Recruitment and Mortality of *Spisula solidissima*: field and flume experiments

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Introduction

Recruitment of the commercially important surfclam (*Spisula solidissima*) is both spatially and temporally variable in continental shelf sediments. At the Long-term Ecosystem Observatory (LEO-15) located on Beach Haven Ridge (Fig. 1A) this variability has been linked to differences in larval supply, upwelling and downwelling circulation, and predation (Ma 2005, Weissberger and Grassle 2003). Surfclams have two recruitment events each year, with a larger event in June/July, and a smaller one in October/November. Large numbers of juvenile surfclams were present at LEO-15 in January 2009 which indicates that a high-density settlement and recruitment event occurred last year (Fuller, pers. comm. et al. 2009). Despite high-density settlements, most surfclams disappear by early winter because newly settled surfclams are susceptible to predation by crabs, snails, sea stars, and shrimp. Thus their survival following settlement may also depend on the habitat where larvae settle.

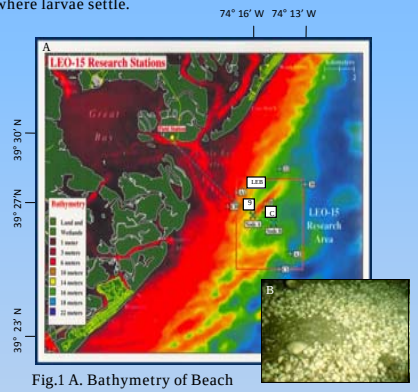

Fig.1 A. Bathymetry of Beach Haven Ridge at LEO-15 (red square) (39° 28' N, 74° 15' W) showing sampling stations. Stations sampled in this study: Sta. C., Sta. 9, LEB, and B. shell-hash beds at Sta. C.

At LEO-15 large numbers of surfclams have been observed in sediments underlying shell-hash beds (Fig. 1B) Ephemeral shell hash patches (aggregations of surfclam valves covering the seafloor) vary within and among the LEO-15 stations (Grassle and Petrecca, unpubl. observ.). Such habitat may provide refuge for juvenile surfclams by acting as a physical and chemical barrier to predators. For example, shell-hash patches may provide a refuge from predators and reduce erosion of surfclams from the sediments. Also, since many predators rely on chemosensory cues to locate their prey, increased turbulence caused by shell-hash may provide a more diffuse odor cue thus reducing the ability of the predator to locate its prey (see Fig. 6D-E).

Objectives

- To compare surfclam recruitment and mortality among three stations at LEO-15 for 2008 (surfclams >2mm) and early July 2009 (surfclams <2mm).
- In a racetrack flume experimentally determine if there are differences in surfclam mortality due to predation by green crabs in two habitats including a sandy bed covered with shell-hash, and a flat sand bed.

Methods & Results

Field Work

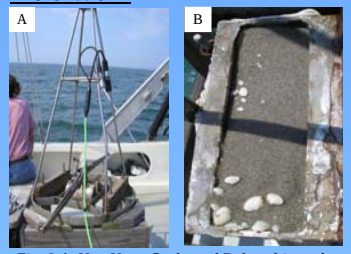

Fig. 2 A. Van Veen Grab, and B. benthic grab with surfclams

To compare the recruitment and mortality of surfclams at LEO-15 three Van Veen grabs (0.04m^2; 5 cm deep) were collected at Sta. 9, C, and LEB, (Fig. 1A). Samples were sorted for live and recently dead surfclams (i.e. whole clams, half valves, valves with snail borehole). Recently dead surfclams = surfclam shells still shiny with no pits or cracks. A benthic trawl was also conducted at the same stations.

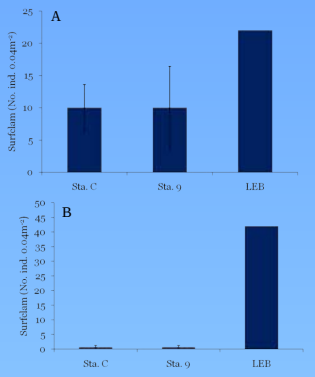

Fig.3. Mean number of surfclams (± S.E., n=7) at Stations C, 9, and LEB A. recruitment 2008 (clams >2mm),B. newly settled July 2009 (clams <2mm) Note: scales y-axis differ

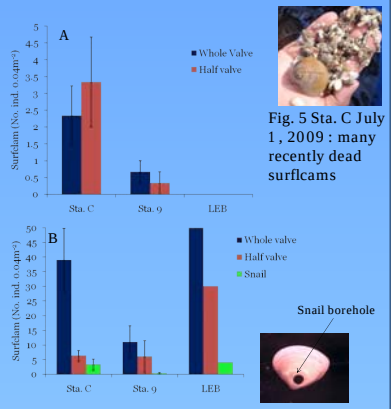

Fig. 4 Mean number of recently dead surfclams (±S.E., n=7) at Stations C, 9, and LEB A. From the 2008 recruitment (clams>2mm), B. July 2009 (clams<2mm) Note: scales y-axis differ

