

Appendix A6: Surfclam annulus verification study

In summary, several lines of evidence support the procedures used to age surfclams sampled during NEFSC clam surveys since the 1970s. In particular, ring counts from the chondrophores of surfclam shells sampled during NEFSC clam surveys correspond to age and assumptions about the location of the first annulus appear valid (Appendix Figure A6-4).

The 2005 *Atlantic Surfclam Ageing Workshop* (Jacobson et al. 2006) noted that, in spite of the strong correlation between the number of annular marks in shell valves and sectioned chondrophores, chondrophores have not been formally validated as an ageing structure. Additionally, there is uncertainty as to both the mechanism and seasonal timing associated with annulus formation. In particular, the interpretation of the last annual mark may depend on latitude as well as sample date. To address both of these concerns, the Fishery Biology Program, in collaboration with staff in the Population Dynamics Branch and the surfclam industry, has undertaken a study which is nearing completion.

Monthly samples were collected on a monthly basis by industry vessels from three geographic regions including Cape Cod, northern New Jersey, and Delmarva from August 2007-December 2008 totaling over 2,200 clams. Sample size ranged from approximately 50-75 clams per month in each of the three areas. Clams were measured and weighed, and chondrophores were sectioned. Digital images of sectioned chondrophores were taken and measurements were taken on the image from the umbo to each annulus. Edge type and width were also annotated.

Approximately 1,400 clams have been aged to date (work is ongoing and a full report is forthcoming). Surfclams in samples ranged from 85 to 194 mm SL and ages ranged 2 to 30 years. Preliminary results indicate that hyaline zones identified as annuli occur only once per year, during August-September. In both 2007 and 2008, annulus formation began earlier in more northern locations with an approximate one month difference in formation from the northern-most to the southern-most regions (Appendix Figures A6-1 through A6-3, respectively).

