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1983-84 TRAINEE REPORT

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USC SEA GRANT



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

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3/85

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

Dorothy M. Bjur, Director of Training, Institute for Marine
and Coastal Studies, University of Southern California

Since 1975, the USC Sea Grant Graduate Student Trainee Program has offered students the opportunity to apply classroom knowledge to actual working situations. In this program, students work on marine-related research under the direction of faculty members on selected Sea Grant projects.

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 marine research projects that help graduate research requirements for their degrees.
3. It provides Sea Grant principal investigators with qualified students who will substantially contribute to research results.
4. It provides students with experience in their chosen fields to help prepare them for leadership roles in research and development of marine-related topics.

An important measure of the success of the trainee program is shown by the percentage of students who successfully finish their research projects and receive their graduate degrees.

Students who participated in the trainee program during 1983-84 represented five disciplines: Biology, Mechanical Engineering, Marine Affairs, Urban and Regional Planning and Sociology. Two of the seven trainees received their Master of Marine Affairs (MMA) degrees. The remaining five students are scheduled to receive their degrees in 1985-86.

A highlight of the year was the selection of Mohammad Yazdandoust as USC's second recipient of a national Sea Grant Association Award for his research project on "Bioaccumulation of Paralytic Shellfish Poison by Crab Larvae Fed on Gonyaulax catenella."

During the year, monthly luncheons were held for the trainees and their principal investigators. At these luncheons, trainees presented their research progress, helping to keep students and researchers abreast of the various Sea Grant projects.

1983-84 USC SEA GRANT GRADUATE STUDENT TRAINEES

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

Mary E. Dempsey, Institute for Marine and Coastal Studies, master's candidate in Marine Affairs.
"Factors Affecting the Survival of Nearshore Larval Fishes," R/RD-13.
Principal Investigators: G. Brewer and G. Kleppel.

Margo Koss, Sociology, doctoral candidate.
California's Coastal Population: Transition and Development," R/CM-27.
Principal Investigator: M. Van Arsdol.

Shishir Shah, Mechanical Engineering, master's candidate.
"Corrosion Fatigue of Weldments in Offshore Structures," R/CE-8.
Principal Investigator: J. Todd

Penelope G. Jones Van Dyke, Institute for Marine and Coastal Studies, master's candidate in Marine Affairs.
"Fees for Service at Seaports: Pricing Approaches, Federal User Fees, and Public Policy Issues," R/CM-26.
Principal Investigators: W. Price, P. Kenyon and D. Bryan.

Kathleen A. West, Urban and Regional Planning, doctoral candidate.
"Fees for Service at Seaports: Pricing Approaches, Federal User Fees, and Public Policy Issues," R/CM-26.
Principal Investigators: W. Price, P. Kenyon and D. Bryan.

Mohammad H. Yazdandoust, Biological Sciences, doctoral candidate.
"Problems of Paralytic Shellfish Poisoning (PSP)," R/EQ-31.
Principal Investigators: B. Abbott, M. Ross and A. Siger.

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

Alexander Andrasi, Department of Biological Sciences,
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 the 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 invariably suffers drastic losses following PSP outbreaks, due to consumer apprehension about seafood.

GOALS AND OBJECTIVES

The overall goals are to develop the fly bioassay, to demonstrate its advantages, and to describe a standard protocol.

The trainee's objectives for second year of funding were:

1. To extend the bioassay to other fly species.
2. To assess the causes and range of variability in assay results.
3. To conduct additional feeding experiments with Mytilus edulis (bay mussels).

RESULTS AND FINDINGS

During the second funding year of this project, additional experiments were conducted to evaluate the fly bioassay for dinoflagellate toxins. Two new species of fly were tested: Phaenicia cuprina (green bottle fly) and Sarcophaga bullata (blowfly), in addition to the original species, Musca domestica (common housefly). Variability of bioassay results was closely examined; several biological and physical sources of this variability were identified and the magnitudes of their effects were measured. Feeding experiments revealed direct uptake of dissolved dinoflagellate toxin from seawater by M. edulis. This previously unreported finding indicates that these bivalves may acquire toxin from the water even when toxic dinoflagellates are no longer present.

Dose-response curves for P. cuprina and S. bullata were obtained by injecting flies with serially diluted saxitoxin (Fig. 1). The sensitivities of S. bullata and M. domestica to the toxin are similar, while that of P. cuprina is about three times greater. We expected that this greater sensitivity, as well as substantially larger size, would make this fly superior to the others in the bioassay. It was found, however, that P. cuprina does not tolerate the injection of non-toxic M. edulis extract, and further testing was abandoned. S. bullata was somewhat lethargic in behavior, making it difficult to assess the effect of the toxin; its use was also discontinued.

After noting the effect of non-toxic mussel extract on P. cuprina, it became necessary to determine whether the presence of non-toxic extract could affect the toxin sensitivity in M. domestica. Standardization of the fly bioassay with M. domestica was conducted using appropriate dilutions of a standard saxitoxin solution provided by the U.S. Food and Drug Administration. Two serial dilutions with identical toxin concentrations were prepared using two diluents: an aqueous solution of NaCl and HCl at pH 3.3 (adopted from the standard mouse bioassay procedure, Association of Official Analytical Chemists), and an extract of non-toxic M. edulis (Fig. 2). The flies were nearly three times more sensitive to the saxitoxin diluted in M. edulis extract (E.D. 50 = 90 ng/ml) than they were to saxitoxin diluted in the aqueous NaCl/HCl (E.D. 50 = 250 ng/ml.)

The age of the flies did not influence their sensitivity to saxitoxin in M. edulis extract within the age range of 1-8 days; flies over 17 days old showed increasing sensitivity (Fig. 3). Increased sensitivity was not found to saxitoxin in aqueous NaCl/HCl.

Flies exposed to brief freezing temperatures before assay were more sensitive to saxitoxin in M. edulis extract than were identical flies which had been cooled gradually to four degrees in a refrigerator before assay (Fig. 4). The freeze-exposure was not drastic enough to kill any of the flies tested, as verified by warming them to room temperature and observing their activity before conducting the tests.

Flies that were dehydrated for two days prior to assay showed a large increase of sensitivity to saxitoxin in M. edulis extract (Fig. 5). Restoring their water supply caused partial reversal of this effect, but the dehydrated-rehydrated flies remained significantly more sensitive than the controls.

These results reaffirm the potential value of the fly bioassay as a viable procedure for routine shellfish monitoring, demonstrating that it will detect smaller amounts of saxitoxin in actual shellfish samples than the standard mouse bioassay. The assays have detection limits of 90 and 220 ng/ml, respectively. The findings of age, freezing and dehydration effects on assay results allow us to maintain and handle the flies in a manner that minimizes variability, thus enhancing the reliability and reproducibility of the bioassay.

