a novel, conceptually simple approach to a very old and general problem about how environmental variation (here, species richness) arises.

A medium-scale study of Galápagos Archipelago land snails pertaining to the genus *Bulimulus* has provided evidence that species richness resulting from between-island colonization is mainly driven by island area and insularity, whereas species richness resulting from within-island speciation is mainly determined by habitat heterogeneity[4,5] (Parent and Crespi, 2006; Losos and Parent, 2009). In the present study I extend the results of this study to all land snail insular lineages for which molecular phylogenies could be obtained to test specific hypotheses related to the role of within-island speciation and between-island colonization in determining species diversification in land snail island communities. This approach can inform us of the ecological and evolutionary processes involved in the formation of species at the community level, as well as the relative importance that various biogeographical and ecological factors have on these processes.

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Identity confirmation of the turbellarian *Urastoma cyprinae* parasite of the Mediterranean mussel *Mytilus galloprovincialis* by molecular genetics

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The Mediterranean mussel *Mytilus galloprovincialis* was introduced from Europe to the southern part of the Northwest coast of North America at the beginning of the 20th Century. Nowadays, there is a well established wild population in protected bays of Baja California and its culture is a growing economic activity. Among its parasites, the turbellarian worm *Urastoma cyprinae* has been identified by traditional taxonomy, which considered the description of the reproductive system as a specific character for differentiation among species within the genus. The development of molecular genetics using amplification of specific sequences of the genome from one species, allows us a complementary and powerful tool for confirmation of species identification. This work presents the results of the identification of *U. cyprinae*, using the amplification of the 18SrDNA gene with the primers A3/A4 and B7/B9.

Evaluating competition between the invasive slug *Arion subfuscus* (Draparnaud) and the native slug *Philomycus carolinianus* (Bosc)

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The degree to which invasive species have altered the demography, ranges, and microhabitat occupation of native species is poorly known. Yet, the competition-mediated decline of native populations, in concert with other factors such as habitat degradation, can place native species at risk of extirpation. Understanding whether competition between native and invasive species can take place under ordinary environmental conditions can allow us to extrapolate whether native species are likely to have experienced harm in the past and/or if they are likely to do so in the future. The native slug *Philomycus carolinianus* is likely to compete for resources with the aggressive invasive slug *Arion subfuscus* in central Maryland forests. In order to establish whether competition occurs between these two species, I tested for the following criteria: the existence of competitive displacement in the field, overlap in the use of limited resources (shelter and food), a decline in the fitness of *P. carolinianus* in the presence of *A. subfuscus*, and the action of competition mechanisms (interference and exploitation) between them. Field surveys showed that displacement between *A. subfuscus* and *P. carolinianus* does not apparently occur within mixed natural populations. Resource use of the two slugs overlapped, with part of the diet (*i.e.*, fungus) and a large proportion of the microhabitats occupied (*i.e.*, coarse woody debris) in common. A lab experiment established that low natural levels of food (fungus) can limit the fitness of each slug species, whereas shelter (coarse woody debris) was not limiting. When sharing a low-resource lab cage with either *A. subfuscus* or conspecifics, *P. carolinianus* experienced a similar decline in fitness, suggesting that exploitative resource competition was no greater between heterospecifics than between conspecifics. No evidence of heterospecific interference (competition independent of resource levels) was found. Given the limited support for the criteria of competition, *A. subfuscus* was not shown to be an immediate threat to the persistence of *P. carolinianus*.

Carnivore bites the dust: Land snail *Ancotrema hybridum* is *A. sportella*

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Obsolescence of radial sculpture on the last whorl of the carnivorous land snail *Ancotrema hybridum* (Ancey, 1888) has been used to separate it from *A. sportella* (Gould, 1846). However, species identification of some shells is difficult to determine, leading to the question whether they are really separate species. Factor analysis of shell characters of 272 specimens of *Ancotrema* Baker, 1931, including characters of size, rib density, and strength of surface sculpture, revealed continuous variation of these characters without bimodality. Radial sculpture weakened about whorl 5 on all specimens, so shells that stopped growing at whorl 5 have *A. sportella*-like morphology, whereas those that continued growing after whorl 5 have *A. hybridum*-like morphology. The change in sculpture at whorl 5, lack of bimodality of shell characters, and lack of anatomical differences lead us to conclude that the two forms are a single species. *Ancotrema hybridum* would be a junior synonym of *A. sportella*.

A bernayine cowrie species radiation from the Plio-Pleistocene Everglades pseudoatoll

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Of the four subfamilies of Cypraeidae found in the fossil record of the Everglades region of Florida (Cypraeinae, Luriinae, Erosariinae, and Bernayinae), the subfamily Bernayinae evolved the largest number of taxa and formed the largest single cowrie species radiation ever found in the Americas. In the Pliocene and early Pleistocene, this radiation was centered in the Everglades Pseudoatoll of southern Florida, the most extensive coral reef structure of the Neogene western Atlantic. During the Pliocene and early Pleistocene, 97 species of bernayine cowries, comprising 6 genera and 12 subgenera, evolved in the carbonate and estuarine environments contained within the pseudoatoll. These included the genus *Akleistostoma* Gardner, 1948 (with three unnamed subgenera), the genus *Siphocypraea* Heilprin, 1886 (with three unnamed subgenera), the genus

Pahayokea Petuch, 2004 (with two unnamed subgenera), the genus *Calusacypraea* Petuch, 1996 (with the subgenus *Myakkacypraea* Petuch, 2004), the genus *Okeechobea* Petuch, 2004 (with one unnamed subgenus), and the genus *Pseudadusta* Petuch, 2004 (with two unnamed subgenera). The members of the genera and subgenera are differentiated by shell morphology, including structure and form of the apical sulcus, shape and width of the aperture, degree of shell inflation, the development of the auricles, and the structure of the apertural dentition. These morphological differences reflect the ecological preferences of the species groups, with each higher taxon being restricted to one of the diverse neritic environments present within the Everglades Pseudoatoll. The neotenic genera *Okeechobea* and *Calusacypraea* evolved in the intertidal mudflat areas within coastal mangrove environments, with *Okeechobea* being found primarily in the mangrove jungles of the Kissimmee Embayment and with *Calusacypraea* being confined to the extensive mangrove estuaries of the Myakka Lagoon System. The genus *Pseudadusta* preferred coralline environments and was most abundant on the zonated reefs and coral bioherms of the Immokalee and Miami Reef Tracts. The genera *Akleistostoma*, *Siphocypraea*, and *Pahayokea* preferred Turtle Grass (*Thalassia*) environments and occurred in large aggregations on the shallow Hendry Platform and within the sea grass beds of the Kissimmee Embayment.

Unique middle Miocene limestone deposits assigned to the "Topanga" Formation in southern Orange County, California: Its molluscan fauna and geology

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A molluscan fauna of 76 taxa (35 bivalves, 41 gastropods) occurs with a few representatives of the phyla Rhodophyta, Porifera, Bryozoa, Brachiopoda, Annelida, Arthropoda, Echinodermata, and Chordata in limestone lenses from the Saddleback Valley of southern Orange County. Characteristic fossils of these deposits include the bivalve *Lyropecten crassicardo*, the gastropod *Turritella ocoyana*, and the echinoid *Vaquerosella merriami*. These deposits also contain middle Miocene "Temblor" California provincial molluscan stage index fossils, including the bivalve *Pacipecten andersoni*, and the gastropods *Cancellaria dilliana*, *Conus hayesi*, *Megasurcula keepi*, and *Priscofusus geniculus*. A significant number of southern ranging genera are present, including the bivalves *Arca, Anadara*, and *Spondylus*, the gastropods *Forreria*, *Hexaplex*, and *Strombus*, and the echinoderm *Eucidaris.* Modern representatives of these genera indicate tropical water temperatures. Depth ranges of genera and extant species from these deposits co-occur on the continental shelf, indicating water depths likely less than 100 m. New taxa include two bivalves, in the genera *Limularia* and *Trachycardium*, and three gastropods, in the genera *Diodora, Cypraea*, and *Turritella.* Of special interest is an incomplete steinkern questionably assigned to the genus *Busycotypus*, a western Atlantic genus.

The fossiliferous limestone occurs as scattered channelized deposits in a section over 300 m thick. Fine- to coarse-grained, friable, brown sandstone referred to the "Topanga" Formation surrounds these limestones and conformably interfingers with the upper San Onofre Breccia and unconformably with the overlying "Monterey" Formation. These limestones have been referred to as the basal unit of the "Monterey" Formation, but their stratigraphic placement and terriginous composition argues against this assignment. Significant intertidal to subtidal deposits of the "Topanga" Formation are exposed to the east against the Santa Ana Mountains and to the west into the San Joaquin Hills. These rocks correlate with the "Topanga" Formation and accompanying limestone channels of the Saddleback Valley. Of historical note is that these limestones were quarried as a source for stone and cement used to build Mission San Juan Capistrano in the late 1790's. Mission records chronicled the recovery of limestone by Native Americans; fossils remain are still visible today in the mission walls.

Elevated temperatures have a minimal effect on growth in *Nucella lamellosa*

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Nucella, a wide-ranging genus of intertidal gastropods, is ideal for exploring how species will respond to global climate change because it spans different bioregions characterized by different temperatures. In this study, I examined how the growth rates of the cold water species, *N. lamellosa* (from Friday Harbor, Washington) change when submerged in warmer temperatures typical of summers in Point Conception, California, a markedly different bioregion where sister species *N. emarginata* and *N. canaliculata* live. Because a slight increase in water temperature has already been demonstrated to lead to faster growth (Yamane & Gilman, 2009) and because the organic matrix of shells is easier to grow in warmer waters (Palmer, 1983), I hypothesized that growth rates would increase. To test this hypothesis, *N. lamellosa* individuals were each maintained in separate mesocosms with running seawater and fed barnacles (*Balanus glandula*) *ad libitum* for 24 days. Ten individuals were maintained at 19° C, and another 20 individuals were maintained at 13° C. The change in tissue weight, shell weight, height and the total degrees of new growth were measured at the end of the experiment. Although all individuals grew substantially during the course of the experiment (up to 215° of marginal growth), average growth between the treatments did not differ (t-test, $P > 0.12$ in all comparisons). However, the high temperature treatment exhibited a larger variance in growth rates of shells (F-test, $P \leq 0.01$ in all cases) but not soft tissue (F-test, $P = 0.15$). These unexpected results suggest that shell growth rates increase when temperature is raised until *Nucella* experiences a threshold temperature that is so stressful, that the benefit is compromised, and growth rates slow again. The fact that individuals varied so much in their response to elevated temperature is consistent with the hypothesis that tolerance to thermal stress in *Nucella* is genetic and subject to local adaptation (Kuo & Sanford, 2009). The variation in the reaction to higher temperatures could allow for rapid selection of the individuals with higher temperature tolerance in the face of global climate change.

Phylogenetic relationships among *Ostrea* species in the Gulf of California

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The Olympia oyster, *Ostrea lurida*, is the only native oyster to the west coast of the United States and has been the focus of current restoration efforts. *Ostrea lurida* was previously synonymized with its southern congener, *O. conchaphila*, calling into question the long-standing use of *O. lurida* for the Olympia oyster. Our lab had previously refuted this synonymy based on DNA sequence comparison, thus reviving *O. lurida* as a distinct species, but large portions of each species' respective range on either side of the Baja California Peninsula remained unsampled. Our lab's previous study also found weak support for a sister species grouping between these species, except that other recognized species of *Ostrea*, including some reported from the Gulf of California, remained unsampled. In order to further resolve relationships within the family Ostreidae, 11 sites in the Gulf of California were surveyed for a variety of oyster species. A standard portion of the mitochondrial 16S rDNA gene was sequenced for each individual because this gene marker had already proven useful at distinguishing species. Preliminary results have corroborated *O. lurida* as distinct from *O. conchaphila*, and these have remained weakly supported as sister species. However, another species currently known as *Myrakeena angelica* is surprisingly closely related. Its close phylogenetic affinity calls into question the recognition of a separate genus for this monotypic species. We also found a fourth and possibly undescribed *Ostrea* species that is still under investigation. We also sequenced many specimens of *Saccostrea palmula* from all of our study sites. This species had very little genetic variation but was found to exhibit a much greater range of shell morphology than has previously been reported. It is possible that some of the nominal oyster species actually refer to this variable species. We also sequenced several species of *Crassostrea*, including species that have been introduced in oyster farms. In order to refine these current results, we are exploring additional genetic markers including available microsatellites designed for *O. lurida* and a portion of the mitochondrial CO3 gene. We are also undertaking morphological comparisons to search for diagnostic features for each oyster species.

Polyplacophora community in the rocky middle-intertidal zone at Acapulco, Guerrero, México

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Polyplacophora is a group of marine mollusks that inhabits the rocky shores. They have nocturnal activity and some are better represented at rocky intertidal middle zone. There are very scarce works on the Mexican littoral of the Pacific such as Reyes Gómez (1999, 2004), and Reyes Gómez and Salcedo Vargas (2002) updating the chiton listed species for this area. Meanwhile, Kaas and Van Belle (1985, 1994), López Uriarte *et al.* (2007); Flores Campaña *et al.* (2007), and Ortiz Arellano *et al.* (2009) mentioned Chiton species within the malacology diversity they reported. In particular for the State of Guerrero there are reports as those of Flores Rodríguez (2004), Flores Garza *et al.* (2007) and in particular at Acapulco by Villalpando (1986), García-López (1994), Flores Rodríguez *et al.* (2003), and Valdés González *et al.* (2004). This work represents a community diversity analysis of Polyplacophora, dealing with species richness, diversity, dominancy and basic aspects of the community structure. It was carried out in the rocky middle-intertidal zone of the Municipality of Acapulco beaches such as Playas Majahua (16° 50' 58.27'' N, 99°54'01.85'' W), Tlacopanocha (16° 50'40.8''N, 99°54' 25'' W, and Parque de la Reina 16°50'40.8''N y 99°54'25'' W). Sampling took place during April and May 2009, the methodology consisted of the quadrant – transect with an area of 10 m^2, the sampling unit was of one meter by side, and starting point at random. Polyplacophorans were identified in place and collected only the ones that required further analysis. Species richness was considered as the number of species present and density as number of Polyplacophora / m^2, taking note on the length of all the specimens within the quadrant. Dominant species for the community was considered only the species been present in at least 1 specimen / m^2. Diversity was obtained by the Shannon-Weinner (H') Index. Thirteen species of Polyplacophora were identified, belonging to five families and nine genera. Four species for the State and seven in Acapulco were considered as new records. The best represented family was Ischnochitonidae followed by Chitonidae. The density was of 30.91 Polyplacophora / m^2. *Chiton articulatus* (Sowerby 1832) and *Tonicia forbesii* (Carpenter, 1857) are the species with larger averaged size, and *Chaetopleura hanselmani* (Ferreira, 1982) and *Lepidochitona beanii* Carpenter, 1857, showed the smaller averaged size. Four were considered as the dominant community species, with Shannon-Weinner (H') = 1.432 bit/individual. Acapulco's rocky intertidal middle zone richness outcomes all reported data for the Mexican Pacific. Because of the presence of *Chiton* species previously reported on greater depth we suppose that depth is not as a determinant factor, and that type of substrate, substrate stability and wave intensity could be a more influencing factors on Polyplacophora species distribution.

The high species richness found is believed to be the result of the origin, structure and complexity of the beach, mainly aggregate substrate, with subtle tide waves of minimal abrasion, for those we suggest as the reason for this greater species richness, combined altogether with the sampling methodology used, for we meticulously searched the area.

Case studies in the confounding factors involved in appropriate shell specimen identifications from cultural middens: Recommendations for future amelioration of such problems

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Shell identification to taxon and species level at archaeological excavations is often confounded by many variables, including such factors as the 'trampling effect', bioturbation and its' impact on the extent of intact specimens, dessication, discoloration and other issues. As modern site investigations now often include screening for shell remains with mesh sizes as small as 1/16 inch, the recovered remain are often fragmentary (to the 1 to 2 cm in length). Two case studies with specific shell samples, which were in question, are offered from contemporary excavation sites to illustrate this problem. Cases cited explore the difficulty in appropriate identification of various chiton species from a late Holocene midden in Baja California, as well as the ongoing identifications of oyster species from the early Holocene sites on the west coast of Isla Cedros, Baja California.

The importance of correct identification is obvious to those who are specialists in malacology, but the impact for archaeological inference is often overlooked. In the case of certain misidentifications, the implications of human manipulation of both species and local marine environment may result in erroneous extrapolations regarding human environmental manipulations. The suggestions offered in this presentation include the continued support for interdisciplinary teamwork between malacologists and archaeologists; in specific terms, it is suggested that consultation with malacologists should be routine prior to final publication of data from site analyses. The examples discuss consultation of the staff at LACMNH as well as Douglas Eernissee on two problems encountered in Baja California midden analyses.

Further implications of these confirmations will be offered, as the faunal analysis often provides crucial evidence for seasonality as well as the types of procurement patterns that are inferred by archaeologists for all periods of the Holocene, and occasionally for the terminal Pleistocene.

