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Increased Catches of Northern Shrimp (*Pandalus borealis*, Kroyer) in a 2002 Spanish Bottom Trawl Survey in NAFO Division 3N

by

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Abstract

A significant increase in catches (total of 407.88 kg) of the northern shrimp (*Pandalus borealis*, Kroyer) was observed for the very first time by a Spanish bottom trawl survey since 1995 in the NAFO Regulatory Area (Divisions 3NO) series 1995-2002, and carried out by the Instituto Español de Oceanografía (Vigo Centre). These catches were obtained in a few hauls and were located within a small area to the Northwest of Div. 3N. There have been no records for such high shrimp concentrations in the area.

The higher shrimp catches with respect to surveys undertaken prior to 2001 could be explained as due to a higher efficiency of the new catching gear used viz.; Campelen 1800, however it could not account for the steep increase in catches in the 2002 survey as compared to that of the 2001 (14.62 kg), the year that the gear was actually changed.

This work presents data obtained over 5 length-frequency sampling programs (1 097 individuals) as well as the length-weight relationship of 2 sampling programs (469 individuals) from Div. 3N. A comparison of the same biological parameters from the EU survey in Div. 3M (Flemish Cap 2002) is also presented.

Introduction

The northern shrimp (*Pandalus borealis* Kroyer, 1883) is a stenohaline, discontinuous circumpolar species which is found in greatest concentrations in the NW Atlantic in latitudes greater than 46ºN. Stock distributions of this species within NAFO Div. 3LNO, are found along the edge of the Grand Bank at depths of between 180 and 550 m. Temperature, salinity, depth and substrate determine the distribution pattern and abundance of this species (Shumway *et al*., 1985).

Most of the scientific literature on the northern shrimp in the NAFO Regulatory Area corresponds to Div. 3M, where the most important fishery is conducted (Skuladottir *et al*., 1999; Skuladottir, 2000; Bakanev, 2001; Nicolajsen and Brynjolfsson, 2001; Kristjansson, 2001; Skuladottir and Diaz, 2001). Bibliography for northern shrimp from Div. 3N can be found principally in those works dedicated to Div. 3LNO (Orr *et al*., 2002).

Since 1995 Canadian multi-species stratified random surveys have been used to estimate northern shrimp biomass and abundance indices within NAFO Div. 3LNO (Orr *et al*, 2002).

The Vigo Centre of the Instituto Español de Oceanografía has been conducting research cruises since 1995 in the

NAFO Div. 3LNO, beyond the 200-mile exclusive economic zone. A stratified, random, bottom trawl, multi-species research sampling program was carried out to obtain abundance and biomass indices as well as other biological data for the many species present in the area.

This research survey was carried out from 1995-2000 on board the FV *Playa de Menduiña*, using a *Pedreira* gear (Paz *et al*., 1995), an inefficient gear for shrimp fishing. Catches during the period were insignificant. During 2001 and 2002, the survey was carried out on board the oceanographic research vessel *Vizconde de Eza*, using a Campelen 1800 (Walsh *et al*., 2001). In spite of the improvements due to the new vessel and the use of a Campelen 1800, which is highly efficient for this species (Vazquez, 2002), the total catches were poor, i.e. 14.62 kg.

High sporadic catches in Div. 3N (Fig. 1), i.e. a maximum of 204.9 kilograms in a 30 minute trawling operation were obtained for the first time ever during 2002.

The catch results from the surveys and data analysis are discussed in this paper.

Materials and Methods

The 2002 Spanish bottom trawl survey was carried out from the 29th of April to the 19th of May, following set guidelines that were already established for the series of IEO research surveys (Walsh *et al*., 2001).

Samples of approximately 1.5 kilograms were taken to determine length frequencies in those hauls with the most significant catches.

Males and females were separated with reference to the endopodite of the first pleopod (Rasmussen, 1953). Those individuals that were in the middle of a sex change were considered as males under this criterion. The females were differentiated into mature and immature, following the sternal spines criteria (McCray, 1971). Ovigerous females were considered as an independent group not included within the mature females.

Individuals were measured on board by noting the distance from the base of the eye to the posterior mid dorsal point of the cephalothorax rim -OCL- (Shumway *et al*., 1985). Such measurements were made using electronic callipers to the lower half millimetre.

Samples were taken from five of the thirty-nine hauls with presence of the species. Depths of the sampled hauls varied from 184 to 366 m. A total of 1 097 individuals were measured. Data were used to obtain an estimate of the size distributions of the population in the area.

