SECTION 4 – FISH BIOLOGY, TAXONOMY AND ECOLOGY

A STUDY ON THE GROWTH OF *Pseudotolithus elongatus*, *Chrysichthys nigrodigitatus* AND *Cynoglossus goreensis* OCCURRING IN THE CROSS RIVER ESTUARY

By

I. G. Nawa
Department of Fisheries Technology
University of Science and Technology
Port–Harcourt, River State
Nigeria

ABSTRACT

Samples of *Pseudotolithus elongatus*, *Chrysichthys nigrodigitatus* and *Cynoglosus goreensis* obtained from the Cross River Estuary (which is most probably the largest estuary water system along the coast of West Africa) between January 1980 and May 1981 were evaluated on basis of population dynamic analytical method postulated by Pauly (1980) for tropical fish stocks. The following growth parameters were obtained for the three fish species:–

P. elongatus: K = 0.28, L = 48.04cm, to = –0.04, L_{max} = 45.6cm

C. nigrodigitatus: K = 2.39, L = 68.38cm, to = –0.29, L_{max} = 82.0cm

C. goreenis: K = 0.097, L = 82.1cm, to = 0.01, L_{max} = 78.0cm

Wherever possible, these results were compared to those obtained by Longhurst (1964d) and LeGuen (1971) in other West African waters. On the whole, results obtained in this study tend to indicate that the growth of the croaker, bagrid catfish and the sole in the Cross River Estuary is allometric, the third and fourth year-classes of *P. elongatus* the second and third class-year of *C. nigrodigitatus* and the fourth, fifth and sixth year classes of *C. goreensis* dominated in the age distribution of these fish species.

INTRODUCTION

Growth studies on tropical fish species have so far proven difficult owing to problems associated with the age determination of these fish species. Studies carried out by Longhurst (1964d), Troadec *et al* (1966), Bayagbona (1969), Le–Guen (1971), Pauly (1979; 1980), and Nawa (1982) on various tropical fish species have definitely made useful contributions, but a better understanding of this important phenomenon demands increased research work in this field.

Growth is a very appropriate property for system analysis. A study of growth in fishes therefore, offers ecologist many opportunities to inquire into the dynamic balance and stages of change in aquatic ecosystems. Growth studies are important for the assessment of fish stocks (i.e. the biomass of standing stocks and predictions on the strength of future stocks) and they also create a basis for making suggestions for optimal exploitation, so as to avoid overfishing and its attendant problems.

Chrysichthys nigrodigitatus, *Cynoglossus goreensis* and *Pseudotolithus elongatus* form the bulk of the commercially important fishes in the Cross River Estuary. These three fish species constitute about 39.6% and 82.6% of the annual catches in the artisanal and trawl fishes of the estuary respectively (Nawa, 1982). This study was necessitated by the absence of growth data of these fish species in the Cross River water system.

MATERIALS AND METHODS

Samples for this study were collected from various parts of the Cross River estuary between January 1980 and May 1981. The Cross River estuary is most probably the largest estuary in West Africa and belongs to the drowned-river-mouth type of estuary (Nawa, 1982). It has a total area of about 580km2 and consists of several islands distributed over a large expanse of land most especially in the upper reaches of the esturay. The estuary, located in the rain forest belt of the south-eastern corner of Nigeria, lies between latitudes 4^0 30'N and 4^0 58'N, and 8^0 09'E and 8^0 30'E. A distinctive feature of the surrounding vegetation is the dominance of mangroves

(genera: *Avicennia* and *Rhizophora*). During the sampling period, both the artisanal and trawl fisheries were covered. The total length of individual specimens of these fish species was measured immediately during each sampling exercise, and the otoliths and scales were preserved for subsequent analysis in the laboratory. The surface temperature of each sampling area was also measured In the trawl fisheries, fish species investigated in this study were caught with the aid of a bottom trawl net with a mesh size of 60–70mm (stretched) in the cod end, while set gill nets with a mesh size ranging between 50–60mm (stretched) were used in the artisanal fisheries.

