KECK GEOLOGY CONSORTIUM

PROCEEDINGS OF THE TWENTY-FIFTH ANNUAL KECK RESEARCH SYMPOSIUM IN GEOLOGY

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INVASIVE FRESHWATER CLAM, CORBICULA FLUMINEA, HABITATS IN THE LOWER CONNECTICUT RIVER

DANIELLE MARTIN, Wesleyan University
Research Advisor: Suzanne O'Connell

INTRODUCTION

Corbicula fluminea is a rapidly reproducing freshwater clam, also referred to as the Asian Clam. Native to Southeast Asia and Africa, today it is found throughout Asia, North America, South America, Europe and parts of Africa. It was suspected to have been brought to North America by immigrants from China intending to harvest the Asian Clam (Müller, 1774). The Asian Clam is known as a popular biofouler, costing companies millions of dollars annually.

In this study we tried to identify the factors which contribute to the life cycle of the Asian Clam in the Connecticut River. Specifically, we wanted to see if the clam had a preference as to where it lived on the river bedform. We used samples from four different areas in the Glastonbury Meanders of the Connecticut River (Ostfeld 2011). Bedforms were identified using a Datasonics SIS-1000 sidescan with sub-bottom profiler. Sample locations (Fig. 1) were identified from these images and grab samples were taken by scuba divers at specific locations on the bedform.

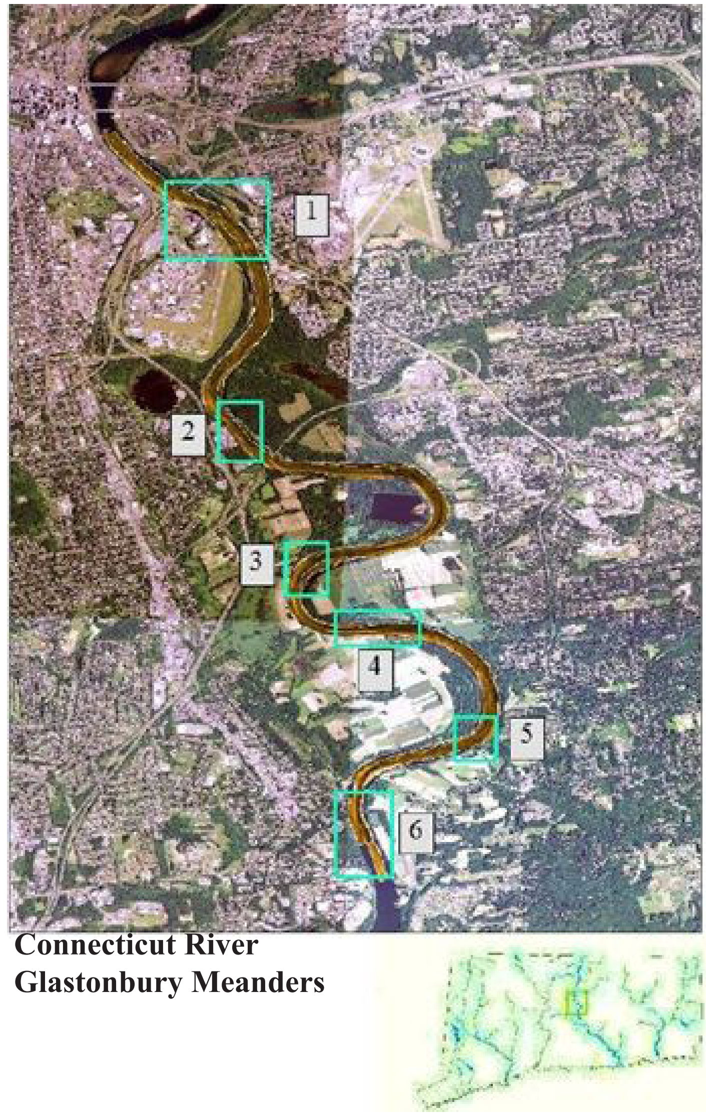

Figure 1. April 2010 sidescan survey highlighting six major bedform fields (Ostfeld 2011)

