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# New biological data on the shrimp, *Pandalus borealis*, in the Baffin Island waters (ICNAF Statistical Area 0)

by

J.P. Minet, A. Forest and J.B. Perodou

Institut Scientifique et Technique
des pêches maritimes
St-Pierre et Miquelon

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## I - Introduction.

From a research groundfish survey carried out on board the R/V "Cryos" from 16 September to 23 October 1977 on the Baffin Island shelf (ICNAF Statistical Area 0) numerous data were collected on the northern deepwater prawn Pandalus borealis KRØYER, 1838. Results on distribution and abundance, minimum biomass estimate, bycatches, compositions in length and ages and biometrical relationships are presented in this note.

## II - Material and methods.

The material used in this paper was collected during a stratified groundfish survey using a stratification scheme (Fig. 1) set up on the Canadian chart No. 7011 with 27 strata as follows :

| Depth range (fm) | Stratum No. | Number of sets | Area (sq. nautical) miles | Total area |
|---|---|---|---|---|
| <100 | 011 | 1 | 630 | 630 |
| 100-150 | 01 | 2 | 536 | 6314 |
| | 02 | 1 | 1282 | |
| | 012 | 4 | 1914 | |
| | 013 | 2 | 1390 | |
| | 019 | 2 | 1192 | |
| 150-200 | 03 | 3 | 1136 | 7728 |
| | 07 | 1 | 1336 | |
| | 08 | 4 | 1666 | |
| | 09 | 3 | 1524 | |
| | 014 | 2 | 560 | |
| | 020 | 2 | 1114 | |
| | 025 | 0 | 392 | |
| 200-300 | 04 | 2 | 742 | 7648 |
| | 06 | 3 | 1252 | |
| | 010 | 2 | 660 | |
| | 015 | 2 | 824 | |
| | 021 | 5 | 2270 | |
| | 026 | 3 | 1900 | |
| 300-500 | 05 | 2 | 450 | 5930 |
| | 016 | 3 | 1106 | |
| | 017 | 3 | 1208 | |
| | 022 | 2 | 818 | |
| | 027 | 5 | 2348 | |
| 500-700 | 018 | 2 | 1430 | 2054 |
| | 023 | 3 | 624 | |
| 700-900 | 024 | 0 | 1712 | 1712 |
| TOTAL | 27 strata | 64 | 32016 | 32016 |

Strata 024 and 025 were not sampled during this survey respectively due to depth and to rough bottom.

The standard gear used was a Lofoten research bottom trawl with following specifications : 31.20 m headline, 17.70 m footrope, with 140 mm mesh in the wings and body and 50 mm mesh in the codend. A total of 64 stations were occupied with this trawl.

On shrimp concentrations, three sets were made with a research shrimp trawl with following specifications : 33.10 m headline, 37.80 m footrope with 30 mm mesh in the wings and body and 25 mm mesh in the codend.

Each tow was of 30 minutes duration.

The estimate of the shrimp minimum trawlable biomass in the strata where the species was caught in significant quantities, was calculated using the swept area method. So, the minimum biomass (B) is given by :

$$B = \sum B_h = \sum \bar{Y}_h \cdot \frac{N_h}{b}$$

where : $B_h$ = minimum biomass in the stratum h

$\bar{Y}_h$ = mean yield in the stratum h

$N_h$ = surface of the stratum h

b = mean area swept per tow = 0.15 square nautical mile.

The variance of this estimate is given by :

$$S_B^2 = \sum \frac{N_h^2 \cdot S_h^2}{b^2 \cdot n_h}$$

where : $S_h$ = variance of $B_h$

$n_h$ = number of tows in the stratum h

The measurements of shrimp (total catches or random samples) were made to the nearest millimeter on berried and non-berried specimens separately, using the carapace length from the eye lobe to the dorsal posterior edge. The length frequencies obtained at each set with the groundfish bottom trawl were grouped per stratum. Those obtained at the 3 sets using the research shrimp trawl were also grouped together.

These frequencies were then examined following the CASSIE (1954) method in order to separate the different length groups. Once these groups isolated, an attempt was made to distinguish the age groups present in the catches.

The total and carapace length (Lt/Lc) relationship was obtained from 956 specimens measured to the nearest millimeter. The length (Lc)-total weight relationship was calculated on 245 couples of data (nearest millimeter and weight to the hundredth of a gram).

III - Results.

1) Distribution and abundance.

Data on shrimp catches with both trawls are included in Table 1. Shrimp was present in the groundfish bottom trawl at 25 sets

occupied in 12 strata, from 243 to 519 m depth, where bottom temperatures were ranging from 0.5 to 3.0° C and sediment consisted mainly on rough sand and pebble. However, the largest catches were obtained in stratum 03 (3 yields at respectively 23, 10 and 5 kg/half-hour), in stratum 06 (2 yields at 10 and 1 kg/half-hour), in stratum 08 (4 yields at 29, 27, 7 and 5 kg/half-hour) and in stratum 09 (the largest yield at 6 kg/half-hour).

That means that the largest yields were obtained between 300 and 420 m depth (167 to 233 fathoms). This results also show (Fig. 2) that at the same range of depth, shrimp was absent or very scarce in the southern part of Statistical Area 0, the best catches being obtained in the northern strata between 64°10 N and 65°40 N. However, it was impossible to explore the same range of depth in the extreme northern part of the Area (and especially in stratum 03) because of the compact icefield preventing from all trawling activities.

In the strata of large shrimp concentrations (strata 03 and 08), three sets made using the research shrimp trawl bring yields of respectively 27, 49 and 81 kg/half-hour, at depth ranging from 296 to 310 m (164-172 fathoms) and bottom temperatures from 0.6 to 0.8° C.

2) Estimate of the minimum trawlable biomass.

In the four strata where shrimp was caught in significant quantities, the estimates of minimum biomass were as follow :

| Stratum No. | Surface (sq. nautical) miles | $n_h$ | $B_h$ (metric) tons | $S_{Bh}$ (metric) tons |
|---|---|---|---|---|
| 03 | 1136 | 3 | 1117 | 338 |
| 06 | 1252 | 3 | 315 | 273 |
| 08 | 1666 | 4 | 1943 | 729 |
| 09 | 1524 | 3 | 220 | 204 |
| Total | 5578 | 13 | 3594 | 873 |

From these results, the minimum biomass of shrimp in the four strata considered can be estimated close to 4,000 metric tons. Using the mean value of yields obtained in strata 03 and 08 with the research shrimp trawl, this minimum biomass becomes close to 10,000 metric tons in these two strata only.