Direct absorption of dissolved dinoflagellate toxin from seawater by M. edulis has several important implications. The source of toxin for these experiments was the growth medium from a large scale batch culture of P. catenella in the early stationary phase of development, at a cell density of 2400/ml. It is therefore likely that the dissolved toxin in the water was released from live, intact cells, rather than from dead or disrupted cells which are not prevalent in batch cultures until later stages of development. This may parallel conditions which could exist in the natural environment; direct absorption of dissolved toxin may play an important role in toxification of natural populations of shellfish. It has been repeatedly observed that Mercenaria mercenaria (the principal commercial clam of the northeastern United States) can become highly toxic in the apparent absence of toxic dinoflagellates, a phenomenon which could be explained by the direct absorption of dissolved toxin.

These and related questions will be investigated further during the upcoming year.

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.

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

An abstract of my work was honored by the Sea Grant Association during the Sea Grant Week program in July 1983.

I wish to thank the Sea Grant program for the opportunities that this traineeship has provided me.

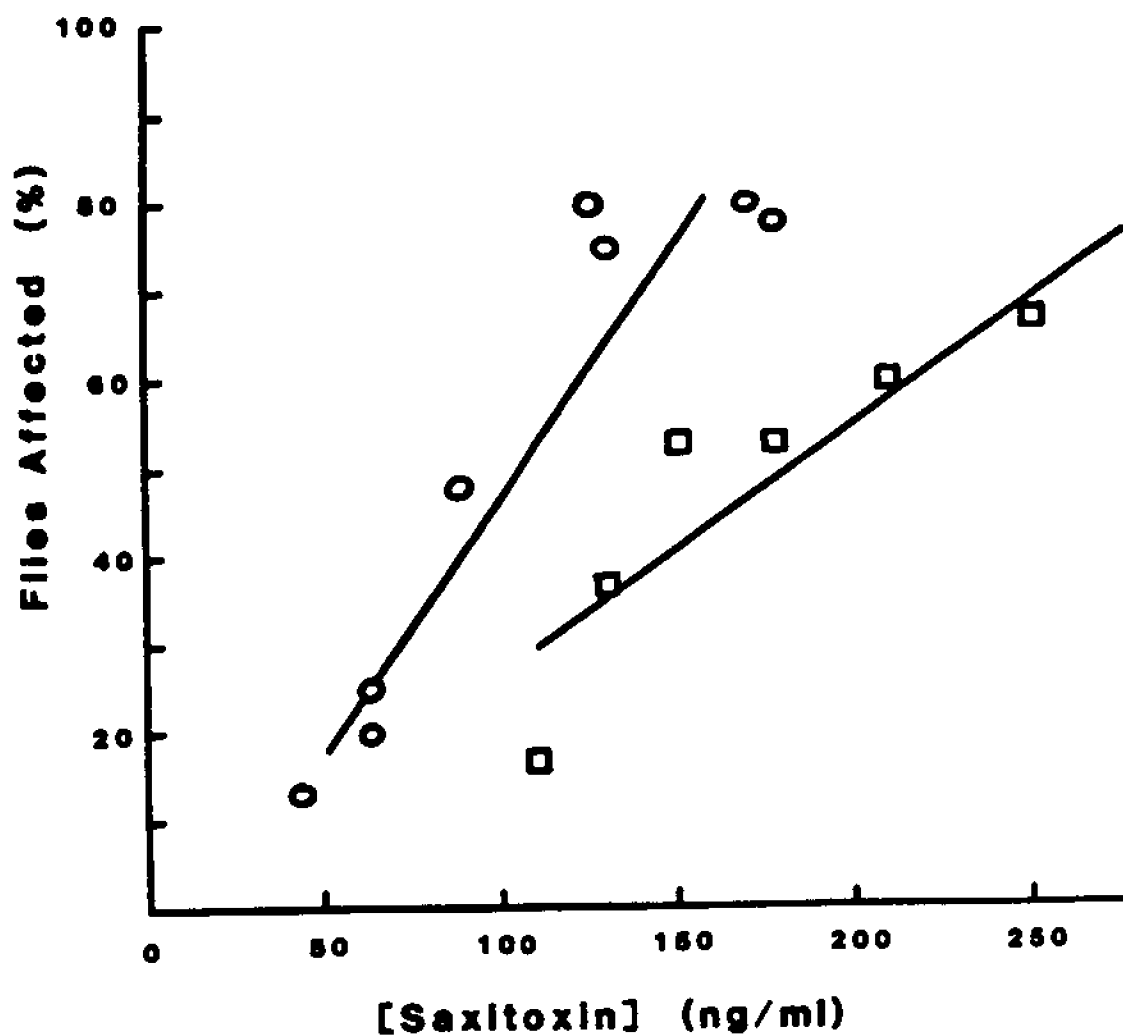


Fig. 1 - Saxitoxin sensitivity in Phaenicia cuprina and Sarcophaga bullata:

Open circles - P. cuprina.

Open squares - S. bullata.

