



Special issue "Proceedings of the 2nd International Invasive Sea Squirt Conference"

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Editorial

An overview of the 2nd International Invasive Sea Squirt Conference: What we learned

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Invasive "sea squirts" (a common name for tunicates or ascidians, a group of primitive chordates) have recently become a nuisance in coastal waters throughout the world. Species in this group are notorious fouling organisms of surfaces in the marine environment, including aquaculture structures. In Canadian waters, aquaculture industries in Prince Edward Island (PEI), Nova Scotia and British Columbia are already challenged by invasive tunicates, and the species have recently spread to Newfoundland, New Brunswick and Quebec (Magdalen Islands). Effects on the mussel aquaculture industry in affected estuaries of PEI have been near-catastrophic for the economic viability of the industry. Because of this, PEI was chosen as the venue to bring together approximately 100 scientists and students from Canada, the USA, Israel, Australia, New Zealand, Brazil and Europe, in October 2007, for the 2nd International Invasive Sea Squirt Conference.

In 2005, the 1st International Invasive Sea Squirt Conference convened scientists and coastal managers to discuss what at that time was a relatively new and rapidly growing problem (see conference papers in *Journal of Experimental Marine Biology and Ecology* 342(1)). Even before the end of the first conference the participants identified the need for a second conference to be held two years later, which would follow up on the ideas and collaborations generated by the first conference.

This special issue in *Aquatic Invasions* reports on the 2nd International Invasive Sea Squirt Conference, held 2-4 October, 2007, at Brudenell, Prince Edward Island, Canada. From the conference venue, participants could see and visit the Brudenell River, an estuary with important bivalve aquaculture industries which are among those most affected by tunicates in the world. On the first day of the conference, participants were taken into the field for an introduction to the cultured mussel industry in PEI, and to observe first-hand the effects of four invasive ascidian species on aquaculture. Fresh specimens collected locally were used in a taxonomic workshop led by Gretchen and Charles Lambert. Thirty-three talks and 30 posters on topics in taxonomy, biogeography, ecology, risk assessment and management of tunicates provided opportunities for interaction and information exchange between scientists studying invasive tunicates, resource managers, and affected aquaculture industry stakeholders.

Thirty papers from the conference are included in this special issue of *Aquatic Invasions*. The first group of contributions deals with taxonomy, tunicate distributions and biogeography (Lambert 2009; Stefaniak et al. 2009; Barros et al. 2009; Izquierdo-Muñoz et al. 2009; Carman et al. 2009a; Locke 2009). Continuing on the theme of determining tunicate distributions, the next paper, by Grey, compares survey methods for tunicates. Next, two papers by Darbyson et al. (2009a), and a paper by

Bernier et al. (2009), address vectors of dispersal. Epelbaum et al. (2009) describes culture methods for tunicates to be used in laboratory experiments. A group of papers (Whitlatch and Osman 2009; Mercer et al. 2009; Bullard and Whitlatch 2009; Lengyel et al. 2009; Valentine et al. 2009) examines aspects of the ecology of tunicates through field experiments and surveys of their impacts on natural ecosystems. The next group of papers (Ramsay et al. 2009; Daigle and Herbingier 2009; Arsenault et al. 2009; Rocha et al. 2009; Morris et al. 2009; Gittenberger 2009; Davis and Davis 2009; Lutz-Collins et al. 2009) investigates the interactions of tunicates with aquaculture and fisheries. The remaining papers deal with management of tunicates. Carman et al. (2009b) and Locke et al. (2009a) examine some control methods and their consequences. Locke et al. (2009b) and Locke and Hanson (2009a,b), review rapid responses in the marine environment and propose a rapid response framework. The issue ends on a positive note with an overview of the market potential of *Styela clava* by Karney and Rhee (2009).

The conference ended with a discussion, chaired by Arthur Smith, of management issues, especially those associated with aquaculture industry impacts. This discussion was designed to provide an opportunity for participation and interaction between researchers and the shellfish and other affected industries, to discuss industry priorities for scientific information and to identify critical research needs. Participants were asked to provide an overview of the effects of invasive tunicates on aquaculture industries in their country or region (state, province) or in those they had recently visited (Annex 1).

