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SGER: Investigation of Potential Co-Introduction of Fucus serratus and Littorina littorea to North America in 1800s

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Project Participants

Senior Personnel

Name: Brawley, Susan
Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Graduate Student

Undergraduate Student

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

James Coyer, Galice Hoarau, Jeanine Olsen and Wytze Stam of the University of Groningen collaborated on aspects of the Fucus serratus work; I sent them part of the Scottish F. serratus I collected and they worked it up, as well as finishing some relevant Irish collections that they had in silica.

Clifford Cunningham of Duke University trained me in molecular systematics and provided space for part of this project while I was on sabbatical at Duke in 2006. He has also helped work up some of the haplotype data for both F. serratus and L. littorea.

April Blakeslee (a recent Ph.D. from the University of New Hampshire, now a Smithsonian Postdoctoral Fellow) extracted most of the DNAs for the Scottish L. littorea and will be helping to analyze the L. littorea data.

Ladd Johnson of Laval University helped to characterize the current range distribution of Fucus serratus in Canada.

Activities and Findings

Research and Education Activities:

Shipping Records: I compiled shipping records for ships entering Pictou Harbour from customs and tax records and newspapers' Shipping Intelligence for 1773-1861 (The Nova Scotian, The Colonial Patriot, The Pictou Observer, The Eastern Chronicle, The Mechanic and Farmer). I spent a week at the National Archives in Edinburgh (Scotland) in June, 2006, going through customs' books there, and did a complete check

on all traffic out of Ft. William, Scotland, from the original 1700s/1800s Custom Master's logs. I spent a week at the Public Archives of Nova Scotia in September 2007 to finish cross-checking customs' records and to view some newspaper files that could only be studied on site.
Collections: I collected Littorina littorea and Fucus serratus from the following localities in Scotland in June 2006, which were indicated as important from shipping traffic records: Peterhead (there was no F. serratus at Aberdeen, curiously, only 30 km S of Peterhead...probably an age-class thing), Cromarty, Ullapool (3 locations, including the exact site from which the Hector is believed to have sailed in 1773---I discovered this by looking on a Sunday), Fort William, and Greenock (where I was pelted with breaking beer bottles in the intertidal zone by drunken British youth in this very depressed area).
Genotyping: I genotyped 30 individuals of Fucus serratus from Ullapool, Greenock, Fort William, Peterhead, and Belfast (this provided by J. Olsen in Groningen) at 9 microsatellite loci and sent the Cromarty collection to J. Olsen for genotyping in 2006-07. I recruited 4 colleagues at Groningen (Olsen, Coyer, Hoarau, Stam) to analyze the F. serratus data in the context of their large European database (which lacked Irish and Scottish materials, but they had Irish material in hand, which they worked up for this collaboration). I also collected the sequences for all these individuals at the mt spacer and am analyzing the number of haplotypes and genotypes (msats) from the Scottish material in comparison to the Nova Scotian material now (all of the NS genotypes etc. were in hand by the time I started the Scottish collections, done with Natl. Geographic funding). I genotyped the cytochrome B sequence for Littorina littorea from all the Scottish collections and from Pictou, NS; I sent duplicate material to April Blakeslee at UNH to do the cytochrome oxidase gene; Blakeslee extracted many of the snails for the cytochrome b sequencing, as well.

We reported last month (see Products) at the Phycological Society of Ameria annual meetings that the microsatellite and mt spacer sequence data on F. serratus support at least two introductions from the British Isles, one from near Galway (Ireland) and one from Greenock, Scotland. We have the cytochrome b sequences in hand for Littorina littorea and will shortly analyze these in combined data sets to see if these match any of the known N. American haplotypes of L. littorea. The shipping records and rates of expansion of F. serratus suggest the importance of the Napoleonic Wars to the introductions. I anticipate submission of the major manuscript from this work to occur before 2008.
Collaboration: I formed a large, collaborative group to work on the hypothesis that Pictou was the nexus of 1800s invasions to the N. American intertidal zone (see Collaborators). The work contributes to international collaboration in science.

