How Old is that Black Sea Bass?

Materials

For the leader:

Whiteboard

Markers (different colors)

PowerPoint slides (projector)

For the activity:

Copies of scale images

Copies of data table handout

Calculators

Graphing Paper

Overview

Scientists studying ecology ask broad questions about how the patterns and behaviors of animals change through space and time and the environmental factors that influence the distribution and abundance of individuals. Therefore for fish ecologists, some major questions when understanding a population of fish are: what is the maximum age of individuals within the population, what is the maximum and typical size that individuals grow to, and how quickly do individuals in the population reach these maximum ages and sizes. These data provide ecologists with an understanding of how organisms grow in their environments over time, which leads to a better understanding of the abundance of individuals within a population.

Answers to questions about size and age of individual fish, as well as for the entire population, have important implications for understanding fish population dynamics, managing fisheries, and protecting marine and aquatic systems. Management and conservation decisions are made using the "best available science," which for fish includes knowledge of how large the population is, how quickly is the population growing, and what factors effect these two components. How quickly individual fish grow to its complete size and age greatly affects the dynamics of the entire population. Therefore, by understanding growth of individuals we can better understand patterns of the population as a whole and thus make better management and conservation choices.

Motivating Question: **How do scientists create growth curves to learn about the age and lengths of fish?**

Take Home Message

Scientists use various body parts (e.g., scales, otoliths, bones) to age fish and then combine that information with known length data to create growth curves.

Engage: Lead the students in a discussion about what they know about growth curves and aging animals.	10 minutes
Explore: Students investigate the age of different Black Sea Bass and create their own growth curves from the data.	25 minutes
Make Sense: Students share their observations, ask questions, and discuss what they can learn from the growth curves.	10 minutes
Total:	**45 minutes**

Audience

Middle and high school students (6^{th}-12^{th} grade).

New Jersey Core Curriculum Content Standards - Science

Grade	Content Statement	CPI#
6	The number of organisms and populations an ecosystem can support depends on the biotic resources available and on abiotic factors.	5.3.6.C.2
6	An ecosystem includes all of the plant and animal populations and nonliving resources in a given area. Organisms interact with each other and with other components of the ecosystem.	5.4.6.G.2
8	Mathematics and technology are used to gather, analyze, and communicate results.	5.1.8.B.2
8	Carefully collected evidence is used to construct and defend arguments.	5.1.8.B.3
8	Scientific reasoning is used to support scientific conclusions.	5.1.8.B.4
8 / 12	Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work.	5.1.8.B.1 / 5.1.12.B.1
12	Mathematical tools and technology are used to gather, analyze, and communicate results	5.1.12.B.2
12	Empirical evidence is used to construct and defend arguments.	5.1.12.B.3
12	Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions.	5.1.12.B.4
12	Biological communities in ecosystems are based on stable interrelationships and interdependence of organisms.	5.3.12.C.1

Preparation (20 minutes)

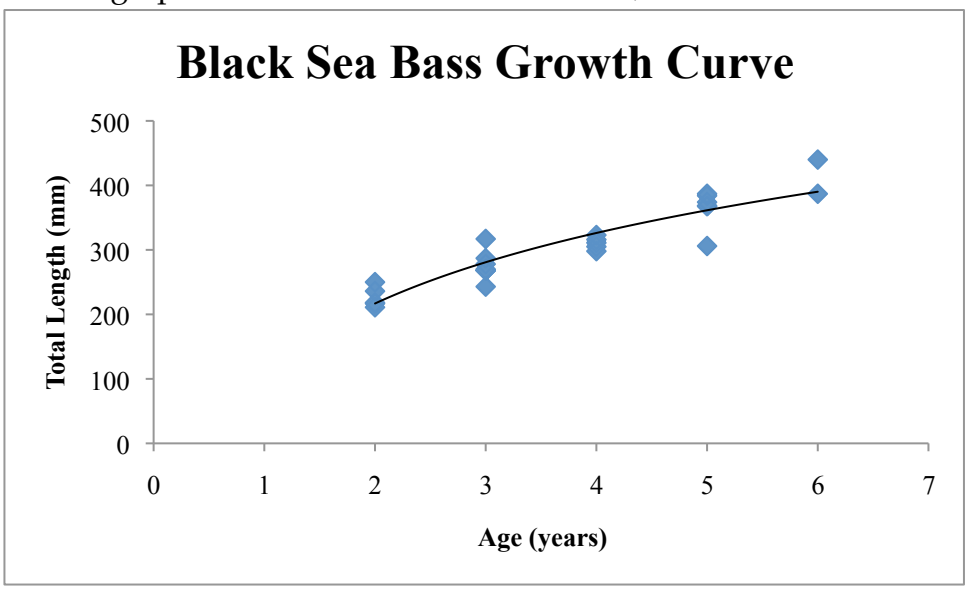
1. Write the motivating question on the board:

How do scientists create growth curves to learn about the age and lengths of fish?

