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Caridean shrimps in the food of demersal fish off the Belgian coast

3. Pleuronectiformes

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Abstract.

The report provides information on the importance of Caridean shrimps in the food of Limanda limanda (dab), Platichthys flesus (flounder) and Pleuronectes platessa (plaice) in the Belgian coastal waters, and gives some biometrical data related to stomach content and composition. The predation mortality of post-larval brown shrimp, Crangon crangon, caused by Pleuronectiform fishes is estimated and compared to the predation mortality caused by Gadiforms and Perciforms. The results show that shrimp is only a minor food component for Pleuronectiform fishes and that the predation mortality of brown shrimp caused by these fish species can be neglected.

Résumé.

Le rapport fournit des données sur l'importance des crevettes Caridées dans la nourriture de Limanda limanda (limande), de Platichthys flesus (flet) et de Pleuronectes platessa (plie) dans les eaux côtières belges, et donne quelques relations biométriques se rapportant au contenu des estomacs et à sa composition. La mortalité de la crevette grise, Crangon crangon, due à la prédation par les poissons Pleuronectiformes est estimée et comparée à celle due à la prédation par les Gadiformes et les Perciformes. Les résultats montrent que les crevettes Caridées ne sont que peu représentées dans la nourriture des poissons Pleuronectiformes et que la mortalité des crevettes grises, due à la prédation par ceux-ci peut être considérée comme négligeable.

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1. Introduction.

Two previous contributions by the second author (REDANT, 1982a, 1982b) described the results of quantitative stomach analyses, using gravimetric methods, on Gadiform and Perciform fishes off the Belgian coast, with special emphasis on the importance of Caridean shrimps in their food. The results of these investigations clearly outlined that shrimps, especially Crangon crangon, are an important food source for juvenile whiting (Merlangius merlangus), bib (Trisopterus luscus), juvenile cod (Gadus morhua), five-bearded rockling (Ciliata mustela), juvenile gurnard (Trigla spp.) and sea snail (Liparis liparis). Some of these predators, together with the sand gobies (Pomatoschistus spp.), cause a substantial mortality amongst brown shrimp in the Belgian coastal area (REDANT, 1980).

Data on the food composition of Pleuronectiform fishes (GILIS, 1952, 1966 ; KUHL, 1963, 1964 ; BRABER and DE GROOT, 1973 and others) on the one hand and on the densities of these fish species in the Belgian inshore waters on the other hand suggested that flatfishes, especially the common dab (Limanda limanda), could be important shrimp predators too. This is the case in e.g. the German Bight, where dab belongs to the most detrimental predators of brown shrimp (TIEWS, 1978).

The major aim of the present study was to quantify the impact of several Pleuronectiforms on the shrimp stock in the Belgian coastal waters.

2. Methods.

The Pleuronectiform fish species studied were Limanda limanda (dab), Plathichthys flesus (flounder) and Pleuronectes platessa (plaice). The investigations were performed during a one year cycle (April 1979 - March 1980). The analyses were spread over the year as representatively as possible, taking into account the geographical and seasonal peculiarities in the distribution and size composition of each species. The numbers of fishes analysed per month and per size class are given in tables 1 and 2. Sampling stations and the numbers of fishes investigated per sub-area are mapped in figure 1.

A review of the methodology (measurements, preservation of stomach contents, analyses of stomach contents, processing of data) can be found in REDANT (1982a). For each length class of fishes the following parameters were calculated : mean body weight of fish, gonads and stomach included (\bar{W}_f), mean weight of stomach content (\bar{W}_g), mean weight of ovaries (\bar{W}_o), mean weight of Caridean shrimps per stomach (\bar{W}_c), mean weight of Crangon crangon per stomach (\bar{W}_{cc}), incidence frequency of Caridean shrimps (IF_c) and of each shrimp species (IF_i), mean number of Caridean shrimps (\bar{N}_c) and of each shrimp species (\bar{N}_i) per stomach.