3) Composition of bycatches.

The bycatches of commercial fishes taken with shrimp in the groundfish bottom trawl and in the research shrimp trawl are indicated in Table 2. Among the 12 species caught with shrimp, greenland halibut (Reinhardtius hippoglossoides) and redfish (Sebastes marinus mentella) constitute the main bycatches. The mean largest bycatch is 44 kg for 141 specimens of greenland halibut per half-hour in stratum 06, and 16 kg for 211 specimens of redfish per half-hour in stratum 013.

The composition in length of the bycatches of greenland halibut with the two types of gears is shown in Fig. 3. The modal length (about 22 cm Lt) is very similar in both cases with however larger specimens caught with the groundfish bottom trawl (up to 85 cm Lt). The compositions in length of the bycatches of redfish (Fig. 4) are very different with the two gears. In the research shrimp trawl, only small specimens are taken (from 7 to 15 cm Lt with a modal length at 9 cm Lt) while larger specimens are caught in the groundfish bottom trawl (from 6 to 30 cm Lt with a main modal length at 14 cm Lt).

4) Length distributions.

The length frequencies of shrimp obtained from catches with groundfish bottom trawl and research shrimp trawl are respectively given in Figures 5 and 6. It appears that the two length distributions are very similar : a first mode around 12 mm Lc in the bottom trawl (absent in the shrimp trawl), a second mode at 18 mm Lc, a third mode at 23 mm Lc and the last one at 30 mm Lc. However, the proportion of ovigerous females obtained with the two gears are different : 37 % of the total in the bottom trawl and only 17 % in the shrimp trawl.

When examining the length distributions obtained with the groundfish bottom trawl in the four strata (03, 06, 08 and 09) where shrimp was concentrated (Fig. 7), the same 4 modes can be distinguished but their relative importance varies in each distribution. Using the CASSIE's method, the percentage of each length-group in each stratum is as follows :

| modal length (mm Lc) | st. 03 | st. 06 | st. 08 | st. 09 |
|---|---|---|---|---|
| 12 | 1 | 0 | 1 | 0 |
| 18-19 | 6 | 36 | 10 | 1 |
| 23 | 19 | 9 | 37 | 8 |
| 29-31 | 74 | 55 | 52 | 91 |

The percentages of oviferous females on the total number caught vary in each stratum :

- 58 % in stratum 09
- 45 % in stratum 06
- 35 % in stratum 03 (with 0.3 % included in the group of 23 mm Lc modal length)

and 34 % in stratum 08

5) Identification of age-groups.

The modal length already distinguished in the total catches with the groundfish bottom trawl (Fig. 5) are also found in the 4 strata where shrimp is mainly concentrated. So, the length distribution of these total catches was used to calculate the mean length of each group with the CASSIE's method (Fig. 8). This analysis leads to mean carapace length of 12.9 mm, 17.9 mm, 23.1 mm and 29.5 mm.

The last group (mean length of 29.5 mm Lc) is entirely composed of females, a great part of which is oviferous, and where several year-classes are perhaps accumulated (HORSTED, 1976). However, if, as it occurs in Greenland waters (SMIDT, 1965), the natural mortality after 5 years of age is very high in Statistical Area 0, this group is mainly constituted of 5 years old individuals.

Furthermore, it is known that some individuals become females at 4 years old (CARLSSON and SMIDT, 1976). In the group at mean length of 23.1 mm Lc, some oviferous females are noted (mainly in stratum 03) indicating that it would be that of transitional stages between males and females, of 4 years old.

So, the group at 17.9 mm Lc would be mainly constituted of males of 3 years old and the group at 12.9 mm Lc of immature individuals of 2 years old.

To summarize, the age composition of the catches would be as follows :

| | Age-group | | | |
|---|---|---|---|---|
| | II | III | IV | V+ |
| % | 1 | 10 | 25 | 64 |
| mean length (Lc mm) | 12.9 | 17.9 | 23.1 | 29.5 |
| Standard Deviation | 1.05 | 1.40 | 1.10 | 1.83 |

6) Biometrical relationships.

Biometrical observations were also made on samples of catches in Statistical Area 0, during the survey. These results are given here to be used in future research on this stock.

Lt/Lc relationship (fig. 9) :

$$Lc = 0.273\ Lt - 1.958$$

Lc/Wt relationship (fig. 10 A) and B)) :

$$\text{Log } Wt = 2.757 \text{ Log } Lc - 6.598$$

or

$$Wt = 1.363.10^{-3}\ Lc^{2.757}$$

IV - Conclusion.

From the research catches of R/V "Cryos" in autumn 1977, three major conclusions can be drawn on shrimp in ICNAF Statistical Area 0 :

- The species is concentrated at depth ranging from 300 to 420 m (167-233 fathoms) and mainly in the northern part of the Area. The most important concentrations are found in four strata included between the latitudes 64°10 and 65°40 N. However, it is probable that is only the southern portion of the general geographical area occupied by shrimp in the Baffin Island waters.

- The minimum biomass, estimated from yields with a research shrimp net, is close to 10,000 metric tons in the concentration area only.

- Catches from a groundfish bottom trawl and from a research shrimp net are composed of 4 groups with mean length at 12.9 mm, 17.9 mm, 23.1 mm and 29.5 mm, corresponding respectively to age-groups II, III, IV and V+.

References

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CASSIE (R.H.), 1954.- Some uses of probability paper in analysis of size frequency distributions.- Austr. J. mar. Freshw. Res., 3 (2) : 170-198.

HORSTED (S.A.), 1976.- The life cycle of the shrimp (Pandalus borealis Kr.) in Greenland waters discussed in relation to the potential yield of the stocks.- ICNAF Res. Doc. 76/XII/154, 21 p.

SMIDT (E.), 1965.- Deep-Sea prawns and the prawn fishery in Greenland waters.- Cons. int. Explor. Mer, Rapp. et P.V., 156 : 100-104.

