International Council for the
Exploration of the Sea.

C.M. 1983/K : 20
Shellfish Committee
Ref. Demersal Fish
Committee

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

3. Pleuronectiformes

E. Nierynck [1] and F. Redant [2]

1) Laboratory for Ecology and Systematics, VUB, Brussels, Belgium
2) Fisheries Research Station, Ostend, Belgium

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 considerée comme négligeable.

This study was subsidized by the Institute for Scientific Research in Industry and Agribulture, Brussels, Belgium.

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 ($\overline{W}_f$), mean weight of stomach content ($\overline{W}_s$), mean weight of ovaries ($\overline{W}_g$), mean weight of Caridean shrimps per stomach ($\overline{W}_c$), mean weight of Crangon crangon per stomach ($\overline{W}_{cc}$), incidence frequency of Caridean shrimps (IF_c) and of each shrimp species (IF_i), mean number of Caridean shrimps ($\overline{N}_c$) and of each shrimp species ($\overline{N}_i$) 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 $\overline{W}_s = 0.0000077\ L_f^{3.94}$ (r = 0.983)

Pf $\overline{W}_s = 0.0000147\ L_f^{3.63}$ (r = 0.966)

Pp $\overline{W}_s = 0.0000342\ L_f^{3.35}$ (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 developped 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 mentionned 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) :

Limanda	0.075 shrimps m^{-2} $year^{-1}$
Platichthys	0.025
Pleuronectes	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) :

Pomatoschistus	10.86 ± 5.51 shrimps m^{-2} $year^{-1}$
Merlangius	1.48 ± 1.20
Trisopterus	0.89 ± 0.40
Trigla	0.41 ± 0.23
Agonus	0.25 ± 0.19
Liparis	0.14 ± 0.08
Gadus	0.06 ± 0.02
Ciliata	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.

5. References.

ARNDT, E. and NEHLS, H. (1964) : Nahrungsuntersuchungen an Postlarvalstadien und Jungtieren von Pleuronectes flesus L. und P. platessa L. in der äusseren Wismarer Bucht. Z. Fischerei, NF 12, 45-73.

ARNTZ, W.E. (1971) : Die Nahrung der Kliesche (Limanda limanda) in der Kieler Bucht. Ber. Dt. Wiss. Komm. Meeresforsch., 22 (2), 129-183.

BLEGVAD, H. (1917) : On the food of fish in the Danish waters within the Skaw. Rep. Dan. Biol. Stat., 24, 17-72.

BLEGVAD, H. (1932) : On the flounder (Pleuronectes flesus) and the Danish flounder fishery in the Baltic. ICES, Rapp. Proc.-Verb. Réun., 78, 1-28.

BRABER, L. and DE GROOT, S.J. (1973) : The food of five flatfish species (Pleuronectiformes) in the Southern North Sea. Neth. J. Sea Res., 6 (1/2), 163-172.

DAWES, B. (1930) : The absorption of fats and lipoids in the plaice (Pleuronectes platessa L.). J. Mar. Biol. Ass. UK, 17, 75-102.

DE CLERCK, R., CLOET, N. and REDANT F. (1973, 1974a, 1974b and 1975) : Bestandsopname langsheen de Belgische kust (7), (8), (9) and (10). Min. Landbouw, Comm. TWOZ, Publ. nr 81-B/10/1973, 87-B/12/1974, 98-B/13/1974 and 110-B/15/1975.

DE GROOT, S.J. (1971) : On the interrelationship between morphology of the alimentary tract, food and feeding behaviour in flatfishes (Pisces, Pleuronectiformes).
Neth. J. Sea Res., 5 (2), 121-196.

DE GROOT, S.J. (1973) : De invloed van trawlen op de zeebodem.
Visserij, 26 (7), 401-409.

GILIS, C. (1952) : De garnaalvisserij op de Belgische kust : haar evolutie in de loop van de jaren 1935-1951 en haar invloed op de garnalenstapel.
Ed. ZWI, Oostende, Verhandeling nr 8.

