

ABSTRACTS OF PAPERS

Twenty-Fourth Annual Albert L. Tester Memorial Symposium, 15–16 April 1999¹

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 Hawai'i. 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 biology 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 Hawai'i Foundation, and from other sources within the university, is used to provide two prizes for best papers, judged on quality, originality, and importance of research reported, as well as on the quality of the public presentation. The Waikiki Aquarium presents the Mike Weekley Award for a third prize, 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 guest is Robert E. Ricklefs from the Department of Biology, University of Missouri at St. Louis. Professor Ricklefs has a distinguished career as an evolutionary ecologist interested in all aspects of avian life history, as a community ecologist interested in internal and external aspects of ecomorphology and in patterns of species diversity, and as a biogeographer interested in taxon cycles. His experience includes field and laboratory studies as well as mathematical modeling. He is the author of several influential books, including *Ecology* for an advanced undergraduate course, *The Economy of Nature* for a nonmajors undergraduate course, and *Aging: A Natural History*, coauthored with Caleb Finch, for a diverse set of readers. His approach to ecology integrates a physiological with an evolutionary approach, thereby focusing on questions of major importance to biology as well as ornithology. He was a coauthor of a major article in *Science* titled "Contributions of Bird Studies to Biology."

Carotenoids, Essential Nutrients for Aquatic Animals?²

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² Sponsors: Dr. Harry Ako and Dr. Clyde Tamaru.

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Effects of orally administered carotenoid supplements on several species of freshwater ornamental fish held in algal-free aquariums were investigated. Initial results utilizing

synthetic carotenoids were inconsistent because the color of fish that received the synthetic pigment did not differ significantly from that of control individuals. Natural carotenoids from cultured algae, *Spirulina pacifica* and *Haematococcus pluvialis*, were mixed in with commercial feed and fed to several species of juvenile fish. At the end of each experiment, an independent panel ($n = 15$) evaluated the color of treated and control groups. Both male and female swordtails, *Xiphophorus helleri*; 24K mollies, *Poecilia latipinna*; topaz cichlids, *Cichlosoma myrnae*; rainbowfish, *Pseudomugil furcatus*; and rosy barbs, *Barbus conchonius*, were significantly more colorful than their control counterparts. Absorption and deposition of carotenoids in the skin seemed to be dependent on several factors. Age was one factor

observed for 24K mollies, topaz cichlids, rosy barbs, and rainbowfish. Juveniles did not display adult coloration regardless of treatment. For some species (rainbowfish and rosy barbs) only males exhibited an intensification of their respective color, whereas females acquired only a hint of color. Last, expression of color was dependent on tank environment for rosy barbs and topaz cichlids. The colors of male rosy barbs intensified with the addition of floating substrate, whereas topaz cichlids seemed to acquire color only after division of tanks into defined territories. The age, sex, and environment specificity of carotenoid-dependent coloration raise a question as to whether carotenoids may be nutrients essential for courtship rituals and mate selection. Further studies are suggested to examine the hypothesis.

Social Facilitation of Spawning Synchrony in a Coral Reef Fish⁴

KAZUE ASOH⁵

A hypothesis that spawning synchrony was socially facilitated in the Hawaiian dascyllus damselfish, *Dascyllus albisella*, was tested. At a small reef complex in Hawai'i, *D. albisella* occurred in four semidiscrete feeding aggregations. Both females and males of each aggregation displayed a significant 6-day cycle in spawning. Nest preparation by males

of each group also displayed a significant 6-day cycle. Spawning by females, spawning by males, and male nest preparation were significantly more synchronized between neighboring aggregations than between more distantly located ones. Results suggest that the observed cyclic spawning synchrony in *D. albisella* was mediated by a social mechanism.

DNA Sequence Evolution of the *Period* Locus in Hawaiian *Drosophila*⁶

DAVID BAER⁷

The over 1000 species of endemic Hawaiian *Drosophila* are an extreme example of an

adaptive radiation event. The combination of the large number of speciation events that have occurred and the recency of these events make this a unique taxon for study of the genetics of speciation. In addition, the extensive base of information on the phylogenetics, behavior, and molecular genetics of this genus and the model organism *Drosophila melanogaster* offers the tools necessary to conduct such an investigation. Theoretical

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as well as experimental studies have suggested the importance of sexual selection acting on mating behaviors as a potential mechanism of this extreme frequency of speciation, and this study attempts to assess the role of a behavioral gene, *period* (*per*), in establishment and maintenance of premating isolation and speciation. In *D. melanogaster*, *per* has been shown to affect such diverse behaviors as circadian activity cycles, pupal emergence timing, and male mating displays. In *D. melanogaster* and closely related species *per* has been shown to control a species-

specific component of the male premating display, interpulse interval cycling. The demonstrated role of *per* in generating variation in interpulse interval raises the possibility that this could be a genetic element important in establishing premating isolation in Hawaiian *Drosophila*. In an attempt to observe the hallmarks of positive selective sweeps resulting from sexual selection, statistical tests of neutrality were applied to population- and species-level DNA sequence data from the *period* locus.

