

ORIGINAL RESEARCH ARTICLE

Length and Weight Relationships in Two Species of Sea Snakes from Tamilnadu, South East Coast of India**P. Damotharan, D. Varadharajan, A. Veeruraj, M. Arumugam and T. Balasubramanian***Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai – 608 502, India*

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ABSTRACT

Length and weight relationships and morphometric patterns in two sympatric sea snakes of *Enhydrina schistosa* and *Lapemis curtus* were estimated. In both species of sea snakes, snout-vent length has been a strong positive correlation to the weight and tail length. Sexual dimorphism in terms of snout vent length, body weight and tail length is not evident in both species which supports previous findings in *L. curtus*, but contradicts those in the case of *E. schistosa*. The estimated parameters should only be applied to the species analyzed.

Key words: Marine environment, sea snakes; habitat; morphometric; sexual dimorphism.**INTRODUCTION**

The reptiles, body size is an important for life history traits that influences microhabitat type, diet, vulnerability to predators and reproductive success^[1, 2]. In snakes, differences in mean body size can result in interspecific variation of ecology^[3] and length and weight relationships have been demonstrated in many species of snakes^[4-6]. In two thirds of the snake species for which data are available, female snakes grow longer and consequently weigh more than males and it is also true in sea snakes^[7-9]. In sea snake two species of *Enhydrina schistosa* and *Lapemis curtus* for which data length-weight relationship and morphometric patterns in two sympatric species of sea snakes^[10]. Sea snakes are very different biologically from most fish that are caught as by-catch. They are extremely venomous animals has been lungs and breathe air like other reptiles. Consequently, snakes whose habitats overlap with trawl grounds have a greatly increased likelihood of dying, either from drowning in the net or from being killed by boat crew once on board^[11]. Sea snakes are the seasonal movement between inshore and offshore waters either in search of food or for bearing young^[12-14] suggested that the females of most species appear to be gravid in the summer, and presumably bear young towards the end of the period. There are commonly encountered as by-catch in various fishing

activities, yet there is little published information on allometric relationships of most species. Both *E. schistosa* and *L. curtus* (family Hydrophiidae) are widely distributed species of sea snakes. *L. curtus* occurring in the Persian Gulf, Indian Ocean, South China Sea, Straits of Taiwan, Indo Australian archipelago, the Philippines and Australia^[15]. *E. schistosa* is a known from the Indian Ocean, the northern coast of Australia and the South China Sea and it was the most common species along the coast of India^[16, 17]. Hence, in the presence investigate the estimation of length and weight relationships and sex ratio on the two differing sea snakes (*E. schistosa* and *L. curtus*) encountered the by-catch in prawn trawls along the Tamil Nadu Coast of India.

MATERIALS AND METHODS**Collection of samples**

Sea snakes were collected from the Tamilnadu coastal waters in South East Coast of India, using by-catch of commercial bottom trawler during the period April 2009 to March 2010. Species were measured to the nearest cm (total length) and body weight to the nearest g. Subsequently, snout-vent length and tail length of and the total weight was measured using measuring tape an electronic balance.

The length and weight relationships were estimated from the allometric formula, $W = a L^b$, Where W is total body weight (g), L the total length (cm), a and b are the coefficients of the functional regression between W and L. In order to confirm whether b values obtained in the linear regressions were significantly different from the isometric value ($b=3$), t-tests with appropriate degrees of freedom were used.

Species identification

At the laboratory, specimens were preserved using 5% formalin solution and identified up to the species level by employing orthodox taxonomic methods, such as morphometric and meristic characters aided by an identification key^[18]. The major key characteristics, listed roughly in order of ease of observation are length, body shape, head shape, color pattern and difference in the scales pattern. Apart from above characteristics geographical location and habitat also provide important clues. Although no single characteristic is sufficient to make an identification, a reasonably accurate identification can usually be made from a scale pattern of snakes (lepidosis). Scales do not play an important role in distinguishing between the families but are important at generic and specific level identification. There is an elaborate scheme of nomenclature of scales. Scale patterns, by way of scale surface or texture, pattern and coloration and the division of the anal plate, in combination with other morphological characteristics, the principal means of classifying sea snakes up to the species level, describes the scales given below.

Morphometric data were recorded for 174 and 42 individuals of *E. schistosa* and *L. curtus* respectively and they captured in trawl nets from a total of 186 trawls. Snout to vent length (SVL) and tail length (TL) were taken to the nearest 0.5cm with a steel freeman tape and weight (Wt) of all snakes were measured to the nearest Kilogram using a Pesola TM Scale within 30 min after the catch was spread on board. The dead snakes (N = 144) were dissected on board to identify the sex. The live ones (N = 72) were gently pressed on the vent in order to protrude the hemipenis.

