Biogeography Specialty Group
2006 Graduate Student Research Grant Competition

Cover Sheet

Name of Applicant: **Ranya B. Henson**

Department: **Geography**

University: **University of Hawai‘i at Manoa**

Mailing Address: **Saunders 445, 2424 Maile Way, Honolulu, Hawai‘i 96822**

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The proposed study is for (circle one): **Master's**/Doctorate

Anticipated date of graduation: **May 2007**

Title of project: **Genetic Structure in the Hawaiian Intertidal Zone: Space, Scale and Disturbance**

Amount requested: **$412**

I am a student member of the AAG (yes/no): **Yes. (Signed up online 1/11/2005)**

Signature of Applicant: **Ranya Henson**

Date: **January 13, 2005**

Proof of student eligibility:
I certify that the applicant is currently a graduate student under my supervision and that the proposed project is part of her/his thesis research.

Name of Advisor: Signature:
Stacy Jorgensen
Department of Geography
University of Hawai‘i at Manoa
Honolulu, Hawai‘i 96822

Or if submitting by e-mail, Advisor's e-mail address: **jorgy@hawaii.edu**

PROJECT DESCRIPTION

Genetic Structure in the Hawaiian Intertidal Zone: Space, Scale and Disturbance

Hypothesis

Patterns of spatial genetic structure in Hawaiian marine intertidal organisms will be dependent on the scale of analysis and the degree of disturbance. I predict that among populations of the echinoderm *Colobocentrotus atratus* geographic clines will be present at broad spatial scales, while at more local scales chaotic genetic patchiness will predominate. Furthermore, the scale at which chaotic genetic patchiness occurs should be greater (i.e., more broad) on shorelines with higher levels of disturbance.

Introduction

Studies of the genetic diversity of marine organisms have found an almost shocking variety of spatial genetic patterns (Hellberg et al. 2002). Furthermore, disparate patterns are often seen among species with similar life histories (Johnson and Black 1982, Sotka et al. 2004), suggesting that evolutionary processes alone cannot explain the patterns of geographic genetic diversity seen in marine organisms. Other factors must also be at play.

One such factor may be the issue of scale, a subject that is often neglected or poorly examined in most population genetic analyses. For example, few studies go beyond a simple regression of geographic versus genetic distance among populations sampled and fewer still explicitly address how the sampling grain may affect measures of population differentiation. Disturbance intensity is another issue that is often under-addressed or ignored in population genetic studies of marine organisms. High levels of disturbance may cause higher rates of local population extinction and recolonization, which may preclude the formation of significant genetic autocorrelation at local scales and, instead, result in chaotic spatial genetic patterns (Hellberg et al. 2002, Johnson et al. 1982). Conversely, low levels of disturbance may allow for significant genetic autocorrelation over both local and broad scales.

Variously battered by waves and burned by the sun—all in the course of a single typical day—the intertidal zone exemplifies disturbance in the marine realm. The zone's linear pattern on the landscape also provides a relatively simple system for geographic analysis. Despite the harsh conditions and its geographically narrow extent, the intertidal system contains a rich assemblage of species, many of which occur nowhere else (California Coastal Commision 1987). In Hawaiʻi, the intertidal zone supports less overall biomass than its better-studied temperate counterparts, but appears no less diverse (Baumgartner and Zabin 2004). Furthermore, the region contains a large number of endemics, many of which are of conservation concern (Baumgartner and Zabin 2004).

Study Locale and Organism

The Hawaiian Archipelago is an ideal location for examining how issues of scale and varying levels of disturbance affect patterns of genetic diversity in the intertidal realm. The islands, which comprise both high volcanic islands and low-lying atolls, stretch for some 2200 km across the central North Pacific Ocean. Latitudinal variation among islands is controlled for by the predominantly east-west distributional pattern of the chain. Wave-driven disturbance does vary considerably among shorelines of the individual high islands, however. The north and west shores, whose wave climate is dominated by the North Pacific winter swell, are exposed to average wave heights several times that of southern and eastern shorelines, which receive waves as products of the Southern Ocean swell and Northeast Tradewinds (Moberly and Chaimberlin 1964). Thus, the islands provide a natural system allowing sample replication at multiple spatial scales across different types of islands and shorelines.

An ideal research organism is one whose life history characteristics are emblematic of many intertidal organisms and one that occurs in abundant numbers and at many sites across the islands. My research with marine invertebrates for my senior thesis and at the Bishop Museum has proven invaluable for identifying such an organism: *Colobocentrotus atratus*, a small sea urchin found throughout the Indo West Pacific (Ebert 1987), usually in fully exposed wave swept shores (Ebert 1987, Denny and Gaylord1996). Like many intertidal species, adults are nearly sessile, while larvae and eggs may be carried long distances by ocean currents during a planktonic phase of several weeks (Palumbi 1996).

Methodology

A minimum of three high and low-lying islands each will be selected. Three to five populations will be sampled from each of the low-lying islands. High islands will be stratified into high and low wave disturbance shorelines. Five areas separated by a minimum of 1 km will be selected along each type of shoreline, and three populations will be sampled from each area. Thirty mature individuals will be collected from all sampled populations.