The role of particle surface properties on selection by the Eastern Oyster *Crassostrea virginica* and the Blue Mussel *Mytilus edulis*

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Suspension-feeding bivalves are integral components of benthic ecosystems, playing a vital role in seston composition and nutrient cycling. Bivalves are known to be capable of ingesting particles preferentially based upon nutritive value; however, little is known about the mechanisms upon which bivalves rely to differentiate between particles. The surface properties of particles have been proposed as a factor that mediates the selection process.

In this study we examined the effects of particle surface properties upon selection by suspension-feeding bivalves. Specifically, we quantified surface charge (zeta potential) and wettability (contact angles) of various 10-µm microspheres. These microspheres were then delivered to the eastern oyster (*Crassostrea virginica*, pseudolamellibranch) and blue mussel (*Mytilus edulis*, filibranch), which possess different gill architectures. Mussels and oysters were allowed to feed on pairs of microspheres with different surface characteristics and all biodeposits were collected. The proportions of particles rejected as pseudofeces and egested as feces were determined by flow cytometry.

Preliminary results suggest that when given a choice, both mussels and oysters preferentially select the non-wettable micropsheres with a reduced surface charge over the wettable microspheres. When fed two different particles with similar surface properties, no selection occurred. The fact that both bivalve species, whose gill architecture and particle selection process are known to be different, have thus far shown the same pattern of selectivity suggest a generalized mechanism of selection. More assays are currently being carried out to determine whether wettability or surface charge, under certain circumstances, plays a more central role in particle selection by these two bivalves.

Phylogenetic analysis of Jamaican Annulariidae (Mollusca: Gastropoda)

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Jamaica has about 65 described species of land snails in the family Annulariidae, all of which are endemic. They are currently classified in 12 genera/subgenera and three subfamilies. A preliminary DNA based phylogeny was obtained for 66 Jamaican OTUs and 25 annulariid species from elsewhere in the Caribbean Basin and Florida; four species of Pomatiasidae served as outgroups. The monophyly of the Jamaican genera/subgenera was supported, except for *Parachondrella*, which had species mixed with *Parachondria*; *Tudorops*, which may be paraphyletic to *Tudorisca*; and *Jamaicia* for which no material was available. None of the subfamilial compositions from prior classifications are supported. Subfamilial distinctions have been based largely on opercular characters, but these appear to be convergent. Jamaican diversity can be explained by one or two colonization events with subsequent radiation. One of these radiations has given rise to species in Mexico and the Cayman Islands. Several putatively undescribed Jamaican species were discovered in the process of selecting material for DNA extraction, and their status was supported by COI sequences. The phylogeny also supports the elevation of several named subspecies and varieties to full species.

Anomalous by nature: A fresh look at Anomalodesmatan systematics

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Anomalodesmatans comprise an ancient and ecologically diverse group of marine bivalves, but are nonetheless inconspicuous in most extant shallow water communities. For various reasons, which include their present scarcity and a bewildering array of disparate morphologies, representatives of the group have always proved difficult to interpret, and their systematics lagged behind those of most other major bivalve taxa. In recent years, morphological and molecular studies of the Anomalodesmata have produced incongruent results, casting doubts over the monophyletic status of component superfamilies and precluding the recognition of putative synapomorphies for clades recovered in molecular investigations (Harper *et al.*, 2000, 2006).

In the present survey, cladistic analysis of a novel matrix of morphological characters, the largest compiled for anomalodesmatans to date, suggests that enhanced taxonomic sampling and more rigorous character analyses and delimitation are paramount in solving conflicts among the distinct datasets. Among traditionally recognized superfamilies, Pholadomyoidea, Clavagelloidea and Septibranchia were found to be monophyletic groups. Taxa commonly referred to Pandoroidea and Thracioidea were recovered as part of two new clades, which are also supported by recent molecular studies. A sister group relationship between Parilimyidae and the septibranch families, commonly advocated in authoritative treatments of the Anomalodesmata (*e.g.*, Poutiers and Bernard, 1995), was rejected by the present analysis. Interpreted in the light of the fossil record, reconstructed phylogenetic relationships favour the iterative evolution of shallow infaunal and epifaunal anomalodesmatans from deep-burrowing ancestors. These results challenge previously advanced patterns for the history of the clade, namely ventral migration of the ligament and irreversible radiations into a deep infaunal mode of life (Runnegar, 1974).

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The curious posture of the Cretaceous aporrhaid gastropod *Tessarolax*

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The genus *Tessarolax* was described by Gabb in 1868 based on a specimen of Late Cretaceous age from the Chico Formation at Tuscan Springs (a long defunct spa) on Little Salt Creek, Tehama Co., California. Gabb's specimen was incomplete and workers studying aporrhaids have commonly misunderstood its shape and orientation to the substrate. Occurrences of *Tessarolax* are uncommon, but the northwest Pacific Slope Cretaceous deposits have yielded a sequence of *Tessarolax* species ranging in age from Early Cretaceous (Hauterivian age, about 133 MA) to Late Cretaceous (early Maastrichtian age, approx. 68 MA). Hauterivian *Tessarolax* had callus deposits mainly near the aperture. Successive species of *Tessarolax* added more callus to the exterior of mature specimens, until by Campanian time shells were totally incased.

Juvenile *Tessarolax* were wingless and without digitations; they probably burrowed in the substrate as do similarly wingless juveniles of modern *Aporrhais* and *Arrhoges*. Maturing *Tessarolax* reshaped their rather plain turriculate juvenile shape by adding digitations and callus deposits. Adult *Tessarolax* had four, long digitations and rather than sit upon the substrate, they perched above it, with only four shell areas touching the substrate. These are 1) the callus knob at the bend of the anterior labral digitation, 2) the callus extension on the left side of the shell, 3) the apical callus, and 4) the distal end of the posterior lip digitation. These areas of contact commonly show scuff marks. The complex shape of adult *Tessarolax* suggests that it would not have burrowed, but lived, below wave base, upon the ocean floor.

Coating of the shell including digitation exteriors required expansion of the mantle out over these surfaces. The layered aspect of the callus suggests multiple expansions of the mantle. An overall-umbrella-style expansion would have deployed a lot of mantle, as do mature cypraeids that need to expand their mantle over the shell to feed effectively, and can be pestered to death by fish if they are unable to spend enough time with the mantle deployed. We suggest that *Tessarolax*'s mantle may have been "digitated" with fingers of mantle extending along the digitation grooves and capable of wrapping around each long digitation to deposit callus all over it. As are other aporrhaids, *Tessarolax* were probably herbivores or detritivores and gathered food in rather than pursuing it.

Specimens have been most commonly collected from fine-grained rock such as siltstone. Their occurrences suggest a life offshore, perhaps on soft to firm bottoms. Additionally, with respect to substrate, *Tessarolax* is found in British terrigenous sediments such as the Gault of Early Cretaceous age, but is not associated with chalk facies strata.

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Fight or flight: *Lottia gigantea* agonistic encounters

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Territoriality, defined as an animal or group of animals defending an exclusive area, is thought to have evolved as a means to acquire limited resources such as food, nest sites or mates. Most studies of territoriality have focused on vertebrates, which have large territories and even larger home ranges. While there are many models used to examine territories and territorial interactions, testing of these models is limited by the logistics of working with the typical model organisms and their large territories. With a small territory and slow movements, the interactions of *Lottia gigantea*, the owl limpet, can be easily monitored. *Lottia gigantea* is thought to be territorial in order to protect food resources. When exposed to an area with an ample food resource, *L. gigantea* will prudently graze the area, returning to graze the same spot every 3 to 4 days. Based on a model by Stamps and Krishnan (1999), this study tested if an individual would return to an area where it experienced agonistic losses and whether *L. gigantea* has learned behavior. Stamps and Krishnan assume an individual will avoid an area where it has had agonistic encounters if there is suitable, novel space available for territory expansion. Eleven *L. gigantea* were placed in individual corrals and their behavior was followed for 7 weeks with time-lapse photography. Individuals were placed in arenas larger than a territory (territories are correlated with limpet size) and were inhibited from interacting with one another by wooden barricades. To examine home range formation, time-lapse photography was used to track the 11 *L. gigantea* in the lab on a mock intertidal setup for three weeks after which individuals were subjected to agonistic losses, *i.e.*, 'training,' on randomly selected tiles for two weeks. Their movements were scored to examine the probability of return based on their experience. Individuals were photographed for three more weeks to determine their final home ranges. Individuals moved their home scars, but not necessarily away from the agonistic loss tiles. Visits to the agonistic loss tiles were reduced, both during the 'training' and after, but home range size varied when the size was compared among the before, during and after 'training' periods, depending on the individual.

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Stamps, J. A., and Krishnan, V. V. 1999. A learning-based model of territory establishment. The Quarterly Review of Biology, 74: 291-318.

Groups of northeast Pacific Cretaceous gastropods and bivalves

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In his global analysis of Cretaceous shallow-marine gastropod genera, Sohl (1987) subdivided them into three groups (1-3), each characterized by its time of origin, percentage of gastropod orders, and, to a lesser degree, paleoclimate realm. He did not provide, however, any details about the northeast Pacific area. Based predominantly on our own publications, we recognize these groups, as well as a new group (4), as being present in both gastropod and bivalve faunas in NE Pacific Cretaceous strata. Most of the taxa were derived from the Old World Tethys Ocean region. In the NE Pacific area, they are all found in shelfal siliciclastic sand-and-mud deposits.

Group 1 members all have their origins in the Triassic or Jurassic, were important in the Early Cretaceous, and became extinct by the end of the Cretaceous. There are no neogastropods. Examples in the NE Pacific are the gastropods *Aphanoptyxis*, *Nerinella*, *Paosia*, and *Tylostoma* and the bivalve *Cercomya*. Group 1 taxa, most of which have strong morphologic affinities to their Tethyan relatives, lived in warm waters.

Group 2 members originated in the Early Cretaceous, were most diverse in the middle Cretaceous, and became extinct in the Late Cretaceous. Examples in the NE Pacific are the gastropods *Nerita* (*Amphinerita*), *Sogdianella*, *Tessarolax*, *Trochactaeon* s.s., and *Trochactaeon* (*Neocylindrites*) and the bivalves *Icanotia* and *Opis* s.s. Group 2 taxa mostly lived in warm waters, but *Tessarolax* lived in cooler (more offshore) waters.

Group 3 members originated in the Late Cretaceous, with a few members ranging into the Paleocene or Eocene. Most of its members are neogastropods. Examples in the NE Pacific are the gastropods *Alamirifica*, *Atira*, *Deussenia*, *Fimbrivascum*, *Lysis*, *Otostoma*, *Pentzia*, *Plectocion*, *Vernedia*, and *Volutoderma* and the bivalves *Meekia*, *Opis* (*Hesperopis*), and *Pterotrigonia*. Representative genera that ranged younger than the Cretaceous are the gastropods *Gyrodes* s.s., and *Otostoma* and the bivalves *Calva* and *Glycymerita*. Group 3 taxa mainly lived in warm-temperate waters. Some (*e.g.*, *Pentzia*, *Plectocion*) were endemic to the NE Pacific.

Group 4 (newly recognized) members originated in the Jurassic or Early Cretaceous and range to the Recent. Examples in the NE Pacific are the gastropods *Cidarina*, *Tegula*, and *Turritella* and the bivalves *Acila* (*Truncacila*), *Carycorbula*, *Glycymeris* s.s., *Limopsis*, *Plicatula*, and *Pteria*. Group 4 taxa originally mostly lived in warm waters, but after these conditions diminished near the end of the Eocene, some species adapted to cool/cold waters or, as in the case of *Turritella*, migrated southward toward warm waters.

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Sohl, N. F. 1987. Cretaceous gastropods: Contrasts between Tethys and the temperate provinces. Journal of Paleontology 61(6): 1085-1111, figs. 1-11.

Gastropod and bivalve community diversity in the rocky middle-intertidal zone of Acapulco, Guerrero, México

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Intertidal rocky shores represent one of the most highly diversified habitats of the marine environment. The substrate is secure and stable for the many different organisms to be settled in. The state of knowledge or understanding of the marine fauna is scarce for the Guerrero State. Although some reports exist on it, mainly mollusks, those studies are not adequate. The subject of this work was to determine the species richness of gastropods and bivalves, determine their community structure at the class, family and generic level; estimate their density, dominant species and diversity index. This work was carried out at the rocky intertidal middle zone of Majahua (16°50'58.27'' N, 99°54'01.85'' W), Tlacopanocha (16°50'40.8'' N, 99°54'25'' W), and Parque de la Reina (16°50'40.8'' N, 99°54'25'' W) at Acapulco, during April and May 2009. Employing the methodology of quadrant-transect with an area of 10 m^2 with a sampling unit of one meter square and starting point at random. Mollusks found within were quantified, collecting only what was needed to ensure its identification. Richness was established as the number of species present, density was set as specimens by squared meter, dominant species of the community was established by the criteria of at least one specimen by sampling unit of one m^2, and the Shannon-Weinner (H') Diversity Index was used. With eightytwo species total, 69 were gastropods within 21 families and 42 genera, and 13 bivalves species, corresponding to 7 families and 10 genera. Twentyfour gastropods and three bivalve species are newly reported for the State of Guerrero, same as 35 gastropods and three bivalves are new for Acapulco, best represented families were Columbellidae, Muricidae, Clyptraeidae y Fissurellidae; and for Bivalves Chamidae and Mytilidae; With a density of 84.23 specimens by m^2, (78.18 gastropods and 6.05 bivalves. Twenty dominant species (eighteen and two, respectively) for the community and with a Diversity Index of H'= 4.803 bits/ind. Columbellidae is the best represented family within Acapulco. Likewise, Acapulco proved to have the highest species richness reported up to now for the mesolittoral middle zone of rocky shores of the State of Guerrero, coinciding with previous works on it that gastropods have the greater dominant species number and best represented by families.

Diversity of soft bottom molluscs from Isla Santa Catalina, Gulf of California

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The Gulf of California Program of the World Wildlife Fund-Mexico has assigned a high level of conservation priority (80%) to Isla Santa Catalina because of anthropogenic threats. This situation makes it necessary to create an inventory and ecological assessment that would ensure that future actions taken for the island will be positive actions in the management of its coastal zone. Thus we studied the composition and structure of the soft-bottom mollusc community of the island as an index of environmental quality. We selected 16 sampling sites on five pocket beaches, where we collected 32 sediment samples by scuba diving. We used temperature, chlorophyll a (Sea WIFS), and grain size sediment as environmental indicators. We analyzed the abundance and diversity of the benthic malacological community as ecologic descriptors.

We found 65 mollusk species, 33 taxa of Bivalvia class and 32 Gastropoda. The most common family in the zone was Siphonariidae; the most abundant species was *Siphonaria maura* (22% of abundance), followed by *Crepidula aculeata* (9%). The bivalve *Septifer zeteki* was the most widely distributed species on the sampling sites. The greatest specific richness was found in shallow bottoms of coarse sands between depths of 2 to 30 m. The average values of the diversity index obtained for the zone (2bits/indv) were lower compared with other sites from different latitudes of the eastern coast of the Gulf of California.

Biogeography of northwest Pacific sacoglossan opisthobranchs

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Spanning a range from 22° to 50°N latitude, Japanese shores support ca. one third of all sacoglossan species recorded worldwide and occur in three to four biogeographic regions. Eight of the nine currently recognized sacoglossan families are represented and ca. 80% of the genera. Japanese shores have >120 species of sacoglossans; ca. 75% of these are recorded from subtropical Okinawa in the Ryukyu Archipelago. Additional records from Hong Kong, Singapore, and Guam increase the estimates to >150 sacoglossan species on NW Pacific shores. In contrast, the NE Pacific coastline has ca. 35 recorded sacoglossan species from Alaska to Peru. NW Pacific diversification has occurred within temperate, subtropical, and tropical biogeographic regions; the boreal region (*e.g.*, northern Hokkaido and the Kuril Islands) has been insufficiently surveyed to evaluate. The temperate shores of Honshu have been investigated in more detail; the Noto Peninsula (Japan Sea) and Cape Inubo (Pacific Ocean) of Honshu are important faunal biogeographic breaks. The region from the southern end of Kyushu to the southern Yaeyama Islands is considered subtropical with extraordinary sacoglossan species diversity. The vast majority of Japanese sacoglossans, irrespective of whether endemic or broadly distributed, have planktotrophic larvae with potentially long-distance dispersal. Yet, few sacoglossan species occur on both NW and NE Pacific shores: *Hermaea vancouverensis*, *Alderia modesta*, *"Placida dendritica"*, *Placida cremoniana*, *Lobiger souverbii*, and *Elysia pusilla*. "*Placida dendritica*" is a complex of sibling species; NE and NW Pacific taxa are distinct. Furthermore, *P. cremoniana* and *L. souverbii* have not been examined in sufficient detail to confirm their status as broadly distributed individual species. The sacoglossan fauna of NW Pacific shores shows little similarity to those of Atlantic shores but considerable affinity to those of Indo-Pacific shores (30-40%). Regional comparisons among six Asian localities (Russia, Japan, South Korea, Hong Kong, Singapore, and Guam), using Jaccard's similarity index, indicate that Japan is most similar to Guam and secondarily to South Korea; classification analyses show different patterns. Finally, Japanese sacoglossan diversification has occurred within most genera and families as well within most ecological feeding guilds.