The length frequency distributions of *Chrysichthys nigrodigitatus* (bagrid catchfish), *Cynoglossus goreensis* (sole) and *Pseudotolithus elongatus* (croaker) covering a sampling period of one year were used for the computation of the age of these fish species. The method employed is a combination of the Ford-Walford Plot and a modified version of the Von Bertalianfy growth function (VBGH) developed by Paul (1980) specifically for tropical fish species

RESULTS

Otoliths and Scales

The scales of these fish species with a wide range of length distribution were obtained during the sampling period and examined under a high-power microscope. These were no clear boundaries on the annuli that would have facilitated the recognition of year-classes and thereupon confirm results obtained by other methods. An attempt made to relate the number of rings on the scales to the length of the fish proved futile. In all scales examined, the number of rings seemed to be distributed randomly in time. Furthermore, there was no indication of spawning marks on them. The use of fish scales for the separation of the age groups was, therefore, not given further consideration. Unlike temperature fishes, an examination of the otoliths of the fish species obtained from the Cross River Estuary for possible occurrence of annual growth rings did not yield favourable results. The use of daily growth rings in the determination of the age of fishes was given due consideration. The work of Panelia (1971) who worked on several tropical fish species, and that of Worthmann (1980) which dealt with the early growth stages of the pescada *(Plagioscion monti*, Soares) obtained from the Amazon Basin have shown that the daily growth rings could successfully be used in determining the age of tropical fishes. Otoliths of soles, sciaenids and catfish obtained from the Cross River estuary indicated that this is possible. The laboriously prepared otoliths of *Pseudotolithus elongatus, C. goreensis* and *Chrysichthys nigrodigitatus* showed daily-laid rings, some of which could not be separated from each other; an exact count proved difficult. Results obtained from this attempt are, therefore, not incorporated into this study. This aspect needs further investigation.

Length Frequency Analysis

Length frequency polygons, based on the relative abundance of *C. nigrodigitatus, C. goreensis* and *P. elongatus* obtained from the Cross River estuary, were plotted to examine the modal distribution.

The resultant wave-like mode of distribution was an indication of the presence of year-classes but these were blurred. In order to facilitate the separation of the year-classes, the relative values of abundance were "smoothed" according to the formula:–

$$a = \frac{2b + C}{n}$$

whereby,

a = Relative abundance of the preceeding length group,
b = Relative abundance of the length group being "smoothed",
c = Relative abundance of the succeeding length group,
n = The number of length groups (in this case n = 4).

Thereafter, the length frequency polygons gave more favourable modes of distribution (Figure 2a, b, c), with clearer boundaries between the various peaks. For further analysis, these peaks were assumed to represent the mean modal lengths of the various year-classes.

The evaluated growth parameters of the three main fish species occurring in the Cross River Estuary, *Pseudotolithus elongatus, Chrysichthys nigrodigitatus* and *Cynoglossus goreensis,* are depicited on Table 1 (a,b, and c).

The symbols used on the table represent the following:–

LT_m = Modal total length (cm) of each age group

G_L = Annual increment in length (cm)

X = Relative abundance of each age-group in the sample (5)

WT_m = Modal wet weight of each age-group (gm).

The asymtotic length (L_∞) and von Bertalanffy growth coefficient (K) were obtained with the aid of the For Walford plot. The evaluated data of both parameters was subsquently used to compute the length-at-birth (to) according to the empirical relationship postulated by Pauly (1980a):

$$\text{Log}_{10}(-t_0) = 0.3922 - 0.2752 \log_{10} L_\infty - 1.038 \log_{10} K.$$

