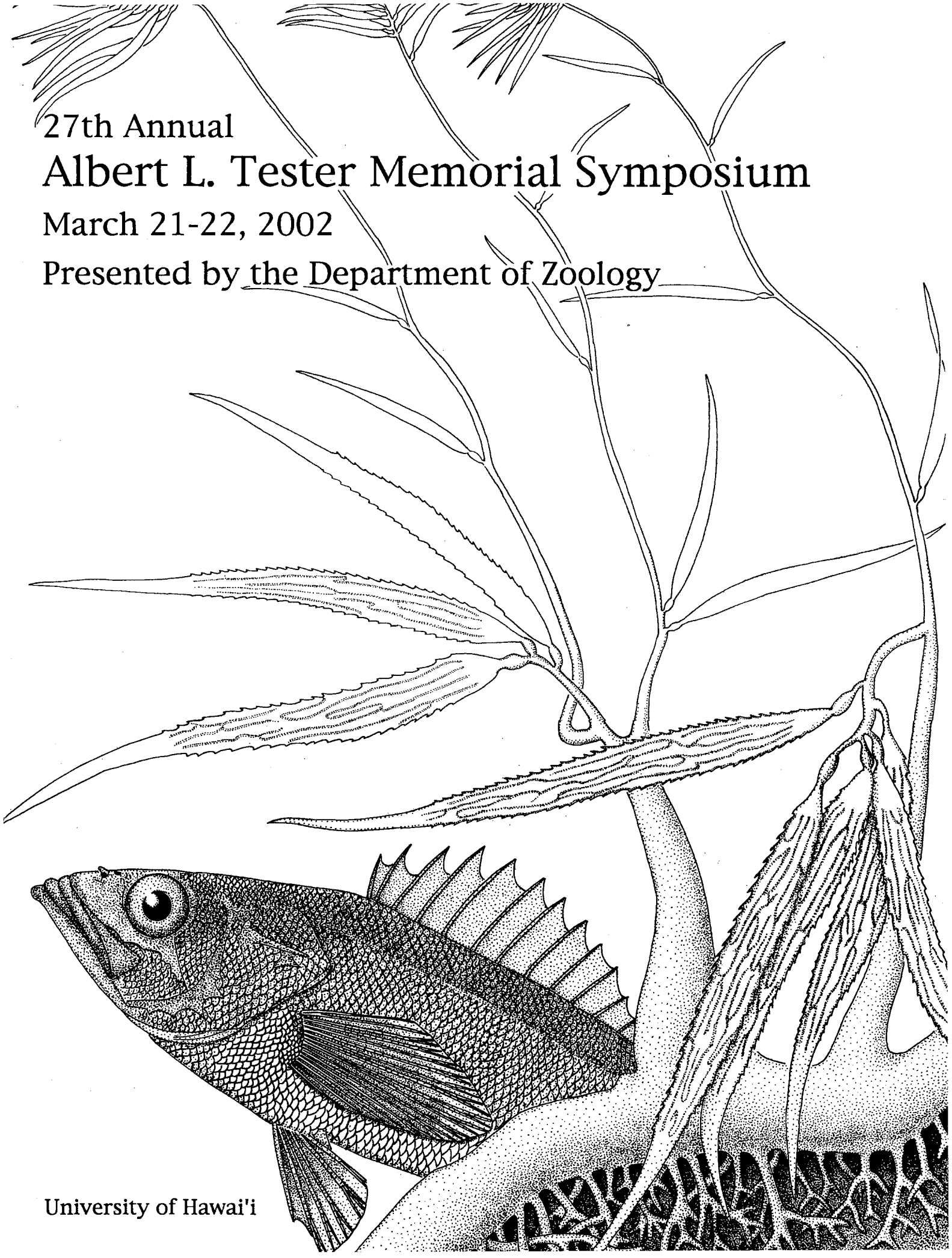
27th Annual

Albert L. Tester Memorial Symposium

March 21-22, 2002

Presented by the Department of Zoology



University of Hawai'i

27th Annual
Albert L. Tester Memorial Symposium

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We also acknowledge the office staff of the Department of Zoology for logistical assistance and Sue Monden for providing the artwork for this program

Presented by Department of Zoology
University of Hawai'i at Manoa

March 21-22, 2002

27th Annual Albert L. Tester Memorial Symposium
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Student Seminar Sessions
East West Center, Keoni Auditorium

Thursday, March 21st

8:30 **Introduction,** Dr. Alison Kay

Session 1 (Chaired by Dr. Steve Robinow)

8:45 **Fabio Moretzsohn,** Department of Zoology
More than just a pretty pattern: what the spots of *Cypraea cribraria* tell about its biology (Mollusca: Cypraeidae)

9:00 **Pia Untalan,** Department of Cell and Molecular Biology
Mapotgi1, a gene containing a novel BTB-POZ domain sequence from the genome of the Mediterranean fruit fly, *Ceratitis capitata*

9:15 **Amy Baco-Taylor,** Department of Oceanography
Community Succession on Deep-Sea Whale Skeletons

9:30 **Patricia Lee,** Department of Zoology
Hox genes and the cephalopod arm crown: homology and morphology

9:45 **Michael Melzer,** Department of Plant and Environmental Protection Sciences
Pineapple mealybug wilt-associated virus - 1: An example of intergenera viral recombination?

10:00 **Coffee Break**

Session 2 (Chaired by Dr. Michael Hadfield)

10:30	**Tanya Koropatnick,**	Department of Zoology
	Bacteria-induced hemocyte infiltration during morphogenesis of the light organ of *Euprymna scolopes*	
10:45	**Rebecca Scheinberg,**	Department of Oceanography
	Clearance Rates and Prey Size Selection of Appendicularians in Coastal Hawaiian Waters	
11:00	**Janos Molnar,**	Department of Anatomy
	The Role of *Drosophila* Lysyl Oxidases	
11:15	**Kanesa Duncan,**	Department of Zoology
	Nearshore nursery use in the hammerhead, *Sphyrna lewini*	
11:30	**Johann Urschitz,**	Pacific Biomedical Research Center
	A serial analysis of gene expression in sun-damaged human skin	
11:45	**John E. Bailey,**	Department of Geology & Geophysics
	The evolving morphology of an open channel lava flow on Mt. Etna	

12:00 **Lunch Break**

Session 3 (Chaired by Dr. Heinz Gert de Couet)

1:45	**Brian Nedved,**	Department of Zoology
	Fate of Larval Muscles During Metamorphosis of *Hydroides elegans*	
2:00	**Raju Pandey,**	Department of Plant and Environmental Protection Sciences
	Development of *Anagyrus ananatis* Gahan (Hymenoptera: Encyrtidae) at constant temperatures	
2:15	**Daniel S. Gruner,**	Department of Zoology
	Top-down and bottom-up influences in a Hawaiian arboreal arthropod food web	
2:30	**Shaun Johnston,**	Department of Oceanography
	Scattering of the internal tide by seamounts, ridges, and islands	

2:45 Coffee Break

Session 4 (Chaired by Dr. Leonard Freed)

3:15	**Simona Ognjanovic,**	Department of Anatomy
	The role of PBEF in the human fetal membranes	
3:30	**Claudia Farfan,**	Department of Zoology
	Distal-less and the embryonic development of *Euprymna scolopes*	
3:45	**Marian Westley,**	Department of Oceanography
	Nitrous oxide production in the Eastern Tropical North Pacific and the Black Sea	
4:00	**Erin Baumgartner,**	Department of Zoology
	Size differences influence aggressive behavior in the mangrove blenny, *Omobranchus rotundiceps obliquus*.	
4:15	**Cynthia Nazario,**	Department of Tropical Plant & Soil Sciences
	Propagation techniques in Breadfruit (*Artocarpus altilis*)	

Friday, March 22nd

East West Center, Keoni Auditorium

Session 5 (Chaired by Dr. Petra Lenz)