Observations on the biology of *Neosimnia barbarensis* and predator-pray interaction with the sea pen host, *Acanthoptilum* sp.

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Biological information on the deep water ovulid *Neosimnia barbarensis* (Dall, 1892) had been lacking. Numerous species of gorgonians, sea pens and other colonial cnidarians occur in Mission Bay, California, but only the sea pen *Acanthoptilum* sp. was found to be a host of *N. barbarensis*. The shells of female *N. barbarensis* averaged 35.9 mm in length (STD 2.1 mm) while males averaged 31.3 mm (STD 1.1 mm). Snails live on the richis portion of the sea pen and feed on the polyps. Females deposit many dozens of globular egg capsules in a mass around the upper portion of the richis. With approximately 1600 eggs/capsule, a typical egg cluster may contain well over 100,000 eggs. The planktonic larvae develop a shell and begin emerging from the capsules after 21 to 42 days. Females both tended and cleaned the egg capsules but adults always abandoned the sea pen after 4 to 9 days, which would seemingly increase the probability of survival for both the sea pen and attached eggs.

Acanthoptilum sp. sea pens successfully escape 90% or greater of those snails that come in contact with the sea pen's peduncle. The sea pen releases its foot from the sand and drifts away with the current. The pen's flight response is triggered between 13 and 115 seconds after the snail makes contact. Sea pens do not demonstrate a flight response if the snail reached the pen at the level of the shift or polyps. Sea pens may be at greatest risk of a successful attack during slack tide. Photographs and video documentation of this predator–pray interaction and additional experiments were conducted to identify the means by which sea pens recognize the *Neosimnia*. For additional life history and snail-pen interaction, see Tuskes and Kelly (2008).

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Tuskes, P. R., and Kelley, J. A. 2008. Observations and biology of *Neosimnia barbarensis* and its sea pen host in Mission Bay, San Diego, California. The Festivus, 40(10): 117-120, 6 figs.

Cerithium maculosum and *Cerithium adustum*: The unsolved problem

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Seashells show great morphologic flexibility. Phenotypic characters can be modified by biological, chemical and physical factors, or even by non-adaptive events such as age and illness. Because of this variation, taxonomic mistakes are common and many true species have been classified as ecotypes of other species.

This work is part of a bigger project to understand the phenotypic variation of *Cerithium maculosum* Kiener, 1841, throughout its entire distributional range. The objective of this contribution is validate the identity and distribution of the easily confused *C. maculosum* and *C. adustum* Kiener, 1841.

Specimens from five malacological collections (1,700 *C. maculosum* and 150 *C. adustum*), were compared using geometric morphometry (with 19 landmarks). No significant differences in the morphometry were found. The pattern of variation was very similar (with most of the variation in the aperture). The distribution of the examined specimens does not coincide with the literature, and thousands of misidentifications were found.

With this information we can only speculate about the identities and actual distributions of these two species.

Systematics, evolution, and cryptic diversity of tropical Atlantic *Chelidonura* (Opisthobranchia: Cephalaspidea)

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Several species of *Chelidonura* opisthobranchs are known from tropical and subtropical regions in the Atlantic Ocean. In the Caribbean a number of new species have been described during the last few years, mainly based on external morphology and coloration. Some authors have suggested that at least some of this diversity constitute color forms of previously described species. For the present study we examined all these Caribbean taxa using the reproductive morphology, shell and protoconch morphology as well as sequence data from the COI, 16S and H3 genes. The results indicate that most Caribbean *Chelidonura* species need to be synonymized. Additionally, a strong phylogenetic signal and the application of molecular clock techniques allowed us to hypothesize on the origin and diversification of some *Chelidonura* clades in the tropical Atlantic.

Analysis of a mortality episode of cultured red abalone *Haliotis rufescens* associated with the presence of *Xenohaliotis californiensis* and *Pseudoklossia* (=*Margolisiella*) *haliotis*

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The intracellular bacteria *Xenohaliotis californiensis*, recognized as the causal agent of abalone withering syndrome can be found in wild and cultured abalone species in California, USA, and in Baja California, Mexico. The negative effects of this pathogen, especially for the black abalone *Haliotis cracherodii* have been widely recognized. However *X. californiensis* may also infect other abalone species. An analysis of the red abalone *Haliotis rufescens* collected from the bottoms and walls of two culture tanks, where an increase of mortality was occurring, revealed the presence of *X. californiensis*. Prevalence was 89% in abalones from the wall (WA) versus 100% in abalones from the bottom (BA); moreover, there was a trend of major intensity of infection in BA than in WA. Damages in the gastric epithelia, digestive gland and gonad of BA were in concordance with final stages of infection. Similarly, abalone samples were taken from the walls of two tanks where no abnormal mortalities were recorded. In this case, prevalence of *X. californiensis* varied from 67 to 100%; however, the intensity of infection was low. The coccidian *Pseudoklossia* (= *Margolisiella*) *haliotis* in renal tissues was also detected. Prevalence in WA from tanks affected by mortality was 22% and 78% in BA, while prevalence in WA from tanks not affected by mortality ranged from 11 to 55%. These data suggest a major susceptibility to *P. haliotis* of organisms with high intensity of infection by *X. californiensis*. Differences in the intensity of infection by *X. californiensis* could be related to culture practices and environmental quality. Cleaning of the culture tanks, a decrease in density and an increase in water flow could aid in reducing the impact of *X. californiensis*.

Parasites of the clam *Chione fluctifraga* cultured in Bahía San Jorge, Sonora, México

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The clam *Chione fluctifraga* is collected and cultured in Sonora, in the Pacific coast of Mexico and the improvement and promotion of its culture is seen as a possibility for the economic development of coastal populations. However, its parasite fauna is almost completely unknown. A histopathological survey carried out in Bahía de San Jorge, Sonora, reveals the presence of parasites that have not been previously documented in *C. fluctifraga*. Those parasites include: rickettsiales-like prokaryotes, *Nematopsis* sp., *Trichodina*-like ciliates, *Pseudoklossia*-like coccidian (PLCs), the copepod *Pseudomyicola spinosus*, and trematodes. Trematodes and PLCs where associated with important tissue alterations and seem to represent a major risk for the health of clams among the

other parasites; and surveillance and control is needed for the development of the culture of *C. fluctifraga*.

Annual reproductive cycle for female *Chiton virgulatus* Sowerby, 1840 in Bahía de La Paz, Baja California Sur, México

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The annual reproductive cycle of female *Chiton virgulatus* Sowerby, 1840 was characterized for a population of this species living in the Bay of La Paz, Baja California Sur. Correlations between this reproductive cycle and temperature were also considered. Female *C. virgulatus* were collected at monthly intervals from September 2008 to September 2009. Fixed ovary tissues were embedded in paraffin and sectioned, with each section stained with hematoxylin and eosin. We divided ovary development into four phases: undifferentiated, developing, ripe, and spent. The frequency of observed undifferentiated ovaries was the lowest (0 to 4%) in May 2009 and highest from December 2008 to February 2009 (above 85%). Some developing ovaries were found in almost every month of sampling, except October and December 2008 and January and February 2009. The highest frequency of developing ovaries were observed from April to June (96%), peaking in May, 2009. Ripe ovaries were observed between September and October 2008 and again from July-September 2009, implying somewhat different reproductive peaks in 2008 and 2009, and these peaks correlated with the differing warmest temperature extremes in each year. Spawning was observed in August 2008 and September 2009, coinciding with the corresponding peak of ovary maturity in each respective year. Spent ovaries were observed only after the breeding season of 2008. We found a statistically significant correlation between temperature and gonad maturity, although experimental evidence for a causal relationship remains lacking.

Cataloging diversity in the Sacoglossa: Documenting species through the Encyclopedia of Life

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The Sacoglossa is an order of mostly herbivorous marine and estuarine sea slugs with nearly 400 described species (Jensen, 2007; Krug *et al*., 1997). Many species can sequester actively photosynthetic chloroplasts from their algal hosts and others have evolved defensive adaptations such as crypsis, autotomy, and noxious anti-predator chemicals (Pierce *et al*., 2003). Because sacoglossans are generally small and cryptically colored, current faunal lists are considerable underestimates of true species diversity (Trowbridge *et al*., 2009; Carlson and Hoff, 2003). For example, in the most recent guide to Indo-Pacific opisthobranchs, more than half of all identified sacoglossans (n=122) were undescribed (Gosliner *et al.*, 2008). This hidden diversity makes the Sacoglossa an excellent clade to catalogue through the Encyclopedia of Life (EOL).

The Encyclopedia of Life is an online resource and species database of taxa from across the tree of life (http://www.eol.org/). As an EOL Rubsenstcin Fellow I am creating approximately 400 species pages for the sacoglossan molluscs. Genera of particular focus are *Alderia* Allman, 1846, *Elysi*a Risso, 1818, *Costasiella* Pruvot-Fol, 1951, *Thuridilla* Begh, 1872, and *Plakobranchus* van Hasselt, 1824. An improved understanding of the Sacoglossa as a result of EOL species pages has the potential to inform comprehensive studies of their reproduction, development, speciation, phylogeography, morphological and molecular evolution, and changes in species range.

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Predation at a snail's pace: Time-lapse photography in neogastropod whelks

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Time-lapse photography has been used to elucidate and digitally capture diverse biological phenomena across the tree of life. Within the Gastropoda, time-lapse technology has been used to chronicle behaviors such as drilling predation in muricids, desiccation avoidance in mud snails, and the tracking of mucus trails in freshwater pulmonates. In this study, time-lapse photography was used to record the predatory behaviors of neogastropod whelks (family Buccinidae), including *Kelletia kelletii* and *Busycotypus canaliculatus*. Members of thc Buccinidae range in depth from the intertidal to bathyal zone and in feeding preference from specialist carnivore to generalist predator and scavenger.

Predation behaviors were observed during laboratory trials using bivalve molluscs as the prey item. The time-lapse technique allowed for comprehensive observation of prey handling, use of the foot and proboscis, and predation mechanisms (*e.g.*, between-valve wedging, marginal chipping, smothering, engulfment, etc.). Success rate, duration of attack and number of attempts were also recorded, as were resulting damages to the shells of the bivalve and/or the gastropod predator. Predatory mechanisms of these and other buccinid taxa across the family are considered in a molecular phylogenetic context.

Shell microstructure of the earlist known clams and the independent origin of nacre within the Mollusca

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Pojetaia and *Fordilla* are the oldest bivalve molluscs, occurring in roughly co-eval rocks from the Tommotian (about 530 million years ago). and are the only undisputed, well known clams from the Cambrian Period. New specimens and unpublished photographs reveal that *Pojetaia* and *Fordilla* had a laminar inner shell microstructure of foliated aragonite, a newly discovered texture found in many modern monoplacophorans. A similar shell microstructure, a probable precursor to foliated aragonite, is seen in *Anabarella* and *Watsonella*, providing support for the hypothesis that these tall, laterally compressed "monoplacophoran" molluscs are the ancestors of bivalves. Foliated aragonite shares many similarities with nacre and it was probably the precursor to nacre in bivalves. No cases of undisputed nacre occur in the Cambrian, in spite of much shell microstructure data from molluscs of this time period. Also, recent studies of nacre in modern molluscs show variation between the major groups of molluscs that have it (gastropods, bivalves, cephalopods, and monoplacophorans) in fine-scale structure, protein composition, and genetic control. Thus, although nacre is considered by many to be homologous among molluscs, we conclude that it originated independently in different molluscan lineages. This independent origin of nacre appears to have taken place during, or just prior to, the Great Ordovician Biodiversification Event and represents a significant step in the arms race between predators and molluscan prey.

Geographic variation in predatory drilling on bivalves across four ecoregions in Brazil: Implications for the fossil record

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Escalation posits an evolutionary arms race in which predator-prey interactions drive evolution. Drilling predation provides much of the evidence for this controversial hypothesis based on fossil assemblages. Although the history of predation can be explored through paleontology, understanding the influence of spatial variation on temporal patterns poses a greater challenge due to the limited availability of fossil exposures. Modern molluscan communities, however, provide an ideal opportunity to examine latitudinal variation in drilling frequency (DF); spatial patterns of the present have implications for the fossil record.

Previous reports of geographic variation in DF using modern assemblages are contradictory, supporting either an increase or decrease in drilling with latitude or a peak in DF at mid-latitudes. In addition, data focus almost exclusively on mollusks from North America. This study brings a much-needed perspective of latitudinal variation in DF by incorporating data on drilling predation from a broad latitudinal range in the Southern Hemisphere. Our investigation encompasses Western Atlantic mollusks from tropical through polar-influenced environments along eastern South America. Preliminary results presented here reflect only a subset of our field collections from Brazil.

Fieldwork in April 2009 covered ~30 beaches across Brazil from 6°S - 34°S. Bulk samples of shells were collected approximately every 2° in latitude. The present analysis includes data from eight latitudes within four biogeographic ecoregions: Northeastern Brazil (8°S & 10°S), Eastern Brazil (16°S & 18°S), Southeastern Brazil (24°S & 26°S), and Rio Grande (32°S & 34°S). Two bulk samples were analyzed from each ecoregion (one per latitude) yielding >7,500 bivalve shells with a minimum of 800 shells representing each ecoregion. To compare geographic variation in DF, data were aggregated within individual ecoregions.

Drilling predation peaked in Northeastern Brazil (24.9%) and moderate levels of drilling were detected for Eastern Brazil (18.7%) and Southeastern Brazil (16.1%). Drillholes were absent in assemblages from Rio Grande near the Uruguay border. Differences in DF were statistically significant upon comparing all ecoregions except for Eastern vs. Southeastern Brazil ($p = 0.083$). Results to date indicate that drilling predation increases into the tropics; however, more shells remain to be processed before this pattern can be confirmed. Temperate and polar-influenced faunas from Argentina shall be integrated into future analyses as well, extending our latitudinal comparisons from 36°S to 52°S.

Why are freshwater mussels so big?
Size, reproduction, and the evolution of the Unioniformes

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As a group, freshwater mussels (Unioniformes) are larger in size than nearly any other bivalve group. Their size is the result of their unique parasitic life cycle. Two factors seem to control the minimum adult size of freshwater mussels. The first is the necessary volume to bear enough glochidia to support their parasitic life cycle. This is directly related to the minimum functional size of their parasitic larvae and the size of the marsupial region of the ctenidia. The second factor is the mode of parasitization: whether the mussel broadcasts glochidia, forms conglutinates, or has mantle lures. These modes require different numbers of glochidia. The size of mussels is therefore dependent on purely mechanistic factors involved with being a parasite.

Recovering the Riffleshell: The propagation and translocation of a federally endangered freshwater mussel to Ohio

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The Northern Riffleshell, *Epioblasma torulosa rangiana*, is a federally endangered freshwater mussel. Once common in the Darby Creek system of Ohio, the population experienced a decline in the 1980-1990s. However, based on the current abundance of other mussels exhibiting recruitment it is believed that the creek has recovered sufficiently to support the Riffleshell again. In August 2007 two trial populations of 23 and 21 individuals were moved from the Allegheny River of Pennsylvania to Big Darby Creek and fitted with passive integrated transponder (PIT) tags. These populations were recovered in October 2007 and July 2008 with only 4% mortality. Based on this trial success, in June and July 2008 1,773 Riffleshells were collected from the Allegheny River, fitted with PIT tags, and moved to Big Darby Creek. Eight individuals died in transit or before release (0.5% mortality). Nine experimental populations were established at six sites within Battelle-Darby Metro Park: two of 500, two of 200, two of 100, two of 50, and one of 69. The 69 individuals had been used for propagation work that resulted in ~700 juveniles that were released as well. The hosts for this propagation (rainbow darters) were raised from eggs specifically for the project. Monitoring in 2009 found an overall 49% of the released individuals, with success at sites ranging from 34% to 80% recapture. A single dead specimen was found in a muskrat midden. It is hoped that these releases will reestablish this unique mussel in Ohio.

Demographics and eradication of two new invasive populations of *Batillaria attramentaria* in California

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Few data exist describing founder populations in marine systems. New invasions can elucidate founder processes, but most invasions are not detected until populations are well-established. In spring 2005 and 2007, we discovered the first known populations of *Batillaria attramentaria* in San Francisco Bay and Bodega Harbor, respectively. The double discovery of this Japanese mud snail offers an opportunity to investigate early invasion dynamics of a species that has

been detrimental to West Coast mudflat communities for decades. Field surveys from 2006-2010 show a steady increase in mean densities and a modal size class shifting towards smaller individuals, reflecting recruitment. Mean densities have increased by an order of magnitude in San Francisco Bay (46-461 snails/sq.m.), and have also increased in Bodega Harbor. Mean sizes have decreased in both new populations from 13 to 5 mm and 12 mm to 8 mm in SFB and BH, respectively. In contrast, they have remained between 5 and 6 mm in Tomales Bay, where the species has been established for a century. Trematode parasite infection rates remain low overall (< 11% in the new populations), although in Bodega Harbor rates increased from 0-23% in the size class at which the snails are most likely to become infected (20-25 mm). These low infection rates contrast with infection rates of 42% overall in Tomales Bay, a strikingly high rate considering the very small mean snail size. In addition to these population data, we initiated eradication efforts centered around public education and volunteer recruitment to remove snails by hand from the mudflats, with limited success. New techniques are currently being tested, including vacuum collection for more effective surficial snail removal. The results from these population characterizations and eradication efforts will further our understanding of founder populations of invasive species and permit evaluation of eradication efforts in soft sediments.

