Atlantic States Marine Fisheries Commission

2024 Report of the Quality Assurance/Quality Control Fish Ageing Workshop

March 19-20, 2024
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Sustainable and Cooperative Management of Atlantic Coastal Fisheries

Table of Contents

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Statement of Problem

Many of the stock assessments for fish species managed by the Atlantic States Marine Fisheries Commission (ASMFC) identify the collection of ageing hard parts, development of sample processing and reading protocols, and regular sample exchanges as research priorities. Several species managed by the ASMFC have had their own ageing structure exchange and workshop to address this. However, there is a continued need for a quality assurance/quality control (QA/QC) workshop because any gradual decline in ageing accuracy could have detrimental effects on stock assessments and consistency should be monitored over time (Campana 2001). Following the Gulf States Marine Fisheries Commission (GSMFC) protocol to hold annual QA/QC workshops for its participating members, the ASMFC made an annual QA/QC fish ageing workshop a research priority. Since 2016, a QA/QC Fish Ageing Workshop has been held, with the exception of the pandemic years of 2020-2022, to provide a yearly check-in for species that have had their own ageing workshop, have age data in their assessments, or are assessed with an age-structured model.

The full QA/QC sample collection contains approximately 20 samples from each of the following species: Atlantic croaker *Micropogonias undulatus*, Atlantic menhaden *Brevoortia tyrannus*, Atlantic striped bass *Morone saxatilis*, American eel *Anguilla rostrata*, black drum *Pogonias cromis*, black sea bass *Centropristis striata*, bluefish *Pomatomus saltatrix*, cobia *Rachycentron canadum*, red drum *Sciaenops ocellatus*, scup *Stenotomus chrysops*, spot *Leiostomus xanthurus*, summer flounder *Paralichthys dentatus*, tautog *Tautoga onitis*, weakfish *Cynoscion regalis*, and winter flounder *Pseudopleuronectes americanus*. Samples were provided by various ageing labs and programs along the Atlantic coast and each collection program, sample preparation, and age determination method by species and lab are described in Appendix A.

The workshop previously evaluated river herring (alewife *Alosa pseudoharengus* and blueback *A. aestivalis*) but in 2018, the Ageing Committee decided to remove this species from future workshops because only three participating states age river herring, the species varies greatly by river system, and agers use different methods (scales or otoliths) to obtain ages. Similarly, American eel was added to the collection in 2019 following its own ageing workshop but agers did not recommend maintaining this species in the QA/QC collection because few agers at the workshop age American eel, ages are not used in the stock assessment, and sample appearance varies widely by collection area.

Samples in the QA/QC collection include scales, whole otoliths, sectioned otoliths, spines, and/or opercula depending on the species and which hard part is used to provide ages to the ASMFC during stock assessments. The Ageing Committee decided to rotate species every few years so that more species could be included in the workshop. Atlantic croaker, black drum, black sea bass, bluefish, cobia, scup, spot, striped bass, summer flounder, tautog, and winter flounder were identified as species to evaluate for the 2024 workshop which took place from March 19-20th at the Florida Fish and Wildlife Research Institute (FL FWRI) in St. Petersburg, Florida. This was the first year that black drum and spot have been evaluated by the workshop.

Workshop Objectives

The objectives of the 2024 workshop were to:

(1) Age samples collected and prepared from labs along the Atlantic coast for black sea bass, striped bass, tautog, croaker, bluefish, summer flounder, winter flounder, scup, cobia, spot, and black drum
(2) Identify areas of inconsistency that persist for processing or reading ageing structures
(3) Provide information on ageing error for each species to inform future stock assessments, including APE for group consensus ages and comparisons between individual agers that routinely age each species
(4) Develop recommendations to address any problems that emerge from this workshop so as to improve age data along the Atlantic coast
(5) Maintain samples as a reference collection for future QA/QC workshops as well as archive in a digital library

Workshop Proceedings and Methods

All species included in the 2024 QA/QC Fish Ageing Workshop sample collection are assessed using an age-structured model except Atlantic croaker, American eel, black drum, and spot and all have previously had their own ageing workshop except for black drum, cobia, and weakfish (Table 1). Complete reports and results from those ageing workshops are available at http://www.asmfc.org/fisheries-science/research and are summarized along with the history of how age data is used in their respective stock assessments in Appendix B.

Workshop participants met on Tuesday, March 19th, in a conference room at the FL FWRI building in St. Petersburg to go over the goals of the workshop, agenda, and to make introductions (Appendix C). Jessica Carroll and the staff at Florida's Fish and Wildlife Conservation (FL FWC) Commission including Kristin Cook, David Westmark, Kiley Gray, and Brittany Bottom set up stations ahead of the workshop for the hard part reading exercise. Participants broke into five groups, each led by a FL FWC employee, and began ageing the structures at each station. Not all states or labs routinely age all the species at the workshop, so the groups were developed to mitigate the effects of readers unfamiliar with a species. Individual ages were also recorded for species that are routinely aged and supplied to ASMFC by that reader.

For each of the 11 species, every member of the group aged the samples (n=20-30 per species) and the group came to a consensus for annulus count, margin code, and final age. Each structure was assigned a margin code from 1-4 (Figure 1). A code 1 represented a structure with an annulus just forming or having just finished forming at the edge of the structure. Code 2 was assigned when the growth outside the last visible annulus was less than 1/3 the growth between the two previous annuli. Code 3 represented 1/3 to 2/3 growth and code 4 was for more than 2/3 growth. A catch date and state where the sample was caught was provided for each sample to make final age determinations, but no other information was provided during reading. In addition to group ages, the participants also recorded their individual age readings and experience level for additional analysis.

Ageing precision between groups for consensus ages were evaluated using average percent error (APE). Participants also reviewed individual age comparisons for agers who routinely age each of the species. Individual age comparisons represent those at the workshop with experience ageing the species, so the lab may age the species but the ager who attended does not so they were not included in the analysis. Exact agreement was tested using Bowker's test of symmetry around the diagonal 1:1 line (Evans and Hoenig 1998) where a significant p-value (<0.05) indicates systematic bias between the age readings. Without knowing the true age of the fish, this test does not identify which reader is more accurate, but rather identifies whether there are differences or not. Mean coefficient of variation (CV), percent of exact agreement between readers, and percent agreement within one year was also calculated for each lab and reader to provide a measure of precision. While this does not serve as a proxy for accuracy, it does indicate the level of ease for assigning an age to that ageing structure, the reproducibility of the age, or the skill level of the readers. Generally, CVs of 5% serve as a reference point for determining precision, where greater values indicate ageing imprecision (Campana 2001).

Workshop Results

On March 20th, the attendees of the workshop met to go over the APE for each species and results from individual age readers, revisit samples with high disagreement, and make recommendations for following workshops or coastwide ageing. The APE varied by species throughout the six years of the workshop (Table 2). Discussion and results for each species follows and sample images are available in Appendix D.

I. Atlantic Croaker

In the first two years of the QA/QC Workshop, Atlantic croaker had high disagreement due to the 'smudge,' or check mark, near the otolith's core. While it has been determined by a previous workshop that this check mark should not be counted (ASMFC 2008), many workshop participants felt, and continue to feel, that fish are not being classified to their correct year class. In the subsequent years, the APE has decreased for Atlantic croaker as readers are aware of the protocol for the species (Table 2). The ageing timeline for Atlantic croaker can be found in Figure 2.

The sample with the highest individual APE was #4 (Table 3) and the workshop participants reviewed that otolith. Most groups aged this sample as an age-1, except for group 5 which aged it as a 2-year-old. Katie Messer (Maryland Department of Natural Resources, MD DNR), from group 5, said that she aged it as an age-2 but would have wanted to know the length to make an age determination. There was some debate about if group 5 was counting the smudge on sample #4. Sample #5 was also reviewed by participants. This sample was aged as a 2-year-old by all groups except group 5 which aged it as a 3-year-old. Similar to sample #4, participants discussed if group 5 counted the smudge or not. The group also reviewed sample #11 as a good example of the smudge issue.

Kristen (ASMFC) reminded the participants that at the 2023 QA/QC Workshop, the group discussed a recent decline in size-at-age for Atlantic croaker, as observed by Virginia Marine Resources Commission (VMRC) and other ageing labs, and that length should not be used to determine age.

Agers from New Jersey Division of Fish and Wildlife (NJ DFW), MD DNR, Virginia Institute of Marine Science (VIMS), VMRC, North Carolina Division of Marine Fisheries (NC DMF), South Carolina Department of Natural Resources (SC DNR), and FL FWC reported that they routinely age Atlantic croaker and provide ages to ASMFC for this species. There were no CVs greater than 5%, but there were some significant p-values from Bowker's test of symmetry indicating some systematic bias between the reader at MD DNR and other labs (Table 4). Similarly, the highest disagreement was between the reader at MD DNR and the other labs, but all readers were in 100% agreement within one year (Table 5). This may indicate that the smudge issue remains a challenge for ageing Atlantic croaker.

II. Black Drum

This was the first year that the QA/QC Workshop has evaluated black drum and APE between groups was low (3.41%; Table 2). The group reviewed sample #11 since it was aged from an age-1 to an age-3 (Table 6). Jessica (FL FWC) noted that samples from Florida, like this one, might confuse some readers since they appear more clear or lighter than samples from elsewhere along the Atlantic coast. Additionally, agers at FL FWC have begun to see annuli formation in December. Melanie (VIMS) chimed in to say that black drum samples collected in the Northeast Management and Assessment Program (NEAMAP) have begun to show annulus deposition in the fall. In these cases, it is not a full annulus but the beginning of one later than the timeline indicates (Figure 3), similar to the recent changing timeline for bluefish discussed at the 2023 QA/QC Workshop.

Workshop participants also noted that no agers in groups 3-5 age black drum, so discrepancies in age from those groups should not be an issue for the assessment. Regardless, the low APE for this species indicates the ease of age determination for black drum, despite the unfamiliarity of most readers with this species.

Agers from VIMS, VMRC, NC DMF, SC DNR, and FL FWC routinely age this species and provide ages to support its stock assessment. There were no significant p-values from Bowker's test of symmetry indicating no systematic bias and all CVs were less than 5% (Table 7). Exact agreement varied from 90-100% (Table 8) and increased to 95-100% within one year.

III. Black Sea Bass

The APE for black sea bass has varied for the years it has been evaluated at the workshop from as low as 3.67% in 2016 to as high as 12.71% in 2018 (Table 2). The APE in 2024 was 7.06%, similar to the APE in 2023. Previous to 2024, the 20 samples for black sea bass included scales, whole otoliths, and sectioned otoliths, but scales were removed after it was determined that no labs or states are currently using them for ageing. The 20 samples were therefore revised for the 2024 QA/QC Workshop to include only whole and sectioned otoliths, so this should be kept in mind when comparing the APE from year-to-year. For 2024, workshop participants noted that the APE for otoliths sections was very low (0.44%), indicating high agreement, and that most of the disagreement came from the whole otolith samples (Table 9). Both the NEFSC and FL FWC use whole otoliths for black sea bass ageing, although NEFSC uses the guideline of sectioning otoliths over age 5, while FL uses 8. Florida noted, and the group agreed, that black sea bass samples from FL look very different from those collected elsewhere and age-8 might be an appropriate cutoff given the regional differences. The ageing timeline for black sea bass can be found in Figure 4.

Sample #8 was the only sectioned otolith sample to have any disagreement among readers (Table 9). Most groups aged this sample as an age-7, but group 4 aged it as an age-8. Participants noted that they struggled with identifying the first annulus on this sample. Whole otolith samples #12-14 were also reviewed since they had high disagreement. These samples represent young ages and Eric (Northeast Fisheries Science Center, NEFSC) reminded the group that workshop participants often debate samples ages 0-2 for this species. Additionally, there are differences between northern and southern black sea bass within its range, where southern fish do not grow as fast as northern fish. To address this issue, state was added to the ageing sheet at the workshop beginning this year.

Agers from Massachusetts Division of Marine Fisheries (MA DMF), NEFSC, Rhode Island Department of Environmental Management (RI DEM), New York Department of Environmental Conservation (NY DEC), VIMS, and FL FWC reported routinely ageing black sea bass. There were no significant p-values from Bowker's test of symmetry indicating no systematic bias, although there were CVs greater than 5% indicating some imprecision (Table 10). Exact agreement varied from 89-100% (Table 11) and increased to 100% within one year. Like the group ages, regional differences could also be seen in the individual ages, with agers from Massachusetts through New York having higher agreement among their readers and VIMS and FL FWC agreeing more with each other (Table 11). The differences between agers were attributed to the regional differences in northern and southern samples and the workshop participants did not think this was a cause for concern.

IV. Bluefish

The APE for bluefish at the workshop decreased to 2.95%, its lowest value for all years of the workshop (Table 2). Similar to 2016-2023, problems distinguishing between age-0 and age-1 bluefish dominated the discussion. Eric Robillard from NEFSC reminded the group that one should always look for the crenellation on the side on a sample. If it is present, that sample cannot be an age-0. Additionally, the group discussed the timeline for the species (Figure 5). In 2023, workshop participants discussed that the timeline for bluefish may be changing in recent years and samples were added to the 2024 collection to include newer samples (e.g., 2020 or later). The group reviewed sample #7 (Table 12) as an example of a bluefish caught in July in 2022. The assumption is that a bluefish should have laid an annulus in April and so the reader would not anticipate a ring to be laid down in July or August and it is unclear whether to bump this fish or not. Eric noted that he is seeing annulus deposition all the way in October now. He recommended that readers look at their recent samples and determine when annulus deposition is so they know when to bump. Scott said that MA DMF does not collect bluefish throughout the year so taking this recommendation will be a challenge for states without continuous sampling.

For individual reader comparisons, readers from MA DMF, NEFSC, RI DEM, Connecticut Department of Energy and Environmental Protection (CT DEEP), NY DEC, Delaware Division of Fish and Wildlife (DE DFW), VMRC, VIMS, SC DNR, and FL FWC reported that they routinely age bluefish. When comparing the experienced bluefish readers, there were eight significant p-values from Bowker's test of symmetry this year, indicating systematic bias between the readers (Table 13). CVs ranged from 0-13% and 24 out of the 45 comparisons had CVs greater than 5%, indicating some imprecision. Exact agreement varied from 65-100% and increased to 100% for all readers for agreement within one year (Table 14).

V. Cobia

The 2023 QA/QC Workshop was the first year that cobia was included and its samples had high agreement between readers with an APE of 4.35% in 2023 and 4.87% in 2024 (Table 2; Table 15), despite the unfamiliarity of most readers with this species. No individual samples were reviewed from cobia since most of the disagreement in ages occurred between groups that did not include a cobia ager. The ageing timeline for cobia can be seen in Figure 6.

For individual reader comparisons, readers from VMRC, SC DNR, and FL FWC indicated they routinely age cobia. When comparing the experienced cobia readers, there were no significant p-values from Bowker's test of symmetry this year, indicating no systematic bias between the readers (Table 16). CVs ranged from 1-2%, indicating no imprecision. Exact agreement varied from 80-90% and did not increase for agreement within one year (Table 17).

VI. Scup

The APE for scup decreased to 5.32% in 2023 from 11.60% in 2018 (Table 2). The average APE in 2024 for scup was 8.25%. Otoliths had an APE of 6.09% and scales had an APE of 13.31%. In the collection, there are three paired otolith and scale samples. CT DEEP uses scales to age scup and they do not collect other hard parts from the species. The group reviewed sample #3 since it was aged as a 2 and 3-year-old by the groups (Table 18). Agers noted that there was a lot of growth on the edge which may have led to some disagreement. The group also reviewed sample #10 which was aged from 2-4 years old. Agers noted that cut on the sample is not to the core but if it was closer to the core the separation would be more clearly seen. Eric said that since this scup was collected in February, it should be bumped. The ageing timeline for scup can be seen in Figure 7.

The MA DMF, NEFSC, RI DEP, CT DEEP, and VIMS all routinely age scup although CT only uses scales. There were no significant p-values from Bowker's test of symmetry indicating no systematic bias and CVs ranged from 0-15% depending on the hard part (Table 19). Exact agreement between readers ranged from 33-100% and increased to 86-100% for agreement within 1 year (Table 20). Comparing ages from three paired samples for the five readers, otoliths were aged as older than the scales on average (Figure 8).

VII. Spot

This was the first year that the QA/QC Workshop has evaluated spot and APE between groups was low, indicating high agreement (4.56%; Table 2). The spot collection for the QA/QC Workshop is all sectioned otoliths, but agers from VIMS and NC DMF age spot using whole otoliths. MD DNR is also considering ageing spot using whole otoliths since they usually see ages 0-1 in their waters. Additionally, it was noted that spot also can have a smudge issue as seen in Atlantic croaker. Similar to

Atlantic croaker, the ager from MD DNR appeared to be ageing differently from the other agers, as can be seen in the individual age comparisons, and may be counting the smudge. Samples #11, 19, and 20 were reviewed by the group (Table 21). The timeline for spot can be found in Figure 9.

Agers from MD DNR, VIMS, NC DMF, SC DNR, and FL FWC all indicated that they routinely age spot. There were no significant p-values from Bowker's test of symmetry indicating no systematic bias and CVs ranged from 0-11% depending on the hard part (Table 22). Exact agreement between readers ranged from 80-100% and increased to 100% for agreement within 1 year (Table 23).

VIII. Striped Bass

For the 2016-2018 QA/QC Workshops, the sample set for striped bass was 10 scales and 10 otoliths. For 2019, additional paired samples were added. In 2024, the sample set was 15 scales and 15 otoliths, mostly paired. In 2024, the APE for striped bass was 11.50%, the highest in the 4 years that the species has been included in the workshop (Table 2; Table 24). Participants attributed the high APE to the microfiche used at the workshop, noting that the scale APE was 18.54% and the otolith APE was 4.45%. Nicole (RI DEP) recommended that the 15 scale samples be circulated among the states ageing striped bass scales to read on their own equipment to determine if the high APE for striped bass scales is an ageing or equipment error. Nicole also polled the group about if agers use a heat or jewelers press to prepare samples, noting that she thinks a heat press does a better job. The ageing timeline for striped bass can be found in Figure 10.

Agers from MA DMF, RI DEP, NJ DFW, VIMS, VMRC, NC DMF, and SC DNR indicated that they routinely age striped bass. There were no significant p-values from Bowker's test of symmetry indicating no systematic bias (Table 25). The CVs for the otolith samples ranged from 0-1%, indicating no imprecision, whereas the scale CVs ranged from 0-19%, indicating some imprecision (Table 25). Exact agreement between readers ranged from 80-100% for otoliths and 13-100% for scales (Table 26). Agreement increased to 93-100% for agreement within 1 year for otoliths and 60-100% for the scale samples (Table 26). There are 10 paired scale and otolith samples in the 2024 QA/QC Workshop collection. On average, otoliths are aged older than the scale samples (Figure 11).

IX. Summer Flounder

Summer flounder has been included in the QA/QC Workshop three times and the APE of 2.37% in 2024 was the lowest APE yet for the species (Table 2; Table 27). Sample #11 had the highest APE of the 20 samples and was reviewed by participants of the workshop. Groups aged the sample as a 1–2-year-old. It was acknowledged that it was a dark sample and hard to read. Sample #4 was also reviewed at the workshop since it was aged from 10-12 years old. Agers agreed that the cut of the sample makes it hard to identify the first annulus. The timeline for summer flounder can be found in Figure 12.

Agers from MA DMF, NEFSC, RI DEP, CT DEEP, NY DEC, VIMS, and NC DMF indicated that they routinely age summer flounder. There were no significant p-values from Bowker's test of symmetry indicating no systematic bias (Table 28). CVs for summer flounder ranged from 0-11%, indicating some imprecision.

Exact agreement between readers ranged from 75-100% and increased to 95-100% for agreement within 1 year (Table 29).

X. Tautog

Tautog has been evaluated during the QA/QC Workshop every year (2016-2019, 2023-2024; Table 2). Over the years, the sample set for tautog has changed. For 2016-2018, the tautog samples included 20 opercula. In 2019, additional paired samples were added to include pelvic spines and otoliths since both were approved hard parts for ageing the species following its recent ageing workshop (ASMFC 2021b). For 2023, the workshop included only the paired samples, although not all paired samples had all three hard parts. The set was revised again for 2024 to include more older (>11 years old) paired samples since there were not samples representing all age classes used in the assessment (Table 1; Table 30). The ageing timeline for tautog can be seen in Figure 13.

The APE for tautog has varied from 6.09% in 2016 to 11.28% in 2018 and was 5.48% in 2024 (Table 2). Otolith samples had the lowest APE at 3.58%, followed by pelvic spines at 6.30%, and then opercula at 6.89% (Table 30). The workshop participants noted that agreement was high for tautog given that so many of the samples in the collection represented older tautog. Scott (MA DMF) recommended reading spines on a compound scope, but was satisfied with the agreement on a hard part that is not routinely aged by all states or labs.

For individual reader comparisons, readers from MA DMF, RI DEM, CT DEEP, NY DEC, NJ DFW, VIMS, and VMRC indicated they routinely age tautog. Only MA DMF routinely ages spines, but all states were included in the analysis to evaluate the agreement on the structure given its recent ageing workshop. When comparing the experienced tautog readers by ageing structure, there were no significant p-values from Bowker's test of symmetry, indicating no systematic bias between the readers (Table 31). CVs ranged across the ageing structures with several CVs > 5% for opercula and spines, indicating some imprecision. Exact agreement also varied across hard parts with the highest agreement on otoliths. Agreement increased within one year for all structures, but otoliths had the highest within-one-year agreement (Table 32). Comparing ages from paired samples, there were no consistent patterns of over- or under-ageing between opercula and otoliths or spines and otoliths, whereas opercula provided older ages than spines (Figure 14 - Figure 16). The significant p-values indicate systematic bias and differences between ages in the paired structures and the CVs indicate some imprecision.

XI. Winter Flounder

Winter flounder had an APE of 7.75%, which was similar to the previous years at the species has been evaluated at the workshop (Table 2; Table 33). Sample #18 had a high APE and was reviewed by the group. Ages 0 and 1 were debated by agers given the collection date and the dark band of the first annulus is difficult to interpret. Sample #17 was also reviewed by the group since it was aged as a 3 and 4-year-old. Some agers did not think that a fish caught in May would have an annulus yet and agers debated the timeline and if May fish should be bumped. The timeline for ageing winter flounder can be found in Figure 17.

For individual reader comparisons, readers from MA DMF, NEFSC, RI DEM, CT DEEP, and VIMS indicated they routinely age winter flounder. There were no significant p-values from Bowker's test of symmetry indicating no systematic bias (Table 34). CVs for winter flounder ranged from 0-11%, indicating some imprecision. Exact agreement between readers ranged from 75-100% and increased to 100% for agreement within 1 year (Table 35).

Workshop Recommendations

Overall, the participants of the workshop were satisfied with the ageing agreement among species and no major issues were identified by the workshop. The group made the following recommendations:

- Atlantic menhaden, black sea bass, red drum, scup, striped bass, tautog, and winter flounder should be aged at the 2025 QA/QC Fish Ageing Workshop.
- Black sea bass sample #7 should be replaced by the NEFSC.
- Striped bass scales from the QA/QC set should be circulated to the states/labs that routinely age the species (MA DMF, RI DEP, NJ DFW, DE DFW, VIMS, VMRC) and aged on their own equipment over the next few months to determine if disagreement among the scale ages is due to the microfiche at the workshop or an ageing issue.
    - This exercise was done following the workshop and the results can be seen in Appendix D.
- Atlantic menhaden should be included in the workshop again since its individual workshop should be complete by the end of 2024. The Atlantic menhaden sample set for the QA/QC Workshop should be replaced with 10 paired scales and whole otolith samples for 2025.
- Groups at the workshop should be assigned with representation from along the coast so that readers from New England, for example, are not in the same group but in a group with agers from the south.

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Tables

Table 1. Species included in the QA/QC reference collection along with the model used in the stock assessment and age plus group used in the model. Stock assessment models include trend analyses, surplus production models (Just Another Bayesian Biomass Assessment, or JABBA-Select), or statistical catch-at-age models (SCA), including the Beaufort Assessment Model (BAM) and ASAP (Age-Structured Assessment Program). If the species has had its own ageing workshop, it is indicated in the last column of the table.

Species	Model	Age Plus Group	Source	Ageing Workshop
American eel	Trend analyses	N/A	ASMFC 2022a	X
Atlantic croaker	Trend analyses	N/A	2022 TLA Report	X
Atlantic menhaden	BAM	6+	ASMFC 2022b	X
Black drum	JABBA-Select	N/A	ASMFC 2023	
Black sea bass	ASAP	8+	SAW 62 (NEFSC 2017)	X
Bluefish	ASAP	6+	SAW 60 (NEFSC 2015)	X
Cobia	BAM	12+	SEDAR 58 (2020)	
Red drum	SCA	7+	ASMFC 2022c	X
Scup	ASAP	7+	SAW 60 (NEFSC 2015)	X
Striped bass	SCA	15+	ASMFC 2022c	X
Spot	Trend analysis	N/A	2022 TLA Report	
Summer flounder	ASAP	7+	SAW 66 (NEFSC 2019)	X
Tautog	ASAP	12+	ASMFC 2021a	X
Weakfish	SCA	6+	ASMFC 2019	
Winter flounder	Swept-area (Gulf of Maine Stock) or ASAP (S. New England/MA Stock)	7+	SAW 52 (NEFSC 2011)	X

Table 2. The ageing structure with sample size in parentheses and average percent error (APE) between the five ageing groups for each species aged at the annual QA/QC Fish Ageing Workshops.

Species	Ageing structure (sample size)	2016	2017	2018	2019	2023	2024
Alewife herring	scales (5), otoliths (5)	13.23%	------	29.20%	-------	-------	-------
American eel	otoliths (20)	-------	-------	-------	10.37%	-------	-------
Atlantic croaker	otoliths (20)	7.76%	10.57%	-------	0.62%	-------	3.03%
Atlantic menhaden	scales (19)	-------	15.42%	13.45%	-------	-------	-------
Black drum	otoliths (20)	-------	-------	-------	-------	-------	3.41%
Black sea bass	otoliths (20)[1]	3.67%	------	12.71%	-------	7.55%	7.06%
Blueback herring	scales (5), otoliths (5)	13.23%	------	23.09%	-------	-------	-------
Bluefish	otoliths (20)	23.06%	25.60%	17.69%	-------	5.78%	2.95%
Cobia	otoliths (20)	-------	-------	-------	-------	4.35%	4.87%
Red drum	otoliths (20)	-------	-------	26.77%	-------	0.31%	-------
Scup	otoliths (14), scales (6)	-------	-------	11.60%	-------	5.32%	8.25%
Spot	otoliths (20)	-------	-------	-------	-------	-------	4.56%
Striped bass	scales (15), otolith (15)[2]	4.96%	------	7.54%	5.90%	-------	11.50%
Summer flounder	scales (6), otoliths (14)	-------	3.63%	-------	6.85%	-------	2.37%
Tautog	opercula (7), pelvic spine (9), otolith (9)[3]	6.09%	10.89%	11.28%	8.17%	9.55%	5.48%
Weakfish	otoliths (20)	-------	-------	-------	-------	0.00%	-------
Winter flounder	scales (5), otoliths (15)	-------	4.41%	-------	7.78%	-------	7.75%

[1] For 2016-2023, the sample set for black sea bass was 4 scales and 16 otoliths. In 2024, the collection was replaced with 10 sectioned and 10 whole otoliths.

[2] For 2016-2018, the sample set for striped bass was 10 scales and 10 otoliths. For 2019, additional paired samples were added. In 2024, the sample set was 15 scales and 15 otoliths, mostly paired.

[3] For 2016-2018, the sample set for tautog was 20 opercula. For 2019, additional paired samples were added for a total of opercula (28), pelvic spines (6), otoliths (8). For 2023, the sample size was reduced to only the paired samples. In 2024, more paired samples >10 years were added.

Table 3. Ageing worksheet for Atlantic croaker at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. All samples are otoliths.

Sample #	Lab	Structure	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age		
1	VMRC	Otolith	7/13/2022	8	2	8	8	2	8	8	1	8	7	2	7	8	2	8	7.8	4%
2	NJ	Otolith	10/1/2012	0	3	0	0	3	0	0	4	0	0	4	0	0	2	0	0	0%
3	GA	Otolith	7/1/2014	5	2	5	5	2	5	5	1	5	5	2	5	5	2	5	5	0%
4	GA	Otolith	5/15/2012	0	4	1	0	3	1	0	4	1	1	1	1	1	3	2	1.2	27%
5	SCDNR	Otolith	5/17/2022	2	2	2	2	1	2	2	1	2	2	1	2	3	1	3	2.2	15%
6	NJ	Otolith	9/16/2010	12	3	12	12	3	12	12	2	12	12	2	12	12	3	12	12	0%
7	GA	Otolith	6/29/2011	4	2	4	4	1	4	4	1	4	4	2	4	4	1	4	4	0%
8	VIMS	Otolith	5/10/2014	8	1	8	8	1	8	8	1	8	8	2	8	8	2	8	8	0%
9	VMRC	Otolith	7/1/2020	3	2	3	3	2	3	3	2	3	3	2	3	3	2	3	3	0%
10	SCDNR	Otolith	8/29/2022	2	4	2	2	3	2	2	3	2	2	1	2	2	4	2	2	0%
11	NJ	Otolith	10/3/2006	4	4	4	4	3	4	4	3	4	4	4	4	4	4	4	4	0%
12	NCDMF	Otolith	3/26/2013	5	1	5	4	4	5	5	1	5	6	1	6	6	1	6	5.4	9%
13	MD	Otolith	9/15/2015	2	4	2	2	4	2	2	3	2	2	4	2	2	4	2	2	0%
14	VMRC	Otolith	7/11/2022	5	1	5	5	1	5	5	1	5	5	1	5	5	1	5	5	0%
15	VIMS	Otolith	11/5/2014	0	4	0	0	4	0	0	3	0	0	4	0	0	3	0	0	0%
16	NCDMF	Otolith	3/26/2013	5	4	6	5	4	6	6	1	6	6	1	6	6	1	6	6	0%
17	MD	Otolith	9/15/2015	3	3	3	3	3	3	3	3	3	3	1	3	3	4	3	3	0%
18	MD	Otolith	8/17/2015	7	3	7	7	2	7	7	3	7	7	2	7	7	3	7	7	0%
19	NCDMF	Otolith	6/13/2013	3	2	3	3	1	3	3	1	3	3	2	3	3	2	3	3	0%
20	VIMS	Otolith	4/26/2014	7	1	7	7	3	8	7	4	8	7	1	7	7	2	7	7.4	6%
																			Average APE	3.03%

Table 4. **Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for Atlantic croaker. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (α < 0.05) are highlighted in orange. There were no CVs > 5%.**

	NJ	MD	VIMS	NC	SC	FL
NJ		0.09	0.32	0.37	0.32	0.37
MD	5		0.06	0.04	0.06	0.04
VIMS	0	4		0.32	1.00	0.32
NC	1	4	1		0.32	1.00
SC	0	4	0	1		0.32
FL	1	4	1	0	1	

Table 5. **Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for Atlantic croaker.**

	NJ	MD	VIMS	NC	SC	FL
NJ		100	100	100	100	100
MD	80		100	100	100	100
VIMS	95	85		100	100	100
NC	90	90	95		100	100
SC	95	85	100	95		100
FL	90	90	95	100	95	

Table 6. Ageing worksheet for black drum at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. All samples are otoliths.

Sample #	Lab	Structure	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age		
1	SCDNR	Otolith	7/23/2005	8	1	8	8	2	8	8	1	8	8	1	8	8	1	8	8	0%
2	VMRC	Otolith	5/3/2022	36	4	37	36	4	37	42	4	43	35	1	35	34	4	35	37.4	6%
3	VMRC	Otolith	8/4/2022	7	1	7	7	2	7	7	1	7	7	1	7	7	2	7	7	0%
4	FL	Otolith	4/9/2015	7	4	8	7	4	8	7	4	8	7	4	8	7	4	8	8	0%
5	FL	Otolith	4/8/2015	15	4	16	16	1	16	16	4	17	16	2	16	16	1	16	16.2	2%
6	VMRC	Otolith	6/1/2022	17	1	17	16	4	17	17	1	17	17	1	17	17	1	17	17	0%
7	SCDNR	Otolith	10/15/2022	3	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3	0%
8	SCDNR	Otolith	8/4/2012	6	3	6	6	2	6	6	2	6	6	2	6	6	2	6	6	0%
9	SCDNR	Otolith	7/17/2004	12	2	12	12	2	12	12	1	12	12	4	13	12	1	12	12.2	3%
10	VMRC	Otolith	7/30/2022	4	2	4	4	2	4	4	2	4	4	2	4	4	2	4	4	0%
11	FL	Otolith	12/17/2017	1	4	1	2	2	2	1	4	1	2	3	2	3	2	3	1.8	36%
12	FL	Otolith	4/1/2015	9	4	10	9	4	10	9	4	8	9	4	10	9	4	10	9.6	7%
13	VMRC	Otolith	6/7/2022	8	1	8	8	1	8	8	1	8	8	1	8	8	2	8	8	0%
14	FL	Otolith	2/10/2021	1	4	2	1	4	2	2	1	2	1	4	2	1	3	2	2	0%
15	VMRC	Otolith	5/6/2022	19	4	20	21	1	21	20	4	21	20	1	20	17	4	18	20	4%
16	SCDNR	Otolith	1/4/2022	2	4	3	2	3	3	2	4	3	2	4	3	2	3	3	3	0%
17	SCDNR	Otolith	11/7/2022	0	4	0	0	3	0	0	3	0	0	3	0	0	3	0	0	0%
18	FL	Otolith	6/15/2020	4	2	4	4	2	4	4	1	4	4	4	4	4	2	4	4	0%
19	VMRC	Otolith	9/20/2022	14	3	14	14	2	14	14	2	14	14	2	14	14	3	14	14	0%
20	FL	Otolith	2/5/2019	2	4	3	2	4	3	3	1	3	2	2	2	2	4	3	2.8	11%
																			Average APE	3.41%

Table 7. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for black drum. P-values appear above the shaded diagonal line and CVs are below. There are no significant p-values (α < 0.05) or CVs > 5%.

	VMRC	VIMS	NC	SC	FL
VMRC		0.16	0.16	0.16	0.16
VIMS	3		1.00	1.00	1.00
NC	3	0		1.00	1.00
SC	3	0	0		1.00
FL	3	0	0	0	

Table 8. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for black drum.

	VMRC	VIMS	NC	SC	FL
VMRC		100	100	100	95
VIMS	90		100	100	100
NC	90	100		100	100
SC	90	100	100		100
FL	90	95	95	95	

Table 9. Ageing worksheet for black sea bass at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples #1-10 are sectioned otoliths and samples #11-20 are whole otoliths.

Sample #	Lab	Structure	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age		
1	VIMS	Section	5/8/2009	5	1	5	4	4	5	4	4	5	5	1	5	5	1	5	5	0%
2	VIMS	Section	10/21/2015	1	4	1	1	4	1	1	3	1	1	4	1	1	4	1	1	0%
3	SCDNR	Section	4/26/2022	3	2	3	3	1	3	3	1	3	3	1	3	3	1	3	3	0%
4	VIMS	Section	5/15/2008	7	1	7	7	1	7	6	4	7	7	1	7	7	1	7	7	0%
5	VIMS	Section	9/23/2010	11	3	11	11	2	11	11	2	11	11	1	11	11	2	11	11	0%
6	FL	Section	5/16/2012	6	4	7	6	4	7	6	4	7	6	4	7	6	4	7	7	0%
7	MA	Section	8/22/2022	7	2	7	7	2	7	7	2	7	7	1	7	7	2	7	7	0%
8	MA	Section	Spring	6	4	7	7	2	7	6	4	7	7	4	8	6	3	7	7.2	4%
9	SCDNR	Section	4/26/2022	2	1	2	2	2	2	2	1	2	2	1	2	2	2	2	2	0%
10	SCDNR	Section	8/3/2022	6	2	6	6	2	6	6	2	6	6	1	6	6	2	6	6	0%
11	SCDNR	Whole Oto	4/26/2022	2	2	2	2	1	2	2	1	2	2	1	2	2	2	2	2	0%
12	SCDNR	Whole Oto	4/26/2022	3	2	3	3	3	4	3	2	3	3	1	3	3	2	3	3.2	10%
13	NEFSC	Whole Oto	3/18/2013	0	4	1	0	4	1	1	4	2				1	4	2	1.5	47%
14	NEFSC	Whole Oto	3/15/2013	0	3	0	0	2	0	0	4	1	0	4	1	0	4	1	0.6	80%
15	NEFSC	Whole Oto	3/18/2013	3	1	3	2	3	3	2	4	3	2	4	3	2	3	3	3	0%
16	NEFSC	Whole Oto	4/13/2014	4	4	5	4	4	5	4	4	5	4	4	5	4	3	5	5	0%
17	FL	Whole Oto	11/27/2012	4	4	4	4	4	4	4	3	4	4	3	4	4	2	4	4	0%
18	NJ	Whole Oto	10/11/2012	0	3	0	0	2	0	0	3	0	0	0	0	0	3	0	0	0%
19	SCDNR	Whole Oto	8/3/2022	6	2	6	6	2	6	6	2	6	6	1	6	6	2	6	6	0%
20	FL	Whole Oto	5/6/2012	4	2	4	4	2	4	4	1	4	4	1	4	4	2	4	4	0%

Average APE	7.06%
Section APE	0.44%
Whole APE	13.67%

Table 10. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for black seas bass. P-values appear above the shaded diagonal line and CVs are below. There are no significant p-values (α < 0.05). CVs > 5% are highlighted in orange.

	MA	NEFSC	RI	NY	VIMS	FL
MA		0.37	1.00	1.00	0.37	0.37
NEFSC	0		0.37	0.37	0.39	0.39
RI	0	0		1.00	0.37	0.37
NY	0	0	0		0.37	0.37
VIMS	9	8	9	9		1.00
FL	9	8	9	9	0	

Table 11. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for black sea bass.

	MA	NEFSC	RI	NY	VIMS	FL
MA		100	100	100	100	100
NEFSC	95		100	100	100	100
RI	100	95		100	100	100
NY	100	95	100		100	100
VIMS	90	89	90	90		100
FL	90	89	90	90	100	

Table 12. **Ageing worksheet for bluefish at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. All samples were otoliths.**

Sample #	Lab	Structure	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age		
1	NJ	Otolith	6/4/2014	3	4	4	3	4	4	3	4	4	3	4	4	3	3	4	4	0%
2	NCDMF	Otolith	3/29/2014	4	4	5	3	4	4	4	4	5	3	4	4	3	3	4	4.4	11%
3	VMRC	Otolith	7/29/2020	1	2	1	1	2	1	1	2	1	1	2	1	1	2	1	1	0%
4	ODU	Otolith	3/10/2015	12	1	12	10	4	11	10	4	11	11	4	12	10	4	11	11.4	4%
5	SCDNR	Otolith	7/30/2022	1	3	1	1	2	1	1	2	1	1	2	1	1	3	1	1	0%
6	MA	Otolith	6/23/2022	8	2	8	7	4	8	7	4	8	7	1	7	7	2	7	7.6	6%
7	SCDNR	Otolith	7/30/2022	1	4	2	1	3	2	1	2	1	2	1	2	2	2	2	1.8	18%
8	RI	Otolith	11/2/2012	2	3	2	2	3	2	2	2	2	2	4	2	2	3	2	2	0%
9	FL	Otolith	5/23/2012	6	4	7	6	4	7	7	1	7	6	4	7	6	3	7	7	0%
10	NJ	Otolith	6/14/2014	2	4	3	2	4	3	2	4	3	2	4	3	2	3	3	3	0%
11	VMRC	Otolith	7/26/2021	0	4	0	0	3	0	0	2	0	0	4	0	0	2	0	0	0%
12	NY	Otolith	5/3/2012	3	4	4	3	3	4	3	4	4	3	4	4	3	3	4	4	0%
13	RI	Otolith	6/10/2012	6	4	7	6	4	7	6	4	7	6	4	7	6	4	7	7	0%
14	VIMS	Otolith	10/9/2009	1	3	1	1	3	1	1	3	1	1	3	1	1	2	1	1	0%
15	VMRC	Otolith	7/11/2022	4	4	5	4	2	4	4	4	5	4	4	5	4	3	5	4.8	7%
16	NCDMF	Otolith	2/20/2014	6	4	7	6	4	7	6	4	7	5	4	6	6	4	7	6.8	5%
17	NCDMF	Otolith	2/20/2014	8	4	9	8	4	9	8	4	9	8	4	9	8	4	9	9	0%
18	MA	Otolith	6/14/2022	3	4	4	3	2	3	3	4	4	3	4	4	3	4	4	3.8	8%
19	VIMS	Otolith	5/11/2014	8	4	9	8	4	9	8	4	9	8	4	9	8	4	9	9	0%
20	NY	Otolith	5/31/2013	2	1	2	2	1	2	1	4	2	2	1	2	2	1	2	2	0%
																			Average APE	2.95%

Table 13. **Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for bluefish otoliths. P-values appear above the shaded diagonal line and CVs are below. There were no significant p-values (α < 0.05) or CVs > 5%.**

	MA	NEFSC	RI	CT	NY	VMRC	VIMS	NC	SC	FL
MA		0.26	1.00	0.26	0.13	0.13	0.06	0.06	0.04	0.04
NEFSC	4		0.26	1.00	0.24	0.27	0.05	0.05	0.06	0.06
RI	0	4		0.26	0.13	0.13	0.06	0.06	0.04	0.04
CT	4	0	4		0.24	0.27	0.05	0.05	0.06	0.06
NY	4	2	4	2		0.37	0.04	0.04	0.04	0.04
VMRC	3	5	3	5	3		0.08	0.08	0.09	0.09
VIMS	10	8	10	8	9	13		1.00	0.20	0.20
NC	10	8	10	8	9	13	0		0.20	0.20
SC	10	9	10	9	9	12	1	1		1.00
FL	10	9	10	9	9	12	1	1	0	

Table 15. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for bluefish otoliths.

	MA	NEFSC	RI	CT	NY	VMRC	VIMS	NC	SC	FL
MA		100	100	100	100	100	100	100	100	100
NEFSC	75		100	100	100	100	100	100	100	100
RI	100	75		100	100	100	100	100	100	100
CT	75	100	75		100	100	100	100	100	100
NY	85	80	85	80		100	100	100	100	100
VMRC	85	70	85	70	90		100	100	100	100
VIMS	80	85	80	85	75	65		100	100	100
NC	80	85	80	85	75	65	100		100	100
SC	85	80	85	80	80	70	95	95		100
FL	85	80	85	80	80	70	95	95	100	

Table 16. **Ageing worksheet for cobia at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. All samples were sectioned otoliths.**

Sample #	Lab	Structure	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age		
1	VMRC	Otolith	7/9/2018	3	2	3	3	1	3	3	2	3	3	1	3	3	1	3	3	0%
2	VMRC	Otolith	9/2/2018	8	2	8	7	2	7	8	2	8	8	2	8	7	3	7	7.6	6%
3	FWRI	Otolith	10/8/2021	3	4	3	3	3	3	3	3	3	4	2	4	3	3	3	3.2	10%
4	VIMS	Otolith	9/1/2012	4	3	4	4	2	4	4	2	4	4	1	4	4	2	4	4	0%
5	SCDNR	Otolith	6/11/2016	4	1	4	4	2	4	4	1	4	4	1	4	5	2	5	4.2	8%
6	FWRI	Otolith	10/11/2021	5	4	5	5	3	5	5	3	5	5	2	5	4	2	4	4.8	7%
7	FWRI	Otolith	10/8/2021	4	3	4	4	3	4	4	3	4	4	2	4	4	2	4	4	0%
8	VMRC	Otolith	6/1/2018	6	4	7	7	1	7	7	1	7	6	1	6	6	1	6	6.6	7%
9	SCDNR	Otolith	5/24/2016	6	1	6	5	4	6	6	4	7	7	1	7	5	4	6	6.4	8%
10	SCDNR	Otolith	5/26/2016	9	4	10	8	4	9	9	4	10	9	1	9	9	4	10	9.6	5%
11	SCDNR	Otolith	5/17/2016	7	4	8	7	4	8	8	4	9	7	4	8	6	4	7	8	5%
12	VMRC	Otolith	7/16/2022	8	2	8	8	1	8	8	1	8	8	1	8	8	2	8	8	0%
13	VMRC	Otolith	7/8/2022	3	1	3	3	1	3	3	1	3	3	1	3	3	1	3	3	0%
14	VIMS	Otolith	5/1/2019	3	2	3	2	4	3	3	1	3	3	1	3	5	3	6	3.6	27%
15	SCDNR	Otolith	6/9/2016	9	1	9	9	1	9	9	1	9	10	1	10	8	1	8	9	4%
16	FWRI	Otolith	3/15/2021	1	4	2	2	1	2	1	4	2	1	4	2	1	4	2	2	0%
17	VMRC	Otolith	8/11/2018	11	2	11	11	2	11	11	2	11	11	1	11	11	2	11	11	0%
18	VMRC	Otolith	6/16/2018	3	4	4	4	1	4	5	1	5	5	1	5	3	4	4	4.4	11%
19	VIMS	Otolith	9/1/2017	2	3	2	2	3	2	2	2	2	2	2	2	2	2	2	2	0%
20	FWRI	Otolith	2/26/2021	2	1	2	1	4	2	2	1	2	2	1	2	2	1	2	2	0%
																			Average APE	4.87%

Table 17. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for cobia otoliths. P-values appear above the shaded diagonal line and CVs are below. There are no significant p-values (α < 0.05) or CVs > 5%.

	VMRC	SC	FL
VMRC		0.37	0.42
SC	2		0.39
FL	2	1	

Table 18. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for cobia otoliths.

	VMRC	SC	FL
VMRC		90	80
SC	85		85
FL	80	90	

Table 19. **Ageing worksheet for scup at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples #1-14 are otoliths and samples #15-20 are scales. Paired samples are color coded in the catch date column.**

Sample #	Lab	Structure	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age		
1	RI	Otolith	7/13/2016	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2	2	0%
2	NEFSC	Otolith	1/26/2017	3	4	4	3	4	4	3	4	4	4	4	5	3	4	4	4.2	8%
3	VIMS	Otolith	10/13/2016	2	4	2	2	4	2	3	1	3	3	1	3	2	4	2	2.4	20%
4	VIMS	Otolith	5/20/2015	9	4	10	9	3	10	9	4	10	10	4	11	9	3	10	10.2	3%
5	RI	Otolith	5/17/2016	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	0%
6	NEFSC	Otolith	2/4/2017	3	4	4	4	1	4	3	4	4	4	1	4	4	1	4	4	0%
7	VIMS	Otolith	10/15/2016	7	4	7	8	2	8	8	2	8	9	1	9	8	1	8	8	5%
8	RI	Otolith	7/13/2016	7	2	7	8	2	8	8	1	8	8	4	9	7	1	7	7.8	8%
9	NEFSC	Otolith	1/26/2017	10	4	11	11	3	12	11	4	12	10	4	11	10	4	11	11.4	4%
10	NEFSC	Otolith	2/4/2017	2	4	3	2	3	3	3	3	4	3	4	4	2	2	2	3.2	20%
11	VIMS	Otolith	10/15/2016	8	4	8	9	2	9	8	3	8	9	1	9	8	3	8	8.4	6%
12	VIMS	Otolith	10/14/2016	5	4	5	5	2	5	5	3	5	6	1	6	5	2	5	5.2	6%
13	VIMS	Otolith	10/12/2016	6	4	6	6	2	6	6	3	6	7	1	7	6	2	6	6.2	5%
14	VIMS	Otolith	5/18/2015	1	4	2	1	4	2	1	4	2	1	4	2	1	4	2	2	0%
15	MA	Scale	5/21/2016	10	4	11	12	4	13	11	4	12	11		11	7	1	7	10.8	14%
16	RI	Scale	5/17/2016	1	1	1	0	4	1	0	4	1	1		1	0	4	1	1	0%
17	MA	Scale	7/6/2016	4	2	4	5	1	5	4	4	5	5		5	4	3	5	4.8	7%
18	RI	Scale	7/13/2016	2	1	2	1	1	1	0	4	1	1		2	0	4	1	1.4	34%
19	MA	Scale	6/17/2016	3	2	3	4	4	5	3	4	4	4		4	3	2	3	3.8	17%
20	RI	Scale	7/13/2016	5	1	5	5	1	5	5	2	5	6		6	4	3	4	5	8%

Average APE	8.25%
Otolith APE	6.09%
Scale APE	13.31%

Table 20. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for scup otoliths (top) and scales (bottom). P-values appear above the shaded diagonal line and CVs are below. CVs > 5% are highlighted in orange. Scup scales had 100% agreement and are not included in the table.

	MA	NEFSC	RI	CT	VIMS
MA		0.22	1.00	0.22	0.42
NEFSC	6		0.22	1.00	0.33
RI	0	6		0.22	0.42
CT	6	0	6		0.33
VIMS	5	10	5	10	

	MA	NEFSC	RI	CT	VIMS
MA		0.42	1.00	0.42	0.42
NEFSC	11		0.42	1.00	1.00
RI	0	11		0.42	0.42
CT	11	0	11		1.00
VIMS	15	8	15	8	

Table 21. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for scup otoliths (top) and scales (bottom). Scup scales had 100% agreement and are not included in the table.

	MA	NEFSC	RI	CT	VIMS
MA		100	100	100	100
NEFSC	43		100	100	86
RI	100	43		100	100
CT	43	100	43		86
VIMS	64	36	64	36	

	MA	NEFSC	RI	CT	VIMS
MA		100	100	100	100
NEFSC	50		100	100	100
RI	100	50		100	100
CT	50	100	50		100
VIMS	33	50	33	50	

Table 22. **Ageing worksheet for spot at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. All samples are otoliths.**

Sample #	Lab	Structure	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age		
1	MD	Otolith	8/19/2014	0	3	0	0	3	0	0	2	0	0	1	0	0	3	0	0	0%
2	VMRC	Otolith	9/7/2022	0	3	0	0	3	0	0	3	0	0	1	0	0	2	0	0	0%
3	FL	Otolith	12/19/2016	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	0%
4	MD	Otolith	6/10/2014	1	2	1	1	1	1	1	2	1	1	1	1	1	2	1	1	0%
5	SCDNR	Otolith	1/4/2022	0	4	1	0	4	1	0	4	1	0	4	1	0	3	1	1	0%
6	SCDNR	Otolith	9/12/2022	1	3	1	1	3	1	1	3	1	1	4	1	1	3	1	1	0%
7	FL	Otolith	7/21/2021	2	2	2	2	2	2	2	1	2	3	2	3	2	2	2	2.2	15%
8	VMRC	Otolith	10/17/2022	2	3	2	2	3	2	2	2	2	2	3	2	2	4	2	2	0%
9	MD	Otolith	8/19/2014	2	3	2	2	3	2	2	2	2	2	3	2	2	2	2	2	0%
10	SCDNR	Otolith	9/26/2022	3	3	3	3	3	3	3	2	3	3	3	3	3	2	3	3	0%
11	FL	Otolith	5/8/2017	3	3	4	3	3	4	1	4	2	3	4	4	2	4	3	3.4	21%
12	SCDNR	Otolith	5/16/2022	2	1	2	1	4	2	1	4	2	2	1	2	1	4	2	2	0%
13	MD	Otolith	6/16/2014	1	2	1	1	2	1	1	2	1	1	1	1	1	2	1	1	0%
14	FL	Otolith	7/21/2021	3	2	3	3	2	3	3	2	3	3	1	3	3	2	3	3	0%
15	SCDNR	Otolith	3/4/2022	1	4	2	1	3	2	1	4	2	1	3	2	1	4	2	2	0%
16	VMRC	Otolith	7/5/2022	4	1	4	3	2	3	3	1	3	3	1	3	3	1	3	3.2	10%
17	MD	Otolith	8/19/2014	2	3	2	2	3	2	2	2	2	2	2	2	2	2	2	2	0%
18	FL	Otolith	2/23/2015	0	4	1	1	1	1	0	4	1	0	4	1	1	2	1	1	0%
19	VMRC	Otolith	6/21/2022	3	1	3	3	1	3	3	1	3	4	1	4	3	1	3	3.2	10%
20	VMRC	Otolith	5/16/2022	0	4	1	1	1	1	2	4	3	2	1	2	2	2	2	1.8	36%
																			Average APE	4.56%

Table 23. **Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for spot otoliths. P-values appear above the shaded diagonal line and CVs are below. There are no significant p-values (α < 0.05) or CVs > 5%.**

	MD	VIMS	NC	SC	FL
MD		0.22	0.26	0.22	0.37
VIMS	4		0.32	1.00	0.32
NC	11	7		0.32	0.37
SC	4	0	7		0.32
FL	3	1	8	1	

Table 24. **Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for spot otoliths.**

	MD	VIMS	NC	SC	FL
MD		100	100	100	100
VIMS	85		100	100	100
NC	80	95		100	100
SC	85	100	95		100
FL	90	95	90	95	

Table 25. Ageing worksheet for striped bass at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples #1-15 are scales and #16-30 are otoliths. Paired samples are color coded in the catch date column.

Sample #	Lab	Structure	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age		
1	RI	Scale	8/5/2015	9	2	9	10	2	10	10	2	10	11	1	11	11	1	11	10.2	6%
2	NY	Scale	7/15/2015	6	1	6	6	2	6	5	2	5	9	1	9	4	2	4	6	20%
3	NY	Scale	7/1/2015	3	2	3	3	2	3	2	2	2	4	1	4	1	2	1	2.6	34%
4	NJ	Scale	3/28/1996	6	1	6	8	3	9	7	2	7	8	1	8	6	2	6	7.2	14%
5	MA	Scale	10/13/2018	7	3	7	7	3	7	6	3	6	11	1	11	6	4	6	7.4	19%
6	ME	Scale	6/20/2012	2	2	2	1	1	1	2	1	2	2	1	2	1	1	1	1.6	30%
7	MA	Scale	7/6/2022	16	2	16	15	2	15	16	2	16	13	1	13	11	1	11	14.2	12%
8	DE	Scale	3/19/2018	4	1	4	7	2	7	4	4	5	7	1	7	3	3	4	5.4	24%
9	VMRC	Scale	7/6/2021	6	2	6	7	2	7	4	1	4	7	1	7	3	2	3	5.4	28%
10	MA	Scale	8/3/2018	11	3	11	12	3	12	10	1	10	11	1	11	10	1	10	10.8	6%
11	RI	Scale	1/25/2018	1	4	2	1	4	2	2	4	3	2	4	3	1	3	2	2.4	20%
12	VIMS	Scale	3/21/2018	13	4	14	14	2	14	11	4	12	16		16	12	3	13	13.8	8%
13	DE	Scale	12/3/2018	2	3	2	1	4	1	1	3	1	1		1	1	3	1	1.2	27%
14	VIMS	Scale	3/19/2018	4	4	5	6	3	7	4	4	5	5	4	6	4	4	5	5.6	13%
15	RI	Scale	5/21/2018	2	4	3	2	3	3	3	4	4	5	1	5	3	4	4	3.8	17%
16	SCDNR	Otolith	12/18/2014	1	4	1	1	4	1	1	4	1	1	4	1	1	4	1	1	0%
17	DE	Otolith	3/19/2018	6	4	7	7	4	8	6	4	7	7	4	8	5	4	6	7.2	9%
18	VIMS	Otolith	3/19/2018	6	4	7	6	3	7	6	4	7	7	4	8	6	4	7	7.2	4%
19	MA	Otolith	9/15/2014	9	3	9	9	3	9	9	2	9	9	1	9	9	4	9	9	0%
20	SCDNR	Otolith	4/8/2014	1	1	1	1	1	1	1	1	1	2	1	2	0	4	1	1.2	27%
21	VIMS	Otolith	6/1/2014	3	2	3	3	1	3	3	1	3	3	1	3	3	1	3	3	0%
22	VIMS	Otolith	3/21/2018	18	4	19	18	3	19	18	4	19	19	4	20	17	4	18	19	2%
23	MA	Otolith	10/13/2018	8	3	8	8	3	8	8	2	8	9	4	10	7	3	7	8.2	9%
24	RI	Otolith	5/21/2018	3	4	4	3	3	4	3	3	4	3	4	4	3	4	4	4	0%
25	MA	Otolith	7/3/2014	10	2	10	10	2	10	10	4	11	11	1	11	9	4	9	10.2	6%
26	DE	Otolith	12/3/2018	1	3	1	1	3	1	1	3	1	1	4	1	1	4	1	1	0%
27	RI	Otolith	1/25/2018	2	3	3	2	3	3	2	3	3	2	3	3	2	3	3	3	0%
28	VMRC	Otolith	7/6/2021	7	1	7	7	1	7	6	4	7	7	1	7	6	4	6	6.8	5%
29	MA	Otolith	7/6/2022	25	1	25	24	2	24	25	4	26	25	1	25	25	3	25	25	2%
30	MA	Otolith	8/3/2018	15	2	15	14	3	14	15	2	15	13	4	14	15	1	15	14.6	3%

Average APE	11.50%
Otolith APE	4.45%
Scale APE	18.54%

Table 26. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for striped bass otoliths (top) and scales (bottom). P-values appear above the shaded diagonal line and CVs are below. There are no significant p-values (α < 0.05) or CVs > 5% for otoliths, but there were several CVs > 5% for scales.

	MA	RI	NJ	VIMS	VMRC	NC	SC
MA		1.00	0.32	1.00	0.32	1.00	1.00
RI	0		0.32	1.00	0.32	1.00	1.00
NJ	1	1		0.32	1.00	0.32	0.32
VIMS	1	1	1		0.32	1.00	1.00
VMRC	1	1	1	1		0.32	0.32
NC	1	1	1	0	1		1.00
SC	1	1	1	0	1	0	

	MA	RI	NJ	VIMS	VMRC	NC	SC
MA		1.00	0.65	0.54	0.65	0.54	0.54
RI	0		0.65	0.54	0.65	0.54	0.54
NJ	19	19		0.54	0.37	0.54	0.43
VIMS	15	15	15		0.81	0.32	1.00
VMRC	16	16	4	18		0.81	0.66
NC	15	15	15	1	18		0.32
SC	16	16	15	0	19	1	

Table 27. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for striped bass otoliths (top) and scales (bottom).

	MA	RI	NJ	VIMS	VMRC	NC	SC
MA		100	100	100	93	100	100
RI	100		100	100	93	100	100
NJ	80	80		100	93	100	100
VIMS	87	87	80		100	100	100
VMRC	80	80	87	87		100	100
NC	87	87	80	100	87		100
SC	87	87	80	100	87	100	

	MA	RI	NJ	VIMS	VMRC	NC	SC
MA		100	60	87	60	87	80
RI	100		60	87	60	87	80
NJ	20	20		73	100	73	73
VIMS	20	20	40		73	100	100
VMRC	27	27	80	20		73	73
NC	20	20	40	93	20		100
SC	20	20	33	100	13	93	

Table 28. Ageing worksheet for summer flounder at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. All samples are otoliths.

Sample #	Lab	Structure	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age		
1	ODU	Otolith	3/17/2015	4	4	5	4	4	5	4	4	5	4	4	5	4	3	5	5	0%
2	VMRC	Otolith	7/20/2020	4	1	4	4	1	4	4	2	4	4	1	4	4	1	4	4	0%
3	VIMS	Otolith	10/12/2015	0	3	0	0	3	0	0	4	0	0	4	0	0	3	0	0	0%
4	ODU	Otolith	3/21/2015	10	4	11	10	3	11	11	4	12	11	4	12	9	4	10	11.2	6%
5	NCDMF	Otolith	2/26/2014	6	4	7	6	4	7	5	4	6	6	4	7	5	3	6	6.6	7%
6	VIMS	Otolith	5/22/2015	1	4	2	1	4	2	1	4	2	1	4	2	1	3	2	2	0%
7	ODU	Otolith	3/17/2015	2	4	3	2	3	3	2	4	3	2	4	3	2	4	3	3	0%
8	VIMS	Otolith	10/10/2015	4	3	4	4	2	4	4	2	4	4	2	4	4	2	4	4	0%
9	NCDMF	Otolith	12/5/2013	2	4	2	2	3	2	2	2	2	2	4	2	2	3	2	2	0%
10	ODU	Otolith	7/21/2015	7	1	7	7	1	7	7	1	7	7	1	7	7	2	7	7	0%
11	ODU	Otolith	11/20/2015	1	4	1	1	3	1	1	3	1	2	2	2	1	3	1	1.2	27%
12	VIMS	Otolith	10/24/2015	7	2	7	7	2	7	6	2	6	7	4	7	7	1	7	6.8	5%
13	NCDMF	Otolith	2/3/2014	11	4	12	11	3	12	11	4	12	11	4	12	11	3	12	12	0%
14	VIMS	Otolith	5/16/2015	8	4	9	8	4	9	9	1	9	8	4	9	8	4	9	9	0%
15	VIMS	Otolith	10/18/2015	1	4	1	1	4	1	1	4	1	1	4	1	1	3	1	1	0%
16	NCDMF	Otolith	2/3/2014	9	4	10	9	3	10	9	4	10	10	4	11	9	3	10	10.2	3%
17	NCDMF	Otolith	2/3/2014	2	3	3	2	3	3	2	2	3	2	4	3	2	3	3	3	0%
18	VMRC	Otolith	8/10/2020	5	2	5	5	2	5	5	2	5	5	2	5	5	1	5	5	0%
19	VIMS	Otolith	10/24/2015	2	3	2	2	2	2	2	2	2	2	1	2	2	2	2	2	0%
20	VMRC	Otolith	7/11/2022	3	1	3	3	1	3	3	1	3	3	1	3	3	1	3	3	0%
																			Average APE	2.37%

Table 29. **Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for summer flounder. P-values appear above the shaded diagonal line and CVs are below. There are no significant p-values (α < 0.05). CVs > 5% are highlighted in orange.**

	MA	NEFSC	RI	CT	NY	VIMS	NC
MA		0.06	1.00	0.06	0.37	0.41	0.41
NEFSC	11		0.06	1.00	0.08	0.06	0.06
RI	0	11		0.06	0.37	0.41	0.41
CT	11	0	11		0.08	0.06	0.06
NY	1	11	1	11		0.26	0.26
VIMS	1	10	1	10	1		1.00
NC	1	10	1	10	1	0	

Table 30. **Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for summer flounder.**

	MA	NEFSC	RI	CT	NY	VIMS	NC
MA		100	100	100	95	100	100
NEFSC	75		100	100	95	100	100
RI	100	75		100	95	100	100
CT	75	100	75		95	100	100
NY	90	75	90	75		100	100
VIMS	85	80	85	80	90		100
NC	85	80	85	80	90	100	

Table 31. **Ageing worksheet for tautog at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes, and final age as well as average percent error (APE) values between groups. Samples are grouped in pairs and paired samples are color coded in the catch date column.**

Sample #	Lab	Structure	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age		
1	VIMS	Otolith	10/5/2017	2	3	2	2	3	2	2	3	2	2	2	2	2	2	2	2	0%
2	MA	Otolith	10/11/2017	17	4	17	16	3	16	15	3	15	16	1	16	16	3	16	16	3%
3	RI	Otolith	11/20/2019	17	4	17	17	4	17	17	3	17	18	1	18	18	3	18	17.4	3%
4	DE	Otolith	11/18/2018	4	3	4	4	3	4	4	2	4	4	4	4	4	3	4	4	0%
5	DE	Otolith	11/18/2018	9	3	9	10	4	10	10	3	10	11	1	11	9	4	9	9.8	7%
6	RI	Otolith	11/20/2019	11	3	11	11	4	11	11	3	11	11	4	11	12	3	12	11.2	3%
7	VMRC	Otolith	3/5/2022	19	4	20	19	4	20	20	2	20	17	1	17	18	3	19	19.2	5%
8	DE	Otolith	11/18/2018	8	3	8	7	4	7	9	3	9	9	1	9	9	3	9	8.4	9%
9	MA	Otolith	7/27/2022	10	2	10	11	2	11	9	2	9	10	1	10	10	1	10	10	4%
10	DE	Spine	11/18/2018	4	3	4	3	4	3	3	3	3	4	1	4	4	1	4	3.6	13%
11	MA	Spine	10/11/2017	16	3	16	14	3	14	14	3	14	13	1	13	13	2	13	14	6%
12	RI	Spine	11/20/2019	18	4	18	17	4	17	18	3	18	19	1	19	17	2	17	17.8	4%
13	RI	Spine	11/20/2019	11	3	11	11	3	11	11	4	11	12	1	12	11	4	11	11.2	3%
14	VIMS	Spine	10/5/2017	2	3	2	2	2	2	2	3	2	2	2	2	2	2	2	2	0%
15	DE	Spine	11/18/2018	8	3	8	10	3	10	9	3	9	9	1	9	8	4	8	8.8	7%
16	VMRC	Spine	3/5/2022	17	4	18	19	4	20	16	4	17	14	1	14	17	3	18	17.4	9%
17	DE	Spine	11/18/2018	9	3	9	9	3	9	9	3	9	9	1	9	7	3	7	8.6	7%
18	MA	Spine	7/27/2022	10	4	10	11	2	11	13	4	13	12	1	12	10	4	11	11.4	8%
19	RI	Opercle	11/20/2019	18	3	18	18	3	18	19	3	19	19	1	19	19	2	19	18.6	3%
20	DE	Opercle	11/18/2018	8	3	8	9	3	9	9	3	9	9	4	9	11	2	11	9.2	8%
21	DE	Opercle	11/18/2018	8	3	8	10	3	10	8	3	8	8	1	8	10	2	10	8.8	11%
22	DE	Opercle	11/18/2018	4	3	4	4	2	4	4	3	4	6	2	6	5	2	5	4.6	16%
23	RI	Opercle	11/20/2019	13	4	13	12	3	12	12	3	12	13	4	13	12	4	12	12.4	4%
24	VMRC	Opercle	3/5/2022	18	4	19	18	4	19	19	4	20	15	1	15	18	4	19	18.4	7%
25	VIMS	Opercle	10/5/2017	2	4	2	2	3	2	2	3	2	2	2	2	2	2	2	2	0%

Average APE	5.48%
Otolith APE	3.58%
Spine APE	6.30%
Opercle APE	6.89%

Table 32. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for tautog opercula (a), otoliths (b), and pelvic spines (c). P-values appear above the shaded diagonal line and CVs are below. CVs > 5% are highlighted.

(a)

	MA	RI	CT	NY	NJ	VMRC	VIMS
MA		1.00	1.00	0.41	1.00	1.00	0.41
RI	1		1.00	0.41	1.00	1.00	0.41
CT	9	8		0.39	1.00	1.00	0.39
NY	11	11	18		0.41	0.39	1.00
NJ	5	4	11	10		1.00	0.41
VMRC	6	5	8	11	2		0.39
VIMS	4	3	8	14	5	6	

(b)

	MA	RI	CT	NY	NJ	VMRC	VIMS
MA		0.42	0.39	0.42	0.55	0.55	0.57
RI	1		0.57	1.00	0.32	0.32	0.39
CT	5	4		0.61	1.00	1.00	0.74
NY	5	4	3		0.37	0.37	0.41
NJ	4	4	5	5		1.00	0.37
VMRC	4	4	5	5	0		0.37
VIMS	3	4	5	3	3	3	

(c)

	MA	RI	CT	NY	NJ	VMRC	VIMS
MA		0.41	0.41	0.57	0.57	0.41	0.39
RI	1		1.00	0.29	0.29	0.42	0.29
CT	6	6		0.29	0.29	0.42	0.29
NY	8	7	7		1.00	0.41	0.61
NJ	4	3	9	7		0.41	0.61
VMRC	5	4	8	9	1		0.55
VIMS	6	5	6	4	6	7	

Table 33. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for tautog opercula (a), otoliths (b), and pelvic spines (c).

(a)

	MA	RI	CT	NY	NJ	VMRC	VIMS
MA		100	57	86	71	71	86
RI	86		71	86	71	71	100
CT	57	57		57	43	71	71
NY	29	43	14		71	86	57
NJ	43	57	29	43		86	86
VMRC	43	57	29	43	71		71
VIMS	43	43	43	14	43	43	

(b)

	MA	RI	CT	NY	NJ	VMRC	VIMS
MA		100	89	89	89	89	89
RI	89		89	89	78	78	89
CT	33	44		78	78	78	78
NY	22	33	67		89	89	100
NJ	56	56	44	33		100	100
VMRC	56	56	44	33	100		100
VIMS	56	44	44	44	56	56	

(c)

	MA	RI	CT	NY	NJ	VMRC	VIMS
MA		89	89	67	67	67	78
RI	89		89	78	78	78	89
CT	44	44		67	78	78	78
NY	22	33	33		67	67	78
NJ	56	67	22	44		100	67
VMRC	44	56	33	22	78		56
VIMS	33	44	33	67	44	33	

Table 34. Ageing worksheet for winter flounder at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups.

Sample #	Lab	Structure	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age	Annulus Count	Margin Code	Final Age		
1	VIMS	Otolith	10/9/2015	3	3	3	3	2	3	3	2	3	3	1	3	3	2	3	3	0%
2	NY	Otolith	3/21/2002	6	4	7	6	3	7	6	4	7	6	4	7	5	3	6	6.8	5%
3	MA	Otolith	5/14/2013	9	4	10	9	4	10	9	4	10	9	4	10	9	4	10	10	0%
4	VIMS	Otolith	10/8/2015	3	3	3	3	2	3	3	2	3	3	2	3	3	2	3	3	0%
5	NY	Otolith	4/30/2002	5	3	6	5	4	6	5	4	6	5	4	6	5	3	6	6	0%
6	VIMS	Otolith	10/8/2015	5	3	5	5	2	5	5	2	5	5	1	5	5	2	5	5	0%
7	NY	Otolith	3/24/2003	5	3	6	5	4	6	5	4	6	5	4	6	5	3	6	6	0%
8	VIMS	Otolith	10/8/2015	7	2	7	7	2	7	7	2	7	7	1	7	7	2	7	7	0%
9	VIMS	Otolith	5/21/2015	10	4	11	10	3	11	10	4	11	10	4	11	10	3	11	11	0%
10	MA	Otolith	5/9/2013	1	4	2	1	4	2	1	4	2	1	4	2	1	4	2	2	0%
11	NY	Otolith	4/3/2003	3	4	4	3	4	4	3	4	4	3	4	4	3	4	4	4	0%
12	MA	Otolith	5/8/2013	7	4	8	7	4	8	7	3	8	8	4	9	8	3	9	8.4	6%
13	MA	Otolith	5/7/2013	4	4	5	4	4	5	4	4	5	4	4	5	5	2	5	5	0%
14	VIMS	Otolith	5/17/2015	12	2	12	11	4	12	12	4	13	12	1	12	12	3	13	12.4	4%
15	MA	Otolith	5/6/2013	6	4	7	6	4	7	6	4	7	6	4	7	6	4	7	7	0%
16	MA	Otolith	5/13/2022	1	4	2	1	4	2	1	4	2	1	4	2	1	3	2	2	0%
17	MA	Otolith	5/15/2022	3	2	3	3	2	3	3	1	3	3	4	4	3	3	4	3.4	14%
18	MA	Otolith	9/9/2022	0	3	0	0	3	0	0	3	0	1	4	1	1	2	1	0.4	120%
19	MA	Otolith	9/11/2022	3	2	3	3	1	3	3	1	3	3	1	3	3	2	3	3	0%
20	MA	Otolith	9/13/2022	6	3	6	6	3	6	6	2	6	7	1	7	5	4	5	6	7%
																			Average APE	7.75%

Table 35. **Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for winter flounder otoliths. P-values appear above the shaded diagonal line and CVs are below.**

	MA	NEFSC	RI	CT	VIMS
MA		0.39	0.32	0.39	0.32
NEFSC	11		0.37	1.00	0.37
RI	1	9		0.37	1.00
CT	11	0	9		0.37
VIMS	2	9	0	9	

Table 36. **Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for winter flounder.**

	MA	NEFSC	RI	CT	VIMS
MA		100	100	100	100
NEFSC	70		100	100	100
RI	95	75		100	100
CT	70	100	75		100
VIMS	90	80	95	80	

Figures

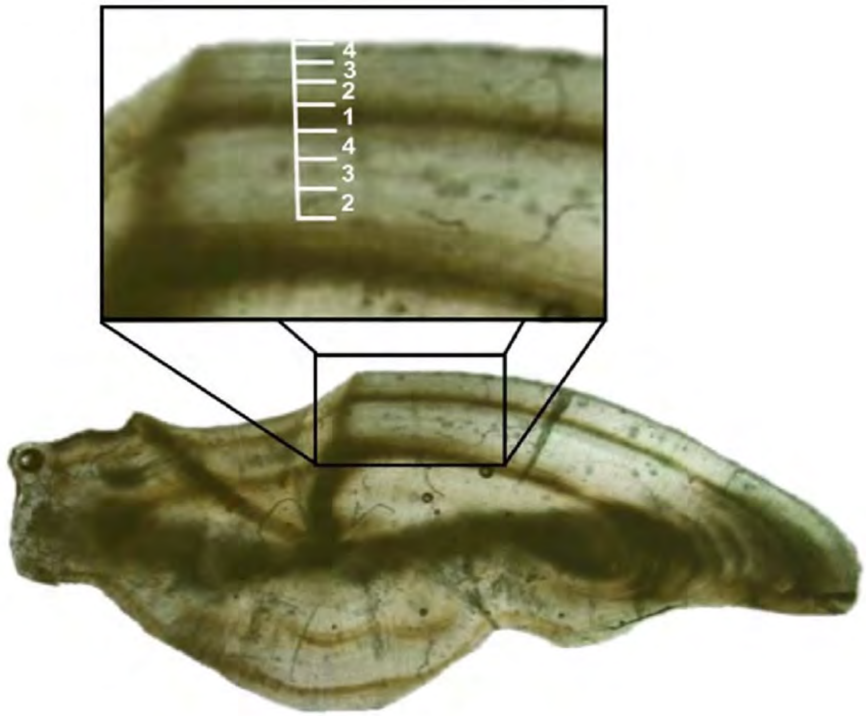


Figure 1. Margin code 1-4 example from a sciaenid otolith section. Source: GSMFC 2020.

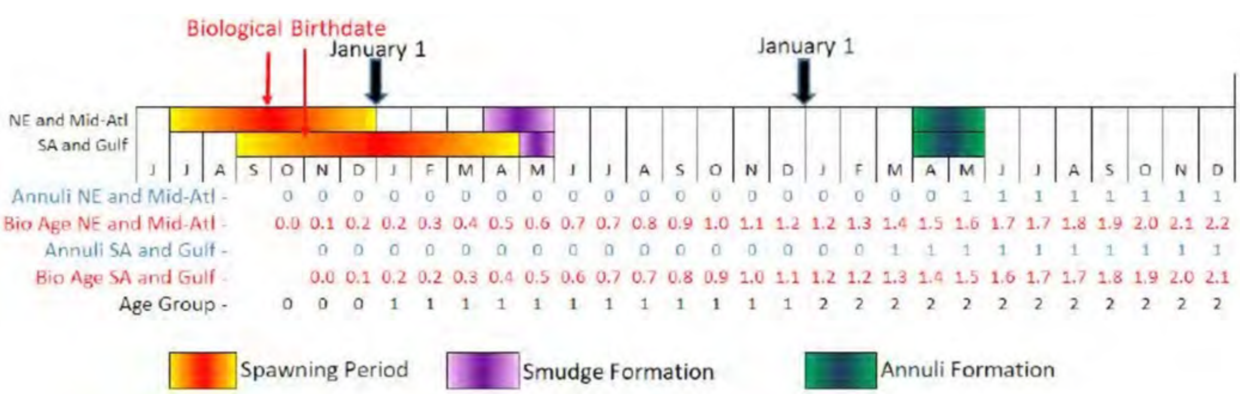


Figure 2. Timeline showing spawning period and annuli deposition for Atlantic croaker from New England to the Gulf of Mexico. Source: GSMFC 2020.

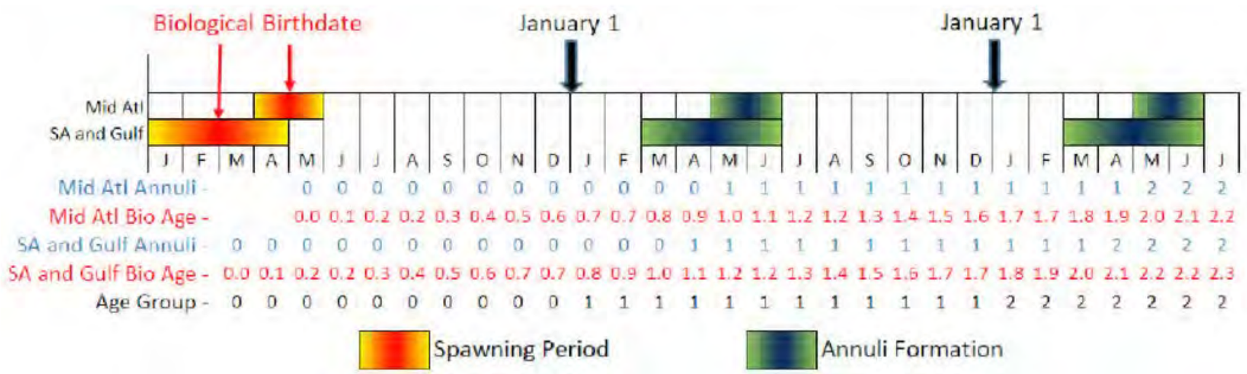


Figure 3. Timeline showing spawning period and annuli deposition for black drum in the Mid-Atlantic and South Atlantic/Gulf. Source: GSMFC 2020.

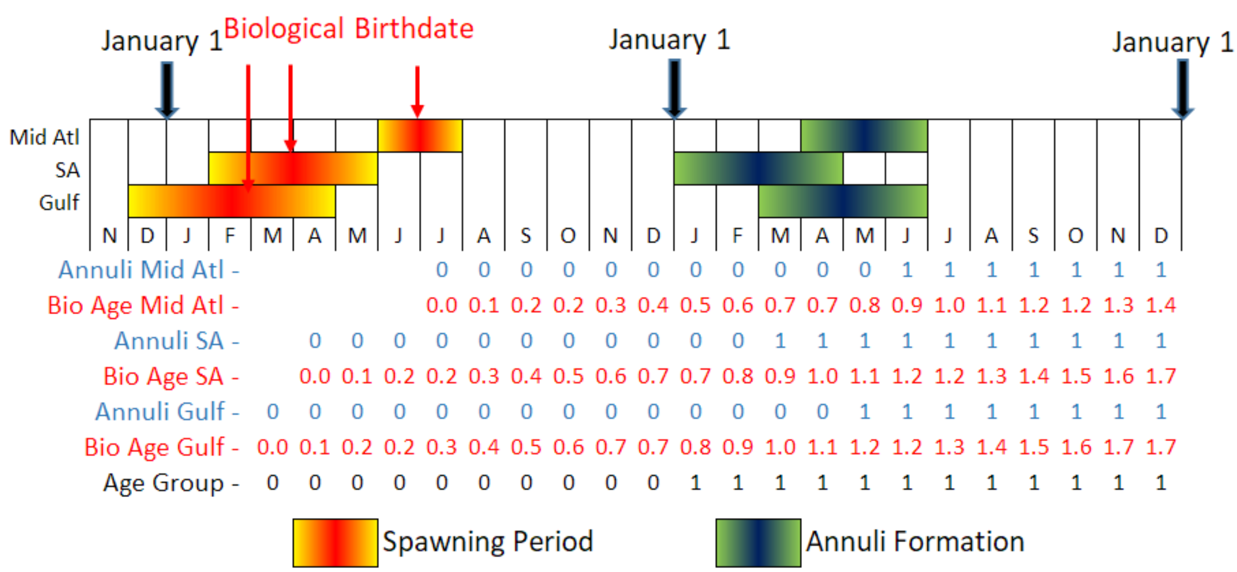


Figure 4. Timeline showing spawning period and annuli deposition ranges for black sea bass from the North Atlantic to the Gulf of Mexico. Source: GSMFC 2020.

