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MORPHOLOGIC AND MORPHOMETRIC ANALYSIS OF THE OTOLITHS: *SAGITTA*, *ASTERISCUS* AND *LAPILLUS* OF *ISTIOPHORUS PLATYPTERUS* (PERCIFORMES: ISTIOPHORIDAE) IN THE MEXICAN PACIFIC COAST

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ABSTRACT

In the present study morphologic and morphometric analysis is carried out for the first time in the three pairs of otoliths of the sailfish *Istiophorus platypterus* (Shaw 1792): *sagittae*, *asterisci* and *lapilli.* Samples were obtained during a period that covers the years from 2001 to 2003, in 11 fishing tournaments in different ports of the Central Mexican Pacific, and in 6 fishing cruises of median size ships. *Sagittae* of *I. platypterus,* as those from other billfishes, is characterized by presenting an *excisura major*that divides the otolith in *rostrum* and *posrostrum*, and an *excisura minor* that divides the otolith in *posrostrum* and *pararostrum,* being this a peculiar character observed in these species and in the dolphinfish. The growth of these three pairs of otoliths is eccentric to the core; a larger quantity of material is deposited in the dorsal areas and borders, in relation to the ventral areas. No statistically significant morphometric differences were observed between the right and left otolith and between sexes. Seasonal growth rings could notbe observed in the *sagittae*, but were present in a some*asterisci*. Results are discussed with those reported by other authors. It is recommended that studies of daily growth increases in one-year organisms or less be carried out. We suggest that a capture quota of this fishery is given to the commercial fishermen.

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INTRODUCTION

The sailfish belongs to the Istiophoridae family and is highly appreciated in the recreational fishing industry for the spectacular characteristics that its capture produces. Its distribution covers tropical and subtropical waters, as a pelagic species of the Pacific and Indic oceans (Nakamura, 1985). In México the species *Istiophorus platypterus* (Shaw &Nodder, 1792) is a reserved species for the sport fishing. Mexican government only allows the capture of the sailfish with sport fishing gear as trolley hooks and fishing rod.

The legal protocol is the National Fisheries Chart (Alvarez-Torres *et al.*, 2002), which tries to avoid the billfish species overexploitation in the Mexican Pacific. According to this, the Mexican government controls a number of permits for sport fishing per boat and day. Fishing of sailfish is carried out mainly on the coast of Colima, Sinaloa and Baja California Sur, but its distribution is along the coast of Sinaloa and Baja California Sur to Chiapas. There are several studies on the biology and dynamics of this species, as that of Macías-Zamora *et al.* (2011) on the "Spatial explicit model for seasonal migration of sailfish (*Istiophorus platypterus*) in the Mexican Pacific", where the movements of the sailfish during summer from the south to the north of the Gulf of California and its return south after this season are evaluated. Also there are studies on the mitochondrial DNA of this species and other billfishes (McDowell and Graves, 2001). However, studies on otoliths of this species are very scarce, they were studied by Radtkeand Dean (1981). This study poses the following objectives: a) analyze the morphology of the *sagittae*, *asterisci* and *lapilli.* b) Study the morphometry of the otoliths and its variation between left and right and regarding sex. c) Identify growth marks.d) Compare results with those of other authors. Studies on billfish otoliths at the scanning microscope level could provide valuable information for determining the age of these organisms. Therefore we recommend persevere in these types of studies that will also provide valuable information on the impulse transmission from the otolith to the brain, given the high specialization that evolutionary has occurred in these organisms.

MATERIALS AND METHODS

Data were obtained from 2001 to 2003 in 11 tournaments in Puerto Vallarta, Barra de Navidad, Manzanillo, Zihuatanejo, Salina Cruz (ports on the Pacific coast of México) and 6 fishing cruises on medium sized boats. Organisms were captured with long line and hand line.

Data were taken *in situ* for each organism: fork to eye length (cm) and sex. *Sagittae*, *asterisci* and *lapilli* were obtained by doing a transversal cut in the organism's skull, removing the brain, and extracting the semi-circular canals (left and right). Otoliths were liberated from the otic capsules, cleaned in water and dried. They were preserved dry in Eppendorf tubes with the number of the organism, capture date, fork to eye length and sex. The structure and microstructure of the otoliths were studied with a scanning electronic microscope, from the Institute of Physics of the Universidad Nacional Autónoma de México.

Otoliths were analyzed with a dissecting microscope. The terminology of the Secor *et al.* (1992) glossary was used to describe the *sagittae* of this species. In the case of the *asterisci* and *lapilli*, similar concepts were used for their description as in Gallardo-Cabello *et al*. (2006, 2011, 2012, 2014 and 2016) and Espino-Barr *et al.* (2006, 2013, and 2015). Measurements of the length and width of the three pairs of otoliths (right and left) were registered, with the help of a graduated measuring ocular in the microscope. Sample size was corroborated (Daniel, 1991). Regressions by least squares were used to calculate the relationship constants of the *sagitta rostrum* length (SL) *vs*. *antirostrum* length (SA) and width (SW). In the case of the *asterisci* and *lapilli* the regression indexes were only used for length (L) *vs.* width (W). The allometric relationships between total length of the fish and the length and width of each otolith were also obtained by least square regression. A one way variance analysis (ANOVA) (Zar, 1996) was used to determine if there were morphometric differences between male and female otoliths, and between right and left otolith.