This overview of worldwide aquaculture impacts indicated that other areas of the world which have some, if not all, of the same invasive species as PEI - or in some areas more invasive species - are not reported to be experiencing impacts on their aquaculture industry operations at the level of severity observed in PEI. Evidently, with changing environmental conditions and increasing international maritime trade there is the potential for an even sharper increase in the number of successful invasions. Research into "high probability" species and the mechanisms of the invasion process itself will play a vital role in assessing where best to focus monitoring efforts. Proactive research on the ecology, possible impacts, and mitigation of tunicate species with a high likelihood of

invading PEI waters was one of the priorities expressed by local industry members. *Didemnum vexillum*, in particular, is a species of concern to the PEI aquaculture industry. The opportunity to learn about work being done elsewhere on *Didemnum vexillum*, and to understand its environmental requirements, was a useful outcome of this conference for local industry.

Clearly, the development of methodologies and protocols for the management of tunicates to mitigate their impacts on aquaculture and fisheries industries, and to reduce the likelihood of establishment in new regions is a priority, especially for the aquaculture industry in PEI. New Zealand has also been very active in this area. One message that clearly came across in this conference is the degree to which invasive tunicates are an international issue. The same species of tunicate show up over and over as being established in the worldwide invader fauna, particularly in the temperate zones.

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Annex 1

Summary of responses to the following questions on worldwide aquaculture impacts posed to conference attendees:

1. What invasive tunicate species are present in your area and what impact have they had on aquaculture operations?
2. What management practices have been put in place in an attempt to control the further spread of tunicates and how successful have the practices been?
3. What (if any) mitigation techniques have been developed to control the fouling and how successful they have been?

