1984-85 TRAINEE REPORT

USC SEA GRANT

UNIVERSITY OF SOUTHERN CALIFORNIA
Institute for Marine and Coastal Studies
University Park, Los Angeles, CA 90089

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Contents

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8/85

USC Sea Grant Graduate Student Trainee Program (E/M-1)

James A. Fawcett, Ph.D., Trainee Coordinator,
Sea Grant Program, University of Southern California

For the past 10 years, the USC Sea Grant Graduate Student Trainee Program has offered students the opportunity to apply classroom knowledge to actual research projects. Students work under the direction of faculty members on Sea Grant-funded research projects and further develop research skills learned in the classroom while working along side principal investigators.

The program accomplishes several objectives:

1. It provides qualified students with the opportunity to work under the direction of experienced faculty members.

2. It provides students with the opportunity to do marine research that may contribute to a master's thesis or doctoral dissertation.

3. It provides Sea Grant principal investigators with qualified students who will substantially contribute to the success of projects.

4. It provides students with experience in their chosen fields to help prepare them for leadership roles in marine research.

The seven Sea Grant Trainees chosen for 1984-85 represented a rather wide spectrum of academic disciplines, all with interests in the marine environment. Three trainees — Alexander Andrasi, William Jaeckle and Mohammed Yazdandoust — are doctoral students n biology. Their research encompassed questions such as the effects of dissolved organic material on the nutrition of nonfeeding invertebrate larvae, and the influence of the dinoflagellate toxicity on paralytic shellfish poisoning in California.

In the Department of Materials Science, Dr. Vedantham Raman, a post-doctoral investigator, worked on a project that investigated the micro-structural, mechanical and environmental factors controlling the rate of fatigue in steel exposed to marine atmospheres.

In another project from the natural sciences, Suzanne Reynolds, a doctoral student in geology, has explored the genesis of enigmatic submarine depressions off the coast of Southern California, making an assessment of the geologic stability of these areas for bottom-resting structures.

In the social sciences, Kathleen West, a doctoral candidate in the School of Urban and Regional Planning, has been looking at the viability of smaller seaports given the rapid changes in maritime shipping technology that have drastically affected the competitive position of smaller ports during the past 20 years. Jael Mongeau, a doctoral student in sociology, examined policy alternatives influencing population change and distribution in the coastal areas of California.

Following a longstanding policy of the USC Sea Grant Program, monthly research seminar luncheons were held to allow the trainees to present their research progress to their trainee colleagues and other Sea Grant principal investigators, as well as interested faculty and students. The opportunity provided by these luncheons to share methodology and substance of the research has been of great value to the trainees in refining their research processes and has been useful to the other participants in appreciating the diversity of issues subsumed under the rubric "marine."

At the conclusion of the academic year, all seven of the trainees remain on campus and will continue at USC during the coming year. Dr. Raman is continuing his post-doctoral research in the Department of Materials Science. Of the remaining six trainees, each is continuing his or her research toward the dissertation. We expect that two of them will complete their studies during the 1985-86 academic year.

1984-85 USC SEA GRANT GRADUATE STUDENT TRAINEES

Alexander Andrasi, Biological Sciences,
Doctoral Candidate.
"Problems of Paralytic Shellfish Poisoning,"
(R/EQ-31).
Principal Investigators: B. Abbott, M. Ross,
A. Siger.

William Jaeckle, Biological Sciences,
Doctoral Candidate.
"Nutritional Implications of Dissolved Organic Material in Seawater for Culturing Oysters (Crassostrea gigas),"
(R/RD-27).
Principal Investigator: D. Manahan.

Jael Mongeau, Sociology,
Doctoral Candidate.
"Population Policies in California's Coastal Zone,"
(R/CM-29).
Principal Investigator: M. Van Arsdol.

Vedantham Raman, Materials Science
Post-Doctoral Scholar.
"Corrosion Fatigue of Weldments in Offshore Structures," (R/CE-8).
Principal Investigator: J. Todd

Suzanne Reynolds, Geology,
Doctoral Candidate.
"Origin and Distribution of Enigmatic Upper Slope Depressions on the Arguello Slope, California,"
(R/RD-26).
Principal Investigators: D. Gorsline, R. Douglas.

Kathleen A. West, Urban and Regional Planning,
Doctoral Candidate.
"Small Seaports: An Examination of Selected Attributes and Analysis of Trends," (R/CM-30).
Principal Investigator: W. Price

Mohammed H. Yazdandoust, Biological Sciences,
Doctoral Candidate.
"Problems of Paralytic Shellfish Poisoning,"
(R/EQ-31).
Principal Investigators: B. Abbott, M. Ross,
A. Siger.

Problems of Paralytic Shellfish Poisoning (R/EQ-31)

Alexander Andrasi, Department of Biological Sciences,
Doctoral Candidate, University of Southern California

INTRODUCTION

Paralytic shellfish poisoning (PSP) is a serious and sometimes fatal disease which occurs after the ingestion of marine bivalve molluscs that have fed on toxin-producing dinoflagellates of the genera Gonyaulax and Protogonyaulax. The toxins are accumulated to deadly concentrations in the shellfish meat, and are retained for varying periods of time. Monitoring programs, using the standard mouse bioassay, are conducted to measure toxin levels in shellfish, and quarantines are established as necessary to minimize illness and death in humans.

This project is designed to expand our understanding of the dynamics of toxin accumulation in shellfish, and to improve the monitoring programs through the development of a new assay for the toxins. Our fly bioassay is a sensitive, reliable and inexpensive method to measure very small quantities of dinoflagellate toxins. As an adjunct to or replacement for the standard mouse assay, it may eventually improve shellfish monitoring programs by lowering detection thresholds, allowing on-site testing at the collection area and reducing monitoring costs. This would result in enhanced safety for the shellfish consumer and would also protect the fishing industry, which, due to consumer apprehension about seafood, invariably suffers drastic losses following PSP outbreaks.

GOALS AND OBJECTIVES

The overall goal of the project is to develop the fly bioassay, to demonstrate its advantages, and to describe a standard protocol.

The trainee's objectives for this third year of the project:

1. To conduct additional feeding experiments with Mytilus edulis (bay mussels).

2. To further investigate the direct uptake of dissolved dinoflagellate toxins by M. edulis.

3. To use M. edulis as a bioaccumulator of very low levels of dissolved dinoflagellate toxins in seawater, which, in conjunction with the fly bioassay, will allow the detection and measurement of previously undetectable quantities of dissolved toxin.

RESULTS

During the third funding year of this project, additional experiments were conducted to evaluate the fly bioassay for dinoflagellate toxins. A series of new experiments were conducted to measure: 1) the release of toxins by dinoflagellates into the surrounding seawater (in absolute terms and as a function of total production in the cultures); 2) the ability of M. edulis to take up these toxins from particle-free culture filtrates; 3) the amount of toxin taken up by M. edulis from resuspended cells of the same cultures; and 4) the relative contribution of these two components of toxin acquisition during the course of toxification in M. edulis.

Cell counts and toxin content values for the G. catenella cultures in two of these experiments are summarized in Table 1. Each cell count value is the mean of three direct counts rounded to two significant digits. Toxin content was determined as:

$$\text{Toxin content (pg/cell)} = \frac{\text{Extract toxicity (ng/mL)} \times \text{Vol. of extrct (mL)}}{\text{Cell count} \times \text{Vol. of cuture extracted}} \times 1000$$

where extract toxicity is the mean of two 40-fly assays. Agreement between assays was typically within ±7%.

The toxicities of the cell-fed, filtrate-fed and control mussels are reported in Table II, and are shown both in ng/mL, as used in this procedure, and also as ug/100g shellfish tissue, which is readily recognized as the standard reporting unit of the mouse bioassay (1 ng/mL = 0.20 ug/100g shellfish tissue).

In both of these trials, the cell-fed animals became approximately five times more toxic than the animals exposed to the particle-free culture medium; the controls contained no detectable levels of toxin. The toxicity of the filtrate-fed mussels approached the threshold of detection of the mouse bioassay procedure, although there has been evidence to suggest that the mouse assay underestimates low levels of toxin due to a protective effect on the mouse of the salts in the shellfish extract, which are not present in the dilute HCl/NaCl diluent in which the standard STX is administered for calibration of the bioassay. The fly bioassay procedure used here avoids possible errors of this type by administration of standard STX in non-toxic shellfish extract of the same species as the animals under study. Although the use of standards diluted in shellfish extract may be too cumbersome for routine use in shellfish monitoring, it may be the only way to gauge the possible antagonism of synergism to the action of the dinoflagellate toxins that may result from their interaction with substances derived from the shellfish.

In these experiments, G. catenella toxins serve as a tracer for uptake of dissolved organic matter (DOM), and their presence is easily detected in the tissues by virtue of their toxicity. Unlike radionuclide uptake experiments, there is no ambiguity as to the direction of overall flux; initial toxin levels in the tissues are below the detection threshold, so there is a clear net inward flux, and any efflux is very small by comparison. The demonstration of dissolved toxin uptake from seawater by M. edulis suggests new avenues of research into the role of DOM as a nutritional resource in marine bivalves; the structural relationshiop between the purine nucleotides and the saxitoxin class of dinoflagellate toxins indicate the possible existence of nucleotide transferases on the epithelial membranes of these animals.

The finding that G. catenella releases toxins into the surrounding medium during early growth is of particular interest. Earlier studies indicate that toxin was not detectable in the medium until the stationary phase, and the levels continued to increase over time as the culture deteriorated; it was concluded that loss of toxin from the cells was the result of deterioration of the cell membrane and cell lysis. It was recognized, however, that leakage of toxin from healthy cells could occur during earlier stages in the growth cycle without raising the toxin concentration in the surrounding medium enough to be detected by the mouse bioassay. In these experiments, the mussels act as monitoring devices which concentrate the low-level dissolved toxin and allow its detection, analogous to the widespread use of marine and freshwater bivalves as bio-accumulators of organic and heavy metal residues for pollution monitoring programs.