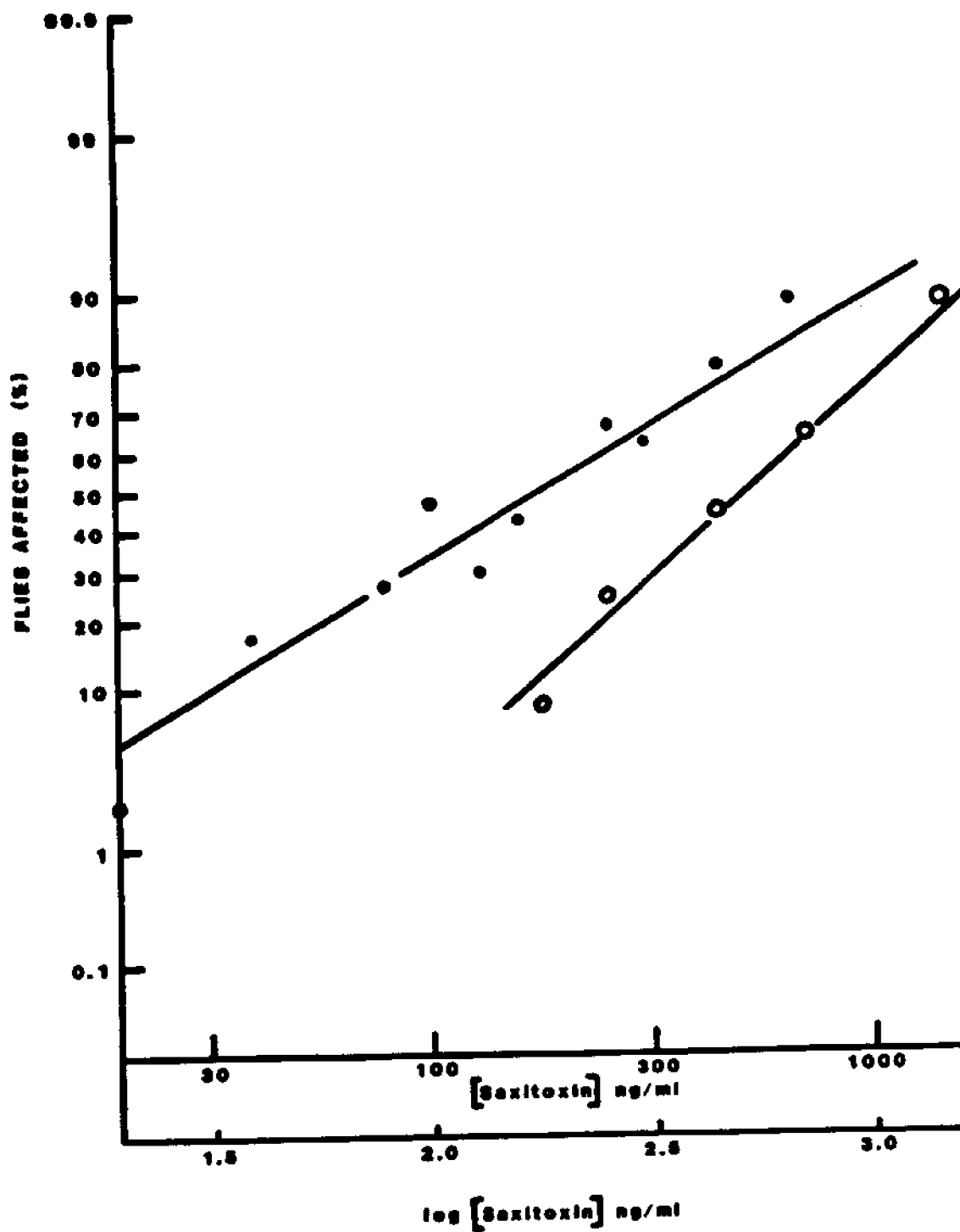


Fig. 2 - Augmentation of saxitoxin sensitivity in Musca domestica induced by Mytilus edulis extract:

Open circles - Saxitoxin in NaCl/HCl diluent.
 Solid Circles - Saxitoxin in M. edulis extract.

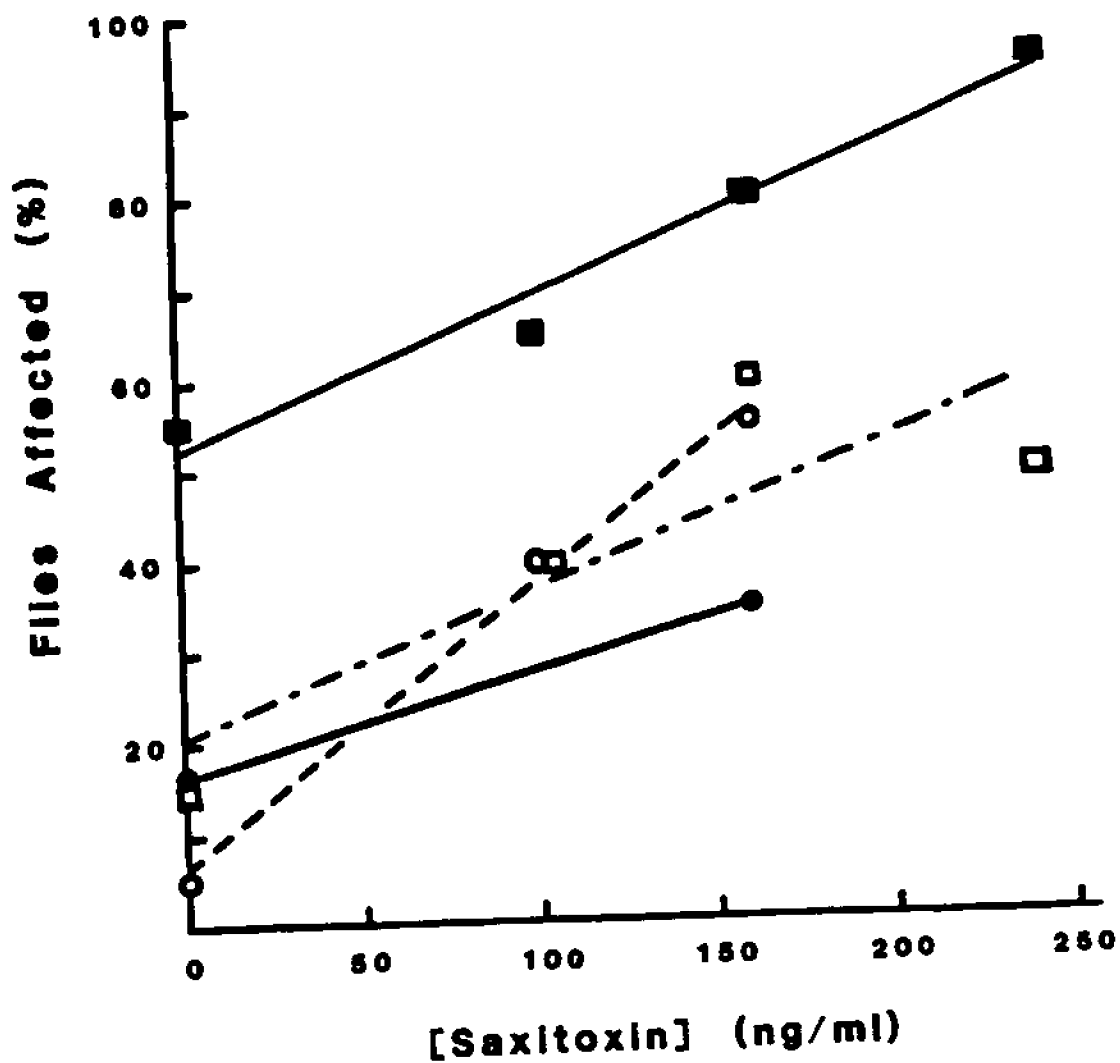


Fig. 3 - Saxitoxin sensitivity variation with age in Musca domestica:

Open circles - 0-3 d
 Solid circles - 3-5 d
 Open squares - 5-8 d
 Solid squares - 17-20 d

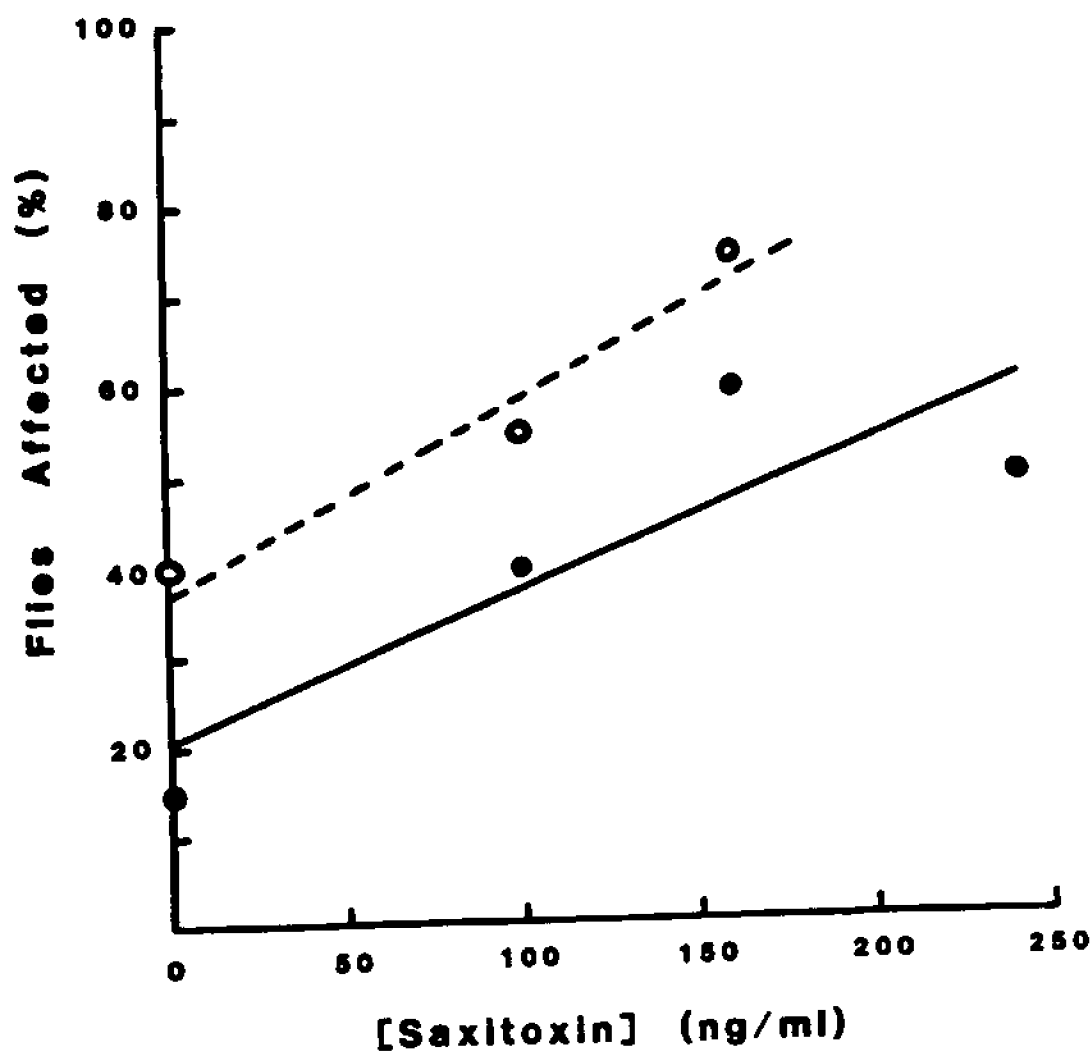


Fig. 4 - Effect of non-lethal low temperature on saxitoxin sensitivity in Musca domestica:

Open circles - exposed to low temperature.
Solid circles - control.

