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Reproductive biology aspects of *Alopias pelagicus* and *A. superciliosus* (Lamniformes: Alopiidae) in the Ecuadorian Pacific

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The reproductive biology of thresher shark species of the Ecuadorian Pacific was analysed based on 1236 specimens of *Alopias pelagicus* (711 females and 525 males) and 354 of *A. superciliosus* (164 females and 190 males) landed in "Playita Mía", from January to December of 2019. The length of *A. pelagicus* females ranged between 67.2 and 184 cm PCL (precaudal length) and the males between 69.0 and 178.4 cm PCL, *A. superciliosus* registered a minimum and maximum size of 76.0 and 202.2 cm PCL for females and 94.0 and 204.8 cm PCL for males. The most frequently captured size class for *A. pelagicus* was 147.2–157.2 cm PCL and for *A. superciliosus* was 156.0–166.0 cm PCL. The sex ratio (F:M) for *A. pelagicus* and *A. superciliosus* was 1.35F:1M and 0.86F:1M respectively. For *A. pelagicus* males the inflection point of the clasper length adjustment, was 134.2 cm PCL and size at first sexual maturity (L_{50}) was estimated at 136.0 cm PCL. For *A. superciliosus* males the inflection point of the clasper length adjustment, was 136.8 cm PCL, and the first sexual maturity (L_{50}) was estimated at 138.7 cm PCL.

Keywords: Ecuador, Conservation, Lengths, South Pacific, Shark.

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A biologia reprodutiva de espécies de tubarão debulhador do Pacífico Equador foi analisada com base em 1236 exemplares de *Alopias pelagicus* (711 fêmeas e 525 machos) e 354 de *A. superciliosus* (164 fêmeas e 190 machos) desembarcados em “Playita Mía”, entre janeiro e dezembro de 2019. O comprimento das fêmeas de *A. pelagicus* variou entre 67,2 e 184 cm PCL (comprimento pré-corte) e os machos entre 69,0 e 178,4 cm PCL, *A. superciliosus* registrou um tamanho mínimo e máximo de 76,0 e 202,2 cm PCL para as fêmeas e 94,0 e 204,8 cm PCL para machos. A classe de tamanho mais frequentemente capturada para *A. pelagicus* foi 147,2–157,2 cm PCL e para *A. superciliosus* foi 156,0–166,0 cm PCL. A proporção sexual (F:M) para *A. pelagicus* e *A. superciliosus* foi de 1,35F:1M e 0,86F:1M, respectivamente. Para machos de *A. pelagicus*, o ponto de inflexão do ajuste do comprimento do grampo foi de 134,2 cm PCL e o tamanho na primeira maturidade sexual (L_{50}) foi estimado em 136,0 cm PCL. Para machos de *A. superciliosus* o ponto de inflexão do ajuste do comprimento do grampo foi de 136,8 cm PCL, e a primeira maturidade sexual (L_{50}) foi estimada em 138,7 cm PCL.

Palavras-chave: Ecuador, Conservação, Comprimentos, Pacífico Sul, Tubarão.

INTRODUCTION

The analysis of the reproductive variables linked to the life history of sharks, helps to gather information of great importance to improve fisheries management (Fischer *et al*., 2009; Cotton *et al*., 2011). The estimation of sexual maturity at a certain average length, is a key element to estimate the productivity of species (Corro-Espinosa *et al*., 2011; Liu *et al*., 2015). Similarly, the estimation of the sex ratio in fish makes it possible to reduce the presence of structural biases in the stock assessment models, improving the diagnosis of the biological reference parameters (Morson *et al*., 2015). There are currently three species of thresher sharks descripted, the common thresher *Alopias vulpinus* (Bonnaterre, 1788); the pelagic thresher *Alopias pelagicus* Nakamura, 1935, and the bigeye thresher *Alopias superciliosus* (Lowe, 1841), all of them from the family Alopiidae (Compagno, 1984; Sepulveda *et al*., 2005; Dharmadi, Wiadnyana, 2013), with all three species reported in Ecuador (Aguilar *et al*., 2005). The thresher sharks are distinguished from other shark species, because of their long scythe-like caudal fins, and are part of the Lamniformes order. They form part of worldwide fisheries with big mortality rates, because of the high fishing pressure on them, since their meat and fins are very appreciated for human consumption (Compagno, 1984; Smith *et al*., 2008; Nelson *et al*., 2016; Young *et al*., 2016).