Quantitative Assessment of Impact of Swimmers, Kayaks, and Motorized Vessels on Behavior and Acoustic Emissions of Spinner Dolphins (*Stenella longirostris*)⁸

CARMEN BAZÚA-DURÁN⁹

In Hawai'i, local conservation groups along with State and Federal agencies have expressed concerns about the long-term ramifications of swim-with-dolphin programs and commercial tour operators. It is unknown if such activities are either beneficial or harmful to dolphins. Therefore, there is an urgent need to investigate the effects on dolphins of such activities. A study was established in Kealahou Bay, Hawai'i, to investigate impact of swimmers, kayaks, and motorized vessels on behavior and acoustic emissions of spinner dolphins (*Stenella longirostris*) in June 1998. Data were recorded for number of aerial displays, group coordination, diving interval, general behavior state, and group

size (behavioral data), as well as for number of whistles, burst-pulses, and echolocation click trains (acoustic data). Statistically significant results were obtained for the overall effect of swimmers, kayaks, and motorized vessels using behavioral and acoustic data. It is unknown if this change in the variables sampled is harmful to spinner dolphins, but it at least indicates that the behavior of spinner dolphins is being changed when swimmers, kayaks, and motorized vessels are present. It is suggested that swimmers decrease the level of activity of spinner dolphins, kayaks do not disturb them, and motorized vessels promote the separation of dolphins, decreasing the level of acoustic communication among them. These results indicate that regulations of swim-with-dolphin programs and commercial tour operations should be enforced. Acoustic and behavioral sampling may be an efficient means of monitoring trends of a population and thus provide early warning of changes in behavioral patterns.

⁸ MMRP, Hawai'i Institute of Marine Biology. Sponsor: Dr. Whitlow W. L. Au.

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Partial Purification and Characterization of Hawaiian Box Jellyfish (*Carybdea alata*) Venom¹⁰

JOHN CHUNG, KRISTIN FERNANDEZ, AND LAL RATNAPALA¹¹

Venoms of coelenterates (hydras, jellyfishes, sea anemones, and corals) have been shown to contain several compound and polypeptide constituents with neurotoxic, hemolytic, immunogenic, and dermatologic effects. The most severe of coelenterate stings in Hawaiian waters, the Hawaiian Box Jellyfish (*Carybdea alata*) sting can cause itching welts, muscle weakness, and even intense pain, difficulty breathing, and anaphylactic shock. Because there is currently no effective treatment and the mechanism of action is unknown, we aimed to purify and analyze the mechanism of action of venom components of *Carybdea alata* nematocysts. Live jellyfish were collected from Waikīkī Beach. Jellyfish tentacles were autolysed and the nematocysts

were collected by centrifugation. Crude venom was obtained by sonicating nematocysts in phosphate buffer. Venom hemolytic activity was determined by sheep red blood cell lysis. Venom proteolytic activity was determined by measurement of hydrolysis of casein. With gel filtration chromatography and HPLC, we obtained an approximately 60 kD protein fraction with a 10-fold increase of hemolytic specific activity when compared with crude venom. The same fraction induced a marked reduction in conduction velocity and action potential response in stimulated crayfish nerve cords after 10 min. Proteolytic activity, present in the crude venom, was also present in a > 200 kD protein fraction.

Harbor-Dwelling Marine Sponges of the Hawaiian Islands¹²

RALPH C. DEFELICE¹³

Extensive surveys of marine invertebrates in harbors on O'ahu and preliminary surveys of commercial and small boat harbors throughout the main Hawaiian Islands were conducted. Marine sponges were abundant and conspicuous members of the fouling communities in all harbors. Sponges occurring in the harbors of Kaua'i, Maui, and Hawai'i

appear to be a subset of the species collected in the larger harbors of O'ahu. Forty-two species were found in Pearl Harbor alone, and 25 of these, including nine endemic species, are considered new records for the state. Currently, 26 sponge species known from the Hawaiian Islands are categorized as non-indigenous or cryptogenic species. Several of these may have been recently introduced to Pearl Harbor, but no distinct patterns of species introduction have been established. Distributions of nonindigenous and cryptogenic species collected include the Indo-Pacific, the Pacific end of the Panama Canal, and the Caribbean. Several species may have cosmopolitan temperate and tropical distributions. Because of the persistently encrusting habits of many species, pelagic larval strategies, and their ability to reproduce asexually, sponges may be easily transported

¹⁰ Bekey Laboratory of Neurobiology, University of Hawai'i. We thank Drs. S. Patil and P. Sun. This work was supported by grants from the Geist, Hawai'i Community, and Queen Emma Foundations. Sponsors: Dr. Angel Yanagihara and Dr. Ian Cooke.