Table 1. Basic data on catches of shrimp made with the two types of gears during the R/V *Cryos* groundfish survey, ICNAF Statistical Area 0, 16 September-23 October 1977.

| Stratum No. | Set No. | mean position Lat. | mean position Long. | Date | mean time | Depth (m) | near bottom temperature (° C) | Sediment | Catches/half-hour W (kg) | Catches/half-hour N |
|---|---|---|---|---|---|---|---|---|---|---|
| **Bottom trawl (50 mm codend mesh)** | | | | | | | | | | |
| 01 | D484 | 64°59.9 | 62°02.8 | 23.09 | 16.50 | 300-306 | 1.3 | gravel | (0)* | 9 |
| 03 | D486 | 65°17.2 | 60°51.5 | 24.9 | 07.29 | 300-305 | 0.7 | rough sand + pebble | 23 | 2167 |
| | D524 | 65°01.1 | 60°11.2 | 02.10 | 13.02 | 330 | 0.6 | rough sand + gravel | 5 | 442 |
| | D522 | 65°12.5 | 60°01.2 | 02.10 | 09.27 | 375-385 | 0.8 | gravel | 10 | 672 |
| 04 | D518 | 66°03.6 | 60°01.4 | 01.10 | 10.41 | 505-510 | 1.0 | absent | (0) | 6 |
| | D512 | 65°38.6 | 60°01.6 | 30.09 | 14.51 | 512-519 | 1.2 | gravel | (0) | 26 |
| 06 | D514 | 65°32.2 | 59°14.8 | 30.09 | 17.44 | 465-470 | 2.0 | gravel + pebble | 1 | 53 |
| | D520 | 65°09.0 | 59°53.0 | 02.10 | 07.28 | 405-420 | 1.2 | rough sand + gravel | 10 | 942 |
| 07 | D480 | 64°51.2 | 62°22.4 | 23.09 | 10.36 | 415 | - | absent | (0) | 28 |
| 08 | D494 | 64°38.7 | 61°00.0 | 25.09 | 10.30 | 350-360 | 1.6 | absent | 7 | 336 |
| | D492 | 64°43.4 | 61°28.8 | 25.09 | 07.28 | 325 | 2.0 | fine sand + pebble | 27 | 1647 |
| | D496 | 64°42.2 | 60°20.2 | 25.09 | 15.08 | 373-380 | 1.1 | - | 29 | 1918 |
| | D498 | 64°31.4 | 60°23.5 | 25.09 | 17.17 | 385-388 | 2.5 | mud + fine sand | 5 | 324 |
| 09 | D539 | 64°02.8 | 60°22.0 | 04.10 | 17.14 | 342-347 | 2.8 | - | (0) | 12 |
| | D502 | 64°17.0 | 59°36.2 | 26.09 | 11.20 | 350-360 | 2.2 | gravel + pebble | 6 | 433 |
| | D533 | 64°09.0 | 60°10.0 | 04.10 | 07.32 | 344-356 | 2.5 | - | (0) | 34 |
| 010 | D500 | 64°41.8 | 59°04.5 | 26.09 | 07.36 | 460-490 | 2.1 | gravel | (0) | 4 |
| | D504 | 64°17.0 | 59°22.0 | 26.09 | 14.10 | 425 | 1.9 | rough sand | 0.5 | 25 |
| 013 | D474 | 63°02.2 | 61°57.0 | 22.09 | 16.00 | 277 | 2.6 | rough sand + gravel | 4 | 265 |
| | D528 | 63°57.5 | 61°20.0 | 03.10 | 07.32 | 243-245 | 1.9 | gravel | (0) | 13 |
| 014 | D535 | 63°53.0 | 60°28.0 | 04.10 | 11.23 | 325-345 | 1.7 | - | (0) | 19 |
| | D476 | 63°03.0 | 61°25.2 | 22.09 | 18.14 | 340-350 | 3.0 | rough sand + gravel | (0) | 10 |
| 015 | D543 | 63°29.9 | 60°31.8 | 05.10 | 11.05 | 380 | 2.5 | - | (0) | 10 |
| | D586 | 63°13.0 | 61°06.0 | 15.10 | 08.05 | 430 | 2.4 | - | (0) | 2 |
| 019 | D584 | 62°41.8 | 62°26.0 | 14.10 | 16.41 | 250-255 | 0.5 | - | (0) | 6 |
| **Shrimp trawl (25 mm codend mesh)** | | | | | | | | | | |
| | D488 | 65°02.8 | 60°38.5 | 24.09 | 14.15 | 306-307 | 0.6 | - | 81 | 6360 |
| | D490 | 65°10.9 | 60°49.8 | 24.09 | 16.18 | 296-306 | 0.8 | - | 27 | 1843 |
| | D526 | 64°57.0 | 60°32.5 | 02.10 | 17.07 | 305-310 | 0.7 | - | 49 | 5128 |

* (0) : < 0.5 kg

Table 2. By-catches in weights and numbers of commercial fishes taken with shrimp in the two types of gears during the R/V *Cryos* groundfish survey, ICNAF Statistical Area 0, 16 September-23 October 1977.

| | Bottom trawl (50 mm codend mesh) | | | | | | | | | | | | Shrimp trawl (25 mm codend mesh) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 03 | | 06 | | 08 | | 09 | | 013 | | | | | |
| | W | N | W | N | W | N | W | N | W | N | W | N | W | N |
| Pandalus borealis | 14 | 1219 | 4 | 332 | 17 | 1072 | 2 | 162 | 2 | 133 | 52 | 4468 | | |
| Raja radiata | 1 | 1 | | | (0) | 3 | | | | | (0) | 1 | | |
| Raja spinicauda | (0) | 1 | (0) | 1 | | | (0) | 1 | 1 | 6 | (0) | 3 | | |
| Gadus morhua | | | | | | | | | 3 | 3 | | | | |
| Boreogadus saida | | | | | (0) | 1 | | | (0) | 1 | (0) | 13 | | |
| Macrourus berglax | 1 | 1 | 1 | 3 | | | 3 | 9 | 19 | 34 | | | | |
| Anarhichas minor | 1 | 1 | | | 1 | 1 | 3 | 1 | | | | | | |
| Lycichthys denticulatus | | | | | 4 | 1 | | | 13 | 1 | 2 | 1 | | |
| Lycodes sp. | 1 | 5 | (0) | 2 | (0) | 1 | (0) | 1 | (0) | 2 | 1 | 5 | | |
| Sebastes marinus mentella | 1 | 35 | 7 | 91 | 12 | 243 | 2 | 34 | 16 | 211 | 2 | 186 | | |
| Hippoglossoides platessoides | 2 | 7 | (0) | 1 | 1 | 1 | (0) | 1 | 10 | 39 | 8 | 31 | | |
| Hippoglossus hippoglossus | | | | | | | | | 2 | 1 | | | | |
| Reinhardtius hippoglossoides | 21 | 175 | 44 | 141 | 31 | 250 | 30 | 93 | 42 | 239 | 18 | 218 | | |

