

Length and length / weight relationships for the silky shark *Carcharhinus falciformis*, in the western Indian Ocean.

John Filmalter<sup>1</sup>, Bernard Seret<sup>2</sup>, Laurent Dagorn<sup>1</sup>

<sup>1</sup> IRD, UMR 212, B.P. 171, Av. Jean Monnet, 34203 Sète Cedex, France

<sup>2</sup> IRD, UMR 212, Muséum national d'Histoire naturelle, Département Systématique et Evolution, C.P. n° 51, 55 rue Buffon, 75231 Paris cedex 05, France

## Abstract

Meristic relationships between total length, fork length and pre-caudal length as well as between total length and whole weight are described for silky sharks *Carcharhinus falciformis* from the western Indian Ocean.

## Introduction

Information on the length/weight relationship and relationships between the various length measurements are important for monitoring and stock assessment purposes. Similarly, the due to the variety of measurements available in the literature, the establishment of the relationships between these measures is essential for comparative purposes. Several studies have examined these relationships for silky sharks (Branstetter 1987; Brouard & Grandperrin, 1984; Kohler et al 1995; Bonfil et al 1990; 1993; Oshitani et al 2003; Joung et al 2008, Romanov & Romanova 2009), however none have reported on the various length relationships for the Indian Ocean stock. This is important as growth rates are known to differ between stocks of the same species of elasmobranchs. Here we briefly present data on these relationships collected from sharks caught incidentally by tropical tuna purse seine vessels in the western Indian Ocean.

## Methods

Silky sharks were captured during standard tuna purse seine operation in the western Indian Ocean (Fig. 1). Only sharks that were dead on deck were used in this study, all others were released. Sharks were frozen whole onboard the vessels. Once offloaded the sharks were defrosted and various length measurements taken (Total Length, Fork Length and Pre-caudal Length as per Branstetter and Stiles, 1987) to the nearest centimetre using large callipers. Weights were obtained using either an electronic or spring balance and were accurate to 0.5 kg. All weights refer to whole wet weight, after the sharks were defrosted.

For fork length and total length measurements, samples included measurements taken on sharks during tagging experiments. These two measurements were obtained for a total of 265 (63 – 208 cm TL, Fig. 2) silky sharks between 2009 and 2012. Lengths and weights were obtained for a total of 208 individuals (114 Females, 94 males).

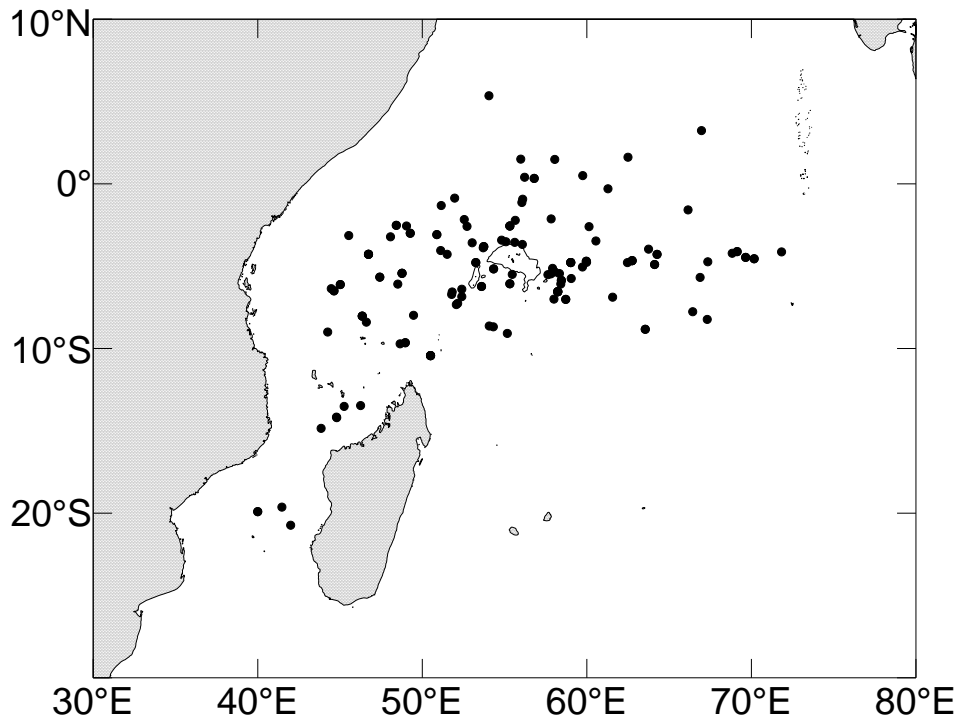


Figure 1 Capture locations of sampled silky sharks *Carcharhinus falciformis* from tuna purse seine vessels in the western Indian Ocean.