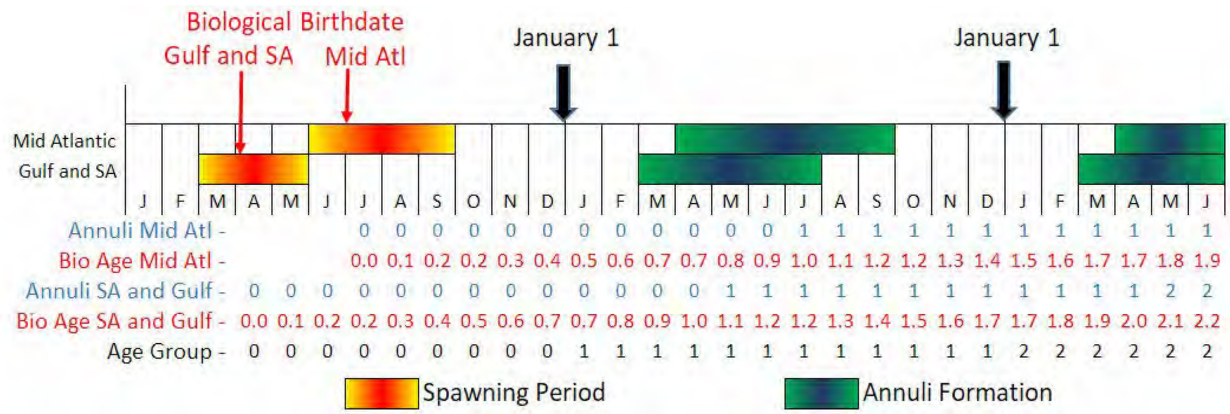


Figure 5. Birthdate assignment timeline for bluefish. Age and year group are based on biological birthdate of July 1 in the Mid-Atlantic and April 1 in the South Atlantic and Gulf. Early spawned fish can have a mark in the core region, or smudge, but it is not generally counted as an annulus. Source: GSMFC 2020.

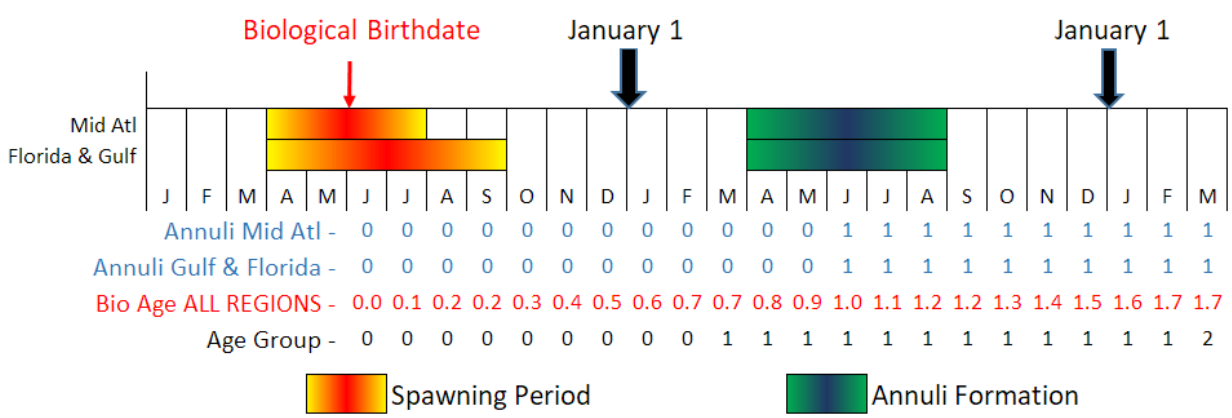


Figure 6. Birthdate assignment timeline for cobia in the Mid-Atlantic, Florida, and Gulf. Biological age is the same for all regions with the accepted June 1 birthdate. Source: GSMFC 2020.

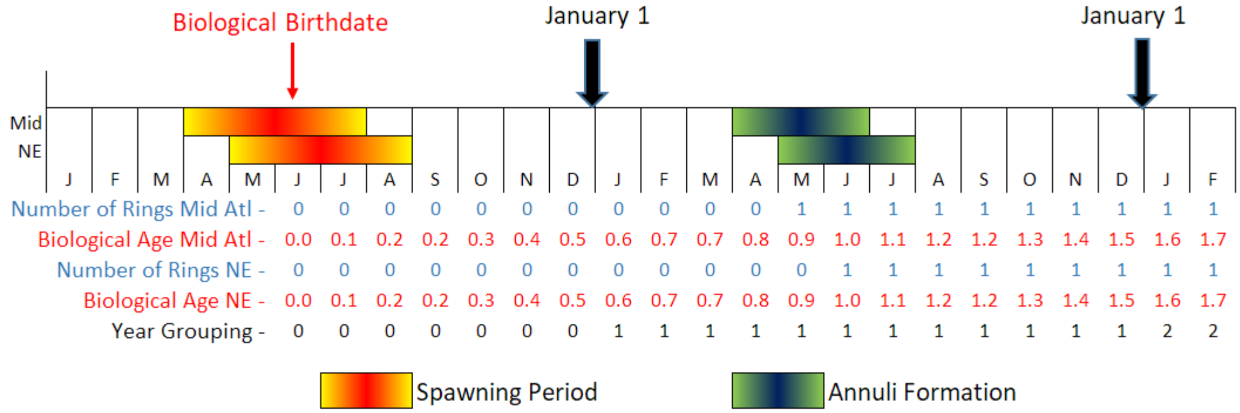


Figure 7. Spawning periodicity and age assignment timeline for scup in New England and Mid-Atlantic waters. Source: GSMFC 2020.

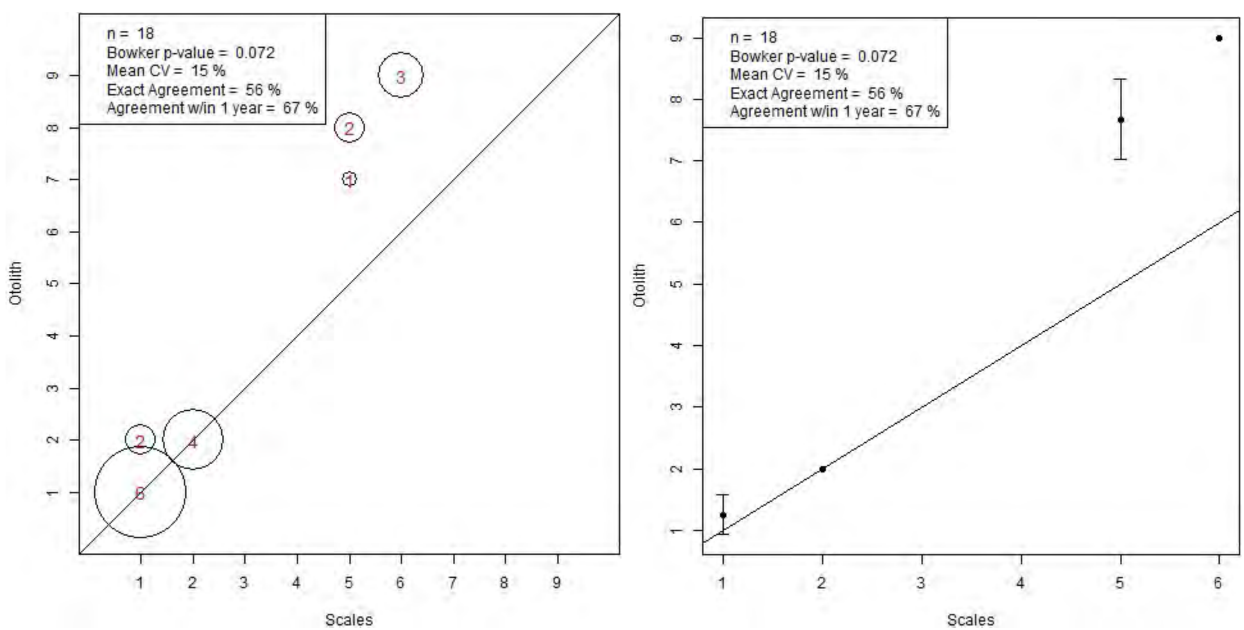


Figure 8. Age frequency (left) and age bias (right) plots for scup paired scale and otolith samples. Circles are proportional to number of observations.

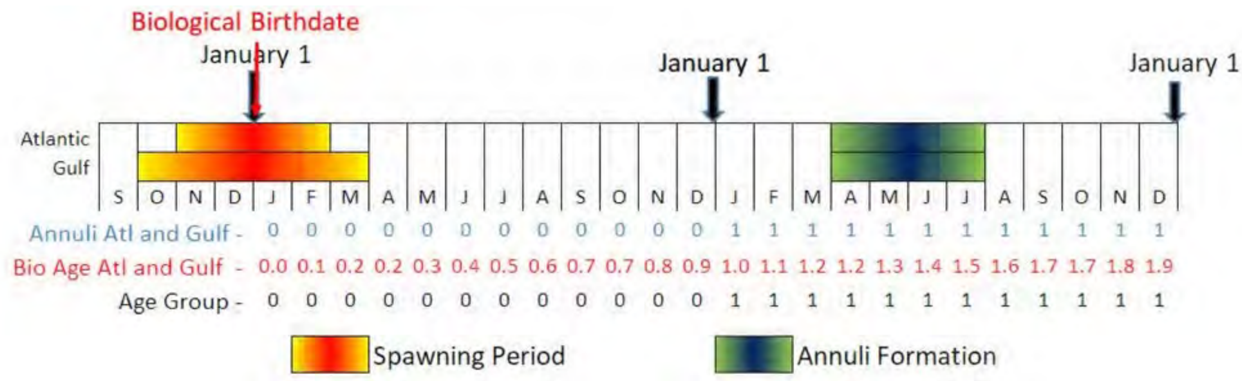


Figure 9. Spawning periodicity and age assignment timeline for spot across the Atlantic Coast to the Gulf of Mexico. Source: GSMFC 2020.

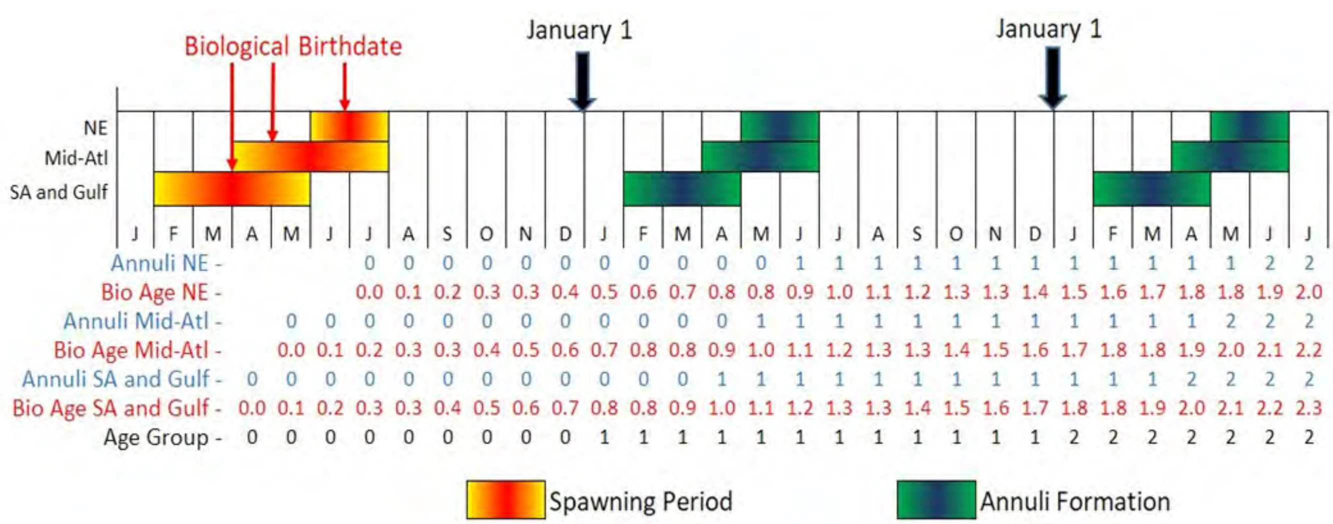
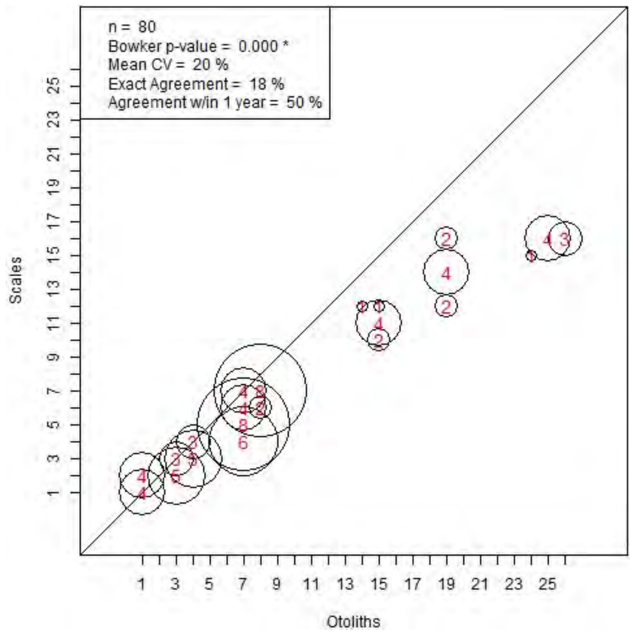


Figure 10. Spawning periodicity and age assignment timeline for striped bass from New England to the Gulf of Mexico. Source: GSMFC 2020.



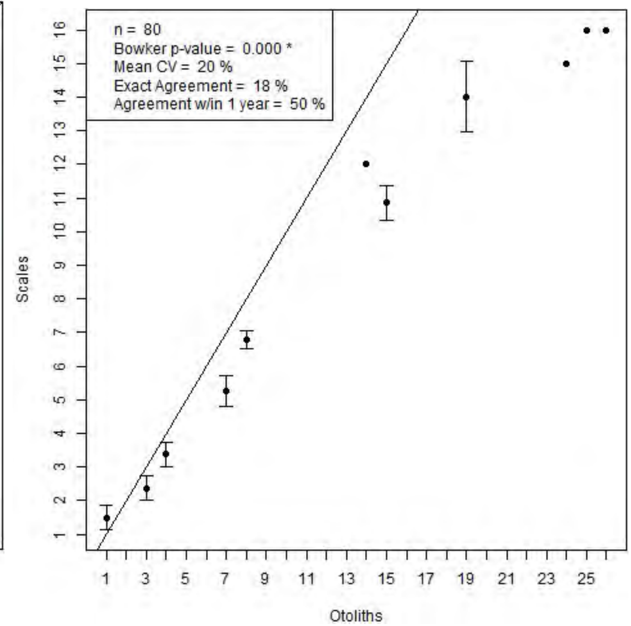


Figure 11. Age frequency (left) and age bias (right) plots for striped bass paired scale and otolith samples. Circles are proportional to number of observations.

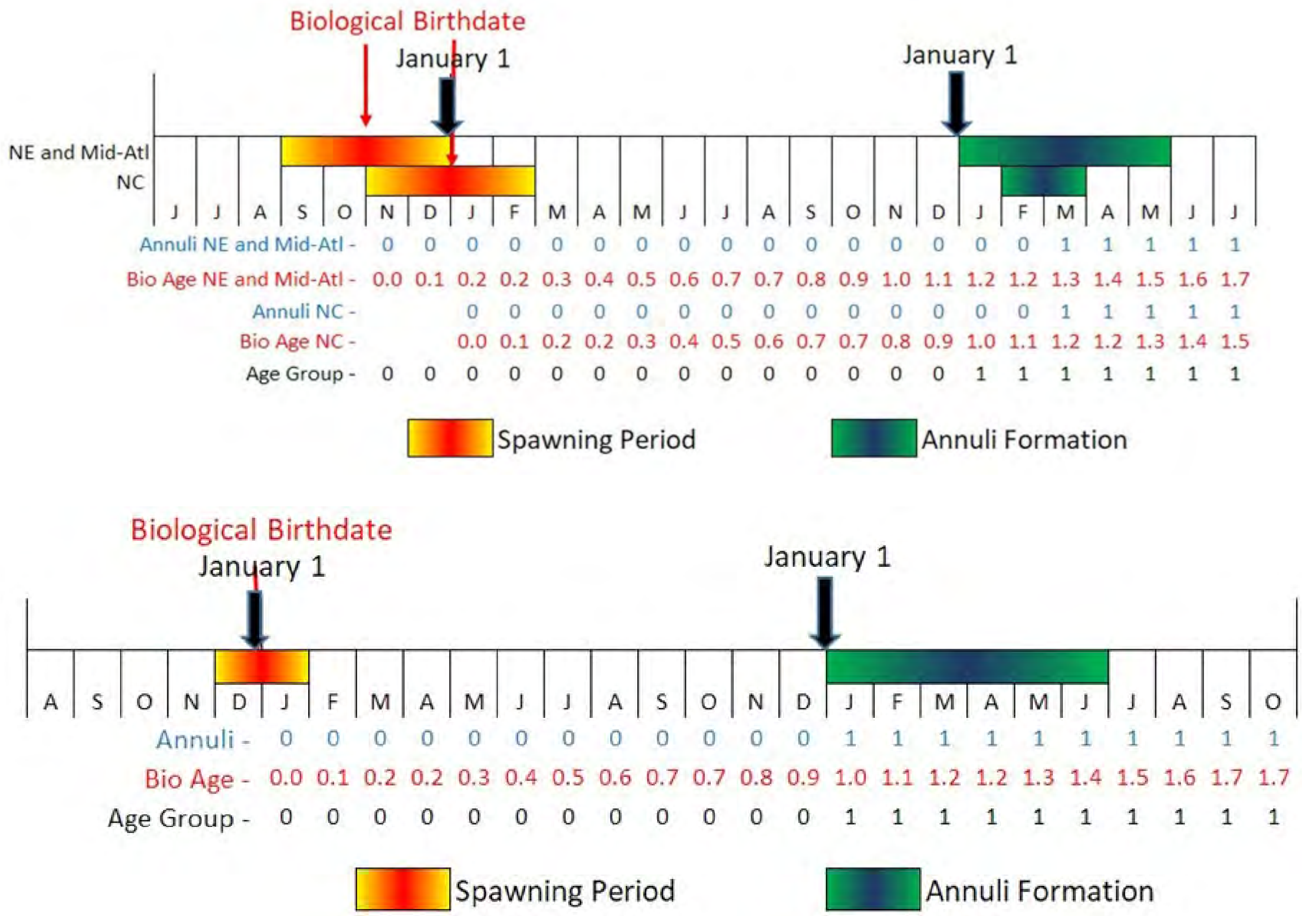


Figure 12. Timeline showing spawning period and annulus deposition ranges for summer flounder from New England to North Carolina (top) and in the South-Atlantic and Gulf (bottom). Source: GSMFC 2020.

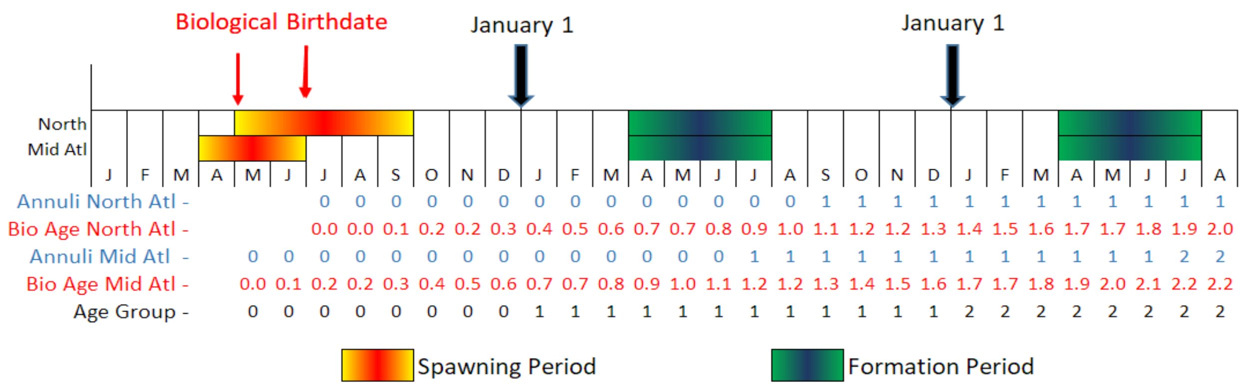


Figure 13. Spawning periodicity and age assignment timeline for tautog in the Mid-Atlantic and northeastern US. Source: GSMFC 2020.

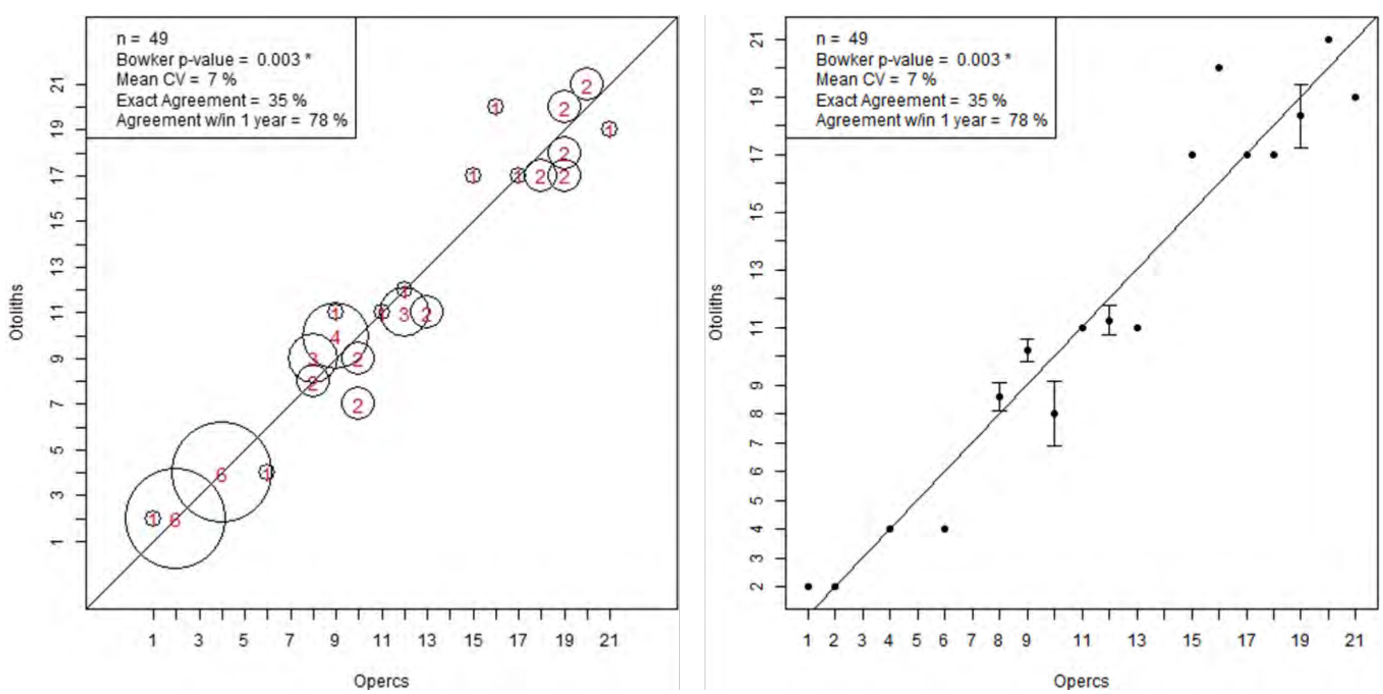


Figure 14. Age frequency (left) and age bias (right) plots for tautog paired opercula and otolith samples. Circles are proportional to number of observations.

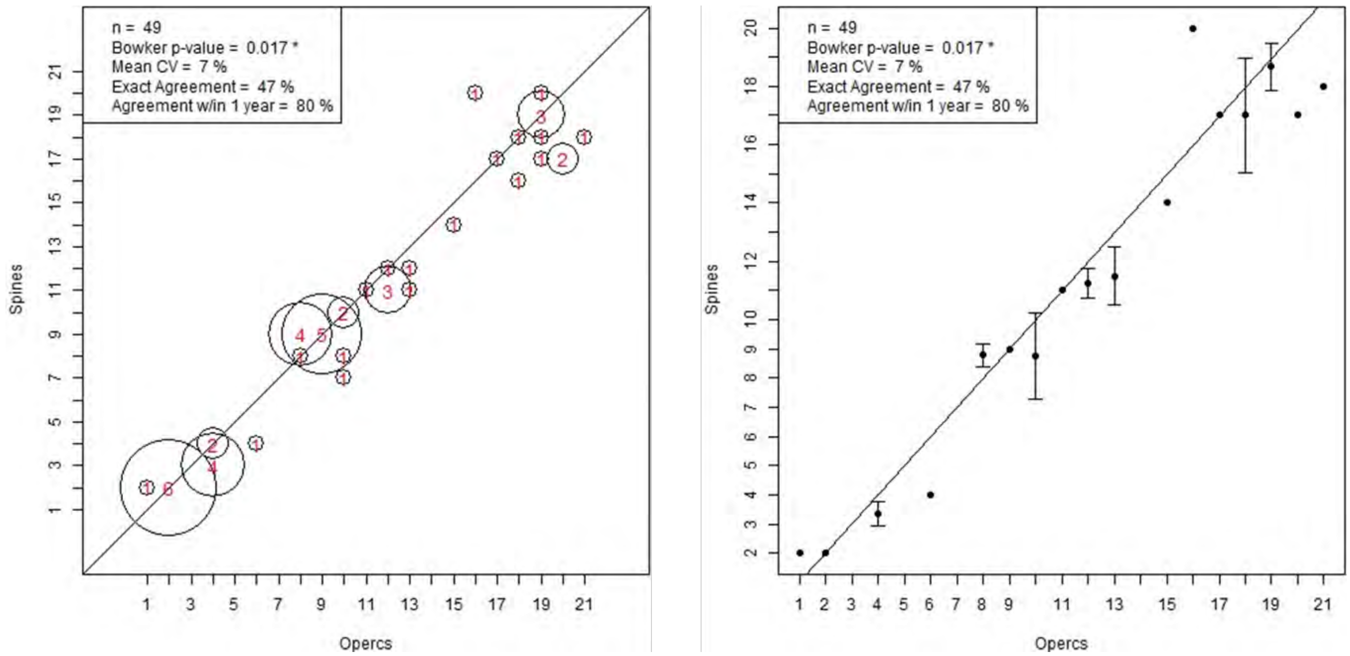


Figure 15. Age frequency (left) and age bias (right) plots for tautog paired opercula and pelvic spine samples. Circles are proportional to number of observations.

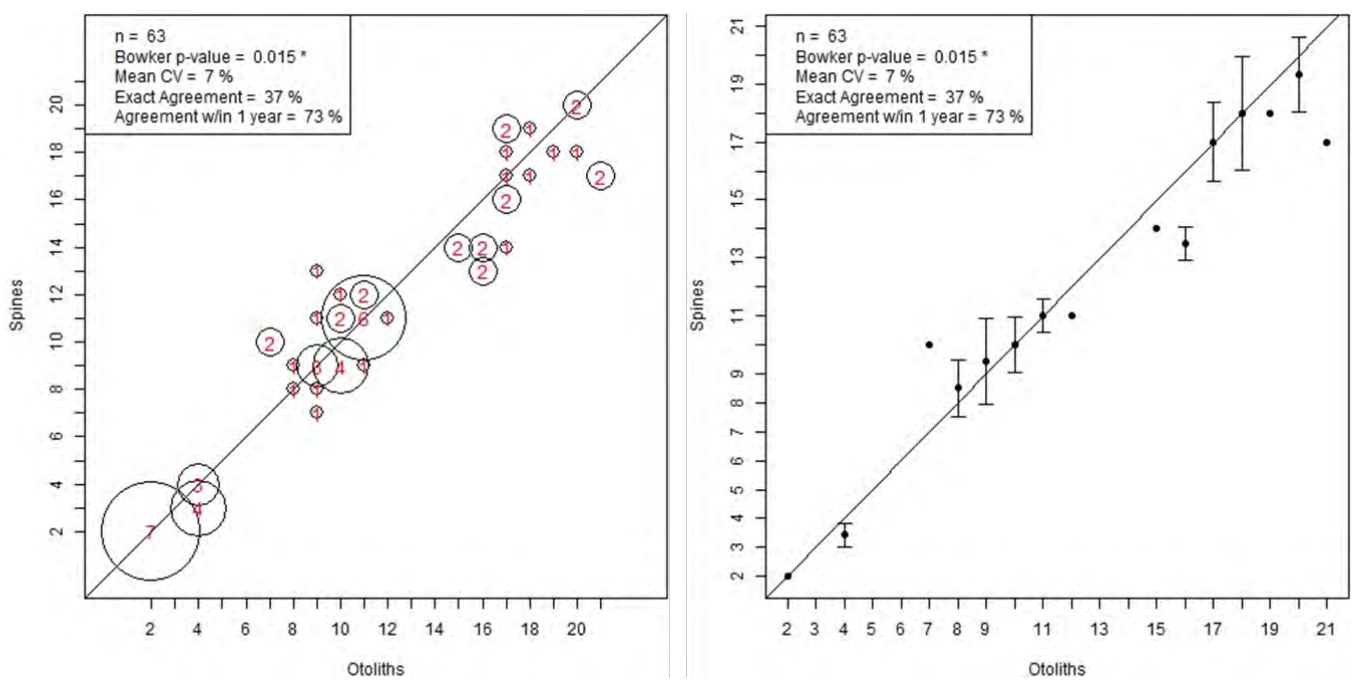


Figure 16. Age frequency (left) and age bias (right) plots for tautog paired otolith and pelvic spine samples. Circles are proportional to number of observations.

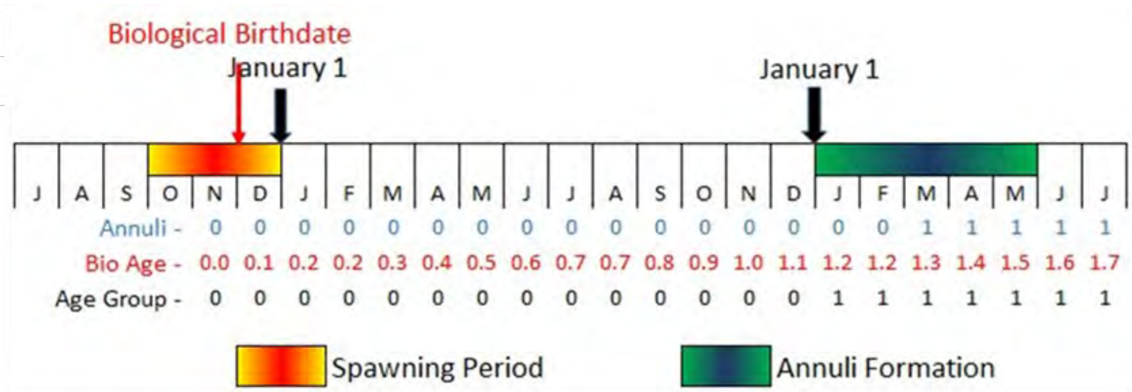


Figure 17. Timeline showing spawning period and annulus deposition ranges for winter flounder in the north and mid-Atlantic. Source: GSMFC 2020.

Appendix A: State Sample Collection, Preparation, and Ageing Methodology

I. Atlantic Croaker

New Jersey Division of Fish and Wildlife (NJ DFW)

Since 2006, Atlantic croaker have been collected during dockside sampling by NJ DFW staff. Fishery independent samples are also seasonally collected aboard the NJ DFW Ocean Trawl Survey. Samples are weighed, measured, and otoliths are removed as samples are being offloaded from commercial fishing vessels. Once otoliths are extracted, they are sectioned and aged under a microscope at NJ DFW's Nacote Creek Research lab. To date, 3,888 samples have been collected, with 52 samples collected in 2018.

Maryland Department of Natural Resources (MD DNR)

Maryland Atlantic croaker otoliths were collected from commercial pound nets in 2000 and then from 2002 through present (2016). A minimum of 20 samples were taken in 20 mm TL bins annually for all size groups available. Additional randomly collected pound net, gill net, and trawl commercial samples were obtained from fish dealers from 2009 to 2014. These were opportunistic sampling events, did not collect all gear in all year, and may or may not occur in the future. In 2012, croaker otoliths were also sampled randomly from commercial gill nets. All fish sampled for age were measured to the nearest mm TL, weighed to the nearest gram and sex was determined from internal examination of the gonads.

Prior to 2011, Atlantic croaker otoliths were processed and aged by the South Carolina Department of Natural Resources (SC DNR). Otoliths from 2011 to 2015 were aged by MD DNR biologists. The left otolith from each specimen was mounted to a glass slide for sectioning. If the left otolith was damaged, missing, or miscut the right otolith was substituted. Otoliths were mounted in Crystalbond 509 and were sectioned with a Buehler Isomet™ Low SpeedSaw using two blades separated by a 0.4 mm spacer. The Buehler 15 HC diamond wafering blades are 101.6 mm in diameter and 0.3048 mm thick. The 0.4 mm sections were then mounted on microscope slides and viewed under a microscope to determine the number of annuli. All age structures were read by two readers. If readers did not agree, both readers reviewed the structures together, and if agreement still could not be reached the sample was not assigned an age.

Virginia Institute of Marine Science (VIMS)

The Northeast Area Monitoring and Assessment Program (NEAMAP) is a cooperative state-federal program that has operated a Near Shore Trawl Survey in the mid-Atlantic Bight and southern New England since fall 2007. The Virginia Institute of Marine Science (VIMS) has been awarded the contract to carry out the survey. It continues and extends the methods of the Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP) which started in 2002. Atlantic croaker is a "Priority" species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS uses sectioned otoliths for age determination. VIMS has disputed that an interior 1st annulus should be counted for accurate age determination due to the time of year the species spawns and their annuli deposition. For continuity VIMS has made separate ages for including the first annulus as well as excluding it, which is recommended by the Commission for stock assessment purposes among other agencies (ASMFC 2008). Ages have ranged from age-0 to a max age of 18.

There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

Virginia Marine Resources Commission (VMRC)

The VMRC Biological Sampling Program has collected Atlantic Croaker otoliths with their biological information since 198, and the VMRC Ageing Lab (previously the Ageing Lab at Center for Quantitative Fisheries Ecology at Old Dominion University) process and age the otoliths. Otoliths are processed following the methods described in Barbieri et al. (1994) with a few modifications. The left or right sagittal otolith is randomly selected and sectioned using the glue method described in detail in Protocol of Preparation of Otolith Transverse Cross-Sections for Age Estimation.

All fish are aged in chronological order based on collection date, without knowledge of the specimen lengths. Two readers must age each otolith independently. When the readers' ages agree, that age is to be assigned to the fish. When the two readers disagree, both readers must re-age the fish together, again without any knowledge of previously estimated ages or specimen lengths and assign a final age to the fish. When the readers are unable to agree on a final age, the fish is excluded from further analysis.

Atlantic croaker are assigned a January 1st birthdate by convention. The sample date is used to assign the final age. If the sample was taken before the period of annuli formation (April to May), the age is the annulus count plus one. If the sample was taken after that, the age is the annulus count.

Historically, Virginia has counted the wide band/smudge closest to the otolith core as the first annulus, whereas most other states do not. Since 2008 Virginia has not counted the smudge as the first annulus, and also subtracted one year from those ages estimated prior to 2008, consistent with the age-class assignment used by other states.

The following are links to the preparation and ageing protocols for Atlantic croaker.

- Otolith Preparation Protocol

https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Otolith-Thin-Sections-for-Age-Estimation.pdf

- Otolith Ageing Protocol

https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/atlantic-croaker-otolith-ageing-protocol.pdf

North Carolina Division of Marine Fisheries (NC DMF)

Atlantic croaker sagittal otolith samples have been collected since 1996 from the winter trawl, long haul seine, pound-net, sink-net, recreational hook-and-line fisheries, and NC DMF fishery independent programs. Otoliths are removed, cleaned, and stored dry. Samples are weighed to the nearest 0.01 kg and measured for total length to the nearest millimeter. Date, gear, and water location are also recorded for each sample. A transverse section through the focus on a plane perpendicular to the horizontal axis of the left otolith is prepared using a Hillquist thin-sectioning machine as described by Cowan et al. (1995). The Age Lab biologist reads the otolith section and then samples are independently read by the species lead biologist. The readers record annuli count and margin code (1-4). Ages are bumped during the period of annulus formation when there is a margin code of 3 or 4. A third reader will age any samples where the previous readers disagreed. If any differences cannot be resolved, the data are omitted.

The NC DMF publishes three-year reports that include species-specific age-length keys, which have been applied to expanded length-frequency data to estimate length-at-age for total commercial landings on an annual basis. The age-length keys and expansions are applied on a seasonal basis: winter (January–March and October– December); and summer (April–September).

South Carolina Department of Natural Resources (SC DNR)

Atlantic croaker samples are collected from several different methods in South Carolina including inshore trammel net survey (2014), SEAMAP nearshore trawl (2001 to present) and MRFSS/MRIP survey. SC DNR Inshore Fisheries section also processes croaker otoliths from National Marine Fisheries Service’s Northeast groundfish survey since 1996. Otoliths are embedded in resin to facilitate cutting, cut on a low-speed saw to obtain a 0.4mm transverse cross-section and then mounted on microscope slide. The sections are read using a dissecting microscope with an attached camera so that the image can be viewed with a computer program like Image Pro. All samples are aged independently by two readers to insure accurate ages. Some Atlantic croaker otoliths vary with respect to diffuse, undefined marking near the core of the otolith. These diffuse areas are not interpreted as being a ring. The first annulus is considered the first well-defined, opaque band that can be traced around the entire section.

Georgia Department of Natural Resources (GA DNR)

Atlantic croaker were collected from Georgia's coastal waters using a variety of gear types in 2010-2012 as part of a graduate thesis (Franco 2014). Transverse sections were read from 2,401 otolith samples from age 0-6. The majority (98%) of otoliths exhibited the dark, opaque area near the core that is the smudge or check mark. While the majority of age samples for GA croaker came from this project, in the fall of 1997 GA DNR initiated the Marine Sportfish Carcass Recovery Project. This project takes advantage of the fishing efforts of hundreds of anglers by turning filleted fish carcasses that anglers would normally discard into a source of much needed data on Georgia's marine sportfish. The project is a true partnership of saltwater anglers, marine businesses, conservation groups, and the Coastal Resources Division (CRD). Since 1999, a total of 43 Atlantic croaker have been donated to the project. It was decided that the largest of the croaker would be sectioned and aged for the QA/QC Fish Ageing Workshop.

II. Black Drum

VMRC

The VMRC Biological Sampling Program has collected Black Drum otoliths with their biological information since 198, and the VMRC Ageing Lab process and age the otoliths. Otoliths are processed following the methods described in Bobko (1991) and Jones and Wells (1998) with a few modifications. The left or right sagittal otolith is randomly selected and sectioned using the glue method described in detail in Protocol of Preparation of Otolith Transverse Cross-Sections for Age Estimation .

All fish are aged in chronological order based on collection date, without knowledge of the specimen lengths. Two readers must age each otolith independently. When the readers' ages agree, that age is to be assigned to the fish. When the two readers disagree, both readers must re-age the fish together, again without any knowledge of previously estimated ages or specimen lengths and assign a final age to the fish. When the readers are unable to agree on a final age, the fish is excluded from further analysis.

Black Drum are assigned a January 1st birthdate by convention. The sample date is used to assign the final age. If the sample was taken before the period of annuli formation (May to June), the age is the annulus count plus one. If the sample was taken after that, the age is the annulus count.

The following are links to the preparation and ageing protocols for Black Drum.

- Otolith Preparation Protocol

https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Otolith-Thin-Sections-for-Age-Estimation.pdf

- Otolith Ageing Protocol

https://ww1.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/black-drum-otolith-ageing-protocol.pdf

SC DNR

Black drum samples are collected from a fishery-independent, year-round estuarine trammel net survey. Length bins are used to sub-sample specimens to ensure full coverage of age and growth curve. Otoliths are embedded in epoxy resin and sectioned using a low-speed saw, then mounted to a microscope slide with Cytoseal medium. Slides are looked at by two independent readers who record annuli count. If any disagreements occur, both readers look at the section together and come to a consensus or the sample is excluded from analysis. Ages are then assigned based on date of capture and margin code with annulus deposition being April to June.

Florida Fish and Wildlife Research Institute (FL FWRI)

Black drum otoliths are collected from fishery-independent monitoring surveys, and have historically been incidental collections, averaging around 10 samples annually from the east coast of Florida. Fishery collections are a mix of commercial and recreational sources, also averaging around 10 samples annually. In 2024, the Fishery Independent Monitoring section at FWRI added black drum to the standard inshore culling list and, based on previous catches of black drum, expect otolith collections to increase to an average of 400 samples from the east coast of Florida annually. Black drum otoliths are mounted on card stock with hot glue, and thin sectioned using a Buehler low-speed saw equipped with four blades; processing yields three transverse sections of the otolith core. The sections are aged with transmitted light, by two independent readers, using a stereo microscope. The readers record annuli count and margin code (1 - 4) without knowing the size of fish. Ages are determined using annuli count and margin code at date of capture.

III. Black Sea Bass

Northeast Fisheries Science Center (NEFSC)

Scales and otoliths from black sea bass have been collected since 1984 during fall and spring fishery-independent trawl surveys conducted by NOAA Fisheries from New England to Cape Hatteras, NC. Approximately 350 samples are collected from each survey annually (~700 total). Scales are typically collected from the commercial fishery by port samplers. Samples have been collected from the commercial fishery since 2008, with an emphasis on collecting samples from large and jumbo market size fish. A few thousand samples are collected from the commercial fishery annually. The size range of fish sampled is 4-60 cm. One reader is currently ageing both scales and whole otoliths. Samples that the age reader considers unreliable for age determination are discarded. The NEFSC will phase out scale ages and begin providing age data only from otoliths. The reader tests precision six times a year, once following each trawl survey and each quarter of the commercial fishing season and provides the results of these tests online (http://www.nefsc.noaa.gov/fbp/QA-QC/) . The threshold for precision testing is 80% agreement and a 5% mean CV.

Massachusetts Division of Marine Fisheries (MA DMF)

Black sea bass scales were collected from commercially captured fish at the fish houses (2013-2015) and from recreationally captured fish (2013-2022). The Massachusetts Resource Assessment fishery-independent trawl survey has collected otoliths since 2013. Otolith samples have also been collected from a ventless lobster trap survey since 2015. Otoliths have been read whole, submerged in mineral oil with reflected light under a stereo microscope. Otoliths aged 6 and older are then sectioned and re-aged. Beginning in 2021, all otoliths are sectioned prior to reading. Scales are pressed into acetate with a heat press and aged with a microfiche projector.

Rhode Island Department of Environmental Management (RI DEM)

Scales have traditionally been collected on fishery-independent surveys, at recreational fishing tournaments, and from the commercial fishery. In 2016, DEM began collecting otoliths when the whole fish was available and being sacrificed. Since then, sample collection has exclusively included otoliths. The annual target number of samples is 100. Otoliths are dried, mounted in epoxy resin, and thin-sectioned using an IsoMet™ slow speed saw. Thin sections are then mounted onto microscope slides with Flo-Texx™ and aged with a microscope. All samples are currently aged annually by a single reader. A second read is conducted by the same reader on at least 10% of the samples to obtain precision estimates. Starting 2023, DEM changed protocols to age all otoliths whole and then section and re-age otoliths 6 and older.

NJ DFW

The NJ DFW initiated sampling for black sea bass in 2010. Otoliths have been collected exclusively for ageing (no scales), and samples have been derived from fishery-independent survey efforts and fishery-dependent sources. Samples are collected throughout the year which includes length, weight, sex, diet, and otoliths. Once otoliths are extracted, they are sent to the NEFSC for processing and ageing.

VIMS

Scales and otoliths from black seas bass have been collected from two fishery-independent trawl surveys, the Chesapeake Bay Multispecies Monitoring and Assessment Program

(ChesMMAP) since 2002 and NorthEast Area Monitoring and Assessment Program (NEAMAP) since 2007. Black sea bass is a “Priority” species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS ages sectioned otoliths but has conducted comparison studies with scales and whole otoliths from 2010 to 2013. Black sea bass have been aged from age-0 to a max age of 16.

There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

SC DNR

South Carolina collects black sea bass samples for the South Atlantic from Cape Hatteras to Cape Canaveral using fishery-independent chevron trap survey. Otoliths are embedded in epoxy resin and two sections are taken using a Buhler saw, then they are mounted to a microscope slide with Cytoseal liquid coverslip. Two readers look at the sections independently, and without any size or capture data, to record annuli count and margin code. Any disagreements are looked at by both readers together to come to a consensus, or if none is reached the sample is excluded. Then a final age is assigned using the capture date and margin code.

FL FWRI

Black sea bass otoliths are collected on fishery-independent monitoring surveys. Black sea bass otolith collections started in 2011. A total of 1,219 samples were collected in the first two years of the original study, but collections have continued since, at an average of ~200 otoliths annually. Most black sea bass otoliths in the collection came from a directed project was conducted in 2011 and 2012. Otoliths are read whole, submerged in water with reflected light and a black background under a stereo microscope.

IV. Bluefish

MA DMF

The MA DMF has been sampling and ageing bluefish since 2009. Samples come from a combination of commercial and fishery independent sources. Otoliths are the only hard part aged for bluefish in Massachusetts. Otoliths are baked, sectioned, and aged with transmitted light on a compound microscope.

RI DEM

Bluefish otoliths have been collected since 2012 on fishery-independent surveys and from the recreational and commercial fisheries. The annual target number of samples is 100 per the requirements of Addendum I to Amendment I to the Bluefish FMP. Otoliths are dried, mounted in epoxy resin, and thin-sectioned using an IsoMet™ slow speed saw. Thin sections are then mounted onto microscope slides with Flo-Texx™ and aged with a microscope. All samples are currently aged annually by a single reader. A second read is conducted by the same reader on at least 10% of the samples to obtain precision estimates.

New York Department of Environmental Conservation (NY DEC)

The NY DEC has been collecting length, sex (when available), and age (otoliths) data from bluefish since 2012. The majority of samples are collected from fishery dependent sampling of commercial markets, with additional samples of larger bluefish coming from the recreational fishery. Staff sample as many bluefish as possible, but age a maximum of 10 fish per 1 cm bin. Otoliths are embedded in West System Epoxy and sectioned using an Isomet Low-Speed Saw to a thickness of ~0.3mm. Otoliths are aged on a compound microscope using transmitted light. Samples are processed and read by one person.

NJ DFW

The NJ DFW initiated a sampling program for bluefish in 2010 with the intent of filling gaps in the stock assessment age-length key. Otoliths have been collected exclusively for bluefish ageing (no scales), and samples have been derived from fishery-independent survey efforts and fishery-dependent sources. All otolith samples are sent to the NEFSC annually for processing and age determination and protocols follow those specified in the 2011 ASMFC bluefish ageing workshop.

VIMS

Bluefish is a “Priority” species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS uses sectioned otoliths to age bluefish. Otoliths are sectioned using a method similar to VMRC’s (previously ODU). However, VIMS wet-sands the sections to a thinner width than VMRC and does not bake the sections. Annulus counts are adjusted to reflect the timing of sample collection relative to ring formation. Age is assigned as the mode of three independent readings. Bluefish have been aged from age-0 to a max age of 10. The majority of the specimens sampled were ages 0-2.

There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

VMRC

VMRC obtains bluefish otoliths from the commercial catch and have been collected by VMRC since 1998. A random subsample of otoliths in each length bin are chosen to age. The left or right sagittal otolith is randomly selected and sectioned using the epoxy resin method described in detail in [Protocol of Preparation of Otolith Transverse Cross-Sections for Age Estimation](#) .

The VMRC Ageing Lab uses sectioned otoliths to age Bluefish. Each section is read under transmitted light using a polarizing filter. The characteristics described in Robillard et al. (2009) are used to identify the first ring and false annuli. Bluefish are assigned a January 1st birthdate by convention. In addition to recording the number of annuli, the margin or the growth width after the last annulus is coded from 1 to 4. Each section is aged by two readers. If the first readings disagree, the readers re-age the fish together. If a consensus cannot be reached, the sample is excluded from further analysis and, if available, another sample from the same length bin replaces it. Each year, readers revisit a reference collection of samples from 2000 to increase consistency across years.

The following are links to the preparation and ageing protocols for Bluefish.

- Otolith Preparation Protocol

https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Otolith-Thin-Sections-for-Age-Estimation.pdf

- Otolith Ageing Protocol

https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/cqfe-bluefish-otolith-ageing-protocol-black-white-2011.pdf

NC DMF

NC DMF has collected and aged bluefish scales from 1983-1998, and collected and aged otoliths from 1996-2000 and from 2006 to the present. From 1996-1998, NC DMF collected paired samples of scales and otoliths for a comparison of the two structures (NC DMF 2000). NC DMF did not collect any hard parts for bluefish from 2001-2005, when the Bluefish Technical Committee switched to a surplus production model for assessment purposes. The SAW/SARC review of that assessment (NEFSC 2005) found a lumped biomass model inappropriate for bluefish and recommended the use of an age-structured model instead. Thus, NC DMF began collecting otoliths for bluefish again in 2006. Bluefish are collected through fishery dependent sampling programs including commercial fish house sampling, recreational fishing tournaments, and the carcass collection program, and are also collected through NC DMF fishery independent programs. An average of 800 bluefish otoliths are aged annually.

Despite training at ODU's lab (now VMRC), NC DMF could not replicate ODU's process to produce readable otolith sections and began ageing whole otoliths for fish less than 500 mm in fork length. Whole otoliths are read by submerging the sample in water over a black background and viewing with reflected light. The left otoliths from individuals with a fork length ≥ 500 mm are sectioned on a Hillquist thin-sectioning machine using a rapid processing technique described in Cowan et al. (1995), and sections are ground down along the transverse plane to a final thickness of 0.35 mm. The Age Lab biologist reads the otolith section and then samples are independently read by the species lead biologist. The readers record annuli count and margin code (1-4). Ages are bumped during the period of annulus formation when there is a margin code of 3 or 4. A third reader will age any samples where the previous readers disagreed. If any differences cannot be resolved, the data are omitted.

SC DNR

The Southeast Area Monitoring and Assessment Program (SEAMAP) is a cooperative state-federal program that has operated a fishery independent Shallow Water Trawl Survey in the nearshore waters from Cape Hatteras, North Carolina, to Cape Canaveral, Florida, since 1986. The survey is conducted by SC DNR.

In 2011, bluefish was added to the list of species that received a full work-up including the collection of otoliths for ageing. As with the NEAMAP samples, most bluefish samples are small, young fish. From 2000 to 2010 before SEAMAP took over sample processing, SC DNR Inshore Fisheries section was using SEAMAP caught bluefish for otolith ageing. Otoliths are embedded in epoxy resin and a thin section is cut through the core with a Buehler low-speed saw. The sections are looked at with transmitted light, by two independent readers, using a stereo microscope. The readers record annuli count and margin code (1 - 4) without knowing the date of capture or the size of fish. Ages are determined using annuli count and margin code at date of capture. Bluefish spawn during the summer, and first annulus formation is the following spring to summer.

FL FWRI

Bluefish otoliths are collected on fishery-independent monitoring surveys, and are typically incidental collections. Fishery collections come from primarily from commercial samplers, but because bluefish is not a highly-targeted species, annual collections are typically around fifty samples. Otoliths are embedded in epoxy resin and a thin section is cut through the core with a Buehler low-speed saw. The sections are looked at with transmitted light, by two independent readers, using a stereo microscope. The readers record annuli count and margin code (1 - 4) without knowing the size of fish. Ages are determined using annuli count and margin code at date of capture.

V. Cobia

VIMS

Cobia is “Priority” species for the NEAMAP and ChesMMAP surveys. Length, weight, sex, maturity, stomachs for diet analysis, and otoliths are collected from 5 specimens from each length bin from each tow. Otoliths have been sectioned for the best results and accuracy with ageing. Despite lower encounters with this species, the surveys maintain cobia as a priority species and provide data when applicable for assessment needs. Otoliths are sectioned and wet-sanded to a thinner width. Annulus counts are adjusted to reflect the timing of sample collection relative to ring formation. Age is assigned as the mode of three independent readings.

There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

VMRC

VMRC obtains cobia otoliths from the recreational catch and have been collected by VMRC since 1999. All samples are processed for ageing. The left or right sagittal otolith is randomly selected and sectioned using the epoxy resin method described in detail in Protocol of Preparation of Otolith Transverse Cross-Sections for Age Estimation .

The VMRC Ageing Lab uses sectioned otoliths to age cobia. Each section is read under transmitted light using a polarizing filter. Cobia are assigned a January 1st birthdate by convention. In addition to recording the number of annuli, the margin or the growth width after the last annulus is coded from 1 to 4. Each section is aged by two readers. If the first readings disagree, the readers re-age the fish together. If a consensus cannot be reached, the sample is excluded from further analysis and, if available, another sample from the same length bin replaces it. Each year, readers revisit a reference collection of samples from 2000 to increase consistency across years.

The following are links to the preparation and ageing protocols for cobia.

- Otolith Preparation Protocol

https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Otolith-Thin-Sections-for-Age-Estimation.pdf

- Otolith Ageing Protocol

https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/cobia-otolith-ageing-protocol.pdf

SC DNR

SC DNR Mariculture section direct targets cobia, with hook and line, to use as broodstock in a marine gamefish stocking program. A subsample of these fish is kept for life history analysis of the species. Otoliths are embedded in epoxy resin and a thin section is cut through the core with a Buehler low-speed saw. The sections are looked at with transmitted light, by two independent readers, using a stereo microscope. The readers record annuli count and margin code (1 - 4) without knowing the date of capture or the size of fish. Ages are determined using annuli count and margin code at date of capture. Cobia are summer spawners with the first annulus formation during the following summer.

FL FWRI

FL FWRI primarily collects cobia as part of a multi-year study on reproductive characteristics; samples are obtained from fishery dependent and independent collections. Cobia samples are also obtained from the recreational fishery, but are irregular collections.

Otoliths are embedded in epoxy resin and a thin section is cut through the core with a Buehler low-speed saw. The sections are looked at with transmitted light, by two independent readers, using a stereo microscope. The readers record annuli count and margin code (1 - 4) without knowing the size of fish. Ages are determined using annuli count and margin code at date of capture.

VI. Scup

NEFSC

NEFSC samples come from a combination of commercial and fishery-independent sources. Prior to 2016, scales were used to age scup. Scales were impressed in acetate using a press and aged by examining impressions on a microfiche projector. Since 2016, otoliths are the hard part aged for scup. Otoliths are sectioned and aged with transmitted light on a compound microscope. Samples that the age reader considers unreliable for age determination are discarded. The reader tests precision six times a year, once following each trawl survey and each quarter of the commercial fishing season and provides the results of these tests online (http://www.nefsc.noaa.gov/fbp/QA-QC/http://www.nefsc.noaa.gov/fbp/QA-QC/) . The threshold for precision testing is 80% agreement and a 5% mean CV.

MA DMF

MA DMF processed scup scales collected by volunteer recreational anglers (2013-2022). The scales were wiped clean, pressed into acetate using a heated press, and aged by examining the impressions on a microfiche projector. In 2023 MA DMF began ageing scup otoliths collected on our resource assessment trawl survey. Otoliths are embedded in epoxy, sectioned, and aged using transmitted light through a compound microscope.

RI DEM

Scales have traditionally been collected on fishery-independent surveys, at recreational fishing tournaments, and from the commercial fishery. In 2017, DMF began collecting otoliths when the whole fish was available and being sacrificed. Since 2019, sample collection has exclusively included otoliths. The annual target number of samples is 100. Otoliths are dried, mounted in epoxy resin, and thin-sectioned using an IsoMet™ slow speed saw. Thin sections are then mounted onto microscope slides with Flo-Texx™ and aged with a microscope. All samples are currently aged annually by a single reader. A second read is conducted by the same reader on at least 10% of the samples to obtain precision estimates.

VIMS

Scup is “Priority” species for the NEAMAP and ChesMMAP surveys. Length, weight, sex, maturity, stomachs for diet analysis, and otoliths are collected from 5 specimens from each length bin from each tow. Otoliths have been sectioned for the best results and accuracy with ageing. Annulus counts are adjusted to reflect the timing of sample collection relative to ring formation. Age is assigned as the mode of three independent readings.

There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

VII. Spot

MD DNR

A subsample of spot was retained based on a yearly length bins and brought back to the lab for processing from the onboard sampling effort. Otoliths were taken and individual weights (grams), TL (millimeters) and sex were determined from subsampled. All spot otoliths were processed and aged by two project biologists. The left otolith from each specimen was mounted to a glass slide for sectioning. If the left otolith was damaged or missing, the right otolith was substituted. Otoliths were mounted to a glass slide using Crystalbond® 509 and sectioned with a Buehler IsoMet® low speed saw using two blades separated by a 0.4 mm spacer. Allied High Tech Products Inc. impregnated diamond metal bonded, high concentration cutting blades, measuring 102 mm in diameter and 0.31 mm thick (model number 60-20070) were used. The core of the otolith was determined, and the cut was made. When the otolith is held up to a light the opaque area is determined to be the core. The 0.4 mm sections were then mounted on microscope slides and viewed under a microscope at five to six power to determine the number of annuli. All age structures were read by two readers. If readers did not agree, both readers reviewed the structures together, and if agreement still could not be reached the sample was not assigned an age.

VMRC

The VMRC Biological Sampling Program has collected Spot otoliths with their biological information since 198, and the VMRC Ageing Lab process and age the otoliths. Otoliths are processed following the methods described in Barbieri et al. (1994) with a few modifications. The left or right sagittal otolith is randomly selected and sectioned using the epoxy resin method described in detail in Protocol of Preparation of Otolith Transverse Cross-Sections for Age Estimation.

All fish are aged in chronological order based on collection date, without knowledge of the specimen lengths. Two readers must age each otolith independently. When the readers' ages agree, that age is to be assigned to the fish. When the two readers disagree, both readers must re-age the fish together, again without any knowledge of previously estimated ages or specimen lengths and assign a final age to the fish. When the readers are unable to agree on a final age, the fish is excluded from further analysis.

Spot are assigned a January 1st birthdate by convention. The sample date is used to assign the final age. If the sample was taken before the period of annuli formation (May to July), the age is the annulus count plus one. If the sample was taken after that, the age is the annulus count.

The following are links to the preparation and ageing protocols for Spot.

- Otolith Preparation Protocol

https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Otolith-Thin-Sections-for-Age-Estimation.pdf

- Otolith Ageing Protocol

https://ww1.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/spot-otolith-ageing-protocol.pdf

SC DNR

Spot were not historically aged in SC, but starting in 2010 an effort was made to look at life history of the species. Otolith samples are mostly taken from a fishery-independent trammel net survey but have also been taken from near-shore trawls and fishery-dependent angler interactions. Otoliths are embedded in epoxy resin and sectioned using a low-speed saw, then mounted to a microscope slide with Cytoseal medium. Slides are looked at by two independent readers who record annuli count. If any disagreements occur, both readers look at the section together and come to a consensus or the sample is excluded from analysis. Ages are then assigned based on date of capture and margin code with annulus deposition being April to June.

FL FWRI

Spot otoliths are collected from both fishery-independent monitoring surveys as well as fishery-dependent sources, but collections are typically incidental and average less than 10 samples annually. Spot otoliths are embedded in a plastic resin, mounted on card stock with hot glue, and thin sectioned using a Buehler low-speed saw equipped with four blades; processing yields three transverse sections of the otolith core. The sections are aged with transmitted light, by two independent readers, using a stereo microscope. The readers record annuli count and margin code (1 - 4) without knowledge of the size of fish. Ages are determined using annulus count and margin code at date of capture.

VIII. Striped Bass

Maine Department of Marine Resources (ME DMR)

Historically, ME DMR collected scales from some striped bass caught by rod and reel. Since 2010, scales have been collected from fish that were caught as part of an acoustic tagging program. In this program, striped bass are caught with rod and reel, tagged, and scales were removed from most of the fish for ageing. Additionally, young of the year (YOY) are captured as part of a beach seining project in the summer and fall. Scales were removed from a few of these young of the year fish in the past.

MA DMF

MA DMF primarily collects and ages striped bass scales. Samples are collected from the commercial fishery at the fish houses, the recreational fishery via a scale collection program involving volunteer recreational anglers, and from tagging projects. MA DMF also collects racks from a fishing club and several charter boats that are processed for scales and otoliths. These structures are used to make a yearly comparison between hard parts. Scales are impressed in acetate using a heated press and aged by examining impressions on a microfiche projector. Otoliths are cross-sectioned, baked and read with transmitted light on a compound microscope.

RI DEM

Scales have been collected on from the commercial fishery since 2001 and on fishery-independent surveys and the recreational fishery since 2013. The annual target number of samples is 150 rod and reel and 150 from the commercial floating fish trap fishery. Sample collection primarily includes scales; however, otoliths are also collected on fishery-independent surveys when the whole fish is being sacrificed or when fish racks are donated from the recreational fishery. Scales are cleaned, pressed onto acetate with a heat press, and aged using a microfiche reader. Otoliths are dried, mounted in epoxy resin, and thin-sectioned using an IsoMet™ slow speed saw. Thin sections are then mounted onto microscope slides with Flo-Texx™ and aged with a microscope. All samples are currently aged annually by a single reader. A second read is conducted by the same reader on at least 10% of the samples to obtain precision estimates.

NY DEC

New York began collecting scales from striped bass in 1984. Samples are collected through our fishery-dependent commercial fish market sampling, and recreational fishery cooperative angler program. In addition, scales are collected from our fishery-independent western Long Island juvenile striped bass beach seine survey. A sample of scales is collected from each fish and pressed onto clear acetate sheets using a heated Carver Press. Scales are aged on a microfiche by a minimum of two readers and compared for agreement. A group reading or repress of the sample settles disagreements. Samples for which no agreement can be reached are discarded from the set. Any otoliths collected are archived and stored.

NJ DFW

Striped bass scale samples have been collected regularly during several fishery independent surveys since 1989 including but not limited to the Striped Bass Tagging Survey in Delaware Bay, the Ocean Trawl Survey along the New Jersery coast, the Delaware River Recruitment Survey, and during sampling at fishing tournaments and on party/charter boats. Approximately 135 paired scale/otolith samples have also been collected annually although no otoliths have been processed or aged. Scales are processed using a heated Carver Press and aged using a microfiche reader.

MD DNR

Since 1985, biologists at MD DNR have been conducting the spawning stock survey in historic spawning locations (http://dnr2.maryland.gov/fisheries/PublishingImages/striped-bass-spawning-map.jpg) on the Upper Chesapeake Bay and the Potomac River. In concurrence with monitoring the spawning stock, MD DNR is part of the Cooperative Coastal Striped Bass Tagging Program (https://www.fws.gov/northeast/marylandfisheries/projects/Striped%20Bass.html). This program tags spawning striped bass with United States Fish and Wildlife Service (USFWS) internal anchor tags to evaluate stock dynamics of the migratory Atlantic Coast striped bass. The goal of this survey is to characterize the age, size, and sex structure, and abundance at age of spawning striped bass in Maryland's portion of the Chesapeake Bay. The survey is conducted up to six days a week from late March to mid-May. Striped bass are sampled using experimental drift gill nets in the Upper Chesapeake Bay and Potomac River. The experimental drift gill nets are a series of different mesh size and each panel is approximately 150 feet long and 10 feet deep, with about 10 feet in-between each net. Drift nets are deployed for short periods of time during and near slack tide, twice a day at one random site each, in the Upper Chesapeake Bay and Potomac River.

All striped bass captured in the nets were measured for total length (mm TL), sexed by expression of gonadal products, and released. Scales were taken from 2-3 randomly chosen male striped bass per 10 mm length group, per week, for a maximum of 10 scale samples per length group over the entire season. Scales were also taken from all males over 700 mm TL and from all females regardless of total length. Scales were removed from the left side of the fish, above the lateral line, and between the two dorsal fins. Additionally, if time and fish condition permitted, US Fish and Wildlife Service internal anchor tags were applied.

The scales that are selected for processing are taped shiny side up on the acetate slide. Impressions were made by the Carver press at 170°F and 18,000 lbs. of pressure for 5.5 to 6 minutes depending on the size of the fish. The final impressions were viewed in a microfiche machine to obtain the final age. At least two biologists looked at each scale sample to arrive at an agreed age, if they did not agree a third biologist views them, if no agreement then a fourth reader views. If still no agreement, the scales were replaced with different sample, reprocessed with different scales or thrown out.

VIMS

Striped bass are collected as part of NEAMAP and ChesMMAP sampling programs. Additionally, striped bass is a "Priority" species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS uses sectioned otoliths for age determination. The ChesMMAP survey encounters everything from Young-Of-Year specimens to fully matured adults. The NEAMAP survey often encounters large mature adults feeding on schools of prey. Ages have ranged from age-0 (YOY) to a max age of 24. Additionally, a striped bass monitoring and tagging program was absorbed by the Multispecies Research Group at VIMS, in which approximately 2000 scales and sectioned otoliths are processed annually.

There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

VMRC

VMRC has been collecting striped bass biological data since 1988. The field sampling program is designed to sample striped bass harvests within specific water areas. Since 2003, Virginia has managed its Coastal Area and Chesapeake Bay Area harvests by two different ITQ systems, with data collections procedures intending to ensure adequate representation of both harvest areas. Samples of biological data are collected from seafood buyers' places of business or dockside from offloaded striped bass caught by pound nets or haul seines. Some gill net or commercial hook-and-line fishermen's harvests may be sampled directly. Some striped bass sampled for scales are also sampled for otoliths. Supplementary data is collected for each biological sample, such as date of collection, harvest location, market grade, harvest area, and gear type.

Otoliths samples are cleaned and baked in a Thermolyne 1400 furnace. After baking, both otoliths from each fish are embedded in epoxy resin and sectioned. All fish are aged in chronological order based on collection date, without knowledge of the specimen lengths. The two readers must age each otolith independently. When the readers' ages agree, that age is to be assigned to the fish. When the two readers disagree, both readers must re-age the fish together, again without any knowledge of previously estimated ages or specimen lengths and assign a final age to the fish. When the readers are unable to agree on a final age, the fish is excluded from further analysis.

Striped bass are assigned a January 1st birth date by convention. The sample date is used to assign the final age. If the sample was taken before the period of annuli formation (April to June), the age is the annulus count plus one. If the sample was taken after that, the age is the annulus count.

The following are links to the preparation and ageing protocols for striped bass.

- Otolith Preparation Protocol

https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Otolith-Thin-Sections-for-Age-Estimation.pdf

- Scale Preparation Protocol

https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Scale-Impressions-for-Age-Estimation.pdf

- Otolith Ageing Protocol

https://ww1.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/striped-bass-otolith-ageing-protocol.pdf

SC DNR

Striped bass have been aged in South Carolina since the 1950s by the Wildlife and Freshwater Fisheries Division of SC DNR, which still ages them today. Historically, striped bass were aged with scales although some are now aged with otoliths. Gill nets and electrofishing are the methods used to collect the specimens. SC DNR Marine Research Division released mariculture-raised striped bass from 2006 through 2014. During 2014 some of these fish were recaptured and processed by SC DNR Inshore electrofishing survey and otoliths were kept for ageing.

IX. Summer Flounder

RI DEM

Summer flounder are sampled by the RI DFW on fishery-independent surveys and from the recreational and commercial fisheries. Each year a target number of 100 samples are collected with scales being the primary ageing structure prior to 2019. As of 2019, DFW will be focusing sampling on the collection of otoliths from fishery-independent surveys and will still collect length-frequency data from the commercial fishery when possible. Otoliths are embedded in epoxy resin, sectioned, mounted on microscope slides, and aged with a microscope. Structures are aged by a single reader annually. A second read is conducted by the same reader on at least 10% of the samples for each structure to obtain precision estimates.

VIMS

Summer flounder is a "Priority" species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS uses sectioned otoliths to age summer flounder. Otoliths are sectioned using a method similar to ODU's. However, VIMS wet-sands the sections to a thinner width than ODU and does not bake the sections. Annulus counts are adjusted to reflect the timing of sample collection relative to ring formation. Age is assigned as the mode of three independent readings. Summer flounder have been aged from age-0 to a max age of 13. The majority of the specimens sampled were ages 0-7. There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

VRMC

VMRC has obtained summer flounder otoliths and scales from the commercial and recreational catch and fishery independent sampling programs since 1999. Ageing hard parts are processed and read by VMRC. The lab chooses a random subsample collected in each length bin to age.

Otoliths samples are cleaned and baked in a Thermolyne 1400 furnace. After baking, both otoliths from each fish are embedded in epoxy resin and sectioned. Each section is read under transmitted light using a polarizing filter. Summer flounder are assigned a January 1st birth date by convention. The sample date is used to assign the final age. If the sample was taken before the period of annuli formation (January to June), the age is the annulus count plus one. If the sample was taken after that, the age is the annulus count.

Each section is aged by two readers. If the first readings disagree, the readers re-age the fish together. If a consensus cannot be reached, the sample is excluded from further analysis and, if available, another sample from the same length bin replaces it. Each year, readers revisit a reference collection of samples from 2000 to increase consistency across years.

The following are links to the preparation and ageing protocols for summer flounder.

- Scale Preparation Protocol

https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Scale-Impressions-for-Age-Estimation.pdf

- Otolith Preparation Protocol

https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Otolith-Thin-Sections-for-Age-Estimation.pdf

- Otolith Ageing Protocol

https://ww1.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/summer-flounder-otolith-ageing-protocol.pdf NC DMF

Summer flounder otoliths have been collected from fisheries dependent and fishery independent sampling programs since 1995. Samples are weighed to the nearest 0.01 kg and measured for fork length to the nearest millimeter. Date, gear, and water location are also recorded for each sample. The left otoliths are sectioned on a Hillquist thin-sectioning machine using a rapid processing technique described in Cowan et al. (1995). Two otolith sections are set onto each slide, as long as they are from the same collection. The Age Lab biologist reads the otolith section and then samples are independently read by the species lead biologist. The readers record annuli count and margin code (1-4). Ages are bumped during the period of annulus formation when there is a margin code of 3 or 4. A third reader will age any samples where the previous readers disagreed. If any differences cannot be resolved, the data are omitted.

X. Tautog

MA DMF

Tautog otoliths and operculum are collected from several sources; cooperation from commercial fisherman, within division fish potting, and cooperation with several recreational anglers. Opercula collections began in 1995 and ceased in 2019. Otoliths have been collected since 2012. Otolith and pelvic spine samples have been collected from our ventless lobster trap survey since 2015 as well as from a tautog rod and reel survey (2016-2018). Opercula are boiled and brushed clean before being dried and aged without magnification. Otoliths are baked, sectioned and aged with transmitted light under a compound microscope.

Tautog pelvic fin spines have been collected from primarily recreational sources since 2014. Spines are boiled for 1-2 minutes, brushed clean with a small brush then allowed to air dry for at least 48 hours. The spines are embedded in epoxy and 0.75 mm sections are cut. Three successive sections are removed starting just above the condyle. Sections are affixed to a slide with a liquid coverslip and aged through a compound microscope with transmitted light.

RI DEM

Opercula have been collected by RI DEM since 1987, primarily from donated recreational carcasses. The annual target number of samples is 200 per the requirements of Addendum III to the FMP for Tautog. Sample collection has primarily included operculum; however, otoliths have also been collected since 2012 following the recommendations of the 2012 Tautog Ageing Workshop. Additionally, in 2017, RI DEM began collecting tautog pelvic spines for ageing.

Following the recommendations of the 2023 QA/QC workshop, RIDEM will conduct one year of paired otolith/spine age readings in 2022. In 2023, RIDEM will fully transition to collecting and ageing spines as the primary ageing structure. Collection and processing will follow Elzey and Trull (2016). All samples are currently aged annually by a single reader. A second read is conducted by the same reader on at least 10% of the samples for each structure to obtain precision estimates.

NY DEC

Fishery-dependent tautog samples are primarily collected from commercial markets and headboat fish racks. While the current goal is to satisfy the requirements of the FMP, availability of samples has fluctuated over time. The total length of each fish is measured, and the opercula bone is removed and frozen until further processing. Otoliths from a subset of these fish are also collected. Previously frozen samples are thawed and boiled for two minutes and the flesh is gently scraped off the opercula. The bones are allowed to air dry overnight and are then read without magnification using overhead lighting. Aged samples are available from 1993 to the present.

NJ DFW

Sampling for tautog was initiated in 2007, collecting samples primarily from commercial and party/ charter vessels. Currently, NJ collects its samples primarily from fishery-dependent party/charter vessels and supplements sample for outside the recreational catch limits with fishery-independent sources, the NJ FW Ocean Trawl Survey and NJ's Artificial Reef Ventless Trap Survey. Racks are collected from fishery-dependent vessels, where lengths and sex are recorded, and opercula are removed. The opercula are processed and aged at the Nacote Creek Research lab, where they are viewed using transmitted and reflected light.

MD DNR

Maryland has collected tautog opercula for ageing since 1996. The current FMP requires that each state collect 200 opercula and 50 otolith samples per year. Tautog have been collected by hook and line, commercial fish pots and on rare occasion spearfishing. Juvenile tautog have also been collected by seining eel grass beds in 2015 which provided samples of the smallest length groups in the population. The most productive method is hook and line with a partnering professional charter boat.

The goal is to randomly sample and fill each 10 mm length group with five samples. Each fish is measured (mm total length) and weighed (kg) using the digital scale. The gonads are observed to determine the sex of the fish. These data are recorded on each scale envelope. Both opercula are removed and placed in the envelope(s). The fish heads are tagged with a tuna or yellow perch tag and that tag number is recorded on the opercula envelope(s). All heads are frozen until the otolith bins are calculated to ensure all 10 mm length groups have ample representation; all large fish (> 600mm) have otoliths removed. Starting in 2013, DNA was collected for scientists at VIMS.

Each operculum is boiled in water, cleaned, and placed in a new envelope for reading. All readers must re-read the reference collection that contains 20 opercula samples for each year since 1996 (except for 1997 and 1998 which has less than 20) prior to reading the current year samples. The reader uses no magnification. The first-year annular line is typically 7-8 mm from the articular apex and the second year around 12-15 mm. The spacing between year's decreases as the fish gets older. The outer edge (new growth) is counted to promote (X+1) if the operculum was collected between 1 Jan to 30 June, otherwise it is not counted. A representative sample of 20 aged opercula is added to the reference collection for the following year.

VIMS

Tautog are collected for both NEAMAP and ChesMMAP surveys and additionally is considered a "Priority" species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS uses sectioned otoliths, pelvic spines, and opercula for age determination. Both opercula and otoliths have been collected since 2010 as per comparison purposes due to the low number of encounters by each survey over their time series. Additionally, paired pelvic spines have been collected since 2017. Prior to 2010 only opercula were collected. To date, VIMS tautog data has not been requested but not used in assessments due to the low number of samples across the surveys time series.

There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

VMRC

VMRC obtains tautog otoliths, operculum, and pelvic fin spines from the commercial and recreational catch. Tautog have been collected as part of VMRC's Biological Sampling Program since 1998. All samples are processed for ageing.

Operculum and pelvic fin spines are removed and frozen until prepared for age reading. Thawed samples are boiled 5-6 minutes to loosen attached tissue. When the sample is removed from the water, skin and tissue are removed. Clean opercula are read using transmitted light, usually from a window or overhead light. Pelvic fin spines are allowed to air dry for at least 24hrs after cleaning. Then they are embedded in epoxy resin and sectioned. Otoliths samples are cleaned and baked in a Thermolyne ™ 1400 furnace. After baking, both otoliths from each fish are embedded in epoxy resin and sectioned.

All tautog samples are aged by two different readers. When readers disagree, they re-age the fish together without knowledge of lengths or previously estimated ages. Fish that do not result in agreement are excluded from analysis.

Tautog are assigned a January 1st birthdate by convention. The sample date is used to assign the final age. If the sample is taken before the period of annuli formation (May to July), the age is the annulus count plus one. If the sample is taken after that, the age is the annulus count.

The following are links to the preparation and ageing protocols for tautog.

- Preparation Protocol

https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Opercula-for-Age-Estimation.pdf

https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Otolith-Thin-Sections-for-Age-Estimation.pdf https://mrc.virginia.gov/ageing-lab/Tautog-Operculum-Preparation-Protocol.pdf

- Otolith Ageing Protocol

https://ww1.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/tautog-otolith-ageing-protocol.pdf

XI. Winter Flounder

NJ DFW

Sampling for winter flounder began in 1993 for New Jersey. Winter flounder otoliths are collected during the April Ocean Trawl Survey due to higher occurrence from the fish leaving the estuaries after spawning. From 1995-2005, we had a spawning survey of winter flounder in some of our northern estuaries, and samples also were collected from that survey. The otoliths are then aged whole for younger fish and when the annuli become difficult to read on older individuals they are sectioned using low speed Isomet^{TM} saws. The sections are then read by two individual readers, and discrepancies are then read by a tie breaker.

MA DMF

Winter flounder otoliths are collected from our resource assessment trawl survey. Collected otoliths have been aged in the MADMF age and growth lab since 2012. Samples collected from 1982-2011 were aged by the NMFS NEFSC. Otoliths have typically been read whole with reflected light. Samples assigned an age of 5 or older were then thin sectioned and read either with a stereoscope using reflected light or with a compound microscope with transmitted light. Beginning in 2022 all otoliths are being sectioned prior to being aged as described previously.

RI DFW

RI DFW began sampling winter flounder on fishery-independent surveys in 2014. Additionally, a small number of samples were donated by the commercial fishery in 2016. Each year a target number of 100 paired scale and otolith samples are collected. Although scales are collected, the primary ageing structure for winter flounder is otoliths. Scales are cleaned and pressed onto acetate and aged on a microfiche reader. Otoliths are embedded in epoxy resin, sectioned, mounted on microscope slides, and aged with a microscope. Both structures are aged by a single reader annually. A second read is conducted by the same reader on at least 10% of the samples for each structure to obtain precision estimates.

NY DEC

NY DEC has not processed or aged winter flounder since the late 1990s, although archived samples were provided for this workshop. Winter flounder otoliths were embedded in Buehler

Epoxy, sectioned to a thickness of ~.4mm on an Isomet™ low-speed saw and read on a compound microscope with transmitted light.

VIMS

Winter flounder is a "Priority" species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for five individuals from each length bin on each tow. VIMS uses sectioned otoliths to age winter flounder. Otoliths are sectioned using a method similar to VMRC's. However, VIMS wet-sands the sections to a thinner width. Annulus counts are adjusted to reflect the timing of sample collection relative to ring formation. Age is assigned as the mode of three independent readings. Winter flounder have been aged from age-1 to a max age of 19. Young of the year fish have not been recruited by the NEAMAP survey gear. The majority of the specimens sampled were ages 2-6. There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

Appendix B: Ageing Workshops and Stock Assessment History

I. Atlantic Croaker

Age data is used to describe the life history of Atlantic croaker in stock assessment reports, as well as in the statistical catch-at-age model in the 2010 assessment. All ages used in the assessment reports have been from otoliths. Recommendations from the stock assessment subcommittee and the review panel during the 2005 and 2010 stock assessments identified the need to standardize ageing protocols for this species (ASMFC 2010). An age-structured model was developed for the 2017 benchmark stock assessment, but the assessment did not pass peer review and was not used for management.

The ASMFC hosted a joint ageing workshop for Atlantic croaker and red drum in 2008 to standardize methods for processing and reading otoliths (ASMFC 2008). Additionally, a goal of the workshop was to resolve the issue of identifying the first annulus from any smudges, or check marks, laid down near the core. Otolith sections were exchanged and read by participants from New Jersey to Georgia and the Southeast Fisheries Science Center (SEFSC). The workshop concluded that the smudge should not be counted but rather the first distinct ring is the first annulus.