Analysis of reproduction

In order to have an insight into reproductive behavior, the sex of each specimen was determined based on anatomical features (hemipenes in males and ovaries in females). In the case of gravid females, uterine tubes containing ova were separated from the viscera

and the diameter (cm) and weight (g) of each ovum measured using vernier callipers and an electronic balance. The morphometric variables were first subject to log normal transformation and past plots were made to depict the relationships between snout-vent length and tail length and weight in the case of *E. schistosa* and *L. curtus*. The regression equations were fit on the data points and the regression line was forced through the origin^[19]. The coefficients of variation were computed for each morphometric measurements. The statistical analysis was carried out using software SPSS 10.5 (SPSS Inc). Mann Whitney U tests were employed to test whether the coefficients of variation in the morphometric measurements in males and females were significantly different at $\alpha=0.05$ level. The sexual size dimorphism (SSD), a measure of degree of sex difference in body size, was quantified by dividing the mean size of the larger sex by the mean size of the smaller sex based on the following method^[20].

RESULTS

Totally 56 and 118 in *E. schistosa* and 16 and 26 *L. curtus* were measured in males and females respectively. In *E. schistosa* and *L. curtus* was observed that the SVL explains most of the variation in Wt and TL (**Table 1**). There was no obvious sexual dimorphism observed in the species. The sexual size dimorphism (SSD) value calculated was 0.98 in *E. schistosa* and 0.97 in *L. curtus*. The frequencies of sea snakes in different size classes were normally distributed in both sexes and species (kolmogorov smirnov test for normality; $p > 0.05$). The sex ratios in both species were highly biased towards females. (**Figure 1**) shows the observation of data both species sea snakes were largest and smallest values in individuals of females. The coefficient of variation morphometric variation such as weight was higher in females than males *E. schistosa* and the coefficient of variation morphometric variation such as weight was higher in males than female species (**Table 2**). However, the values were not significantly different in males and females of both species (Man Whitney U test, *E. schistosa* and *L. curtus* $U = 3234$ to 166 , $P = 0.739$ to 0.2824). Confirmation from this study, suggests that the long history of trawling hasn't caused selective mortality of males and females of a larger size.

DISCUSSION

Family Hydrophiidae true sea snakes form an important component of the coastal habitats of

tropical and sub-tropical marine environments. These marine reptiles are known to occur in large numbers in the Indo-Pacific region [8, 21, 22]. In, our data confirm to the broad body size-weight relationship observed in many other snake species [4-6]. Body size did not vary between sexes in both species. Lack of sexual dimorphism in size among sea snakes is an exception. Only *L. curtus* and *Emydocephalus ijimae* exhibit such similarity between the sexes in 29 species of sea snakes (family Hydrophiidae) examined [8]. Body size and sex ratios have theoretical relationships [23]. The ultimate objective of any assessment of the effects of fishing on by-catch is to identify those species or populations potentially under threat. Most international conventions on endangered species include protection of populations as well as a species [24]. Approaches to date, using international union for conservation of nature (IUCN) criteria on marine animals have proved unsatisfactory [25-27] advocate a formal screening process against appropriate criteria to provide a better assessment of extinction risk. This is the first study to systematically assess the susceptibility to fishing of trawl by-catch species by using a defined set of life history characteristics.

Often population with sexual dimorphism manifest biased sex ratios. In sea snakes TL and SVL are important fitness traits and are under strong selection pressure in sea snakes, which play an important role in reproduction [28]. It is interesting to note that no such relation was found in the populations studied. Body size was not dimorphic among the sexes in *L. curtus* and probably males and females attained similar sizes at maturity [8].

Our finding on *E. schistosa* population contradicts an earlier study of the species in Malaysia, where it was found that females are larger and heavier than males [29]. The skewed sex ratios observed during this short study does not reflect the temporal and spatial variability that is inherent in populations of the species studied elsewhere [30]. Skewed sex ratio such as the one presented here for *E. schistosa* could be due to a function habitat selection by the sexes [30] and the bias in sampling certain areas using trawlers. Since TL, SVL and Wt are strongly influenced by the growth rate; it would be very difficult to draw conclusions on their sexual dimorphism without long term studies, since there are known that growth at

maturity of stabilizes on these characters [30]. Growth at maturity is also influenced by annual variation in the habitat and prey availability [31].

The data collected during this study also revealed that mortality was biased towards smaller individuals rather than larger ones in both sexes and species. Therefore, the data collected through morphometric from these studies were probably not influenced by trawl related mortality in the past. Female snakes showed large variation in their morphometric variables were in, it was found that the longest and heaviest and the smallest and lightest in *L. curtus* were females. It is possible that the observed ranges in size were obtained from study animals and therefore reflect the differences in sampling the sexes rather than real differences in their populations. Alternatively, this could have been caused due to differential growth rates, resulting in females attaining larger sizes at maturity [7]. Among the sea snakes caught during the present study, *E. schistosa* (> 65%) dominated the trawl catch as compared to *L. curtus* (< 35%). However, [13, 33] reported that *L. hardwickii* (*L. curtus*) contributes to about 81-88% and 53% of all the sea snakes caught in the coastal waters of Thailand and Gulf of Carpentaria, Australia, respectively. Though differential growth rates could be accountable for a larger body size of females, the occurrence of females smaller than males in the population is left to speculation. A detailed study of the reproductive biology of the species would provide an insight into the mechanism that governs these patterns.

