

**LENGTH-FREQUENCY OF *PRIONACE GLAUCA* L. 1758 CAUGHT BY SANTOS LONGLINERS
OFF SOUTH AND SOUTHEAST OF BRAZIL (1971-88)¹**

de Amorim, A.F.², F.M.S. Braga³, C.A. Arfelli²

SUMMARY

In the south and southeast of Brazil, longliners based at Santos, Sao Paulo State, caught blue shark all year round. This important fishing resource, representing about 30% of the total Santos longliners catch, was the second most important species in the 1988 catch and the first most important from 1983 to 1993. The relationships between total length/dressed weight ($Wd = 2.81 \times 10^{-5} Lt^{2.52}$) and total length/pectoral-caudal length ($Lp = 0.45 Lt^{1.03}$). The individual dressed weight from commercial sheets was converted to length and utilized for the length-frequencies. In the annual length-frequency distribution of the 1971-1973 period, three peaks were observed: the major one between 265 and 285 cm, the second from 240 to 250 cm, and the third ranging from 220 to 230 cm. For the next period (1974-1988), three peaks very similar to the previous ones were also observed: the major from 220 to 230 cm, and the following between 240 to 250 cm and 255 to 275 cm. The above-mentioned distributions presented a homogeneous pattern for the whole period studied, due not only to the hook selectivity but also to the species own characteristics. The monthly length-frequency distribution for the 1983-1986 period was established, and it was observed that from September to February (mainly from November to January) a new year-class was recruited. These distributions were probably influenced by sex ratio. In the second and third quarters they were mainly comprised of males, from November to February the sex ratio was in equal proportion, and from March to April there were almost only females. The decrease in the average length of blue shark in the second period studied was probably due to the fact that the fishermen gradually stopped rejecting blue shark as by-catch after 1974, commercializing all blue sharks caught, including the small fish, and directing the fishery to blue shark part of the time.

RÉSUMÉ

Les palangriers basés à Santos (Etat de Sao Paulo) capturent des requins bleus toute l'année au large des côtes Sud et Sud-Est du Brésil. Cette importante ressource de pêche, qui représente environ 30% des captures totales des palangriers basés à Santos, était la seconde espèce la plus capturée en 1988, et la première entre 1983 et 1993. Le rapport longueur totale (Lt) / poids manipulé (Wd) a été calculé comme suit : $Wd = 2,81 \times 10^{-5} Lt^{2.52}$, et le rapport longueur totale (Lt)/longueur nageoire pectorale-fourche caudale (Lp) a été calculé comme suit : $Lp = 0,45 Lt^{1.03}$. Le poids individuel manipulé, tel qu'il est consigné sur les bordereaux commerciaux, a été converti en longueur et utilisé pour le calcul des fréquences-longueur. Dans la distribution annuelle des fréquences-longueur de la période 1971-1993, trois pics ont été observés: 265-285 cm, 240-250 cm et 220-230 cm. Entre 1974 et 1988, les trois pics étaient très semblables aux précédents : 255-275 cm, 240-250 cm et 220-230 cm. Les distributions mentionnées ci-dessus présentent un mode homogène pour l'ensemble de la période étudiée, en raison non seulement de la sélectivité des hameçons mais également des caractéristiques propres aux espèces. La distribution mensuelle fréquence-longueur a été définie pour la période 1983-1986 et on a observé qu'entre septembre et février (et plus particulièrement entre novembre et janvier), une nouvelle classe annuelle avait été recrutée. Ces distributions ont été probablement influencées par le sex-ratio. Au cours des deuxième et troisième trimestres, les captures sont composées en majorité de mâles ; entre novembre et février, le sex-ratio est équilibré ; et entre mars et avril, on observe une majorité de femelles. La diminution de la longueur moyenne du requin bleu au cours de la période étudiée est probablement due au fait que les pêcheurs ont progressivement cessé, à partir de 1974, de rejeter les requins bleus capturés accessoirement, puis se sont mis à commercialiser tous les requins bleus capturés, y compris les individus de petite taille et, dans certains cas, à viser cette espèce directement.

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² Instituto de Pesca. Av Bartolomeu de Gusmão, 192 Santos-SP, 11030-906 Brazil.

³ UNESP, Depto. de Zoologia. C.P. 199, Rio Claro-SP, 13506-900 Brazil.