RESULTS

The sample was of 412 individuals: 233 females, 130 males and 49 undetermined. Organisms' sizes were 164.4 cm average eye-fork length (from 111.0 cm to 208.0 cm) and average total weight of 28.1 kg (from 17.6 kg to 43.7 kg). The calculated sample sizes of otoliths are: for *sagitta* 286 individuals, *asteriscus* 214 and *lapillus* 265.

Description of the otoliths of *Istiophorus platypterus*

Description of the sagitta. Otoliths of the billfish in general are very small and fragile (Figure 1). *Excisura major* divides the otolith in *rostrum* and *antirostrum*, and the *excisura minor* in *postrostrum* and *pararostrum* (Figure 2). The rostrum is elongated and prominent, arrow-like, and the *antirostrum* has a saw like side with small dentitions (Figures 3 and 5). The acoustic canal is very developed; wide and deep (Figure 4). The internal aspect in concave and the external convex; this character becomes more pronounced as the age groups increase.

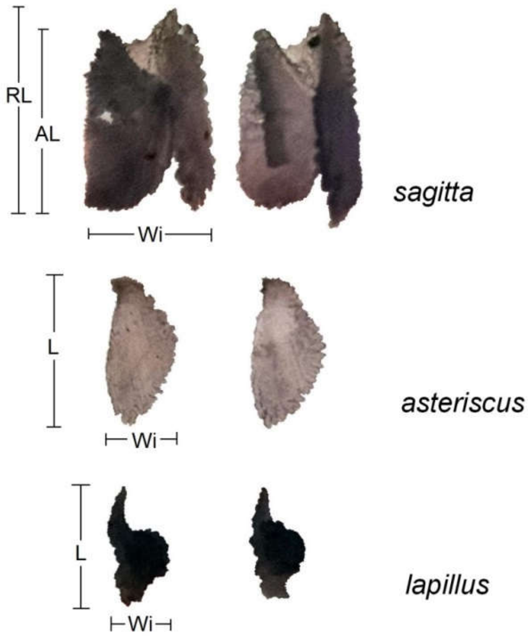

Figure 1. Relationship between the three pairs of otoliths of *Istiophorus platypterus*, left side are the external aspect, right side internal aspect; RL = *rostrum* length, AL = *antirostrum* length, Wi = width, L = length

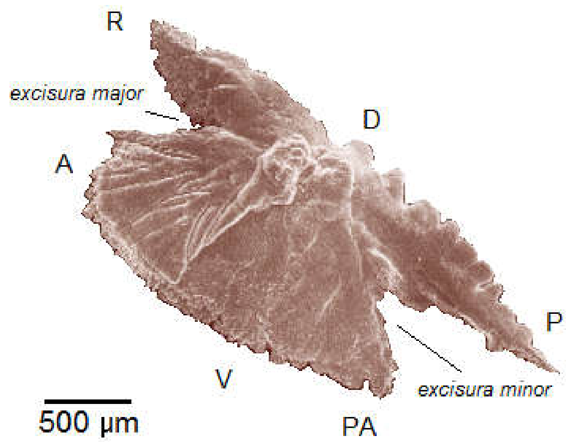

Figure 2. Scanning photograph of the left *sagitta*external aspect of *Istiophorus platypterus*. R= *rostrum*, A= *antirostrum*, P= *postrostrum*, PA = *pararostrum*, D= dorsal margin, V= ventral margin

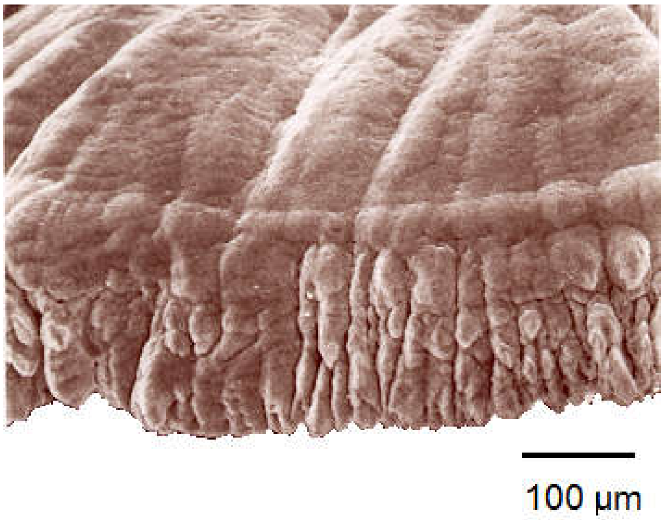

Figure 3. Detail of the ventral margin of the left *sagitta* external aspect of *Istiophorus platypterus*