Alopias pelagicus is an epipelagic and relative large (up to 330 cm TL) shark species, which has a limited distribution to the Indian and Pacific oceans (Cardeñosa *et al*., 2014). This species presents embryonic oophagy as a reproductive strategy, which is a form of matrotrophic viviparity where, after initial yolk-sac nutrition, growing embryos ingest unfertilized eggs to support further development (Musick *et al*., 2005). This species also presents a low fecundity, with gestations of only 1–2 pups after an unknown reproductive period, which is presumed to have a duration of a year or less.

It is one of the most abundant pelagic shark species in the Eastern Tropical Pacific (ETP) and the Western Pacific (WP), it is a cosmopolite species that lives in tropical and subtropical waters, in which the pelagic thresher is exposed to the overexploitation produced by commercial, artisanal and also illegal fisheries from these regions (Liu *et al*., 1999; Tsai *et al*., 2010; Drew *et al*., 2015).

Alopias superciliosus is a highly migratory species, with a circumtropical and subtropical distribution, from coastal to oceanic waters and also tempered zones, it can be found at depths of 750 m (Liu *et al*., 1998; Camhi *et al*., 2009; Gökoğlu *et al*., 2017). It is easily distinguished from the other species of their family, because of the unique shape of its head, since it has a dorsal crest that gives them a peculiar 'helmeted' appearance, this is because of the deep grooves that this species presents, which extends from the superior part of the eyes to the superior region of the gill openings; it has large and oval eyes, with an interorbital space that is almost flat (Weng, Block, 2004; Navia*,* Mejía-Falla, 2011; Mas *et al*., 2014; Farrag, 2017). Its reproductive ontogeny is also achieved by embryonic oophagy, where unfertilized eggs are produced by the pregnant female throughout most of their pregnancy, which the developing embryos ingest and store in a large bulging yolk-stomach, this being their only energy supply until birth (Snelson *et al*., 2008).

In virtue of the current capture volumes, both species have recently shifted from the "Vulnerable" (VU) to the "Endangered" (EN) category of the International Union for Conservation of Nature (IUCN) (Camhi *et al*., 2009; Rigby *et al*., 2019). This study has the main objective to gain updated information about some of the reproductive aspects of the thresher sharks of Ecuador, examining elements such as the sex ratio, the frequency and lengths distribution, and the size at first sexual maturity (L_{50}) , with the aim of providing data that help in the efforts for those species conservation.

MATERIAL AND METHODS

The samplings were carried out at the landing stage of Tarqui beach, located in the canton of Manta (00°56'59"S 80°42'34"W), Ecuadorian Pacific, throughout the months of January to December of 2019. The landed organisms were sexed and measured in centimetres (cm) with a graduated measuring tape, the taken measures were: precaudal length (PCL) and the interdorsal length (IDL), this was because the landed individuals lacked the superior lobe of their caudal fin, which difficulted the recording of the total length (TL). In males, the exterior clasper length (CL) was registered in centimetres (cm), and other characteristics such as the rotation, calcification (null, partial or total), the riphiodon aperture, and the presence or absence of sperm (Mejía-Falla *et al*., 2012). The males that presented a non-calcified clasper, were classified as juveniles or immatures; and those individuals that presented calcification, rotation and an easy aperture of their riphiodon, were considered as adults or mature (Clark, von Schmidt, 1965; Aguilar *et al*., 2007; Martínez-Ortíz, 2012; Romero-Caicedo, Carrera-Fernández, 2015).

The length composition was represented with frequency histograms of combined sexes from both species, via a null hypothesis based on a 1:1 proportion, using the Chi-square test. Normality tests were applied, as well as tests of homogeneity of variance and tests of hypothesis to determine the presence of significant differences between sexes

(Milton, 1964; MacFarland, Yates, 2016). The Pearson's correlation coefficient between IDL and PCL, and an analysis of variables (ANOVA) to determine the existence of significant differences between the lengths of the sampled months.

Normally, the fishermen cut the superior lobe of the caudal fin. For that reason a simple linear regression analysis between IDL and PCL was made, in order to acquire reliable data based on extrapolations extracted from the equation of the line $y = a + b\ (x)$ (Romero-Caicedo *et al*., 2014).