3. Results.

3.1. Stomach weight.

Mean stomach weights, mean weights of Caridean shrimps and of Crangon crangon per stomach in relation to fish length are given in figure 2. The stomach weight - fish length relationships for Limanda (L), Platichthys (Pf) and Pleuronectes (Pp) were expressed by the following regression equations (lengths in cm, weights in grams) :

$$L \quad \bar{W}_g = 0.000077 L_f^{3.94} \quad (r = 0.983)$$

$$Pf \quad \bar{W}_g = 0.0000147 L_f^{3.63} \quad (r = 0.966)$$

$$Pp \quad \bar{W}_g = 0.0000342 L_f^{3.35} \quad (r = 0.988)$$

3.2. Stomach weight/body weight ratio.

The relative weight of the stomach content versus body weight or stomach weight/body weight ratio for all length classes of fish together averaged 1.16 % (maximum 10.1 %) in Limanda, 1.08 % (maximum 9.8 %) in Platichthys, and 0.96 % (maximum 5.7 %) in Pleuronectes.

Nearly 14.5 % of the dab, 10.5 % of the flounder and 7.5 % of the plaice had empty stomachs (stomach weight/body weight ratio smaller than 0.1 %) (figure 3).

The observed stomach weight/body weight ratios are somewhat lower than the ones reported in the literature : 0.7-3.5 % in dab from the Western Baltic (ARNTZ, 1971), 1.3-5.5 % in dab, 2.5-5.5 % in flounder and 1.4-4.0 % in plaice from the Danish waters (BLEGVAD, 1917).

In all species the relative weight of the stomach content seems to increase very slightly with increasing fish size (figure 4). Similar results already have been published for dab from the Western Baltic (ARNTZ, 1971). In flounder and plaice however, the slopes of the regression lines are so small that the stomach weight/body weight ratios can be considered as being roughly constant and independent from fish size, at least for the size range under investigation.

Large flounder with fully developed ovaries (relative weight of the ovaries exceeding 10 % of total body weight) continued feeding prior to and during the spawning period (December-January). The same applied to spent females. The relative weight of the stomachs of large flounder remained almost constant throughout the year and the percentages of fishes with empty stomachs did not increase during and immediately after the spawning period. The numbers of similar observations on dab and plaice, however, were too limited to be conclusive with respect to the interaction between feeding and spawning.

3.3. Shrimps as a food component.

Only 4.4 % of the dab stomachs, 3.1 % of the flounder stomachs and 1.2 % of the plaice stomachs contained shrimp, mostly Crangon crangon. The mean number of shrimps per stomach was 0.048 in dab, 0.045 in flounder and 0.013 in plaice.

The relative contribution of Caridean shrimps to the stomach contents or shrimp weight/stomach weight ratio, averaged 2.59 % in dab, 0.46 % in flounder and 0.64 % in plaice.

The findings for flounder and plaice are in agreement with the results of earlier investigations in comparable inshore or estuarine regions, such as the English Channel, the Wash, the Southern Bight, the Waddensea, the German Bight, the Danish and the Baltic (TODD, 1915 ; BLEGVAD, 1917, 1932 ; HERTLING, 1928 ; STEVEN, 1930 ; LARSEN, 1936 ; GILIS, 1952 ; ZIEGELMEIER, 1952 ; BRABER and DE GROOT, 1973).

The results for dab, however, are lower than the ones reported in the literature for most of the areas mentioned above. GILIS (1952, 1966) recorded Crangon in 10-35 % of dab stomachs from the Belgian coast and an average of 0.22 shrimps per stomach. Similarly, KUHL (1963, 1964) found Crangon in 18 % of dab stomachs from the German Bight and an average of 0.30 shrimps per stomach. BRABER and DE GROOT (1973), in their extensive study on the food of flatfishes from the Southern Bight, reported an average of 0.14 shrimps per stomach. Finally, HERTLING (1928) recorded 0.23 shrimps per stomach in dab from the Southern Baltic.

Different authors described dab as a non-selective predator (HERTLING, 1928 ; STEVEN, 1930 ; KUHL, 1963 ; WHEELER, 1969 and others). Regional, seasonal or long term changes in prey availability strongly influence the composition of its food. Evidence for this is given by e.g. BLEGVAD (1917), who analysed and compared the food of dab from different bottom communities in the Danish waters. The non-selective feeding behaviour of dab could explain the differences in incidence frequencies and mean numbers of shrimp per stomach between our data and the results of investigations in other areas or periods.