Life history of *Leptoxis* (Gastropoda: Pleuroceridae)

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The critically imperiled freshwater snails of the genus *Leptoxis* of the southeastern United States have been traditionally overlooked in many systematic and ecological studies. This is especially troubling in light of recent extinctions within the genus and the conservation status of many species – the round rocksnail (*L. ampla*), plicate rocksnail (*L. plicata*) and the painted rocksnail (*L. taeniata*) are listed under the U.S. Endangered Species Act. As part of a total systematic revision of *Leptoxis*, I am performing a study concerning the life history strategies of the genus. Observations of life history strategies (*i.e.* period of oviposition, egg laying strategies, shape and size of egg clutches) for each *Leptoxis* species will be made in order to provide novel insights concerning the evolution and ecology of *Leptoxis*. Due to the inherent difficulties of studying life history strategies in the wild, I developed a unique culturing set-up at the Alabama Aquatic Biodiversity Center in Marion, Alabama specifically designed for this study. Thus far, culturing has been successful for all Mobile River Basin species, and additional species found outside the Mobile River Basin will be placed into culture before winter 2011. I have found distinct interspecific differences in egg laying strategies of *Leptoxis* and period of oviposition. Many Leptoxis species also show differences in egg clutch shape. Different age classes of *Leptoxis foremani* also demonstrate statistically significant differences in egg clutch size and this is likely true for all *Leptoxis* species. Furthermore, contrary to much of the literature, *Leptoxis* is iteroparous as females will lay eggs in multiple years. Future directions include using these data as part of a total systematic revision of *Leptoxis* to aid in species delineation and in the context of a molecular phylogeny to trace the evolution of *Leptoxis* life history strategies.

Shell geometry and plasticity in the surfgrass limpet, *Lottia paleacea*, and its effects on reproductive life history traits

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Phenotypic plasticity is a phenomenon that is typically found in many marine gastropods. Limpets provide good examples of phenotypic plasticity that often reflect different microhabitats within the intertidal zone, and individuals from such contrasting microhabitats can vary dramatically in their shell growth, color and morphology. The surfgrass limpet, *Lottia paleacea*, shows great phenotypic plasticity in the shell volume between the two species of surfgrass it inhabits. We hypothesized that limpets that live on the thinner blade of *Phyllospadix torreyi* would have a lower total volume than those that live on the wider blade of *P. scouleri*. We also hypothesized that this plasticity in volume will have effects on the reproductive life history traits of this organism, including body volume or age at first reproduction, and lifetime fecundity. We tested the first part of these predictions by directly measuring the volume of water required to fill each of 30 limpet shells selected to represent observed variation throughout California. We then demonstrated that this volume could be effectively modeled as a pyramid as computed form[from?] three maximum shell dimensions, (LWH)/3, so these measurements alone would allow an approximate estimate of a surfgrass limpet's internal volume. We then estimated the volume of roughly 400 limpets from Cambria, California found on either surfgrass species. Our results suggest that limpets on the narrower *P. torreyi* have a lower total volume than those on *P. scouleri*, and that limpets on *P. torreyi* do not get as large as those on *P. scouleri*. Currently we are counting the number of eggs in each female limpet to get an estimate of the volume devoted to gonad when collected. With these data we will be able to examine the role that phenotypic plasticity has on the life history traits of this limpet.

Effect of geography, tectonics, ecology and glacio-eustatic processes on speciation of marine intertidal gastropods

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The benthic, shallow-sea is defined as the region bordered on the one hand by the shoreline and on the other by a thermocline that separates warmer, shallower water from a more homogeneous, cooler deep-sea. Most marine adaptive radiations have occurred in this region, with more than 90% of marine animals occurring in shallow, benthic seas, much of it associated with tropical waters and coral reefs. Of all the shallow-water regions, the tropical Indo-West Pacific (IWP) harbours the greatest biodiversity in terms of numbers of species. Thus, the factors affecting speciation in shallow-sea are of vital importance if we are to understand how present-day levels of biodiversity arose. Four interrelated factors, ecology, geography, tectonics and sea level changes, play pivotal roles in the evolution of shallow-sea organisms within the IWP. Large-scale geographic boundaries such as the East Pacific Barrier, tectonic events such as the collision of continents and ecological limits such as thermal tolerances define generic and subgeneric distributions. The geography of habitat within a biogeographic zone, for instance, two dimensional island arrays or one dimensional coastlines, affects hydrological conditions and combined with dispersal abilities may affect the mode and rate of speciation. Sea level changes as a result of glaciation events and tectonic events have been important for speciation in some taxon groups, but in others isolation has been of insufficient duration for the formation of species and instead has left evidence at the level of population genetics. In this talk, I discuss patterns observed in turbinid gastropods.

Asian clam (*Corbicula fluminea*) invasion in Lake Tahoe: The ecology and management of an invasive bivalve in an oligotrophic lake

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The invasive Asian clam (*Corbicula fluminea*) is established in the littoral zone of Lake Tahoe, California–Nevada. *Corbicula fluminea* was first observed in Lake Tahoe in 2002, and by 2009, high density populations (up to 6000/m^2) have been observed in the southeast region of the lake, where it has negative impacts on benthic diversity and is associated with filamentous algal blooms of *Zygnema* sp. and *Cladophora glomerata*. As part of a study of the ecology and lakewide distribution of *C. fluminea*, benthic samples were collected every 6-8 weeks from October 2008 through April 2010. *In situ* growth experiments are used to estimate the abundance and growth of the *C. fluminea* population and track cohort growth rates. Widely distributed (2-70 m water depth) along Lake Tahoe's well-oxygenated littoral zone, *C. fluminea* maximum size and life expectancy is lesser in this subalpine, oligotrophic ecosystem, but growth rates and population densities are similar and can exceed those in warmer, more nutrient-rich ecosystems. Despite the observed high densities, *C. fluminea* populations are not exhibiting density dependence and range expansion continues within the lake with long distance dispersal events. Experimental efforts to manage new populations using two non-chemical strategies (diver assisted suction removal and bottom barrier application) are currently underway. Diver assisted suction removal is effective at reducing *C. fluminea* as well as native macroinvertebrate communities. However, recolonization of these plots occurs, and financial costs are high. Bottom barrier application resulted in 100% *C. fluminea* and 70-95% benthic macroinvertebrate mortality after a 28-day period from August to September 2009. A cost and feasibility analysis of large-scale bottom barrier application in Lake Tahoe is under consideration.

New records of bivalves and gastropods from Isla Socorro, Revillagigedo, Mexico

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Despite the efforts made in previous studies at this area of Revillagigedo, we still have very little knowledge about biodiversity. In order to extend the current knowledge of the taxonomy and ecology of mollusks, we performed a prospective study of benthic fauna, mainly on micromollusks associated to sandy substrate and on some of macromollusks from rocks.

The collect was conducted as a part of a project about diversity of echinoderms and mollusks at "Instituto de Ciencias del Mar y Limnologia, UNAM" during rainy season in fall of 2008. Were sampled fifteen sand samples randomly on different points around the island with a volume of 800 ml on average, those ones were processed in a laboratory to be conserved.

At this moment the study is in progress of analyzing data. The specimens were identified using basic bibliography and in some cases in collaboration with some specialists.

Most of the organisms were found in juvenile stages form macroscopic morphs. 185 morphs were found, 123 were determined to species level, 37 to genus level and 7 were found close to some genus or species, the rest of them stayed at the family level or could not be identified. 66 new records to species level and 62 new records to genus level were reported from the total of organisms analyzed.

Significantly, there have been few studies focused especially on micromollusks , due to difficult working with them principally by size, moreover, the processing of the material is slow.

However, the micromollusks cover many adult and juvenile forms, which are still unknown. Therefore, that knowledge is important at the ecological and taxonomic level in the first instance.

The next stage on this study will be analyzed on ecological aspects about the factors influencing diversity, analyzing if there's a relationship between the type of substrate with the abundance and species richness.

Morphometric analysis and diversity of chitons from the Oaxacan coast

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The knowledge of molluscan taxonomy has been focused on qualitative characteristics. Only recently, quantitative and genetic techniques have been adopted which has helped to reduce taxonomic confusion of a large number of taxa. Morphometric analysis is a powerful technique, helping to discern the adaptation in base of the geographic factors or in terms of morphological differences that show the different roles and functions of the same body parts. We collected samples over six months from February to July 2009 at eleven sites in intertidal and subintertidal zones of the coast of Oaxaca. The Elliptic Fourier feature of a closed contour was use for identification of chitons from the Oaxaca Coast. This analysis was carried out on cephalic, medium, and anal valves. Contours were extracted by image processing and were quantitatively evaluated by principal component scores and discriminate analysis. After image processing the contour of each valve was expressed as chain-code and then described by 88 coefficients of elliptic Fourier descriptors. Twenty harmonics were used as outline descriptors. We found sixteen species of chitons along the Oaxacan coast. Of these, ten are new records for the Mexican Pacific and twelve are new records for the state of Oaxaca. We found significant differences in valve shapes according to species but also between families. Likewise, we analyzed valve shapes in *Chiton* (*Diochiton*) *articulatus* in function of sampling location and found significant differences. We corroborated that morphological analysis is a powerful technique and very applicable for mollusks. This tool can be used to for future analysis. The differences in shape could be linked to the particular environmental conditions of each site.

SUBMITTED PAPERS

Methods for the cytogenetic study in shellfish

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Abstract: Methods for obtaining chromosomes for cytological and cytogenetic analysis are of value in the understanding of intra- and inter-generic specific biological behavior. The aim is that these methods will contribute to the standardization and establishment of cytogenetic techniques that focus on the dot identification architecture chromosome of cells with high mitotic index from invertebrate organisms such as mollusks, with the aim that they be used as a tool in the study and preservation of these organisms.

Introduction:

Chromosome studies in mollusks are of particular interest in cytology, as this group of organisms is diverse and important with respect to its physiology, morphology and anatomy, genetic variability among related and/or taxonomically closely related species (Babrakzai & Miller, 1984), and the great number of organisms that exist (Nakamura, 1986). This type of analysis may be used for other invertebrates, particularly those of commercial importance, such as crustaceans, echinoids and holothuroidians, among others.

Since 1946, Husted and Burch have used a variety of techniques to describe the chromosome morphology of terrestrial gastropods of the family Polygyridae. A good source of molluscan chromosome material is cell culturing (a technique incorporated into the study of mollusks by Burch and Cuadros, 1965). This was also applied by Burch (1968) in the analysis of chromosome karyotypes, although earlier efforts were inadequate and inefficient. By 1974, Babrakzai and Miller were able to observe chromosomes, both in the mitotic and meiotic phases (this last in gonad tissue), following a technique using fresh preparation slides based on cytological experiments that involved squashing and direct dyeing with acetocarmin. Parting from these experiments, cytogenetic research was carried out on various taxa, mainly in the class Gastropoda (Thiriot-Quiévreux, 2003). The chromosome bands “G” and “C” and the nucleoli organizer were identified, and a database of karyotypes was created. Tissues of the ovotestis and gill were used as the main resource for the chromosome analysis (knowledge of the cellular and reproductive cycles of species is of particular interest and necessary to obtain good results). Techniques that have been perfected for terrestrial (Diupotex-Chong and Babrakzai, 1993) and freshwater (Diupotex-Chong, 1993, 1994; Diupotex-Chong *et al.*, 2004, 2007) gastropod mollusks have been applied to the developmental stage of the embryo that is required to adequately obtain chromosomes.

This paper aims to provide a tool with which to aid in the resolution of diverse problems with respect to uncertainties in anatomy, unclear physiology, and systematic and taxonomic inquiry.

Chromosome standardization methods for mollusks:

In general terms, chromosomes are interpreted following the patterns observed in vertebrate animals. However, mollusk chromosomes often do not behave as do those of other organisms, such as crustaceans, echinoderms and fish, as there are marked differences in their physiology, metabolism and cellular cycles in general. A resource that is excellent, and cannot be replaced, for obtaining mitotic chromosomes, is live embryonic tissue (tissue under constant cellular division and differentiation). For this, it is recommended that organisms be maintained alive and stable under artificial laboratory conditions. In the case of gastropod mollusks, they must be kept healthy, viable and fertile in order to obtain trustworthy genetic material with a good cytogenetic quality that will make it possible to carry out representative interpretations and verifications.

The gonad of gastropod mollusks is an excellent tissue from which to obtain both mitotic and meiotic chromosomes, and with which to carry out precise architectural analyses of karyotype reading. However, it is necessary to know the cellular cycle. Another possibility is to use cells undergoing differentiation (embryos), as these present rapid cell divisions with the advantage that under controlled conditions one may obtain material for several months or years. Similar objectives may be attained working with cell tissue culture.

Preparation of chromosomes:

Live adult aquatic organisms are collected from their habitat, together with data on the natural environmental conditions (*e.g.*, temperature, salinity, pH, probable type of food, etc.) in order to imitate these conditions as much as possible and implement them in the laboratory under artificial conditions. It is very important to maintain the specimens alive and isolated under stable conditions for at least two weeks and to strive to reduce physiologic changes caused by stress, up to the time of the cytogenetic processing.

1. Ovules and/or sperm

Gonad tissue cells in hypotonic solution are treated with the squash technique that was proposed by Babrakzai and Miller (1974) and perfected in this present study, in order to obtain both mitotic and meiotic chromosomes. Temporal fresh preparations slides are squashed, after being dyed with 2% acetic orcein, and the best fields are selected.

For conservation, the cover slip is lifted with the aid of a thin blade, after quickly freezing with dry ice (CO_2), in order to avoid damage to the tissue. The tissue obtained is then dehydrated by applying changes of ethyl alcohol (starting with 70% alcohol and increasing it up to 100%). They are again dyed with 45% acetic orcein for approximately 30 min., regulating dyeing process time as the cellular layer requires. The preparation slides are allowed to dry, are fixed by mounting with euparal or fresh Canada balsam, and are incubated at 60°C for 24 hours. This method is recommended when perfectly defined chromosomes are observed, to conserve the data as a cytogenetic collection of the studied organisms (similar to a database).

2. Chromosome identification in embryos

The use of gastropod embryos for the identification of chromosomes was first recorded by Patterson (1971), and changes have now been carried out to perfect the process, although maintaining the same cellular principles. Among the specialized studies on cytogenesis, the manipulation of cellular tissues with a high mitotic index is vital. Several changes to standardize the method have been carried out considering this. The specialized techniques proposed by several authors are followed, basically considering the group of vertebrates (Ocalewicz *et al.*, 2004). We have applied readaptations and manipulations for use with gastropod mollusk embryos (freshwater, marine and terrestrial snails). These are presented here.

2a. *Identification of chromosomes in embryos of terrestrial mollusks*

The adult organisms that are collected are deposited in a terrarium where the environmental conditions are kept as similar as possible to the natural conditions (with respect to space, type of soil, rocks, humidity and type of food). After two weeks, fertilized eggs are located a few centimeters below the surface of the soil and are carefully collected with a spatula. They are washed with running water to remove sand and detritus that may contaminate them, and are placed on a damp towel in Petri dishes. The Petri dishes (with the eggs) are placed in a damp room at a constant temperature of 25°C for incubation for 5 to 12 days. Growth is checked every two days by means of micro-dissections. Cytogenetic processing starts once the required biological material is obtained. To begin, the cells are placed in hypotonic solutions in order to work exclusively with cellular nuclei. For this, the embryo tissues are treated with a 0.075 M KCl solution. Simultaneously and under the stereoscopic microscope, the embryos are liberated from their capsules, manipulating them with very fine tweezers and a dissection needle. They are incubated for 60 min, placed in a solution 0.04% mitostatic colchicine solution, again incubated for 60 min, and manipulated with a Pasteur pipette so as not to damage the live embryos. The albumin that surrounds the embryos is carefully withdrawn, and they are left in a preserving solution (known as Carnoy solution, a methanol:glacial acetic acid at a ratio of 3:1) for at least 24 hours at a temperature of 4°C. After these 24 hours, slides are prepared following recommendations of Kligerman and Bloom (1977), who noted that fish gill tissue goes through a cellular de-scaling in a 50% acetic acid solution. The cells are collected with a capillary to read the microcites at a temperature of 50°C. In our case, we worked directly with the molluscan embryos one at a time, bursting them with a previously sterilized dissection needle, and spreading the cells across the slide. Finally, the preparation slides are dyed with a Giemsa solution prepared with a phosphate buffer base at pH 6.8.

2b. *Identification of chromosomes in embryos of freshwater mollusks*

Live freshwater adult gastropods are carefully collected from their natural habitat and placed in aquaria under controlled conditions, as near as possible to those (pH, luminosity, appropriate food) found in their natural environment in order to establish stability and avoid stress to the specimens.