PERSONAL GAINS

This project has allowed me to advance my doctoral research, and has given me valuable experience in the art of presenting data and findings to colleagues. I wish to thank the Sea Grant program for the opportunities that this traineeship has provided me.

PROJECT COMMUNICATIONS

Data was presented and the fly bioassay was demonstrated at the Conference on Paralytic Shellfish Poisoning, California Department of Health Services, Berkley, CA, September 1981.

An abstract of my thesis work was published by the Sea Grant Association in the Sea Grant Week program, July 1983.

The work was presented at the Third International Conference on Toxic Dinoflagellates, St. Andrews, New Brunswick, Canada June 8-12, 1985, and will appear as "Uptake of dissolved Gonyaulaz catenella toxins from seawater Mytilus edulis Linne," in the conference proceedings (in press).

Table I. Toxicity of *G. catenella* cultures

Trial	Cells/mL	Toxin/cell (pg Stx Equiv.)
1	2600	10
2	3100	12

Table II. Toxicity of *M. edulis* extracts

Trial	Cell Fed		Filtrate Fed		Control	
	ng/mL	(ug/100g)	ng/mL	(ug/100g)	ng/mL	(ug/100g)
1	950	(190)	180	(36)	< 30	(< 6)
2	1200	(240)	220	(44)	< 30	(< 6)

Nutritional Implications of Dissolved Organic Material in Seawater for Culturing Oysters (Crassostrea gigas) (R/RD-27

William B. Jaeckle, Department of Biological Sciences,
Doctoral Candidate, University of Southern California

INTRODUCTION

Approximately 70% of benthic marine invertebrates release gametes, embryos and postembryonic larvae into seawater (Thorson, 1946). Based on their mode of nutrient acquisition, planktonic larval stages are separated into two broad categories: those that possess a functional digestive system — "feeding" larvae — and those larval forms that lack a complete gut — "nonfeeding" larvae. By definition, feeding larvae must obtain particulate forms of food, while nonfeeding larvae are considered to be nutritionally independent of the environment, the necessary food stores for further development being provided maternally in the eggs.

However, it has been shown that adult representatives of most marine soft-bodied phyla have the ability to take up dissolved organic material (DOM) directly from seawater across their body walls and these transported compounds are biochemically utilized (e.g., protein synthesis, oxidative metabolism) (Ferguson, 1982) and this process is completely independent of a functional digestive system. These animals are feeding, but they are using a different nutrient source, dissolved organic material. The concentrations of DOM in seawater represent nearly 10 times the amount of particulate forms of food (e.g., phytoplankton).

Recently it has been shown that invertebrate embryos and feeding larvae can take up DOM from seawater, in the form of dissolved amino acids, at substrate concentrations comparable to those existing in the marine environment (Manahan, 1983a, 1983b; Manahan et al., 1983). The body walls of those invertebrate larvae that have been examined possess a ciliated microvillar outer epithelium; these structures are characteristic of absorbing epithelia.

Given that adults, embryos and feeding larvae of soft-bodied marine invertebrates have the ability to remove DOM from seawater, is it reasonable to assume the "nonfeeding" invertebrate larvae are nutritionally independent of their environment? The focus of this project is that nonfeeding invertebrate larvae also will have the ability to transport dissolved nutrients across their body walls and use the transported compounds to augment pre-existing energy stores.

The larvae of the green abalone (Haliotis fulgens) and the red abalone (Haliotis rufescens) were used to test this hypothesis. Both species produce larvae that are planktonic for a short time period (12-15 days) and the larvae lack a digestive system.

In the Southern California area, there is increasing interest in the mariculture of abalones. Many commercial growers have requested that research be conducted on nutritional factors affecting growth of the early stages of these species (personal communications: John McMullen, owner, AbLab, Port Hueneme, CA; Tom McCormick, owner, McCormick & Associates Aquaculture Specialists, Oxnard, CA).

GOALS AND OBJECTIVES

1. To determine the ability of abalone larvae to take up dissolved organic materials from seawater in the form of dissolved amino acids.

2. To determine the rates of amino acid uptake (per larvae).

3. To determine the contribution of absorbed dissolved amino acids to the growth and development of abalone larvae.

RESULTS

Veliger larvae of both H. fulgens and H. rufescens take up dissolved amino acids from seawater. Figure 1 shows the incorporation of a single radiolabelled amino acid (leucine) by H. rufescens veliger larvae (5 days old). To simultaneously measure the uptake of multiple amino acids, High-Pressure Liquid Chromatography (HPLC) was used.

Figure 2 shows chromatograms (representing initial and final substrate concentrations) from experiments with H. fulgens veliger larvae (3 days old), demonstrating the simultaneous removal of 15 dissolved amino acids from seawater. During this three hour experiment, these larvae were able to remove from 7%-67% of the amino acids (100nM each) initially present in the medium; no decreases in amino acid concentration were detected in experimental controls containing no larvae.

Figure 3 shows the close correspondence between two independent methods of measuring larval amino acid uptake, (HPLC and isotope techniques) in demonstrating alanine uptake, by H. fulgens larvae (3 days old). Figures 4 and 5 demonstrate the veliger larvae (5 days old).

During uptake experiments using H. fulgens larvae, a single amino acid, taurine, increased in concentration during the experimental time course (Figure 2). Taurine is a non-nutritive amino acid that functions as an osmolyte. Subsequent experiments with H. rufescens larvae also showed the same increase (Figure 6). During every experiment, the amount of taurine in the medium increased for the first 90 minutes, decreased and finally reached equilibrium.

For the first time it has been demonstrated that abalone veliger larvae, previously considered to be nonfeeding larval forms, can feed by taking up dissolved amino acids from seawater. The presented data represent the only evidence that nonfeeding larvae are not nutritionally independent of the surroundings. The ability to gain nutritional benefit from DOM may act a "nutrient buffer" by augmenting initial endogenous stores.

The nutritional contribution of dissolved amino acids to developing abalone larvae is being further addressed by determining the rates at which the absorbed amino acids are biochemically processed into protein and lipid for growth. In addition, experiments are being conducted to determine the physiological significance of taurine release in abalone larvae.

PERSONAL BENEFITS

As a Sea Grant trainee, I have had the opportunity to work on a project that will be included in my Ph.D. dissertation. More importantly, the traineeship allowed me the opportunity to use and become familiar with the analytical and biochemical equipment and techniques that I need to conduct my dissertation research.

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Thorson, G. 1946. Reproduction and larval development of Danish marine bottom invertebbrates, with special reference to the plaktonic larvae in the Sound (Oresund). Meddr. Komm. Havunders., Ser. Plankt. 4(1): 1-523.

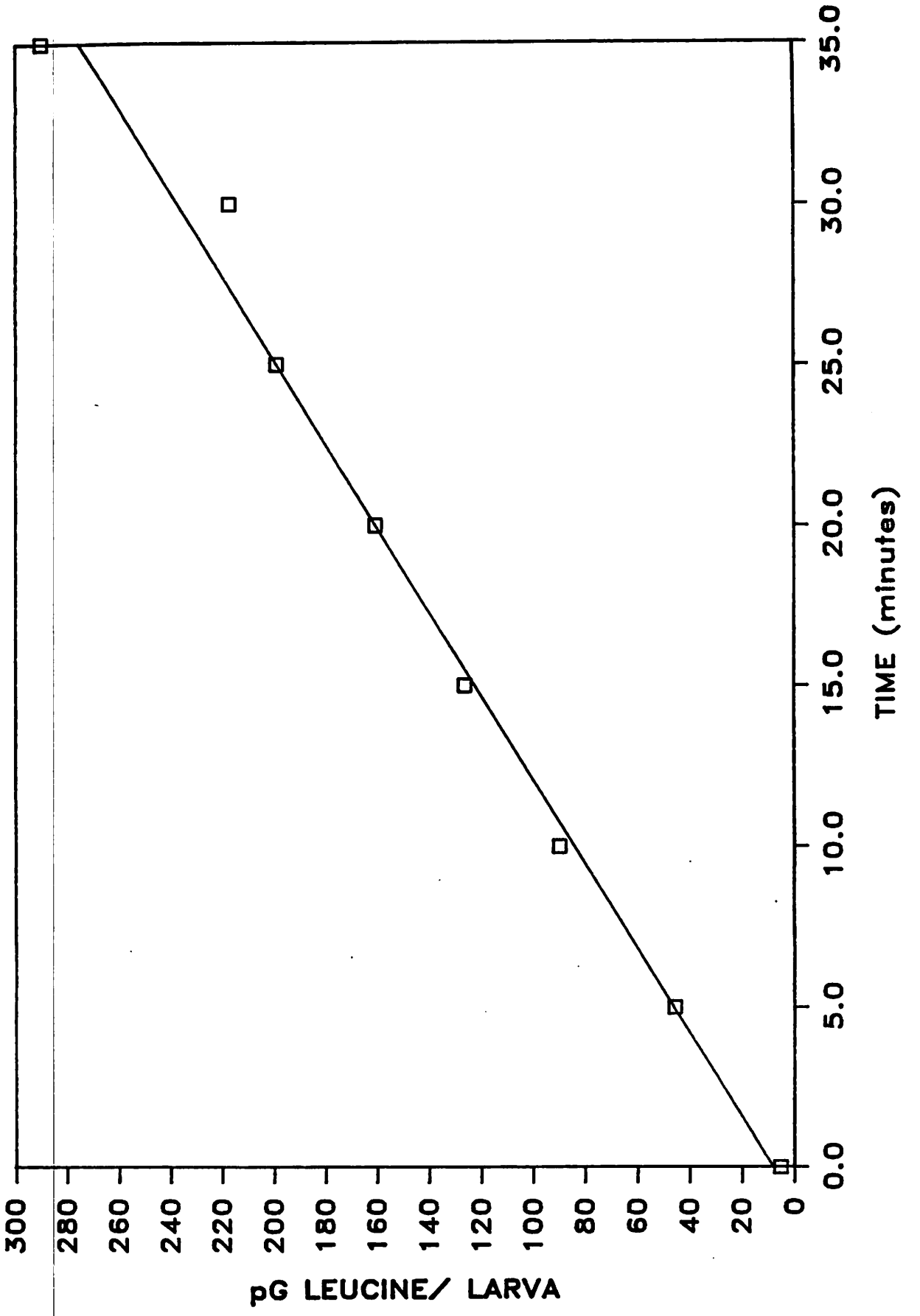

FIGURE 1

Rate of incorporation of 14-C leucine (pG leucine/larva) by Haliotis rufescens veliger larvae (5 day old). Initial substrate concentration = 1 uM. [] = individual data points with regression line (R-square = 0.99)