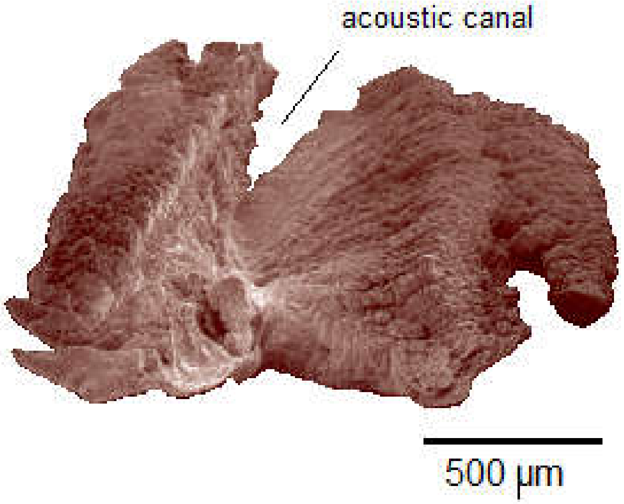

Figure 4. Scanning photograph of the right *sagitta*, internal aspect of *Istiophorus platypterus* showing the acoustic canal

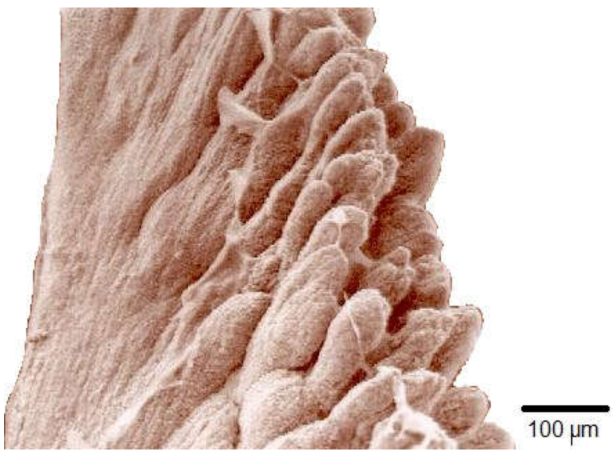

Figure 5. Detail of the ventral margin of the right *sagitta* of *Istiophorus platypterus*

The core is eccentric in each plane of the otolith and the *rostrum* grows more than the *postrostrum*, and the *antirostrum* more than the *pararostrum*. Also, more material is deposited in the ventral border than the dorsal. The dorsal margin shows, at the beginning, arrow characteristic features of the *rostrum*, many irregularities similar to denticles extend from the *rostrum* to the *postrostrum*. The *sagitta*'s internal aspect is convex, this feature increases with age; the acoustic channel runs along the total otolith surface (Figure 4), which increases in width from the anterior to the posterior part of the otolith; but it does not differ in the *cauda* and the *ostium*. The *sagitta* is concave in its external aspect, slightly thicker in the middle of the *sagitta* than the *rostrum* and the *postrostrum* (Figure 2). Growth rings of different periodicities are observed in different parts of the *sagitta*, both on its inner surface (Figure 6), as in the structures that form the edges (Figure 7). They appear as dark lines around different parts of the *sagitta* (Figure 7).

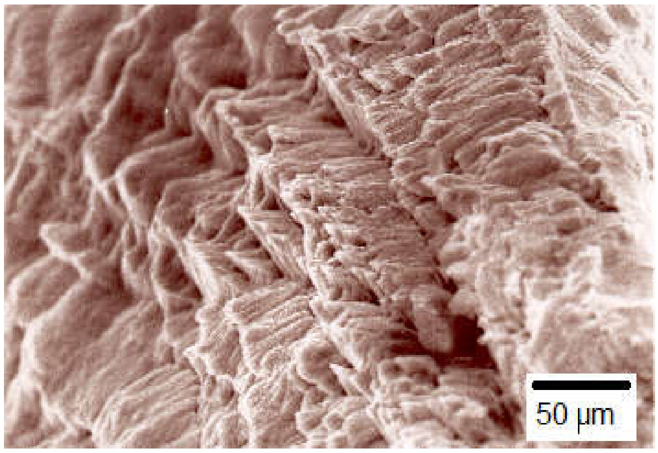

Figure 6. Crystals of carbonate calcium forming growth rings in the *sagittae* of *Istiophorus platypterus*. Between these crystals otoline is dispersed forming a reticular network