Furthermore, two samples were frozen on board to determine the length-weight relationship in the laboratory. Four hundred and sixty-nine individuals were selected, dried and weighed with a precision of 0.1 g to calculate the length-weight relationship.

The Spanish bottom trawl survey data are presented as sampling values.

Data of the samples taken is as under:

Depth (m.)	No. of sampled lengths (No. of individuals)	No. of biological samples (No. of individuals)
184-274	3 (576)	-
275-366	2 (521)	2 (469)

The data from Flemish Cap presented in this paper were obtained from the U.E. survey in Div. 3M (Flemish Cap 2002) and are presented as sampling values.

Results

Table 1 shows the catches of northern shrimp from the multi-species surveys carried out by IEO Vigo in the NAFO Div. 3NO area during the spring season from 1995-2002. The year 2002 shows an abrupt increase with respect to earlier years both for catches and for the number of hauls with presence of the species. Caution must be exercised with this data because the Pedreira net used until 2001 is not as efficient for shrimp as the Campelen gear used during the years 2001-02.

Table 2 shows total northern shrimp catches for the 2002 survey and details of depths and number of hauls per depth with presence of this species. Total catches during this survey were 407.88 kg and presence was noted in 39 hauls from Div. 3N. The most important catches were concentrated in latitudes higher than 45°N (Fig. 1) and 93.7% of the catches were made at depth of between 184 and 366 m.

The percentages by sex and maturity were: males 58.07%, immature females 30.99%, mature females 10.21% and ovigerous females 0.73 % (Fig. 2).

The length range for males varied between 10.5 and 25 mm; that for immature females between 19.5 and 26 mm; that for mature females between 19 and 27 mm and that for ovigerous females between 18 to 26.5 mm (Table 3.)

Figure 5 shows the size distribution by sex and maturity stage. A mode can be seen in 20 mm males, in 22.5 mm immature females, in 24 mm mature females. Only eight ovigerous females were found with a mode in 23.5 mm.

A modal size analysis program could not be used due to the low number of sampled individuals. An age-length key was used (Orr *et al*., 2002) based on observations made in adjacent waters (Orr *et al*., 2002; Nicolajsen, 2001; Skuladottir, 2001; Skuladottir and Diaz, 2001).

Age (years)	OCL (mm.)
0	<8.5
1	8.5-12
2	12.5-17
3	17.5-20
4	20.5-22.5
5	23-24.5
6	25-27
7+	>27

According to the enclosed age-length key, we can observe that the males with a 20 mm modal length would belong to the 1998 year-class (age 3). The immature females would be dominated by the 1997 annual class (age 4) and the mature females dominated by the 1996 annual class (age 5). The mode for the ovigerous females would belong to the 1996 annual class (age 5).

Table 4 shows weights *versus* length and number of individuals obtained by the length-weight relationship (Fig. 3).

The weights with respect to size in the Flemish Cap survey (Table 5) and the length-weight relationship (Fig. 4) are similar to those observed in Div. 3N.

By comparing the size distribution data of the 2002 survey (Fig. 5) with those of the Flemish Cap 2002 survey (Fig. 6 and 7) of nearly the same dates and geographic area, one can observe differences in the percentage of mature and ovigerous females. Data on the proportions of each survey are given in the following table:

	[1] Spanish survey 02,3N (184-366 m depth)	[2] U.E survey 02, 3M (all strata)	[2]U.E survey 02,3M (184-366 m. depth)
Males	58.07	44.27	51.09
Immature females	30.99	30.03	26.88
Mature females	10.21	25.67	22.01
Ovigerous females	0.73	0.01	0.01

[1] Campelen 1800 codend 20 mm. mesh size.
[2] Lofoten gear codend 35 mm. mesh size.

Although the percentage of mature females in the Flemish Cap is double that of Div. 3N, the percentage of ovigerous females is quite different. Such differences can apparently be explained as due to temperature and latitude (Shumway *et al*., 1985).

Figure 8 presents size distributions for each sex and maturity stage in Div. 3N and the Flemish Cap for the year 2002. The modal length in the males from Div. 3N is greater (20 mm) than in the Flemish Cap (18.5 mm) although both sizes belong to the same age-class (age 3).

The immature females from Div. 3N, with modal lengths 21.5 and 22.5 mm. and those of the Flemish Cap, modal lengths 23 and 24.5 mm. belonged to two different age classes; 4 and 5, respectively.