RESUMEN

En el sur y sudeste de Brasil, los palangreros con base en Santos, Estado de Sao Paulo, capturaron tintorera durante todo el año. Este importante recurso, que representa aproximadamente el 30% de la captura total de los palangreros de Santos, fue la segunda especie en importancia en 1988 y la primera en el período 1983-93. Se obtuvieron las relaciones longitud total/peso eviscerado: $Wd=2.81 \times 10^{-5} Lt^{2.52}$, y longitud total/longitud pectoral-caudal: $Lp=0.45 Lt^{1.03}$. El peso eviscerado individual obtenido en los registros comerciales se convirtió a talla y se utilizó para las frecuencias de tallas. En la distribución anual longitud-frecuencia del período 1971-73 se observaron tres picos: el mas alto entre 265 y 285 cm, el segundo entre 240 y 250 cm, y el tercero entre 220 y 230 cm. En el siguiente período, 1974-88, se observaron también tres picos muy similares a los anteriores: el principal de 220 a 230 cm y los siguientes entre 240 y 250 cm y 255 y 275 cm. Las distribuciones antes mencionadas presentaban un esquema homogéneo en todo el período estudiado, debido no sólo a la selectividad del anzuelo sino también a las características de la especie en sí. Se estableció la distribución mensual de frecuencias de talla para el período 1983-86 y se observó que entre septiembre y febrero (sobre todo de noviembre a enero), se había reclutado una nueva clase anual. Estas distribuciones estaban probablemente influenciadas por la sex ratio. En el segundo y tercer trimestres se componían sobre todo de machos, desde noviembre hasta febrero la sex ratio estaba en igual proporción y de marzo a abril eran casi todas hembras. La disminución en la talla media de la tintorera en el período estudiado se debía probablemente al hecho que los pescadores a partir de 1974 dejaron gradualmente de desecharla como captura fortuita, comercializando todos los individuos capturados, incluyendo los pequeños, y dirigiendo la pesquería a esta especie durante parte del tiempo.

INTRODUCTION

Longliners settled in Santos city, São Paulo state caught blue shark all year round in the South and Southeast of Brazil. This important fishing resource, represented about 30% (1977 to 1994) of Santos longliners catch. It was the second most caught species in 1988 and 1994, and the first from 1983 to 1993.

In Santos, a Japanese leased tuna boats company started fishing in 1958, operating until 1961 (LIMA & WISE, 1963). A Brazilian tuna fishery began in 1965/1966 operating with 2 boats. This fleet gradually increased: from 1971 to 1975 there were 3 boats (AMORIM, 1976) increasing to 8 in 1984, decreasing to 6 from 1985-1987 (ARFELLI & AMORIM, 1988) and increasing again to 9 in 1988. In this period these longliners operated in the area 20° - 33° S and 39° - 50° W.

In this paper the annual and monthly length-frequency and the average length were studied from 1971 to 1988.

MATERIAL AND METHODS

The data and biological material analyzed in this paper were obtained from fishing companies settled in Santos, as following: Imaipesca Ind. Com. Pescados Ltda., Irmãos Ono, Akama Com. Pescados Ltda. and Kawai-Suisan Com. Ind. Pescados Ltda., Cooperativa Mista de Pesca Nipo-Brasileira. Some samples were taken from research trips on board of Santos longliners, and others were obtained in the Fishing Terminal (TPS) in Santos-São Paulo.

For obtaining the total length it was used the method proposed by SADOWSKY (1968) as follow: distance from the tip of the snout to the origin of caudal fin (Loc), plus the distance from it to the upper caudal lobe (La) (Figure 1A). The dressed weight is obtained from the carcass (without head, gill, gut and fins - Figure 1B), as the fish is commercialized, was obtained at the TPS in a scale with 1 kg of approximation.

In order to convert the individual weights into length, it was made a total length-dressed weight relationship, from 110 specimens analyzed from September 1988 to June 1991 (95 males and 15 females). They were individually computed, utilizing the following expression:

$$Wd = a \cdot Lt^b$$

where: Wd = dressed weight, in kilograms

Lt = total length in centimeters

a and b = constants

The constants **a** and **b** were estimated by least squares method, from logarithmic transformation.

Aiming to establish the relationship between pectoral-caudal length (L_p) and total length (L_t), data of 234 specimens were taken during research trips on tuna boats, from September 1988 to June 1991. This relationship gives the possibility to obtain the total length, when the dressed weight is not available, but only the pectoral-caudal length collected at TPS. They were individually computed, utilizing the following expression:

$$L_p = a \cdot L_t^b$$

where: L_p = pectoral-caudal length, in centimeters

L_t = total length in centimeters

a and **b** = constants

The constants **a** and **b** were estimated by least squares method, from logarithmic transformation.

