



PROGRAM and ABSTRACTS
60th ANNUAL MEETING

Hyatt Regency Downtown

July 9 - 14, 1994

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AMERICAN MALACOLOGICAL UNION, INC.
Executive Council 1993-1994

PRESIDENT:	Constance E. Boone
PRESIDENT-ELECT:	E. Alison Kay
VICE-PRESIDENT:	Rudiger Bieler
SECRETARY-TREASURER:	David Hargreave
BULLETIN EDITOR:	Ronald B. Toll
COUNCILLORS-AT-LARGE:	Warren D. Allmon
	Arthur E. Bogan
	James F. Quinn
	Paul H. Scott
IMMEDIATE PAST PRESIDENTS:	Carole S. Hickman
	Robert C. Bullock
	Fred G. Thompson
PAST PRESIDENTS (4-10 YRS):	Alan J. Kohn
	James Nybakken
PAST PRESIDENTS (OVER 10 YRS):	Harold D. Murray
	Donald R. Moore
HONORARY LIFE PRESIDENT:	Harald A. Rehder

Honorary Life Members

R. Tucker Abbott	Harald A. Rehder	Ruth D. Turner
William K. Emerson	Margaret C. Teskey	J. Z. Young

AMERICAN MALACOLOGICAL UNION
Past Presidents

Henry A. Pilsbry	1931-32	Juan Jose Parodiz	1965
Paul Bartsch	1933	Ralph W. Dexter	1966
Junius Henderson	1934	Leo G. Hertlein	1967
William J. Clench	1935	Arthur H. Clarke	1968
Calvin Goodrich	1936	Joseph Rosewater	1969
Joshua L. Bailey, Jr.	1937	G. Alan Solem	1970
Carlos de la Torre	1938	David H. Stansbery	1971
Maxwell Smith	1939	Arthur S. Merrill	1972
Horace B. Baker	1940	Dolores S. Dundee	1973
Harald A. Rehder	1941	Harold D. Murray	1974
Frank C. Baker	1942	Donald R. Moore	1975
Louise M. Perry	1943-45	Dorothea S. Franzen	1976
Henry van der Schalie	1946-47	George M. Davis	1977
A. Myra Keen	1948	Carol B. Stein	1978
Elmer G. Berry	1949	William E. Old, Jr.	1979
Fritz Haas	1950	Clyde F.E. Roper	1980
Joseph P.E. Morrison	1951	Richard S. Houbrick	1981
Jeanne S. Schwengel	1952	Louise Russert-Kraemer	1982
A. Byron Leonard	1953	Alan J. Kohn	1983
Joseph C. Bequaert	1954	Robert Robertson	1984
Morris K. Jacobson	1955	Melbourne R. Carriker	1985
Allyn G. Smith	1956	James Nybakken	1986
Ruth D. Turner	1957	William G. Lyons	1987
Aurele LaRocque	1958	Richard E. Petit	1988
R. Tucker Abbott	1959	James H. McLean	1989
Katherine V. W. Palmer	1960	Roger T. Hanlon	1990
Thomas E. Pulley	1961	Carole S. Hickman	1991
William K. Emerson	1962	Robert C. Bullock	1992
Albert R. Mead	1963	Fred G. Thompson	1993
John Q. Burch	1964		

AMU 1993-1994 COMMITTEE CHAIRS

Nominating.....	Fred Thompson
Auditing and Budget.....	E. Alison Kay
Finance and Endowment.....	George Davis
Conservation.....	Arthur Bogan
Membership.....	Paul Scott
Archives.....	George Davis
Student award.....	Robert S. Prezant
Publications.....	Ron Toll
Constitutions, By-laws.....	Harold D. Murray
Auction and Bourse.....	Anne Joffe
T-shirts and Logo.....	Sue Stephens

MEETING ORGANIZERS AND SPONSORS

Gulf Symposium.....	Joseph C. Britton and John W. Tunnell, Jr.
Unionid Workshop.....	R. G. Howells
Houston Museum of Natural Science.....	Truett Latimer, President
Houston Conchology Society.....	Mary Martin (73-74) & Darwin Alder (74-75), Presidents
Sea Shell Searchers of Brazoria County.....	Dean Woodard, President
Fiesta.....	Virginia Joiner, Chair
Conchs' Country Caper.....	Jean Holman, Chair
Western Auctioneer.....	William H. Abbott
Reception Slides.....	Jean Holman, Chair

Local shell club members are handling registration, projection duties, T-shirt sales, decorations, and favors. We are grateful for this support.

We thank all donors for auction materials. We remind you funds resulting from the Tuesday night event augment the AMU Symposium Endowment. Come join the auction!

MEETING COURTESIES

- The free trolley (pick up & return on Dallas Street bordering north side of the Hyatt) and the free hotel courtesy van (inside motor driveway) will take you to shopping areas. The courtesy van will afford transportation to the Houston Museum of Natural Science by special arrangement (see Connie).
- Coffee and Danish are served for small fees in the lobby from 6:00 to 9:00 a.m.
- Request parking tokens when registering at hotel or at the AMU registration to receive discount on valet parking (\$6.50 per day) or all-day garage (no in or out) (\$3.50 per day).
- The entrance to the tunnel to underground shops and eating facilities is located on the northeast lobby area. Closed Saturday and Sunday. Open Monday-Friday 7:00 am. to 7:00 pm.
- The Hyatt's information desk is a mine for information on local and Texas areas to visit. Pick up some folders to help you enjoy Texas.
- Smoking will not be allowed in meeting rooms. Smoking is allowed in the hotel lobby.
- Speakers are urged to set up slides in trays before session to avoid delays and mix ups. Some trays will be available at the AMU registration desk.
- Let Connie know if you need something special to make your visit memorable!
- Please wear your badges to facilitate attending sessions, boarding buses, and generally identifying your participation in this meeting.



DOWNTOWN HOUSTON

LANDMARKS & HOTELS

- 1 ALLEN'S LANDING PARK
- 2 ALLEY THEATRE
- 3 CHRIST CHURCH CATHEDRAL
- 4 CITY HALL
- 5 DAYS INN-DOWNTOWN
- 6 DOUBLETREE HOTEL-ALLEN CENTER
- 7 FOUR SEASONS HOTEL
- 8 GEORGE R. BROWN CONVENTION CTR
- 9 HYATT REGENCY HOUSTON-DOWNTOWN
- 10 JONES HALL
- 11 JULIA IDESON LIBRARY
- 12 SAM HOUSTON PARK
- 13 TRANQUILITY PARK
- 14 WORTHAM CENTER

PROGRAM SUMMARY

Saturday, July 9

- 9:00-12:00 AMU Executive Council Meeting (closed) - Dogwood B
9:00-12:00 Set up Bourse, Exhibits, and Posters
1:00-5:00 Registration - Arboretum foyer, Regency Room side
1:00-5:00 T-shirts, AMU Publications - Library, Regency Room side
1:00-5:00 Bourse and Exhibits - Arboretum 3-5
1:00-5:00 Posters and Exhibits - Back portion of Regency Room
1:30-3:00 Conservation Committee - Arboretum 1-2
3:00 Refreshment Break - Foyer outside Arboretum 1-5
3:30-5:00 Council of Systematic Malacologists - Arboretum 1-2
7:00-9:00 President's Reception with food and liquid refreshments - Window Box

Sunday Morning, July 10

- 8:00-12:00 Registration - Arboretum foyer, Regency Room side
8:00-12:00 T-shirts, AMU Publications - Library
8:00-8:30 Opening Session - Regency Room
8:00-11:50 Posters and Exhibits - Back portion of Regency Room
8:25-11:50 Gulf of Mexico Symposium - Regency Room
8:30-11:50 Bourse and Exhibits - Arboretum 3-5
10:00 Refreshment Break - Foyer outside Arboretum 1-5
11:50 Break for photo - on stone steps across the street from Hyatt at Allen Center on Smith Street; take Motor Lobby exit to Smith Street
12:00 Group photo

Sunday Afternoon, July 10

- 1:30-4:30 Registration, T-shirts, AMU Publications - Library Room
1:30-4:30 Gulf Symposium - Regency Room
1:30-4:30 Bourse and Exhibits - Arboretum 3-5
1:30-4:30 Posters and Exhibits - back of Regency Room
1:30-4:30 Contributed Paper Session - Arboretum 1-2
2:40-3:10 Refreshment Break - Arboretum foyer
4:45 Departure for ranch party; board buses at hotel entrance on Louisiana Street

Monday Morning, July 11

8:30-12:00 Registration, T-shirts, AMU Publications - Library Room
8:30-11:50 Gulf Symposium - Regency Room
8:30-12:10 Mussel Workshop - Arboretum 1-2
8:30-12:00 Bourse and Exhibits - Arboretum 3-5
8:30-12:00 Posters and Exhibits - back of Regency Room
9:50-10:20 Refreshment Break - Arboretum foyer
12:00 Lunch Break

Monday Afternoon, July 11

1:30-5:00 Registration, T-shirts, AMU Publications - Library
1:30-4:30 Gulf Symposium - Regency Room
1:30-5:00 Mussel Workshop - Arboretum 1-2
1:30-5:00 Bourse and Exhibits - Arboretum 3-5 (closes down at 5pm)
1:30-5:00 Posters and Exhibits - back of Regency Room
2:55-3:20 Refreshment Break - Arboretum foyer
6:00-6:30 Depart by shuttle bus to Houston Museum of Natural Science for Fiesta evening
8:30-9:00 Return to hotel

Tuesday Morning, July 12

8:30-11:50 Mussel workshop - Arboretum 1-2
8:30-12:00 Breakdown for Bourse exhibitors
8:30-12:00 Gulf Symposium - Regency Room
8:30-12:00 Posters and Exhibits - back of Regency Room
9:00-12:00 Registration, T-shirts, Publications - Library Room
9:50-10:20 Refreshment Break - Arboretum foyer
12:00 Lunch Break

Tuesday Afternoon, July 12

1:30-4:00 Mussel Workshop - Arboretum 1-2
1:30-3:40 Contributed Papers - Regency Room
3:00 Refreshment Break
3:40-5:00 Meet with Poster and Exhibit presenters - Regency Room
4:00-6:00 Editor's Meeting - Boardroom, Arboretum
6:00 Dinner Break
7:00-9:30 Annual Book and Shell Auction - Regency Room

Wednesday Morning, July 13

- 8:30-12:00 Contributed Papers - Arboretum 1-2
- 8:30-12:00 Contributed Papers - Regency Room
- 8:30-12:00 Final Registration, T-shirts, AMU Publications - Library Room
- 10:00-10:20 Refreshment Break - Arboretum foyer
- 12:00 Lunch Break

Wednesday Afternoon, July 13

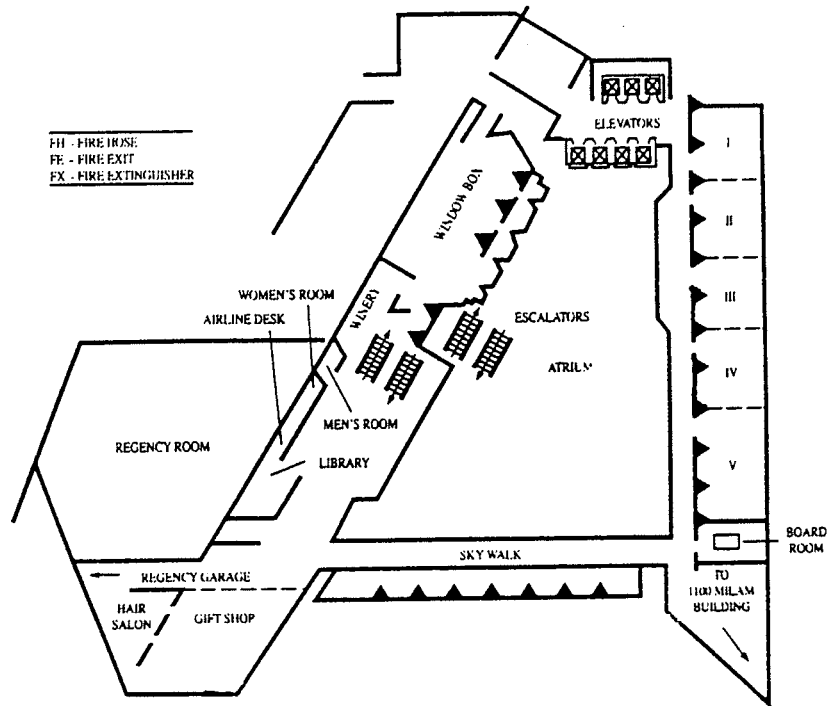
- 1:00 Group Photos for distribution at 1:00 in Library Room
- 1:00-3:00 Removal of Posters and Exhibits from Regency Room
- 1:30-3:00 Contributed papers - Arboretum 1-2
- 3:00-3:30 Refreshment Break - Arboretum foyer
- 3:30-4:30 AMU Annual Meeting - Arboretum 1-2
- 7:00-8:00 Cash bar preceding banquet - Regency Room
- 8:00-10:00 Conchs' Country Caper: dinner, music, entertainment

Thursday, July 14

- 7:00-late afternoon
Fossil field trip to Bryan and Stone City Formation. Board van in front of Hyatt on Louisiana Street.
- 8:00-early afternoon
Picnic provided and beach walk, Surfside.
Board van in front of Hyatt on Louisiana Street.
- 8:00-mid afternoon
Mussel field trip: Board vans or bus in front of Hyatt on Louisiana Street.
- 8:00-early afternoon
UTMB Cephalopod labs, beach visit, and stop to buy fish lunch. Board bus in front of Hyatt on Louisiana Street.
- 9:00-5:00
Malacological collections will be open at Houston Museum of Natural Science. Contact Connie Boone for information and transportation.

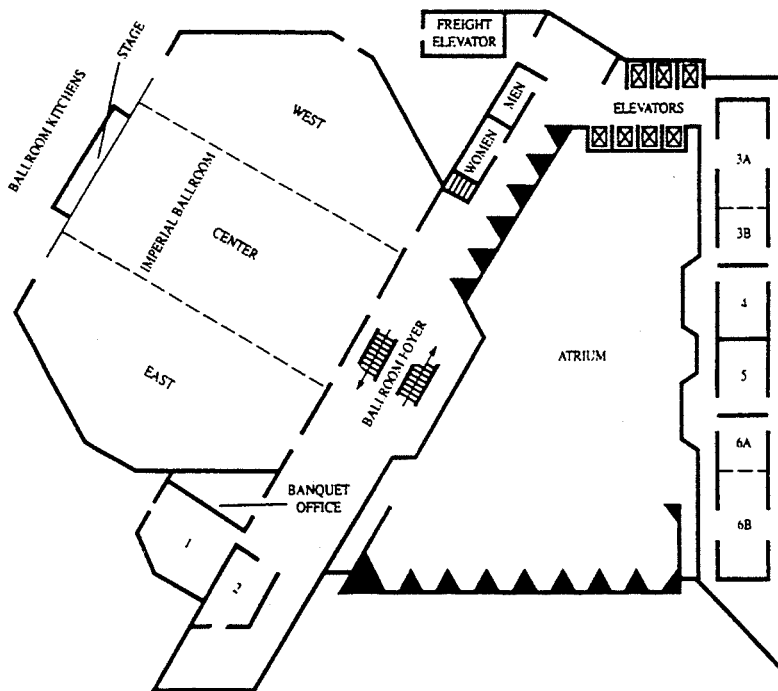
Friday, July 15

- 9:00-5:00
Malacological collections will be open at Houston Museum of Natural Science for anyone wishing to visit. Contact Connie Boone for information and transportation.