The females start to deposit fertilized eggs after a couple of weeks. Observations are carried out every 48 hours. The different stages of embryonic development are inspected, bearing in mind that embryos in very early or very late stages do not present well differentiated mitotic chromosomes (this fact must be considered to obtain legible chromosomes that will provide a correct analysis). The perfect stage for chromosomal reading must be recognized. Several embryos are extracted from the egg mass with the aid of very fine tweezers and dissection needles under a stereoscopic microscope, are placed in a Petri dish with a 0.04% colchicine solution, and are incubated for 60 min. Next, in order to hypotonize the cells, the sample is placed in a 0.075M KCl solution for a couple of hours, after which the tissue fragments are fixed in a Carnoy solution (methanol:glacial acetic acid at a ratio of 3:1) for 24 hours at 4°C. Slides are then prepared and the cells are de-scaled in a 60% glacial acetic acid solution, as post-fixing, at an approximate temperature of 50°C (Kligerman and Bloom, 1977).

2c. *Evaluation of the haploid complement*

Samples of fresh gonad tissue are processed with the squash technique and dyed with acetic orcein (2%) (Griffin *et al.*, 1997). The slides are dyed with Giemsa (sigma) in a phosphate buffer at pH 6.8, and are mounted with xylene and Canada balsam.

The time of action of the mitostatic (colchicin) affects both the constriction and the extension of the chromosomes, characteristics that are required to observe the "G" and "C" bands, and/or the nucleolar organizer. The slides are read using a phase contrast microscope, and once the mitotic fields with the required quality are located, they are placed in two treatment groups. One part is treated for the identification of the nucleolar organizer (NOR) and the other for the "G" and "C" bands (with specific dyes). Finally, another group is dyed with Giemsa diluted in a phosphate buffer at pH 6.8 for 30 to 45 min. Observations are carried out every 10 min in order to obtain legible chromosomes in mitosis, and to avoid finding them overlapped, dilated or compressed.

IN CONCLUSION

Cytogenetics is a study tool that employs well established techniques that may help resolve various problems in the field of biology, including the identification of homologous chromosomes, the description of karyotypes, and the solution to problems related to systematics and taxonomy, as well as phylogenetic considerations in both the evolutionary description of relatively closely related species and their inter-relationships at the highest levels. Inventories of species, as a tool to measure biodiversity, are focused today on evaluations for the conservation of ecosystems, and on the species that inhabit the ecosystems and their genetic variability. Knowledge of these factors is fundamental to establish adequate management plans including conservation priorities.

MÉTODOS PARA EL ESTUDIO CITOGENÉTICO EN MOLUSCOS

Resumen: Se proponen algunos métodos para la obtención de cromosomas en estudios citogenéticos de valiosa importancia, en la comprensión del comportamiento biológico específico intra e inter genérico. Se pretende que esos métodos ayuden a la estabilización y estandarización de técnicas citogenéticas, enfocadas a la identificación de la arquitectura cromosómica puntual en células con alto índice mitótico de organismos invertebrados, en este caso moluscos, con el fin de ser utilizados como una herramienta para el estudio y conservación de esos invertebrados.

Estudios cromosómicos en moluscos, son de interés especial en citología; por la enorme diversidad e importancia de este grupo de organismos, en cuanto a su fisiología, morfología y anatomía, por la variabilidad genética que presentan principalmente entre especies emparentadas y/o taxonómicamente cercanas (Babrakzai y Miller, 1984), así como por el gran número de organismos existentes (Nakamura, 1986), siendo posible el extender este tipo de análisis entre otros invertebrados, fundamentalmente de importancia comercial, como la clase Crustacea, la clase Echinoidea o la clase Holoturoidea, entre otros.

Desde 1946, Husted y Burch, utilizando diversas técnicas describieron por primera vez la morfología cromosómica de gasterópodos terrestres de la familia Polygyridae. Otro de los recursos irrefutables en la obtención de material cromosómico para moluscos, es el cultivo celular (técnica incorporada en los estudios sobre moluscos por Burch y Cuadros, 1965) aplicado para el análisis de cariotipos cromosómicos por Burch (1968), técnica que en sus primeras fases resultó inadecuada y poco eficiente.

Para 1974, Babrakzai y Miller con sus técnicas basadas en preparaciones frescas apoyadas en experiencias citológicas por medio del prensado (aplastón, squash) y tinciones directas de acetocarmin, lograron observar cromosomas, tanto en fases mitóticas, como meióticas (este último en tejido gonádico). A partir de esas experiencias se realizaron investigaciones citogenéticas sobre diversos taxones principalmente de la clase Gastropoda (Thiriot-Quiévreux, 2003), se identificaron las bandas cromosómicas "G", "C" y el organizador nucleolar y se ha creado una base de datos de cariotipos. Los tejidos de ovotestis y branquia fueron utilizados como principal recurso para el análisis cromosómico (el conocimiento de los ciclos reproductivos y celulares de especies de interés es indispensable en la obtención de buenos resultados)

Para la etapa de desarrollo de los embriones dentro del estadio requerido para la obtención adecuada de cromosomas, se han aplicado técnicas que en la actualidad han sido perfeccionadas para moluscos gasterópodos terrestres (Diupotex-Chong y Babrakzai, 1993) y dulceacuícolas (Diupotex-Chong, 1993, 1994; Diupotex-Chong *et al.*, 2004; Diupotex-Chong *et al.*, 2007).

Esta contribución, pretende brindar una herramienta en apoyo a la solución de diversos problemas, sobre anatomía incierta, fisiología confusa, encasillamiento sistemático y taxonómico, inconvenientes que se presentan en moluscos dentro de su filogenia y además puede servir de apoyo para su conservación.

Métodos de estandarización cromosómica en moluscos

Generalmente los cromosomas son interpretados siguiendo los patrones observados en los vertebrados, sin embargo, es frecuente que los cromosomas estudiados entre los moluscos no se comporten de forma semejante a otros organismos como crustáceos, equinodermos y peces, puesto que hay marcadas diferencias dentro de la fisiología, metabolismo y, en general, en los ciclos celulares.

Un excelente e irremplazable recurso para la obtención de cromosomas mitóticos, se presenta en el tejido embrionario en vivo (tejidos en constante división y diferenciación celular), para lo cual es recomendable tratar de mantener a los organismos vivos en forma estable bajo condiciones artificiales en el laboratorio; en el caso de los moluscos gasterópodos, estos deben mantenerse sanos, viables y fértiles para obtener material genético confiable y de buena calidad citogenética que permita realizar comprobaciones e interpretaciones representativas.

La gónada de los moluscos gasterópodos es un tejido excelente para la obtención de cromosomas tanto mitóticos como meióticos, así como para realizar análisis arquitectónicos precisos de la lectura cariotípica, sin embargo, es necesario conocer el ciclo celular. Otra posibilidad es el manejo de células en diferenciación (embriones), ya que éstos presentan divisiones celulares de rápido crecimiento, con la ventaja que bajo condiciones controladas, se puede obtener material por varios meses o años, o bien, para lograr objetivos similares, se puede emplear el cultivo de tejidos celulares.

PREPARACIÓN DE CROMOSOMAS

Para organismos acuáticos adultos recolecta de organismos acuáticos vivos adultos en el medio natural, teniendo la precaución de averiguar las condiciones ambientales naturales en que se encuentra: temperatura, salinidad, potencial hidrógeno (pH), tipo probable de alimento, etcétera, a fin de imitar en lo posible esas condiciones e implantarlas dentro del laboratorio, bajo condiciones artificiales.

Es muy importante mantener a los ejemplares vivos en aislamiento, al menos por dos semanas en condiciones estables, tratando de reducir en lo posible los cambios fisiológicos causados por el estrés, hasta su procesamiento citogenética.

1. Óvulos y/o espermatozoides

Para la obtención de cromosomas tanto mitóticos como meióticos, se someten las células de tejido gonádico, bajo condiciones de solución hipotónica, a la técnica de prensado (squash) que fue propuesta por Babrakzai y Miller (1974) y perfeccionadas en la presente contribución.

Se hacen preparaciones frescas temporales, por prensado (squash), bajo previa tinción con orceina acética al 2% y se seleccionan los mejores campos.

Para su conservación se remueve el cubre objetos, por medio de congelación rápida con ayuda de bloques de hielo seco (CO2), con objeto de evitar al máximo algún daño a los tejidos y separando el cubre objetos del porta objetos con auxilio de una navaja delgada, posteriormente se deshidrata el tejido obtenido, con cambios de alcohol etílico (comenzando con alcohol al 70% hasta el 100%), luego se tiñen nuevamente con orceina acética 45%, por 30 minutos aproximadamente; regulando el tiempo de tinción, según requiera la capa celular.

Las preparaciones se dejan secar y se fijan montándolas con euparal ó bálsamo de Canadá fresco, incubando a 60°C por 24 horas. Este método es recomendable cuando se han observado cromosomas perfectamente definidos, para conservar los datos se forma una colección citogenética de los organismos estudiados (similar a una base de datos).

2. Identificación cromosómica en embriones

El uso de embriones de moluscos gasterópodos en la técnica para identificar cromosomas, fue registrado por primera vez por Patterson (1971), actualmente continuando con los mismos principios celulares, se han realizado modificaciones para su perfeccionamiento. Entre los estudios de citogenética especializados, la manipulación en tejidos celulares con alto índice mitótico es vital, al respecto se han realizado diversas modificaciones para lograr la estandarización del método. Las técnicas especializadas propuestas por diversos autores, se realizan basándose principalmente en el grupo de los vertebrados (Ocalewicz et al., 2004), por nuestra parte, hemos hecho readaptaciones y manipulaciones para la aplicación en embriones de moluscos gasterópodos (caracoles dulceacuícolas, marinos y terrestres), que a continuación se presentan:

2a. Identificación de cromosomas en embriones de moluscos terrestres

Los organismos adultos colectados, son depositados en un terrario, manteniendo las condiciones ambientales lo más aproximado a las condiciones naturales (en cuanto a espacio, tipo de tierra, rocas, humedad y tipo de alimento), al cabo de un par de semanas, se localizan los huevos fertilizados, unos pocos centímetros por debajo de la tierra, se recolectan gentilmente con la ayuda de una espátula. Posteriormente se lavan cuidadosamente con agua corriente para remover arena y detritus que puedan contaminarlos, se colocan sobre una toalla húmeda en cajas de petri. Las cajas de petri (con los huevecillos) se colocan en un cuarto húmedo, a temperatura constante (25°C), para su incubación por un período de 5 a 12 días, cada dos días se revisa su crecimiento por medio de micro-disecciones. Una vez obtenido el material biológico requerido, se lleva a cabo el procesamiento citogenético. En primer lugar se someten las células a soluciones hipotónicas, con objeto de trabajar exclusivamente con núcleos celulares, para ello los tejidos embrionarios, se tratan con una solución de KCl 0.075 M; simultáneamente, bajo el microscopio estereoscópico, se libera el embrión de su cápsula manipulándolo con ayuda de pinzas muy finas y aguja de disección. Se incuban por 60 minutos, posteriormente los embriones se trasladan a una solución (mitostática de colchicina 10-4 M) nuevamente se incuban por 60 min, y con el propósito de no maltratar al embrión vivo, se manipula con pipeta Pasteur, cuidadosamente se le retira la albúmina que rodea al embrión, se deja al embrión en reposo en una solución fijadora, al menos por 24 horas, conocida como solución de Carnoy (metanol: ácido acético glacial en proporción de 3: 1) a una temperatura de 4°C. Transcurridas las 24 horas, se preparan laminillas siguiendo las propuestas de Kligerman y Bloom (1977) en el que los tejidos branquiales de peces, se someten a una descamación celular con ayuda de una solución de ácido acético al 50 %. Se recolectan estas células con un capilar para lectura de microcitos y a una temperatura de 50° C, en nuestro caso, trabajamos directamente con los embriones de moluscos uno por uno, haciéndolos estallar con ayuda de una aguja de disección, previamente esterilizada, expandiendo con destreza las células sobre el portaobjetos, finalmente se tiñen con solución Giemsa, preparada a base de buffer de fosfatos pH 6.8.

2b. Identificación de cromosomas en embriones de moluscos dulceacuícolas

Organismos adultos dulceacuícolas vivos de la clase Gastropoda, son recolectados cuidadosamente de su hábitat natural, teniendo la precaución de mantenerlos vivos en acuarios, bajo condiciones controladas, lo mas cercanamente posible a esas de su medio natural (salinidad, pH, luminosidad, alimentación apropiada) con la finalidad de lograr su estabilidad y evitando en lo posible el estrés de los ejemplares.

Al cabo de un par de semanas, las hembras, comenzarán a depositar huevecillos fertilizados, con ello se procede a realizar observaciones cada 48 horas, se inspeccionan las diversas etapas del desarrollo embrionario, recordando que un embrión en etapas muy tempranas o entre etapas de desarrollo embrionario muy avanzadas, no presenta cromosomas mitóticos bien diferenciados (este hecho deberá considerarse para obtener cromosomas legibles que facilitarán la obtención de un correcto análisis). Así, se identifica el estadio perfecto en cuanto a la lectura cromosómica. Bajo el microscopio estereoscópico, con ayuda de pinzas muy finas y agujas de disección, se extraen varios embriones del conjunto de huevecillos colocándolos en una caja de petri con una solución de colchicina al 0.04% y, se incuban por un período de 60 minutos. Posteriormente, con el objeto de hipotonizar las células, la muestra se somete a una solución de KCl 0.075M, por un par de horas, posterior a este proceso, los fragmentos de tejido son fijados en una solución Carnoy (metanol- ácido acético glacial en proporción de 3: 1) por 24 horas a 4° C.

Se preparan laminillas, descamando células con ácido acético glacial al 60% como posfijación, a temperatura aproximada de 50° C (Kligerman y Bloom, 1977).

2c. **Evaluación del complemento haploide.**
Muestras de tejido gonádico en fresco, son trabajadas con la técnica de prensado (squash) y tinción con orceina acética (2%) (Griffin et al., 1997); las laminillas se tiñen con Giemsa (sigma) en buffer de fosfatos pH 6.8, se montan con xileno y bálsamo de Canadá. El tiempo de acción del mitostático (colchicina), influye tanto en la constricción como en la extensión de los cromosomas, características indispensables para observar bandas "G", "C" y/u organizador nucleolar.

Las laminillas son leídas al microscopio de contraste de fases y una vez localizados los campos mitóticos de la calidad requerida, son seleccionados en grupos de tratamiento, una parte son tratados para la identificación del organizador nucleolar (NOR) y otra para bandas "G" y "C" (con tinciones específicas). Finalmente otro grupo, se tiñe con Giemsa diluida en buffer de fosfatos, a un pH 6.8, por un tiempo de 30 a 45 minutos, realizando observaciones cada 10 minutos, con la finalidad de obtener cromosomas en mitosis legibles, evitando que se encuentren empalmados, dilatados o comprimidos Figure 3.

En conclusión

La citogenética como herramienta de estudio, dentro de diversas ramas de la biología, con técnicas excelentes, nos puede ayudar a solucionar diversos problemas, como son la identificación de cromosomas homólogos, la descripción de cariotipos, la solución de problemas dentro de la sistemática y taxonomía, en consideraciones filogenéticas, tanto en la descripción evolutiva entre especies relativamente cercanas, como en interrelaciones a más altos niveles y en la hoy en día en la evaluación para la conservación de ecosistemas, de las especies que habitan en los mismos y su variabilidad genética. El conocimiento de estos factores resulta fundamental para un adecuado manejo estableciendo prioridades de conservación.

Los inventarios de especies, son utilizados como herramienta en mediciones de la biodiversidad, están enfocados hoy en día para la evaluación y la conservación de ecosistemas, de las especies que habitan en los mismos y su variabilidad genética. El conocimiento de estos factores resulta fundamental para un adecuado manejo estableciendo prioridades de conservación.

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New records of land mollusks from southeastern Selva Lacandona, Chiapas, Mexico

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Abstract:

Records of land mollusks from eastern Chiapas, Mexico, date from the mid 1800s (Morelet, 1849, 1851). By the late 1950s, Bequaert (1957) noted that 41 species had been reported in the literature from Chiapas and that an additional 31 species had been collected by an expedition led by R. A. Paynter in 1954 to the mid-eastern section of the Selva Lacandona (Lacandon Jungle), the montane rainforest that stretches from Chiapas into Guatamala and the southern part of the Yucatán Peninsula (Figure 1). Subsequently, Avendaño-Gil *et al.* (2002) found 28 taxa in the southwestern corner of Selva Lacandona. Land mollusks for the present study were collected in the southeastern corner of Selva Lacandona during a freshwater molluscan project, during which trails inside the tropical rainforest were visited and shells and humus samples taken. To date, 14 families and 33 species have been recognized from these samples. The Helicinidae appears to be the most diverse family with eight species, followed by the Subulinidae with six. Seven families are represented by a single species only. The current malacofauna of the region has a close relationship with that of Guatemala, which supports the existence of a Chiapas-Guatemalan biogeographical subregion in Central America (Figure 3) as proposed by Bequaert (1957).