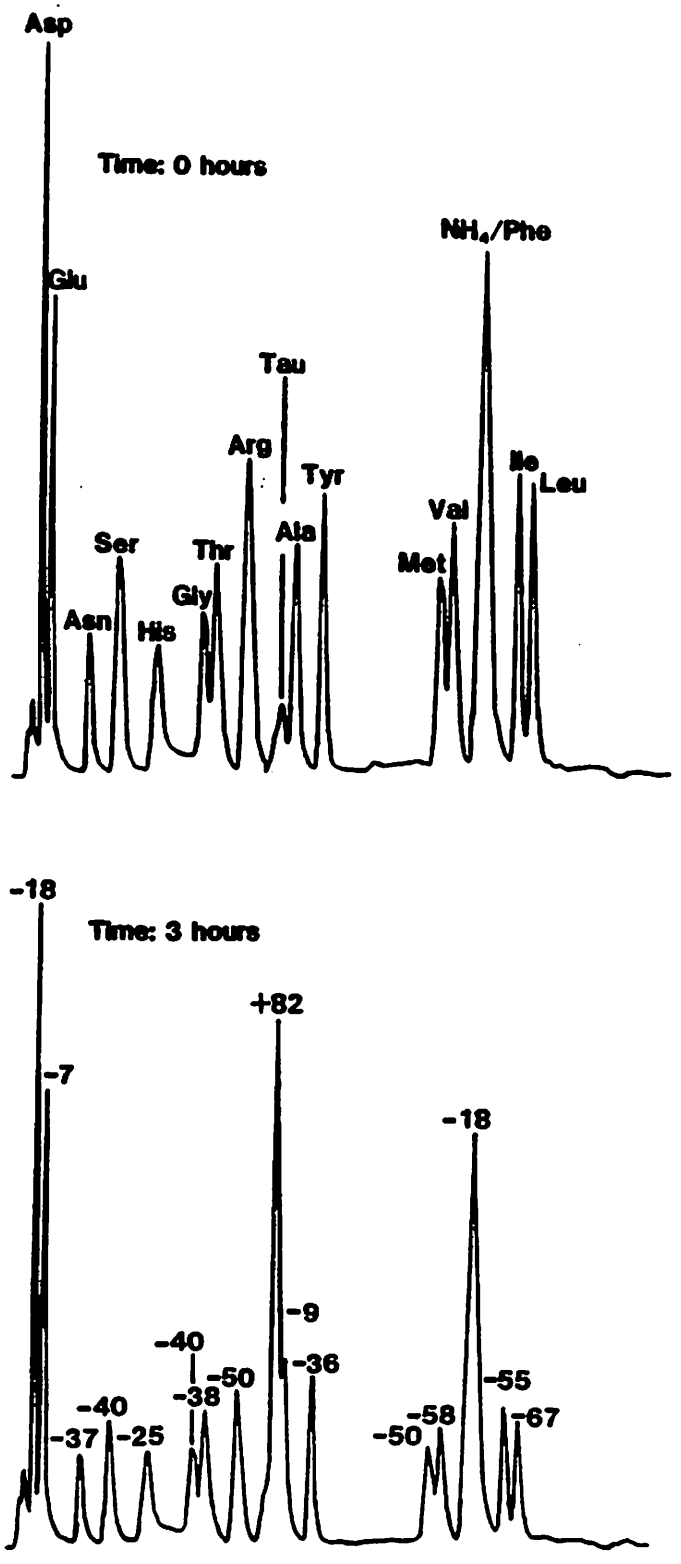

FIGURE 2

Percent removal of dissolved amino acids in seawater by Haliotis fulgens veliger larvae (3 day old) during a 3 hour experiment. Larval density = 50/ml; total volume = 100 ml; total number of larvae = 5000.

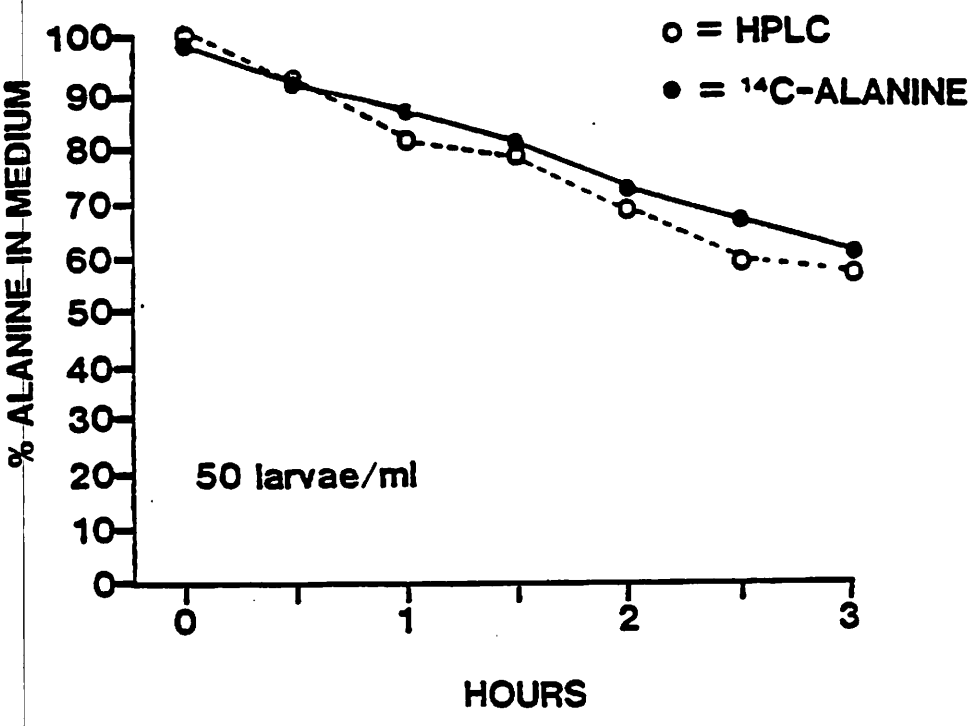

FIGURE 3

Comparison of percent depletion of alanine from the medium by Haliotis fulgens veliger larvae (3 day old) as measured by HPLC and liquid scintillation. Larval density = 50/ml; total volume = 100 ml; total number of larvae = 5000.