3.4. Impact on the shrimp stock.

The predation mortality of brown shrimp, Crangon crangon, caused by dab, flounder and plaice was computed from (1) the densities of these fish species in the coastal waters and (2) the quantities of shrimp consumed by them per unit of time (daily shrimp rate).

Data on the densities of dab, flounder and plaice within the area up to 10 miles offshore were obtained from the Demersal Young Fish and Brown Shrimp Surveys in spring and autumn 1973-1980 (DE CLERCK, CLOET and REDANT, 1973, 1974a, 1974b, 1975 and unpublished data). Since juvenile dab, smaller than 11 cm, and juvenile plaice, smaller than 13 cm, do not feed on shrimp, these length classes were omitted from the calculations (table 3, column 2). Real densities were estimated by multiplying the observed densities with a factor 5, assuming that the shrimp trawl used during the surveys catches only 20 % of the Pleuronectiform fishes present on the sea floor (table 3, column 3). Evidence from studies on the sampling efficiency of shrimp trawls (DE GROOT, 1973 ; DE CLERCK and REDANT, unpublished data) suggests that this factor may be smaller. The correction factor used therefore should be considered as a rather pessimistic safety factor in order to avoid underestimating of the predator densities.

Daily shrimp rates (table 3, column 5) were derived from the mean numbers of shrimp per stomach (table 3, column 4), assuming an average digestion time of 24 hours (DAWES, 1930 ; HEMPEL, 1956 ; ARNDT and NEHLS, 1964 ; MILLER, 1967 ; DE GROOT, 1971).

The computation of the (maximum) predation mortality of post larval shrimp caused by dab, flounder and plaice yielded the following results (table 3, column 6) :

| | |
|---------------------|--|
| <u>Limanda</u> | 0.075 shrimps m ⁻² year ⁻¹ |
| <u>Platichthys</u> | 0.025 |
| <u>Pleuronectes</u> | 0.015 |

These values, which are likely overestimated, are much lower than the mean values obtained for several Gadiform and Perciform fish species in a previous study on the population dynamics of brown shrimp (REDANT, 1980) :

| | |
|-----------------------|---|
| <u>Pomatoschistus</u> | 10.86 ± 5.51 shrimps m ⁻² year ⁻¹ |
| <u>Merlangius</u> | 1.48 ± 1.20 |
| <u>Trisopterus</u> | 0.89 ± 0.40 |
| <u>Trigla</u> | 0.41 ± 0.23 |

| | |
|----------------|-------------|
| <u>Agonus</u> | 0.25 ± 0.19 |
| <u>Liparis</u> | 0.14 ± 0.08 |
| <u>Gadus</u> | 0.06 ± 0.02 |
| <u>Ciliata</u> | 0.03 ± 0.02 |

Dab could be responsible for, at the most, 0.5 % of the predation mortality of brown shrimp in the Belgian coastal waters, flounder for 0.2 % and plaice for 0.1 %. This situation largely differs from the one in the German Bight, where dab causes, on the average, 5.5 % (minimum 1.3 % and maximum 22.3 %) of the predation mortality amongst brown shrimp (TIEWS, 1978).

4. Conclusions.

Caridean shrimps only play a minor part in the food of Pleuronectiform fishes in the Belgian coastal area. Limanda, Platichthys and Pleuronectes hardly feed on shrimp and, although they occur in high numbers (especially dab), their impact on the shrimp stock can be neglected.

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Table 1 - Numbers of Pleuronectiform fishes investigated per month.

| Month | Limanda limanda | Platichthys flesus | Pleuronectes platessa |
|-------------|-----------------|--------------------|-----------------------|
| 01 | 68 | 26 | 67 |
| 02 | 62 | 99 | 44 |
| 03 | 43 | 20 | 49 |
| 1st quarter | 173 | 145 | 160 |
| 04 | 90 | 152 | 191 |
| 05 | - | - | - |
| 06 | - | 77 | 116 |
| 2nd quarter | 90 | 229 | 307 |
| 07 | 53 | 64 | 79 |
| 08 | 90 | 25 | 144 |
| 09 | 76 | 4 | 70 |
| 3rd quarter | 219 | 93 | 293 |
| 10 | 241 | 33 | 108 |
| 11 | 98 | 33 | 73 |
| 12 | 178 | 44 | 50 |
| 4th quarter | 517 | 110 | 231 |
| Total | <u>999</u> | <u>577</u> | <u>991</u> |