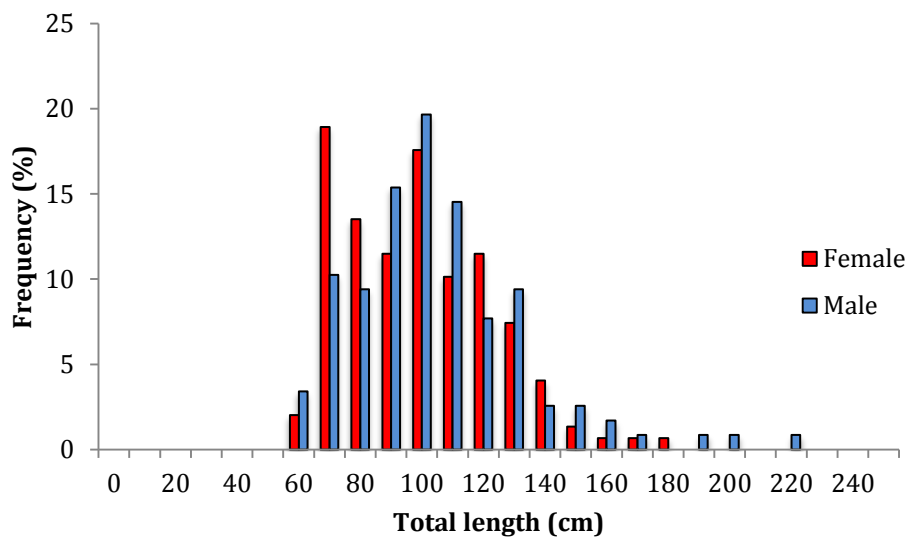


Figure 2 Size distribution of silky sharks *Carcharhinus falciformis* sampled from tuna purse seine catches in the western Indian Ocean, n= 265.

## Results

For each length relationship assessed an analysis of covariance was conducted between male and female samples. No significant difference was found between the sexes at the 5% level across all relationships.

### Total length vs. Fork Length

Both sexes

$$TL = 1.20FL + 2.90 \quad (n = 265, r^2 = 0.99)$$

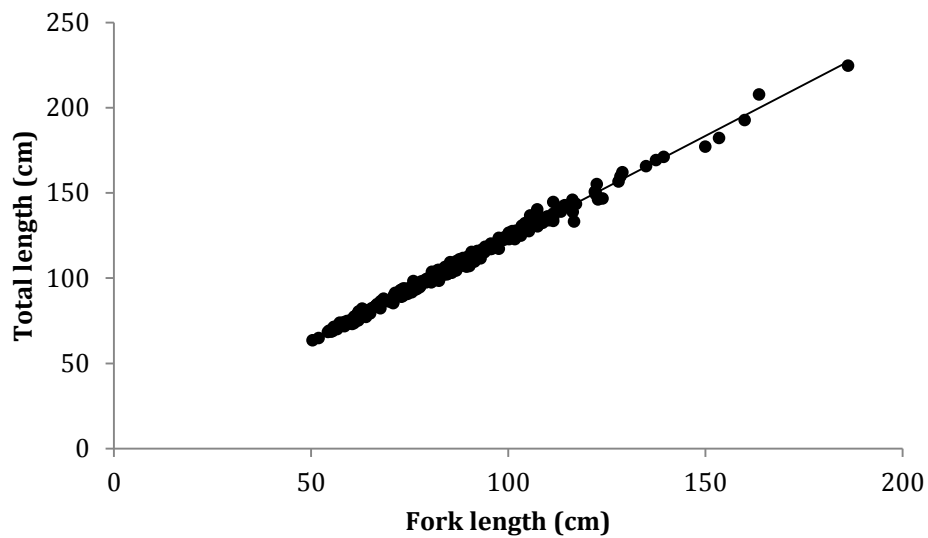


Figure 3 Total length vs. fork length relationship for silky sharks *Carcharhinus falciformis* (both sexes combined) from the western Indian Ocean.