Lifestyle of *Corbicula Fluminea* Lifestyle

Because of its highly reproductive nature and low mortality rate, *C. fluminea* populations quickly come to dominate any environment that they are introduced into, even man-made structures. The Asian Clam is a popular biofouler, costing companies over one billion dollars annually in damages by blocking ventilation systems and water intake valves. The majority of studies have concluded that this species reproduces twice a year, taking place between late spring and early fall, but this can vary depending on the environment it's living in. A single clam can release an average of 400 of juveniles a day and up to 70,000 per year. It does not require a fish host to incubate its larvae. This greatly eliminates the problem of reduced transformation success of larvae. After the larvae are released into the water, measuring about 250 μm in dimension, they settle and bury into the substratum. After the water column release, juveniles anchor to sediments and vegetation using a mucilaginous byssal thread, a tough fibrous structure which is secreted and used to attach to substrate. Juveniles are also dispersed over long distances by turbulent flows.

The maturation period of the mollusk occurs within the first 3 to 6 months when the shell length reaches 6 mm to10 mm, and the life span of *C. fluminea* varies from 1 to 7 years (Antunes, Guilhermino, Sousa 2008).

Past research has shown that this mollusk prefers to live in low salinity (up to 13 ppt), and well-oxygenated and has inhabited lakes, streams and estuaries (Aguirre and Poss 1999). It prefers fine grained, sandy substrates but has also been found to live amongst sediments ranging in size from silt to boulders. Although research shows that they thrive best in tropical temperatures (20-30°C), they have been found to survive in temperatures ranging from 2 to 30°C. And like many bivalves, the mollusk consumes food through its filtration system.

METHODS

Six sandwaves in the Glastonbury Meanders (Geiger 2011), between Hartford and Rocky Hill, CT were imaged using a Datasonics SIS-1000 sidescan with sub-bottom profiler. The instrument was towed along the starboard side of a 28' pontoon boat, as it emitted sound waves into the river to create and image of the riverbed below. Two runs were made through these areas, one in April 2010 just after the spring freshet and the other in July 2010.

The grab samples were taken by SCUBA divers on September 13, 2010 in slack water between the rivers high and low tide cycles. To best collect a representative data, they took samples from each of the four parts of the bedforms for three consecutive sandwaves (A, B and C illustrated in Figure 2) in each bedform field. The four parts of the bedform refer to the stoss, crest, lee and trough, which is also illustrated in Figure 2.

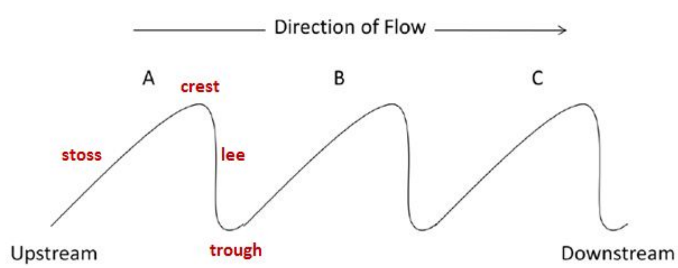

Figure 2. Sampling strategy for three consecutive sandwaves and basic sandwave morphology. Two samples taken from each part of sandwave

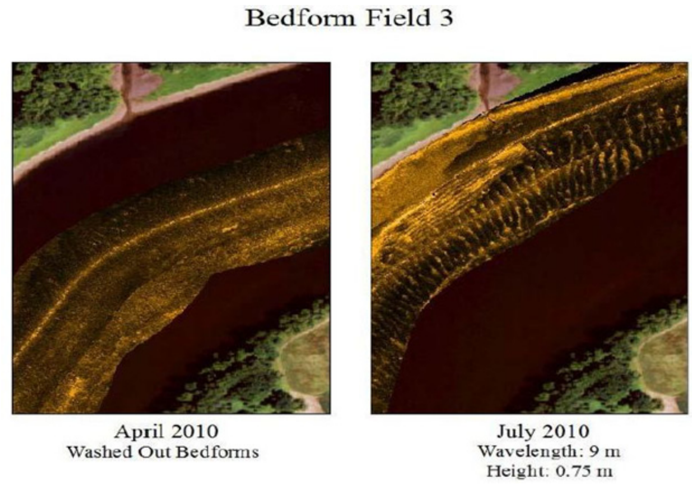

Figure 3. Bedform field 3 sidescan and aerial survey. (Ostfeld 2011)