SECOND LEVEL

I-V (1-5), Arboretum, Regency, Registration, Bourse, T-shirts, Posters



THIRD LEVEL

6B - Dogwood (Council Meeting)

* Presenters

** Student presenter, candidate for best student paper award

Sunday Morning, July 10

OPENING OF MEETING AND GULF SYMPOSIUM - Regency Room

- 8:00-12:00 Registration - Arboretum foyer, Regency Room
- 8:00-12:00 T-shirts, AMU Publications - Library Room; Bourse open - Arboretum 3-4
- 8:00-8:25 Opening of meeting and Gulf Symposium - Regency Room.
President: Constance E. Boone
Introduction of special sponsors
Introduction of Symposium organizers
Opening remarks by J. C. Britton, Symposium organizer and chairperson of session
- 8:25-8:50 FROM THE BIG BEND TO ST. JOE: A SURVEY OF MARINE MOLLUSCS OF THE NORTHEASTERN GULF OF MEXICO
James H. Keeler, Tallahassee, Florida
- 8:50-9:15 ECOLOGY OF INFAUNAL MOLLUSCA IN SOUTH TEXAS BAYS
Paul A. Montagna* and **Richard D. Kalke**, University of Texas at Austin, Marine Science Institute, Port Aransas, Texas
- 9:15-9:40 ORIGIN AND COMPOSITION OF THE MOLLUSK FAUNA OF THE NORTHWESTERN GULF OF MEXICO
H. Odé, 3319 Big Bend Tr., Austin, Texas
- 9:40-10:00 MOLLUSKS IN GULF OF MEXICO COASTAL LAGOONS: A COMMUNITY ANALYSIS
Martha Reguero and **Antonio Garcia-Cubas**, Universidad Nacional Autónoma de Mexico, Instituto de Ciencias del Mar y Limología, Mexico D. F.
- 10:00-10:20 Refreshment Break - Arboretum foyer
- 10:20-10:40 HOW MANY SPECIES OF GASTROPODS ARE ENDEMIC TO THE GULF OF MEXICO?
Gary Rosenberg, Academy of Natural Sciences, Philadelphia PA.
- 10:40-11:00 MOLLUSKS OF THE CORAL REEFS OF VERACRUZ, MEXICO
Antonio Garcia-Cubas and **Martha Reguero**, Universidad Nacional Autónoma de Mexico, Instituto de Ciencias del Mar y Limología, Mexico D. F.
- 11:00-11:25 ECOLOGICAL DISTRIBUTION OF MOLLUSKS ON ALACRAN REEF, CAMPECHE BANK, YUCATAN, MEXICO
J. W. Tunnell, Jr.* and **David W. Hicks**, Center for Coastal Studies, Texas A&M University, Corpus Christi, Texas
- 11:25-11:50 SOME INTERESTING MOLLUSKS FROM MARINE WATERS OFF THE COAST OF ALABAMA
Douglas N. Shelton, Barry A. Vittor & Associates, Inc., Mobile Alabama
- 11:50-1:30 Break for photo and lunch

Sunday Afternoon, July 10
GULF SYMPOSIUM continued
Chairperson: Ernesto Chavez

- 1:30-1:50 **MOLLUSCA OF SOUTHWESTERN GULF OF MEXICO ROCKY SHORES, VERACRUZ, MEXICO**
Sandra A. Alvarado* and **Dennis Rocha**, Center for Coastal Studies, Texas A&M University - Corpus Christi, Texas
- 1:50-2:15 **THE MICROMOLLUSCAN FAUNA OF THE EAST FLOWER GARDEN BANK, NORTHWESTERN GULF OF MEXICO**
Carl R. Beaver**, Center for Coastal Studies, Texas A&M University - Corpus Christi, Texas
- 2:15-2:40 **LONG TERM HISTORY OF GULF OF MEXICO HYDROCARBON SEEP BIVALVE COMMUNITIES**
Kenneth A. Warren*, and **Eric N. Powell**, Department of Oceanography, Texas A&M University, College Station, Texas
- 2:40-3:00 Refreshment Break - Arboretum foyer
- 3:00-3:25 **MEXICAN OYSTER RESOURCES. A GENETIC CONSIDERATION FOR THEIR IMPROVEMENT AND EXPLOITATION IN GULF OF MEXICO**
Faustino Rodriguez-Romero, Instituto de Ciencias del Mar y Limnologia, UNAM, Mexico, D. F.
- 3:25-3:45 **INTERACTION OF FOOD QUANTITY, WATER FLOW AND POPULATION DENSITY ON FOOD AVAILABILITY TO OYSTER POPULATIONS: FIELD AND MODELING RESULTS**
Elizabeth A. Wilson-Ormond* and **Eric N. Powell**, Department of Oceanography, Texas A & M University, College Station, Texas
- 3:45-4:10 **THE USE OF ARCHAEOLOGICAL OYSTER DEPOSITS IN THE DETERMINATION OF PREHISTORIC ENVIRONMENTAL CONDITIONS OF THE CENTRAL TEXAS COAST**
Susan A. Cox**, Center for Coastal Studies, Texas A&M University - Corpus Christi, Texas
- 4:10-4:30 **LA OSTRICULTURA EN EL GULFO DE MEXICO: PROBLIMATICA Y PERSPECTIVAS**
Dalila Aldana Aranda, **Eduardo Garcia-Santaella**, and **Thierry Brule**, Laboratory of Marine Biology, Cinvestavipn Unit Merida, Yucatan, Mexico
- 4:30 Break for Ranch Party

Sunday Afternoon, July 10
CONTRIBUTED PAPERS SESSION - Arboretum 1-2
Chairperson: Elizabeth L. Raiser

- 1:30-1:55 UNIONIDS AND MARGARITIFERIDS IN THE SAINT CROIX RIVER,
AFTON AND WILD RIVER STATE PARKS, MINNESOTA, 8-17 JUNE
1992
Marian E. Havlik, Malacological Consultants, La Crosse, WI.
- 1:55-2:20 A NEW SUBGENUS OF *PHILOMYCUS* (GASTROPODA:
PHILOMYCIDAE) FROM KENTUCKY
Lee F. Fairbanks, Pennsylvania, State University, Monaca, PA.
- 2:20-2:45 THE FRESHWATER GASTROPOD FAUNA (MOLLUSCA) OF THE
CAHABA AND COOSA RIVER DRAINAGES IN ALABAMA
Art Bogan*, Freshwater Molluscan Research, Sewell, New Jersey; **Pierson, J. Malcolm**,
Calaria, AL., and **Hartfield, Paul**, U. S. Fish and Wildlife Service, Jackson, MS.
- 2:45--3:05 RELATIONSHIPS AMONG UNIONACEAN MUSSELS ASSESSED
WITH MITOCHONDRIAL DNA SEQUENCE VARIATION.
Margaret Mulvey*, Savannah River Ecology Lab, Aiken, S. C.; **Charles Lydeard**,
University of Alabama, Tuscaloosa, AL, **Debra L. Pyer**, Savannah River Ecology
Laboratory; and **George Davis**, Academy of Natural Sciences, Philadelphia, PA.
- 3:05-3:30 Refreshment Break - Arboretum foyer
- Chairperson: Margaret Mulvey**
- 3:30-3:55 THE FRESHWATER MUSSELS OF VENEZUELA (UNIONACEA
& MUTELACEA): THE FIRST CUT
Kevin S. Cummings* and **Christine A. Mayer**, Illinois Natural History Survey,
Champaign, IL.
- 3:55-4:20 ANALYSIS OF LAB AND FIELD TECHNIQUES OF FECUNDITY
STUDY FOR *TULOTOMA MAGNIFICA* (GASTROPODA:
PROSOBRANCHIA: VIVIPARIDAE).
Elizabeth L. Raiser**, Florida Museum of Natural History, Gainesville, FL.
- 4:20 Break to depart for ranch party

Monday Morning, July 11
GULF SYMPOSIUM continued
Chairperson: Jerry Harasewych

- 8:30-8:55 MOLECULAR MARKERS AND THE BIOGEOGRAPHY OF *DONAX*
Laura Adamkewicz*, George Mason University, Fairfax, VA, and **M. G. Harasewych**,
National Museum of Natural History, Smithsonian Institution, Washington D. C.
- 8:55-9:15 THE POPULATION GENETICS OF *LITTORINA IRRORATA*:
IS FLORIDA THE BOUNDARY IT SEEMS?
Robert T. Dillon, Jr.* and **Nathan S. Dayan**, Department of Biology, College of
Charleston, SC.
- 9:15-9:35 REGULATION OF CARDIAC CONTRACTILITY IN *GEUKENSIA*
DEMISSA GRANOSISSIMA
Daniel W. Duhon and **Lewis E. Deaton**, University of Southwestern Louisiana,
Lafayette, LA.
- 9:35-9:55 RELATIONSHIP OF POLAR FATTY ACID ON GROWTH RATE OF
STROMBUS COSTATUS (G.) LARVAE FED WITH MICROALGAL DIETS
Luis A. Rodriguez, University of Puerto Rico, Department of Marine Sciences,
Mayaguez, P.R.
- 10:00-10:20 Refreshment Break - Arboretum foyer
- 10:20-10:45 EXAMINATION OF THE HYPOBRANCHIAL GLAND OF THE
SOUTHERN OYSTER DRILL *STRAMONITA HAEMASTOMA*
CANALICULATA (PROSOBRANCHIA: MURICIDAE)
Richard A. Roller, Center for Coastal Marine Studies, Dept. of Biology, Lamar
University, Beaumont, Texas
- 10:45-11:10 CONGRUENCE BETWEEN RADULAR CHARACTERISTICS AND
CONCHOLOGICAL ON SPECIES OF THE FAMILY MURICIDAE
(GASTROPODA: NEOGASTROPODA)
Zoila G. Castillo, Instituto de Ciencias del Mar y Limnologia, UNAM, Mexico D. F.
- 11:10-11:35 A REVIEW OF THE SEA HARES (GASTROPODA:
OPISTHOBRANCHIA) OF THE NORTHWESTERN GULF OF MEXICO
Ned E. Strenth* and **Leigh H. O'Connor**, Department of Biology, Angelo State
University, San Angelo, Texas
- 11:35-11:50 TAPHONOMY OF SUBSURFACE HOLOCENE SHELL BEDS ON THE
NORTHEASTERN GULF OF MEXICO SHELF
Laurie C. Anderson*, Department of Geology and Geophysics and **Randolph A.**
McBride, Coastal Studies Institute, Louisiana State University, Baton Rouge, LA.
- 11:50 Break for lunch

Monday Morning, July 11
AMU MUSSEL WORKSHOP - Arboretum 1-2
Organizer: Robert G. Howells

- 8:30-8:40 Introduction and greeting, Robert G. Howells
- 8:40-9:10 AN INTRODUCTION TO BIOCHEMICAL GENETICS AND ELECTROPHORETIC ANALYSIS
R. G. Howells*, Texas Parks and Wildlife Department, Heart of the Hills Research Station, Ingram, Texas
- 9:10-9:20 Questions
- 9:20-9:40 ELECTROPHORETIC EXAMINATION OF SELECTED UNIONIDS FROM TEXAS
R. G. Howells* and **D. Van Meter**, Texas Parks and Wildlife Dept., Heart of the Hills Research Station, Ingram, Texas
- 9:40-9:50 Questions / Discussion
- 9:50-10:10 Refreshment Break - Arboretum foyer
- 10:10-10:30 GENETIC VARIATIONS WITHIN AND AMONG POPULATIONS OF THE FRESHWATER MUSSEL, *ANODONTA GRANDIS GRANDIS*, IN COLORADO.
Hsiu-Ping Liu**, University of Colorado, Department of Environmental, Population, and Organism Biology, Boulder, CO.
- 10:30-10:40 Questions
- 10:40-11:00 FACTORS MAINTAINING DIVERSITY OF FRESHWATER MUSSELS IN THE UPPER CLINCH RIVER, VIRGINIA/TENNESSEE
Brenda Rashleigh, Environmental Sciences Division, Oak Ridge National Laboratory, Oakridge, TN.
- 11:00-11:10 Questions
- 11:10-11:30 OBSERVATIONS OF THE MOLLUSKS OF HUNTER CREEK, CONECUH COUNTY, ALABAMA
Douglas N. Shelton, Barry A. Vittor & Associates., Inc. Mobile AL.
- 11:30-11:40 Questions
- 11:40-12:00 GPS USE DURING A 1992 UNIONID MOLLUSK BRAIL AND DIVE SURVEY, LOWER OHIO RIVER MILE 938.9 TO 981.0, PADUCAH, KY. TO CAIRO, IL.
Marian Havlik, Malacological Consultants, 1603 Mississippi St., La Crosse, WI.
- 12:00-12:10 Questions
- 12:10 Lunch Break

Monday Afternoon, July 11
GULF SYMPOSIUM continued - Regency Room
Chairperson: John W. Tunnell, Jr.

- 1:30-1:50 THE ESTUARINE CLAM *RANGIA CUNEATA* AS A STANDARD MONITOR OF HAZARDOUS SUBSTANCES IN GULF COAST ESTUARIES AND INLAND WATERS: DIOXINS AND FURANS
Richard C. Harrel* and **M. A. McConnell**, Lamar University, Beaumont, Texas
- 1:50-2:10 THE ESTUARINE CLAM *RANGIA CUNEATA* AS A STANDARD MONITOR OF HAZARDOUS SUBSTANCES IN GULF COAST ESTUARIES AND INLAND WATERS: HEAVY METALS
Marc. A. McConnell and **R. C. Harrel***, Lamar University, Beaumont, Texas
- 2:10-2:30 THE ESTUARINE CLAM *RANGIA CUNEATA* AS A STANDARD MONITOR OF HAZARDOUS SUBSTANCES IN GULF COAST ESTUARIES AND INLAND WATERS: EFFECTS OF REPRODUCTIVE PHASE ON SURVIVAL
R. M. Masters, **M. A. McConnell**, **R. Roller**, and **R. C. Harrel***, Lamar University, Beaumont, Texas
- 2:30-2:55 A DIMINISHING BRACKISH WATER CLAM (*RANGIA CUNEATA*) FISHERY AND PERSPECTIVES OF RECOVERY IN LAGOON OF POM, CAMPECHE, MEXICO
Francisco Arreguin-Sanchez, **Julia Ramos-Miranda**, **Julio A. Sanchez**, **Domingo Flores-Hernandez**, **Patricia Sanchez-Gil**, and **Alejandro Yanez-Arancibia**, Programa de Ecologia, Pesquerias y Oceanografia del Golfo de Mexico (EPOMEX), Campeche, Mexico
- 2:55-3:15 Refreshment Break - Arboretum foyer
- 3:15-3:40 ASPECTS OF GROWTH AND RECRUITMENT OF THE RECENTLY INTRODUCED MUSSEL, *PERNA PERNA* (LINNAEUS, 1758), FROM THE SOUTH TEXAS COAST
David W. Hicks* and **John W. Tunnell, Jr.**, Center for Coastal Studies, Texas A&M University - Corpus Christi, Texas
- 3:40-4:05 POPULATION DYNAMICS OF OCTOPUS (*O. MAYA*) FISHERY OF THE CAMPECHE BANK, MEXICO
Francisco Arreguin-Sanchez, Programa EPOMEX, Campeche, Mexico; **Manuel J. Solis-Ramirez**, CRIP-yucalpeten, INP., Progreso, Yucatan, Mexico; **Juan C. Seijo**, CINVSTAV-IPN., Merida, Yucatan, Mexico; and **Ernesto A. Chavez**, CIAD, Mazatlan, Sinaloa, Mexico
- 4:05-4:30 OPTIMUM YIELDS FOR THE OCTOPUS FISHERY (*O. MAYA*) OF THE SOUTH GULF OF MEXICO
Ernesto A. Chavez, **Ciad**, Calzada Sabalo-Cerritos y Estero del Yugo, Mazatlan, Sinaloa, Mexico and **Francisco Arreguin-Sanchez**, Programa EPOMEX, Universidad Autonoma de Campeche, Mexico

- 4:30-4:50 MOLLUSCS OF THE STATE OF VERACRUZ REPRESENTED BY THE COLLECTION FOUND AT THE ECOLOGY LABORATORY OF THE ZOOLOGY DEPARTMENT AT THE NATIONAL POLITECHNICAL INSTITUTE, MEXICO
Aurora C. Gonzalez, Escuela Nacional de Ciencias Biologicas, Instituto Politecnico Nacional, Prof. de Carpio y Plan de Ayala, Mexico D. F.
- 6:00-6:30 Shuttle departure for FIESTA at Houston Museum of Natural Science
- 8:30-9:00 Return to hotel

Monday Afternoon, July 11
AMU MUSSEL WORKSHOP continued - Arboretum 1-2
Chairperson: R. G. Howells

- 1:30-1:50 AN UNUSUAL UNIONID ASSEMBLAGE FROM AN UNEXPECTED LOCATION
J.A.M. Bergmann*, Boerne, Texas and **C.M. Mather**, University of Science and Arts of Oklahoma, Chicksha, OK.
- 1:50-2:00 Questions
- 2:00-3:00 FRESHWATER MUSSELS OF TEXAS: AN OVERVIEW
R.G. Howells, Texas Parks and Wildlife, Heart of the Hills Research Station, Ingram, Texas
- 3:00-3:20 Refreshment Break - Arboretum foyer
- 3:20-5:00 Continuation of Howells' MUSSELS OF TEXAS with discussion.
- 6:00-6:30 Departure by shuttle buses for FIESTA AT HOUSTON MUSEUM OF NATURAL SCIENCE
- 8:30-9:00 Return to hotel