Introduction to studies of terrestrial molluscs of Chiapas:

The earliest records of land molluscs from northeastern Chiapas start with the findings of Arthur Morelet around Palenque in Chiapas (1849, 1851). According to Martens (1890-1901), Morelet was the first explorer to visit Palenque and Guatamala. Morelet published the results of his exploration in Cuba, Mexico and Guatemala as well as descriptions of his own findings (Morelet, 1849, 1851), including seven species he recorded from the northern limit of Selva Lacandona and Palenque. A century later Bequaert (1957) reported on 31 land species that were collected by an expedition led by Raymond A. Paynter in 1954 to the mid-eastern section of Selva Lacandona, at Monte Líbano, Laguna Ocotal, El Censo and El Real (Figure 1). The most recent work is the study by Avendaño *et al.* (2002) in the southwest section of Selva Lacandona. Those authors focused their attention around the town of Ixcán, where they recorded 28 taxa.

The Montes Azules Biosphere Reserve (Figure 1), located in the southeastern part of the Selva Lacandona, was created in January of 1978. Among the objectives of the Reserve are research and educational activities, as well as supporting efforts to educate the local people and to provide recreational entertainment (Vargas Márquez, 1984), monitoring of the Reserve, and studying the social and productive systems. Long-term conservation and use of cultural resources, restoration incentives, environmental conservation, forest protection and protection of faunal refugia are also among the aims (Vázquez Sánchez and Ramos, 1992).

The Montes Azules Biosphere Reserve has an area of 331, 200 hectares (Vargas-Márquez, 1984; García-Gil and Lugo-Hubb, 1992). The climate is warm and semi-humid, with a mean annual temperature of about 22° C and 1,500 mm of rainfall in the southern portion (García-Gil and Lugo-Hubb, 1992). The rainy season is from May to October but with some rain falling during winter as well (García-Gil and Lugo-Hubb, 1992). Along the southern margin of the tropical rain forest, sub-deciduous and deciduous forest dominate the landscape (García-Gil and Lugo-Hubb, 1992) with the sub-deciduous forest comprising 70% of the surface area (Vargas-Márquez, 1984). Original vegetation to the east and north of the Reserve has been replaced by farm land and the cultivation of corn and beans (García-Gil and Lugo-Hubb, 1992).

Methods:

To reach the collecting sites, transportation by motorboat was required. At the Chajul Biological Station (in the Montes Azules Reserve) various trails were visited by foot. Land snails were searched for below tree trunks, leaf litter, rocks, over plants and on walls at 13 sites. All molluscs found were taken by hand or with tweezers and very small specimens with a brush. Later, shells were divided by size, large from small. Live molluscs were relaxed either with bits of tobacco and water or with 0.05 % Nembutal (Paraense, 1986) and left overnight in a cool place. When no movement was noticed, specimens were changed to 40% alcohol, and later to 70% alcohol. Shells were soaked in a weak solution of Photo-Flo® (a wetting agent), briefly cleaned with a brush or in an ultrasonic cleaner, thoroughly rinsed after either treatment, and allowed to dry on paper towels. As identification proceded species were separated.

Results:

Fourteen families and 33 species of terrestrial molluscs are recorded from the Montes Azules Biosphere Reserve in southeastern Selva Lacandona. The Helicinidae is the most diverse family, followed by the Subulinidae, with eight and six species, respectively. The other twelve families were represented by one to three species each (Table 1).

Seven species were recorded for the first time in Selva Lacandona and the State of Chiapas: *Helicina delicatula* Shuttleworth, 1852, *H. punctisulcata* Martens, 1890, *Carychium mexicanum* Pilsbry, 1891, *Lamellaxis guatemalense* (Crosse and Fischer, 1877), *Leptopeas guatemalense* (Strebel, 1882), *Thysanophora plagioptyca* (Shuttleworth, 1854) and *Xenodiscula taintori* Goodrich and Schalie, 1937.

Lucidella lirata (Pfeiffer, 1847) was the most frequently recorded helicinid species at the southeastern end of Selva Lacandona but was sporadic in other parts of Chiapas.

Helicina amoena Pfeiffer, 1849 and *H. tenuis* Pfeiffer, 1849 were less frequently recorded than *Lucidella*. The other 30 species were represented by between 1 to 9 specimens each at only one or two of the 13 localities.

Helicina tenuis, *H. ghiesbreghti* Pfeiffer, 1856 and *H. amoena*, which are relatively widely distributed in Chiapas, were also found at Selva Lacandona and Guatemala (Hinkley, 1920; Goodrich and Schalie, 1937; Schalie, 1940).

A strong tropical component of the fauna recorded to date at the southeastern end of Selva Lacandona is indicated by the presence of the Helicinidae (8 species), Cyclophoridae (2 species) and Annnulariidae (1 species).

The total number of species previously recorded for Selva Lacandona, including those from this study, is 57 species (excluding specimens identified only to the generic level). Selva Lacandona shares 30 species in common with Guatemala and 14 species with Tabasco State (Table 2). Martens (1890-1901) and Bequaert (1957) considered the area, along with Veracruz, Tabasco, Yucatan, Chiapas and Guatemala (Martens) (Figure 2), and Chiapas and Guatemala (Bequaert) (Figure 3), to constitute a biogeographical unit. Our present state of knowledge of the terrestrial Mollusca of the area is still incomplete, but a long-term study of the terrestrial molluscs at Selva Lacandona or in the

State of Chiapas should provide more evidence supporting these two points of view. Furthermore, substratum, climate and type of vegetation are all factors having a strong influence on terrestrial mollusc distribution. Until now, no species found in the tropical deciduous forest in Oaxaca had been recorded in Chiapas, *e.g. Tryonigens remondi* (Tryon, 1863).

Conclusions:

Fourteen families and 33 species of terrestrial snails are recorded from the Montes Azules Biosphere Reserve in the Selva Lacandona. Of these, the Helicinidae is the most diverse family with eight species and the Subulinidae with six species. Seven species are recorded for the first time in Selva Lacandona and the state of Chiapas. *Lucidella lirata* is the most common species in the Montes Azules Reserve, followed by *Helicina amoena* and *H. tenuis*. The prosobranchs families Helicinidae (7 species), Cyclophoridae (2 species) and Annnulariidae (1 species) represent the tropical component of the fauna.

A total of 57 species is known to inhabit Selva Lacandona. Selva Lacandona shares 29 species with Guatemala and 13 species with Tabasco. The current malacofauna of the region has a close relationship with the fauna of Guatemala, and this supports the existence of a biogeographical unit that includes Veracruz, Tabasco, Yucatan, Chiapas and Guatemala as suggested by Martens (1890-1901), or a Chiapas-Guatemalan Subregion as proposed by Bequaert (1957). Further studies will provide a better panoramic understanding of the biogeography of the region and its land mollusc fauna.

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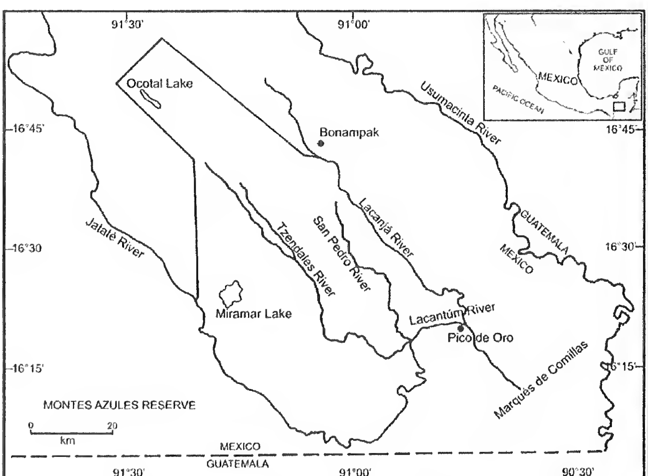


Figure 1. Location of the Montes Azules Biosphere Reserve in Chiapas, Mexico (shaded area).

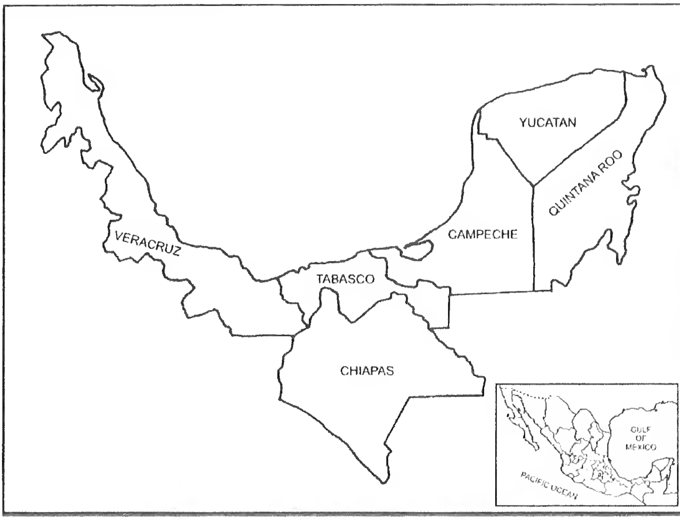


Figure 2. Martens (1890-1901) considered Veracruz, Tabasco, Yucatan, Chiapas and Guatemala to represent a single biogeographical unit.

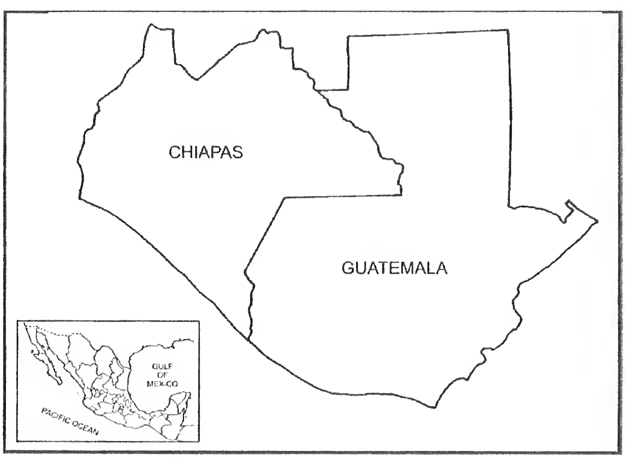


Figure 3. Bequaert's (1957) idea of a single biogeographical unit covering Chiapas and Guatemala.

Table 1. Terrestrial mollusc species found at the Montes Azules Biosphere Reserve (Reserva Ecológica de Montes Azules), Chiapas, Mexico. Sites 1 through 7 are: 1) Arroyo San Pablo; 2) Arroyo Manzanares; 3) Río Chajul; 4) Arroyo Miranda; 5) Arroyo Lagarto; 6) Río Tzendales; 7) confluenence of Rio San Pedro/Tzendales. Table 1 continues on the following page with Sites 8 through 13. Abbreviations: c = shell; juv = juvenile; liv = live; frag = fragment.

Family/species Site and date	1 [Dec 08]	3 [May 09]	4 [Dec 08]	5 [Oct 10]	6 [Dec 08]	6 [Feb 10]	6 [Oct 10]	7 [May 08]	7 [May 09]	7 [Feb 10]
Helicinidae										
Helicina (*Oxyrhombus*) *amoena* Pfeiffer, 1849	-	1c	2c	-	-	-	-	-	-	-
H. (*Tristramia*) *punctisulcata punctisulcata* Martens, 1890	-	1c	-	-	-		-	-	-	-
Helicina (*T.*) *tenuis* Pfeiffer, 1849	-	4c	-		-	-	-	-	-	-
Helicina spp.		7c								
Lucidella (*Poenia*) *lirata* (Pfeiffer, 1847)	-	45c	13c	-	3c	4c	-	7c	3c	3c
Cyclophoridae (Neocyclotidae of Thompson, 2008)										
Amphicyclotus palenquensis (Pilsbry, 1935)	1c	-	-	-	-	-	-	-	-	-
Succineidae	-	-	-	1 liv	-	-	-	-	-	-
Orthalicidae										
Drymaeus sp.	-	1c	-	-	-	-	-	-	-	-
Subulinidae	-	-	-	-	-	-	-	2 frag	-	-
Allopeas gracile (Hutton, 1834)	-	3c	-	-	-	-	-	-	-	-
Lamellaxis guatemalensis guatemalensis (Crosse and Fischer, 1877)	-	2c	-	-	-	-	-	-	-	-
Lamellaxis martensi martensi (Pfeiffer, 1856)	-	-	-	-	-	-	1c juv	-	-	-
Lamellaxis sp.	-	-	-	-	-	-	-	-	2c	-
Leptopeas guatemalense guatemalense (Strebel, 1882)	-	6c	-	-	-	-	-	-	-	-
Leptopeas micra (D'Orbigny, 1835)	-	4c, frag	-	-	-	-	-	-	-	-
Charopidae										
Rotadiscus sp.	-	-	-	-	-	-	-	1c	-	-
Zonitidae										
Hawaiia minuscula (Binney, 1840)	-	1c	-	-	-	-	-	-	-	-
Cf. Retinella sp.	-	5c	-	-	-	-	-	-	-	-
Polygyridae										
Polygyra yucatanea (Morelet, 1849)	-	4c	-	-	-	-	-	-	-	-
Thysanophoridae										
Thysanophora (*Lyroconus*) *plagioptycha* (Shuttleworth, 1854)	-	1c	-	-	-	-	-	-	-	-

Table 1, continued. Terrestrial mollusc species found at the Montes Azules Biosphere Reserve (Reserva Ecológica de Montes Azules), Chiapas, Mexico. Sites 8 through 13 are: 8) Chajul Biological Station I; 9) Arroyo José; 10) Poblado Playón de la Gloria; 11) Río Lacantún; 12) Arroyo Tehuacán; 13) Chajul Biological Station, trail La Hamaca, *ca.* 100 m from installations. Abbreviations: c = shell; juv = juvenile; liv = live; frag = fragment.

Family/species Site and date	8 [May 08]	8 [Dec 08]	8 [May 09]	9	9 [Dec 08]	9 [Feb 10]	12	13	13 [Dec 08]	13 [May 09]
Helicinidae										
Helicina (Oxyrhombus) amoena Pfeiffer, 1849	3c	23c	-	-	-	-	1c	1c	-	-
H. (Tristramia) delicatula Shuttleworth, 1852	-	1c	-	-	-	-	-	-	-	-
H. (T.) punctisulcata punctisulcata Martens, 1890	-	2c	-	-	-	-	-	-	-	-
Helicina (T.) tenuis Pfeiffer, 1849	-	5c	-	-	-	-	-	-	-	-
Helicina sp.	2c	-	-	-	-	-	-	-	-	-
Lucidella (Poenia) lirata (Pfeiffer, 1847)	4c 1 liv	23c	-	1 liv	-	2 liv 1c	-	-	-	-
Lucidella sp.	2c	-	-	-	-	-	-	-	-	-
Cyclophoridae (Neocyclotidae of Thompson, 2008)										
Neocyclotus dysoni cf. ambiguus (Martens, 1890)	-	7c	-	-	1c	-	-	-	-	-
Carychiidae										
Carychium mexicanum Pilsbry, 1891	-	-	-	-	-	-	-	1c	-	-
Orthalicidae										
Orthalicus boucardi Pfeiffer, 1860	-	2 c	-	-	-	-	-	-	-	-
Orthalicus sp.	-	-	-	-	-	-	-	2c	-	-
Drymaeus sp.	1c frag	-	-	-	-	-	-	-	-	-
Subulinidae										
Leptopeas micra (D'Orbigny, 1835)	1c	-	-	-	-	-	-	-	-	-
Spiraxidae										
Euglandina (Singleya) ghiesbreghti (Pfeiffer, 1856)	-	-	-	-	-	-	-	3c	-	-
Euglandina sp.	-	1c	1c	-	-	-	-	2c	1c	1c
Euconulidae										
Guppya sp.	3c	-	-	1iv Dec08	-	-	-	-	-	-
Zonitidae										
Retinella 2	2c	-	-	-	-	-	-	-	-	-
Sagdidae										
Xenodiscula taintori Goodrich and van der Schalie, 1937	-	-	-	-	-	-	-	1c	-	-
Xanthonichidae										
Trichodiscina coactiliata (Deshayes in Férussac, 1838)	-	1c	-	-	-	-	-	-	-	-
Thysanophoridae										
Thysanophora (Setidiscus) impura (Pfeiffer, 1866)	-	-	-	-	-	-	-	1c	-	-

Table 2. Terrestrial molluscs from Chiapas, Tabasco, Oaxaca and Guatemala by author, with some remarks.