(0) : < 0.5 kg

W : mean weight/half-hour

N : mean number/half-hour

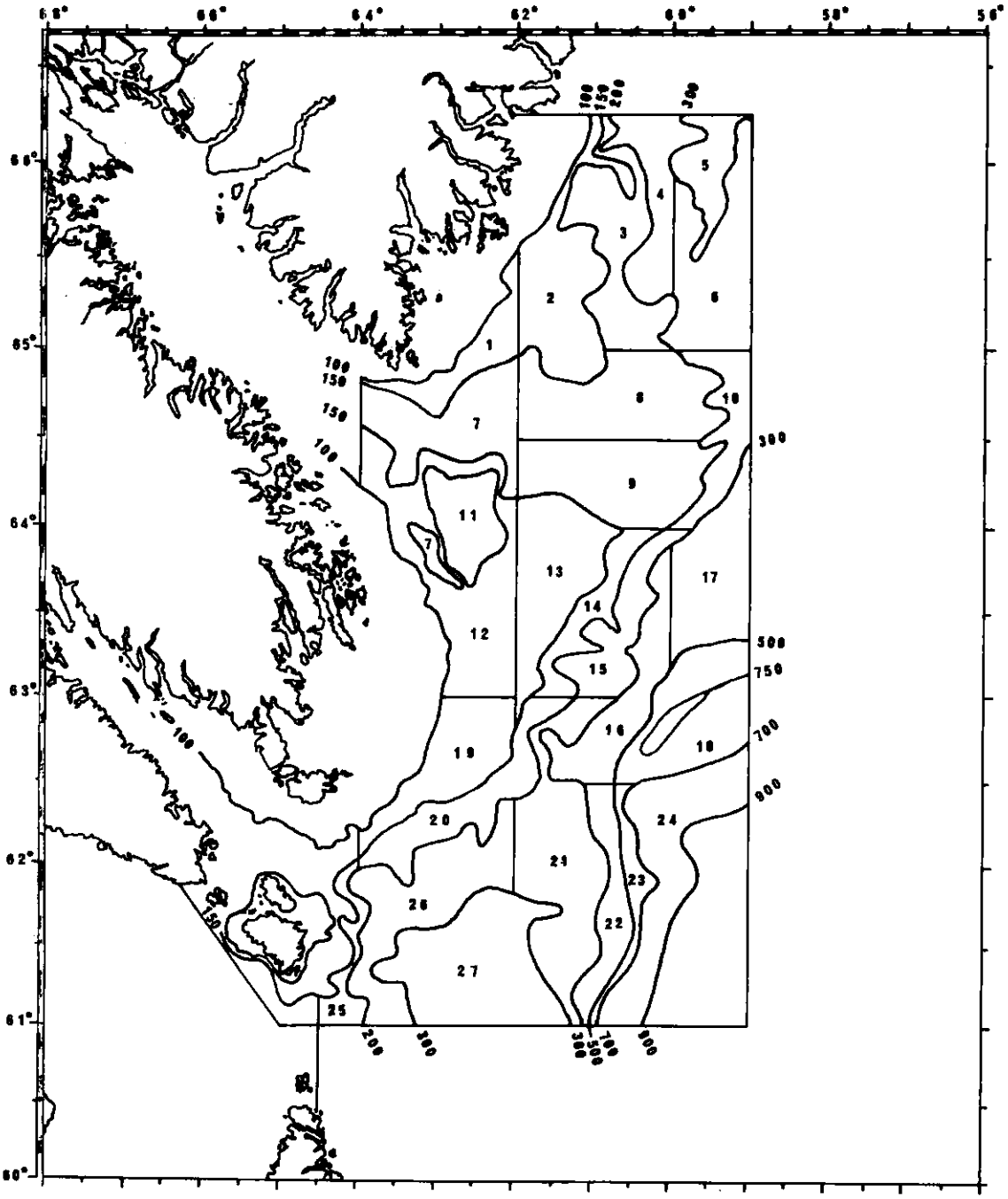


Figure 1. Stratification scheme used for ICNAF Statistical Area 0 during the R/V *Cryos* groundfish survey (16 Sept-23 Oct 1977).