II. Black Drum

Black drum was most recently assessed in 2023 (ASMFC 2023). The assessment noted that age data was very limited, preventing an age-structured model. Therefore, a version of a surplus production model was developed. A growth curve was developed and used in the model using the length and age data, so the age data does support parts of the assessment even without an age-structured model. A research recommendation was made to increase biological sampling in the commercial and recreational fisheries to >1,000 age samples a year, so identifying ageing issues will continue to be of value to this species.

The ASMFC has not held an ageing workshop for black drum, nor has one been requested by the Ageing Committee or Black Drum Technical Committee

III. Black Sea Bass

Early assessments for black sea bass were developed using simple index-based models. Beginning in 2008, a statistical catch-at-length model was developed. Depending on the lab, age data was taken from scales, sectioned otoliths, and whole otoliths. The most recent benchmark assessment was completed in 2016 (NEFSC 2017) and updated in 2021 (NEFSC 2021). The assessment used an age-structured assessment model (ASAP) with age-8 as the plus group in the model (Table 1).

A sample exchange and ageing workshop was held for black sea bass in 2013 to standardize ageing methodology and evaluate the consistency of ageing along the Atlantic coast (ASMFC 2013). Differentiating between check marks and true annuli were discussed as well as the continued need for sample exchanges in the future for consistency. Participants of the 2013 workshop recommended that whole and sectioned otoliths can be used to accurately age black sea bass, but difficult to read otoliths and otoliths from fish older than 5 should be sectioned.

IV. Bluefish

The most recent research track stock assessment used in the management of bluefish was NEFSC 2015. The assessment has undergone five data updates since then with the most recent in 2023. The research track assessment noted that both scales and otoliths have been used to age bluefish, although scale ages tend to overestimate younger fish and underestimate older fish. Scale ages were used in the stock assessment through 1997 and in 1998 the model began using otolith ages. Inaccuracies due to false annuli, regenerated scales, varying annuli counts between scales from the same fish, identifying the first annulus, and identifying annuli on scales from larger fish have all been documented (Richards 1976; NC DMF 2000; Robillard et al. 2009; NEFSC 2015). Because of these challenges, the stock assessment has used a 6+ age group in the statistical catch-at-age model to minimize the effects of ageing error for scales ages from 1985-1995.

In 2011, an ageing workshop was held for bluefish to standardize sample processing and reading procedures (ASMFC 2011). The results of this workshop established sectioned otoliths as the preferred ageing method over scales or whole otoliths and the standard protocol for processing and reading samples is that of Old Dominion University's (ODU) Ageing Lab (now Virginia Marine Resource Commission Ageing Lab) and Robillard et al. (2009). Following the workshop, Addendum I to the Bluefish Fishery Management Plan (FMP) was established that required all states with substantial bluefish landings to collect and age at least 100 bluefish samples annually. Additionally, the ASMFC maintains a digital reference collection for reference and training purposes.

V. Cobia

The most recent stock assessment for Atlantic cobia was completed in 2020 and included age data from several fishery-independent and -dependent sources, although more ages were available from the recreational fishery than the commercial (SEDAR 2020). Ages were used for describing life history traits, such as growth, and for describing the age composition of the landings. A catch-at-age model was used in the assessment with a plus group of 12 (Table 1). There were a few concerns about the cobia age data including the non-random nature of carcass donation programs for obtaining ageing hard parts and the inclusion of age samples collected from tournament fish.

The ASMFC has not held an ageing workshop for cobia, nor has one been requested by the Ageing Committee or Cobia Technical Committee.

VI. Scup

Scup underwent a research track assessment in 2015 (NEFSC 2015), which was updated in 2021. The Northeast Fishery Science Center (NEFSC) provided the age information from their trawl survey for the stock assessment to estimate growth parameters and maturity-at-age. Ages were also used in the age-structured model used to determine if the stock was overfished or if overfishing was occurring. The age-structured model used to assess scup included a plus group of 7 (Table 1).

A scup ageing workshop was held by the Northeast Fisheries Science Center (NEFSC 1979) to compare ages and accuracy between fisheries biologists. Both scales and otoliths were evaluated and both were deemed acceptable for ageing scup, although otoliths were better for ages over 5. Disagreement between ages was attributed to difficulty interpreting scale ages, weak first annulus, false “cutting over,” and the presence of checks. The ASMFC sponsored an ageing workshop for scup and summer flounder in December, 2014, through a partnership with Virginia Institute of Marine Science (VIMS). Scales and otoliths were evaluated and some imprecision and bias was detected between labs.

VII. Spot

The first stock assessment for spot was developed and peer reviewed in 2017. A simple staged-based model was developed which used the available age data along the Atlantic coast. The assessment failed peer review and was not used in management. A stock assessment is anticipated for spot following the completion of a stock assessment currently under development for Atlantic croaker.

The ASMFC has not held an ageing workshop for spot, nor has one been requested by the Ageing Committee or Spot Technical Committee.

VIII. Striped Bass

Age data for striped bass has been used in its stock assessments for the last few decades, so ageing consistency among coastwide agencies and ageing labs is critical for the management of this species. A benchmark stock assessment was completed in 2019 and updated in 2022 (ASMFC 2022c). The assessments used a forward projecting SCA model using catch-at-age data. For this assessment, states that had otolith ages were allowed to submit those instead of scale ages for use in the model.

Scales have been the most common hard part collected and aged, but it has been acknowledged that they underestimate ages in older fish when compared to otoliths (Secor et al. 1995). In 2003, the ASMFC organized an exchange of 102 known-age scale samples and held an ageing workshop (ASMFC 2003). While there was some overestimation of year 1 and 2 samples by one year, participants felt that this issue could be mitigated by routine training in the labs. Results indicated that there was good agreement between states and readers for scales ages 3-7 and that otoliths were more precise among readers and ages. Overall, the workshop concluded that scales provided accurate and reliable ages until age 10-12 (about 800 mm TL). While the cost of collecting and processing otoliths can be a limiting factor, the ASMFC began working with states to collect otoliths for striped bass 800 mm or larger for future analysis. Both the technical committee and stock assessment committee for striped bass expressed interest in collecting more paired samples and developing regional and annual scale age-otolith age conversion keys to correct for scale bias (ASMFC 2013a).

IX. Summer Flounder

The most recent stock assessment for summer flounder was a management track assessment (NEFSC 2023) which used an age-structured model. Age data was used throughout the assessment including length and sex at age data, age-dependent values of natural mortality, and discards at age and therefore accurate and precise age data is critical for this assessment and its updates. There are several age-related research recommendations for summer flounder including a need for age frequency data from recreational discards, continued collection of otoliths for catch-at-age matrices, and the need for a reference collection of scales and otoliths to facilitate quality control of summer flounder production ageing.

A significant amount of summer flounder ageing work has been done by the Northeast Fisheries Science Center. Both scales and sectioned otoliths have been used to age summer flounder. The ASMFC sponsored an ageing workshop for scup and summer flounder in December 2014 through a partnership with Virginia Institute of Marine Science (VIMS). While summer flounder does not have a published age validation study, increased interest in the species necessitated that labs use the same protocol and ageing method. Samples were paired scale and otoliths from the NEFSC and VIMS. Agreement between readers for summer flounder was low and attributed to difficulties finding the first annulus and distinguishing check marks from true annuli.

X. Tautog

A statistical catch-at-age model was developed for the 2015 stock assessment (ASMFC 2015; Table 1) which has been updated several times, most recently in 2021. Most states use opercular bones for ageing, but in 2001, Virginia began using otoliths to standardize readings of the operculum. Recognizing the importance that age data plays in the assessment of tautog and addressing concerns that were raised over the change in protocols in Virginia, it was recommended that a workshop be organized and conducted among participating states.

In 2012, the ASMFC organized a hard part exchange and ageing workshop for tautog to evaluate the age precision among states and establish best practices for consist age readings (ASMFC 2012). The workshop aged operculum and otoliths, when available, and determined that precision was similar for both hard parts. Participants of the workshop recommended that operculum remain the standard for biological sampling but also encouraged otolith collection for paired sub-samples. Additionally, it concluded that the Virginia data is not significantly different from other states and it should be used in the assessments going forward. In 2013, a follow-up to the workshop was done and states remained consistent in their readings.

With the publication of Elzey and Trull (2016), there was increased interest in the use of pelvic spines for ageing tautog. From 2019-2021, tautog agers took part in an ageing workshop and sample exchange of opercula, spines, and otoliths (ASMFC 2021b). Following that project, agers advised the Tautog Technical Committee (TC) to use spine ages from ageing labs that have demonstrated that their spine ages are consistent with either opercula or otoliths.

XI. Winter Flounder

Winter flounder was assessed using an age-structured model (NEFSC 2011) and ages were used throughout the assessment for size at age, fishing mortality at age, and calculations of spawning stock biomass and life history parameters. As part of the research recommendations, the assessment suggested that port samplers collect otoliths from large flounder since scales cause under-ageing in larger fish and that the amount of age samples from MRFSS/MRIP should be maintained or increased.

In 1998, the ASMFC organized a winter flounder otolith ageing comparison study between four readers that exhibited systematic differences between them and inconsistent age readings. Identifying a need to develop a protocol for processing and age reading for winter flounder, the ASMFC sponsored a workshop in 2001 (ASFMC 2012b). Participants found that whole otoliths could be used to age samples and that this method was superior to ageing scales for older fish. From this workshop, it was recommended that both scales and otoliths should be collected when possible and age samples from both retained and discarded fish in the recreational fishery should be collected.

Appendix C: Agenda

Atlantic States Marine Fisheries Commission's

QA/QC Fish Ageing Workshop

Tuesday, March 19th, 2024 – 9:00 a.m. to 5:00 p.m.

Wednesday, March 20th, 2024 – 9:00 a.m. to ~12:00 p.m.

FWC Fish and Wildlife Research Institute

100 8th Ave SE

St. Petersburg, Florida

Agenda

Tuesday, March 19th

- Introductions
- Conduct age readings for black sea bass, striped bass, tautog, croaker, bluefish, summer flounder, winter flounder, scup, cobia, spot (new), and black drum (new)

Wednesday, March 20th

- Review comparison of ages by group and participant
- Discussion of issues and differences encountered during age reading exercise
- Make recommendations
- Other Business
- Adjourn

Appendix D: Results of Striped Bass Scale Mini-Exchange

One of the recommendations of the workshop was to circulate the 10 striped bass scales from the QA/QC set to the states/labs that routinely age the species (MA DMF, RI DEP, NJ DFW, DE DFW, VIMS, VMRC). This recommendation was so that samples could be aged on the lab's equipment to determine if disagreement among the scale ages is due to the microfiche at the workshop or an ageing issue. The 10 samples were circulated in a "mini-exchange" among the states following the workshop. The agers who indicated that they wanted to re-age the striped bass scales (MA DMF, RI DEP, NJ DFW, DE DFW, VIMS, VMRC) were slightly different from those who indicated that they aged striped bass scales at the workshop (MA DMF, RI DEP, NJ DFW, VIMS, VMRC, NC DMF, SC DNR).

At the workshop, there were no significant p-values from Bowker's test of symmetry for the striped bass scales indicating no systematic bias (Table 25). The mini-exchange also did not result in any significant p-values (Table 36). At the workshop, the CVs for the scales ranged from 0-19%, indicating some imprecision (Table 25), and from the mini-exchange, the CVs ranged from 3-26% (Table 36).

Exact agreement between readers at the workshop ranged from 13-100% for scales (Table 26). From the mini-exchange, exact agreement ranged from 13-73% (Table 37). Agreement increased to 60-100% for agreement within 1 year for the scale samples at the workshop (Table 26) and to 47-87% from the mini-exchange (Table 37).

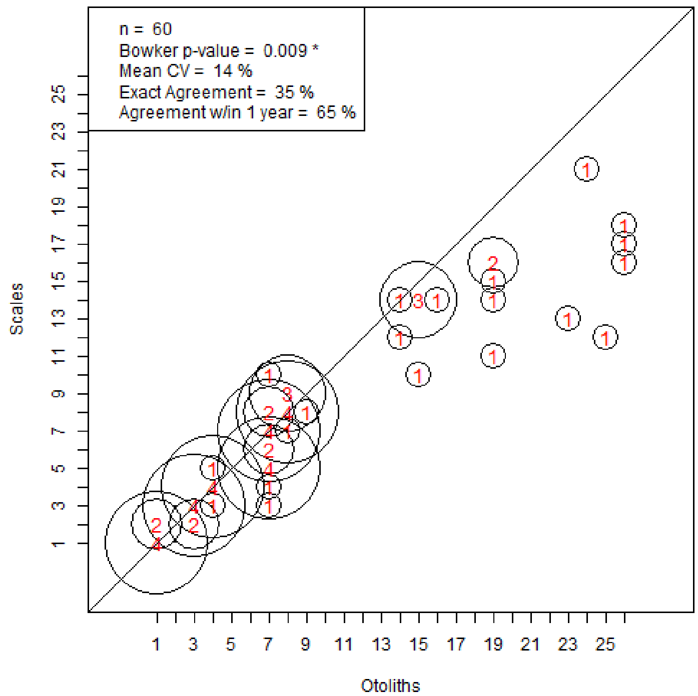
There are 10 paired otolith and scale samples in the exchange set and the re-aged scale ages were compared to the otoliths aged at the workshop (Figure 18). Overall, there was a slight improvement in agreement between the ages when compared to the results from the workshop (Figure 11). Exact agreement increased from 18% to 35% and agreement within one year increased from 50% to 65%. The mean CV decreased from 20% to 14%. Whether aged at the workshop or on "home" lab equipment, scales provided younger ages than otoliths at older ages. Agreement between scales and otoliths was high until about age 12, after which the ages diverged.

Table 37. **Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for striped bass scales in the mini-exchange. P-values appear above the shaded diagonal line and CVs are below. There are no significant p-values (α < 0.05) but there were several CVs > 5%.**

	MA	RI	NJ	DE	VIMS	VMRC
MA		0.36	0.39	0.36	0.37	0.39
RI	7		0.37	0.54	0.35	0.29
NJ	9	8		0.37	0.45	1.00
DE	15	13	17		0.42	0.45
VIMS	21	22	26	11		0.45
VMRC	8	6	3	16	25	

Table 38. **Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for striped bass scales in the mini-exchange.**

	MA	RI	NJ	DE	VIMS	VMRC
MA		87	87	80	60	80
RI	60		80	80	47	80
NJ	47	53		60	47	87
DE	20	33	27		67	67
VIMS	13	13	13	33		47
VMRC	60	73	73	33	20	



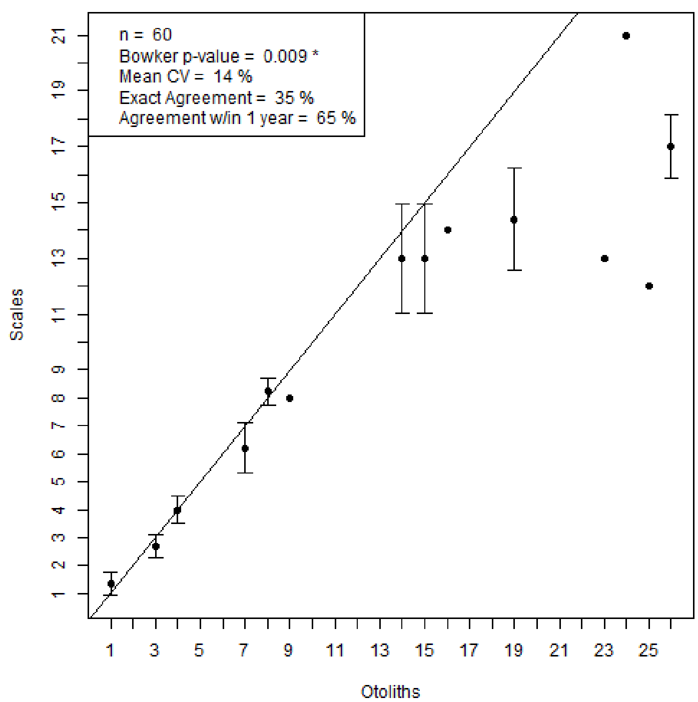
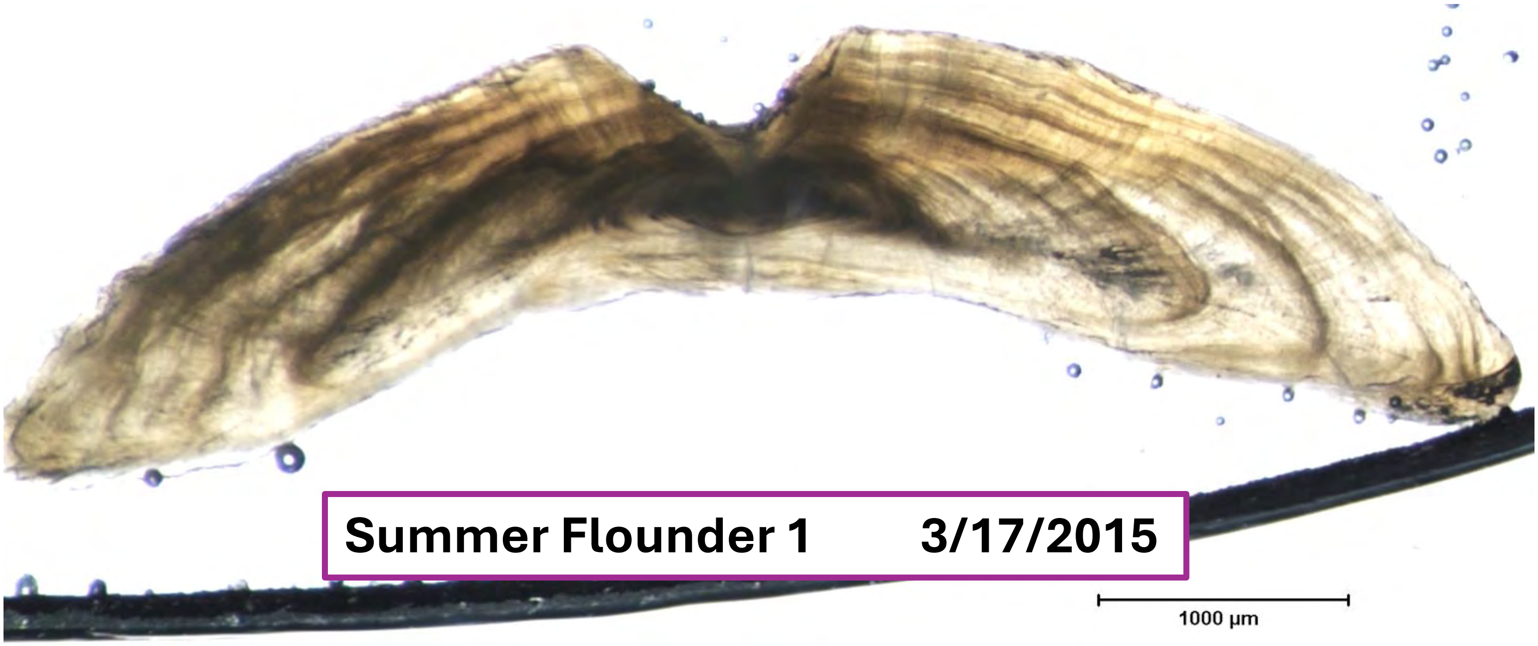


Figure 18. Age frequency (top) and age bias (bottom) plots for striped bass paired scale and otolith samples. Circles are proportional to number of observations.

Appendix E: Sample Photos



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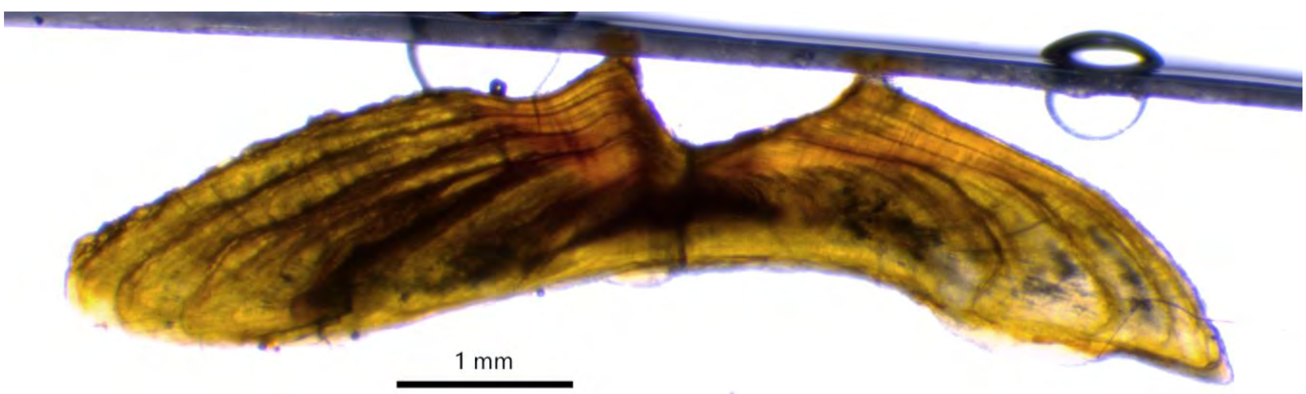

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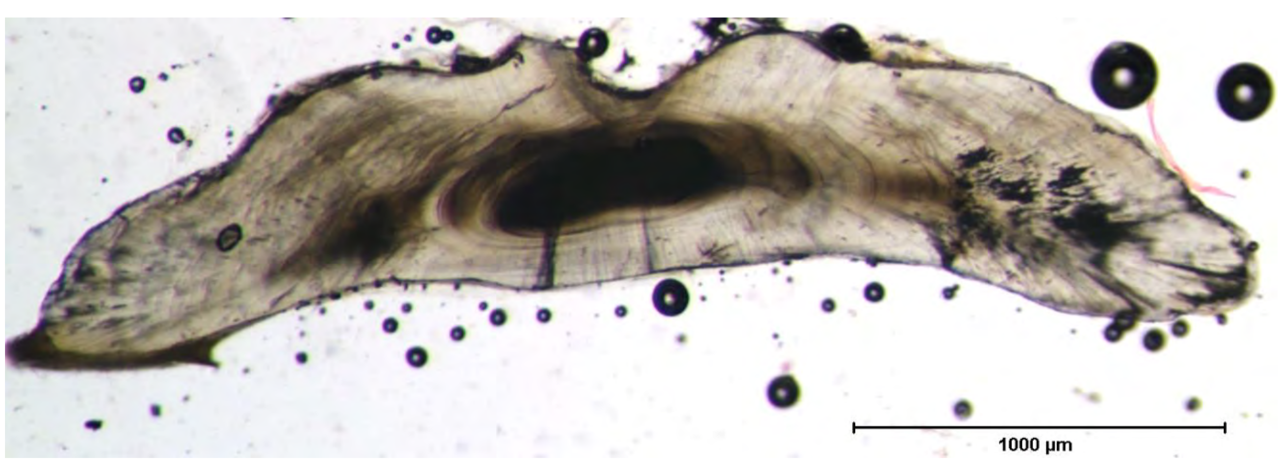

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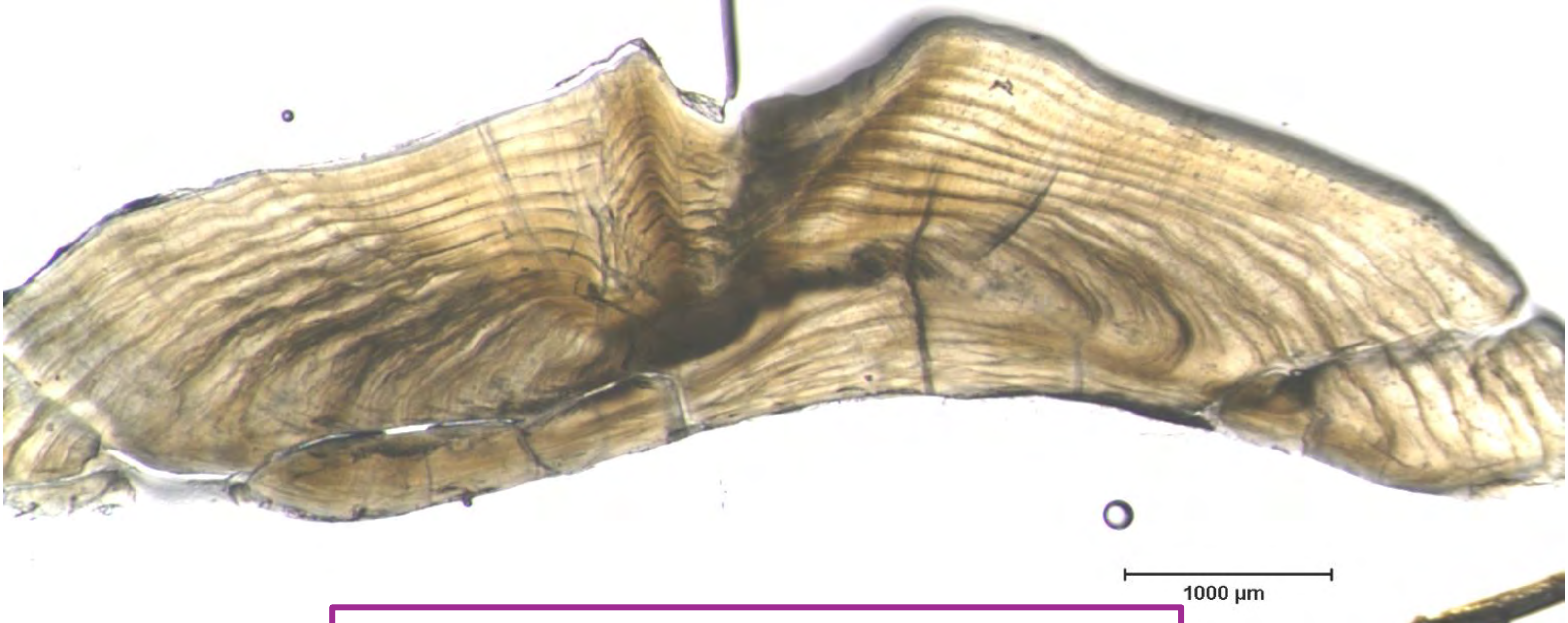
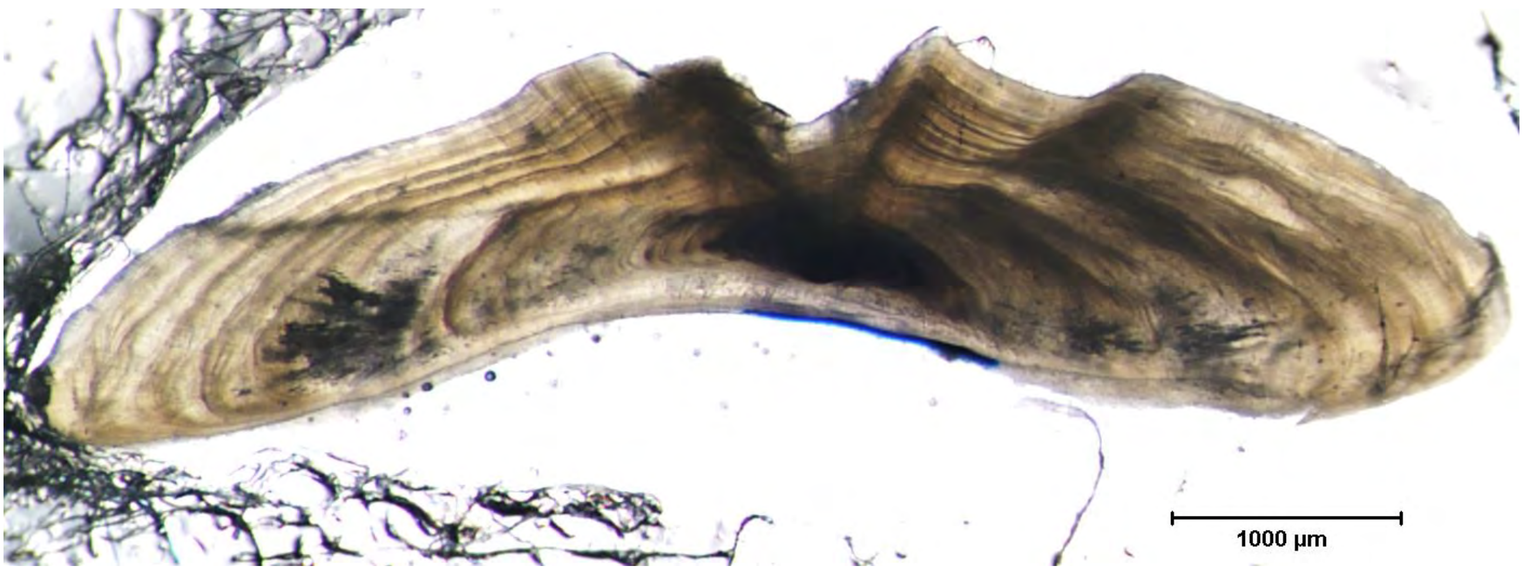


Summer Flounder 4 3/21/2015



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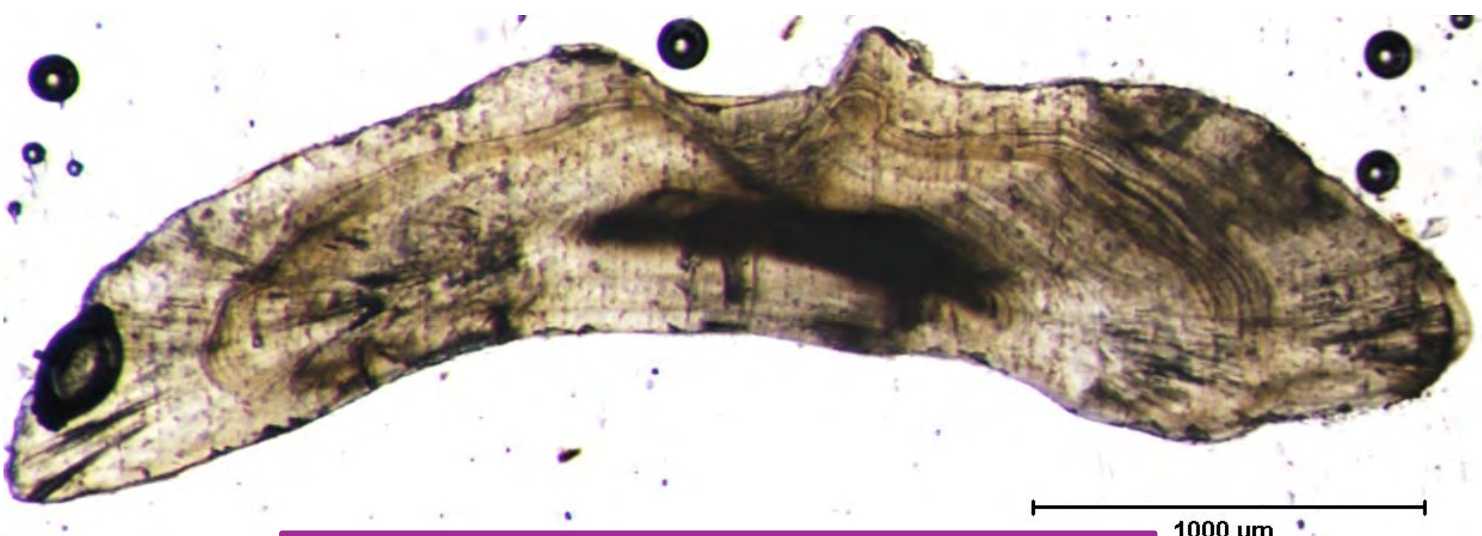

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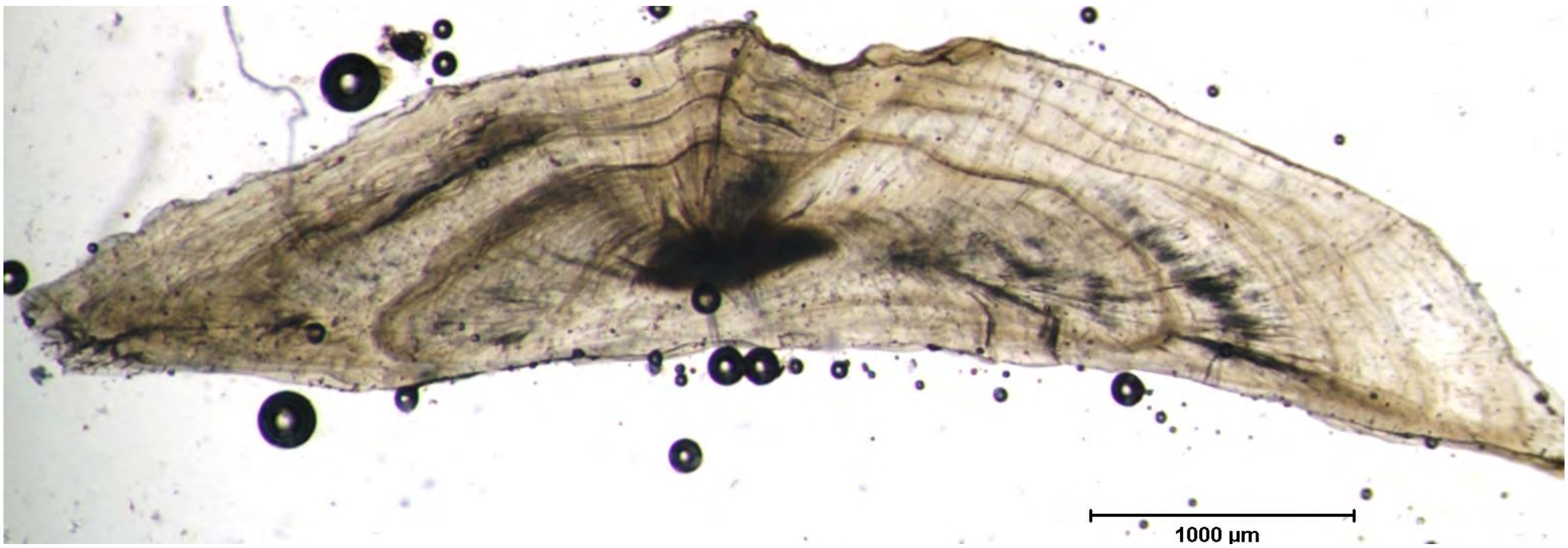
Summer Flounder 7 3/17/2015



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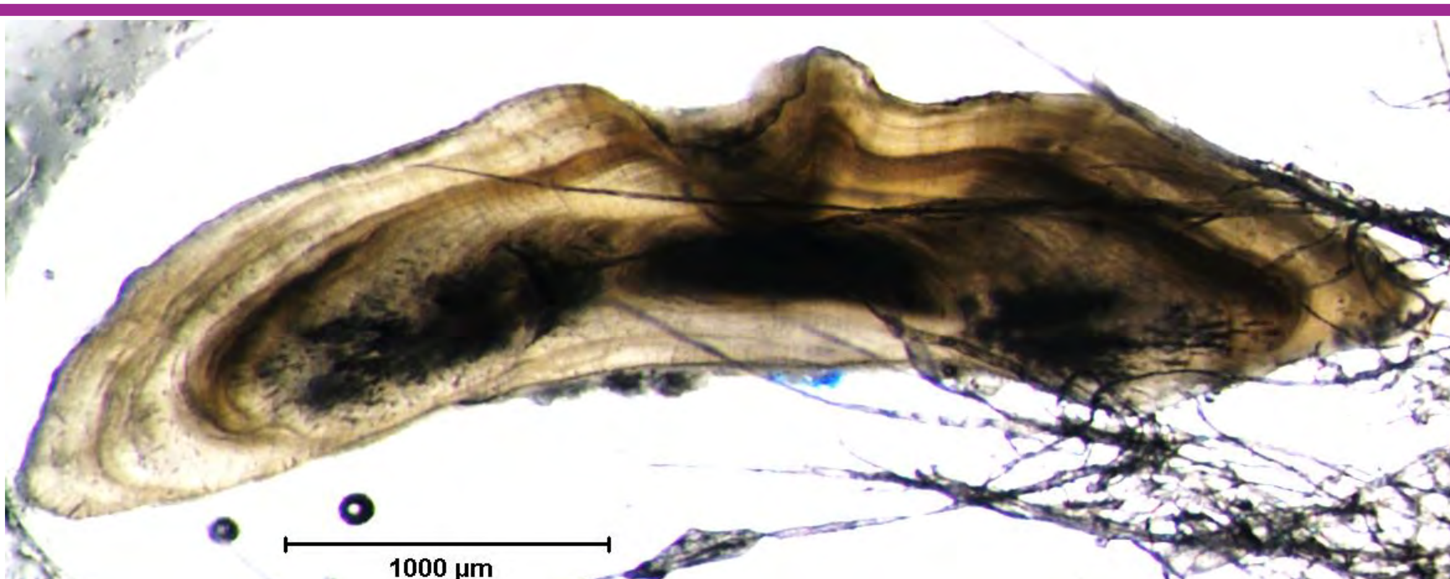

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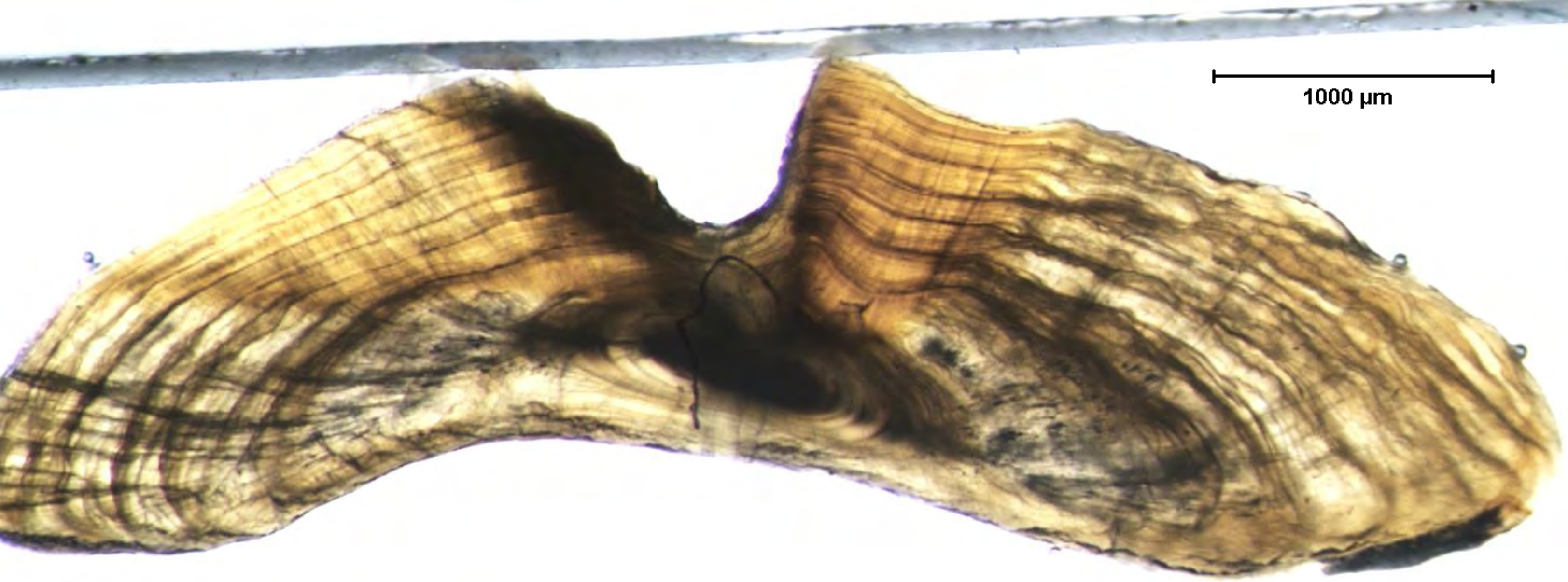

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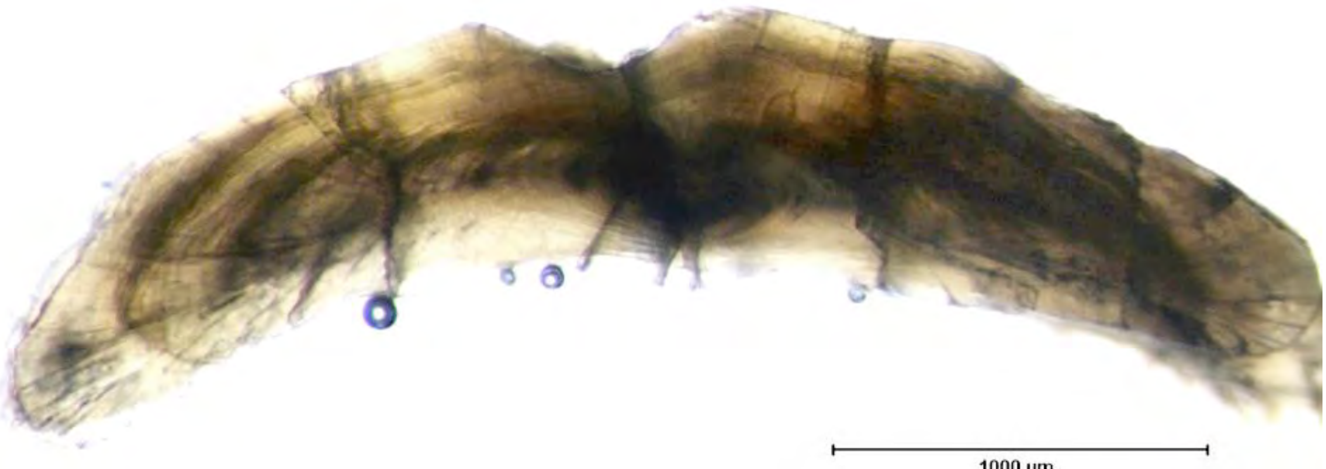
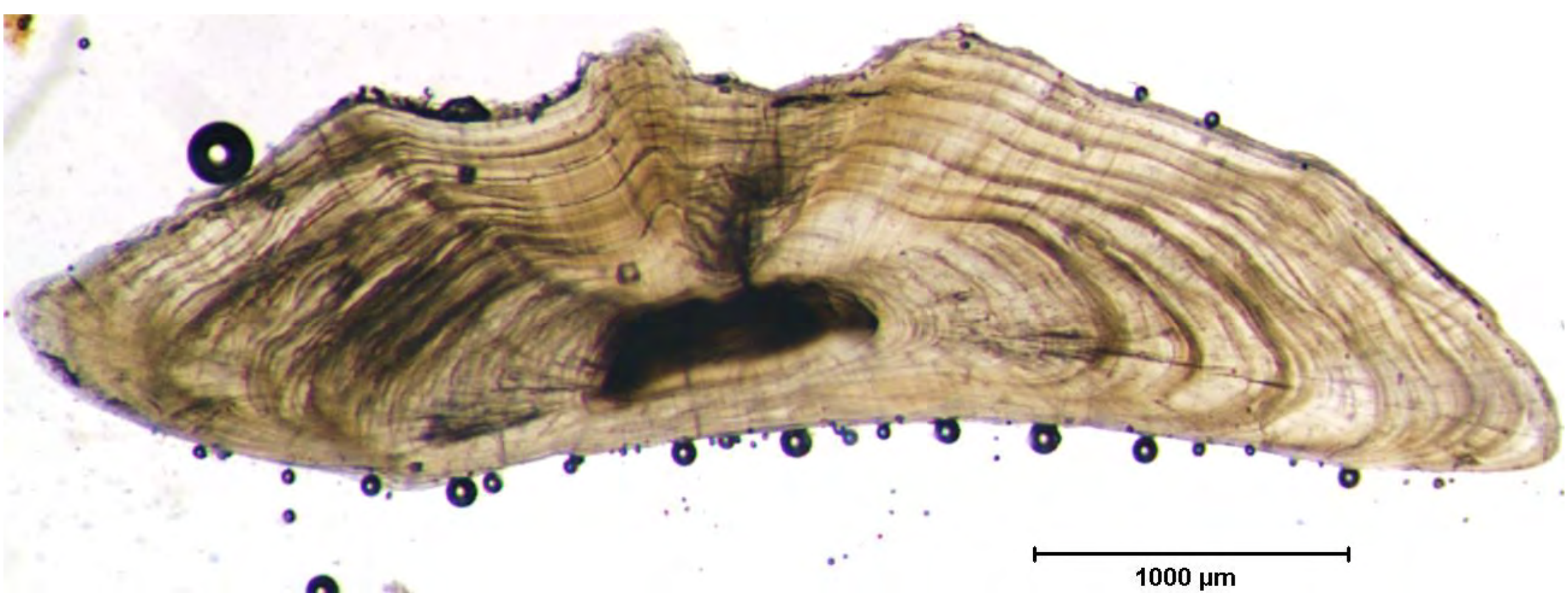


Summer Flounder 11   11/20/2015



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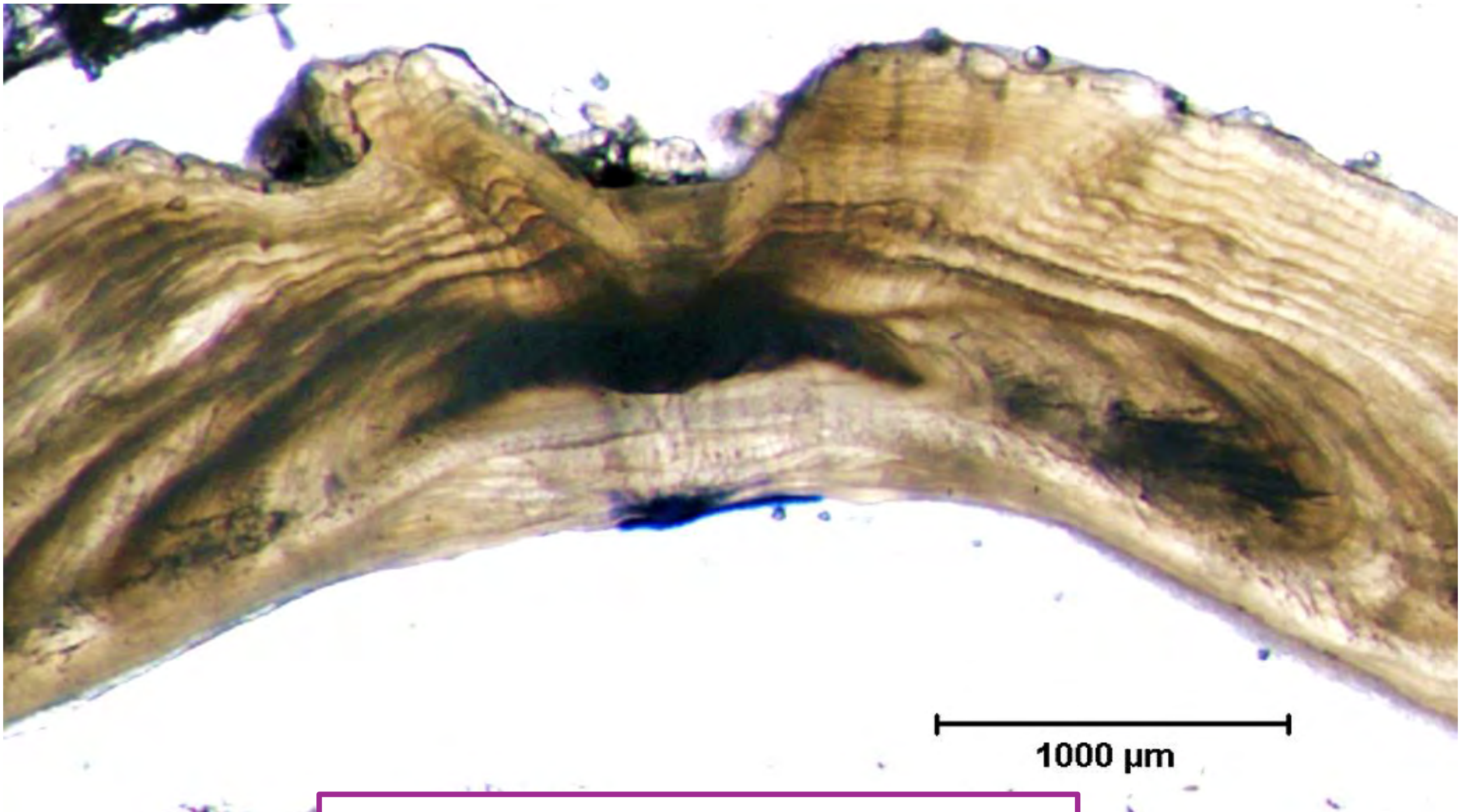

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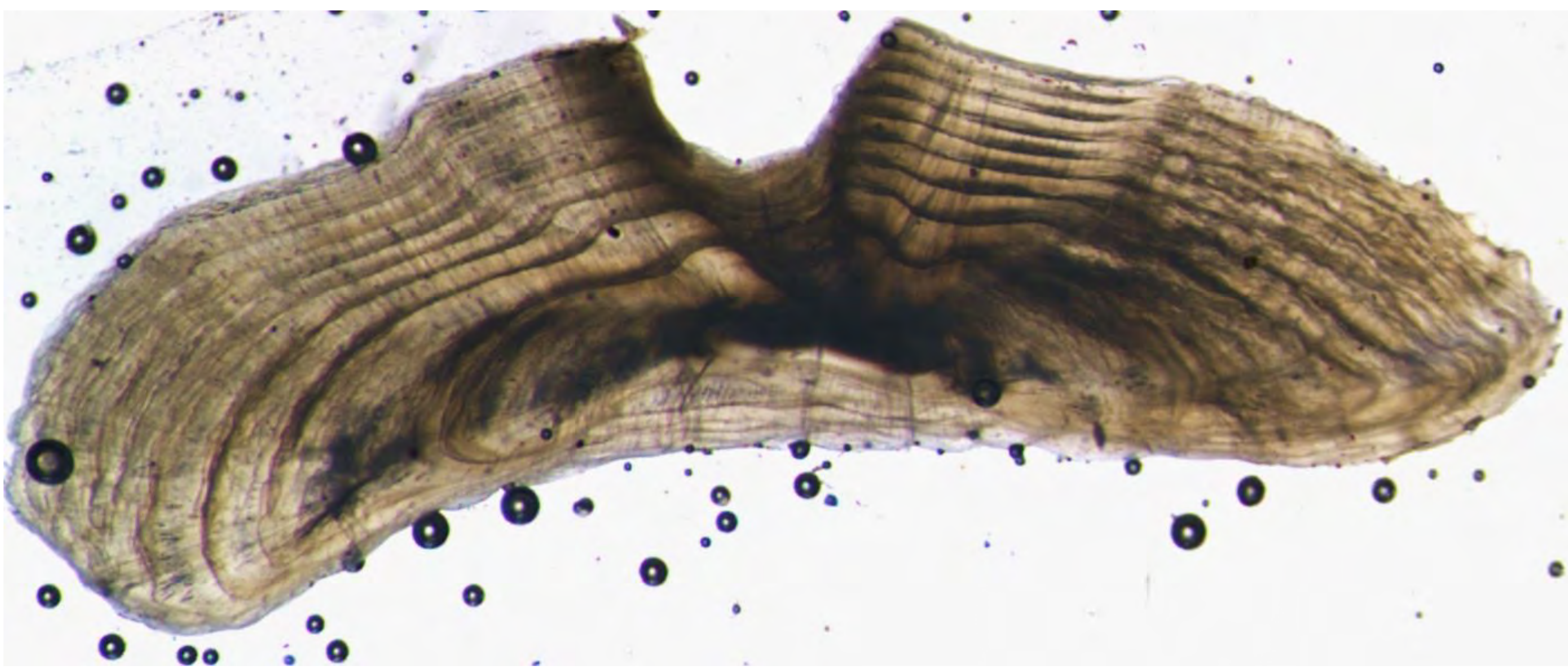

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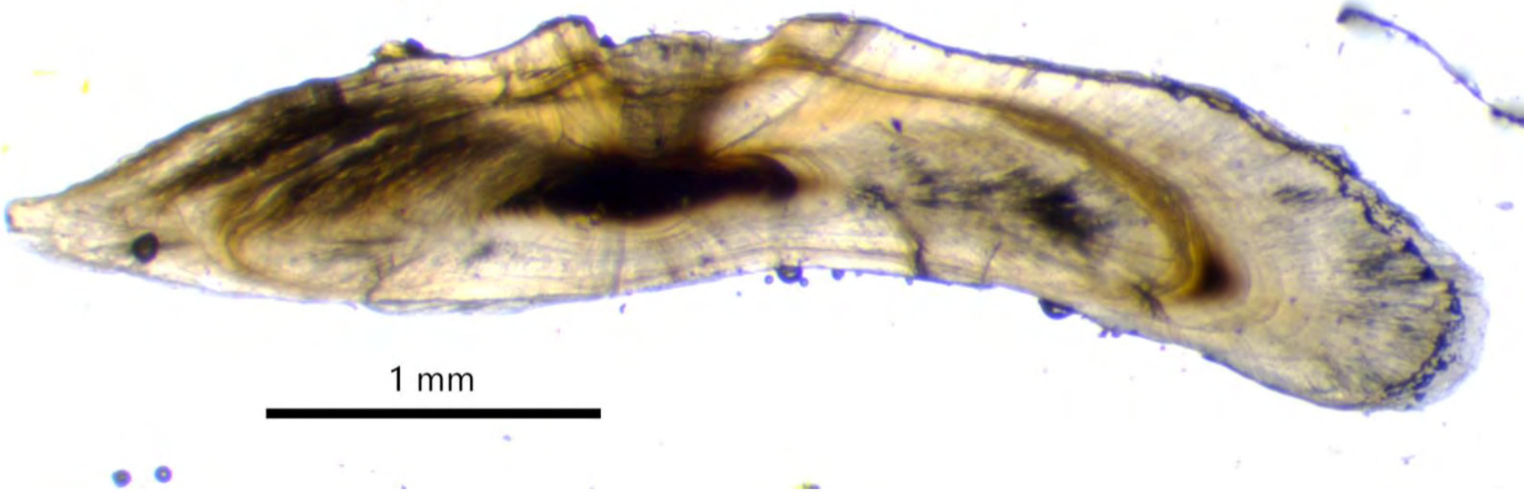

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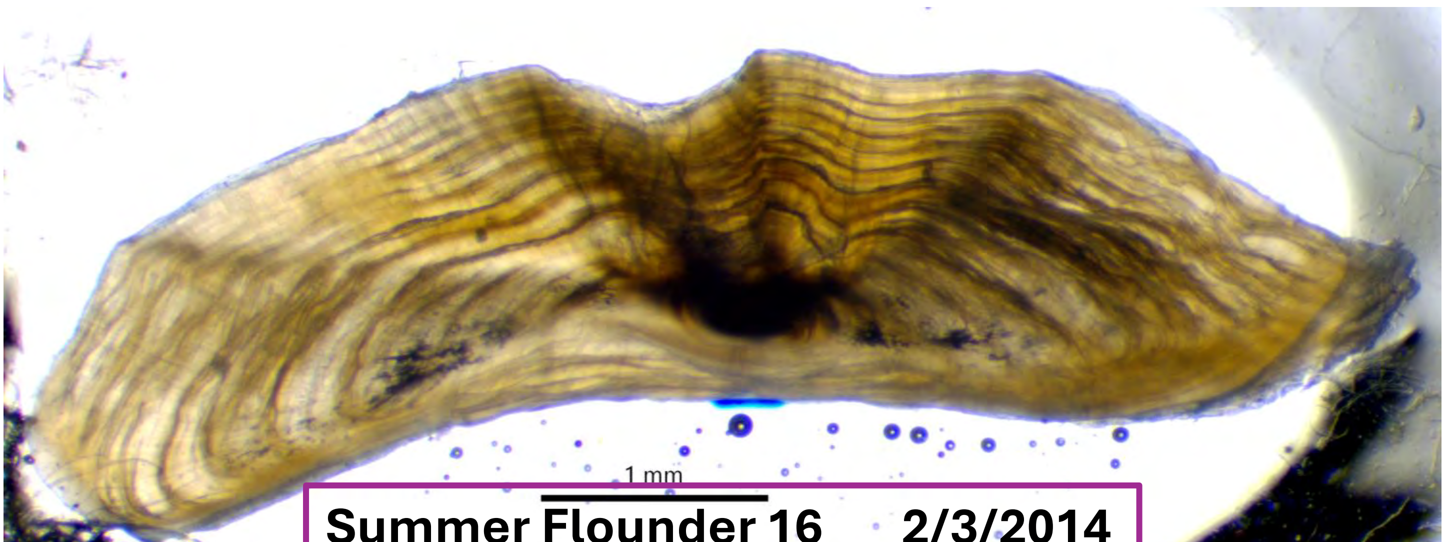

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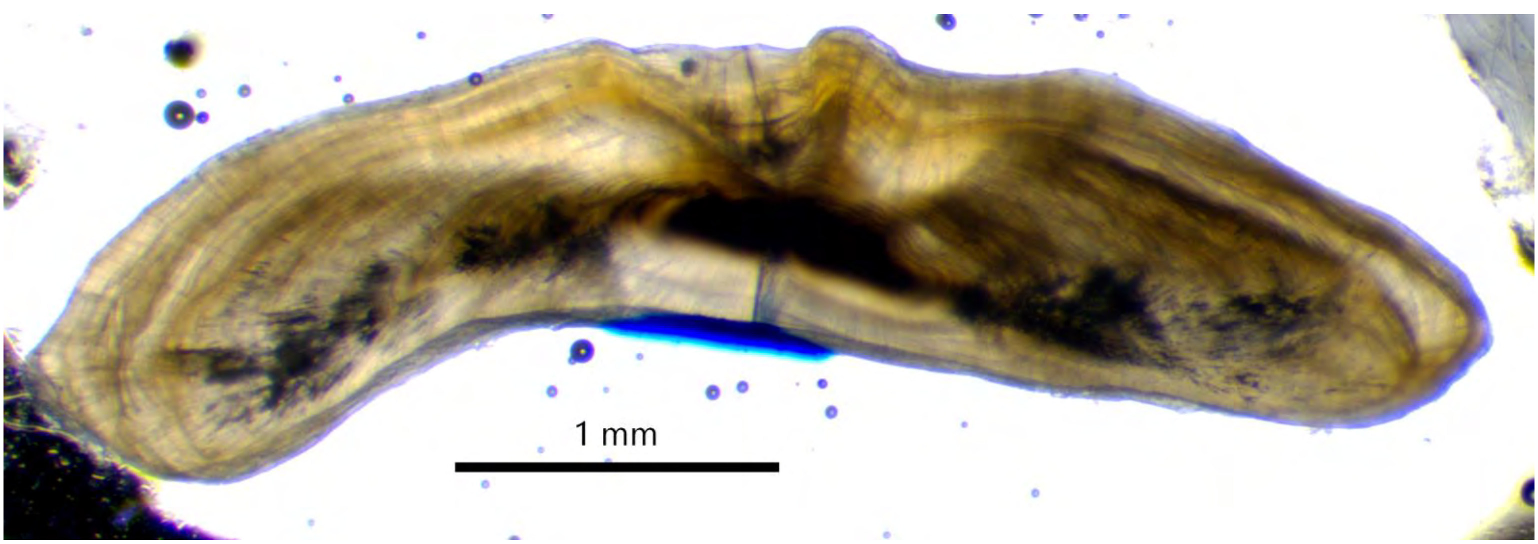

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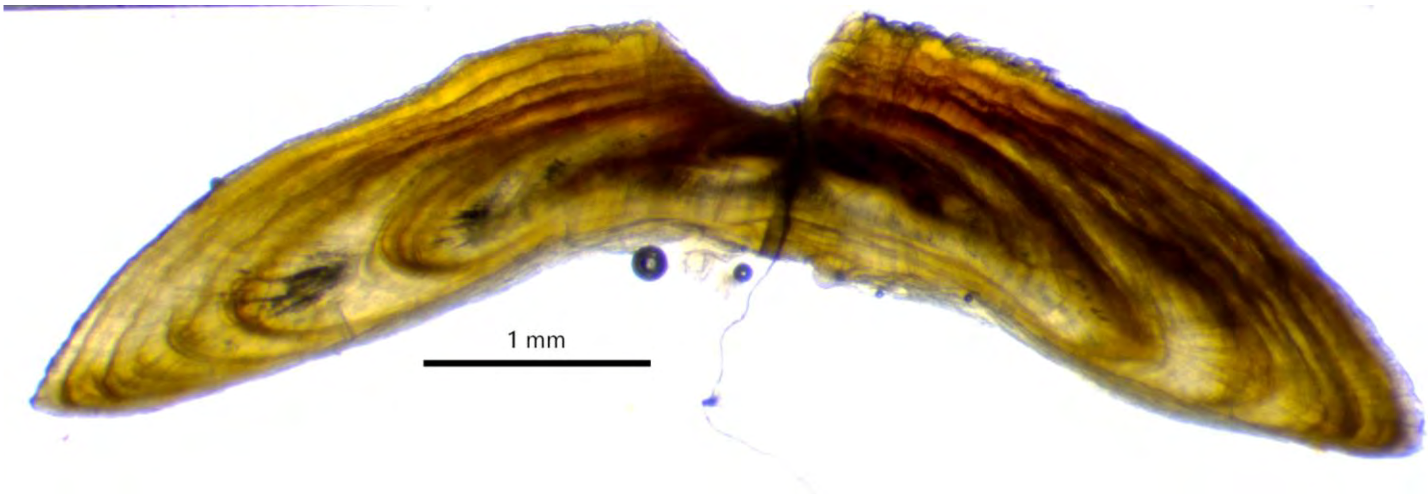

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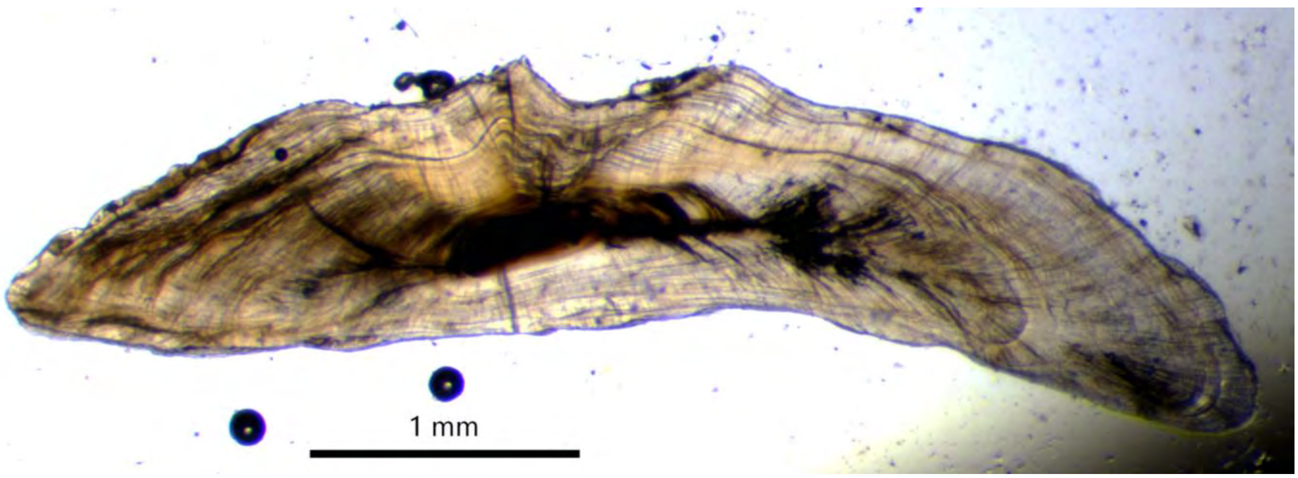

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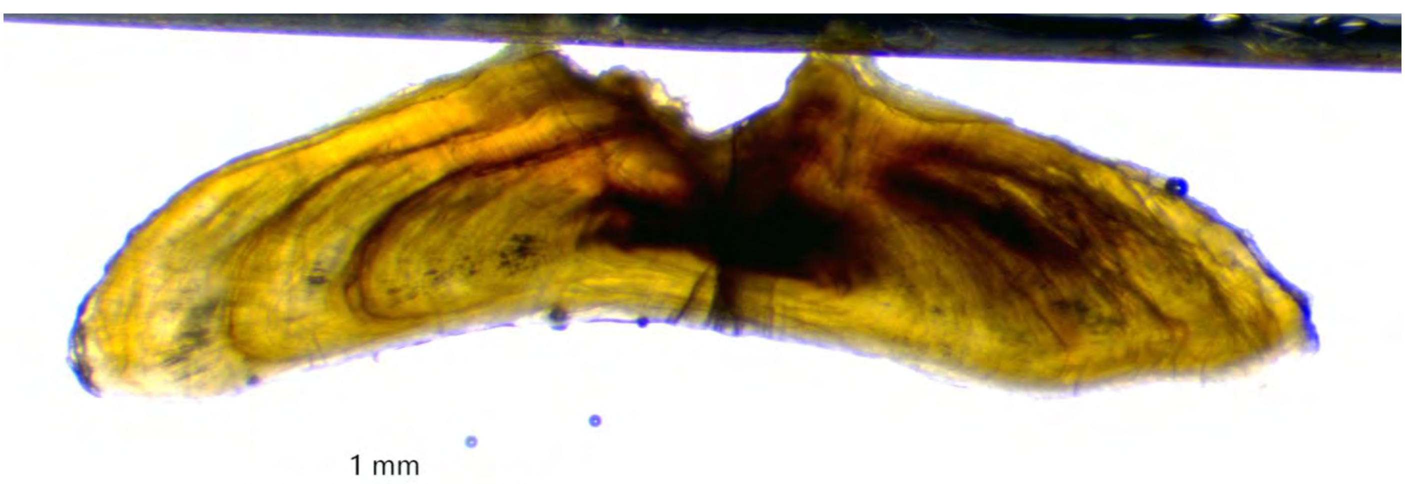

Summer Flounder 20 7/11/2022

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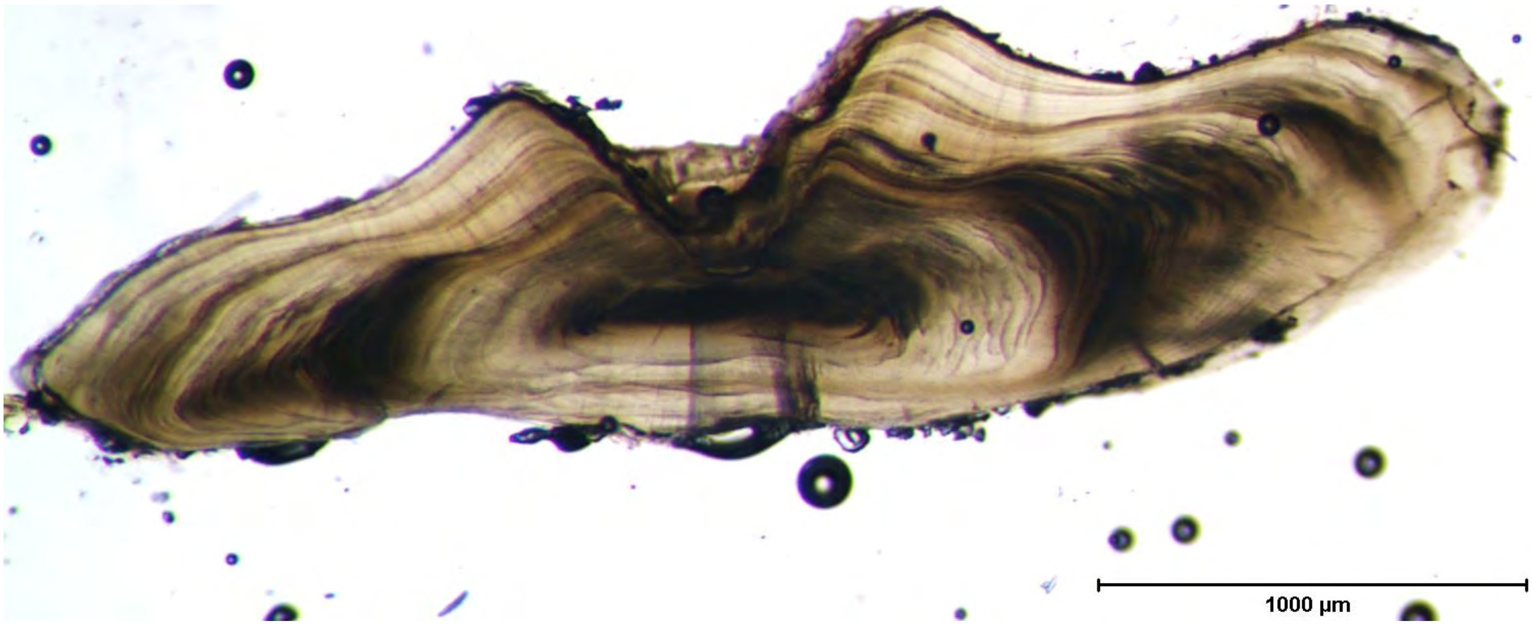

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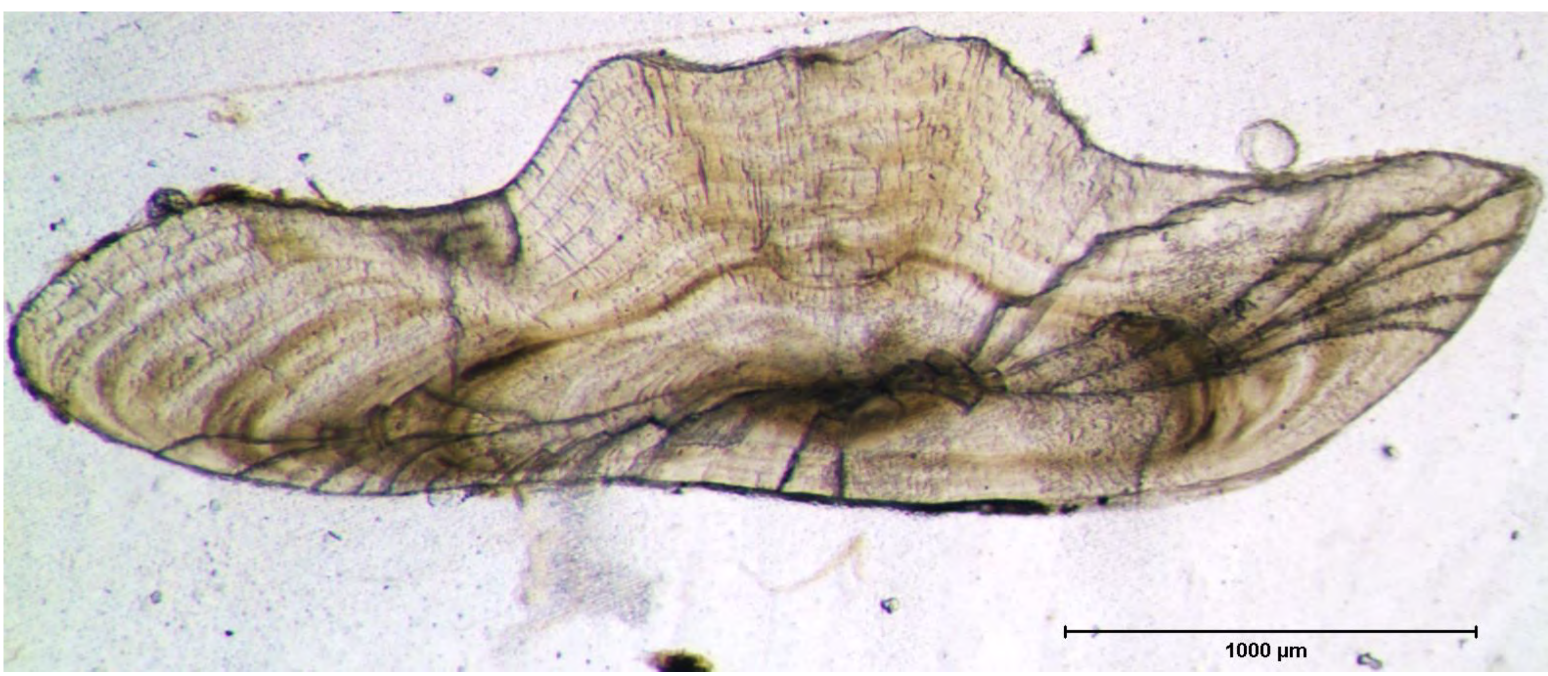

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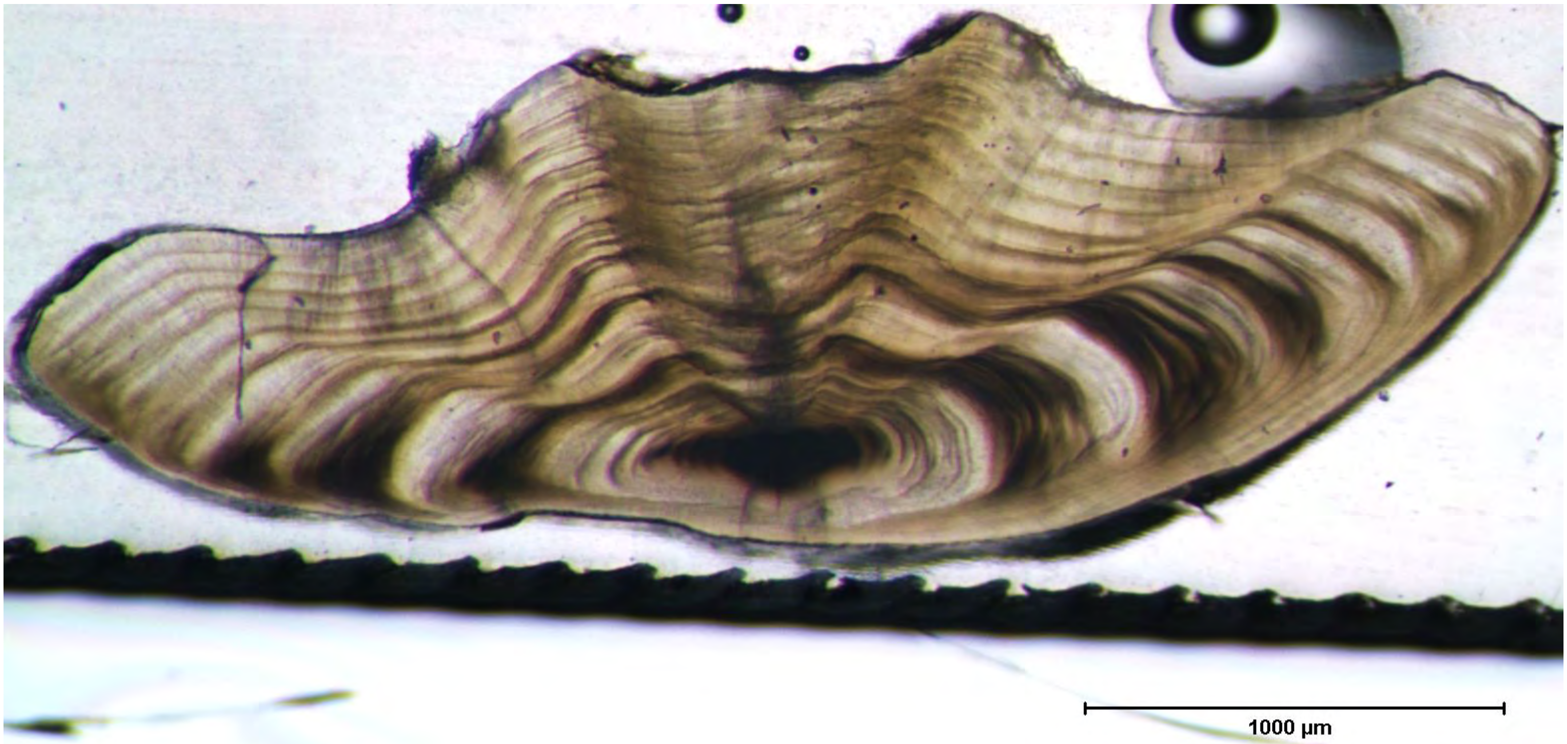

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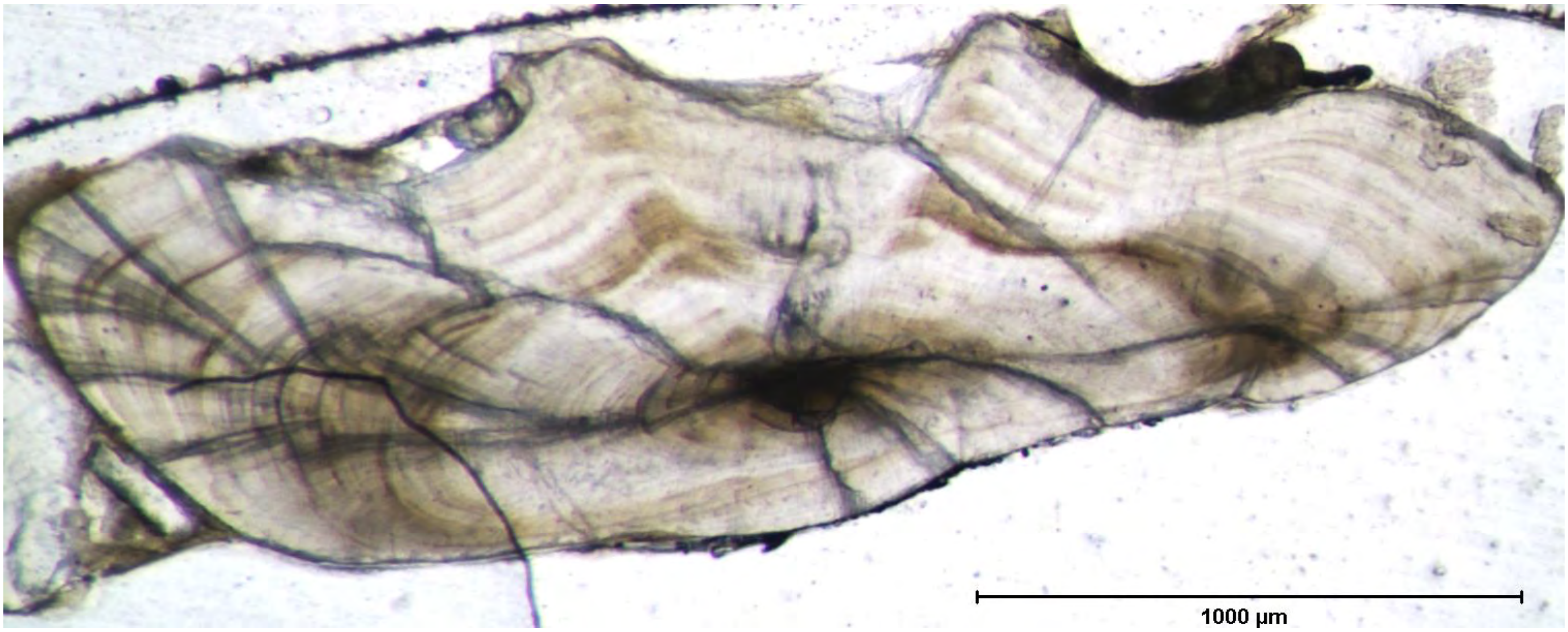
Winter Flounder 4 10/8/2015