Family / species	Morelet	Fischer & Crosse	Martens	Strebel	Schalie (1940)	Recorded at Guatemala	Bequaert	Avendaño *et al.*	Naranjo-García [this paper]	Tabasco
Helicinidae										
Helicina (*Oxyrhombus*) *amoena* Pfeiffer, 1849	-	-	-	-	X	Hinkley	X	X	X	-
H. (*Tristramia*) *delicatula* Shuttleworth, 1852	-	Oax	-	-	-	-	-	-	X	-
H. (*T.*) *zephyrina deppeana* Martens, 1863	-	Oax	-	-	-	-	-	-	-	-
H. (*O.*) *ghiesbreghti* Pfeiffer, 1856	-	X	Chis	-	-	-	X	-	-	Rangel – R. & Gamboa 2001, Rangel-R. *et al.* 2004
H. (*Succincta*) *flavida flavida* Menke, 1828	-	X	Chis	-	X	Hinkley	X	-	-	-
H. (*Gemma*) *fragilis fragilis* Morelet, 1851	-	-	-	-	-	Hinkley	-	-	-	-
H. (*T.*) *punctisulcata punctisulcata* Martens, 1890	-	-	-	-	-	-	-	-	X	-
H. (*T.*) *rostrata rostrata* Morelet, 1849	-	-	-	-	-	Hinkley	-	X	-	-
H. (*T.*) *tenuis* Pfeiffer, 1849	-	X	Chis	-	X	-	X	-	X	Rangel-R. & Gamboa 2001
H. (*Succincta*) *oweniana oweniana* Pfeiffer, 1849	-	X	Chis	-	X	-	X	X	-	Rangel-R. & Gamboa 2001, Rangel-R. *et al.* 2004
H. (*S.*) *o. coccinostoma* Morelet, 1849	-	-	-	-	-	Hinkley	-	X	-	-
Lucidella (*Poenia*) *lirata* (Pfeiffer, 1847)	-	-	Chis	-	-	Hinkley	X	X	X	Rangel-R. & Gamboa 2000, 2001, Rangel-R. *et al.* 2004
Pyrgodomus microdinus microdinus (Morelet, 1851)	-	-	-	-	-	Hinkley	-	-	-	-
Schasicheila (*Atoyac*) *alata* (Pfeiffer, 1849)	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa 2001
Sch.(*Necaxia*) *minuscula* (Pfeiffer, 1859)	-	-	-	-	X	-	-	-	-	-
Sch. (*Schasicheila*) *hinkleyi* Pilsbry, 1919	-	-	-	-	-	Hinkley	-	-	-	-
Sch. (*Sch.*) *nicoleti* Shuttleworth, 1852	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa 2001
Schasicheila (*Sch.*) *pannucea* (Morelet, 1849)	-	-	-	-	X	-	-	-	-	
Schasicheila (*Sch.*) *misantlensis* Fischer & Crosse, 1893	-	-	-	-	X	-	-	-	-	-

Sch. (*Sch.*) *walkeri* Hinkley, 1920	-	-	-	-	-	Hinkley	-	-	-	-
Cyclophoridae (=Neocyclotidae of Thompson, 2008)										
Amphicyclotus boucardi (Pfeiffer, 1856)	-	-	-	-	-	Hinkley	-	-	-	-
A. palenquensis (Pilsbry, 1935)	-	-	-	-	-	-	X	-	X	-
A. paulsonorum Thompson, 1969	-	-	-	-	-	-	-	-	-	-
A. texturatus (Sowerby, 1850)	-	-	-	-	X	-	-	X	-	-
Neocyclotus dysoni (Pfeiffer, 1851)	-	-	Chis	-		Hinkley	-	-	-	-
Neocyclotus dysoni ambiguus (Martens, 1890)	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa 2001
Neocyclotus dysoni cf. N. d. ambiguus (Martens, 1890)	-	-	-	-	-	-	-	X	X	-
N. d. aureus (Bartsch & Morrison, 1942)	-	-	-	-	-	-	X	-	-	-
Neocyclotus dysoni cooki (Bartsch & Morrison, 1942)	-	-	-	-	X	-	-	-	-	-
Neocyclotus bisinuatus (Martens, 1864)	-	-	-	-	X	Hinkley	-	-	-	-
Megalomastomatinae										
Tomocyclus gealei Crosse & Fischer, 1872	-	-	Chis	-	-	-	-	-	-	-
T. simulacrum (Morelet, 1849)	-	-	-	-	X	Hinkley	-	-	-	-
T. guatemalensis (Pfeiffer, 1851)	-	-	-	-	-	Bartsch & Morrison, 1942	-	-	-	-
Diplommatinidae										
Adelopoma stolli (Martens, 1890)	-	-	-	-	-	Hinkley	-	-	-	-
Annulariidae										
Chondropomatinae										
Chondropoma (*Chondropomium*) *rubicundum* (Morelet, 1849)	-	-	-	-	X	Hinkley	X	-	-	-
Annulariinae										
Choanopoma (*Choanopomops*) *martensianum* (Pilsbry, 1900)	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa, 2000; Rangel-R *et al.* 2004
Ch. (*Chps.*) *radiosum* (Morelet, 1849)	-	-	-	-	-	Hinkley	-	X	-	-
Ch. (*Chps.*) *terecostatum* Thompson, 1966	-	-	-	-	-	-	-	X	-	Rangel-R. & Gamboa, 2000; Rangel-R. *et al.* 2004
Choanopoma trochleare (Pfeiffer, 1851)	-	-	Chis	-	-	-	-	-	-	-
Carychiidae										
Carychium mexicanum Pilsbry, 1891	-	-	-	-	-	Hinkley	-	-	X	Rangel-R. & Gamboa, 2001
Veronicellidae										
Leidyula moreleti (Fischer, 1871)	Palenque	Palenq	Palenq	-	-	-	X	-	-	-
Succineidae										

Succinea recisa Morelet, 1851	-	-	Guat	-	-	Hinkley	-	-	-	-
S. undulata undulata (Say, 1829)	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa, 2000
Strobilopsidae										
Strobilops salvini (Tristam, 1863)	-	-	-	-	-	Martens	-	-	-	-
S. strebeli guatemalensis Hinkley, 1920	-	-	-	-	-	Hinkley	-	-	-	--
Pupillidae (= Vertiginidae)										
Bothriopupa breviconus Pilsbry, 1917	-	-	-	-	-	Hinkley	-	-	-	-
Pupisoma (Ptychopatula) dioscoricola dioscoricola (C.B. Adams, 1845)	-	-	-	-	-	Hinkley	-	-	-	-
Pupisoma (Pty.) dioscoricola insigne Pilsbry, 1920	-	-	-	-	-	Basch, 1959	-	-	-	-
Gastrocopta (Gastrocopta) pellucida hordeacella (Pilsbry, 1890)	-	-	-	-	-	Hinkley	-	-	-	-
Gastrocopta (Vertigopsis) pentodon (Say, 1822)	-	-	-	-	-	Hinkley	-	-	-	-
Orthalicidae										
Orthalicus boucardi Pfeiffer, 1860	-	-	-	-	-	-	-	-	X	-
Orthalicus princeps princeps (Broderip, 1833)	-	-	-	-	-	Hinkley	X	-	-	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
Orthalicus cf. zoniferus Strebel, 1882	-	-	-	-	-	-	-	-	-	-
Bulimulus corneus corneus (Sowerby, 1833)	-	-	-	-	-	Hinkley	-	-	-	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
Bulimulus unicolor (Sowerby, 1833)	-	-	-	-	-	Thompson, 1967	-	-	-	-
Drymaeus (Drymaeus) castus castus (Pfeiffer, 1846)	-	-	-	-	-	Hinkley	-	-	-	-
Drymaeus (D.) chiapensis chiapensis Pfeiffer, 1866)	-	Chis	Chis	Chis	-	-	-	-	-	-
D. (D.) emeus (Say, 1829)	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
D. (D.) lilacinus lilacinus (Reeve, 1849)	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa, 2001
D. (D.) moricandi hyalinoalbidus (Fischer & Crosse, 1875)	-	-	Chis	-	-	-	-	-	-	-
Drymaeus (Mesembrinus) dominicus (Reeve, 1850)	-	-	-	-	-	-	-	X	-	-
D. (M.) ghiesbreghti ghiesbreghti (Pfeiffer, 1866)	-	Chis	Chis	Chis	-	-	-	-	-	-
D. (M.) jonasi (Pfeiffer, 1846)	-	-	-	-	-	Hinkley	-	-	-	-

D. (M.) recluzianus recluzianus (Pfeiffer, 1847)	-	Chis	Chis	Chis	-	-	-	-	-	-
D. (M.) sulfureus (Pfeiffer, 1856)	-	-	-	-	-	Hinkley	-	-	-	Rangel-R. & Gamboa, 2001
Drymaeus (M.) translucens alternans (Beck, 1837)		-	-	-	-	Hinkley	-	-	-	-
Simpulopsis aenea Pfeiffer, 1861	-	Oax	-	-	-	-	-	-	-	-
Simpulopsis simula (Morelet, 1851)	-	-	-	-	-	-	X	-	-	-
Urocoptidae										
Eucalodium (E.) decollatum decollatum (Nyst, 1841)	-	-	-	-	-	Hinkley	-	-	-	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
E. (E.) mexicanum mexicanum (Pfeiffer, 1860)	-	Chis	Chis	Chis	-	-	-	-	-	-
Eucalodium (Resupinata) deshayesianum Crosse & Fischer, 1872	-	Chis	Chis	Chis	-	-	-	-	-	-
E. (Oligostylus) sumichrasti Crosse & Fischer, 1878	-	Chis	Chis	-	-	-	-	-	-	-
Eucalodium (O.) walpoleanum Crosse & Fischer, 1872	X	-	-	-	-	-	-	-	-	-
Anisospira (Anisospira) liebmanni (Pfeiffer, 1846)	-	-	Oax	Chis	-	-	-	-	-	-
C. (Coelocentrum) fistulare (Morelet, 1849)	-	-	-	-	-	Hinkley	-	-	-	-
C. (C.) gigas Martens, 1897	-	-	-	-	-	Hinkley	-	-	-	-
Coelocentrum (C.) tomacella clava (Pfeiffer, 1865)	-	Chis	Chis	Chis	-	-	-	-	-	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
Coelocentrum (C.) tomacella tomacella (Morelet, 1849)	Palenque	Palenq	Palenq	Palenq	-	-	X	X	-	-
Coelocentrum (C.) turris (Pfeiffer, 1856)	-	Chis	Chis	Chis	-	-	-	-	-	Rangel-R. & Gamboa, 2001
Epirobia berendti albida (Fischer & Crosse, 1873)	-	Chis	Chis	-	-	-	-	-	-	-
Epirobia gassiesi (Pfeiffer, 1867)	-	Chis	Chis	-	-	-	-	-	-	-
Epirobia polygyrella (Martens, 1863)	-	-	-	-	-	Hinkley	-	-	-	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
Epirobia berendti albida (Fischer & Crosse, 1873)	-	Chis	Chis	-	-	-	-	-	-	-
Brachypodella dubia (Pilsbry, 1891)	-	-	-	-	-	-	-	X	-	-
Brachypodella subtilis pulchella (Martens, 1886)	-	-	-	-	-	Hinkley	-	-	-	-

Microceramus concisus concisus (Morelet, 1849)	-	-	-	-	-	Hinkley	X	X	-	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
Ferussaciidae										
Cecilioides (*Karolus*) *consobrinus primus* (De Folin, 1870)	-	-	-	-	-	Hinkley	-	-	-	-
Subulinidae										
Allopeas gracile (Hutton, 1834)	-	X, Chis	Chis	Chis	X	-	X	-	X	-
Lamellaxis exiguus (Martens, 1898)	-	-	-	-	-	-	X	-	-	Rangel-R. & Gamboa, 2001
Lamellaxis guatemalensis guatemalensis (Crosse and Fischer, 1877)	-	-	-	-	-	Hinkley	-	-	X	-
Lamellaxis cf. L. martensi (Pfeiffer, 1856)	-	-	-	-	-	Basch, 1959	-	X	-	-
Leptinaria elisae Tristam, 1861	-	-	-	-	-	Hinkley	-	-	-	-
Leptinaria livingstonensis Hinkley, 1920	-	-	-	-	-	Hinkley	-	-	-	-
Leptopeas guatemalense guatemalense (Strebel, 1882)	-	-	-	-	-	-	-	-	X	-
Leptopeas micra micra (D'Orbigny, 1835)	-	-	-	-	-	Hinkley	-	X	X	Rangel-R. & Gamboa, 2000, 2001; Rangel-R. *et al.* 2004
Leptopeas semitriatum (Morelet, 1851)	Palenque	Palenq	Palenq	-	-	-	X	-	-	-
Opeas pumilum (Pfeiffer, 1840)	-	-	-	-	-	Hinkley	-	-	-	-
Subulina octona (Bruguière, 1789)	-	-	-	-	-	Hinkley	-	-	-	Rangel-R. & Gamboa, 2000, 2001
Beckianum beckianum beckianum (Pfeiffer, 1846)	-	-	-	-	X	Hinkley	X	-	-	-
Spiraxidae										
Guillarmodia (*Proameria*) *albersi albersi* (Pfeiffer, 1854)	-	-	-	-	-	-	-	X	-	-
Guillarmonia (*P*) *cordovana* (Pfeiffer, 1856)	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa 2001; Rangel-R. *et al.* 2004
Euglandina (*Cosmomenus*) *cumingi* (Beck, 1837)	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
Euglandina (*Singleya*) *decussata* (Deshayes, 1840)	-	-	-	-	-	Hinkley	-	X	-	-
Euglandina (*S.*) *ghiesbreghti* (Pfeiffer, 1856)	-	-	Chis	-	-	-	X	-	X	-

Varicoturris (*Varicoturris*) *dubia* (Pfeiffer, 1856)	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa, 2001
Varicoglandina monilifera monilifera (Pfeiffer, 1845)	-	-	Chis	-	-	Hinkley	-	-	-	-
Mayaxis chiapensis (Pfeiffer, 1856)	-	Chis	Chis	Chis	-	-	-	-	-	-
Mayaxis martensiana (Pilsbry, 1920)	-	-	-	-	-	Hinkley	-	-	-	-
Mayaxis mitescens (Martens, 1898)	-	-	-	-	-	Hinkley	-	-	-	-
Pseudosubulina salvini Martens, 1898	-	-	-	-	-	Hinkley	-	-	-	-
Pseudosubulina trypanodes (Pfeiffer, 1856)	-	Chis	Chis	-	-	-	-	-	-	-
Pseudosubulina (*Pseudosubulina*) *berendti gracilior* Martens, 1898	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa, 2001
Pseudosubulina (*Ps.*) *splendens* Thompson, 1959	-	-	-	-	-	Thompson, 1959	-	-	-	-
Salasiella (*Salasiella*) *subcylindrica* Pilsbry, 1903	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa, 2001
Salasiella (*S.*) guatemalensis Pilsbry, 1919	-	-	-	-	-	Hinkley	-	X	-	-
S. (*S.*) *pulchella* (Pfeiffer, 1856)	-	-	Chis	-	-	-	-	-	-	-
Salasiella sp.	-	-	-	-	-	-	-	X	-	-
Streptostyla (*Chersomitra*) *chiapensis* Pilsbry, 1909	-	Chis	Chis	-	-	-	-	-	-	-
Streptostyla (*Chr.*) *lurida* (Shuttleworth, 1852)	-	Chis	Chis	Chis	-	-	-	-	-	-
Streptostyla (*Chr.*) *nigricans* (Pfeiffer, 1845)	-	-	-	-	-	Hinkley	-	-	-	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
Streptostyla (*Peteniella*) *catenata* (Pfeiffer, 1856)	-	Chis	Chis	-	-	-	-	-	-	-
S. (*P.*) *ligulata* (Morelet, 1849)	Palenque	Palenq	Palenq	-	-	Hinkley	-	-	-	-
Streptostyla (*Streptostyla*) *biconica* Pfeiffer, 1856	-	Chis	Chis	-	-	-	-	-	-	-
S. (*Str.*) *delibuta* (Morelet, 1851)	-	-	-	-	-	Hinkley	-	-	-	-
S.(*Str.*) *lattrei* (Pfeiffer, 1845)	-	-	-	-	-	Hinkley	-	-	-	-
S. (*Str.*) *meridana* (Morelet, 1849)	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa, 2001
Streptostyla (*Str.*) *nebulosa* Dall, 1894	-	-	Chis	-	-	-	-	-	-	-
Streptostyla (*Str.*) *oblonga* (Pfeiffer, 1856)	-	Chis	Chis	-	-	-	-	-	-	-
Streptostyla (*Str.*) *shuttleworthi* (Pfeiffer, 1856)	-	Chis	Chis	Chis	-	-	-	-	-	-
Streptostyla (*Str.*) *turgidula guatemalensis* Fischer & Crosse, 1870	-	-	-	-	-	Hinkley	-	-	-	-
Streptostyla (*Str.*) *sololensis* Crosse and Fischer, 1869	-	-	-	-	-	Hinkley	-	-	-	-
Miraradula similaris (Strebel, 1882)	-	-	-	-	-	-	X	-	-	Rangel-R. & Gamboa, 2001