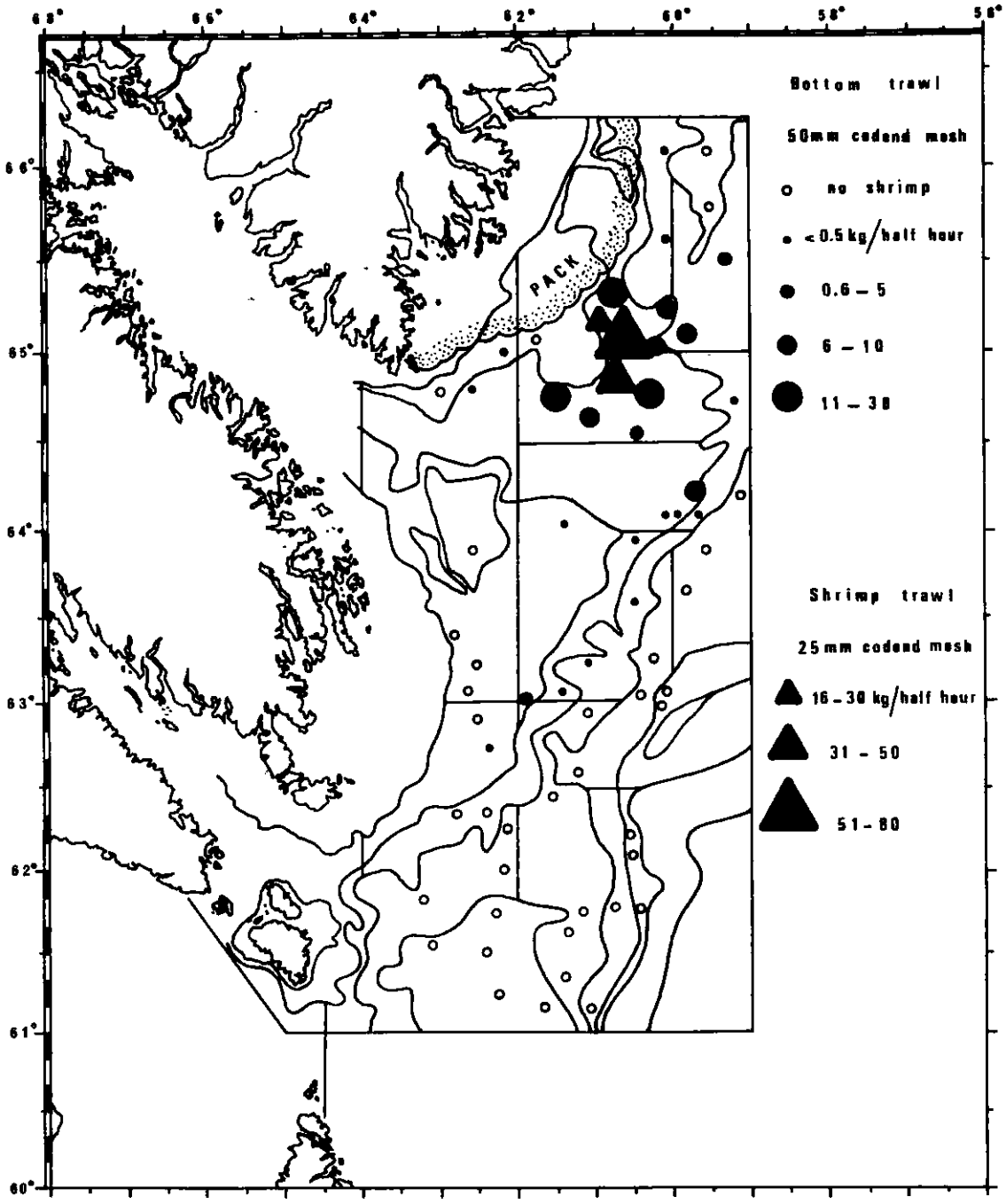


Figure 2. Catches of shrimp (*Pandalus borealis*) at stations occupied during the R/V *Cryos* groundfish survey (16 Sept-23 Oct 1977) in relation to the type of gears used.

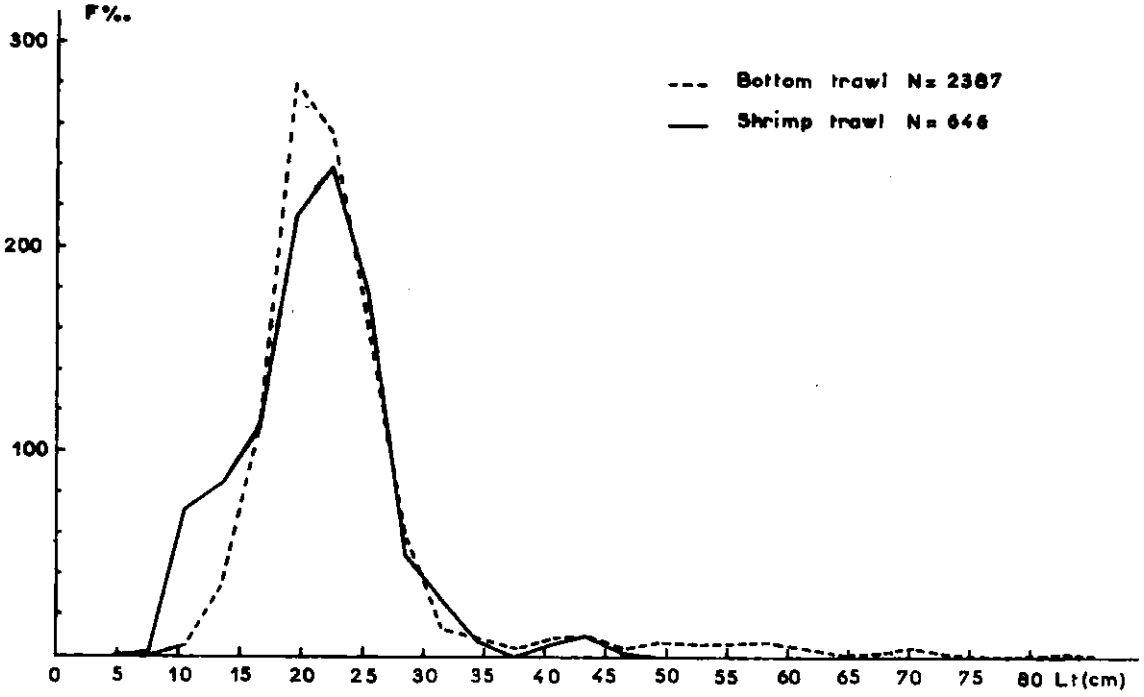


Figure 3. Length frequencies of greenland halibut taken as by-catches with shrimp, using two types of gears. (R/V *Cryos* groundfish survey, 16 Sept-23 Oct 1977).