2. Make class copies of the scale images (the number depends on how big your class size is and how many scales you want each student to age).
3. Make copies of the student handouts for each student (last page of this write-up).
4. Draw out the data table with the Fish ID# and Length information completed on the board.

Fish ID #	Age (Years)	Total Length (mm)
BSB00001A		368
BSB00016C		298
BSB00020A		387
BSB00047B		306
BSB00048B		287
BSB00053C		317
BSB00091C		323
BSB00148A		374
BSB00156B		316
BSB00172C		387
BSB00237B		270
BSB01303B		368
BSB01311B		311
BSB01317B		305
BSB01326A		440
BSBD17C		217
BSBD18B		218
BSBD20A		211
BSBD21A		250
BSBD23C		268
BSBD29B		278
BSBD32A		236
BSBD33C		243
BSBD43E		268
BSBD77A		384

5. Make a graph of the actual data on the board, but make sure it is hidden from the students.



6. Go through the PowerPoint slides to become familiar with the material (if you plan on using it).
7. If you are interested, a great resource is the "Age Reading Demonstration" put together by the Alaska Fisheries Science Center – National Marine Fisheries Service – NOAA (http://www.afsc.noaa.gov/refm/age/interactive.htm)

Engage (10 minutes)

1. Lead the students in a discussion about growth curves and what they know about aging animals.

Q. How do scientists age an animal?

Q. Why do scientists age an animal? What questions are scientists trying to answer when they collect information from the ages of an animal?

Q. Why would scientists be interested in understanding the growth curve of an animal population?

2. Ask the students what they know about aging techniques used to collect this information about animals. Be accepting of all responses from the students. If they are stuck, ask them what kinds of things would they use to learn the age of an animal (or tree).
3. After a minute or two and depending on what the students already know, share some information with them that you feel they need to know to understand the activity of the day. You can use the included PowerPoint on fish aging if you would like.

Explore (25 minutes)

1. Explain to the students that they will be taking a closer look at fish aging techniques, in fact they will be aging Black Sea Bass to create their own growth curves for the New Jersey Black Sea Bass population.
2. Explain Part 1 of the activity to the students:

   a. In a few moments they will receive images of scales of Black Sea Bass. Tell them that the Fish ID# can be found in the top right corner of each image.
   b. First, they need to determine how old the fish is by counting the annuli (rings).
   c. Once they have determined how old the fish is, they should add their data in the appropriate row in the data table for "Age."
3. Use slides #9-10 in the PowerPoint to walk through how the students will age the Black Sea Bass scales they are using in the activity. They need to count complete dark bands to go from the far left across the scale to the far right.
4. Ask the students if they have any questions about Part 1 of the activity.
5. When ready, pass out the scale images to the students.
6. After all of the students have added their data to the class data table, ask the students:

   Q. What do we do with multiple data points of age for the same fish? (You average them)

   Q. What are the next steps for creating a growth curve? (Plotting the length vs. age for each fish on their graphs; each fish is represented by 1 data point on the graph)

   Q. What kind of graph will we use? (Scatterplot) What is the x-axis? (Age in years) What is on the y-axis? (Total Length in mm)
7. Have the students plot the growth curve using the class data. It may be helpful for them to copy the class data table onto their own data table. (As the students are creating their individual graphs, plot both the class data in a different color on top of the actual data on the class graph.)
8. As the students finish their graphs, ask them to write a written response to:

   Q. What patterns can you observe in the data? Is there a relationship between age and length of Black Sea Bass? If so, what is the relationship?

Make Sense (10 minutes)

1. After a few minutes of writing their responses, tell the students that we are going to interpret and analyze data as a class.
2. Have the students report out what patterns and/or relationships they observed in the data. Make sure to have the students support their statements of the patterns and/or relationships by stating what evidence they are using.
   a. Help the students see that as the age of Black Sea Bass increases the Total Length of fish also increases. However, this is not a linear relationship (1:1) and that the relationship (slope) changes as the fish get older.
3. After a few students have shared their ideas, show the class graph to the students and explain the different colors on the graph. Discuss with the students what the graph can tell us about the New Jersey Black Sea Bass population.
   a. Help the students understand how to draw a line representing the relationship between length and age on the graph (aka they do not connect the dots, but rather look more for the median at each age category and then connect those).

   b. The students may be concerned that their data does not match the actual data for the fish, remind them that people spend months to years getting trained on reading scales.