Fig. 5 Sta. C July 1 , 2009 : many recently dead surfclams

Flume Experiments

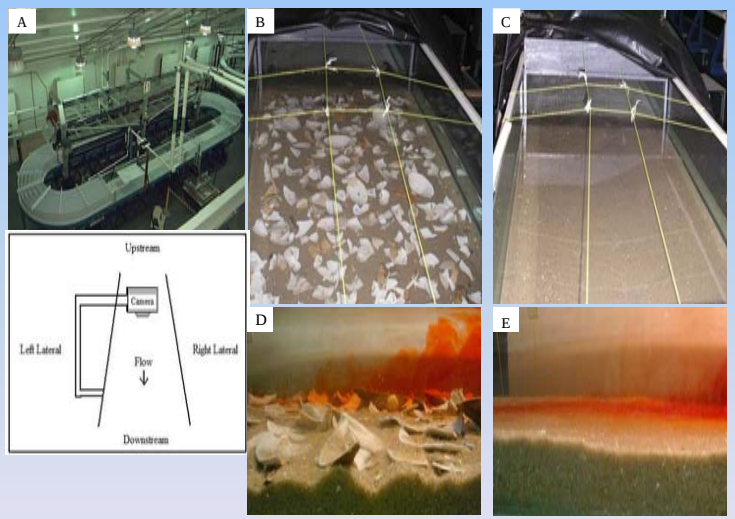

Fig. 6 A. Racetrack flume with camera set up, B. sandy bed covered with shell-hash, C. flat sand bed, D-E. dye-test to show flow/turbulence in shell-hash and flat sand bed

In the racetrack flume at the Institute of Marine and Coastal Sciences (IMCS), Rutgers University predation by crabs on surfclams was examined in two habitats: 1. a sandy bed covered in shell-hash (65% cover) (Fig. 6B), and 2. flat sand bed (Fig. 6C). A patch of 60 burrowed surfclams (12.8 mm ± 1.34) were placed in the center of the flume working area. For each experiment a crab (6.4 cm ± .53) was placed downstream of the surfclam patch and feeding behavior in the patch was recorded for 120 min. Free stream velocity was 5 cm s^{-1}, comparable to mean flow at LEO-15 and experiments were conducted in dim light to simulate the crab's natural environment for foraging. Uneaten surfclams were counted and videos to examine crab behavior were analyzed for, time spent in patch, time to initial patch entry, and the number of entries into the patch.

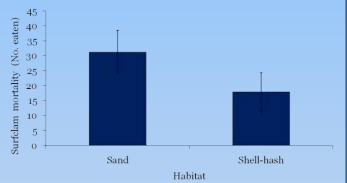

Fig. 7: Mean number of surfclams consumed by green crabs in flat sand bed versus shell-hash bed (±S.E., n=6)

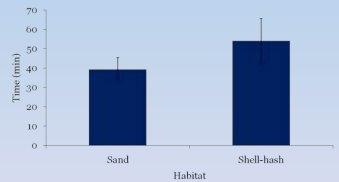

Fig. 8: Mean total time green crabs spent in clam patch for the flat sand bed versus shell-hash bed (±S.E., n=6)

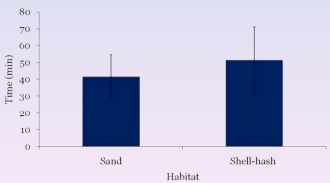

Fig 9: Mean time it takes for green crabs to enter the clam patch for the first time (±S.E., n=6)

Organisms of Interest

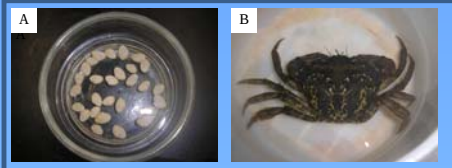

Fig. 10 A. *Spisula solidissima*, B. *Carcinus maenas*

Spisula solidissima (Fig. 10A) is an economically important biomass-dominant organism in sandy sediments on the New Jersey continental shelf. The invasive green crab, *Carcinus maenas*, is a predator of bivalves, crustaceans, and polychaetes (Fig. 10B). Along with other crab species, *C. maenas* (3.2-4.1 mm) has been found to settle at LEO-15 in June and August (maximum density 86 ind. m^{-2}).

Significance

Since the mid-to late 1990's the commercially valuable NJ surfclam population has declined severely. Predation on post-larval surfclams may be one factor contributing to the decline. By examining the role habitat plays in the survival of juvenile surfclams we may be able to identify ways to help facilitate successful surfclam recruitment in natural populations.

Discussion & Conclusions

Field:

- Recruitment and mortality of surfclams in 2008 and early July 2009 differed among the three LEO-15 stations.

-recruitment in 2008 and newly settled clams (July 2009) were highest at LEB and similar at Sta. C and 9.

-mortality was also highest at Sta. C for 2008 recruits and at Sta. C and LEB for newly settled clams. A trawl at Sta. C. (July 2009) also contained a large number of starfish and empty surfclam valves (Fig. 5).

Flume Experiment:

- Surfclam mortality differed between the two habitats with higher mortality in the sand bed compared to the shell-hash bed.
- These results suggest that shell-hash habitat may provide a physical and hydrodynamic refuge for juvenile surfclams.

Crabs spent more time foraging in the clam patch in the shell-hash bed than the sandy bed and were observed physically cleaning away the shell-hash to locate clams. Time taken for crabs to initially locate the clam patch took longer in the shell-hash bed which suggests that increased turbulence caused by the shell-hash may provide a more diffuse and less direct odor cue making the clams more difficult to locate.

Acknowledgements

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References

Ma , H. 2005. Spatial and temporal variation in surfclam (*Spisula solidissima*) larvalsupply and settlement on the New Jersey inner shelf during summer upwelling and downwelling. *Estuar. Coast. and Shelf Sci.* 62: 41-53.

Weissberger, E.J., and J.P. Grassle. 2003. Settlement, first-year growth, and mortality of Surfclams, *Spisula solidissima*. *Estuar. Coast. and Shelf Sci.* 56: 669-684.