In males, the sexual maturity was based on a logistic curve, which was modified with raw data, as a way to obtain the inflection point of the clasper length, the following equation was used $LC = LC_{min} + (LC_{max} - LC_{min})\ [1+ eb(\text{a-L})] - 1$ where a is the inflection point, LC_{min} and LC_{max} are the values of the clasper length, being respectively the minimum and the maximum value (Piner *et al*., 2005). For the adjustment of a logistic model for the binominal data of maturity (0 immatures; 1 matures), these were grouped in the category of 0, non-calcified; and 1, calcified, this category was calculated from the equation $1/1 + e^{a}+^{(b.Tl)}$ in order to estimate the size at first sexual maturity (L_{50}) (Smart *et al*., 2016). All the statistical analyses carried, were performed using the software R Studio Development Core Team 2016 package, AquaticLifeHistory in R (Smart *et al*., 2016; Smart, 2019).

RESULTS

During the sampling period, 1236 individuals of *A. pelagicus* were registered, with 711 (57.52%) being females, and 525 (42.48%) being males. The sex ratio was 1.35F:1M (x^2, P < 0.05) in which significant differences were found, specifically in the months of January, February, April, and June (Tab. 1A). The minimum and maximum length of females were respectively 67.2 and 184.0 (average = 141.1 ± 0.8) cm PCL, and in the case of males, their sizes ranged from 69.0–178.4 (average = 142.0 ± 0.9) cm PCL. The maximum length frequency interval, for both males and females, was registered at 147.2–157.2 cm PCL (Fig. 1A). The females presented larger lengths than males, but there were no significant differences between sexes (U Mann-Whitney, P > 0.05; K-S, P > 0.05). A positive correlation between PCL and IDL was found (R^2 = 0.93) (Fig. 2A) and no differences between sexes were registered (ANCOVA = 0.73, P > 0.05). Samples were obtained during all months of 2019, June was the month that presented the highest frequency (n = 259, 20.95%; 113 (9.13%) males and 146 (11.81%) females), whilst the lowest frequency was registered in October (n = 30, 2.43%; 11 (0.89%) males and 19 (1.54%) females), significant differences were notified between the sampled months (ANOVA K-W, P < 0.05).

Alopias superciliosus registered a total of 354 individuals, which were distributed between 164 females (46.33%), and 190 males (53.67%), displaying a sexual proportion of 0.86F:1M (x^2, P > 0.05) (Tab. 1B). The length of the males oscillated from 94.0–204.8 (average = 160.30 ± 1.39) cm PCL, while the females ranged from 76.0–202.2 (average = 159.03 ± 1.84) cm PCL, for both males and females. The highest frequency interval was registered between 156–166 (Fig. 1B). The males showed larger lengths than the females, but there were no significant differences between sexes (U Mann-Whitney, P > 0.05; K-S, P > 0.05). Between IDL and PCL, a positive correlation was found (R^2 =

TABLE 1 | Monthly distribution of sex ratio and chi-square (x^2) of *Alopias pelagicus* (**A**) and *A. superciliosus* (**B**). *Present significant differences.

A					
Month	Female	Male	Proportion	x^2	p-value
January	45	22	2.05F:1M	7.22	P<0.05*
February	44	26	1.69F:1M	4.13	P<0.05*
March	84	65	1.29F:1M	2,17	P>0.05
April	93	63	1.48F:1M	5.39	P<0.05*
May	101	96	1.05F:1M	0.08	P>0,05
June	146	113	1.29F:1M	3.95	P<0.05*
July	73	51	1.43F:1M	3.56	P>0.05
August	34	19	1.79F:1M	3.70	P>0.05
September	35	20	1.75F:1M	3.56	P>0.05
October	19	11	1.73F:1M	1,63	P>0.05
November	15	20	0.75F:1M	0,46	P>0.05
December	22	19	1.16F:1M	0,10	P>0.05

B					
Month	Female	Male	Proportion	x^2	p-value
January	13	18	0,72F:1M	0.52	P>0.05
February	15	18	0,83F:1M	0.12	P>0.05
March	14	15	0,93F:1M	0.00	P>0.05
April	14	14	1F:1M	0.04	P>0.05
May	21	12	1,75F:1M	1.94	P>0.05
June	20	21	0,95F:1M	0.00	P>0.05
July	11	20	0,55F:1M	2.06	P>0.05
August	6	7	0,86F:1M	0.00	P>0.05
September	15	14	1,07F:1M	0.00	P>0.05
October	13	22	0,59F:1M	1.83	P>0.05
November	11	16	0,69F:1M	0.59	P>0.05
December	11	13	0,85F:1M	0.04	P>0.05