GILIS, C. (1966) : La limande (Limanda limanda L.) de la côte belge.
ICES, Near Northern Seas Comm., CM 1966/C : 1 (mimeo).

HEMPEL, G. (1956) : Studien zur Tagesperiodik der Aktivität von Fischen. II. Die Nahrungsaufnahme der Scholle.
Kurze Mitt. Inst. FischBiol. Univ. Hamburg, 6, 22-37.

HERTLING, H. (1928) : Quantitative Nahrungsuntersuchungen an Pleuronektiden und einigen anderen Fischen der Ostsee.
Ber. Dt. Wiss. Komm. Meeresforsch., NF 4 (2), 25-121.

KUHL, H. (1963) : Über die Nahrung der Scharbe (Limanda limanda L.).
Arch. Fischereiwiss., 14 (1/2), 8-18.

KUHL, H. (1964) : Protokolle zu den Nahrungsuntersuchungen an Scharben (Limanda limanda (L.)).
Veröff. Inst. Küsten und Binnenfisch. Hamburg, 33.

LARSEN, K. (1936) : The distribution of the invertebrates in the Dybsø Fjord, their biology and their importance as fish food.
Rep. Dan. Biol. Stat., 41, 3-36.

MILLER, B.S. (1967) : Stomach contents of adult starry flounder and sand sole in East Sound, Orcas Island, Washington.
J. Fish. Res. Bd. Canada, 24 (12), 2515-2526.

REDANT, F. (1980) : Population dynamics of brown shrimp (Crangon crangon) in the Belgian coastal waters. 2. Predation mortality.
ICES, Shellfish Comm., CM 1980/K : 33 (mimeo).

REDANT, F. (1982a and 1982b) : Caridean shrimps in the food of demersal fish off the Belgian coast. 1. Gadiformes and 2. Perciformes.
ICES, Shellfish Comm., CM 1982/K : 25 and K : 26 (mimeo).

STEVEN, G.A. (1930) : Bottom fauna and the food of fishes.
J. Mar. Biol. Ass. UK, 16 (3), 677-700.

TIEWS, K. (1978) : The predator-prey relationship between fish populations and the stock of brown shrimp (Crangon crangon L.) in German coastal waters.
ICES, Rapp. Proc.-Verb. Réun., 172, 250-258.

TODD, R.A. (1915) : Report on the food of the plaice.
MAFF, Fish. Invest. London, Series 2, 2 (3).

WHEELER, H. (1969) : The fishes of the British Isles and North West Europe.
Ed. Macmillan, London.

ZIEGELMEIER, E. (1952) : Food of plaice.
Ann. Biol., 9, 139-140.

Correspondence address : Dr. F. Redant
Werkgroep Biologie
Fisheries Research Station
Ankerstraat 1
B-8400 Oostende
Belgium.

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	999	577	991

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	45
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	999	577	991

a : Smaller than or equal to length mentionned.

b : Larger than or equal to length mentionned.

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 $\geqslant$ 11 cm	84.3	421.5	0.049	0.049	0.075
Platichthys	30.4	152.0	0.045	0.045	0.025
Pleuronectes $\geqslant$ 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