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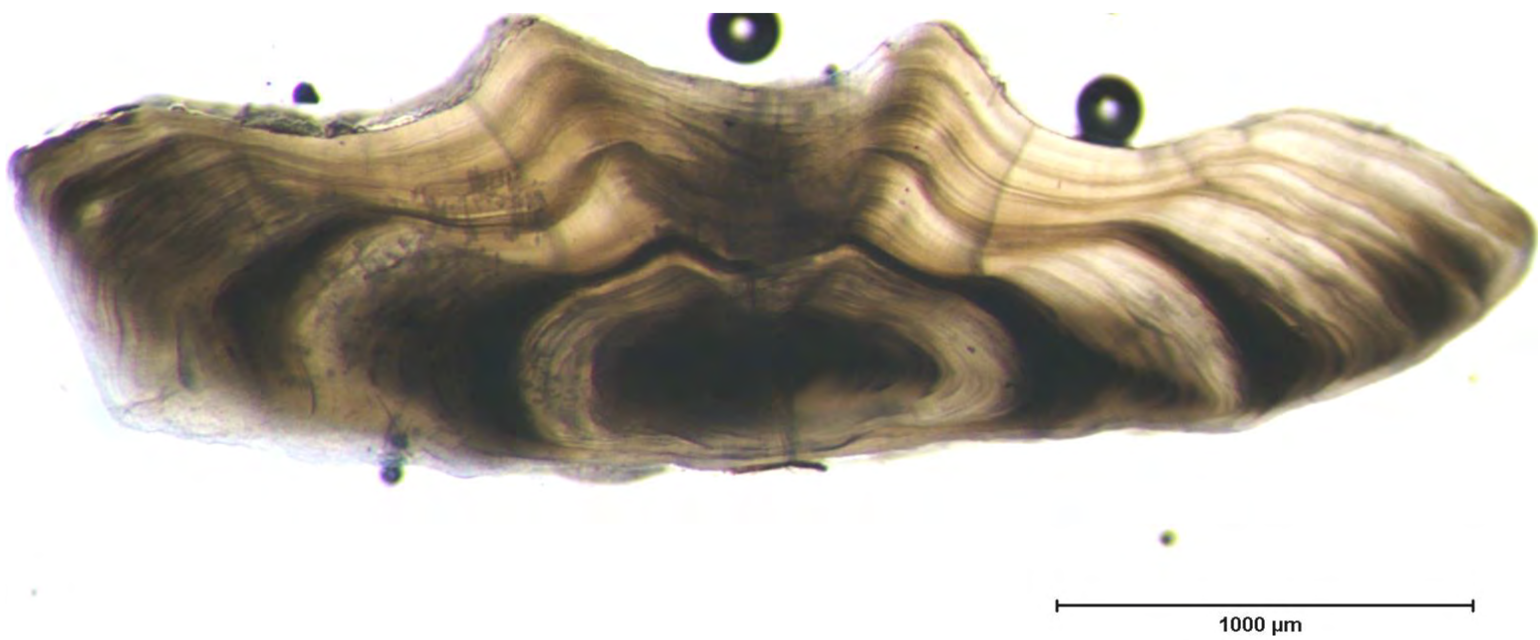

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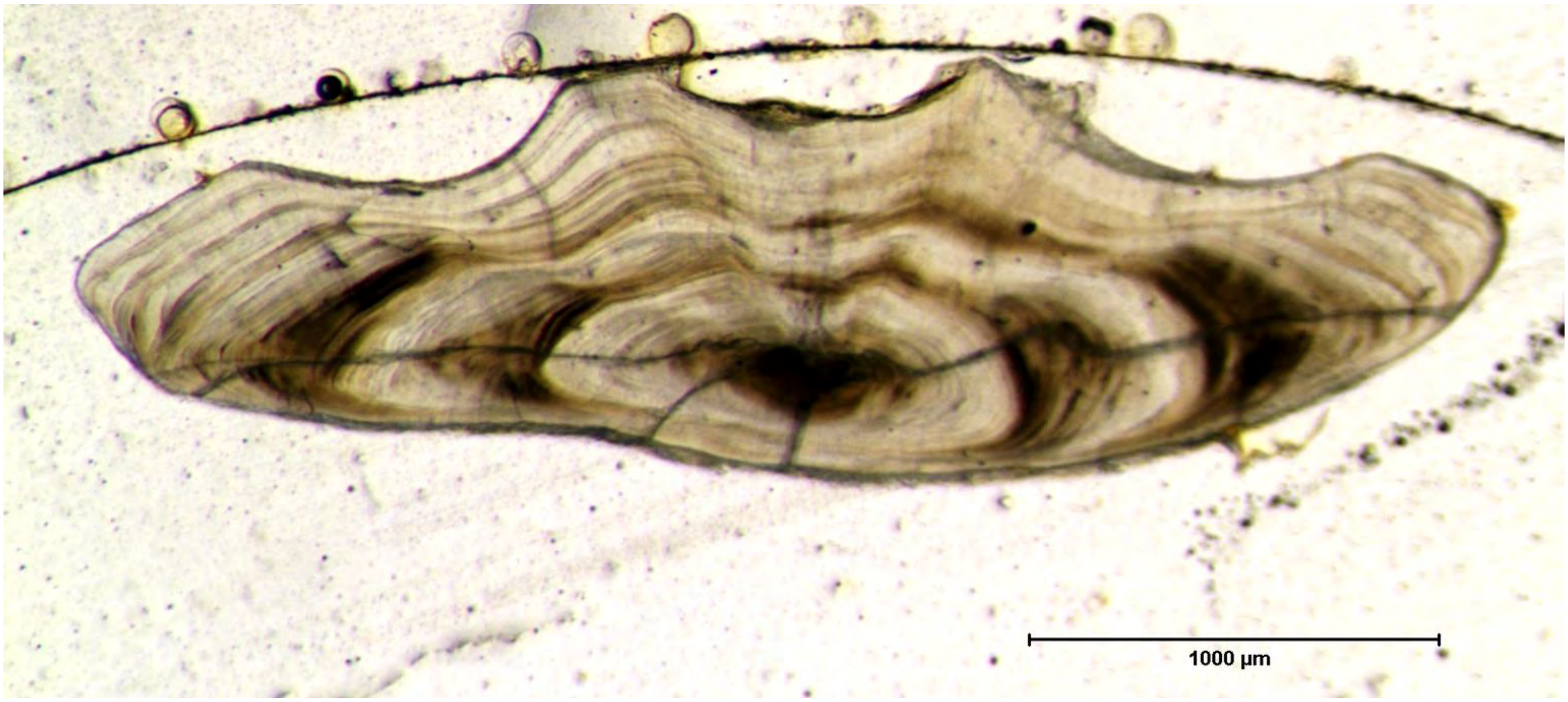

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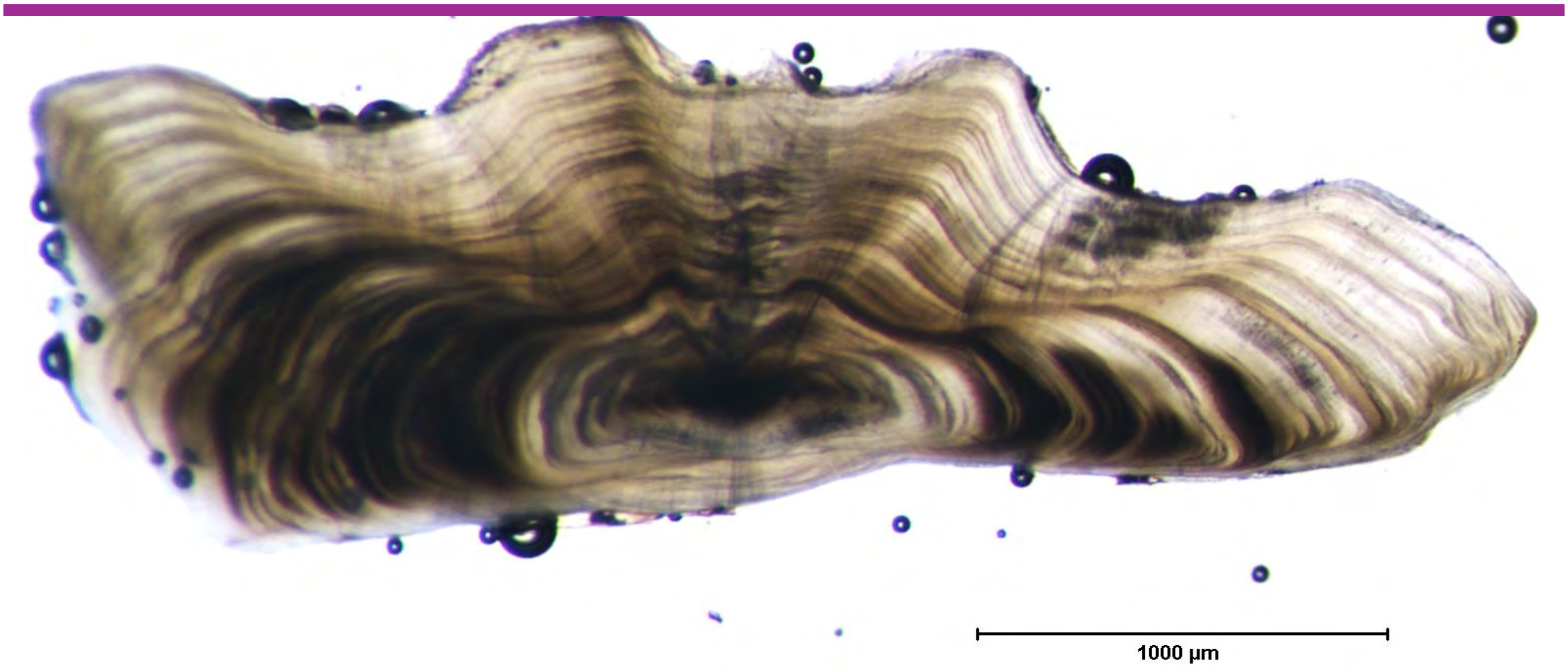

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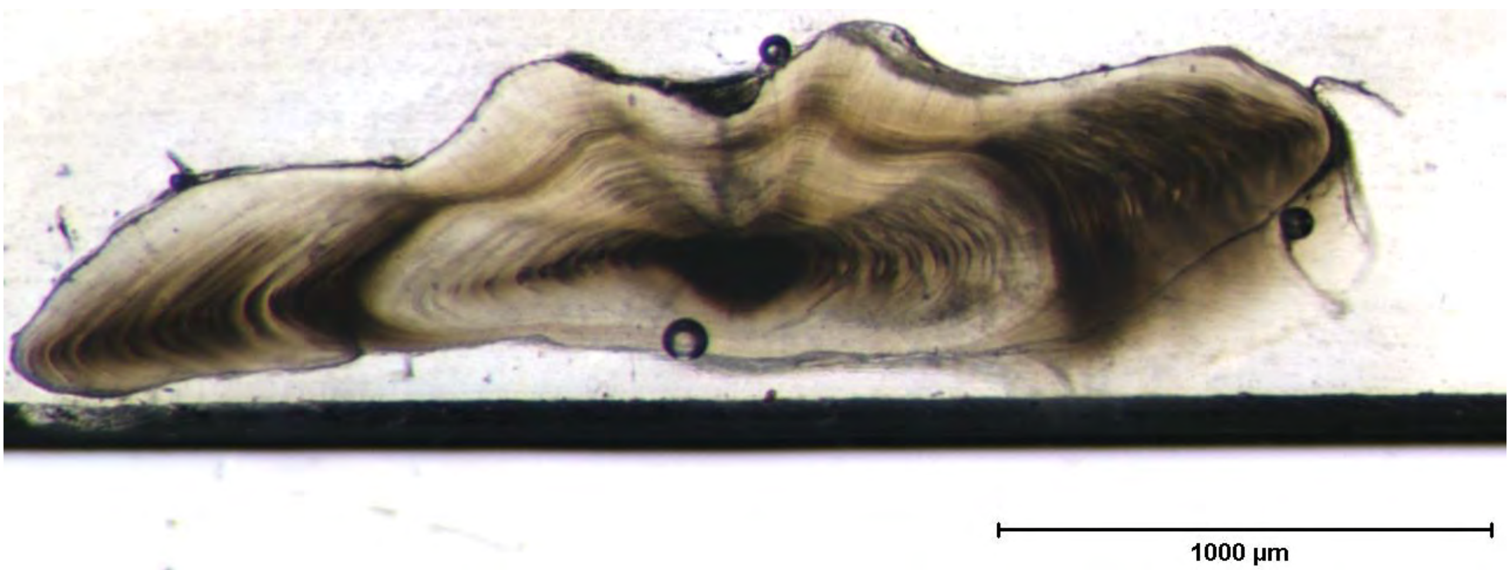
Winter Flounder 9 5/21/2015



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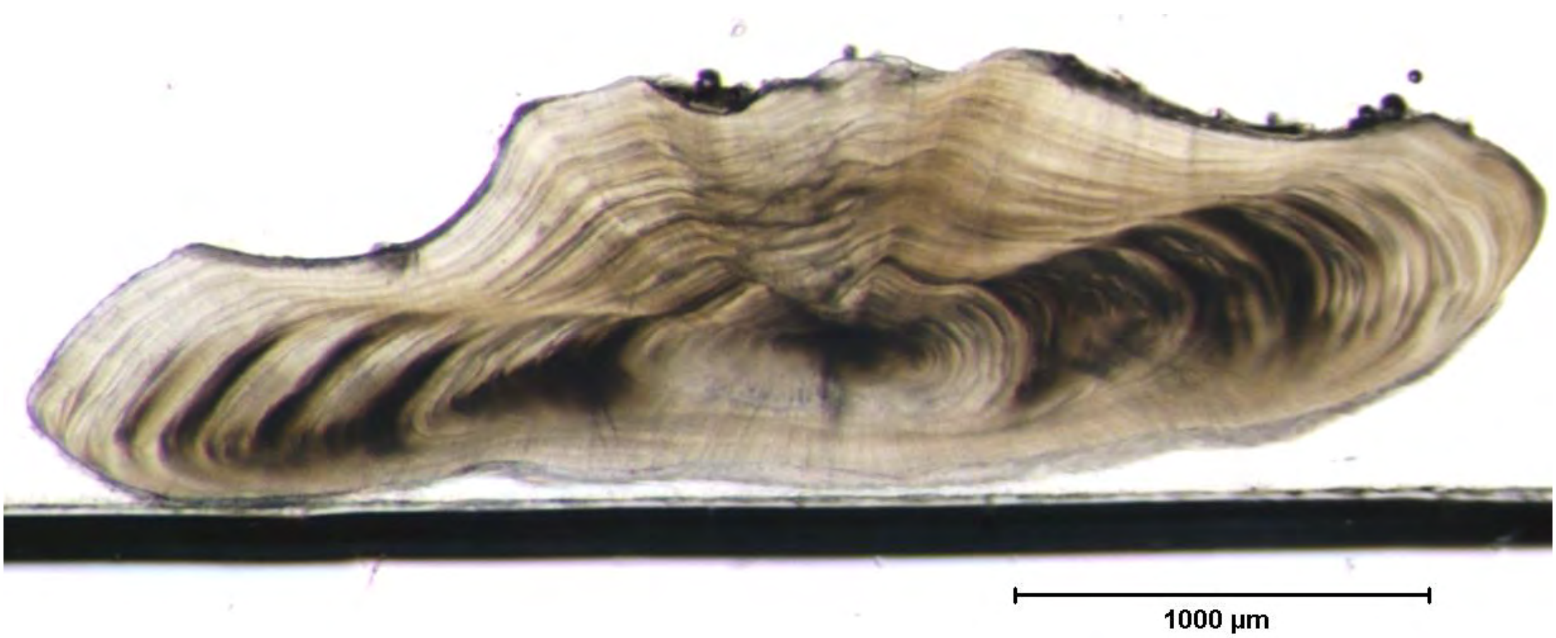

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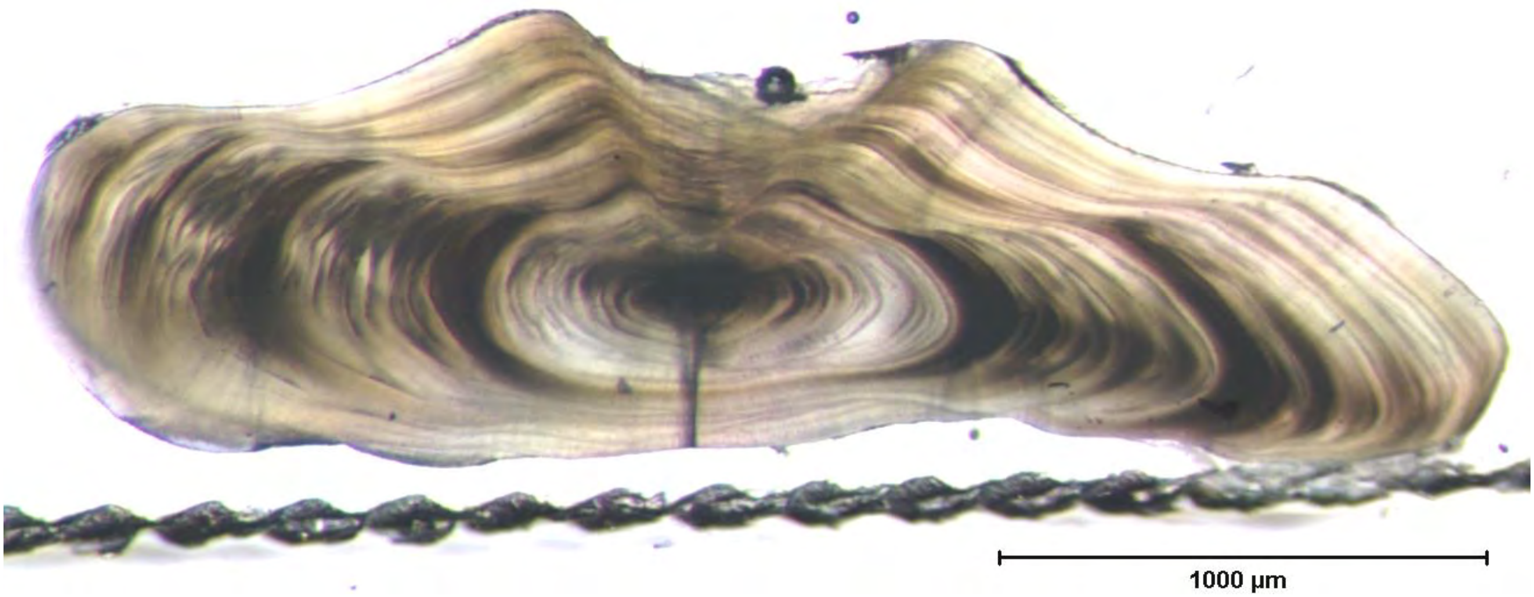

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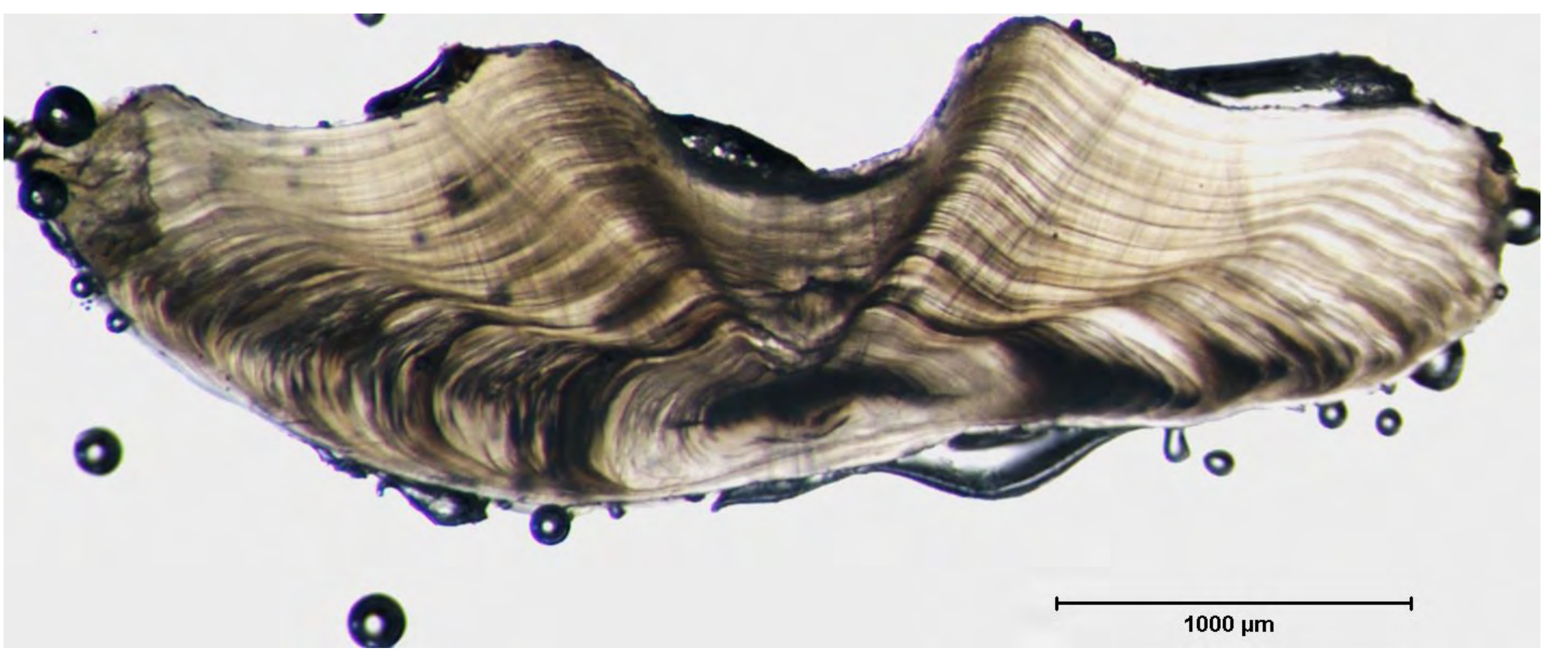

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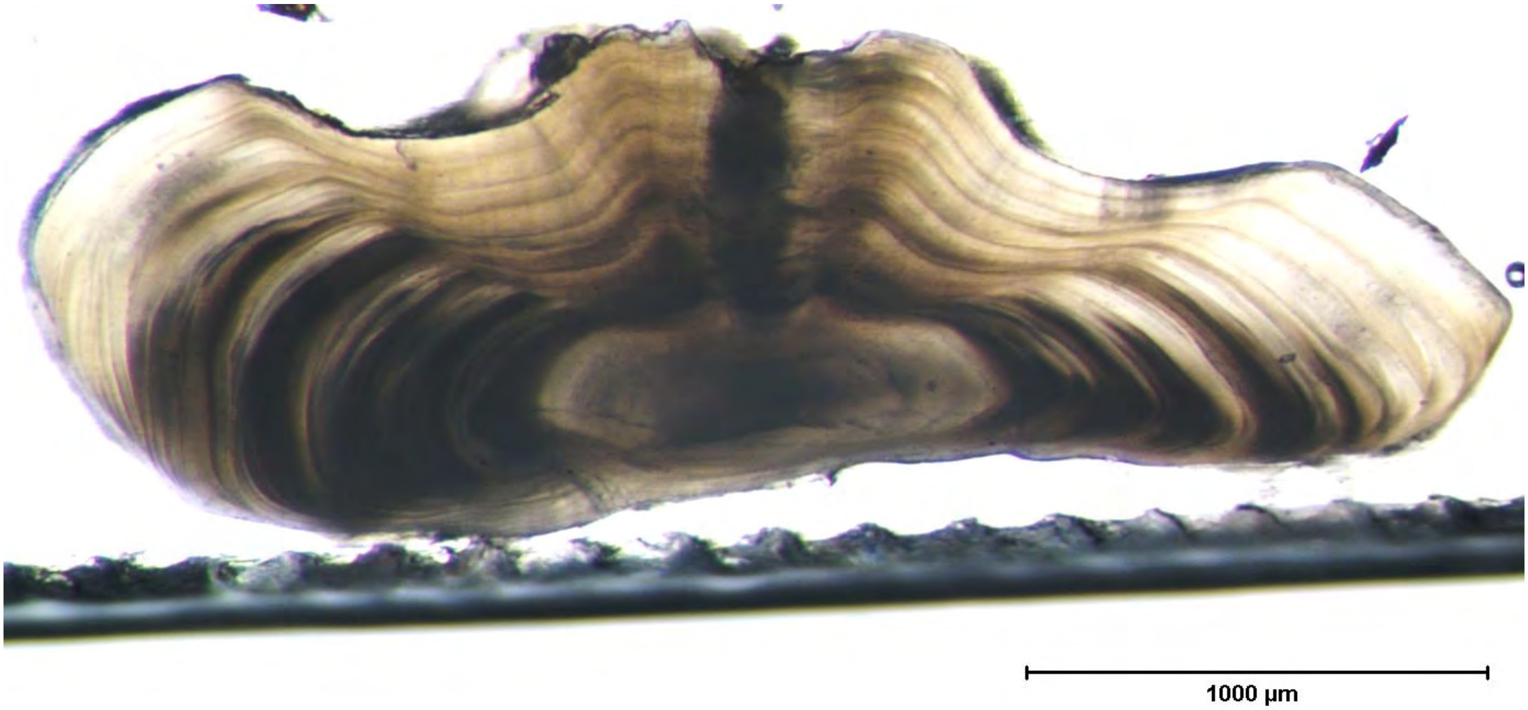

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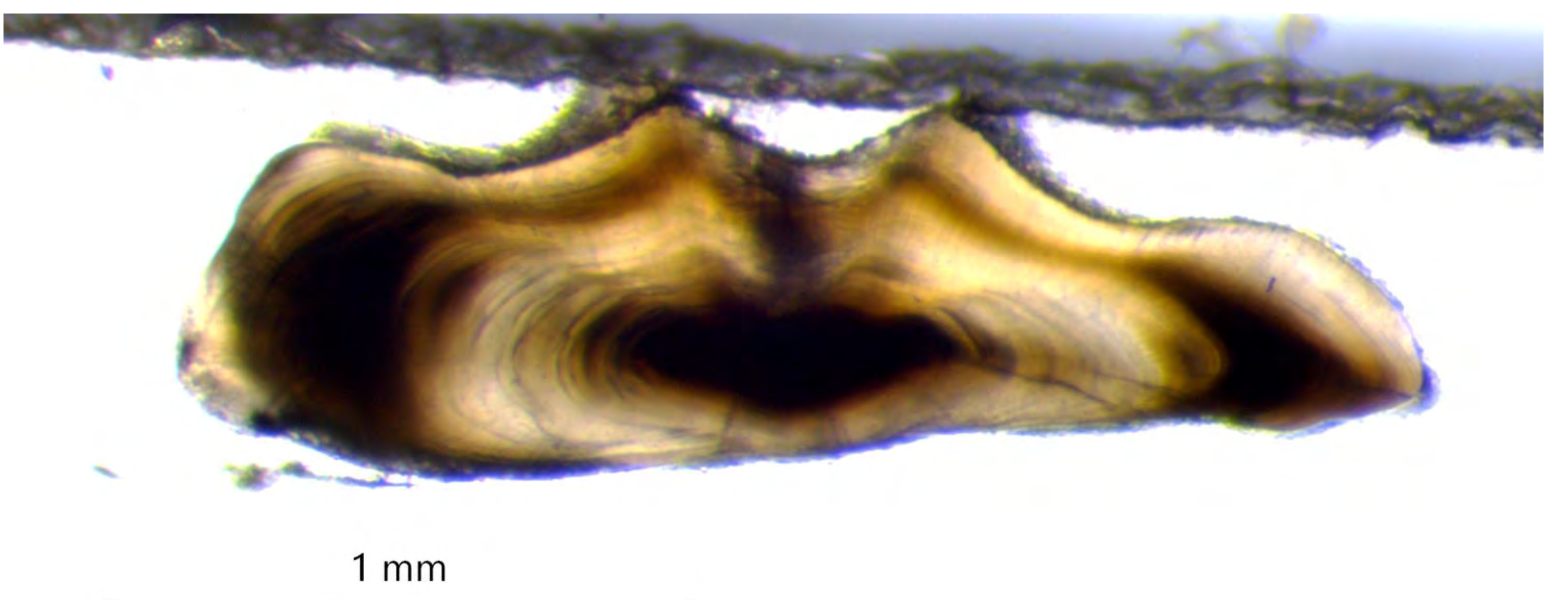

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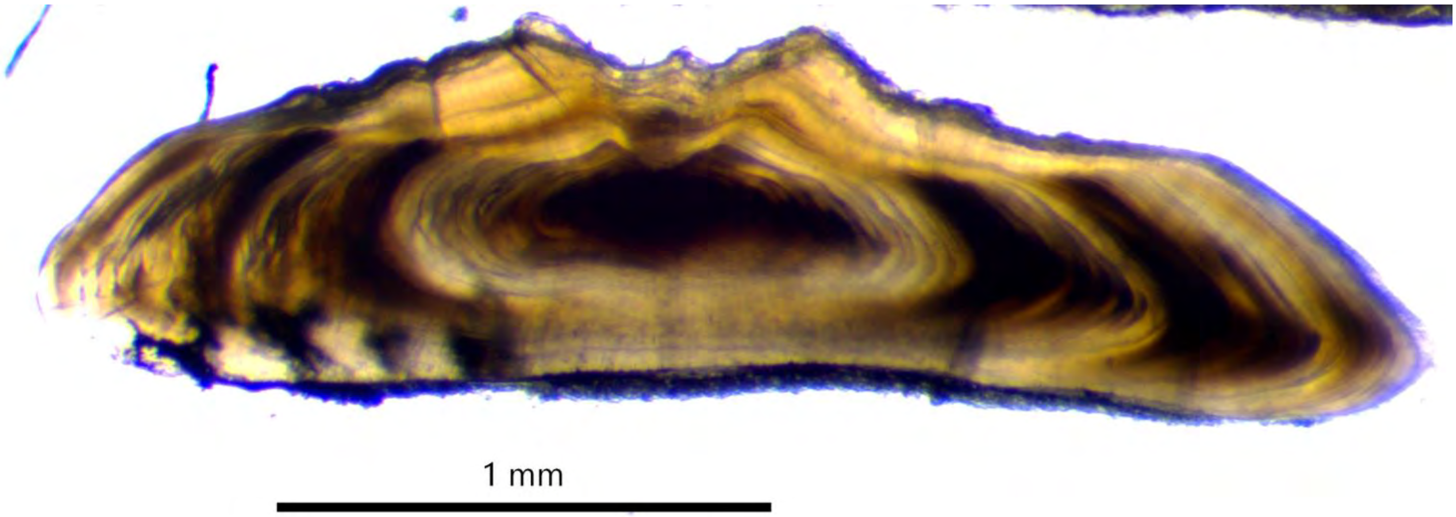

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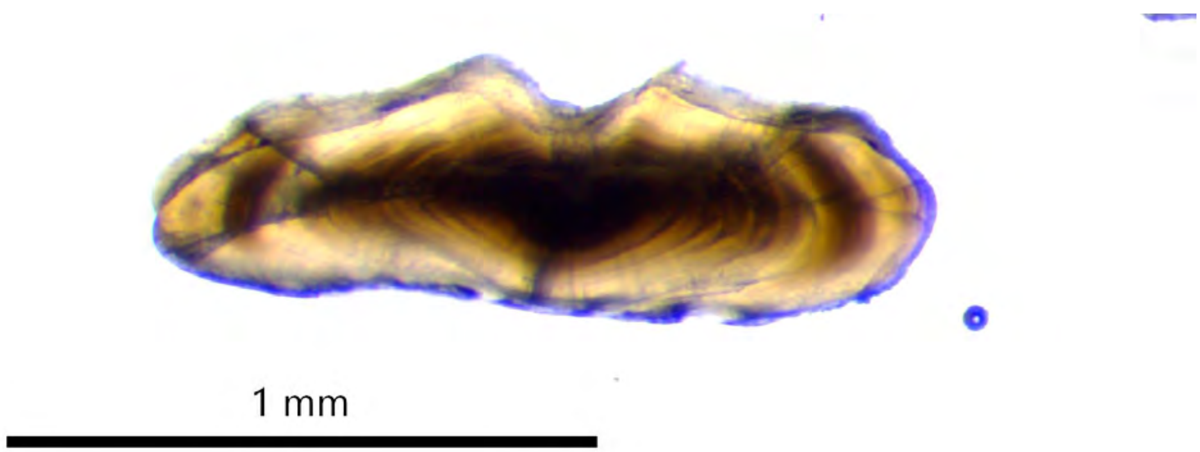

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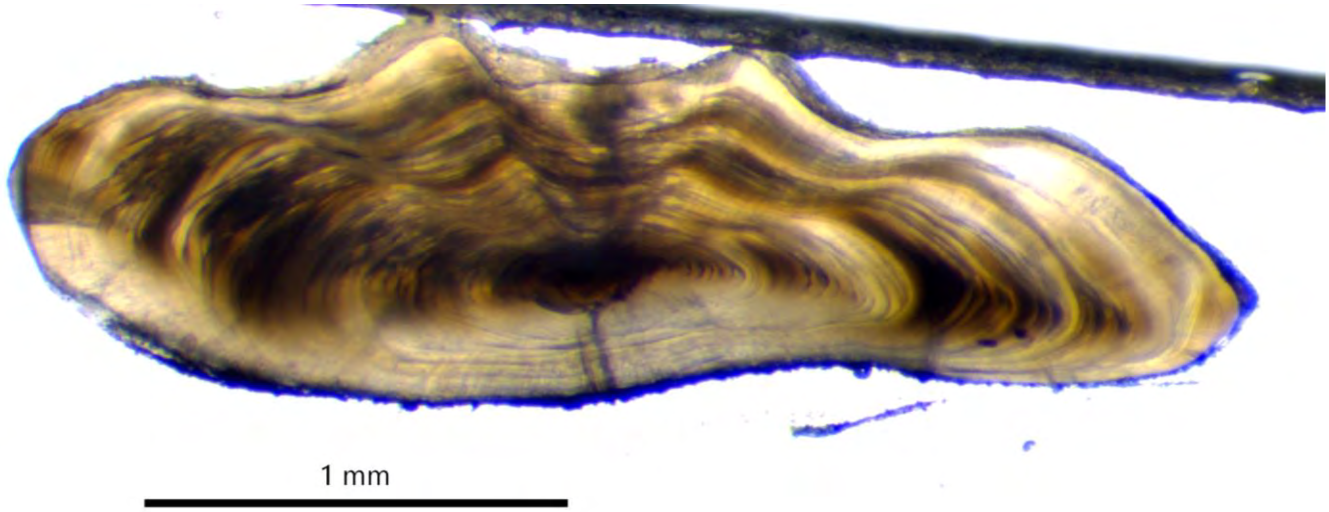

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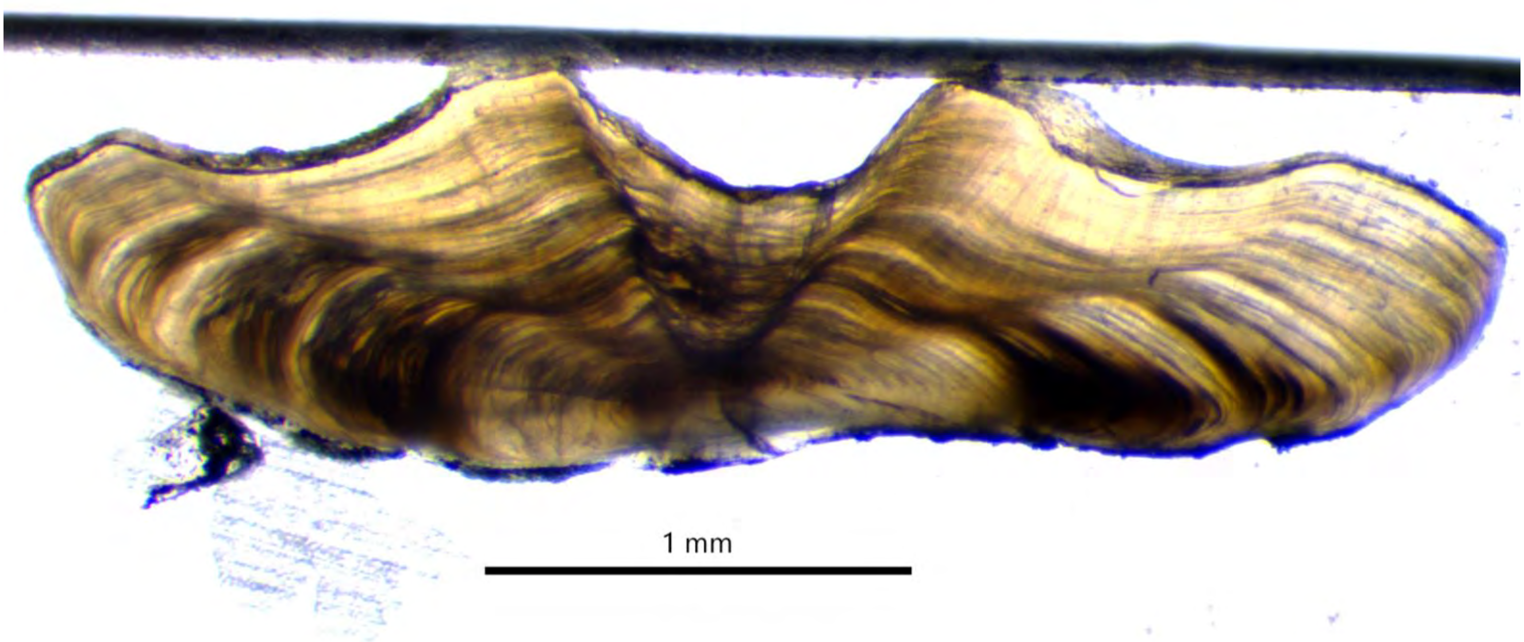

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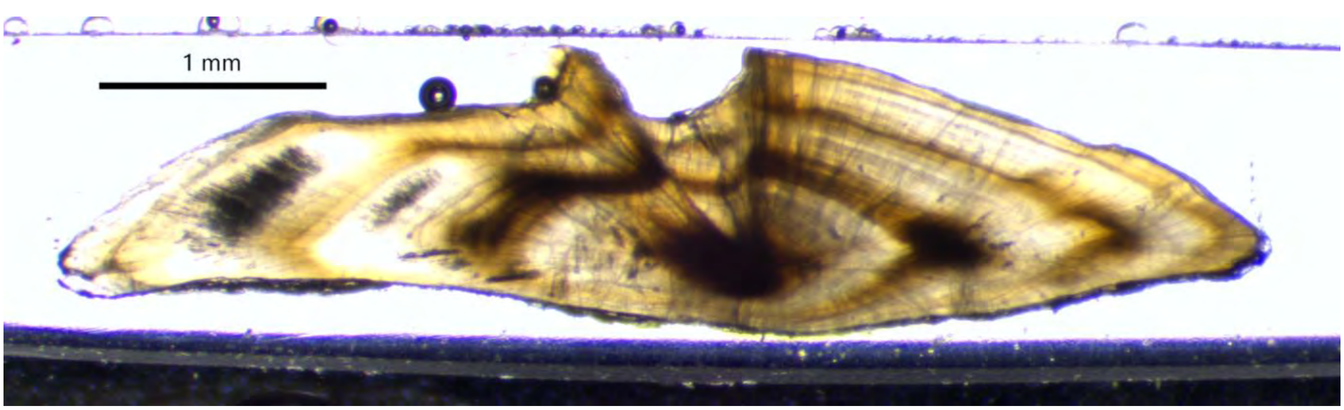

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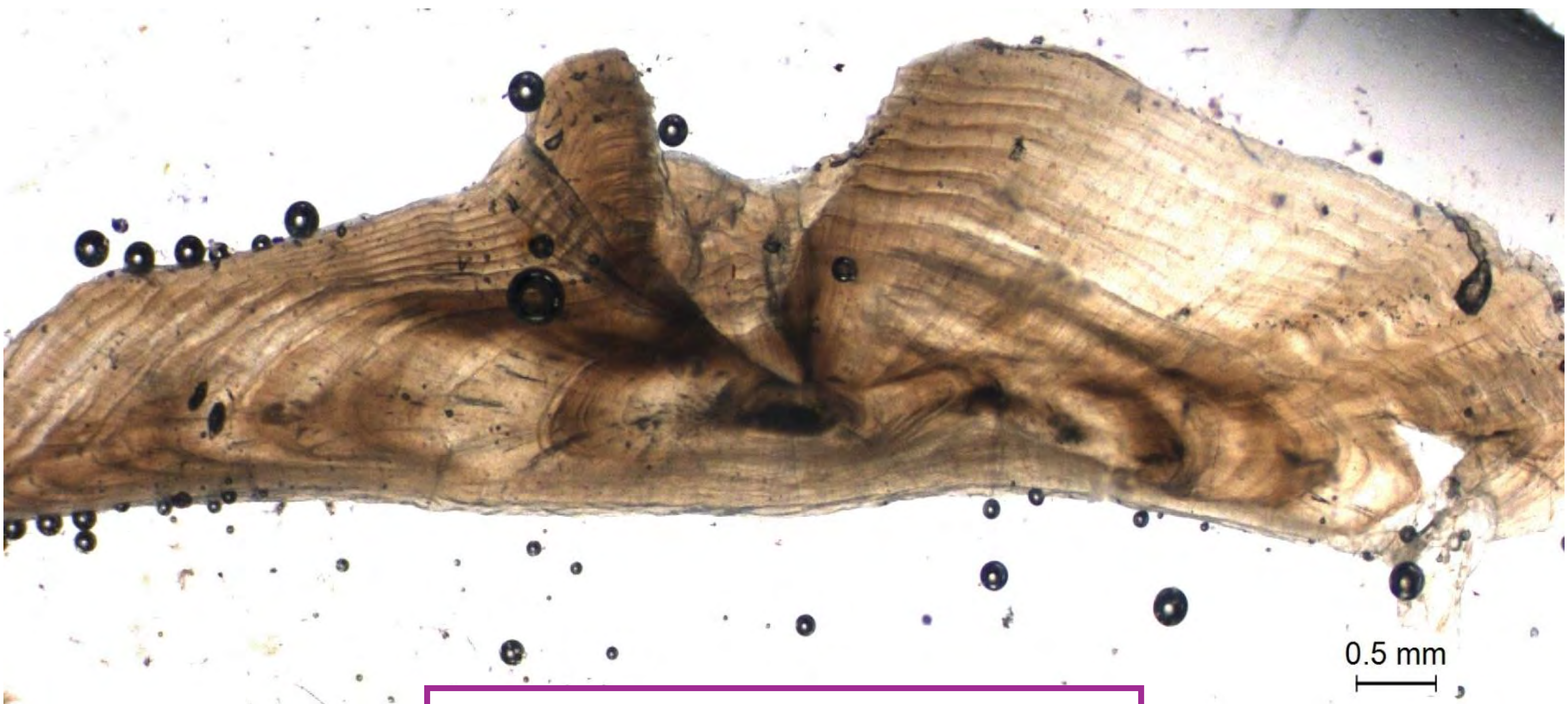
BSB 4 5/15/2008



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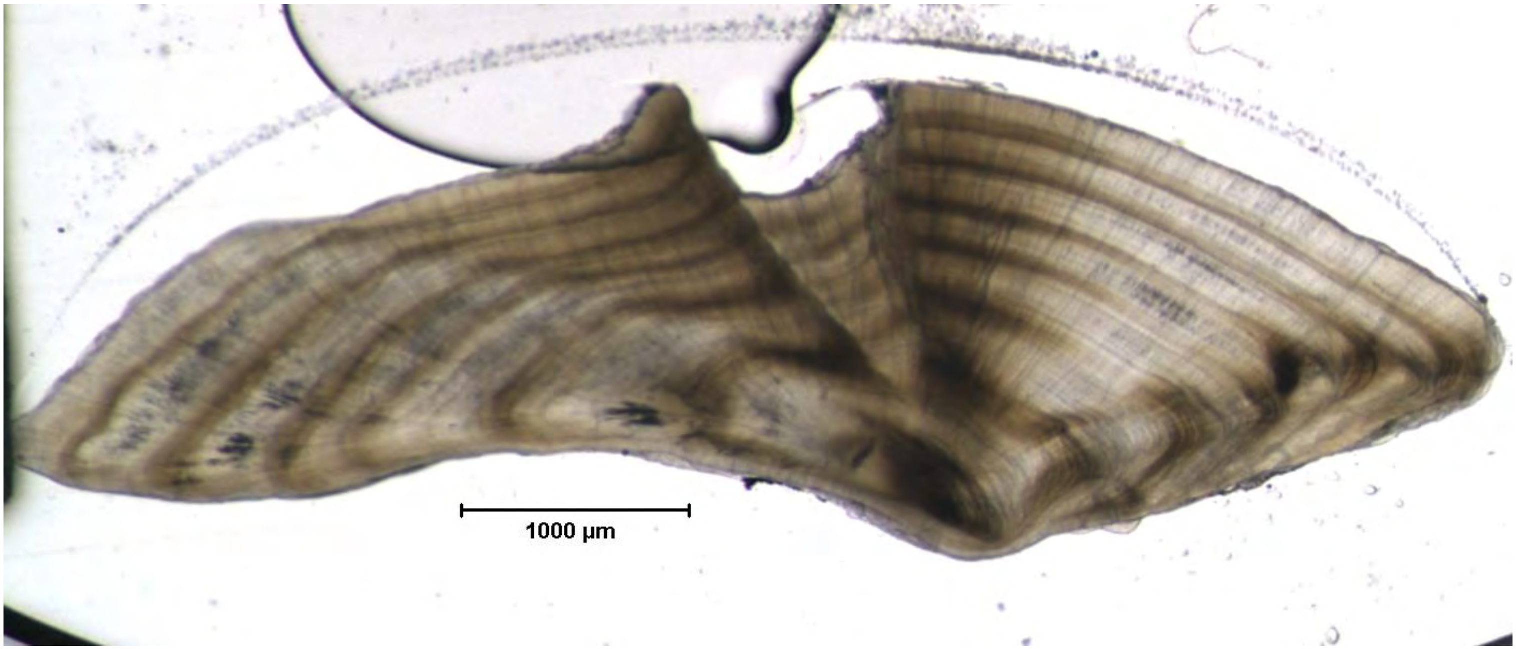

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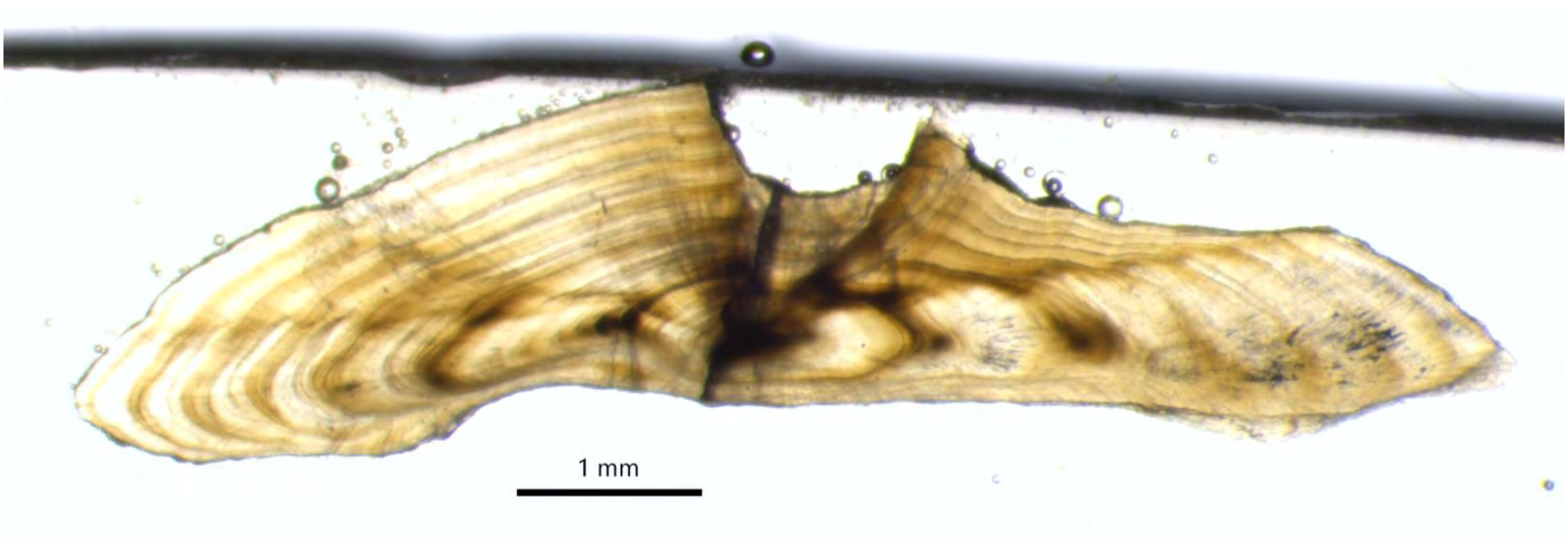

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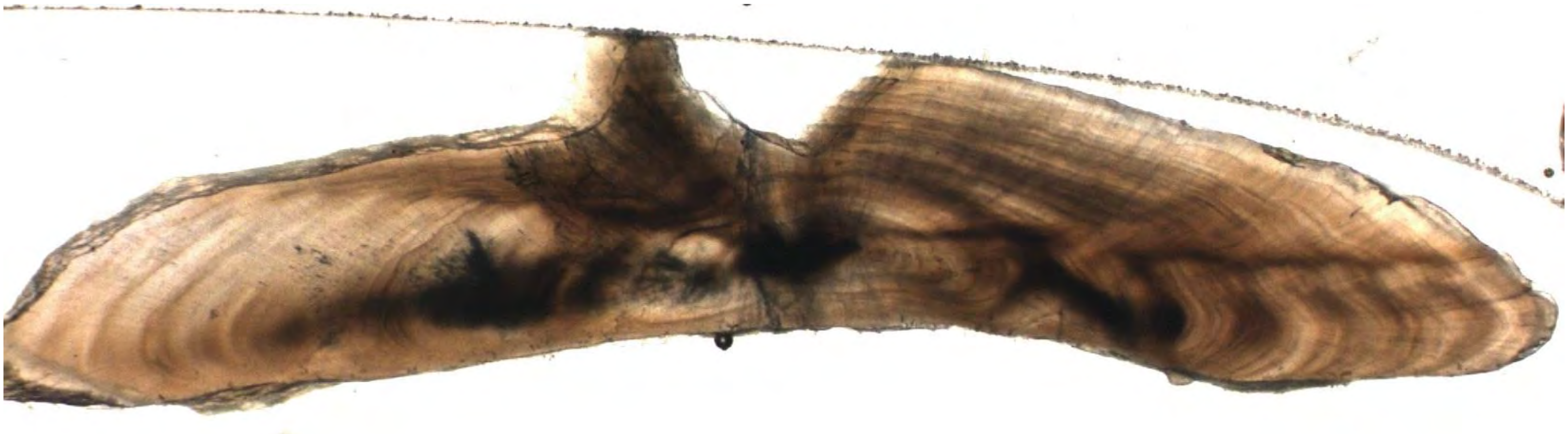

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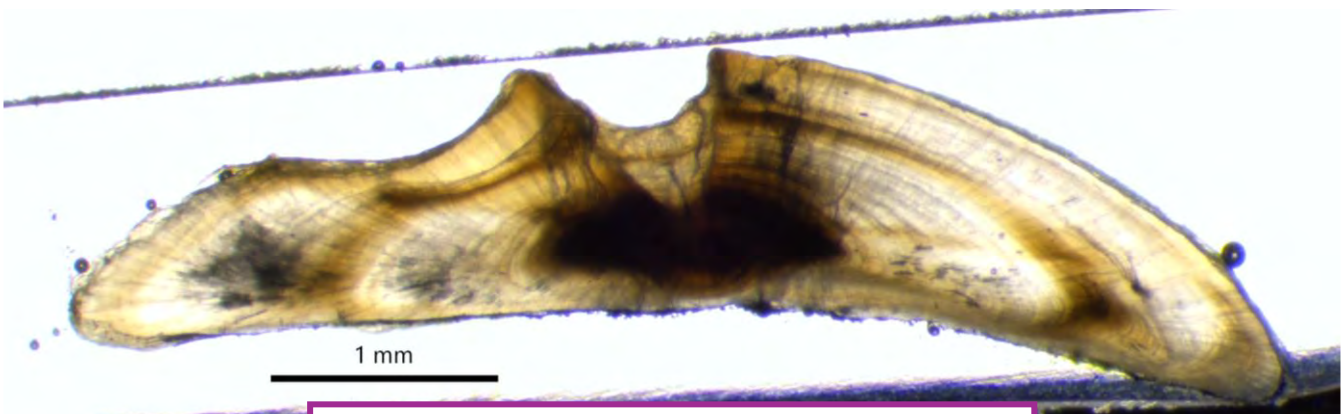

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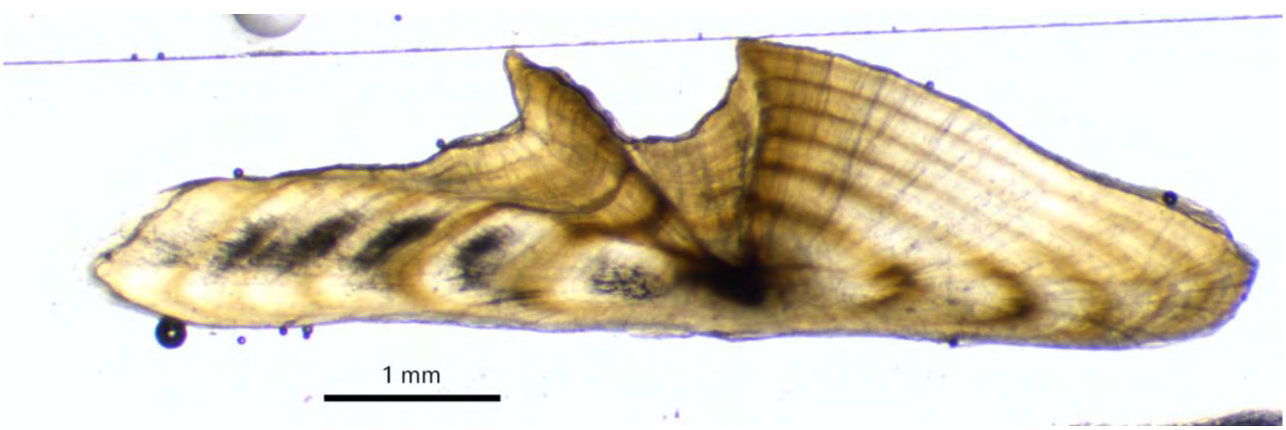

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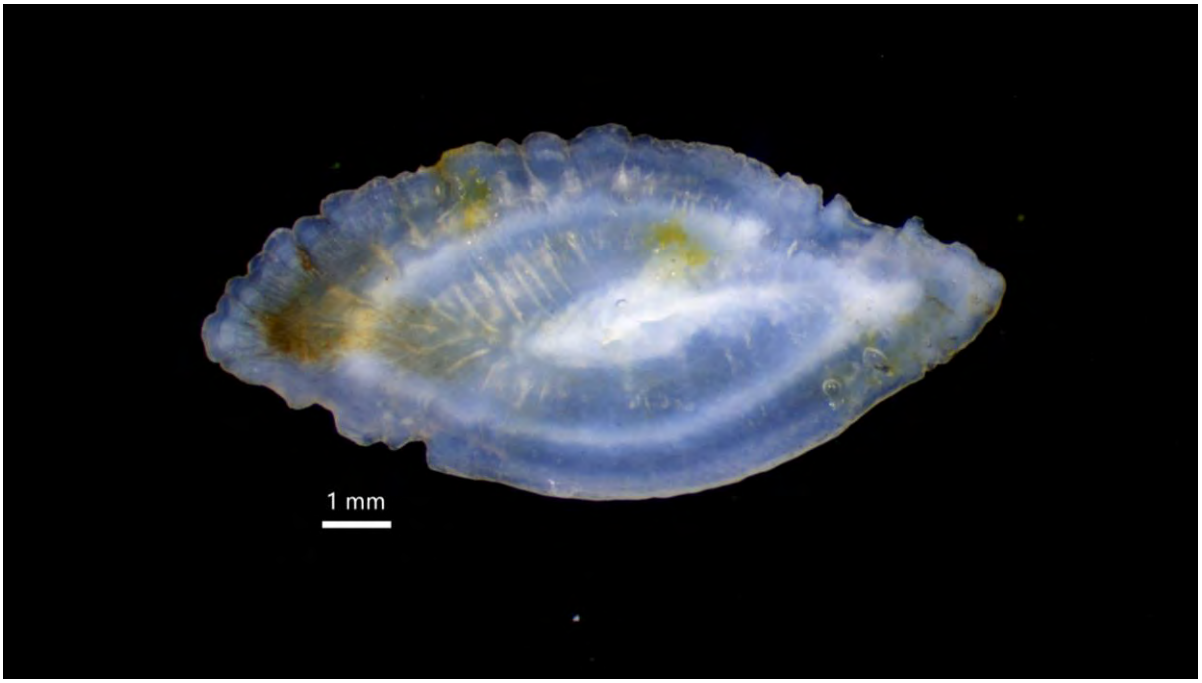

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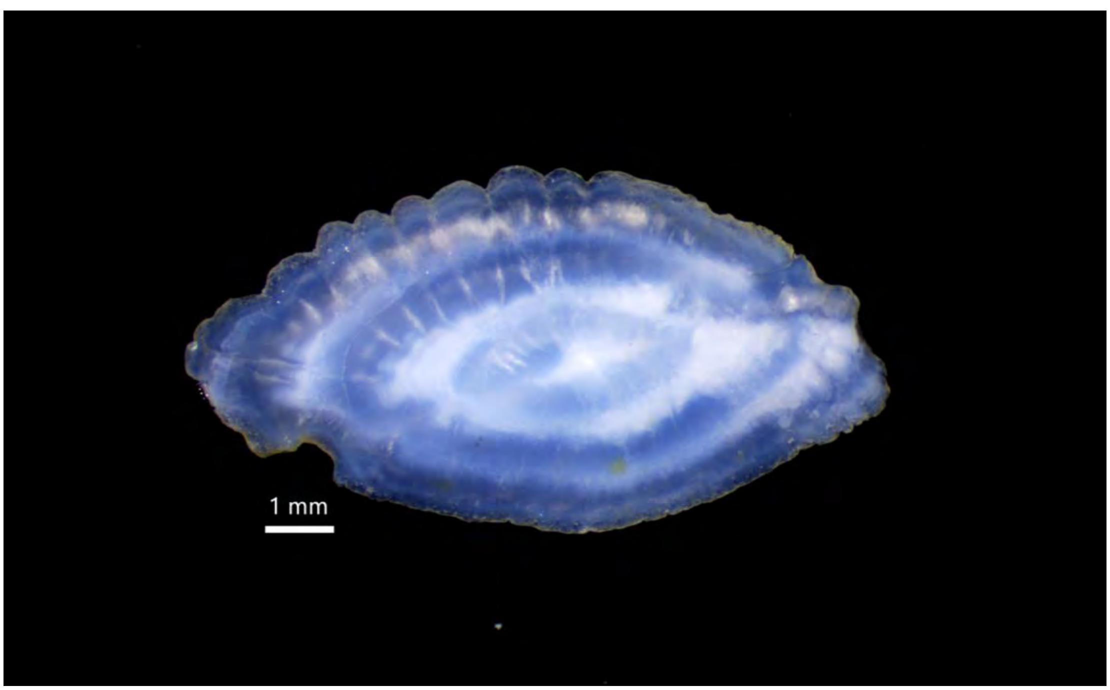

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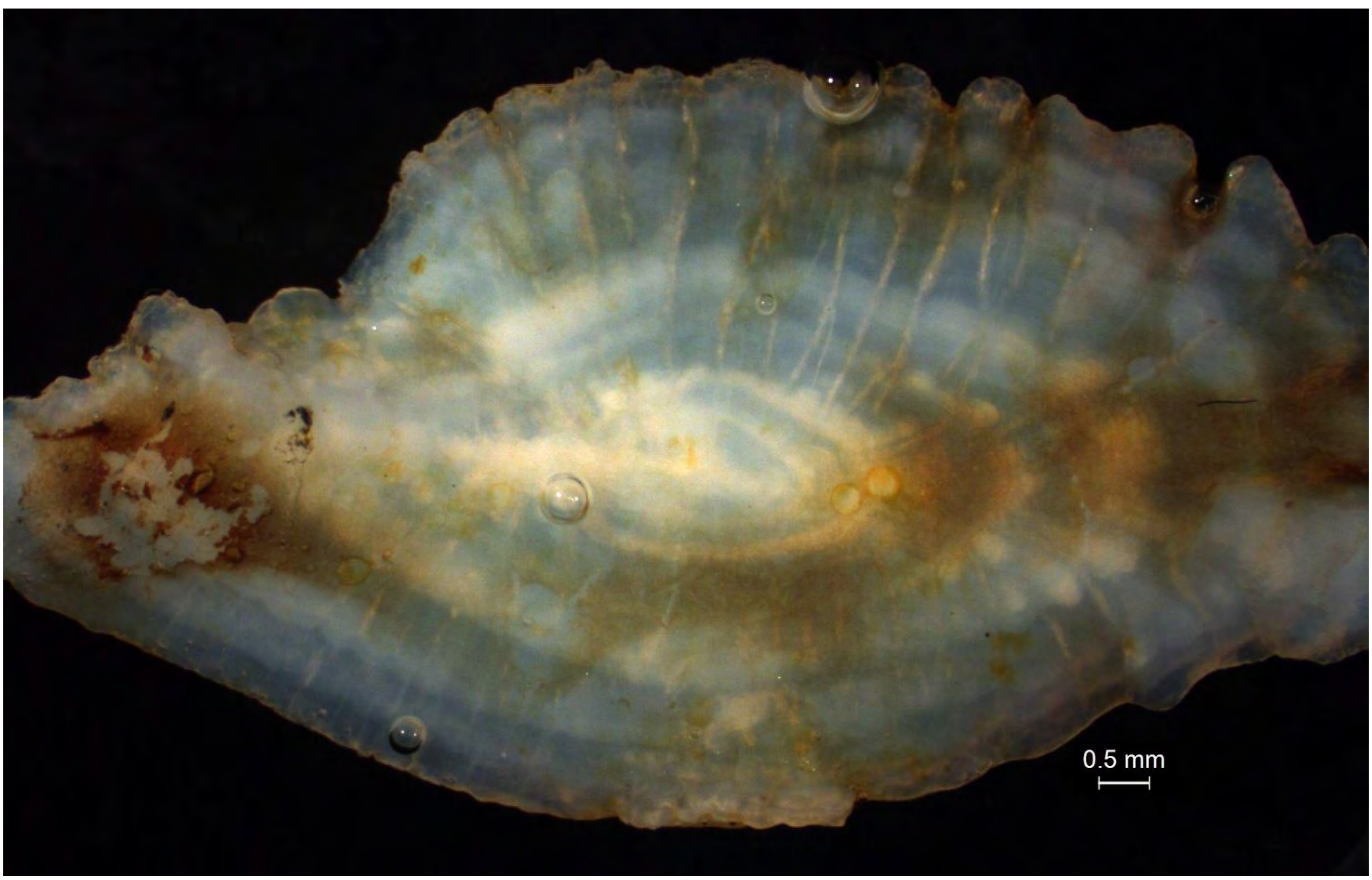

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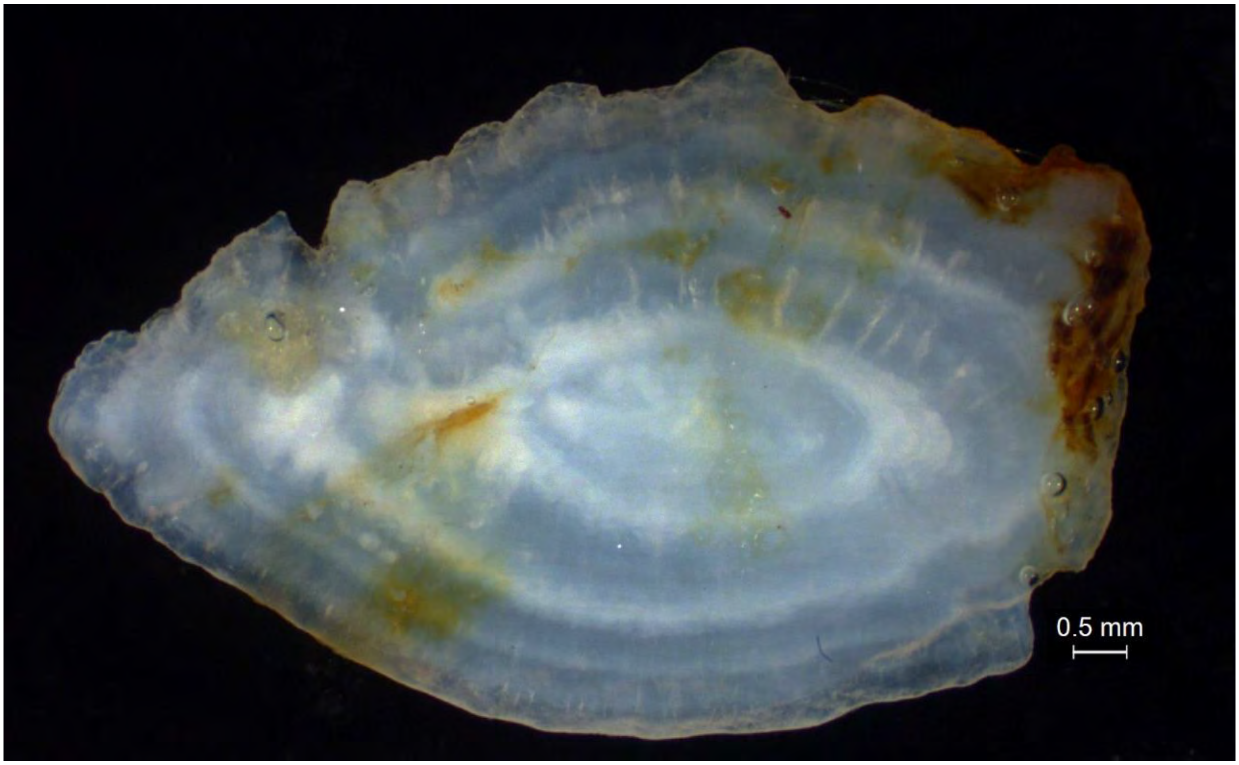

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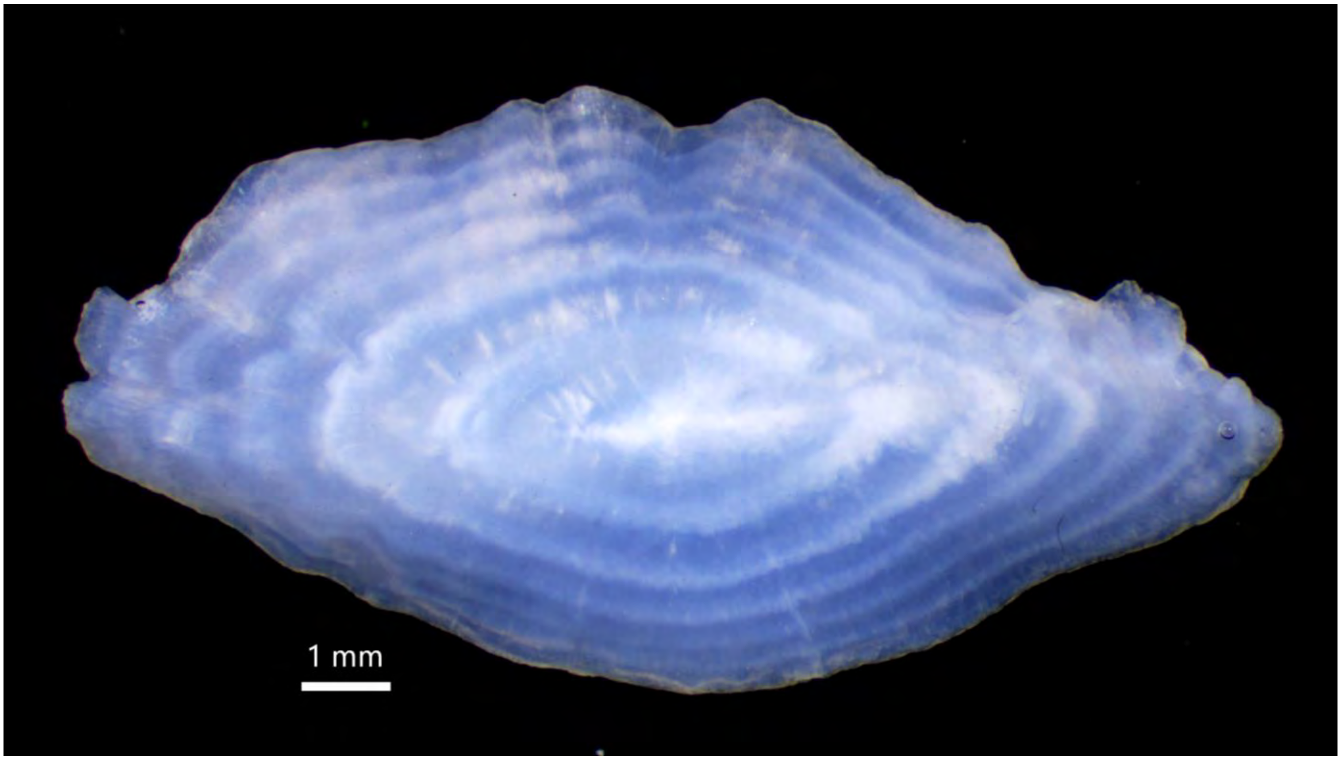

BSB 19 8/3/2022

BSB 20
5/6/2012

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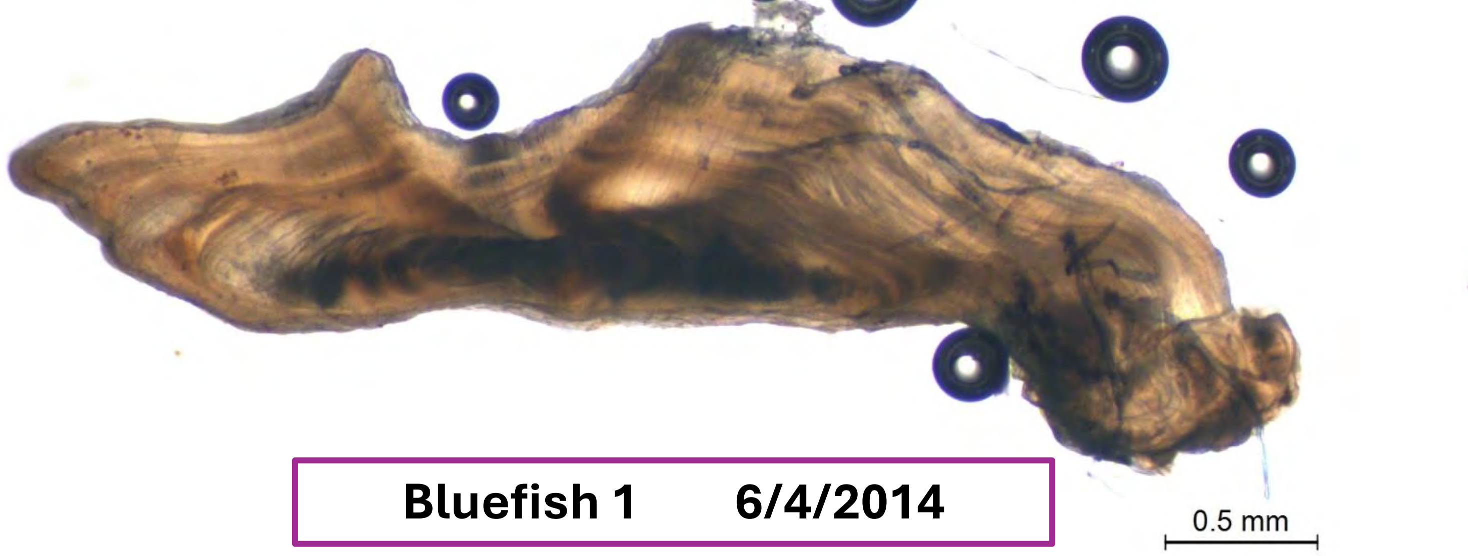

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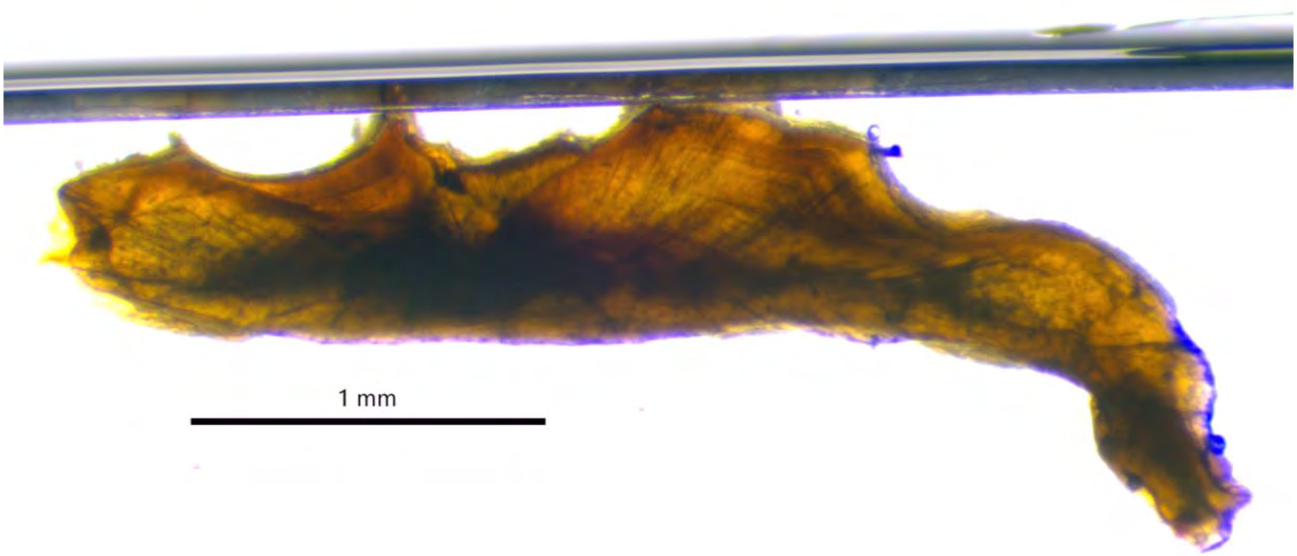
Bluefish 2 3/29/2014



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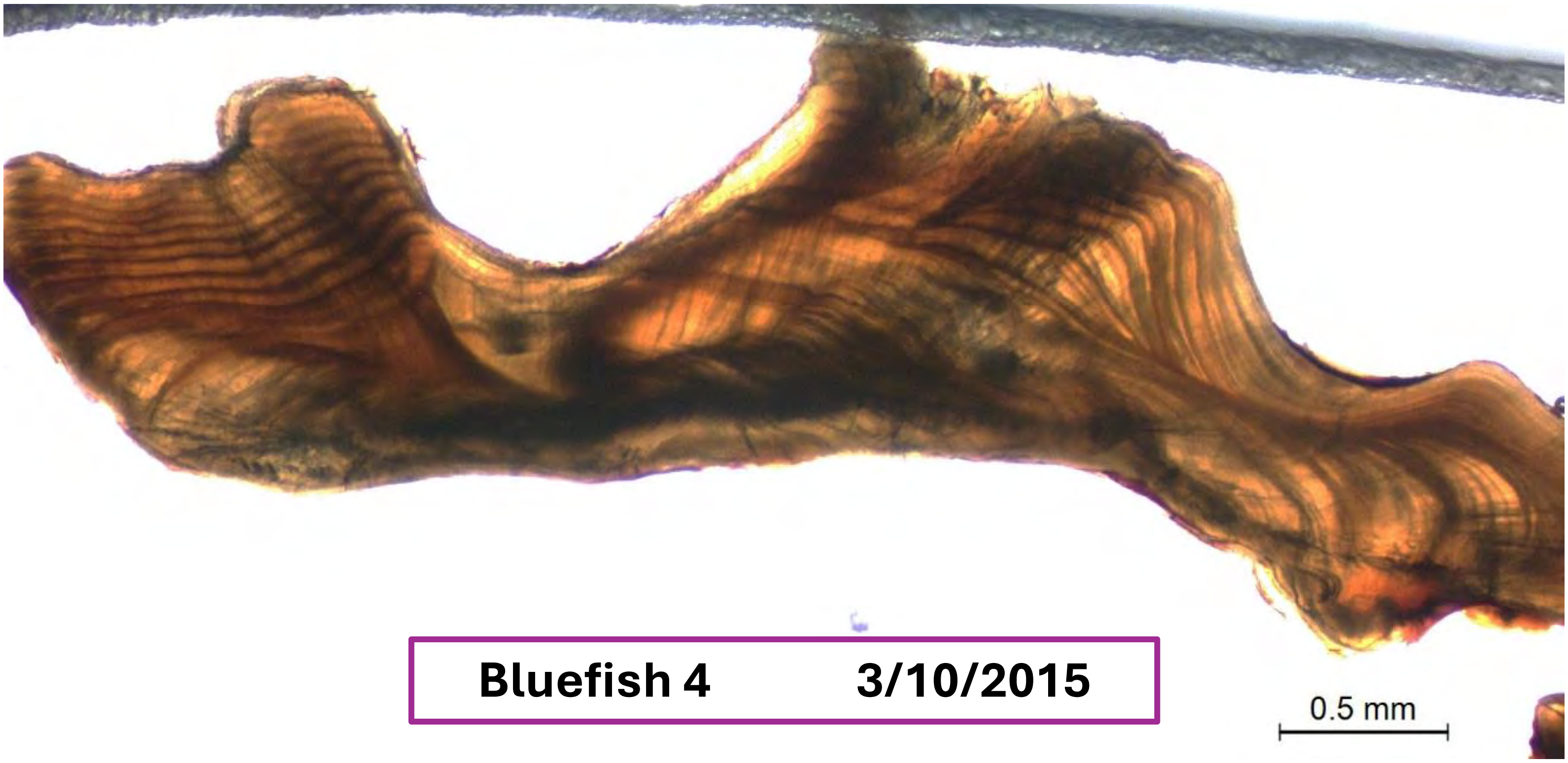

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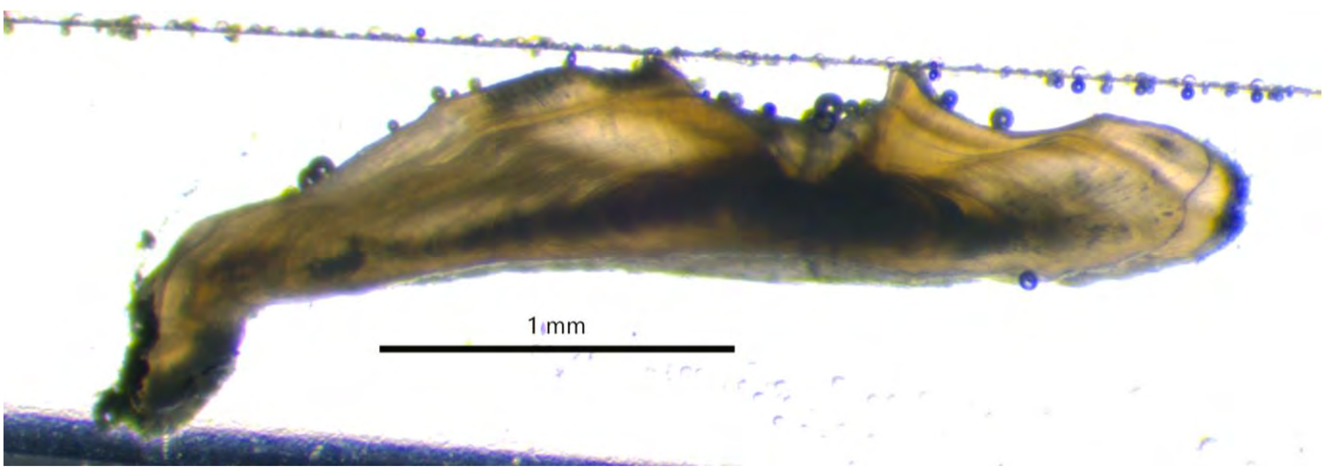
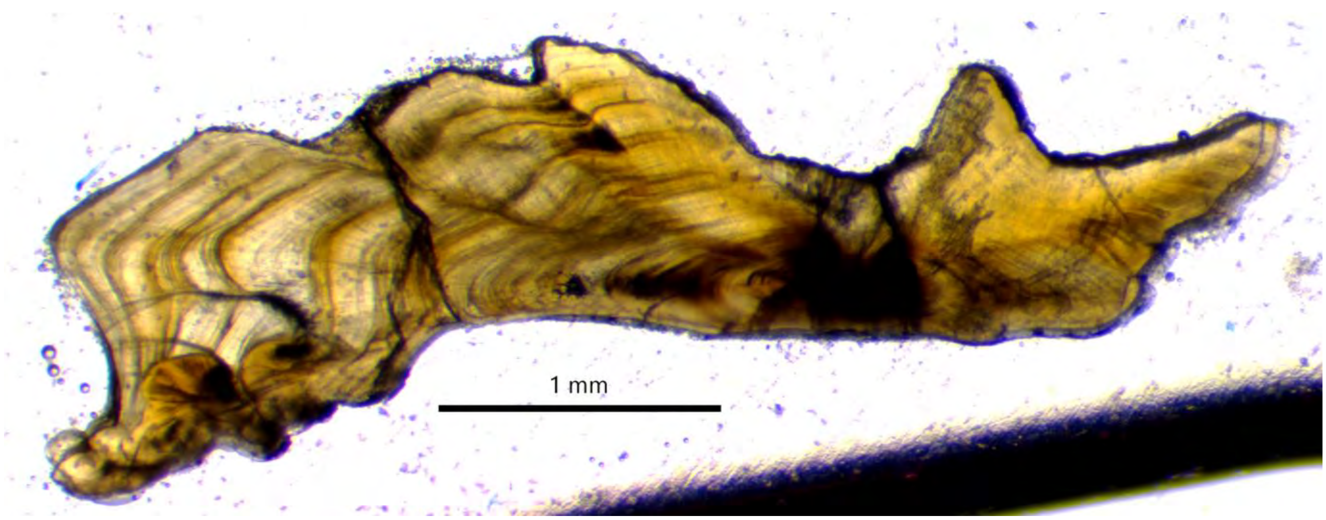