The data of 113,761 specimens of blue shark from 1971-88 were used, for the length-frequency of total length. The individual dressed weight was converted to total length through the mentioned relationship and gathered in classes. The length-frequency is presented by year from 1980 to 1982, and grouped for 1980-82 and 1971-88 periods. It was also made the monthly length-frequency of the most representative years (1983-86), in order to observe the year class of recruitment.

RESULTS AND DISCUSSION

The following expressions were established:

- total length/dressed weight (Figure 2)

$$W_d = 2.81 \times 10^{-5} L_t^{2.52}$$

$N = 110$

as a result of the logarithmic transformation

$$\ln W_d = -10.48 + 2.52 \ln L_t$$

$$r^2 = 0.686$$

The total length and dressed weight ranged from 203 to 302 cm and 11 to 60 kg.

- total length/pectoral-caudal length (Figure 3)

$$L_p = 0.45 L_t^{1.03}$$

$N = 234$

as a result of the logarithmic transformation

$$\ln L_p = -0.7985 + 1.03 \ln L_t$$

$$r^2 = 0.939$$

The pectoral-caudal length and total length ranged from 41.7 to 168 cm and 80.5 to 302 cm.

From 1971-82 the annual average dressed weight showed a decreasing trend from 55 kg in 1971 to 33 kg in 1982 coming to a stability in the following period, reaching an average weight of 30 kg (Figure 4A). The reduction of the annual average length in 20 cm was also observed, changing from 267 to 247 cm (Figure 4B).

The annual length-frequency for the whole period showed an homogeneous pattern (Figures 5A, B and C). It probably was not only due to the hook selectivity.

Figure 5C shows the grouped frequency from 1971-88 and the influence of the hook selectivity, catching fish mainly among the 200-300 cm classes. It is concluded that the decline of the average weight and total length of blue shark was because in the beginning of the period the smallest specimens used to be discarded, and gradually from 1975 to 1977, they started to be brought on board and landed. It happened because the price of shark on the market has raised.

In the traditional fishing area the sex ratio ranged a lot during the analyzed period. In the first quarter (mating season) it was 1:1; in the second 4.2:1; in the third 4.9:1; and in the fourth 1.8:1, showing sexual segregation of the species. This behavior was related to the reproduction patterns. After mating season males and females were found at the same region but at different areas. In March of 1992, two boats fishing in the same region at different areas, caught groups of fish comprised by just males or females in each area. In March and April there were almost only females. It confirms the blue shark sexual segregation, as previously mentioned by STRASSBURG (1958) and GUBANOV & GRIGORÝEV (1975).

Analyzing the monthly length-frequency from 1983-86 (Figures 6 and 7), it is observed that a new year class was recruited from September to February mainly from November to January.

Comparing Figures 6 and 7 that analyses monthly length-frequency it is observed the existence of cohorts, that are not different when the samples are analyzed in the whole year or period. Considering blue shark length structure, as a viviparous fish, with restrict fecundity and high longevity, it presents similar patterns among the years. The swordfish (*Xiphias gladius*) a bone fish caught by the same selective longline presents less similarity in the length structure among the years (AMORIM & ARFELLI, 1984). As observed in blue shark, COSTA (1994) found a similar annual length pattern for short mako shark (*Isurus oxyrinchus*). Probably not only the hook selectivity can influence the length-frequency pattern, but also the own characteristics of the species, related to reproduction and recruitment.

CONCLUSIONS

Blue shark was the great responsible for the increase of the shark yield in 1977-88. The catches range mainly from fish of 200 to 300 cm, presenting three peaks, the highest of 240-250 cm class, and the second between the 255 to 275 cm class the third peak was in the 220-230 cm class. The annual length-frequency for the whole period presented an homogeneous pattern due to not only the hook selectivity but also the own characteristics of the elasmobranch species. The monthly distributions are probably also influenced by sex ratio and reproduction of the species. In the second and third quarters, these distributions are mainly comprised by males, from November to January of the same proportion of male and female, and from March to April of almost only females. Nevertheless, this sex ratio is related to the catches in traditional areas, and different values can be observed in other fishing areas. The decline on the average length from 1975-88 is due to factors like changes in the target species, commercialization of all the blue shark caught, including small specimens and increase of shark catch.