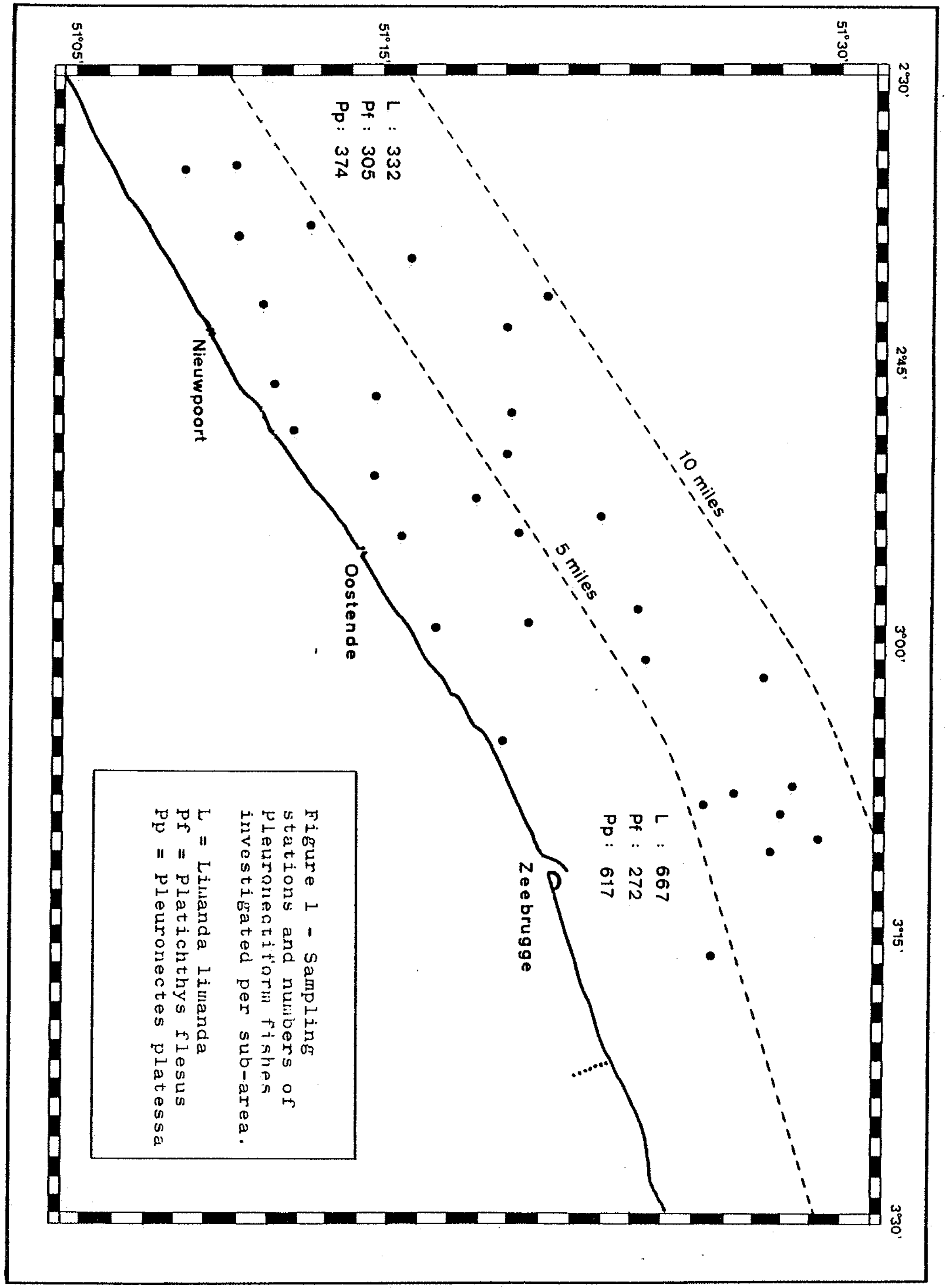

Figure 1 - Sampling stations and numbers of Pleuronectiform fishes investigated per sub-area.

