SIZE COMPOSITION AND MORPHOMETRY OF INCIDENTALLY CAPTURED SEA TURTLES AT VIZHINJAM, SOUTH-WEST COAST OF INDIA[1]

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The paper deals with the size composition of incidentally captured sea turtles in different fishing gears, such as gill net, hooks and line, boat seine, and other gears at Vizhinjam coastal area from September 1998 to December 2001. The size composition and the relationships between various morphometric characters of the incidentally caught sea turtles have been discussed. Size composition of 1,216 Olive Ridleys *Lepidochelys olivacea*, 56 Green Turtles *Chelonia mydas*, 43 Hawksbills *Eretmochelys imbricata* and 5 Leatherback Turtles *Dermochelys coriacea* were studied. In the carapace length, significant variations were found among the species ($F=407.47$; $p<0.001$), year ($F=7.17$; $p<0.001$), gear types ($F=10.40$; $p<0.001$) and sex ($F=272.43$; $p<0.001$). In the weight, significant variations were noticed among the species ($F=1,325.18$; $p<0.001$), and sex ($F=345.17$; $p<0.001$). Among the incidentally caught sea turtles, significant differences were observed between the species, and sex in relationship between different morphometric characters and weight.

Key words: morphometric measurements, sea turtles, size composition, fishing gears, analysis of variation, regression equation

INTRODUCTION

The size frequency of a population is important and is an essential parameter of that population's demographic structure (Bolten 1999). By analyzing the size composition of sea turtles, habitat quality and physiological status can be understood (Bolten 1999). Morphometric data on the incidentally caught sea turtles can be used as a tool to estimate from the measurement of one body part, the weight and measurement of other parts. Morphometric characteristics of a population can help to identify the population status and to find out the species and size group that get entangled in the fishing gears. They also help to suggest measures to reduce the mortality by altering the mesh size or by any other effective conservation measures. Available information on sea turtle morphometry is restricted to nesting Olive Ridleys (Silas *et al.* 1983; James *et al.* 1989; Dash and Kar 1990) and some reports on the Green Turtle, Hawksbill, and Leatherback Turtle stranded along the Indian coast (Sraimeetan 1985; Tripathy and Choudhury 2002; Bhupathy and Karunakaran 2003). However, considerable amount of work is available on the morphometric measurements of sea turtles from Sri Lanka (Deraniyagala 1953), North Carolina (Fahy 1954), Queensland and Papua New Guinea (Limpus 1985) and from Oceanic in Azores and Baleares Islands. The literature available on the morphometry is very fragmentary in India and there is no detailed work on the morphometry of incidentally caught sea turtles. Therefore, the present study was undertaken to analyze the size composition of the stranded turtles from different fishing gears and to find out the relationship between various morphometric characteristics of incidentally caught sea turtles.

MATERIAL AND METHODS

Measurements were taken from the incidentally caught Olive Ridleys *Lepidochelys olivacea*, Green Turtles *Chelonia mydas*, Hawksbills *Eretmochelys imbricata*, and Leatherback Turtles *Dermochelys coriacea* at Vizhinjam of Kerala coast. Data were collected from September 1998 to December 2001. On locating the stranded sea turtles, different morphological measurements, such as curved carapace length and width, plastron length and width were taken for all turtles. Bolten (1999) was followed for taking measurements of different parts of the body.

RESULTS

Size composition of sea turtles

The morphometric measurements and weight of sea turtles incidentally caught in Vizhinjam, Kerala are given in Table 1.

Morphometric Relationship between different species of sea turtles

Multiway Analysis of Variance was applied to investigate the difference in the morphometric measurements among the four species of sea turtles. In the carapace length significant variations were found among the species