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by shipping and subsequently become established. Despite the importance of sponges in the study of species introductions to the Hawaiian Islands, it is difficult to categorize species as introduced or indigenous because

of the limited collecting effort previous to this research and the difficulty of reliable and consistent taxonomic assignments of sponges in general.

Hermaphrodites and Parasites: A Sordid Tale of Shrimp Sex and Isopod Manipulation¹⁴

G. CURT FIEDLER¹⁵

Two species of hippolytid shrimp from the genus *Lysmata* are known as simultaneous hermaphrodites, including *Lysmata amboinensis* from Hawai'i. The objective of this study was to ascertain the presence of simultaneous hermaphroditism in three additional Hawaiian *Lysmata* species. Specimens of *L. kuekenthali*, *L. acicula*, and *L. trisetacea* were collected at various coastal locations on the island of O'ahu during 1998. For each species, some individuals were fixed for histological examination and others were kept alive in aquariums to observe sexual function. In all species, small individuals reproduced as males, and large individuals were simultaneous hermaphrodites, as in *L. amboinensis*. In two species (*L. acicula* and *L. trisetacea*), individuals were observed carrying abdominal isopod parasites of the family

Bopyridae. The bopyrid infection rate of field-caught individuals was approximately 30% in both species. In nearly all cases, infected shrimp could still reproduce as males, but hermaphrodites invariably lost female function. This is consistent with bopyrid infections of gonochoristic crustaceans. The parasites occupy abdominal space normally filled with eggs. This suggests strong selective pressure on the parasite to control the female reproductive function of their host. Furthermore, hermaphrodite hosts are able to obtain at least some reproductive success as males during the time they are parasitized. Therefore, hosts that are simultaneous hermaphrodites have a selective advantage over gonochoristic and purely sequential hermaphroditic (protandrous) hosts.

Lipopolysaccharide Induces Apoptosis But Not Complete Morphogenesis of the Light Organ of the Squid *Euprymna scolopes*¹⁶

JAMIE S. FOSTER¹⁷

Interactions with symbiotic bacteria are often essential for the normal development of ani-

mal tissues. A useful model for study of these associations is the symbiotic mutualism between the Hawaiian sepiolid squid *Euprymna scolopes* and the luminous bacterium *Vibrio fischeri*. In this mutualism, juvenile squid undergo dramatic morphological changes as a result of interactions with the luminous bacteria. The bacteria are housed in a specialized organ called the light organ. On either side of this organ there are two ciliated appendage-

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like structures composed of a single layer of epithelial cells, which facilitate inoculation of the light organ. Within 12 hr of colonization by the bacteria, an irreversible signal is transmitted to the host initiating a remodeling of the juvenile light organ morphology. The ciliated structures undergo an apoptotic cell death event followed by a regression of the epithelium. In this study, we examined the nature of the bacterial signal initiating these changes in the host squid. Previously, I reported that the bacterial surface molecule lipopolysaccharide (LPS) can initiate a program of apoptosis much like that in the native association. However, even after 4 d incubation with this molecule, LPS was unable to initiate any regression of the superficial

appendages. Because cell death alone is unable to account for loss of the superficial appendages, I hypothesized that the superficial structures were undergoing cell division. Thus a second signal may rely on inhibiting cell proliferation in the superficial epithelial cells. Cell proliferation inhibitors were used in concert with the cell death inducer LPS. Together these two compounds mimicked the natural regression event. Although apoptosis seems to be an integral component to the mechanism by which the superficial ciliated epithelium undergoes its developmental remodeling, it is not the sole signal. A complex dialogue consisting of at least two components is required for the bacteria to successfully initiate morphogenesis.

Differential Effects of Water and Nutrients on Flowering and Seed Set in a Native and an Invasive Grass in Hawai'i¹⁸

ERIN GOERGEN¹⁹

Native *Heteropogon contortus* (pili grass) populations have declined in Hawai'i over the past few decades, and many remaining *H. contortus* grasslands appear threatened by the invasion of alien *Pennisetum setaceum* (fountain grass). This study compared the reproductive response of these grasses to various water and nutrient levels to determine conditions that give *P. setaceum* a reproductive advantage over *H. contortus*. Plants were

grown from seed in a greenhouse at two levels of water and nutrients. *Heteropogon contortus* flowered under all treatments, but plants receiving supplemental nutrients produced more inflorescences. In contrast, *P. setaceum* flowered only at high nutrient levels. Although inflorescence production was increased in *H. contortus* at high nutrient levels, seed set rate was lower than in low nutrient treatments. In low water conditions, *P. setaceum* inflorescences failed to mature seeds, but *H. contortus* produced seeds even at the lowest water and nutrient treatments. The invader, *P. setaceum*, appears to require higher resource levels (water and nutrients) than the native, *H. contortus*, for flowering and seed production.