On Table 1 (a,b,c) L_{max1} denotes the maximum length of each species obtained in the Cross River Estuary, while L_{max2} is the maximum length of each species calculated according to the forumal suggested by Taylor

$$L_{max} = L_\infty \quad .095.$$

The asymtotic length (L_∞) of *Pseudotolithus elongatus* is slightly higher, but compares favourably with results earlier obtained. In the Sierra Leone River Estuary, Longhurst (1964d) and Le Guen (1971) obtained an asymototic length of L_∞= 46.7cm for *P. elongatus* in the Congo River Estuary. The evaluated growth coefficient (K) for specimens from the Cross River Estuary was 0.28; this is good agreement with the result obtained by Le Guen (K = 0.274), but much longer than that of Longhurst (K = 0.61) in the afore-mentioned areas. The elngth-at-birth (to) recorded in the estuary is lower than tha' obtained by the above-mentioned workers, but lies closer to the value obtained by Le Guen (1971) in the Congo River Estuary. As shown on Table 1, it is evident that the second, third, and fourth age-groups with modal lengths ranging between 18cm and 32cm make up the bulk.

Table 1 – Evaluated growth parameters for *P. elongatus* (a); *C. nigrodigitatus* (b); and (c). *goreensis (c) in the Cross River Estuary*

Year Class		LT_m (cm)	X %)	G_L (cm)	WT_m (g)
(a)	I	13.5	3.4		21.0K = 0.28
	II	18.0	13.2	3.5	97.0 L_∞ = 48.04cm
	III	25.0	39.7	7.0	120.0 t_0 = 0.04cm
	IV	31.5	21.1	6.0	230.0 L_{max1} = 58.0cm
	V	36.0	8.3	4.5	340.0 L_{max2} = 45.6cm
	VI	39.0	7.8	3.0	440.0
(b)	0	9.0	4.7	6.0	50.0 K = 2.39
	I	15.0	5.5		91.0 L_∞ = 68.38cm
	II	20.0	16.8	5.0	128.0 t_0 = –0.293
	III	25.0	35.5	5.0	150.0 L_{max1} = 90.0cm
	IV	33.0	10.5	8.0	220.0 L_{max2} = 82.1cm
	V	36.0	14.8	3.4	300.0
	VI	40.0	12.0	4.0	346.0
(c)	I	17.0	5.0		85.0 K = 0.097
	II	22.0	12.4	5.0	96.0 L_∞ = 82.1cm
	III	27.0	7.1	5.0	115.0 t_0 = –0.01
	IV	34.0	20.7	7.0	163.0 L_{max1} = 88.0cm
	V	37.0	17.7	3.0	270.0 L_{max2} = 78.0cm
	VI	42.0	22.4	5.0	310.0
	VII	45.0	13.6	3.0	340

18cm and 32cm make the bulk of *P. elongatus* caught in the Cross River Estuary. The maximum length sampled (L_{max1}) was higher than that evaluated (L_{max2}) according to the method suggested by Taylor (1962). Growth parameters obtained for *Chrysichthys nigrodigitatus* are shown in Table 1 (b). An asymtotic size of L_∞ = 86.38cm and a growth coefficient of K = 2.39 was evaluated for this fish species. The size during the first birthday t) was in the magnitude of –0.293. A maximum length of 90.0cm was recorded in the catch, but L_{max2} (82.1), was much lower. It seems most probable that a year-class, which would otherwise lie between the third and fourth year-classes, was not sampled because the length increment between both year-classes is considered to be abnormally high, as contrasted with the others, modal lengths of 20cm and 25cm respectively, were the dominant age-groups obtained (Table 1b). The various modal length-at-age for this fish species are shown in Figure 2 (b). The tongue sole, *Cynoglossu goreensis* had an asymtotic length of 82.1cm and a growth coefficient of K = 0.097 Table 1, c). The evaluated size-at-birth (t_0) was –0.01. The maximum size recorded in the estuary during the sampling period (L_{max1}) was 88.0cm and much higher than L_{max2} (78.0cm). A relatively high length increament was also recorded between the third and fourth year-classes. The most abundant year-classes were the IV–VI age groups whose modal lengths ranged between 34–42cm. Figure 3 (c) depicts the modal length-at-age of the various age-groups sampled.