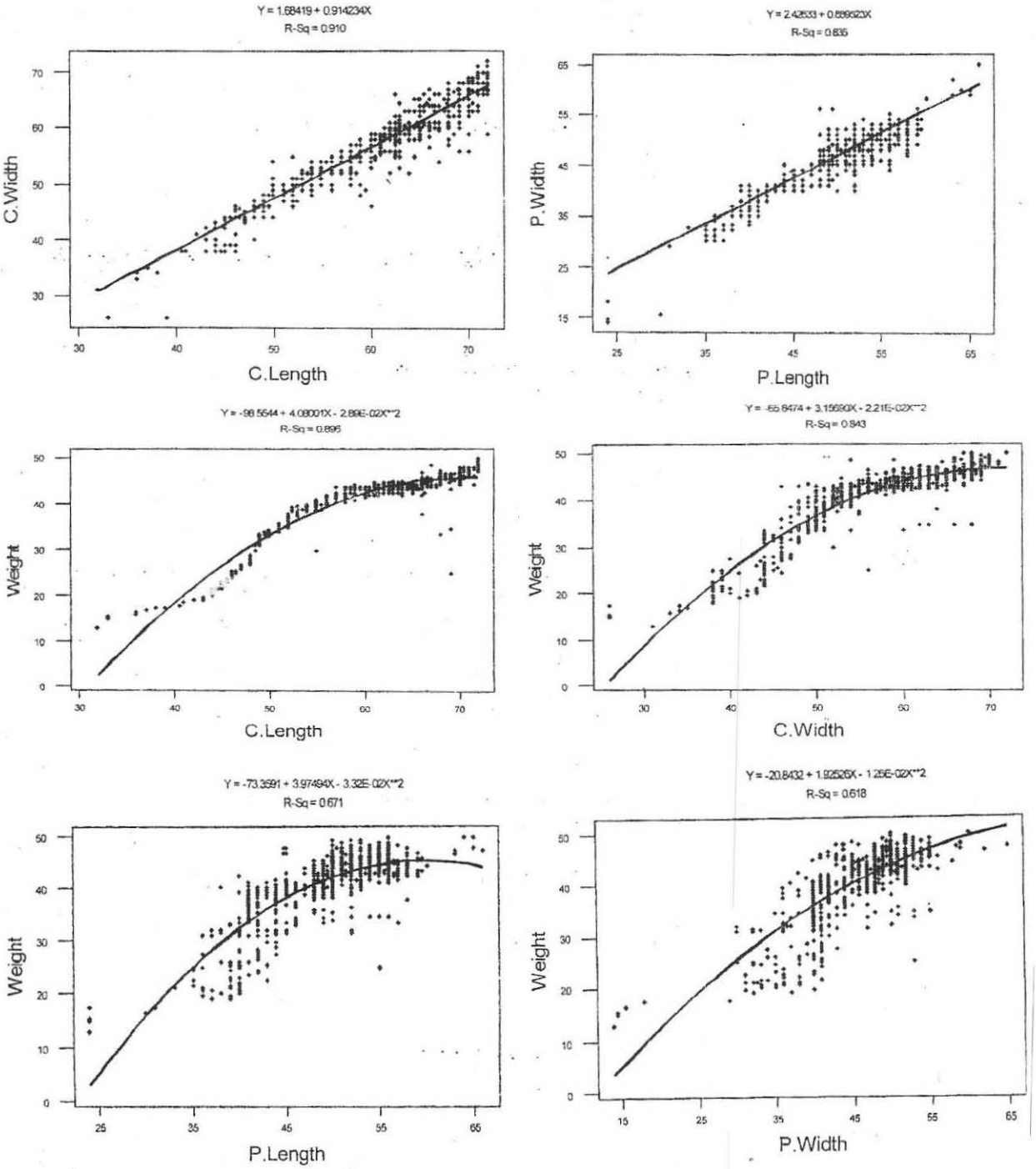

Fig. 1: Regression plots for *Lepidochelys olivacea*

51 to 72 cm in curved carapace length (mean of 62.2 cm), curved carapace width from 48 to 63 cm (mean 57.8 cm), plastron length from 44 to 57 cm (mean 51.8 cm) and plastron width from 43 to 53 cm (mean 49.3 cm). The report by Bhupathy and Karunakaran (2003) states that the size of the Olive Ridley recorded from the Nagapattinam coast of Tamil Nadu ranged from 50 to 77 cm in curved carapace length (mean 68.7±2.5 cm). Dash and Kar (1990) stated that at Gahirmatha, the range of carapace length for male olive ridleys was 67.5 to 70.0 cm and for females, it was 66.0 to

California (Caldwell 1962) and Honiara (McKeown 1977). Pritchard (1969) opined that the average size of Olive Ridleys was slightly larger in the Indian Ocean than elsewhere; hence it appears that there is some geographical difference in the size of the Ridleys. This is also evident from the maximum sizes recorded at Sri Lanka: 79.0 cm by Deraniyagala (1939). However, compared to earlier records, in this study both sexes showed lower carapace ranges. The Ridley is the smallest of all the sea turtles; seldom has it weighed more than 50 kg and very rarely more than 60 kg (Dash and Kar 1990). The present study showed that the average body weight of males and females were 42.7 ±3.3 kg (range: 30 to 49.5 kg) and 42.9 ±3.1 kg (range: 33 to 50 kg) respectively. Pritchard (1969) reported the average weight of 14 turtles as 78.28 ±7.58 kg, with a range of 68-97 kg. Kar and Bhaskar (1982) found the average weight of 291 turtles to be 43.4 kg. According to Zwinberg (1976), a female from Surinam had a carapace length of 69.0 cm and weighed 44 kg. McKeown (1977)