Males

$$TL = 1.20 FL + 3.35 \quad (n = 117, r^2 = 0.99)$$

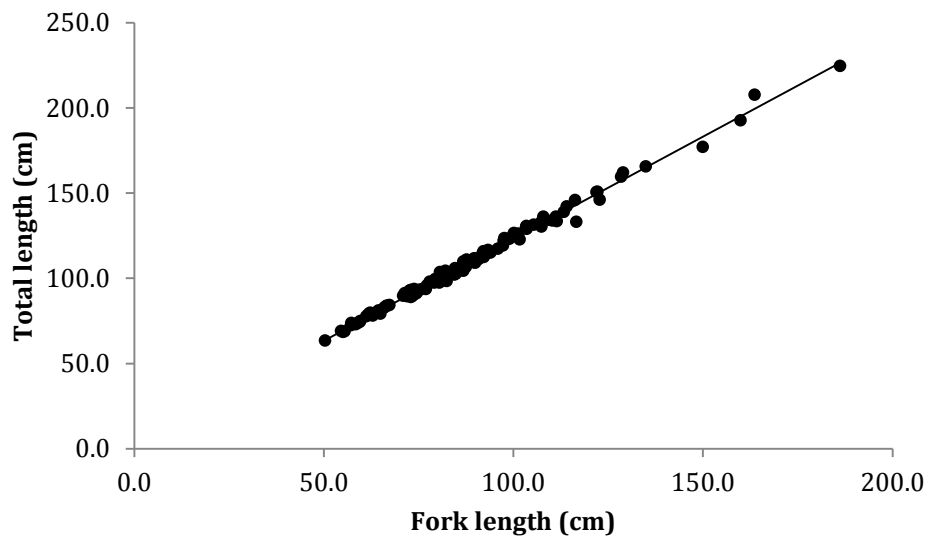


Figure 4 Total length vs. fork length relationship for male silky sharks *Carcharhinus falciformis* from the western Indian Ocean.

Females

$$TL = 1.21FL + 2.24 \quad (n = 148, r^2 = 0.99)$$

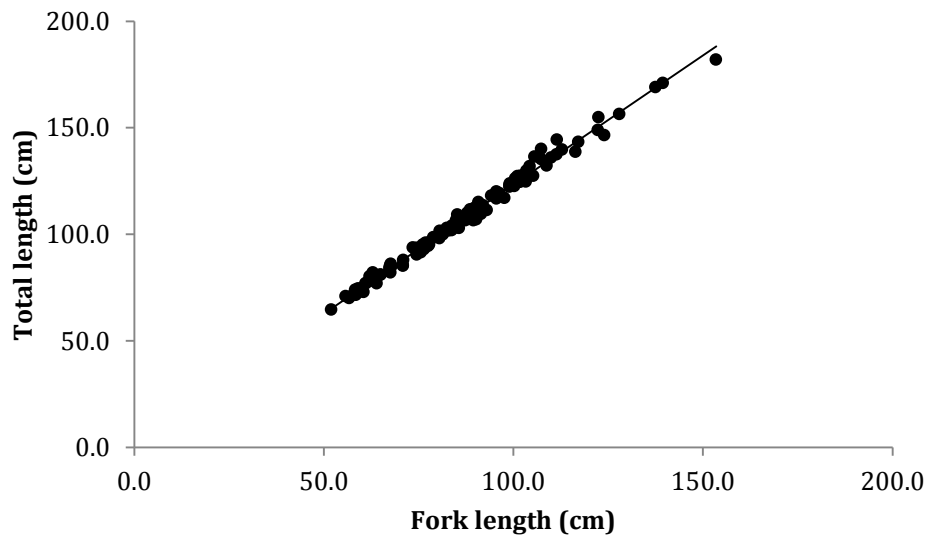


Figure 5 Total length vs. fork length relationship for female silky sharks *Carcharhinus falciformis* from the western Indian Ocean.