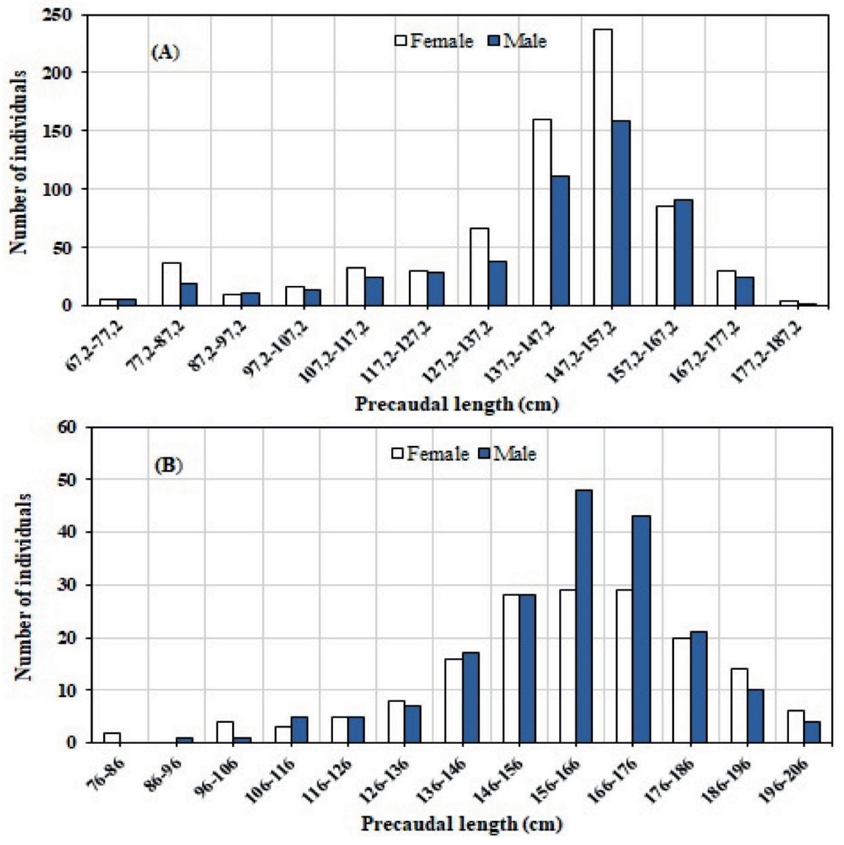

FIGURE 1 | Composition of sizes of male and female thresher sharks *Alopias pelagicus* (**A**) and *A. superciliosus* (**B**) landed in the town of Playita Mia, Manta Ecuador.

