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**Memorandum**

To: Board of Pesticides Control

From: Pam Bryer, Toxicologist

Subject: Question from June 6, 2018 Board Meeting

Date: May 18, 2018

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At the June 6, 2018 board meeting the question of whether *Bt* is toxic to lobsters was asked. Here is a brief answer to that question. Not surprisingly, the answer is we don't know.

Question: Is *Bt* harmful to lobsters?

Answer: *Bt* has not been tested on lobsters. Attached is a table based on available pesticide toxicity data for lobsters. Few compounds have been tested on any species of lobsters. Both lobsters and *Bt* are fairly unique entities so generalizations are not helpful in extrapolating to other pesticides exposure scenarios.

Reasonable follow-up question: Since *Bt* targets insects and lobsters are closely related can we assume that lobsters would be just as sensitive?

Answer: Typically, shared phylogeny could help predict toxicity, however, the marine environment places a different set of physical constraints on digestive physiology and since *Bt* is a stomach poison we should not speculate. Marine organisms typically have modified intestinal tracts to deal with maintaining the homeostatic balance of outside-saltwater to internal-body composition.

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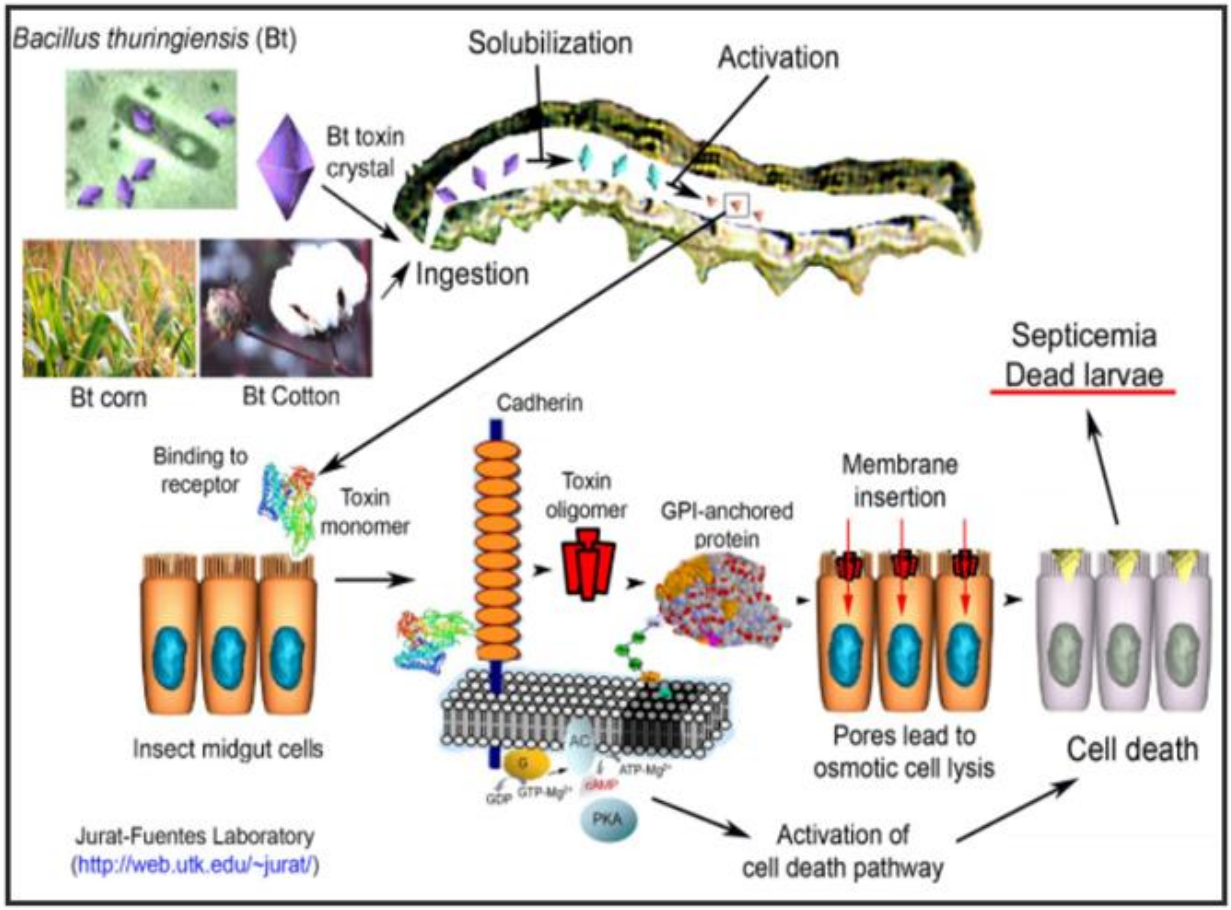


The above figure shows the uptake of *Bt* endospore into the larval gut demonstrating how *Bt's* mechanism of action centers around cells lining the intestinal tract.