¹⁸ Sponsor: Dr. Curtis C. Daehler.

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Patterns of Abundance and Diversity of Arthropods on the Dominant Tree *Metrosideros polymorpha* (Myrtaceae) in the Hawaiian Islands²⁰

DANIEL S. GRUNER²¹ AND DANIEL A. POLHEMUS²²

The Hawaiian Archipelago forms a linear time series of replicated communities, with ages of volcanic origin varying over seven orders of magnitude. Important ecosystem attributes, such as parent substrate, climate, and elevation, may be held constant at selected sites along the series. Previous studies along a montane mesic chronosequence (300 yr–4.1 million yr) have shown that rates of many ecosystem processes peak at sites of intermediate volcanic substrate age (20,000 yr–1.4 myr). At these sites, the canopy is dominated by a single tree species, *Metrosideros polymorpha* (Myrtaceae), and arthropod lineages are largely conserved. These features make the Islands an ideal natural laboratory to test the relative importance of ecological versus historical and evolutionary hypotheses of community organization. In 1997, we used pyrethrum canopy

fogging to sample free-living arthropods on 41 *M. polymorpha* trees at four sites on three islands. Total arthropod densities and biomass were highest at sites of intermediate age. Foliar nitrogen concentrations were highly correlated with total arthropod density on individual trees. Species richness of phytophagous true bugs (Heteroptera) and predatory carabid beetles (Coleoptera: Carabidae) also was highest at more productive, intermediate-aged sites. However, one of three indigenous tribes of Carabidae (Psyrini) was completely absent from, and presumably has not colonized, the oldest site. These preliminary results support the notion that although phylogenetic accident may place constraints on composition, community organization is determined largely by contemporary ecological processes.

Why Do Hawaiian Birds Flock?²³

PATRICK J. HART²⁴

²⁰ We gratefully acknowledge D. Foote and K. Heckmann for field and laboratory assistance, J. K. Liebherr for identification of specimens, The Nature Conservancy and the Department of Land and Natural Resources for field access. Funding was provided by the Ecology, Evolution, and Conservation Biology (EECB) Program at the University of Hawai'i at Mānoa, the Federal Environmental Protection Agency, and the Smithsonian Institution. Sponsor: Dr. Andrew Taylor.

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The endangered Hawai'i 'Ākepa, *Loxops coccineus coccineus*, is a strongly sexually dichromatic, insectivorous honeycreeper that takes part in seasonal mixed-species flocks on the island of Hawai'i. I measured vigilance levels of this bird in and out of flocks to evaluate the hypothesis that flocking has a predator avoidance function and to test the prediction that there is a cost to bright orange plumage in males in terms of increased vigilance behavior for predators. In addition, I compared time spent per patch of food for 'Ākepa in and out of flocks to test an alternate hypothesis that flocking improves foraging efficiency through "local enhancement." There was no difference in vigilance levels in versus out of flocks for the cryptic-

cally colored females, nor was there a difference between sexes within flocks. However males were much more vigilant when foraging outside flocks. This supports the predator avoidance hypothesis for males, as well as the prediction that they must compensate for

their brightness by being more vigilant for predators. In contrast, the local enhancement hypothesis was not supported. There was no difference in time spent on a patch of food between flocking and nonflocking individuals.

A Model of the Population Dynamics of the Mongoose (*Herpestes auropunctatus*) in Hawai'i²⁵

WARREN HAYS²⁶

A compartmental, numerical model was used to examine the annual population cycle of the small Indian mongoose in areas between 17° and 22° N latitude and to assess population control regimens. Strong evidence was found that females produce two litters per year and that juveniles generally stay with their mothers until 5 months of age. Pop-

ulations with male-favored sex ratios were predicted to show high survivorship. For protection of seasonally nesting species, the most cost-effective control regimen was found to be an intense initial removal effort, followed by a brief effort each year before the nesting season of the protected species.