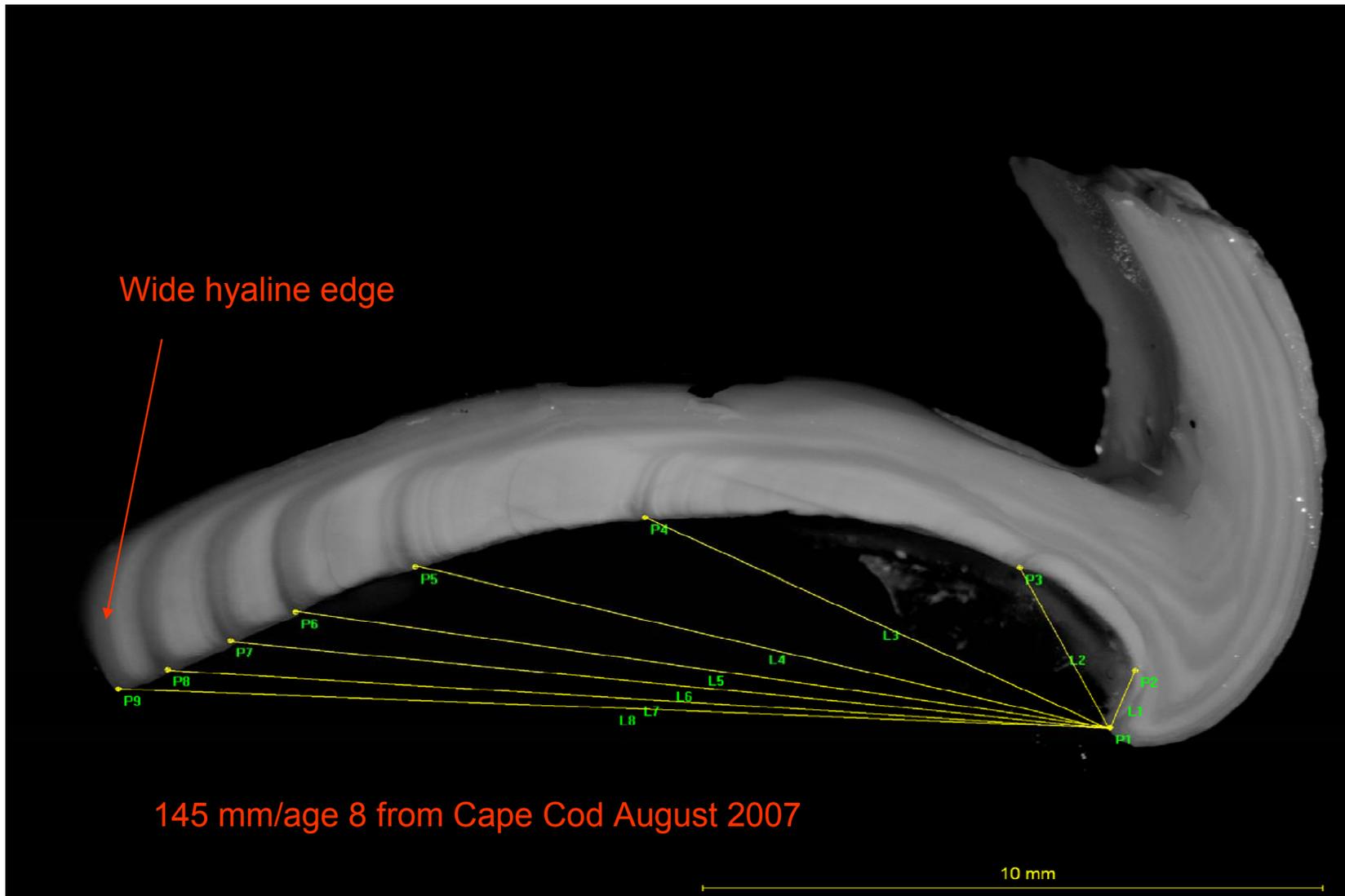
Verification of first annulus

The first hyaline zone close to the umbo (Appendix Figure A6-4) is assumed to be the first annulus in ageing surfclams (Ropes 1980). In a separate but relevant study, shell valves and chondrophores from young-of-the-year (juvenile) surf clams were collected during June 16 to August 11, 2005 by New Jersey's Division of Fish and Wildlife (Jeff Normant, NJ DFW, personal communication). The samples were taken off the coast of New Jersey from grab samples during routine survey work and used to determine if current assumptions about the first annulus are valid. Small surfclams in the sample ranged from 3-14 mm SL. Sectioned chondrophores from these small shells lacked a hyaline zone at the umbo, indicating that the first annulus had not yet formed. This result is consistent with the current assumption that the first annulus forms during September-October following spawning in the NJ region.