Table 2 - Numbers of Pleuronectiform fishes investigated per size class.

| Length class -cm- | Limanda limanda | Platichthys flesus | Pleuronectes platessa |
|-------------------|-----------------|--------------------|-----------------------|
| 8 | | | 5 ^a |
| 9 | | | 21 |
| 10 | 43 ^a | | 25 |
| 11 | 21 | | 32 |
| 12 | 55 | | 37 |
| 13 | 82 | | 28 |
| 14 | 118 | | 34 |
| 15 | 131 | | 32 |
| 16 | 108 | 8 ^a | 30 |
| 17 | 109 | 9 | 27 |
| 18 | 85 | 7 | 34 |
| 19 | 49 | 7 | 39 |
| 20 | 54 | 9 | 54 |
| 21 | 34 | 15 | 48 |
| 22 | 23 | 16 | 51 |
| 23 | 23 | 29 | 69 |
| 24 | 13 | 35 | 81 |
| 25 | 17 | 42 | 76 |
| 26 | 34 ^b | 42 | 71 |
| 27 | | 57 | 59 |
| 28 | | 47 | 15 |
| 29 | | 29 | 20 |
| 30 | | 34 | 19 |
| 31 | | 34 | 54 ^b |
| 32 | | 28 | |
| 33 | | 27 | |
| 34 | | 28 | |
| 35 | | 13 | |
| 36 | | 17 | |
| 37 | | 12 | |
| 38 | | 32 ^b | |
| Total | <u>999</u> | <u>577</u> | <u>991</u> |

a : Smaller than or equal to length mentioned.

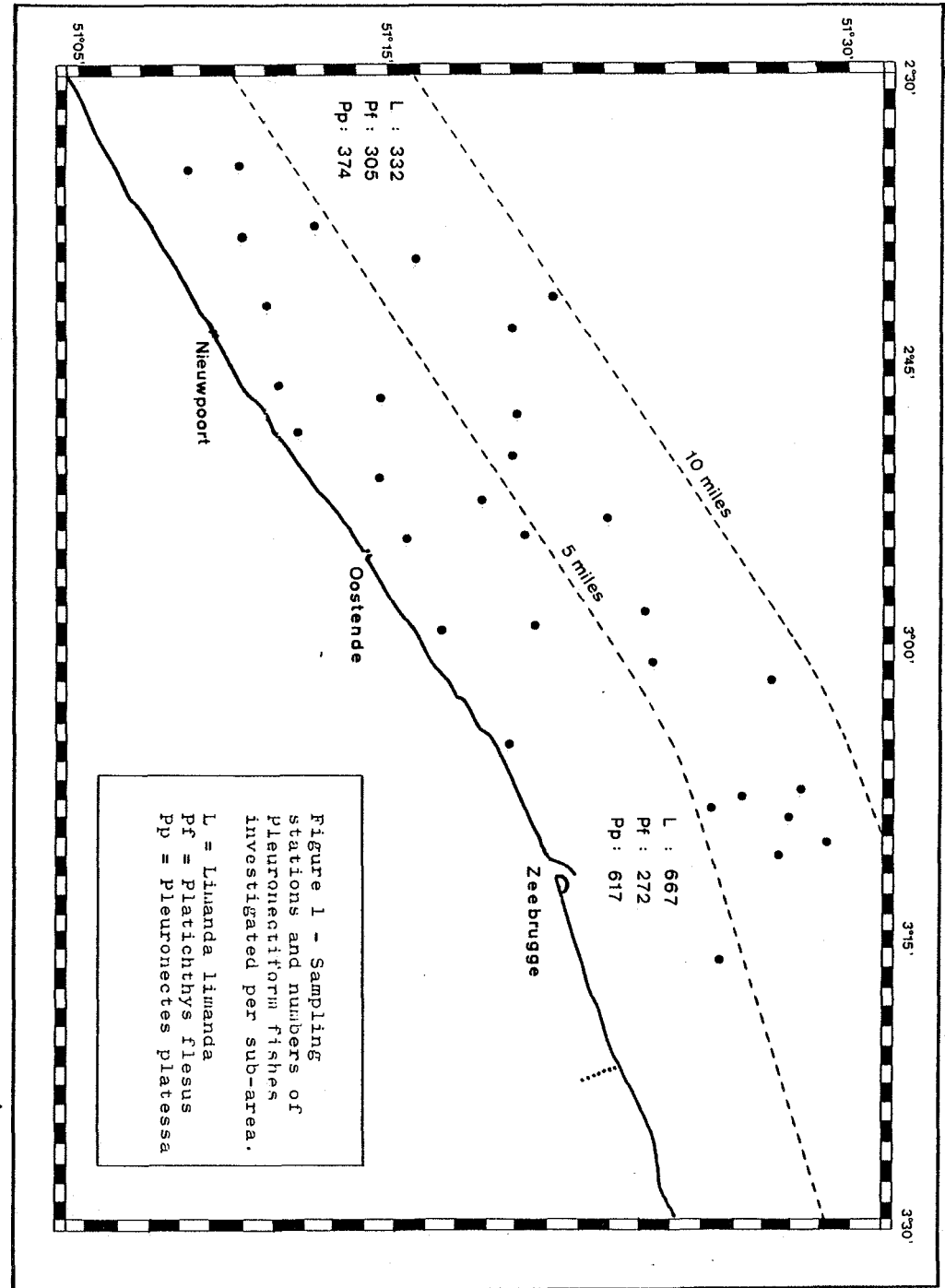
b : Larger than or equal to length mentioned.