8:30	**David A. Phillips,**	Department of Geology & Geophysics
	Plate Tectonics in the Southwest Pacific: GPS Estimates of Crustal Velocity in the Tonga-Lau System	
8:45	**Kelly Benoit Bird,**	Department of Zoology
	Acoustic backscattering by Hawaiian Lutjanid snappers	
9:00	**Zhaohui Wang,**	Department of Chemistry
	Investigations into the cross-coupling of phenylacetylene with aryl chlorides	
9:15	**Matthew Parry,**	Department of Oceanography
	The trophic ecology of two oceanic squids in Hawaiian waters	
9:30	**Ming-yi Chou,**	Department of Plant and Environmental Protection Sciences
	Integrated Management Strategies against Aspidiotus destructor (Homoptera: Diaspididae) in Banana	
9:45	**Anuschka Faucci,**	Department of Zoology
	Molecular Phylogeny of a Pacific nudibranch	

10:00 Coffee Break

Session 6 (Chaired by Dr. Sheila Conant)

10:30 **Brett Schumacher,** Department of Zoology
Daytime habitat specialization of *Lutjanus kasmira* and several goatfishes (Family: Mullidae)

10:45 **Chrystie Naeole,** Department of Cell and Molecular Biology
Use Of DNA Arrays For Molecular Systematic Studies Of Species Within The *Bactrocera dorsalis* Complex

11:00 **David Matus,** Department of Zoology
Molecular Investigations into the Phylogenetic Position of the Chaetognaths

11:15 **Albert Arcinas,** Department of Plant and Environmental Protection Sciences
Hot water treatments for the Control of Burrowing Nematode in Tropical Ornamentals

11:30 **Christopher Bird,** Department of Botany
Pattern in Hawaiian rocky intertidal community structure along wave exposure gradients

3:00 Tester Symposium Distinguished Visitor's Address

East West Center, Keoni Auditorium

Dr. Marc Mangel

"What Does the Evolutionary Theory of Aging Tell Us About the Limits of Human Life Span?"

Introduction

The Albert L. Tester Memorial Symposium is held in honor of Professor Albert Tester who, at the time of his death in 1974, was Senior Professor of Zoology at the University of Hawaii. The faculty and students of the Department of Zoology proposed an annual symposium of student research papers as a means of honoring, in a continuing and active way, Dr. Tester's lively encouragement of student research in a broad range of fields within marine biology. Papers reporting original research on any aspect of science are solicited from students at the University and these papers are presented at the Symposium, which takes place during the spring semester. Income from contributions to the Albert L. Tester Memorial Fund of the University of Hawaii Foundation is used to provide prizes for the two best papers, judged on quality, originality, and importance of research reported, as well as the quality of the public presentation. The Waikiki Aquarium presents the Mike Weekley Award, based on the same criteria. Judges include Department of Zoology faculty members and the previous year's student award winners. In addition, a distinguished scholar from another university or research institution is invited to participate in the Symposium as a judge and to present the major Symposium address.

This year's distinguished visitor and judge is Dr. Marc Mangel, Professor of Environmental Studies at the University of California at Santa Cruz. Dr. Mangel received his B.S. and M.S. degrees from the University of Illinois, and his Ph.D. from the University of British Columbia. Following positions at the University of Rochester and U.C. Davis, he has been at U.C. Santa Cruz since 1996. He has authored or co-authored 6 books, including "The Ecological Detective" with Ray Hilborn, and "Dynamic State Models in Ecology" with Colin Clark, as well as over 100 scientific papers. The hallmarks of his research are an effective integration of mathematical models with experimental and observational data, and an interest in applied problems. He has worked on diverse subjects, ranging from fisheries and endangered-species management and insect pest control to applied mathematics and theoretical chemistry. His current research focuses on the evolutionary ecology of growth, aging and longevity, on quantitative fisheries management, and on the ties between these two areas of research.

Albert L. Tester
Senior Professor of Zoology

This Symposium is dedicated to Dr. Albert Lewis Tester, scholar and teacher, who died in Honolulu, Hawaii, on November 27, 1974, his 66th birthday. He was a multi-talented man who developed an international reputation in not one, but several aspects of marine biology, as well as being an outstanding teacher of both university students and laymen. Dr. Tester was a delightful friend, a meticulous worker, and a valued colleague.

A native of Toronto, Canada, Dr. Tester received his doctorate from the University of Toronto in 1936. In 1931 he joined the Pacific Biological Station of the Biological (now Fisheries Research) Board of Canada where he conducted highly significant work on herring.

In 1948 Dr. Tester joined the Department of Zoology at the University of Hawaii where he remained, except for a short time away, until his death. From 1955 to 1958, he was director of the Pacific Oceanic Fisheries Investigations of the U.S. Fish and Wildlife Service in Honolulu. In 1957 he served as chief of the Service's Division of Biological Research in Washington, D.C., a job he found to be hectic and frustrating. Consequently, in 1958 Dr. Tester returned to the University of Hawaii as Senior Professor of Zoology.

At the University, Dr. Tester studied the life history of the baitfish used to catch tuna and the response of tuna to various stimuli as part of an overall program designed to improve tuna fishing in the Pacific. Long after Dr. Tester stopped active tuna research he continued his contributions in this area through his participation on the Governor's Task Force on Hawaii and the Sea, and on the Marine Resources Committee of the Pacific islands Development Commission.

Dr. Tester's most valuable and well known work were in the field of elasmobranch biology which he began in 1960 and continued until his death. He had, in fact, planned to do further work on sharks after his retirement. His interests in elasmobranch biology were broad and included studies on the ecology, behavior, and sensory biology of sharks as well as practical aspects of shark attack and control. From 1967 to 1969 Dr. Tester directed the Cooperative Shark Research and Control Program of the State of Hawaii, and in 1967 he was appointed to the Shark Research Panel of the American Institute of Biology Sciences.

Dr. Tester's major research interest was the shark sensory systems. He did significant morphological and behavioral studies of olfaction, vision, and the chemical senses. During the last 7 years of his life Dr. Tester intensively studied the acoustico-lateralis system, especially the innervation and morphology of neuromasts and the cupula structure in the lateral line, and broadened his interest to include the inner ear, especially that of the carcharinid sharks.

Al Tester was the author of more than 100 publications. In 1974, in acknowledgement of the excellence of his work, the University of Hawaii awarded him the University's Research Medal.

While Dr. Tester's scientific contributions are highly significant, many of us will remember him best as a dedicated teacher, who greatly enjoyed his work with students, and as an active and respected participant in the University community. Dr. Tester served a term as chairman of the Department of Zoology and then continued to be a major influence in many areas of college life. Warm and congenial, he had a winning sense of humor that surfaced at informal gatherings. Whether demonstrating the hula (which he led the Zoology faculty in learning in the '50s), or singing, or playing the organ, he was an affable host, the complete man.

This tribute to Al Tester was written by Arthur N. Popper, formerly of the Zoology Department, University of Hawaii, and now at the University of Maryland, Department of Zoology, and Claire and Perry W. Gilbert of the Mote Marine Laboratory, Sarasota Florida. It is modified from a tribute to Dr. Tester that appeared in American Zoologist, 1977, 17:289-291.

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Dr. Albert L. Tester

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Albert L. Tester Memorial Symposium

Past Symposia

Best Paper Awards

1976
Tina Weatherby
Dennis Gorlick & Paul Atkins

1977
Charles van Riper
Craig MacDonald & Bruce Thompson

1978
Jon Hayashi
James Wyban

1979
Gerald Heslinga
Frank Perron

1980
Stephen C. Kempf
Clyde S. Tamaru

1981
Carol N. Hopper
Michael Walker

1982
Ronaldo Ferraris
Evelyn Cox

1983
Thomas L. Smalley
Sharon Hendrix

1984
Janice Bell
Joan Canfield
Cynthia Hunter & Cedar Kehoe

1985
Karla McDermid
Hing-Chung Lee
Timothy Tricas

1986
James Howard
Charles Madenjian
Tom Hourigan

1987
Amy Ringwood
Joyce Rundhaug
Jeff Burgett

1988
Teresa Telecky
Randall Kosaki
Jay Jones

1989
Rachel Behnke
Catherine Hurlbut
Edward Metz

1990
Carol Reeb
Bailey Kessing
Kevin Hill

1991
Vanessa Gauger
Gary Jahn
Andrew Martin

1992
Greta Aeby
Robert Feldman
J. Koji Lum

1993
Kazue Asoh
Deborah J. Gochfeld
Andrea Fleig

1994
Kevin Beach
Susan Murphy-Walker
Richard L. Pyle

1995
Eric Vanderwerf
Christopher Lowe
Gwen Lowe
Kabi Raj Neupane

1996
Scott Larned
Patrick Hart
Patricia Lee

1997
Aaron Bush
Angel Yanagihara
Ilsa Kuffner

1998
Elizabeth Nemeth
Jessica Garb
Jamie Foster

1999
Wendy Kuntz
Lisa Privitera
James Leary

2000
Kelly Benoit Bird
Timothy D. Male
Jennifer Smith
Jill Zamzow

2001
Buffy Cushman
Timothy Fitzgerald
Carl Meyer

Invited Speakers:

1976 A. A. Myrberg, Jr., University of Miami
1977 R. Glenn Northcutt, University of Michigan
1978 Karel F. Liem, Harvard University
1979 Edmund S. Hobson, Southwest Fisheries Center, Tiburon Laboratory
1980 Gareth Nelson, American Museum of Natural History
1981 Stephen Jay Gould, Museum of Comparative Zoology, Harvard University
1982 Howard A. Bern, University of California, Berkeley
1983 Robert T. Paine, University of Washington, Seattle
1984 Joseph Connell, University of California, Santa Barbara
1985 George W. Barlow, University of California, Berkeley
1986 Jared Diamond, University of California, Los Angeles
1987 Lynn Margulis, Boston University
1988 Eric Davidson, California Institute of Technology, Pasadena
1989 Jonathan Roughgarden, Stanford University, Palo Alto
1990 Corey S. Goodman, University of California, Berkeley
1991 John Maynard Smith, Univeristy of Sussex
1992 Robert Warner, University of California, Santa Barbara
1993 Stephen Hubbell, Princeton University
1994 Nancy Knowlton, Smithsonian Tropical Research Institute
1995 Mimi A.R. Koehl, University of California, Berkeley
1996 George L. Gabor Miklos, The Neurosciences Inst., La Jolla
1997 Stephen A. Wainwright, Duke University
1998 Kenneth B. Storey, Carleton University
1999 Robert E. Ricklefs, University of Missouri-St. Louis
2000 John A. Endler, University of California, Santa Barbara
2001 Steve Jones, University College, London

2002 Symposium Invited Speaker

Marc Mangel
University of California at Santa Cruz

Judges

Marc Mangel
Athula Wikramanayake
Buffy Cushman
Timothy Fitzgerald
Carl Meyer

Abstracts

(in alphabetical order)

Albert C. Arcinas,
Department of Plant and Environment Protection Sciences
(Advisor: Brent S. Sipes)

HOT WATER DRENCH TREATMENTS FOR THE CONTROL OF BURROWING NEMATODE IN RHAPIS AND FISHTAIL PALMS

Exporters of potted nursery stock face strict quarantine regulations against the burrowing nematode (BN). Currently, there are no approved quarantine treatments to disinfest plants of BN. Interceptions lead to significant economic loss and curtailment of trade. Therefore, hot water drench treatments were investigated for quarantine utility. Drenches with 50 °C water were applied for 10-16 minutes to two economically important palm species, Rhapis and Fishtail. Each plant was inoculated with 5,000 mixed life stages of BN and allowed to establish for 14 weeks prior to treatment. In Rhapis palms, a moderately good host, a 16-minute hot water drench had the highest efficacy achieving 99.6% mortality of BN. In Fishtail palms, a poor host, all treatments longer than 10 minutes at 50 °C achieved 100% mortality. Probit regression estimates were used to estimate LT_{99}, resulting in 16.9 and 10.3 minutes respectively, however χ^2 goodness-of-fit tests for deviation from observed data was significant ($\chi^2 = 21.136$, df =3, $p<.0001$) for Rhapis. The high efficacy of hot water drenches for the control of BN is approaching the Probit 9 standard of 99.9968% mortality that is required for United States Department of Agriculture approval as a quarantine treatment.

Amy R. Baco, Department of Oceanography
(Advisor: Craig Smith)

ROTTEN STEPPING STONES IN THE DEEP SEA? EVOLUTIONARY RELATIONSHIPS OF WHALE-FALL, SUNKEN WOOD, COLD SEEP, AND HYDROTHERMAL VENT MUSSELS

The evolutionary origins of hydrothermal-vent and cold-seep mytilid mussels have been the subject of speculation. Hypotheses include evolving from a seep ancestor and evolution from shallow water to the deep sea. Little attention has been given to the role of organic-remain habitats. We examined DNA sequences for mitochondrial 16S and COI genes to determine the recent evolutionary relationships between mytilids from a range of deep-sea reducing habitats including hydrothermal vents, cold seeps, whale falls and wood islands. These genes provide evidence for an evolutionary sequence from sunken wood to whale falls to seeps and finally to vents that is consistent with previous 18S and allozyme studies. There is also some evidence of an evolutionary trend from shallow-water to the deep sea. Because many vent and seep mytilids have been shown to harbor sulfur-oxidizing and/or methanotrophic endosymbionts, we also examined stable carbon isotopes for these mytilids. Carbon isotope values support the evolutionary sequence suggested by the DNA phylogenies and imply increasing dependence on chemoautotrophy and later methanotrophy over evolutionary time. These results taken together substantially support the hypothesis that organic remains in the deep-sea may have played a role as evolutionary stepping-stones for vent and seep species.

John E Bailey, Department of Geology & Geophysics
(Advisor: Andrew Harris)

THE EVOLVING MORPHOLOGY OF AN OPEN CHANNEL LAVA FLOW ON MT. ETNA
(Hawaii Institute of Geophysics and Planetology)

From mid-May to mid-July 2001 a small eruption from the southeast cone on Mt. Etna into the Valle del Leone persistently fed a classic example of a compound flow field, with multiple bifurcated channels that extended 1km across and 2km down the mountain. This flow field provided the opportunity to study changes in the thermal structure and morphology of an open lava channel, over a period of days. This was done using temperature-calibrated digital images from a FLIR (Forward-Looking Infrared) camera and continuous recordings from a radiometer, which provided an integrated radiance value over the area of the channel in the field of view. The images and patterns of change in these data showed many features, such as different types of tube formation, channel blockages, overspills, diverted flows, crust formation / break-up and "surges" in the volume of lava flowing in the channel. There were small surges or "pulses" and large surges that totally over filled the channel. The pulses resulted from lava build up behind channel blockages, which then partly broke-up allowing the rapid lowering of the channel fill level, before blockages formed again. The larger surge events however, completely overwhelmed the channel and were attributed to a change in supply volume. Changes in the integrated thermal output (of the channel) lag behind when compared to changes in the surface velocity of the flowing lava, which would be consistent with the hypothesis of a changing supply volume. This study represents one of the first uses of a FLIR to study active lava flows and suggests it has great potential for helping understand eruption dynamics.

Erin Baumgartner, Department of Zoology
(Advisor: Dave Greenfield)

SIZE DIFFERENCES INFLUENCE AGGRESSIVE BEHAVIOR IN THE MANGROVE BLENNY, *OMOBRANCHUS ROTUNDICEPS OBLIQUUS.*
(Hawaii Institute of Marine Biology)

The mangrove blenny *Omobranchus rotundiceps obliquus* is an invasive species, found in sheltered fouling communities in Kaneohe Bay, Oahu. The fish arrange their territories in a diffuse fashion, where the territory is a small area around the refuge. The territory moves along with the fish as it switches refuges. Access to these refuges is controlled by position in the dominance hierarchy. Aggression and aggressive interactions influence the position of the fish in the dominance hierarchy. This study examines those factors that influence the likelihood of aggressive behavior occurring between individual blennies. Two laboratory experiments involving communities and dyads of blennies examined the influence on size, sex, and size asymmetry on aggressive behavior. Size and sex did not have a significant influence on aggressive behavior in blennies, but size asymmetry significantly influenced aggressive behavior. The proportion of aggressive encounters, the ratio of one-sidedness of the relationship, and the number of fights between pairs in communities of blennies were all significantly influenced by size asymmetry, with similar sized combatants being more likely to behave aggressively to one another. The number of high intensity interactions and the amount of time spent on high-level intensity interactions were significantly influenced by size asymmetry in dyad trials of blennies. The amount of time it took to achieve a dominance relationship as indicated by a color shift was also significantly influenced by size asymmetry. Blennies that were similar in size spent more time behaving aggressively and had more aggressive interactions, and took longer to achieve a dominance relationship.