Table 2: Analysis of Variance to investigate the effect of species, year, gear types and sex on the morphometric measurements of incidentally caught sea turtles

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Analysis of Variance for Carapace Length						
Species	3	71,527.7	58,919.3	19,639.8	407.47	0.001
Year	3	783.5	1,036.8	345.6	7.17	0.001
Gear types	3	55.1	1,504.1	501.4	10.40	0.001
Sex	2	26,261.6	26,261.6	13,130.8	272.43	0.001
Error	1,309	63,092.7	63,092.7	48.2		
Total	1,323	1,61,924.6				
Analysis of Variance for Carapace Width						
Species	3	29,179.3	22,620.4	7,540.1	180.82	0.001
Year	3	519.1	588.7	196.2	4.71	0.003
Gear types	3	24.1	1,292.6	430.9	10.33	0.001
Sex	2	23,024.3	23,024.3	11,512.1	276.07	0.001
Error	1,309	54,584.5	54,584.5	41.7		
Total	1,323	7,509.3				
Analysis of Variance for Plastron Length						
Species	3	32,300.6	28,659.8	9,553.3	336.00	0.001
Year	3	203.9	580.4	193.5	6.80	0.001
Gear types	3	356.7	352.5	117.5	4.13	0.006
Sex	2	12,752.4	12,752.4	6,376.2	224.26	0.001
Error	1,231	35,000.7	35,000.7	28.4		
Total	1,245	80,727.3				
Analysis of Variance for Plastron Width						
Species	3	13,291.8	9,106.1	3,035.4	122.85	0.001
Year	3	186.0	236.1	78.7	3.18	0.023 ns
Gear types	3	177.7	160.7	53.6	2.17	0.090 ns
Sex	2	12,531.4	12,531.4	6,265.7	253.59	0.001
Error	1,232	30,440.8	30,440.8	24.7		
Total	1,246	56,735.8				
Analysis of Variance for Weight						
Species	3	1,75,574	1,63,749	54,583	1,325.18	0.001
Year	3	201	639	213	5.17	0.002 ns
Gear types	3	97	277	92	2.24	0.082 ns
Sex	2	28,435	28,435	14,217	345.17	0.001
Error	1,265	52,104	52,104	41		
Total	1,279	2,56,726				

ns = Statistically not significant, Seq SS = Sequential sum of square, Adj SS = Adjusted sum of square, Adj MS = Adjusted mean square, F = Ratio, P = Probability, DF = Degree of freedom

et al. (1972) opined that the Pacific Ridley has a trend towards the demersal life and the individuals that drifted to the Japanese waters were subadults. Deraniyagala (1953) mentioned that the dimensions of subadult female from Mortuva, Sri Lanka, had carapace length of 49.0 cm, carapace width of 45.0 cm and plastron length of 40.0 cm. Hughes and Richard (1974) suggested that in South Africa most turtles caught in shark nets were subadults. Hillestad *et al.* (1982) stated that the turtles captured by trawlers in Georgia and South Carolina from 1978 to 1979, were subadults. In the present study, the size of the subadults ranged from 32.0-56.0 cm (mean = 50.2 ±8.3 cm) and the weight from 13-39 kg (mean = 28.4 ± 8.2 kg) and they formed a substantial portion of the incidental catches.

Martin *et al.* (2002) recorded that the average carapace length of the Green Turtle was 93.3 cm in Cuba. In India, Siraimeetan (1985) pointed out that the curved carapace length of Green Turtle males ranged from 33-81.5 cm and the most dominant size group was 65-75 cm; the female ranged between 41-80.5 cm and the majority of the turtles belonged to the size group 65-75 cm. The weight of the males ranged from 3.5-55 kg and the females from 6.5 to 51.5 kg. The modal weight of

Table 3: Regression equation models among the morphometric measurements and weight of the *Lepidochelys olivacea*

Variable	N	Regression equation	R^2 (%)	Model F	P
Carapace Length vs carapace width	1,216	Carapace width^2 = 1.68 + 0.91 Carapace length	91.0	12,319.6	<0.001
Plastron length vs plastron width	1,143	Plastron width = 2.43 + 0.89 Plastron length^2	83.5	5,780.18	<0.001
Carapace length vs weight	1,179	Weight = -98.50 + 4.08 Carapace length - 0.0289 Carapace length^2	89.6	5,046.01	<0.001
Carapace width vs weight	1,179	Weight = -65.84 + 3.15 Carapace width - 0.022 Carapace width^2	84.3	3,158.81	<0.001
Plastron length vs weight	1,134	Weight = -73.3 + 3.97494 Plastron length - 0.033 Plastron length	67.1	1,159.51	<0.001
Plastron width vs weight	1,139	Weight = -20.84 + 1.93 Plastron width - 0.0126 Plastron width^2	61.8	919.528	<0.001