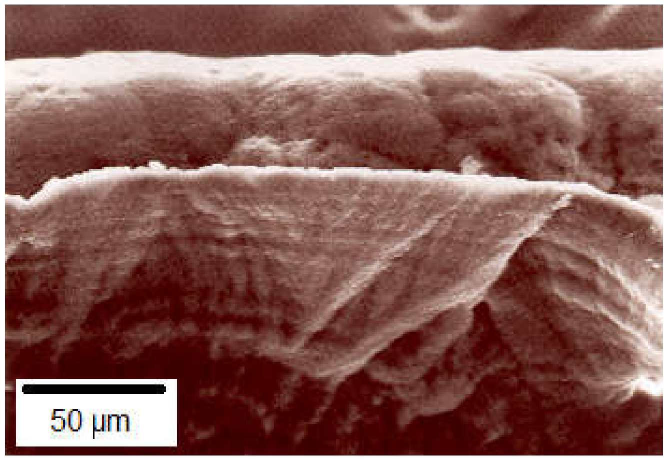

Figure 7. Growth rings of different periodicities than seasonal on the border of the *sagitta* in *Istiophorus platypterus*

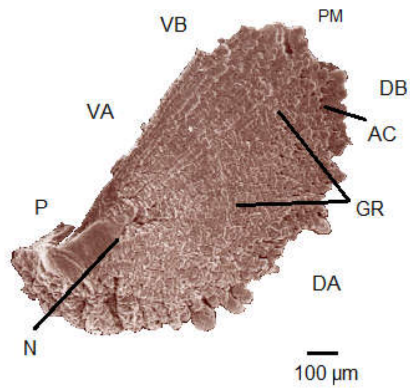

Figure 8. Scanning photograph of the left *asteriscus*, internal aspect of *Istiophorus platypterus*:P= projection, N= core or primordia, DA = dorsal area, VA = ventral area. GR = growth ring, AC=acoustic canal, DB =dorsal border, VB = ventral border

There was no difference between the right and left *sagitta* ($F'_{0.05\ (2,\ 233=3.86)}$ = 0.609), nor between females and males ($F'_{0.05(2,\ 106\ =\ 3.877)}$ = 0.531). The average width of the *sagitta* (SW) is 1.45 times its average length (SL) (Figure 1).

Description of the asteriscus: The shape of the *asterisci* can vary between specimens (Figure 1), but there are no statistical differences between the length of right and left otoliths ($F'_{0.05(2,\ 123\ =\ 3.88)}$ = 0.001). A blunt projection is present in the anterior margin which divides the *asteriscus* in two areas: a dorsal area with a larger surface than the ventral area (Figure 8). The anterior margin has sections that are not rectilinear from the dorsal to the ventral margins. The posterior margin is curved and shows irregularities. This curved section presents a groove all around the dorsal and ventral margin; on the surface of the *asterisci* calcium carbonate crystals are present, forming the seasonal periodicity growth rings (Figures 8 and 9). The internal aspect of the otolith is concave and the external aspect is convex, a feature which increases as the fish ages. Small indentations are present in both aspects of the *asteriscus* (Figures8, 10 and 11). The average length of the *asteriscus* (AL) is 2.06 times its average width (AW) (Figures 1, 8 and 10).

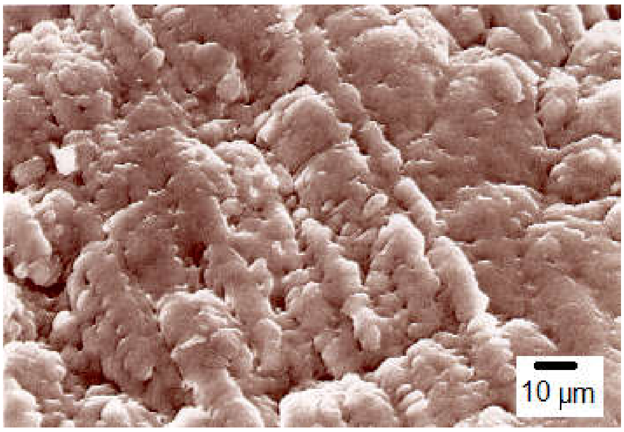

Figure 9. Crystals of carbonate calcium forming growth rings in the *asteriscus* of *Istiophorus platypterus*. Between these crystals otoline is dispersed forming a network with epitaxial growth

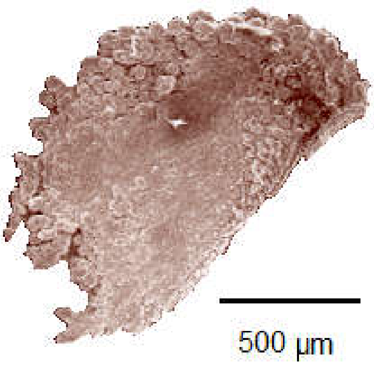

Figure 10. Ornaments on the surface of the *asteriscus* of *Istiophorus platypterus*, related with the impulse transmission