4. Some discussion points you might want to hit on:
   a. Help the students think about how if we are only fishing the largest fish in a population, then we are removing the oldest fish in that population.
      i. For many marine fish, the older the female the more offspring she produces and the more successful her offspring are at surviving (BOFFFF - Big, Old, Fat, Fecund Female Fish). Knowing this, what could be a problem for the fish population size if we are only taking the oldest fish?
      ii. Also the length at which fish grow to and at which they mature is a trait that changes over time based upon the environment. So again, if we are fishing only the largest fish in a population how might that change the maximum length of a species or the age at which fish mature?
      iii. Black Sea Bass are an interesting species of fish in that they are *protogynous hermaphrodites*, they first mature as females and later most become males. Again ask the students what this might mean for the Black Sea Bass population if we are only fishing the largest fish in the population.

5. Once the discussion slows down, point to the motivating question and ask:
   Q. How do scientists create growth curves to learn about the age and lengths of fish?
   Ask students to share their ideas about the question with a partner. After a minute, ask volunteers to share the ideas they discussed with the entire class. Be accepting of all responses from the students. This is your opportunity to make sure the students understand the "take home message" that you identified.

6. Ask if the students have any questions about the activity or the graphing.

** Data and consultations on this lesson plan were provided by:
Mikaela Provost, Dr. Paola Lopez-Duarte and Dr. Olaf Jensen of Rutgers University. **

How Old is that Black Sea Bass? Worksheet

Name: _____

Date: _____

Fish ID# _____

Age (years) _____

Data Table:

Fish ID #	Age	Total Length
BSB00001A		
BSB00016C		
BSB00020A		
BSB00047B		
BSB00048B		
BSB00053C		
BSB00091C		
BSB00148A		
BSB00156B		
BSB00172C		
BSB00237B		
BSB01303B		
BSB01311B		
BSB01317B		
BSB01326A		
BSBD17C		
BSBD18B		
BSBD20A		
BSBD21A		
BSBD23C		
BSBD29B		
BSBD32A		
BSBD33C		
BSBD43E		
BSBD77A		

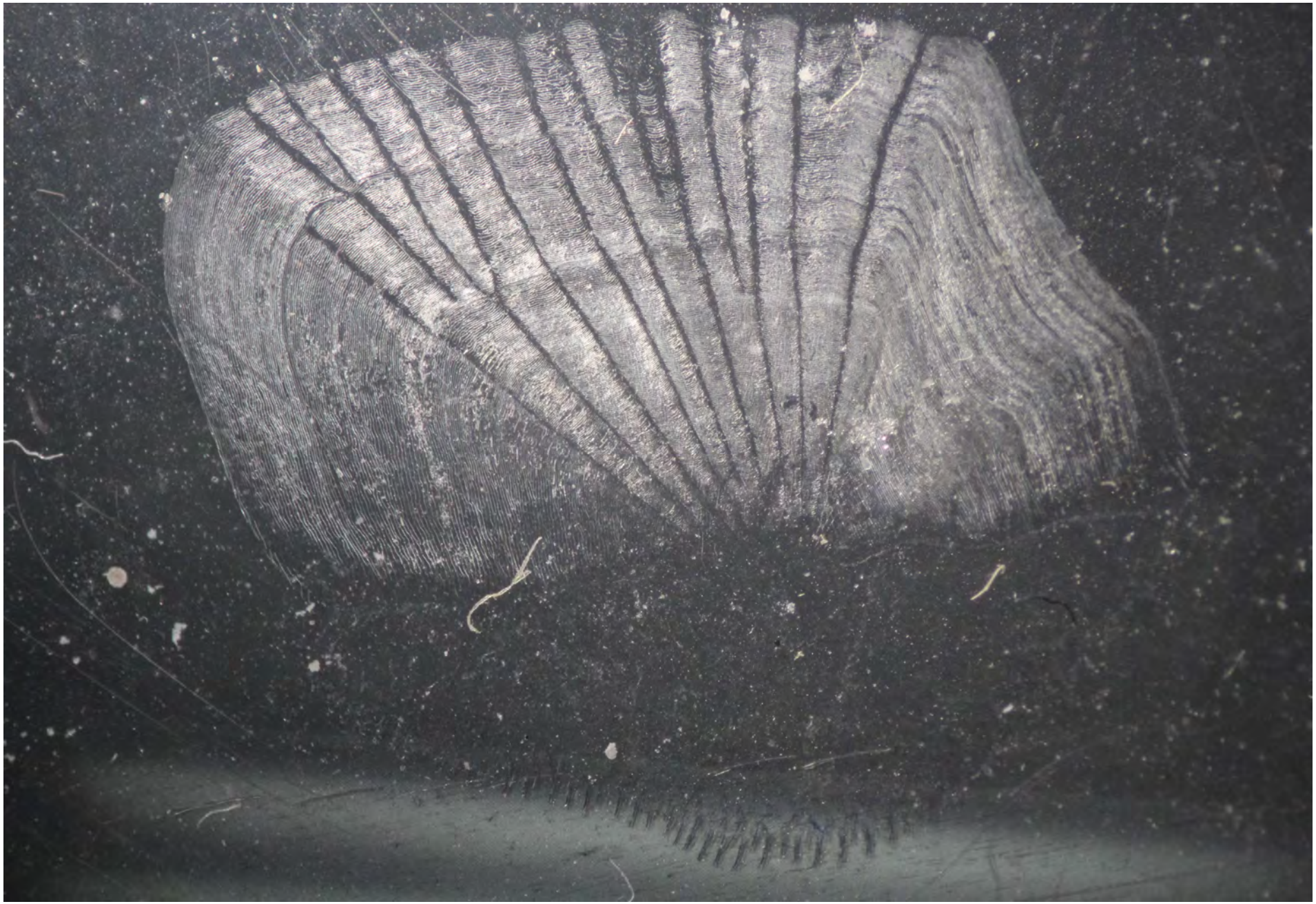
Writing Prompt:

What patterns can you observe in the data? Is there a relationship between age and length of Black Sea Bass? If so, what is the relationship?

Actual age and length data for Black Sea Bass scales included in this activity

Fish ID #	Age (Years)	Total Length (mm)
BSB00001A	5	368
BSB00016C	4	298
BSB00020A	5	387
BSB00047B	5	306
BSB00048B	3	287
BSB00053C	3	317
BSB00091C	4	323
BSB00148A	5	374
BSB00156B	4	316
BSB00172C	6	387
BSB00237B	3	270
BSB01303B	5	368
BSB01311B	4	311
BSB01317B	4	305
BSB01326A	6	440
BSBD17C	2	217
BSBD18B	2	218
BSBD20A	2	211
BSBD21A	2	250
BSBD23C	3	268
BSBD29B	3	278
BSBD32A	2	236
BSBD33C	3	243
BSBD43E	3	268
BSBD77A	5	384

BSB00001A

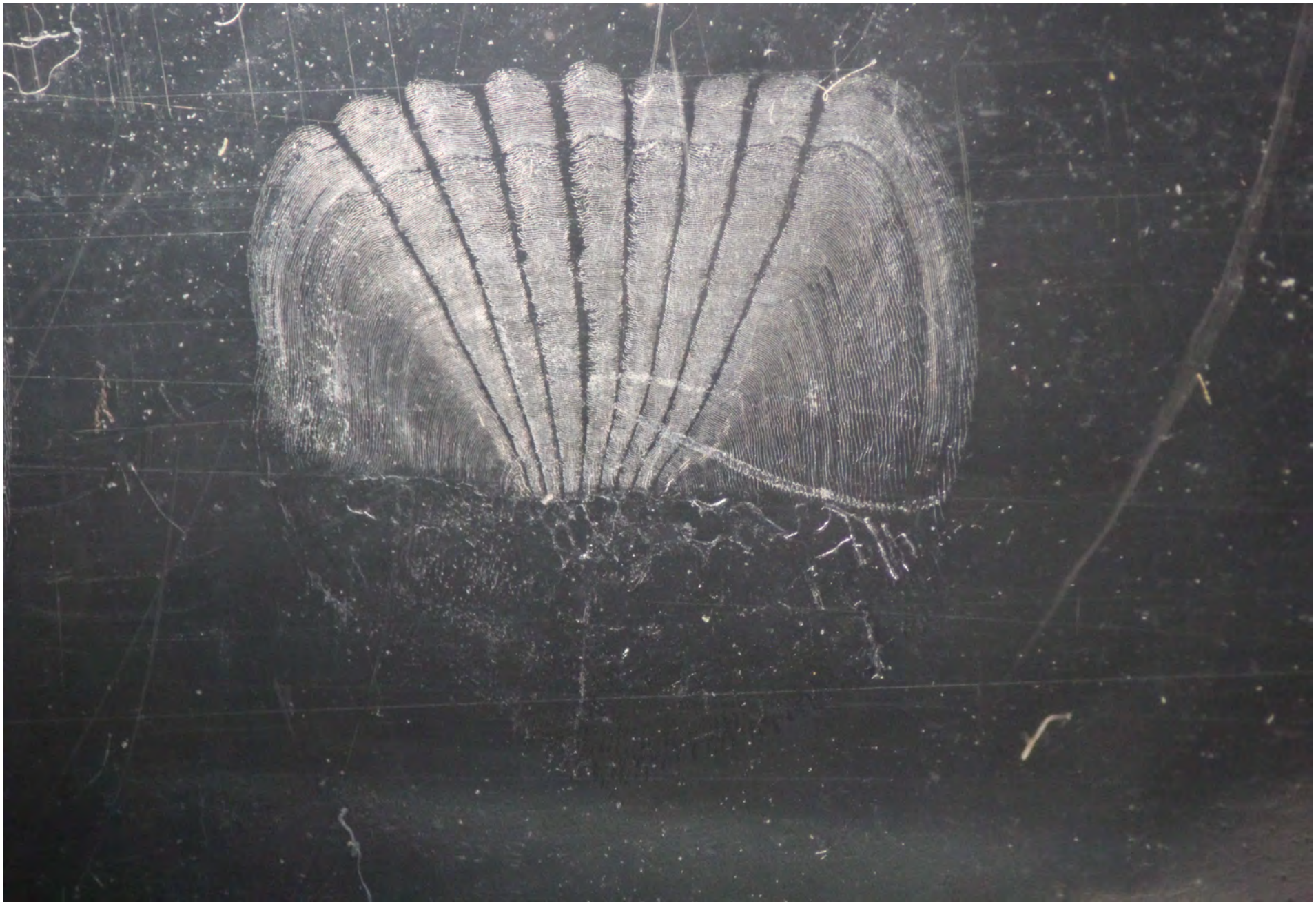


BSB00016C

BSB00020A

BSB00047B

BSB00048B



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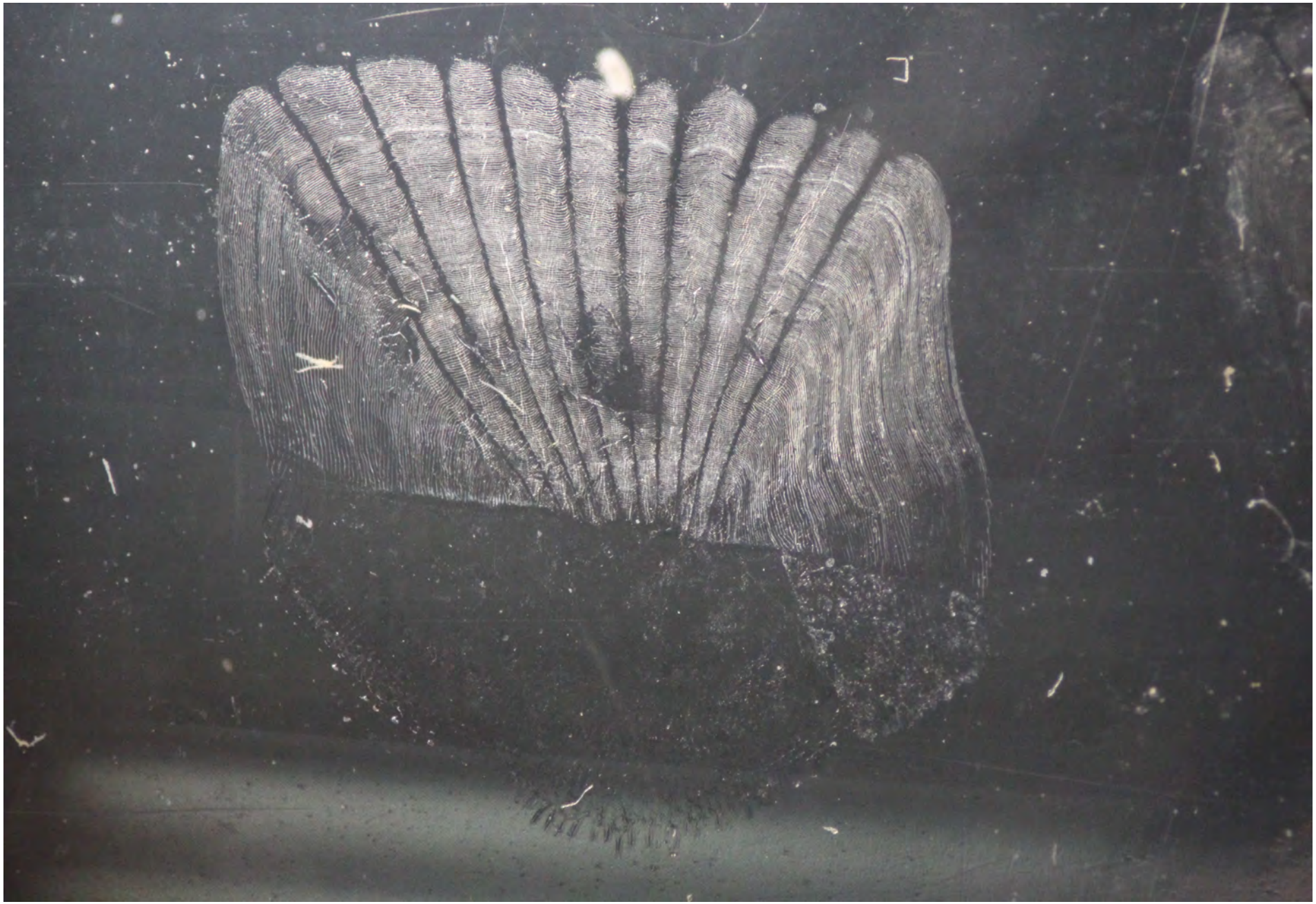