Kelly Benoit-Bird, Department of Zoology
(Advisor: Whitlow Au)

ACOUSTIC BACKSCATTERING PROPERTIES OF HAWAIIAN LUTJANID SNAPPERS
(Hawaii Institute of Marine Biology)

The acoustic properties and swimbladders of six species of commercially important bottom-dwelling Hawaiian Lutjanid snappers, for which backscatter data are not available in the literature, were investigated using broadband sonar, x-rays, and plaster swimbladder casts. X-rays revealed species-specific differences in the shape, size, and orientation of the swimbladders, shown to be the primary source of backscattering. Backscatter data were obtained from anesthetized, live fish mounted to a rotor, and rotated around each of their three axes. Fish were ensonified with broadband signals (60-200 kHz). As in other fish species, maximum dorsal aspect target strength was correlated with fish length within each species. *In situ* echoes taken from a submersible were not significantly different from surface measures; showing surface measures are valid for fish at depth. Species-specific swimbladder characteristics were correlated with changes in echo characteristics. For example, the angle between the fish's dorsal aspect and the major axis of its swimbladder was consistent between individuals within a species. This angle and had a one-to-one relationship with the angle at which the maximum dorsal aspect target strength was measured. Species-specific differences in the echo structure characteristics such as the number of highlights and the length of the echo were also evident, as were differences in the spectral characteristics such as the peak frequency and the degree of spectral rippling. The distributions of these characteristics did have overlap between species, however, with a combination of multiple broadband acoustic characteristics, species identification is possible.

Christopher E. Bird, Department of Botany
(Advisor: Celia Smith)

PATTERN IN HAWAIIAN ROCKY INTERTIDAL COMMUNITY STRUCTURE ALONG WAVE EXPOSURE GRADIENTS

The community structure on Hawaii's rocky intertidal shores has received relatively little attention when compared with reef, pelagic, forest, and grassland communities. In fact, many individuals are under the impression that there is no intertidal in Hawaii due to the small 2.8 ft tidal fluctuation. I deployed maximum wave force dynamometers, temperature loggers, and wetted sponges on transects running perpendicular to the shore line along a wave exposure gradient. Wave force was correlated with lower temperature and desiccation at a given height above mean lower low water. I propose that this is due to wave height approaching and/or eclipsing the tidal range, effectively expanding the zone of biotically favorable habitat for intertidal organisms above that set by the tides. Thus the physical conditions on the shore grade from tide domination in low wave exposure to wave domination in high wave exposure. I successfully used digital photography to sample the rocky intertidal community along wave exposure gradients on Oahu and Maui. Turf and macro algae were much more prominent in mid to low wave exposures than high wave exposure. Crustose algae and macro grazers such as *Colobocentrotus atratus* were most abundant in zones receiving high wave exposure. Gross community structure on Hawaiian rocky intertidal shores is correlated with the physical conditions controlled by wave exposure.

Ming-yi Chou,
Department of Plant and Environmental Protection Sciences
(Advisor: Ronald F. Mau)

INTEGRATED MANAGEMENT STRATEGIES AGAINST *ASPISDIOTUS DESTRUCTOR* SIGN. (HOMOPTERA: DIASPIDIDAE) IN BANANA

Infestations of *Aspidiotus destructor* Sign. (Homoptera: Diaspididae) in banana caused significant loss for Hawaii's growers at the export market. Integrated pest management tactics were evaluated against the quarantine pest. Seasonal population dynamics were investigated at 6 commercial orchards to analyze the population density and spatial distribution of *A. destructor* in banana. No significant difference was found between seasonal population densities at most survey locations. Low population densities were observed with the maximum density at 1.38 out of 5 point density scale. Formulated pesticides diazinon (Diazinon), imidacloprid (Provado), pyriproxyfen (Esteem), and thiamethoxam (Actara) were found effective against nymphal stage while adult mortalities varied from 0.39 to 0.96. Complete control of adult stage was performed by hot water immersion with temperature ranged from 47 to 49 °C.

Kanesa Duncan, Department of Zoology
(Advisor: Kim Holland)

NEARSHORE NURSERY USE IN THE SCALLOPED HAMMERHEAD SHARK, *SPHYRNA LEWINI*

(Hawaii Institute of Marine Biology)

Scalloped hammerhead shark pups (*Sphyrna lewini*) inhabit nursery grounds in coastal embayments where they act as apex predators and may seasonally dominate vertebrate biomass. I tested several hypotheses concerning pups' distribution, residency, growth, and survivorship in nursery areas by conducting mark-recapture and captive growth studies of young *S. lewini* in Kaneohe Bay, Oahu, Hawaii. Shark pups were present in the bay during all months of the year with highest catch rates in July, August, and September. I found little spatial segregation of pups within Kaneohe Bay and while the majority of recaptures occurred close to the point of release, some sharks dispersed up to 5 km across the bay after only one week at liberty. These data are contrary to previous suggestions that the pups congregate in the south part of Kaneohe Bay. Most recaptures occurred within four months of tagging but some sharks were at liberty for more than one year. Combined growth rate data from recaptures and from captive sharks suggest that *S. lewini* pups grow very slowly in the months immediately after birth. The presence of larger juvenile sharks within the bay, the recapture of sharks at liberty for over a year and the growth rates of captive sharks, suggest that coastal nursery areas may remain important hammerhead habitat throughout the first three years of life. This finding has important fishery implications for Kaneohe Bay and also for pupping grounds throughout tropical waters where *S. lewini* is heavily gill netted.

Claudia Farfán, Department of Zoology
(Advisor: H. G. de Couet)

THE ROLE OF THE GENE *DISTAL-LESS* IN THE DEVELOPMENT OF *EUPRYMNA SCOLOPES*

Distal-less encodes a homeodomain protein best known for its role in proximo-distal patterning of *Drosophila* limbs. Expression surveys of presumptive *Distal-less* orthologues in celomate phyla, including chordates, has prompt the suggestion that this gene is ancient and maybe involved in the patterning of body wall outgrowths of protostomes and deuterostomes. However, these surveys did not include representatives of the Mollusca, a phylum characterized by morphological plasticity and unique anatomical specializations. Cephalopod arms are conspicuous body wall outgrowths, appendages non-homologous to other structures outside the Mollusca, and a morphological novelty within the taxa. Thus it is of interest to know if Dll function is required for the formation of these appendages. In a first phase to assess the role of Dll in the development of the arms of the sepiolid *Euprymna scolopes*, I isolated a fragment of the *Dll* homeobox by RT-PCR and performed a preliminary expression study (whole-mount) using a highly cross-reactive Dll antibody raised against the butterfly *Precis coenia* Dll homeodomain. The isolated fragment (66 bp long) is 95% homologous to the Dll of *P. coenia* and *Tribolium castaneum*, and to a number to vertebrate Dlx orthologues. The presumptive *E. scolopes* Dll is expressed in the arms, funnel, eyes, optic lobes and all over the epidermis. This data suggest that Dll have pleiotropic roles in the development of *E. scolopes* including arm development.

Anuschka Faucci, Department of Zoology
(Advisor: Michael G. Hadfield)

GENETIC POPULATION STRUCTURE IN RELATION TO DISPERSAL POTENTIAL IN PACIFIC NUDIBRANCHS
(Kewalo Marine Laboratory)

Marine organisms vary greatly in their potential for dispersal of larvae. Levels of gene flow among populations depend on this potential and the extent to which it is realized. Population genetic data can be used as an indirect measurement of dispersal in marine species. Species of the nudibranch genus *Phestilla* occur throughout the Pacific, feeding on different coral species. They differ in their larval developmental mode and therefore dispersal potential, e.g. *Phestilla sibogae* and *P. minor* have lecithotrophic larvae (non-feeding, short planktonic period), whereas *P. lugubris* has planktotrophic larvae (feeding, obligate long planktonic period). A 680-base pair region of the mitochondrial cytochrome *c* oxidase I (COI) gene was sequenced for the following species: *P. sibogae* (Oahu and Guam), *P. lugubris* (Guam), *P. minor* (Oahu and Guam), *P. melanobrachia* (Oahu and Guam), *P.* sp1 (Guam), *P.* sp2 (Guam). A neighbor-joining tree was produced using the two nudibranchs *Caloria indica* and *Hypselodoris infucata* as outgroups. *P. sibogae* from Guam and *P. lugubris* from Guam are genetically more closely related than *P. sibogae* from Guam and Oahu. *P. sibogae* from Oahu has an intrapopulation divergence of 0-0.3% (mean 0.19%), *P. sibogae* from Guam 0-0.6% (0.4%), and *P. lugubris* from Guam 0-0.6% (0.4%). These preliminary results indicate no substantial intrapopulation structuring, although no interpopulation values have yet been obtained. Expected results would have been that *P. lugubris* has a lower intraspecific divergence than *P. sibogae*. All other species are genetically distinct from each other and show some degree of geographical structuring.