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

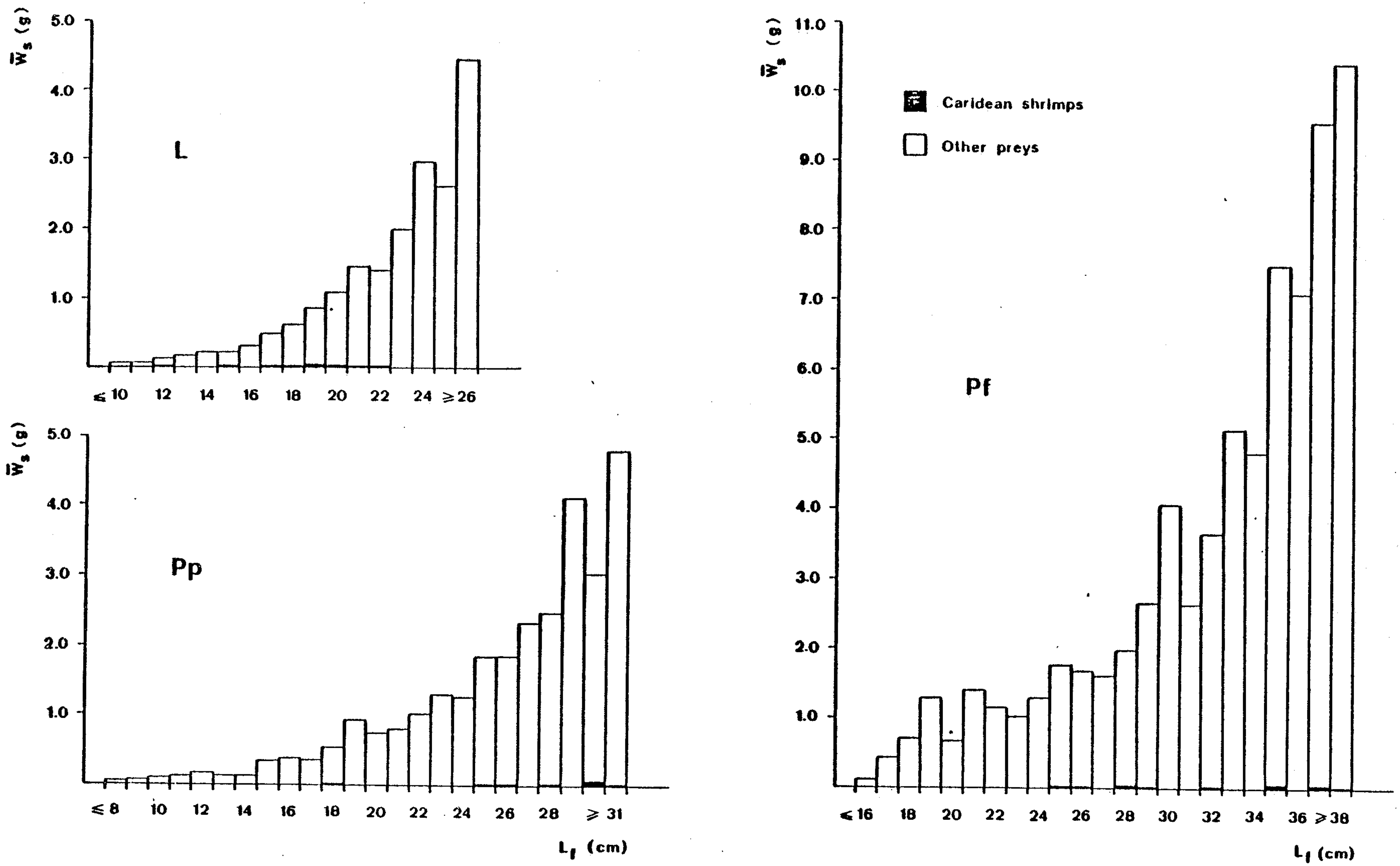

Figure 2 - Stomach weight and composition of Pleuronectiform fishes, in relation to fish length.
L = Limanda limanda   Pp = Pleuronectes platessa   Pf = Platichthys flesus