Tuesday Morning, July 12
GULF SYMPOSIUM continued - Regency Room
Chairperson: Joseph C. Britton

- 8:30-8:55 LARVAL DEVELOPMENT AND GROWTH IN THE QUEEN CONCH
STROMBUS GIGAS (MOLLUSCA, GASTROPODA)
Eduardo Garcia Santaella and **Dallia Aldana Aranda**, Laboratory of Marine
Biology, CINVESTAV-IPN Unit Merida, Yucatan, Mexico
- 8:55-9:20 REPRODUCTIVE SEASONALITY, PERIODICITY, AND ASSOCIATED
BEHAVIOR IN A COLONY OF *STROMBUS PUGILIS* (MOLLUSCA:
GASTROPODA) IN SOUTHWESTERN PUERTO RICO.
Shawna E. Reed, Langley, B. C., Canada
- 9:20-9:40 THE LARVAL STAGES OF *ORTHOTHERES STROMBI* (RATHBUN,
1905): A CRAB COMMENSAL WITH *STROMBUS PUGILIS*
Shawna E. Reed, Langley, B. C., Canada
- 9:40-10:00 AN EMBEDDING TECHNIQUE FOR ASSESSING GASTROPOD
LARVAE GROWTH.
Eduardo Garcia Santaella and **Dallia Aldana Aranda**, Laboratory of Marine
Biology, CINVESTAV-IPN, Unit Merida, Yucatan, Mexico
- 10:00-10:30 Refreshment Break - Arboretum foyer
- 10:30-10:55 DEAD ZONE IN THE NORTHERN GULF: IMPACTS OF LOW OXYGEN
ON MOLLUSCAN AND ASSOCIATED FAUNA
Donald E. Harper, Jr.*, Texas A&M Marine Lab, Galveston, Texas and **Nancy N.
Rabalais**, Louisiana Universities Marine Consortium, Cocodrie, LA.
- 10:55-11:30 THE FLOWER GARDEN BANKS: ISOLATED TROPICAL OASES,
Stephen R. Gittings, National Oceanic & Atmospheric Administration, Flower Garden
Banks National Marine Sanctuary, Bryan, Texas
- 11:30-12:00 Closing remarks by J. C. Britton
- 12:00 Lunch Break

*QED - most fresh insects & molluscs from
impoundments
Sellester
Industrial Pollution
Coal mining*

*Reuben of Creek (Aspergillum)
only area with good mussels
2 mi above mouth
a tubular running reef*

Tuesday Morning, July 12
MUSSEL WORKSHOP continued - Arboretum 1-2
Chairperson: R. G. Howells

- 8:30-8:50 THE UNIONID FAUNA (MOLLUSCA: BIVALVIA) OF SOUTHWESTERN PENNSYLVANIA: PAST AND PRESENT
A. E. Bogan*, Freshwater Molluscan Research, Sewell, New Jersey, and **Thomas Proch**, Dept. of Environmental Resources, Pittsburgh, PA.
- 8:50-9:00 Questions
- 9:00-9:20 STATUS AND RECOVERY OF THE FEDERALLY ENDANGERED CURTIS PEARLY MUSSEL
B. Sletman*, **D. Figg**, and **A. Buchanan**, Missouri Department of Conservation, Jefferson City, MO.
- 9:20-9:30 Questions
- 9:30-9:50 RECENT FRESHWATER MUSSEL POPULATION DECLINES IN TEXAS: POSSIBLE CAUSES
R. G. Howells, Texas Parks and Wildlife Department, Heart of the Hills Research Station, Ingram Texas
- 9:50-10:00 Questions
- 10:00-10:20 Refreshment Break - Arboretum foyer
- 10:20-10:40 PRELIMINARY EXPERIMENTS TO PROPAGATE JUVENILE FRESHWATER MUSSELS (UNIONIDAE)
Richard J. Neves*, **Catherine M. Gatenby**, and **Braven Beaty**, Virginia Cooperative Fish and Wildlife Research Unit, Virginia Tech, Blacksburg, VA.
- 10:40-10:50 Questions
- 10:50-11:10 PRE-PLEISTOCENE NORTH AMERICAN UNIONOIDEANS
G. Thomas Watters, Aquatic Ecology Laboratory, Ohio State University, Columbus, OH.
- 11:10-11:20 Questions
- 11:20-11:40 A KEY TO THE GLOCHIDIA OF THE UNIONIDAE OF TEXAS
Michael A. Hoggarth, Department of Life and Earth Sciences, Otterbein College, Westerville, OH.
- 11:40-11:50 Questions
- 12:00 Lunch Break

Tuesday Afternoon, July 12
MUSSEL WORKSHOP continued
Chairperson: R. G. Howells

- 1:30-2:10 OBSERVATIONS ON THE REPRODUCTIVE ANATOMY AND BEHAVIOR
OF CERTAIN GULF COAST UNIONIDS
Paul Hartfield, U. S. Fish and Wildlife Service, Jackson, MS.
- 2:10-2:20 Questions
- 2:20-2:50 FRESHWATER MUSSEL REPRODUCTIVE BIOLOGY: A BRIEF
DISCUSSION OF RECENT WORK IN TEXAS
R. G. Howells, Texas Parks and Wildlife Department, Heart of the Hills Research
Station, Ingram Texas (WITH VIDEO PRESENTATION)
- 2:50-3:00 Questions
- 3:00-3:20 Refreshment Break - Arboretum foyer
- 3:20-4:00 Open Discussion; Unionid Exchange
- 4:00-5:00 Visit Exhibits and Posters - Regency Room
- 6:00 Dinner Break
- 7:00-9:00 AMU Auction - Regency Room

Tuesday Afternoon, July 12
CONTRIBUTED PAPERS - Regency Room
Chairperson: Paula Mikkelsen

- 1:30-1:50 RECYCLING AS A SURVIVAL STRATEGY: BRYOZOAN INCRUSTED
GASTROPOD SHELLS, PROBABLY INHABITED BY HERMIT CRABS
Penny A. Morris*, Department of Natural Sciences, University of Houston-Downtown,
Houston, TX. and **Judith T. Smith**, School of Earth Sciences, Stanford University,
Stanford, CA.
- 1:55-2:20 A NEW EOCENE SPECIES OF *CHEILEA* FROM SOUTH CAROLINA
WITH POSSIBLE PHYLOGENETIC IMPLICATIONS
David C. Campbell**, UNC-CH, Chapel Hill, NC.
- 2:20-2:45 BIOEROSION OF MOLLUSCAN CARBONATE BY ENDOLITHIC
BORERS IN THE SANTEE LIMESTONE (EOCENE, SOUTH CAROLINA)
AND ITS TAPHONOMIC AND SEDIMENT OLOGIC IMPLICATIONS
Glen K. Merrill, University of Houston-Downtown, Houston, Texas
- 2:50-3:20 Refreshment Break - Arboretum foyer
- 3:30-5:00 Visit with Poster and Exhibits - Regency Room
- 6:00 Dinner Break
- 7:00-9:00 AMU Auction - Regency Room

Wednesday Morning, July 13
CONTRIBUTED PAPERS - Arboretum 1-2
Chairperson: James Nybakken

- 8:40-9:00 MOLLUSKS OF THE INDIAN RIVER LAGOON, FLORIDA -
BIODIVERSITY TO BE CONSERVED
Paula M. Mikkelsen*, Harbor Branch Oceanographic Institution, Ft. Pierce, FL.; **Paul S. Mikkelsen**, Palm Beach Co., Environmental Resources Management, West Palm Beach; and **David J. Karlen**, Florida Institute of Technology, Melbourne
- 9:10-9:30 NURSE EGG FEEDING PROSOBRANCHS: A COMPARATIVE
QUALITATIVE ANALYSIS OF EGGS AND HATCHLINGS
Patricia Miloslavich, Universidad Simon Bolivar, Departamento de Biologia de Organismos, Caracas, Venezuela
- 9:40-10:00 PRELIMINARY DISCUSSION OF HIGHER ORDER RELATIONSHIPS
AMONG THE OCTOPODA
Janet R. Volght, Dept. of Zoology, Field Museum, Chicago, IL.
- 10:10-10:30 Refreshment Break - Arboretum foyer
- 10:40-11:00 THE MTDNA OF *HALIOTIS DIVERSICOLOR* (REEVE, 1846)
Wen-lung Wu*, Inst. Zoology, Academia Sinica, Taiwan; **L. Chang**, Dept. Zoology, National Taiwan University; and **P.C. Huang**, Inst. Mol. Biol. National Tsing Hua Univ.
- 11:05-11:45 PROGRESS TOWARD REVISION OF THE LIOTIINAE AND
COLLONIINAE OF THE WORLD
James H. McLean, Los Angeles County Museum of Natural History, Los Angeles, CA.
- 12:00 Lunch Break

Wednesday Morning, July 13
LAND AND FRESHWATER CONTRIBUTED PAPERS - Arboretum 3-4
Chairperson: F. G. Hochberg

- 8:40-9:00 BIOLOGY OF THE ENDANGERED ALABAMA LIVE BEARING SNAIL,
TULOTOMA MAGNIFICA
Stephen P. Christman, Florida Museum of Natural History, Gainesville, FL.
- 9:10-9:30 EFFECT OF INTRASPECIFIC CROWDING ON GROWTH RATES IN
THREE SPECIES OF TERRESTRIAL SNAILS
Timothy A. Pearce**, Museum of Zoology, Mollusk Division, University of Michigan, Ann Arbor, MI.
- 9:40-10:00 A SURVEY OF THE UNIONID MOLLUSKS OF THE PLATTE RIVER
BASIN IN NEBRASKA
F. Ellet Hoke, Ballwin, MO.
- 10:10-10:20 Refreshment Break

- 10:30-10:50 **HYPEROSMOTIC VOLUME REGULATION IN TWO FRESHWATER MOLLUSKS**
Percy J. Jordan*, and **Lewis E. Deaton**, Biology Department, University of Southwestern Louisiana, Lafayette, LA.
- 11:00-11:20 **VENUSTACHONCHA ELLIPSIFORMIS (BIVALVIA: UNIONIDAE): AN INTERMEDIATE HOST FOR *PHYLLODISTOMUM* (TREMATODA: GORGODERIDAE) IN A MICHIGAN STREAM**
Archie W. Martell*, Department of Biology, Saginaw Valley State University, University Center, MI and **Richard J. Trdan**, Department of Biology, Saginaw Valley State University, University Center, MI.
- 11:25-11:50 **DECLINE OR DIVERSIFICATION? BERMUDA'S LAND SNAILS REVISITED**
Rudiger Bieler and **John Slapcinsky***, Field Museum of Natural History, Chicago, IL.
- 11:50 Lunch Break

Wednesday Afternoon
CONTRIBUTED PAPERS - Arboretum 1-2
Chairperson: Elizabeth A. Wilson-Ormond

- 1:30-1:55 **THE STATUS OF THE NORTHERNMOST GIANT CLAMS IN THE RED SEA.**
R. Kilada**, Dept. of Marine Science, Suez Canal University, Ismalia, Egypt
- 2:00-2:30 **DETERMINANTS OF LANDSNAIL SPECIES RICHNESS IN THE HAWAIIAN ISLANDS**
Robert H. Cowie, Bishop Museum, Honolulu, HI.
- 2:30-2:50 **FEEDING BIOLOGY OF THE NOTASPIDEAN *PLEUROBRANCHAEA CALIFORNICA***
Karen Battle and **James Nybakken***, Moss Landing Marine Laboratories
- 2:50-3:20 Refreshment Break
- 3:30-4:30 **AMU Annual Meeting - Arboretum 1-2:**
Election of officers, announcement of future meetings, student awards
- 7:00-8:00 Cash bar - Regency Room
- 8:00-10:00 **Conchs' Country Caper**
Banquet, Music, Entertainment - The Hickory band, dance troupe from Theater Under the Stars, and the Yellow Rose dancers

**Thursday, July 14
FIELD TRIPS**

Buses and Vans in front and on north side of hotel

7:00-all day	Fossil trip to Stone City, Bryan, leaders Penny Morris-Smith and Glen Merrill
8:00-early afternoon	Surfside Beach, leader Darwin Alder
8:00-early afternoon	UTMB LABS, Galveston, Texas, leader John W. Tunnell, Jr.
8:00-afternoon	Freshwater trip, leader R. G. Howells

Collections at Houston Museum of Natural Science will be open to visitors Thursday and Friday - check with Connie Boone, Curator of Malacology at HMNS.

**POSTERS AND EXHIBITS - back of Regency Room
Saturday Afternoon through Tuesday Afternoon**

1. THE GROWTH AND DEVELOPMENT OF THE RADULA AND CRANIAL CARTILAGE IN THE CALIFORNIA MARKET SQUID *LOLIGO OPALESCENS* (CEPHALOPODA: MYOPSIDA)
Frank E. Anderson, Institute of Marine Sciences and Department of Biology, The University of California, Santa Cruz, CA.
2. STUDY ON THE RADULAE OF POLYPLACOPHORA IN TAIWAN
Wen-lung Wu and **Miao-fang Lin**, Institute of Zoology, Academia Sinica, Taiwan
3. GENETIC ANALYSIS OF FRESHWATER MUSSELS: *AMBLEMA* AND *MEGALONAIAS*
Debra L. Pyer, Savannah River Ecology Lab, Aiken, SC.
4. SPECIES SURVEY OF SOUTH CAROLINA UNIONIDS, WITH EMPHASIS ON *ELLIPTIO*
Kimberly Hicks, Savannah River Ecology Lab, Aiken, SC.
5. SMALL SCALE DISTRIBUTION AND ABUNDANCE PATTERNS OF *TUBULARIA* FEEDING NUDIBRANCHS
Eric Lovely, University of New Hampshire, Zoology Department, Durham, NH.
6. TENNESSEE SHELL COMPANY COMMERCIAL UNIONID COLLECTING
D'Ion Dobson, Camden, TN.
7. AMERICAN ACADEMY OF UNDERWATER SCIENCES - EXHIBIT
Don Harper, Galveston A & M University

MOLECULAR MARKERS AND THE BIOGEOGRAPHY OF *DONAX*.
ADAMKEWICZ, Laura, George Mason University, Fairfax, VA 22030,
and HARASEWYCH, M.G., National Museum of Natural History,
Smithsonian Institution, Washington, DC 20560.

J.P.E. Morrison recognized six taxa of the bivalve genus *Donax* as occurring along the Atlantic and Gulf coasts of North America: *D. fossor* from New Jersey to Cape Hatteras, *D. parvulus* from Cape Hatteras to eastern Florida, *D. variabilis* from the Chesapeake to Alabama, *D. v. roemeri* from the Mississippi to Campeche, *D. dorotheae* from Alligator Point to Louisiana, and *D. texasianus* from Louisiana to Vera Cruz Mexico. Recent work with RAPD DNA markers has discovered no fixed differences between the subspecies *D. v. variabilis* and *D. v. roemeri* but has confirmed the distinctiveness of *D. parvulus* and *D. texasianus* and established that *D. parvulus* is more closely related to *D. variabilis* than to *D. texasianus*, which it otherwise resembles. An examination of RAPD markers in the remaining two species has shown that *D. fossor* does not differ from *D. parvulus* for any marker and appears to be identical to it. Similarly, *D. dorotheae* does not differ from *D. texasianus*. Thus, the biogeography of *Donax* is considerably simplified. *Donax variabilis*, the larger, more inter-tidal species, occurs on both coasts. It shares each coast with a smaller, more sub- tidal species, *D. parvulus* on the Atlantic and *D. texasianus* in the Gulf. This pattern of two *Donax* species partitioning their habitat may be common in the genus world wide.

MOLLUSCA OF SOUTHWESTERN GULF OF MEXICO ROCKY SHORES, VERACRUZ, MEXICO.

ALVARADO, Sandra A., and ROCHA, Dennis,
Center for Coastal Studies, Texas A&M
University-Corpus Christi, 6300 Ocean
Dr., Corpus Christi, TX 78412.

The molluscan communities of the rocky shores of the southwestern Gulf of Mexico were characterized from molluscs collected and archived over a period of eighteen years by personnel from Texas A&M University-Corpus Christi. A total of 145 species (62 alive) were identified from five volcanic rocky shore sites that exhibited differing physiographical features. The study area exhibited a transition from temperate to tropical molluscan species coinciding with a similar climatic change.