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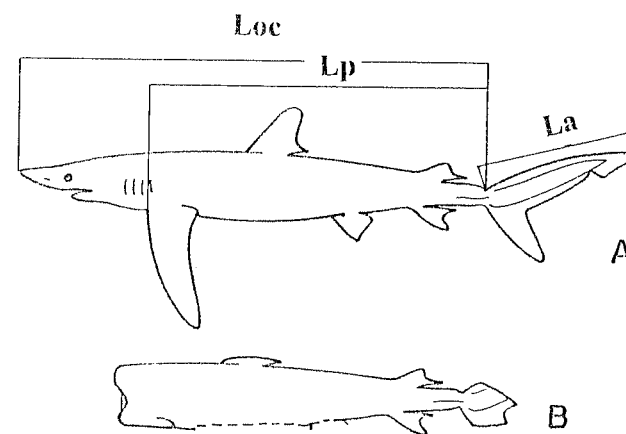


Figure 1. Blue shark: A) Total length (Lt) = Loc (distance from the tip of snout to the origin of caudal fin) plus La (upper caudal lobe length), and pectoral-caudal length (Lp); and B) carcass (without head, gill, gut and fins).

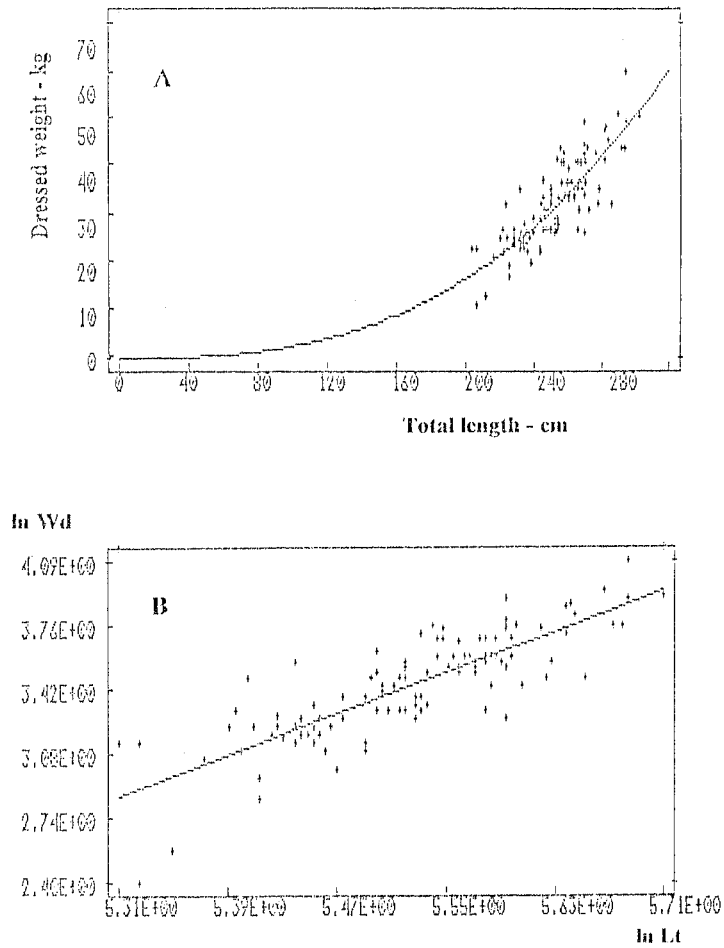


Figure 2. Blue shark: A) Total length (Lt)-dressed weight (Wd) relationship; and B) Logarithmic transformation.