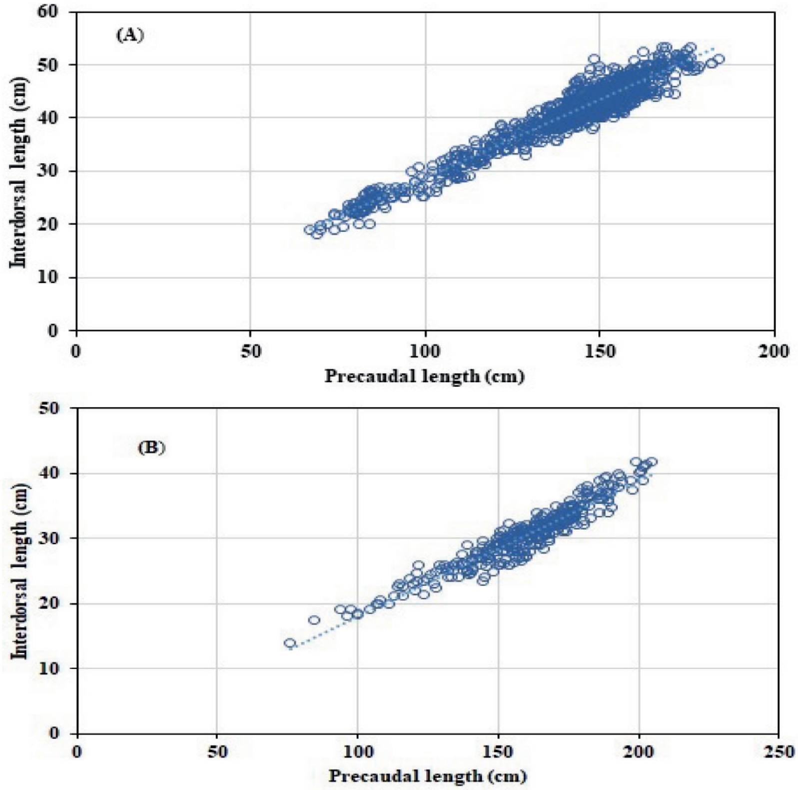

FIGURE 2 | Relationship between interdorsal and length precaudal of the thresher sharks *Alopias pelagicus* (**A**) and *A. superciliosus* (**B**). A linear regression, coefficient of determination (R2 = 0.93 A, R2 = 0.91, B).

0.91) (Fig. 2A) and no differences between sexes were detected (ANCOVA = 0.87, P > 0.05). The month with the highest frequency was June (n = 41, 11.58%; 20 (5.65%) females and 21 (5.93%) males), and the month that presented the lowest frequency was August (n = 13, 3.67%; 6 (1.69%) females and 7 (1.98%) males), between the sampled months there were no significant differences registered (ANOVA, P > 0.05).

The males of the pelagic thresher shark registered 161 (30.73%) specimens with non-calcified claspers, while 363 (69.27%) presented total calcification (Fig. 3A). The males with immature claspers (non-calcified), had lengths that ranged from 69–155 cm PCL with a clasper length (CL) of 3–20.2 cm, but in the case of the males with mature claspers (calcified) exhibited lengths of 130.6–178.4 cm PCL, and 16.6–27 cm of CL. The inflection point of the clasper was estimated at 134.2 cm PCL, while the average size at first maturity for males was estimated at 136.03 cm PCL (Fig. 4A).

Alopias superciliosus registered 20 (10.53%) individuals with non-calcified claspers, and 170 (89.47%) with totally calcified claspers (Fig. 3B). The males with immature claspers (non-calcified) displayed lengths of 94–140 cm PCL with a clasper length (CL) that ranged from 5.8–21.2 cm, while the males with mature claspers (calcified) exhibited lengths of 134–204.8 cm PCL and with a CL that went between 17–27.8 cm. The inflection point of the clasper was estimated at 136.8 cm PCL, while the average size at first maturity size of males was estimated at 138.73 cm PCL (Fig. 4A).

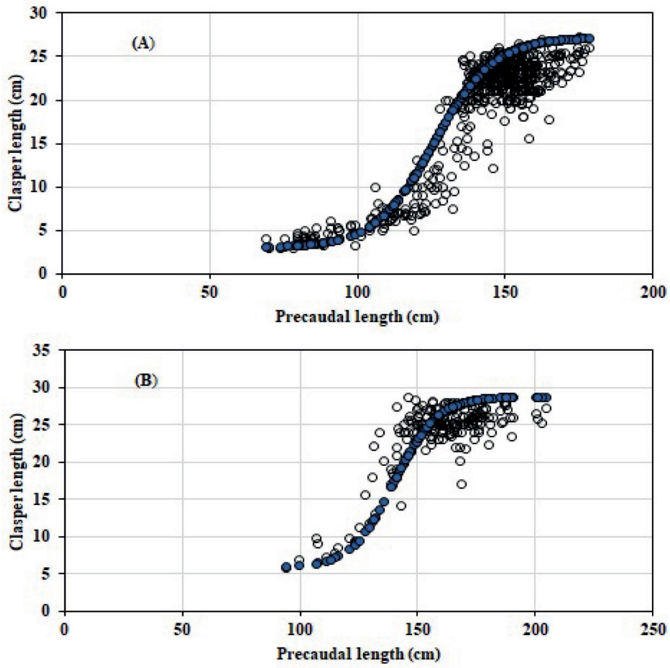

FIGURE 3 | Relationship between the length of the clasper and the length precaudal of the thresher sharks *Alopias pelagicus* (**A**) and *A. superciliosus* (**B**).

