Application of Elemental Fingerprinting to Evaluate the Dynamics of Larval Exchange

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Grant Number: N00014-00-1-0174
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LONG-TERM GOALS

A major goal of this research is to develop a complete methodology for estimating bay-ocean, bay-bay, and within-bay larval exchange rates that can be applied to several invertebrate taxa and to a range of bays and estuaries within the United States (or elsewhere). This methodology will employ larval and recruit origin determinations using elemental 'fingerprints'. An ultimate goal is to incorporate dispersal information into population dynamic models to examine the consequences of different dispersal patterns and population connectivity.

OBJECTIVES

Objectives of this research are to: (1) extend the elemental fingerprinting approach developed for crab zoea to mussels in southern California, (2) evaluate physical connectivity of bay and ocean habitats (and thus potential for dispersal) using thermistor, elemental , drifter and current meter data, (3) apply elemental fingerprinting to the detection of bay-ocean larval exchange and inter-bay larval exchange , and (4) model consequences of bay-ocean exchange for population dynamics using *P. crassipes* as a test organism. For southern California mussel populations we hope to determine whether bay-released larvae develop inside or outside a specific bay, whether populations are self seeding, and whether there is larval exchange with other bays or coastal populations.

APPROACH

Investigators Lisa Levin and Claudio DiBacco will characterize the elemental composition of several species of mussel larvae and newly settled recruits collected from different regions of San Diego Bay, the open coast and neighboring embayments using an ICP OES and ICP-MS. Discriminant function analyses will be used to determine canonical variables (linear combinations of sampled trace elements) that serve as 'fingerprints' to identify larval origin. Larvae and newly settled post-larval recruits will be collected inside and outside southern California bays to examine exchange potential within bays,

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
SEP 2000		**00-00-2000 to 00-00-2000**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Application of Elemental Fingerprinting to Evaluate the Dynamics of Larval Exchange	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Marine Life Research Group,Scripps Institution of Oceanography,,La Jolla,CA,92093**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**5**	

between different embayments, and with the open coast. Dispersal potential estimates for larvae originating from southern California bays will be established by John Largier through a physical connectivity analysis of within-bay longitudinal dispersion, bay-ocean exchange and along- shore coastal dispersion. Larval and recruit sampling will be conducted in conjunction with long-term temperature measurements and real-time trace elemental analyses of seawater (in collaboration with J. Gieskes [SIO] and B. Chadwick [SPAWAR]). DiBacco and Levin intend to assess the population-level consequences of observed larval dynamics and developmental influences of bay vs. coastal water through whole-life cycle and metapopopulation modeling approaches. Matrix methods will be applied to modeling of decapod life histories, with the intent of developing a protocol for application to other species. Information about growth, and survival as a function of water type (bay vs coastal) will be integrated with element-based quantification of larval origins and flux rates to evaluate the consequences of different larval vertical migration strategies, release sites, residence times and population connectedness.

WORK COMPLETED

Tasks completed include (1) Development of methods for collection and handling of day-old recruits of *Mytilus galloprovincialis* and *Musculista senhousia*. (2) determination of trace element concentrations in new recruit shells using ICP-OES, (3) deployment of a thermistor array in southern California bays and coastal waters to study water exchange (4) collation of life-history data and egg counts for *Pachygrapsus crassipes* to obtain vital rate estimates for population matrix modeling, (5) equipment proposal preparation including (a) successful co-authoring of an NSF proposal to obtain funds for a magnetic sector ICP-MS and (b) preparation of a DURIP proposal for a laser-ablation unit for the ICP-MS.

RESULTS

We have begun to extend the tagging approach developed for crab larvae (DiBacco and Levin 2000) to mussels, by developing baseline information about elemental concentrations in new recruits collected from San Diego Bay, neighboring embayments and nearshore coastal habitats. Effort to date has focused on establishing the effectiveness of ICP-OES for evaluating trace element concentrations in the calcium carbonate matrix (shell) of newly settled mussels. Day-old *Mytilus galloprovincialis* recruits, collected from Harbor Island in San Diego Bay exhibit enhanced concentrations of Al, Cu, Fe, Mg, Mn and Zn relative to recruits from Mission Bay and open-coast populations (Fig.1). Cd, Ag and Pb are similar in open coast and bay recruits (Fig.1). Sr/Ca ratios are much lower in *M. galloprovincialis* than in *Musculista senhousia*. Preliminary results indicate that elemental fingerprinting could be an effective technique to distinguish among mussels originating from Bay and coastal habitats. Comparisons of instrument sensitivity are being made with a sector field ICP-MS, as an instrument switch is anticipated in 2001.

IMPACT/APPLICATIONS

This research will advance understanding of marine invertebrate dynamics by (a) further development of techniques to evaluate larval origins and exchange, (b) relating physical exchange probabilities to actual estimates of bay-ocean and bay-bay larval exchange and (c) linking elements of larval behavior and transport to larval success and population dynamics. Expansion of element-based tagging approaches to identification of invertebrate recruit origins, and to questions of bay-bay exchange,

should open up a wide range of applications including assessment of the interdependence of different habitats, evaluation of controls on population dynamics, and assessment of pollution consequences.

TRANSITIONS

Knowledge derived from a review of historical data on transport is also being used in developing water quality studies of San Diego Bay. Inquiries were made by Tom Shirley (Alaska Park Service) regarding use of trace elemental fingerprinting to study larval exchange in Dungeness crab populations.