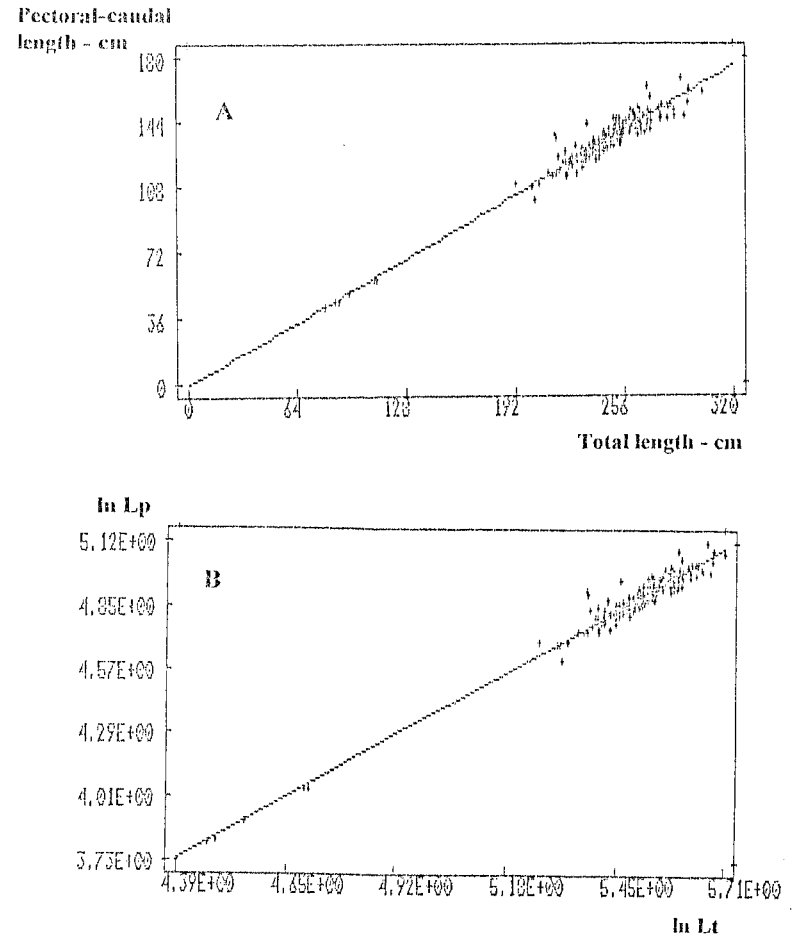


Figure 3. Blue shark: A) Total length (Lt)/pectoral-caudal length (Lp) relationship; and B) Logarithmic transformation.

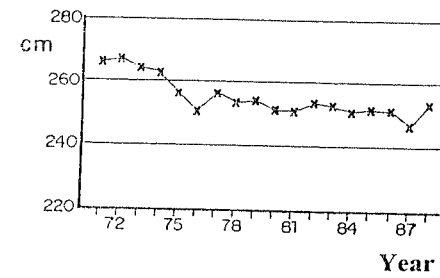


Figure 4. Annual length composition of blue shark (1971-88):

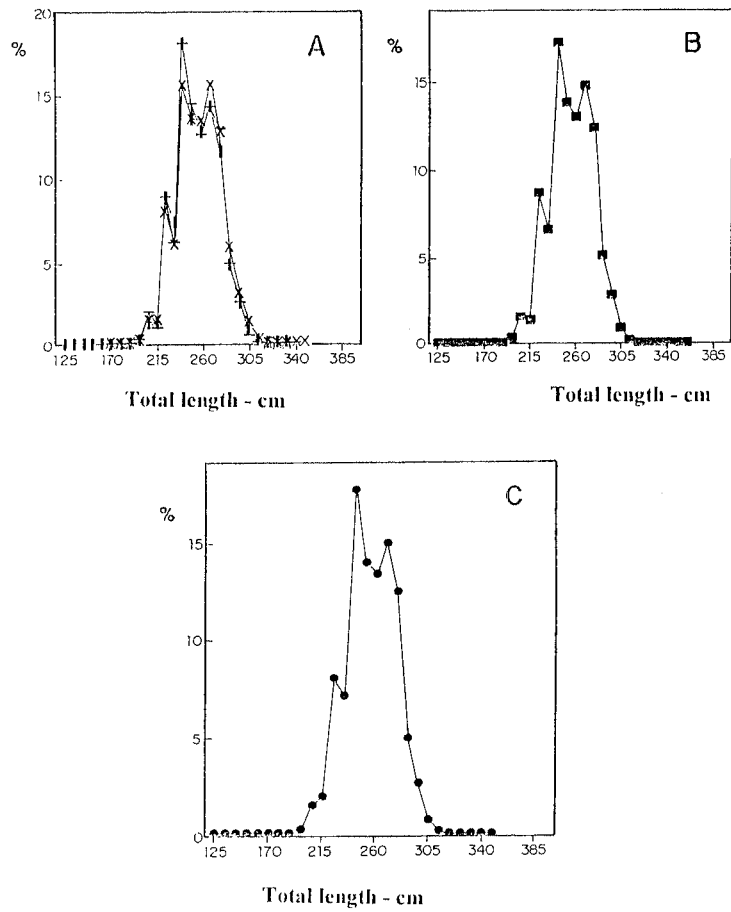


Figure 5. Annual length frequency of blue shark from Santos longliners: A) 1980, 1981 and 1982; B) 1980-1982; and C) 1971-1988.