Findings:

1) 99.8% of all ships entering Pictou Harbor between 1773-1861 were from Britain with the following ports particularly important: Greenock, Cromarty, Fort William, Leith, Newcastle, Liverpool, and Aberdeen. The record includes nearly 800 ships. In the 1840s, ships from several Irish ports become more common, and there are also a few ships from the Baltic, France, and The Netherlands in customs and newspaper records. There was a great deal of local traffic within the Maritimes and traffic to and from the US that has been recognized but not tabulated (I do have the hard records should this become useful).
2) Assignment tests of the genotypes reveal that, as hypothesized, F. serratus did not come from Brittany. At least two sources were revealed for Nova Scotian F. serratus: Greenock, Scotland and nearby Galway, Ireland, 3) The mt spacer haplotypes found in Nova Scotian F. serratus are only found in Europe in Scotland and Ireland. I found 3 haplotypes at Pictou (Coyer et al. had reported 1 haplotype from the smaller number of individuals they sampled). This part of the study will probably continue as part of a proposal to NSF in 2008 but it suggests multiple introduction events from the British Isles.
4) The snail sequencing is complete. To date, combining the new cytochrome B sequences with Cliff Cunningham's lab's published and unpublished sequences has filled in two of the clades that were previously only represented by N. American snails. However, 6 N. American only clades remain. The amazing diversity of haplotypes of snails in any one site is a strong contrast to F. serratus. This is probably due to a) the planktonic larva of the snail, 2) the very large extent to which snails were transported throughout Europe, and especially in Britain, in food markets etc., and 3) the large extent to which rock ballast was transported from harbor to harbor in Ireland and Scotland. April Blakeslee will soon be analyzing these sequences in her much larger haplotype database (from her Ph.D. work). We hope to identify a source population for at least part of the 1800s L. littorea introductions to N. America through this work. More broadly, I think we will find that Pictou Harbour and the Scottish/Irish emigrations into Nova Scotia in the 1800s led to a set of co-introductions.

Training and Development:

This grant was absolutely critical to the success of my sabbatical work and I am immensely grateful to NSF for the award. It provided me with new training in molecular systematics and phylogeographic analysis, which is benefiting my undergraduate and graduate students at home, and is of great satisfaction to me. I added a month of related laboratory exercises to one of my courses (SMS 373. Algal Biology) at the University of Maine last year because of it. I was also able to support extension of a novel aspect of a Ph.D. student's research in my lab (Jessie Muhlin) on another NSF grant because of this training. Lastly, the SGER award brought together a collaborative group of scientists from The Netherlands, Canada, and the USA who I interested in helping figure out the origins of F. serratus and L. littorea. I believe that all of these individuals will have strengthened interdisciplinary interests because of this project.

Outreach Activities:

None yet.

Journal Publications

Books or Other One-time Publications

Web/Internet Site

Other Specific Products

Product Type:

abstract

Product Description:

Abstract from the 2007 (August 2007, Rhode Island) Phycological Society of America meetings:
Brawley, S. H., J. A. Coyer, G. G. Hoarau, L. E. Johnson, W. T. Stam, A. M. H. Blakeslee, C. Cunningham & J. L. Olsen. 2007. European Influences on the North American Shore. Abstract booklet, and being published by Blackwell on-line (although it doesn't appear to be up yet).

Sharing Information:

See above.

Contributions

Contributions within Discipline:

This work helps to determine the sources of several important marine invasions of the North American shore in the 1800s. It highlights the importance of interdisciplinary work (e.g., historical analyses) to biological research.

Contributions to Other Disciplines:

This work will be significant to historians, especially to those interested in the effects of the Napoleonic Wars.

Contributions to Human Resource Development:

As mentioned in an adjoining section, this work provided sabbatical training to me in the fields of molecular systematics and phylogeography, in Cliff Cunningham's laboratory at Duke University.

Contributions to Resources for Research and Education:

A database of all shipping records for Pictou Harbour, N.S. from 1773-1861 will be a supplement to the publication being prepared from this work.

Contributions Beyond Science and Engineering:

This work will help to understand the factors that lead to marine invasions in the 1800s, some of which are still relevant to current invasion threats.

Conference Proceedings

Categories for which nothing is reported:

Organizational Partners

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