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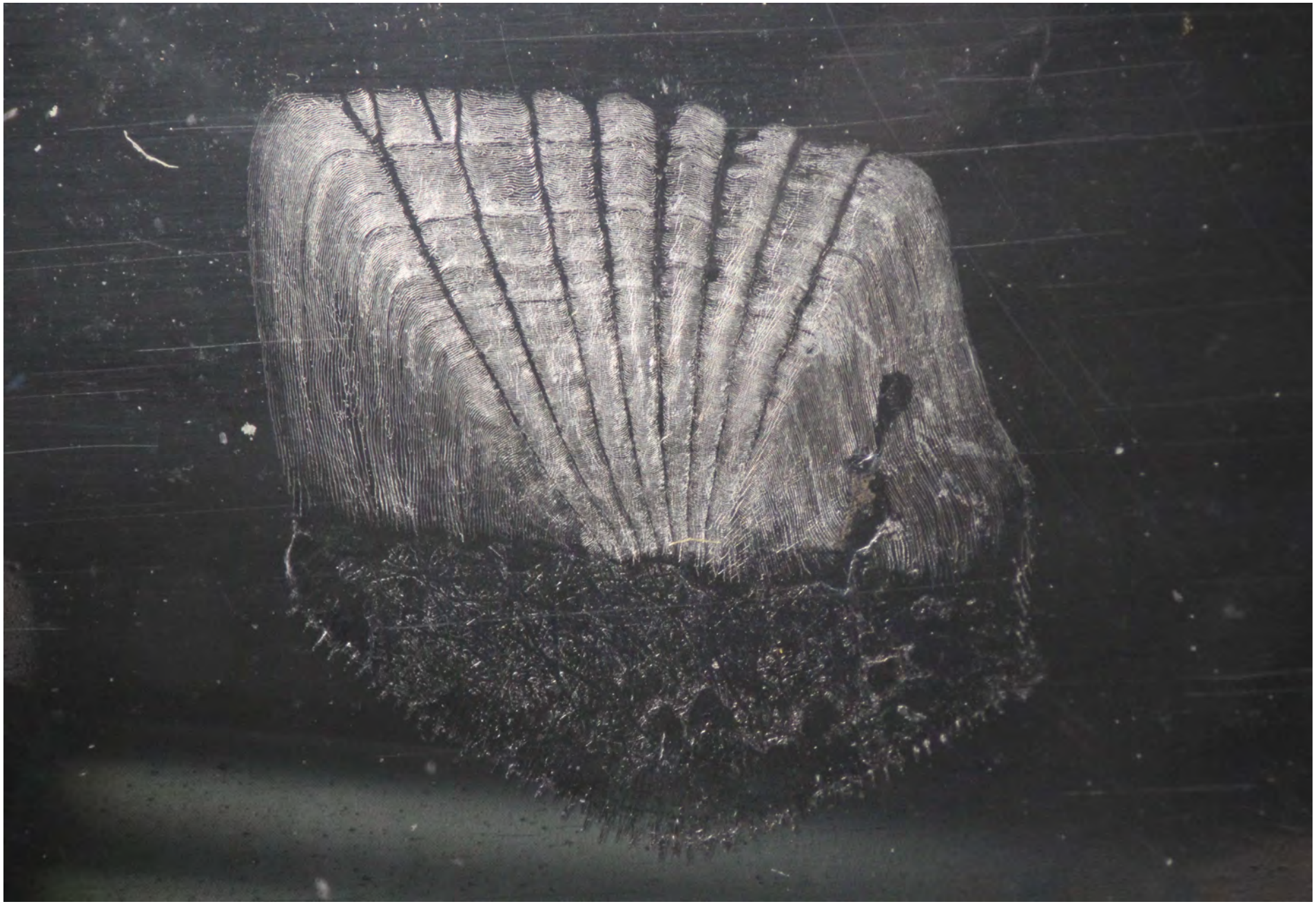