The mature females found in Div. 3N would correspond to age class 5 with modal length 23.5 mm, while the mature females in the Flemish Cap corresponded to modal lengths 23.5 and 26.5 mm, with age-classes 5 and 6 years respectively.

The small size of the sample in Div. 3N warrants cautious data interpretation.

More studies in the years to come are needed for a better knowledge of the distribution of the northern shrimp in Div. 3N, as well as to see if this significant increase was a one off event or whether it manifests an oncoming tendency.

Acknowledgements

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Table 1. Northern shrimp catches (kg) on Spanish bottom trawl survey 1995-2002.

Year	Catch (kg.)	Nº hauls
1995 [1]	4.6	1
1996 [1]	2.4	1
1997 [1]	0.14	1
1998 [1]	4.95	5
1999 [1]	13.29	13
2000 [1]	3.95	13
2001 [2]	14.62	16
2002 [2]	408.1	39

[1] Pedreira codend 35 mm.mesh size.

[2] Campelen codend 20 mm.mesh size

Table 2. Northern shrimp catches (kg) by strata (m) on Spanish bottom trawl survey 02.

Depth strata (m.)	Catch (kg.)	Nº hauls
<=56	0	0
57-92	0.013	2
93-183	11,535	6
184-274	78,747	7
275-366	303,4	7
367-549	8,3	6
550-731	2,116	3
732-914	0,06	2
915-1097	3,707	2
1098-1280	0,015	3
1281-1463	0,005	1

Table 3. Northern shrimp length frequencies by sex and maturity stage on Spanish bottom trawl survey 2002.

OCL (mm.)	Males	I. females	M. females	Ovigerous	Total
8.0	0	0	0	0	0
8.5	0	0	0	0	0
9.0	0	0	0	0	0
9.5	0	0	0	0	0
10.0	0	0	0	0	0
10.5	1	0	0	0	1
11.0	0	0	0	0	0
11.5	0	0	0	0	0
12.0	1	0	0	0	1
12.5	0	0	0	0	0
13.0	1	0	0	0	1
13.5	2	0	0	0	2
14.0	2	0	0	0	2
14.5	0	0	0	0	0
15.0	3	0	0	0	3
15.5	1	0	0	0	1
16.0	4	0	0	0	4
16.5	15	0	0	0	15
17.0	13	0	0	0	13
17.5	21	0	0	0	21
18.0	25	0	0	1	26
18.5	43	0	0	0	43
19.0	63	0	1	0	64
19.5	95	2	0	1	98
20.0	96	2	0	0	98
20.5	92	10	0	0	102
21.0	78	34	4	0	116
21.5	35	75	8	1	119
22.0	29	66	15	0	110
22.5	12	77	14	0	103
23.0	4	40	16	0	60
23.5	0	12	14	2	28
24.0	0	11	18	1	30
24.5	0	8	7	0	15
25.0	1	2	9	0	12
25.5	0	0	3	0	3
26.0	0	1	1	1	3
26.5	0	0	0	1	1
27.0	0	0	2	0	2
27.5	0	0	0	0	0
TOTAL	637	340	112	8	1097

Table 4. Northern shrimp weights at length from Spanish bottom trawl survey 2002 in Div. 3N, obtained by length-weight relationship.

OCL (mm.)	Weight (gr.)	N° individuals
7.5	-	-
10	0.7	4
12.5	1.3	3
15	2.1	17
17.5	3.2	179
20	4.6	212
22.5	6.3	53
25	8.3	1
27.5	-	-
30	-	-
32.5	-	-
35	-	-
37.5	-	-

Table 5. Northern shrimp weights at length in July 2002 on Flemish Cap survey, obtained by length-weight relationship (Del Rio, 2002).

OCL (mm.)	Weights (gr.)	N°individuals
7.5	-	-
10	0.6	116
12.5	1.1	54
15	1.9	149
17.5	3.1	169
20	4.5	338
22.5	6.4	298
25	8.4	484
27.5	11.5	244
30	14.8	339
32.5	18.7	112
35	23.2	8
37.5	-	-

