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TECHNICAL REPORT ON THE PRELIMINARY AGE ESTIMATION OF ATLANTIC BLUE MARLIN, WHITE MARLIN AND SAILFISH USING SAGITTAL OTOLITHS

K. Krusic-Golub[1], A. Sutrovic[1], D. Rosa[2,3], R. Coelho[2,3] and F. Ngom[4]

SUMMARY

*This paper presents the result of a study to evaluate the use of sagittal otoliths to estimate the annual age and provide preliminary otolith-based estimates of longevity for Atlantic blue marlin (*Makaira nigricans*), white marlin (*Kajikia albida*) and sailfish (*Istiophorus albicans*). Otoliths were transversely sectioned and revealed alternating patterns of opaque and translucent zones, consistent with that observed in otolith sections from southwestern pacific swordfish and striped marlin. Increment counts ranged from 0 to 15 for blue marlin, 0 to 14 for white marlin and 0 to 17 for sailfish. A sub-sample of otoliths from each species were prepared for daily ageing. Assumed daily growth zones were evident in the otoliths of all three species. While increment pattern was clearly discernable for the first 150-170 zones, the pattern of daily increments was interrupted at point in the otolith that corresponded to the position of the first observed annual opaque zone. Results indicated that annual ageing of otoliths from billfish is possible, and that daily ageing of otoliths should be restricted to otoliths from larval and early juvenile samples only.*

RÉSUMÉ

*Ce document présente les résultats d'une étude visant à évaluer l'utilisation des otolithes sagittaux pour estimer l'âge annuel et fournir des estimations préliminaires, basées sur les otolithes, de la longévité du makaire bleu (*Makaira nigricans*), du makaire blanc (*Kajikia albida*) et du voilier (*Istiophorus albicans*) de l'Atlantique. Les otolithes ont été sectionnés transversalement et ont révélé des schémas alternés de zones opaques et translucides, qui coïncident avec ceux observés dans les sections d'otolithes de l'espadon et du marlin rayé du Pacifique Sud-Ouest. Les comptages des incréments allaient de 0 à 15 pour le makaire bleu, de 0 à 14 pour le makaire blanc et de 0 à 17 pour le voilier. Un sous-échantillon d'otolithes de chaque espèce a été préparé pour la détermination de l'âge quotidien. Les zones de croissance quotidienne postulées étaient évidentes dans les otolithes de l'ensemble de ces trois espèces. Alors que le schéma des incréments était clairement discernable pour les 150-170 premières zones, le schéma des incréments quotidiens était interrompu au point de l'otolithe correspondant à la position de la première zone opaque annuelle observée. Les résultats indiquaient que la détermination de l'âge annuel des otolithes d'istiophoridés est possible, et que la détermination de l'âge quotidien des otolithes devrait se limiter uniquement aux échantillons de larves et de juvéniles précoces.*

RESUMEN

*Este artículo presenta el resultado de un estudio para evaluar el uso de otolitos sagitales para estimar la edad anual y proporcionar estimaciones preliminares de longevidad basadas en otolitos para la aguja azul del Atlántico (*Makaira nigricans*), la aguja blanca (*Kajikia albida*) y el pez vela (*Istiophorus albicans*). Los otolitos se seccionaron transversalmente y revelaron patrones alternados de zonas opacas y translúcidas, coherentes con lo observado en secciones de otolitos de marlín rayado y de pez espada del Pacífico sudoccidental. Los recuentos de incrementos oscilaron entre 0 y 15 para la aguja azul, entre 0 y 14 para la aguja blanca y entre 0 y 17 para el pez vela. Se preparó una submuestra de otolitos de cada especie para la determinación de la edad diaria. Las zonas de crecimiento diario asumidas eran evidentes en los otolitos de las tres especies. Mientras que el patrón de incrementos era claramente*

[1] Fish Ageing Services, Queenscliff, Victoria (Australia)
[2] IPMA – Instituto Português do Mar e da Atmosfera. Av. 5 de Outubro s/n, 8700-305 Olhão, Portugal
[3] CCMAR – Centro de Ciências do Mar da Universidade do Algarve, Campus de Gambelas 8005-139 Faro, Portugal
[4] CRODT/ISRA - Centre de Recherches Océanographiques de Dakar Thiaroye, LNERV - Route du Front de Terre - BP 2241, Dakar, Senegal

discernible para las primeras 150-170 zonas, el patrón de incrementos diarios se interrumpía en el punto del otolito que correspondía a la posición de la primera zona opaca anual observada. Los resultados indicaron que es posible la determinación de la edad anual de los otolitos de los istiofóridos y que la determinación de la edad diaria de los otolitos debería limitarse únicamente a los otolitos de las muestras de larvas y de los primeros juveniles.

KEYWORDS

Billfish, blue marlin, white marlin, sailfish, ageing, otoliths, annual, age

1. Introduction

Accurate estimates of age and growth are required for age based structured stock assessments and the effective management of fisheries resources. The majority of age and growth studies on billfish have relied on the presence of incremental structure within sectioned fin spines as they are easy to collect and prepare for ageing while otoliths from billfish were considered too small and fragile to analyse. In the case of spines, however, it is often difficult to differentiate annual zones from split zones and to account for zones obscured by vascularisation and resorption (Kopf *et al.,* 2010). When this occurs, incorrect interpretation can lead to ageing errors and systematic bias. In contrast, otoliths grow throughout the life of a fish and are not vascularised, and therefore not subject to resorption, and are generally considered to be a more accurate structure to age fish (Mugiya & Uchimura, 1989; Campana *et al.,* 1995).

A recent study estimated the age of swordfish (*Xiphias gladius*) in the southwest Pacific using spines and otoliths from the same fish (Farley *et al.,* 2016). A direct comparison of age from the two structures showed no bias in young age classes, however, a clear bias was evident in the older age classes (>7 years for females and >4 years for males), with age from spine counts lower on average than counts from otoliths. Although direct validation of the ageing methods is still required, the study provided strong arguments supporting the use of otolith-based age estimates rather than ray-based estimates and recommended that otolith-based age estimation is investigated for other billfish stocks (Farley *et al.,* 2016). Further to the work on southwestern Pacific swordfish, the same methods were applied to striped marlin and recommended using the otolith-based growth parameters obtained in this study in preference to the observed or back-calculated spine-based growth parameters from Kopf et al. (2011), since spines are subject to bone remodelling and vascularisation, and there are inherent biases in back-calculation methods.

Otoliths have been used in several billfish studies to provide estimates of age; however, the majority have used counts of microincrements assumed to be deposited on a daily basis (Shimose *et al.,* 2015; Prince *et al.,* 1991; Wilson *et al.,* 1991). Unfortunately, daily aging has been shown to be unsuitable suitable in otoliths from medium to long-lived species as the outer micro-increments become very narrow once fish reach a certain size and growth asymptotes, making them difficult to discern (Campana, 1992; Jones, 1992). In addition, increments may not be deposited daily after a certain age or size (Krusic-Golub & Ailloud 2022; Neilson & Campana, 2008). Even though otoliths from billfish are difficult to collect, are small and fragile and difficult to prepare, a small number of studies have investigated the use of otoliths for age determination and noted annual like structures on the surface and within thin sections of the otoliths (Prince *et al.,* 1984; Hill *et al.,* 1989). The later study concluded that although more difficult to collect and interpret, sagittal otoliths from blue marlin provided more detailed age information and provided maximum estimates of age up to 18 years for males and 27 years for females. More recently Andrews et al. (2018) reported on the age validation of an extremely large Pacific blue marlin and the results in that study supported the extended longevity of this species to be 20 years or greater. Conversely, the study by Prince et al. (1991) were able to develop an age and growth model for young blue marlin from the Atlantic Ocean, however they were unable to validate their aging method for adult fish. This paper provides the results of the analysis of sagittal otoliths from Atlantic blue marlin, white marlin and sailfish to assess their suitability to provide estimates of annual age.

Billfish otoliths were collected as part of the Enhanced Program for Billfish Research (EPBR) of ICCAT (International Commission for the Conservation of Atlantic Tunas). This program has been established since 1986, with several objectives aiming to improve biological and fisheries data for billfishes in the Atlantic area. The specific growth studies for billfish in the eastern area has been running since 2018 with sampling of anal fin spines and otoliths. This paper presents the result of a study to evaluate the use of otoliths to estimate the annual age and provide some preliminary otolith-based estimates of potential longevity of Atlantic blue marlin (*Makaira nigricans*), Atlantic white marlin (*Kajikia albida*) and Atlantic sailfish (*Istiophorus albicans*).

2. Methods

Sample Preparation

Whole sagittal otoliths were obtained from samples collected from the artisanal fishery carried out off west Africa and sampled by the Centre de Recherches Océanographiques Dakar-Thiaroye (CRODT/ISRA), and from the Portuguese pelagic longline fishery carried out along the Atlantic and sampled by the Instituto Português do Mar e da Atmosfera (IMPA), following the protocol described in Rosa et al. (2022).The samples were stored in numbered vials with the following data provided: source agency, sample code, lower jaw fork length (LJFL) in cm, sex and the number of sagittae extracted.

All samples received at Fish Ageing Services (FAS) are given a unique identification code (Sample ID) that is appropriate for our data systems. The sample consists of a 15-digit code, which is comprised of five sets of triplets, with each triplet being a category. An example of this would be 082010316001003 and comprised of:

1. The client code is the first three digits (082), International Commission for the Conservation of Atlantic Tunas (ICCAT) related studies.
2. The job identification (010), the first job for this client
3. Species code (316), the species code for blue marlin (Makaira nigricans)
4. The batch ID (001), the second batch of blue marlin processed at FAS
5. The fish ID, of fish number (003), fish number 3 from the first batch.

Using this method, all samples can be identified quickly and uniquely. Throughout this report, the client code and job code may be omitted for brevity, and underscores may be used between placeholders. Images collected, whether they are of whole otoliths or during the ageing process use this code.