Movement Patterns of Foraging Manini, *Acanthurus triostegus*, on the Reef Flat of Coconut Island, Kāne'ohe Bay²⁷

LISA IWAHARA²⁸

A preliminary analysis on foraging patterns of *Acanthurus triostegus* was conducted on the reef flat of Coconut Island in Kāne'ohe Bay, Hawai'i, from 5 February to 5 October 1998. The purpose of the study was to relate *A. triostegus* movement patterns to algal distribution and proximity to shelter. Data were taken from two reef flat sites with high and low algal cover. Individual fish were visually

tracked by dropping markers every minute for observation periods of 30 to 60 min. Positions of the markers were measured by triangulation and converted into coordinates for further data analysis. Transects on bottom cover were also taken. Fish foraging in the low algal site showed greater shoreward movement patterns, whereas fish in the high algal site foraged closer to the reef crest. Fish spent all their time foraging over continuous coral cover at the high algal site, but fish from the low algal site spent time away from the continuous coral area. There seemed to be a short-term optimal foraging area of about 100 m², because the foraging area was similar regardless of fish length. In addition, time lapse data showed overlap between the area used by a single fish in the first and last 30 min. Orientation differences, and time and

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distance away from potential shelter (coral cover) suggest that fish at the low algal site may be taking more risk in their foraging

behavior compared with fish foraging in the high algal area.

Ultrastructural Characterization of Nematocyst Tubules from Hawaiian Box Jellyfish (*Carybdea alata*) and *Physalia physalis*²⁹

JANELLE KUROIWA AND DENNIS KUNKEL³⁰

The venom of *Carybdea alata* produces the most severe of coelenterate stings in Hawaiian waters. Symptoms can last up to 16 weeks and include irregular heartbeat, welts, and burning sensations. Persistent dermatitis subsequent to a *Carybdea* sting presents a clinical challenge not encountered in other coelenterate stings. Stinging involves implanting of chitinous barbed tubes and ejection of venom by specialized cells (nematocysts) into the prey. To understand these structures to aid design of clinical treatment, we examined nematocysts by Hoffman modulation contrast microscopy and scanning

electron microscopy (SEM). *Carybdea* tentacles exhibited protruding long tubules with back-faced barbs in a spiral array. *Carybdea* tubules were 250 to 300 μm long and had a diameter of 2.5 μm at the base but tapered to 2 μm at the tip. *Carybdea* tubule barbs measured 1.5 μm at the base and 0.5 μm at the tip. *Physalia* had two different nematocyst sizes, with tubule lengths of 240 μm (2- μm diameter at the base) and 840 μm (3- μm diameter at the base). *Physalia* tubules had a discrete arrangement of barbs measuring 1.5 μm near the base, which were observed to be absent at the tip.

Occurrence and Behavior of Hawaiian Spinner Dolphins (*Stenella longirostris*) along Leeward and South O'ahu: Implications for Conservation and Management³¹

MARC O. LAMMERS,³² MANDY HAPNER,³³ AND DANIELLE LANYARD³⁴

Next to humpback whales (*Megaptera novaeangliae*), spinner dolphins (*Stenella longi-*

rostris) are the most visible species of cetaceans in Hawaiian waters. Large populations ranging from hundreds to thousands of animals occur along the coastlines of all the major Hawaiian Islands. A recent statewide surge in public and commercial interest in these animals has raised concerns regarding the impact that increased anthropogenic activity might have on local populations. In June of 1997, an effort was launched to define distribution, movements, and behavioral patterns of spinner dolphins along the leeward and south shores of O'ahu. Using quantifiable behavioral cues an ethogram was created to reliably assess spinner dolphin

²⁹ Thanks to the staff at the Wai'ikī Aquarium. This work was supported by grants from the Geist, Hawai'i Community, and Queen Emma Foundations. Bekesy Laboratory of Neurobiology, University of Hawai'i. Sponsors: Dr. Angel Yanagihara and Dr. Ian Cooke.

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behavioral state. Subgroups of dolphins were visually tracked and their movements recorded using a global positioning system (GPS). Results indicate that animals from this population range widely and use both coasts extensively in a well-defined daily behavioral cycle. A distribution plot of the occurrence of spinner dolphins along the coast reveals three primary "hot spots" where subgroups regularly converge during the socializing and resting phases of their diurnal cycle.

These sites share specific physical characteristics important to the animals that regularly frequent them. This suggests that a cautious, managed approach should be taken in dealing with human encroachment on spinner dolphin near-shore habitats. Continued monitoring is necessary to assess the long-term implications of growing public and commercial interests in this population of dolphins.

Histological Evidence of Sequential Hermaphroditism in the Sanddiver *Crystallodytes cookei* (Pisces: Creedidae)³⁵

ROSS C. LANGSTON³⁶

Gonads of *Crystallodytes cookei* were examined to determine size at sexual maturity and to elucidate mechanisms of their reproductive biology. Specimens were obtained from numerous collections, imbedded in paraffin, and sectioned for microscopic examination. Gonads of *C. cookei* are bilobed, each lobe being further subdivided into ovarian and testicular portions, which can be differentiated in individuals greater than 20 mm standard

length (SL). Testes appear active around 25–30 mm SL and mature ova are present in individuals greater than 38 mm. Sequential hermaphroditism is tentatively suggested based on the following: (1) presence of a nonfunctioning bisexual gonad in juveniles, (2) bimodal size distribution of functional males and females, (3) simultaneous presence of mature spermatozoa and hydrated ova within a single (46 mm) individual.