Daniel S. Gruner, Department of Zoology and EECB
(Advisor: Andrew Taylor)

TOP-DOWN AND BOTTOM-UP INFLUENCES IN A HAWAIIAN ARBOREAL ARTHROPOD FOOD WEB

Predator (top-down) and resource (bottom-up) influences in food webs are strong and pervasive, but few studies have investigated their interactive effects in real terrestrial ecosystems. This study focuses on arthropods associated with the dominant species in these young successional systems, Metrosideros polymorpha- (Myrtaceae), also the dominant tree in the Hawaiian Islands. In August and September of 1998 on a 120-year-old flow, severe nutrient limitation was removed by fertilization and combined with bird predator removal cages in a large-scale, well-replicated, randomized block design. Arthropod densities were measured from foliage clipping samples at the outset and conclusion of the experiment. After 2.75 years, foliar nitrogen content and M. polymorpha growth were directly increased in fertilized relative to unfertilized plots, but were unaffected by indirect effects of top predator exclusion. Fertilization increased densities of detritivores and bird exclusion increased spider densities. Arthropod combined densities, besides spiders, were reduced in the interaction treatment, suggesting cascading effects of these intermediate level predators to the detritivores. Herbivore numbers were unchanged by either treatment, but herbivores were sensitive to another bottom-up influence, foliar pubescence, as confirmed by separate arthropod collections. Top-down effects in this system are complementary, not purely additive, to bottom-up influences, and the details are dependent on the structure of the food web.

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Shaun Johnston, Department of Oceanography
(Advisor: Mark Merrifield)

SCATTERING OF THE OCEANIC INTERNAL TIDE FROM A SEAMOUNT

Internal tides are generated as the surface tide forces stratified water up and down the flanks of mid-ocean topography. Internal tides are generated on length scales ranging up to 150 km. The smaller scale waves are dissipated near the topography contributing to the mixing of the deep ocean. The larger scale waves are observed to propagate away from the topography with decay scales on the order of 1000 km. These waves carry much of the energy contained in the oceanic internal wave field and it is not well known how they are dissipated. So the question this paper addresses is: how is energy transferred from the large-scale internal tides to smaller scales and ultimately to the smallest scales where mixing takes place? In a numerical model, we produce a large-scale internal wave on the western boundary and let it propagate 5 wavelengths before encountering an idealized Gaussian seamount in a constant stratification ocean. We find greatly enhanced energy density directly over the crest of the seamount and a strong directional distribution (i.e. regions of enhanced and reduced energy density) in the lee of the seamount. Over the seamount the sloping topography forces the incident internal tide to smaller horizontal and vertical length scales thereby increasing current shear. These sheared currents are dynamically unstable and lead to enhanced mixing directly over the topography.

Tanya Koropatnick, Department of Zoology
(Advisor: Margaret McFall-Ngai)

INVESTIGATING SYMBIONT-INDUCED HEMOCYTE TRAFFICKING DURING LIGHT ORGAN MORPHOGENESIS IN THE HAWAIIAN BOBTAIL SQUID, *EUPRYMNA SCOLOPES*

(Pacific Biomedical Research Center)

The symbiotic association between the sepiolid squid *Euprymna scolopes* and the luminous marine bacterium *Vibrio fischeri* begins when the hatchling host gathers symbionts from the environment using currents created by 2 ciliated epithelial fields on the surface of the host light organ. Upon infection with *V. fischeri*, the light organ undergoes a 4-d morphogenesis involving widespread apoptosis in the ciliated epithelia, and regression of the ciliated fields, including the anterior and posterior ciliated appendages. This study investigates the potential role of host hemocytes in this dramatic morphogenesis. Confocal microscopy was used to characterize hemocyte trafficking within the blood sinuses of the ciliated appendages over time in both symbiotic (infected with *V. fischeri*) and aposymbiotic (uninfected) animals, and in animals exposed to microbial products, lipopolysaccharide (LPS), lipid A, and peptidoglycan (PG). In the presence of the symbiont a statistically significant ($p<0.05$) increase in hemocyte number could be seen in the sinuses as early as 2 h post infection, and a peak in number was reached by 24 h. A significant increase in hemocyte number was also induced by both LPS and PG alone or in combination. LPS has been shown to induce cell death in the ciliated epithelium, but PG alone did not induce apoptosis. Lithium chloride, which delays hemocyte migration, decreased symbiont-induced hemocyte trafficking while cell death levels remained unaltered. These data suggest that hemocytes are not mediating apoptosis during light organ morphogenesis. However, high numbers of hemocytes continue to be present in the blood sinuses throughout regression, suggesting a role for these cells in the loss of the epithelial appendages.

Patricia N. K. L. Lee, Department of Zoology
(Advisor: H. G. de Couet)

HOX GENES AND THE CEPHALOPOD ARM CROWN – HOMOLOGY AND MORPHOLOGY

(Kewalo Marine Laboratory)

Cephalopods are highly derived molluscs. One striking evolutionary modification is the derivation of a prehensile arm crown from the molluscan foot. The arms are an important morphological character used in cephalopod taxonomy, dividing coleoid cephalopods into Octopodiformes (octopods with four arm pairs) and Decapodiformes (squid with five arm pairs). The ancestral coleoid is proposed to have possessed five pairs of unmodified arms. Which arm pair has been lost in the octopods? Relying solely on morphological comparisons, assigning arm homologies between the two groups and determining which arm pair has been lost have been difficult. In addition, there have been morphological specializations of specific arms in different groups. How might these specializations have evolved? To address these questions, we examined *Hox* genes in the sepiolid squid, *Euprymna scolopes*, as potential molecular markers. *Hox* genes are key regulatory genes involved in specifying body regions along the anterior-posterior axis of all bilaterians. We determined the expression patterns of eight *Hox* orthologs during *E. scolopes* development by whole mount *in situ* hybridization. Each arm pair expresses a unique combination of *Hox* genes during development, which may play a role in specifying arm identity. Although this is the first cephalopod in which these genes have been studied, we suggest *Hox* genes may potentially be used as molecular markers for verifying arm homologies between octopods and decapods. Additionally, with a potential role in body region specification, *Hox* genes may be involved in the modifications of various arms during cephalopod evolution.

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David Matus, Department of Zoology
(Advisor: Mark Q. Martindale)

MOLECULAR INVESTIGATIONS INTO THE PHYLOGENETIC POSITION OF THE CHAETOGNATHS
(Kewalo Marine Laboratory)

Chaetognaths, or arrow worms, are small marine invertebrates, ubiquitous in the zooplankton in all the world's oceans. For centuries, the position of this phylum within metazoa has been enigmatic at best, having been allied with a wide variety of other phyla, due to a variety of confusing morphological and developmental characters. While most invertebrate textbooks place the chaetognaths within the deuterostomes, molecular evidence from the last eight years suggests that this placement is inaccurate, though no clear consensus exists in the literature as to their true affiliation within metazoa. Recent work involving a "total evidence" approach combining morphological, developmental, and molecular data suggests an affiliation of chaetognaths to ecdysozoans, a clade of molting animals within the protostomes. While previous studies have attempted to resolve their position using structural and housekeeping genes, this work represents the first use of developmental regulatory genes (genes that code for body plan formation, axial patterning, etc.) to determine the position of the chaetognaths within metazoa. A PCR-based survey of a local species of chaetognath, *Flaccisagitta enflata*, has resulted in the identification of several different homeobox genes, including three characteristic ecdysozoan Hox gene orthologs: *Ultrabithorax*, *Abdominal B*, and *Antennapedia*. Multiple methods of phylogenetic analysis suggest that the *Antennapedia* ortholog is more closely related to other ecdysozoan *Antennapedia* orthologs than to any other group of genes, providing support for the inclusion of the chaetognaths within Ecdysozoa.

