Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 1997		**00-00-1997 to 00-00-1997**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Determining Trace Element Concentrations in Marine Larvae Using Electrothermal Vaporization and Laser Ablation Technology	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) **University of California, San Diego,Scripps Institution of Oceanography,Marine Life Research Group,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)**	**2**	

Determining Trace Element Concentrations in Marine Larvae Using Electrothermal Vaporization and Laser Ablation Technology

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N00014-97-1-0344

LONG TERM GOALS

The overall objective of this DURIP award was the acquisition of two analytical instruments to enhance analytical capabilities in support of grant no. N00014-96-1-0025. This research is concerned with determining the uptake and retention of toxicants by invertebrate larvae as well as the effect of contaminants on larval survival, rates of development, dispersal and recruitment.

OBJECTIVES

This DURIP provided funds to improve analytical capabilities of an existing Inductively Coupled Plasma-Mass Spectrometer (ICP-MS) owned and operated by the Scripps Institution of Oceanography's (SIO) Analytical Facilities. ICP-MS is an extremely sensitive analytical tool used to simultaneously characterize and quantify elemental composition, including rare earth elements, transition and heavy metals. The previous facility could not handle small sample sizes, such as microscopic larvae (dry weight ≈ 0.01 mg), or solid samples. The objective was to acquire equipment which would permit analyses of individual larval crabs while maintaining the accuracy, speed and ease of multiple elemental analysis associated with ICP-MS.

APPROACH

Prior to purchasing any instrumentation, a considerable amount of time and effort was invested to study analytical options which would meet the small sample size criteria described above. Several manufacturers of analytical instrumentation were consulted, including Perkin Elmer and Mikron Instruments, who ultimately provided equipment for solution and solid based analyses, respectively. Consultations with Perkin Elmer included a visit to their Research and Development Laboratory in San Jose, CA to view and run low-volume test samples on an Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-AES, model Optima 3000DV) outfitted with a micro-concentric nebulizer. The same instrument is also being outfitted with a laser ablation system for the analysis of solid samples.

WORK COMPLETED

An ICP-AES was purchased and delivered to Scripps Institution of Oceanography in mid-July 1997. Perkin Elmer's specification for the room housing this instrument were met and subsequently the instrument was set up in SIO's Analytical Facilities by the end of August 1997. The micro-concentric nebulizer has since been installed and tested successfully in analyzing small sample volumes. The laser ablation system is presently being assembled with initial tests to be conducted by December.

RESULTS

The ICP-AES outfitted with the micro-concentric nebulizer to handle low sample volumes performed comparable to or better than other instruments used to date. It performed particularly well at low concentrations (e.g., <10ppb copper, magnesium, strontium) and distinguished differences in larvae sampled from San Diego Bay and open coastal sites.

IMPACT

Our original approach was to pool crab larvae for analysis of origins and dispersal. However, preliminary results have shown that certain elements (e.g., copper, zinc) can be quantified for individual larvae. The requested equipment will provide an ability to analyze individual larvae while maintaining the accuracy, speed and ease of multiple elemental analyses associated with ICP-AES. This will allow us to refine our scientific questions to address the fate of individual larvae as opposed to drawing more general conclusions from pooled samples.

TRANSITIONS

The instrumentation described has been made available to all users of the Analytical Facilities at Scripps Institution of Oceanography. Both faculty members and students have expressed interest in employing this instrumentation in their own research, including studies of (1) natural rock glasses and mineral grains (e.g., pyroxene) separated from rocks, (2) the zonation in veins and concretions in diagenetic or hydrothermal systems, (3) the cements of sediment (with laser ablation) which otherwise are next to impossible to separate from impurities, and (4) microscopic inclusions of carbonaceous matter representing the oldest known traces of organic life on Earth.

RELATED PROJECTS

This award is linked directly to the Harbor Processes project, N00014-96-1-0025, Bay Ocean Exchange Processes: Development and Application of a Meroplankton Tracer Technique.