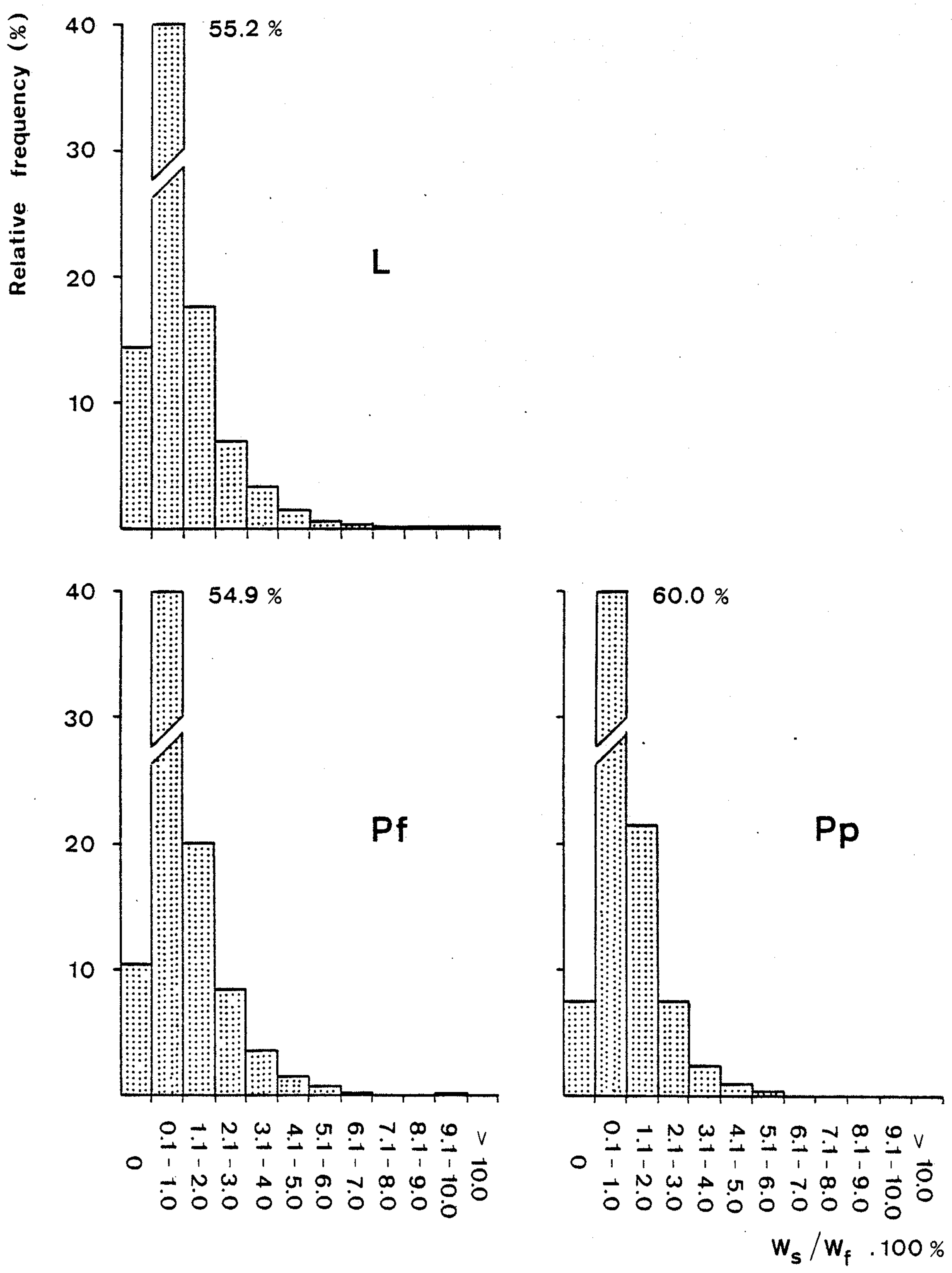

Figure 3 - Relative frequencies of stomach weight/body weight ratios for individual fishes.