Yield Response of Eggplant (*Solanum melongena*) Production in a Buffelgrass (*Cenchrus ciliaris*) Living Mulch System in Hawai'i³⁷

JAMES K. LEARY³⁸

The objective of this research was to characterize growth and yield responses of eggplant

(*Solanum melongena*) and changes within the microenvironment in chemically stunted living mulches compared with the conventional bareground production system. The experiment consisted of four treatments (trt). Trt 1 is the conventional bareground production system, which includes the use of a pre-emergence herbicide and hand weeding to maintain a weed-free plot. Trt 2, 3, and 4 are the living mulch plots with buffelgrass (*Cenchrus ciliaris*) established in the between-row space and treated with various sublethal rates

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of the selective grass herbicide sethoxydim. Results indicate significantly higher marketable yields, with an average increase of 86% for the living mulch plots versus the conventional bareground plots. The increase in yield was attributed to the reduction in insect and mite pressures within the living mulch plots. Soil moisture within the top 5 cm of the between-row soil surface was significantly higher, with an average increase of 17% in all living mulch plots compared with the conventional bareground plots. This indicates that the amount of soil moisture taken up by the buffelgrass at that depth was less than the

amount due to evaporative loss on the exposed soil surface of the bareground plots. An economic analysis was conducted on hand weeding within the plots. The cost of conventional bareground plots averaged \$540.75 compared with the highest cost in a living mulch plot of \$360.50. There was a 102% reduction in herbicide use for the living mulch plots compared with the bareground plots. The living mulch system is a Best Management Practice for mitigating non-point source pollution, and research shows this to be an economically viable solution for Hawai'i's growers.

Size at Maturity Estimates and Their Effects on Perceptions of Community Structure in Cryptic Fishes of the Spur and Groove Habitat³⁹

KEN LONGENECKER⁴⁰

Mortality of coral reef fishes varies among species and over the lifespan of individual species. Thus total abundance data do not represent the number of individuals that will survive and reproduce. This suggests that research on community structure should be based on adult numbers. There is no published information on adult size for cryptic fishes of the spur and groove habitat outside Kāne'ohe Bay. I used standard histological techniques to determine size at maturity for several species. Fifty percent of 10 mm standard length (SL) *Eviota epiphanes* and *E. rubra* (Gobiidae) were mature. All *Amblycirrhitus bimaculatus* (Cirrhitidae) were mature by 39 mm SL. Protogynous hermaphroditism was diagnosed in this species based on a sex-

based bimodal size distribution, presence of oocytes and yellow bodies in testes, and the presence of transitional individuals. Considering only adults drastically alters community composition overall and within sampling units. *Eviota epiphanes* was the most abundant species, with 263 individuals in 27 samples. However only 49% of these are adults. Decreases in abundance estimates within sampling units varied from 0 to 100%. *Eviota rubra* is rare, and my results suggest that it does not survive to adulthood in the area I studied. Overall abundance estimates for *A. bimaculatus* only decreased 27%; however decreases were between 50 and 100% when changes occurred within sampling units. Also, studies on the diet and microhabitat choice of *A. bimaculatus* should consider the potential effects of protogyny. Information from other investigators indicates that abundance estimates for two other cirrhitids are not changed by considering only adults, whereas those for two creolid species change considerably.

³⁹ Hawai'i Institute of Marine Biology, University of Hawai'i. Sponsor: Dr. David Greenfield.

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Population Viability Analysis of Endangered Passerines: Computer Modeling Results for a Translocated Metapopulation⁴¹

ANDREW MCCLUNG⁴²

Population Viability Analysis (PVA) has proven useful in assessing management options for endangered species, especially when the biology of the species is well known. Most studies to date have focused on continental species and habitat fragmentation, but few have addressed management options for relict species in island ecosystems. The Northwestern Hawaiian Islands contain several species of passerine birds that could be so described and formerly contained many others since gone extinct. Our research, using the VORTEX PVA modeling program, indicates that one of these birds, the Laysan Finch, may be in the process of losing a group of populations at Pearl and Hermes Reef (PHR). Translocated to PHR in 1967 as insurance against catastrophic events at Laysan, the PHR finches face environmental stochasticity comparable with that affecting

their parent population, but patch sizes and effective population sizes at PHR are much smaller. Also, local population extinctions remain problematic because of low interislet migration rates and consequent lack of population replenishment. Furthermore, the vegetation composition has changed substantially over the last 20 yr, creating a severe limitation on nest sites and shifts in behavior that may be affecting breeding success. Preliminary VORTEX results suggest that inbreeding is much more a problem at PHR than at Laysan and, in concert with earlier genetic studies, indicate that the PHR populations provide neither a sufficient reserve of genetic diversity nor of demographic stability. Whether to respond to this decline by attempting an additional translocation at a more stable island habitat remains to be answered.