Upon collection, samples will be immediately frozen. Total genomic DNA will be extracted following protocols established at the Hawaii Institute of Marine Biology (HIMB). Genetic variation will be determined by both mitochondrial (sequence variation) and nuclear ('anonymous' amplified markers) markers using established protocols. Population structure will be quantified by measures including Wright's *F*-statistics (Wright 1965) and the maximum likelihood approach of Beerli and Felsenstein (2001).

Significance

This study will significantly improve our understanding of the population dynamics of marine invertebrates in the intertidal zone. There has been no previous analysis of these organisms within the Hawaiian Archipelago. A better understanding of the dynamics of this region is essential for conservation planning, something that is paramount in a location with the dubious title 'extinction capital of the world.' Furthermore, my integration of population genetics with a spatially explicitly framework is an approach seldom realized for empirical studies of geographical genetic structure.

LITERATURE CITED

Baumgartner EP, Zabin CJ (2004) High numbers of invasive species in O'ahu's intertidal zone. Hawai'i Conservation Conference, Honolulu.

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California Coastal Commission (1987) *California Coastal Resource Guide*. The University of California Press, Berkeley.

Denny M, Gaylord B (1996) Why the sea urchin lost its spines: hydrodynamic forces and survivorship in three echinoids. *The Journal of Experimental Biology* **199**, 717-729.

Ebert TA (1982) Longevity, life history and relative body wall size in sea urchins. *Ecological Monographs* **52**, 353-394.

Hellberg ME, Burton RS, Neigel JE, Palumbi SR (2002) Genetic assessment of connectivity among marine organisms. *Bulletin of Marine Science* **70 suppl.**, 273-290.

Johnson MS, Black R (1982) Chaotic genetic patchiness in an intertidal limpet, *Siphonaria* sp. *Marine Biology* **70**, 157-164.

Moberly RM, Chaimberlin T (1964) *Hawaiian Beach Systems*. University of Hawai'i Press, Honolulu.

Palumbi SR (1996) What can molecular genetics contribute to marine biogeography? An urchin's tale. *Journal of Experimental Marine Biology and Ecology* **203**, 75-92.

Sotka EE, Wares JP, Barth JA, Grosberg RK, Palumbi SR (2004) Strong genetic clines and geographical variation in gene flow in the rocky intertidal barnacle *Balanus glandula*. *Molecular Ecology* **13**, 2143-2156.

Wright S (1965) The interpretation of population structure by *F*-statistics with special regards to systems of mating. Evolution **19**, 395-420.

BUDGET AND BUDJECT JUSTIFICATION

Funds from this grant will be used to travel to two of the 'high' Hawaiian Islands; most likely these will be the Big Island (Hawai'i) and Maui. To keep expenses low, I will be camping when visiting these islands. The low-lying islands will be visited during research cruises. Airfare and car rental costs were determined from visits to airline (Hawaiian Air, Aloha Air) and car rental (travelocity.com) websites during the week of January 9, 2006.

Item	Description	Cost
Airfare	$156 round-trip @ 2 trips	$312
Car Rental	$25/day @ 4 days	$100
Total Funds Requested		**$412**

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EDUCATION

Master of Arts, Geography, University of Hawaii, Manoa. Degree expected Spring 2007
Thesis: Genetic Structure in the Hawaiian Intertidal Zone: Space, Scale and Disturbance
Advisor: Dr. Stacy Jorgensen

Bachelor of Science, Marine Biology and Zoology, Humboldt State University, Spring 2003

CERTIFICATIONS/LICENSURE

U.S. Coast Guard 25-ton Captain's License, March 1998
PADI Scuba Instructor, December 1996

PROFESSIONAL AND RESEARCH EXPERIENCE

Bernice Pauahi Bishop Museum, Honolulu, HI — 11/2003 – present
Taxonomic identification of marine invertebrates for museum collection, perform duties of underwater surveyor during research cruises of Northwestern and Main Hawaiian Islands.

U.S. Fish and Wildlife Service, Arcata Office, Arcata, CA — 5/2003 – 8/2003
Conducted surveys of Marbled Murrelets and other seabirds on the ocean.

Humboldt State University, Biological Sciences Dept., Arcata, CA — 5/2002 – 5/2003
Assisted with graduate and undergraduate student research.
Conducted surveys of intertidal algal and invertebrate species.

Redwood Sciences Lab, U.S. Forest Service, Arcata, CA — 5/2001 – 4/2002
Conducted surveys of Marbled Murrelets and other seabirds on the ocean.

University of Hawaii, Honolulu, HI — 10/2000 – 11/2000
Responsible for divers compliance with safety rules and regulations during cruise of the Northwestern Hawaiian Islands.

U.S. Fish and Wildlife Service, Midway Atoll — 5/2000 – 9/2000
Designed and conducted a reef survey using random sampling sectors based on substrate habitat.