Table 3 - Predation mortality of brown shrimp caused by Pleuronectiform fishes.

| Species | Observed density (a) | Estimated real density (a) | Number of shrimps per stomach | Daily shrimp rate | Predation (b) |
|---------------------------|----------------------|----------------------------|-------------------------------|-------------------|---------------|
| Limanda \geq 11 cm | 84.3 | 421.5 | 0.649 | 0.049 | 0.075 |
| Platichthys | 30.4 | 152.0 | 0.045 | 0.045 | 0.025 |
| Pleuronectes \geq 13 cm | 56.5 | 282.5 | 0.015 | 0.015 | 0.015 |

(a) numbers per 10^5 m^2

(b) numbers of shrimps consumed per m^2 per year



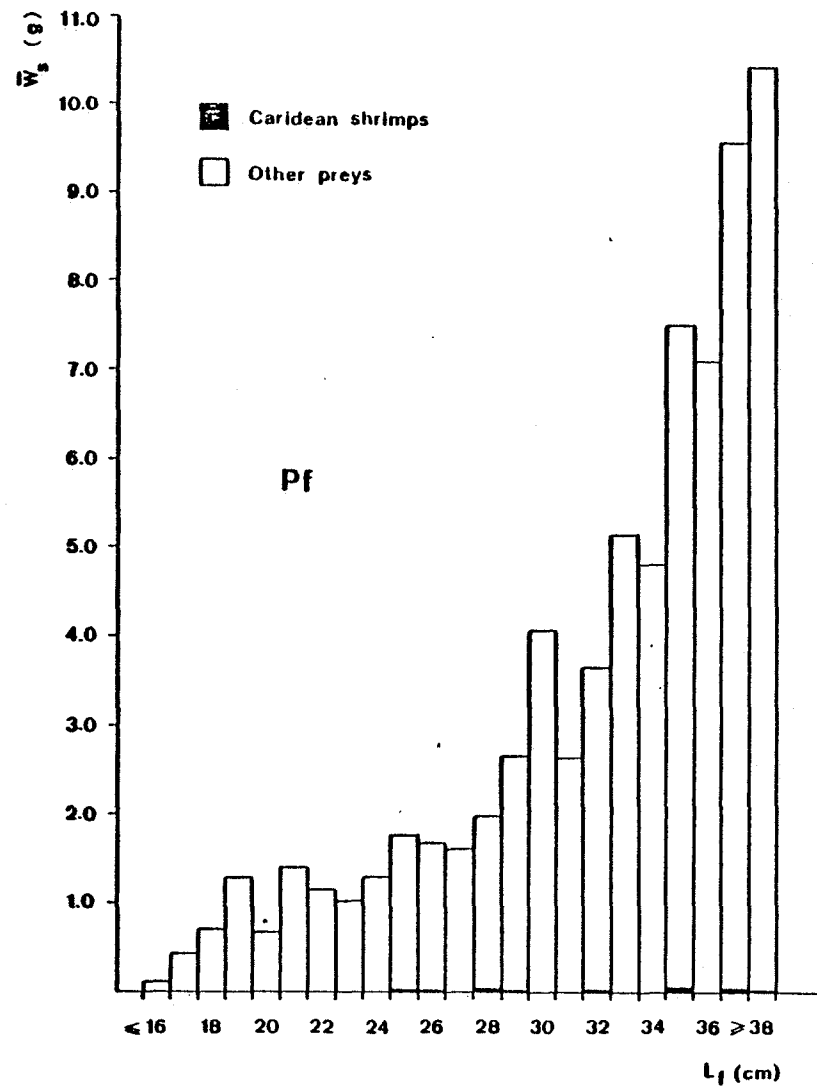
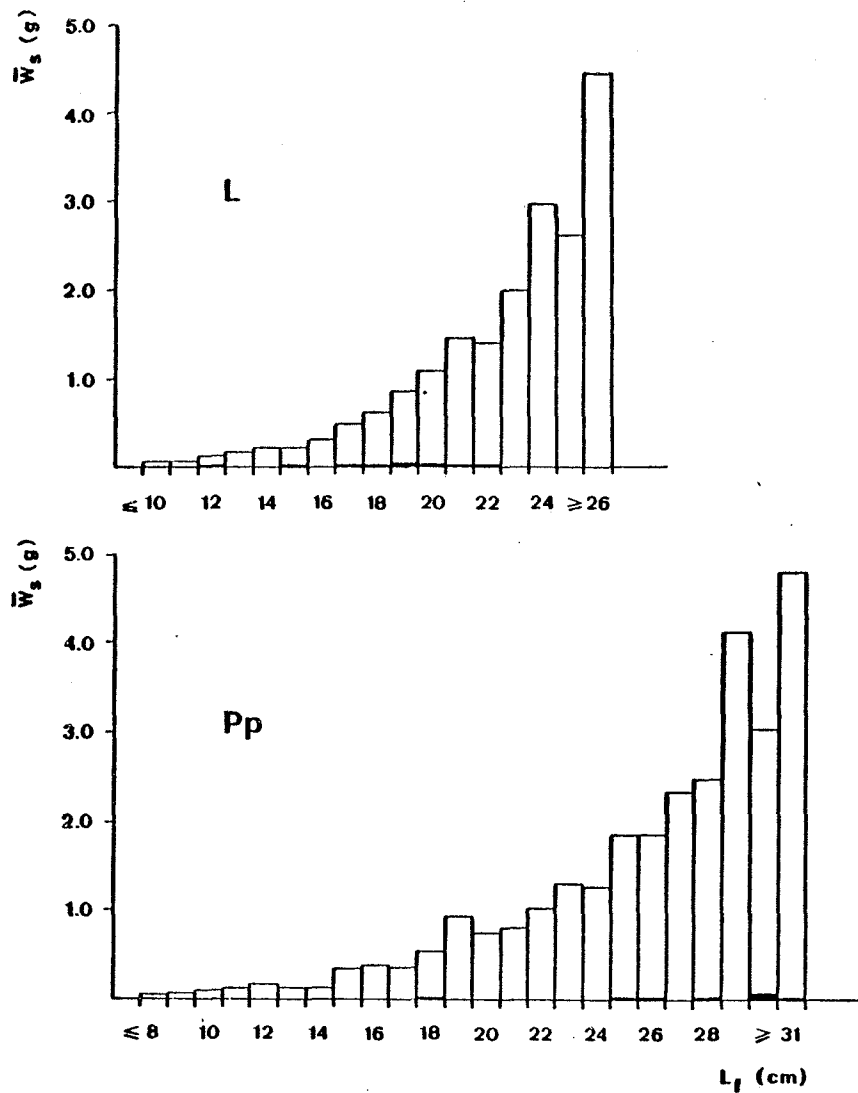


Figure 2 - Stomach weight and composition of Pleuronectiforma fishes, in relation to fish length.