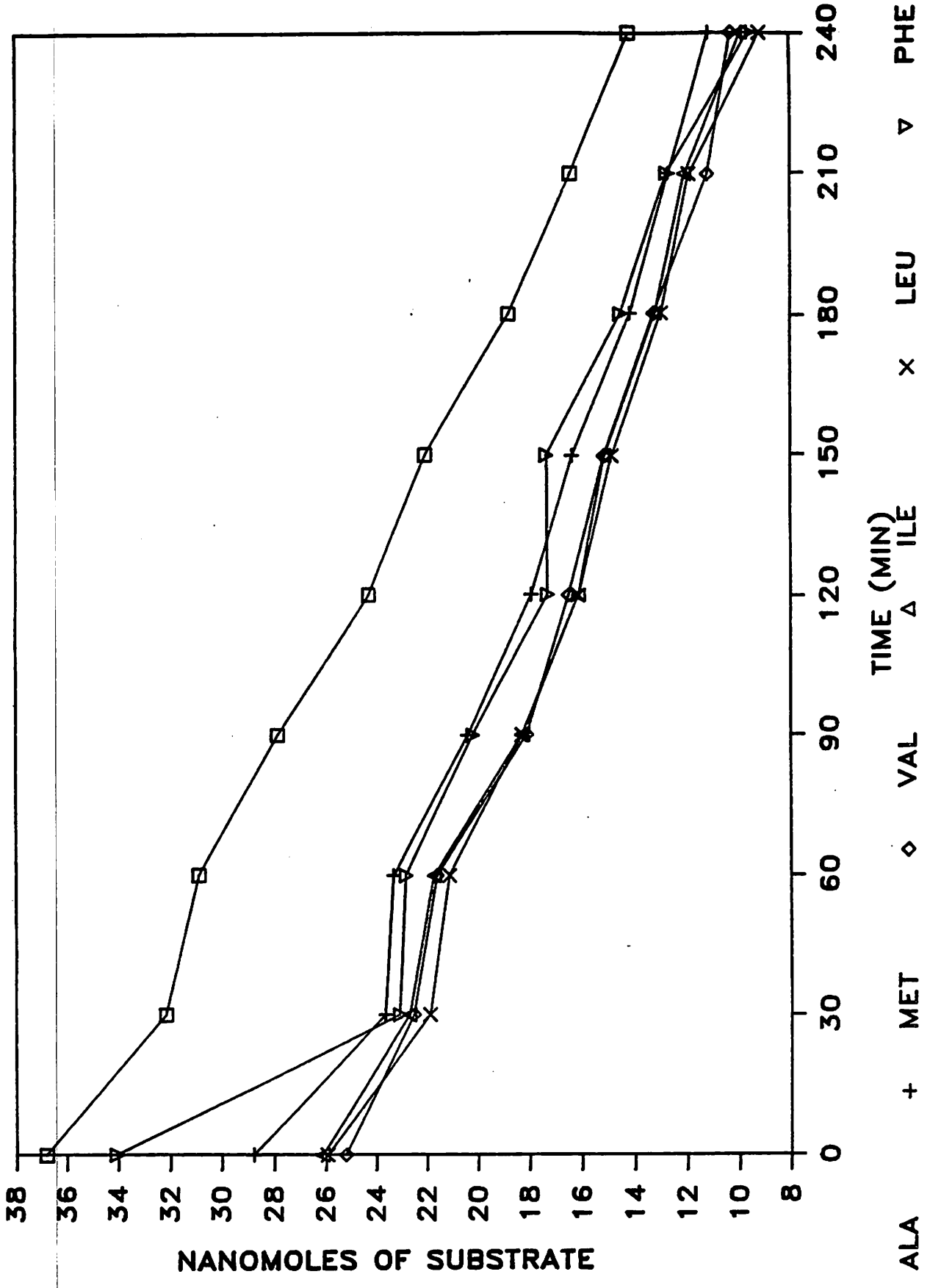

FIGURE 4

Removal of dissolved neutral amino acids from seawater by Haliotis rufescens veliger larvae (5 day old). Larval density = 40/ml; total volume = 100 ml; total number of larvae = 4000

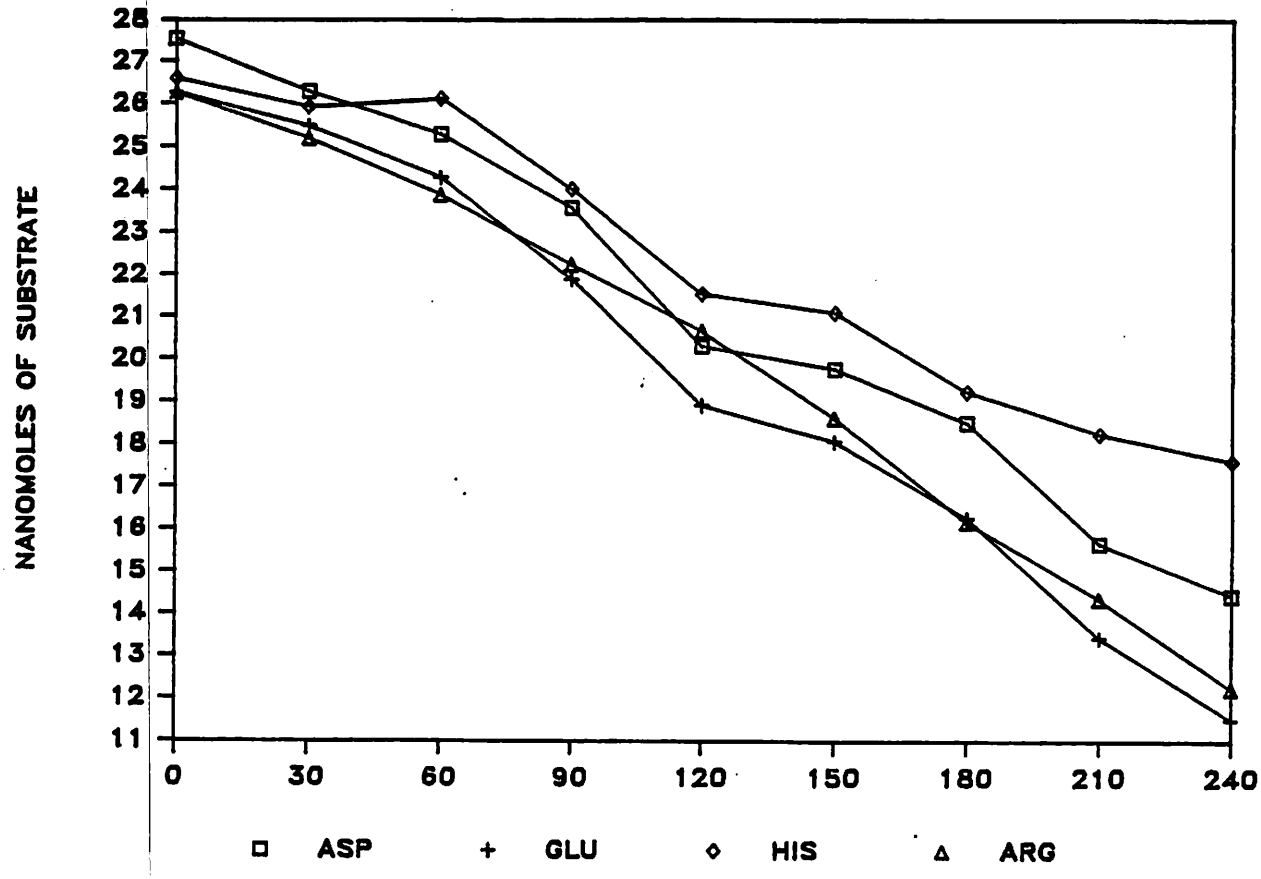

FIGURE 5

Removal of dissolved acidic and basic amino acids from seawater by Haliotis rufescens veliger larvae (5 day old). Larval density = 40/ml; total volume = 100 ml; total number of larvae = 4000.

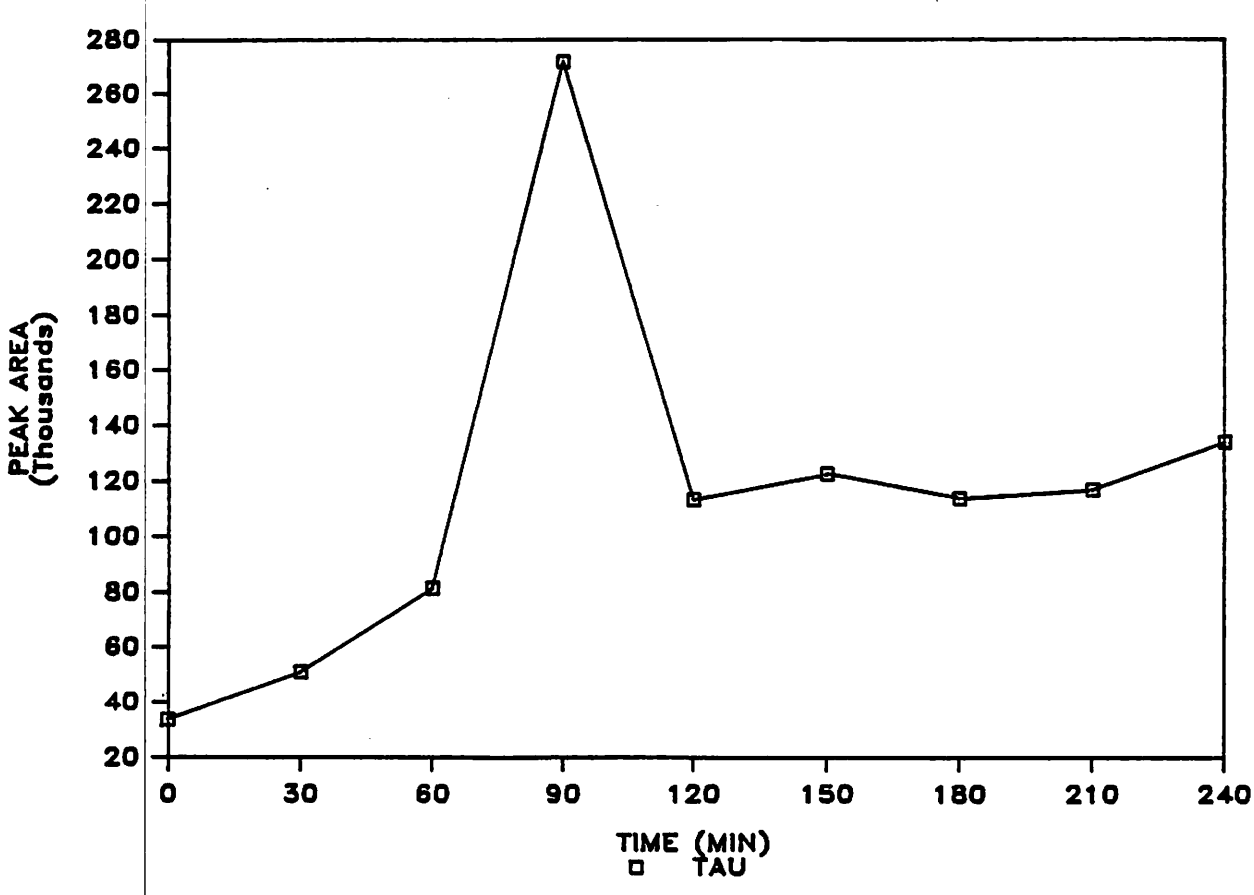

FIGURE 6

Changes in the amount of taurine during a 4 hour experiment with Haliotis rufescens veliger larvae (5 day old). Taurine amount is expressed in the total peak area from HPLC chromatogram.

Population Policies in California's Coastal Zone (R/CM-29)

Jael Mongeau, Department of Sociology,
Doctoral Candidate, University of Southern California

INTRODUCTION

More than three-quarters of California's population lives in the coastal counties, with California's coastal population having increased by 15% from 1970 to 1980. Such an increase in an already heavily populated territory has a great impact on coastal environments. There are ways of controlling population growth, but policies that affect population now come from several sources and are lacking coordination. Effects of policies on population growth may be debated before adoption, but are rarely studied after the policy is implemented.