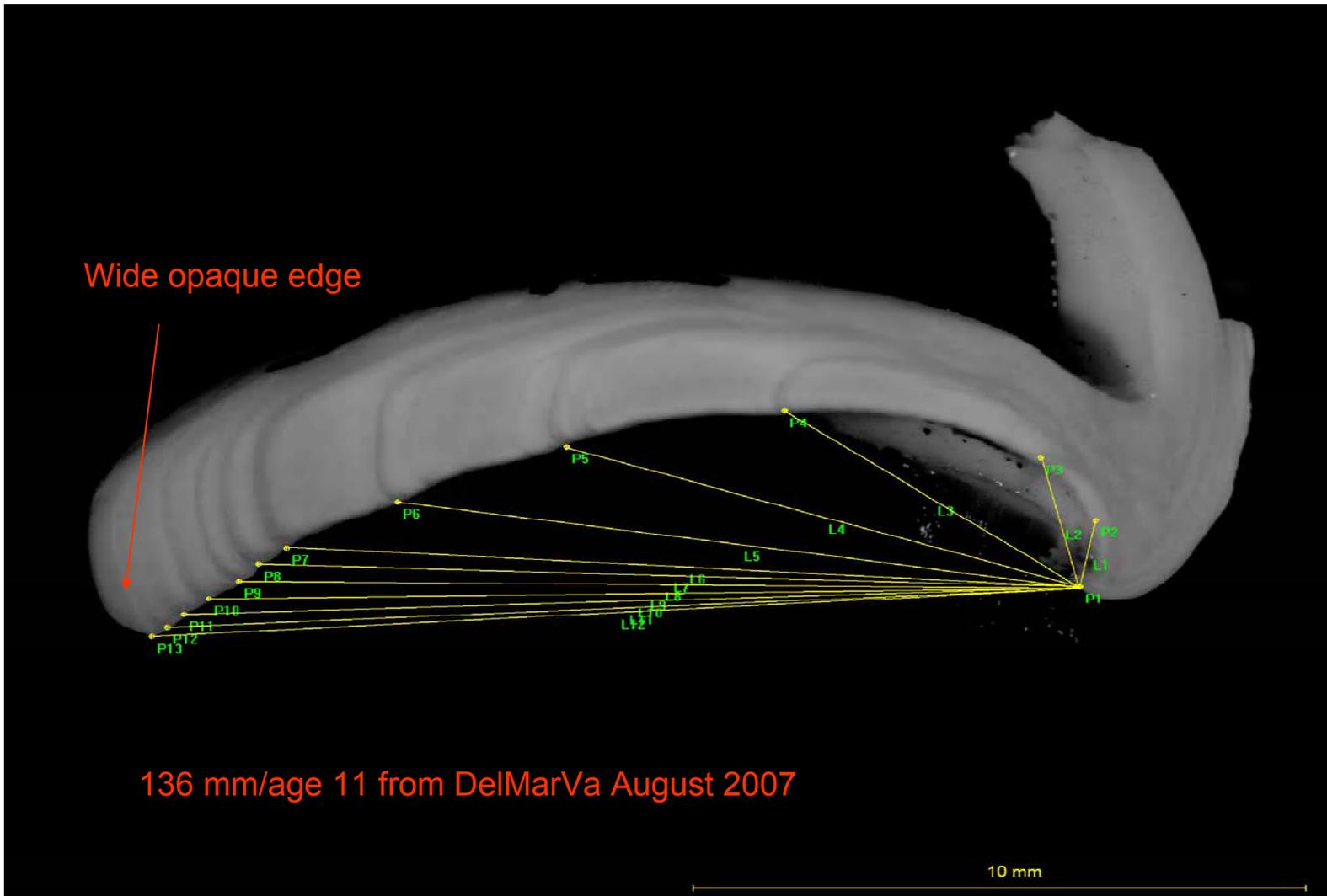
Samples of larger surfclams also support the current assumption about the first annulus. The range of shell valve lengths at the first annulus formed during September-October in larger surfclams from the NJ region was 9-19 mm which is larger than the range of shell lengths for juvenile clams (3-14 mm SL) caught two to three months previously. As additional evidence, the observed range 9-19 mm SL is consistent with predicted sizes at age 1 estimated from growth modeling performed by Picariello (2006).

References:

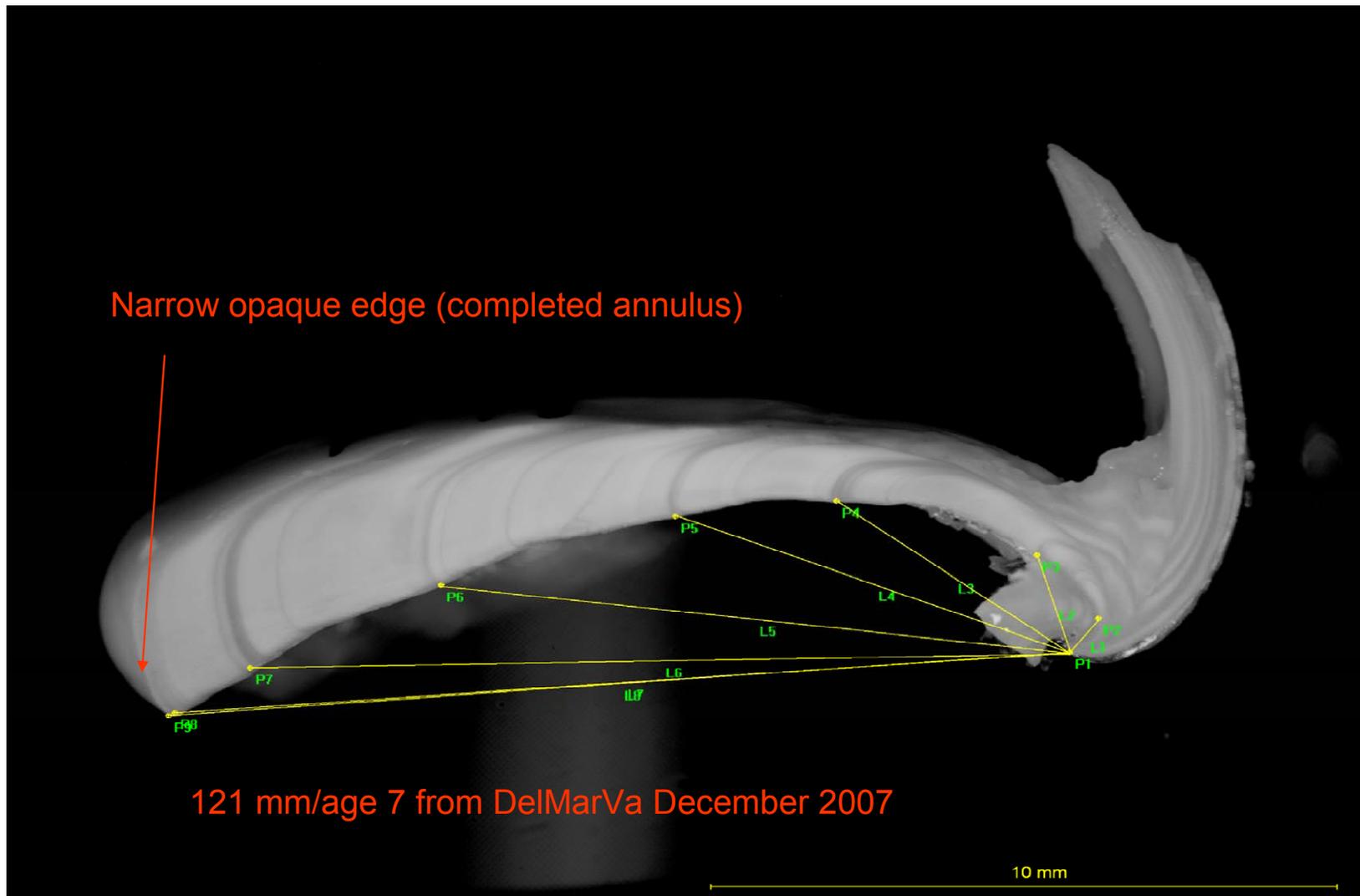
- Jacobson L, Sutherland S, Burnett J, Davidson M, Harding J, Normant J, Picariello A, Powell E. 2006. Report from the Atlantic Surfclam (*Spisula solidissima*) Aging Workshop, Northeast Fisheries Science Center, Woods Hole, MA, 7-9 November 2005. NEFSC Ref Doc. 06-12. 24 p
- Picariello A. 2006. The effects of climate change on the population ecology of the Atlantic surf clam, *Spisula solidissima*, in the Middle Atlantic Bight. M.Sc. thesis, The College of William & Mary in Virginia, 169 pp.
- Ropes JW. 1980. Biological and fisheries data on the Atlantic surf clam, *Spisula solidissima* (Dillwyn). Tech. Serv. Rep. 24, Woods Hole Lab, NMFS, NOAA, Woods Hole, MA 02543, 88 p.