Description of the lapillus. The anterior margin of the *lapillus* is oriented toward the front of the fish and it is round (Figure12). Dorsal and ventral margins go from the anterior margin towards the central part of the otolith making a fan-shaped structure. The ventral margin is rounded and the dorsal edge of this structure is notably larger (Figures 1 and 12). However, the ventral margin can vary and show a similar length to the dorsal margin and / or the dorsal margin bifurcate forming two structures (Figure 13). The external aspect of the *lapillus* presents numerous crystal groups of calcium carbonate, with very different forms, dimensions and orientations that could be related to the transmission impulses to the brain by means of the eighth cranial nerve (Figure 12). The inner *lapillus* surface is concave, a feature which increases with age. The otolith is divided in several lobes by radios. The posterior border has a barely apparent *sulcus* which enters in contact with the acoustic macula, and extends along the dorsal and ventral margins. The outer aspect is convex; its dorsal margin shows indentations and other irregularities, which become smaller at the ventral margin (Figure 12).

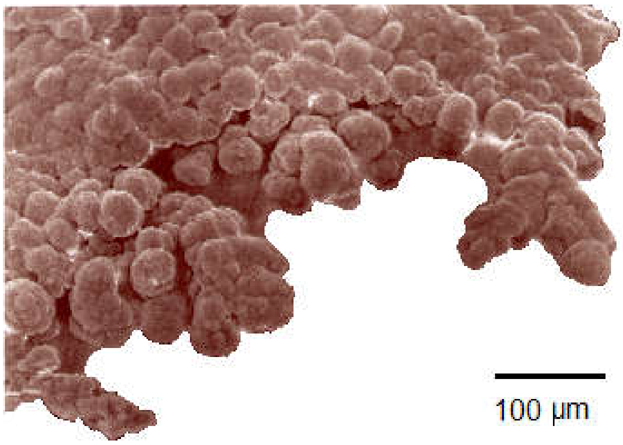

Figure 11. Scanning photograph of ornamentations of the posterior margin of an *asteriscus* of *Istiophorus platypterus*

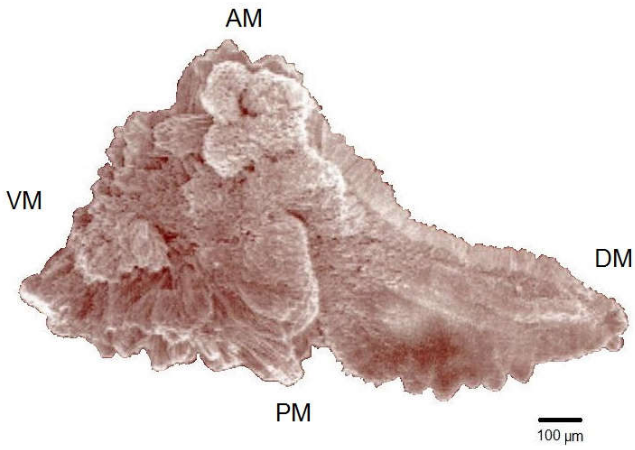

Figure 12. Scanning photograph of the right *lapillus*, external aspect of *Isthiophorus platypterus*: AM = anterior margin, PM = posterior margin, DM = dorsal margin and VM = ventral margin

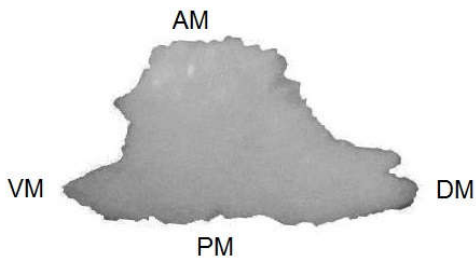

Figure 13. *Lapillus* of *Istiophorus platypterus* showing very symmetrical dorsal and ventral borders lengthwise, and a bifurcated dorsal border

No difference between the right and left *lapilli* were found ($F'_{0.05\ (2,\ 180=3.867)}$ = 0.321), nor between females and males ($F'_{0.05(2,\ 160\ =\ 3.864)}$ = 0.355). Average length of the *lapillus* (LL) is 1.61 times its average width (LW).

Table 1. Calculated measures of *rostrum* (SL), *antirostrum* (SA) and width (SW) of *sagitta* at different size classes of *Istiophorus platypterus*