Bluefish 5 7/30/2022



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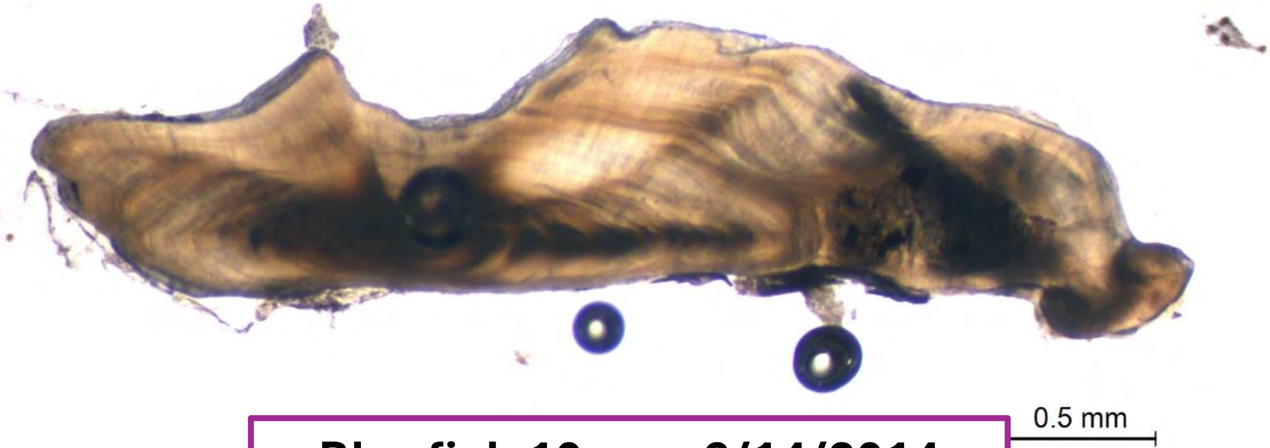
Bluefish 7 7/30/2022

Bluefish 8 11/2/2012

Bluefish 9 5/23/2012



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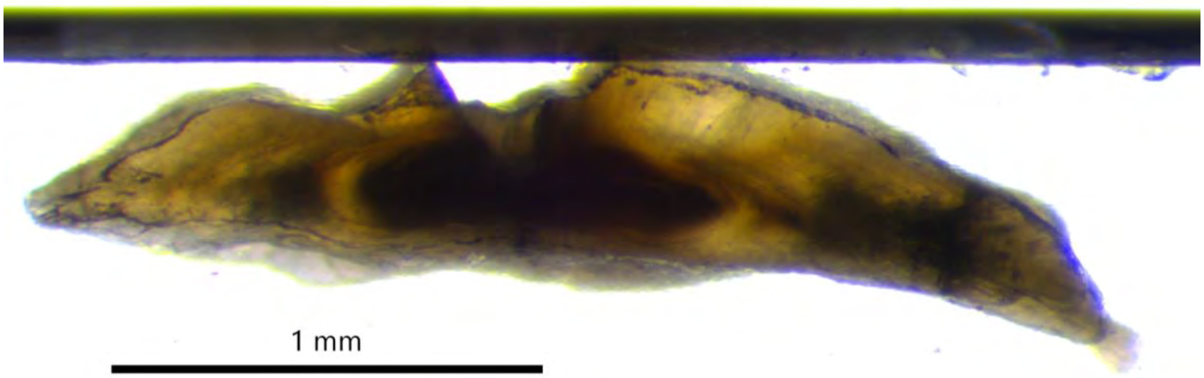
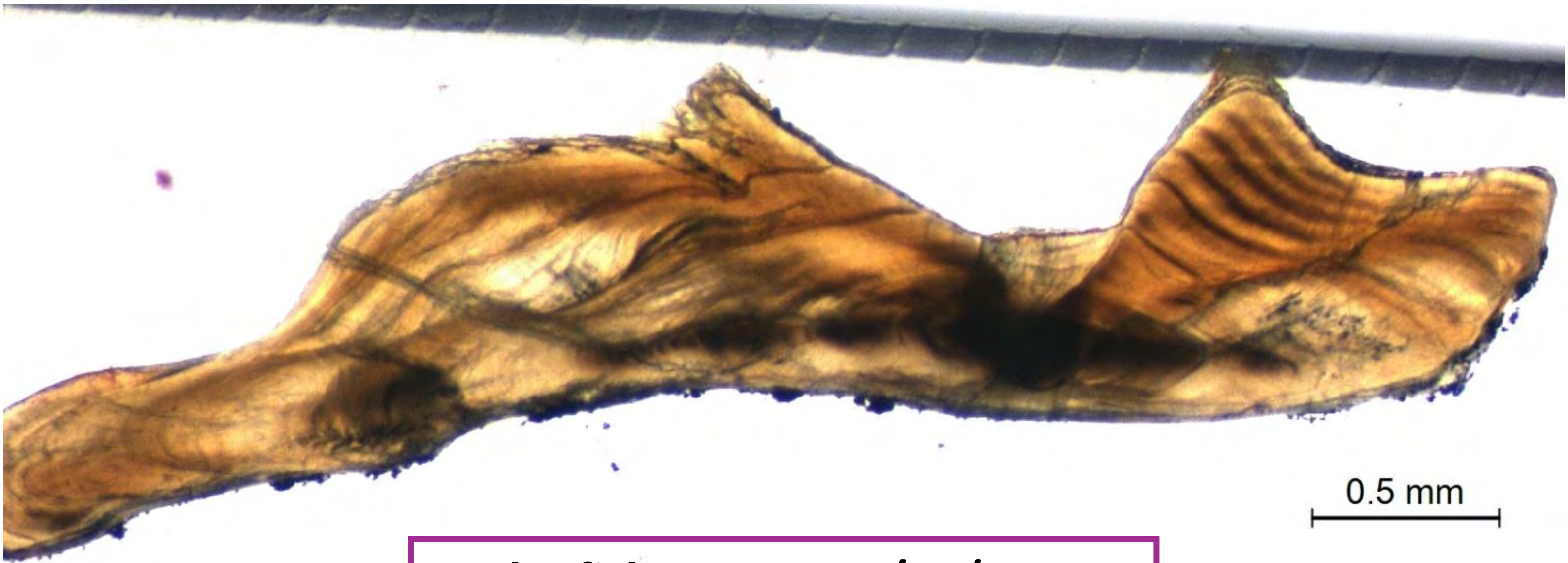


Bluefish 11 7/26/2021

Bluefish 12 5/3/2012



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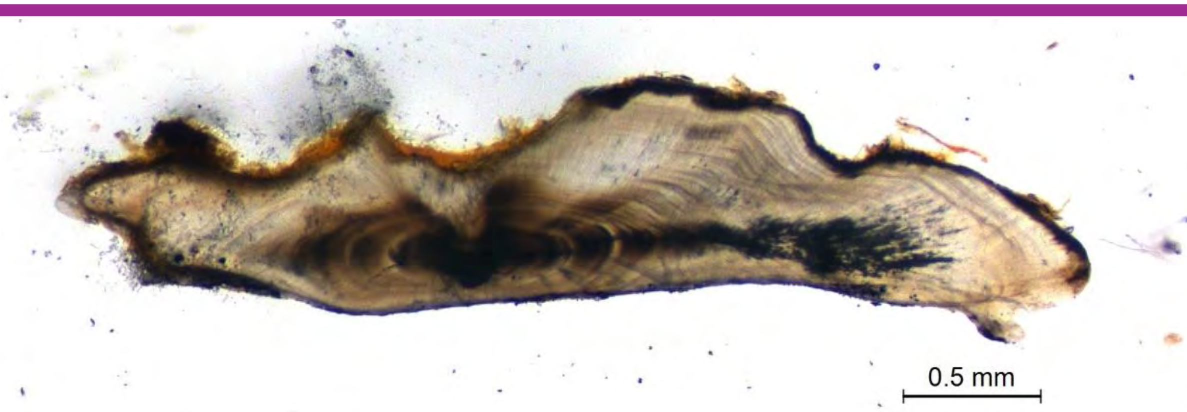

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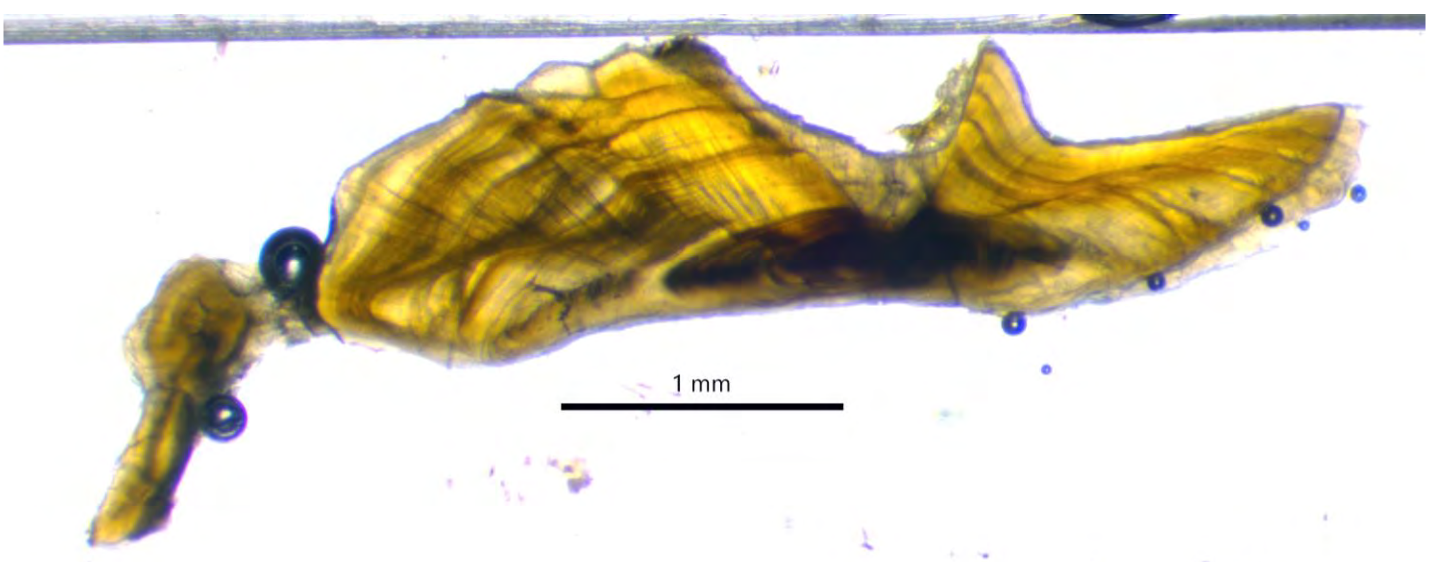

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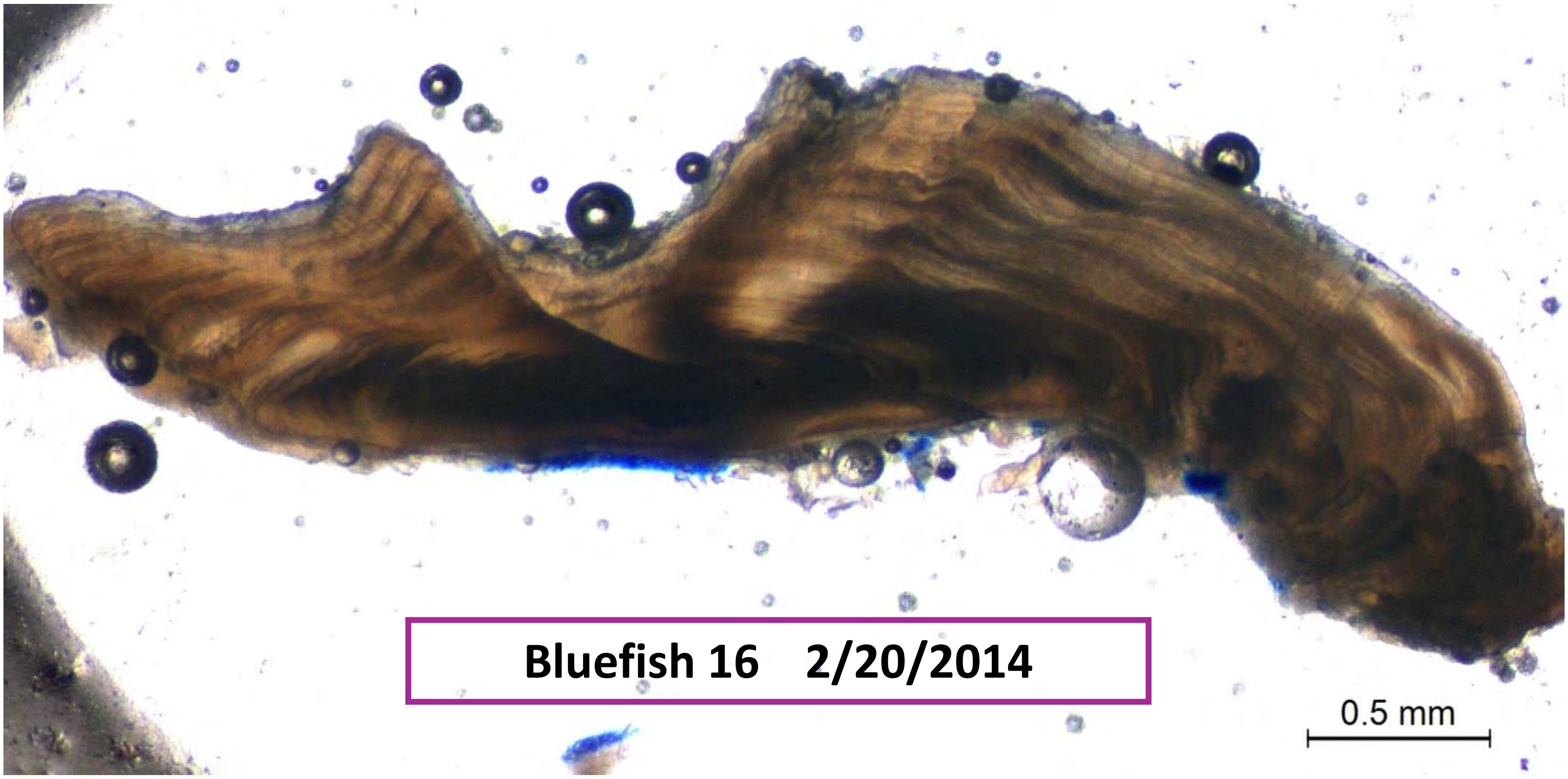

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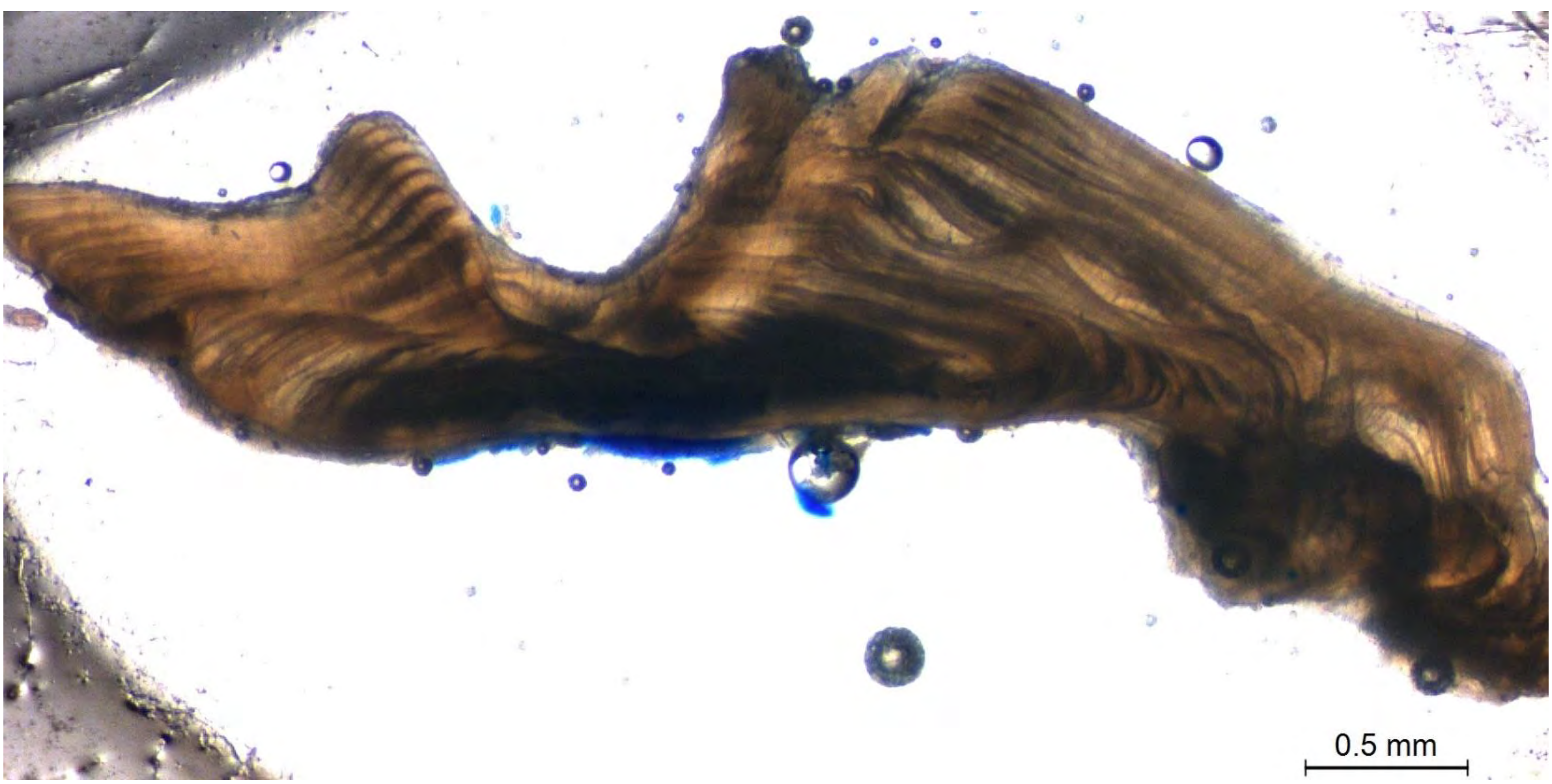

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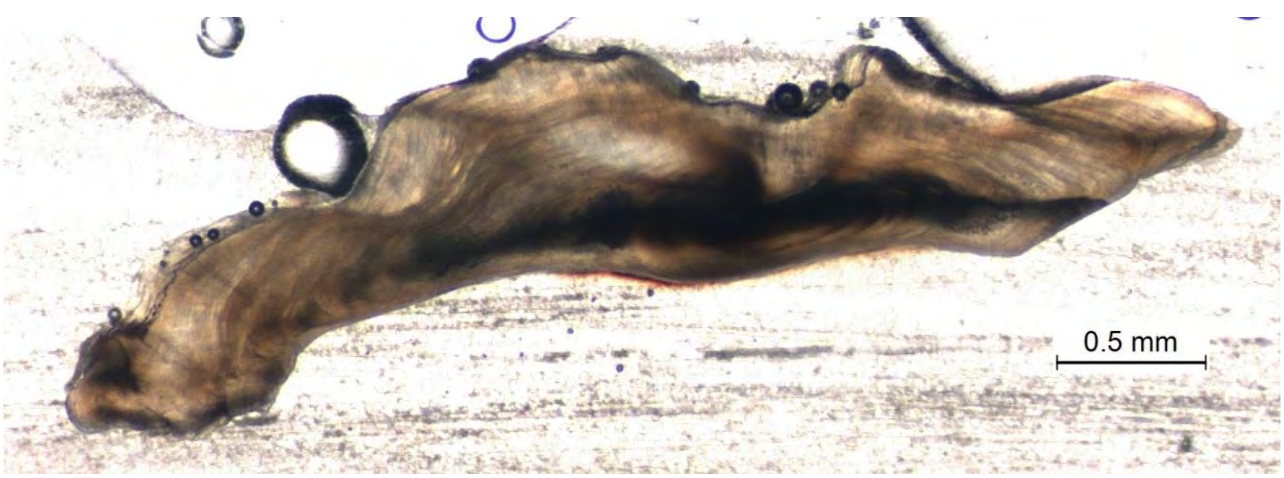
Bluefish 18 6/14/2022

Bluefish 19 5/11/2014



Bluefish 20 5/31/2013

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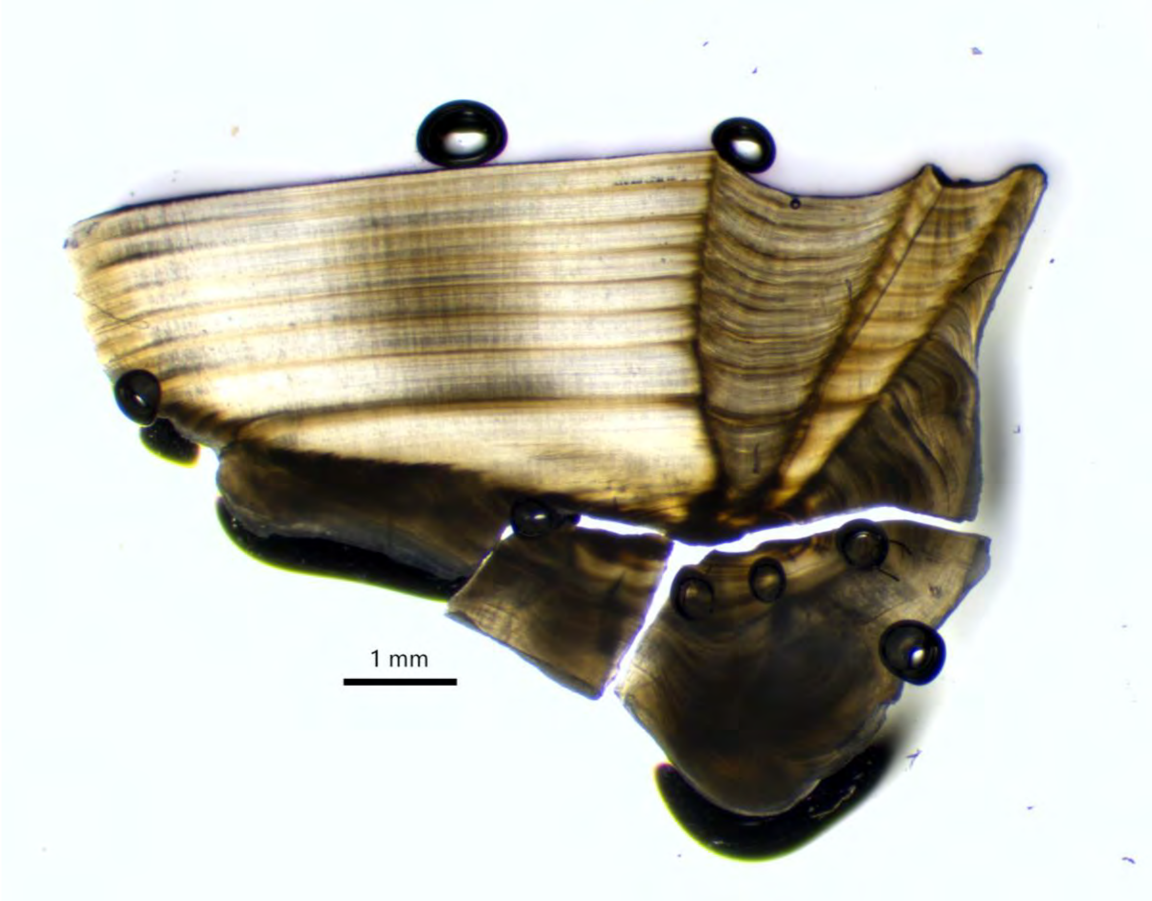
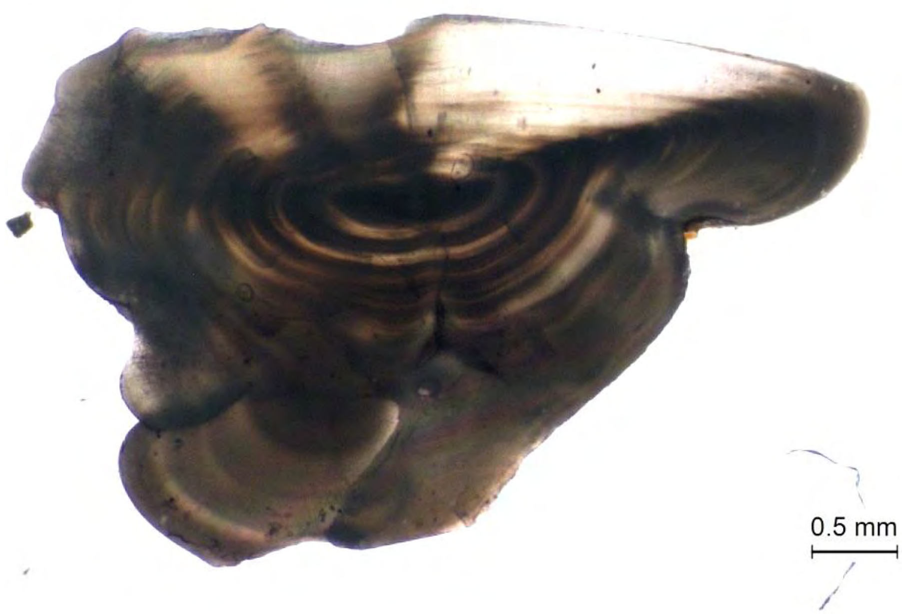


Atlantic Croaker 1 7/13/2022



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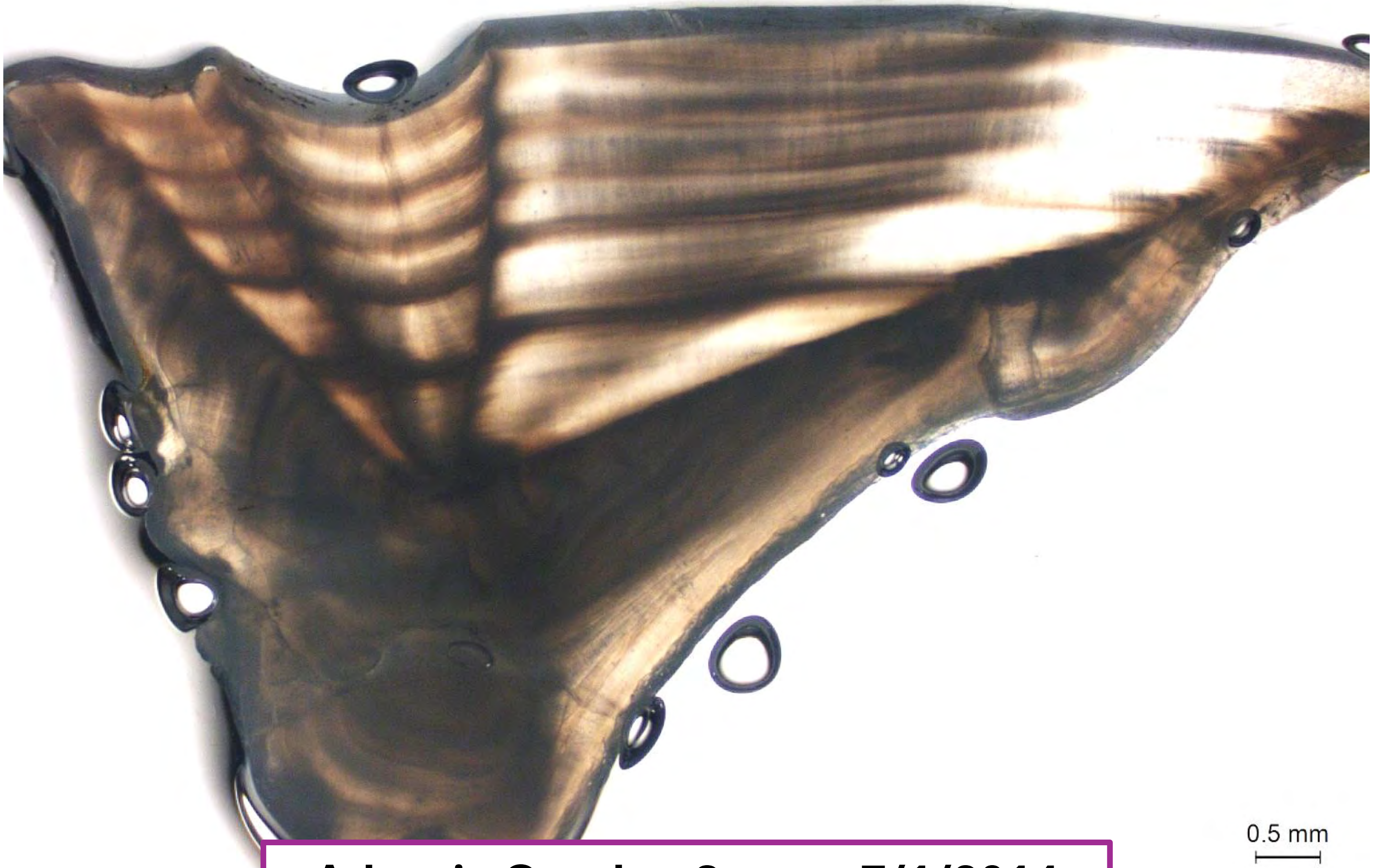

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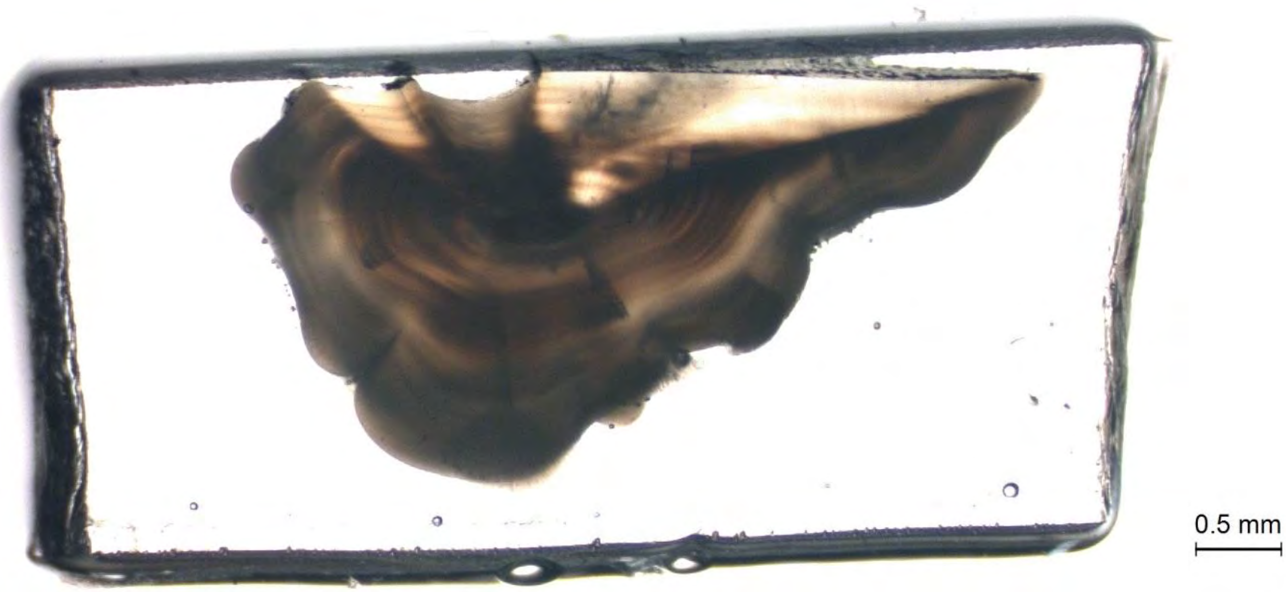

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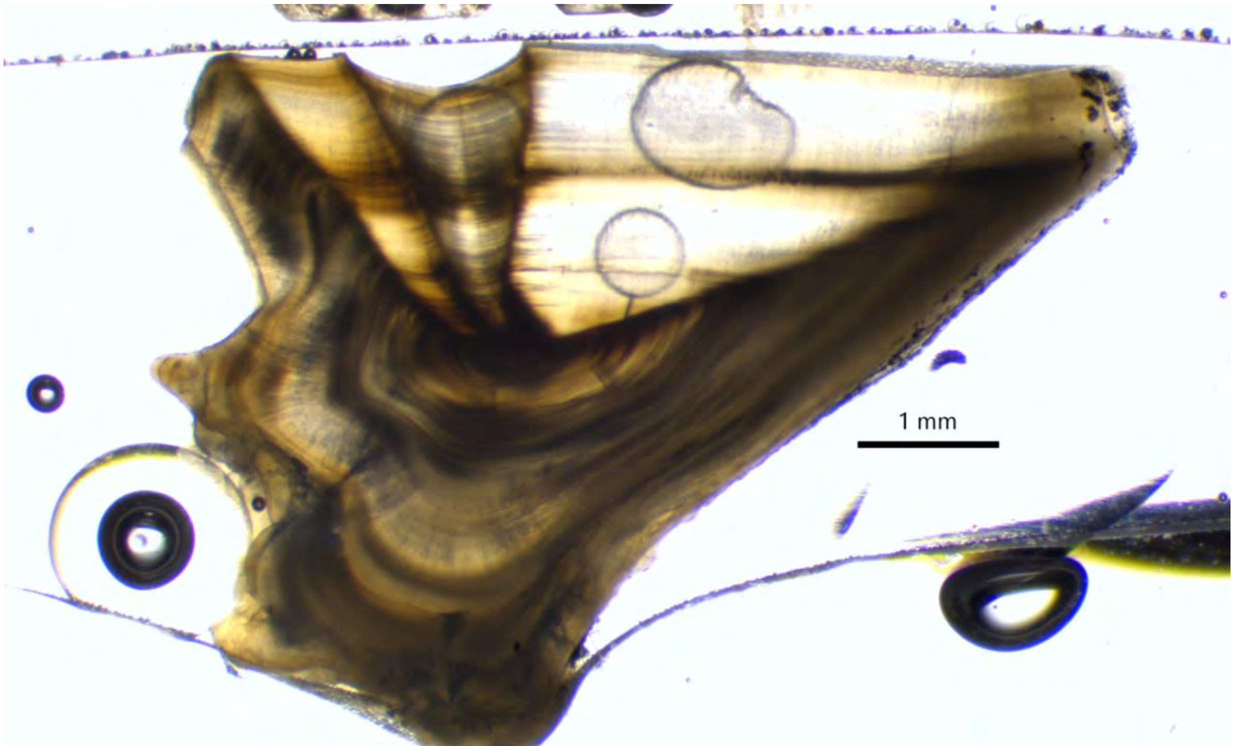

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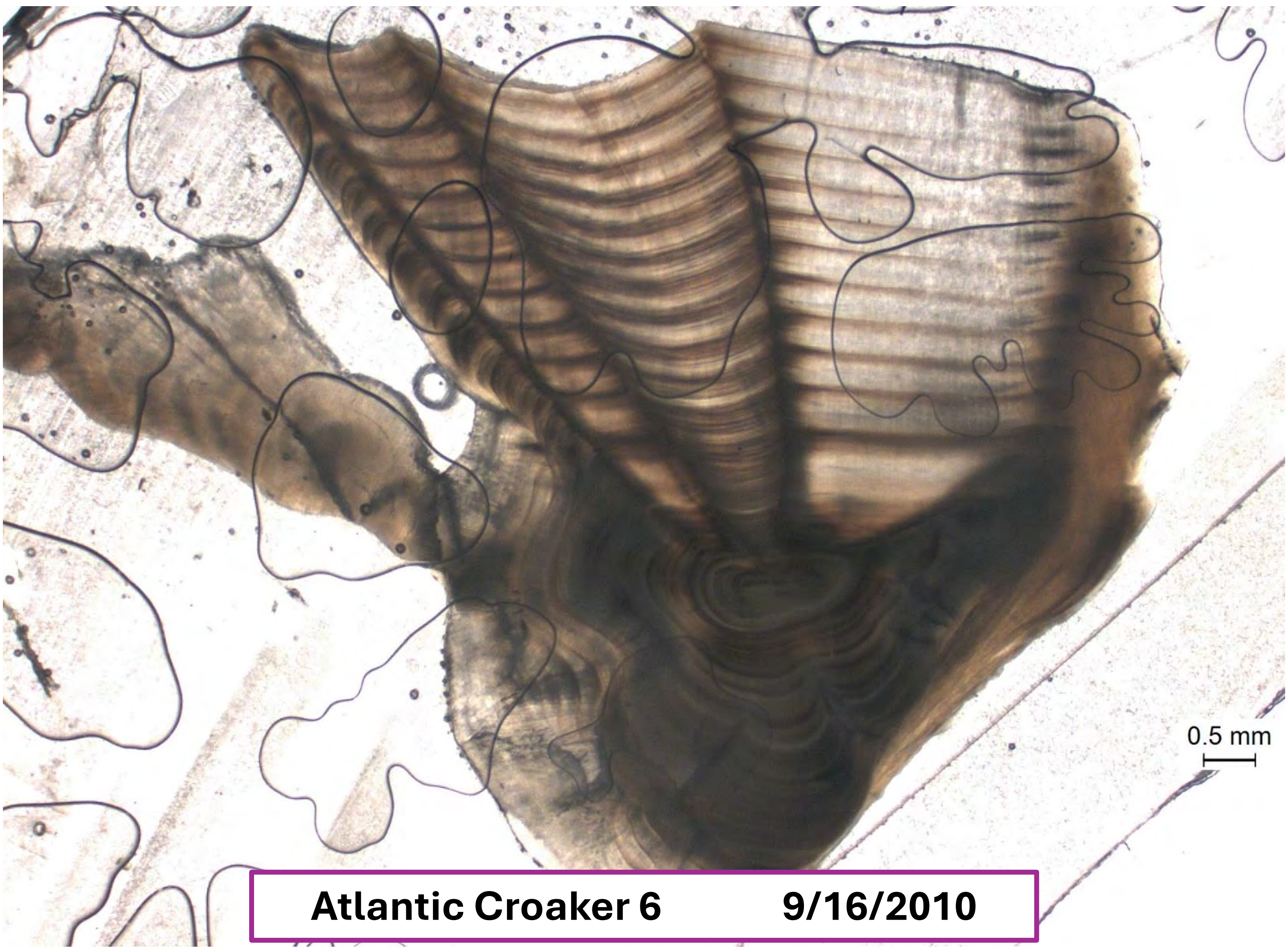

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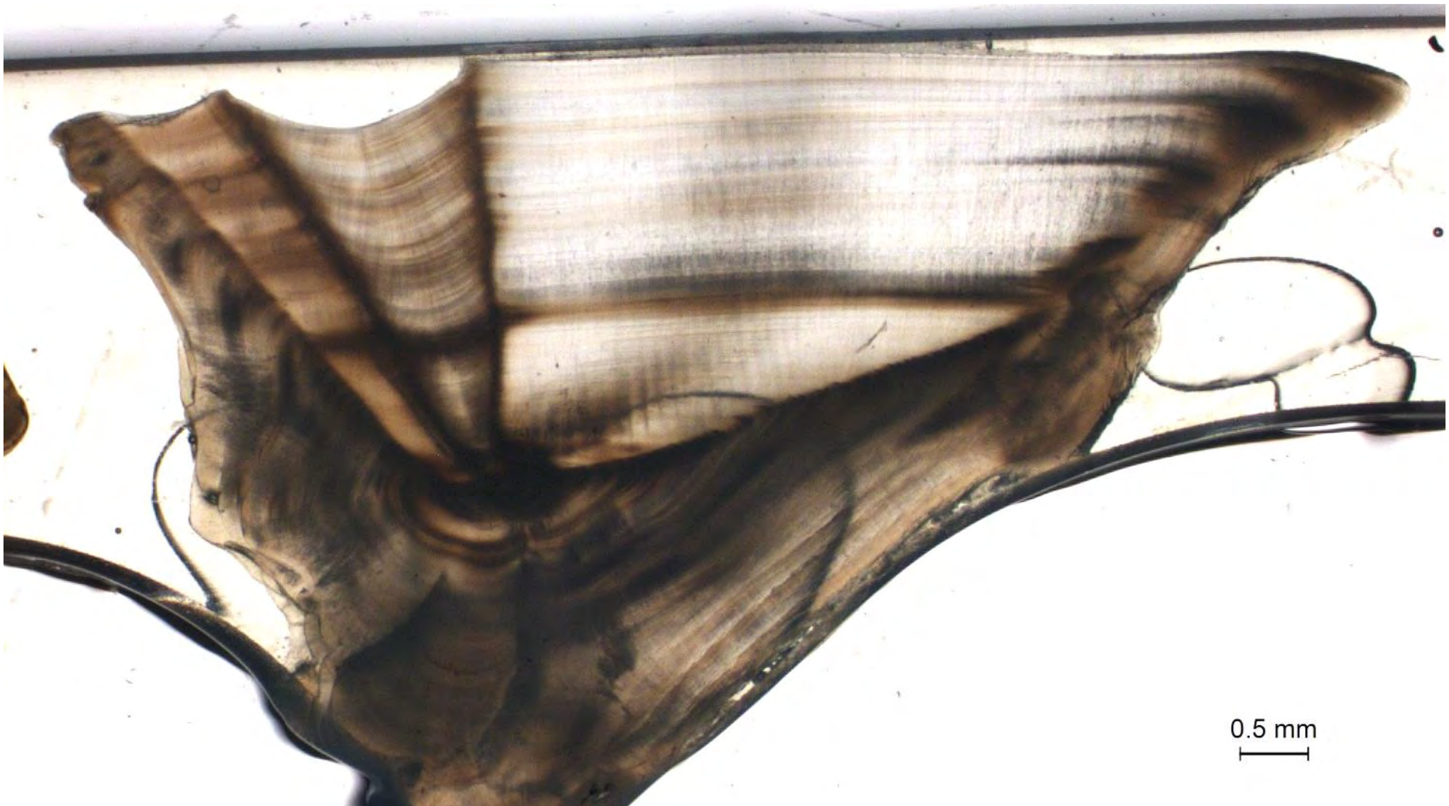

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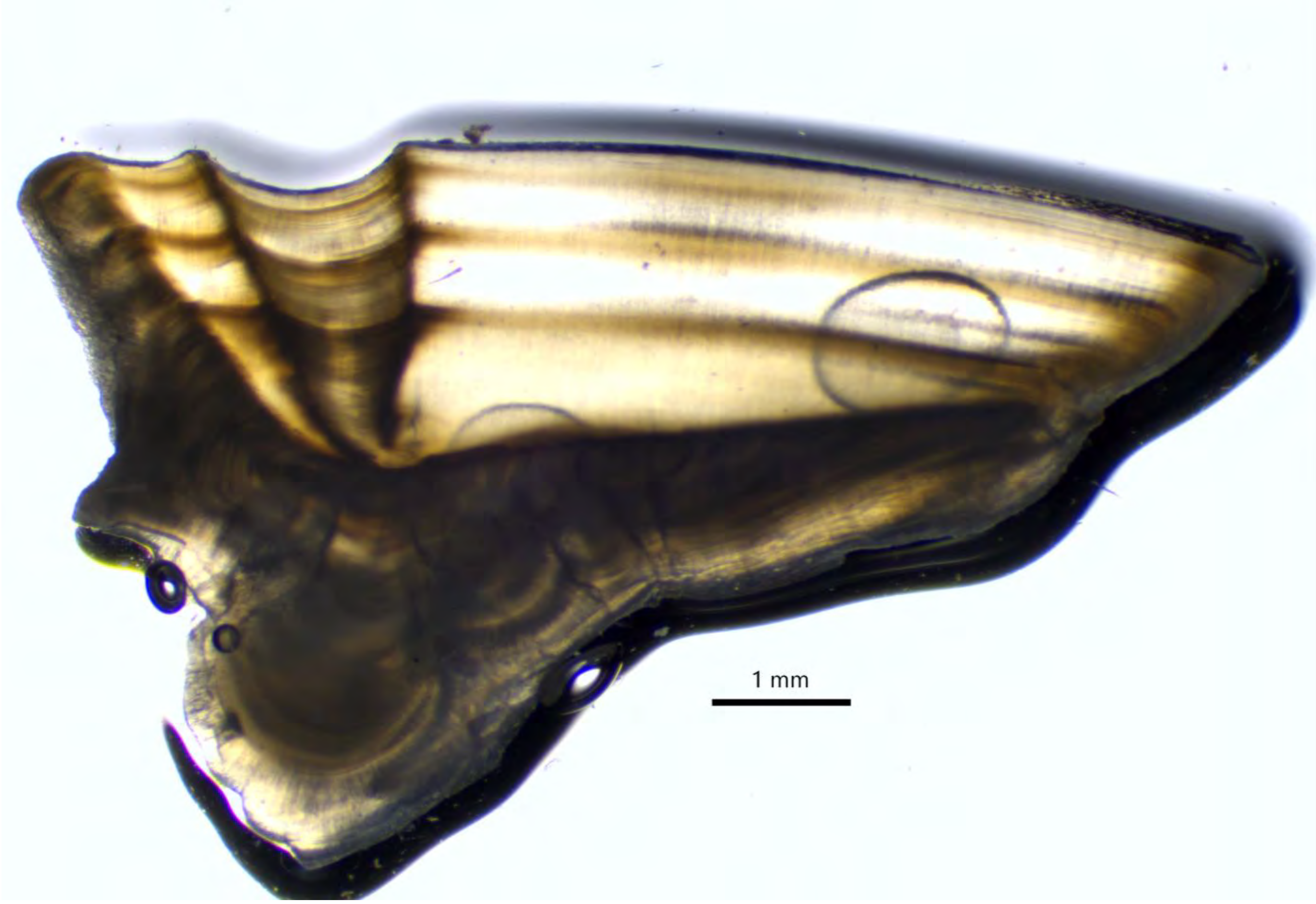
Atlantic Croaker 8 5/10/2014



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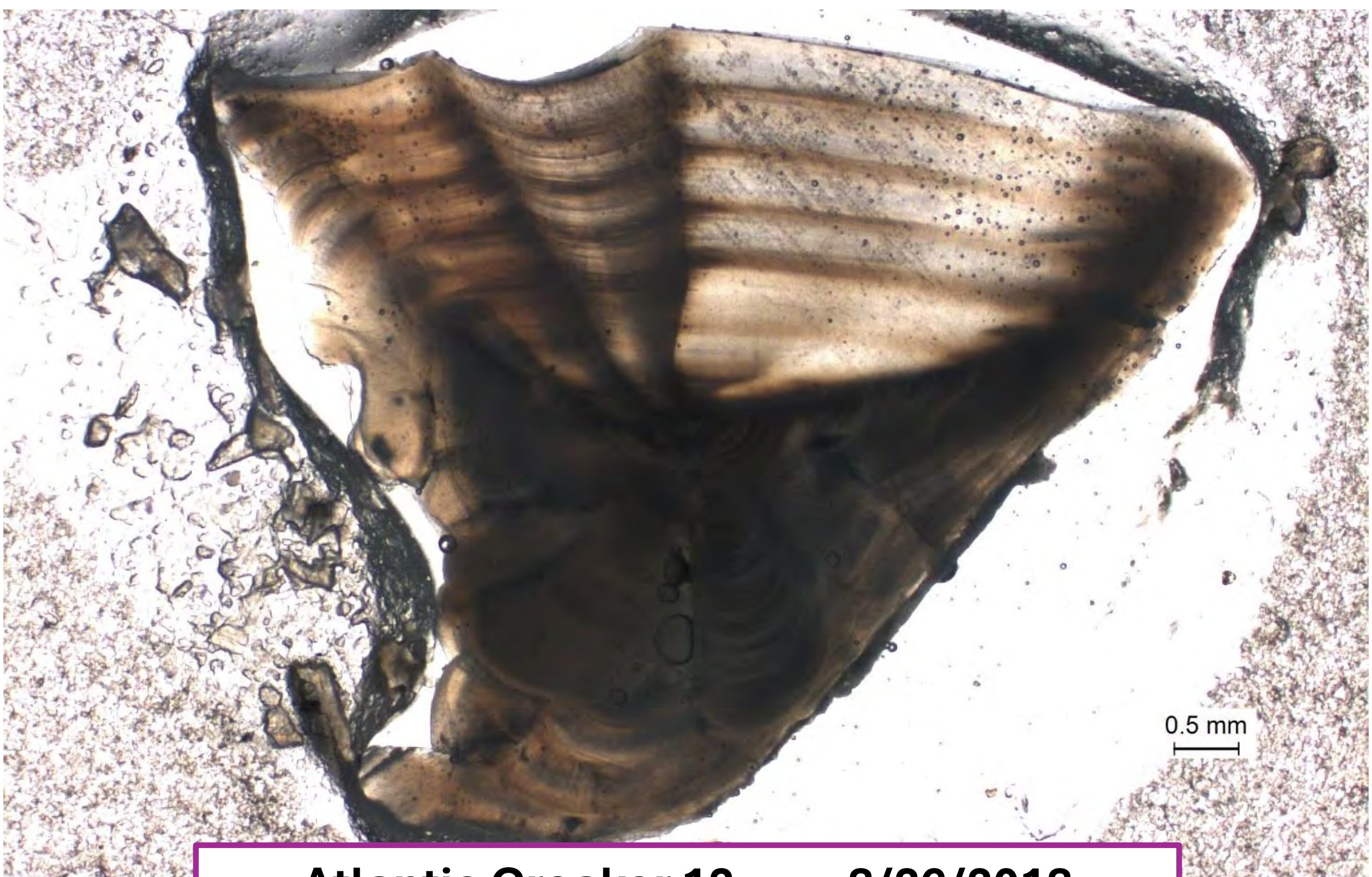
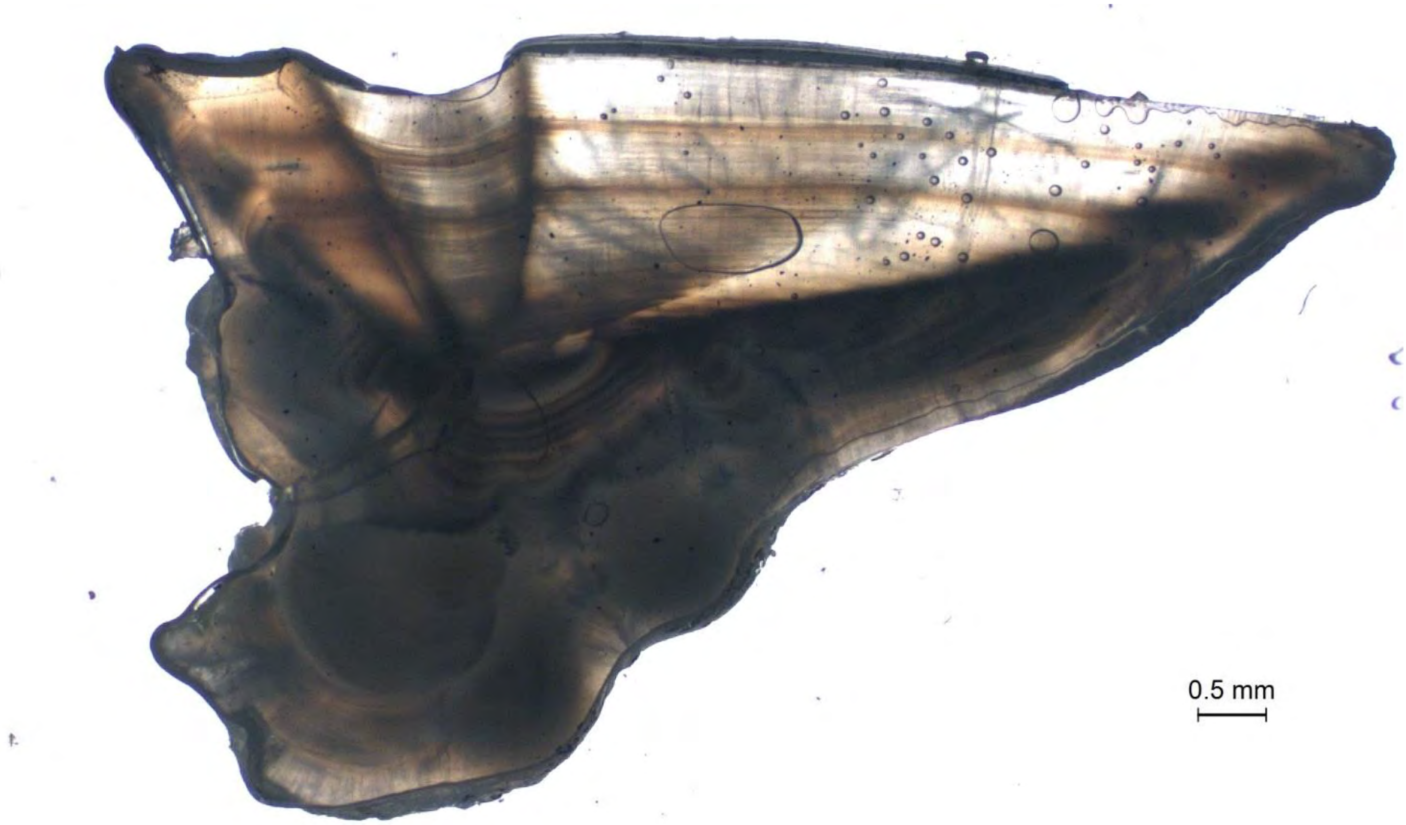
Atlantic Croaker 10 8/29/2022

Atlantic Croaker 11 10/3/2006



Atlantic Croaker 12 3/26/2013



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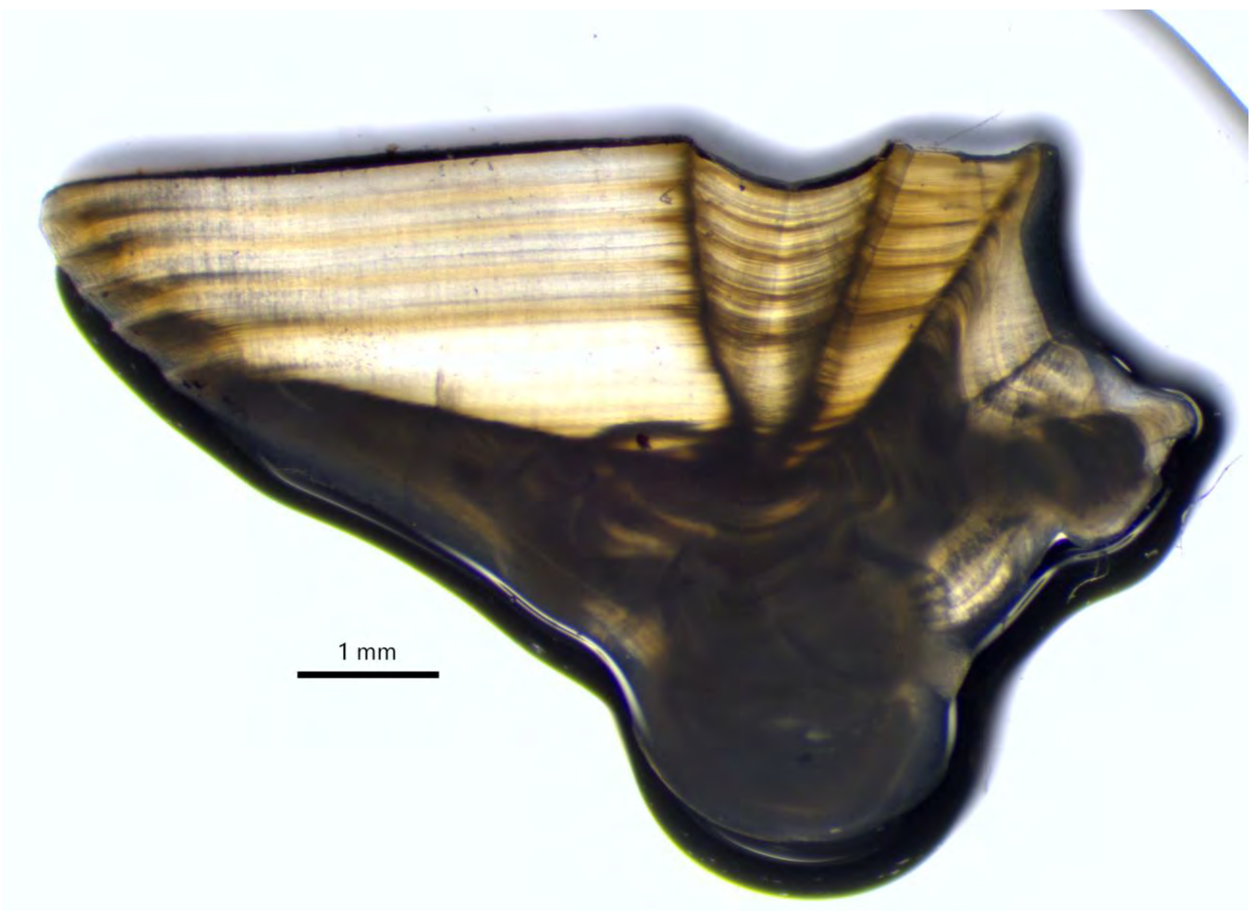

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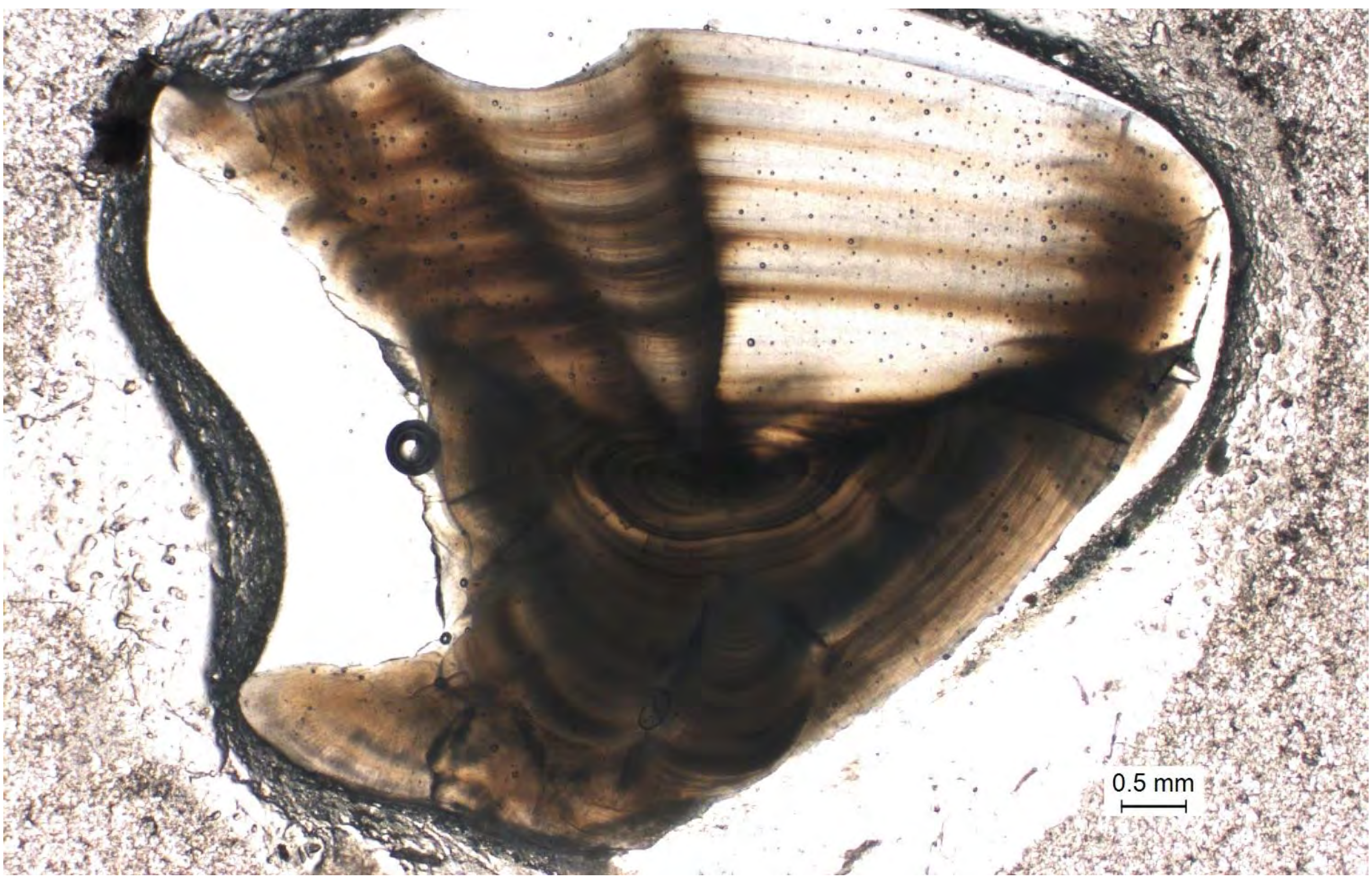
Atlantic Croaker 15 11/5/2014



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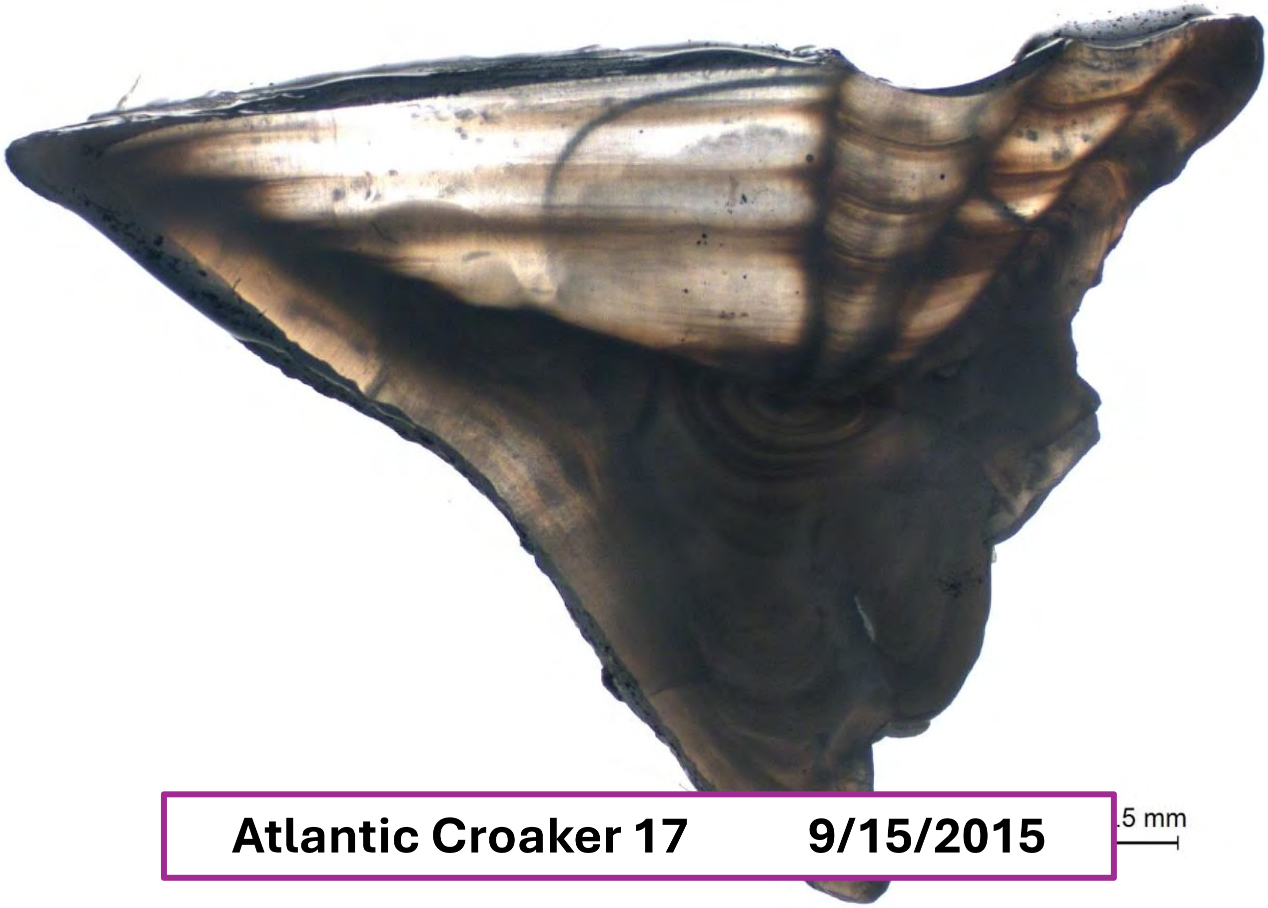

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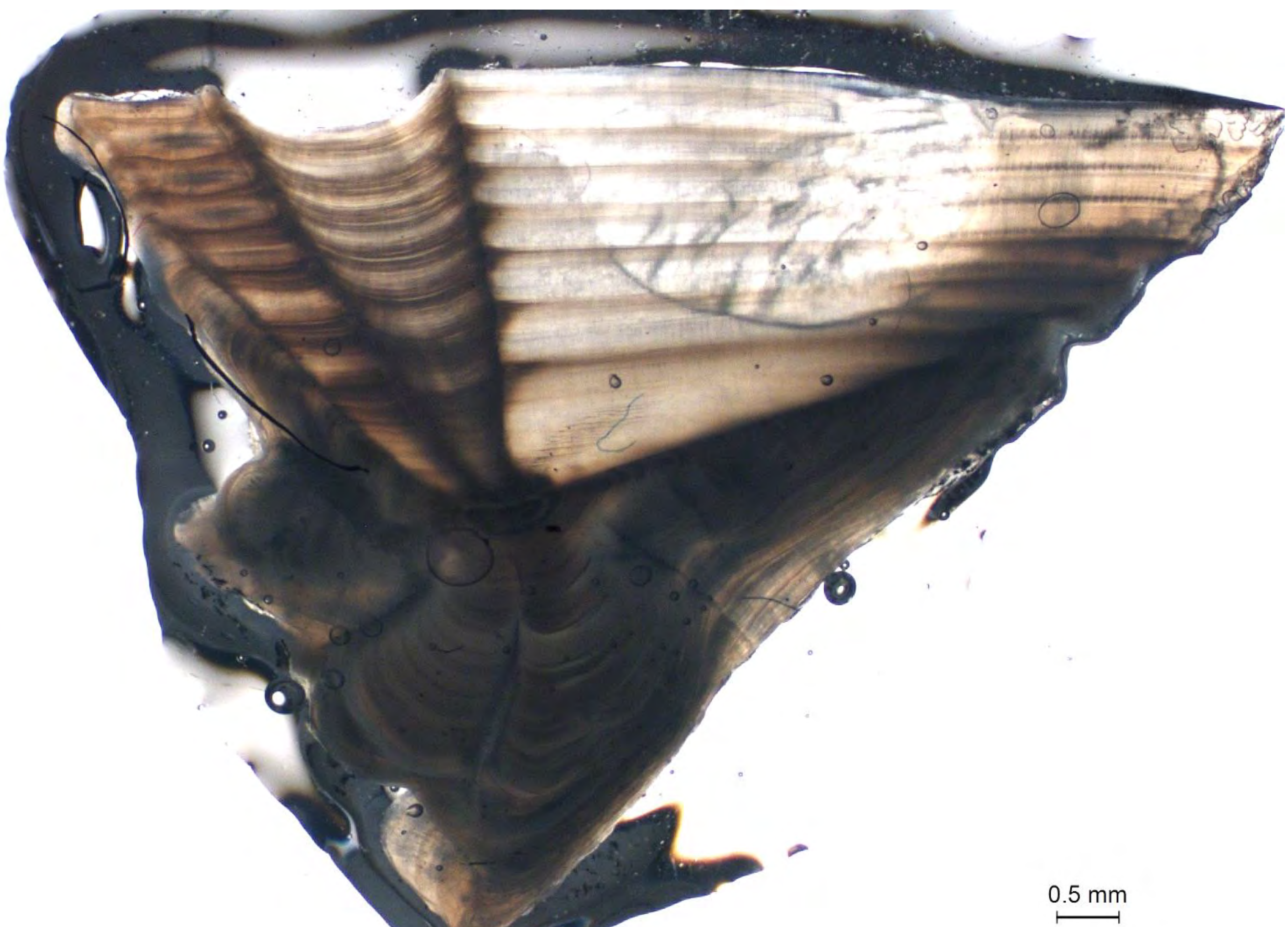

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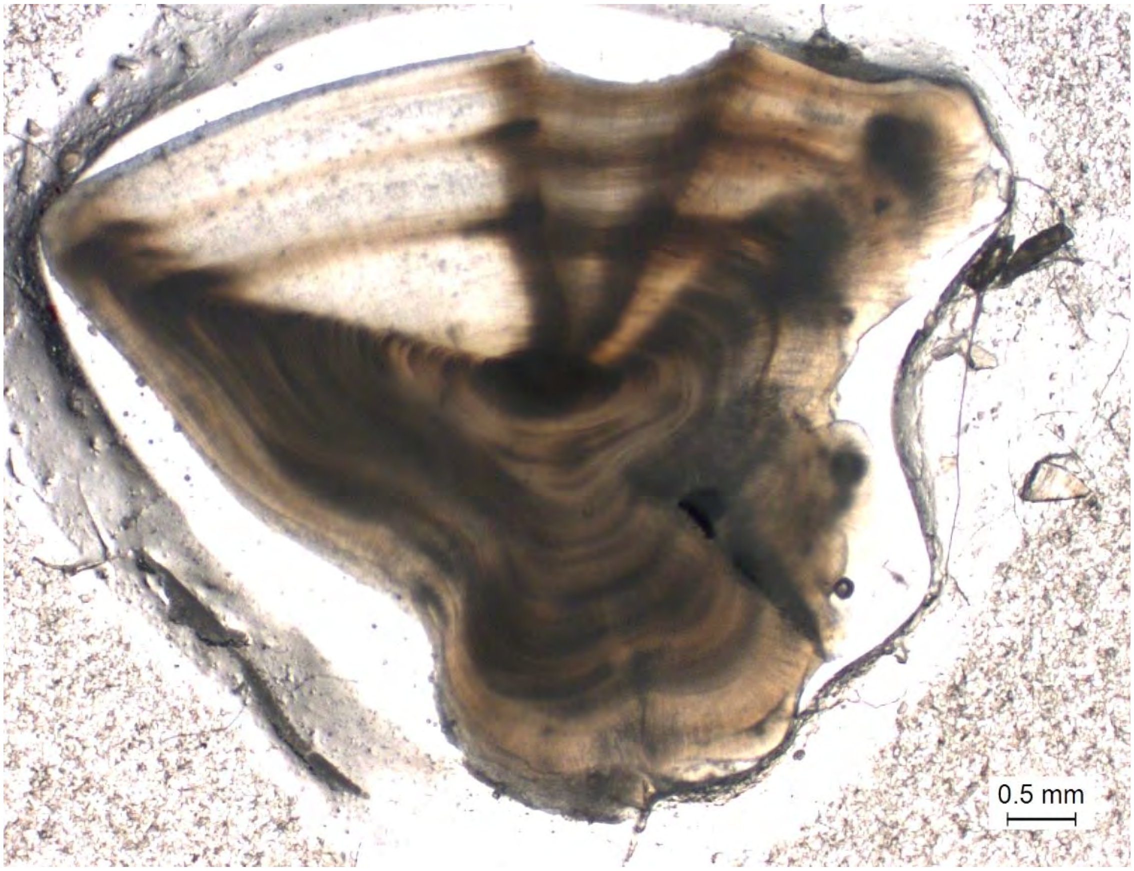
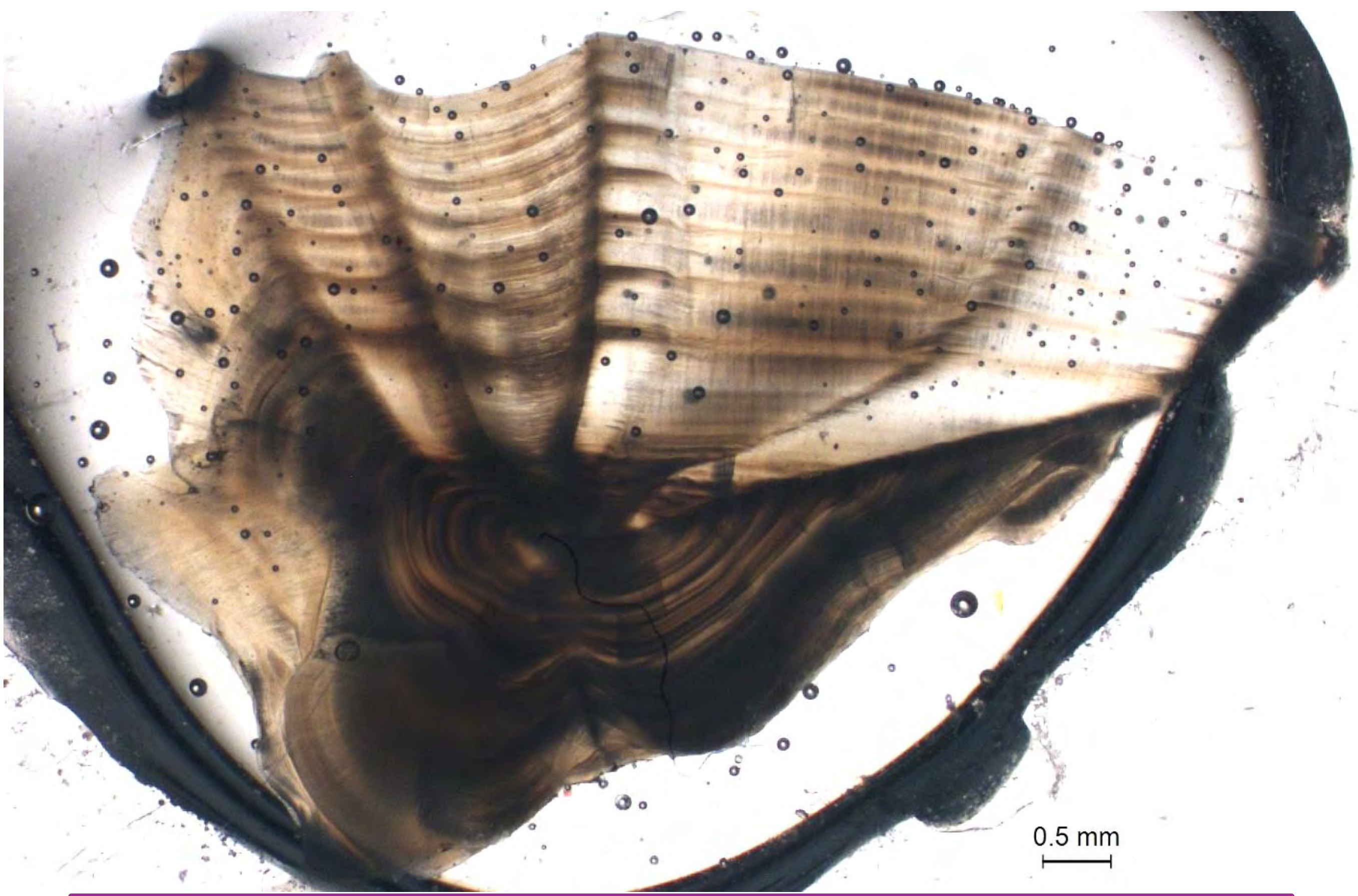


