CAN WE DISCERN MAJOR METEOROLOGICAL AND ENVIRONMENTAL EVENTS IN THE GROWTH RECORD OF THE LONG LIVED CLAM *Arctica islandica*?

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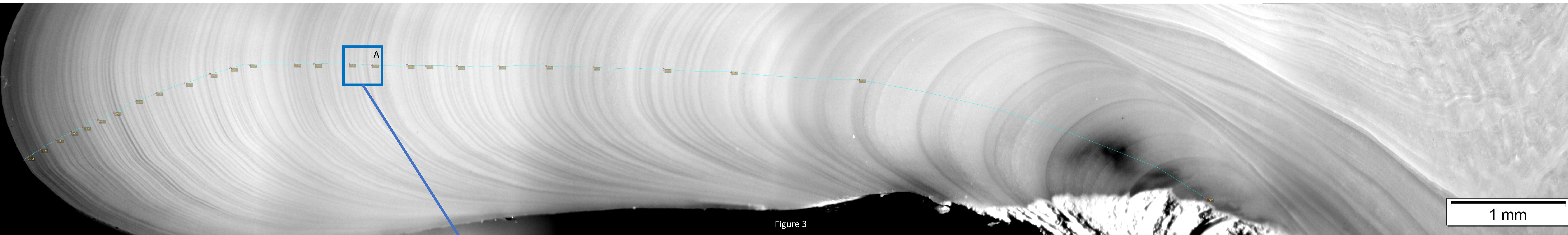


Figure 3

Abstract

The ocean quahog *Arctica islandica* is the longest living metazoan on the planet. A substantial population in excess of several million metric tonnes exist in the Georges Bank and mid-Atlantic regions in depths commensurate with the seasonal cold pool of water. As part of an extensive program to examine age structure and recruitment dynamics of these populations we have sectioned and polished over a thousand ocean quahog valves to facilitate counting of internal shell signatures. The analytical procedure produces images that labels each signatures with a year of origin. The intensity and interval spacing of these signatures provide more than just a counter of years of age – they provide an index of inter-annual variation in growth and the intensity of environmental stimuli that drive the shell deposition process to produce variation in the observed signature. Given that each clam is an effective fixed location recording station we pose the question "*Can we discern major meteorological and environmental events in the growth record*?"

Materials & Methods


Figure 1


Figure 2

Step 1: Quahogs were collected in 5-minute tows of a hydraulic dredge (Figure 1) at stations off the coast of Long Island, New York, USA.

Step 2: To prepare them for imaging, quahogs were shucked, cleaned, cut along the height axis (Figure 2 and 5) using a modified tile saw ground, and polished on a wet polishing wheel, resulting in the section shown in Figure 3.

Step 3: Imaging is done by using a high-definition digital microscope to take a series of consecutive images which are then stitched together with the aid of microscope imagine software.

Step 4: Quahogs were aged using the ObjectJ plugin of ImageJ by manually placing points on each visible growth line beginning from the first visible growth line nearest the umbo outward toward the edge of the hinge.

Results

1938 Hurricane

A dark band in the quahog pictured above (Figure 3) is evidence of growth stunted by burying in response to a major local hurricane

A series of multiple checks surrounding the winter of 1955 in the quahog pictured below (Figure 4) is the result of a series of named hurricanes that hit the Long Island area in 1954.

1954 Named Hurricanes

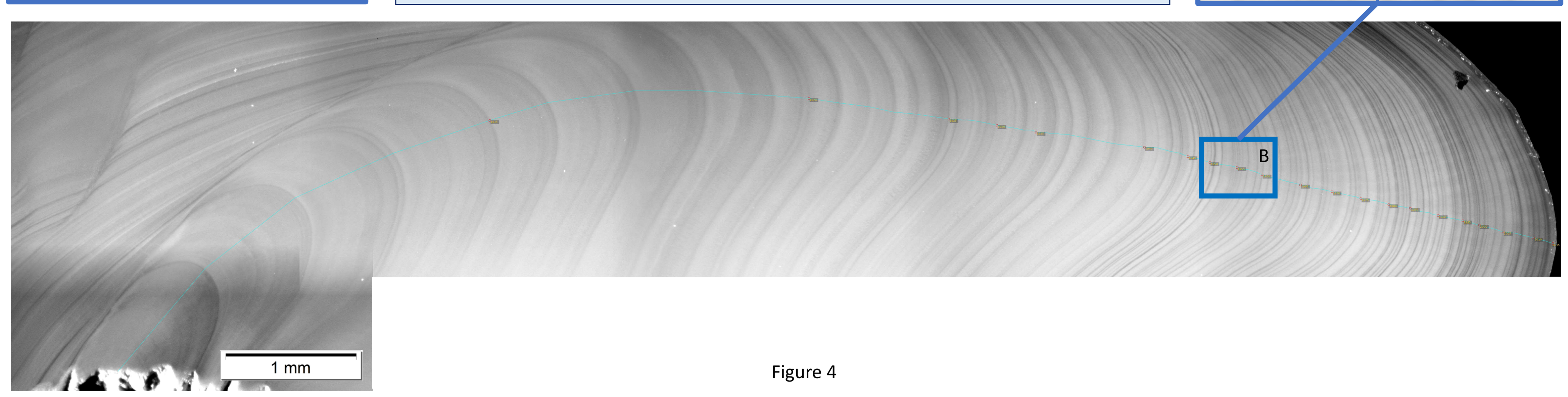
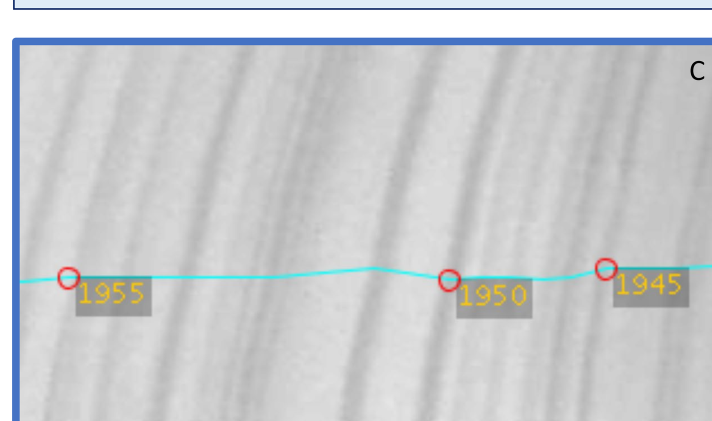