Although survey's from this investigation crossed the inshore northern boundary of the Caribbean biogeographical province within the state of Veracruz, most of the rocky shore communities retain a dominant temperate faunal character. An increasingly diverse distribution of Caribbean molluscs occurred at the southernmost sites of Montepio and Playa Escondida, two regions located at the Gulf terminus of a mountainous tropical rain forest environment.

LA OSTRICULTURA EN EL GOLFO DE MEXICO: PROBLEMATICA Y PERSPECTIVAS.

ALDANA ARANDA, Dalila, GARCIA SANTAELLA, Eduardo and BRULE, Thierry. Laboratory of Marine Biology, CINVESTAV-IPN Unit Merida, A.P. 73-CORDEMEX, 97110 Merida. Yucatan, Mexico.

En México existen 9 especies de ostión de importancia comercial, sin embargo la que soporta la mayor explotación pesquera es *Crassostrea virginica*, cuyo volumen de captura se ha mantenido alrededor de 40 000 desde 1974. Esto sitúa a México como el 5 productor mundial del molusco. La explotación del recurso en el Golfo, está en manos de 46 sociedades cooperativas que reúnen aproximadamente 15 000 pescadores. A pesar de lo anterior, es una acuicultura extensiva donde el volumen de producción esta muy por debajo del potencial que ofrecen los litorales de las lagunas costeras del Golfo de México. En la actualidad, para su cultivo son utilizadas solo 4 630 Ha de las 573 000 Ha de uso potencial.

En los últimos 20 años, la ostricultura en el Golfo ha sido extensiva y se limita a programas de rotación de bancos, captación de semilla y mejoramiento de fondos duros para su crecimiento. Si bien se realiza un esfuerzo en esta actividades, desafortunadamente no se ha visto reflejado en los volúmenes de producción.

En el presente trabajo se efectúa un análisis cronológico del desarrollo de la ostricultura en el Golfo de México, así como de su problemática y perspectivas para su consolidación.

THE GROWTH AND DEVELOPMENT OF THE RADULA AND CRANIAL CARTILAGE IN THE CALIFORNIA MARKET SQUID *LOLIGO OPALESCENS* (CEPHALOPODA: MYOPSIDA)

ANDERSON, Frank E.

Institute of Marine Sciences and Department of Biology
The University of California, Santa Cruz, CA 95064

Investigations of radular ontogeny have proven informative in evolutionary studies of some groups of mollusks, particularly chitons and gastropods. Similar research on the growth and development of cartilaginous structures in cephalopods allows an examination of characters of potential value for future phylogenetic analyses. The radula and cranial cartilages were removed from various life stages of the California market squid *Loligo opalescens*, including late pre-hatching and early post-hatching squids raised in the laboratory, and small and large mature adult stages collected from Monterey Bay. The radula and cranial cartilage were mounted, and viewed and photographed with a scanning electron microscope (SEM). Differences in radular and cranial cartilage size and shape through development were assessed, as were the order of appearance of radular teeth. Aspects of radular and cranial cartilage fine structure and the order of radular tooth appearance should be useful in phylogenetic analyses of particular cephalopod taxa.

TAPHONOMY OF SUBSURFACE HOLOCENE SHELL BEDS ON THE NORTHEASTERN GULF OF MEXICO SHELF

ANDERSON, Laurie C., Department of Geology and Geophysics, and McBRIDE, Randolph A., Coastal Studies Institute, Louisiana State University, Baton Rouge, LA 70803

Subsurface Holocene shell beds encountered in 20 of 39 vibracores from the Gulf of Mexico shelf (3 to 40 m) between Mobile Bay, AL and Pensacola Bay, FL provide a rare opportunity to examine preserved faunas from these depths. The fauna is dominated by gastropod and bivalve mollusks, but also contains scaphopods, barnacles, larger foraminifera, cupularid bryozoans, and irregular echinoids. Paleoenvironmental, taphonomic, and sedimentologic analyses, along with Carbon-14 dating of pristine mollusk shells indicate a complex depositional history. Bioclast age varies from core to core. Some beds apparently formed during early Holocene transgression, while others are only a few thousand years old. Although differences in bioclastic fabric and faunal composition are apparent among beds, beds show many similarities. Assemblages are typical of open bay, sound, tidal inlet and tidal-inlet delta, and shoreface environments. Most species are shallow infaunal and epifaunal inhabitants of soft substrates (both sand and mud). Oyster-reef and shell-gravel dwellers are also common. Bioclasts typically are well preserved, indicating relatively rapid sedimentation rates and minimal postmortem exposure of shells to destructive physical or biological processes. Assemblages are time-averaged (more than one generation in a single horizon) and predominantly parautochthonous (not in situ but deposited where they lived). Many shell beds are graded, indicating deposition during high energy, short-term events (most likely storms) that vertically mixed and concentrated bioclasts. These shell beds do not show trends predicted by models of shell bed formation based on changes in sedimentation rate alone because the processes responsible for forming these beds caused pervasive vertical mixing during deposition.

A DIMINISHING BRACKISH WATER CLAM (RANGIA CUNEATA) FISHERY AND PERSPECTIVES OF RECOVERY IN LAGOON OF POM, CAMPECHE, MEXICO.

ARREGUIN-SANCHEZ, Francisco; RAMOS-MIRANDA, Julia; SANCHEZ, Julio A.; FLORES-HERNANDEZ, Domingo; SANCHEZ-GIL, Patricia; YAÑEZ-ARANCIBIA, Alejandro. Programa de Ecología, Pesquerías y Oceanografía del Golfo de México (EPOMEX). Apdo. Postal 520, Campeche 24030, Campeche, México.

Brackish water clam Rangia cuneata was a valuable fish resource in the Pom Lagoon, in the Southern Gulf of Mexico, being an important part of the economy of the local families. The population declined dramatically during the last decade due to environmental stress and an inappropriate fishery management strategy. An evaluation of the current state of the population and causes of declination are required as a starting point for its possible recovery. Dredging related to the oil industry caused increments in suspended sediments, which covered an important portion of the population, causing massive mortality. At this time fishing intensity increased more than 200%. Assessment of the population was performed using global and structured models. The analysis was based on the reconstruction of the population at time when higher yields were obtained, and compared with current population. At present the total biomass is 11% of the population that existed ten years ago. The problem is the inexistence of recruits due to the very low probability of fecundation.

POPULATION DYNAMICS OF OCTOPUS (O. maya) FISHERY OF THE CAMPECHE BANK, MEXICO.

ARREGUIN-SANCHEZ, Francisco, Programa EPOMEX. Apdo. Postal 520, Campeche 24030, Campeche, México. SOLIS-RAMIREZ, Manuel J. CRIP-Yucalpetén, INP. Apdo. Postal 73, Progreso, 97020, Yucatán, México. SEIJO, Juan C. CINVESTAV-IPN, Apdo. Postal 73-Cordemex, 97310, Mérida, Yucatán, México. CHAVEZ, Ernesto A. CIAD, Apdo. Postal 711, Mazatlán, 82010, Sinaloa, México.

Octopus fishery is one of the most important fish resources in the Gulf of Mexico. Annual yields averaged 9000 t which are caught during 4.5 months. Because the complexity of the life cycle, population dynamics studies are reviewed. A number of length based methods have been applied to estimate grow, but different results have been obtained. The ϕ' index is here used to analyze grow performance. Natural mortality has been poorly studied, particularly in relation to mortality of females after reproduction. Inter-annual variations in recruitment pattern suggest population dynamics is heavily affected by environmental fluctuations, although specific mechanisms are unknown. There are important tasks to be focused in further work in order to sustain management decisions and fishing strategies: Growth validation; dynamics of the population out of the fishing season; spawning stock recruitment relationship; spatial dynamics and its relationship with distribution of the fishing effort; trophic role in the ecosystem.

FEEDING BIOLOGY OF THE NOTASPIDEAN PLEUROBRANCHAEA CALIFORNICA.

BATTLE, Karen and NYBAKKEN, James, Moss Landing Marine Laboratories, P. O. Box 450, Moss Landing, CA 95039

Specimens of Pleurobranchaea californica were collected by otter and interfacial trawls in Monterey Bay over a one year period. Collected animals were preserved and the digestive tracts examined to ascertain the food.

P. californica was found to be a carnivore. The dominant recognizable food items in the gut were three species of opisthobranchs, Armina californica, Aglaja sp. and other Pleurobranchaea californica. The incidence of cannibalism was very high and was not the result of consumption in the trawl.

The diet was found to change little with season or with depth. Ancillary information suggested that Pleurobranchaea californica is an annual species.

THE MICROMOLLUSCAN FAUNA OF THE EAST FLOWER GARDEN BANK, NORTHWESTERN GULF OF MEXICO.

BEAVER, Carl R., Center for Coastal Studies, Texas A&M University-Corpus Christi, 6300 Ocean Drive Corpus Christi, TX. 78412
Reefal sediments from the East Flower Garden Bank (EFG) were examined for the presence of micromolluscs. Sediments were divided into 50 ml subsamples and sorted under a stereoscopic microscope. All shells were retained for later identification. A total of 124 species of molluscs were identified from the sediment samples including 92 species of gastropods and 32 species of bivalves. *Cingula floridana* was the most common gastropod while Cerithiidae was the most common family with 7 species recorded. Arcidae was the most common bivalve family, with 6 species.

The micromolluscan fauna of the EFG Bank appears to be an assemblage of tropical Caribbean and temperate Texas coastal species. Population centers for the majority of these species are in the Caribbean/West Indies.

DECLINE OR DIVERSIFICATION? - BERMUDA'S LAND SNAILS REVISITED

BIELER, Rüdiger, and SLAPCINSKY, John, Field Museum of Natural History, Chicago, IL 60605

Bermuda's rich history of faunal surveys presents a unique opportunity to study the change of the molluscan fauna of an Atlantic Island during historic times. The fauna can be divided into (1) species unique to Bermuda, (2) forms that apparently arrived by 'rafting' from the West Indies, (3) species accidentally and (4) deliberately introduced by human activities.

A survey of published information, museum collections, and new collecting data from Bermuda demonstrate a steady increase in species diversity (with some turnover among the introduced species) that had little effect on diversity of native species.

Since the last published survey several predatory snails including *Gonaxis quadrilateralis* and *Euglandina rosea* were introduced in an ill-advised attempt at biologically controlling *Otala lactea*. *Euglandina rosea* is implicated in the extinction of several land snails native to the Pacific islands where it was also introduced. In Bermuda population densities and distribution of species in the endemic genus *Poecilozonites* are reported to be declining rapidly.

The present faunal survey finds *Euglandina* has spread from the release sites and is generally distributed around the islands that make up Bermuda, while dead shells of *Gonaxis* were found in only one of its original release sites. The present survey also finds two species new to Bermuda, *Zonitoides arboreus* and *Tornatellides* sp. Both species frequent tree-trunks and were probably introduced on exotic trees. Two extant species of the endemic genus *Poecilozonites* were found. *P. circumfirmatus* was found alive in two localities and recently dead shells of *P. bermudensis* were found in another.

AN UNUSUAL UNIONID ASSEMBLAGE FROM AN UNEXPECTED LOCATION.

BERGMANN, J.A.M., and C.M. MATHER. Observation, Management, Conservation, 110 Scottie Dr., Boerne, TX 78006 and University of Science and Arts of Oklahoma, P.O. Box 82345, Chickasha, OK 73018

The study of the streams flowing into the Red River from northeast Texas is a logical extension of research conducted by the authors since 1973. Sampling of all major Texas and Oklahoma streams covered on this area. The literature, experience, museum records, and discussions with other researchers led us to believe little of significance would come from the investigation, but we were surprised. Several species, including one federally endangered species new to Texas, were found outside their normal range and habitat. The collections include two instances of species not previously reported living together. A curiosity is the dominance of different species in each of the four streams investigated so far. Also puzzling is the mysterious absence of several species common to the areas surrounding the study sites. In this paper, we pose several questions, examine some implications of the assemblage, and review plans for further research.

THE UNIONID FAUNA (MOLLUSCA: BIVALVIA) OF SOUTHWESTERN PENNSYLVANIA: PAST AND PRESENT.

BOGAN, A.E. Freshwater Molluscan Research, 36 Venus Way, Sewell, NJ 08080 and PROCH, Thomas, Dept. of Environmental Resources, 400 Waterfront Drive, Pittsburgh, PA 15222.

The unionid fauna is poorly known in the Monongahela River Basin and streams directly tributary to the Ohio River in southwestern Pennsylvania. This fauna was almost extirpated from the Monongahela River by 1900. Thirty-four species of unionids were known historically from the Monongahela River Basin and seven species were known from four creek basins tributary to the Ohio River in southwestern Pennsylvania. In the summer of 1993, 96 stations were examined in the Monongahela River Basin. Thirty-seven sites in eight creek basins tributary to the Ohio River were examined, only four contained unionids (ten species). Many of the streams surveyed were heavily impacted by acid mine drainage. No federally endangered species were found during this survey. Dunkard Creek retained the most diverse unionid fauna in the Monongahela Basin (20 species historically; 16 species collected during this survey, 12 species found alive). Archaeological materials from along the Monongahela River document the former occurrence of many extirpated species (eg. *Pleurobema clava*, *Epioblasma torulosa rangiana*). The unionid fauna of the Monongahela Basin in Pennsylvania based on all available information was 40 species.

THE FRESHWATER GASTROPOD FAUNA (MOLLUSCA) OF THE CAHABA AND COOSA RIVER DRAINAGES IN ALABAMA.

BOGAN, Arthur E. Freshwater Molluscan Research, 36 Venus Way, Sewell, NJ 08080, PIERSON, J. Malcolm, 515 Southern Hills Drive, Calera, AL 35040, HARTFIELD, Paul, U.S. Fish and Wildlife Service, Jackson, MS 39213

The freshwater gastropod fauna of the Cahaba and Coosa River drainages in Alabama were surveyed in 1992. A total of 178 sites in the Coosa River drainage and 159 sites in the Cahaba River drainage were examined. Twenty four gastropod taxa were identified from the Cahaba River drainage and 30 taxa were identified from the Coosa River drainage. Taxa presumed to be extinct in the Coosa drainage include four genera: Clappia, Gyrotoma, Amphigrva, and Neoplanorbis, representing a total of 13 extinct species. Additionally, 13 pleurocerid species originally described from the shoals of the Coosa River were not collected and are presumed extinct. Only four species reported historically from the Cahaba River drainage were not found and are presumed extinct. The Cahaba River drainage pleurocerid fauna represents probably the only extant opportunity to study what is perceived to be clinal variation in a suite of species from the headwaters to big river habitats in the Mobile Bay Basin.

CONGRUENCE BETWEEN RADULAR CHARACTERS AND CONCHOLOGICAL ON SPECIES OF THE FAMILY MURICIDAE (GASTROPODA: NEOGASTROPODA).

CASTILLO, Zoila G., Instituto de Ciencias del Mar y Limnología, UNAM., Apdo. Postal 70-305 México 04510, D.F.

Mostly classifications of the taxa of the Muricidae family to date are reliant on shell morphology. A number of authors in this century have reported on the considerable effects of environmental influences on shell morphology. However Kool, 1987 and 1988 suggest that in shell morphology of Thaidids and muricid exist convergence.

The purpose of this study is to establish a classification based on radular characters compared with one based on shell characters. Radular and shell data are based on the following specimens: Thais biserialis, I. speciosa, I. melones, Acanthina brevidentata, Vitularia salebrosa, Neorapana muricata, Murex beauui, M. recurvirostris, Homalocantha oxyacantha and Muricanthus nigritus. Terminology used for the tooth is taken from Kool, 1987.

Considerable congruence exists in the classification of radulae characters and conchological first in two groups of species of the genera Thais-Acanthina and other one Murex-Muricanthus.

Some species there are not congruence between the shell and radular structure. This is possible as a case of convergence.

A NEW EOCENE SPECIES OF CHEILEA FROM SOUTH CAROLINA WITH POSSIBLE PHYLOGENETIC IMPLICATIONS.

CAMPBELL, David C., UNC-CH, Chapel Hill, NC 27599-3315

An undescribed species of Cheilea is common in the moldic Santee Limestone of South Carolina. Species of Cheilea have traditionally been difficult to define because of the variability in their shape and sculpture. In these features the new species falls within the range of the cosmopolitan Recent C. equestris, but it differs in the shape of its protoconch. C. equestris and the Eocene Cheilea janitrix from New Zealand have neritiform protoconchs, whereas the South Carolina Eocene species has a globose protoconch.

Determination of which of these protoconch forms is more primitive may help resolve the taxonomic affinities of Cheilea, which is variously assigned to the Hipponicoidea or the Calyptraeidea. The globose protoconch resembles that of Capulus, whose hipponicid versus calyptraeid affinities are likewise uncertain. The neritiform protoconch of other species of Cheilea resembles that of many hipponicids and calyptraeids.