DISCUSSION

The slight differences between the asymtotic size (L_∞) and the growth coefficient (K) of *Pseudotolithus elongatus* in the Cross River estuary and those obtained by Longhurst (1964d) and Le Guen (1971 in the Sierra Leone River and Congo River Estuaries, respectively, are not unexpected and may result from differing environmental conditions (though of a low magniture) in these water systems Unfortunately, corresponding growth parameters from the Cross River Estuary or similar water systems are not available for a comparative analysis of results obtained for *Chrysichthys nigrodigitatus* and *Cynoglossus gorennsis.* The significant differences recorded between L_∞ and Lmax2 for the three fish species are most probably related to the fact that several large specimens were included in the samples analysed. A scrutiny of the evaluated length frequency data and the conclusions derived from the work done on some otoliths reveals that the growth of the three fish species is allometric.

A limitation of this study is related to the fact that the fish samples collected over a period of one year were combined together for the final computation of data. Consequently, the assessment of the growth of the various year-classes in time (i.e. time intervals of less than one year) is not considered here. However, this limitation is partially offset by the fact that most tropical fish species have a comparatively slow rate of growth; small time unit intervals may therefore, yield insignificant size increament. From the modal length-at-age distribution, it would seem that *Chrysichthys nigrodigitatus* enters the fisheries in the Cross River Estuary much earlier than *Pseudotolithus elongatus* and *Cynoglossus goreensis.* The empirical observations made during this study tend to infer that the growth of the last two species is slower than that of the bagrid catfish. This may explain the delayed period of recruitment of *P elongatus* and *C. goreensis.*

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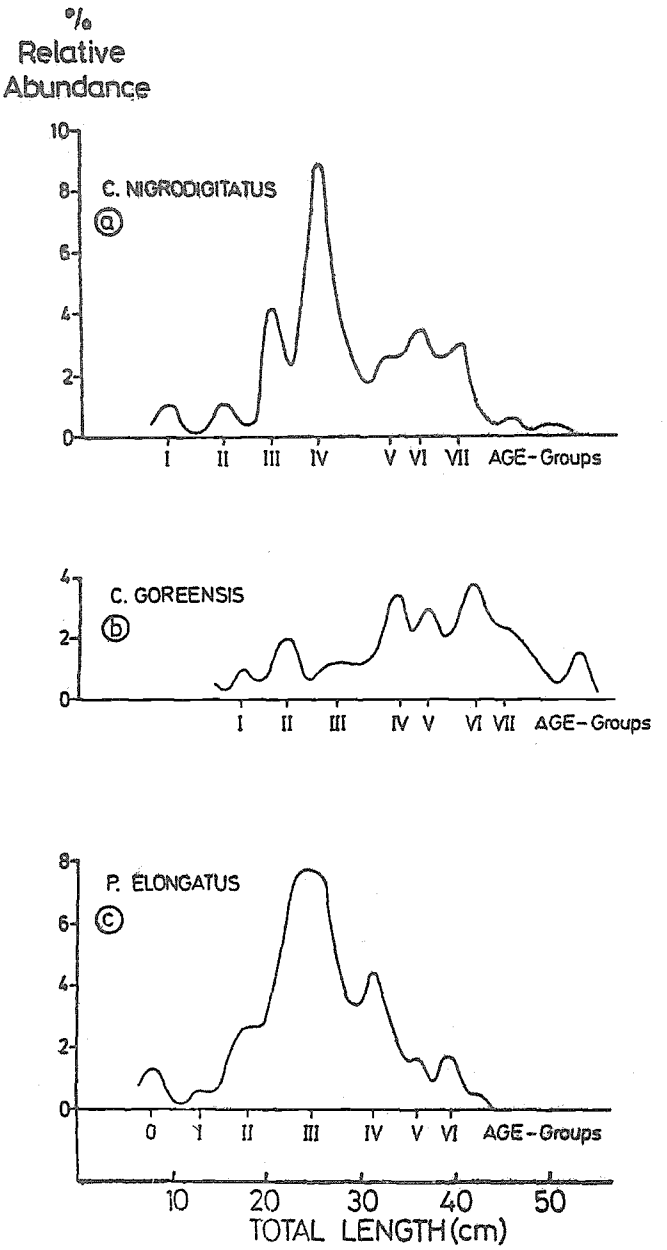

Fig. 1 a, b, c,: Growth curves of C. nigrodigitatus C. goreensis and P. elongatus showing mean modal lengths of the age-groups.