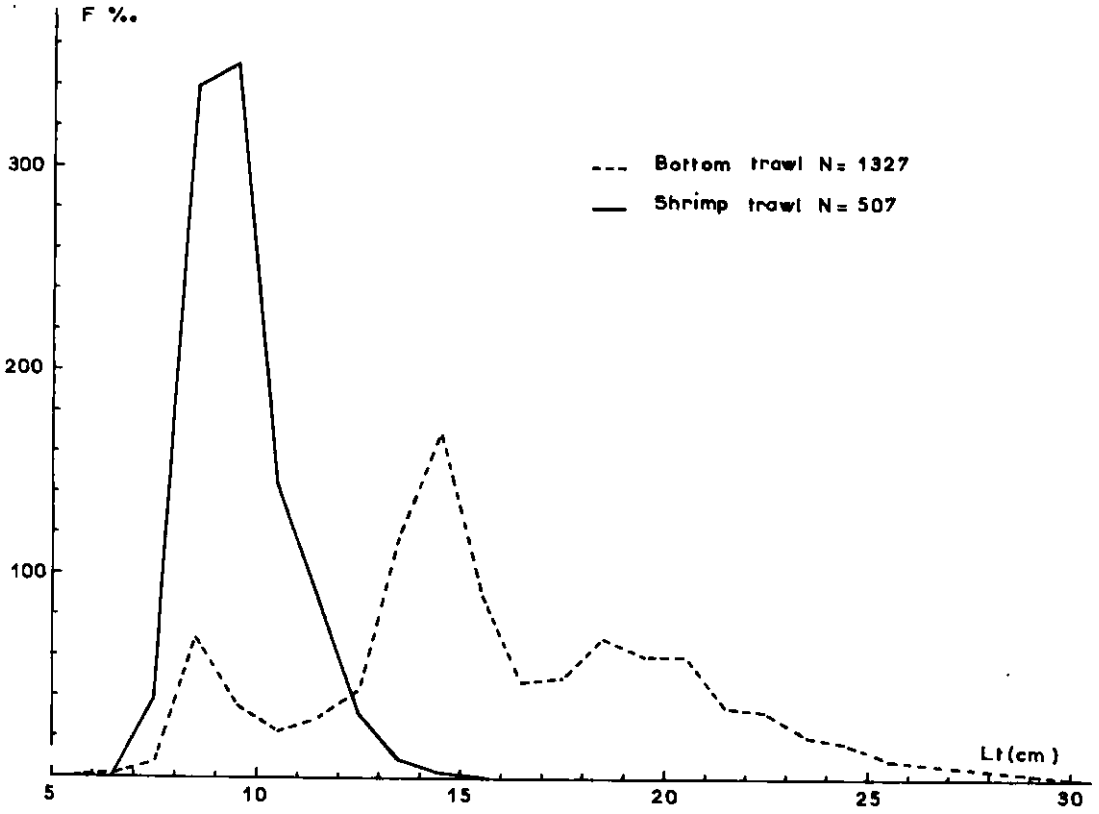


Figure 4. Length frequencies of redfish taken as by-catches with shrimp, using two types of gears (R/V *Cryos* groundfish survey, 16 Sept-23 Oct 1977).

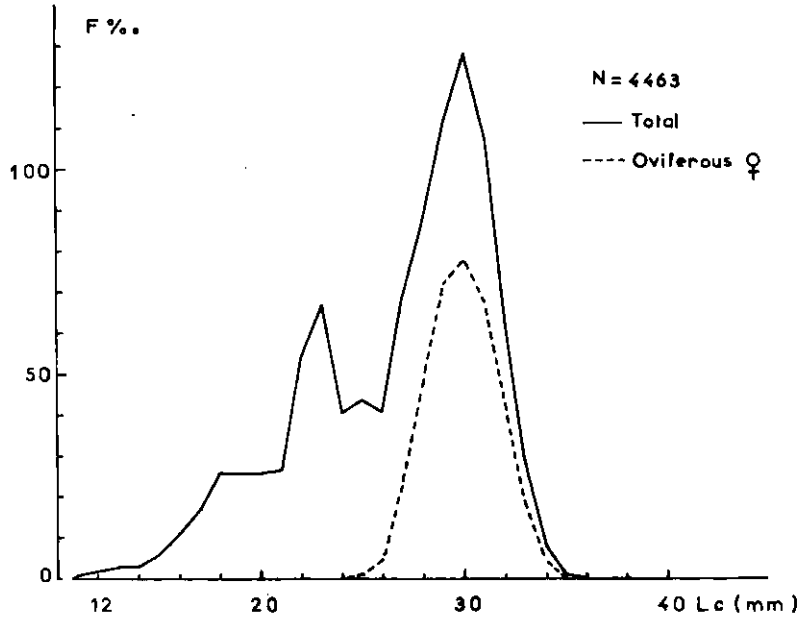


Figure 5. Length frequencies of shrimp caught with the groundfish bottom trawl during the R/V *Cryos* groundfish survey of ICNAF Statistical Area 0 (16 Sept-23 Oct 1977).

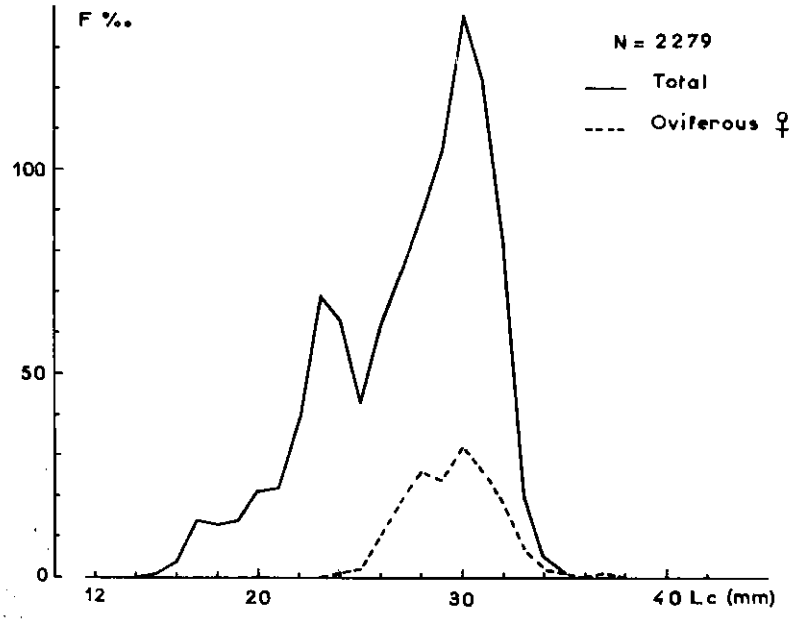


Figure 6. Length frequencies of shrimp caught with the research shrimp trawl during the R/V *Cryos* groundfish survey of ICNAF Statistical Area 0 (16 Sept-23 Oct 1977).