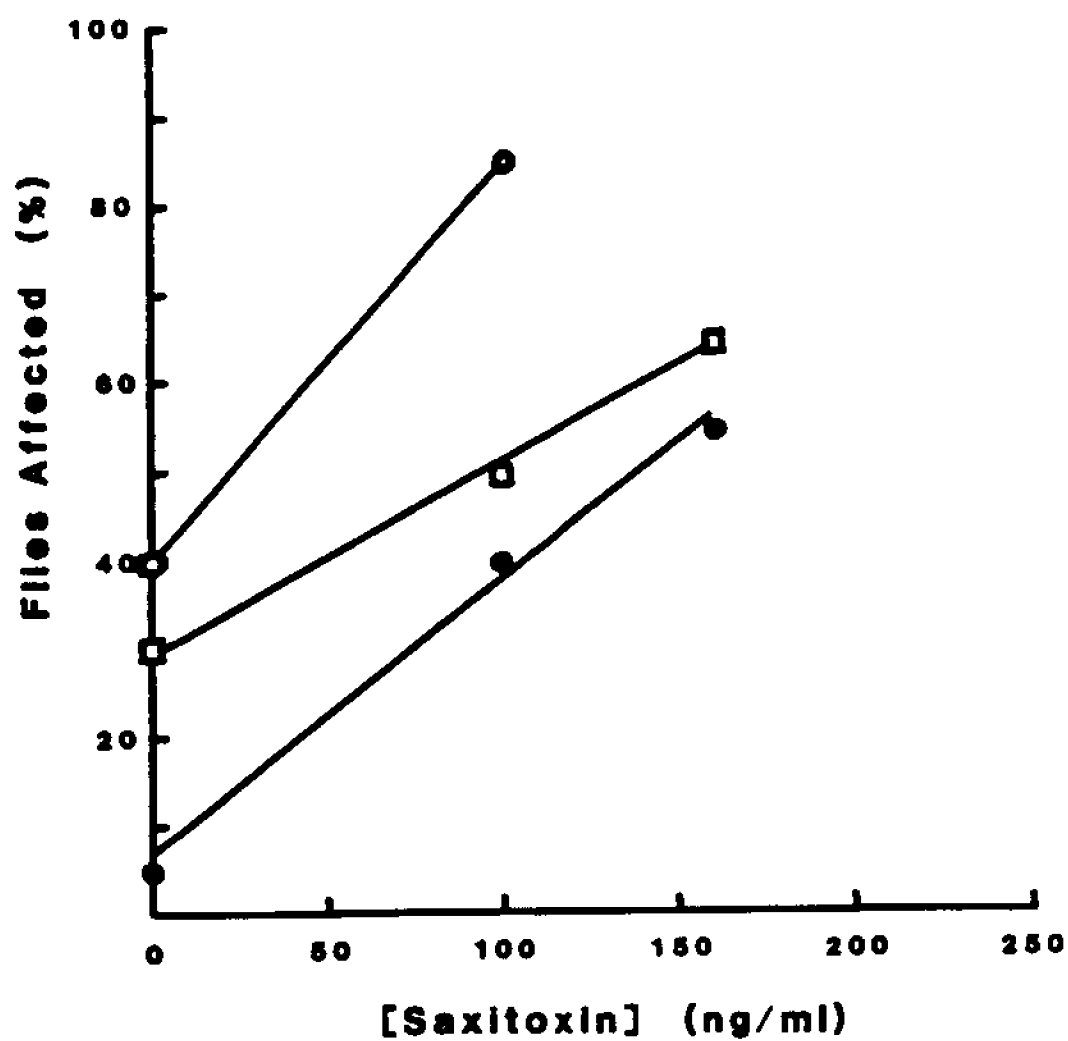


Fig. 5 - Effect of dehydration on saxitoxin sensitivity in Musca domestica:

Open circles - dehydrated.
Open squares - dehydrated / rehydrated.
Solid circles - control.

Factors Affecting the Survival of Nearshore Larval Fishes (R/RD-13)

Mary E. Dempsey, Master of Marine Affairs, University of Southern California

INTRODUCTION

Since 1948, CalCOFI has sponsored larval and egg surveys of commercial fish species in offshore waters off Southern California and northern Mexico. From 1978-1980, Ichthyoplankton Coastal and Harbor Studies (ICHS) sampled the waters between San Diego and Point Conception — waters inshore from the CalCOFI areas — as a supplement for CalCOFI data.

It appeared from the CalCOFI and ICHS studies that the nearshore area was not a preferred spawning area but perhaps a nursery area. This was believed to be a fish nursery area since the number of larvae surviving to the recruitment age was higher in the shallower waters. These studies and Gary Kleppel's research on phytoplankton in Santa Monica Bay were the major impetuses for our Sea Grant study.

Dr. Kleppel found that the concentration of phytoplankton in Santa Monica Bay appeared to be high enough to support a large number of larvae. The dinoflagellates are the preferred food of the larvae and the ratio of this larval food to the diatom population increased inshore. This finding gave credence to the theory of the nearshore area as a nursery area.

In the inshore waters, predation was, perhaps, the key mortality factor for the fish larvae while offshore the key factor to survival of these larvae was starvation. The two factors of predation and starvation are generally believed to be the overwhelming causes of larval mortality and subsequent recruitment failures. The Sea Grant study wanted to examine these phenomenon.

The Sea Grant study is important to the scientific community for a number of reasons. Such an extensive ichthyological survey of this nearshore area had not been undertaken, although a large data base of physical parameters, such as temperature data over the years, existed. This type of field study complements larval laboratory feeding studies and is necessary before any conclusion can be made of larval feeding; our laboratory methods are not sophisticated enough to create environments similar to those found in the sea.

GOALS AND OBJECTIVES

The Pisces Cruises were undertaken to extensively sample and analyze the vertical and horizontal distributions of prey and predatory species of the nearshore larval fishes in Santa Monica Bay. This study wanted to describe the area in terms of the physical and biological parameters that affect the survival of fish larvae.

My objective for this project was to familiarize myself with all aspects of ichthyoplankton research; specifically, my tasks included participating in cruises, sorting the samples, reducing the data, and analyzing the results of the gut content analysis.

It was discovered that bivalve veligers were the primary food source of the Geryonemus lineatus (white croaker) larvae that we examined. Unfortunately, gut analysis is biased because the Engraulis mordax (northern anchovy) larvae evacuate their gut contents upon the trauma of capture in the net.

In interpreting the findings of the gut content analysis, one must be very careful; food found in the gut may not represent a food preference but may indicate opportunistic feeding. Also, the food found in the gut might be due to the slow digestion of that particular food item and not be due to preferential feeding or a high concentration of that food in situ.

RESULTS AND FINDINGS

It appears that the survival of fish larvae is less dependent on broad scale levels of productivity than on the fine scale features of certain prey and predator densities.

The results of the food gut content analysis was surprising. A large number of bivalves were found in the guts of G. lineatus larvae but a large concentration of bivalves were not found in our water samples. Our standard sampling devices — the Bongo nets and pumps — were unable to sample this population.

Overall, bivalves ranked as the number one food item out of the 409 food particles detected in the 80 G. lineatus larvae that we examined. In three of the larvae length categories — 1) end of yolk sac to 2.4 mm; 2) 2.5 - 2.7 mm; and 3) 2.8 - 3.2 mm — bivalves were the highest percent of the food item found in the guts. For the larval length category of 3.3 - 5.9 mm, copepod eggs were the #1 food item. Most of the bivalves were found in the surface night samples,

while the 30 meter isobath (as opposed to the 8 and 22 meter isobaths) represented the highest number of bivalves found at these three stations.

Using the Spearman test, no correlation was found between the length of the G. lineatus larvae and the size of the bivalves found in their guts or the number of bivalves found in situ. These preliminary findings point the way to more research needed to understand the role of these bivalve veligers in larval nutrition.

PERSONAL GAINS

During the two years that I spent as a trainee, I gained good scientific experience. I can now better understand the complexities of ichthyoplankton research and can better interpret the findings of other such studies. This work also tied in nicely with my master's degree program in marine affairs: better understanding of larval recruitment is essential information for estimating the stock size, which is vital information for fishery managers. Without this job experience, I would feel a lot less qualified and prepared to find a job in my field of fisheries management.

California's Coastal Population: Transition and Development (R/CM-27)

Margo Koss, Department of Sociology, University of Southern California

INTRODUCTION

California's population is growing rapidly and is concentrated in urban areas along the coast and inland waterways. Analyses of the growth and its distribution and of the associations between population growth and changes in environmental quality and land use are prerequisites for effective policy-making in the areas of land use and growth promotion or limitation. The monograph produced by this project will present these analyses in a thorough but easily comprehended form for policymakers and interest groups involved in coastal population and land use policy. A similar monograph based on the results of the 1970 census (the current project utilizes 1980 census results plus later estimates) was widely used.

GOALS AND OBJECTIVES

The overall goal of the project is to promote more effective coastal population policy by providing an information base for policymakers. The immediate goal -- the approach to accomplishing the overall goal -- is the production and dissemination of the monograph on the population of California's coastal and inland waterway areas.