OPTIMUM YIELDS FOR THE OCTOPUS FISHERY (O. maya) OF THE SOUTH GULF OF MEXICO

CHAVEZ, Ernesto A., CIAD, Calzada Sábalo-Cerritos y Estero del Yugo, A. P. 711, Mazatlán Sinaloa 82010, México and ARREGUIN-SANCHEZ, Francisco, Programa EPOMEX, Universidad Autónoma de Campeche, A. P. 520, Campeche, Camp., México

The concept of maximum sustainable yield is applied to an age structured simulation model of the fishery, at the South Gulf of Mexico (nearly 12,000 tonnes, amounting about 8 % per cent of the world octopus catches). Size of each cohort and population parameter changes (Fishing mortality and recruit numbers) are analyzed year by year. Simulations were carried on in order to examine the variability of yield based upon random changes in recruitment throughout a 40-year period. Minimum size of first catch, optimum yield and maximum benefit/cost ratio are evaluated as harvesting options and their consequences in direct employment were assessed in order to recommend the best management strategy.

**BIOLOGY OF THE ENDANGERED
ALABAMA LIVE BEARING SNAIL,
TULOTOMA MAGNIFICA.**

CHRISTMAN, Steven P., Florida Museum
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Once feared extinct, Tulotoma magnifica (Gastropoda: Viviparidae) still persists in an 8 km reach of the Coosa River between Jordan Dam and Wetumpka, AL, in densities averaging 83 snails per square meter. Preferred habitat consists of shoals with bedrock and boulders, current speed between 0.2 and 1 meter per second, and water depth over 0.5 meters. Reproduction by live birth is concentrated in the spring with females averaging 3.6 offspring per month. The snails grow rapidly, up to 4% increase in shell height per week, reaching sexual maturity in about a year. Dispersal is concentrated in the summer and during periods of high water, and the snails are vulnerable to stranding when water levels recede.

**THE USE OF ARCHAEOLOGICAL OYSTER DEPOSITS
IN THE DETERMINATION OF PREHISTORIC
ENVIRONMENTAL CONDITIONS OF THE CENTRAL
TEXAS COAST.**

COX, Susan A., Center for Coastal
Studies, Texas A & M University -
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Archaeological deposits of the American Oyster, Crassostrea virginica, were examined in conjunction with a two year mitigation of prehistoric resources along the north shore of upper Nueces Bay, San Patricio County, Texas. The examination of encrusting organisms on oysters for salinity and annual growth rings for season of death, as well as other statistical indicators, supported recent theories on the development of highly productive estuarine biotic systems only in times of sea level stillstand. It is suggested that the estuaries of the Texas coast may be highly susceptible to the harmful influences of predicted sea level rise in the next century.

**DETERMINANTS OF LANDSNAIL SPECIES RICHNESS IN
THE HAWAIIAN ISLANDS**

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The native landsnail fauna of the Hawaiian islands consists of over 750 described nomenclaturally valid species. Species richness on each island is strongly correlated with island area, age, maximum altitude and habitat diversity, but only poorly with the island's distance from a source of colonization. Path analysis shows that island area, per se, has the strongest influence on land snail species richness. Island altitude and number of plant communities, both dimensions of habitat diversity, also have major influences. Both are also strongly related to island area. The influence of island age is complex. There is a direct effect, older islands having more species, probably because there has been more time for colonization and in situ radiation. But this effect is more than counterbalanced by the strong indirect effects of age through its effect on area and altitude: older islands are smaller and lower, and the strong direct effects of area and altitude lead to smaller, lower islands having fewer species. As might have been expected a priori, species richness is therefore related predominantly to evolutionary radiation in situ and not to the classic island biogeographic theories of equilibrium between immigration and extinction. Numbers of recorded species are also strongly correlated with the amount of collecting undertaken on each island. Path analysis disentangled this effect from the above natural effects, but this result remains as a warning to others involved in similar studies.

**THE FRESHWATER MUSSELS OF VENEZUELA
(UNIONACEA & MUTELACEA): THE FIRST CUT.**

CUMMINGS, Kevin S., and MAYER, Christine A.
Illinois Natural History Survey, Champaign, IL 61820

The freshwater mussel fauna of Venezuela is very poorly known. Most historical collections were made in northern coastal tributaries or in streams entering Lago de Maracaibo: very few collections are known from the Orinoco or Essequibo river drainages. Field work conducted throughout Venezuela over the past eight years has added many new species to the list of those known from the country. Examination of the literature and museum specimens, combined with field studies, brings the total number of species recorded from the country to approximately twenty. Fourteen species in the family Mycetopodidae are represented and include species in the genera Anodontites, Fossula, Lamproscapha, Mycetopoda, and Tamsiella. The family Hyriidae is represented by six species in the genera Castalia, Diplodon, Paxvodon, and Prisodon. Freshwater mussels are not a common part of the aquatic biodiversity of Venezuela but may be locally abundant. They are usually found in small to medium-sized streams in substrates of clay and mud or loose gravel and sand. Because of the wide variety of habitats and the size of the country, additional collecting will undoubtedly add to the faunal list.

THE POPULATION GENETICS OF LITTORINA
IRRORATA: IS FLORIDA THE BOUNDARY IT
SEEMS?

DILLON, Robert T., Jr., and DAYAN, Nathan S.,
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Charleston, SC 29424

The shallow and intertidal environments of the northern Gulf of Mexico are quite similar to those of the Atlantic coast of the southern United States. Yet these two coasts do not share a large fraction of their molluscan fauna, and substantial genetic divergence is often noted among the shared elements. The more tropical Florida peninsula seems to constitute a barrier to dispersal.

We examined gene frequencies at eight polymorphic isozyme loci in populations of the marsh periwinkle, Littorina irrorata, from Virginia, South Carolina, Atlantic Florida, Gulf Florida, and Louisiana. Fits to Hardy-Weinberg expectation, both within and among populations, were very good ($F_{is} = 0.049$, $F_{st} = 0.033$). No significant interpopulation divergence was detected, in spite of the 1,000 km gap in the distribution of L. irrorata imposed by the southern half of the Florida peninsula. Values of Nei's genetic distance comparing populations between the two coasts were similar to such values calculated among populations sharing the same coast. Either balancing selection is acting strongly at multiple enzyme loci in L. irrorata, or Florida is not the barrier it seems.

A NEW SUBGENUS OF PHILOMYCUS (GASTROPODA:
PHILOMYCIDAE) FROM KENTUCKY.

FAIRBANKS, Lee, Pennsylvania State
University, Monaca, PA 15061
Slugs from six localities in central
Kentucky were collected in May 1993.
On the basis of external characteristics,
three species of Philomycus were identified.
Dissection of the reproductive anatomies
revealed a previously unknown chamber within
the wall of the penes.

The chamber has a single slit-like opening into the lumen of the penis. It is C-shaped in cross section, and its surface is covered by villi. Two variations, in terms of the position of the chamber along the length of the penis, were found. A chamber such as this is unknown in any described species of terrestrial gastropod.

The chamber is the basis for the new subgenus. The function of the chamber is not known, however the villi suggest that it may be involved in some manner with a secretory and/or an absorptive process.

Philomycus batchi, will be the type of the new subgenus. Two new species, still to be described, will be added at a later date.

REGULATION OF CARDIAC CONTRACTILITY IN
GEUKENSIA DEMISSA GRANOSISSIMA.

DUHON, Daniel W. and DEATON, Lewis E., University
of Southwestern Louisiana, Lafayette, LA 70504.
The neuropeptide, FMRFamide, and the neurotransmitter,
5-hydroxytryptamine (5-HT), have been implicated in the
regulation of cardiac activity in Geukensia demissa
granosissima. The mechanical activity of isolated ventricles
is excited by FMRFamide and inhibited by 5-HT. The
cellular mechanisms for these effects are uncharacterized.
We investigated the role of the phosphoinositol signaling
system in mediation of the effects of 5-HT and FMRFamide
on isolated ventricles.

FMRFamide ($10^{-7}M$) increases tissue levels of
diacylglycerol (DAG) and inositol-1,4,5-triphosphate (IP_3).
5-HT had no effect on DAG or IP_3 . Isolated ventricles
were loaded with ^{32}P and homogenized after treatment with
FMRFamide or 5-HT (5,15,30 sec). Proteins in the
homogenates were separated by polyacrylamide gel
electrophoresis. Autoradiograms detected a protein of
approximately 120 kD molecular weight that is
phosphorylated in the presence of FMRFamide.

These results suggest that the phosphoinositide cell
signaling pathway is involved in the effects of FMRFamide
but not 5-HT on the ventricle of Geukensia demissa
granosissima.

LARVAL DEVELOPMENT AND GROWTH IN THE QUEEN
CONCH STROMBUS GIGAS (MOLLUSCA, GASTROPODA).

GARCIA SANTAELLA, Eduardo and ALDANA ARANDA, Da-
lila. Laboratory of Marine Biology, CINVESTAV-IPN Unit Merida,
A.P. 73-CORDEMEX, 97110 Merida, Yucatan, Mexico.

A comparative study of larval development and growth of the queen
conch S. gigas was done, to evaluate the nutritional value of three algae
fed. Larvae were cultured during 20 days, at $29 \pm 1C$, in eighteen 4 liters
culture vessels, holding 275 larvae per liter. Larvae were fed Thalassiosira
fluviatilis, Isochrysis aff. galbana and Tetraselmis succica, on
daily rations ranging from 500 to 40 000 algal cells.larvae $^{-1}$.day $^{-1}$.
Growth was assessed by siphonal length daily increments. Evolution of
the velum lobes was used as a morphological index to evaluate develop-
ment status of larvae.

Measuring daily SL increments allowed us to observe the pattern
of growth constituted of three periods for every treatment no matter the
algae fed. During the first period (PI), the faster growth rates of 71 to
73 μm .day $^{-1}$ were registered. The second period (PII), with an approxi-
mate duration of seven days, registered a drastic reduction of growth,
with rates ranging from 3 to 9 μm .day $^{-1}$. Finally, rates increased to
reach a sustained growth until settlement of 27 to 48 μm .day $^{-1}$.

The period II of slower growth coincided with the days of faster
development and organogenesis, evidencing once more the need for a
better index of physiological status of larvae. Morphological index
used in this work, help us to elucidate the real effect of algae fed over
development and growth. In mollusc larvae, shell growth used frequen-
tly as a response variable in ecophysiological studies, can lead to false
conclusions if development is not considered in the final analysis of
results.

AN EMBEDDING TECHNIQUE FOR ASSESSING GASTROPOD LARVAE GROWTH.

GARCIA SANTAELLA, Eduardo and ALDANA ARANDA, Dalila. Laboratory of Marine Biology, CINVESTAV-IPN Unit Merida, A.P. 73-CORDEMEX, 97110 Merida, Yucatan, Mexico.

Growth of *Strombus gigas* (Mollusca, Gastropoda) larvae has been always reported in terms of siphonal length (SL) increments. Although some difficulties have been found in measuring SL in larvae younger than 10 days, this parameter is still in use. Larval shell orients antero-posteriorly with the siphonal channel pointing up, when larvae retract. This particular position prevents its appropriate measurement since the columellar axis bends down, placing the tip of the shell out of focus.

An embedding technique was developed to orient veliger larvae in a ventro-dorsal position which allows the correct measurement of SL. Using this technique, 3600 larvae were embedded in Glycerol-Gel (Sigma Chemicals Inc., 1% phenol) to assess SL daily increments and also offers the opportunity to evaluate other parameters of growth as the diameter of the shell aperture and the width of the whorl.

THE FLOWER GARDEN BANKS: ISOLATED TROPICAL OASES.

GITTINGS, Stephen R., National Oceanic & Atmospheric Administration, Flower Garden Banks National Marine Sanctuary, 1716 Briarcrest Dr., Suite 702, Bryan, TX 77802

The biological communities of the Flower Garden Banks will be described and depicted in a 10-minute video on the banks. The video also comments on environmental concerns, as well as management and protection of this unique tropical ecosystem. The isolation of the banks will be discussed as well as its effects and the reasons that tropical animals and plants thrive there. Stetson Bank, a nearby feature being considered for protection under the National Marine Sanctuary Program, will be briefly described, as well as the threats that have led to its consideration.

MOLLUSKS OF THE CORAL REEFS OF VERACRUZ, MEXICO.

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Systematic, ecological and zoogeographical aspects of benthic mollusks, inhabiting the Veracruz Reef system, are presented in this paper. At least 74 species of mollusks were found, 51 belonging to the Gastropoda Class and 23 to the Bivalvia Class.

Results show that the presence of these groups is related to the morphology of the reef. Depth and substrate type influence distribution and diversity patterns of populations. Two typical communities were distinguished: a) a shallow water community (0-3 m) present on rocky and sandy bottoms, and b) a deep water community (3-30 m) present only on rocky bottoms.

Strombus alatus, *Pinna carnea*, *Atrina rigida*, *Codakia orbicularis* and *Anodontia alba* are the most important commercial species. Several ornamental shells are also present in the reef.

MOLLUSCS OF THE STATE OF VERACRUZ REPRESENTED BY THE COLLECTION FOUND AT THE ECOLOGY LABORATORY OF THE ZOOLOGY DEPARTMENT AT THE NATIONAL POLYTECHNICAL INSTITUTE, MEXICO.

GONZALEZ, Aurora C., Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, Prol. de Carpio y Plan de Ayala, Col. Plutarco Elias Calles, C.P. 11340, México, D.F.

The collection of the Ecology Laboratory found in the National Biological Sciences School is one of the most ancient of country. It was begun by Doctor Federico Bonet Marco in 1939.

From that date at present on the collection increased due to in the laboratory development of different investigation projects on sea resources of the coast of México, and these collections are deposited in our collection; besides in also has received important deposits from Instituto Nacional de la Pesca.

Thanks to the above, the collection has with more than 7400 registers, in the which the molluscs are a group moderately represented by the State of Veracruz, having a total of 27698 organisms of which 2 begin to class Polyplacophora; 16202 to class Gastropoda; 11422 to class Pelecypoda; and 72 to class Cephalopoda.

In the class Polyplacophora there is a family with a genere; in the class Gastropoda there is 33 families, 43 generes and 72 species; in the class Pelecypoda there is 15 families, 22 generes and 33 species; and 2 families, 3 generes and 6 species in Cephalopoda.

DEAD ZONE IN THE NORTHERN GULF: IMPACTS OF LOW OXYGEN ON MOLLUSCAN AND ASSOCIATED FAUNA

HARPER, Donald E., Jr., Texas A&M Marine Lab, Galveston, TX 77551, and RABALAIS, Nancy N., Louisiana Universities Marine Consortium, Cocodrie, LA 70344

The so called "dead zone" is a region of the northern Gulf of Mexico continental shelf in which bottom water dissolved oxygen (D.O.) concentrations decrease below 2.0 ppm during summer. Hypoxia (< 2.0 ppm D.O.) and/or anoxia (0.0 ppm D.O.) occurs almost annually off Louisiana and episodically off Texas. The extent and duration of the hypoxic water mass varies considerably, depending principally on outflow from the Mississippi-Atchafalaya Rivers and wind conditions.

Research conducted on the Louisiana shelf since 1985 has greatly increased understanding of the phenomenon. Studies have utilized remote instrumentation, remotely operated vehicles (ROV's), and scuba diving. The ROV was used to locate hypoxic areas, and divers were used to measure oxygen uptake, collect bottom samples, and take photographs. The research has documented mats of sulfur-oxidizing bacteria on the bottom, extensive areas of anoxic black mud, and organismal responses to low D.O.

Several stages of biological response are evident as hypoxia intensifies to anoxia. Fish, squid and other motile invertebrates depart the area first. Benthic invertebrates display stress behavior; crabs congregate on elevations, gastropods crawl about the surface with siphons directed vertically, brittlestars elevate their disks off the bottom. As oxygen levels decrease further, deep-burrowing invertebrates move to the surface and are found lying on the bottom, and finally, as hydrogen sulfide diffuses into the water column, benthic organisms die, but remain on the bottom because of decay-inducing aerobic bacteria and scavengers are absent.

OBSERVATIONS ON THE REPRODUCTIVE ANATOMY AND BEHAVIOR OF CERTAIN GULF COAST UNIONIDS.