Michael Melzer, Department of Plant and Environmental Protection Sciences
(Advisor: John Hu)

PINEAPPLE MEALYBUG WILT ASSOCIATED-VIRUS 1: AN EXAMPLE OF INTERGENERIC VIRAL RECOMBINATION?

The plant virus family *Closteroviridae* is classified into three genera: *Closterovirus*, *Crinivirus*, and *Ampelovirus*, which are vectored by aphids, whiteflies, and mealybugs, respectively. Cladistical analysis using various viral genes also supports this classification. *Pineapple mealybug wilt-associated virus-1* (PMWaV-1) is a mealybug-transmissible closterovirus and therefore a putative member of the genus *Ampelovirus*. In this study, a 10 kb region of the PMWaV-1 genome was cloned from viral dsRNA and sequenced. The genome organization of PMWaV-1 was that of a typical closterovirus, and most closely resembled an ampelovirus. Minor discrepancies, however, were evident in the 5'-terminal region of the genome. These included the position and putative mechanism of the +1 ORF1a/1b frameshift and lack of an intergenic region between the polymerase and p6 ORFs. The significance of these minor discrepancies became apparent after cladistical analyses were performed on ORFs in the 5'- and 3'-terminal regions of the genome. Analyses of ORFs from the 3'-terminal region placed this virus within the genus *Ampelovirus*, but analyses of ORFs from the 5'-terminal region placed this virus outside of the three current closterovirus genera. Therefore, PMWaV-1 may have a recombinant genome with the 3'-terminal region coming from an *Ampelovirus*, and the 5'-terminal region coming from an undescribed closterovirus genus.

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Janos Molnar, Department of Anatomy
(Advisor: Katalin Csiszar)

DROSOPHILA LYSYL OXIDASES: EFFECT OF *DMLOXL-1* ON CHROMATIN STRUCTURE AND TRANSCRIPTION AND ADULT-SPECIFIC EXPRESSION OF *DMLOXL-2*

(Pacific Biomedical Research Center)

Lysyl oxidase (LOX) is a copper-containing amine oxidase best known for its role in catalyzing cross-linking in elastin and fibrillar collagens. In addition to its extracellular functions, its intracellular, intranuclear locations, and involvement in tumor suppression and senescence reflect a remarkable functional diversity of LOX. The existence of multiple LOX-like proteins in mammals, however, makes it difficult to interpret how LOX, or the LOX-like proteins, may individually contribute to these diverse functions. We have identified two *LOX*-like genes, *Dmloxl-1* and *Dmloxl-2*, in *Drosophila melanogaster*. The temporal division of gene activities allowed the functional analysis of DmLOXL-1 alone in early development. Selective inhibition of DmLOXL-1 by □-aminopropionitrile (□-APN) resulted in developmental delay, altered pupation, a shift in sex ratio toward fewer males, enhanced position effect variagation (PEV) in males, and lower mRNA levels of seven ribosomal and the glue protein genes. Transgenic *Drosophila* females, but not males, overexpressing *Dmloxl-1* demonstrated suppression of PEV. These results suggest that DmLOXL-1 functions as a trans-acting regulator of transcription rate acting through compositional changes of the chromatin.

Fabio Moretzsohn, Department of Zoology
(Advisor: E. Alison Kay)

MORE THAN JUST A PRETTY PATTERN: WHAT THE SPOTS ON THE SHELL OF *CRIBRARULA CRIBRARIA* TELL US ABOUT ITS ANATOMY (MOLLUSCA: CYPRAEIDAE)

The mantle of cowries is stationary in relation to the shell, meaning that the mantle always returns to the same region of the shell. When fully exposed, the mantle covers the whole shell, and it's the mantle that deposits the $CaCO_3$ layers that compose the shell. In the *Cribrarula cribraria* complex, the characteristic white dorsal spots (DS) on the shell are formed by non-pigmented oval "windows" through which the white background of the dorsum is seen. It is hypothesized here, based on direct observation and photographs of live cowries, that there is a direct correspondence between DS and mantle papillae in the *C. cribraria* complex, the white DS being the record of each papilla at the time the pigmented layer was laid. DS counts from 371 shells assumed to represent all ten species in the *cribraria* complex show species-specific ranges of DS counts. Other DS-related useful taxonomic characters include: position of the dorsal line (indicating the relative sizes of each of the mantle lobes that cover the shell); number of dorsal papillae on each mantle lobe; relative size, density and sharpness of DS, etc. The results obtained in the study of the *cribraria* complex can be extrapolated to other cowries with similar dorsal patterns, such as *Lyncina leucodon* and *Mauritia mauritiana*. Cowrie shells are considered to have few informative characters, with its glossy, involute shell bearing little sculpture (except for the apertural teeth), spines, nor even the protoconch showing. Combined with other data such as anatomical and molecular, the non-traditional conchological characters used here may provide a higher resolution than traditional conchological characters needed to solve some of the taxonomic problems in cowries.

Chrystie Naeole, Department of Cell and Molecular Biology
(Advisor: David Haymer)

USE OF DNA ARRAYS FOR MOLECULAR SYSTEMATIC STUDIES OF SPECIES WITHIN THE *BACTROCERA DORSALIS* COMPLEX.

The *Bactrocera dorsalis* complex is a group of more than fifty very closely related species. A number of these species are major economic pests. Current taxonomic keys are deemed inadequate to make accurate species identification and little is known about the systematic relationships of species within this complex. DNA markers provide characters that may be useful for both purposes. Using PCR primers designed from conserved coding regions of specific genes, we have amplified intron regions of these genes for use as genetic markers. Introns are useful because they tend to harbor differences to a greater extent compared to coding regions, and genes. We are working to demonstrate how DNA sequences from intron regions of particular genes can be combined with DNA array technology to identify and distinguish species within this complex. This approach may also help in characterizing new and undescribed species known to occur within this complex and to help in the resolution of the systematic relationships of these species. (Support by CDFA Grant No. 97-0451)

Cynthia Nazario, Department of Tropical Plant and Soil Science
(Advisor: Diane Ragone)

PROPAGATION OF BREADFRUIT FOR CONSERVATION AND GERMPLASM EXCHANGE

The National Tropical Botanical Garden (NTBG) has established a breadfruit collection at The Kahanu Garden in Hana, Maui. The collection consists of 173 accessions from 17 Pacific Island groups, Indonesia, Philippines and Seychelles. From this collection a core group of breadfruit cultivars have been selected in which further in-depth research is being conducted, including tissue culture, air-layering, and seed germination. Breadfruit is currently propagated vegetatively through root cuttings or shoots. These methods while successful, are slow and can make transport of plant material over long distances difficult (Ragone, 1997). Currently, I am developing a methodology for tissue culture of breadfruit as a method of germplasm exchange. This methodology includes selection of an explant source; development of a sterilization protocol; initiation and proliferation of shoots on various *in vitro* media; rooting of shoots *in vitro* and hardening of plantlets. In addition to *in* vitro propagation, breadfruit air-layer studies comparing auxin concentrations, etiolation, branch size, and seasons are also being conducted to provide another propagation alternative. Both these studies will facilitate the distribution of breadfruit for propagation and research throughout the world while assisting in conservation efforts of endangered breadfruit varieties.