There is a need for the systematic study of the impact of different policies on population growth in California's coastal areas. The results will help to provide decision-makers with information on what policies work best to achieve various goals.

GOALS AND OBJECTIVES

The overall goal is to assemble, in a form usable by policy makers, information regarding the policy alternatives for influencing population change and distribution in California's coastal areas.

The objectives are as follows:

1. Summarize the findings of studies concerning the effect of policies on land use, population growth and density.

2. Identify those public policy makers involved in making policies that affect population growth and identify individuals and organizations that influence policy.

3. Inventory policies currently in effect in California that appear to influence California's coastal land use, population build-up and density.

4. Make a series of projections of the population of coastal counties and small areas, in combining assumptions that follow from different policies drawn from the results of the studies related to objectives 1 and 3 above.

RESULTS

Most of the work done so far pertains to objectives 1 and 3. Objective 2 is in progress now, in the form of interviews conducted with the policy makers. Objective 4 can only be reached after the three first objectives are completed.

Nine general types of policies related to population change were identified: 1) zoning and land use regulation of private land; 2) public ownership of land; 3) infrastructure planning and investment; 4) housing policies; 5) taxation policies; 6) environmental and social regulation; 7) explicit population growth promotion/limitation; 8) population projections; and 9) economic development.

Zoning and land use regulation includes large lot zoning and urban down-zoning, both reducing population density, and density bonuses that increase density and favor concentration of population. Public ownership of land allows more public control on development than private ownership. Infrastructure planning and investment may be used to slow population growth. Housing policies regarding numbers of units may restrict growth; housing policies regarding type of units affect population density. An example of taxation policies is the Williamson Act, which prevents population expansion on agricultural lands. Environmental and social regulation have also the effect of stopping population expansion. Explicit population growth promotion/limitation policies are usually implemented by other measures like housing policies. Population projections have, by themselves, an effect on population growth because, when they are adopted, decisions are made to help the projections become true. Economic development usually favors population growth.

PERSONAL BENEFITS

To be able to study the effect of policies on population growth, we first had to know in detail the past trends of population in California. Participating in this study gave me the opportunity to become acquainted in a very practical way with the American sources of data (mainly censuses, vital statistics and land use studies) and what they teach us. I also learned invaluable information on how the American political system works in concrete situations.

Corrosion Fatigue of Weldments in Offshore Structures (R/CE-8)

Vedantham Raman, Department of Materials Science,
Post-Doctoral Scholar, University of Southern California

INTRODUCTION

Ocean engineering requires weldable, tough and corrosion resistant structural steels for the construction of various marine structures. The growing demand for steels for use in structural applications such as harbor facilities, long span bridges and offshore platforms has led to the development of a certain class of low alloy steels with reasonably good corrosion resistance. A major problem leading to failure in these structural steels is the loss of load bearing capabilities through repeated applications of small value stresses. These stresses could arise from wind, waves, subsidence and other natural factors. The simultaneous exposure of structural steels to aggressive environments and cyclic stresses or strains generally results in a degradation of material properties. This is known as corrosion fatigue. The present study is an effort to systematically characterize the micro-structural, mechanical and environmental parameters that control the rate of damage in materials exposed to marine atmospheres.

A reliable procedure for the analysis and prediction of the mechanical and structural behavior of a component through laboratory testing is through fracture mechanics principles. As mentioned above, marine structures are often subjected to cyclic loadings in service and the possibility, therefore, exists for subcritical extension of defects should such defects be present in the appropriate size, shape and location. The subcritical crack growth involved in corrosion fatigue is represented in fracture mechanics terms by the stress intensity range, K (or its cyclic range, ΔK), a parameter that governs the rate of crack advance. The evaluation of the stress intensity factors allows a simple engineering approach to the prediction of fracture behavior in service. Because many structural designs employ welding as the main method of joining components, it becomes necessary, for completeness, to investigate the crack growth behavior in weldments.

OVERALL GOALS

1. To develop high deposition rate, low heat input weldments with refined microstructures and lower residual stresses.

2. To investigate fatigue crack propagation behavior in welded and base plate specimens in air and natural sea water environments.

3. Establish mechanisms governing corrosion fatigue crack propagation in weldments tested in natural sea water.

Two broad areas were identified to receive our initial attention. The primary objective was to establish a sound test technique for measuring fatigue crack propagation rates using the D.C. potential drop technique and to characterize the microstructure of the steel specimens in the weld, the heat affected zone and the base metal. It was proposed to conduct fatigue tests on base plate and welded specimens in air at 20 Hz as referenced by tests and, thereafter, generate data on crack propagation in natural sea water.

Pressure vessel quality plates of the precipitation hardening steel Ni-Cop corresponding to ASTM A710 were chosen for this study. Six submerged arc welds, two without and four with powder additions were prepared.

A D.C. electrical potential system was constructed to monitor crack growth rates at near-threshold stress intensity levels ($\sim 10^{-6}$ mm/cycle). The crack monitoring system involves a stable D.C. power supply, with current leads mounted to the front face of fatigue samples, a set of voltage probes matching the test material composition and a digital nanovoltmeter. With this crack monitoring technique, accuracies of at least 0.1mm on absolute crack lengths are attainable. Testing in the load controlled testing was performed in a CGS Lawrence electrohydraulic closed loop testing machine. A design for a clamp-on cell to conduct tests using 3.5% NaCl environment was established.

RESULTS

The microstructures of the submerged arc welds, with and without power fill additions, were characterized using optical and transmission electron microscopy. Specifically, the microstructures in the weld, the heat affected zone and the base metal were evaluated. Transmission electron microscopy revealed that the base plate had a disperson of very small particles in the microstructure. Basic mechanical property data such as the yield strength, ultimate tensile strength and percent elongation to failure were obtained.

Fatigue crack propagation data in the near-threshold region were obtained using the stress drop technique. Testing was carried out in air at 20 Hz and 2 Hz using R ratio of 0.1. Complete plots of da/dN vs. ΔK were obtained for each test. Results obtained

to date indicate that the threshold stress intensity factor in these steels (defined as stress intensity level at a growth rate of $\sim 10^{-6}$ mm/cycle) is $\sim$8KSI $\sqrt{in}$. The value of the threshold stress intensity is smaller for the tests conducted at 2 Hz when compared to that obtained at 20 Hz. These trends are consistent with previously published reports for steels of similar strengths. Experiments will now be carried out to examine the behavior of these steels in flowing 3.5% NaCl solution.

PERSONAL BENEFITS

The award of a Sea Grant traineeship has enabled the setting up of a facility to conduct fatigue crack propagation experiments at USC. The opportunity to extend my graduate training in mechanism oriented studies of fatigue into practical engineering aspects with emphasis of environmental interactions has been most useful.

PROJECT COMMUNICATIONS

Paper presented at the NACE Conference, Boston, 1985, "Corrosion Fatigue of Weldments in Offshore Structures."

Paper to be submitted to the Journal of American Welding Society, "Microstructural Characterization of Conventional and Powderfill Submerged Arc Welds in ASTM 710 Steel."

Origin and Distribution of Enigmatic Upper Slope Depressions on the Arguello Slope, California (R/RD-26)

Suzanne Reynolds, Department of Geological Sciences,
Doctoral Candidate, University of Southern California

INTRODUCTION

As part of the required environmental assessment studies for oil and gas development, energy service companies have been investigating the Point Arguello-Point Conception area for possible geohazards. They have identified some interesting and enigmatic depressions on the upper slope in this area. These have been attributed to a variety of processes, including mass movement, gas discharge channelling, current scour, bioerosion, and possibly even subaerial erosion. Identification of the cause of these features is of high economic importance. If it involves a potentially hazardous process, this could materially influence the development of hydrocarbon resources in the area. Thus, the primary objectives of this project were to determine the nature and areal extent of these depressions, delineate the possible range of causative actions and define their potential impact on hydrocarbon production activities.

RESULTS

Data gathering was accomplished during a five-day cruise in August 1984. During the cruise, several hundred trackline-kilometers of high resolution seismic and side-scan sonar data, along with 10 box cores, were taken (Figure 1). This data adequately defined the areal distribution and characteristics of these features over a broad area. In general, the depressions are 100-200 meters wide, with an average negative relief of 20 meters. Positive relief features on the order of several meters high are present within the depressions. These hummocks are attributed to resistant outcrops of Pleistocene material, which have been uncovered by erosion. The depressions are elongate, trend downslope, and occur at fairly regular spacings of 1.7 km.

All of the data obtained suggest that current erosion is the cause of these features. The hypothesis that material has been removed by downslope mass failure was rejected because the depressions do not have the typical arcuate slump scar upslope, and because deposits of the removed material have not been found downslope of the depressions. The activity of currents within the area is well documented by the presence of ripples in sand.

Vertically oriented x-ray radiographs of box cores commonly show an erosional hiatus at 10 cm depth, with Holocene material unconformably overlying denser Pleistocene (?) material. Recently obtained data from current meters in the area show moderate currents in the range of 20–30 cm/s (Alan Bratkovitch, pers. comm.). Furthermore, scientists in diving submersibles have reported periods of very strong currents, up to 4 knots, in this area (Andy Lissner, pers. comm.).

That these features are a result of bottom current erosion is an obvious conclusion from this data. The causative mechanism behind this type of current is less obvious. It is proposed that they are caused by rip currents somewhat similar to those which occur in beach zones. In this environment, incoming surface waves, upon intersectng the shoreline, may set up surface edge waves which propagate in a direction perpendicular to the shoreline. The points of intersection of the troughs of incoming and edge waves create zones of low water height. Water piled up against the shoreline will preferentially move back out along this zone of low ater, creating what is known as rip currents. This mechanism is commonly used to explain periodic erosional features in the nearshore zone. We propose a similar mechanism for the periodic erosional features on the upper slope, where internal gravity waves, rather than surface waves, provide the initial energy.