#### Total Length vs. Pre-caudal Length

Both sexes

$$TL = 1.34PCL + 1.78 \quad (n = 214, r^2 = 0.99)$$

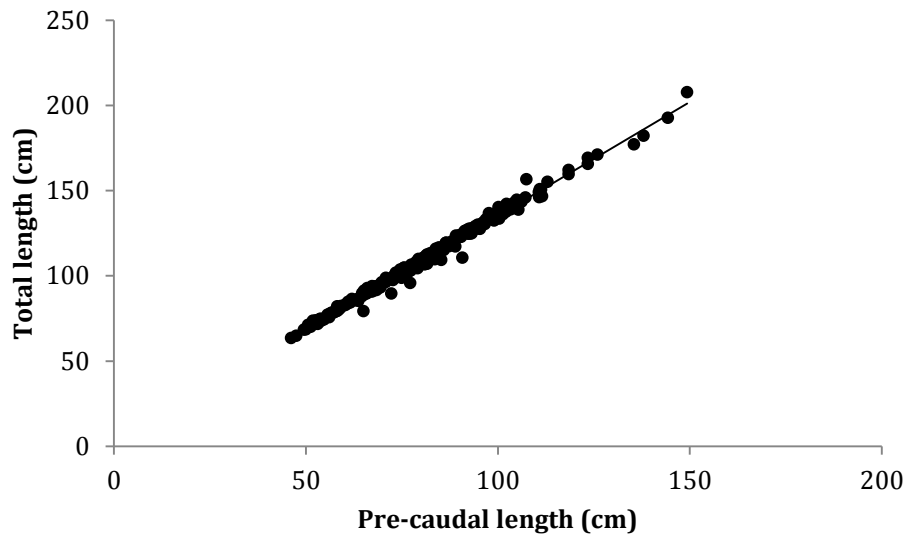


Figure 6 Total length vs. pre-caudal length relationship for silky sharks *Carcharhinus falciformis* (both sexes combined) from the western Indian Ocean.

Males

$$TL = 1.34 PCL + 1.59 \quad (n = 95, r^2 = 0.99)$$

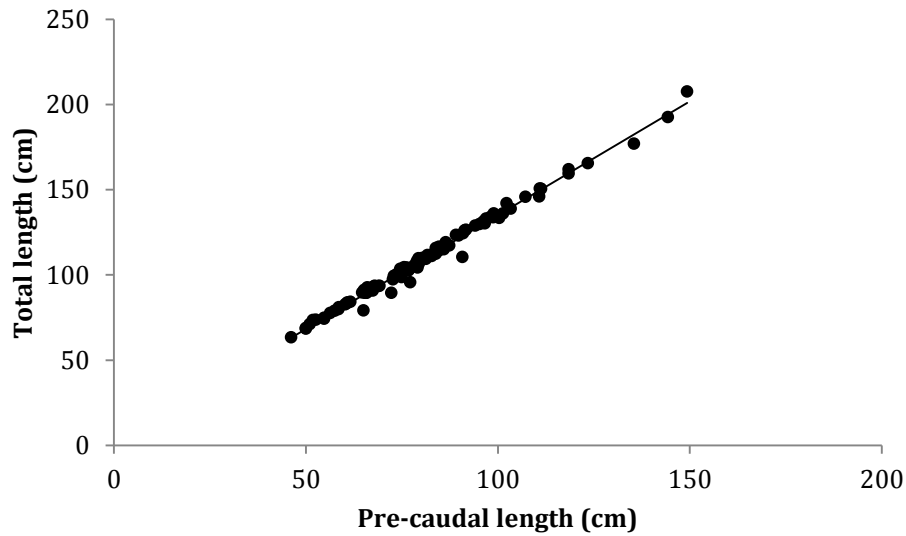


Figure 7 Total length vs. pre-caudal length relationship for male silky sharks *Carcharhinus falciformis* from the western Indian Ocean.