Brian T. Nedved, Department of Zoology
(Advisor: Michael G. Hadfield)

FATE OF LARVAL MUSCLES DURING METAMORPHOSIS OF *HYDROIDES ELEGANS* (Kewalo Marine Laboratory/PBRC)

Metamorphosis of marine invertebrate larvae occurs rapidly and is triggered by the binding of specific external cues with appropriate larval receptors. This binding activates a cascade of events that culminate with the loss or reorganization of larval tissues and the appearance of adult structures. Metamorphosis of the serpulid polychaete *Hydroides elegans* occurs rapidly and is characterized by: the secretion of a proteinaceous primary tube; restriction of the collar region; loss of the trochal cilia; elongation of pygidial region; and development of the branchial crown. While the time course and the external morphogenic events of this process have been determined, relatively little is known about the fate of internal structures (i.e. larval musculature) during metamorphosis. In this study, a TRITC-phalloidin conjugate and confocal microscopy were used to track differentiation of muscle during larval development of *H. elegans* and to determine the fate of these muscles during metamorphosis and early juvenile development. At metamorphic competence, the major components of the larval musculature consisted of 2 pairs of longitudinal muscles and 4 circular muscles. The circular muscles are positioned near the trochal bands, and only the prototrochal muscle persisted through metamorphosis. The paired longitudinal muscles extended from the trochal region through the larval hydrosphere, persisted through metamorphosis, and further differentiated to form the largest muscles of the adult segments. The persistence of these muscles indicated that parts of the larval musculature are incorporated into adult muscles instead of being lost at metamorphosis.

Simona Ognjanovic, Department of Cell and Molecular Biology
(Advisor: Gillian Bryant-Greenwood)

THE ROLE OF PRE-B CELL COLONY ENHANCING FACTOR (PBEF) IN THE HUMAN FETAL MEMBRANES

Pre-B cell colony-enhancing factor (PBEF) is a novel cytokine, which is constitutively expressed in the human fetal membranes throughout pregnancy. Our laboratory showed that this is a mechanically responsive gene upregulated in the fetal membranes both in vitro by their distension and in vivo by the process of labor. In addition, the infection of this tissue significantly increased PBEF expression. We hypothesized that a mechanically-induced protein might cause the growth of the tissue in order to reduce the mechanical strain. Thus, recombinant human PBEF (rhPBEF) was produced in a bacterial system and added to amniotic epithelial (WISH) cells at 1, 10 and 100 ng/ml for four days. Proliferation was assayed with the CellTiter 96 Proliferation Assay (Promega). rhPBEF (100 ng/ml) caused a significant ($p<0.01$) increase in their proliferation when compared to the control (incubated with media only). IGF-II (30 ng/ml) was used as a positive control. To confirm and extend these results, fetal membrane explants from three different patients with no histological evidence of infection, were treated with rhPBEF (100 ng/ml) for 4h, controls were adjacent sections incubated in culture media only. Total RNA was extracted and the expression of 847 genes were compared on the human cytokine cDNA expression arrays (R&D, Inc.). The results show that PBEF causes increased expression of several genes involved in either growth regulation or in infection-induced pathways. These data are being confirmed by Northern blotting. (Supported by NIH grant HD24314)

Raju Pandey,
Department of Plant and Environmental Protection Sciences
(Advisor: Dr. Marshall W. Johnson)

DEVELOPMENT OF *ANAGYRUS ANANATIS* GAHAN (HYMENOPTERA: ENCYRTIDAE) AT CONSTANT TEMPERATURES

Pink pineapple mealybug, PPM, *Dysmicoccus brevipes* (Homoptera: Pseudococcidae) is one of the most widely distributed mealybugs around the world. In association with pineapple mealybug wilt associated closterovirus, PPM can lead to the expression of mealybug wilt disease. *Anagyrus ananatis* Gahan (Hymenoptera: Encyrtidae), a solitary endoparasitoid, is the most commonly distributed biological control agent of PPM in Hawaiian pineapple fields. Two experiments were conducted to determine the effects of constant temperature on the development of *A. ananatis*. In the first experiment, parasitized PPMs were incubated at five different constant temperatures (T), viz.14.6°C, 19°C, 23.8°C, 28.9°C and 31°C. Time (D) taken to complete the life cycle (from oviposition to adult emergence) was noted. A new variable, DT, was calculated and analyzed by regression analysis of DT with T. The lower temperature threshold (T_o) was determined to be 12.68°C with a total heat requirement of 271DD above T_o for *A. ananatis* to complete its life cycle. A typical pineapple plantation accumulated 4311 DD of heat above 12.68°C annually, where *A. ananatis* could complete about 16 generations per year. In the second experiment, parasitized PPMs were incubated at 23.8°C and 20 mealybugs dissected at 24 hours interval to determine the life cycle of *A. ananatis*. Results showed that egg began to eclose after 2 days of oviposition and completed hatching in four days. Larvae were observed from two days after oviposition to until nine days after oviposition, prepupa stage observed from 8 to 12 days, and pupa stage from 10 to 25 days from oviposition. Adult emergence began after 24 days of oviposition and completed in 26 days. These findings are useful in the development of mass rearing techniques for *A. ananatis* for augmentative biological control of *D. brevipes*.

Matthew Parry, Department of Oceanography
(Advisor. Richard Young).

THE TROPHIC ECOLOGY OF TWO OCEANIC SQUIDS IN HAWAIIAN WATERS

The two study species are important members of the pelagic ecosystem. *Sthenoteuthis oualaniensis* (purple squid) has been the target of a traditional local fishery for decades and *Ommastrephes bartramii* (red squid) was once the target of a worldwide fishery. Understanding the trophic dynamics of these squids is vital to understanding the pelagic ecosystem as a whole. Stomach contents and stable isotope analyses using several tissue types were used to determine the trophic status and trophic interactions of these squids. The stomach contents analyzed (*O. bartramii*, N=264, and *S. oualaniensis* N=210) indicate that both squids feed heavily on myctophids with the purple squid feeding almost exclusively (≅ 80%) on myctophids while the red squid appears to feed more generally on several families of fishes. The main myctophid prey is *Symbolophorus evermanni* in both species of squid predator. The stable isotopes show that the red squid is occupying a position roughly 1.5 trophic levels above the purple squid. The red squid appears to range about 3 trophic levels throughout its life from paralarvae to adult while the purple squid ranges only about 2 trophic levels over its lifespan. The red squid seems to plateau at its highest trophic level at mantle lengths of over 300mm while the purple squid does not appear to plateau throughout the size ranges studied. Using the stable isotope signatures of blood and secreted hard structures such as the eye lenses gives good agreement with the values and trends seen in isotope values taken from the mantle tissue of varying sizes of squids.

David A. Phillips, Department of Geology & Geophysics
(Advisor: Michael Bevis)

PLATE TECTONICS IN THE SOUTHWEST PACIFIC: GPS ESTIMATES OF CRUSTAL VELOCITY IN THE TONGA-LAU SYSTEM

The Tonga-Lau system is remarkable for having the highest rates of subduction and back-arc spreading on earth, the highest levels of deep mantle seismicity, and some of the most pronounced mantle velocity and Q anomalies observed on Earth. Bevis et al (1995) provided initial crustal velocity estimates for this system based on Global Positioning System (GPS) survey campaigns conducted in 1990 and 1992. In 1996, I helped establish a continuous GPS (CGPS) network throughout the region and have reoccupied the original survey markers several times between 1996 and 2000. I have reanalyzed the entire 1990-2000 time series using GAMIT/GLOBK geodetic software. Convergence estimates between the Pacific Plate and the Tonga Ridge range from 151 to 247 mm/yr in a Pacific-fixed reference frame. These estimates are far more accurate than those reported previously and represent the fastest tectonic velocities ever measured. Differential motion within the Tonga Arc is observed for the first time, with Niuatoputapu Island moving northeastward at 14 mm/yr in a Tonga-fixed reference frame. This differential motion may suggest the presence of a previously unknown microplate. Counterclockwise rotation of the Fiji Platform is also observed for the first time, with velocities ranging from 7 to 11 mm/yr in an Australian-fixed reference frame. Formal error estimates are at the mm-level are supported by comparisons between velocities determined at nearly coincident campaign and CGPS stations in several islands. This work contributes to a greater understanding of the current plate tectonic regime in the Southwest Pacific and provides insight into the development and behavior of major plate/microplate interactions throughout the world and throughout the Earth's history.

(References: Bevis, M. G., F.W. Taylor, B.E. Schutz, J. Recy, B.L. Isacks, S. Helu, R. Singh, E. Kendrick, J. Stowell, B. Taylor and S. Calmant, *Nature* 375, 249-251 (1995).)

