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Fin to carcass weight ratios for the silky shark *Carcharhinus falciformis* in the western Indian Ocean

by

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1. Introduction

The silky shark, *Carcharhinus falciformis*, is an oceanic species with a very large geographical distribution in the tropical seas. It is one of the main by-catch species of the open-sea pelagic fisheries, mainly in the purse-seine fisheries. Its meat is little marketed, but its fins are valuable on the international shark fins market.

In the frame of the European research program MADE (Mitigating adverse ecological impacts of open ocean fisheries; http://www.made-project.eu) whose aim is to propose methods and protocols to reduce the by-catches in the pelagic fisheries, numerous specimens of silky sharks were collected and studied; it was interesting to valorised these catches in complement of the MADE studies, by an analysis of the fin to carcass weight ratios. It should be mentioned that only the dead sharks were used for these studies, the sharks that were still alive when caught, were released out at sea.

The interest to determine the fin to carcass weight ratios is that these ratios are used in the regulations on finning (= fins cut on board of the fishing vessel and discard of the carcass). The average ratio of 5% often used is controversial (Hareide *et al.*, 2007; Hindmarsh, 2007; IOTC, 2007; Petersen *et al.,* 2007; Fowler & Séret, 2010; Biery & Pauli, 2012).

The international shark fin market distinguished several commercial categories of fins: the first choice or "primary set" is constituted by the first dorsal fin, both pectoral fins and the lower lobe of the caudal fin; the secondary set is constituted by the other fins: the second dorsal fin, the pelvic fins, the anal fin and the upper lobe of the caudal fin (Fig. 1)

The price of the fins is also function of their size: generally, larger fins have higher prices. Also, the fins of some species are more valuable because their contain more fibres (the vermicelli-like component that is extracted from the fins to prepare the famous shark fin soup)

2. Material and methods

The fins treated in this study were collected during the scientific program MADE on board of French tuna purse-seiners working in the western Indian Ocean in 2009-2010. A total of 53 full sets of fins were treated, removed from 26 females and 27 males, ranging from 65 to 182 cm in total length, and 1.3 to 35 kg in weight. The total weight of the samples was 47 kg.

The fins were straight cut at their base and their wet weight measured on board of the purse-seiners. The following parameters were taken on every specimen:

- Total length in cm
- Fork length in cm
- Pre-caudal length in cm
- Total raw weight in g
- Eviscerated weight, with fins on, in g
- Eviscerated weight without the fins, in g
- First dorsal weight in gr
- Second dorsal weight in g
- Weight of both pectoral fins in g
- Weight of both pelvic fins in g
- Anal fin weight in g
- Caudal fin weight in g
- Lower caudal lobe weight in g

In laboratory, all the raw weights (after defrosting) and dried weights (after drying) of the fins were measured to the nearest g (Fig. 2).

The drying of the fins was obtained with an "Excalibur Food Dehydrator" from Parallex® (Fig. 3). The durations of drying varied from 24 to more than 48 hours for the thickest fins. The drying was performed until the weight of fins was constant (Fig. 4).

The following ratios were calculated:

- Wet weight of 1st set / total body weight
- Dried weight of 1st set / total body weight
- Wet weight of 2nd set / total body weight
- Dried weight of 2nd set / total body weight
- Total wet weight of fins / total body weight
- Total dried weight / total body weight

The potential differences between males and females were tested with F-test on the variances and T-test on the means.

3. Results: fin to carcass weight ratios

Table 1 synthetizes the results obtained in this study: the various fin to carsass weight ratios and the statistical tests. These tests show that there is no significant differences between the males and the females.

4. Conclusion

The methods used in this study: uniform drying thanks to the use of a food dehydrator until constant weight and measurementsof fin weights in laboratoiry with precision scales, allowed to obtained accurate and reproductible ratios. Few studies have been made on this matter and even fewer are related to the silky shark (Anderson & Ahmed, 1993; Mejuto & Garcia-Cortes, 2004; Ariz *et al.*, 2005, 2006; Cortes & Neer, 2006; Mejuto *et al.*, 2008; Neves dos Santos & Garcia, 2008). The table 2 summarises the data available for the silky shark for the following two ratios only: FW / RW et FW / DW with FW (wet fins weight). RW (raw body weight) and DW (dressed body weight).