Paul Hartfield, U.S. Fish and Wildlife Service, Jackson, Mississippi, 39213

Recent field observations in the Mobile River Basin suggest an intense competition for host fish attraction and infestation in unionid mussels. Foremost among these observations is the superconglutinate method of glochidial release/host fish attraction recently documented for *Lampsilis perovalis* (Conrad). Conglutinates of *Ptychobranchus greeni* (Conrad) have been found to mimic aquatic dipteran larvae, and use a novel method for maintaining position in shoals and rapids. Temporal, anatomical, and behavioral differences in the display of mantle flaps of live gravid females have been noted between populations of *Villosa vibex* (Conrad). This suggests one or more cryptic species within this taxon, or an inordinate amount of individual and population variation.

Recent collections have found most small individuals (35-95 mm) of *Potamilus inflatus* (Lea) in the Amite River, LA, and the Black Warrior River, AL, to be gravid. Although larger individuals (100-150 SL) are more abundant in both rivers, they have not been observed in the gravid state. This suggests protogyny, which is rare in bivalves and has not been previously reported in the Unionidae. Glochidia of *P. inflatus* are distinct from all other members of the genus, and have valve characters unique to this species.

THE ESTUARINE CLAM *RANGIA CUNEATA* AS A STANDARD MONITOR OF HAZARDOUS SUBSTANCES IN GULF COAST ESTUARIES AND INLAND WATERS: DIOXINS AND FURANS.

HARREL, Richard C. and M. A. McConnell, Lamar University, P.O. Box 10037, Beaumont, TX 77710

Characteristics that make *Rangia* a useful biomonitor will be discussed. Polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) were measured in the tissues of *Rangia* at four sites in the Neches River that received paper mill effluent and at two remote sites. Measurable concentrations were found at all sites, but higher concentrations were present at the Neches River sites. The highest concentrations of PCDDs occurred at sites located 8 km and 16 km upriver from the paper mill outfall indicating transport upriver by saltwater intrusion and/or non-point sources exist upriver. The presence of PCDD/Fs at the remote sites also indicate other sources of these materials exist in the area.

UNIONIDS AND MARGARITIFERIDS IN THE SAINT CROIX RIVER, AFTON AND WILD RIVER STATE PARKS, MINNESOTA, 8 - 17 JUNE 1992.

HAVLIK, Marian E., Malacological

Consultants, La Crosse, WI, 54601-4969.

Large areas of the wild and scenic St. Croix have not been sampled. During quantitative and semi-quantitative diving and wading we found 20 (of 40) bivalve species. Wild River Park (13 shallow sites in 19 miles) yielded 19 live and two dead species (1480 margaritiferids and unionids, up to 74/m², in sand, gravel, cobble, and vegetation, with recruitment in six species. Diversity decreased near high dam. *Elliptio dilatata* (Raf., 1820) (32.0%) and *Actinonaias l. carinata* (Barnes, 1823) (30.8%) dominated. Forty *Cumberlandia monodonta* (Say, 1829) were from 165-235 mm long, and to 70 years of age, which suggests a host problem in limited habitat; species is reproducing below high dam. Rare sp. were *Cyclonaias tuberculata* (Raf., 1820) (23, to 50 years), *Alasmodonta marginata* Say, 1818 (29) and *Pleurobema stultorum* (Raf., 1820) (17).

Afton Park's habitat (Lake St. Croix) was limited, and fauna sparse. Depths were over 6 m, and 12 sites in 2 miles yielded 80 unionids (8 live species, plus 3 dead including a fairly fresh *Lampsilis higginsii* (Lea, 1857). Some were stunted, and there was little evidence of recruitment. No *Dreissena polymorpha* (Pallas, 1771) found.

GPS USE DURING A 1992 UNIONID MOLLUSK BRAIL AND DIVE SURVEY, LOWER OHIO RIVER MILE 938.9 TO 981.0, PADUCAH, KY, TO CAIRO, IL.

HAVLIK, Marian E., Malacological Consultants, La Crosse, WI, 54601-4969. GPS readings were taken at the start/end of 367 brail runs and 60 dives in a COE survey of maintenance dredging and disposal areas. Without Lat/Long on COE charts, it is hard to know where you are, or if "Selective Availability" is causing problems at a time or location. In 1992 we had problems daily. Readings placed sites correctly on large maps but 20 minutes later sites were 500' from the River. Ten % of 427 sites had location errors. Exact locations are difficult with wind/current. Sorting by longitude for the east/west Ohio River showed hand-recorded errors. Data should be downloaded often, and also hand-written. Multiple readings and base stations will help. Sites, and beds, were plotted on 41 large maps. Field plotters are needed, and small maps to show where you "think" sites were. Over 25 miles of unionid beds were found; 81% near IL, 19% near KY. Four unionids/brail run, and two/dive site = 1.0/m². 33% of the sites yielded 653 specimens (24 sp. including 22 juveniles), but no Dreissena polymorpha (Pallas, 1771). Plethobasus cooperianus (Lea, 1834) at Ohio R.M. 949.2, 37° 11' 17.2" N, 88° 49' 6.2" W, was a recent upstream record.

A KEY TO THE GLOCHIDIA OF THE UNIONIDAE OF TEXAS.

Hoggarth, Michael A., Department of Life and Earth Sciences, Otterbein College, Westerville, OH 43081

The Unionidae possess a parasitic larval stage known as a glochidium. During this short parasitic period, the larvae transform into juveniles and then drop from their host to begin a much more lengthy independent stage in their life cycle. Glochidia differ from their adult progenitors both anatomically and conchologically. Many current keys to the adults are available but keys to the glochidia are rare, mostly outdated, and where available are based solely on the light microscope level of study. The present key is a result of the examination of numerous species of unionid glochidia by using Scanning Electron Microscopy (SEM), supplemented by glochidial descriptions at the light microscope level of study. It was constructed to distinguish the Texas fauna but may be of value in some neighboring states as well. Glochidia of most genera of Texas Unionidae are presented at the SEM level of study. A large percentage of the glochidia of Texas species are included also. Although genera may be distinguished at the light microscope level, most positive identifications of glochidia can only be made at the SEM level, if at all.

ASPECTS OF GROWTH AND RECRUITMENT OF THE RECENTLY INTRODUCED MUSSEL, Perna perna (Linnaeus, 1758), FROM THE SOUTH TEXAS COAST. HICKS, David W. and TUNNELL, John W., Jr., Center for Coastal Studies, Texas A&M University-Corpus Christi, Corpus Christi, TX 78412

The first record of Perna perna (family Mytilidae) in the Gulf of Mexico was reported from the jetties at Port Aransas, Texas, in February 1990. Within four years P. perna has become a major fouling organism of hard substrates in lower mid-intertidal habitats having colonized various artificial hard substrates and natural rocky shores between Matagorda Island, Texas and southern Veracruz, Mexico, a distance of over 1,300 kilometers.

Current investigations include monitoring mussel growth, recruitment, mortality, and distribution. Growth rates are high compared to other North American mussels. Local monthly growth rates for P. perna are as high as 6 mm.

Spawning and recruiting trends are being monitored by tracking gonad development through temporal fluctuations in the biomass - shell volume relationship and examining size compositions and modal progressions. The observed rapid spread of P. perna to the south in the Gulf of Mexico is likely the result of coincidence of peak spawning events (late-Fall and early-Spring) with seasonal southerly trends in current direction.

A SURVEY OF THE UNIONID MOLLUSKS OF THE PLATTE RIVER BASIN IN NEBRASKA
HOKE, F. Ellet, 13931 Reflection Court, Apt. 736 Ballwin, MO. 63021

A qualitative survey consisting of 97 collection sites in the Platte River basin resulted in the documentation of 14 species. Five of these were represented solely by weathered valves suggesting the probable extirpation of related live populations from the basin.

Survey results indicate historic species diversity to have been highest in the eastern portion of the study area, declining to only two species in the western portions of the basin.

Unionids were found primarily in basin creeks, sand pits, irrigation canals and reservoirs, and in side channels and backwater areas of the Platte River. Few specimens were recovered from the Platte River between the mouth of the Loup River and the confluence of the Platte and Missouri Rivers south of Omaha.

Analysis of survey results suggests that significant decreases in unionid habitat have occurred due to grazing activities and reduction and diversion of water flow for irrigation and hydrological development in the basin. The loss of natural unionid habitat has been partially mitigated by the creation of new habitat in the form of reservoirs and irrigation canals.

FRESHWATER MUSSELS OF TEXAS: AN OVERVIEW.

Howells, R.G. Texas Parks and Wildlife Department,
Heart of the Hills Research Station, Ingram, TX 78025

A total of about 51 species of freshwater mussels (Family Unionidae) have been reported for Texas waters. The taxonomic status of some of these is questionable. The continued survival of several others is also in doubt. Presented here is a brief overview with color slides of all species and many local morphs.

AN INTRODUCTION TO BIOCHEMICAL GENETICS AND ELECTROPHORETIC ANALYSIS.

Howells, R.G. Texas Parks and Wildlife Department,
Heart of the Hills Research Station, Ingram, TX 78025

Few groups of organisms appear to hold basic principles of Linnean classification in such utter contempt as do members of the family Unionidae. Disagreements on classification based on shell and soft tissue morphology have sometimes raged unresolved for decades. Presented here is an introductory, low-level discussion of electrophoresis and other biochemical techniques which are helping to resolve some identification problems.

ELECTROPHORETIC EXAMINATION OF SELECTED UNIONIDS FROM TEXAS.

Howells, R.G., and D. Van Meter. Texas Parks and Wildlife Department, Heart of the Hills Research Station, Ingram, TX 78025

Horizontal starch-gel electrophoretic techniques were used to examine enzyme differences associated with several taxonomically-problematic groups of unionids. Mapleleaf (Quadrula quadrula) and southern mapleleaf (Q. apiculata) populations were compared as were several pimpleback species (Q. aurea, Q. pustulosa, Q. mortoni, Q. houstonensis, and Q. petrina). Electrophoretic scores were also compared for Texas heelsplitter (Potamilus amphichaenus), pink papershell (P. ohioensis) and fragile papershell (Leptodea fragilis), as well as to specimens of questionable identity from the Brazos River drainage. Comparisons of lilliput, Toxolasma texasensis and mearnsi, populations are also discussed. Preliminary results are presented.

FRESHWATER MUSSEL REPRODUCTIVE BIOLOGY: A BRIEF DISCUSSION OF RECENT WORK IN TEXAS.

Howells, R.G. Texas Parks and Wildlife Department,
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Presented here is a brief discussion of recent work with freshwater mussel reproductive biology by Texas Parks and Wildlife Department's Heart of the Hills Research Station. Included are comments on spawning season, glochidia, host determination, fecundity, and reproductive techniques employed by several unionids in Texas.

RECENT FRESHWATER MUSSEL POPULATION DECLINES IN TEXAS: POSSIBLE CAUSES.

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Formal mussel surveys by Texas Parks and Wildlife Department first began in 1992. From the outset, it was apparent that many unionid populations had declined or been extirpated from some river systems within recent decades. Possible causes for some of these losses are suggested. Apparent causes are complex and interrelated; some were problematic before the turn of the century.

HYPEROSMOTIC VOLUME REGULATION IN TWO FRESHWATER MOLLUSCS.

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The bivalve *Lampsilis teres* and the gastropod *Pomacea bridgesi* were exposed to media of increasing osmotic concentration. *L. teres* survived (80%) in 400 mOsm; *P. bridgesi* was tolerant only of media of 150 mOsm or less. Both animals are good volume regulators; tissue hydration did not decrease markedly in animals acclimated to concentrated media. The amino acid content of the tissues of animals acclimated to concentrated media increased. The primary amino acids employed for volume regulation in *L. teres* gill are β -alanine, alanine, and glycine. In *P. bridgesi* gills, increases in glutamic acid, glycine, alanine, threonine, and serine serve to regulate cellular volume. These results suggest that freshwater molluscs are able to regulate cellular volume in hyperosmotic media, and that volume regulation is accomplished, at least in part, by increases the cytoplasmic levels of selected amino acids. Freshwater bivalves appear to be more tolerant of hyperosmotic media than freshwater gastropods.

FROM THE BIG BEND TO ST. JOE: A SURVEY OF MARINE MOLLUSCS OF THE NORTHEASTERN GULF OF MEXICO.

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From October 1984 to October 1991 marine molluscs were collected from Apalachee Bay on the east to the St. Joe Peninsula on the west. Salt marshes, estuarine bays, barrier islands, high salinity bays, and offshore waters up to 85 feet in depth were sampled. Crabtraps, muddy bottoms, batfish stomachs, sandy reefs, and shell reefs were examined.

There were over 250 shell collecting trips. Detailed data of date, time, locality, and any special circumstances of each trip along with a qualitative list of species collected were recorded.

Major range extensions were found. At least one unnamed species has been noted.

Identified specimens were provided to the organization whose facilities were used or whose area was sampled.

Over 550 marine species were identified and about 15 have resisted identification. Collecting has been suspended but work on identification is continuing. Turbellariids, Tellinidae, Cerithiopsidae, and Triphoridae are the major groups unfinished.

THE STATUS OF THE NORTHERNMOST GIANT CLAMS IN THE RED SEA.

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Line transect (30m x 2m) was used to compare the *Tridacna maxima* population in five different sites in the southern coasts of Sinai peninsula. Eight different depths were surveyed in each site. Clam abundance varied significantly among sites, depths and the sites-depths interaction (two-way ANOVA, $P < 0.0001$). Mean clam density varied between 1.58 and 0.09 individual/m². Clam sizes were between 0.40 and 32.2 cm. There was a significant difference in sizes among different sites ($P < 0.01$), and depths ($P < 0.05$).

Reproduction of *T. maxima* was studied. Spawning took place between June and October 1990. No sections were seen in which mature spermatozoa were not accompanied with primary spermatocyte. By contrast, fully ripe egg stages were not accompanied by early egg stages. This northernmost population of tridacnidae, is different than that in the Great Barrier Reef in the timing of spawning, but it is similar in the distribution pattern within the reefs. This data suggest the following; 1) There is an apparent destruction in the population structure of the giant clams in the Red Sea, exhibited by the disappearance of larger clam size classes in site 1. 2) The mariculture potential of giant clams exists in the Red Sea.

GENETIC VARIATIONS WITHIN AND AMONG POPULATIONS OF THE FRESHWATER MUSSEL, ANODONTA GRANDIS GRANDIS, IN COLORADO.

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Anodonta grandis grandis has a very limited distribution in Colorado and the distribution has changed recently due to habitat destruction and pollution. To guide conservation efforts, we need data describing genetic variation to make wise decisions concerning the management and reintroduction of mussels. For this reason, the genetic diversity within and among populations of Anodonta grandis grandis in Colorado was studied with mitochondrial DNA Restriction Fragment Length Polymorphisms (RFLPs) and isozyme electrophoresis.

Initial results show that there is strong genetic differentiation between different drainage mussel populations, and that males and females examined in 1993 have different mitochondrial DNA fragment patterns.

THE ESTUARINE CLAM RANGIA CUNEATA AS A STANDARD MONITOR OF HAZARDOUS SUBSTANCES IN GULF COAST ESTUARIES AND INLAND WATERS: EFFECTS OF REPRODUCTIVE PHASE ON SURVIVAL.

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This study was conducted to determine if reproductive phase and gonadal biomass burden were responsible for mortalities of Rangia cuneata test animals during laboratory metal exposures. A laboratory retention study was also conducted to determine if gametogenesis could be inhibited to avoid complications caused by the reproductive cycle. Experimental data suggest that during the late active and ripe reproductive phases Rangia can not osmoregulate at salinities of 1 ppt or lower. However, gametogenesis can be inhibited in the laboratory when held at 15 C and healthy animals can be maintained for use in laboratory or field exposures.

VENUSTACHONCHA ELLIPSIFORMIS (BIVALVIA: UNIONIDAE): AN INTERMEDIATE HOST FOR PHYLLODISTOMUM (TREMATODA: GORGODERIDAE) IN A MICHIGAN STREAM

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Laboratory and field data have confirmed that Venustachoncha ellipsiformis is an intermediate host for the trematode Phyllodistomum. Of the thirty-three V. ellipsiformis collected from the mid-branch of the Tobacco River in Gladwin County, Michigan, twenty (60.6%) were found to harbor the larval stages of this helminth parasite. Additionally, forty-three clean V. ellipsiformis (i.e., collected from a site not known to have Phyllodistomum) were placed in a mesh cage at the Tobacco River site from 20 July 1993 through 23 September 1993. Upon subsequent examination, three (6.9%) were found to be infected with Phyllodistomum. Histological examination of infected mussels revealed extensive gonad destruction (i.e., mussel gonad replaced by larval trematodes). In some cases the replacement was so complete that sex determination by gonad analysis was extremely difficult. Two hundred eighty-nine fish, representing four families, were dissected in order to locate the adult worm. Thirty-four (11.8%), all cyprinids, representing six species, were deemed to be definitive hosts for Phyllodistomum. Given that Phyllodistomum in Europe has been shown to infect the zebra mussel, Dreissena polymorpha, it is reasonable to expect that native Phyllodistomum may infect this non-indigenous species in North America. If this infection does occur, either naturally or experimentally, the reproductive capacity of these foreign invaders should be greatly diminished.

