

Emerita analoga (Stimpson) as an Indicator Species for Paralytic Shellfish Poisoning Toxins along the California Coast

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ABSTRACT

Paralytic shellfish poisoning toxins (PSPT) pose a serious threat to public health worldwide. Along the west coast of North America, *Mytilus californianus* has long been used as the primary indicator species for monitoring levels of PSPT in the environment. However, because the distribution of this species is limited to rocky shores, vast stretches of sandy beaches are not monitored for PSPT. This lack of information greatly reduces our ability to track and predict harmful algal bloom development and movement along the west coast of much of North and South America. Early studies on *Emerita analoga*, a common sandy shore invertebrate of the eastern Pacific, showed that this species can sequester saxitoxin (STX, the primary neurotoxin produced by PSPT blooms) in its tissues. The purpose of this study was to develop a PSPT extraction protocol for *E. analoga*, and to compare the utility of this species as a PSPT indicator with that of *M. californianus*. Samples of both species were spiked with known amounts of saxitoxin and processed (*M. californianus* with the standard acid extraction procedure and *E. analoga* with the new adapted acid extraction process). Spike and recovery results show that the percentage of STX recovery for *E. analoga* is 3-9% higher than for *M. californianus*. To compare the uptake and depuration rates of PSPT for the two species under identical field conditions, samples of each were collected at six pairs of adjacent rocky and sandy beaches, along the central coast of California in 1998 and 1999 from April through November, the season of historically high PSPT. Results from these comparisons showed *E. analoga* to be a reliable indicator for PSPT HAB events along sandy shores.

INTRODUCTION and METHODS

Harmful Algal Blooms

- Harmful Algal Blooms (HABs) are caused by dinoflagellates and occur around the world
- Some of these phytoplankton produce a group of neurotoxins called Paralytic Shellfish Poisoning Toxins (PSPT)
- In mammals, high PSPT concentrations block the sodium channels in the brain and can result in respiratory paralysis, and eventually death.

Current Monitoring Program for PSPT's

- The California Department of Health (CDH) monitors for HABs by regularly testing *Mytilus californianus* (Figure 1) for PSPT toxicity.
- A mouse bioassay is used to detect levels of toxicity in the mussels.
- If toxins are present, a warning is immediately sent out to the public.

Where's the Problem?

- Sandy beaches constitute 60% of the California coastline.
- Since *Mytilus* tend to live on rocky shores, sandy beaches are not monitored for PSPT toxicity.
- The result is a lack of information on the occurrence and distribution of Harmful Algal Blooms along our coasts.
- There is then a need for an indicator species of PSP toxicity specifically for sandy shores.

Characteristics of a Sandy Beach Bio-indicator

- The organism should be abundant throughout the study area.
- Sample collection should be easy.
- The organism should be of a reasonable size for tissue extraction.
- The organism should reveal gradations of the toxin relative to the amount found in the environment.

Emerita analoga as an indicator for PSPT (Figure 2)

- Occurs naturally on sandy beaches along the western coasts of North and South America.
- Easy to locate, they aggregate in dense patches on the beach.
- Filter-feed on plankton.
- Known to accumulate PSP toxins.

General Approach

In the laboratory, the *Mytilus* extraction protocol was used as a starting point, and refined for *Emerita* with spike and recovery testing. Simultaneous field sampling of *Mytilus* and *Emerita* at paired rocky and sandy shore sites exposed to the same HAB conditions was used to compare PSPT concentration time series for both species.

Spike & Recovery

- Mytilus* and *Emerita* were spiked at 6 toxicity levels: 0, 50, 100, 200, 500 and 1000 µg (n=3 per level)

Field Comparisons of *Mytilus* and *Emerita*

- 6 sites (Kettle, Limantour, Moss, Pescadero, Pfeiffer and Pfeiffer Beaches) were chosen along a historical PSP gradient based on historical records (Figure 3).
- Paired *Mytilus* and *Emerita* samples were collected from rocky and sandy beaches at each site.
- Samples were collected bi-weekly from April - August in 1998, and April - November in 1999.
- 1998 and 1999 *Mytilus* samples were extracted and analyzed by CDH using mouse bioassay.
- 1998 and 1999 *Emerita* samples were extracted at CSU Monterey Bay, and the resulting extracts were sent to the CDH for mouse bioassay. Minimum detection limits (MDL) = 40µg.