This mechanism of current formation is speculative, but is within reason in light of preliminary calculations based on water characteristics of the area (Alan Bratkovitch, pers. comm.). A program of current measurements specifically designed to test this hypothesis would be necessary before any firm conclusions could be made.

This type of bottom current activity is a possible hazard to production activity in the area, but it is likely that construcon designs may be made to overcome this possibility.

PERSONAL GAINS

I have greatly benefited from my participation in this project. The onboard experience with the side-scan sonar equipment was particularly valuable. The work also increased my knowledge of the processes at work on the slopes of offshore California.

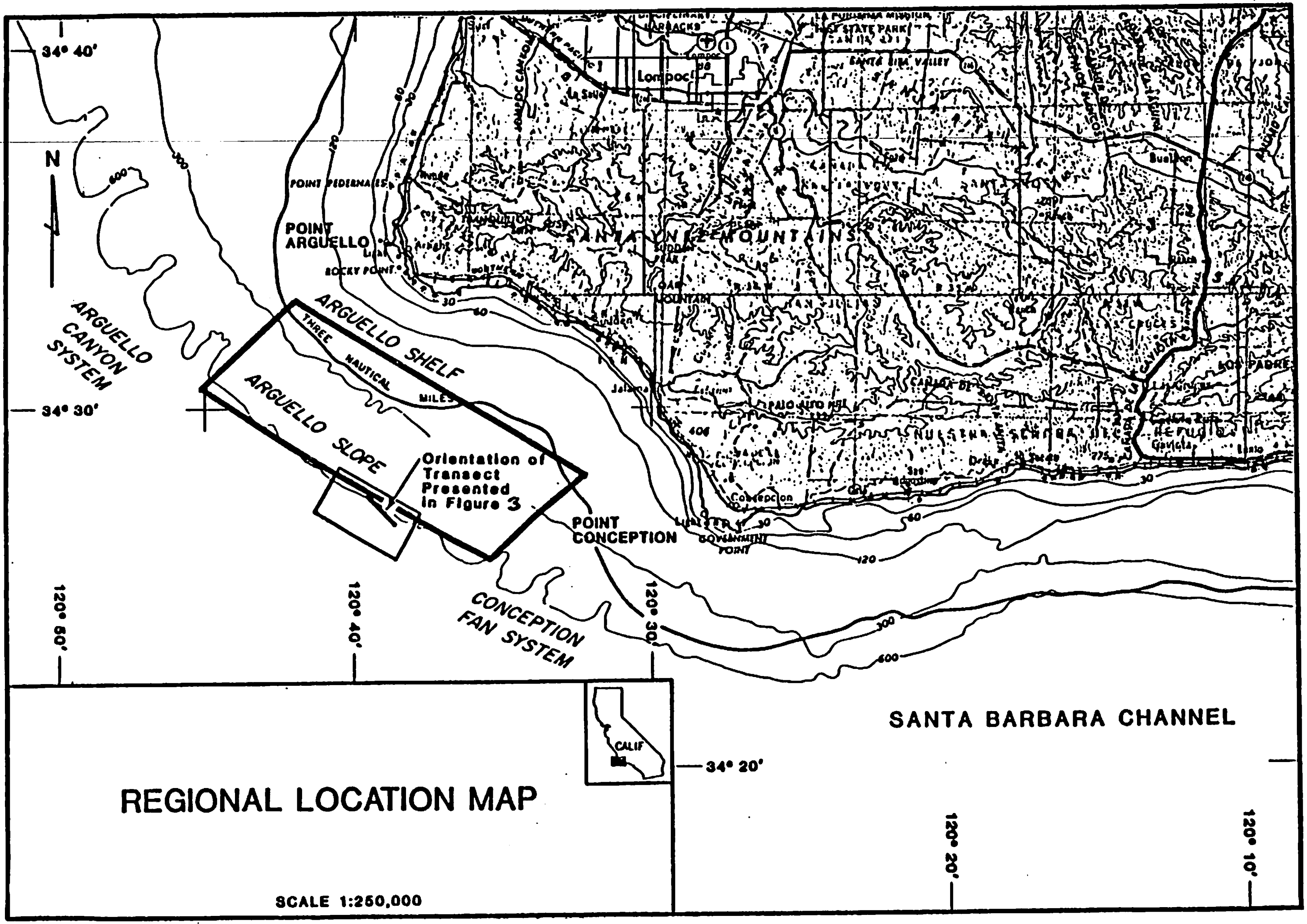

FIGURE 1: Recent Service Company and USC Survey Areas

Small Seaports: An Examination of Selected Attributes and Analysis of Trends (R/CM-30)

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INTRODUCTION

During the last two decades there have been major changes in maritime shipping technology...changes in cargos, ship design and cargo handling. These changes appear to be driving the concentration of cargo movements to fewer larger, "load center," ports. On the West Coast of the United States, there are some 25 active seaports that have the potential for handling the growing Pacific Rim maritime activity; growth, however, seems to be concentrating at the six or seven largest ports.

This may be good news for the larger ports, but what does it mean for the smaller ports? On the West Coast, seaports are typically public enterprise activities that provide significant services for the local economy, control valuable coastal resources and provide employment. What impact has the apparent concentration of cargo movements had on these functions of the smaller seaports? To what extent have they by choice or necessity changed their activities or their management strategies? Are they suffering from various possible symptoms of fiscal stress and budget decline? Have they developed strategies for survival?

GOALS AND OBJECTIVES

The overall goal of this study has been to determine: 1) if the smaller ports are getting smaller; 2) if the smaller seaports are experiencing financial stress as a result of shifts in cargo movements; and 3) what strategies they are adopting to cope with the assumed cargo shifts and revenue changes.

More specifically this study was designed to determine:

1. What changes are actually occurring in cargo movements to the West Coast and to each individual port.
2. Are future changes in the distribution of cargos anticipated by the ports?
3. Are different cargos or activities, including non-maritime land uses, being substituted for declining cargos at the subject port?

4. What are the resulting impacts on the budgets and managements strategies of the subject ports?

   a) Are budgets decreasing or increasing?
   b) How are net revenue (surplus) quantities changing?
   c) Are capital investment and debt levels changing?
   d) To what extent are the subject ports financially dependent on subsidy from local general taxation, state grant/loans, and federal support for dredging or other development?

RESULTS

While the port survey effort and evaluation are continuing, the graphic analysis of cargo movement data in combination with the completed port surveys suggests several significant findings:

1. In Figure 1, "Cargo Movements," there is a fairly clear division of the West Coast ports into two groups: those with more than 10 million short tons of cargo annually and those with less. The ports of Tacoma and Richmond complicate this assessment, but their special circumstances are being explored further. The larger ports have had substantial increases in their reported volumes during the last 10 years. In contrast, in spite of some rather erratic ups and downs, the cargo movements through the smaller ports have remained fairly constant. The smaller ports do not seem to be losing cargo volume to the larger ports; what they are losing is their potential share of net growth.

2. The substantial movement of petroleum cargos through private terminals (largely beyond the control of the public ports) suggested a second comparative approach which is shown in Figure 2, "Non-Petroleum Cargo Movements." The division at 8-10 million tons persists although the difference between the total cargo and the nonpetroleum cargo handled by the smaller ports is relatively insignificant.

3. The erratic variation between the annual volumes handled by the various ports motivated a third form of comparison — Figure 3, "Market Shares." Here, there are a few instances of "criss-crossing," suggesting competition for the same customers, and a few instances of straight lines, indicating secure or captive markets. However, there is not a dominant pattern. One possible interpretation is that the movements of various cargos are strongly dependent on the management and marketing efforts of the individual ports.

4. The interviews conducted to date with the ports of San Diego, Port Hueneme, Redwood City, San Francisco and Richmond support this interpretation to the extent that the managers of these smaller ports are optimistic about their prospects — if they can make the capital improvements necessary improvements to attract particular non-containerized break bulk and specialty cargos as the larger ports specialize more and more in containers and petroleum.

5. The financial data collected from the ports surveyed supports their optimism, although in several instances maritime activities are subsidized by non-maritime activities, district taxes, or municipal general revenues. These ports have reported only isolated instances of sales of capital assets and frequent instances of new or anticipated acquisitions -- to be purchased with the proceeds the sale of revenue bonds or with retained earnings.

The findings of the study will provide the managers of the smaller ports and other policy makers responsible for port jurisdictions with a generalization analysis of the alternative strategies that might be pursued.

PERSONAL BENEFITS

As a trainee I have been involved in virtually all aspects of this study. I have been able to gain valuable experience in several approaches to practical social science research, including statistical analysis, subject interviews, and literature research. Working on this study has stimulated the development of my dissertation topic.