In total, 60 grab samples were analyzed for this study. For each grab sample this process included the following steps: (1) weigh total sample (2) sieve the sample with a 2mm sieve (3) Separate all *C. fluminea* greater than 2 mm what size? Sample, (4) weigh them together and (5) record number of *C. fluminea* and each of their lateral lengths.

Side Scan Results

Overall the bedforms were less well-developed in April 2010 than in July 2010. During the April 2010 sidescan survey, In July survey, the bedforms of bedform field 1 were the same height (1.5 meters) as previously recorded in April, but had a slightly longer wavelength of 49 m. SCUBA divers found accumulations of woody debris in the troughs of this bedform field.

In July, bedforms in bedform field 2 were slightly smaller (8 meters) in wavelength, but slightly greater in height (0.5 meters) during the July 2010 survey. In July 2010, bedforms were more prevalent than during the April 2010 survey. SCUBA divers photographed vegetation growing in the troughs of the bedforms in bedform field 2.

In the April 2010 survey, bedforms in bedform field 3 seemed to be completely washed out. The July 2010 sidescan survey revealed over fifty bedforms in the

Bedform	Location on bedform	Clam abundance (clams per gram of sediment in sample x 10^3)	Clam abundance per location (average abundance of location on bedform x 10^3)	Clam Abuncance per bedform (average abuncance of all locations on bedform x10^3)
4A	Stoss	0.0	2.8	6.7
4B	Stoss	3.4		
4C	Stoss	4.9		
4A	Crest	1.6	4.4	
4B	Crest	2.9		
4C	Crest	8.7		
4B (a)	Lee	7.3	7.5	
4B (b)	Lee	4.9		
4C (a)	Lee	7.8		
4C (b)	Lee	10.1		
4B (a)	Trough	16.7	12.1	
4B (b)	Trough	15.7		
4C	Trough	3.8		
2A	Stoss	14.3	20.4	19.8
2B	Stoss	25.6		
2C	Stoss	21.2		
2A (a)	Crest	10.0	19.0	
2A (b)	Crest	19.0		
2B (a)	Crest	32.0		
2B (b)	Crest	12.7		
2C	Crest	21.4		
2A	Lee	5.7	5.5	
2B	Lee	5.4		
2A (a)	Trough	20.7	34.3	
2A (b)	Trough	39.2		
2B (a)	Trough	40.1		
2B (b)	Trough	37.3		
3A	Stoss	9.8	17.6	12.1
3B (a)	Stoss	25.1		
3B (b)	Stoss	13.1		
3C	Stoss	22.3		
3C	Crest	5.2	9.5	
3B	Crest	11.2		
3A	Crest	12.0		
3A	Lee	6.1	7.0	
3B	Lee	7.2		
3C (b)	Lee	7.8		
3A	Trough	19.0	14.4	
3B	Trough	16.1		
3C	Trough	8.1		
1C (B)	Stoss	11.5	17.8	11.7
1C (a)	Stoss	17.6		
1B (b)	Stoss	10.6		
1B (a)	Stoss	10.3		
1A (b)	Stoss	26.1		
1A (a)	Stoss	30.7		
1A (a)	Crest	12.1	12.5	
1A (b)	Crest	16.6		
1B	Crest	13.1		
19C	Crest	8.1		
1A (a)	Lee	10.1	4.1	
1A (b)	Lee	0.0		
1B	Lee	3.0		
1C	Lee	3.2		
1A (a)	Trough	22.4	12.3	
1A (b)	Trough	5.9		
1B	Trough	12.6		
1C	Trough	8.3		
Total	Stoss		58.5	14.6
Total	Crest		45.4	11.3
Total	Lee		24.2	6.0
Total	Trough		60.8	15.2

Table 1. Grab sample analysis

same location that were 9 m in wavelength, and 0.75 meters in height (Fig. 3).