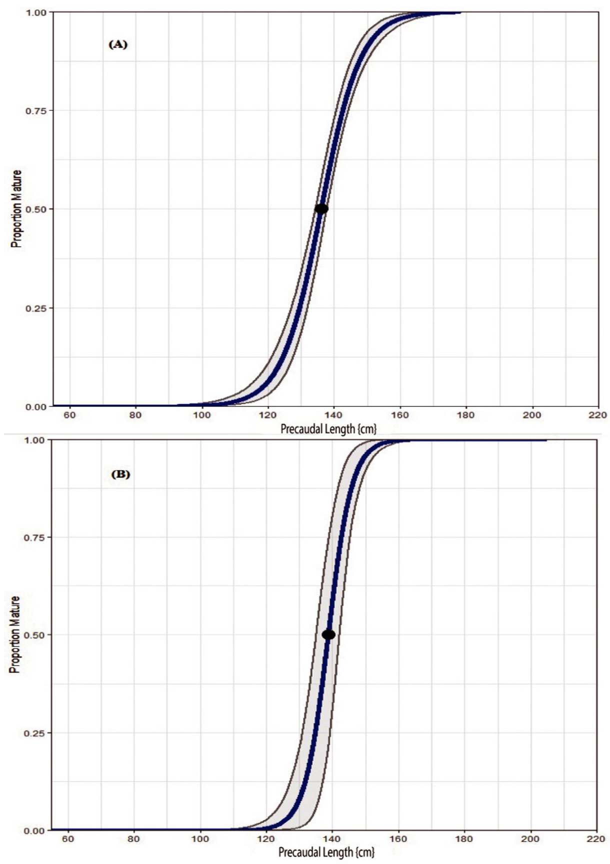

FIGURE 4 | Mean length (CI 95%) at maturity of the thresher sharks *Alopias pelagicus* (**A**) and *A. superciliosus* (**B**).

DISCUSSION

The evaluation of the quantitative relations between the length, maturity and reproductive aspects scientifically reinforces the management plans designed for the future sustainability of the resources (Harry *et al*., 2013). At the Ecuadorian level, for *A. pelagicus*, Martínez-Ortíz *et al.* (2007) reported that the range of the precaudal length (PCL) had values between 48 and 284 cm for females, and 50–210 cm (n = 3685) for males; significant value differences up to 19.2 cm with respect to the minimum length for both sexes, and 100 cm with the maximum length of the females reported in this study (PCL females: 67.2–184 cm and PCL males: 69–178.4 cm) (n = 1236). This variability of lengths may indicate that during the time between studies, the fishing pressure could have decreased the populations of immature individuals of this species (Musyl *et al*., 2011; Oliver *et al*., 2015). The actual fishing efforts is tending towards the capture of individuals whose lengths are superior to the average age of maturity (unimodal distribution: 147.2–157.2 cm); something that, combined to the slow biological recuperation of this species, could lead to overfishing (Smith *et al*., 2008; Drew *et al*., 2015). It has to be taken into account that *A. pelagicus* is the species with the highest capture rate of all elasmobranchs in Ecuador (Herrera *et al*., 2012; Martínez-Ortiz, García-Domínguez, 2013; Coello, Herrera, 2018). According to Martínez-Ortiz *et al.* (2015), shark catches from longlines in Ecuador are largely dominated by thresher sharks (Alopiidae), mainly *A. pelagicus* with 96.8% caught (27380.5 mt per month) and 3.1% (88.68 mt per month) for *A. superciliosus*, data from January 2008 to December 2012. For comparative purpose with the bibliography that is in TL (total length), a data conversion with linear regression of the relation between (TL) and (PCL) was made. It is important to emphasise that before reaching the actual pronounced progression exposed in this study, the measurements of Coello and Herrera (2018) (TL females: 110–338 cm and TL males: 108–341 cm) recollected during the course of 2012, chronologically show a pattern of the increase of minimum lengths captures of *A. pelagicus* in the country. However, in Ecuador, there are no reports of lengths larger than those maximum values described for this species by Martínez-Ortiz and García-Domínguez (2013), which are: TL for females ranging from 96–375 cm, and TL for males 91.4–353 cm. The work of Romero-Caicedo *et al.* (2014), carried out between 2005 and 2006, is the only previous study that reports similar PCL measurements with this present study, which oscillate between 70 and 180 cm in the case of females, and from 68–183 cm for the males, presenting the highest frequency of individuals at lengths of 135–144 cm (n = 241). Regarding other regions, Smith *et al.* (2008) presented a length composition of the Gulf of California in Mexico collected from 1998 to 1999, in which the females and males of *A. pelagicus* presented an average precaudal length (PCL) of 134.3 ± 8.3 cm and 130.4 ± 8.6 cm respectively, clearly those are lower measurements than the ones reported in this investigation (PCL average females = 141.05 ± 0.82 and PCL average males = 142.02 ± 0.95) with a shorter length interval (109–162 cm) and significant differences of the PCL in both sexes. In the Indian Ocean, the measurements fluctuate from 96–350 cm of TL, which might reflect the existence of nurseries and reproduction zones of this species along some coasts (*e.g*., Arabian Sea, India or Indonesia) (Najmudeen *et al*., 2019; Ichsan *et al*., 2020). Additionally, in Indonesia it was noted that immature individuals are dominating the elasmobranch fisheries (Winter *et al*., 2020).

