Brevetoxin exposure in nesting loggerhead sea turtles (Caretta caretta) and effects on immune system health

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Introduction

Florida’s Gulf Coast experiences frequent red-tide events caused by the toxic dinoflagellate Karenia brevis

Karenia brevis releases neurotoxins (brevetoxins) causing fish kills, marine mammal mortalities and adverse affects on human health

Marine turtles are exposed to brevetoxins through inhalation of aerosolized toxins and ingestion of red-tide exposed prey

As predators on filter-feeding organisms, loggerhead sea turtles (Caretta caretta) are especially susceptible to the effects of bioaccumulation; little is known about potential sublethal effects this toxin has on marine turtles

Marine turtles fast during the nest season, thus stored toxin can be metabolized from fat stores

Brevetoxins persist in the environment and in prey items for over a year, which could result in prolonged exposure in marine turtles

The last major red tide event on Florida’s Gulf Coast occurred May 2013

Objectives

1) Determine brevetoxin concentrations (ng PbTx-3/ml) in the plasma and scute of nesting loggerhead sea turtles

2) Determine if brevetoxin exposure was related to immune system health

Materials and methods

Blood and scute samples were collected from nesting loggerhead turtles on Nokomis Beach, Florida USA

Scute samples were prepared for ELISA through solid phase extraction

Plasma and scute samples were analyzed for brevetoxins using a competitive ELISA

Plasma was also analyzed for:

- Superoxide dismutase (SOD) activity using an SOD Assay kit
- Total protein using a handheld refractometer
- Plasma protein fractions (albumin, α1, α2, β, γ) using agarose gel electrophoresis
- Lysozyme activity using a lysozyme assay kit
- Leukocyte differentials using thin blood smear slides

Extracted plasma was analyzed for specific brevetoxin congeners through LC-MS/MS

Plasma from captive turtles was tested for brevetoxin concentrations, SOD activity and lysozyme activity to serve as a control

Results

Figure 1. Mean (±SE) plasma brevetoxin concentrations and (A) lysozyme activity and (B) superoxide dismutase activity in captive and nesting loggerhead sea turtles. Brevetoxin concentrations, lysozyme activity and superoxide dismutase activity were significantly higher in nesting turtles in comparison to captive, unexposed animals. *Brevetoxin concentrations, lysozyme activity and superoxide dismutase activity were significantly different between the captive and nesting turtles (P < 0.05).

Discussion

All nesting females (n = 29) tested positive for brevetoxin exposure, indicating that this toxin is extremely persistent in tissues and the environment

There were significant differences between plasma brevetoxin concentrations, lysozyme activity and SOD activity between captive and nesting turtles (Fig. 1) indicating that brevetoxin may cause upregulation of certain enzymes that are symptomatic of immune and oxidative stress

Plasma brevetoxin concentrations showed a significant positive correlation with γ-globulins (Fig. 2). The γ-globulins consist of immune proteins and so an increase in these proteins may be indicative of immune system stress

PbTx-3 was found through LC-MS/MS in low concentrations in the plasma of nesting turtles (Fig. 3) potentially suggesting recent exposure to this toxin and/or toxin metabolism

Brevetoxin was detected in the scute of nesting loggerheads through the ELISA procedure. Therefore, the scute may serve as a site of elimination for toxin metabolites

These findings show that red-tide events can affect the health of organisms for a long time after the event. This data is important for conservation efforts, as well as for turtles that enter rehabilitation facilities due to brevetoxicosis

In the future, maternal transfer of this toxin should be studied to understand how the lingering affects of this toxin on offspring

Literature cited


Acknowledgments

We thank R. Pimont, M. Henry, K. Lusek, M. Lauten, D. C. Newell, J. L. Nau, M. J. Staud, B. A. Palet, M. J. Smith, M. J. Staud, B. A. Palet, M. J. Smith, M. K. Bunt, L. J. Mcluhan, J., Ulmschneider, C.A., Fallica, V., Medeiros, M.L., Stacy, B.A., Henry, M., Gannon, J., Remis, J.S., Bunt, L., Sanger, J.H. for help with and equipment for the extraction procedure and LC-MS/MS analysis. We also thank A. Fawcett and A. Inbouli for assistance in sample collection and J. L. Nau for assistance with laboratory procedures. This research was made possible by Mike Marine Laboratory, the National Science Foundation Research Experience for Undergraduates Program (#1155600) and the Florida Sea Grant (PD-14-13).