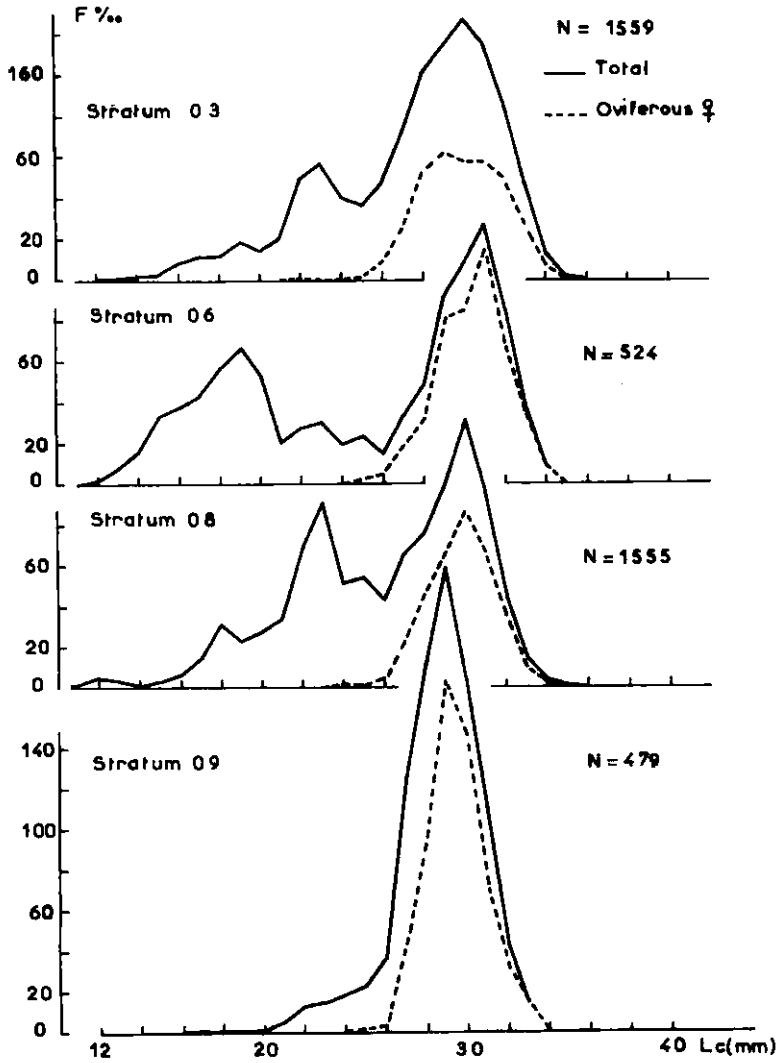


Figure 7. Length frequencies of shrimp caught with the groundfish bottom trawl, ICNAF Statistical Area 0 in the four strata of larger concentration (R/V *Cryos* groundfish survey 16 Sept-23 Oct 1977).

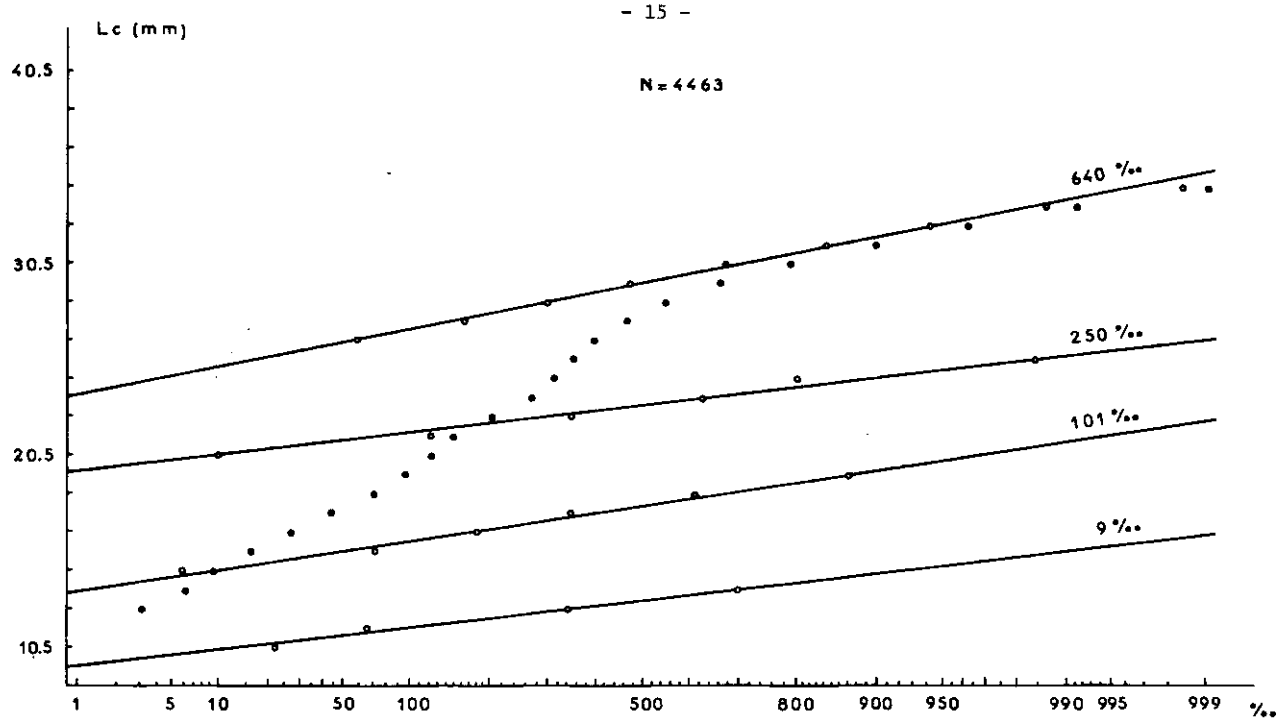


Figure 8. Cumulative length frequencies for shrimp caught with the groundfish bottom trawl and determination of mean length in each group (ICNAF Statistical Area 0, R/V *Cryos* groundfish survey, 16 Sept-23 Oct 1977).