Did a Continental Migratory Species Adjust to Life on a High Tropical Island by Becoming Nonmigratory?⁴³

THERESA MÉNARD⁴⁴

Hawai'i was colonized by two species of migratory tree bats from continental America, of which one remains—the Hawaiian hoary bat, *Lasiurus cinereus semotus*. Whether the bat retained a migratory lifestyle is unknown. I studied the occurrence of the bat on the island of Hawai'i for evidence of altitudinal migration. I collected data on the frequency of bat detections (presence versus absence) at

low (sea level to 2100 ft [600 m]), mid (2100 to 4200 ft [600 to 1200 m]), and high (4200 to 6300 ft [1200 to 1900 m]) altitude zones from February 1996 to August 1998. Bats were detected in each zone year-round, raising the possibility of resident (nonmigratory) populations in each zone. In the mid zone, bats were detected on all survey nights in each season, but averaged over all zones detection frequency was dependent on season without a significant zone by season interaction. Averaged across all seasons, bats were detected more frequently in the mid zone than in the low and high zones. After adjusting for seasonal differences, detection frequency was dependent on zone. These findings are consistent with a "residency model" in which

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(1) the mid zone supports a larger population of bats than the other zones do, and (2) during some seasons bats in the low and high zones become as apparent as bats in the mid zone despite their smaller populations. Alter-

natively, the "migratory model" remains tenable because parallel seasonal changes in detection frequency in the low and high zones do not rule out the possibility of migration into and out of the mid zone.

Effect of Nutrient Enrichment from Bird Guano on Mangrove Root-Associated Communities⁴⁵

DWAYNE MINTON AND DEBORAH GOCHFELD⁴⁶

Guano from birds in red mangroves (*Rhizophora mangle*) trees may provide an important source of nutrients for the community of algae and invertebrates living on the mangrove's extensive root system. This study examined a colony of 300 cattle egrets nesting in an offshore red mangrove tree in St. Ann's Bay, Jamaica. In a reciprocal transplant study, we removed mangrove prop roots at three sites (inner, middle, and outer) from the "bird tree" and from a similar control tree and characterized the percentage cover of attached organisms. Roots were reattached to

their site of origin or to the same site on the other tree (e.g., bird inner to control inner and vice versa). After 23 days, roots transplanted from the bird tree to the control tree showed an increase in percentage cover of algae and a decrease in cover by sponges relative to their transplant controls. The opposite was true of transplants from the control to bird tree. Reciprocal transplants from inner and middle sites showed more dramatic changes than transplants between outer sites. This may be related to differences in nutrient and light levels underneath the two trees.

TaxonBank, A New Online Database for Taxonomic Research⁴⁷

FABIO MORETZSOHN⁴⁸

The Internet offers many resources and possibilities for research. Many museums currently have online databases of their research collection holdings; some even include type specimens, but usually with only scant data that are not sufficient for taxonomic research.

I am proposing the creation of a web-based database to contain detailed information on zoological primary type specimens housed in museums and other academic institutions. The purpose of the *TaxonBank* is to be a central depository of taxonomic data on type specimens, patterned after the successful *GenBank* database for DNA sequences. It would help taxonomists locate type specimens for study, confirm identifications, and make some taxonomic decisions. However, it is not intended to be used in lieu of actual study of specimens, as needed in monographic revisions or descriptions of new species. Among the data that would be useful are image(s), author, original citation, catalog number, availability for loan or whether the institution has other loanable lots of the same species, etc. Other important data

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would be the original paper facsimile (in Adobe Acrobat's PDF format), if copyright law permits, or links to the publisher/copyright holder so that the original description of the species could be obtained via Internet. It seems that most collections start computerization with their type specimens; therefore,

most of the data needed for the *TaxonBank* may already be available. A digital camera and a scanner would simplify the task of digitizing images and text. Submissions would be sent via Internet and could be updated later. I discuss some ideas on how the *TaxonBank* can be started and implemented.