In comparing our results with those available in the litterature. important differences are sometimes obserevd. These differences are mainly due the differet methods used in the studies. For example, there are different ways to cut the fins : in the "straight cut", the fin is cut tangentially at its base (method used in the present study), in the "half oon cut", a curve cut is made upward to minimise the quantity of meat, and in the "crude cut" a curve cut is made donward taken more meat. The crude cut is the common method used on board of Portuguese and Spanish vessels, in order to obtain "the maximal profitable use of the body as fins meat" (Mejuto & Garcia, 2004).

The second reason contributing to explain these difference is the integration of the upper caudal lobe in the fin sets. This lobe has no commercial value because it contains very few fibres, as most of the lobe is "occupied" by the vertebral column (sharks have heterocercal caudal fin). Integrating this upper lobe to the fin sets allows to significantly increase it weight; and as a result the fin to body weight ratios calculated with this method are biaised.

In some studies, the methods used are not described. For example, the values of some american studies seem to indicate that only the primary sets were used to calculate the ratios.

The size and the geographical origin of the samples are also variable and might contibute to these observed differences. Another source of biais could be the use of more or less accurate length/weight relationships to estimate the body weight from lengths taken on board. Then, the weight measured on board of moving vessels might be oter source of variation.

At present, the 5% ratio is commonly used 5% in most of the regulations on fnning. The present study on the silky shark shows that the ratios are function of the definition of the following main parameters "fin weight" and "body weight". For example, in the European regulation CE 1185 / 2003, it is not defined if the body weigth is the raw weight (wet, total weight) or the eviscerated weight. These vaguenesses could allow to get around the regulation. These loopholes should be corrected in the forthcoming update of the EU regulation.

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Figure 1. Commercial shark fin categories: primary and secondary sets.

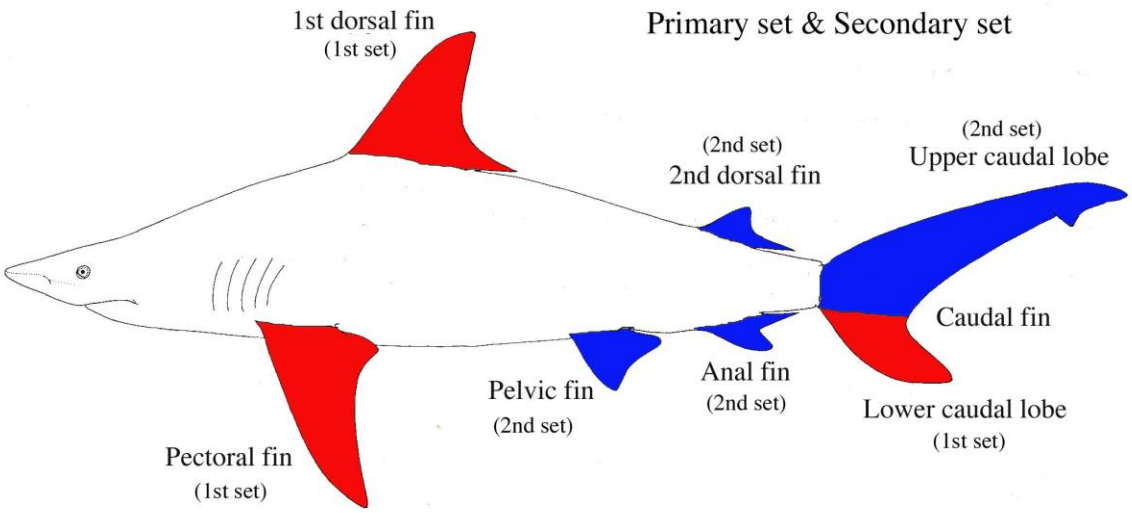

Figure 2. The fins were weighted with an electronic scale in laboratory.

Figure 3. The fins were dried to constant weight with an « Excalibur Food Dehydrator" from Parallex®.

Figure 4. Some dried fin sets of silky shark.

Table 1. Fin to body weight ratios of the silky shark. *Carcharihnus falciformis*. from the western Indian Ocean and statistical tests.