L = *Limanda limanda*

Pp = *Pleuronectes platessa*

Pf = *Platichtys flesus*

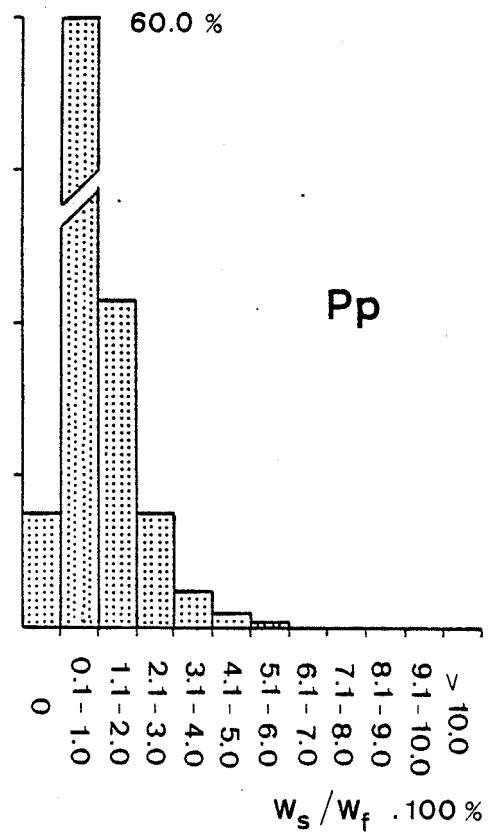
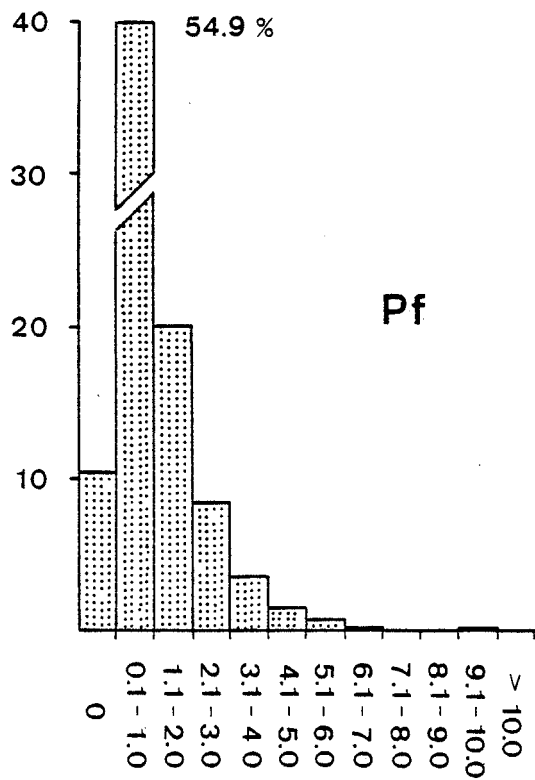
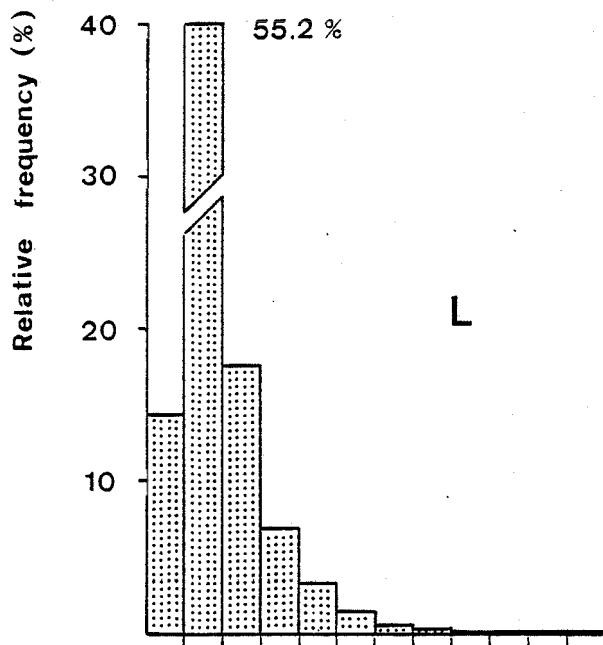


Figure 3 - Relative frequencies of stomach weight/body weight ratios for individual fishes..