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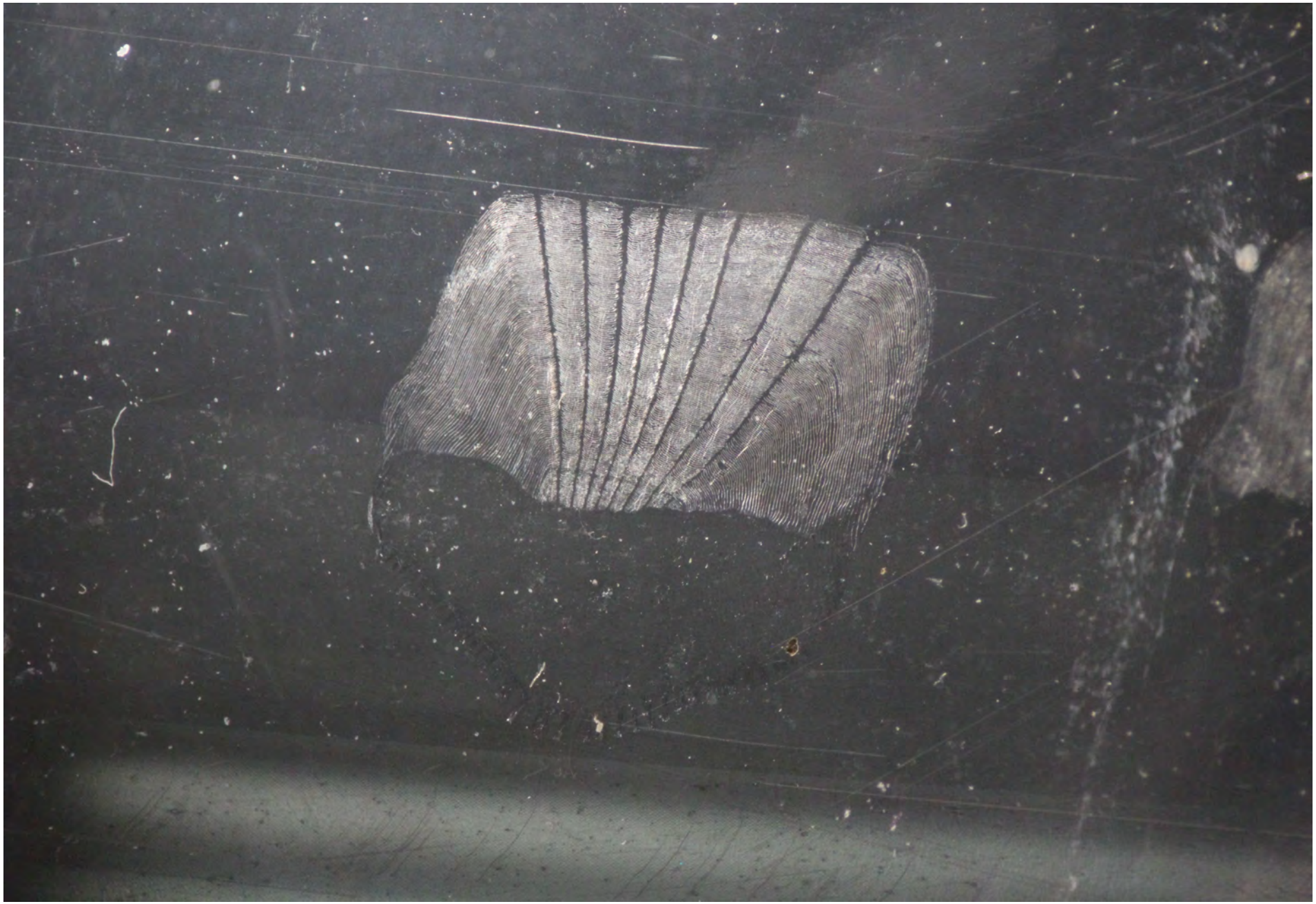