My dissertation is focused on an aspect of population policy and planning in California: the process of adopting and using population projections in planning. My hypothesis is that population projections are to some extent "self-fulfilling prophecies" that may promote population growth when they are high or retard it when they are low. The dissertation requires a thorough knowledge of California population trends and of population data, because testing of the hypothesis requires that I assess whether any population changes have been produced by the use of projections. The work on the Sea Grant project has familiarized me with the population trends and data.

In addition to the dissertation, my objectives in the traineeship are similar to those for the project as a whole: to produce and help disseminate the monograph to policymakers.

RESULTS AND FINDINGS

During my traineeship, I have gathered and analyzed 1980 census data on the population of California's coastal and inland waterway counties, cities and, in some cases, census tracts. I have also gathered information on land ownership in these zones and on changes in land use during the last decade, and analyzed the associations between population changes and land use changes in those areas where land use information was available. Conversion of natural land and agricultural land to urban uses is proceeding at a rapid rate in the coastal zone, and it appears likely that unless stronger policy tools are used, the only coastal land that will be secure from development is that retained and managed as open space either by public ownership or by committed organizations or individuals. Because only a small fraction of the coastal counties' land is publicly owned, projections of population growth and land use based solely upon past trends suggest a densely settled urban strip from Marin County south to the Mexican border by the mid-21st century.

Policymakers must consider whether this settlement pattern is desirable for our coast, and what policy tools may be used to achieve desired population patterns.

PERSONAL GAINS

I have gained a better understanding of the population trends in the state and of their possible implications for the environment. I have also learned that many people are concerned about the issues and have done much work on coastal population and land use policy, but that results have been mixed. It appears that population pressure and development interests threaten to outweigh the public interest in coastal population policy, and I've developed a greater interest in the problems of defining the public interest and developing effective policies to serve it.

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

Shishir Shah, Department of Mechanical Engineering,
University of Southern California

INTRODUCTION

Relatively few studies exist on corrosion fatigue of weldments in the marine environment, particularly for the low frequencies (0.1 - 0.2 Hz) associated with offshore structures. This research undertakes such a fundamental study relating fatigue design parameters to corrosion fatigue mechanisms and crack propagation rates.

GOALS AND OBJECTIVES

1. To study crack growth in weldments in a corrosive fatigue environment.
2. To fix and calibrate the CGS servohydraulic testing system.
3. To make welds on Class II and Class III steel plates by using a "powder filled submerged arc welding technique."
4. To study the microstructure of weldments.

RESULTS AND FINDINGS

Within a few months of beginning the program it became clear that equipment malfunctions would delay the project. However, during the first year, we were still able to move the CGS servohydraulic fatigue machine, level the crosshead, and overhaul the pump and hydraulic systems.

Rockwell International Corp. donated a surplus control console for the CGS Model 110-12A servohydraulic fatigue equipment. The equipment, however, had to be rewired to suit the project.

Another corporate donation, steel plates from ARMCO Inc., Southwestern Steel Division, required welding. In addition, grips and pullrods for the testing machine were designed.

While these modifications were taking place, I was permitted to gain valuable experience as an observer in the fracture mechanics laboratory at Northrop Corp.

Other project assignments included cutting steel for tensile and impact test samples, polishing samples for optical metallography, and photographing progress of the project. We also completed impact tests for Class II and Class III steel, and heat treated and lubricated grips and pull rods.

PERSONAL GAINS

I learned a lot while working on this project. It was a challenging project that required knowledge of various areas such as fatigue analysis, microstructures of steels, welding processes and some electronics. I was able to finish my master's degree in mechanical engineering while working on the project.

The project made me realize that being a research assistant doesn't require only the knowledge of one's own field; one must also have a variety of skills and good knowledge of modern computer technology, photography, etc.

Although this was only my first year with the project, I learned to use the scanning electron microscope, learned how to run fatigue tests and was able to meet many people at Rockwell International and Northrop. In addition, I presented a report on my work during a monthly Sea Grant trainee meeting.

Fees for Services at Seaports: Pricing Approaches, Federal User Fees, and Public Policy Issues (R/CM-26)

Penelope G. Jones Van Dyke, Master of Marine Affairs,
Institute for Marine and Coastal Studies, University of
Southern California

INTRODUCTION

The purpose of this research grant was to examine the public policy implications with respect to the pricing of seaport services. Areas of emphasis were: public pricing theory, using data gathered primarily from California ports and some Oregon ports; the role of marine terminal conferences, with emphasis on California and the California Association of Port Authorities (CAPA); and the impact of federal user fees on port pricing structures.

The first half of the research project was directed toward the role of CAPA in the pricing structure of California ports, (this area to be more thoroughly investigated via questionnaire and personal interviews later in the research); the conceptual notion of pricing port services; tracking the various user fee bills, including comparative analysis; communicating with local port authorities regarding their official positions on the various bills, and the potential impacts of such legislation on shipping, port development, operation and maintenance of ports, and the various consumer levels terminating with the final product user.

GOALS AND OBJECTIVES

The concept and purpose of pricing is to recoup all costs (factors of production) associated with producing a goods or service. Included in the process is the opportunity cost of diverting the capital from another potentially viable product. In addition, there is a risk factor that arises from the assumptions made when evaluating the financial viability, and volatility, of a product. In essence, it is an error factor derived from forecasting the future economic and consumer environment in which the product will, or would be, financially successful.

In addition to opportunity costs and risk factors, a return on investment, or return on invested capital, is calculated into the cost. Normally, all three cost factors are termed the ROI (return on investment) and calculated, in sum, as an addition to the actual cost, including overhead, of providing the goods or service. The notion of profit comes into play because if the intangible assumptions are minimally correct, along with the actual cost factors, then

revenues should exceed costs. The distribution of any such profits, however, is determined by the instrument which established the port authority. This gives rise to the public policy question of should there be any "profits" in a public entity; and if there are "profits," to whom and in what manner should they be disbursed or retained by the port itself. In other words, who should benefit, and to what use should these excess dollars be put. These notions apply to and affect not only pricing theories, but also the impact of and controversy surrounding the potential imposition of user fees.

RESULTS AND FINDINGS

CAPA's role in pricing as a marine terminal conference appears, upon preliminary investigation, to be one of data gathering and coordination. A proprietary formula is applied to all of the cost data submitted by the member ports to the rates and tariffs committee. This committee then submits for approval to the member ports and the Federal Maritime Commission a rate and tariff schedule for most cargoes and services. Conference rate setting alleviates pricing competition between members, thereby allowing competition on the basis of services and/or facilities available or provided; intermodal transportation linkages; and the size, demographics and demands of the hinterland.