Abbreviations used for port names

SD San Diego
LB Long Beach
LA Los Angeles
PH Port Hueneme
SC Sacremento
ST Stockton
SF San Francisco
RC Redwood City
OL Oakland
RM Richmond
HB Humboldt
AS Astoria
LV Longview
KM Kalama
VC Vancouver
PL Portland
CB Coos Bay
PA Port Angeles
OP Olympia
TC Tacoma
SE Seattle
AC Anacortes
BH Bellingham

FIGURE 1: CARGO MOVEMENTS

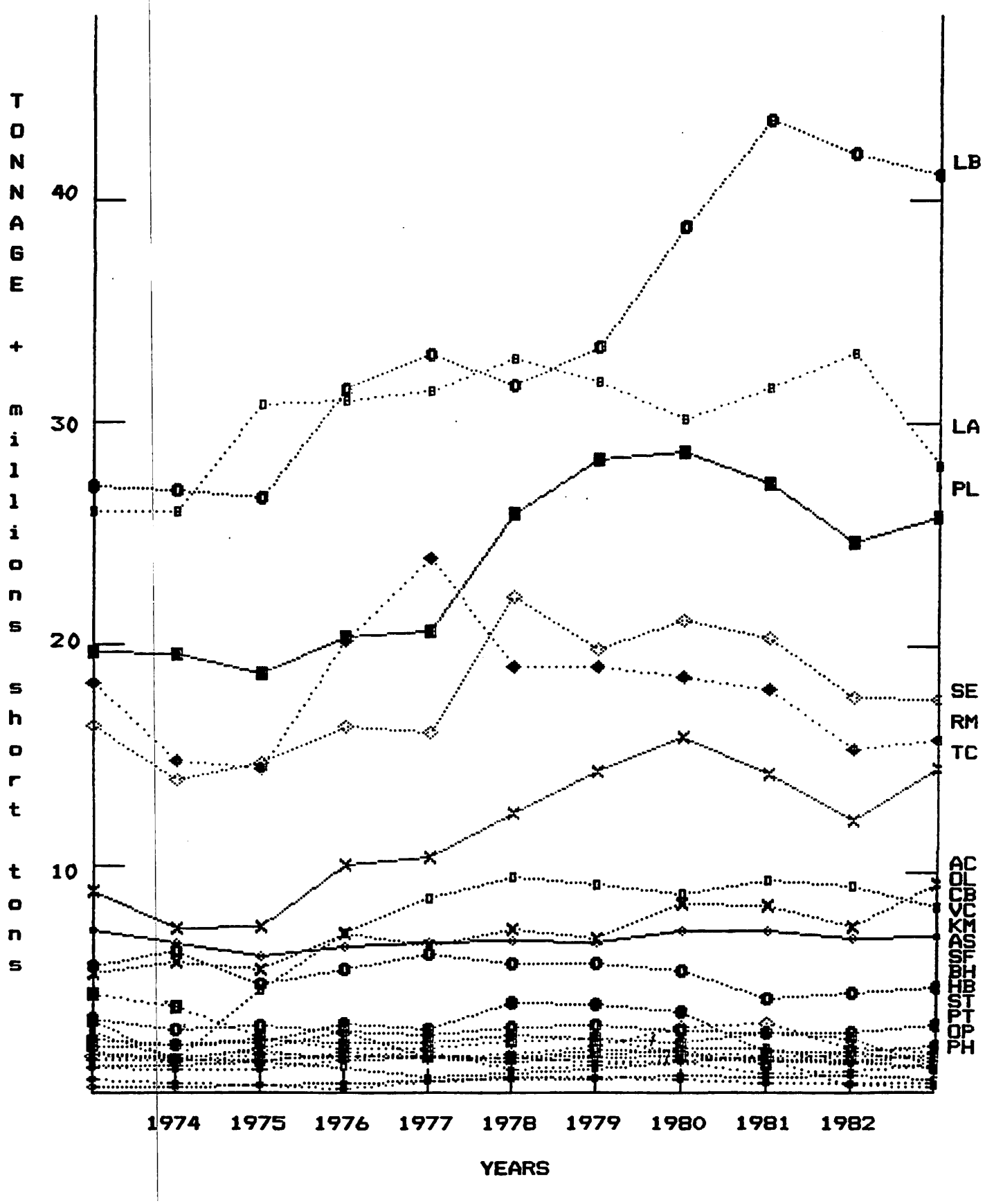


FIGURE 2: NON-PETROLEUM CARGO MOVEMENTS

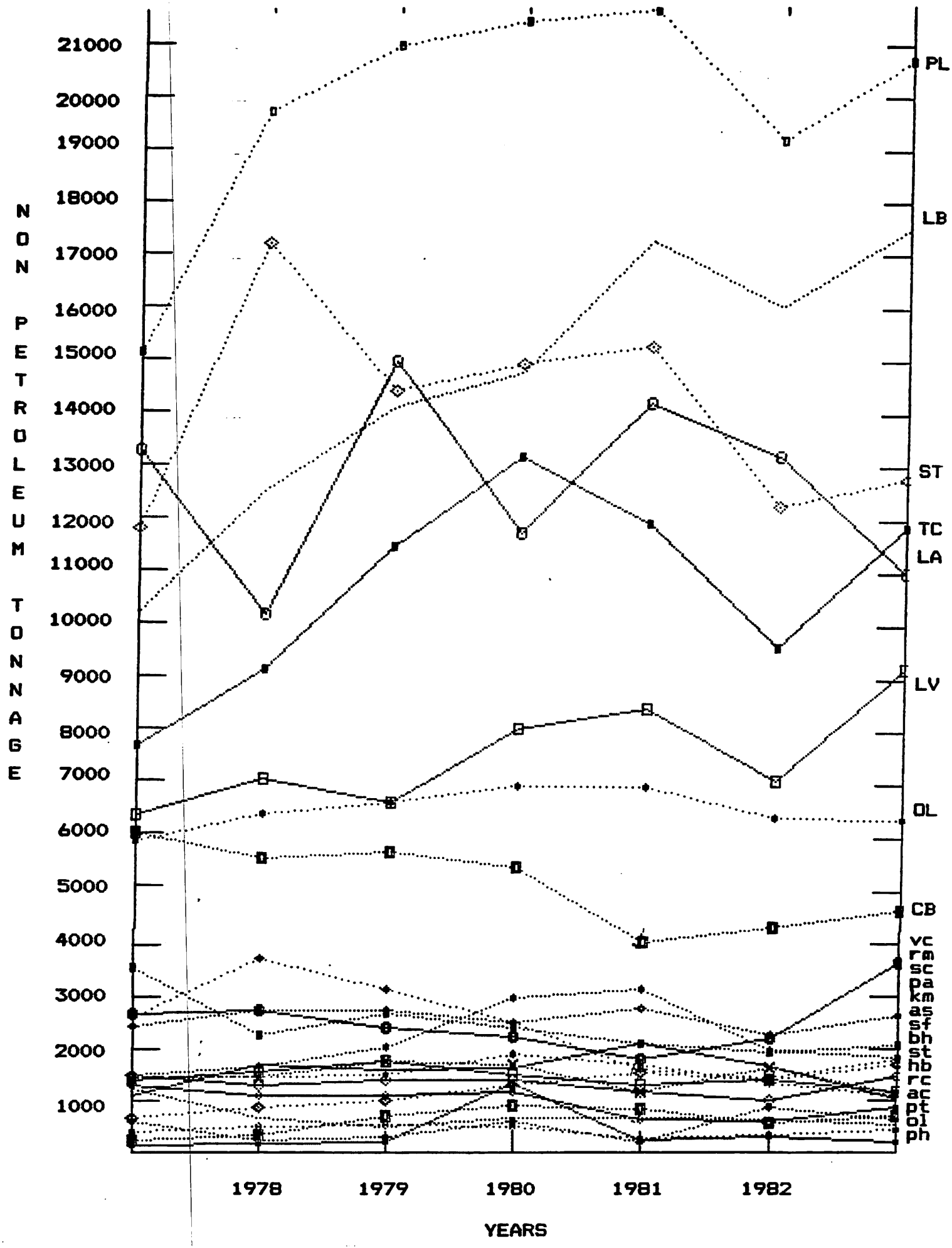
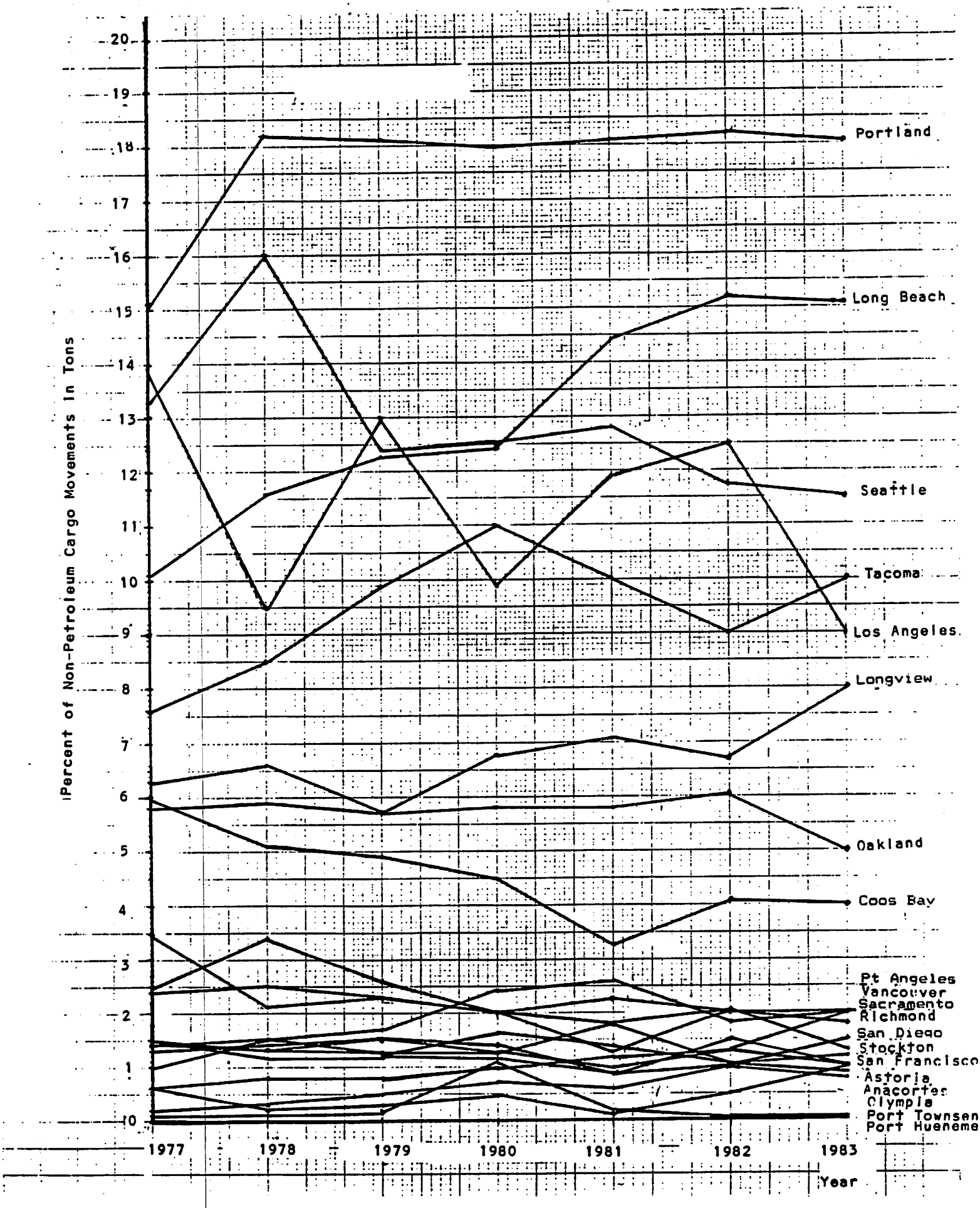