Females

$$TL = 1.39PCL + 1.61 \quad (n = 119, r^2 = 0.99)$$

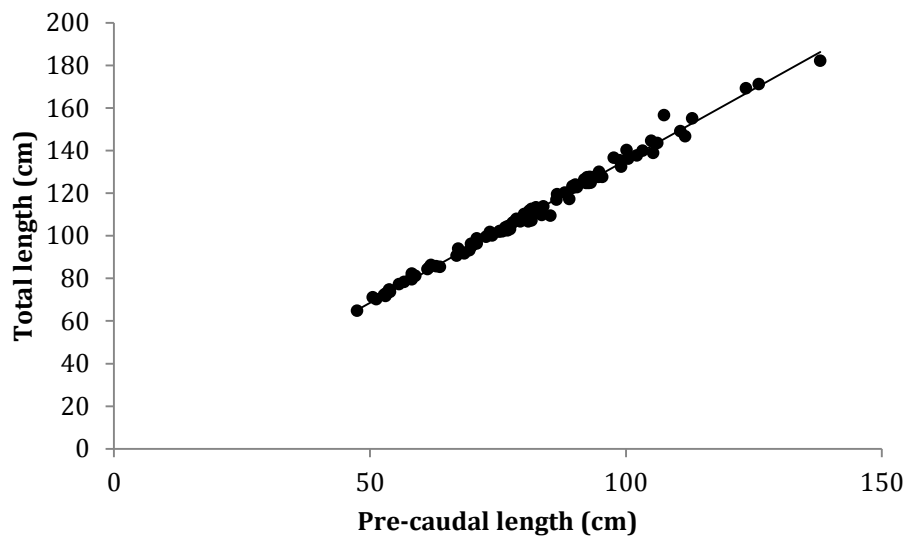


Figure 8 Total length vs. pre-caudal length relationship for female silky sharks *Carcharhinus falciformis* from the western Indian Ocean.

### Fork Length vs. Pre-caudal Length

Both sexes

$$FL = 1.10PCL - 0.44 \quad (n = 214, r^2 = 0.99)$$

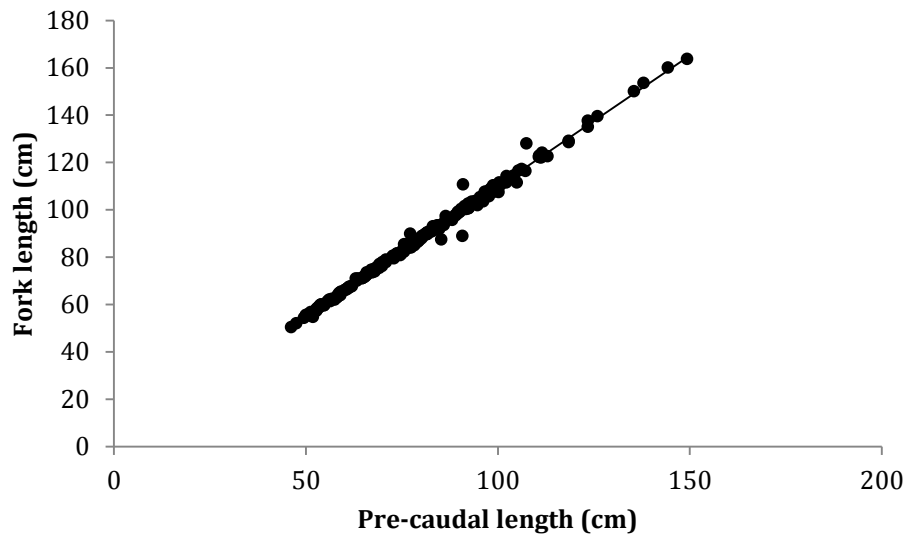


Figure 9 Fork length vs. pre-caudal length relationship for silky sharks *Carcharhinus falciformis* (both sexes combined) from the western Indian Ocean.

Males

$$FL = 1.10PCL - 0.33 \quad (n = 95, r^2 = 0.99)$$

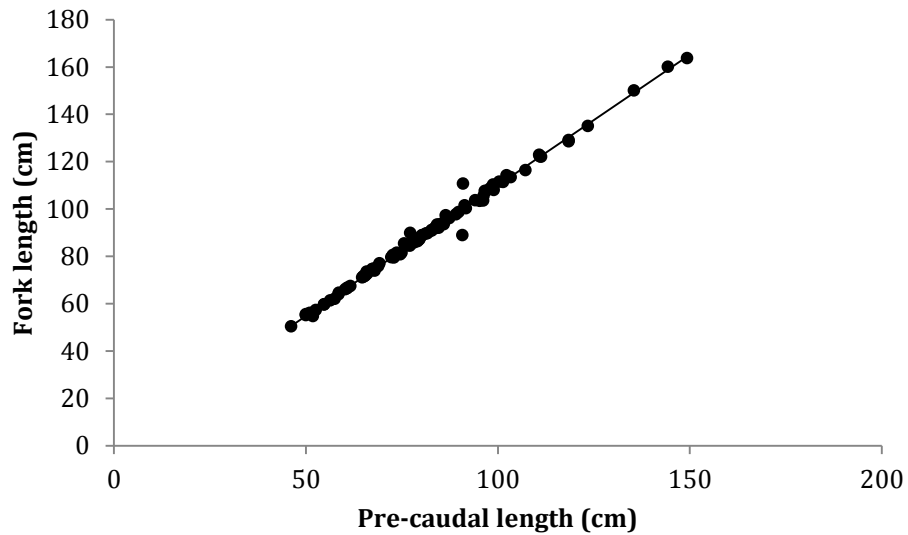


Figure 10 Fork length vs. pre-caudal length relationship for male silky sharks *Carcharhinus falciformis* from the western Indian Ocean.