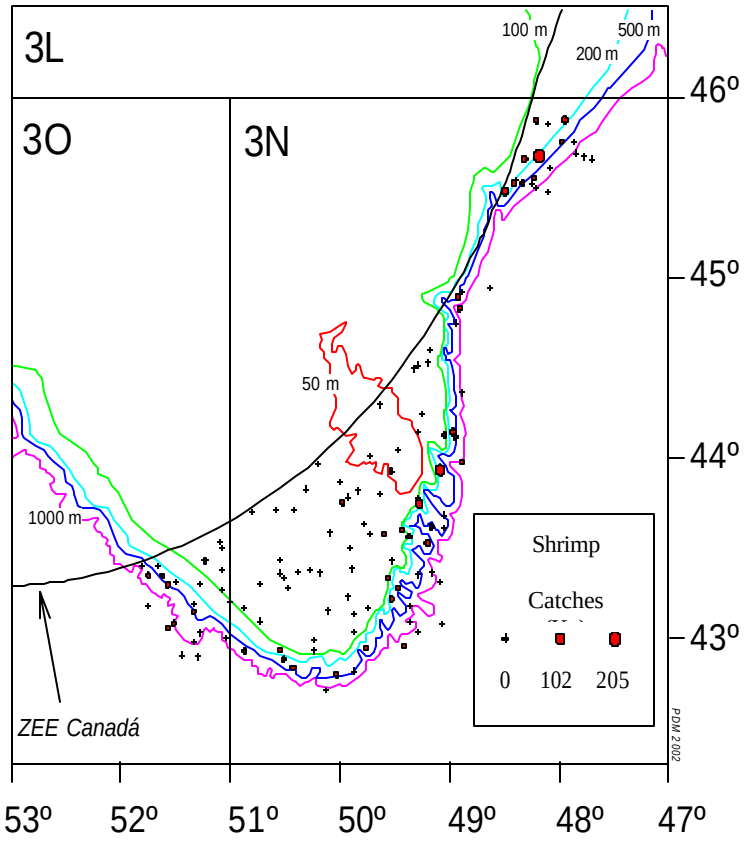

Fig. 1. Northern shrimp catches distribution (kg) in May 2002 on Spanish bottom trawl survey.

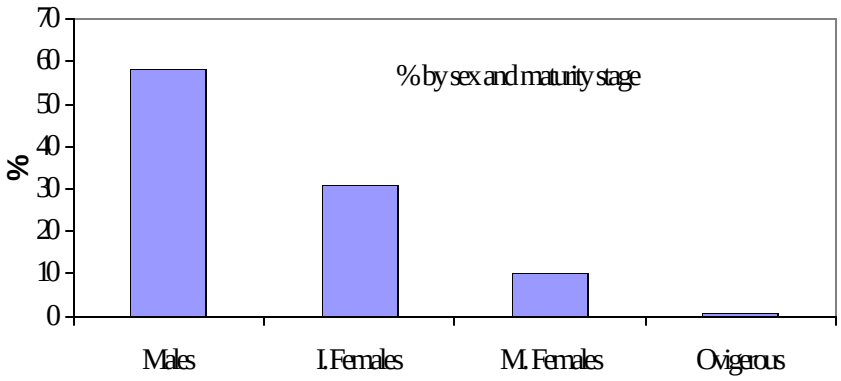

Fig. 2. Northern shrimp percentages by sex and maturity stage on the 2002 Spanish bottom trawl survey in Div. 3N.

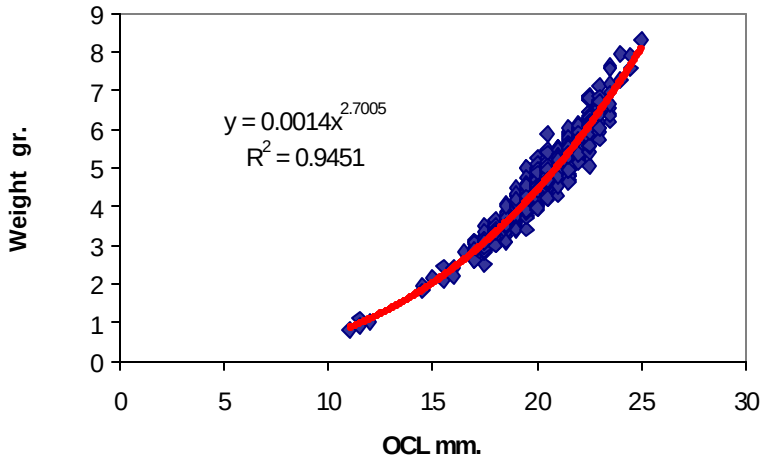

Fig. 3. Northern shrimp length-weight relationship on Spanish bottom trawl survey 2002 in Div. 3N.