There was hardly any appearance of bedforms in Bedform field 4 during the April 2010 survey, but bedforms were clearly defined in the July 2010 survey. The July 2010 bedforms had a wavelength of 19 meters, and a height of 0.75 meters

Quantitative Analysis of Grab Samples

The factors that we used for analyses were the abundance of *C. fluminea* in a sample, illustrated in "Table 4", and the length of each mollusk in a sample. The mean and median grain size for all bedform fields was medium to coarse, 350 microns to 700 microns (Gieger, 2011). The grain size range was too narrow to use as an environmental indicator. We compared the clam densities and clam length to the location of the sample on the bedform and to the location of it within the meanders. Clam densities of the four bedform fields are shown in Figure 5.

We found that Bedform Field 2 contained the most clams, the bedform having a wavelength of 8m and a height of 0.5m, and bedfrom field 4 contained the least, the bedform field having a wave length of 19m and a height of 0.75m. *C. fluminea* abundance was lowest in the lee side for three of the four bedform fields, highest in the stoss for two of the bedform fields and highest in the trough for the remaining two bedform fields. *C. fluminea* abundance was lowest in the lee side for three of the four bedform fields,

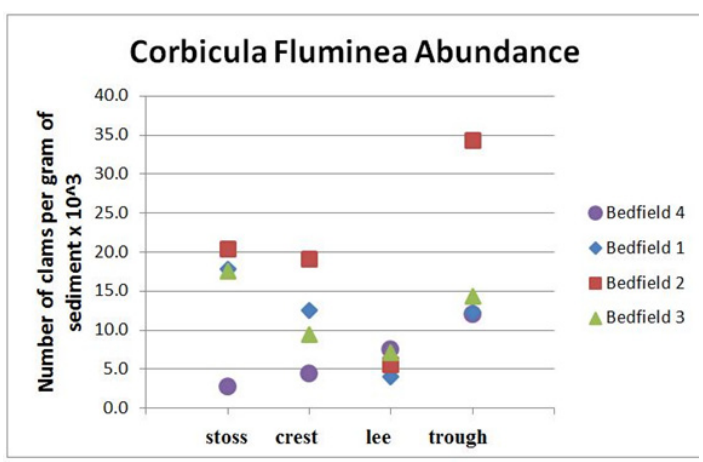

Figure 4. Corbicula fluminea abundance per bedform field

highest in the stoss for two of the bedform fields and highest in the trough for the remaining two bedform fields.

Two native species (suspected to be Eastern Floater, pyganadon cataracta) were found in only two of the 60 grab samples. The number of samples counted was not sufficient to do any statistical analyses.

CONCLUSION

Because of the clam's filter feeding process, we hypothesized that the troughs of the sandwaves would contain the highest density of mollusks. Thinking about the morphology of the sandwave, as the water flows against the stoss side and up over the crest we hypothesized that finer particles in the water would settle in the trough. Stable vegetation was observed in the troughs by the SCUBA divers, supporting our hypothesis of particle settling. But, from our study we found that overall, the trough and stoss are preferred habitat in most bedform fields and there was no significant grain –size difference between or within the bedforms Because of our insufficient sample size collected for statistical analysis, we could not conclude anything about the entirety of the four bedform fields sampled.

Although nothing could be concluded about the preferential sandwave location of *C. fluminea*, we did observe that all the mollusks present in our analyzed samples measured 3 mm to 12.5 mm in length. The maturation period occurs within the first 3 to 6 months when the shell length reaches 6 mm to 10 mm (McMahon 2000). Based on this research we conclude that all these clams are less than two years in age, which brings us to question where the older *C. fluminea*s are located. Are they further downstream because only the small, weak juveniles are washed upstream by the river currents? Or was this species recently introduced to this section of the CT River? These are questions that prompt for further research.

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