Females

$$FL = 1.10PCL - 0.32 \quad (n = 119, r^2 = 0.99)$$

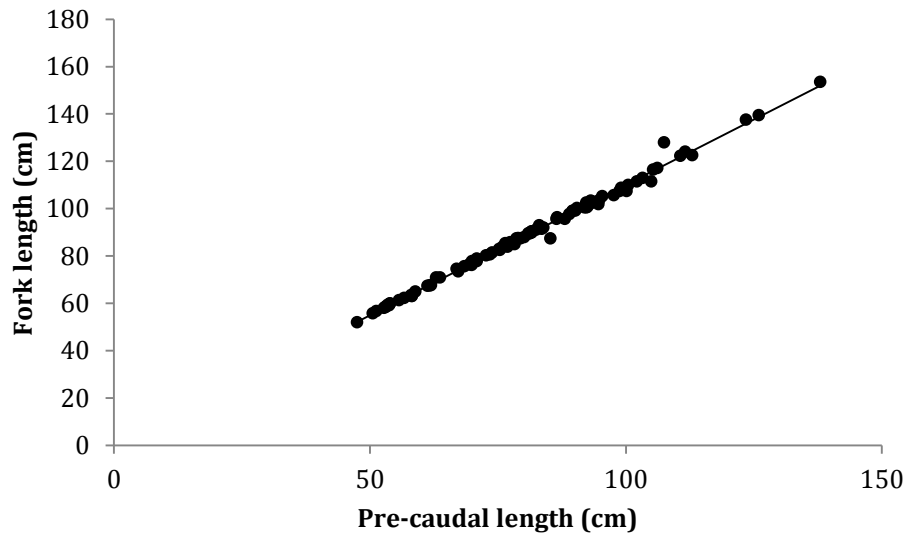


Figure 11 Fork length vs. pre-caudal length relationship for female silky sharks *Carcharhinus falciformis* from the western Indian Ocean.

### Whole weight vs. Total length

Both sexes

$$W = 1.48 \times 10^{-6} TL^{3.29} \quad (n = 208)$$

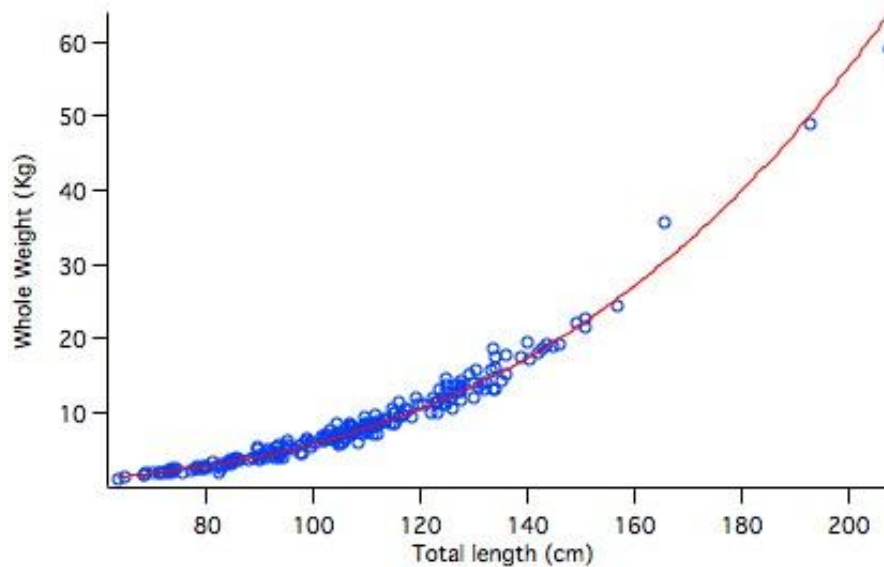


Figure 12 Whole weight vs. Total length relationship for silky sharks *Carcharhinus falciformis* (both sexes combined) from the western Indian Ocean.