THE ESTUARINE CLAM RANGIA CUNEATA AS A STANDARD MONITOR OF HAZARDOUS SUBSTANCES IN GULF COAST ESTUARIES AND INLAND WATERS: HEAVY METALS.

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Bioaccumulation rates and concentrations of copper, chromium, cadmium, and lead were determined under laboratory and field conditions. Bioaccumulation rates and concentrations of metals in tissues and the medium were determined in the laboratory. Bioconcentration ratios ranged between 11 and 534 with significant correlations between exposure time and tissue metal concentrations. Field exposures were conducted in the Neches River below two industrial outfalls that contained some of the metals. High metal concentrations were found in the sediments, low concentrations in the water, and intermediate concentrations in Rangia tissues. No correlation was found between exposure time and tissue concentrations.

PROGRESS TOWARD REVISION OF THE LIOTIINAE AND COLLONIINAE OF THE WORLD

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Liotiinae and Colloniinae are basal subfamilies of Turbinidae in which the radular plan is plesiomorphic, with no distinctions at the generic and specific yet recognized in either group. Opercula differ widely, the multispiral operculum of Liotiinae is ornamented with external calcareous beads, whereas that of Colloniinae is enveloped by the foot and thickened externally with calcareous deposits. Both groups exhibit size extremes ranging from maximum dimensions of 1 mm to 30 mm, although most are under 5 mm. Species of a few genera in each group brood the young in the umbilical cavity, which is larger in females than in males in such genera.

Although opercula are rarely preserved as fossils, the liotiine genera with characteristic lamellar sculpture and thickened lips have been recognized in the Permian and the Mesozoic. Shell characters of Colloniinae are approached by many other trochacean groups and the origin is murky, like that of most Trochacea.

I have had a long standing interest in these groups and have been gathering materials toward complete monographs for many years. Specific names have been tracked in the literature and nearly all type specimens have been photographed. Collections of the major museums have been studied. Manuscript names for the new species have been chosen and generic diagnoses are now in draft but much work remains.

At this time I recognize a total for both subfamilies of 47 genera, of which 18 are new, and 326 living species, of which 139 are new. The high number of new species derives from the fact that most species are small and usually overlooked and that many have very limited distributions, a correlation of the short planktonic life of broadcast spawning archaeogastropods.

47 species (34% of those new) were recognized in the LACM collection, a result of the efforts of volunteers in extracting specimens from sediment samples collected by diving around the world.

MOLLUSKS OF THE INDIAN RIVER LAGOON, FLORIDA - BIODIVERSITY TO BE CONSERVED

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In response to a February 1994 conference on Biodiversity of the Indian River Lagoonal System, mollusks were inventoried using available collection and literature resources, mainly reflect amassed during 1974-1982. 4,503 records documented 428 species-level taxa from the 160-mile coastal lagoon, including 253 estuarine "resident" species. Five north-south faunal areas were defined by intraregional analysis; 39 species were common throughout the lagoon. Inlet localities included 107 species not found elsewhere, including five of the six endemic species. Seagrass beds supported the highest number of species (177), and *Bittolum varium* was most frequently collected as well as quantitatively most abundant. 13 new distributional records were recorded.

Compared to other eastern U.S. estuaries, the IRL shows substantially higher species number, and strongest qualitative similarity to Tampa Bay. High levels of ecological diversity are present in habitat, diet, life mode, and life history strategies. This regional richness is attributed to (1) high habitat diversity, importantly including oceanic inlets and freshwater tributaries, and (2) location within a zoogeographic transition zone, reflected by molluscan species distributions and by those of habitat/food plant species. Recommendations made toward development of a local management plan are discussed, including the importance of inlets, seagrass beds plus endemic, commercial, and CITES-protected species.

BIOEROSION OF MOLLUSCAN CARBONATE BY ENDOLITHIC BORERS IN THE SANTEE LIMESTONE (EOCENE, SOUTH CAROLINA) AND ITS TAPHONOMIC AND SEDIMENTOLOGIC IMPLICATIONS

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Mollusks form the dominant group of fossils in the Eocene Santee Limestone in Berkeley County, South Carolina. Most were originally aragonite and these skeletons were leached prior to the completion of diagenesis yielding considerable biogenic (biomoldic) porosity. Endolithic borers are commonly preserved within the molds of their host shells as micritic sediment fillings, or occasionally sparry calcite fillings, of their borings. Other shells (oysters, plus some echinoderms) remain the original unleached calcite and are best studied in thin sections. A few shells, such as the spondylids, are bimineralic and yield composite preservation.

Bioeroders represent three kingdoms and a host of phyla. In addition to the omnipresent algae and fungi there were clonid sponges, ctenostome bryozoans, acrothoracic barnacles, bivalves, predaceous gastropods and possible polychaete worms.

NURSE EGG FEEDING PROSOBRANCHS: A COMPARATIVE QUALITATIVE ANALYSIS OF EGGS AND HATCHLINGS.

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An electrophoretic study of the eggs and hatchlings of temperate (*Buccinum undatum*, *Buccinum cyaneum*) and tropical (*Fasciolaria tulipa hollisteri*, *Fusinus closter* and *Eualetes tulipa*) nurse egg feeding species was carried out. The objective was to determine how much of the nurse egg material ingested at an early embryonic stage remains as reserve in the hatchlings. Species with more original nurse egg reserves at hatching are the tropical species, with *F. hollisteri* in the first place, followed by *F. closter* and *E. tulipa*. It can be concluded that the nurse egg reserves present in the hatchling seem to be related to its mode of development (intracapsular metamorphosis or lecithotrophic), the developmental period, to the quantity of nurse eggs the embryo ingests and the adelphophagy mode.

ECOLOGY OF INFAUNAL MOLLUSCA IN SOUTH TEXAS BAYS.

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The ecology of Texas estuaries is strongly influenced by latitudinal ecotones that exist along the northwestern Gulf of Mexico coastline. We are conducting long-term studies in four of the seven major estuarine ecosystems in Texas. The objective is to determine the role of climatic variability and differences in freshwater inflow among the ecosystems in structuring benthic infaunal communities and maintaining secondary production. Mollusks are prominent members of the infauna in sediments of both open bays and seagrass beds of Texas estuaries. We measured the abundance, biomass and community structure of mollusks along salinity gradients within the four estuaries. The population size structure was also determined for the dominant species. There are seasonal, interannual and latitudinal patterns of inflow, and these patterns are apparently regulating community structure, population dynamics and secondary production.

RELATIONSHIPS AMONG UNIONACEAN MUSSELS ASSESSED WITH MITOCHONDRIAL DNA SEQUENCE VARIATION.

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DNA sequence data were used to assess phylogenetic relationships among Unionacean mussels. Sequence variation was analysed for a portion (> 300 bp) of the 16S mitochondrial ribosomal gene. The following genera were included in the analysis: *Margaritifera*, *Amblema*, *Elliptioideus*, *Fusconaia*, *Plectomerus*, *Quadrula*, *Tritigonia*, *Megaloniaia*, *Elliptio*, *Anodonta*, *Ellipsaria*, *Lampsilis*, *Medionidus*, *Obliquaria*, and *Villosa*. These represent the three families and six of the nine subfamilies of North American Unionacea. Phylogenetic trees were generated and compared to relationships based on morphological data. DNA sequence data may be especially useful in clarifying the relationships among morphologically convergent taxa.

RECYCLING AS A SURVIVAL STRATEGY: BRYOZOAN INCRUSTED GASTROPOD SHELLS, PROBABLY INHABITED BY HERMIT CRABS

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Heavily incrustated naticid and trochid gastropods that were several centimeters in diameter were collected from late middle Miocene rocks (Salada Formation, 12-14.5 million year old) along an arroyo that drains into Magdalena Bay, western Baja California Sur, Mexico. Associated pelecypods indicate that the formation was deposited in shallow water and has Tertiary Caribbean faunal affinities.

Two genera of anascan bryozoans, *Antropora sp.* and *Cauloramphus ? sp.*, incrustated the gastropods, forming thick layers, narrowing the apertures (*Cauloramphus ? sp.* closed the aperture entirely), and obscuring columellar areas. Modification of apertural and columellar areas is usually not as extensive as in these shells. Narrowed apertures may have protected filter feeding crabs.

Hermit crab-occupied shells in California and Texas are not as heavily incrustated, nor are their apertures narrowed. On both coasts, probably because of shell scarcity, crabs will inhabit broken shells. Broken shells seem to be rare or absent in the Salada Formation. Shells strengthened by incrustating bryozoans probably remained intact for extended periods, thereby allowing longer hermit crab habitation.

Provincial affinities are unknown. Although both bryozoan genera live in southern and Baja California today, comparable Caribbean fossils have not been described.

PRELIMINARY EXPERIMENTS TO PROPAGATE JUVENILE FRESHWATER MUSSELS (UNIONIDAE)

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Propagation experiments were conducted to test various algal diets for juvenile mussels in indoor downweller containers, and to evaluate the use of outdoor tanks to rear juveniles using naturally available food. Laboratory feeding trials tested tri-algal and commercial diets and determined the effect of silt substratum on survival and growth of the rainbow mussel (*Villosa iris*) and giant floater (*Anodonta grandis*). Survival and growth required the presence of a substratum. At 45 days post-metamorphosis, juvenile rainbow mussels doubled their size, with 64% survival. In comparison, juveniles fed algae without a substratum exhibited no shell growth and only 5% survival. Maximum size of giant floaters after 60 days was 1.1 mm, with 59% survival. Juveniles of both species pedal-fed for about the first 140 days.

Juvenile rainbow mussels reared in oval 75-L tanks with two particle size fractions (< 120µm and 120-600µm) exhibited the same survival (27%) and statistically similar growth in length (2.2 and 2.0 mm) after 4.5 months. An empirical distribution function plot of the two treatments indicated that growth of juveniles in the fine substratum was slightly greater with less variance than that of juveniles in the coarse substratum.

Origin and Composition of the Mollusk Fauna of the Northwestern Gulf of Mexico

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Study of the marine mollusks collected in cooperation with various agencies for the Houston Museum of Natural Science has shown that the shelf fauna is derived from the old Caloosahatchian fauna of Florida and has also revealed the presence of Panamic elements. The fauna of the live coral reefs at the shelf edge has not appreciably influenced the shelf fauna. To understand this the geologic history of the area after closure of the Isthmus of Panama and the emergence of the Florida Platform with subsequent change in ocean currents must be considered. The so-called loop current has divided the Gulf of Mexico into two malacologically different areas. The oceans around the Florida Peninsula were invaded by the Caribbean fauna, but the Texas-Louisiana shelf area remained largely untouched. Contributing to its isolation is the sediment-laden plume of the Mississippi River paralleling the Texas coast to past Matagorda. Examples illustrating various faunal components, many derived from a study of the Pyramidellidae, will be given.

ANALYSIS OF LAB AND FIELD TECHNIQUES OF FECUNDITY STUDY FOR *TULOTOMA MAGNIFICA* (GASTROPODA: PROSOBRANCHIA: VIVIPARIDAE)

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Tulotoma magnifica, listed as an endangered species, occurs only in the northern 7 mile stretch of the Coosa River above the Jordan Dam and some of its tributaries. An objective of this ongoing 3 year study is to determine the fecundity of this snail. Twenty five females were taken from the Coosa River each month and brought into the lab for a one-month observation period. Measurements and adult phenotypes are recorded. In addition, ten females were sacrificed monthly at the river site for a comparison to lab findings. Preliminary results show females greater than 12.4 mm in length give birth. Females are shown to give birth year around, but with a peak in May of 70%. Birth rates during the winter months decline to less than 30%. Offspring show variation in size and shell color patterns among and within populations. Forty nine shell color patterns have been noted among the population of juveniles born in the last 2.5 years of this study. Other variables measured are discussed in greater detail. Preliminary analysis of comparative techniques employed in fecundity study also are addressed.

EFFECT OF INTRASPECIFIC CROWDING ON GROWTH RATES IN THREE SPECIES OF TERRESTRIAL SNAILS.

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I examined the effect of density on growth of three land snail species to study the relative importance of behavioral and chemical effects, and to find the location of chemical inhibitors.

In laboratory cages with abundant food and moisture, rate of shell diameter increase in juvenile *Mesodon thyroidus* and *Neohelix albolabris* decreased as number of conspecific adults increased from zero to one to three. Growth of juvenile *Anguispira alternata* was not affected by density of adults.

In 1 m² field cages juvenile *M. thyroidus* grew more rapidly with zero instead of two adults over 72 days. However, growth rates of *M. thyroidus* and *N. albolabris* at those densities did not differ over 44 or 57 days, respectively, with added food and water, suggesting those resources were limiting in the field.

Whether inhibition in the laboratory was behavioral or chemical, and where inhibitors were located, was ambiguous for *M. thyroidus* and *N. albolabris*. Presence of adults, or separate feces and mucus in two of four experiments slowed growth of *M. thyroidus* but total products (mucus, feces, urine, etc., in cages from which adults were removed before juveniles were added) did not. Presence of adults, and total products slowed growth of *N. albolabris* but separate feces and mucus did not. Total products increased growth of *A. alternata* slightly. Chemical inhibitors were volatile for *N. albolabris* but not for *M. thyroidus*, indicating species differences. Possible interpretations include that behavioral interactions may slow growth in *M. thyroidus* but not in *N. albolabris*, or inhibiting chemicals for both species may occur in products irregularly. Growth promotion by mucus has been reported in a few other species and deserves more study in *A. alternata*.

FACTORS MAINTAINING DIVERSITY OF FRESHWATER MUSSELS IN THE UPPER CLINCH RIVER, VIRGINIA/TENNESSEE

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In the Upper Clinch River and in other relatively unimpacted medium-sized stream reaches in the Tennessee Valley, thirty to forty species with seemingly overlapping resource requirements coexist in stable distributions. The most probable mechanisms maintaining diversity include niche diversification of fish hosts or habitat, environmental variability, disturbance, and environmental stress. I have used a simplified computer modeling approach with a yearly time step to simulate growth, survival, and reproduction of three common species of Unionidae at one of the most diverse sites in the Upper Clinch River to evaluate the long-term effects of these factors on community structure.

My results indicate that partitioning of a limited fish host resource is the most reasonable explanation for the biodiversity of mussels. This result is consistent with field observations: freshwater mussels separate the fish host resource according to fish species, timing, and glochidial attachment site. Fish host limitation may be due to a combination of restricted glochidial release periods and host immunological response. Although further modeling study is needed, these preliminary results demonstrate the necessity of combined conservation strategies for mussel and fish resources.

REPRODUCTIVE SEASONALITY, PERIODICITY, AND ASSOCIATED BEHAVIOR IN A COLONY OF STROMBUS PUGILIS (MOLLUSCA: GASTROPODA) IN SOUTHWESTERN PUERTO RICO.

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Aspects of reproduction were studied in the West Indian fighting conch, Strombus pugilis, in southwestern Puerto Rico. This work focused on defining seasonal reproductive dynamics in this species. A colony of S. pugilis was studied from September, 1987, to September, 1989. For both years, reproductive activity began in March, when water temperature rose, and ended in November, when water temperature dropped; complete cessation of reproductive activity occurred in December, when the whole colony buried until emergence in February. During the reproductive season, mating and spawning activity occurred on a monthly basis with some irregularity. The monthly periodicity was significantly correlated with the lunar cycle, with peak spawning occurring in the second week following the full moon. Field observations on behavior were supplemented by observations of conch held in tanks.

MOLLUSKS IN GULF OF MEXICO COASTAL LAGOONS: A COMMUNITY ANALYSIS.

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The structural complexity of the benthic mollusk communities of eleven lagoon systems along the south western Gulf of Mexico is described, based on the abundance, frequency and density of a whole community (live and empty shells) made up of 159 species, 43 of which were alive.

Most of the gastropods that inhabit these coastal lagoons are epifaunal and deposit feeders, whereas the bivalves are mostly filter feeders.