	1st fin set wet weight / total body weight	1st fin set dried weight / total body weight	2nd fin set wet weight / total body weight	2nd fin set dried weight / total body weight	Total wet weight of fin / total body weight	Total dried weight of fin / total body weight	Total wet weight of fins / eviscerated body weight with fins	Total dried weight of fins / eviscerated body weight with fins	Total wet weight of fins / eviscerated body weight without fins	Total dried weight of fins / eviscerated body weight without fins	% eviscerated body weight with fins /total body weight	% eviscerated body weight without fins /total body weight
Number of females	20	20	20	20	20	20	20	20	20	20	19	20
Number of male	22	22	22	22	22	22	22	22	22	22	20	22
Minimum for females	1.74	0.63	2.08	0.82	4.14	1.51	4.93	1.60	5.19	1.69	80.03	75.92
Maximum for females	2.46	1.01	2.83	1.39	5.57	2.54	6.13	2.98	6.51	3.14	92.97	95.06
Minimum for males	1.60	0.55	2.06	0.85	3.90	1.47	3.08	1.65	4.66	1.74	80.50	76.77
Maximum for males	2.26	1.14	2.68	1.43	4.98	2.74	5.67	2.96	6.03	3.11	95.69	95.50
Mean for females	2.05	0.79	2.38	1.07	4.74	1.97	5.44	2.27	5.75	2.40	86.36	82.42
Mean for males	1.99	0.79	2.32	1.10	4.61	2.01	5.09	2.25	5.45	2.37	88.18	84.77
Standard deviation for females	0.22	0.13	0.22	0.19	0.42	0.33	0.40	0.38	0.44	0.41	3.42	4.32
Standard deviation for males	0.16	0.13	0.14	0.15	0.25	0.30	0.57	0.33	0.38	0.35	4.30	5.25
Variance for females	0.05	0.02	0.05	0.04	0.18	0.11	0.16	0.15	0.19	0.17	11.73	18.67
Variance for males	0.03	0.02	0.02	0.02	0.06	0.09	0.32	0.11	0.15	0.12	18.53	27.52
Ratio of variances	1.94	1.00	2.39	1.49	2.91	1.19	0.48	1.32	1.32	1.34	0.63	0.68
F-test on variances	0.14	0.99	0.06	0.37	0.02	0.70	0.12	0.54	0.54	0.51	0.34	0.40
p table	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.17	2.12
	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.
T-test on means	0.27	0.95	0.31	0.58	0.24	0.72	0.03	0.88	0.03	0.83	0.15	0.12
p 0.05	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.
Total number	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	39.00	42.00
Mean	**2.02**	**0.79**	**2.35**	**1.09**	**4.67**	**1.99**	**5.26**	**2.26**	**5.59**	**2.38**	**87.29**	**83.65**
Standard deviation	0.19	0.12	0.18	0.17	0.34	0.31	0.52	0.35	0.43	0.38	3.96	4.92
Minimum	1.60	0.55	2.06	0.82	3.90	1.47	3.08	1.60	4.66	1.69	80.03	75.92
Maximum	2.46	1.14	2.83	1.43	5.57	2.74	6.13	2.98	6.51	3.14	95.69	95.50

Table 2. Comparisons between the results of the present study and the data available in the scientific literature for the silky shark for the following two ratios only: FW / RW et FW / DW with FW (wet fins weight). RW (raw body weight) and DW (dressed body weight).

Reference	FW / RW	n	FW / DW	n	Method	
Present study	4.67	42	5.59	42	Straight cut	Without the upper caudal lobe
Baremore *et al.* *in* Cortes & Neer, 2006	1.45	19	2.53	18	?	Primary set?
NMFS 1993 *in* Cortes & Neer, 2006	1.62	1	_	_	?	Primary set?
Anderson & Ahmed, 1993	4.60	?	7.60	?	?	?
Mejuto & Garcia, 2004	6.50	2	11.09	11	Variable	Caudal fin included
Ariz *et al.*, 2006	_	_	11.16	8	Straight cut	Caudal fin included
Neves dos Santos & Garcia, 2008	4.64	175	8.90	175	Straight cut	Caudal fin included
Biery & Pauly, 2012 (compilation)	4.46	324				