### Males

$$W = 1.56 \times 10^{-6} TL^{3.28} \quad (n = 94)$$

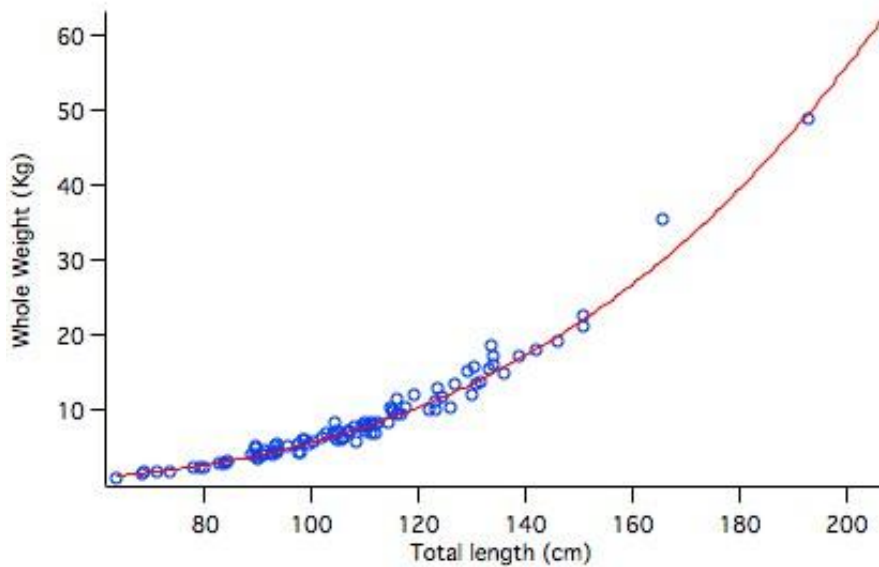


Figure 13 Whole weight vs. Total length relationship for male silky sharks *Carcharhinus falciformis* from the western Indian Ocean.

### Females

$$W = 2.52 \times 10^{-6} TL^{3.17} \quad (n = 114)$$

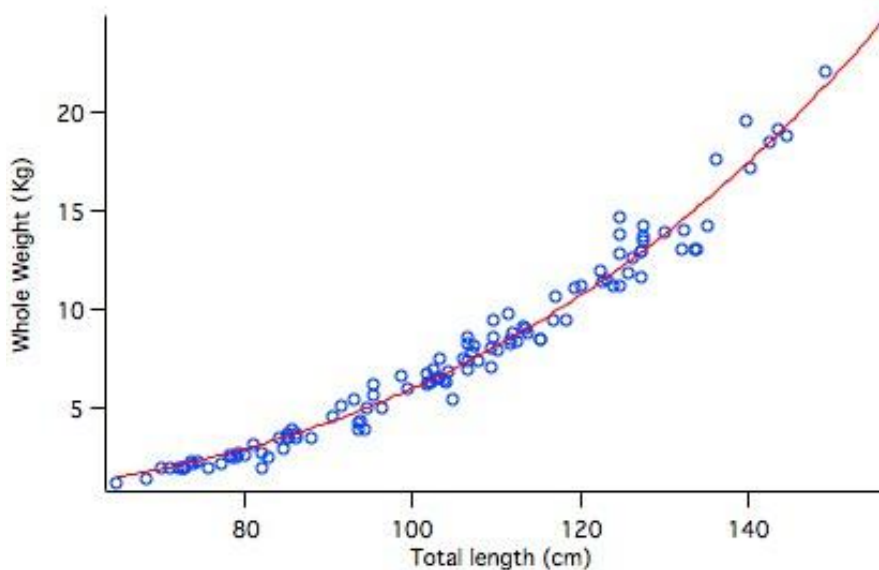


Figure 14 Whole weight vs. Total length relationship for female silky sharks *Carcharhinus falciformis* from the western Indian Ocean.

## Discussion

The various length relationships described here appear to generally match those derived in the western and central Pacific Ocean by Oshitani et al. (2003) and Joung et al. (2008) and those from the western Atlantic (Bonfil et al. 1993),



suggesting that the morphology of silky sharks is globally similar (Table 1). Slight differences are apparent in the length vs. weight relationship, suggesting sharks in the Indian Ocean may be slightly heavier set than those of the Pacific. However, this difference may well be due to the lack of large individuals in the current sample.

Table 1 Total length / fork length, total length / pre-caudal length and fork length / pre-caudal length relationships for *Cacharhinus falciformis*, data from the scientific literature.