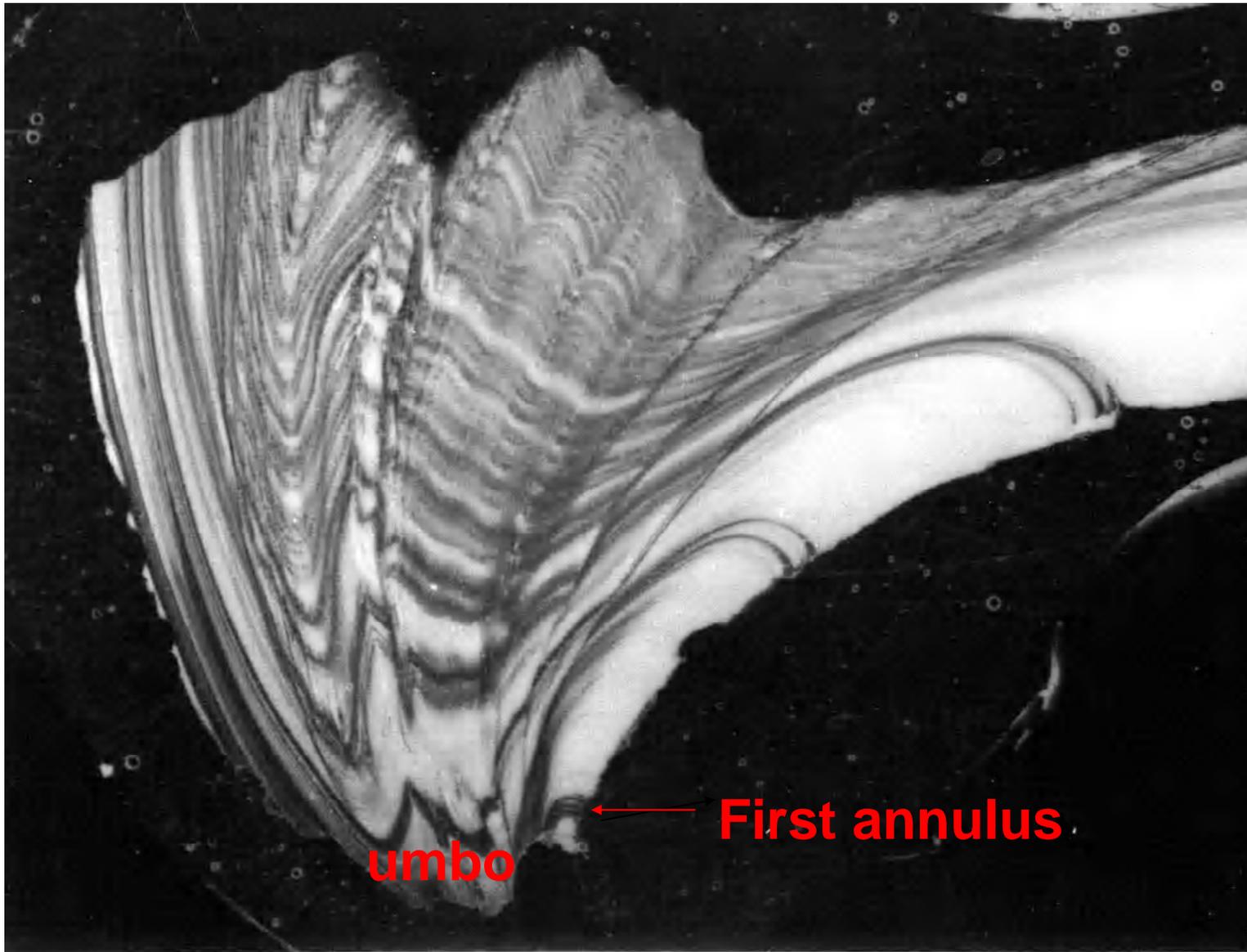
Appendix Figure A6-1. A sectioned chondrophore from a surfclam caught in August off Cape Cod, Massachusetts, the northernmost of the three sampling sites. Note the wide hyaline (transparent; it appears darker on the black background) outer edge indicating the annulus is in the process of forming.



Appendix Figure A6-2. A sectioned chondrophore from a surfclam caught in August off Ocean City, Maryland, the southernmost of the three sampling sites. Note the wide opaque (lighter shell material) outer edge indicating the annulus has not started forming.



Appendix Figure A6-3. A sectioned chondrophore from a surfclam caught in December off Ocean City, Maryland, the southernmost of the three sampling sites. Note the narrow opaque (lighter shell material) outer edge indicating the annulus has completely formed (the hyaline material has stopped being laid down).



Appendix Figure A6-4. The first annulus can be seen here in a section of an adult surfclam chondrophore. This was verified by comparing when the first annulus was laid down by samples of young-of-the-year surfclams to the location of this mark on the shell of adult surfclams.