FIGURE 3: MARKET SHARES



Problems of Paralytic Shellfish Poisoning (R/EQ-31)

Mohammad H. Yazdandoust, Department of Biological Sciences, University of Southern California

INTRODUCTION

In search of the nutritional requirements for the development of larvae of the crab, Cancer anthonyi Rathbun, I isolated from Los Angeles Harbor, California, a chain-forming toxic dinoflagellate, Gonyaulax catenella Whedon and Kofoid, the causative agent of paralytic shellfish poisoning. Previous researchers have shown in their investigations of paralytic shellfish poisoning that G. catenella is the direct source of the poisons found in California mussel, Mytilus californianus. Now it is known that G. catenella is the causative agent of paralytic shellfish toxicity on the Pacific Coast.

The occurrence of dinoflagellate blooms may cause mass mortality of fish and other marine organisms. Fish kills and death of marine organisms during red tides are due to oxygen deficiency in the water, caused either by the extensive number of cells, the products of decay of the red tide organisms or to secondary metabolites (toxins) produced by toxic dinoflagellates. Mass mortality of fish and other marine organisms were reported in laboratory experiments and during the bloom of toxic dino-flagellates, Gonyaulax monilata, Gonyaulax excavata, Gymnodinium veneficum and Ptychodiscus brevis.

In the laboratory, I have raised larvae of the crab C. anthonyi through all zoeal stages to megalopa stage by feeding them certain dinoflagellates or diatoms (unpublished). This has suggested that these larvae can act as herbivorous plankers. Because investigations in paralytic shellfish poisoning suggested the possibility that the planktonic herbivores act as vectors of paralytic shellfish poisons and cause fish kills, a series of laboratory studies were initiated to investigate trophic relationships of paralytic shellfish poisons in selected members of a food chain in the Southern California Bight. G. catenella, C. anthonyi larvae and bluebanded goby Lythrypnus dalli were chosen for the study because: 1) little information and data exist on the interaction of G. catenella and organisms other than bivalve molluscs; 2) decapod crustacean larvae constitute a significant fraction of the zooplankton that may feed on the phytoplankton; and 3) bluebanded gobies display planktonic feeding habits, depending primarily upon planktonic forms including zoeae and diatoms.

This project is very important to the general public and scientific community because the ultimate findings of the project will be very helpful in understanding the problems of paralytic shellfish poisoning, which is a serious public health hazard. Also it has a very important ecological implication in marine coastal food chains. This is the first laboratory investigation of the effects of G. catenella toxins in fish kill (in this case, crab larvae) directly or directly, through vectors of toxins.

GOALS AND OBJECTIVES

The overall goals of the project have been:

1. To study the interaction of the toxin dinoflagellate, G. catenella, and organisms other than bivalve molluscs.
2. To determine the importance of crab larvae in transmission of paralytic shellfish toxins in marine food chains.
3. To study the impact of paralytic shellfish toxins on goby, directly or indirectly through crab larvae.

The trainee's objectives were:

1. To conduct feeding experiments using crab larvae and toxic dinoflagellate, G. catenella, to provide toxic (toxin bearing) crab larvae for further use.
2. To perform feeding studies using G. catenella-fed larvae and goby to study the effects of toxic larvae on fish.
3. To conduct feeding experiments using G. catenella and goby to investigate the direct impact of toxic dinoflagellate on fish.

RESULTS

Crab larvae fed G. catenella accumulated and were resistant to toxins produced by this organism. This was suggested from paralysis of flies (fly bioassay) injected with extract from crab larvae fed on G. catenella. Therefore, crab larvae are able to ingest toxic G. catenella and accumulate and retain the toxins as shellfish do.

Bluebanded gobies died after 24-60 hours of exposure to culture of G. catenella-fed larvae. No different behavior was shown by these fish in comparison with the control fish in seawater. These results suggest a role that herbivorous zooplankters (crab larvae) may play in transfer of G. catenella toxins to higher trophic levels of marine coastal food chains. Few studies have documented herbivorous plankton as vectors of dinoflagellate toxins.

The direct effect of the toxic dinoflagellates on gobies was investigated by placing the fish directly into a cultures of G. catenella. The fish died within 13-14 hours after displaying symptoms of paralysis. Fish died more rapidly in cultures of G. catenella than when presented with G. catenella-fed larvae. The differences in toxicity of dinoflagellate and larvae may be due to loss of toxins from dinoflagellates before and during the ingestion by crab larvae, rapid elimination of toxins from the larvae and alteration of toxins to inactive form.

In summary, these laboratory results suggest mechanisms of toxin transmission through a food chain (Figure 1). C. anthonyi larvae ingest G. catenella and can accumulate and retain the toxins from these cells without ill effects. The larvae when preyed upon by gobies, L. dalli, transmit the toxins to the fish and cause death. In addition, there is an impact of toxic dinoflagellates on gobies, causing fish kill directly.

PERSONAL GAINS

It was a great opportunity for me to participate in this project. It provided me excellent scientific experiences and helped me to advance my doctoral research work. This project gave me the opportunity to participate and present my findings during regularly scheduled Sea Grant meetings. Also it provided me the opportunity to participate in the Third International Conference on Toxic Dinoflagellate Blooms, which was held in Canada during June 1985. At the conference, I presented a poster and also a paper to be published in the conference proceeding.

I wish to express my special thanks to USC Sea Grant Program, which has provided me the above opportunities.

PROJECT COMMUNICATIONS

Poster presentation in: Third International Conference on Toxic Dinoflagellate Blooms held in Canada, June 1985.

Paper (in press) in: Proceeding of Third International Conference on Toxic Dinoflagellate Blooms.

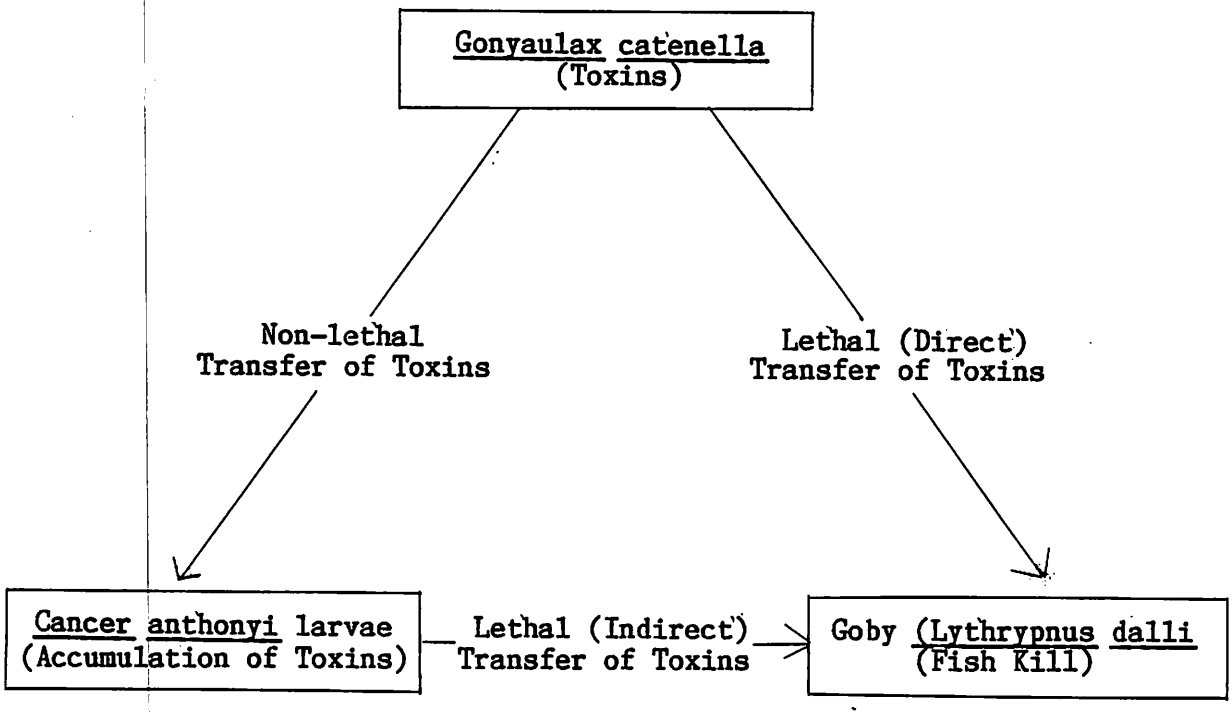


FIGURE 1

Possible toxic dinoflagellate interaction in a marine food chain suggested from laboratory experiments.