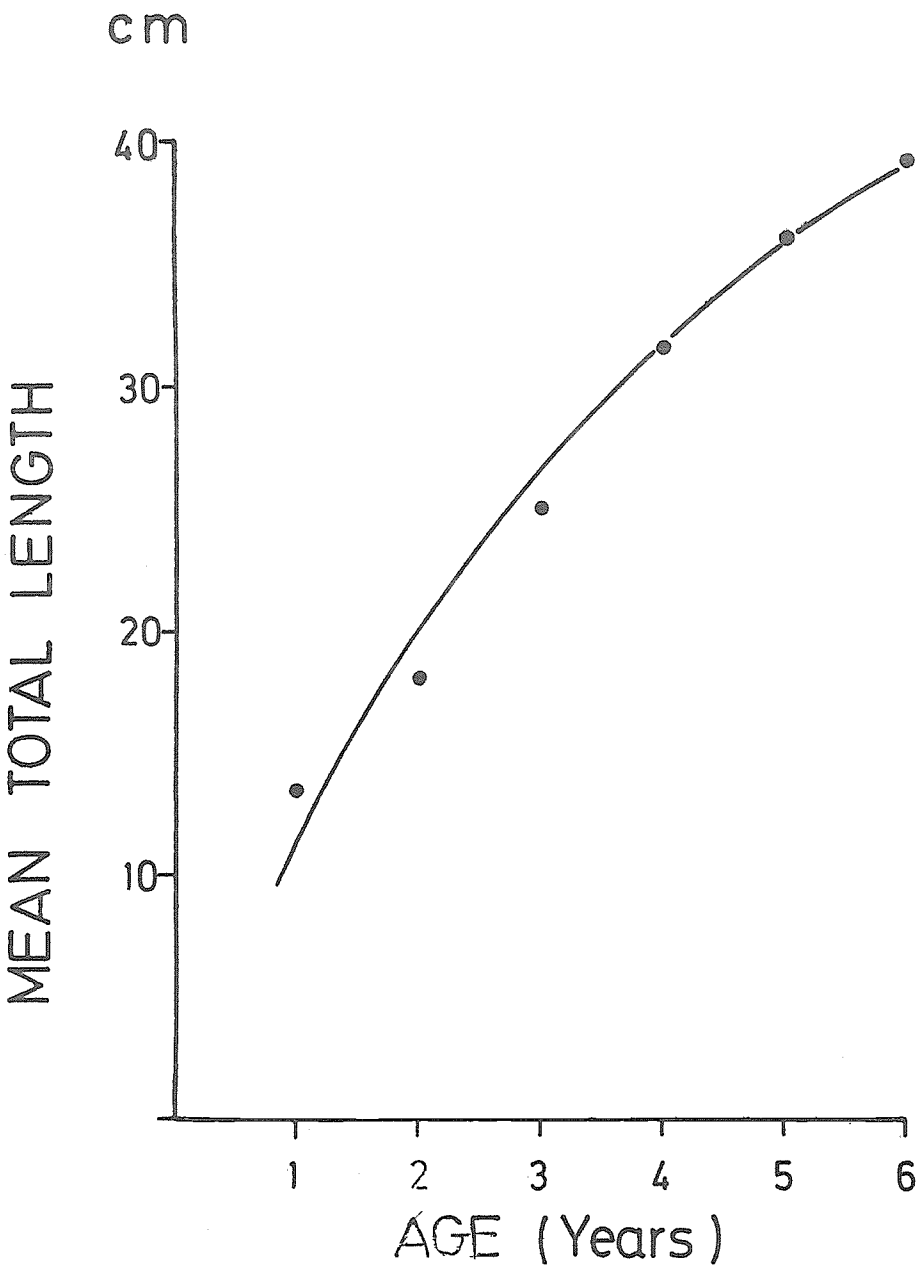

Figure 2 : Growth Curve of P. elongatus showing Mean Modal Lengths of the Age-groups.