RELATED PROJECTS

We are working closely with J Gieskes (Scripps), C. Mahn (Scripps) and B. Chadwaick (SPAWAR) who are examining trace metal concentrations in waters and sediments of San Diego Bay. We are also collaborating with Scripps graduate student Bonnie Becker, who is studying the influence of the Point Loma kelp forest on scales of dispersal and recruitment in mussels at the Cabrillo National Monument, San Diego. Our thermistor data and transport patterns described along the open coast will compliment similar efforts associated with a Pt Loma kelp forest study (M. Tegner and P. Dayton, Scripps) and with a project characterizing dispersion of land runoff.

REFERENCES

DiBacco, C. and L.A. Levin. Development and application of elemental fingerprinting to track the dispersal of marine invertebrate larvae. *Limnol. And Oceanography 45:* 871-880 (2000)

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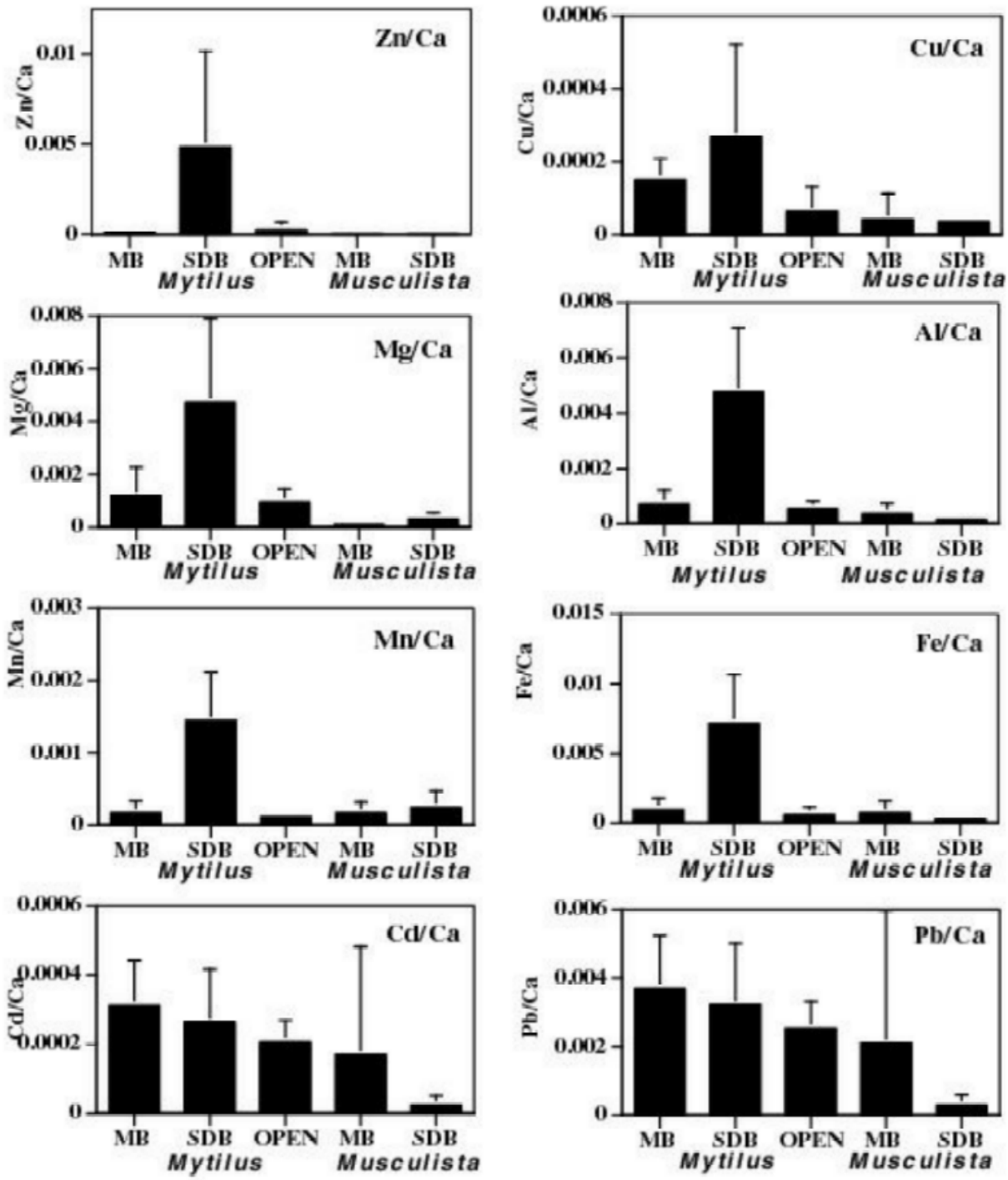

Figure 1. Trace element-calcium ratios (mean + 1 S.D.) in shells of day-old reccruits of Mytilus galloprovincialis and Musculista senhousia. For Mytilus, MB = Dana Landing, Mission Bay, CA; SDB = Harbor Island, San Diego Bay, CA; OPEN = Open Coast, Pacific Beach, CA. For Musculista, MB = Northern Wildlife Preserve, Mission Bay, CA; SDB = Chula Vista, San Diego Bay, CA.