Table 4: Regression equation models among the morphometric measurements and weight *of Chelonia mydas*

Variables	N	Regression equation	R^2 (%)	Model F	P
Carapace length vs carapace width	56	Carapace width = 7.08 + 0.752 Carapace length	84.3	289.90	<0.001
Plastron length vs plastron width	56	Plastron width = -3.6 + 0.907 Plastron length	95.2	1,071.38	<0.001
Carapace length vs weight	53	Weight = -33.7 + 1.20 Carapace length	93.2	702.91	<0.001
Carapace width vs weight	53	Weight = -85.28 + 3.14 Carapace width 0.014 Carapace width^2	84	131.598	<0.001
Plastron length vs weight	53	Weight = - 87.02 + 3.54 Plastron length - 0.018 Plastron^2 - 98.08	82.4	117.149	<0.001
Plastron width vs weight	53	Weight = -1.0 + 4.42 Plastron width - 0.03 Plastron width^2	80.2	101.528	<0.001

15.0-89.0 kg. Considerably larger Green Turtles were recorded in the present study.

Karbari (1981) reported that the Hawksbill Turtle which landed in Bombay (= Mumbai) had a carapace length 78.3 cm, width 61.3 cm, and weight of 80 kg. Ganapathy (1994) recorded a Hawksbill Turtle washed ashore near Thondi, Tamil Nadu in Palk Bay had a carapace length 45 cm. Bellini *et al.* (2000) observed that the Hawksbill in Sueste Bay in Brazil had a curved carapace length of 74 cm and carapace width of 65 cm. When compared to the previous studies it was noted that slightly smaller sized Hawksbills were recorded during the present observation.

Measurement of the Leatherback Turtle, which was washed ashore in the Gulf of Mannar coast, revealed that the carapace length was 162 cm, width 86 cm, plastron length 150, and width of 87 cm (Krishna and Kasinathan 1989). Hasbún and Vásquez (1999) stated that the average curved carapace length of Leatherback was 158 cm. Godley *et al.* (1998) speculated that the mean curved carapace length of Leatherback Turtle was 152 cm (range 120-210 cm). The sizes of the incidentally captured Leatherback were thought to be of adults or subadults (Boulon *et al.* 1996). When compared with earlier studies, the present study showed that the mean value of carapace length of Leatherback Turtle was 142 cm, which is similar to the study by Godley *et al.* (1998).

James *et al.* (1989) recorded that higher percentage of Olive Ridleys carcasses were in the size group of 61-65 cm carapace length during 1984 and 1993, and 66-70 cm during

Table 5: Regression equation models among the morphometric measurements and weight of *Eretmochelys imbricata*

Variables	N	Regression equation	R^2 (%)	Model F	P
Carapace length vs carapace width	43	Carapace width = 1.08 + 0.82 Carapace length	92.3	490.42	<0.001
Plastron length vs plastron width	43	Plastron width = 3. 28 + 0.80 Plastron length	86.9	272.58	<0.001
Carapace length vs weight	43	Weight = - 22.2 + 0.915 Carapace length	84.2	218.35	<0.001
Carapace width vs weight	43	Weight = - 47.80 + 2.50 Carapace width - 0.018 Carapace width^2	72.1	51.67	<0.001
Plastron length vs weight	43	Weight = - 72.32 + 4.27 Plastron length - 0.043 Plastron length^2	67.4	41.42	<0.001
Plastron width vs weight	43	Weight = - 67.86+4.39 Plastron width -0.0472 Plastron width^2	73.6	55.83	<0.001

Table 6: Regression equation models among the morphometric measurements and weight of *Dermochelys coriacea*

Variables	N	Regression equation	R^2 (%)	Model F	P
Carapace length vs carapace width	8	Carapace width = - 2.01 + 0.753 Carapace length	98.1	306.59	<0.001
Plastron length vs plastron width	4	Plastron width = 71.9 + 0. 38 Plastron Length	3.1	0.06	0.823
Carapace length vs weight	5	Weight = -116 + 2.42 Carapace length	97.8	132.67	<0.001
Carapace width vs weight	4	Weight = -109 + 3.22 Carapace width	98.8	171.01	<0.001
Plastron length vs weight	4	Weight = 205 + 0.300 Plastron length	14.8	0.35	0.615
Plastron width vs weight	4	Weight = 11.5 + 3.31 Plastron width	82.9	9.67	0.009