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

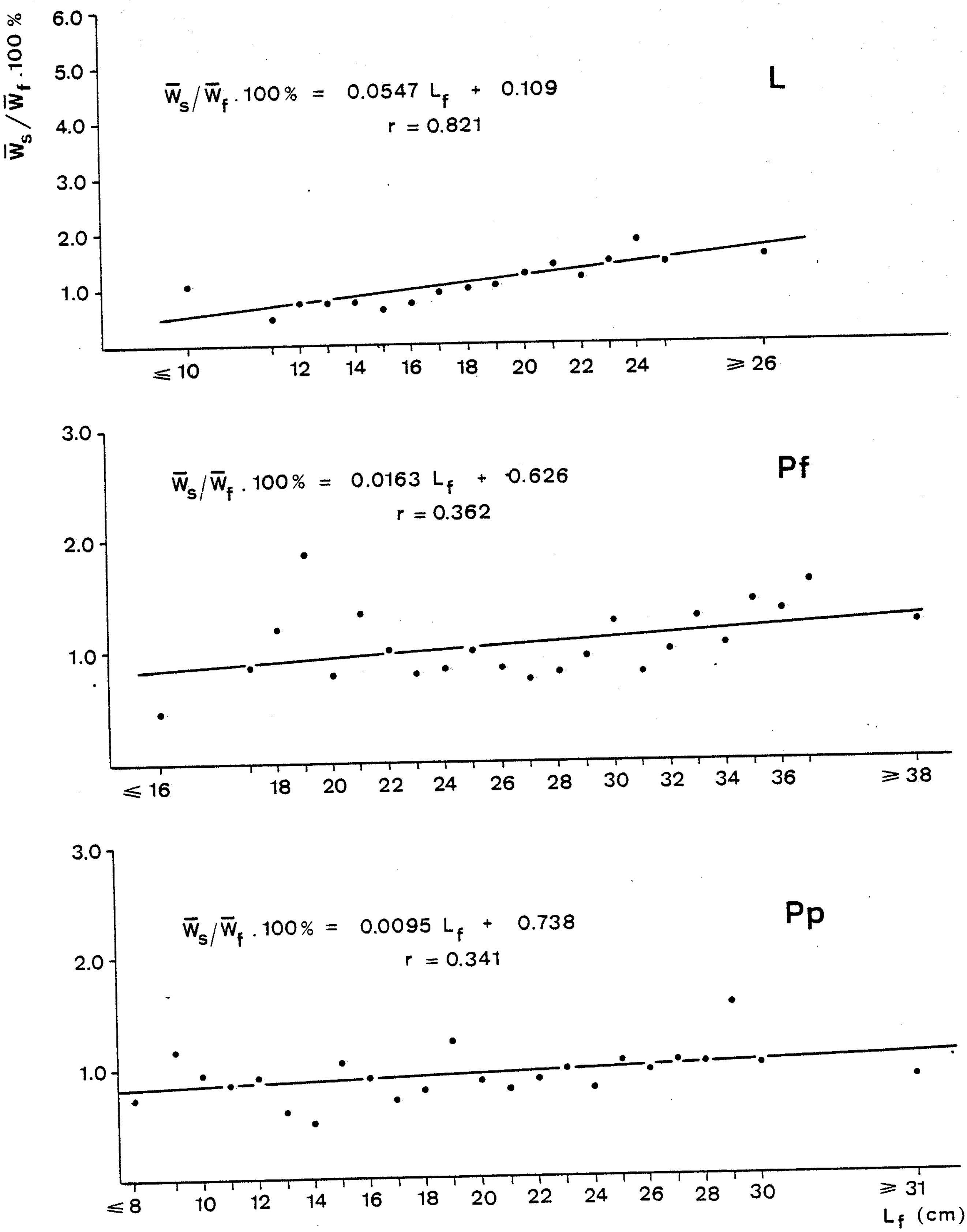

Figure 4 - Stomach weight/body weight ratio of Pleuronectiform fishes, in relation to fish length.

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