In regard of the sex ratio, a greater presence of females was registered (1.35F:1M) differing significantly from the expected (1F:1M), in a similar relation that was estimated by Romero-Caicedo *et al.* (2014); however, the Ecuadorian coast has notified even more biased proportional magnitudes of females in captures, Coello, Herrera (2018) presented a sex ratio of 2.5F:1M; White *et al.* (2020) also reported a sex ratio with a clear prevalence of females (2.6F:1M) for Papua New Guinea in the Pacific Ocean. That higher occurrence of females, could be related with sexual segregation (Klimley, 1987; Sims, 2006), in which females have a preference for warmer and more coastal waters in order to improve the fecundity of their thermic niches (Wearmouth, Sims, 2008), which could entail a biased exploitation pattern of the resource (Hazin *et al*., 2006; Mucientes *et al*., 2009).

This study found a positive correlation between the interdorsal length (IDL) and the precaudal length (PCL), which shows that both values are strongly and directly correlated (Oshitani *et al*., 2003; Polo-Silva *et al*., 2018). This equation can now be used to estimate values of PCL, from measurements of IDL in individuals that have suffered any cephalic mutilation or the removal of the caudal fin, as long as it is measured with very good accuracy (Mas *et al*., 2014; Santana-Hernández *et al*., 2014; Briones-Mendoza *et al*., 2018).

The first sexual maturity length (L_{50}) for males was estimated at 136.03 cm PCL (254.8 TL) from the inflection point of the ogive from the sigmoidal model that ties the clasper length (CL) and the precaudal length (PCL) when the binominal data of the biological condition of the clasper (calcified or non-calcified) are combined; a model that has been already used to estimate the maturity of chondrichthyans (Briones-Mendoza *et al*., 2016), Lamniformes (Jensen *et al*., 2002) and even in species of the family Alopiidae (Natanson, Gervelis, 2013). Almost 70% of mature individuals were registered, of which the immature male that had the longest precaudal length was 155 cm PCL and the mature male that presented the lowest length was 130.6 cm of PCL. For the Ecuadorian coast and employing the same methodology, Romero-Caicedo *et al.* (2014) differed in the calculation of the male L_{50} which was estimated to be at 144 cm of PCL; with clasper length averages of 4.8 cm (immatures) and 22.9 cm (matures), whose numbers are in the range of the clasper dimensions found in this study; similar findings of the biggest immature male (158 cm PCL) and the smallest mature male (138 cm PCL) were emitted. Coello *et al.* (2010) mention that the length for males in which the 50% of the population presents specific sexual characteristics for reproduction is 259 cm TL. Other estimates of L_{50} occur in other regions, such as the published by Reardon *et al.* (2013) which they estimate at 250 cm TL for Australia; Ichsan *et al.* (2020) with 232 cm TL for Indonesia; or Liu *et al.* (1999) and Liu *et al.* (2006) in the range of sizes from 145–150 cm PCL (282–292 cm TL) for Taiwan. The reason why there is a tendency for the diminution of the average sizes reported in this investigation, can be attributed to many factors: amongst them, it is proposed that this species could be responding with a strategy of reducing their average size as a tactic to autoregulate the populations that are exposed to a severe exploitation, something that has already been reported before in pelagic sharks (Baum, Myers, 2004; Frisk *et al*., 2005). However, it is important to also note that environmental factors according to latitudinal gradients and aquatic conditions from different regions (Dharmadi, Wiadnyana, 2013; Alejo-Plata *et al*., 2016) also influence in the variability of the parameter measurements registered in other places of the world.