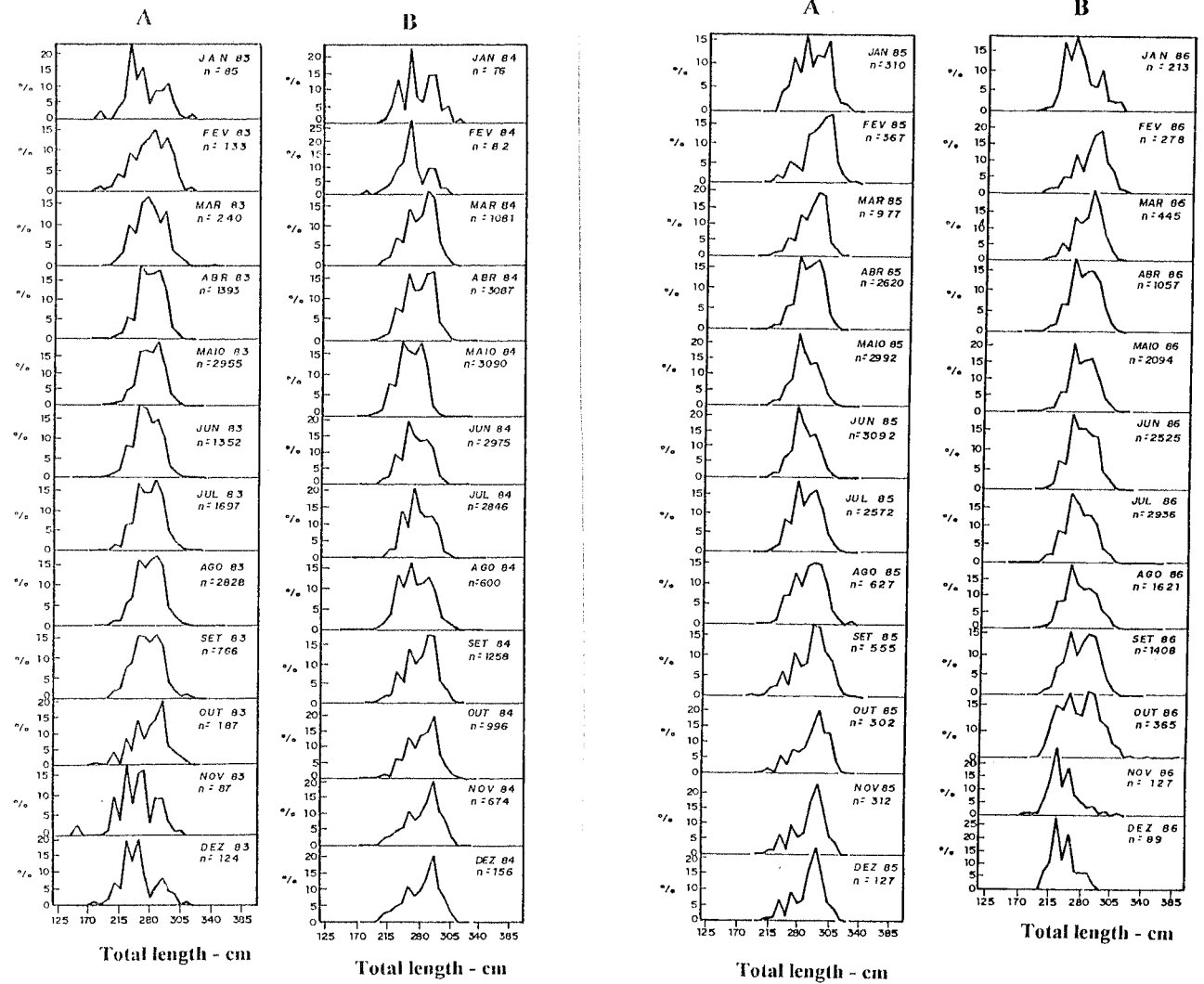


Figure 6. Monthly length frequency of blue shark from Santos longliners: A) 1985; and B) 1986.

Figure 7. Monthly length frequency of blue shark from Santos longliners: A) 1987; and B) 1988.