This practice has very possibly fostered competitive leasing practices, and preferential assignment agreements that allow for a tariff break at specified levels of cargo handling, and/or a percentage split if there is a rate increase. This results in the ability of larger, multi-purpose ports to increase their share of the market and, therefore, their throughput to the possible detriment of smaller ports (other factors remaining equal), which cannot negotiate as favorably because of financial considerations. It is also possible that the long-term effect could result in a highly specialized port system which, in turn, could exacerbate the precarious financial positions of the less financially successful ports. This then could further regionalization and/or cargo specialization.

During the past few years there have been numerous pieces of legislation proposed which would impose a fee, or tax, on the vessels and/or cargo which passes through the ports. The intent is to lessen, or eliminate, the cost of channel operation and maintenance (O & M) to the federal government, and to help finance, either in whole or in part, channel deepening and the resulting increase in O & M. Currently these costs are borne by the federal government. There are various issues raised by the proposed legislation, including: the constitutional mandate to provide for trade within and among the states, and other nations; non-

discrimination between the U.S. ports; low-maintenance versus high-maintenance ports; large ports versus small ports; allocation of the dollars collected; the St. Lawrence Seaway and Great Lake ports which already have special fees and taxes; who should pay for current O & M -- users or the federal government; how should the fees be structured; what structure to apply to deepening project and/or new developments along with the resulting increase in O & M expenditures, etc.

Solutions to these policy questions and others have not yet been defined. Solutions are very much influenced by the differing perspectives of the ports, in addition to the political clout that various port coalitions and other port organizations wield in Congress. Additionally, the various social and political preferences of the legislators themselves contribute greatly to the complexity of the issues.

PERSONAL GAINS

The ability and opportunity to bring together four years of undergraduate work in business management with eighteen months of graduate work in marine affairs has allowed me to focus on the dynamics of the two areas that I have chosen to combine for a professional career. In addition, the project has provided a "real life," practical versus theoretical, educational experience which, is generally not available in the classroom situation.

Fees for Services at Seaports: Pricing Approaches, Federal User Fees, and Public Policy Issues (R/CM-26)

Kathleen A. West, Urban and Regional Planning, University of Southern California

INTRODUCTION

Seaports have two significant features that influence their economic activity. First, largely because of the importance of location and physical setting and the substantial capital investments necessary, modern ports are typically "natural monopolies." Second, they are typically organized as public enterprises that must generate sufficient revenues to recover all capital and operating costs (including surplus revenue to support future capital development to serve increasing demand). Economic theory suggests that seaports, as natural monopolies, are in a position to either reap excess profits with a loss of social welfare or to maximize community welfare and suffer financial losses. Economic theory also assumes the availability of perfect knowledge, which is not a fact in reality. How do port managers balance the theoretical economic extremes and accomodate political and market influences as well?

In the larger perspective, the significance of this project is in its effort to identify and evaluate the efficiency of port pricing methods and mechanisms in allocating private and public resources. Thus, while port expenses, themselves, represent a minor component of the eventual cost of goods to the consumers, they can be a key factor in the distribution of economic activity between communities, modes of transportation, and production intermediaries. The development of a modern port also represents a substantial commitment of public resources -- usually prime waterfront land as well as major capital equipment items (dredging, wharfs, cranes, shed, etc.). The prices set and paid for the use of these resources should function to justify the commitment and to ration use by competing users.

From an even broader perspective, ports are among the most established and experienced examples of public enterprise in the United States. With the revenue and spending constraints instituted in the last decade, local jurisdictions have found the establishment of "public enterprise" authorities the most attractive vehicle for "public" activity. These public enterprises are rather lost in an economic theory gap. They rarely face any substantial market competition. Their private enterprise motivation is modified by some commitment to public purpose.

Their public responsibility, however, also is incomplete because of the explicit effort to protect their supposed free enterprise efficiency from political pressures. The development of this type of economic organization requires substantial evaluation, modification and refinement.

GOALS AND OBJECTIVES

Although this research specifically avoids any systematic comparison of the resulting prices, it does consider a number of potentially significant factors in the organizational and economic environments in which ports set their prices. Of specific interest are:

1. The functional variables considered as a basis for prices -- Cost. Competitors' prices. Political interests. Customers' interests, particularly those of industrial cartels.
2. The availability of any source or type of revenue subsidy.
3. The potential impact of proposals to discontinue the present regulation of port prices. In what way and to what extent does federal regulation influence port prices? And, similarly, in what way and to what extent does the federal antitrust exemption that permits organized pricing action influence port prices?
4. The potential impact of the various proposals to require some form of channel user fees to reimburse the Corps of Engineers for the expense of dredging and maintaining the channels.
5. The direction and extent of the relationship between port service prices and capital development by the ports.

The data base selected for this year's research includes all maritime ports in the State of California:

Crescent City	Redwood City
Humboldt	Richmond
Long Beach	Sacramento
Los Angeles	San Diego
Oakland	San Francisco
Port Hueneme	Stockton

It also includes the ports of Portland, Coos Bay and Astoria in Oregon and the port of Kalama in Washington. These ports are in naturally competitive positions with the California ports. This group of ports includes both larger

ports (Los Angeles, Long Beach and Oakland) and smaller ports (San Diego, Port Hueneme, etc.), enabling further identification of variations due to size.

A survey instrument was developed translating the research issues into questions related to everyday management decisions. Because of variations in port operations (landlord vs. operating, breakbulk vs. containers, etc.) and differing degrees of management sophistication, a number of questions were developed for each research issue. In a number of instances, it took two or three questions on one issue to inspire or stimulate a response that would actually contribute to the research effort. Often the response to the most direct question is "No, we don't do that" or "Sure, we do that." However, as the issue was pursued in subsequent questions, a very different response surfaced. The survey design also attempted to differentiate between theory and reality. In particular, it included questions that attempted to identify the approaches of port management to the reality of uncertainty, risk and imperfect knowledge.

During the fall, the trainee effort by Penny Jones Van Dyke focused on an extensive search of the literature related to port management, port development, public enterprise and pricing policies. The various legislative proposals for changes in the regulatory environment of port operations were identified and their progress monitored, as was the testimony for and against these proposals. This work provided a foundation for development and conducting the survey of port managers and financial officers to identify the methods and considerations which determine the prices charged for port services.

In the spring, my work provided support and assistance for the survey process in Southern California as well as continued work on the literature search. The ports of Long Beach, Los Angeles and San Diego were each visited at least twice to secure the necessary interviews. Port Hueneme refused to be interviewed, but with persistent trainee contact agreed to complete the survey instrument in writing, thereby completing the desired sample.