Prior to preparation, whole otoliths were imaged and weighed. The most complete and unbroken otolith from each pair was placed against a black background and imaged with reflected light at 16x magnification for blue marlin and sailfish and 20x for white marlin using a Leica M80 routine laboratory stereo microscope. Examples of otolith images from the three species are shown in **Appendix 1**. Otoliths were weighed to four decimal places of a milligram by Naomi Clear (Commonwealth Scientific and Industrial Research Organisation, Hobart, Australia) using a Mettler Toledo© balance. Only unbroken samples were weighed and where available, both the left and right otolith from each sample were weighed. Otoliths were then prepared following the procedure described by Farley et al. (2016) for southwestern Pacific swordfish. In summary, individual transverse sections were prepared using a four-step process following methods described by Robbins & Choat (2002). Otoliths were initially fixed on the edge of a slide using thermoplastic mounting media (crystalbond 509) with the anterior side of the otolith balanced over the edge. The primordium was positioned on the slide approximately 100-150 µm in from the edge. The otolith was then ground down to the edge using 400 and 800 grit wet and dry paper. The slide was heated and the otolith removed before being fixed (ground side down) to a new slide. The otolith section was ground horizontally with varying grades of wet and dry sandpaper and finally with 3 µm lapping film until the section was 200-250 µm thick and that the remaining section still contained the core region. The grinding method is illustrated in **Figure 1** and an example of a sailfish otolith indicating the preferred sectioning path in shown in **Figure 2**.

Annual age estimates

All otolith preparations were examined at 40x magnification under transmitted light using a Leica M125 routine laboratory stereo microscope. Each otolith section was viewed once before any attempt was made at age estimation to familiarise the reader with the otolith zone structure. Once familiarised with the otoliths, age was estimated by counting the number of complete opaque zones. It was assumed that one translucent and one opaque zone equated to 1 year of growth within the otolith.

An image analysis system was used to make counts of sectioned otoliths and to capture images of each section. This system counts and measures the distance of each manually marked increment from the primordium and retains an annotated image from each sample aged. The start of each opaque zone was marked and distance from the primordium to each mark and from the final mark to the otolith edge was measured. Opaque zones at the terminal edge of the otolith were counted only if some translucent material was evident after the opaque zone, signifying the completion of the opaque zone. The otolith edge was classified as either narrow translucent (NT), wide translucent (WT) or new opaque (O). A readability score of 1 to 5 was recorded (1 - unable to interpret zone pattern to 5 - clearly alternating opaque and translucent zone pattern) along with any relevant comments relating to the otolith structure or interpretation of the zones.

Daily age estimates

A total of 18 sections were selected for daily age estimation (counts of micro-increments in otoliths). Of these, seven were from small fish estimated to be less than 1 year of age during the annual ageing process (1 blue marlin <180 cm (LJFL), three white marlin <150 cm and three sailfish < 160 cm) and the remaining were from larger fish, to examine if micro-increments were visible in otoliths of older fish and to verify the position and age of the first annually deposited opaque zone. To prepare the sections for daily age reading, the previously prepared sections were ground thinner using 800x and 1200 grit wet dry paper until the preparation thickness was approximately 80-120 µm. If in the grinding process the primordium of the otolith was reached before the desired thickness, the section was flipped and ground from the other side to ensure that the primordium remained within the section. Once ground to the appropriate thickness the surface of the otolith was polished on a felt pad lubricated with a 2 µm grit aluminum oxide slurry, rinsed and dried.

To improve the clarity of the preparations before examination, the prepared side of the otolith was covered with non-drying immersion oil for microscopy (Cargill©). The transverse sections were examined between 400 and 1000x magnification with transmitted light. Daily growth zones were counted on both the dorsal and ventral lobe along the clearest path out to the otolith edge (if possible). The micro-increments in billfish have been previously described in detail (Prince *et al.*, 1991; Sun *et al.*, 2002; Magalofonou *et al.*, 1995). In the samples estimated to be 1 year or more, it was evident that there was a transition point in the otolith approximately 350-400 µm out from the primordia on the ventral side (side used for annual ageing) and the micro-increment structure was difficult to interpret with the pattern of opaque and translucent zones much less concentric (**Figure 3**). If an otolith exhibited this characteristic only the count to the transition point was recorded and no attempt was made to count micro-increments between this feature and the edge. The distance from the primordium to the transition point was also measured.

Growth analysis

A von Bertalanffy (VB) growth model was fit to the otolith age and length data for each species. As the sample size was small males and females were not fitted separately. A Von Bertalanffy growth curve was fitted to the combined length-at-age data using the non-linear least squares method: The VB model has the form:

$$L_t = L_\infty(1 - e^{-k(t-t_0)})$$

where Lt is the fork length at age t, L∞ is the mean asymptotic length, k is a relative growth rate parameter (year-1), and t0 is the age at which fish have a theoretical length of zero.

3. Results

Otoliths available to this study were collected from 46 blue marlin (167 – 286 cm LJFL), 41 white marlin (123 – 194 cm LJFL) and 66 sailfish (132 – 200 cm LJFL). Males were generally smaller and with females accounting for most blue marlin samples greater than 220 cm LJFL, white marlin greater than 150 cm LJFL and sailfish greater than 170 cm LJFL (**Figure 4, Table 1**).

Otolith weight is a useful diagnostic tool in assessing potential errors in age estimates and for examining patterns of otolith growth as otoliths weight has a strong relationship with fish size and age. In long-lived species, the relationship of otolith weight against estimated age may show an increased slope if the ages have been underestimated. Large variation around the relationship may also indicate a lack of precision in the estimates. Also, an outlying data point in the otolith weight/age relationship may indicate incorrect assignment of age and/or length and otolith weight measurements (Morison *et al.,* 1998). The fish length-otolith weight relationships were generally linear and were reasonably consistent between species (**Figure 5**). Results do show that there is a potential difference in growth between female and males in blue marlin and to a lesser extent the other two species. Age was estimated from counts of assumed annually deposited opaque zones for 43 otoliths supplied for blue marlin, 37 otoliths supplied for white marlin and 62 otoliths supplied for sailfish. As only one reading was made of each otolith by one reader, the precision of age estimates were not estimated from this preliminary study. Age in sectioned otoliths ranged from 0 to 15 for blue marlin, 0 to 14 for white marlin and 0 to 17 for sailfish. While alternating opaque and translucent zones were present on most otolith sections examined **(Figures 6-8)**, some otoliths exhibited a clearer pattern than others. The average readability for blue marlin, white marlin and sailfish was 2.9, 2.8 and 2.7 which indicates that the age estimates were relatively difficult to assign and could be subject to small inaccuracies. Examples of sectioned otoliths showing relatively clear increment structure of varying ages are shown in **Appendix 2.** The estimated age-otolith weight relationship was essentially linear for the three species and didn't show outlying points, indicating there wasn't any samples suggesting obvious error within the ageing or length measured (**Figure 9**).

We were able to provide a total daily age estimate for one small blue marlin (177 cm LJFL), three white marlin (129 –146 cm LJFL) and three sailfish (152–163 cm LJFL). Results indicated that initial growth is rapid, potentially reaching lengths of 180 cm, 146 cm and 160cm within the first year of life for blue marlin, white marlin and sailfish, respectively. The remaining samples from the 18 samples selected for daily ageing, were aged at 1 year or greater and we could only complete partial counts on these samples. As per other studies on tunas and billfish species the internal structure showed clear micro-increment structure up to a point where the increment pattern was disrupted and became difficult to interpret. For the three species examined, this point occurred at a count of approximately 150-200 increments. The interruption in the assumed daily growth zones corresponded mostly with the start of the first opaque zone identified in the annual ageing procedure and suggests that the first annual opaque zone is formed before the first year of life. The otolith sections selected for daily increment counting are shown in **Appendix 3** and show the dorsal and ventral ageing transect, the point at which increments became difficult to interpret (transition point at the end of the transects) and the position of the assumed opaque zones marked for ageing. The average age to the transition point was 200, 182 and 198 days for blue marlin, white marlin and sailfish otoliths respectively. The measured distance from the primordium to the transition point within the otolith (ventral transect only) was 0.356 mm for blue marlin, 0.393 mm for white marlin and 0.413 mm for sailfish, indicating that it is likely the first opaque zone formed before the end of the first year of life in all three species.

Due to the small sample size and the preliminary nature of this study we assumed that estimated age was simply the total count of the number of opaque zones. The estimated age-otolith weight relationship for all three species was essentially linear and showed few sample points that were considered as outliers (**Figure 9**). One sailfish sample was identified as an outlier and when the data was checked, the otolith weight was identified as incorrect and removed from the data.

Growth parameters were estimated from the integer age at length data (**Figure 10, Table 2**), however with the absence of small fish within the sample these estimates are considered unrealistic as there were no data points to anchor the value t_0 to a value closer to zero. The collection and daily ageing of otoliths from small fish <150 cm LJFL is needed to refine the growth parameters and should be a consideration of future sampling designs for these species. Another issue using integer ages is the relatively fast initial growth and the fact the age estimates could be biased by almost 1 year. For example, a fish estimated to be age 1 could be anywhere between 12 months and 24 months old depending on the time of year it was caught. It is possible to estimate decimal age without the knowledge of spawning seasons/durations or the timing of increment formation (Farley *et al.,* 2020; Farley *et al.,* 2021), however this method relies on developing a relationship between daily age and the length of the ventral otolith arm for age 0+ samples and determining estimates of average increment width for each age class. This approach requires large numbers of samples to be analysed a priori, something that could not be accomplished within the scope of this study. However, using this approach and completing the necessary analysis should be a consideration in future age and growth studies on these species which are to be based on counts of annuli in otoliths.

4. Summary

Preliminary analysis of otoliths in the current study indicates that otolith-based annual age estimates are possible for the three species of billfish examined. Estimates of age reported in this paper confirm the extended longevity of Atlantic blue and white marlin, reported in an earlier study based on counts of annual zones in otoliths (Hill *et al.*, 1989) and Pacific blue marlin reported by Andrews *et al.,* (2017) using bomb radiocarbon dating. While we were able to provide growth parameter estimates for the three species, the estimates are considered unrealistic due to the absence of small fish within the sample. It is therefore recommended that any future sampling programs for otoliths are designed to target the collection of otoliths from very small and very large fish. Direct validation of the accuracy of the otolith ageing method for billfish has not been undertaken in any study and is required to validate the annual periodicity of the opaque zones counted in this study. Validation of longevity from small amounts of material in billfish otoliths is now technically feasible using bomb radiocarbon dating and the validation and should also be considered as a research priority as the otolith based ageing progresses.

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Table 1. Otolith collection details detailed by agency, species and sex for Atlantic blue marlin (BUM), white marlin (WHM) and sailfish (SAI).