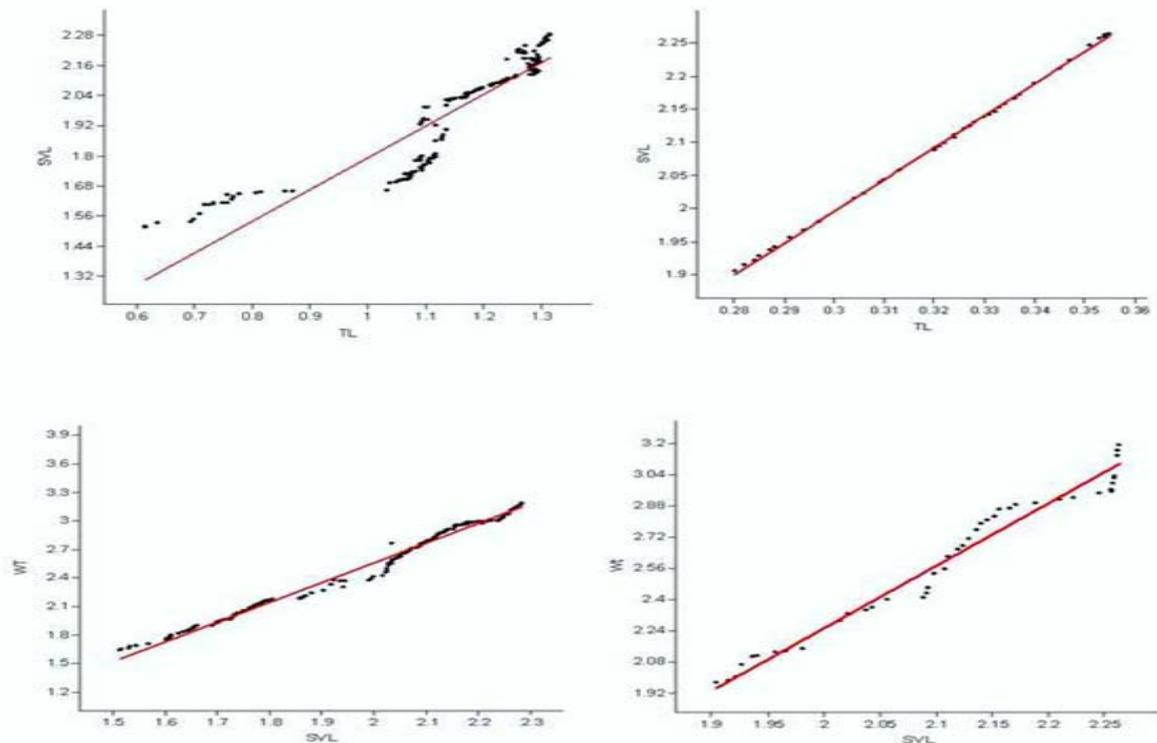
Table 1: Data in regression of snout-vent length (SVL) to body weight (Wt) and tail length (TL) with regression line forced through the origin

Sea snake	WT/L	R2	F	df
<i>E. scistosa</i>	Wt to SVL	0.939	2642.299	172
	TL to SVL	0.856	1023.852	173
	Wt to SVL	0.889	333.546	42
<i>L. curtus</i>	TL to SVL	0.949	783.916	42

Table 2: Mean and coefficient of variance of different morphometric characters in males and females of (a) *Enhydrina schistosa* and (b) *Lapemis curtus* along the Tamil Nadu coast India between April 2009 to March 2010

	Male		Female	
	Mean	CV	Mean	CV
<i>E. scistosa</i> (N= 56) (N=118)				
WT	491.93	74.93	481.72	79.54
SVL	106.226	41.25	103.692	43.68
TL	14.913	31.57	14.728	30.04
<i>L. curtus</i> (N=16) (N=26)				
WT	445.75	76.39	601.154	69.97
SVL	126.956	27.47	136.653	24.32
TL	12.5437	19.4	13.665	16.61

Figure 1: Allometric relationship of tail length (top left and right), weight of snake (bottom left and right) with snout-vent length in *Enhydrina schistosa* and *Lapemis curtus* sampled along the Tamil Nadu Coast India April 2009 to March 2010



CONCLUSION

The intercept of all the stations was positive indicators are perfect linear relationship between the variables. Length and weight, snout vent length and tail length are all indicators that can be used in determining the growth rate of sea snakes and hence in estimating the age. Since TL, SVL and Wt are strongly influenced by the growth rates; it would be very difficult to draw conclusions and their sexual dimorphism without long term studies since it is known that growth at maturity stabilizes on these characters. Growth rates of maturity are also influenced by annual variation in the habitat and prey availability. This study will provide important inputs into sea snakes stock assessment models and data for sustainable management and development of the resources.

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