Shannon & Wiener's diversity index for the whole community of each lagoon varied between 0.39 and 3.27 bits/individual, whereas for the live community it varied between 0.08 and 3.72 bits/individual.

A dominant assemblage made up of seven species common to most of the lagoons was identified through the analysis of their values of relative importance.

THE LARVAL STAGES OF ORTHOOTHERES STROMBI (RATHBUN, 1905): A CRAB COMMENSAL WITH STROMBUS PUGILIS.

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The larval stages of Orthootheres strombi (genus subdivided from Pinnotheres by Sakai, 1969) are described. There are three zoeae and one megalopa in the early life history of this crab, the adult female of which inhabits the mantle cavity of Strombus pugilis, the West Indian fighting conch. The berried female was kept in a jar provided with an airstone. After the eggs hatched, the larvae were reared in the same jar (the female was not removed) in the laboratory at an average daily temperature of 24°C, compared to the average summer ocean temperature of 29°C in southwestern Puerto Rico. The seawater was not changed and not filtered (seawater was added to offset evaporation). The eggs hatched as first zoea, and the larvae molted to the second zoea within two days, then to the third zoea within the next two days, and finally, to the megalopa within eight days of hatching.

RELATIONSHIP OF POLAR FATTY ACID ON GROWTH RATE OF Strombus costatus (G.) LARVAE FED WITH SPECIFIC MICROALGAL DIETS.

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Strombus costatus larvae were cultured under hatchery conditions and harvested 16 days after being fed with five specific microalgal diets consisting of Chaetoceros muelleri clone CHGRA, Thalassiosira fluviatilis clone THAL, Isochrysis sp. clone CISO, Tetraselmis chuii clone UW474, and Dunaliella tertiolecta clone DUN. Microalgae were cultured semicontinuously which Guillard's F'10 media at 26°C. Aerated cultures were grown in 4-liter cultured vessels illuminated with 75-80 $\mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ white fluorescent light during cycles of 12 hr light and 12 hr of dark. Cells were harvested towards the end of log phase. All samples from Fatty Acid Methyl Esters and Dimethyl Disulfide derivatives were analyzed by GC-MS. Growth rates for CISO, THAL, CHGRA, UW474, and DUN were 49, 41, 28, 19, and 17 $\mu\text{m}\cdot\text{day}^{-1}$, respectively. The elongation-desaturation of both families of linoleic and linolenic were low in S. costatus larvae indicating that may be primarily controlled by action of acyltransferases enzymes instead of desaturases. Acyltransferases could be the principal way to control the fatty acid composition in larvae. CISO and THAL contained higher concentrations of long chain of C_{23} and C_{22} PUFA were selectively incorporated, conversely to CHGRA and DUN. Larvae of this species indicate essential requirement of 20:5(n-3), but especially 20:4(n-6) and 20:(n-3) which is similar for many marine organisms.

MEXICAN OYSTER RESOURCES. A GENETIC CONSIDERATION FOR THEIR IMPROVEMENT AND EXPLOITATION I. GULF OF MEXICO
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Prospective studies along the Mexican coasts of the Gulf of Mexico have indicated that Crassostrea virginica and C. rhizophorae wild populations have good possibilities to be cultured and exploited for commercial purposes and for the increase of the annual fisheries production. Evaluation of genetic resources on these mollusks by means of inter specific hybridization is useful to the better understanding of their cytotaxonomy, and genic flow in close related species.

In this work, the cytogenetic characterization of the inter specific hybrid karyotype of C. virginica vs C. rhizophorae has been conducted in order to shed further information on their affinity and possibilities of gene flow between these species

The chromosome complements in all type of hybrids assayed were integrated in an apparent normal way to form the zigote and the chromosome number was consistent to 20.(2n) Only biarmed homomorphic isopignotic chromosomes were present. The classification of the chromosomes of the hybrid karyotype has many similarities with those of the progenitor species

It is expected the results obtained will be useful in a future application for genetic improvement and gene banking in modern oyster culture

HOW MANY SPECIES OF GASTROPODS ARE ENDEMIC TO THE GULF OF MEXICO?

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A computer search of the Malacolog database of Western Atlantic gastropods (Rosenberg 1993, AMU Bulletin 10:257-266) shows that about 1050 species of gastropods have been reported from the Gulf of Mexico. Of these, 122 have been reported only from the Gulf. Species known from the Florida Keys and northwest Cuba are not counted. If species known only from their type localities are excluded, 56 species remain as potential Gulf endemics. To correct for poorer sampling in deep water, species known only deeper than 100 meters were also excluded, leaving 48 species. About 940 species have been recorded in the Gulf in less than 100 meters of water, so about 5% of Gulf gastropod species are endemics.

The endemics are distributed unevenly in 22 families, with 5 families having most of the endemics: Hydrobiidae (4 species), Melongenidae (6), Marginellidae (4), Turridae (5), and Pyramidellidae (7). Twenty-one of the endemics are restricted to the Gulf north of 25°N, 12 to south of 25°N, 26 to west of 86°W and 10 to east of 86°W.

EXAMINATION OF THE HYPOBRANCHIAL GLAND OF THE SOUTHERN OYSTER DRILL STRAMONITA HAEMASTOMA CANALICULATA (PROSOBRANCHIA: MURICIDAE).

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The functional anatomy and physiology of the hypobranchial gland from Stramonita haemastoma canaliculata (Gray) was examined using light microscopy, scanning electron microscopy, transmission electron microscopy, and high performance liquid chromatography (HPLC). This gland is the source of the "Tyrian Purple" dye of antiquity. Previous investigators have speculated on the possibility of certain toxins also being secreted by this gland and used to paralyze prey during the feeding process. Data from this investigation suggest that the hypobranchial gland is not the source of toxins used directly in the feeding process. This hypothesis is supported by gross anatomical and microscopical structure as well as from physiological measurements conducted on bivalves exposed to extracts from the gland.

OBSERVATIONS OF THE MOLLUSKS OF HUNTER CREEK, CONECUH COUNTY, ALABAMA.

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Hunter Creek is a small headwater stream in South Alabama, which is part of the Escambia River System. A casual passing glance of the stream would lead one to believe it devoid of molluscan life, but closer observation reveals the presence of three species of gastropods, ten species of unionid clams, and the Asian clam. Hunter Creek is the habitat for the Alabama pearlshell, Margaritifera marrianae R.I. Johnson, 1983, a species currently under status review by the U.S. Fish and Wildlife Service. The study of this stream has led to important discoveries regarding the life cycle of the Alabama pearlshell and other unionids present. Agricultural activities which threaten the health of Hunter Creek and the continuing survival of its molluscan fauna are noted.

SOME INTERESTING MOLLUSKS FROM MARINE WATERS OFF THE COAST OF ALABAMA

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The molluscan fauna off the coast of Alabama has received little attention by malacologists and collectors in comparison to other regions such as peninsular Florida. Though not a popular area for shallow water collecting, the offshore waters of Alabama are inhabited by nearly 600 species of marine mollusks.

Records of collections from 1950 to the present reveal some surprises among Alabama's marine molluscan fauna, including many species normally considered Caribbean species. Collections along the continental shelf and slope immediately west of De Soto Canyon have revealed a great diversity of species including species of *Cypraea* and *Conus* not previously known from the northern Gulf.

STATUS AND RECOVERY OF THE FEDERALLY ENDANGERED CURTIS PEARLYMUSSEL.

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Freshwater unionid mussels have experienced dramatic declines since the turn of the century, the genus *Epioblasma* of particular concern. Of the 25 nominal species of *Epioblasma*, 15 are presumed extinct. The Curtis pearlymussel (*Epioblasma florentina curtisi*) is endemic to southern Missouri and northern Arkansas. Until recently the range of this species was thought to have been reduced to a seven mile stretch of the Castor River and six miles of the Little Black River. Efforts by Buchanan in 1993 turned up only a single live male suggesting the species has continued to decline over the last decade.

Survey efforts just completed have located additional living individuals, but the current status is precarious and necessarily requires the Missouri Department of Conservation and the U.S. Fish and Wildlife Service to reconsider strategies for recovery. It seems clear that this species is imperiled and extraordinary measures are needed to prevent extinction.

A REVIEW OF THE SEA HARES (GASTROPODA: OPISTHOBRANCHIA) OF THE NORTHWESTERN GULF OF MEXICO.

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A review of the sea hares currently known to occur along the south Texas coast will be presented. *Aplysia cervina* (Dall & Simpson) is reported for the first time from the western Gulf of Mexico. This represents a significant range extension of its previously known distribution. The questionable status of *Aplysia donca* Marcus & Marcus will be reviewed in light of the results of ongoing horizontal starch gel electrophoretic investigations. This will be followed with a proposed revision in the current subgeneric classification scheme of the genus *Aplysia*.

ECOLOGICAL DISTRIBUTION OF MOLLUSCS ON ALACRAN REEF, CAMPECHE BANK, YUCATAN, MEXICO.

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The distribution of Mollusca at Alacran Reef, Mexico was investigated during January and July, 1986. Alacran Reef, a coral atoll, is the largest in a chain of coral reefs situated on the Campeche Bank, a submerged Gulfward extension of the Yucatan Peninsula. The reef complex was divided into eight habitat types from which 18 sampling stations were established. Each station was sampled for macro-molluscs by snorkeling, SCUBA diving or wading.

Beach shells were collected from a series of five sand cays on the leeward edge of the reef: Desterrada, Desertora, Perez, Chica, and Pajarros. In addition, sediments from locally situated *Thalassia testudinum* König beds and other reef habitats were examined for micro-molluscs.

A total of 172 species of molluscs were collected representing 59 families. Macro-gastropod species of the genus *Cerithium* were the most abundant followed by *Neritina* and *Astraea*. *Barbatia* spp. were the most abundant macro-bivalves. The micro-mollusc *Caecum nitidum* was the most abundant infaunal species found in *Thalassia* bed sediments.

PRELIMINARY DISCUSSION OF HIGHER ORDER
RELATIONSHIPS AMONG THE OCTOPODA

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Although most familiar are the benthic octopodids, eleven families of the Octopoda occupy bathy-pelagic and epi-pelagic habitats. The recognized species-level diversity of these families is minimal: 8 are currently considered to be monotypic. Our perception of species-level diversity may be an artifact of previous research which has almost exclusively focused on unique characters which distinguish the families but are unable to either estimate species-level diversity or suggest relationships within the group.

To understand octopod evolution, we first must better understand these enigmatic taxa and characters which define them. Octopods have been suggested to be canalized in morphology and anatomy, yet available evidence suggests that these taxa violate this generality. Explorations of morphological and anatomical variation by these families may be important clues to understanding the evolution of the radically successful benthic octopods. Conversely, the characters that distinguish these families may be adaptations to their pelagic habitats. Furthering our knowledge of these groups is critical to resolving relationships in the suborder.

PRE-PLEISTOCENE NORTH AMERICAN UNIONOIDEANS

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The Pre-Pleistocene unionoideans of North America represent a diverse assemblage of several major lineages, most of which became extinct, or were severely depleted, during the Mesozoic-Cenozoic extinction event. Paleozoic "unionoideans" seem to belong to other, unrelated groups. Triassic forms include margaritiferans, and hyriids that occurred as far north into North America as New England. These groups originated in and were shared with Europe, Africa, and South America during the existence of Pangaea at that time. The unionid vetuloniaians appear in the Triassic, and reached their greatest diversity in the late Cretaceous. A great diversity of unionoideans arose in the Cretaceous, located mainly in western North America. These included the proparreysians, elliptoids, and anodontines. These may be ancestral to some Recent groups. These Mesozoic genera convergently evolved shell shapes very similar to Recent forms, presumably in response to similar ecological needs: anchoring, anti-scouring, etc. They were isolated during much of this period in the western part of the continent by the intracontinental seaway. Most became extinct. Most margaritiferans and anodontines retreated to the northwest, where they crossed the Bering landbridge to Asia. Ancestors of many Recent forms were species that survived the extinction event and moved eastwards when the seaway closed. Lampsiline-like forms first appear in the Eocene, and Miocene of Texas and Louisiana. Thus, the center of unionoidean diversity now has shifted from the west in the Mesozoic to the east in the Cenozoic.

LONG-TERM HISTORY OF GULF OF MEXICO HYDROCARBON
SEEP BIVALVE COMMUNITIES.

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Communities dominated by chemoautotrophic organisms, associated with hydrocarbon seepage, are widely distributed along the continental slope of the northern Gulf of Mexico. Six distinct biofacies have been recognized from petroleum seep assemblages; dominated respectively by mytilid mussels, vesicomid clams, lucinid clams, thyasirid clams, tubeworms, and the normal slope fauna. Assemblages at five sites, GC-184, GC-234, GC-272, GB-386, and GB-425, were sampled by box cores and piston cores. These cores were used to examine the long-term record of seep assemblages by comparing tier and guild structure, paleoenergetics, and changes in community composition. Numerical abundance, paleoproduction, and paleoingestion were utilized for tier and guild structure analysis. In general, seep assemblages were dominated by chemoautotrophs and infauna in terms of guild and tier structure, respectively. Radiocarbon dating of mussel shells from 195 cm depth showed that the shells were between 3000 and 4000 years old. Changes in community composition rarely occurred over the length of the cores. This suggests that the seep sites have supported chemosynthetic communities more or less continuously for long periods of time. Replacement of one chemosynthetic seep species by another seep species was never observed in the cores. Thus, hydrocarbon seep communities are both persistent and resilient over long time scales.

INTERACTION OF FOOD QUANTITY, WATER FLOW
AND POPULATION DENSITY ON FOOD AVAILABILITY
TO OYSTER POPULATIONS: FIELD AND MODELING
RESULTS.

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Field studies were conducted to determine the quantity of food available to oyster populations. Food content and water flow rates were measured 1-3 cm above the oyster population. Flux of food was calculated from the quantity of food measured and water flow rate. Food resources available to the population are nitrogen poor, carbon rich and detrital in origin. Water flow speeds are slow; the median flow rate is typically slower than the mean flow. The resultant flux of food indicates that the median flux is smaller than the mean flux, therefore the population experiences a small flux of food the majority of the time. Water flow may be more important than food content in determining food availability because rapid flow can overcome low food to maintain a higher flux through resupply.

The interaction of food content, water flow speed and population density on determining food availability was studied using mathematical modeling techniques. Results suggest that under realistic population densities, food content is reduced to a point where downstream oysters become food limited. These results stress the importance of measuring both food and water flow on scales important to the oyster population and the ease with which food can be depleted under certain conditions of flow and density resulting in food limitation and reduced productivity.

STUDY ON THE RADULAE OF POLYPLACOPHORA IN
TAIWAN

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The morphology of the radulae in seven species of Polyplacophora (Liolophura japonica, Acanthopleura spinosa, Onithochiton hirasei, Ischnochiton comptus, Ischochiton sp., Crypoplex japonica and Lepidozona nipponica) was examined by using light microscopy and scanning microscope. The shape of the central tooth (C), the first lateral tooth (L1), the second lateral tooth (L2), the fifth lateral tooth (L5), and the eighth lateral tooth (L8) are quite different from species to species. Especially in L2, the number of its cuspids and highly magnitized dark caps strongly affect the animal feeding capability and its habitats. L5 has been discussed as sickle-shaped or spoon-shaped, but in this study also been found that it has variable transformation and is a conspicuous three-dimensional structure inserting itself into the space between L2. With highly magnification, many apparatus on L2, such as tab, wing, and hole can be clearly, and the related function of them will be discussed in this poster.

THE MTDNA OF HALIOTIS DIVERSICOLOR REEVE, 1846
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The mitochondrial DNA (mtDNA) of Haliotis diversicolor Reeve, 1846 was analyzed. A physical map was established with ten restriction endonucleases (BamHI, BclI, BglII, BstEII, EcoRI, HindIII, KpnI, PvuII, SstI and XbaI). This work extends the existing knowledge on molluscan mtDNA, for which therefore only those from scallop (Placopecten magellanicus) and mussels (Mytilus edulis and Mytilus galloprovincialis) have been analyzed. Abalone mtDNA showed an extensive length variation, ranging from 17.33 to 19.74 Kbp. The variation is attributable to the presence of different numbers of tandem repeats of about 0.08 Kbp in unit length.

Based on the endonuclease digestion pattern of the abalone mtDNA, a phylogenetic tree was constructed, which showed that various populations of abalone from discrete localities could be clearly distinguished. The results also showed as extensive degree of inbreeding among populations of wild abalone in Taiwan, and that mitochondrial genomes of cultivated abalone are highly homogeneous. Judging by the upper mitochondrial genome size, H. diversicolor mtDNA may be recognized as the ancestral type.

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