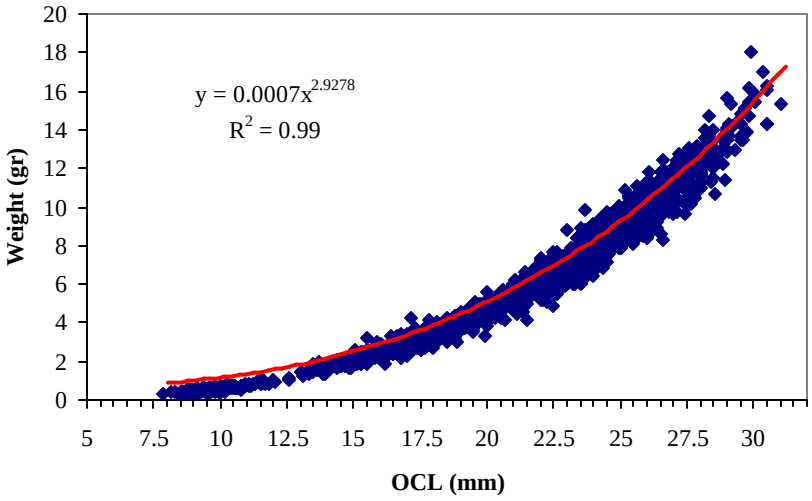

Fig. 4. Northern shrimp length-weight relationship in Flemish Cap 2002 (Del Rio, 2002).

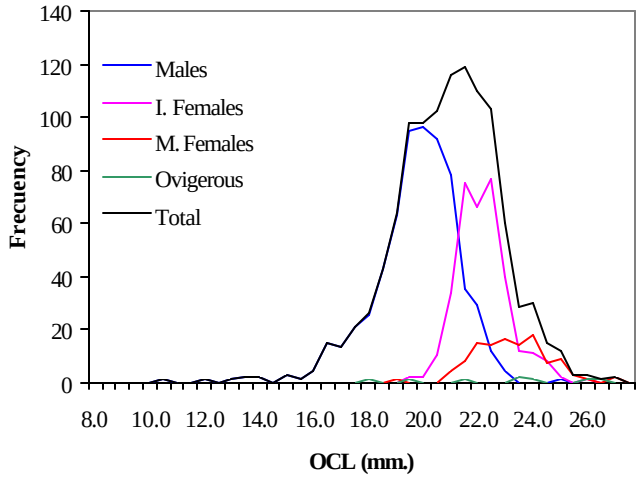

Fig. 5. Northern shrimp length distribution by sex and maturity stage on Spanish bottom trawl survey 2002.

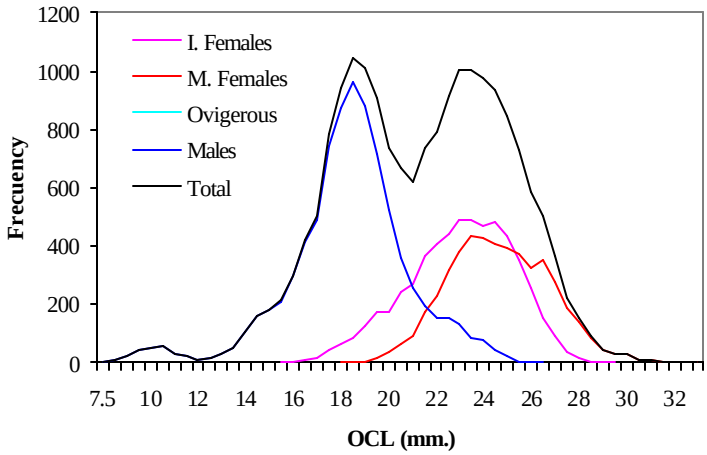

Fig. 6. Northern shrimp length distribution by sex and maturity stage in July 2002 on Flemish Cap survey.

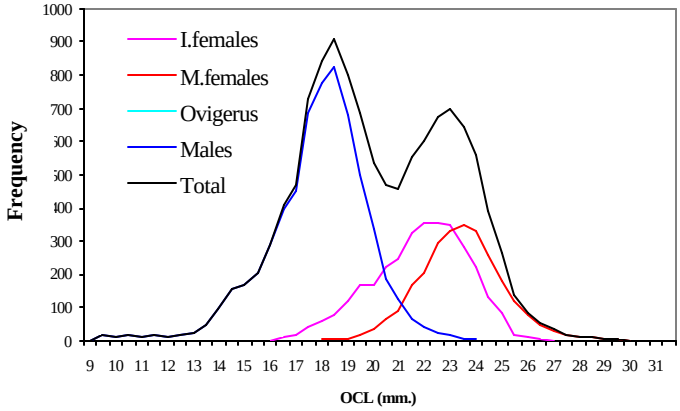

Fig. 7. Northern shrimp length distribution by sex and maturity stage in July 2002 on Flemish Cap survey at 184-366 meters depth.