Rebecca D. Scheinberg, Department of Oceanography
(Advisor: Michael R. Landry)

THE GRAZING IMPACT OF OIKOPLEURA FUSIFORMIS ON PICOPLANKTON IN THE COASTAL SUBTROPICAL PACIFIC

Prey size-selection and clearance rates of *Oikopleura fusiformis* were investigated at two sites along the northern and western shores of O'ahu, Hawaii during the summer of 2001. Experiments were conducted to determine the clearance rates of *O. fusiformis* on *Synechococcus* spp., *Prochlorococcus* spp., autotrophic eukaryotes and heterotrophic bacteria. At each of the experimental sites, individual appendicularians were gently captured *in situ* in 265-ml polycarbonate bottles approximately 20-m offshore. Incubations were conducted onshore in seawater at ambient temperatures for a period ranging from 30 min to 2 h, until the animal no longer maintained a constant feeding current. Clearance rates were determined by measuring the rate of cell decline over the incubation period using flow cytometry. The average abundances of *Synechococcus* spp., *Prochlorococcus* spp., autotrophic eukaryotes and heterotrophic bacteria during the experiments were 4×10^3 cells ml^{-1}, 2×10^4 cells ml^{-1}, 2×10^3 cells ml^{-1} and 1×10^6 cells ml^{-1}, respectively. The average clearance rate of *O. fusiformis* was 1.4 l $animal^{-1}d^{-1}$, ranging from 0.5 - 2.7 l $animal^{-1}d^{-1}$, and was related to size of the organism. Clearance rates were highest on autotrophic eukaryotes (> 1.0 μm) and lowest on heterotrophic bacteria (0.3-0.5 μm). These results suggest that although *Oikopleura fusiformis* feed on less than 1.0-μm cells, they are not a very efficient link between bacteria and higher consumers in the coastal subtropical ocean.

Brett D. Schumacher, Department of Zoology
(Advisor: James Parrish)

DAYTIME HABITAT USE PATTERNS AND THE SPECTRE OF COMPETITION FOR SPACE AMONG DEMERSAL REEF FISHES
(Hawaii Cooperative Fishery Research Unit)

It has been suggested that the introduced snapper, *Lutjanus kasmira,* (Family: Lutjanidae) may compete with native reef fish, such as the goatfishes (Family: Mullidae), for dietary or spatial resources. As part of a larger investigation into the potential competitive impact this alien might have in the nearshore waters of Hawaii, I studied the daytime spatial patterns of *L. kasmira* and several goatfishes. I conducted surveys of the habitat usage patterns of these fishes on fixed transects established both on and off reef, over soft and hard bottoms, and at different depths. Although abundance often varied within species as depth and substrate changed, vertical and horizontal patterns of distribution generally did not. Water currents appeared to be an important factor affecting patterns of fish distribution and abundance. The habitat use patterns of *L. kasmira* were most similar to those of *Mulloidichthys vanicolensis*. Where comparisons between transects of different depths were possible, both species were relatively abundant at deeper sites, but were rare at shallower sites. At all sites where they occurred, both species were primarily observed low in the water column and near areas of vertical relief, though *L. kasmira* appeared to be more closely associated with the substrate. Thus, *L. kasmira* could displace *M. vanicolensis* higher into the water column, where they may be more vulnerable to predators and fishers.

Pia Untalan, Department of Cell and Molecular Biology
(Advisor: David Haymer)

CcMD1, A NOVEL GENE CONTAINING A BTB/POZ DOMAIN SEQUENCE FROM THE GENOME OF THE MEDITERRANEAN FRUIT FLY

Differentially expressed genes can be found in a variety of key developmental pathways within an organism. These pathways include the determination of sex and the formation of morphological characteristics. In an effort to identify genes that are differentially expressed during development in the Mediterranean fruit fly (medfly), *Ceratitis capitata*, a suppression subtractive hybridization (SSH) approach was initiated at the embryonic and adult stages of development. An embryonic subtraction product, designated CcMD1, was recovered. Its cDNA sequence is 1576 nucleotides in length and encodes a protein of 278 amino acid residues. Using RT-PCR, it was established that the CcMD1 transcript is expressed in both females and males at the embryonic stage; it is also expressed in adult female abdomens, while only weakly expressed in the adult female thorax and the adult male abdomen and thorax. Weak expression is also observed at the larval and pupal stages. The difference in expression of CcMD1 at these stages suggests that it is developmentally regulated and may play a role in key developmental processes. Sequence pattern analysis suggests that CcMD1 is a novel gene containing a BTB-POZ domain at its N-terminus. The BTB-POZ domain is an evolutionarily conserved domain that is found in many developmentally regulated gene products and is thought to mediate protein-protein interaction. Further characterization of the representation and function of the BTB-POZ domain in the medfly has been initiated.

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A SERIAL ANALYSIS OF GENE EXPRESSION IN SUN-DAMAGED HUMAN SKIN

Aging of the skin consists of two simultaneous processes: intrinsic, chronologic aging and photoaging, an environmentally-induced remodeling of the dermis that arises as a result of repeated exposure of skin to sunlight. Although both intrinsic aging and photoaging share some common characteristics such as decreased procollagen expression and increased expression of several matrix metalloproteinases, photoaging is considered to be the predominant contributing factor to the prematurely aged appearance of sun-exposed skin. To study the phenotypic changes in human skin associated with repeated sun exposure at the transcription level, we have undertaken a comparative Serial Analysis of Gene Expression (SAGE) of sun-damaged skin and sun-protected skin as well as sun-protected epidermis. SAGE libraries were made to mRNA isolated from human pre-auricular (sun-damaged) skin and post-auricular (sun-protected) skin, as well as epidermal nick biopsy samples. 5,330 cDNA tags from the post-auricular SAGE library were sequenced and compared with cDNA sequences identified from 5,105 tags analyzed from a pre-auricular SAGE library. Of the 4,742 different tags represented in both libraries, we found 34 tags with at least a 4-fold difference of tag abundance between the libraries. Among the mRNAs with altered steady-state levels in sun-damaged skin, we detected those encoding keratin 1, macrophage inhibitory factor and calmodulin-like skin protein. In addition, a comparison of cDNA sequences identified in the SAGE libraries obtained from the epidermal biopsy samples (5,257 cDNA tags) and from both full-thickness skin samples indicated that many genes with altered steady-state transcript levels upon sun-exposure were expressed in epidermal keratinocytes. These results suggest a major role for the epidermis in the pathomechanism of largely dermal changes in chronically sun-exposed skin.

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INVESTIGATIONS ON THE CROSS-COUPLING OF PHENYLACETYLENE WITH ARYL CHLORIDES

The Pd-catalyzed cross-coupling of phenylacetylene with aryl chlorides has been investigated. Among several promoters, $ZnCl_2$ can act as a co-catalyst to convert the electron-rich, electron-neutral and electron-deficient aryl chlorides to their corresponding products in reasonable to excellent yields.

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(Advisor: Brian Popp)

NITROUS OXIDE PRODUCTION IN THE EASTERN TROPICAL NORTH PACIFIC AND THE BLACK SEA

Although the oceans are known to be a major natural source of the potent greenhouse gas nitrous oxide, the magnitude and characteristics of this source are poorly constrained. Nitrous oxide is produced in the ocean as a byproduct of nitrification, the conversion of ammonium in the presence of oxygen to nitrite and nitrate, and denitrification, the reduction of nitrate and nitrite under suboxic or anoxic conditions to diatomic nitrogen. To evaluate the relative importance of these two mechanisms under a range of biogeochemical conditions, I collected water samples along a transect from the oligotrophic North Pacific near Hawaii (22.75N, 158W) to the highly productive, oxygen-poor waters of the eastern tropical North Pacific near Mexico (15N, 98W). I collected additional water samples from the Black Sea, a body of water characterized by a stable suboxic zone overlying a permanently anoxic basin. Concentration measurements reveal a large, shallow source of nitrous oxide in the eastern tropical north Pacific, most likely due to nitrification, and an insignificant source in the Black Sea. Measurements of ^{15}N and ^{18}O in dissolved nitrous oxide support the hypothesis that nitrous oxide is produced by nitrification across the subtropical north Pacific. Similar measurements performed on Black Sea samples remain puzzling and suggest either the presence of isotopically anomalous source compounds or the existence of unique biochemical pathways.