Reference	Relationships	Geographical zone	n	Length range
Bonfil et al., 1993	FL = 1.0758PCL + 1.3017 TL = 1.3358PCL + 3.4378 TL = 1.2412FL + 1.8878	Western Atlantic	292 283 280	65 – 314 cm TL
Oshitani et al., 2003	TL = 1.32PCL + 2.08 FL = 1.09 PCL + 1.03	Pacific	84 362	50 – 180 cm PCL
Joung et al., 2008	FL = 1.09PCL + 1.10 TL = 1.21FL + 2.36 TL = 1.31PCL + 3.64	Western Pacific	469	75 – 260 cm TL
Present study	TL = 1.34PCL + 1.78 TL = 1.20FL + 2.90 FL = 1.10PCL - 0.44	Western Indian	214 265 214	63 – 208 cm TL

Generally the results of the length/weight assessment of the current study appear similar to those obtained in other regions (Table 2). Interestingly there appear to be some differences between this and the only other study in the Indian Ocean. This is possibly a result of the lack of large individuals in the current sample which would strongly influence the fit of the model.

Table 2 Length/weight relationships for *Cacharhinus falciformis*, data from the scientific literature.

Reference	Relationships	Geographical zone	n	Length range
Brouard & Grandperrin, 1984	$W = 0.04635 SL^{2.75}$ with SL meaning probably PCL	Vanuatu		
Branstetter, 1987	$W = 2.01 \times 10^{-6} TL^{3.23}$	Atlantic Gulf Mexico	135	85 – 260 cm TL
Bonfil et al., 1990	$W = 1.5404 \times 10^{-5} FL^{2.9221}$	Yucatan	102	
Kohler et al., 1995	$W = 1.5404 \times 10^{-5} FL^{2.9221}$	NE Atlantic	85	74 – 212 cm FL
Oshitani et al., 2003	$W = 2.73 \times 10^{-5} PCL^{2.86}$	Pacific	322	50 – 180 cm PCL
Joung et al., 2008	$W = 2.92 \times 10^{-6} TL^{3.15}$	Western Pacific	469	75 – 260 cm TL
Romanov & Romanova, 2009	$W = 0.160 \times 10^{-4} FL^{2.91497}$ $W \text{ females} = 0.118 \times 10^{-4} FL^{2.974}$ $W \text{ males} = 0.282 \times 10^{-4} FL^{2.8048}$	Indian	687 279 341	66 – 281 cm FL
Present study	$W = 1.48 \times 10^{-6} TL^{3.29}$ $W = 0.543 \times 10^{-7} FL^{4.102}$ $W \text{ females} = 2.52 \times 10^{-6} TL^{3.17}$ $W \text{ males} = 1.56 \times 10^{-6} TL^{3.28}$	Western Indian	208 208 114 94	63 – 208 cm TL

## References

Bonfil R, de Anda D, Mena R, 1990. Shark fisheries in Mexico: the case of Yucatan as an example. *NOAA Technical Report NMFS*, 90: 427-441.

Bonfil R, Mena R, Anda D, 1993. Biological parameters of commercially exploited silky sharks, *Carcharhinus falciformis*, from the Campeche Bank, Mexico. *NOAA Technical Report NMFS* 115: 73-86.

Branstetter S, 1987. Age, growth, and reproductive biology of the silky shark, *Carcharhinus falciformis*, and the scalloped hammerhead, *Sphyrna lewini*, from the northwestern Gulf of Mexico. *Environ. Biol. Fishes* 19, 161–173.

Branstetter S, Stiles R, 1987. Age and growth estimates of the bull shark, *Carcharhinus leucas*, from the northern Gulf of Mexico. *Environ. Biol. Fish.* 20, 169–181.

Brouard F, Grandperrin R, 1984. Les poissons profonds de la pente récifale externe à Vanuatu. *Notes Doc. Océanogr. Mission ORSTOM, Port-Villa*, 11: 131 p.

Joung J, C.-T. Chen, H.-H. Lee, K.-M. Liu, 2008. Age, growth and reproduction of silky sharks, *Carcharhinus falciformis*, in northeastern Taiwan waters. *Fish. Res.* 90: 78-85.

Oshitani S, Nakana H, Tanaka S, 2003. Age and growth of the silky shark *carcharhinus falciformis* from the Pacific Ocean. *Fish. Sci.* 69: 456-464.

Romanov E, Romanova N, 2009. Size distribution and length-weight relationships for some large pelagic sharks in the Indian Ocean. *IOTC-2009-WPEB-06*: 12 p.