L = *Limanda limanda*
 Pf = *Platichthys flesus*
 Pp = *Pleuronectes platessa*

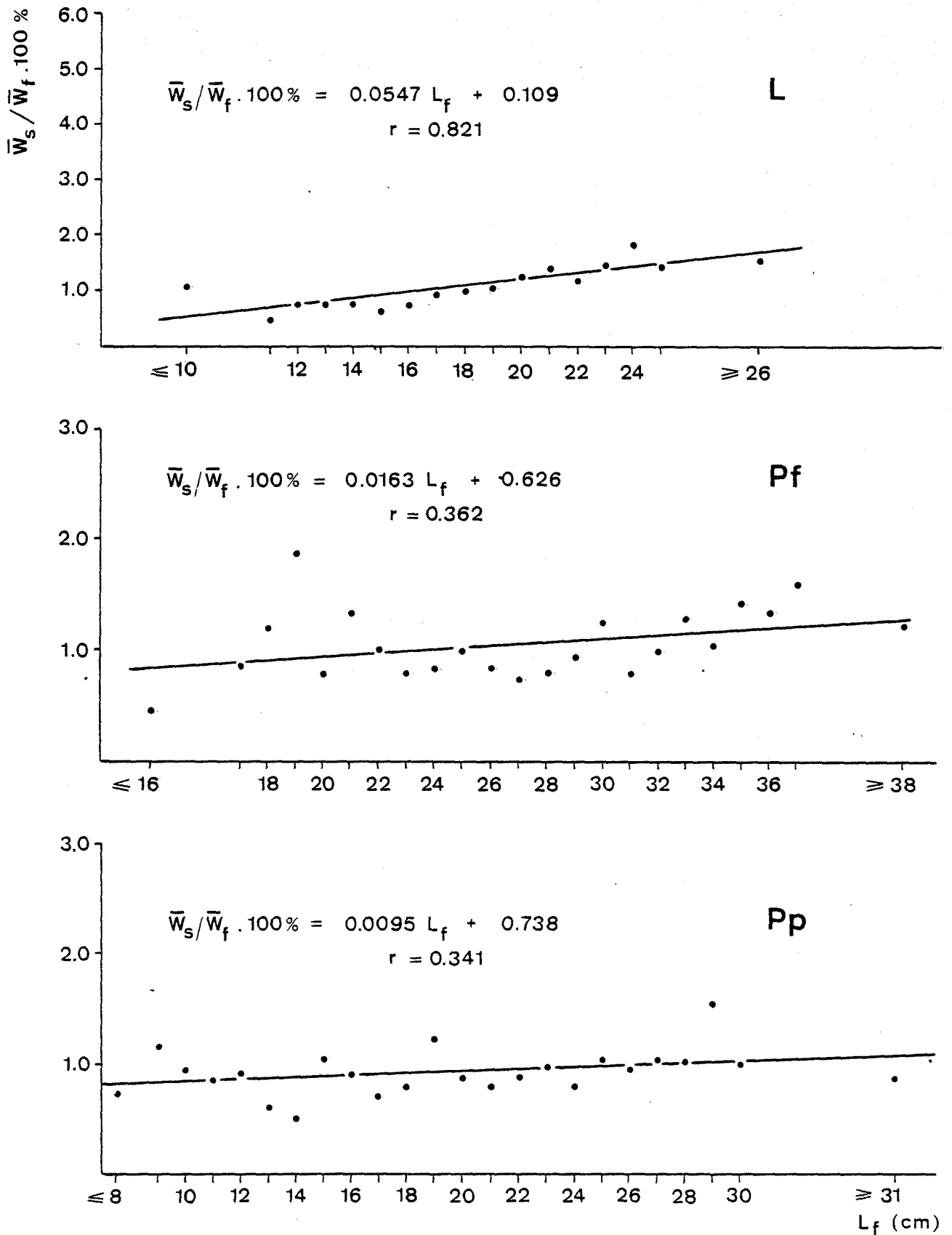


Figure 4 - Stomach weight/body weight ratio of Pleuronectiform fishes, in relation to fish length.

L = *Limanda limanda*

Pf = *Platichthys flesus*

Pp = *Pleuronectes platessa*