<p>Cynthia McKenzie – Canada (Newfoundland)</p> <ol style="list-style-type: none"> 1. <i>Botrylloides violaceus</i> and <i>Botryllus schlosseri</i> were recently detected in Newfoundland. <i>B. schlosseri</i> may have been present for several decades before its recent detection. 2. Currently in the early stages of infestation, Newfoundland is working on preventing the spread using a Rapid Response plan. Protocols are in place, from federal & provincial fisheries departments, for mussel growers to treat harvested mussels with brine before transfer of product to processing, which is 14 hours away on the west coast. However the Canadian Food Inspection Agency requires that this brining be done at the plant, the problem is that after a 14 hour trip, this causes high mortalities. 3. They are trying to develop protocols for the next species.
<p>Arthur Smith – Canada (Prince Edward Island)</p> <ol style="list-style-type: none"> 1. <i>Styela clava</i>, <i>Ciona intestinalis</i>, <i>Botrylloides violaceus</i> and <i>Botryllus schlosseri</i> are present in Prince Edward Island. <i>Ciona</i> and <i>Styela</i> have had severe impacts on suspended mussel aquaculture operations; the two colonials have also affected mussel operations but less than the solitary species. 2. Management is largely through quarantine of affected areas and permitting of transfers of spat and harvested product only between “like” water bodies, i.e., from infested estuaries only to other infested estuaries. 3. Mitigation of fouling is mainly by application of hydrated lime to mussel gear at present. Formerly, acetic acid was used as a mitigation method but is harder to apply evenly.
<p>Nicole Lengyel - USA (Rhode Island)</p> <ol style="list-style-type: none"> 1. In Rhode Island, <i>Ciona intestinalis</i> and <i>Didemnum vexillum</i> are affecting oyster aquaculture. University of Rhode Island is working on this. They also have <i>Styela clava</i>. <i>Didemnum vexillum</i> doesn't seem to have affected the abundance of clams in Georges Bank in the past 4-5 years.
<p>Rosana Rocha - Brazil</p> <ol style="list-style-type: none"> 1. No tunicate problems for Brazilian aquaculture at present, though the industry does have many other fouling organisms (e.g. barnacles, hydroids). 3. Growers harvest crop after 6-8 months. Many growers don't bother to treat the lines, some dry the lines on barges. One farm has a huge 20,000 litre freshwater pool; they put their lines in it overnight once a year to control fouling (<i>Styela plicata</i>). There are no laws or regulations in place.
<p>Viola Liebich - Germany</p> <ol style="list-style-type: none"> 1. There are no problems with tunicates yet in Germany. They have <i>Styela clava</i>, <i>Ciona intestinalis</i>, <i>Botryllus schlosseri</i> and <i>Botrylloides violaceus</i>. Blue mussels are harvested by a wild fishery only; some are intertidal, some subtidal.
<p>Adriaan Gittenberger - Netherlands</p> <ol style="list-style-type: none"> 1. Species including <i>Didemnum vexillum</i>, <i>Styela clava</i>, <i>Ciona intestinalis</i>, <i>Botryllus schlosseri</i> and <i>Botrylloides violaceus</i>, etc. can be found on mussel ropes. 2. They have just stopped imports from Ireland. 3. Some farmers are taking lines out of the water, some spraying with fresh water (perhaps under high pressure) to treat.
<p>Garth Arsenaault - Italy</p> <ol style="list-style-type: none"> 1. During a recent visit to Italy he learned of 10-15 tunicate species in the area, including <i>Didemnum vexillum</i>, <i>Styela clava</i>, <i>Ciona intestinalis</i>, <i>Botryllus schlosseri</i> and <i>Botrylloides violaceus</i>. 3. Mitigation efforts were described as “heroic”. Every long line is taken out of the water and suspended on racks above water for 24 hours every forty days. The mussel product is re-socked two or three times during the production cycle. Farms are 10-100 times smaller than PEI but get twice the return.
<p>Debbie Palzat – Canada (British Columbia)</p> <ol style="list-style-type: none"> 1. Species found in British Columbia include <i>Didemnum vexillum</i>, <i>Styela clava</i>, <i>Botryllus schlosseri</i> and <i>Botrylloides violaceus</i>. 2. The impact of tunicates on aquaculture has been very minimal, so the growers are not very interested in tunicates. They have held some workshops on Aquatic Invasive Species, and brought an affected mussel grower from Nova Scotia to a British Columbia Shellfish Growers meeting to raise awareness. 3. There are no formal management practices as yet; the focus is education and awareness. A complete air dry is suggested before moving product. They tumble oysters to improve the product and leave the trays out to dry as they cycle through their gear.
<p>Erin Grey & Jesse Schultz – USA (Washington)</p> <ol style="list-style-type: none"> 1. <i>Styela clava</i> is present but not in the aquaculture areas, in four marinas. <i>Botryllus schlosseri</i> and <i>Botrylloides violaceus</i> have been there for some time and are not a concern. <i>Ciona savigni</i> was found in the Hood Canal, which was a big concern. There was some discussion as to the current status of that population, which some participants from the area thought might have disappeared; but Gretchen Lambert reported that the population was in fact established and bigger than before. 2. They tried to control <i>Styela clava</i> by removal by commercial divers, and it has not moved out of the marinas in three years. There is very little mussel culture, mainly bottom oyster culture. They are trying to get a management plan going, and are trying to make tunicate species prohibited which would make them illegal to transport, buy or sell.
<p>Sonya Bissmire - New Zealand</p> <ol style="list-style-type: none"> 1. <i>Styela clava</i> has been in New Zealand for two years and <i>Didemnum vexillum</i>, <i>Nodostoma</i> and <i>Pyura</i> arrived recently. <i>Styela clava</i> has not reached any major aquaculture areas. <i>Didemnum</i> has, though they don't have to clean their lines etc. 2. They have worked to develop voluntary protocols for moving product and equipment. Efforts are mainly public education, cleaning vessels and gear, they are seeing spin-off benefits from a strong campaign about the invasive alga <i>Didymo</i> which has recently established in New Zealand. One note, in the early stages of an invasion it is easier to get funding. If the invasion happens in a protected area they are a government responsibility. The discussion/controversy as to responsibility is what if impact is on industry? The beef industry, for example, pays levies to manage pests. In ten years time, government will not pay for aquatic pest management in New Zealand.