RESULTS AND FINDINGS

While the evaluation of the survey responses is continuing, preliminary analysis has exposed several provocative findings. The survey responses suggest:

1. In contrast to the efficient maximizing pricing techniques of economic theory, the prices charged for port services in California are based on the expectation of a "legitimate" return on the public investment and on what the market will bear. The

criteria, however, for a legitimate return on investment remains unclear and may, in fact, be a variable dependent on the circumstances.

2. The prices for port services are not based on costs. In general, the ports have relatively simple accounting systems and they have not adopted the more sophisticated cost accounting systems that are available.
3. The prices for port services are most strongly influenced by the competitive strategy between the ports and the alternative transportation modes rather than perfect competition or a maximizing of "what the market will bear" approach. There is extensive port interaction focused on pricing; port managers appear to be well informed on their price and non-price competition.
4. Although there are several alternative methods for imposing user fees to recoup the costs of dredging and maintaining the channels (by dredging requirements, by traffic regardless of dredging requirement, by value of cargo, by volume of cargo, etc.) none of the alternatives appears to be clearly "the most fair" or the "least distortive." The proposed fees appear to generate minimal concern. Apparently the most viable proposals (and none have evidenced much success) would have minimal impacts on total port service expenditures and, thus, on the existing competitive balance. These findings are in contrast with the Congressional testimony of the various shipping interests on the Atlantic Coast who feel one formulation or another would drastically alter the competitive environment.
5. The review and regulation of the pricing of port services by the Federal Maritime Commission and the exemption of port price discussions by the California Association of Port Authorities (CAPA) from antitrust regulations do not function as typical regulatory and constraint of trade activities. A port, as a natural monopoly, must set the price for its output (unless it is auctioned). The price theoretically indicated for this type of producer requires knowledge of the cost-quantity relationships of demand production, as well as the cost-quantity relationships of supply production, to identify either the producers' optimum or the social optimum. The public review of the port prices and the CAPA discussions, in conjunction with volume data from other sources, supply the ports with the demand curve information they need.

One should also note that this research effort could be replicated using other regional or national data bases. Of particular interest for comparison purposes would be studies of the ports in the Northwest, the Gulf area, the Great Lakes and the Atlantic Coast. An international comparison would extend the range of alternative structures and could provide valuable considerations for federal policy and marketing.

PERSONAL GAINS

The benefits I have gained from working on this project include increased interest and expanded knowledge in public financial activities, particularly the activities of public enterprises. My efforts in the literature search for this project served as the basis for one of the three questions I answered to successfully complete my doctoral qualifying exams last spring. I feel the expertise I am developing in this area will be valuable in the future both as lecture material and as a public finance consulting resource. I have developed a sensitivity and concern for the significance of port activity in the development of a local economy. I anticipate developing this interest into a proposal for my dissertation during the next few months.

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

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INTRODUCTION

A great deal is still unknown about the process involved in the phenomenon of Paralytic Shellfish Poisoning (PSP). What is known is that PSP is related to the presence of toxic dinoflagellates (phytoplankton) in the water column. Also in the water column are decapod crustacean larvae, which constitute a significant fraction of the zooplankton that feed on the phytoplankton.

These toxic dinoflagellates are clearly shown to be spreading and threatening Southern California as shown from our own monitoring studies in the Los Angeles Harbor area. The causative agent of PSP, the toxic dinoflagellate Gonyaulax catenella, was isolated from the waters of the Los Angeles Harbor and subsequently cloned cultures of these cells were obtained. This was the main motivation of the present project.

Further motivation drives from fish kill due to ingestion of copepods that fed on toxic dinoflagellates. In present experiments in the laboratory, feeding crab larvae with toxic dinoflagellates, resulted in the accumulation of PSP by the crab larvae. It is probable that transfer of toxin from crab larvae to fish may also be a cause of fish kill.

The results from these studies may elucidate the effects of PSP on marine trophic levels other than those of bivalve molluscs to man.

GOALS AND OBJECTIVES

The overall goals of the project:

1. To understand the role that unialgal cultures play in the development of yellow rock crab, Cancer anthonyi, larvae.
2. To determine if PSP can enter and affect coastal food chains in any manner other than through adult shellfish.
3. To understand the effect exerted by crab larvae fed on toxic dinoflagellates on certain fish and/or

fish larvae. This will test the possible occurrence of fish kill and the existence of PSP.

The trainee's objectives:

1. To conduct feeding experiments to specifically study the larval stages of a decapod crustacean (C.anthonyi) fed only on unialgal cultures of certain diatoms and nontoxic species of dinoflagellates.
2. To conduct feeding studies using cultures of G. catenella, a toxic dinoflagellate which was isolated from the Los Angeles Harbor waters, to determine the possible bioaccumulation of toxin by the crab larvae.
3. To conduct a series of feeding experiments using different kind of fish and/or fish larvae and those crab larvae fed on toxic dinoflagellate, G. catenella, to determine possible fish kill.

RESULTS AND FINDINGS

In July 1982, I isolated cells of G. catenella, a toxic dinoflagellate and causative agent of PSP, for the first time from the waters of the Los Angeles Harbor. Clonal cultures of these cells have been established, and the extract prepared from these cultures and tested by the new fly bioassay proved to be toxic.

Initially, larvae of yellow rock crab were successfully grown in the laboratory from zoeal stages to megalopa when fed only on unialgal cultures of nontoxic phytoplankton, including diatoms and dinoflagellates as the sole food source. As a feeding experiment, freshly hatched crab larvae were exposed to the cultures of G. catenella. Crab larvae ingested the cells and survived an eight-day experiment. Further feeding studies were made to investigate if the larvae accumulate PSP toxin. Crab larvae were exposed to a culture of G. catenella, then were collected, washed with filtered sea water, blotted dry and homogenized in an acidic solution. The extract of the larvae was tested by the fly bioassay and shown to be toxic.

The crab larvae capable of raptorial feeding on G. catenella showed normal development. They are unaffected by the PSP toxin, but accumulate it.

Further studies are being conducted to investigate the effects of toxic crab larvae (those fed on G. catenella) on

fish and/or fish larvae. This has important ecological implications for coastal food chains.

PERSONAL GAINS

This study has helped me learn the usage of the sensitive fly bioassay and the application of the assay for measurement of PSP toxin and the toxicity. My findings from this project were very important and I have been awarded an honorable mention by the Sea Grant Association for the results of this project. The project also helped me to complete a part of my dissertation research work.