## Table 1. Preliminary literature search results on the toxicity of pesticides on lobsters (*Homarus spp*)

| Contaminant | Concentration (ug/L) | Duration | Experimental Notes | Primary Effects | Source |
|---|---|---|---|---|---|
| ***Organochlorines*** | | | | | |
| Endosulfan | | | | -decr survival & metamorphosis | Bauer et al. 2013 |
| Endosulfan | 0.1 | 96h | | -metabolic scope decr (-25%) | Daoud et al. 2014 |
| ***Organophosphates*** | | | | | |
| Malathion | 3.7 | 48h | 16°C | $LC_{50}$ | Zulkosky et al. 2005 |
| Malathion | 38 | 96h | | $LC_{50}$ | De Guise, Maratea, and |
| | 5 | | | -decr phagocytosis | Perkins 2004 |
| ***Pyrethroids*** | | | | | |
| Mixed pyrethrins | 4.42 | 48h | | Stage I | Burridge & Haya 1997 |
| & PBO | 2.72 | | | Stage II | |
| | 1.39 | | | Stage III | |
| | 0.73 | | | Stage IV | |
| Resmethrin | >1 | 96 h | adult | LC50 | De Guise et al. 2005 |
| | 0.75 | 14 d | | LC50 | |
| | 0.1 | | | -phagocytosis decr day5; | |
| | | | | -CHH stress hormone elevated wk4 | |
| | 0.01 | | | -phagocytosis decr wk4 | |
| Resmethrin | 0.26 | 48h | 16°C | $LC_{50}$ | Zulkosky et al. 2005 |
| | 0.095 | 96h | 16°C | $LC_{50}$ | |
| | 0.1 | 96h | 24°C | $LC_{50}$ | |

| Contaminant | Concentration (ug/L) | Duration | Experimental Notes | Primary Effects | Source |
|---|---|---|---|---|---|
| ***Pyrethroids continued…*** | | | | | |
| Permethrin | | | | 0.95 nM changed NO evolution in heart | Casares et al. 2006 |
| Resmethrin | | | | 0.94 nM changed NO evolution in heart | |
| Sumithrin | >1 | 96h | | -no immunotoxicity | Levin, Brownawell, and De Guise 2007 |
| | >1 | 28 d | | -no immunotoxicity | |
| ***Insect Growth Regulators*** | | | | | |
| Methoprene | 10 | 48h | 16°C | $LC_{50}$<br>-1ppb lethal to Stage II;<br>-5ppb lethal to Stage IV;<br>-changes in chitinsynthesis;<br>-hepatopancreas, nervous, epidermal bioaccumulation<br>-90% mortality Stage IV at 50 ppb 3 days;<br>-adult bioaccumulation at 50 ppb to hepatopancreas (1.55 ppm), gonad (5.18 ppm), epithelial (6.17 ppm), and eyestalk (28.83 ppm);<br>-adult incr stress proteins | Zulkosky et al. 2005<br>Walker et al. 2005 |
| Methoprene | | | | -transcriptional changes (xenobiotic metabolism, structural, various) | Horst et al. 2007 |
| ***Flubenzurons*** | | | | | |
| Teflubenzuron | | | | $LD_{50}$-3mo 10 (mg/kg);<br>-morphological abnormalities | Samuelsen et al. 2014 |
| Teflubenzuron | | | | -transcriptional changes 21 of 39 genes (xenobiotic metabolism, stress, molt);<br>-moderate bioaccumulation;<br>-low mortality | Olsvik et al. 2015 |

| Contaminant | Concentration (ug/L) | Duration | Experimental Notes | Primary Effects | Source |
|---|---|---|---|---|---|
| ***Avermectins*** | | | | | |
| Emamectin benzoate | | | | -prompts egg release | Aiken and Waddy 1989 |
| Emamectin | 0.5 | 1X | Recently | -no change; | Waddy et al. 2010 |
| | 0.25 | 2X | ovigerous pre- | -no change; | |
| | 0.125 | 4X | molt female | -difficult molting & death; | |
| | 0.06 | 8X | | -difficult molting & death | |
| ***Other*** | | | | | |
| Temperature | 19C | 7 d | | -larvae couldn't survive through to Stage IV though grew fast;<br>-pH no effect | Waller et al. 2016 |
| pH | <7.9 | | Larval *H. gammarus* | -no mortality or growth changes;<br>-deformities (fused antenna, twisted legs, misshapen claw, curled carapace, puffy carapace, tail fin damage | Agnalt et al. 2013 |