Species	CRODT-Senegal	IPMA-Portugal	Total
BUM	**9**	**37**	**46**
F	**9**	**20**	**29**
M	**-**	**17**	**17**
SAI	**16**	**49**	**65**
F	**16**	**25**	**41**
M		**24**	**24**
WHM	**12**	**29**	**41**
F	**9**	**22**	**31**
M	**3**	**6**	**9**
Total	**37**	**115**	**152**

Table 2. Von-Bertalanffy growth parameters estimated from the age and length data.

Species	n	L_∞	k	t_0
Blue Marlin	43	243.61	0.87	-1.37
White marlin	37	178.84	0.51	-3.16
Sailfish	62	182.97	0.81	-2.68

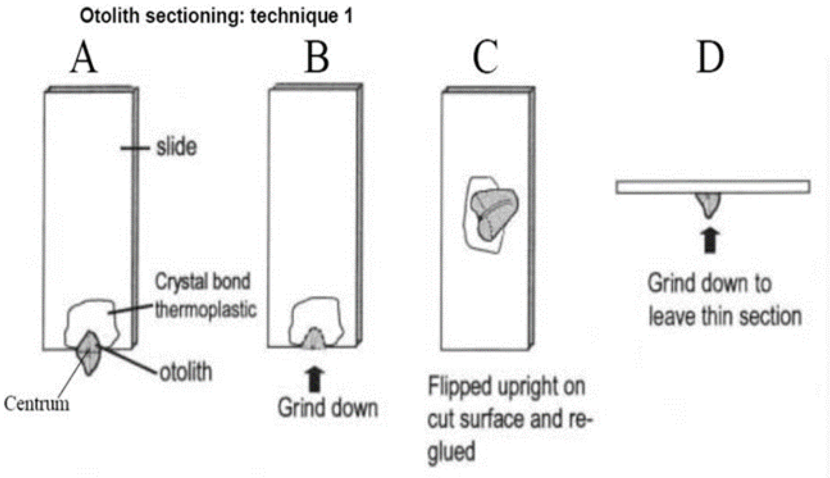


Figure 1. Illustration of the individual grinding process for preparation transverse otolith thin sections (Source: Robbins & Choat, 2002).

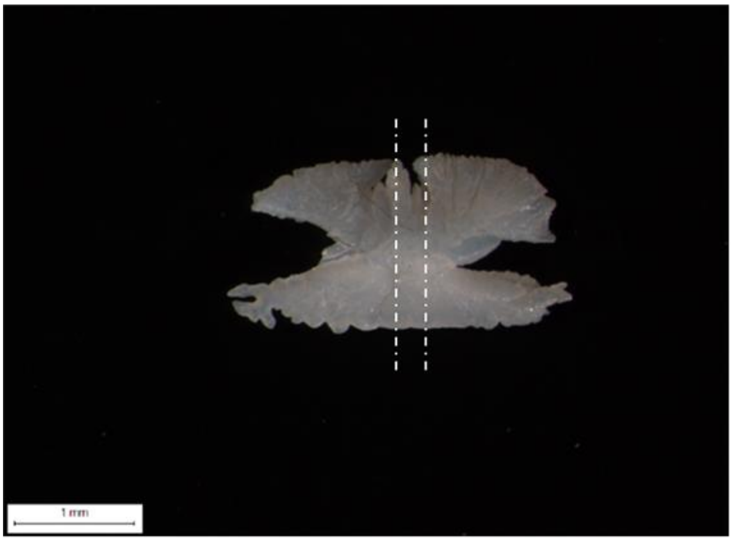


Figure 2. Atlantic sailfish otolith with preferred transverse section indicated (white dotted lines).

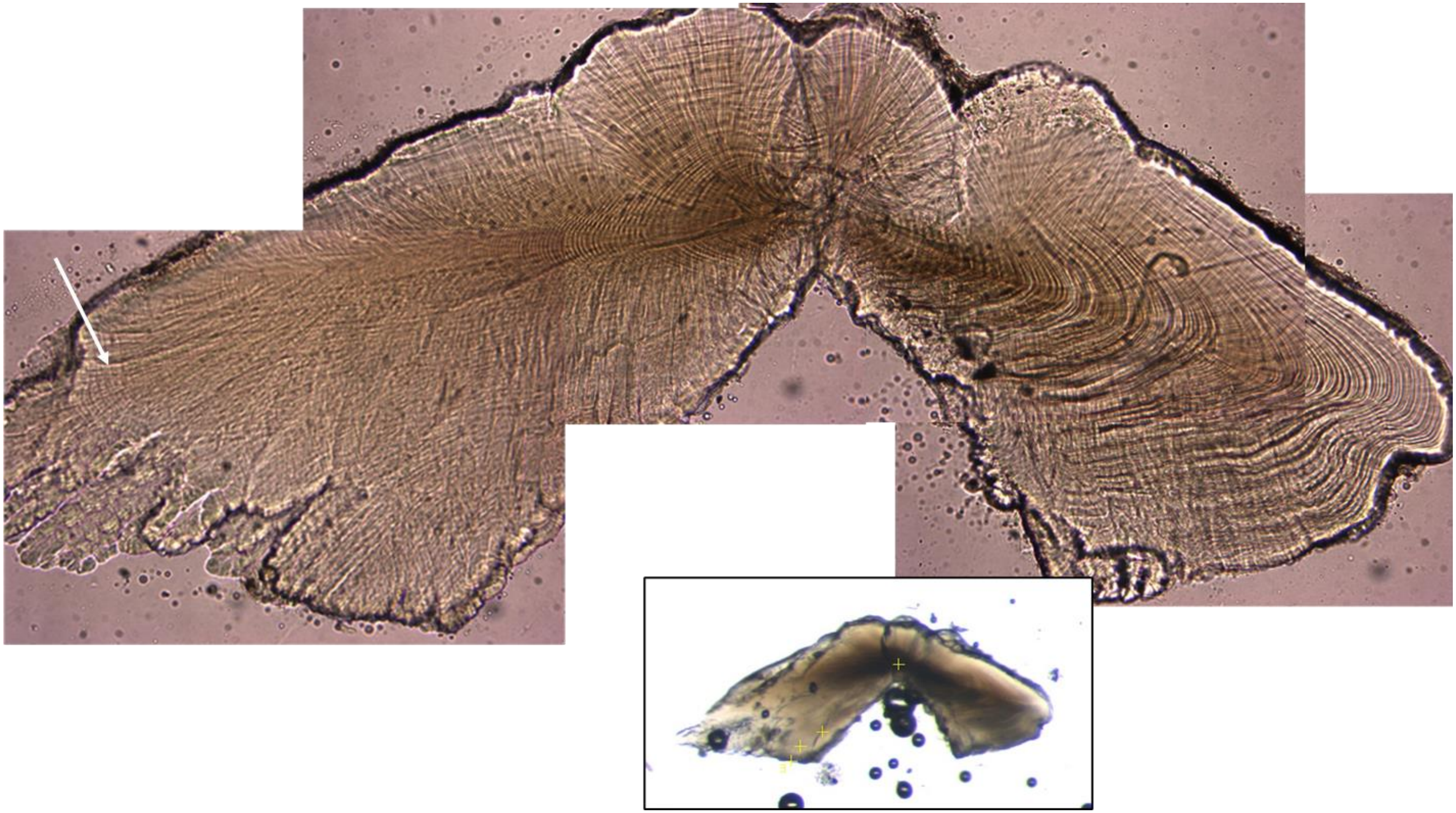


Figure 3. Example of assumed daily increments in a transversely sectioned otolith (318002032 - CT19021577). Image also shows the approximate position (white arrow) where there is a noticeable change in the pattern and clarity of the increments which correlated with the first major opaque zone (Inset image is the same otolith imaged for annual ageing. Yellow +'s indicate the position of the assumed annual increments).

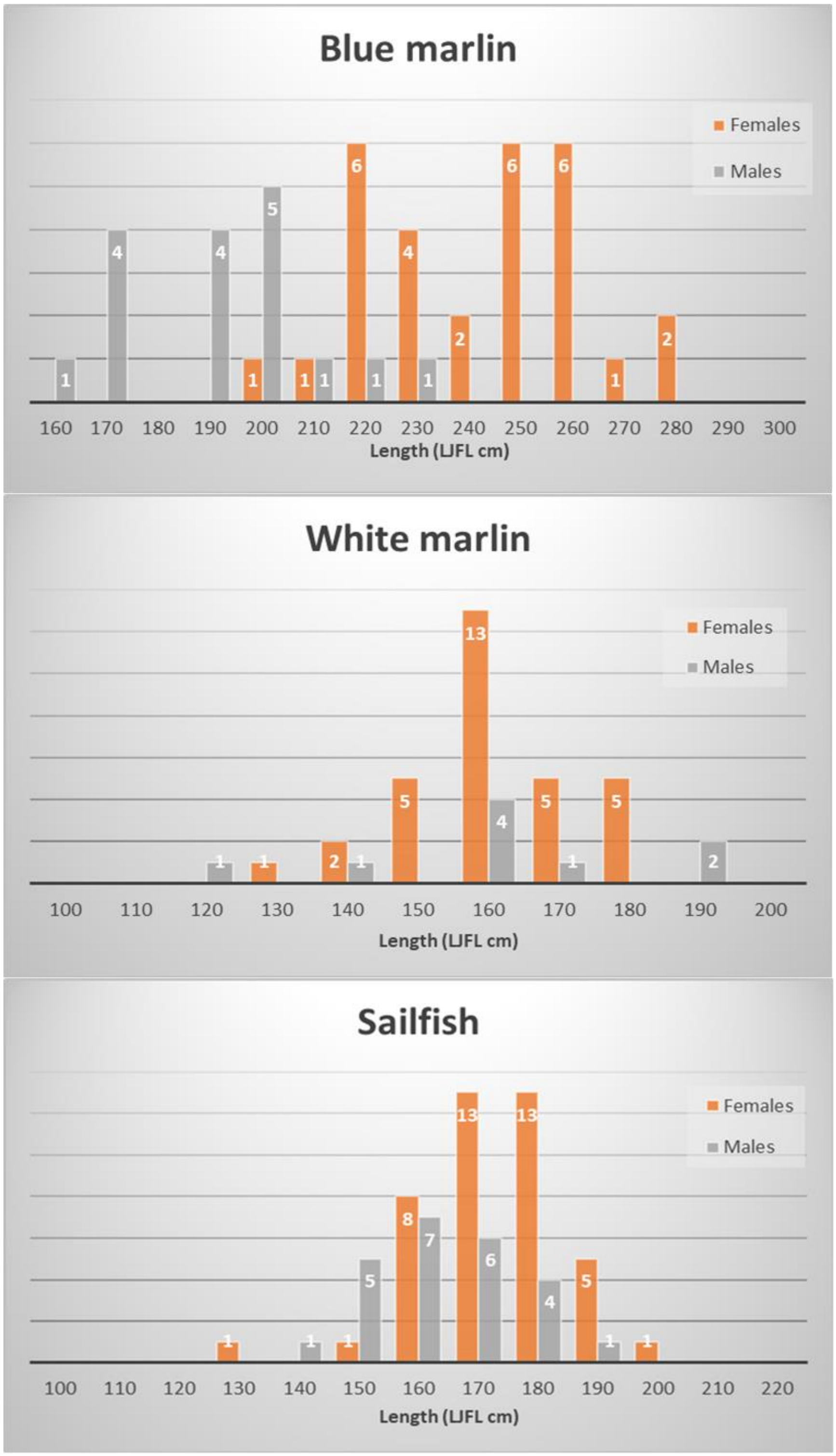


Figure 4. Length composition of the fish sampled for otoliths used in this study.