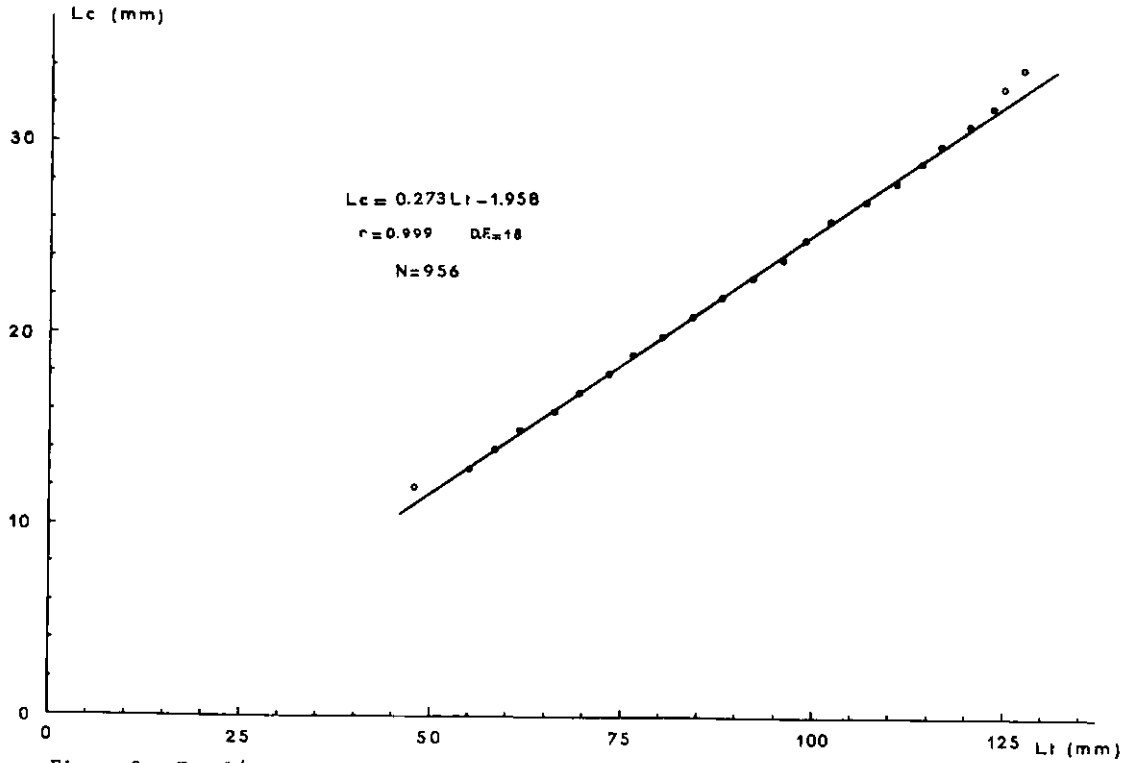


Figure 9. Total/carapace length relationship for shrimp in ICNAF Statistical Area 0 (white circles are not considered for calculation).

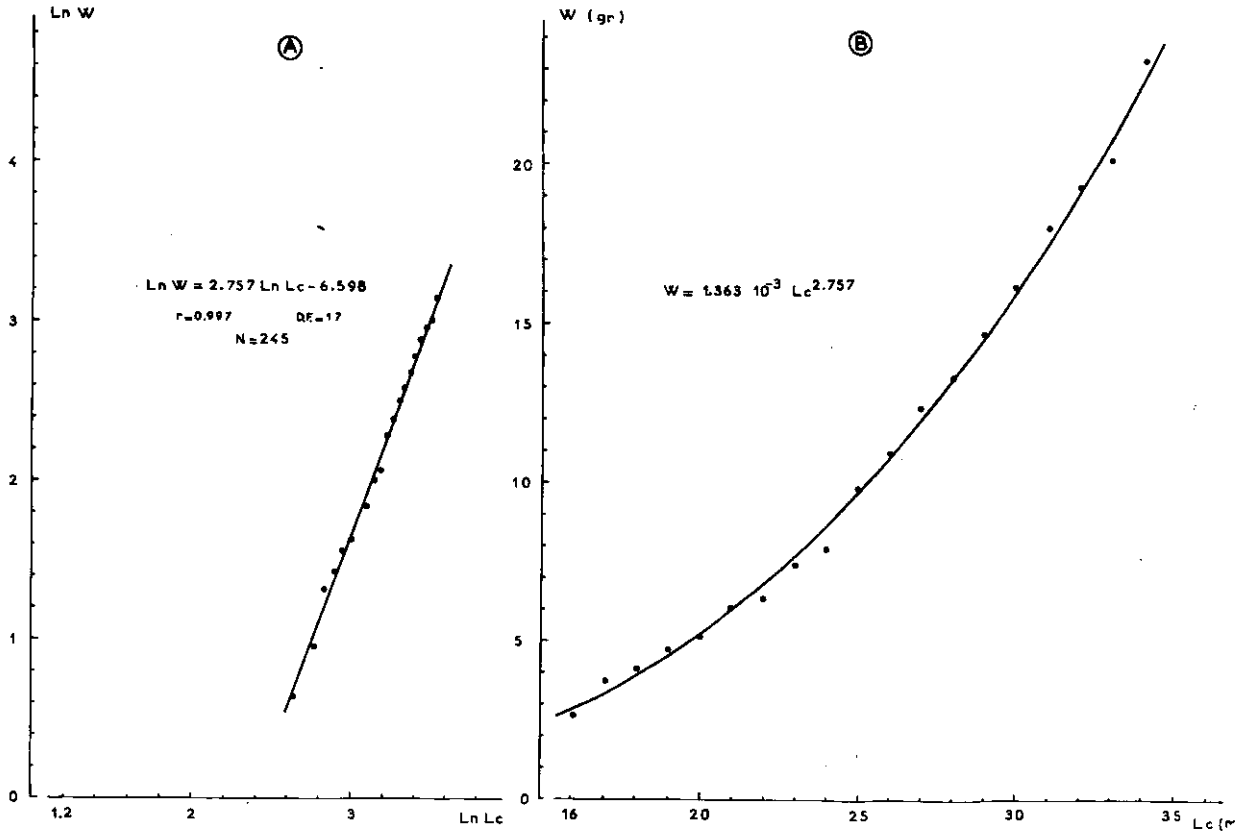


Figure 10. Carapace length/total weight relationship for shrimp in ICNAF Statistical Area 0, A): logarithmic and B) arithmetic.