Figure 3: Study sites

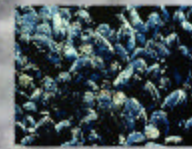


Figure 1: *Mytilus californianus*



Figure 2: *Emerita analoga*

RESULTS

Spike & Recovery Results

- No significant difference in saxitoxin recovery for *Emerita* or *Mytilus* (Figure 4).

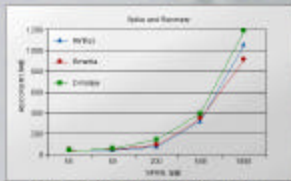


Figure 4: Spike and recover result show no significant difference in recovery for *Emerita* and *Mytilus*.

Mussel versus *Emerita* Field Comparisons

- PSP toxicity values reached or exceeded the 80µg STX quarantine level at least once at each site during the study period for a total of 7 toxic events.
- Mytilus* and *Emerita* toxicity levels generally rose and fell in synchrony at all sites (figures 5-10).
- During 4 of the events both *Mytilus* and *Emerita* toxicities exceeded 80µg STX (figures 5, 6, 8 & 10).
- During 2 of the events *Mytilus* toxicity exceeded 80µg while *Emerita* toxicity was elevated but did not exceed 80µg (figures 5 & 7).
- During one of the events *Emerita* toxicity exceeded 80µg while *Mytilus* did not (figure 6). (But may have prior to the start of the sampling period.)

Conclusions

- Emerita* served as an excellent indicator for PSPT.
- All PSPT events detected with *Mytilus* were also detected with *Emerita*.

Acknowledgements

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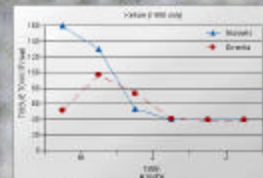


Figure 5: At the beginning of the Kettle sampling period (25 April 1998) *Mytilus* toxicity was at 100µg, while *Emerita* did not peak until the first week of May.

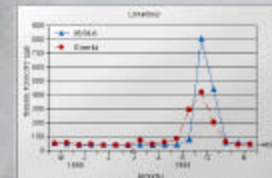


Figure 6: Toxicity levels at Limantour remained low until September of 1998 when *Mytilus* toxicity rose to 810µg and *Emerita* peaked at 410µg.

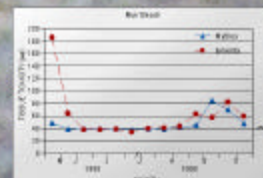


Figure 7: At the start of the Moss Beach sampling period (29 April 1998) *Emerita* toxicity levels were at 130µg while *Mytilus* were below the 80µg quarantine levels. In September of 1998 both species peaked above 80µg.

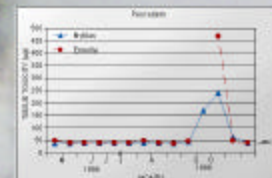


Figure 8: Pescadero *Emerita* and *Mytilus* toxicity rose and fell in synchrony, with *Emerita* exceeding *Mytilus* (408µg and 240µg respectively) in early October of 1998.

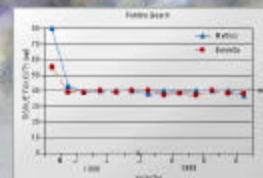


Figure 9: At the start of the 1998 sampling period at Pfeiffer Beach, *Mytilus* and *Emerita* values were at 80 and 50µg respectively. Both declined to the detection limit within two weeks and remained there for the duration of the study.

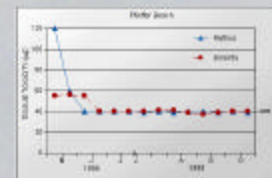


Figure 10: At the start of the 1999 sampling season at Pfeiffer Beach *Mytilus* toxicity values were at 120µg and *Emerita* were slightly elevated to 55µg.