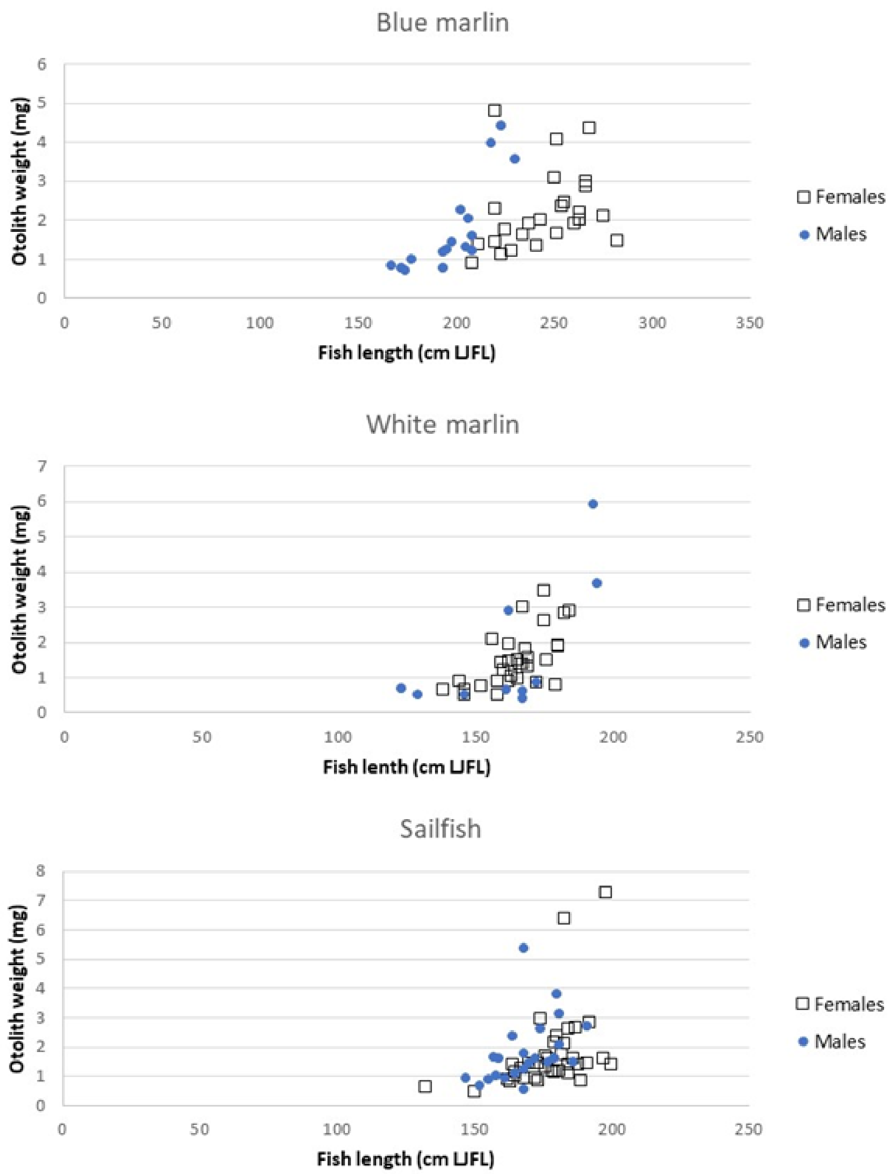


Figure 5. Otolith weight and fish length relationship for the samples used in this study.

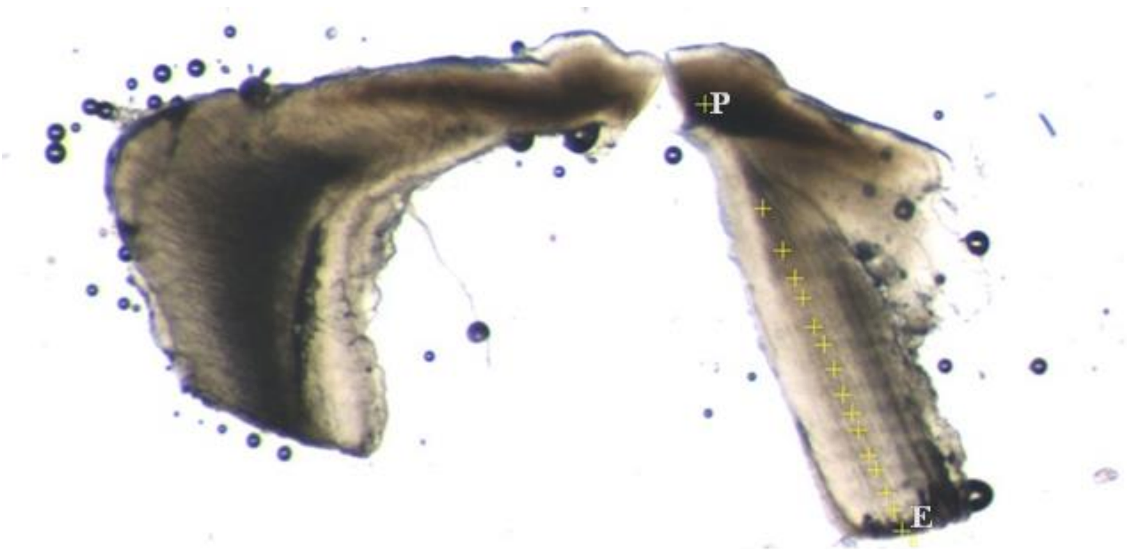


Figure 6. Transverse preparation of a blue marlin sagittae (sample 31601006 - BUM_38) prepared for annual reading and viewed with transmitted light. The nucleus is indicated by the P (primordium) and the otolith edge with an E, subsequent annual opaque zones are indicated by the yellow crosses. The otolith was sampled from a 220 cm LJFL female and estimated to be 14+ years of age. P = primordium, E = edge.

Figure 7. Transverse preparation of a white marlin sagittae (sample 317001007 - WHM_15) prepared for annual reading and viewed with transmitted light. The nucleus is indicated by the P (primordium) and the otolith edge with an E, subsequent annual opaque zones are indicated by the yellow crosses. The otolith was sampled from a 193 cm LJFL male and estimated to be 14+ years of age. P = primordium, E = edge.

Figure 8. Transverse preparation of a sailfish sagittae (sample 318002046 - CT19022494) prepared for annual reading and viewed with transmitted light. The nucleus is indicated by the P (primordium) and the otolith edge with an E, subsequent annual opaque zones are indicated by the yellow crosses. The otolith was sampled from a 193 cm LJFL male and estimated to be 16+ years of age. P = primordium, E = edge.

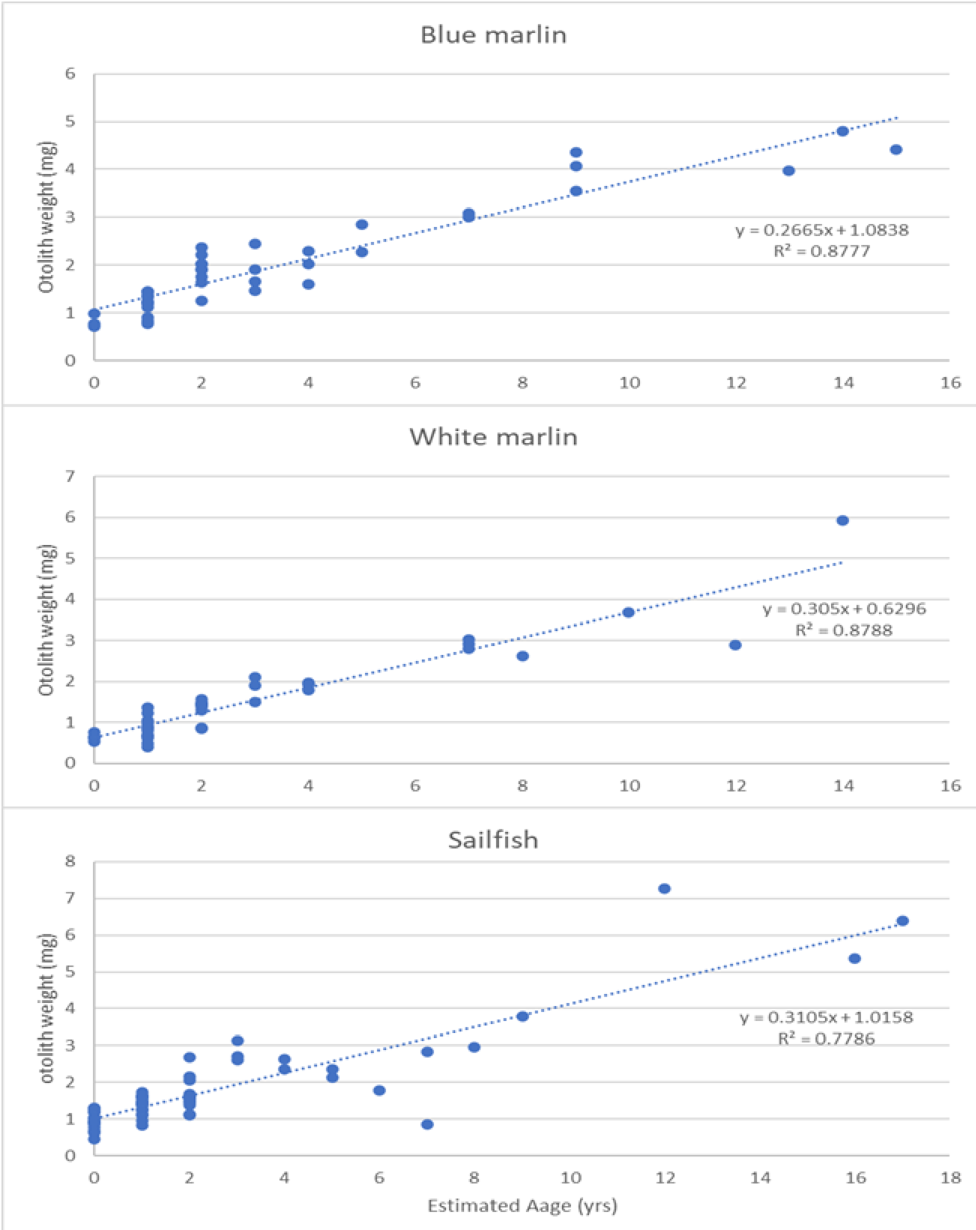


Figure 9. Otolith weight and age relationship.