Volutaxis (*Volutaxis*) *livingstonensis* (Pilsbry, 1920)	-	-	-	-	-	Hinkley	-	-	-	-
Volutaxis (*V.*) *longior* (Pilsbry, 1920)	-	-	-	-	-	Hinkley	-	-	-	-
Volutaxis (*V.*) *scalariopsis* (Morelet, 1851)	-	-	-	-	-	-	X	-	-	-
Volutaxis (*V.*) *sulciferus* (Morelet, 1851)	Palenq	Palenq	Palenq	Palenq	-	-	X	-	-	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
Volutaxis (*V.*) *tenuis* Pfeiffer, 1868	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
Varicoturris dubia (Pfeiffer, 1856)	-	-	Chis	-	-	-	-	-	-	-
Pseudosubulina sargi Crosse & Fischer, 1877	-	-	-	-	-	Hinkley	-	-	-	-
Scolodontidae										
Drepanostomella stolli (Martens, 1892)	-	-	-	-	-	Hinkley	-	-	-	-
Miradiscops maya (Pilsbry, 1920)	-	-	-	-	-	Hinkley	-	-	-	-
Punctidae										
Punctum baschi Thompson, 1962	-	-	-	-	-	Thompson, 1962	-	-	-	-
Charopidae										
Chanomphalus cidarisca (Martens, 1892)	Palenque	-	Palenq	-	-	-	X	-	-	-
Chanomphalus pilsbryi (Baker, 1927)	-	-	-	-	-	Hinkley	X	-	-	-
Euconulidae										
Habroconus (*Ernstia*) *elegantula* (Pilsbry, 1919)	-	-	-	-	-	Hinkley	-	-	-	-
Habroconus (*Habroconus*) *championi* (Martens, 1892)	-	-	-	-	X	-	-	-	-	-
Habroconus (*Habrochonus*) *trochulinus* (Morelet, 1851)	-	-	-	-	-	Basch, 1959	-	-	-	-
Guppya gundlachi gundlachi (Pfeiffer, 1840)	-	-	-	-	-	Hinkley	-	-	-	-
Guppya gundlachi orosciana Martens, 1892	-	-	-	-	-	Basch, 1959	-	-	-	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
Gastrodontidae										
Zonitoides (*Zonitella*) *tehuantepecensis* (Crosse & Fischer, 1870)	-	Oax	-	-	-	-	-	-	-	-
Zonitidae										
Hawaiia minuscula (Binney, 1840)	Palenque	-	Palenq	-	-	Hinkley	X	-	X	-
Mesomphix (*Omphalina*) *zonites* (Pfeiffer, 1845)	-	Chis, Chiapa	Chis	-	-	-	-	-	-	-
Mesomphix (*O.*) *lucubratus lucubratus* (Say, 1829)	-	Oax	-	-	-	-	-	-	-	-
Mesomphix (*O.*) paradensis (Pfeiffer, 1860)	-	Oax	-	-	-	-	-	-	-	-
Mesomphix (*Zonyalina*) *bilineatus* (Pfeiffer, 1845)	-	-	-	-	-	-	X	-	-	-
Sagdidae										

Xenodiscula taintori Goodrich & van der Schalie, 1937	-		-	-	-	-	-	-	X	-
Xanthonichidae										
Leptariontinae										
Leptarionta bicincta (Pfeiffer, 1841)	-	Oax	-	-	-	-	-	-	-	-
Leptarionta trigonostoma trigonostoma (Pfeiffer, 1844)	-	-	-	-	-	-	X	-	-	Rangel R. & Gamboa, 2001; Rangel-R. *et al.* 2004
Tryonigens remondi (Tryon, 1863)	-	-	-	-	-	-	-	-	Oax	-
Lysinoinae										
Lysinoe ghiesbreghti ghiesbreghti (Nyst, 1841)	-	Chiapa	Chis	Chis	-	-	-	-	-	-
Trichodiscininae										
Miraverellia sargi (Crosse and Fischer, 1872)	-	-	-	-	-	Hinkley	-	-	-	-
Miraverellia sumichrasti (Crosse & Fischer, 1872)	-	Oax	-	-	-	-	-	-	-	-
Miraverellia verdensis (Dall, 1910)	-	Oax	-	-	-	-	-	-	-	-
Trichodiscina coactiliata (Deshayes in Férussac, 1838)	-	-	-	-	-	-	-	X	X	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004
Trichodiscina hinkleyi (Pilsbry, 1919	-	-	-	-	-	Hinkley	-	-	-	-
Trichodiscina oajacensis (Koch, 1842)	-	Oax	-	-	-	-	-	-	-	-
Semiconchula breedlovei Naranjo-García, 2003	-	-	-	-	-	-	-	-	Chis	-
Semiconchula custepecana Naranjo-García, Polaco and Pearce, 2000	-	-	-	-	-	-	-	-	Chis	-
Xanthonyx chiapensis (Pfeiffer, 1956)	-	-	-	-	-	-	X	-	-	-
Polygyridae										
Polygyra chiapensis (Pfeiffer, 1856)	-	Chis	Chis	-	-	-	-	-	-	-
Polygyra yucatanea (Morelet, 1849)	-	Chis	Chis	-	-	Hinkley	-	-	X	-
Thysanophoridae										
Microconus (Microconus) wilhelmi (Pfeiffer, 1866)	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa, 2001
Thysanophora (Thysanophora) conspurcatella conspurcatella (Morelet, 1851)	-	-	-	-	-	-	-	-	-	Rangel-R. & Gamboa, 2001
Thysanophora (Lyroconus) fuscula (C.B. Adams, 1849)	-	-	-	-	-	-	X	-	-	-
T. (L.) plagioptycha (Shuttleworth, 1854)	-	-	-	-	-	Hinkley	-	-	X	-
Thysanophora (Setidiscus) impura (Pfeiffer, 1866)	-	-	-	-	-	-	-	-	X	Rangel-R. & Gamboa, 2001; Rangel-R. *et al.* 2004

SOCIETY BUSINESS

Minutes of WSM Executive Board meeting, June 27, 2010

San Diego State University, San Diego, CA

- WSM President George Kennedy called the meeting to order, about 6 PM.
- Current and former WSM officers present include: Kelvin Barwick, Hans Bertsch, Carlos Cáceres Martínez, Esteban Félix-Pico, Nora Foster, George Kennedy, Janet Leonard, and Charles Powell, II.
- Secretary's report – minutes from two previous WSM executive board meetings and general business meeting in the 2009 annual report distributed at meeting. Read and it will be accepted at a later date.
- Tresaurer's report – Kelvin Barwick gave a brief run down on the financial health of the WSM (see attached). Motion to accept by Hans Bertsch, second by Nora Foster, passed unanimously.
    - Bills for the current meeting are still coming in but a preliminary review looks like we'll be in the black. Any profits will be split between the AMS and WSM as this is a joint meeting. To date between 110-115 people have registered for the current meeting.
    - 65 current WSM members
    - Motion by Hans Bertsch to send out dues notices in January (to be done by the treasurer who keeps the latest membership list), second by Nora Foster, passed unanimously.
- Slate of officers presented for 2010-2011 (2011 meeting year):
        - President – Esteban Félix Pico
        - 1st Vice-President – Janet Leonard
        - 2nd Vice-President – Wendy Enright
        - Treasurer – Kelvin Barwick
        - Secretary – Charles Powell, II
        - Members-at-Large – Hans Bertsch and Nora Foster
    - Motion to accept by Hans Bertsch, second by Nora Foster, passed unanimously.
- Student Grant Committee report – Nora Foster reported six proposals were reviewed during the past year and the committee suggested we fund the proposals by Robyn Mieko Dahl "Paleoecological controls on Ordovician gastropod evolution in Laurentia," for $1000, and Maria Meza-Lopez "Is community composition determined by biotic interactions between exotic and native aquatic plants and invertebrate herbivores," for $500.
    - George Kennedy appoints Hans Bertsch (chair), Carlos Cáceres Martínez, Nora Foster, and Jann Vendetti to be on the Student Grant Committee next year.
    - Announcement of new student grant(s) to go out in January.
- Kelvin Barwick discussed getting a computer domain for the WSM web site and blog. A motion by Hans Bertsch to use up to $250 to see what can be done towards developing a WSM web site, second by Janet Leonard, pass unanimously.
- Esteban Félix Pico described the upcoming 44th WSM meeting to be held at the Centro Interdisciplinario de Ciencas Marinas, La Paz, Baja California Sur, Mexico, June 27-30, 2011.
    - Discussion of problems facing the Mexican Malacological Society and their holding a joint meeting with the WSM in La Paz next year. Hans Bertsch and Janet Leonard

  will write a letter to the Mexican Malacological Society to invite their membership to join our meeting, but that the meeting will not be held jointly.
- Janet Leonard described the upcoming 45th WSM meeting to be held at the University of California at Santa Cruz, June 24-27, 2012.
  - Activities will include a public lecture on the opening day of the meeting, symposia, workshops, and field trip(s) either before or after the meeting.
- President George Kennedy thanks Kelvin Barwick and Hans Bertsch for their help with the current meeting.
- Preseident George Kennedy presents plans to have a box made with a plaque listing all the past WSM presidents to date. The box will house the current box that holds WSM gavel. The gavel has a silver band around its head with the names of the first 10 presidents of the Pacific Section of the American Malacological Union (now the WSM)
- Motion to adjourn by Nora Foster, second by Janet Leonard, pass unanimously.

Minutes of WSM General Business meeting, June 30, 2010

San Diego State Univeristy, San Diego, CA

- WSM President George Kennedy called the meeting to order at 3:35 P.M.
- Secretary's report – minutes from previous meeting in annual report (2009) distributed at meeting. All annual reports for the past five years are now published. Motion to accept by Pat LaFollette, second by Kelvin Barwick, passed unanimously.
- Treasurer's report – Kelvin Barwick gave brief run down on the financial health of the WSM (see attached). Motion to accept by Pat LaFollette, second by Chris Kitting, passed unanimously.
- Student Grant Committee report – Nora Foster reported six proposals were reviewed during the past year and the committee suggested we fund the proposals by Robyn Mieko Dahl "Paleoecological controls on Ordovician gastropod evolution in Laurentia" for $1000, and Maria Meza-Lopez "Is community composition determined by biotic interactions between exotic and native aquatic plants and invertebrate herbivores," for $500.
  - Donations were made by the Hans Bertsch ($104), Barbara Chaney ($50), C.L. Davis ($10), Jeff and Elise Goddard ($5), Jules and Carol Hertz ($25), Carol Hickman ($50), Chrisopher Kitting ($2), Pacific Conchological Club ($500), San Diego Shell Club ($300), Southwest Malacological Society (Arizona) (Mary Ellen Miller ($310)$300), Judith Terry Smith ($15), and the auction and reprint sale ($784) to help fund the Student Grants and everyone's help is greatly appreciated.
  - Donations for future grants can be directed to the WSM treasurer Kelvin Barwick.
- New Business
  - Kelvin Barwick discussed getting a computer domain for the WSM web site and blog (see notes from WSM Executive meeting June 27, 2010). Funding of up to $250 has been authorized by the board to follow up on web development.
- Best Student presentation awards
  - Poster – Logan D. Froman "Is a newly discovered chiton brooder on Santa Catalina Island an undescribed species?" (by L. D. Froman & D. J. Eernisse)
  - Paper – Roland C. Zepeta, "Morphometric analysis and diversity of chitons from the Oaxacan coast" (by R. C. Zepeta & A. Reyes Gómez)

- Slate of officers presented for 2010-2011 (2011 meeting year):
    - President – Esteban F. Félix Pico
    - 1st Vice-President – Janet L. Leonard
    - 2nd Vice-President – Wendy __. Enright
    - Treasurer – Kelvin L. Barwick
    - Secretary – Charles L. Powell, II
    - Members-at-Large – Hans Bertsch and Nora R. Foster
  - Motion to elect by Chris Kitting, second by Nora Foster, passed unanimously.
- Presentation by Janet Leonard on the upcoming 45th WSM meeting to be held at the University of California at Santa Cruz, June 24-27, 2012.
- Presentation by Esteban Félix Pico for the upcoming 44th WSM meeting to be held at the Centro Interdisciplinario de Ciencas Marinas, La Paz, Baja California Sur, Mexico, June 27-30, 2011.
- Outgoing president George Kennedy thanked Kelvin Barwick and Hans Bertsch for their help with the current meeting
- Motion to have the WSM Annual Reports submitted to the Biodiversity Heritage Library. Motion by Pat LaFollette, second by Ed Petuch, pass unaminously.
  - Note: 7/30/2010 – All WSM Annual Reports have been submitted to the Biodiversity Heritage Library for inclusion in their online library.
- George Kennedy suggested plans to have a new box made with a plaque of WSM presidents names to hold the old box and WSM gavel. Motion by George Kennedy, second by Nora Foster, passed unanimously.
- New WSM president Estiban Felix Pico takes over meeting.
- Motion to adjorn by Nora Foster, second by Janet Leonard, passed unanimously. Meeting adjourned 4:24 PM.

Treasurer's Report

March 6, 2011

Dear Members,

The WSM bylaws (Article VIII, Section 1) states that the fiscal calendar should be from January 1 to December 31. Last year's annual financial report covered the period from when I first took possession of WSM funds from the previous treasurer, December 12, 2008, to September 30, 2009. In order to bring to bring the WSM fiscal reporting back on schedule I have extended this year's report from October 1, 2009 through December 31, 2010. Next year's, as well as all subsequent reports, will follow the mandated fiscal calendar.

Below is a brief summary of the WSM's cash flows and balances for the period of October 1, 2009 through December 31, 2010.

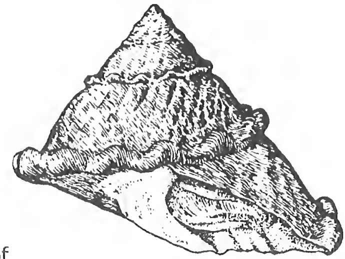
Sincerely,

Kelvin Barwick
WSM Treasurer

	Beginning Balance:	**$19,813.39**
Inflows		
2010 Conference	4,069.54*	
Individual Member Dues	1,626.00	
Institutional Member Dues	115.00	
Interest Earned	8.20	
Student Grant Fund	827.74	
	Total inflows:	**$6,646.48**
Outflows		
Bank Charges	26.80	
CA Nonprofit registry	20.00	
Merchandise (Conf. T- shirts)	179.76	
Office supplies	88.88	
Postage	88.00	
Report Production	1,497.30	
Student Awards	200.00	
	Total outflows:	**-$2,100.74**
	Cash Balance:	**$24,359.13**

* As per an agreement with the American Malacological Society any extra dollars from the 2010 Conference account would be split evenly. The amount above is the total that will be split.

First Announcement, 45th Annual Meeting



Western Society of Malacologists 2012

University of California at Santa Cruz
June 24-27, 2012

Contact: Janet L. Leonard

Joseph M. Long Marine Laboratory
Santa Cruz, CA 95060
Email: jlleonar@ucsc.edu

Venues

The 2012 WSM meeting will be held on the UCSC main campus. Accommodation will be available in one of the UCSC colleges (room and 3 meals/day at approx. $110-120/ day assuming a minimum of 30 attendees for at least 3 nights). The city of Santa Cruz has numerous hotels, motels and campgrounds for those who are not interested in on-campus accommodation. Parking will be free for those staying on campus and day passes will be available at approx. $5/day for commuters. Commuters will also have the opportunity to purchase meals at the dining hall individually. Talks and poster sessions will be held in UCSC classrooms and lecture halls. With sponsorship from a UCSC department, meeting rooms will be free but AV equipment will cost approx. $150/room/day.

Transportation

UCSC is located in the city of Santa Cruz in central California on the north shore of the Monterey Bay. Santa Cruz is located on US Hwy 1, the scenic Coast Highway, and is also connected to the Bay Area by CA Hwy 17. Train connections are provided by several Amtrak buses per day which serve Santa Cruz (see the Amtrak website: www.dot.ca.gov/rail/go/amtrak).

Four airports serve the Santa Cruz area;

- San Francisco International Airport (SFO) is 62 mi away (approx. 1.5 hr driving time)
- Oakland Airport (OAK) is 68 mi away (approx. 2 hr driving time)
- San Jose Airport (SJC) is 33 mi away (approx. 1 hr driving time). Van service from this airport to Santa Cruz locations is available for approx. $35.
- Monterey Peninsula Airport (MRY) is 45 mi away (approx. 1 hr driving time)

All of these airports have rental cars available.

Tentative Schedule

Sunday June 24: noon-9 pm. Arrival and check-in. Evening public lecture (speaker to be announced)

Monday June 25:
9 am – 5 pm. Symposium talks (40 min), Contributed talks (20 min).
7-9 pm. Poster session and reception.

Tuesday June 26:
9 am -5 pm Symposium talks (40 min); Contributed talks (20 min);
5:30 -6:30 Business Meeting
Evening: Banquet or BBQ

Wednesday June 27:
9 am-noon. Symposium talks (40 min)
Afternoon: Field Trips (TBA)

Goals of Meeting

The aim of the 2012 WSM meeting is provide a meeting place for all researchers and students interested in mollusks. Proposals for symposia (with list of speakers) and/or workshops focusing on specific research areas in molluscan biology are encouraged. The meeting is designed to attract students and biologists that use mollusks in their research but may not identify themselves as malacologists *per se*. By keeping the meeting short and using UCSC facilities costs will be reduced. An important function of WSM is provide students with a warm, friendly environment to present their research and we will encourage undergraduate as well as graduate students to participate. We will attempt to have a tentative schedule and complete list of symposia posted on the WSM website by Jan. 1 2012. The proposed public lecture on the first evening will hopefully be co-sponsored by UCSC, the Friends of the Long Marine Laboratory and perhaps the Santa Cruz Natural History Museum Museum. It will be advertised through the UCSC events calendar and the Santa Cruz media and should attract a broad audience. The tides will not be favorable for intertidal field trips during the time of the meeting but the Monterey Bay area offers opportunities for paleontological field trips and, if there is interest, it may also be possible to arrange guided visits to the Monterey Bay Research Institute and/or the Monterey Bay Aquarium.

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