Atlantic Croaker 19 6/13/2013



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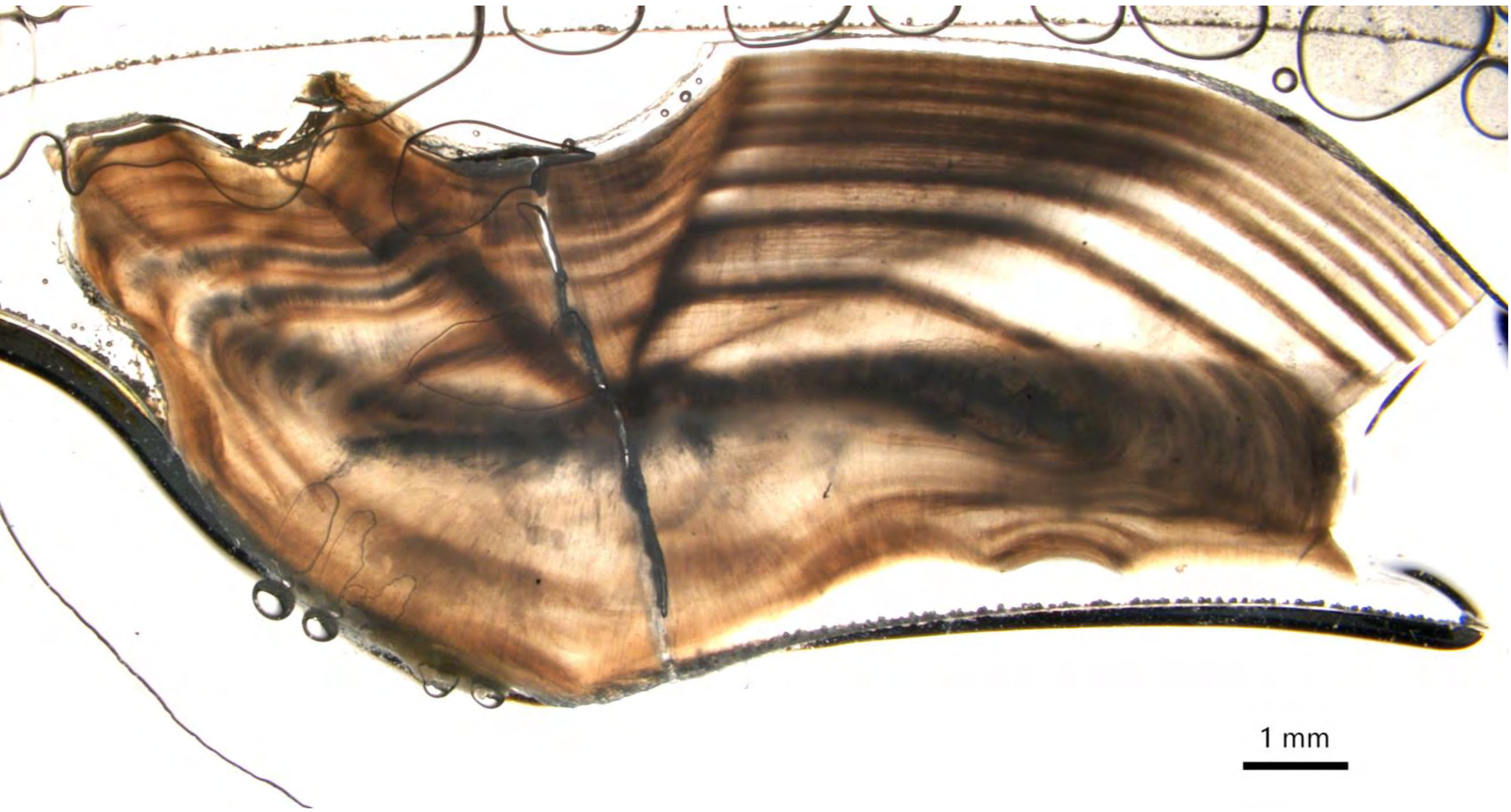
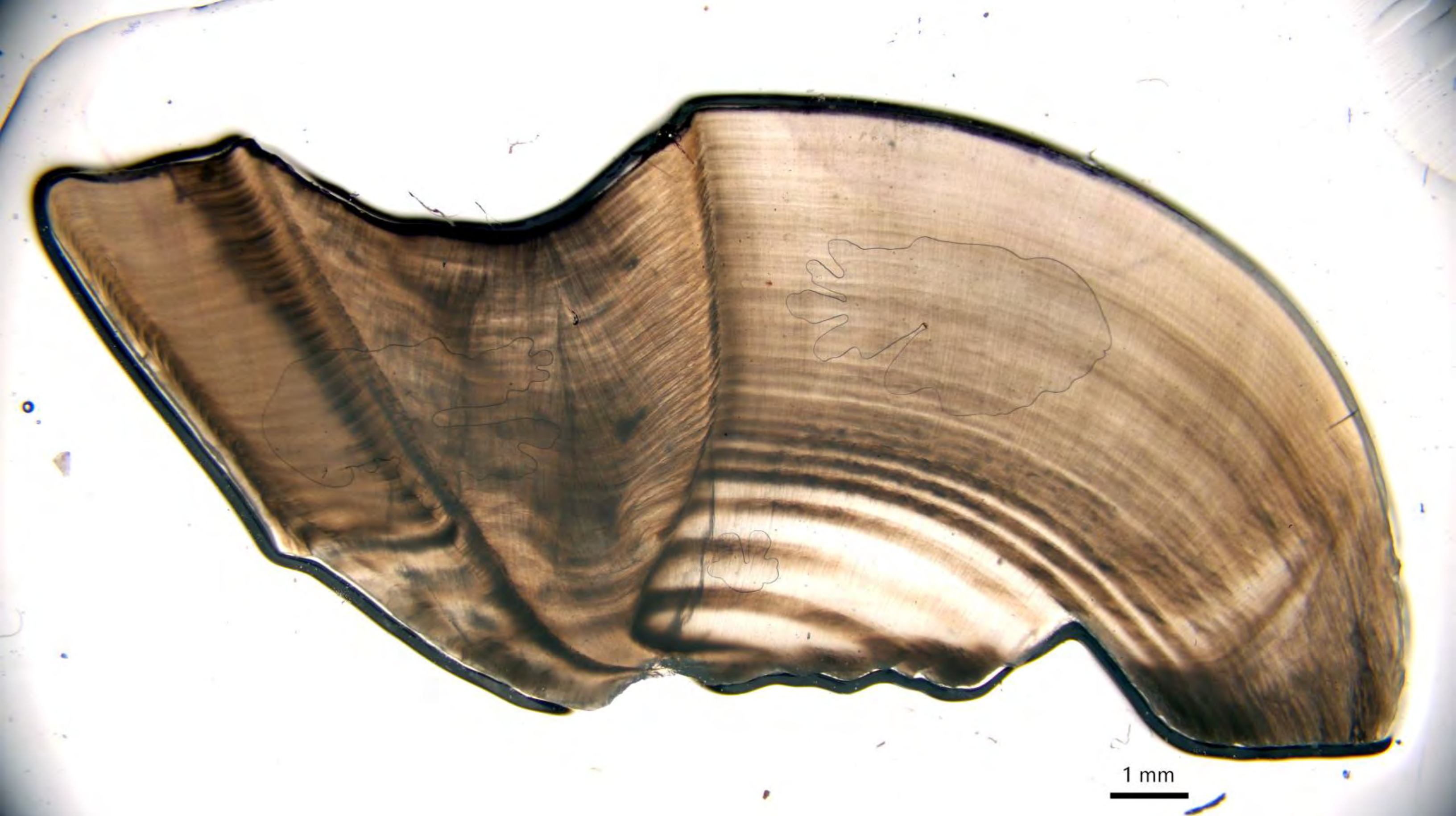
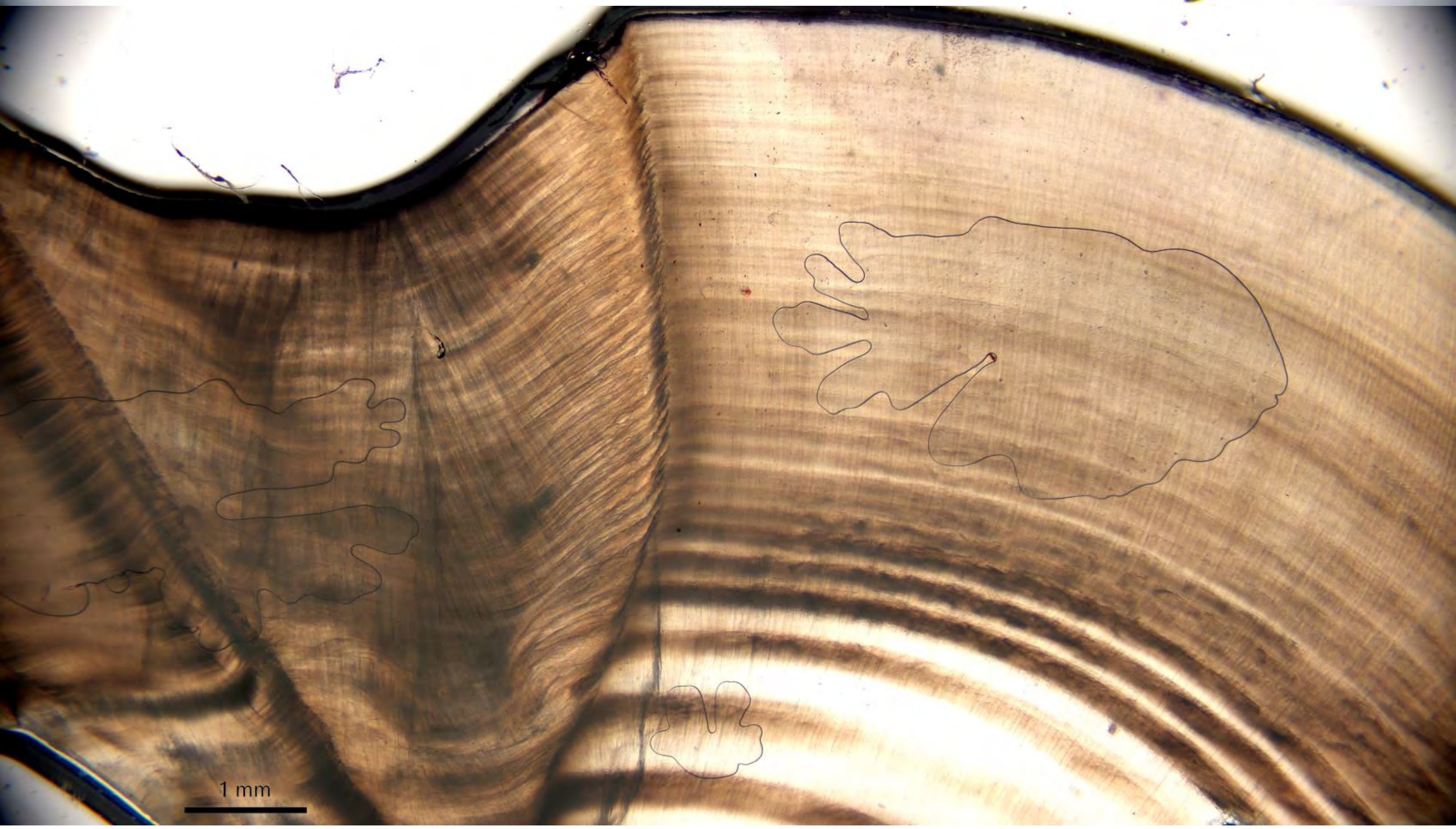


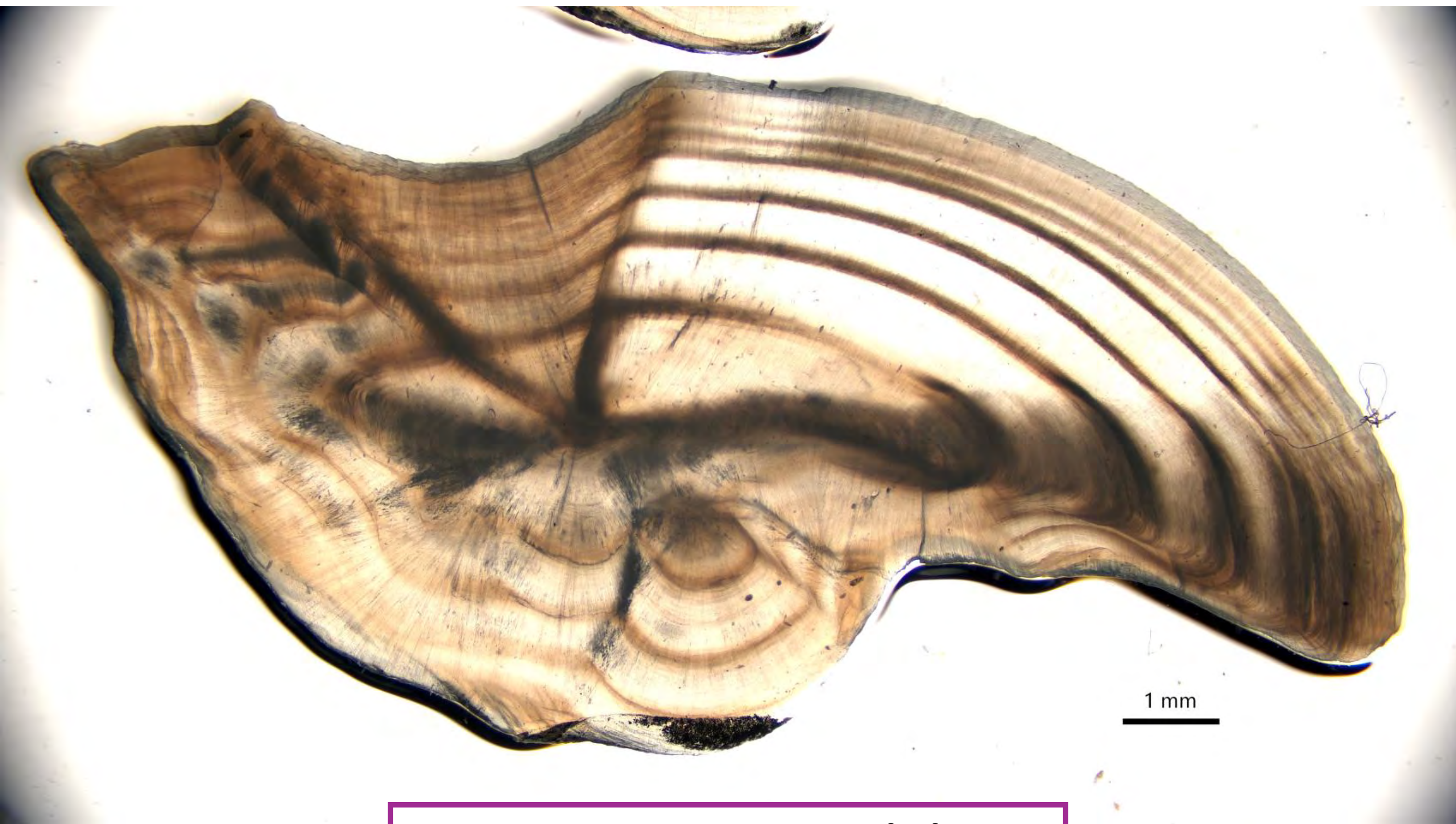
Black Drum 1 7/23/2005





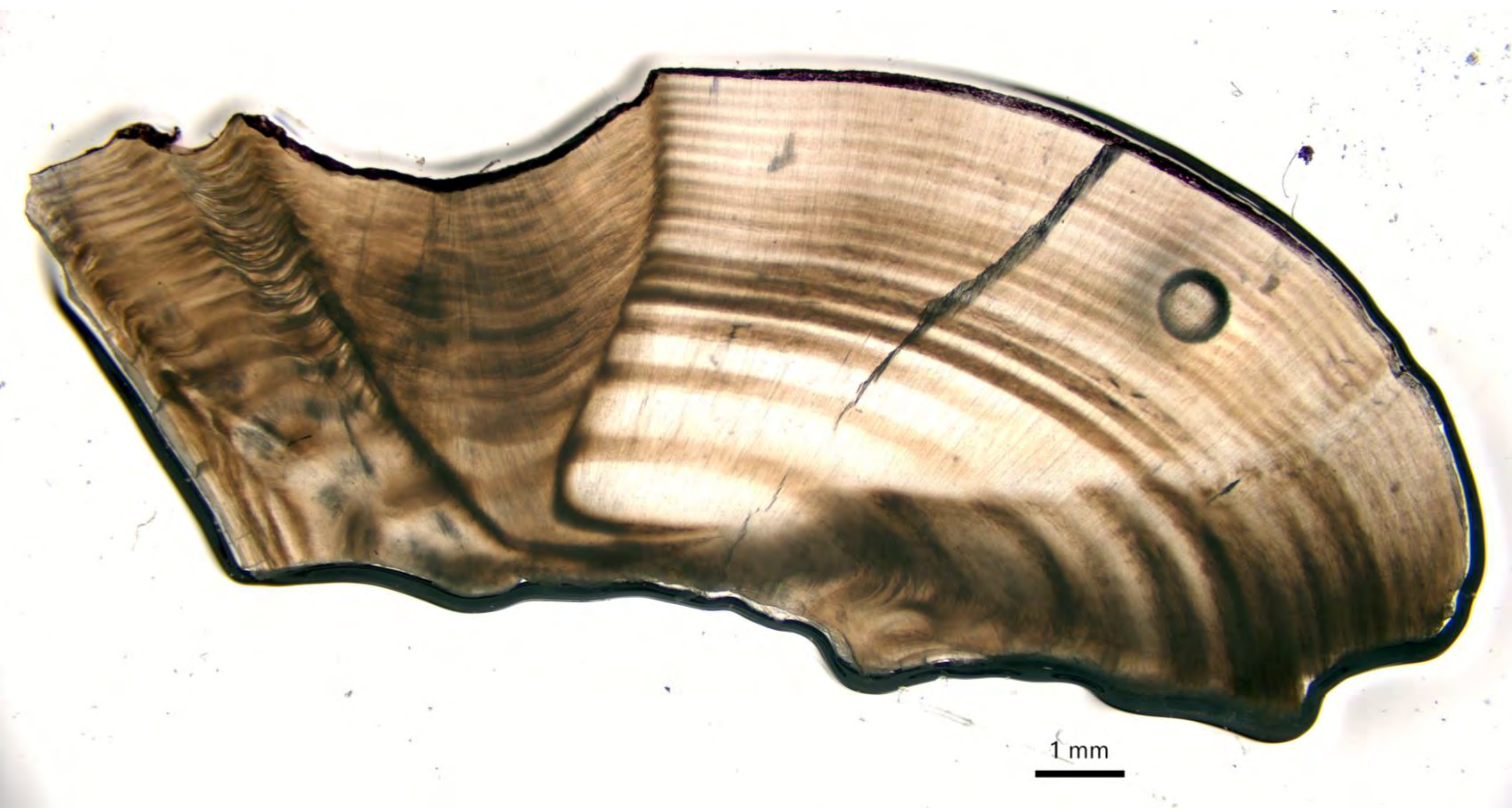
Black Drum 2 5/3/2022

Black Drum 3 8/4/2022



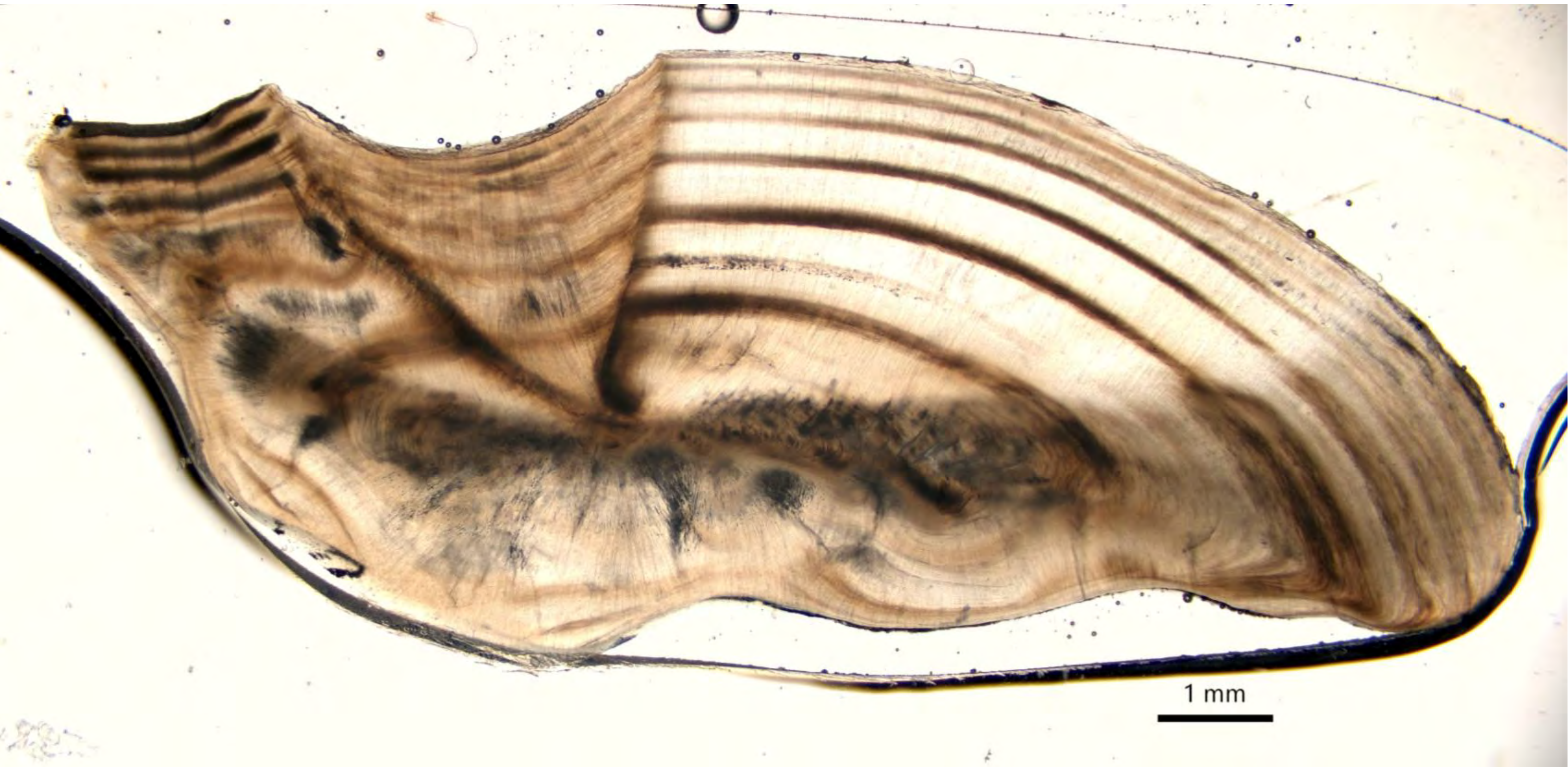
Black Drum 4 4/9/2015

Black Drum 5 4/8/2015



Black Drum 6 6/1/2022

Black Drum 7 10/15/2022



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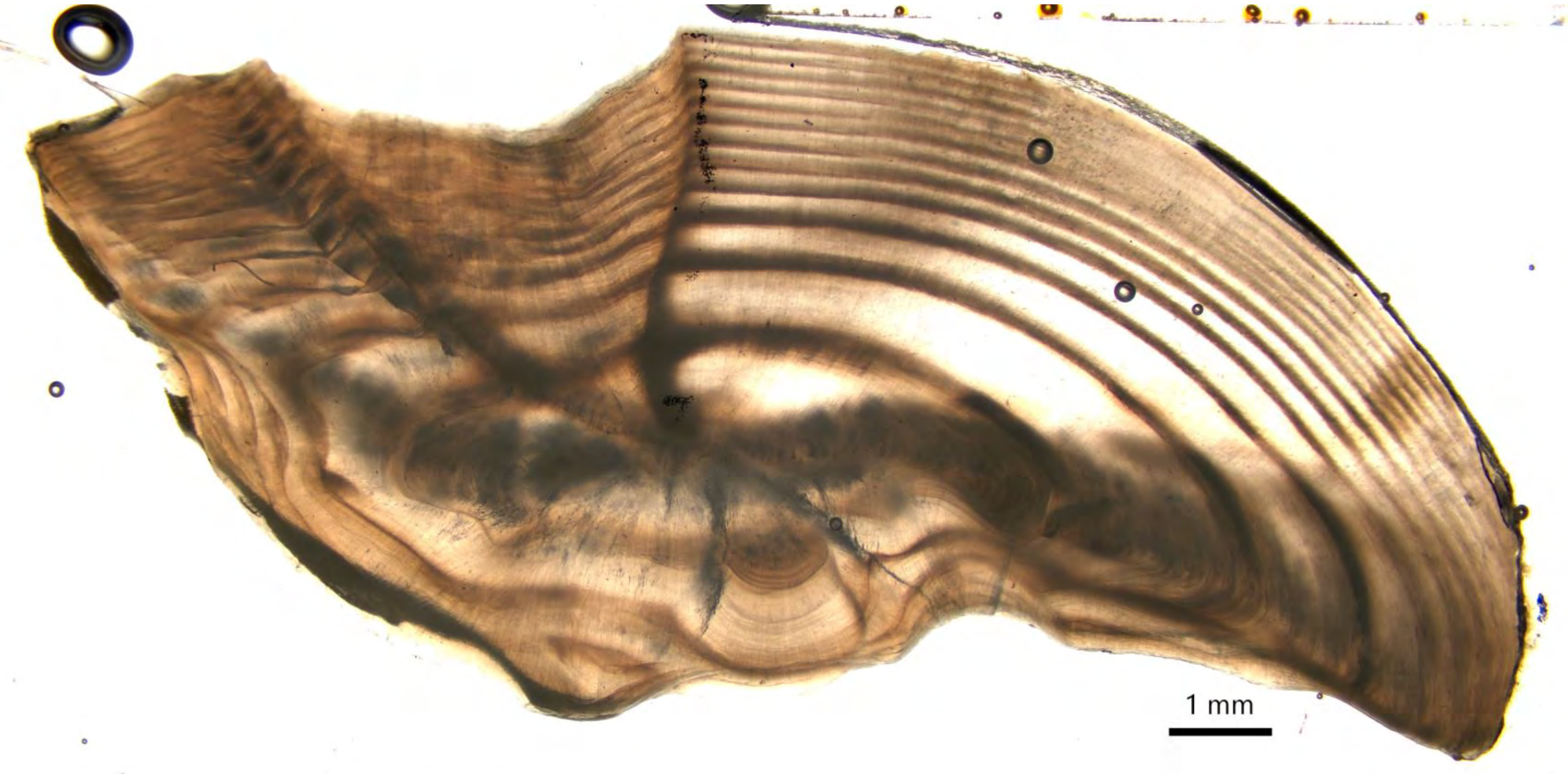
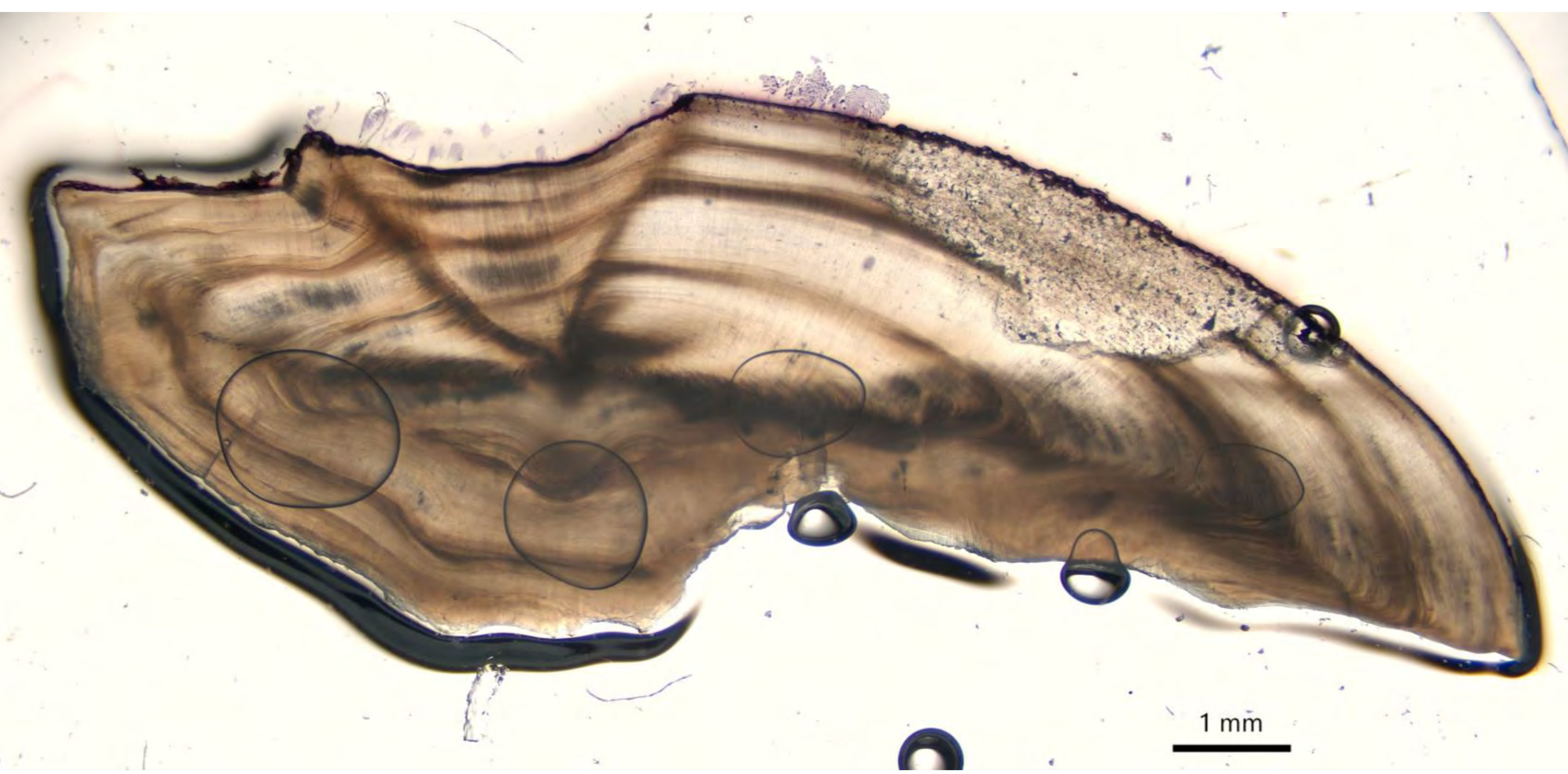


Black Drum 9 7/17/2004



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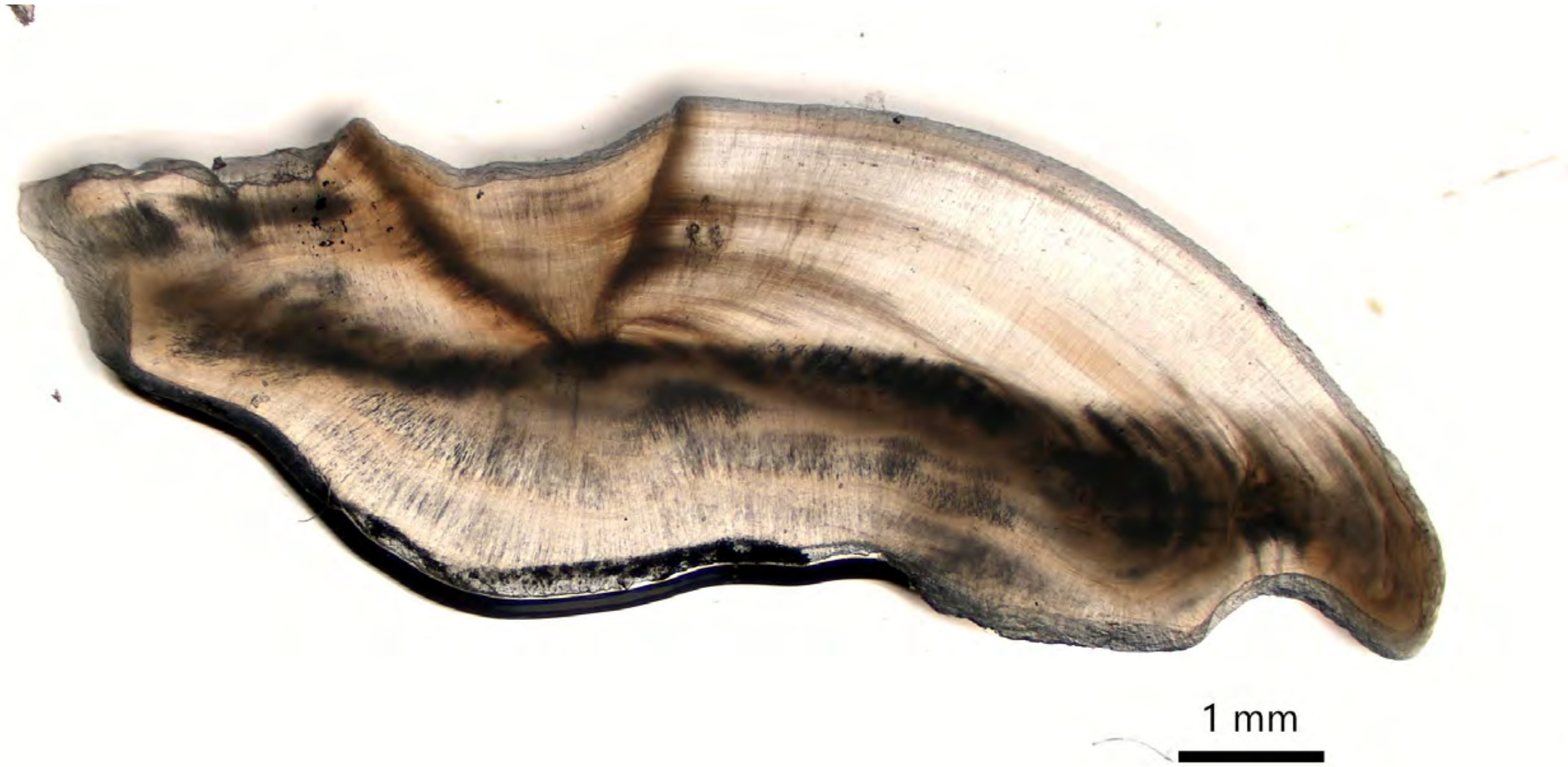
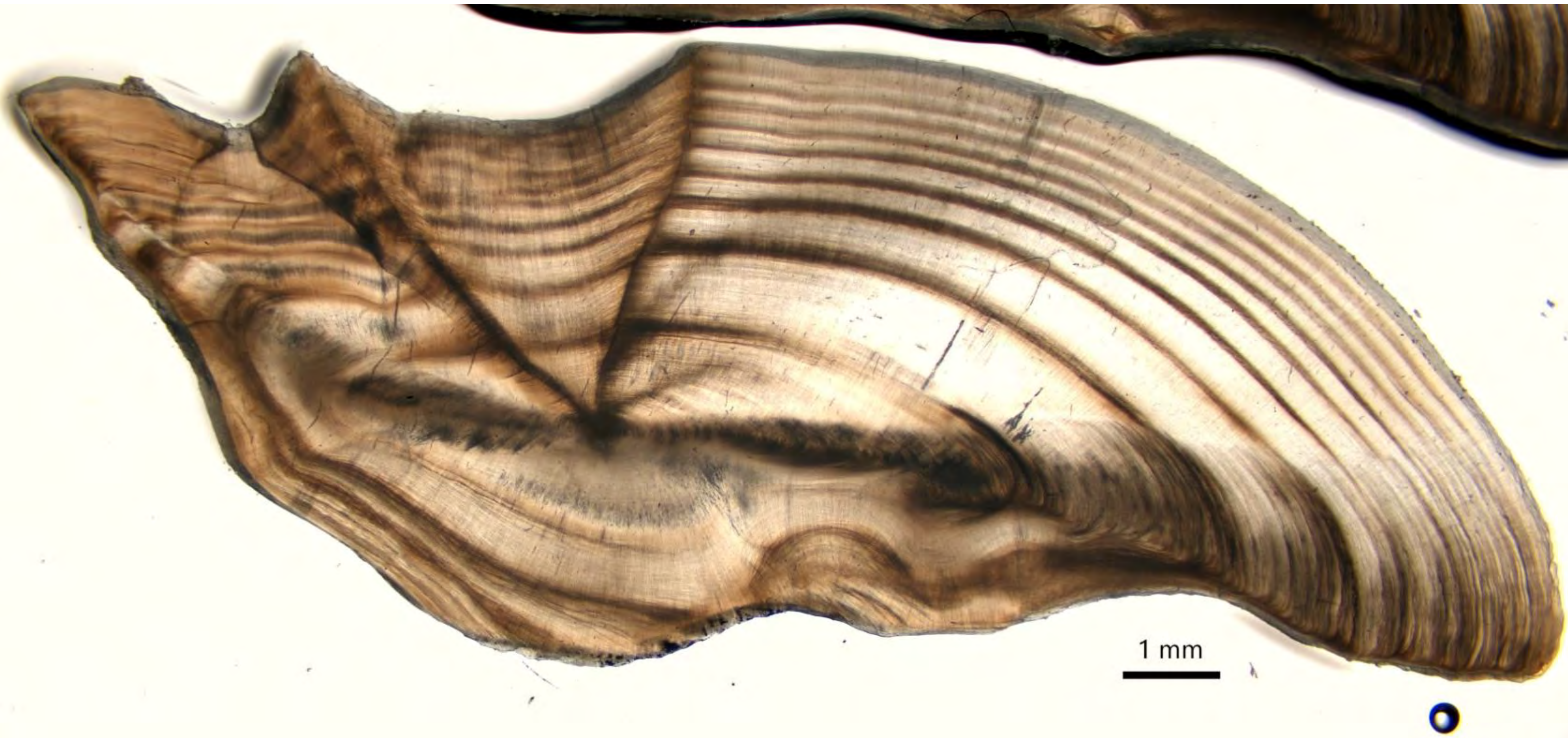
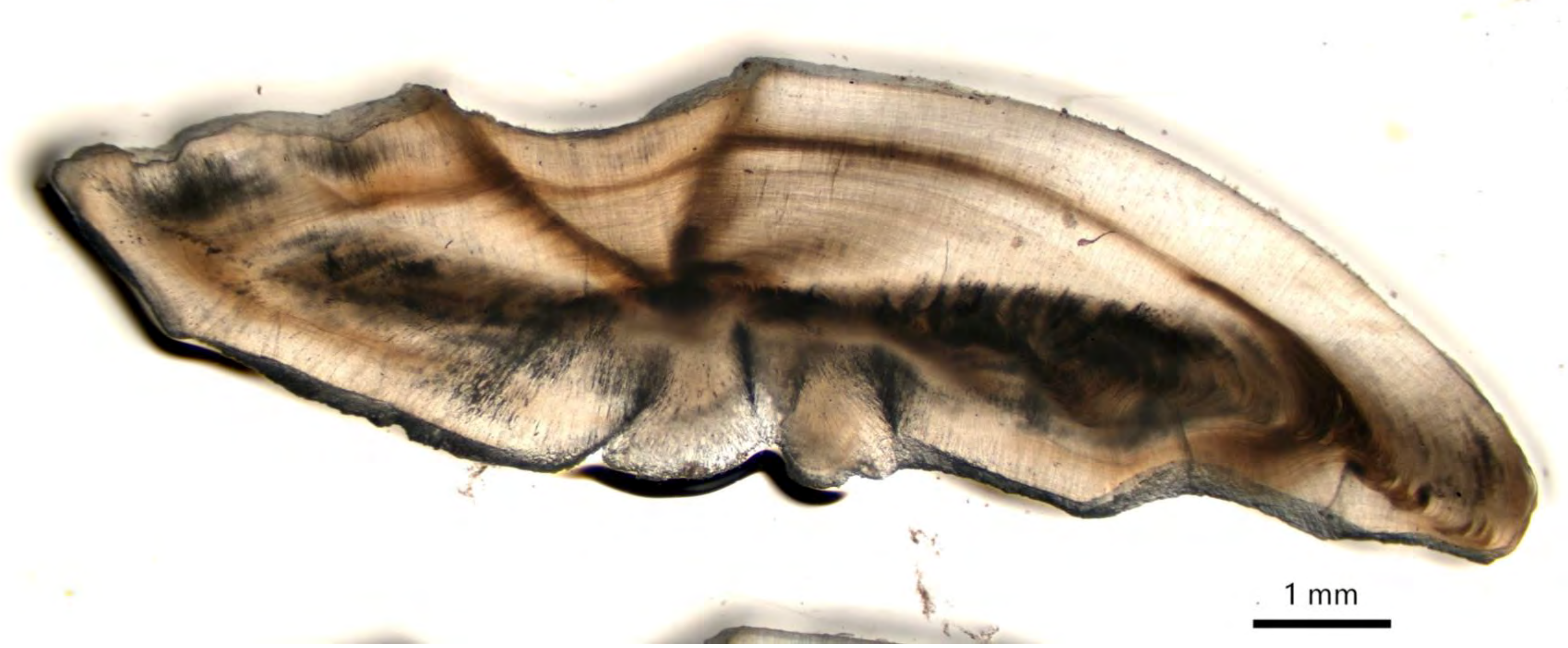


Black Drum 11 12/17/2017



Black Drum 12 4/1/2015

Black Drum 13 6/7/2022



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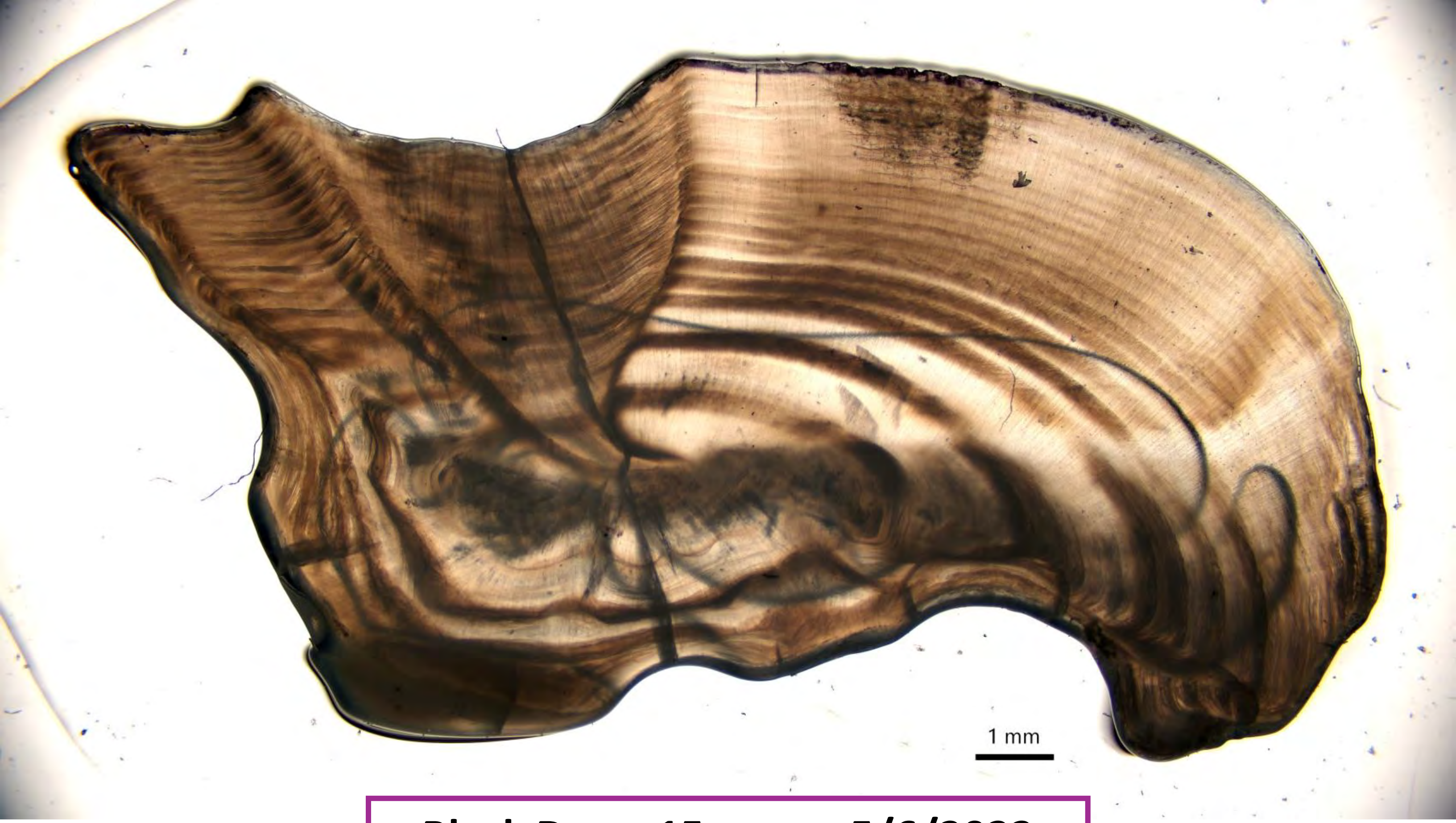
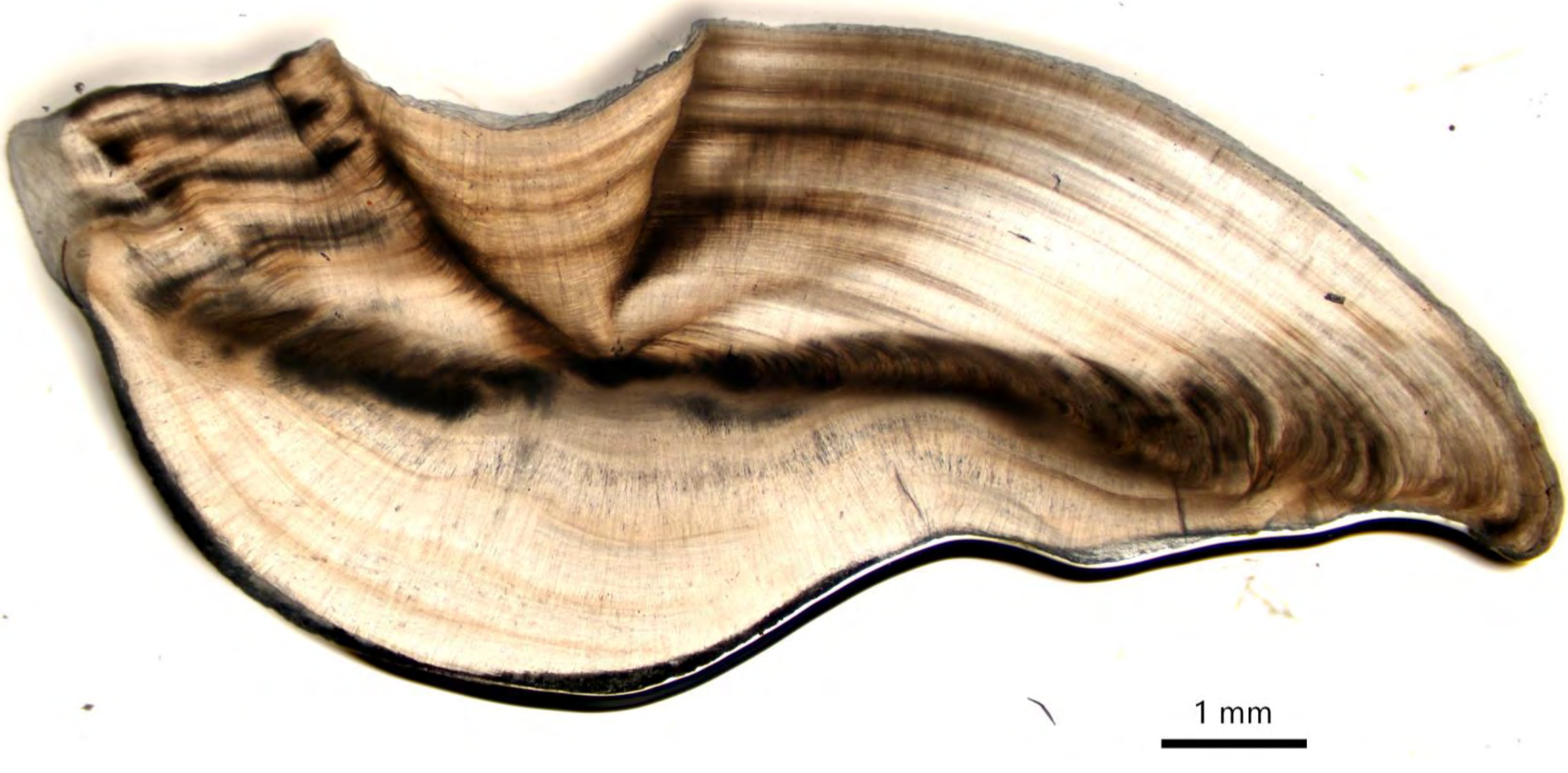


Black Drum 15 5/6/2022

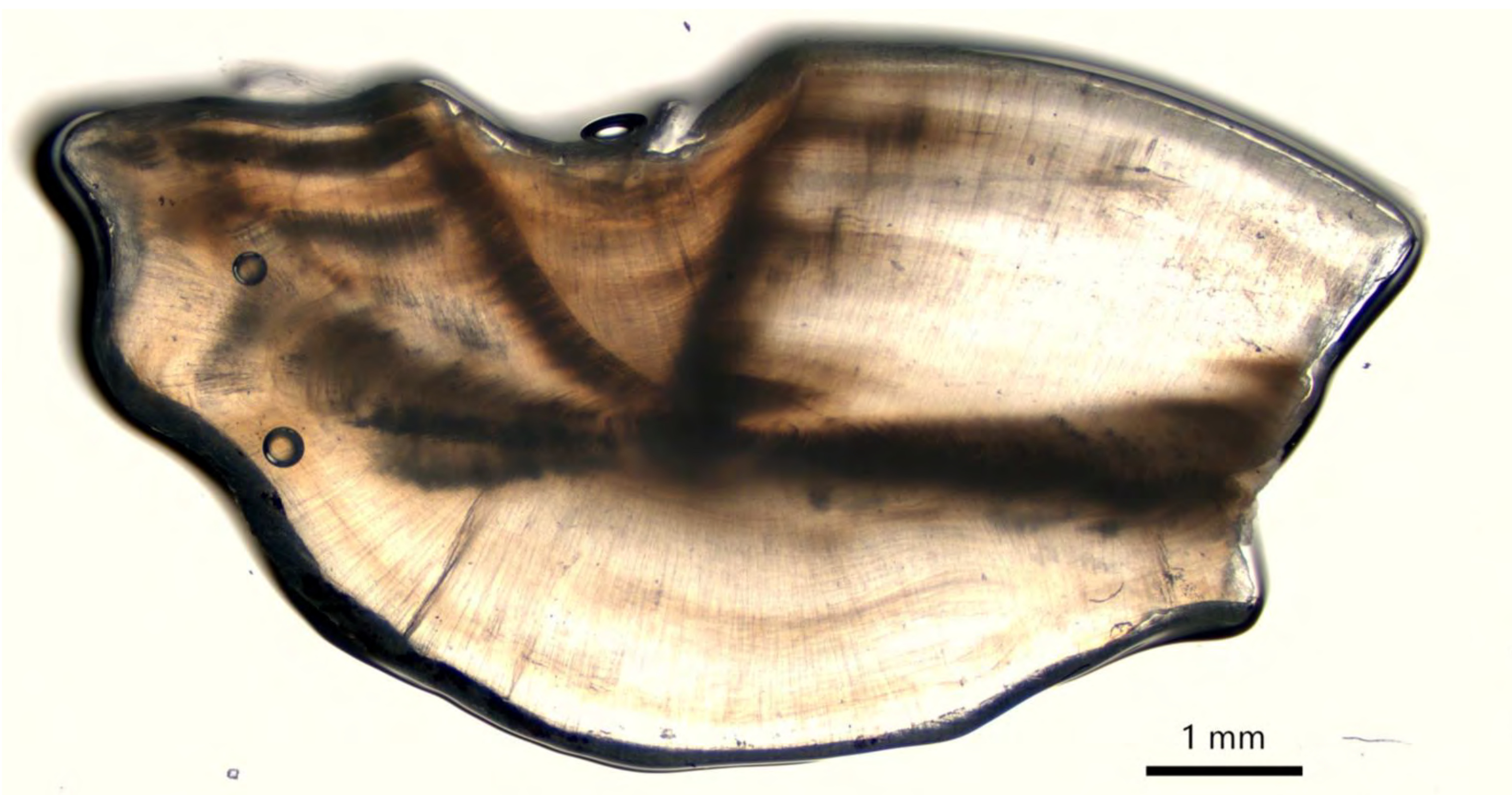
Black Drum 16 1/4/2022

Black Drum 17　　11/7/2022



Black Drum 18　　6/15/2020

Black Drum 19 9/20/2022



Black Drum 20 2/5/2019

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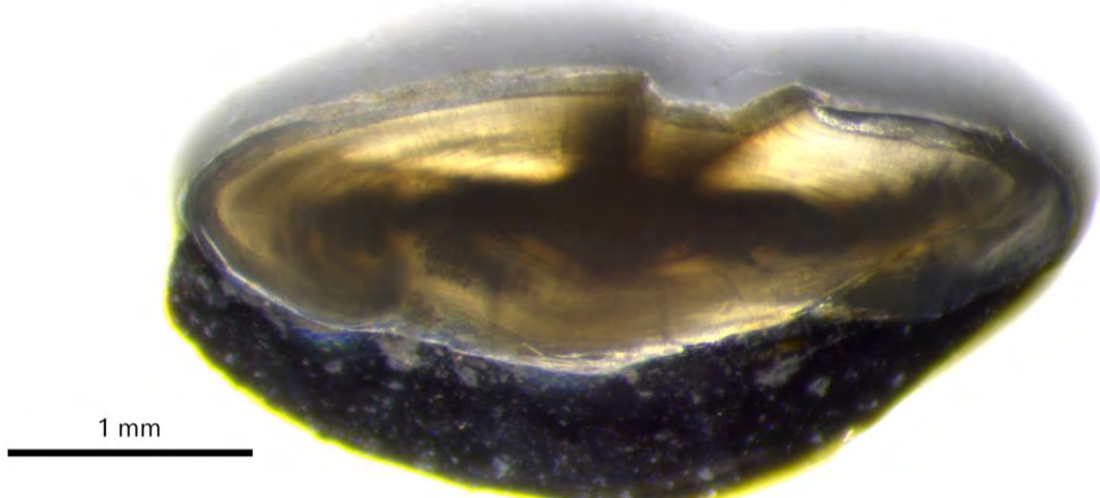
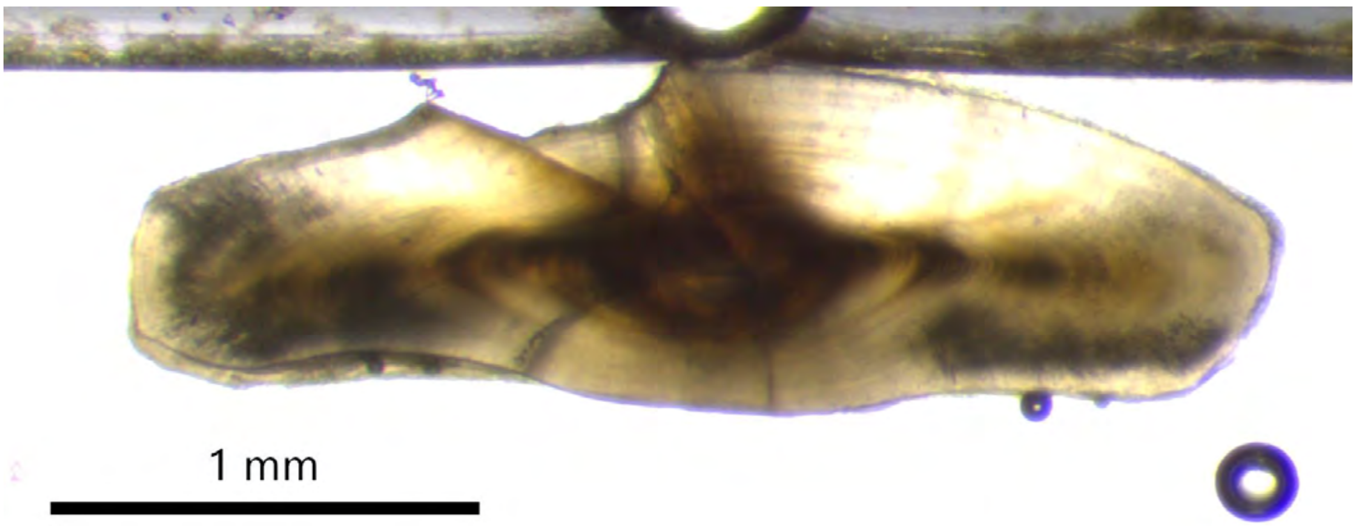


Spot 1 8/19/2014



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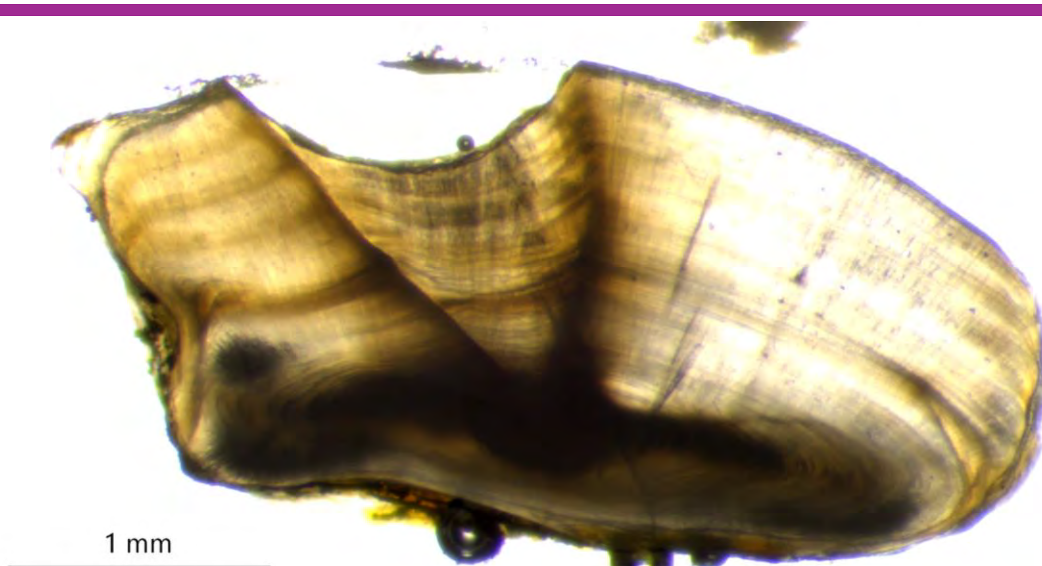
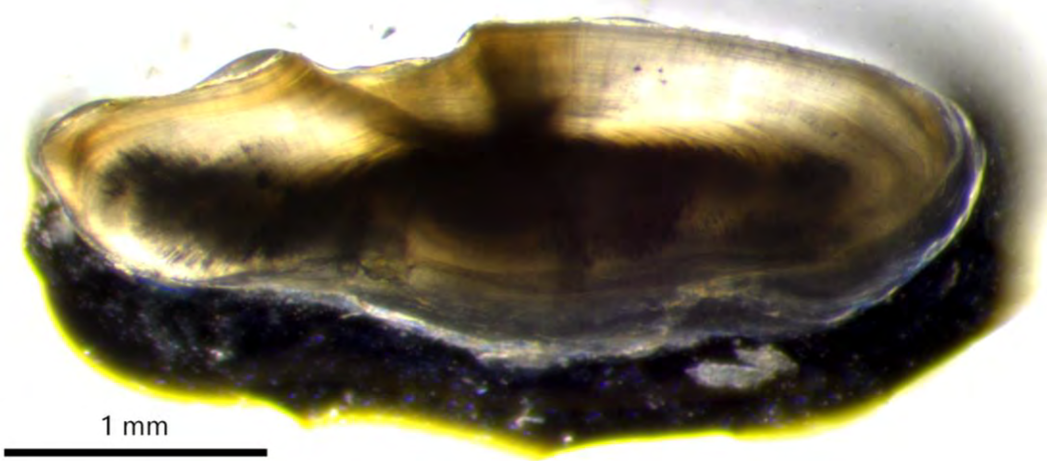


Spot 3 12/19/2016



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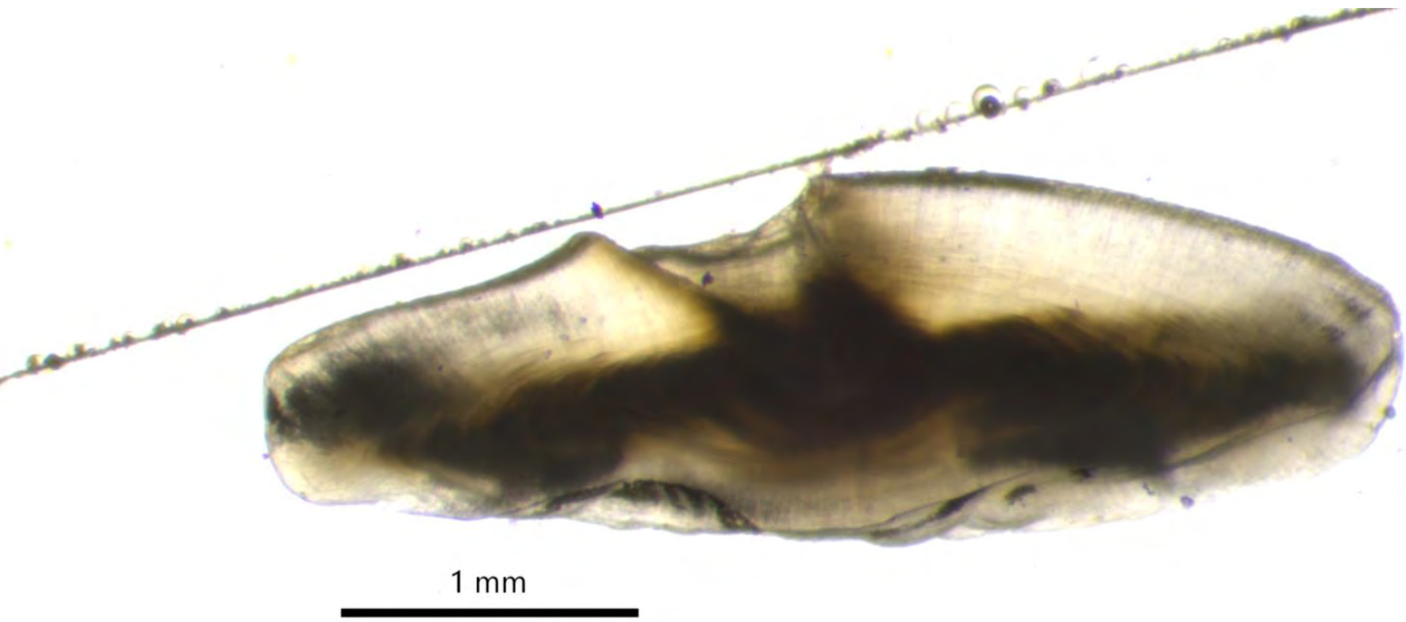

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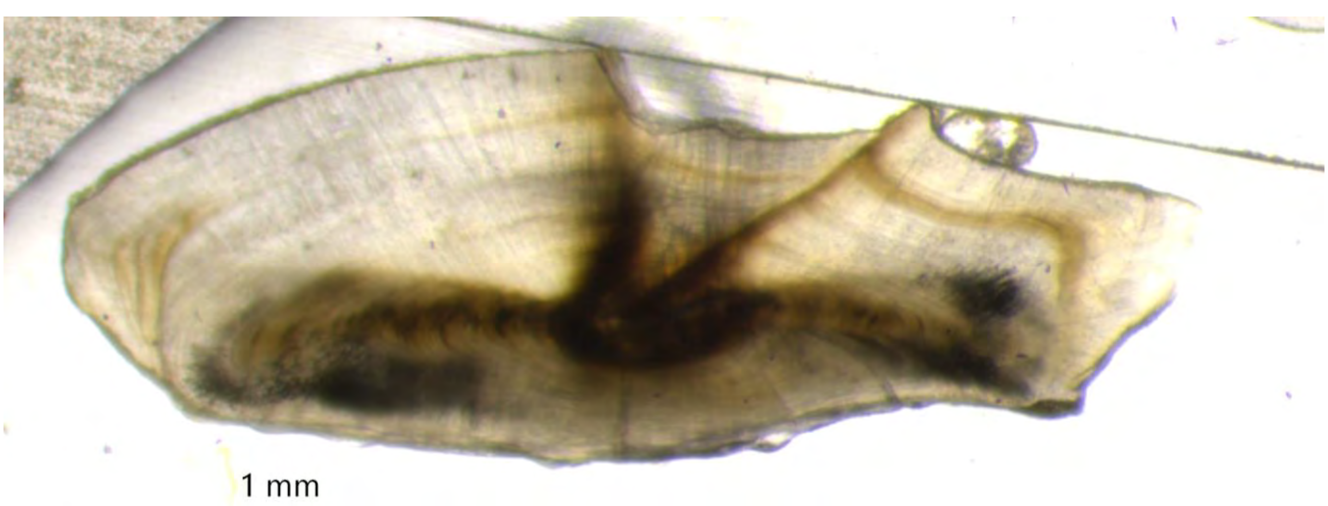
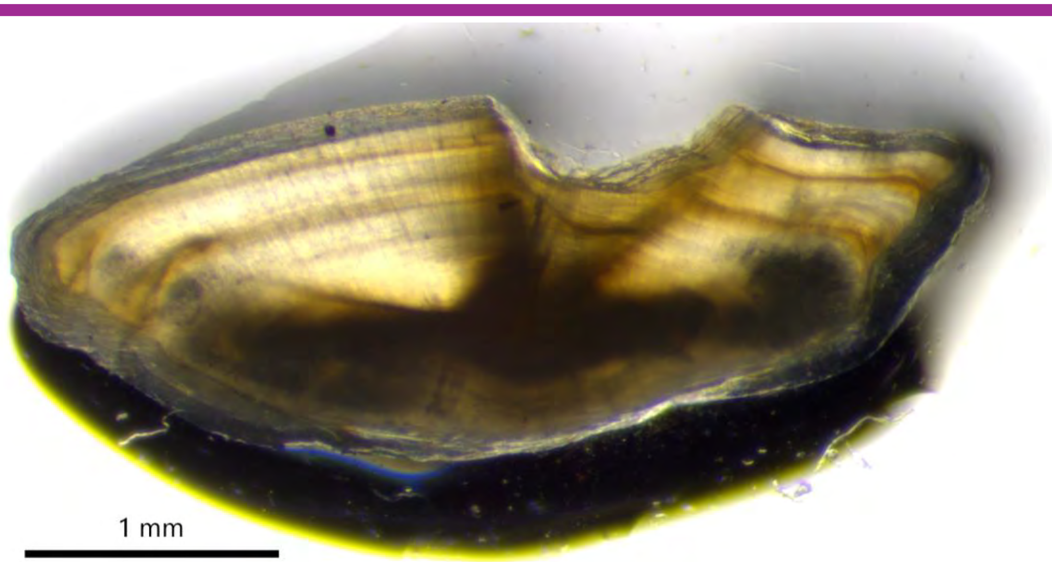


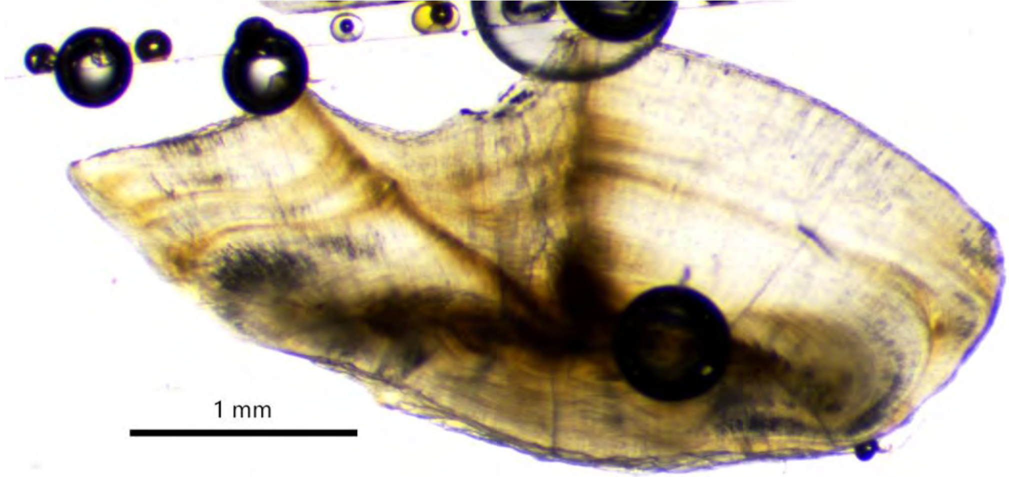
Spot 6 9/12/2022

Spot 7 7/21/2021

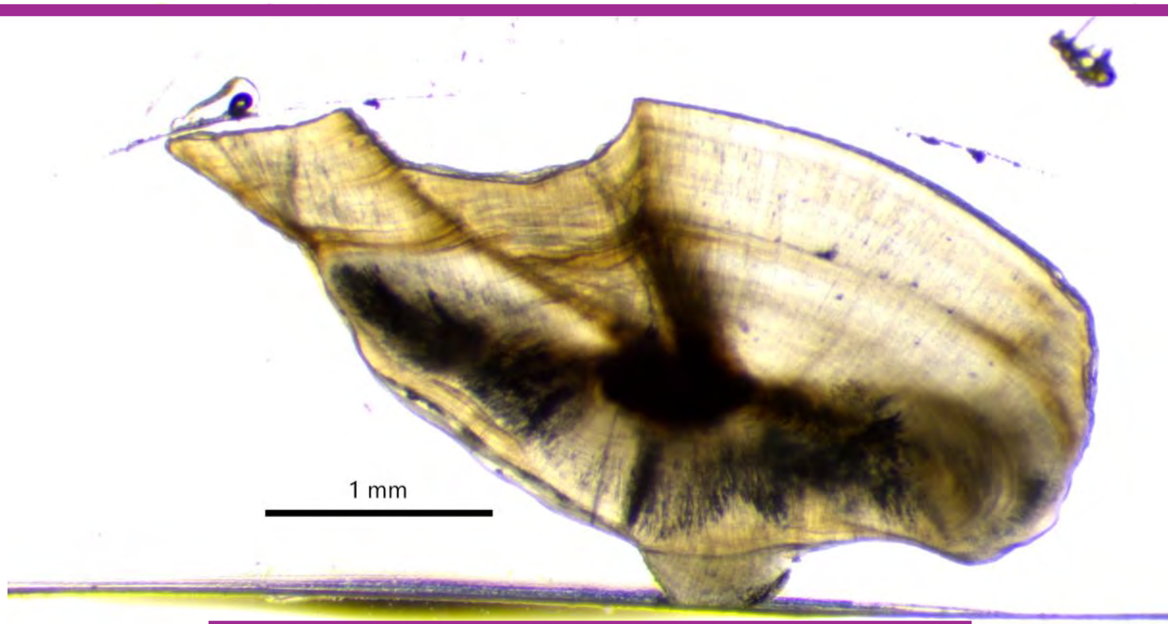
Spot 8 10/17/2022



Spot 9 8/19/2014

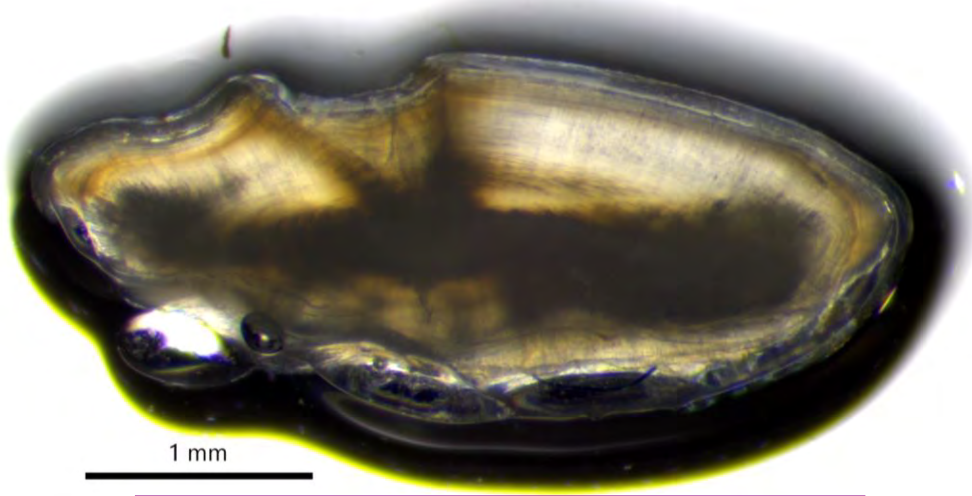


Spot 10 9/26/2022

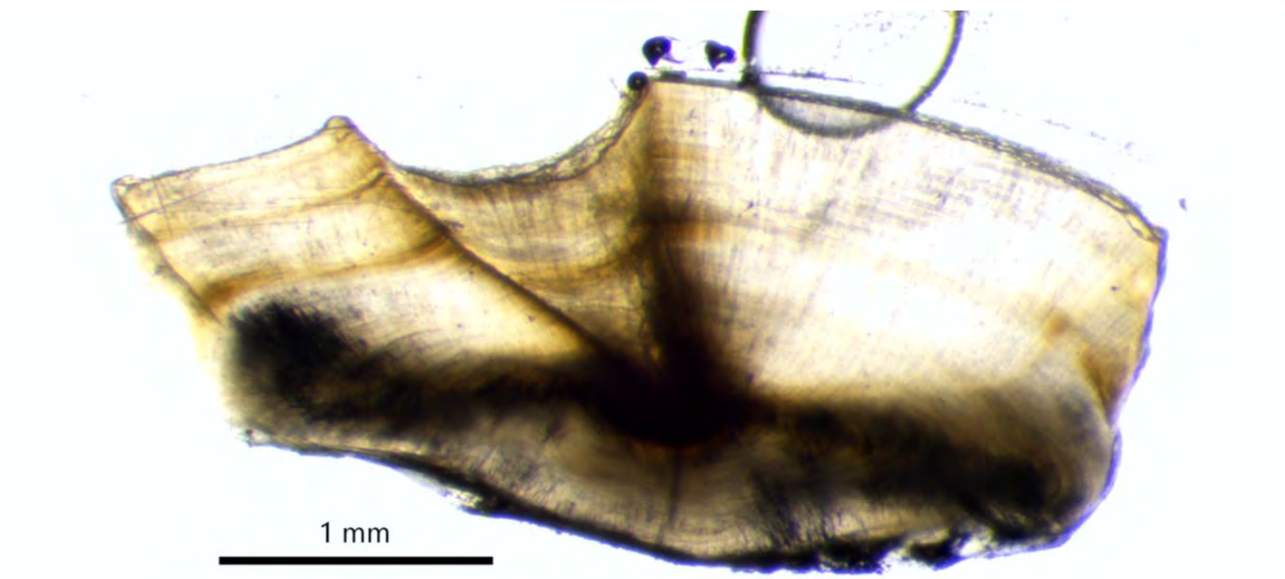


Spot 11 5/8/2017

Spot 12 5/16/2022

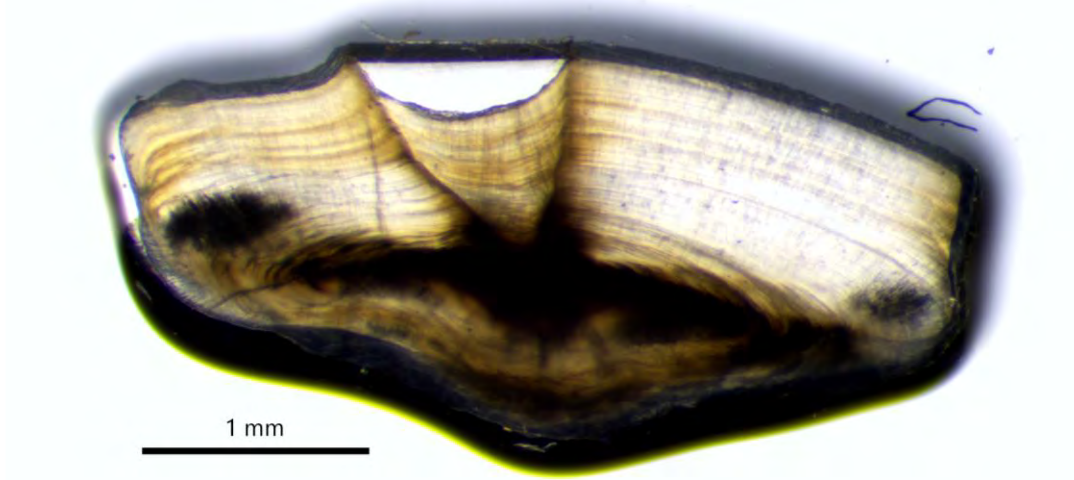


Spot 13 6/16/2014



Spot 14 7/21/2021

Spot 15 3/4/2022



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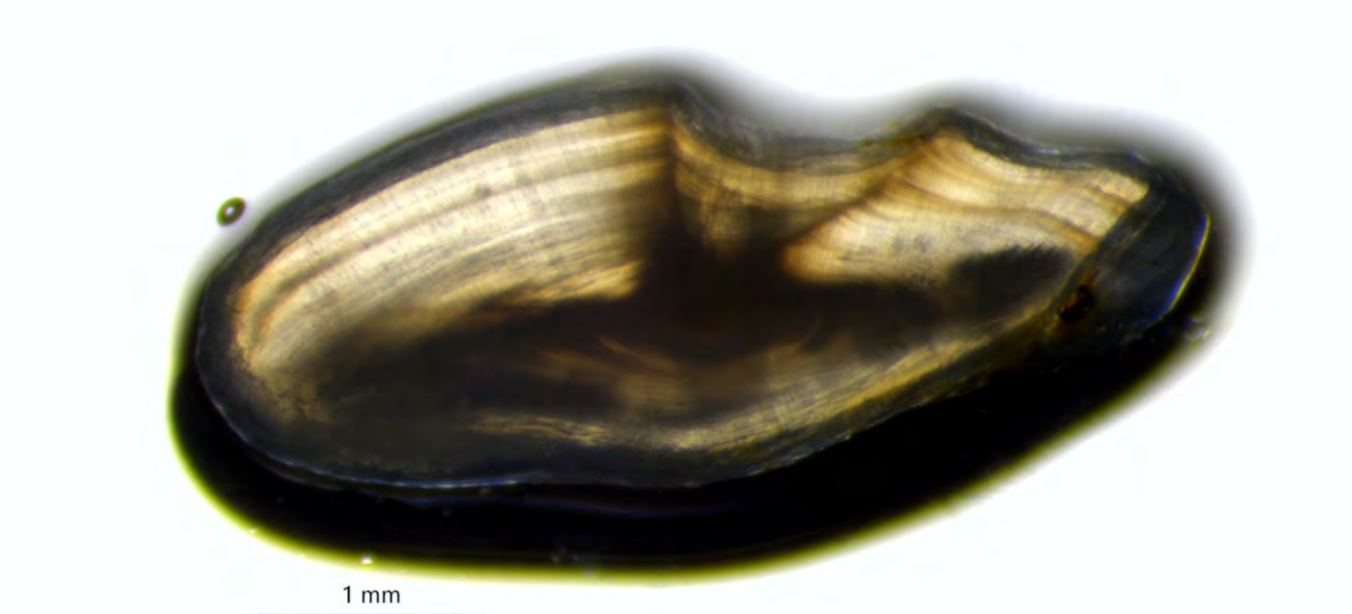
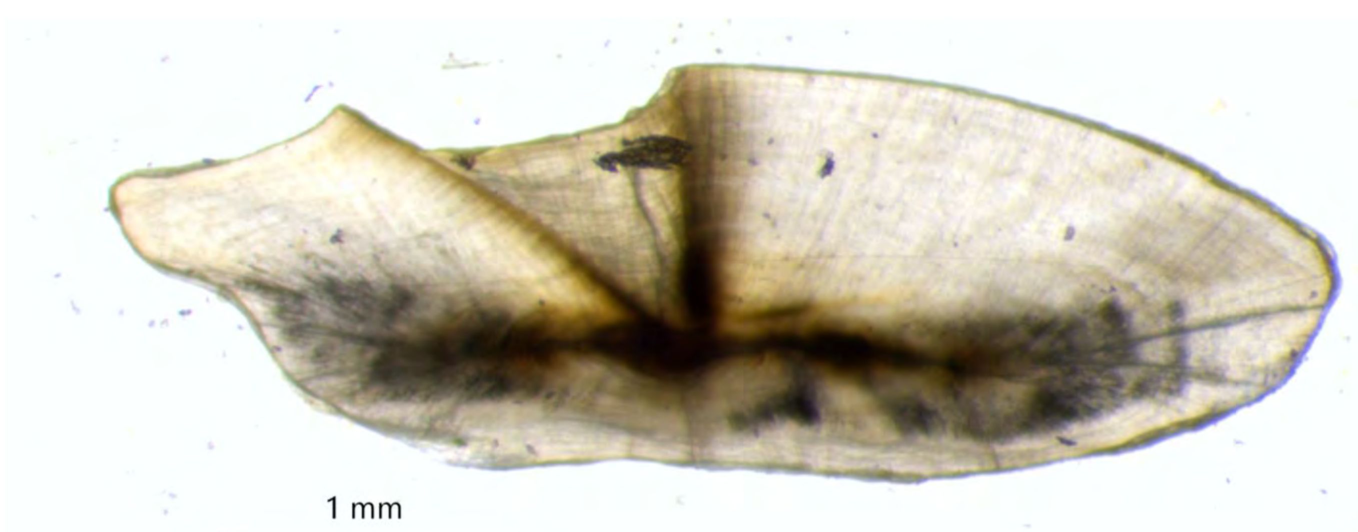
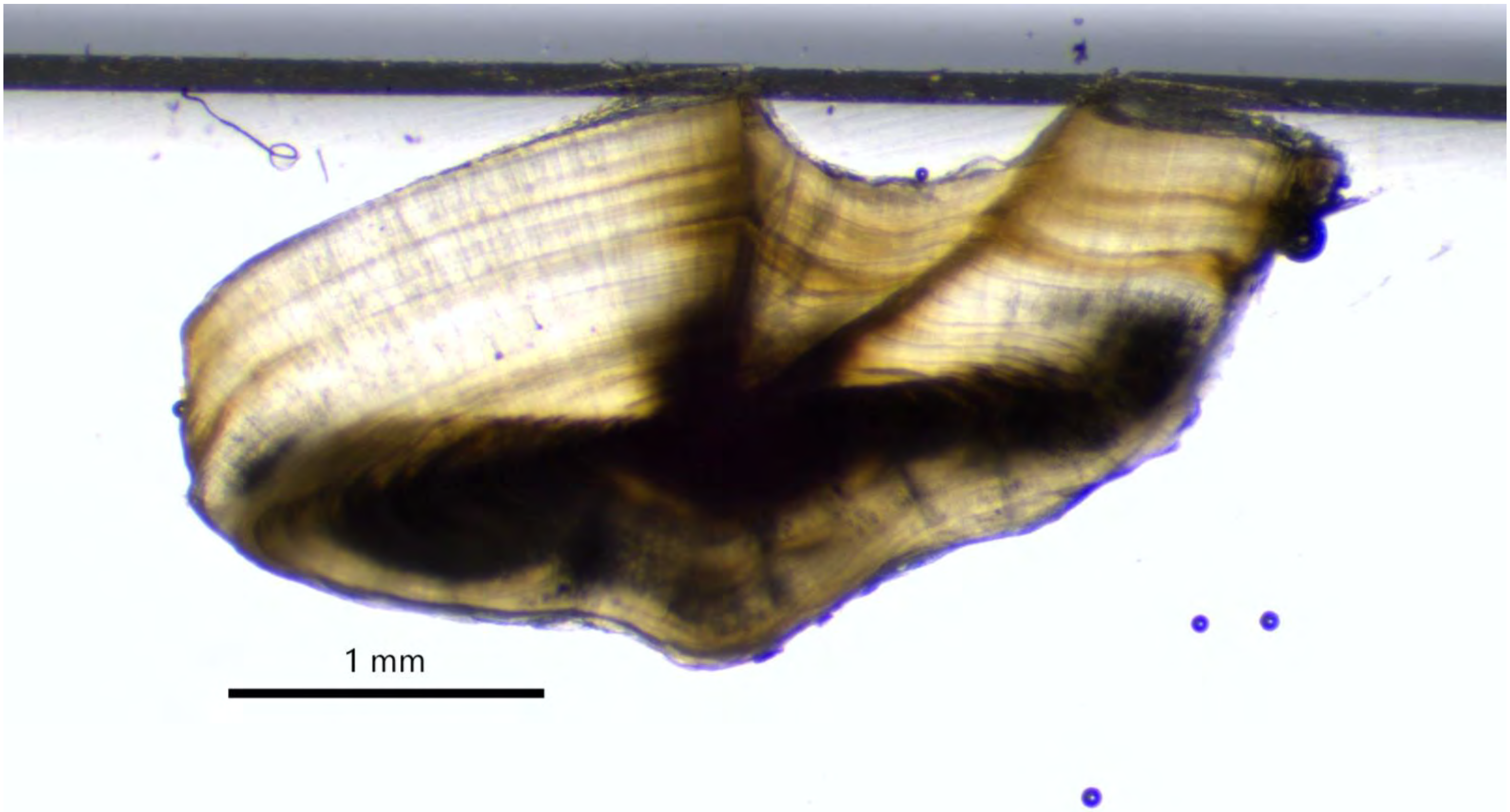