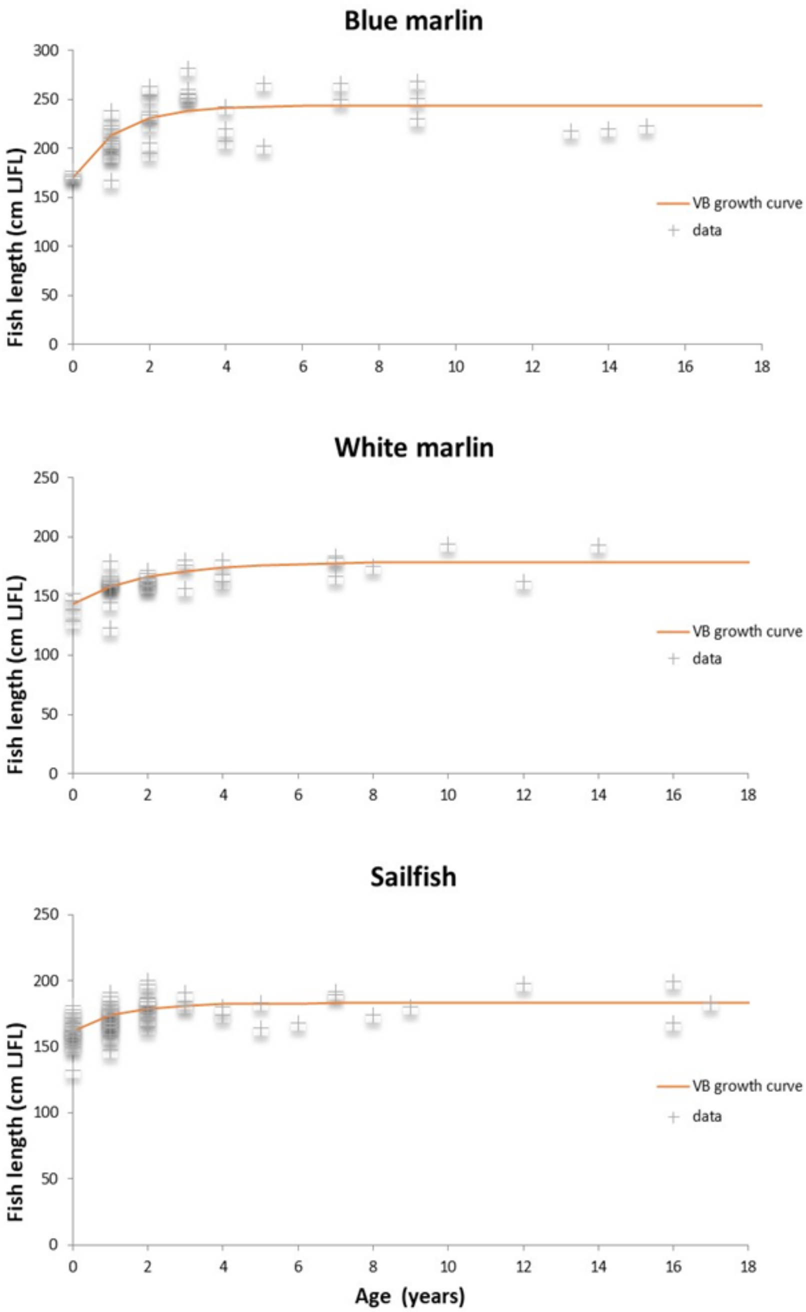
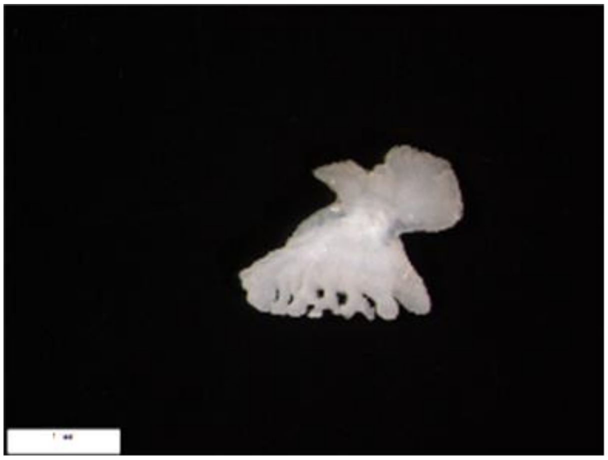


Figure 10. Plots of estimated age versus fish length for three species of Atlantic billfish.

Appendix 1

Examples of whole otoliths from Atlantic blue marlin, white marlin and sailfish

Blue marlin otoliths (BUM)



BUM_CT19020004 - 193cm (LJFL), Male

BUM_ML19013067 – 230cm (LJFL), Male

BUM_38 – 220 cm (LJFL), Female

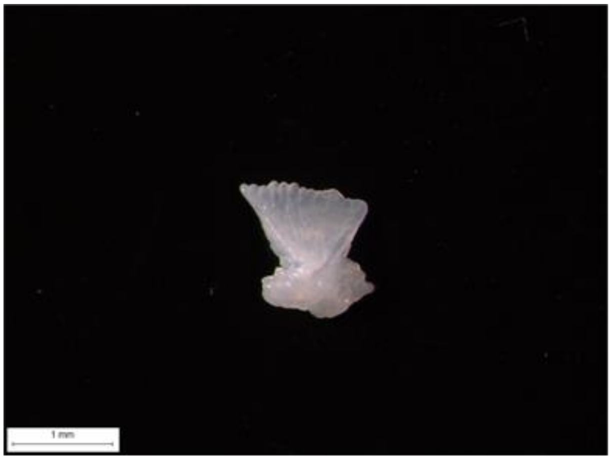
White marlin otoliths (WHM)

WHM_14 – 146cm (JLFL), Male

WHM_19 – 194cm (LJFL), Male

WHM_15 – 193cm (LJFL), Male

Atlantic sailfish otoliths (SAI)



SAI_34 – 150cm (LJFL), Female

SAI_CT19022282 – 174cm (LJFL), Male

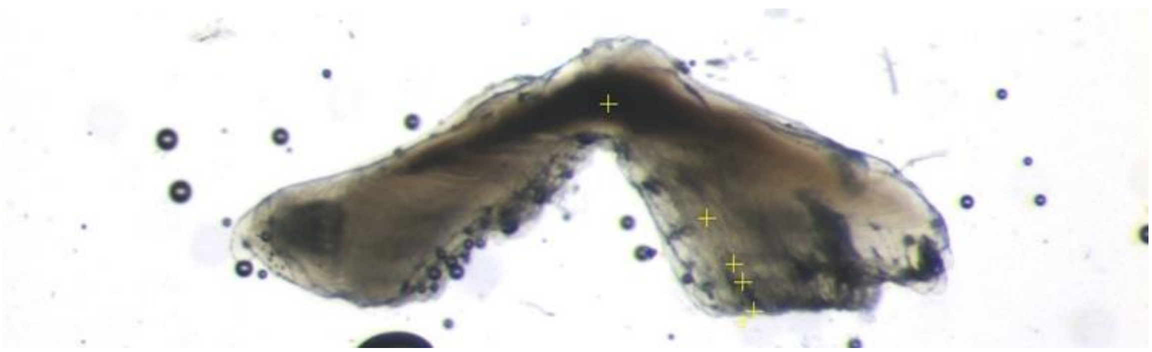
SAI_CT19022983 – 168cm (LJFL), Male

Appendix 2

Images of sectioned otoliths of Atlantic blue marlin, white marlin and sailfish with assumed annual increments annotated (+). The first cross is the position of the primordium and cross marked with an E indicates the position of the otolith edge

Blue marlin

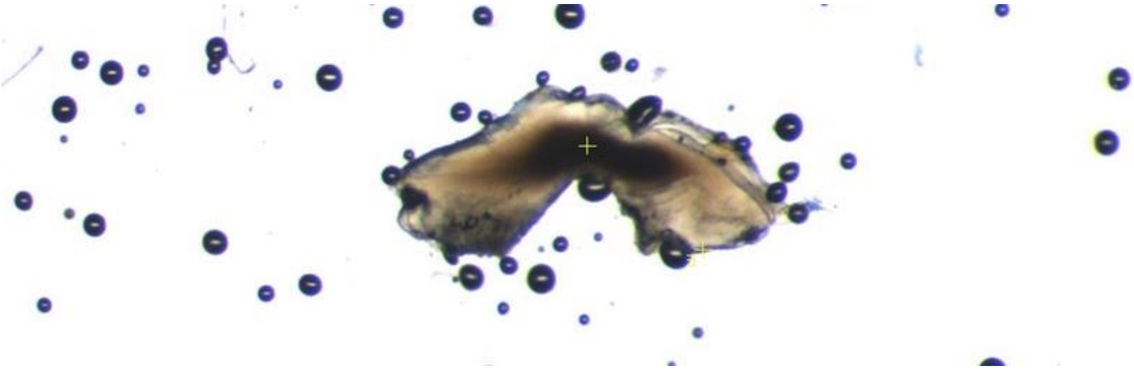
316002037 - CT19021702. Male, 174 cm LJFL, estimated at 0+ years of age



