1984-85 TRAINEE REPORT

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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of the crab C. anthonyi through all zoeal stages to megalopa stage by feeding them certain dinoflagellates or diatoms (unpublished).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.

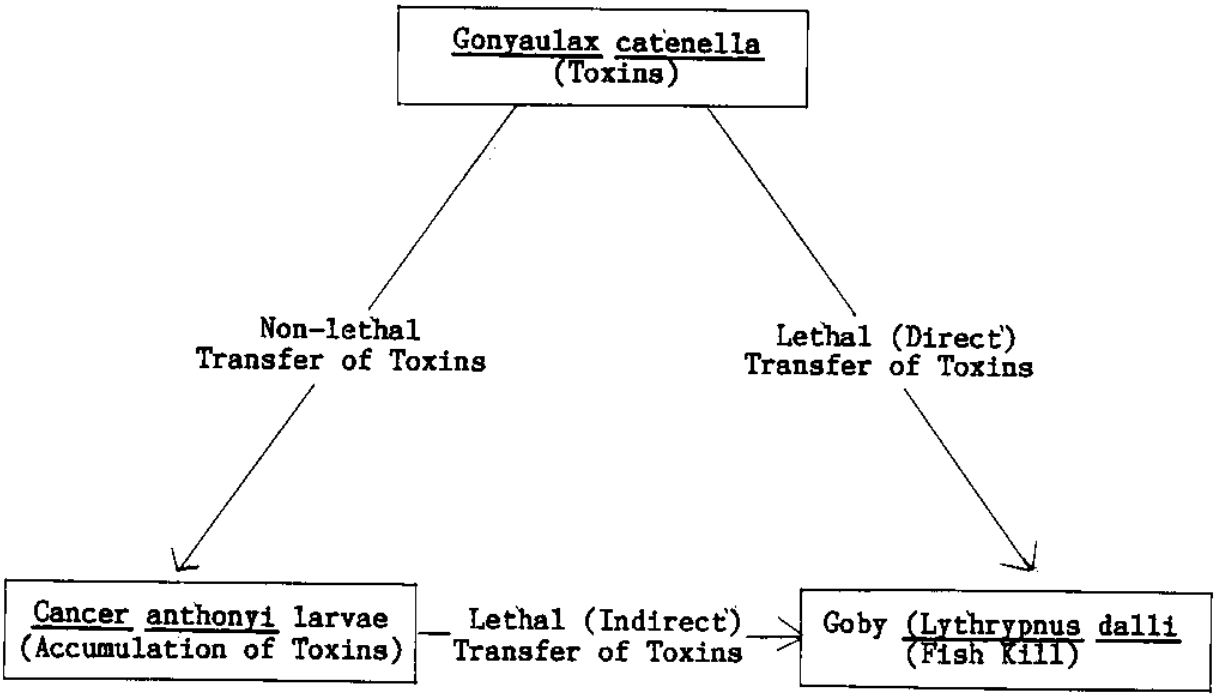

FIGURE 1

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