	Both sexes			females			males		
Classes (cm)	SL (mm)	SA (mm)	SW (mm)	SL (mm)	SA (mm)	SW (mm)	SL (mm)	SL (mm)	SW (mm)
100	1.81	1.27	1.28	1.97	1.49	1.12	1.80	1.37	1.43
110	1.93	1.41	1.36	2.07	1.60	1.22	1.93	1.50	1.50
120	2.05	1.54	1.44	2.17	1.70	1.31	2.05	1.62	1.56
130	2.17	1.68	1.52	2.26	1.81	1.41	2.17	1.74	1.62
140	2.29	1.82	1.59	2.35	1.91	1.50	2.29	1.86	1.68
150	2.40	1.95	1.67	2.43	2.01	1.60	2.40	1.97	1.74
160	2.52	2.09	1.74	2.52	2.11	1.69	2.52	2.09	1.79
170	2.63	2.23	1.81	2.60	2.21	1.78	2.63	2.21	1.85
180	2.73	2.37	1.88	2.68	2.31	1.87	2.74	2.32	1.90
190	2.84	2.50	1.94	2.75	2.40	1.96	2.84	2.44	1.95
200	2.95	2.64	2.01	2.83	2.50	2.05	2.95	2.55	2.00
210	3.05	2.78	2.08	2.90	2.59	2.14	3.05	2.67	2.05

Table 2. Relationships between the *rostrum* and *antirostrum* and width of the *sagitta* of *Istiophorus platypterus*

Sagitta length (mm)	sex	a	b	n	r^2	F
Antirostrum	Both	1.002	0.804	285	0.449	232.610
Width		1.278	0.361		0.080	25.636
Antirostrum	Females	1.141	0.677	153	0.329	76.119
Width		1.324	0.303		0.045	8.083
Antirostrum	Males	1.005	0.798	94	0.487	88.412
Width		1.229	0.433		0.099	11.217

Table 3. Relationship between total fish length and rostrum length (SL), *antirostrum* (SA) and width (SW) of *sagitta* of *Istiophorus platypterus*

Total length (mm)		a	b	r^2	F	n
SL (mm)	Both	0.070	0.706	0.168	58.625	286
	Females	0.178	0.523	0.096	17.243	154
	Males	0.069	0.709	0.154	17.906	94
SA (mm)	Both	0.010	1.054	0.209	140.458	
	Females	0.047	0.750	0.148	27.685	
	Males	0.022	0.896	0.191	22.757	
SW (mm)	Both	0.063	0.653	0.094	55.113	
	Females	0.020	0.878	0.181	63.956	
	Males	0.153	0.485	0.040	8.059	

Table 4. Calculated measures of length (AL) and width (AW) of the *asteriscus* at different size classes of *Istiophorus platypterus*

	Both sexes		Females		Males	
Classes (cm)	AL (mm)	AW (mm)	AL (mm)	AW (mm)	AL (mm)	AW (mm)
100	1.18	0.55	1.26	0.57	1.19	0.50
110	1.26	0.59	1.33	0.61	1.27	0.55
120	1.34	0.63	1.39	0.65	1.35	0.60
130	1.42	0.67	1.45	0.68	1.43	0.65
140	1.49	0.71	1.51	0.71	1.51	0.70
150	1.57	0.75	1.57	0.75	1.59	0.75
160	1.64	0.79	1.63	0.78	1.66	0.80
170	1.71	0.82	1.69	0.81	1.74	0.85
180	1.77	0.86	1.74	0.84	1.81	0.90
190	1.84	0.90	1.79	0.87	1.88	0.95
200	1.91	0.93	1.84	0.90	1.95	1.00
210	1.97	0.97	1.89	0.93	2.02	1.05

Morphometric analysis of otoliths of *Istiophorus platypterus*

Growth of the sagitta: Table 1 shows the relation between *rostrum*, *antirostrum* and width of *sagitta* and the length classes for the species and sexes.Growth of the *rostrum* of *sagitta* is bigger in females at lengths of 100 cm to 150 cm. From 170 cm on, the *rostrum*'s length is bigger in males than in females. In all cases the *rostrum* has a longer size than the *antirostum*. The relationship between length of *rostrum* and length of *antirostrum* of *sagitta* is expressed by the exponent value b = 0.804 (Table 2), which shows a tendency to a negative allometric growth (Figure 2).This indicates that the*rostrum* tends to enlarge as fish ages.

In the case of sexes, results show the same tendency and the relationship between *rostrum* and *antirostrum* length of *sagitta* of males is b = 0.798 and females b = 0.677. The relationship between *rostrum*'s length and *sagitta*'s width shows higher values of negative allometric growth, that is, the *sagitta* tends to enlarge more in length than width with a significant negative allometric growth index of b = 0.361 in all the individuals, b = 0.303 in females and b = 0.433 in males (Table 2).This sharp progressive decline of the width of the *sagitta* shows that the *rostrum* and *antirostrum* tend to close as a pincer or wrench in which the acoustic canal comes in more contact with the ramifications of the eighth cranial nerve, increasing this way the impulse transmission. These results also indicate that the growth of *sagitta* is eccentric to the core. As the fish grows old and ages, the *postrostrum* grows more than the *rostrum* (Figure 2). The dorsal edge grows more than the ventral, and a larger amount of material accumulates on the inner side than the external aspect of the *sagitta*.