Spot 17 8/19/2014



Spot 18 2/23/2015



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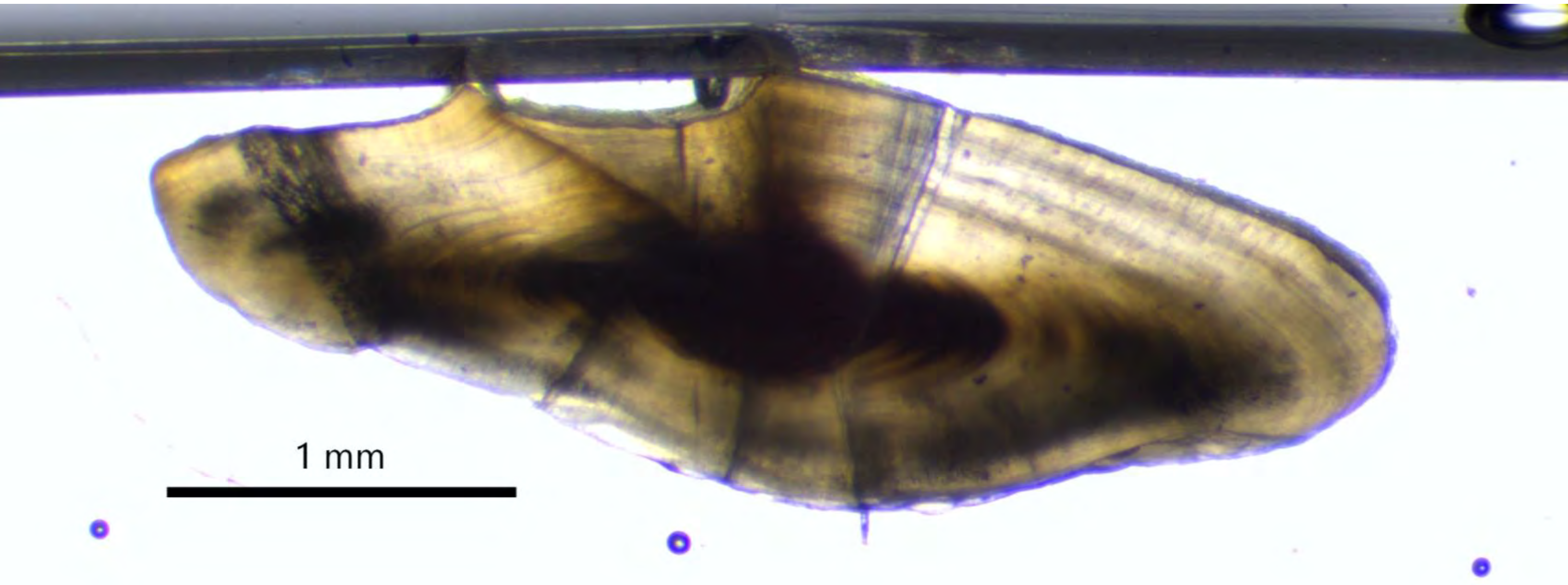

Spot 20 5/16/2022

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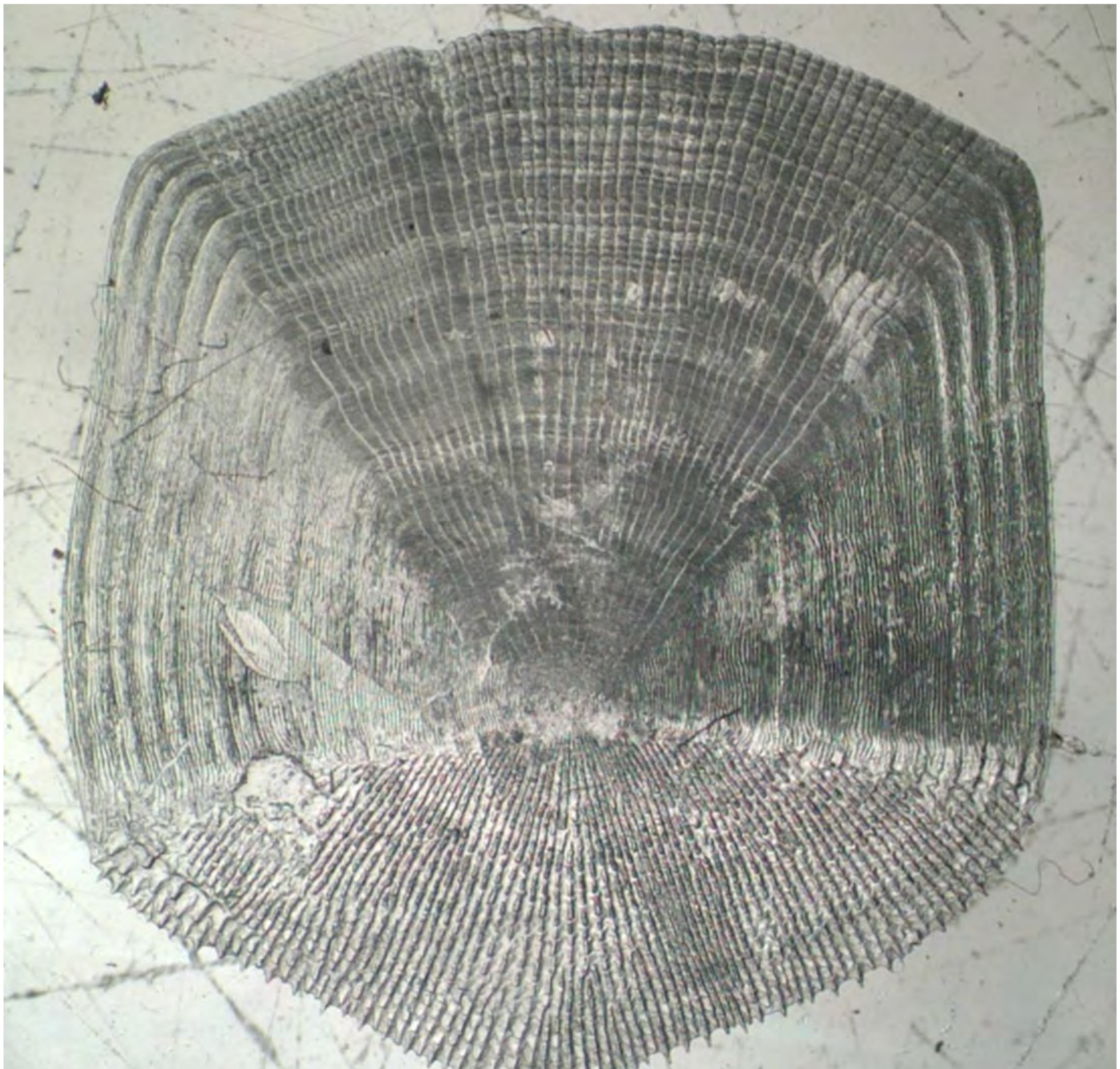

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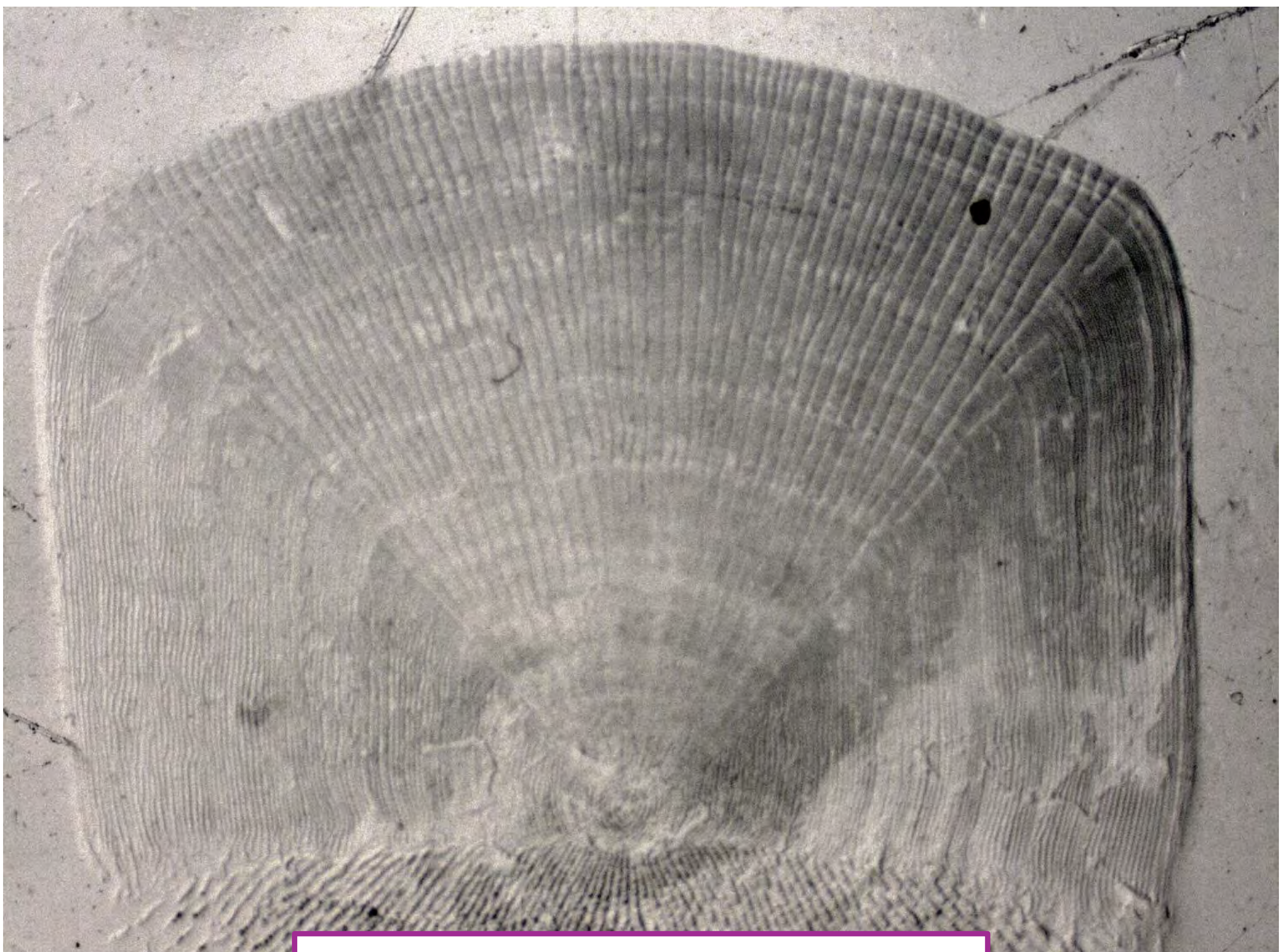
Striped Bass 2 7/15/2015

Striped Bass 3 7/1/2015



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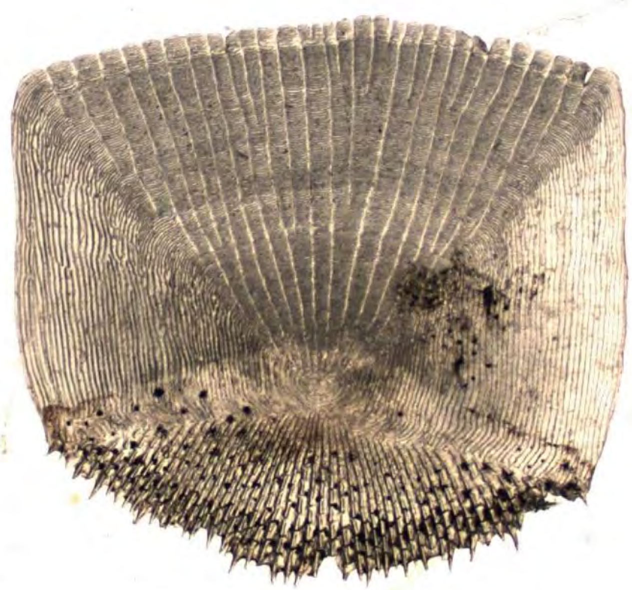
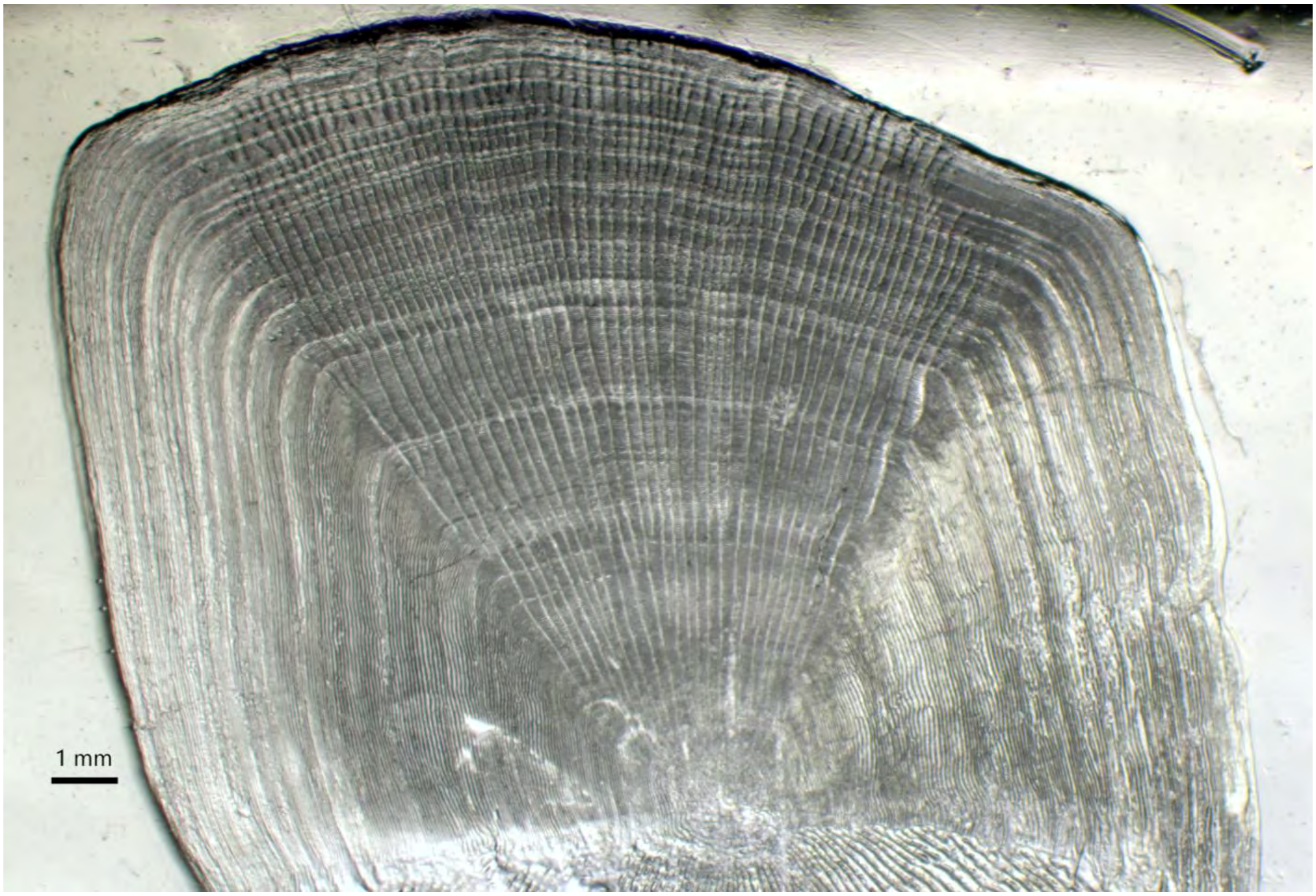
Striped Bass 5 10/13/2018



Striped Bass 6 6/20/2012



Striped Bass 7 7/6/2022

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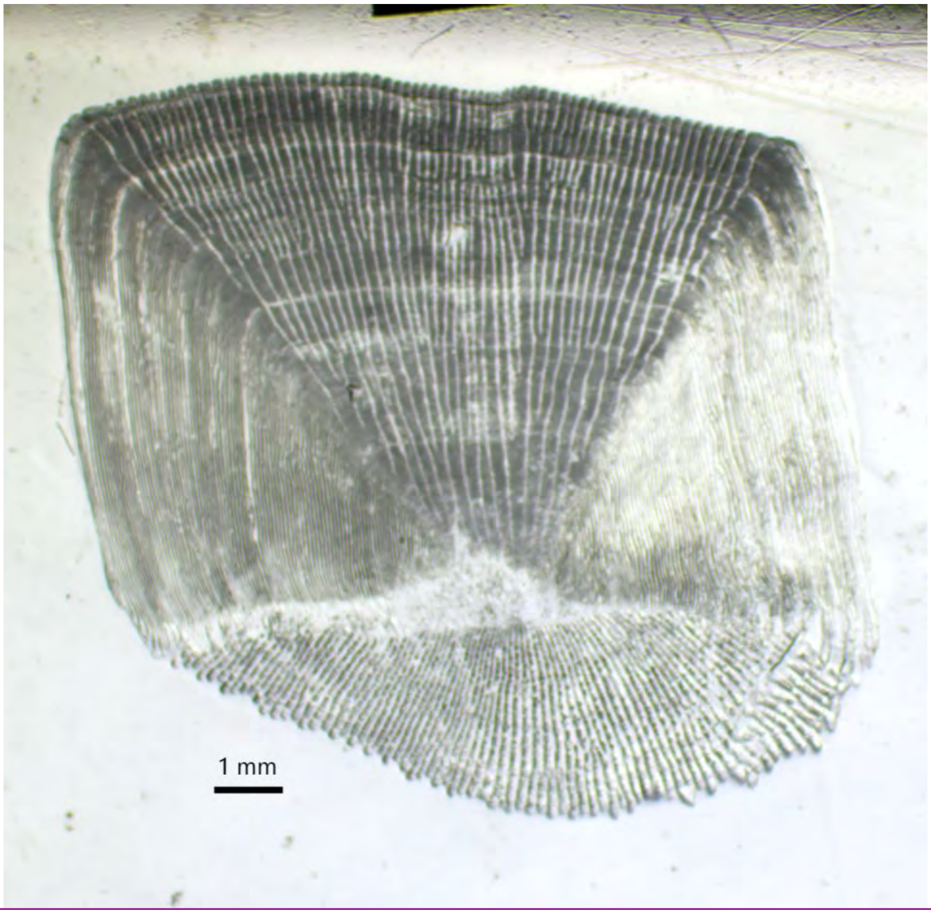

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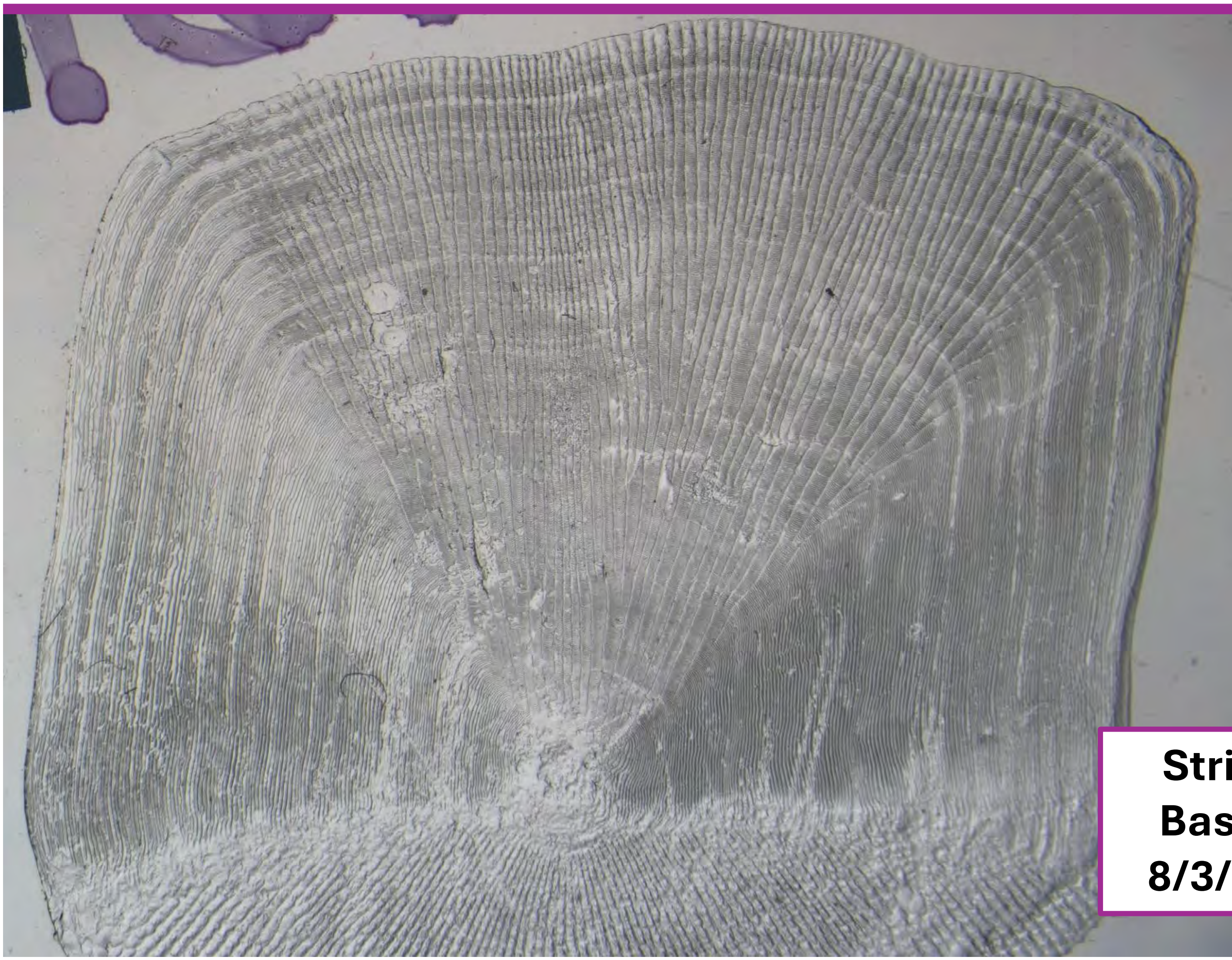
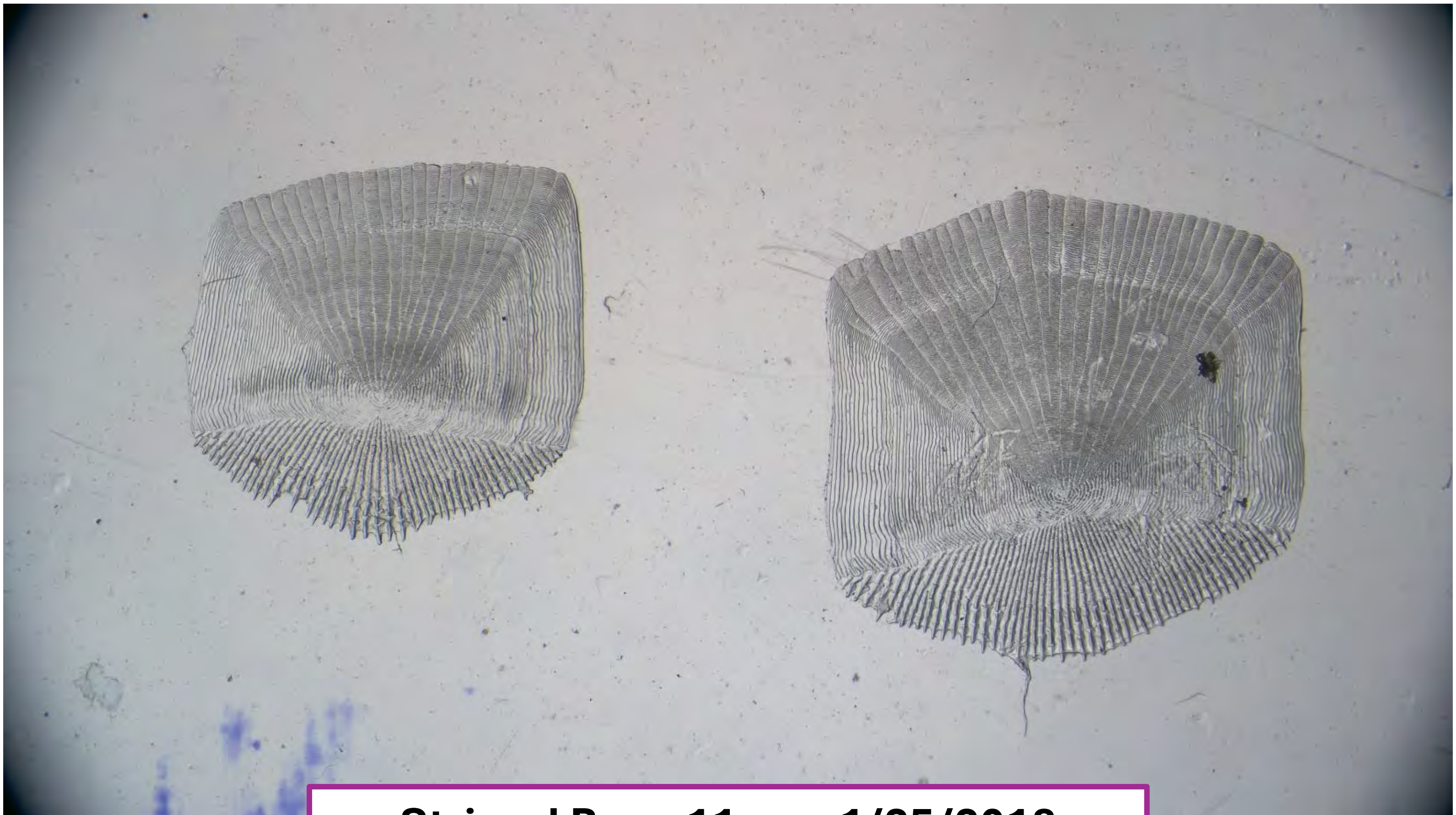
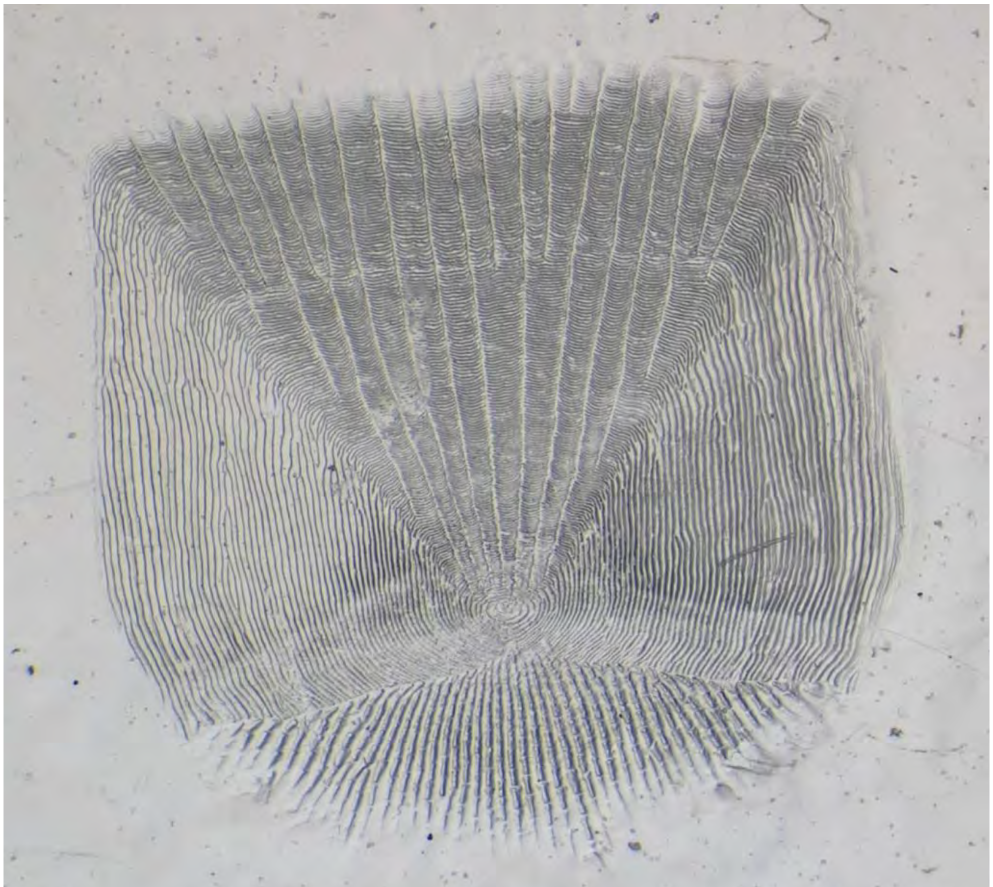


Striped Bass 10 8/3/2018



Striped Bass 11 1/25/2018

Striped Bass 12 3/21/2018



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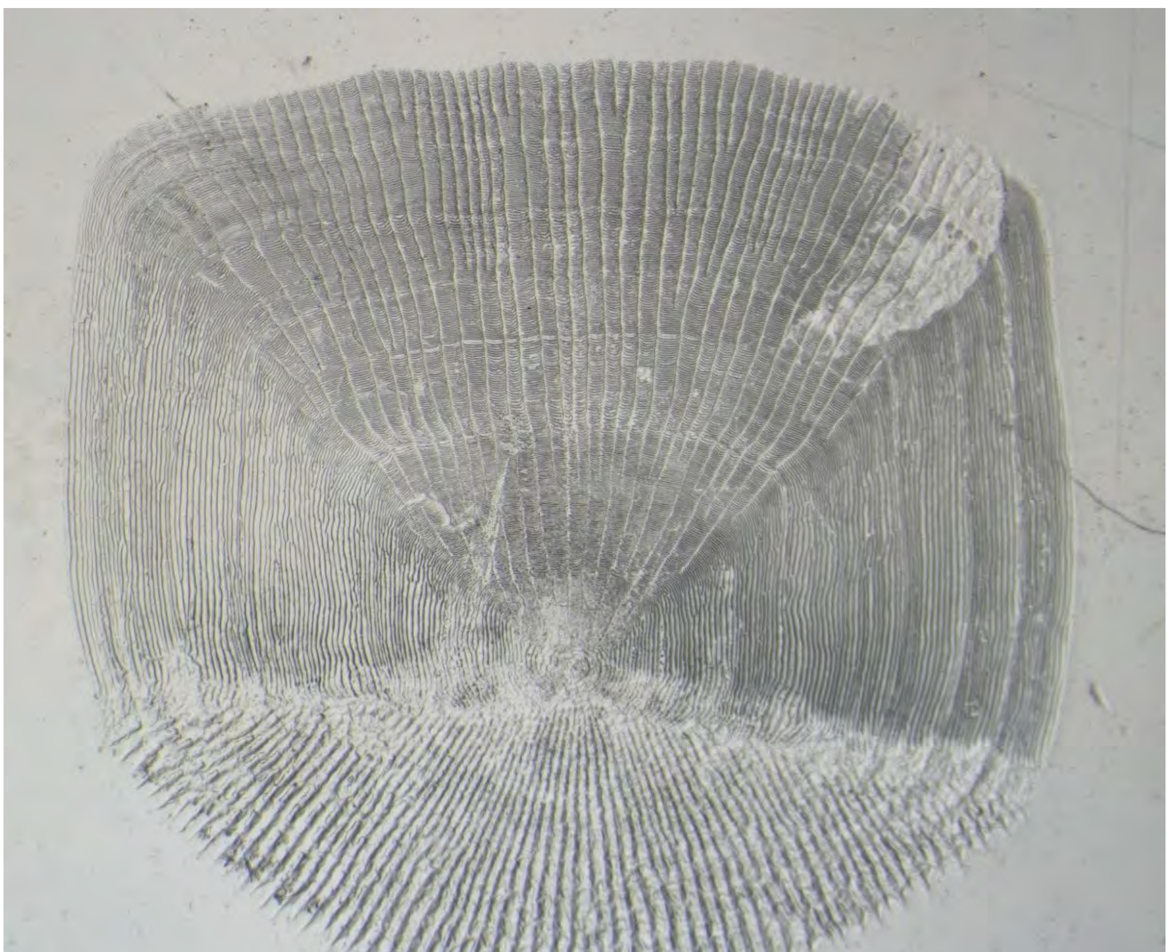

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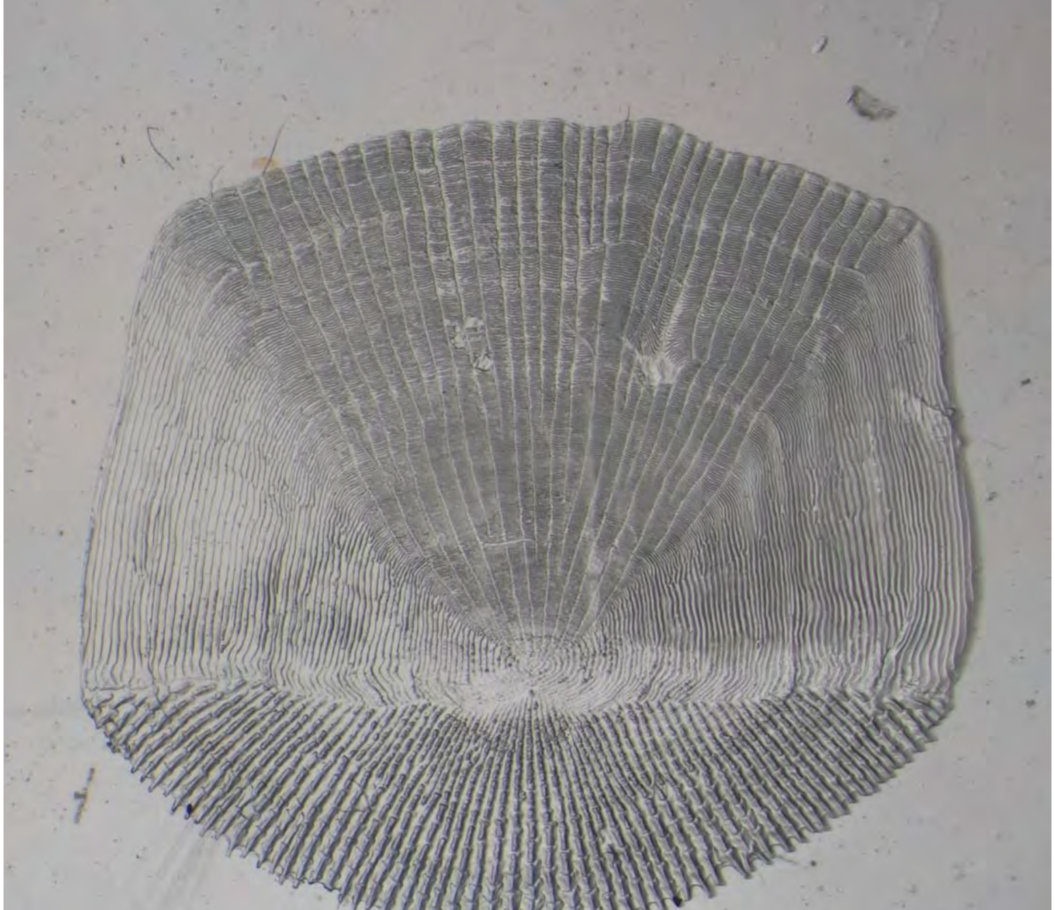
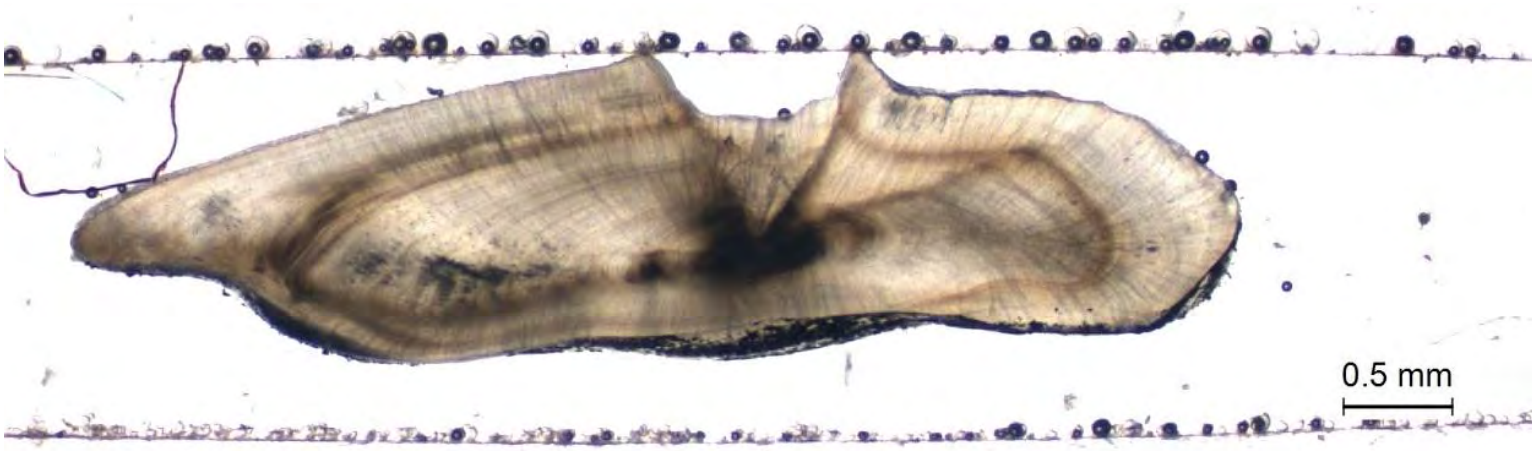


Striped Bass 15   5/21/2018



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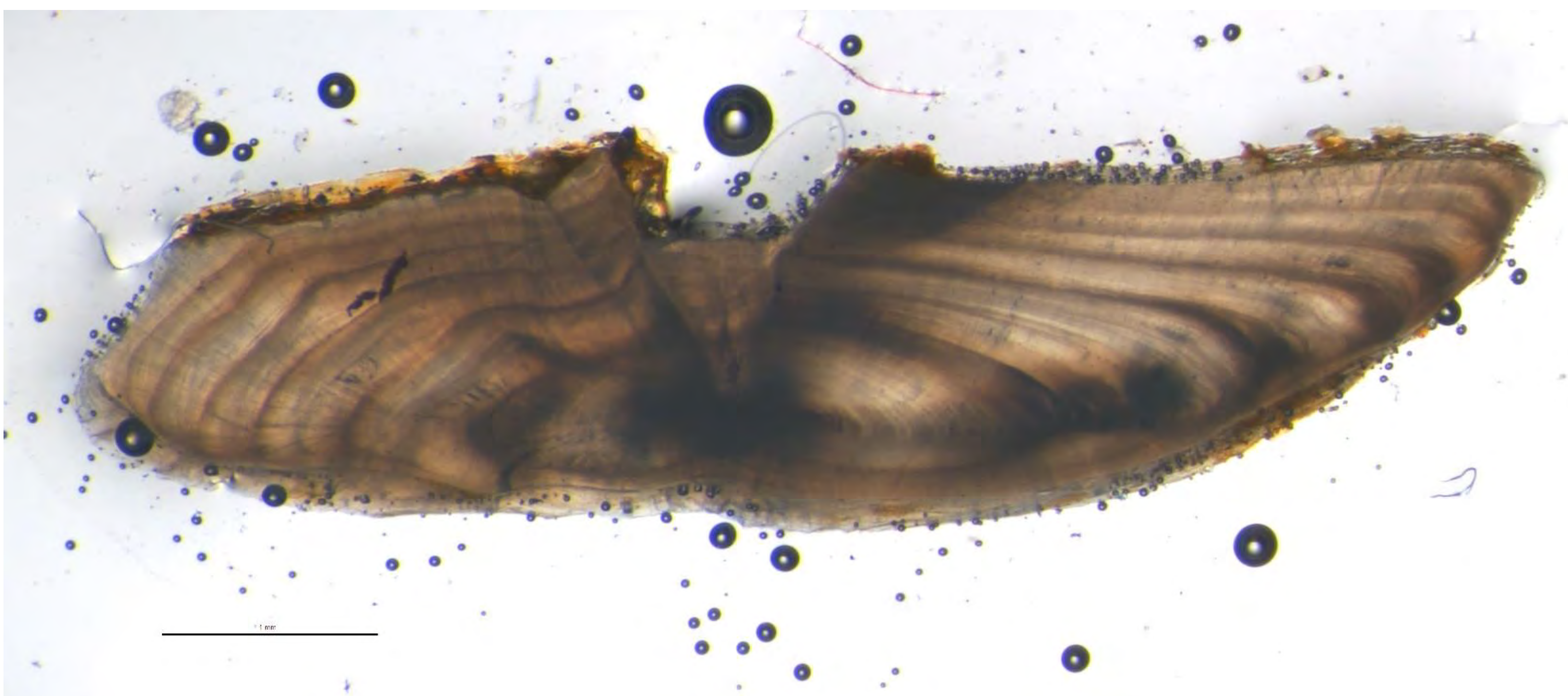
Striped Bass 17 3/19/2018



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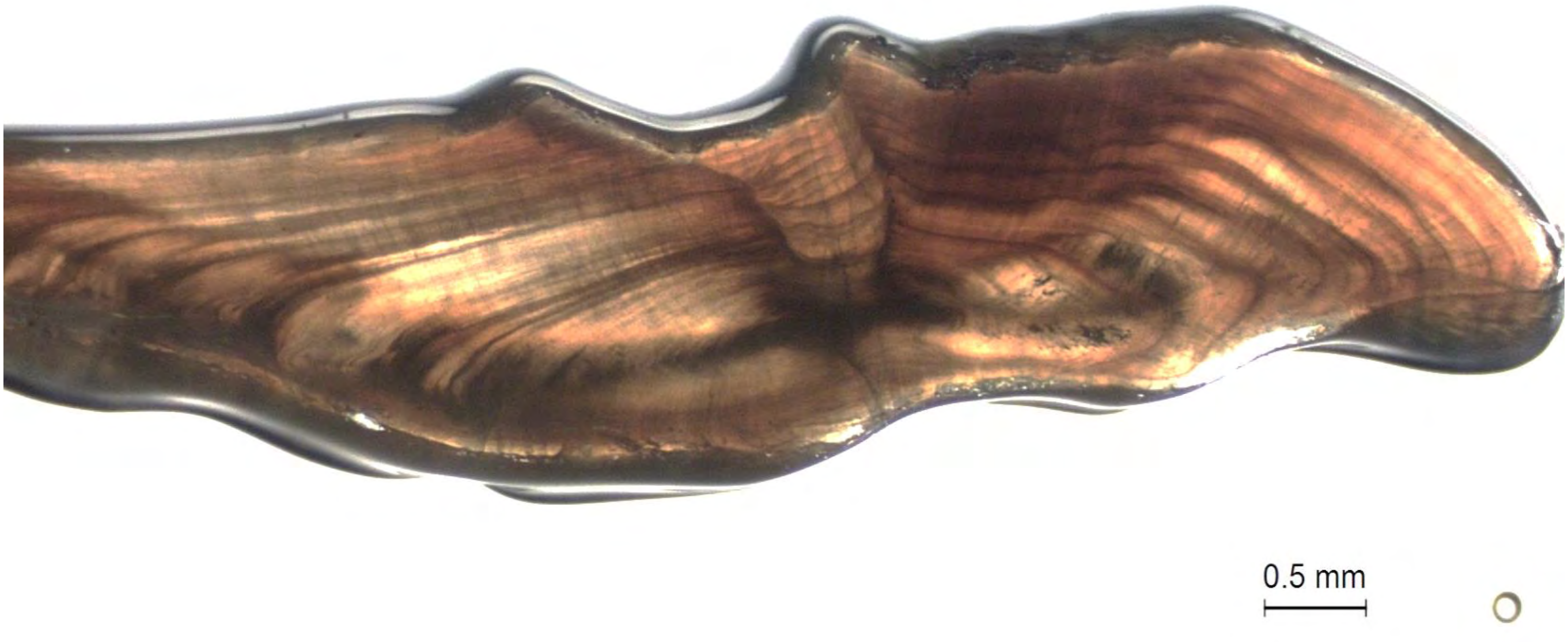

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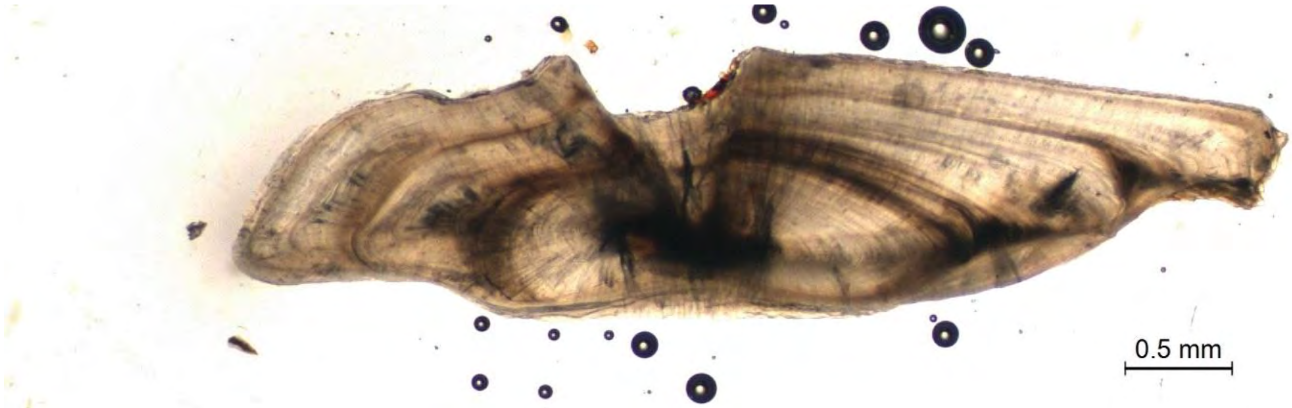

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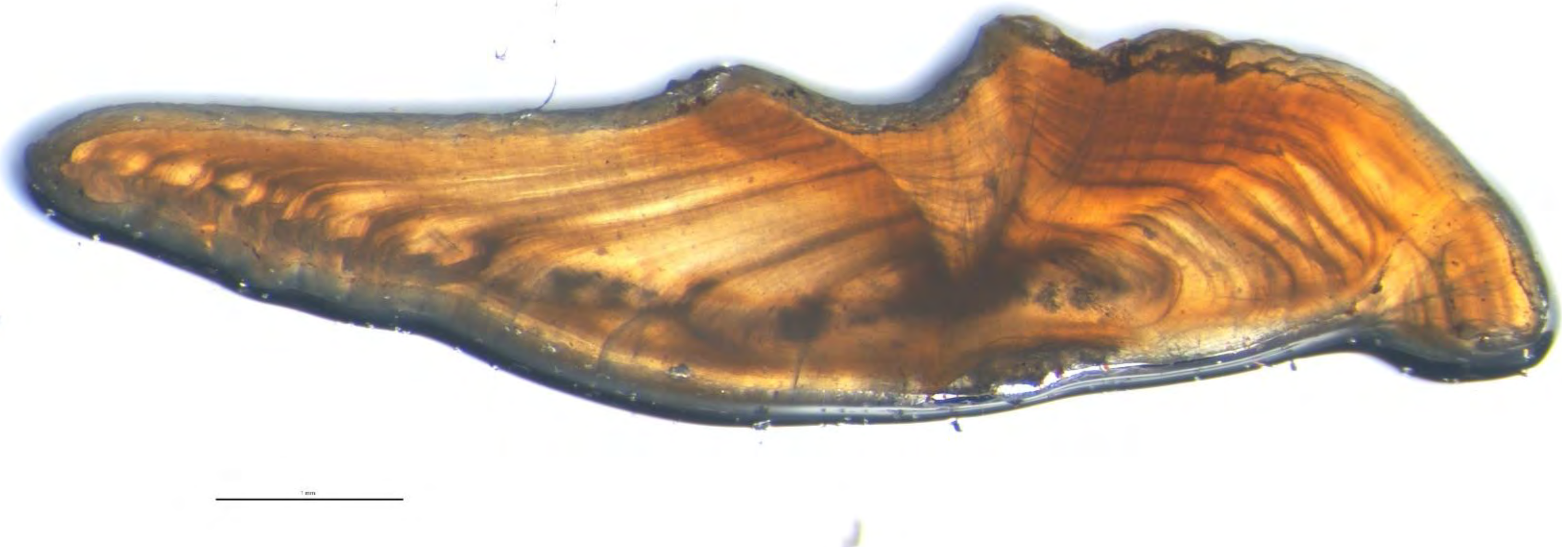

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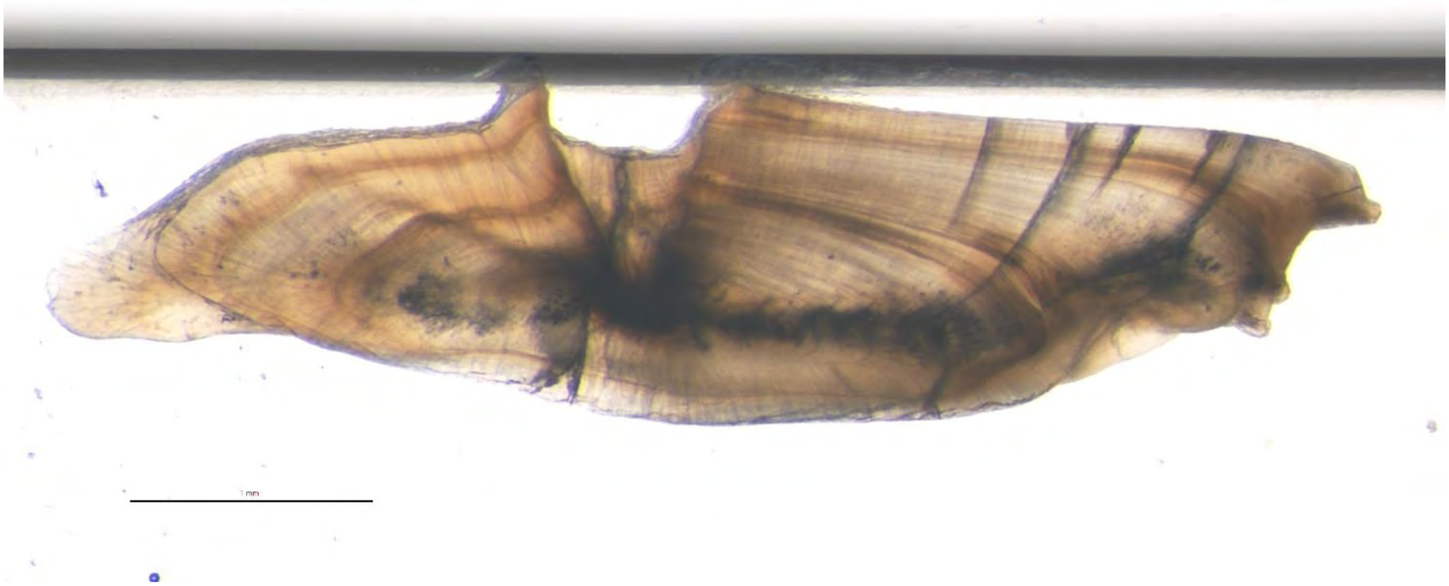
Striped Bass 24 5/21/2018

Striped Bass 25 7/3/2014

Striped Bass 26 12/3/2018



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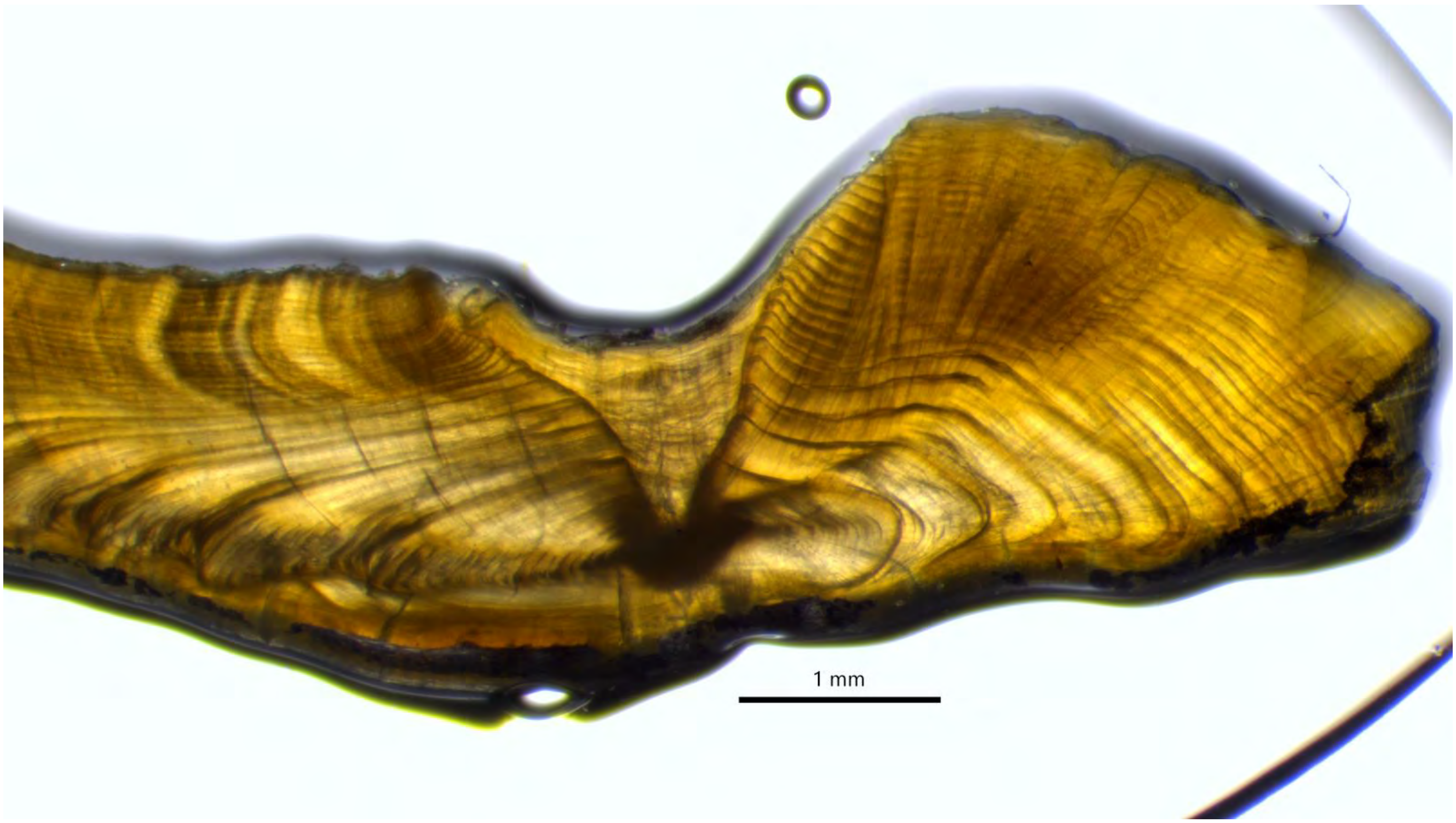
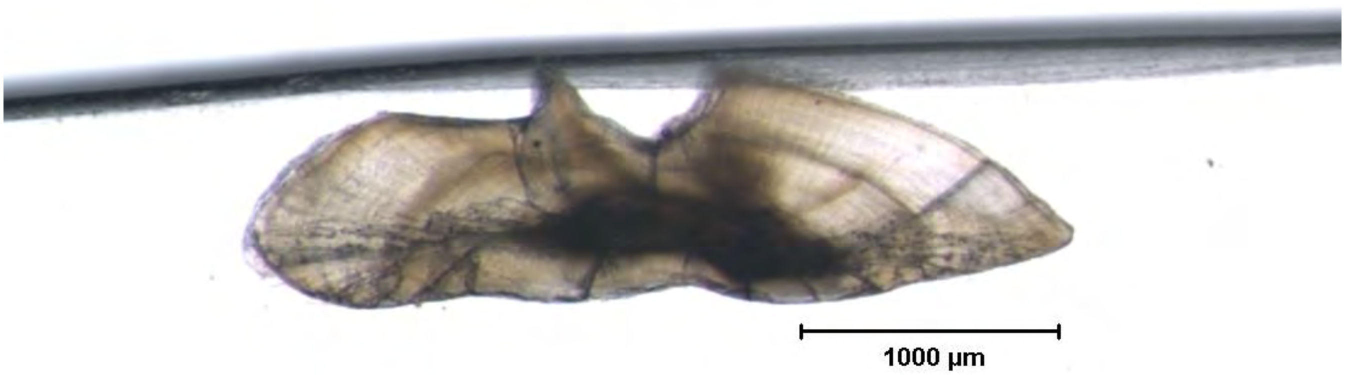
Striped Bass 28 7/6/2021



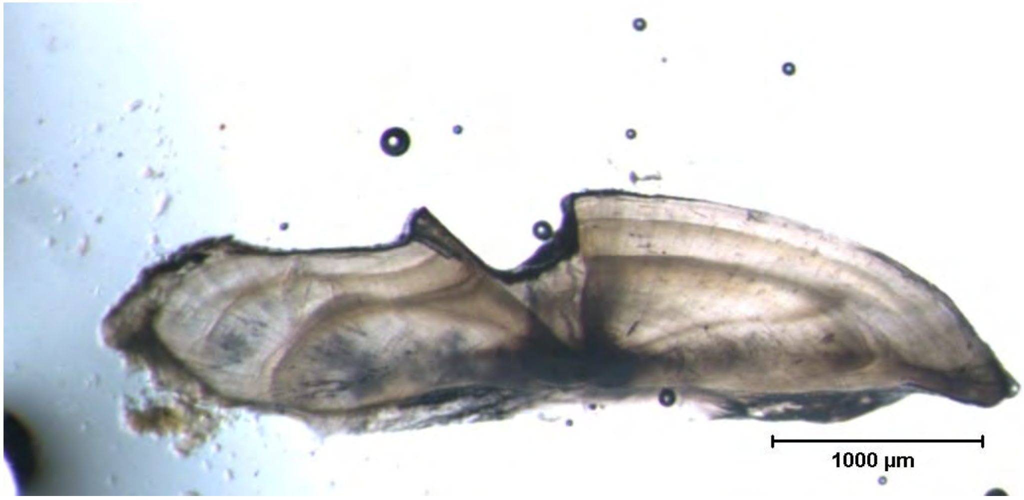
Striped Bass 29 7/6/2022

Striped Bass 30   8/3/2018



Scup 1 7/13/2016

Scup 2 1/26/2017



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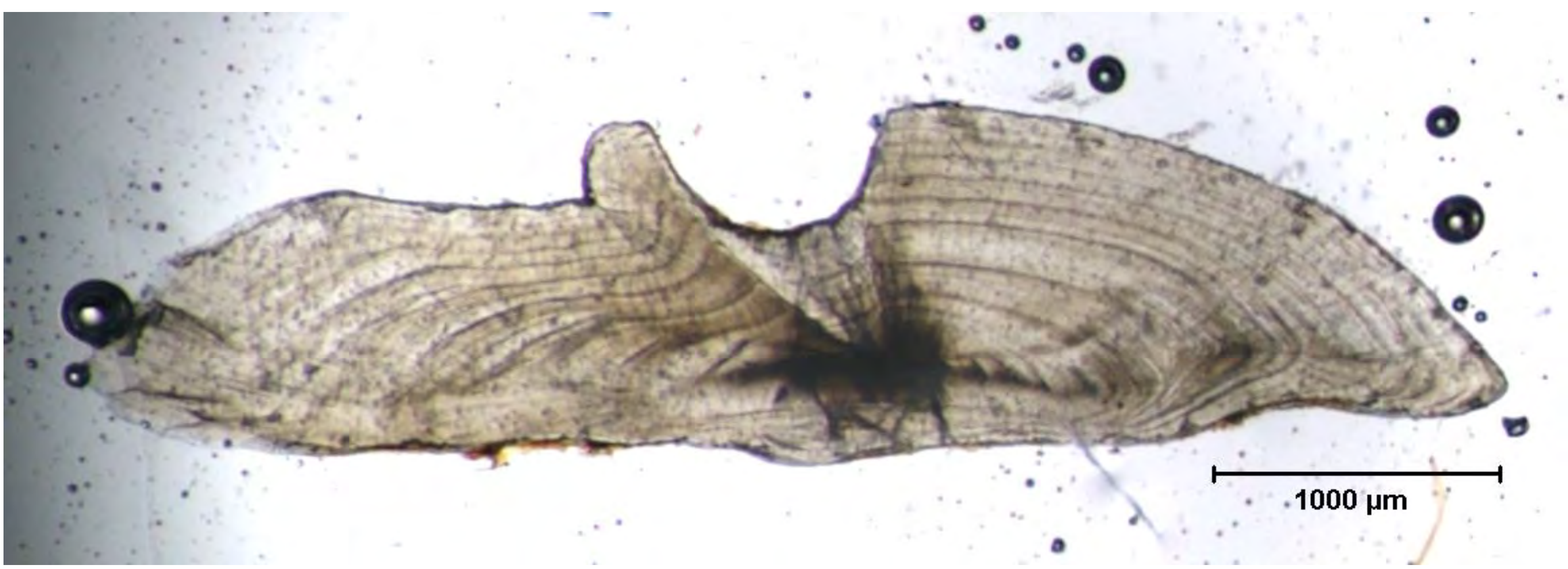

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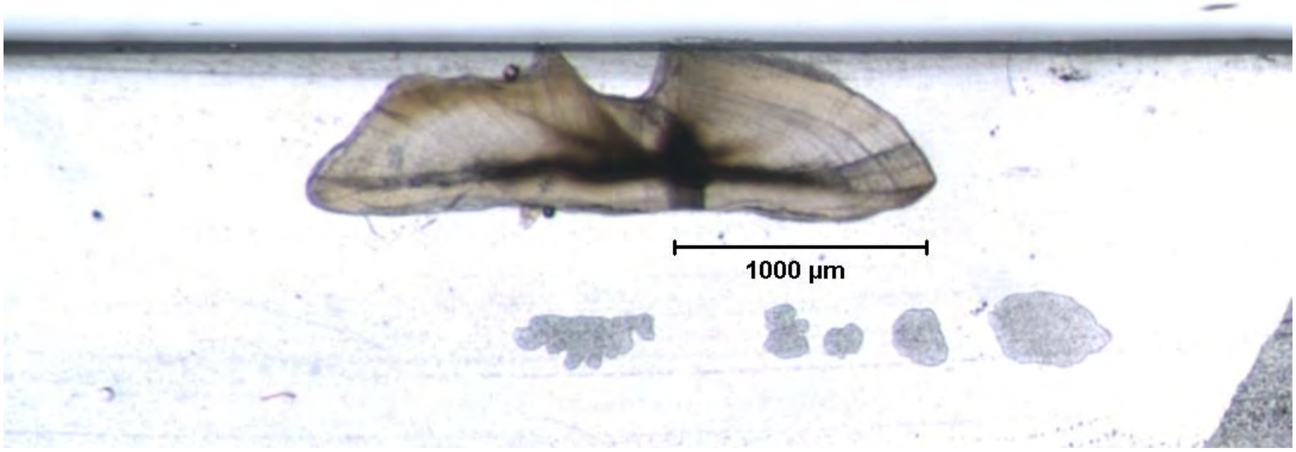

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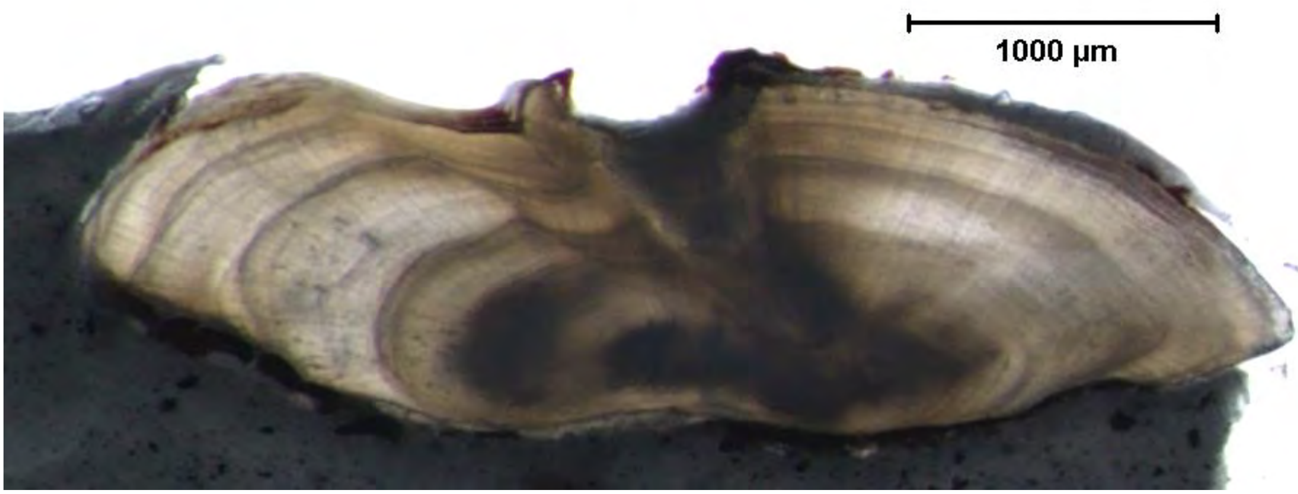

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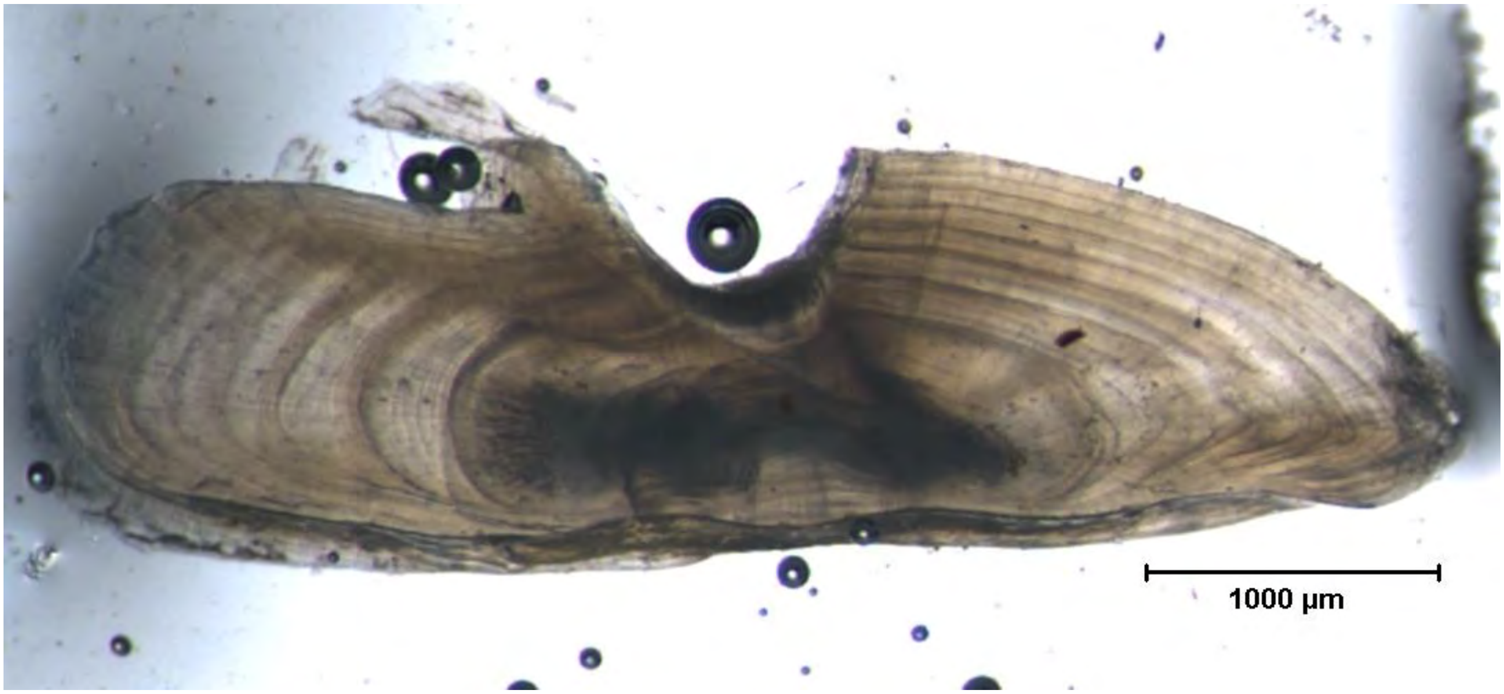

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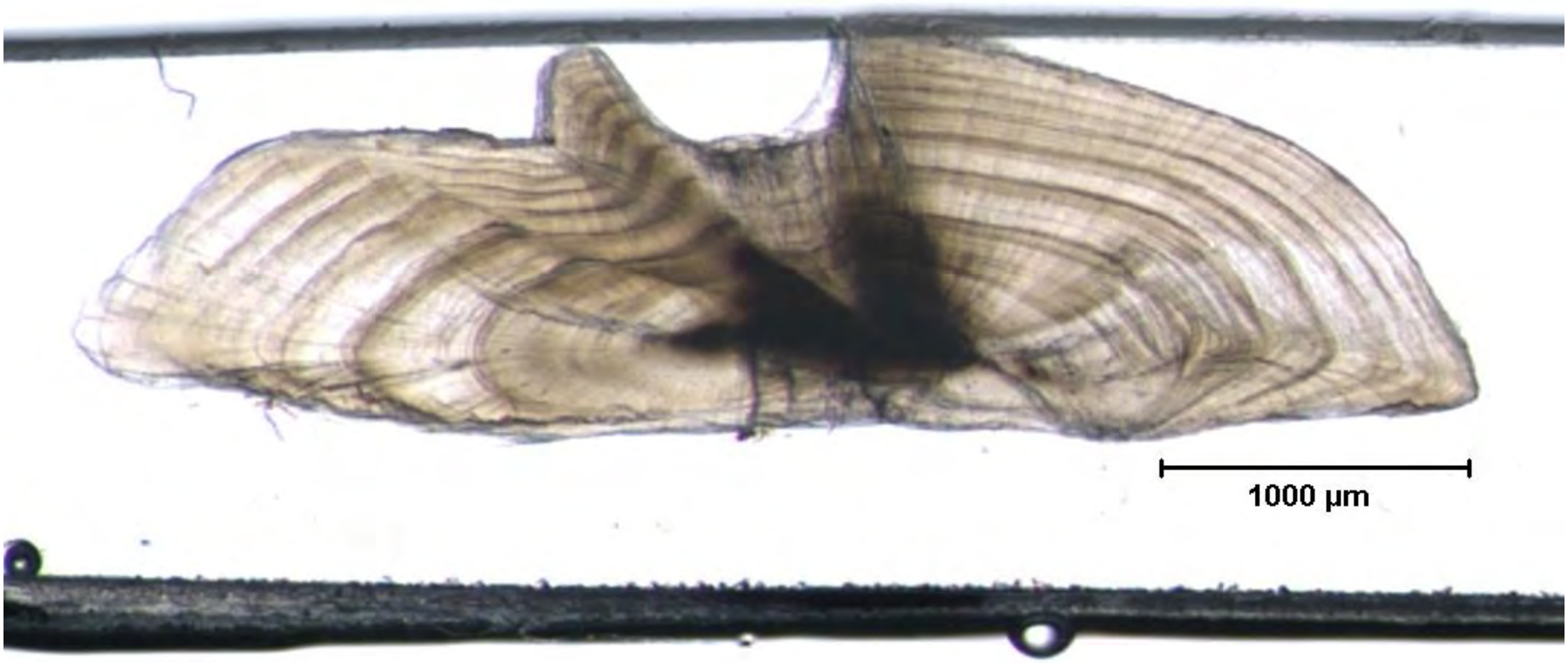