BSBD21A

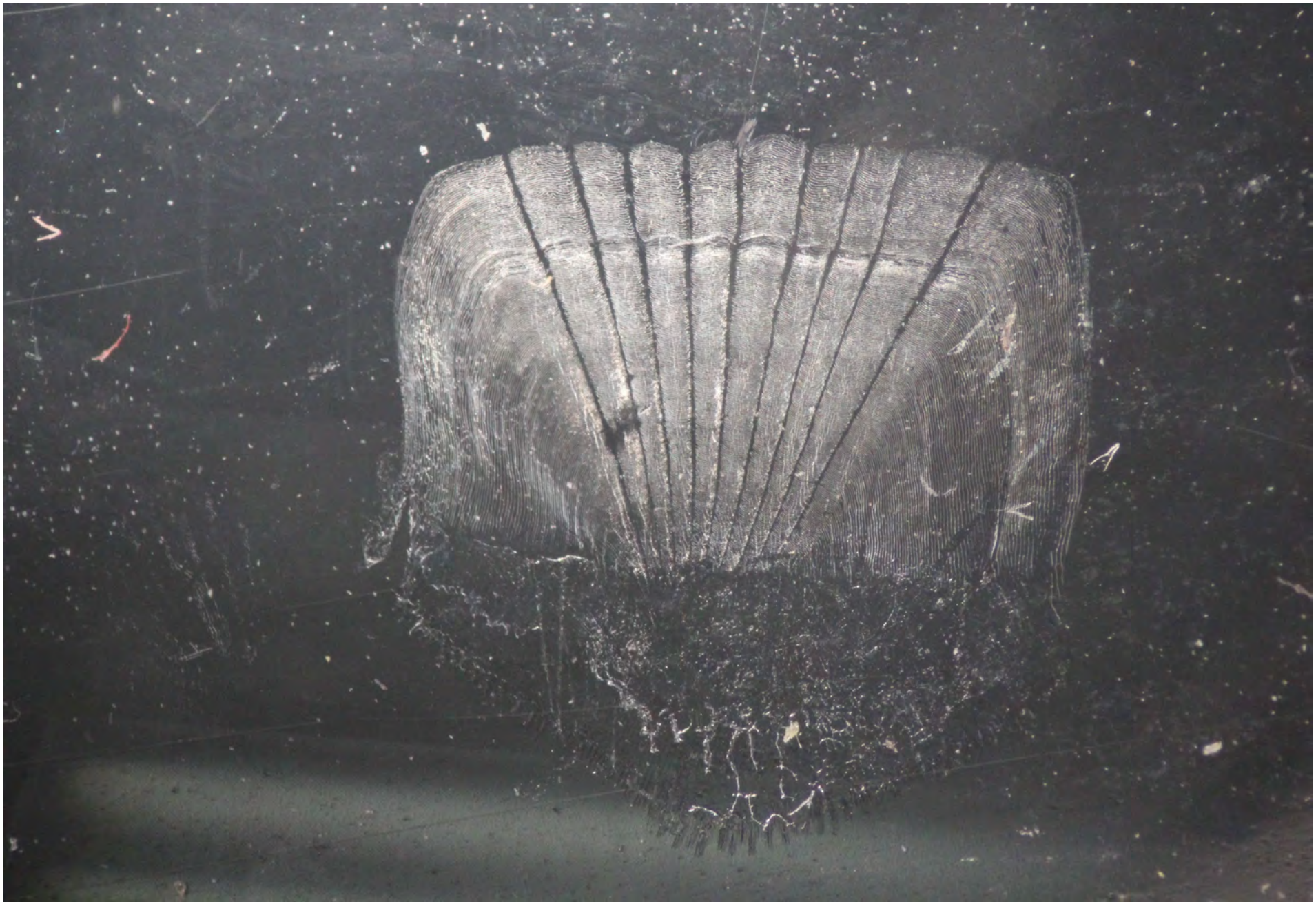
BSBD23C

BSBD29B

BSBD32A

BSBD33C

BSBD43E



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