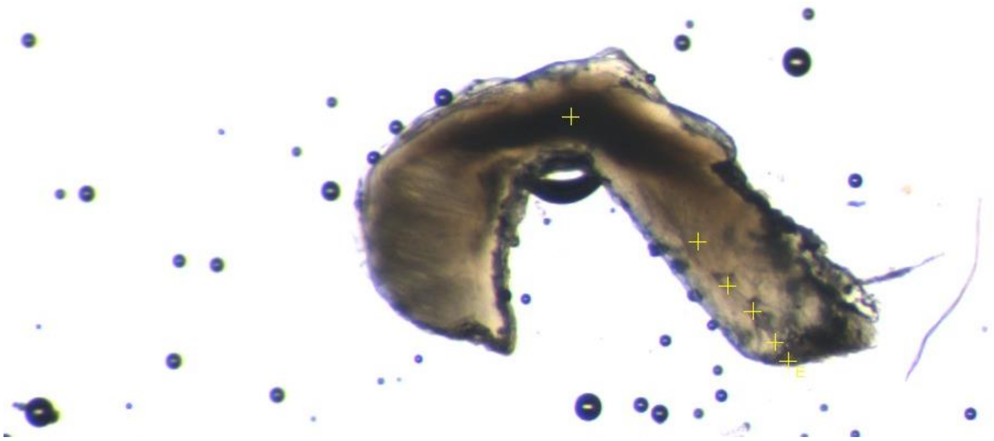
316002004 - ML19011218. Female, 255 cm LJFL, estimated age 3+ years

316002005 - ML19011365. Male, 255 cm LJFL, estimated age 13+ years

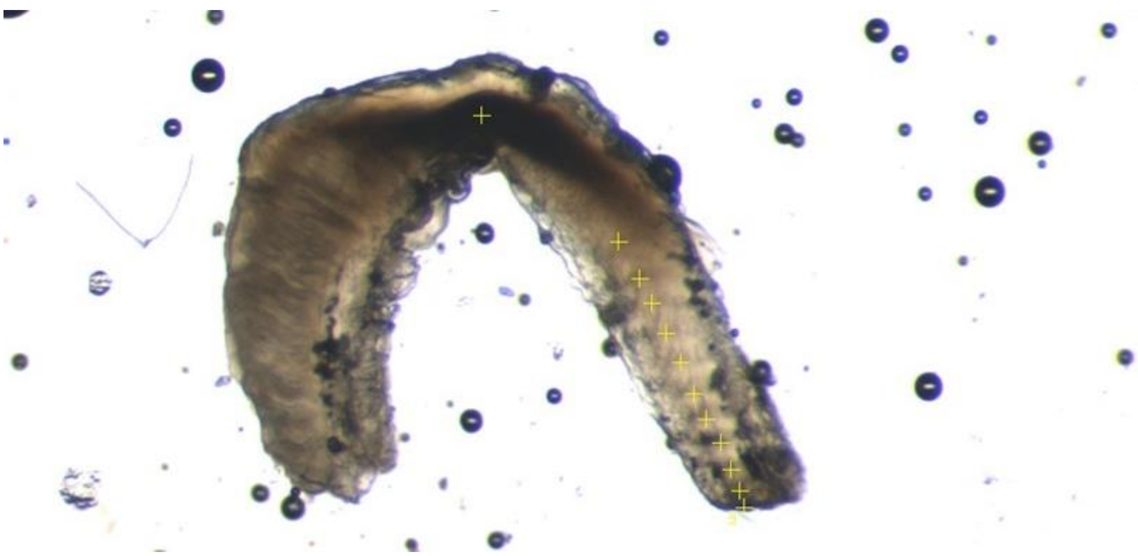
White marlin



317002001 - ML19011224. Male, 129 cm LJFL, estimated age 0+ years



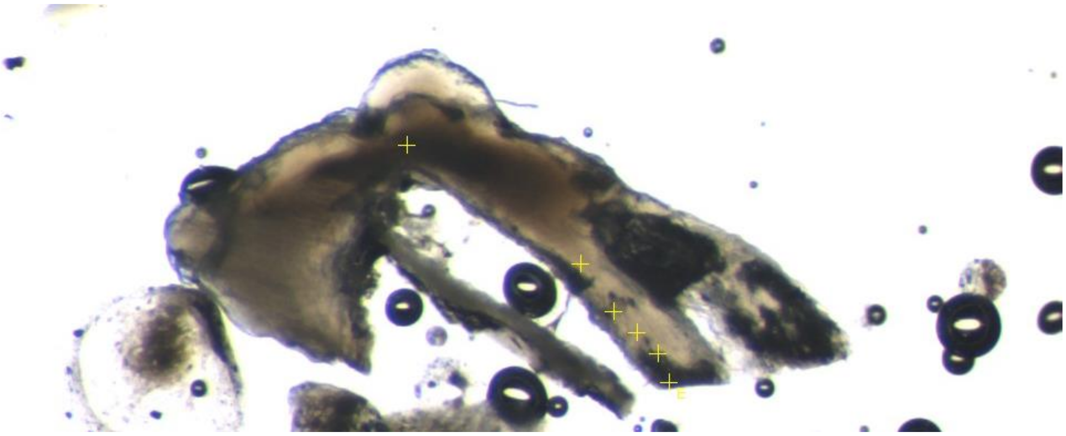
317002024 - CT19020021. Female, 162 cm LJFL, estimated age 4+ years



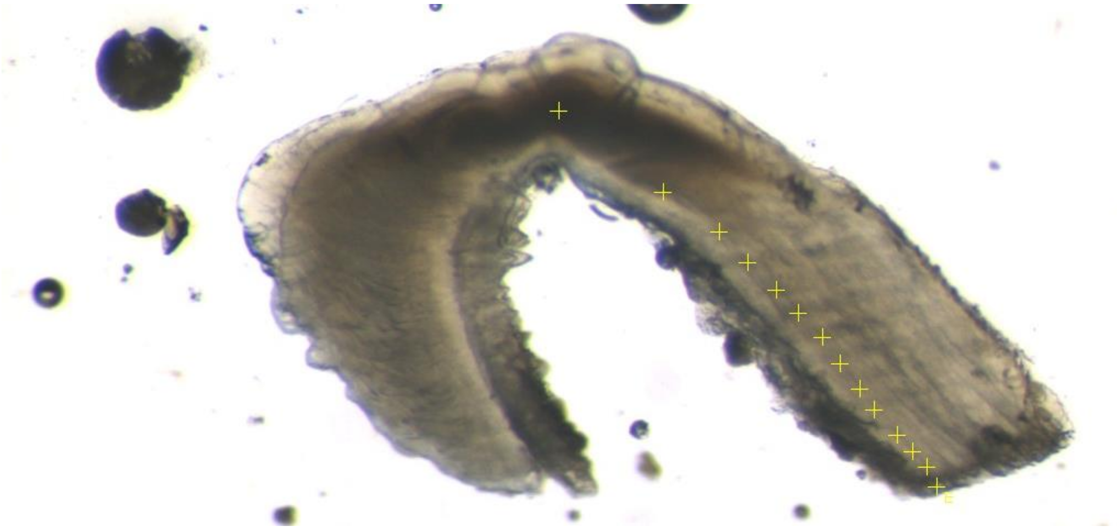
317001011 - WHM_19. Male, 194 cm LJFL, estimated age 10+ years

Sailfish

31802027 - CT19021319. Male, 158 cm LJFL, estimated age 0+ years



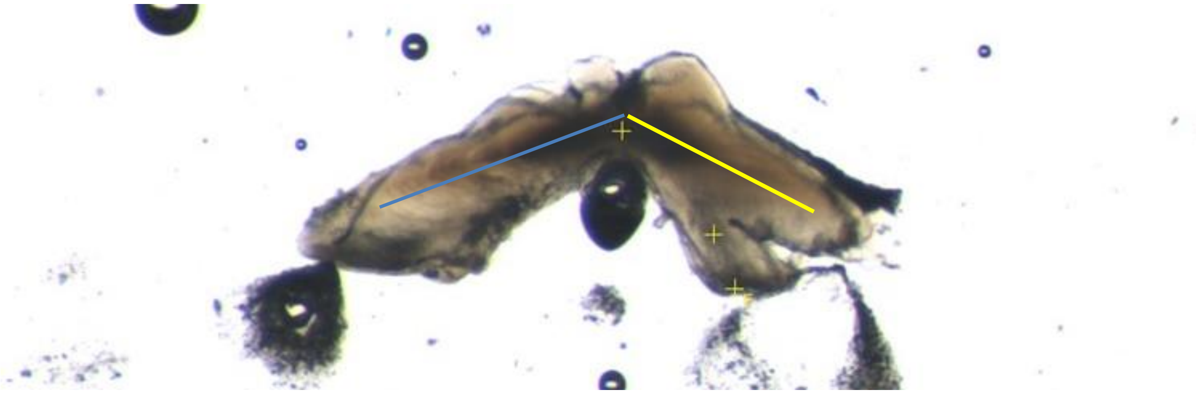
318002016 - CT19020516. Male, 147 cm LJFL, estimated age 4+ years



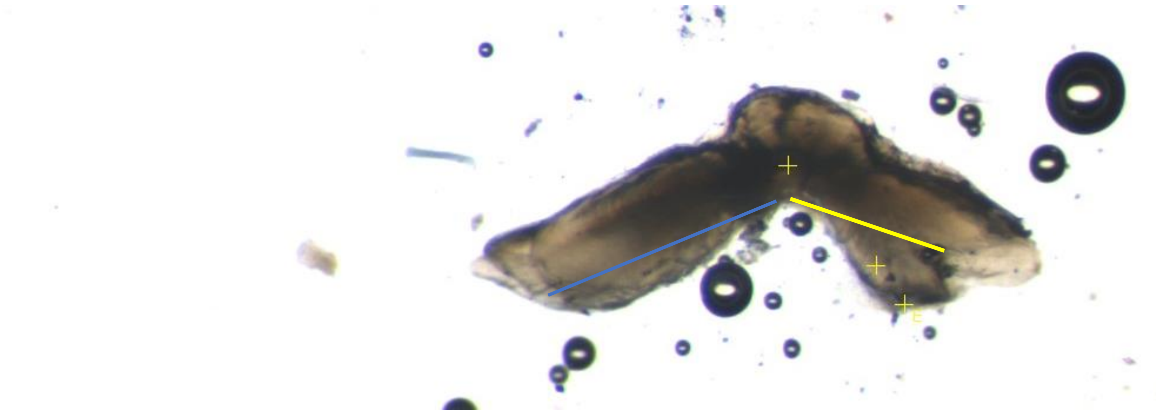
31802002 – ML19011386. Female, 198 cm LJFL, estimated at 12+ years

**Images of sectioned otoliths indicating the transects for daily age estimation.
Opaque zones counted for annual ageing are annotated with a yellow cross (+)**