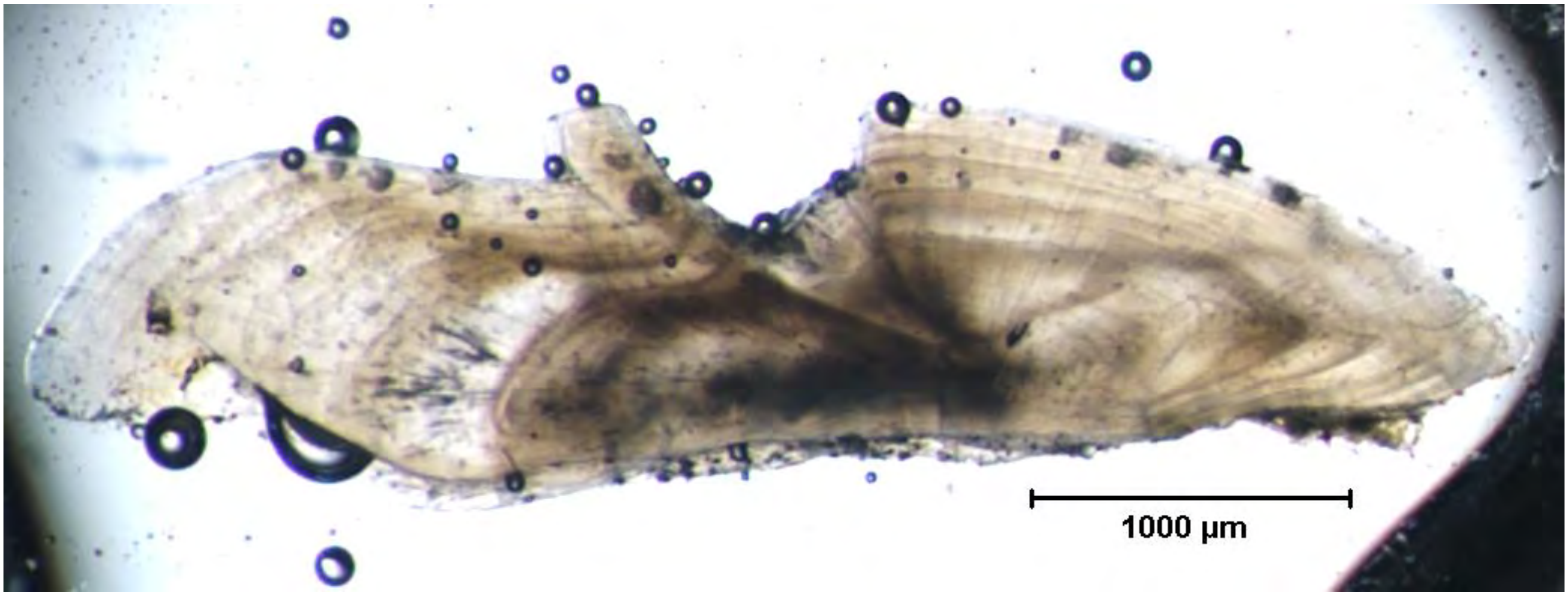
Scup 8 7/13/2016

Scup 9 1/26/2017

Scup 10 2/4/2017

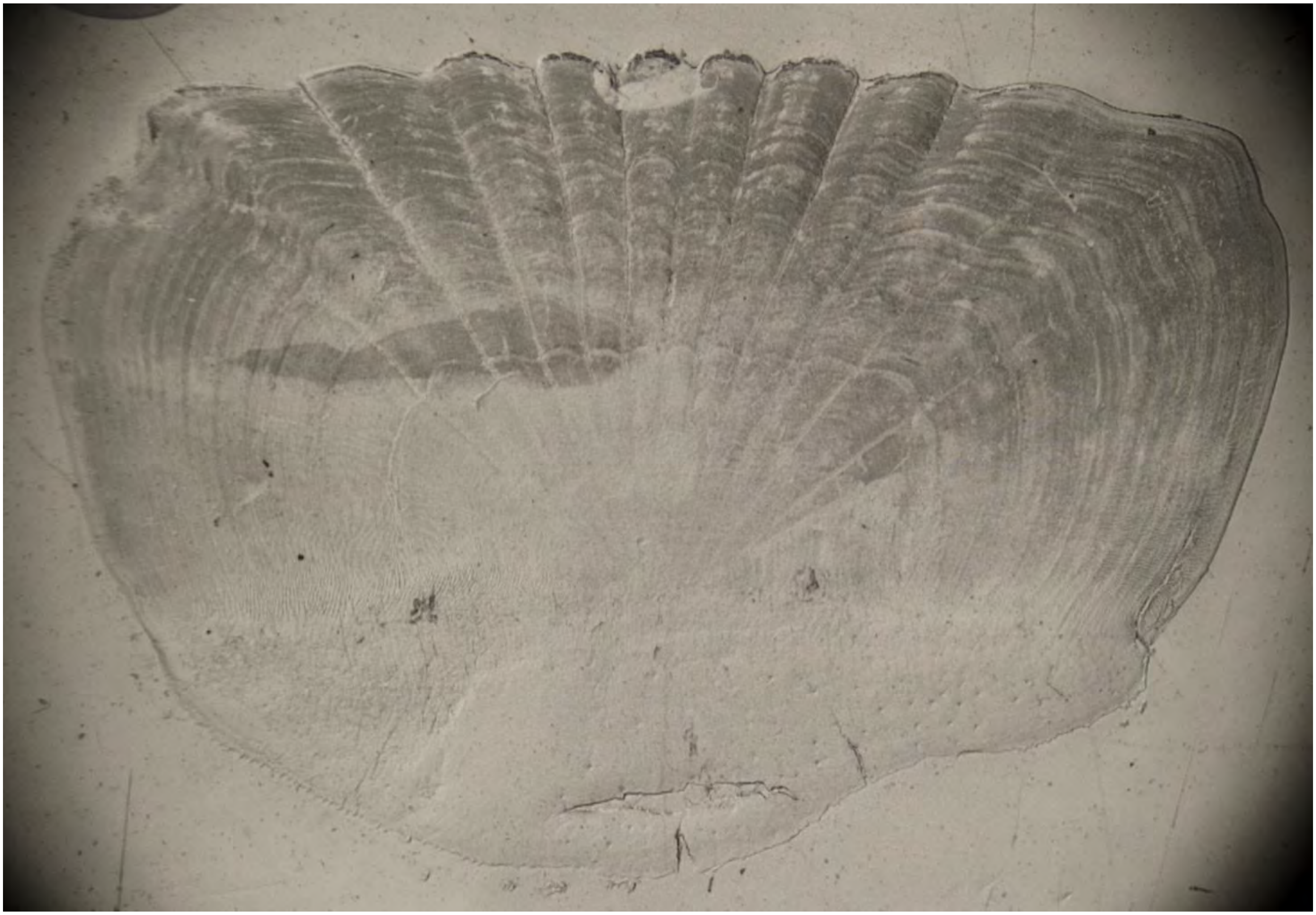
Scup 11 10/15/2016

Scup 12 10/14/2016



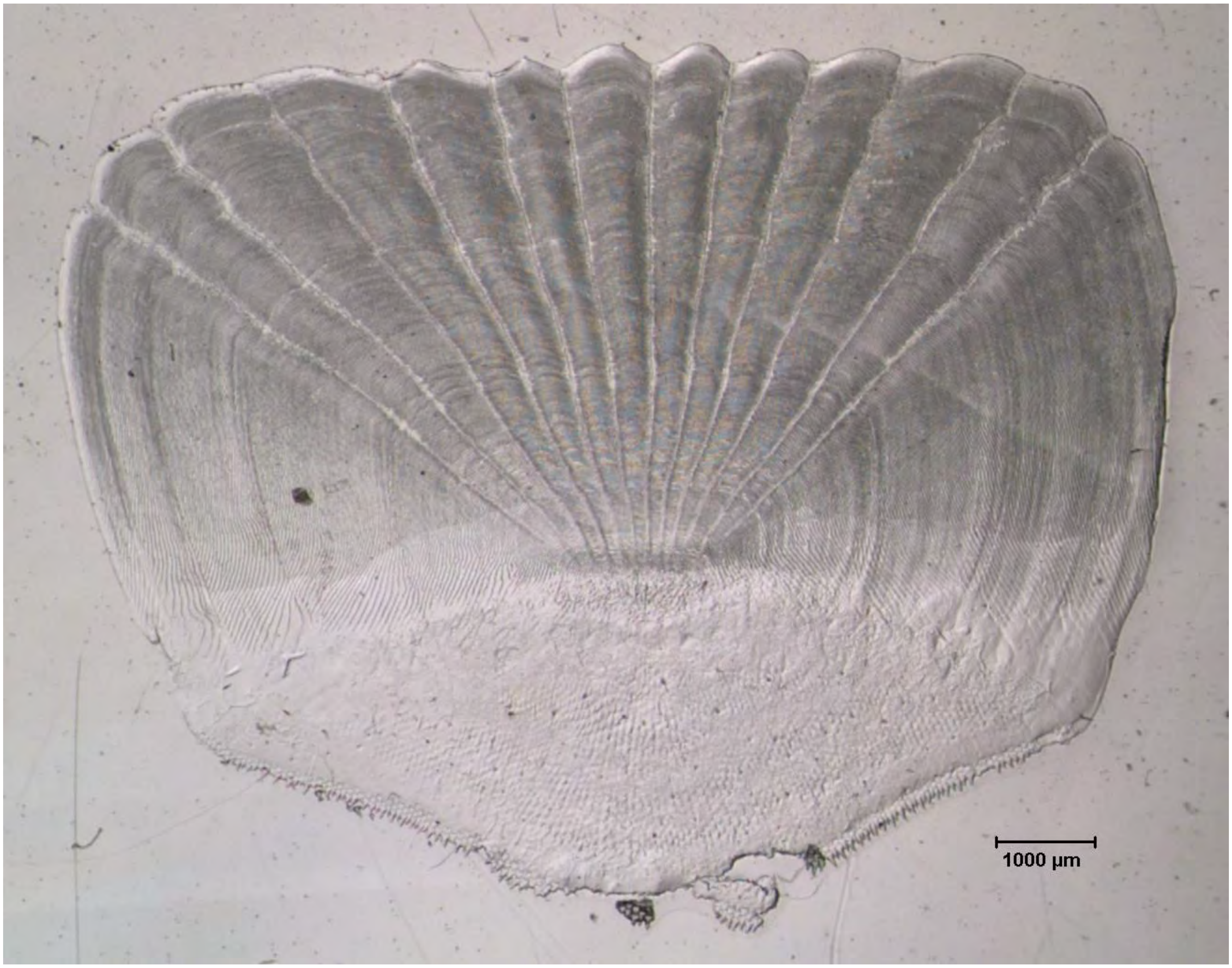
Scup 13 **10/12/2016**

Scup 14 **5/18/2015**

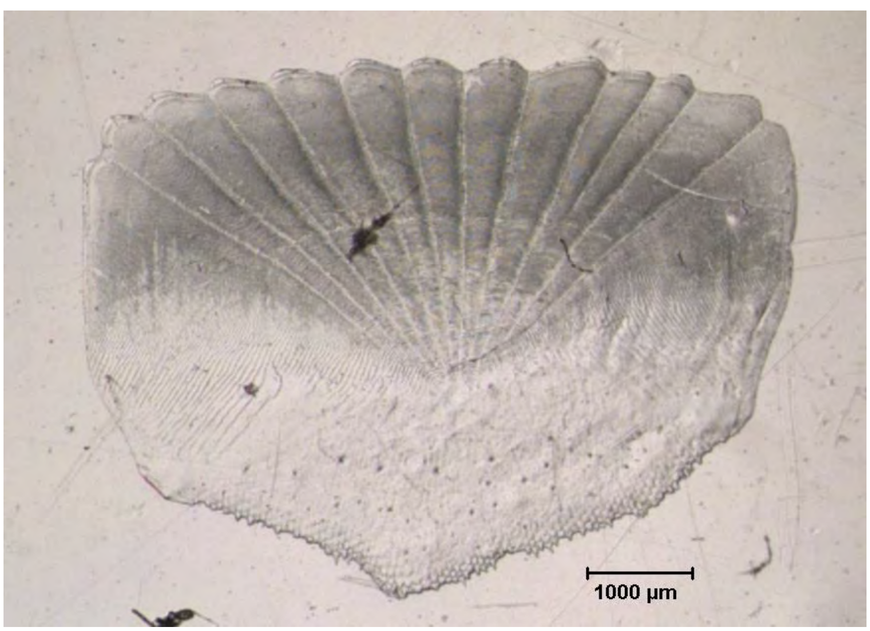


Scup 15 5/21/2016

Scup 16 5/17/2016



Scup 17 7/6/2016



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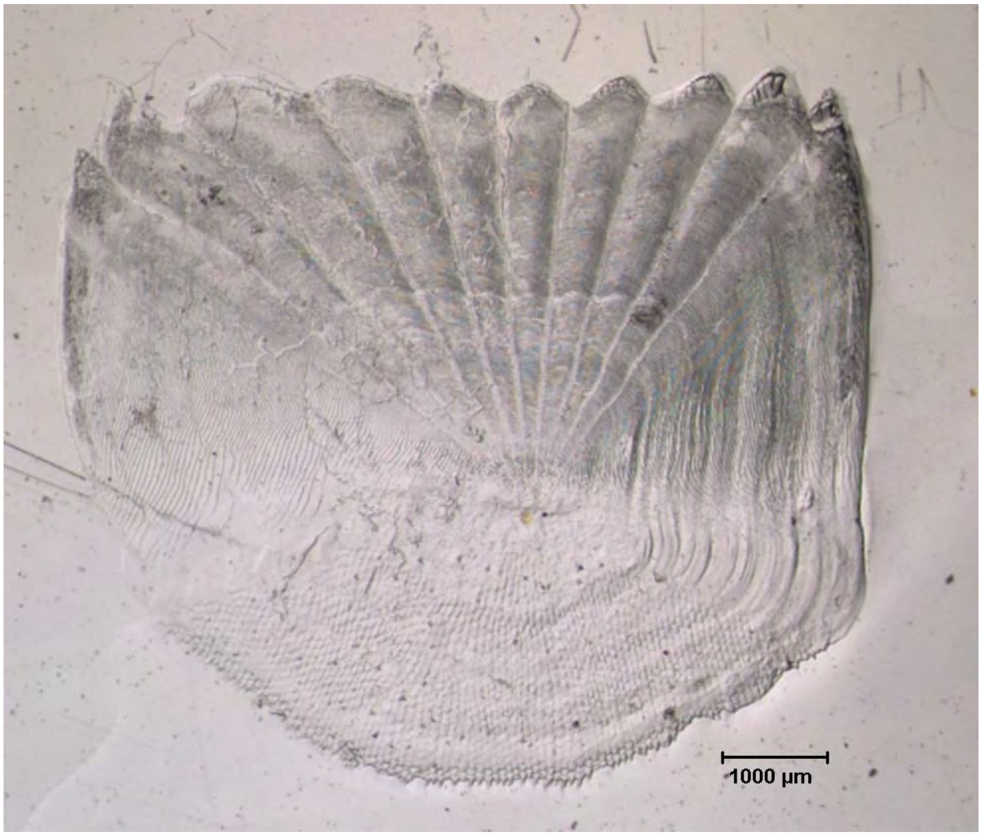

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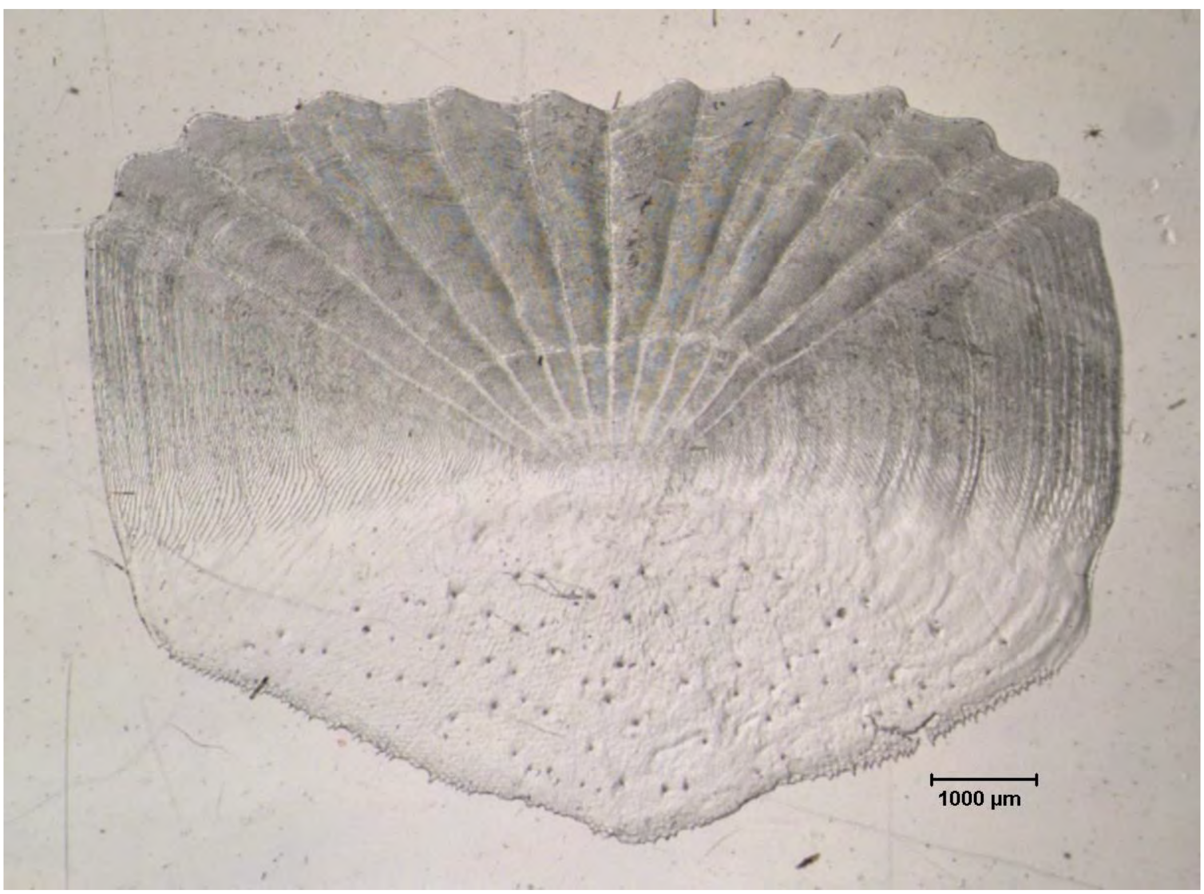

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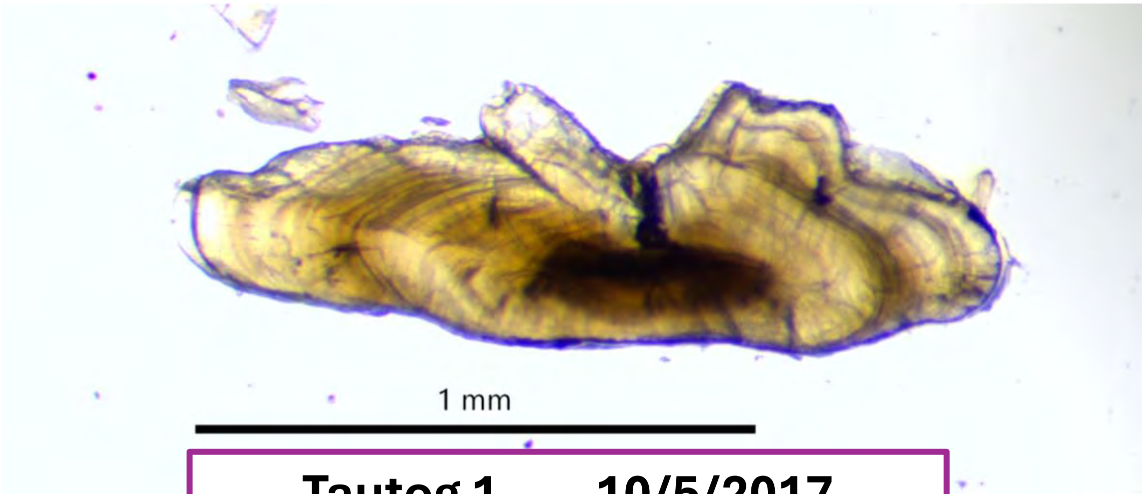

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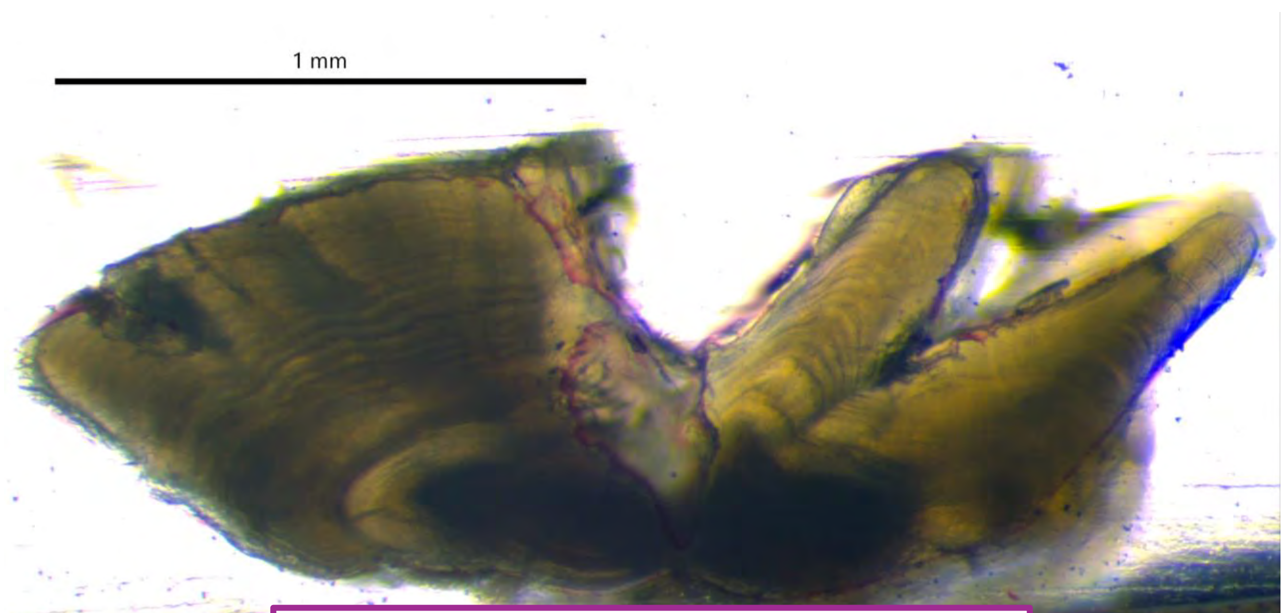

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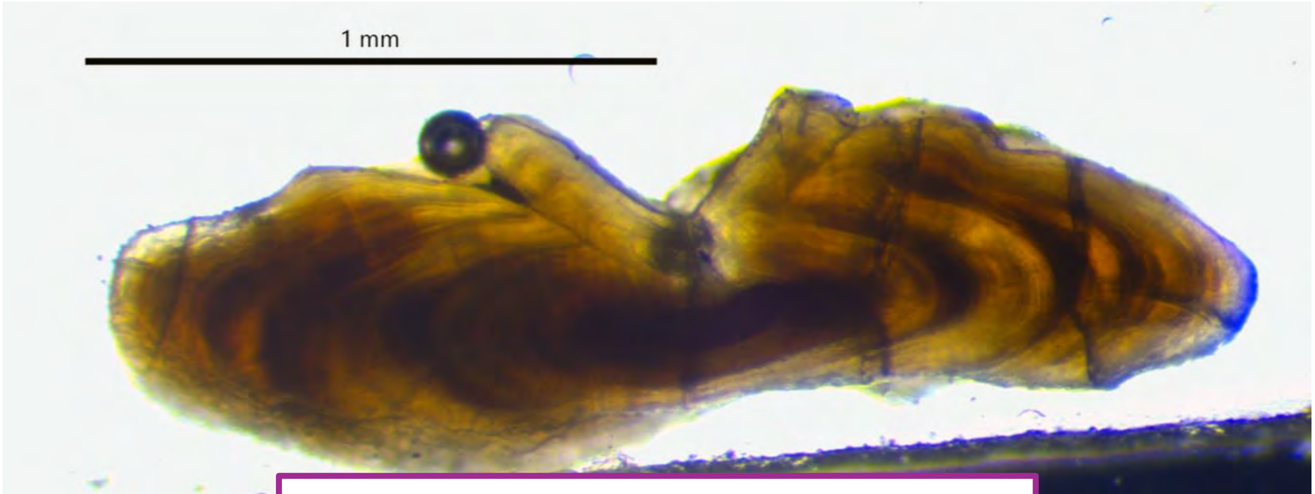

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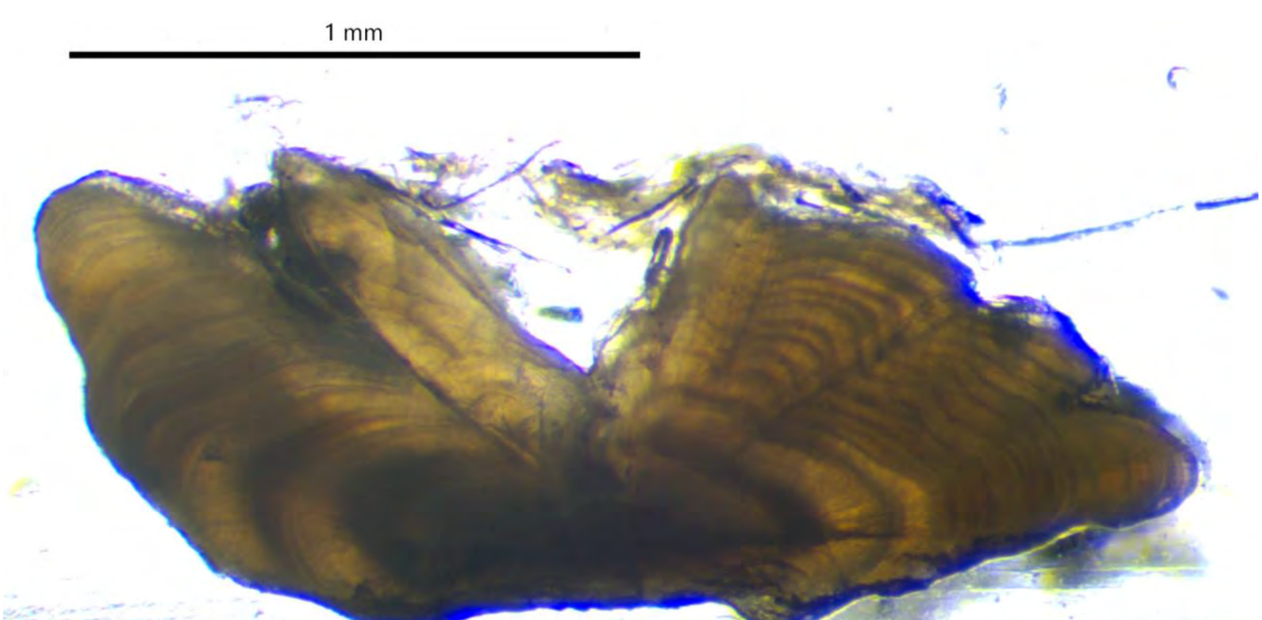

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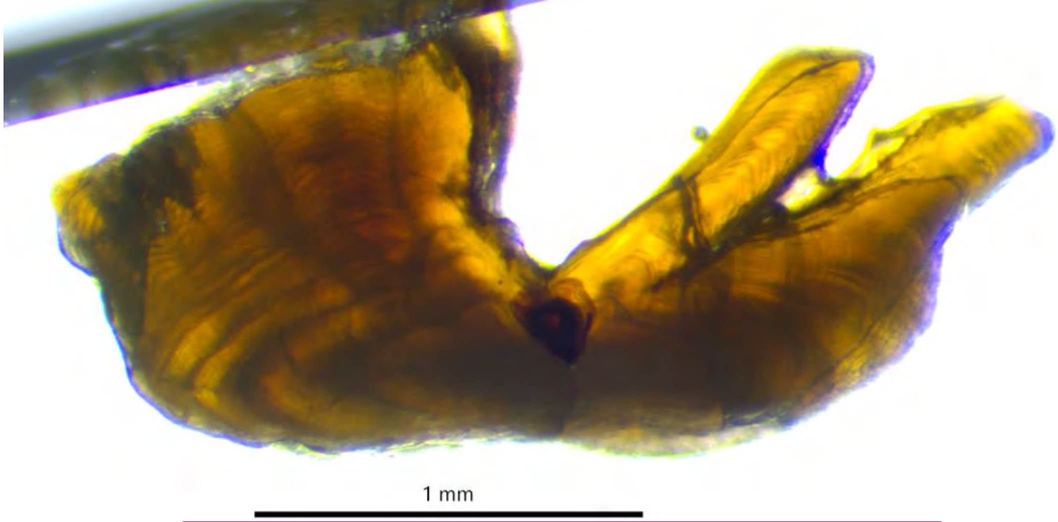
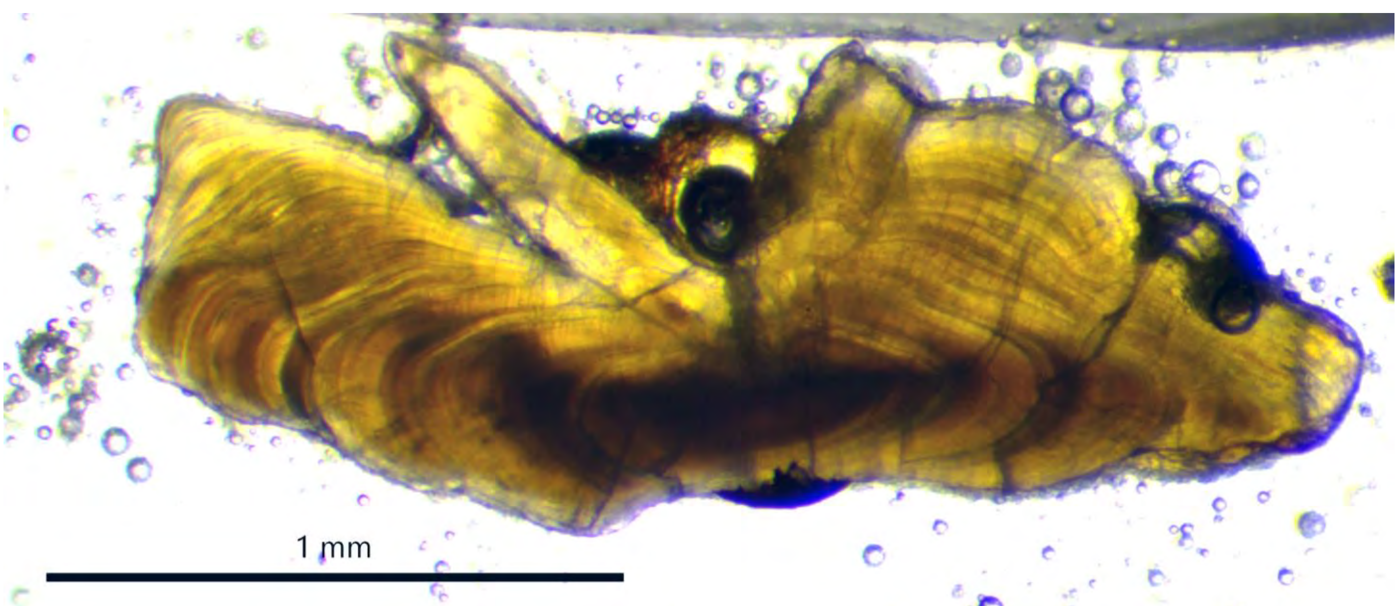


Tautog 7 3/5/2022

Tautog 8 11/18/2018



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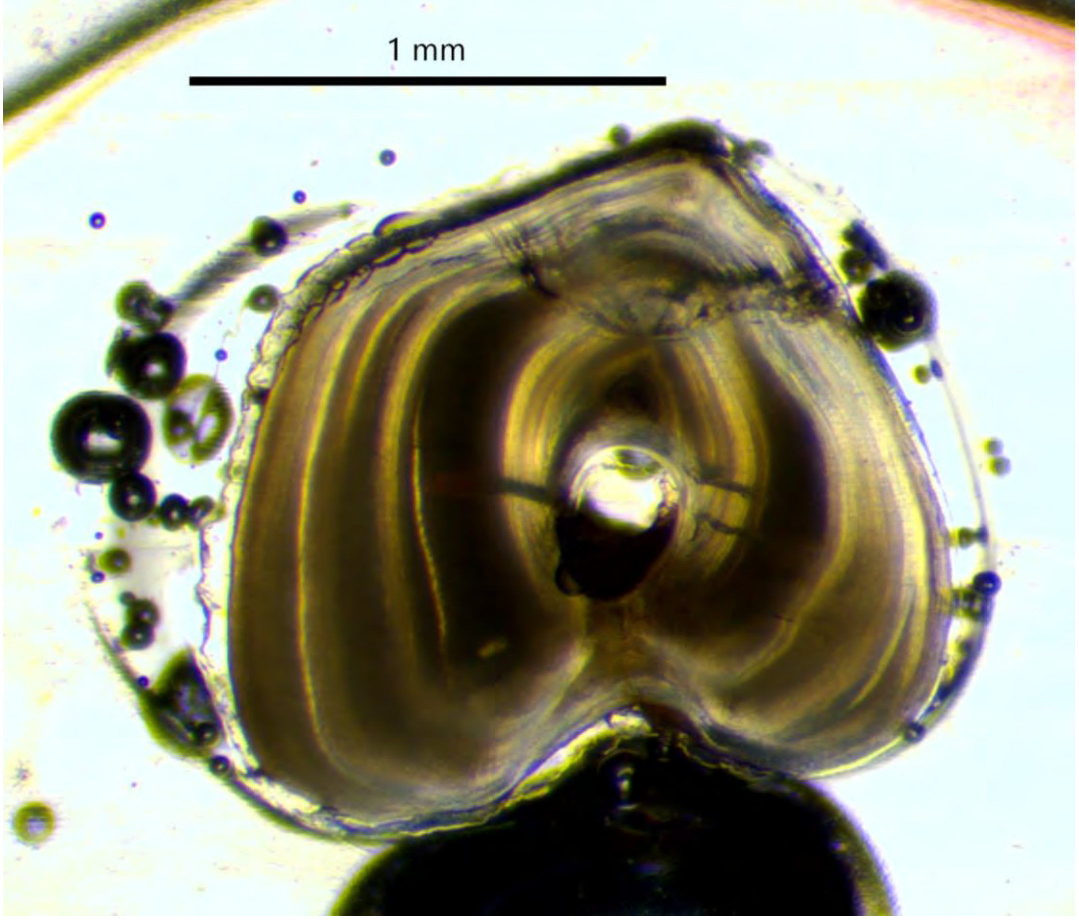

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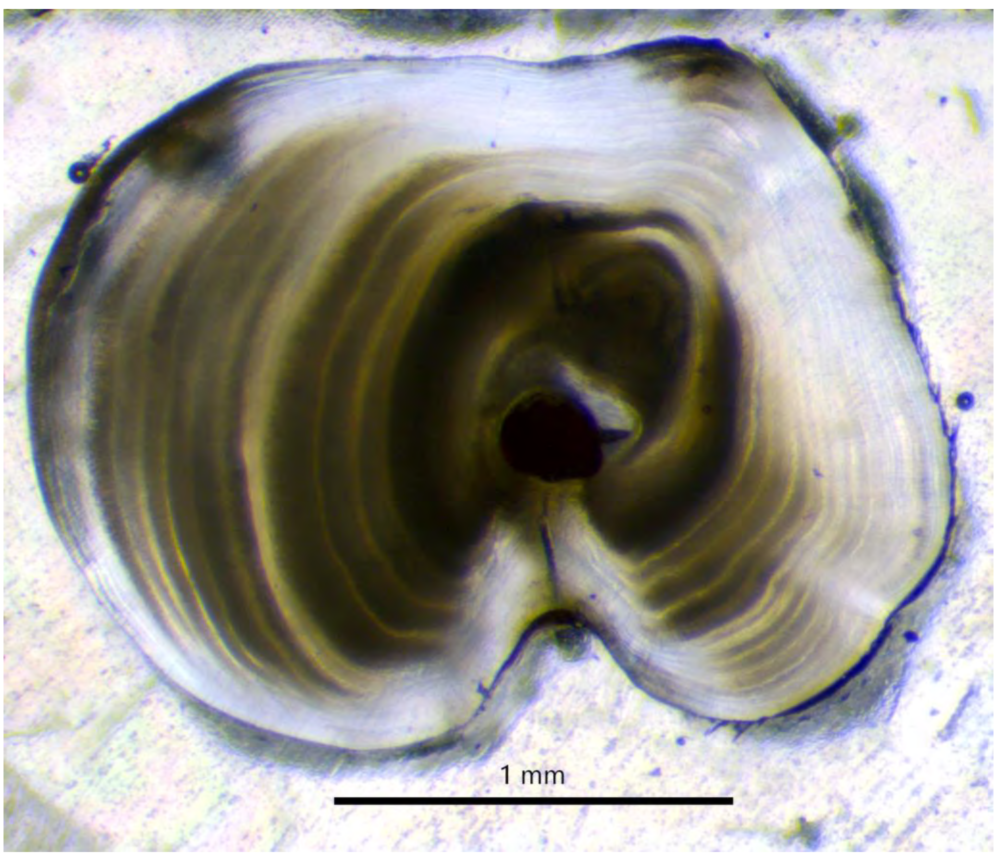

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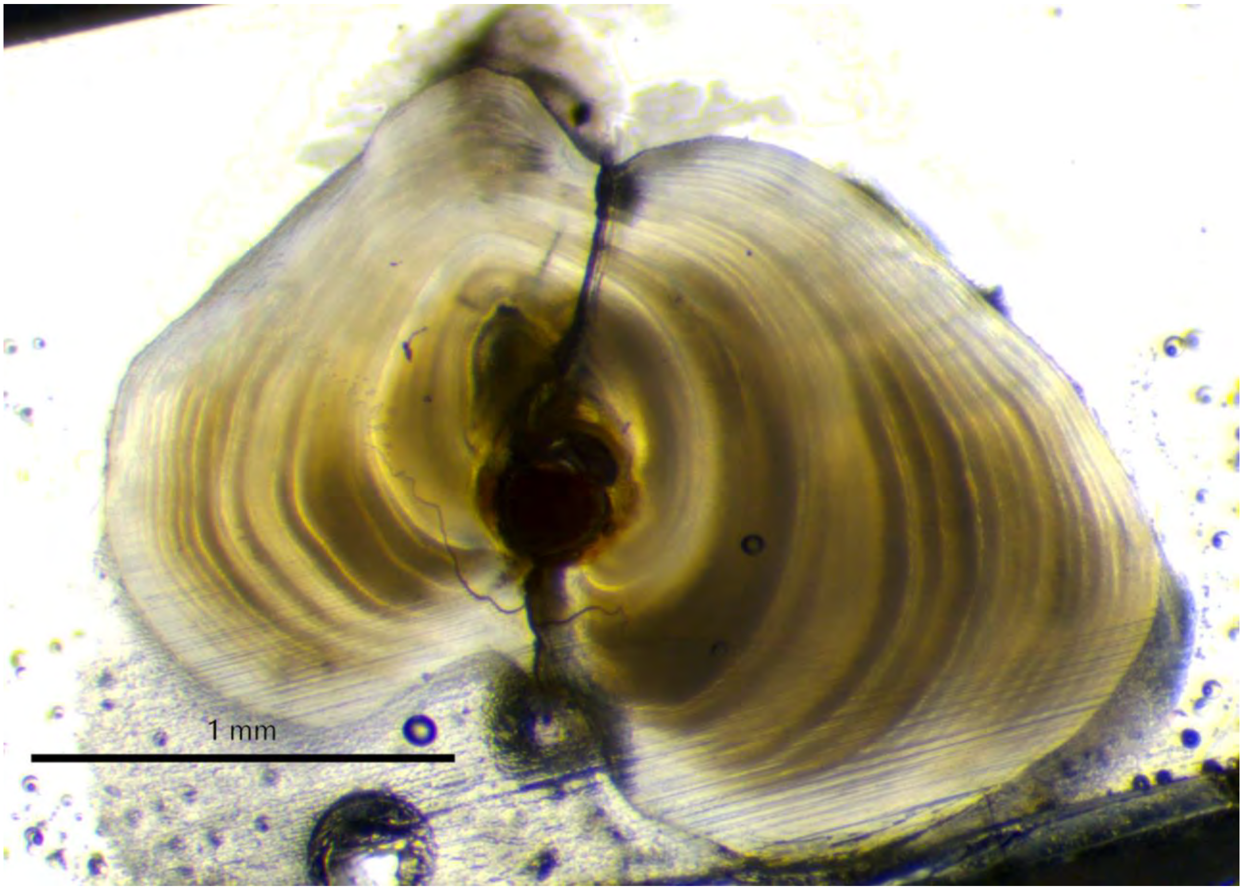

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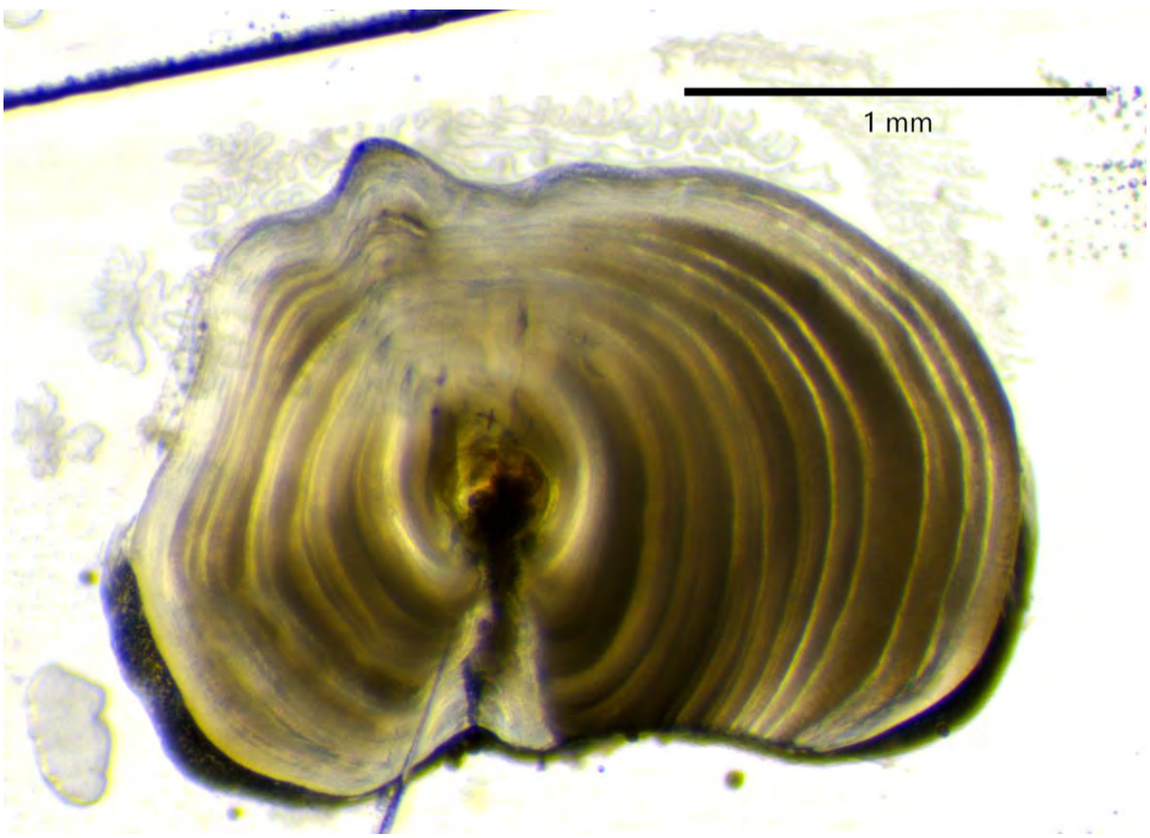

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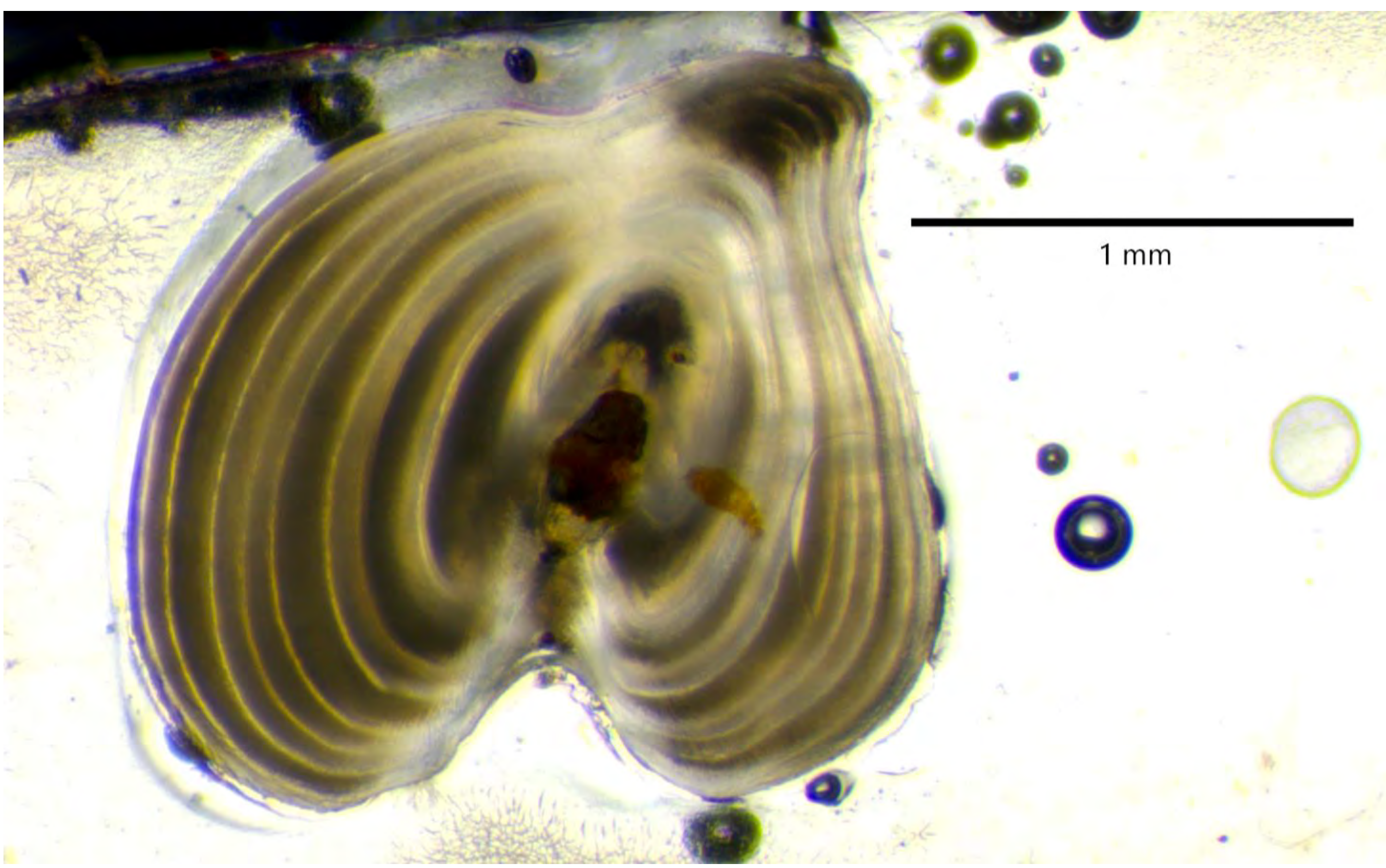

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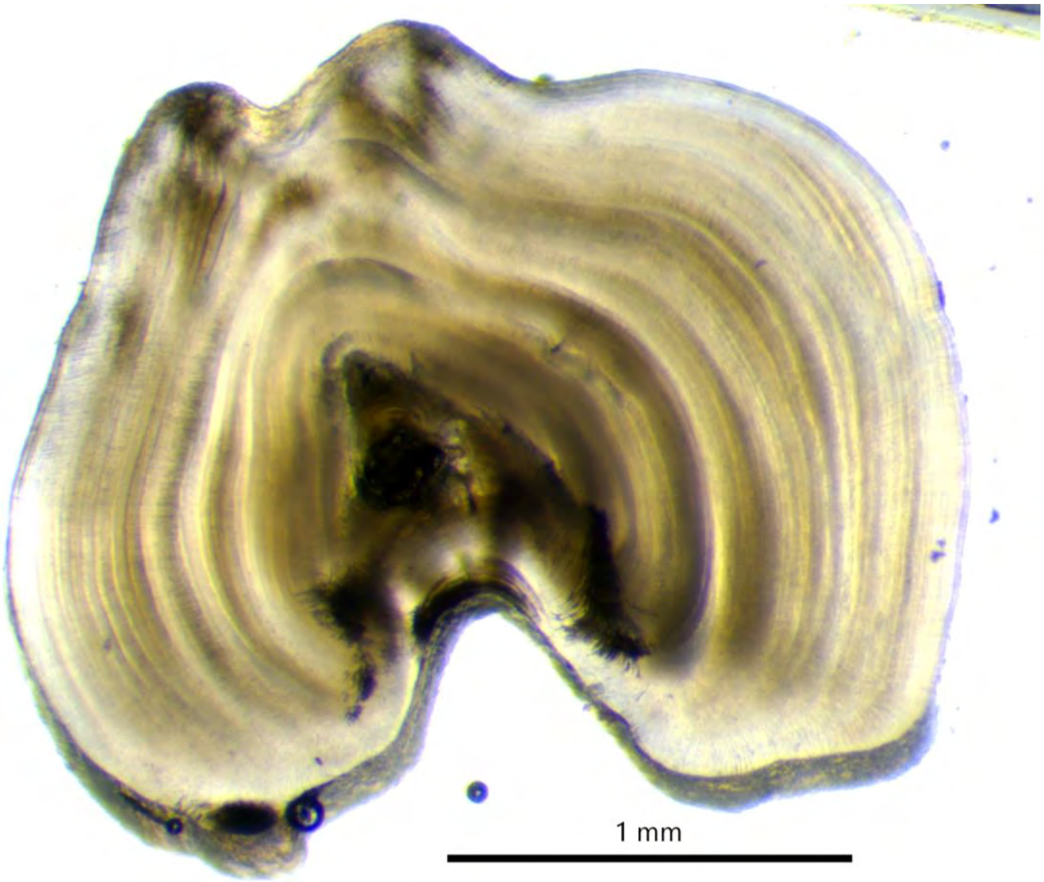

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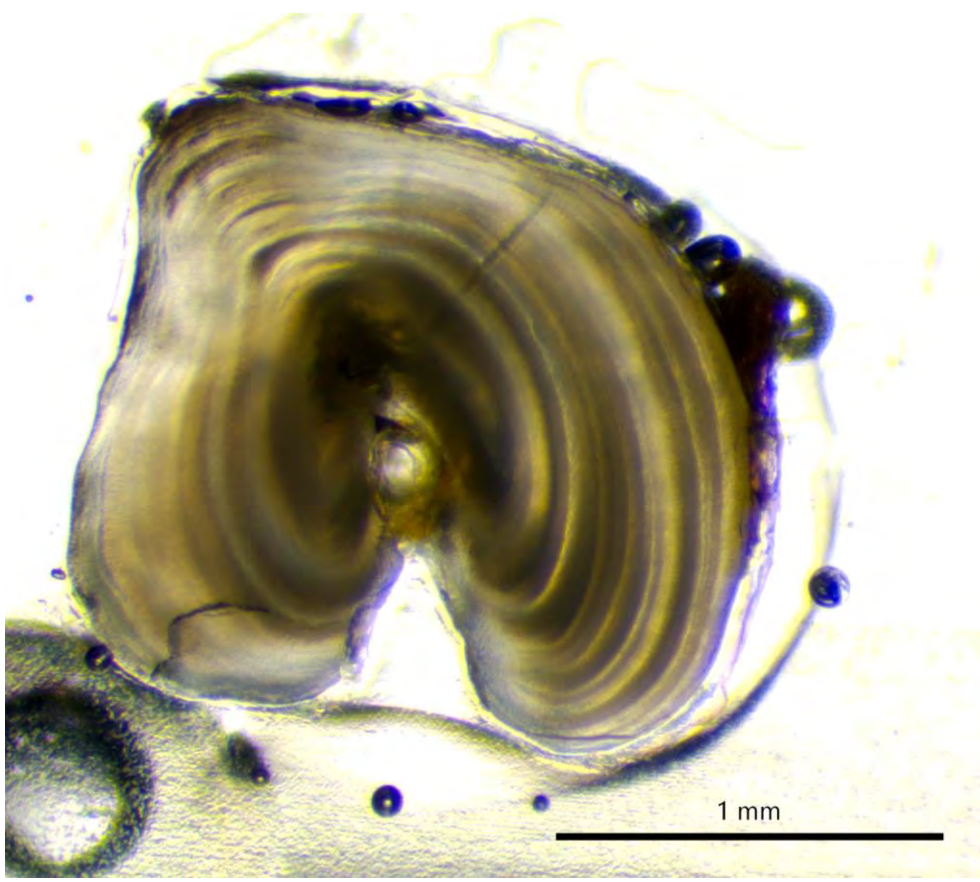

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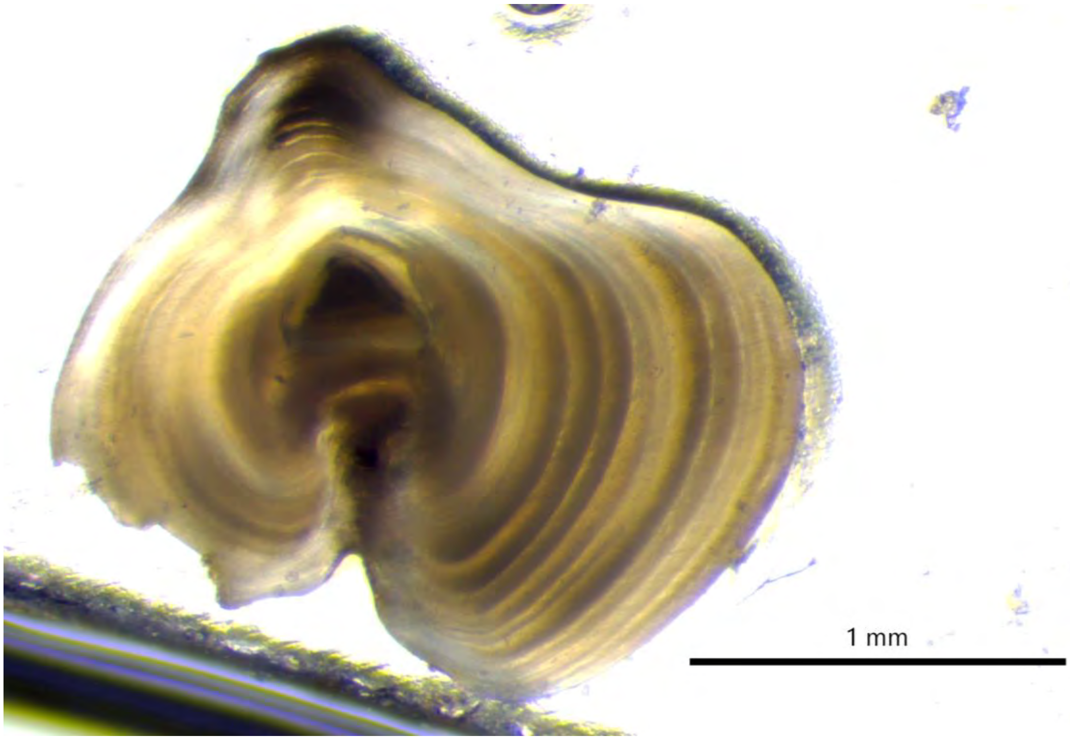

Tautog 18 7/27/2022

Tautog 19 11/20/2019

Tautog 20 11/18/2018

Tautog 21 11/18/2018

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Tautog 23 11/20/2019

Tautog 24
3/5/2022

Tautog 25
10/5/2017

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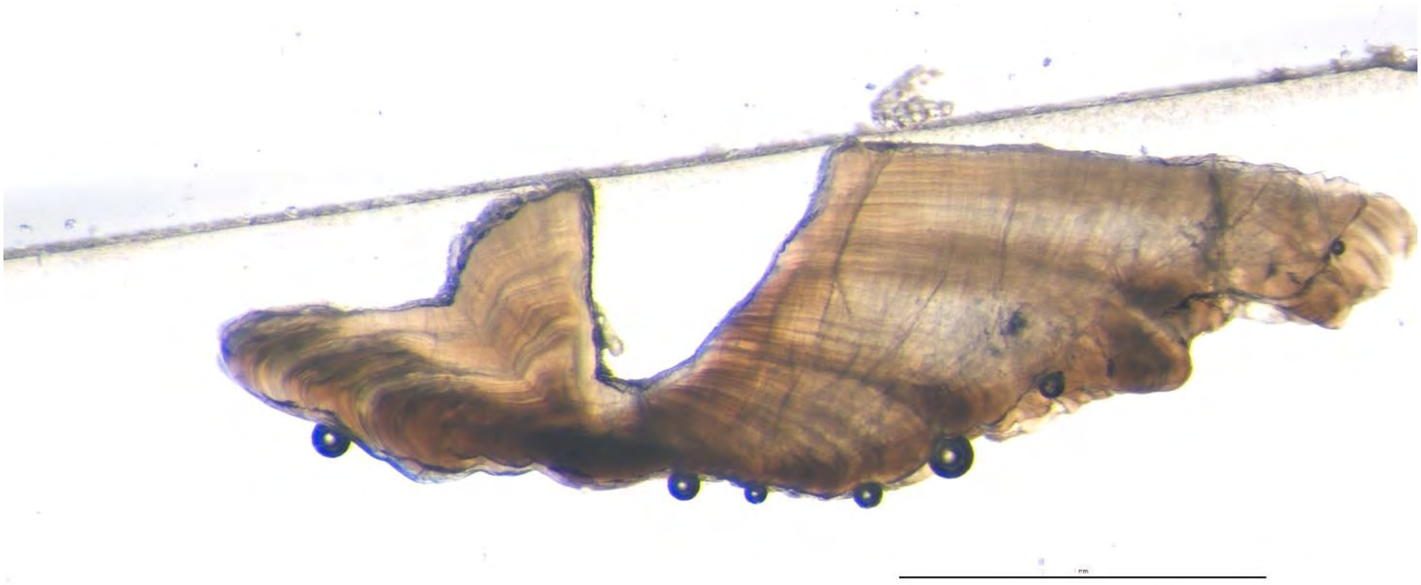

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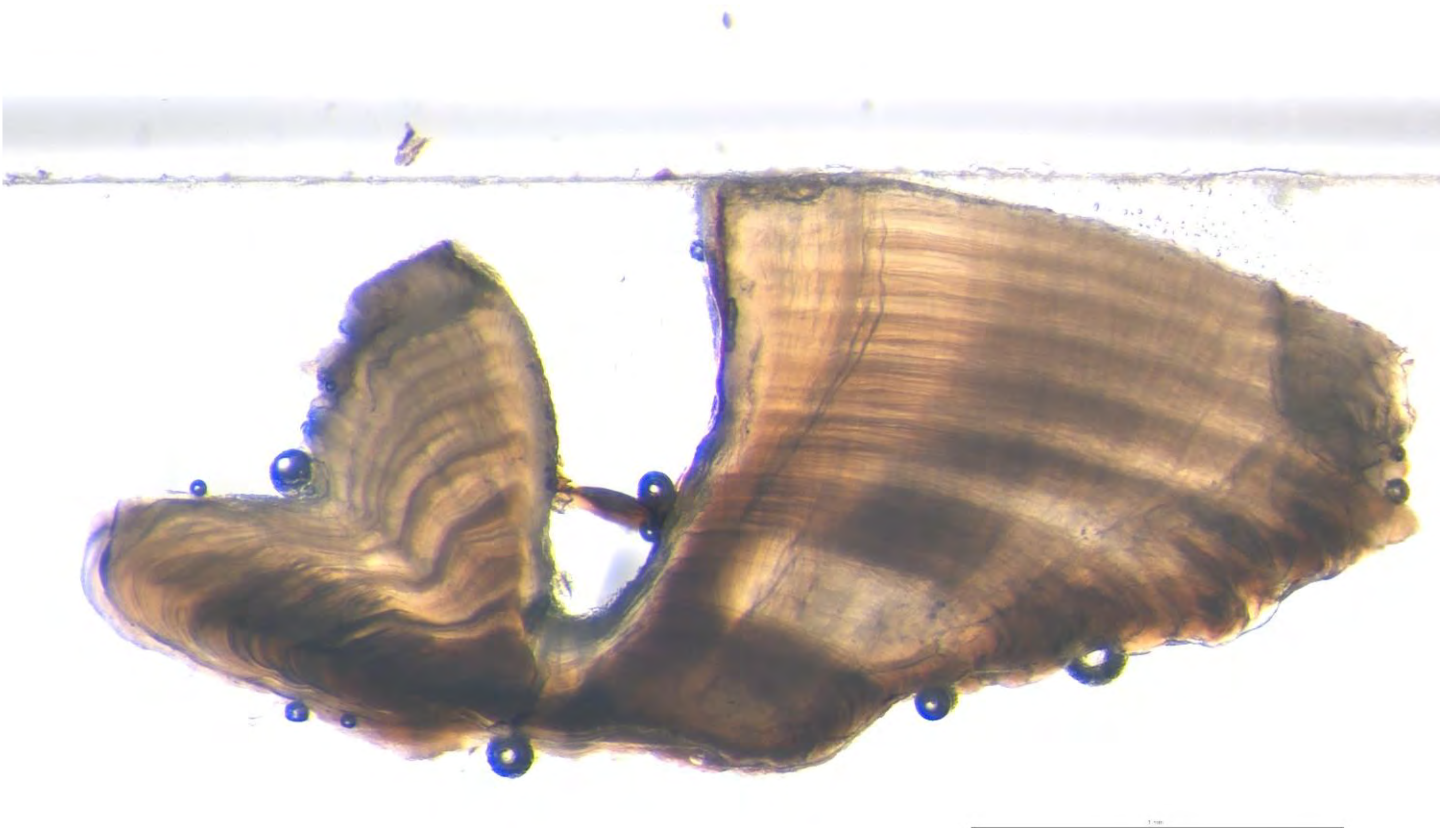

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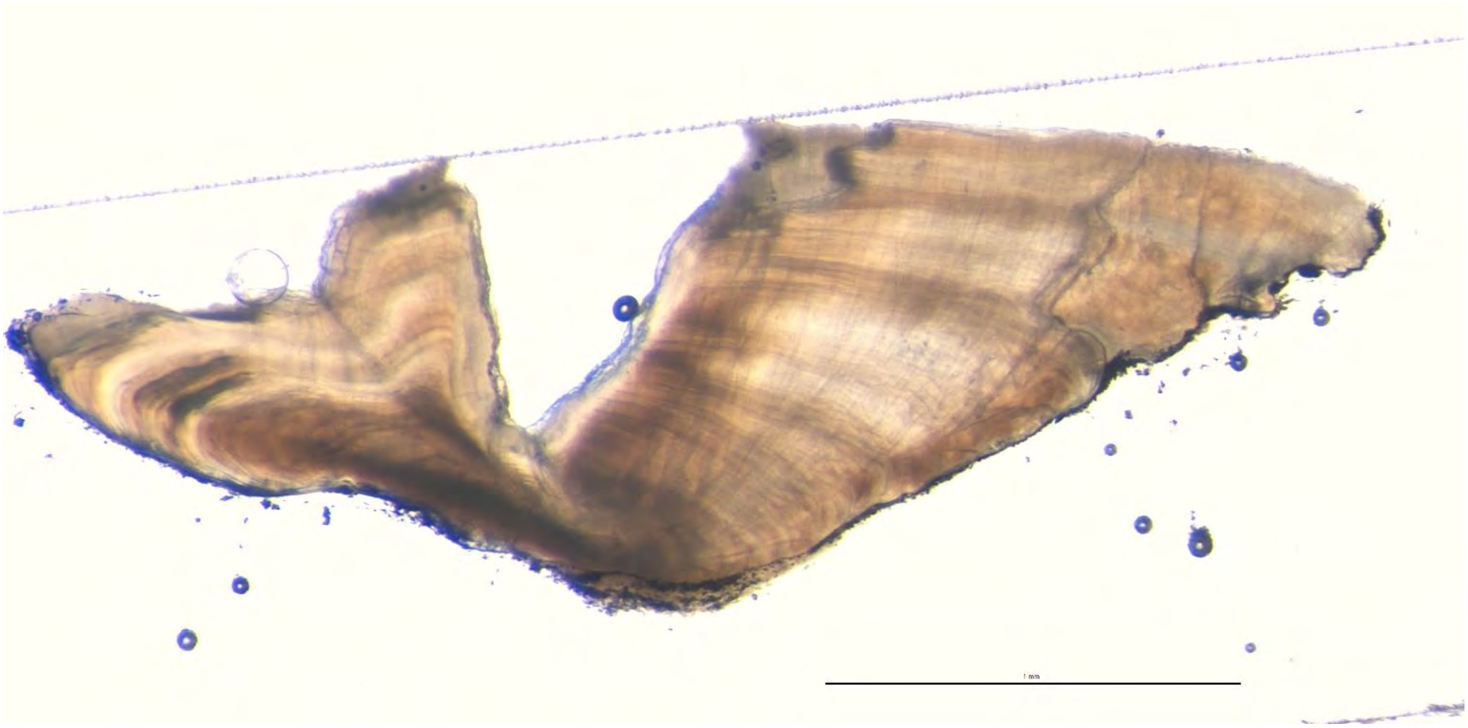
Cobia 3 10/8/2021

Cobia 4 9/1/2012



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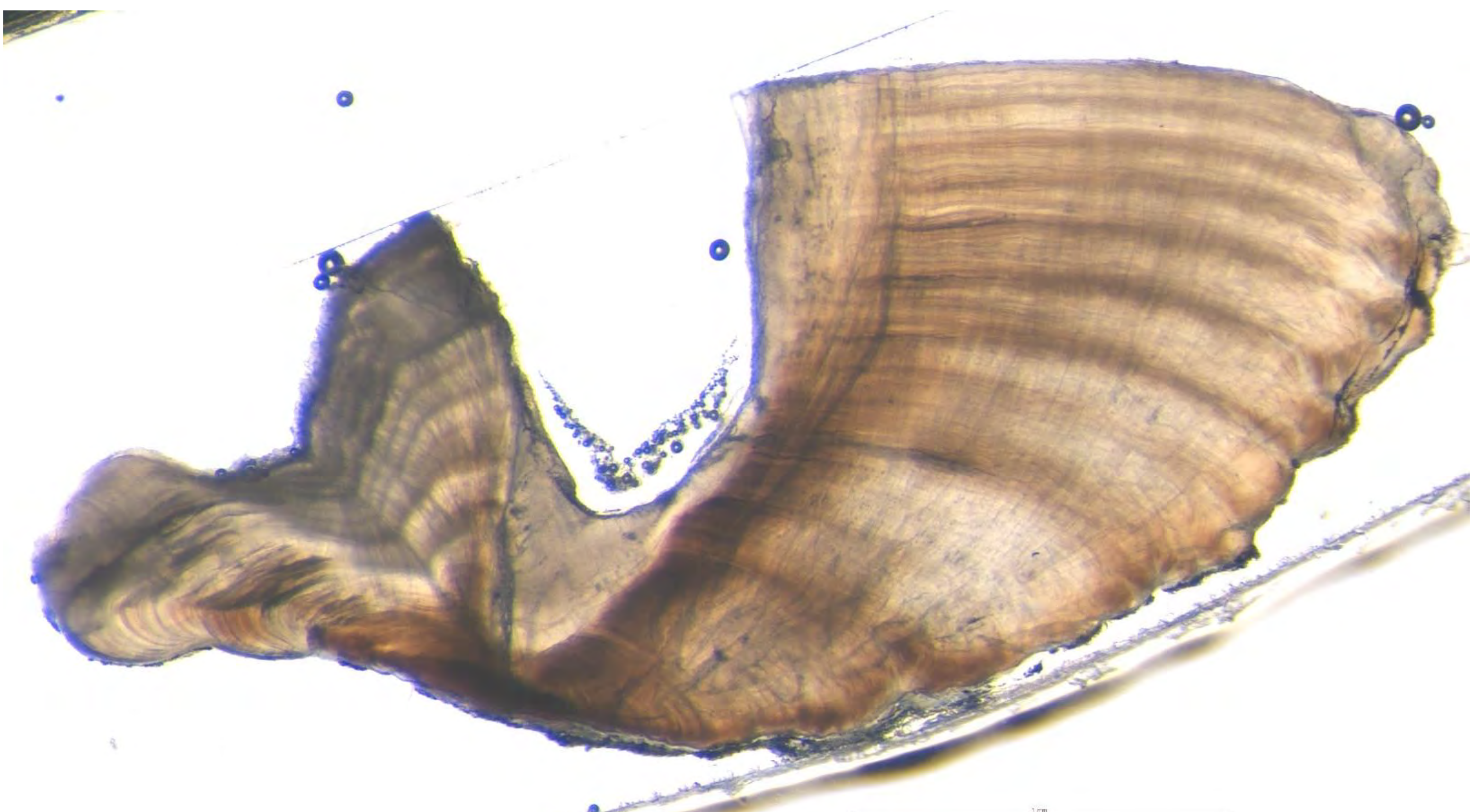
Cobia 8 6/1/2018

Cobia 9 5/24/2016



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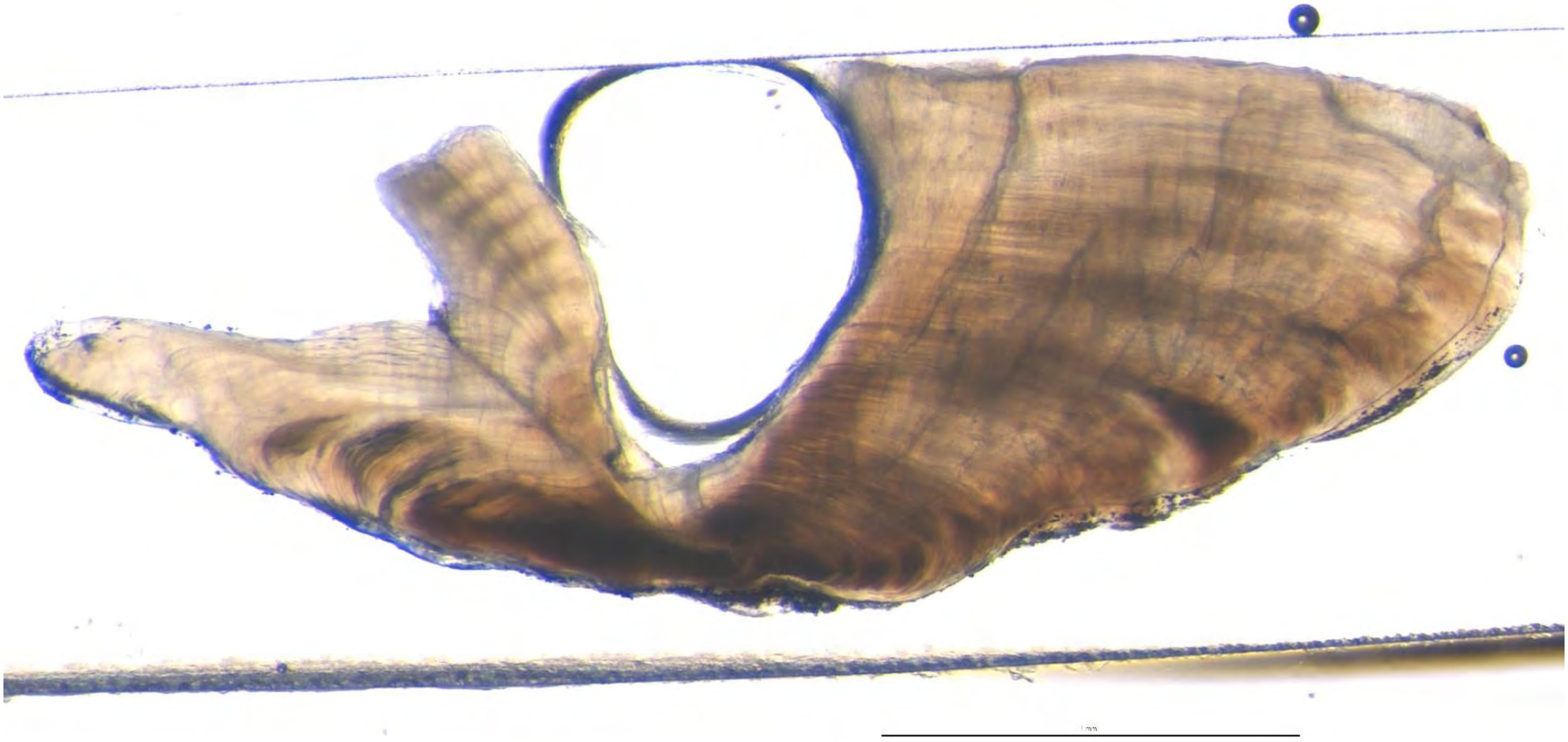

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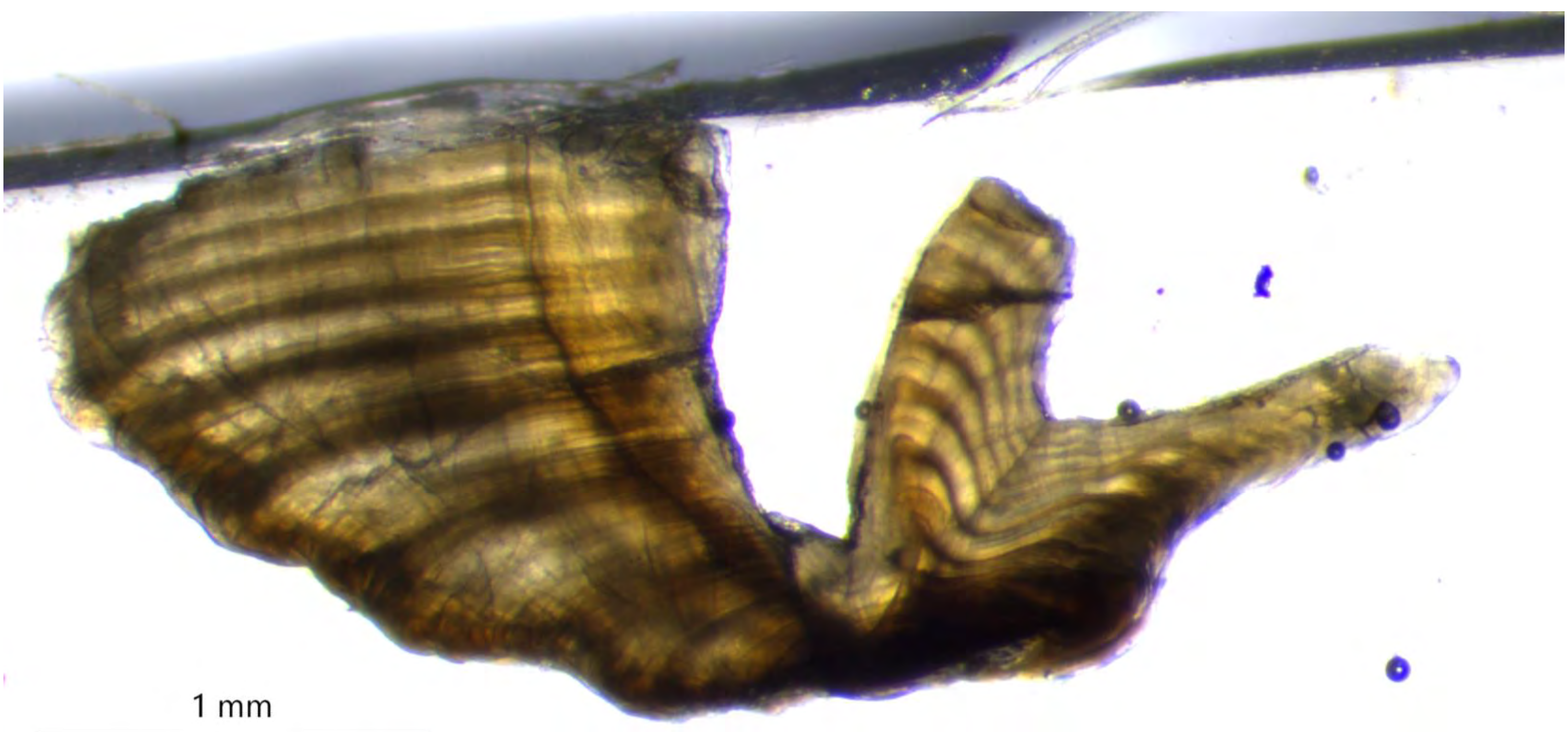

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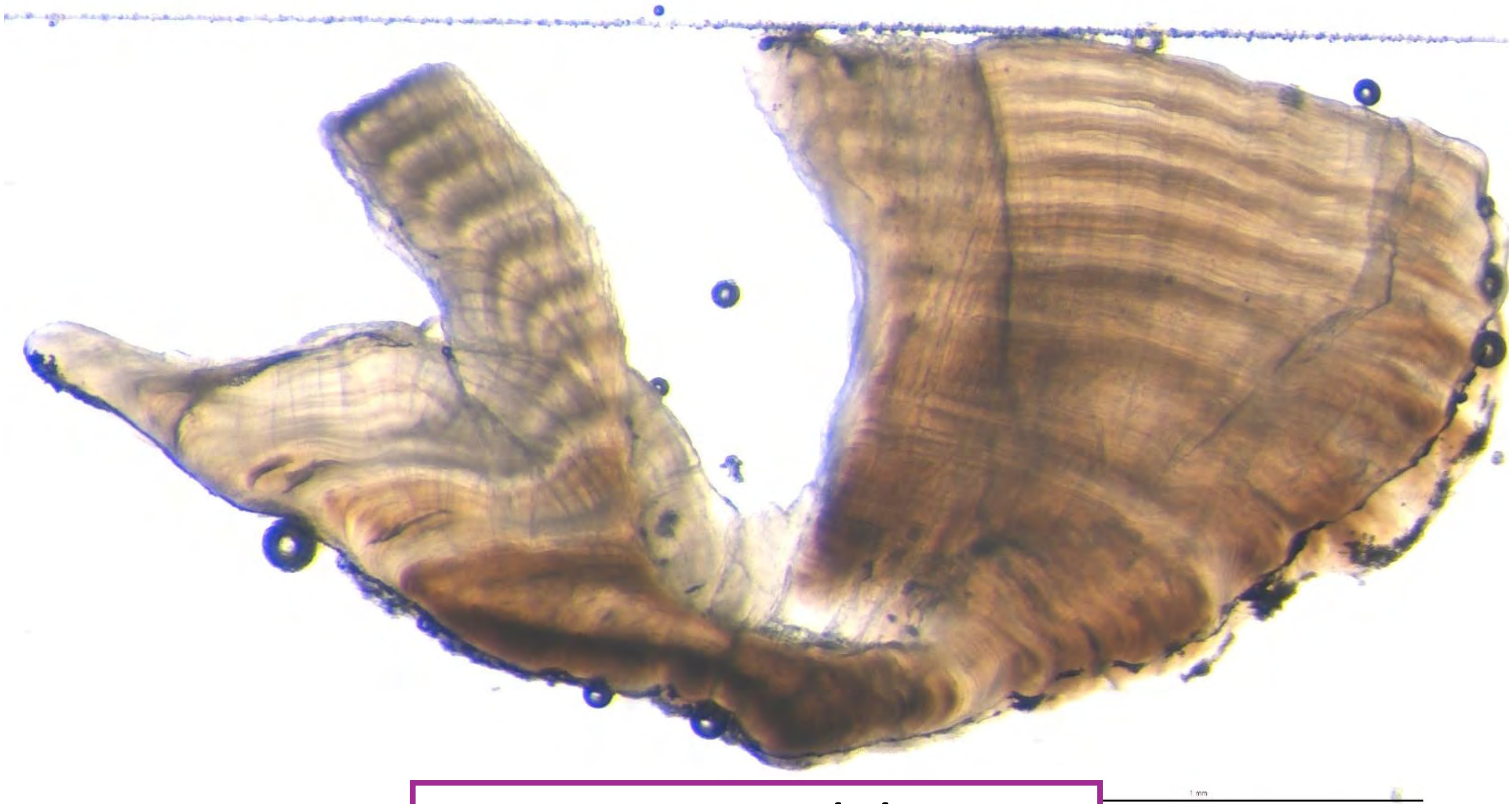

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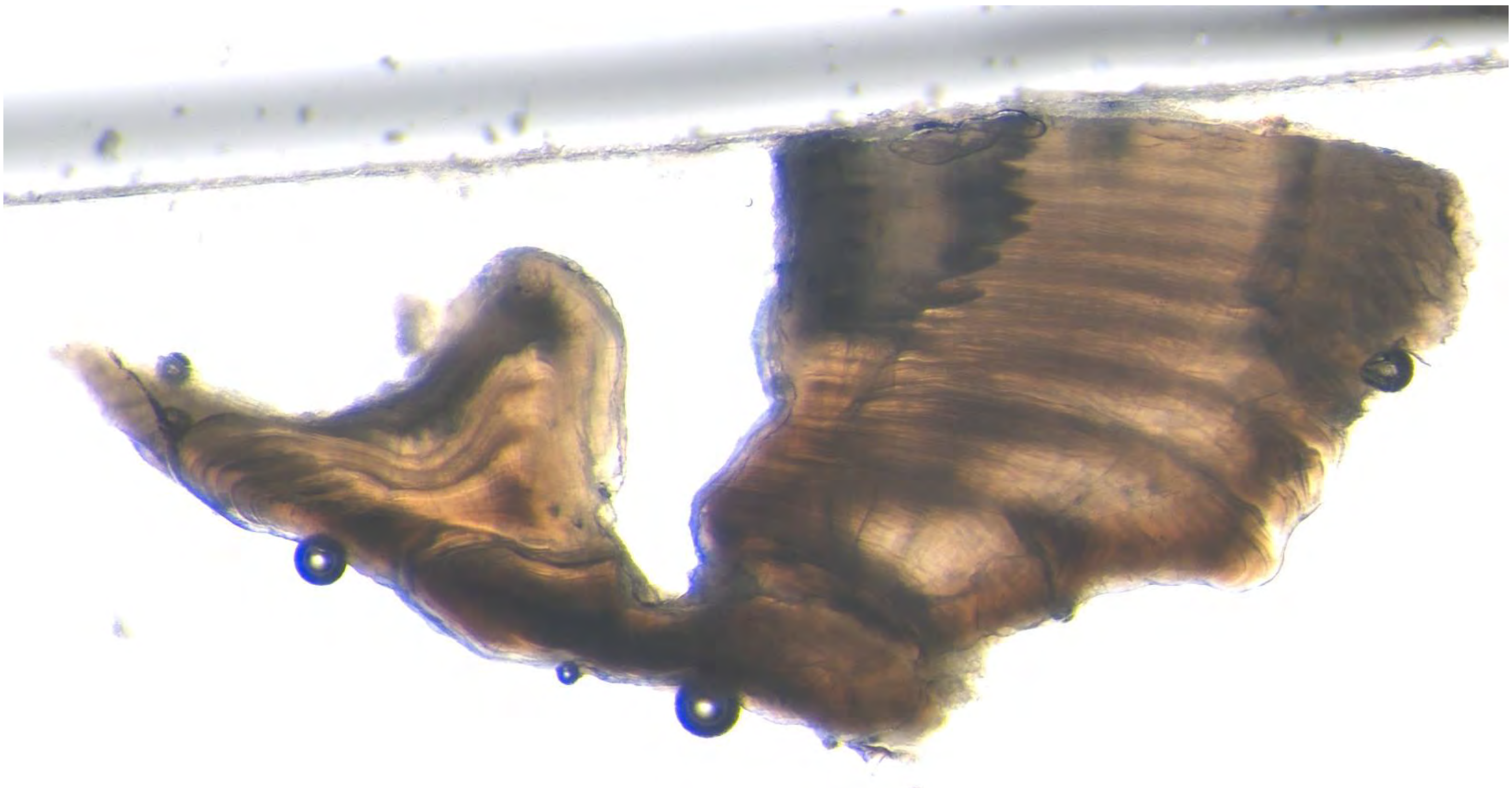

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Cobia 18 6/16/2018

Cobia 19 9/1/2017

Cobia 20 2/26/2021