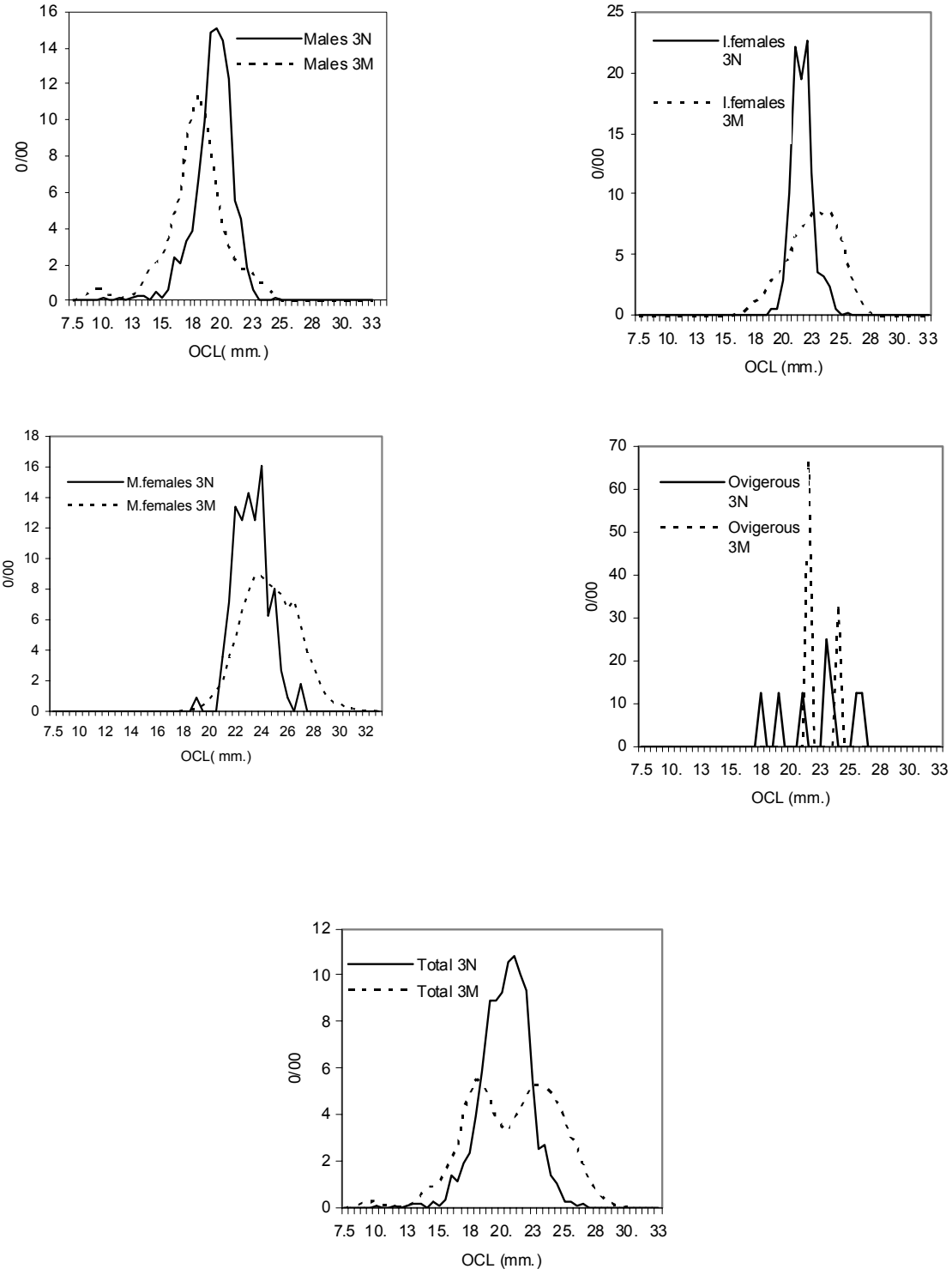

Fig. 8. Northern shrimp length distribution (0/00) comparation by sex and maturity stage between Spanish bottom trawl survey 2002 on Div. 3N and Flemish Cap 2002.