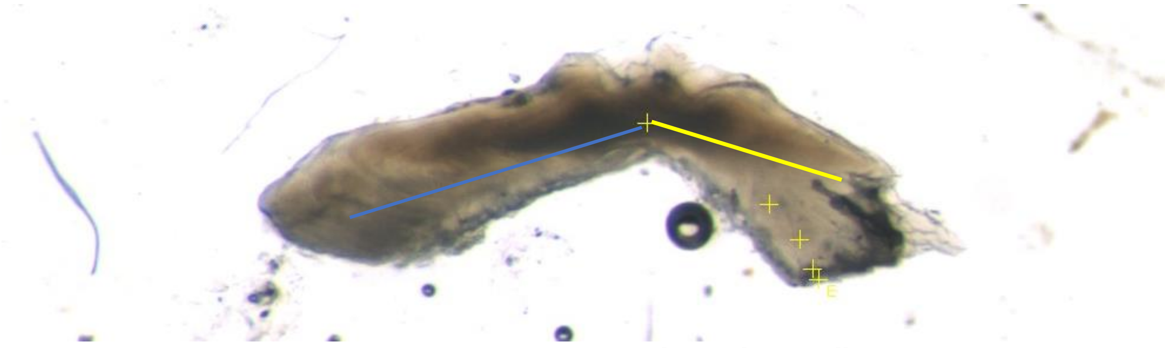
Blue Marlin



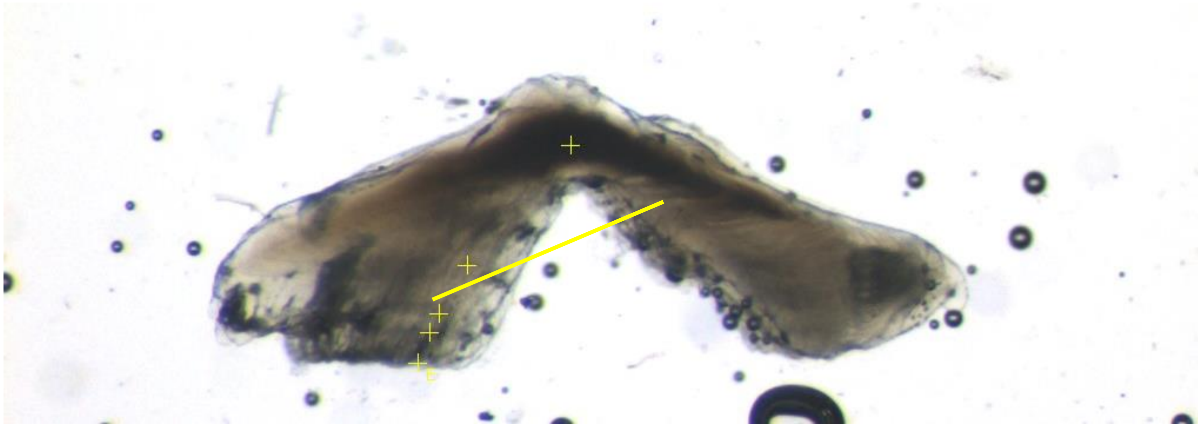
316001002 - BUM_34. Maximum increment count = 176 (blue) and 193 (yellow).



316001004 - BUM_36. Maximum increment count = 210 (Blue) and 199 (Yellow)

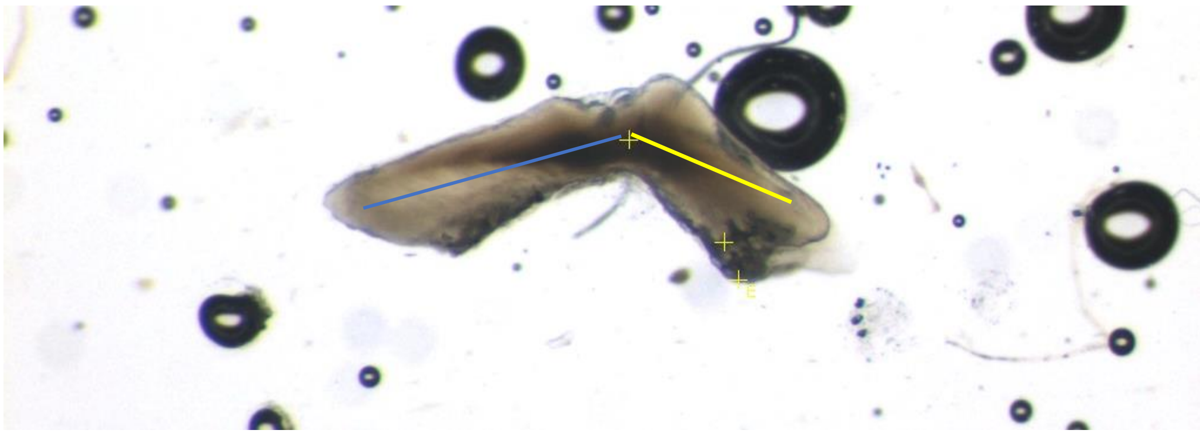


316001007 – BUM_39. Maximum increment count = 146 (Blue) and 168 (yellow).



316002004- ML19011218. Maximum increment count= 246 (Yellow) and N/A

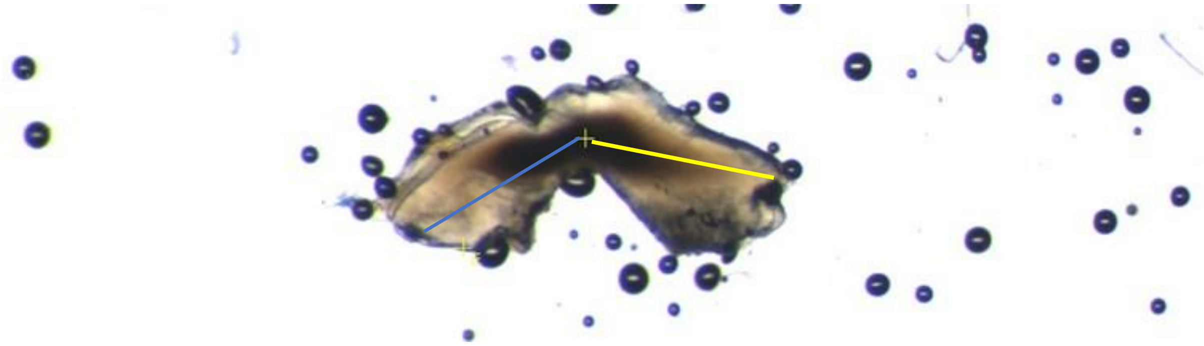
316_002_007 - ML19011440.   Maximum increment count = 192 (Blue) and 204 (yellow).



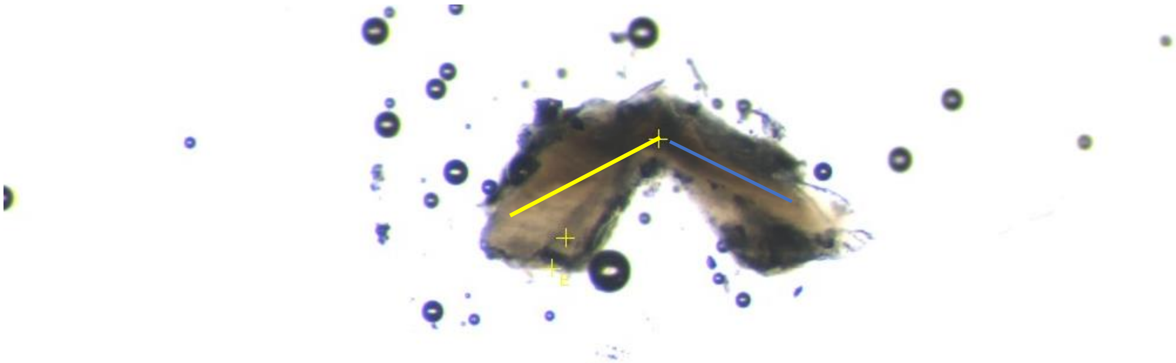
316_002_017 - ML19012021. Maximum increment count = 189 (Blue) and 170 (yellow).

White Marlin

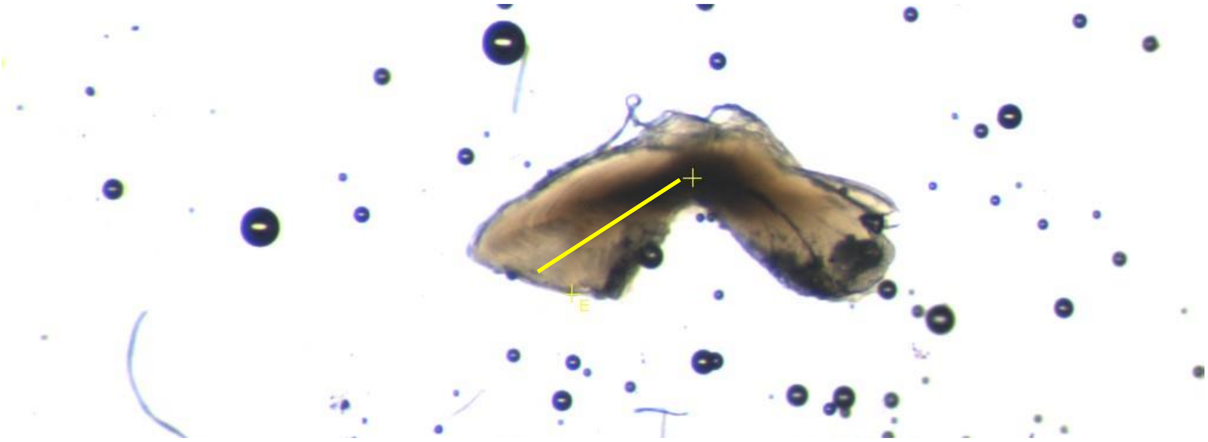
317_001_008 - WHM_16. Maximum increment count = 135 (Blue) and 163 (yellow).