Figure 4

A series of checks represents a similar response to the same series of named hurricanes that hit Long Island in 1954 (Figure 6-C).

A prominent dark band shows the response to the 1933 Chesapeake-Potomac Hurricane (Figure 6-D).

Quick growth surrounded by slower growth corresponds to > average temperature year surrounded by < average years (Figure 6-E).



1954 Named Hurricanes

1933 Chesapeake-Potomac Hurricane

1912 Temperature Anomaly

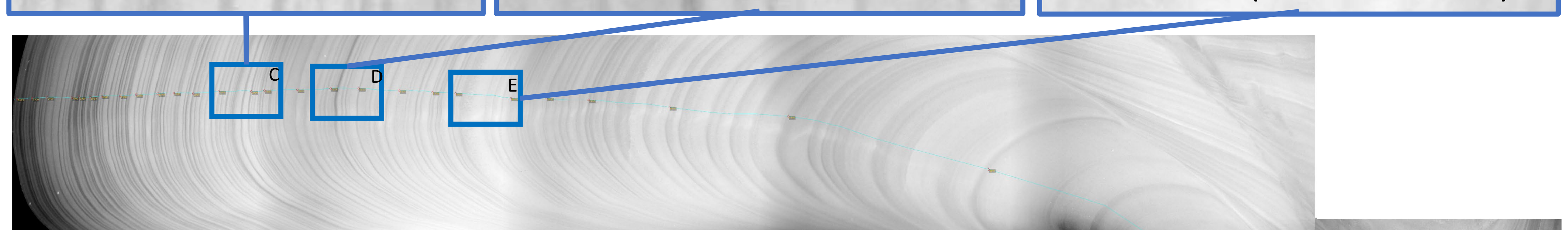


Figure 6

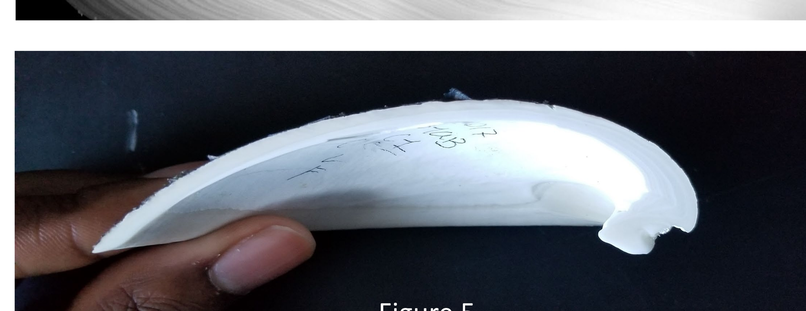


Figure 5

Discussion and Conclusions

Arctica islandica has already been proven to keep reliable records of daily fluctuations in growing conditions. These records are easiest to see in young specimens since their annuli are separated by the most space. This project has been the application of that knowledge to older quahogs, but because of the slower growth rates these animals experience after their first few years of growth, minor fluctuations in growth rate are visibly negligible. However, major disruptive events including hurricanes and major or extended temperature anomalies might leave signatures visible even in the later, slower years of growth. For instance, summer hurricanes cause the mixing of an otherwise highly stratified Long Island thermocline. This infusion of warmer water to the substrate that was previously cool would cause the quahogs to bury to escape the temperature stress. If the hurricane lasted for an extended period, extended burying and the associated anoxic stress would cause the formation of a visible dark line signature, either appearing in the record as a sub-annual check line or a particularly thick winter growth line if the hurricane took place near the end of the growing season.

The quahogs pictured on the center panel are animals which prominently showed relevant signatures that corresponded to major weather events or average annual temperature anomalies. This project served to demonstrate the ability older animals have to record discernable signatures from major disruptive weather events. With further study, the ocean quahog could serve as a reliable weather record for the past 300-500 years. Moreover, by identifying corresponding weather events between quahogs, not only can the procedure for aging quahogs be more effectively validated and improved, but weather events on living specimens can be linked with those on much older specimens, allowing new contextualized access to the information they hold as well.

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