The higher values between length of the fish and *sagitta*'s width were in females (b = 0.878), and that for the species was b = 0.653 and b = 0.485 for males. In all cases, values show that there is a direct proportionality between *rostrum* length, *antirostrum* length, and *sagitta* width and fish length,showing that this structure could beadequate to describe the growth of the organism.

Table 5. Relationships between the length (AL) and width (AW) of the *asteriscus* of *Istiophorus platypterus*

AL vs AW	a	b	r^2	F	n
all	0.544	0.751	0.383	132.985	214
females	0.568	0.641	0.378	71.545	117
males	0.494	0.947	0.404	48.368	71

Table 6. Relationship between total fish length and *asteriscus* length (AL) and width (AW) of *Istiophorus platypterus*

Total length (mm)	sex	a	b	r^2	F	n
AL (mm)	Both	0.050	0.688	0.154	39.884	214
	Females	0.100	0.551	0.083	11.522	117
	Males	0.044	0.717	0.170	15.379	71
AW (mm)	Both	0.017	0.759	0.124	33.497	230
	Females	0.029	0.650	0.106	16.276	131
	Males	0.005	0.998	0.150	13.511	72

Table 7. Calculated measures of length (LL) and width (LW) of the *lapillus* at different size classes of *Istiophorus platypterus*

	Both sexes		females		Males	
Classes (cm)	LL (mm)	LW (mm)	LL (mm)	LW (mm)	LL (mm)	LW (mm)
100	1.01	0.62	1.12	0.69	0.92	0.59
110	1.06	0.65	1.15	0.71	0.99	0.63
120	1.10	0.68	1.17	0.72	1.05	0.66
130	1.15	0.71	1.20	0.74	1.10	0.70
140	1.19	0.73	1.22	0.75	1.16	0.73
150	1.23	0.76	1.25	0.77	1.22	0.76
160	1.27	0.78	1.27	0.78	1.27	0.80
170	1.30	0.80	1.29	0.79	1.33	0.83
180	1.34	0.83	1.31	0.80	1.38	0.86
190	1.37	0.85	1.33	0.81	1.43	0.89
200	1.41	0.87	1.35	0.82	1.48	0.92
210	1.44	0.89	1.36	0.83	1.53	0.95

Table 8. Relationships between the length (LL) and width (LW) of the *lapillus* of *Istiophorus platypterus*

LL vs LW	a	b	r^2	F	n
All	0.713	0.400	0.174	56.748	265
Female	0.709	0.408	0.227	43.882	147
Male	0.722	0.416	0.129	13.424	85

Table 9. Relationship between total fish length and *lapillus* length (LL) and width (LW) of *Istiophorus platypterus*

Total length (mm)	Sex	a	b	r^2	F	n
LL (mm)	Both	0.113	0.476	0.094	28.360	265
	Females	0.325	0.269	0.019	3.759	147
	Males	0.040	0.681	0.215	24.059	85
LW (mm)	Both	0.068	0.481	0.107	32.550	265
	Females	0.210	0.259	0.026	4.896	147
	Males	0.031	0.640	0.149	15.736	85

The relationship between fish length and length and width of *sagitta* is shown in Table 3. The higher value of the allometric index relating fish length to *rostrum* length is for the males with a value of b = 0.709, smaller values are found for the species (all specimens) and females, b = 0.706 and b = 0.523, respectively. In the case of fish length and *antirostrum* length an isometric growth index was observed for all species: b= 1.054,which means that this structure grows directly proportional to fish's length, lower values were calculated for males b = 0.896 and females b = 0.750.

The F values of the ANOVA were high which means that there is a significant correlation between these structures in each case. On the other hand, the allometric growth rate values are lower than one, because they are related to very small structures measured in millimeters with furcal lengths expressed in centimeters.

Growth of the asteriscus: The relationship between fish length and length and width of *asteriscus* is shown in Table 4.The length of the *asterisci* is larger in females of the length classes from 100 cm to 130 cm; from 150 cm on, the length is bigger in males than in females. The relationship between the length and width of the *asterisci* (Table 5) is described for the species by the allometric index b = 0.751 (r^2 = 0.383, F' = 132.985); higher values were obtained for males b= 0.947 and smaller for females b= 0.641. These results show a tendency to a negative allometric growth in which the increase in width is greater than in length. Growth of *asteriscus* is eccentric to the core; its anterior border grows more than the posterior border and the dorsal margin grows more than the ventral margin. Table 6 shows the relationship between total length of fish and length and width of *asteriscus*. The allometric index value closest to one is for males b = 0.998, for fish total length and *asteriscus* width. These indexes decrease for the specie b= 0.759, and females b=0.650. In the case of the relationship between total length and *asteriscus* length, males show the higher value b= 0.717, decreasing for the specie b = 0.668 and females b= 0.551. The ANOVA values (F') show a significant relation between the structure analyzed, with a tendency to a direct proportionality between fish length and *asteriscus* width and length, which could allow age group determination based on the number of growth rings in *asteriscus* as valid in *I. platypterus.*