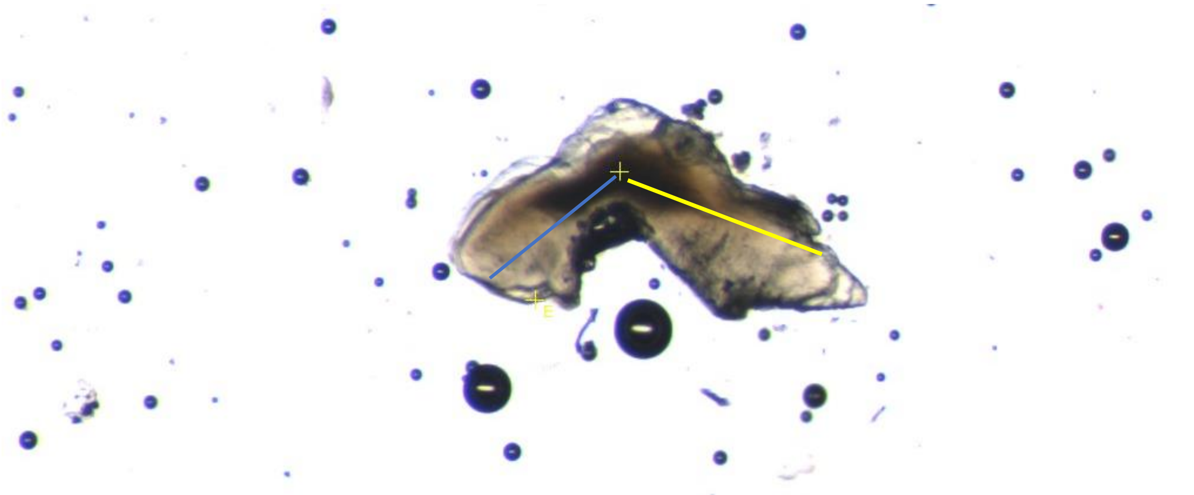
317_002_001 - ML19011224. Total increment count to edge = 169 (Blue) and 147 (yellow).



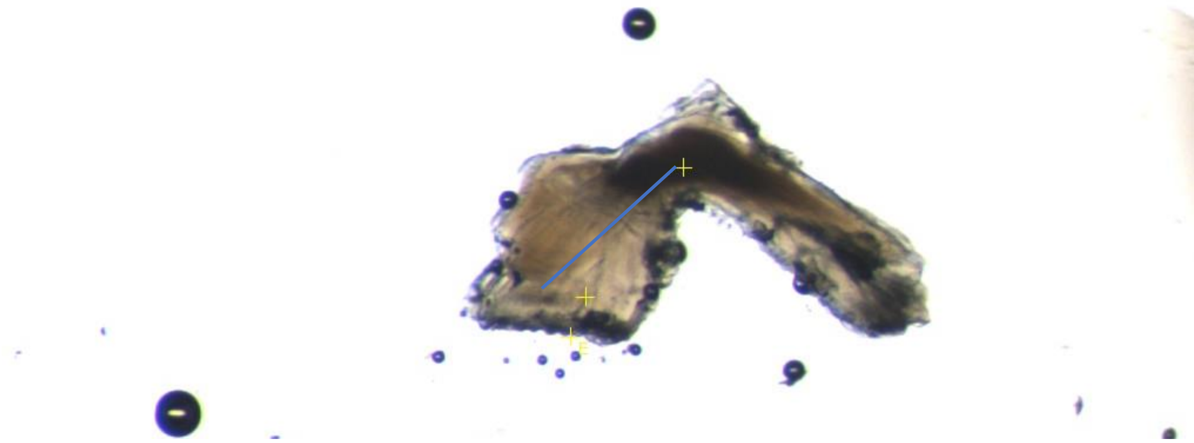
317_002_002 - ML19011436. Maximum increment count = 151 (Blue) and 160 (yellow).



317_002_003 - ML19011710. Total increment count to edge 178 (yellow).

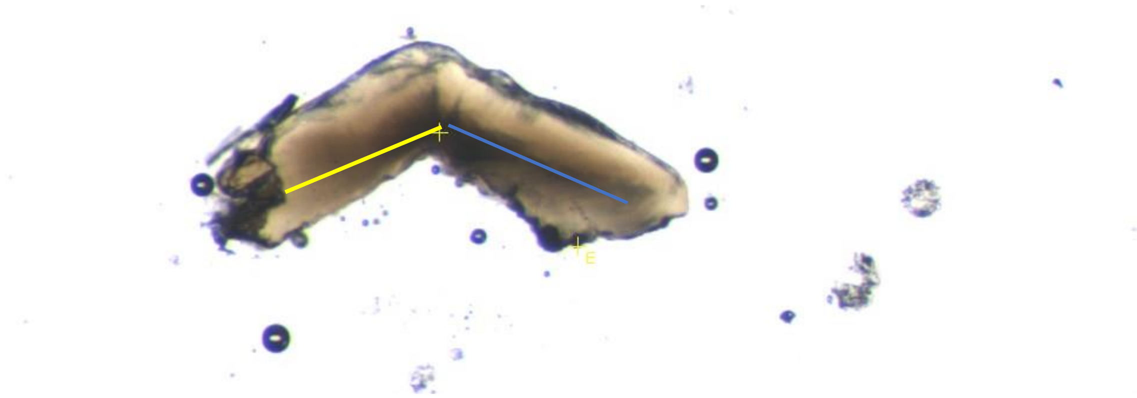


317_002_005 - ML19012919. Total increment count to edge = 180 (Blue) and 152 (yellow).



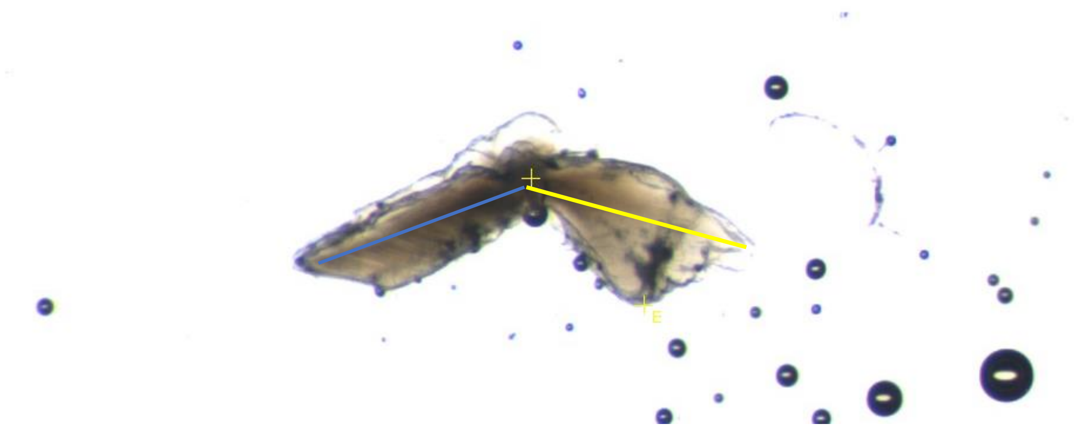
317_002_018 - SI19011324. Maximum increment count = 223 (Blue) and N/A(yellow).

Sailfish

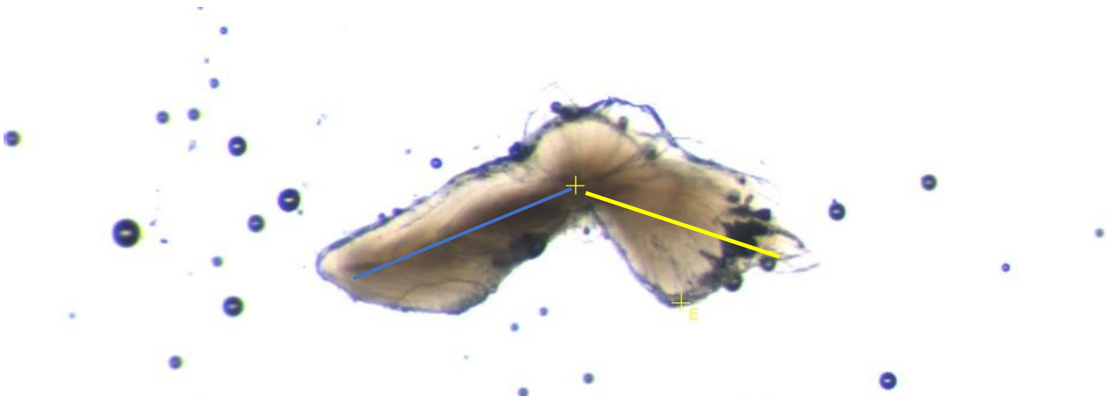


318_001_004 - SAI_18. Total increment count to edge =170 (Blue) and 177 (yellow).

318_002_014 - CT19020002. Maximum increment count to edge = 189 (Blue) and 170 (yellow).

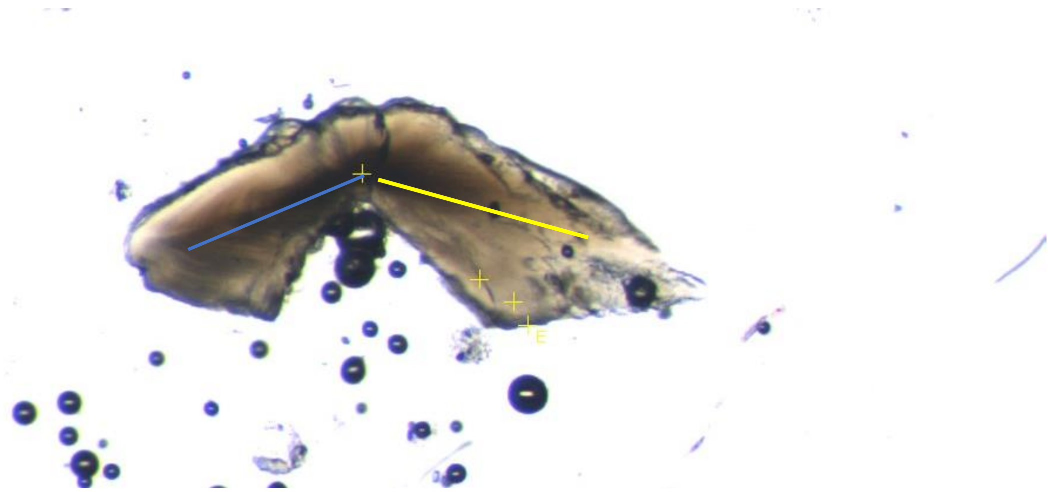


318_002_015 -CT19020153. Total increment count to edge = 175 (Blue) and 169 (yellow).



318_002_027 - CT19021319. Total increment count to edge = 189 (Blue) and 235yellow).

318_002_029 - CT19021466. Total increment count to edge = 184 (Blue) and 195 (yellow).



318_002_032 - CT19021577. Maximum increment count = 179 (Blue) and 210 (yellow).