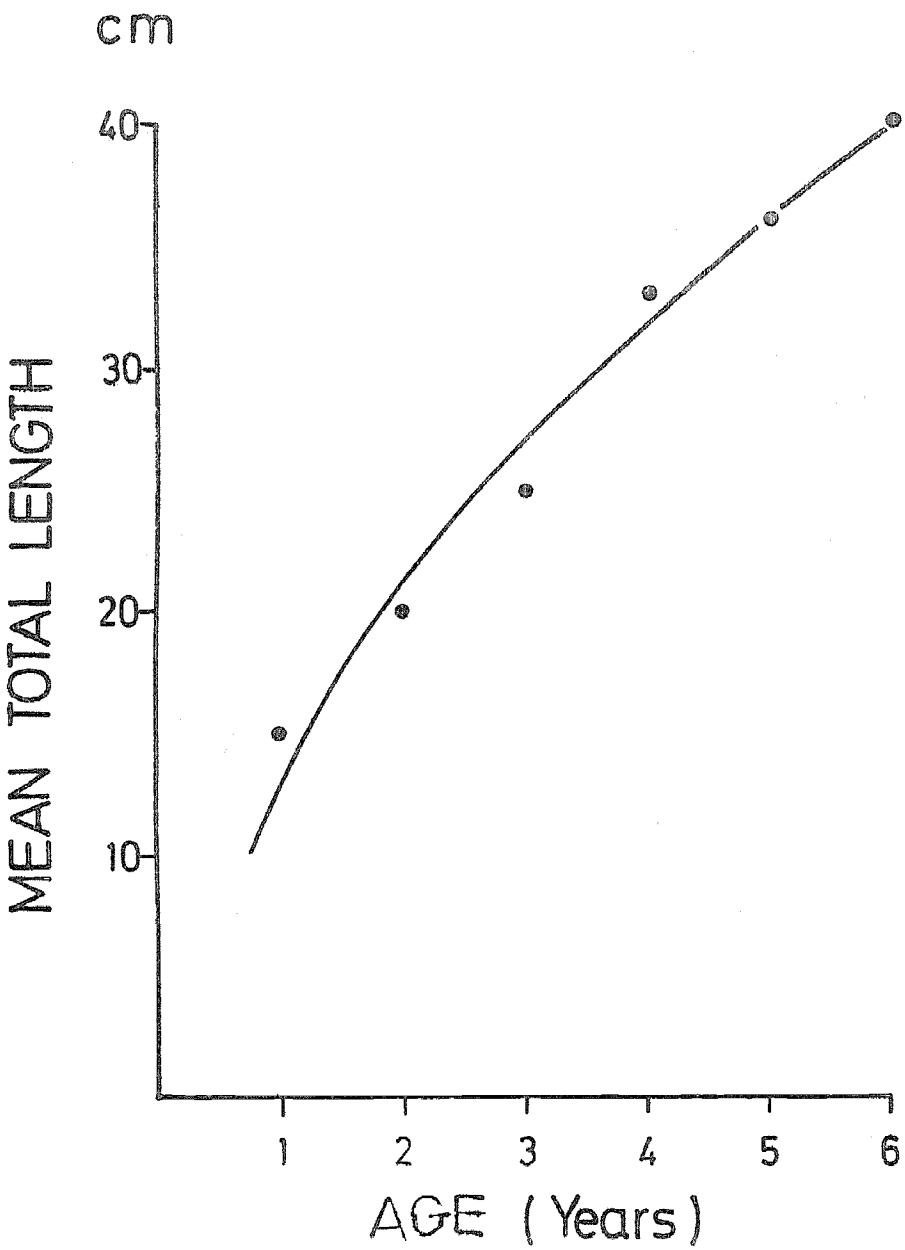

Figure 3 : Growth Curve of C. nigrodigitatus showing Mean Modal Lengths of the Age-groups.