Growth of the lapillus: Table 7 shows the relationship between fish length and length and width of the *lapillus*. As in *sagitta* and *asteriscus*, growth is higher in females from 100 cm to 150 cm. The relationship between the length and width of *lapillus* (Table 8) show very low values of the allometric index b= 0.400 for the species, b= 0.408 in female, and b=0.416 for males. These values represent negative allometric growth, in which *lapillus* grows more in length than in width (Figure 12). *Lapillus* growth is eccentric to the core, but the anterior and ventral margins show a higher deposition of growth materials than the posterior and dorsal margins. The relationship between fish length, and the length and width of the *lapillus* is shown in Table 9. The higher value of the allometric index for the eye-fork length of fish and *lapillus* length was found for males with a value of b = 0.681, smaller indexes were found for the species and females: b = 0476 and b = 0.269, respectively. The higher value of the relationship between fish eye-fork length and *lapillus* width, corresponds to males b= 0.640, smaller values were encountered for the specie b= 0.481, and females b= 0.259.

DISCUSSION

The sailfish *I. platypterus* otoliths are very small if compared to those of other species of bony fishes. *Sagittae* can measure up to 3 mm in organisms of 210 cm eye-fork length. This makes it difficult to extract, not only because of its small size, but also because of their fragility, easily fragmented, particularly in the area where the acoustic canal is located (Figure 4). In the case of the *asterisci*, they also break easily due to its thinness (Figures 1, 8 and 10). No seasonal growth rings were observed, as those described by Radtke (1983) and Radtke and Dean (1981), who placed them in the dorsal and ventral borders of the *sagittae* (Figures 3 and 5). In none of these structures were seasonal rings of growth observed, although of shorter periodicity in other areas of the *sagittae* (Figures 6 and 7). Solano *et al*. (2015) observed daily growth increments in otoliths of *Coryphaena hippurus* specimens who were not yet one year old. For that, otoliths were polished to the level of the nucleus, which made it possible to observe daily growth increments. In the case of *I. platypterus* the use of this technique is difficult given the possibility of obtaining organisms of less than one year in the sport fishery catches. Likewise the *sagittae* are very difficult to polish because of their great fragility that makes it very difficult not to fragment them at the level of the acoustic canal (Figure4). On the other hand, it is possible to observe increments of daily growth in otoliths of sailfish larvae. Luthy *et al.* (2005) analyzed *sagittae* and *lapilli* in 70 larvae of 2.8 to 15.2 mm total length from the Straits of Florida, obtaining an instant daily growth coefficient of 0.14. These values were similar to those found in the blue marlin *Makaira nigricans* by Prince and Brown (1991). In the inner aspect of some *asterisci* of *I. platypterus* analyzed in the present study, seasonal growth rings were observed on its surface (Figures 8 and 9). Seasonal growth rings are analyzed in sailfish because they are easily observed in transversal cuts of the 4^{th} spine of the dorsal fin (Hedgepeth and Jolley, 1983; Alvarado and Felix-Uraga, 1996; Chiang *et al*., 2004; Cerdenares-Ladrón de Guevara *et al*., 2010). Therefore many researchers consider unnecessary to analyze the presence of growth rings in *sagittae*. Morphometric differences between right and left otoliths in the three pairs were not statistically significant. Similarly, differences in otoliths sizes were not statistically significant between sexes.

Conclusions

- The identification of growth rings was carried out in some *asterisci* inner face surface.
- No statistically significant morphometric differences were observed between the right and left otolith and between sexes.
- The growth of these three pairs of otoliths is eccentric to the core; a larger quantity of material is deposited in the dorsal areas and borders, in relation to the borders and ventral areas.

Recommendations

Sailfish larvae should be analyzed, to obtain otolith data at the beginning of its life and observe daily growth increments. Try to obtain organisms of sailfish with ages less than one year, to observe the increments of daily growth through the polishing technique of their *sagittae*. Continue with studies on the characteristics of sailfish otoliths to reach a better understanding of their shape and function, considering that these structures must be of high efficiency in the transmission of impulses to the brain, despite their small size. It is very important to analyze this fishery, which given its abundance could be shared at the level of commercial fishing, in addition to sport fishing, as happens in other countries.Restrictions in relation to the distance from the coast where the animals can be fished, as well as the low catch quotas and exploitation rates deprive the commercial fishermen of the benefits of this species capture and only benefit the sport fishermen, who usually have a high socioeconomic level. We must not forget the beautiful saga written by Ernest Hemingway of the "Old Man and the Sea" that narrates the difficulties of a fisherman who catches a sailfish, with a very small boat and how difficult it is to take his catch to port; the high technology is only available to sport fishermen, who do not have the food needs of commercial fishermen.Opening this fishery to commercial capture represents a fairer treatment for those who have less.

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