Experimental Manipulations of Serotonin Affect Metamorphosis of *Hydroides elegans*⁴⁹

BRIAN T. NEDVED⁵⁰

Metamorphosis of the serpulid polychaete *Hydroides elegans* occurs rapidly after contact with bacterial biofilms. The induction of metamorphosis, probably initiated by binding of bacterial exopolymers to chemoreceptors located on cilia of the apical sensory organ (ASO), triggers a restructuring of tissues to form adult appendages. Although we are beginning to understand some of the mechanisms involved with the initiation of metamorphosis, little is known about how the inductive signal is propagated from larval chemosensory cells to other neuronal and nonneuronal tissues. The neurotransmitter serotonin (5-HT) has been shown to induce metamorphosis in a number of marine invertebrates and may be used by *H. elegans* to coordinate and control morphogenic events associated with metamorphosis. Immuno-

cytochemistry performed on competent larvae of *H. elegans* has revealed that several cells of the ASO phenotypically express the 5-HT. Alterations in the amount of 5-HT available for binding with receptors on postsynaptic cells, or alterations of 5-HT-receptor binding kinetics should affect metamorphosis. In this study, I exposed larvae to 5-HT, the 5-HT precursor 5-HTP, 5-HT depletor PCPA, and the 5-HT reuptake inhibitor fluoxetine (Prozac) to alter the amount of 5-HT present in synapses. I also perturbed the kinetics of 5-HT-receptor binding on postsynaptic cells by using the receptor agonist α -Methyl-5-HT and the antagonist gramine. Settlement assays performed after these treatments clarified the role of 5-HT in metamorphosis of *H. elegans*.

Success of Alternative Mating Tactics Is Size Dependent in Male Gobies⁵¹

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Laboratory experiments using a coral-reef gobiid fish indicate that spawning success is largely determined by a male's relative body size, with intermediate-size males having the lowest success. Only the largest, most dominant males were able to establish nest sites and acquire mates through courtship. It is not surprising that they had the highest mating success. Spawning by smaller males was achieved only through sneak fertilizations at

the nests of the alpha males. Sneaking success was negatively correlated with increasing body size. Thus, males of intermediate body size had the lowest mating success, because they were unable to defend nest sites and least successful at sneaking. Female mate choice tests showed that larger males acquire more mates even in the absence of male contest competition. Thus, sneak mating by

smaller males may have evolved in response to the effects of both male contest competition and female mate choice, each of which results in a large male mating advantage. Preliminary otolith analyses indicate that sneaking is performed mostly by younger males, who later switch to courtship after they have grown large enough to compete effectively for nest sites.

Effects of Disease and Predator Removal on Demography of O'ahu 'Elepaio⁵³

ERIC A. VANDERWERF⁵⁴

To understand the recent decline of O'ahu 'Elepaio (*Chasiempis sandwichensis ibidis*), a monarch flycatcher endemic to O'ahu, I monitored demography of an 'Elepaio population in southeastern O'ahu from 1995 to 1999 and compared it with that of a large, stable 'Elepaio population at Hakalau Forest N.W.R. on Hawai'i Island. Annual adult survival was lower on O'ahu (0.77) than at Hakalau (0.87), primarily because poxvirus was more prevalent on O'ahu and survival of birds with active pox lesions (0.56) was lower than that of healthy birds (0.89). Annual reproductive success also was lower on O'ahu than at Hakalau (0.41 versus 0.62 fledglings per pair). To document the cause of low reproductive success on O'ahu, I placed automatically triggered cameras at artificial nests

with quail eggs; each of 10 photographs showed a black rat (*Rattus rattus*) preying on the eggs. From 1997 to 1999, I attempted to increase reproductive success by removing rats with snap traps and diphacinone poison bait stations. After removal of these introduced predators, nest success increased from 0.41 to 0.60 and number of fledglings per pair increased from 0.37 to 0.70 (89%). The finite rate of population increase was 0.89 without rat removal and 1.04 with removal. Currently there is no practical field method for controlling poxvirus, which is carried by mosquitoes, but rat removal is a promising management technique that it is hoped will help stop the decline of 'Elepaio and other Hawaiian forest birds.

Cleaning Symbioses between Green Sea Turtles, *Chelonia mydas*, and Hawaiian Reef Fishes⁵⁵

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An investigation of the cleaning relationships between Hawaiian reef fishes and green sea turtles was conducted. Cleaning stations on O'ahu, Maui, and the island of Hawai'i were surveyed via remote and/or hand-held video camera; videotape was later analyzed with event-recording software. Events recorded included individual turtle identity, presence or absence of green turtle fibropapillomatosis

(GTFP), number of bites taken by carnivores, duration of cleaning by herbivores, species of cleaner, and reaction of the turtle to the cleaning. Twenty-nine individual turtles were identified, eight of them tumored. *Thalassoma duperrey*, the Hawaiian saddle-back wrasse, was the main cleaner in Kāneʻohe Bay, Oʻahu. *Thalassoma duperrey* concentrated its efforts on tumored turtles, yet did not selectively clean the tumors

themselves. Carnivorous cleaners at Hanauma Bay, Oʻahu, and Honokōwai, West Maui, did target the tumors selectively. Very little carnivorous cleaning and no tumored turtles were observed on the Kona coast of the island of Hawaiʻi. Herbivorous cleaners in Kāneʻohe Bay spent equal amounts of time on tumored versus clean turtles (approximately 20% of total cleaning time).