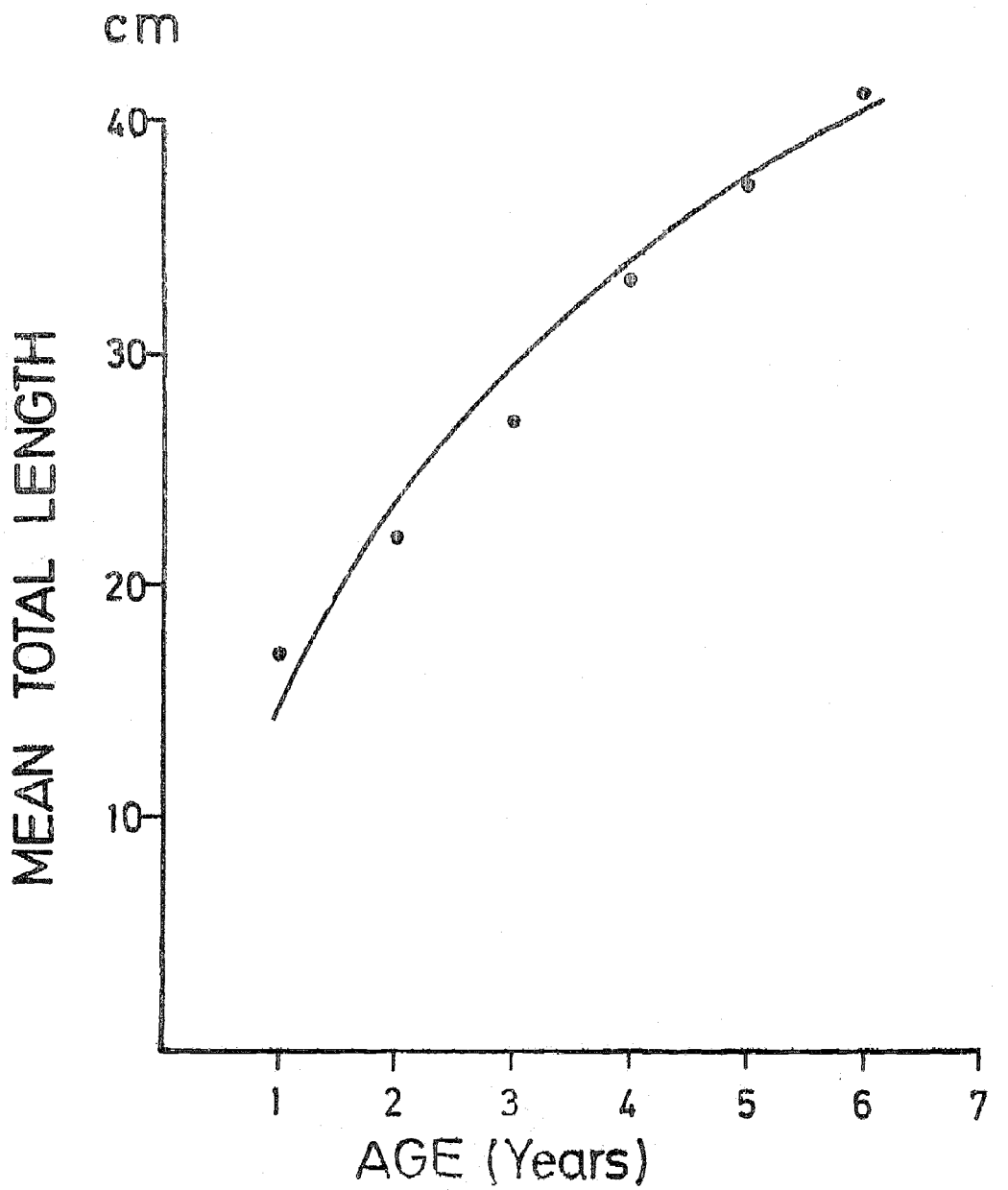

Figure 4 8 Growth Curve of Co. sureensis showing Mean Modal Lengths of the Age-groups.