Alopias superciliosus, by contrast, is a species that has been poorly studied with regards of its biological aspects, because of its low abundance in Ecuadorian waters (Bustamante, Lamilla, 2006). In this context, the work of Martínez-Ortíz *et al*. (2007) reported substantial differences in the male PCL in their investigation, these ones being an average of 20.2 cm smaller than the evaluated in this present study, whilst the females stay in a similar length range; this data may suggests that the populations of juvenile males has been diminishing over the years, and that the capture incidence is currently biasing towards adult organisms whose overfishing is putting this species biological sustainability in danger. Varghese *et al.* (2015) specified an average PCL for the Indian Ocean, whose lengths are lower than the ones from this present study, concretely the specified lengths were 152.19 ± 21.48 cm. In this study, the sex ratio was in favour of the males, similar to what was found by Coello and Herrera (2018). By the contrary, Carr *et al.* (2013) indicated an inverse proportion, in which the females were more abundant (2.27H:1M), documented in the captures of an illegal shark fishing boat in the Galápagos Marine Reserve. The calculation of the sex ratio for other regions tends to have a higher male incidence in coastal waters, such as the notified by Carvalho (2015), Varghese *et al.* (2015, 2016), and Hacohen-Domené *et al.* (2020) for the Arabian Sea, Guatemala and the Atlantic coasts. However, Carvalho (2015) suggests that it may be some hints around some islands of the Atlantic ocean, such as the Cape Verde archipelago, where the sex ratio is biased towards the presence of females, in accordance with what was found by Carr *et al.* (2013) for the Galápagos archipelago in the Pacific ocean; which indicates the preference of *A. superciliosus* females for this type of open ocean geological formations as zones for pupping zones and nurseries, these particular kind of well delimited areas naturally decrease the risk of predation of neonate individuals by other pelagic shark species, and have a high prey availability (Springer, 1967).

De-Wysiecki, Braccini (2017), encourage the use of the morphometry to standardise and improve the usage of the available data, as well as the compilation of biological data based on the length relations of sharks, as long as the statistical analysis is reliable. About 90% of the male sharks that were examined in this study were evaluated as totally mature, and the first sexual maturity length (L_{50}) that was calculated, who determines it at 180.8 cm PCL (+42.07 cm) based on the inspection of the clasper external features, the researcher also informs of a higher margin of the clasper lengths (CL) (4.4–31 cm) for the same region. Varghese *et al.* (2016) by the same token measured CL in organisms from the Arabian Sea and they found a lower interval (3.2–22.4 cm), as well as individuals whose immature lengths were up to 171 cm PCL (+31 cm) and the mature specimens presented the same minimal length as it was reported here. Liu *et al.* (1999) also estimated a L_{50} which is above the calculations, being situated in the class of 150–155 cm PCL (+16.27 cm), this case being for the Taiwanese coastline. Verifying these last values, it is noteworthy that the pattern of the length declining in the valuations of the L_{50} it is present, as is the case of *A. pelagicus* and the causes could be analogous in both species. Additionally, Moreno, Morón (1992) believe that the male maturity length should not be determined by the size and the calcification status of their claspers, but also by the fold level of the deferent ducts when these store sperm, as a clear signal of sexual maturity, adding another argument that could explain the fluctuant model of the results of the diverse studies. The results suggest that the month of June is the most important for the landing of captured individuals of both species, because it presented the highest frequency. It was also noted the existence of a prevalence of adults over juveniles in captures. Also, the sexual proportion observed in both species could indicate a defined sexual segregation. This information is useful to study the impacts of the fisheries on both species, particularly knowing that these species are poorly studied in the Ecuadorian Pacific.

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AUTHORS' CONTRIBUTION

Jesús Briones-Mendoza: Conceptualization, Data curation, Formal analysis Investigation, Methodology, Software, Writing-original draft, Writing-review and editing.

Pol Carrasco-Puig: Conceptualization, Investigation, Methodology, Supervision, Visualization, Writing-original draft, Writing-review and editing.

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