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"ACOUSTIC ABUNDANCE ESTIMATION OF PILCHARD (*Sardina pilchardus* Walb.) IN GALICIAN AND CANTABRIC WATERS. August 1983".

by

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ABSTRACT

Results of the acoustic survey "Saracus-83" are reported in this paper. This cruise was carried out on board the research vessel "Cornide de Saavedra", in august 1983 off the Cantabric and Galician coasts, in the north of Spain. The main objective of the survey was to estimate the abundance by age groups of pilchard (*Sardina pilchardus* Walb.) present in the area, being this population a part of the stock wich is considered to exist in the ICES divisions VIIIc and IXa. The total estimated biomass for pilchard was 697000 tons.

The area of higher abundance was northern Galicia, between Ribadeo and Finisterre, that coincides with the upwelling area described.

SOMMAIRE

On presente ici les resultats de la campagne acoustique realisée par le B/R "Cornide de Saavedra" dans Aout 1983 au large des côtes Cantabrique et Galicienne du N et NW espagnol. Le but de cette campagne a été l'estimation de l'abondance par classe d'age de la sardine (*Sardina pilchardus* Walb.) dans l'aire prospectée qui appartient aux divisions VIIIc et IXa du ICES.

La plus grande abondance a été la partie nord de la Galicie, entre Ribadeo et Finisterre, qui coincide avec la zone de "upwelling" dejá signalée.

INTRODUCTION

Part of the sardine stock of ICES divisions VIIIc and IXa is found in Galician waters and the Cantabrian Sea. This stock, the subject of VPA studies since 1979 (ANON., 1979-1983), was evaluated acoustically during a joint Spanish-Portuguese cruise in August 1982 (DIAS et al., 1983). The aims of this cruise were to determine the distribution, the population structure and 0^+ groupe abundance and to compare the distribution with oceanographic conditions.

The stock was surveyed acoustically again in 1983. Between 5^{th} August and 1^{st} September, the R.V. "Cornide de Saavedra" surveyed the area between the northern Portuguese border and the French border. The aims of the cruise were the same as in the previous year. The cruise was planned to coincide with the timing of recruitment in July-August (ANON., 1982).

In this report we present the results of the 1983 cruise.

METHODS

Figure 1 shows the survey area, the cruise track, the geographic sectors, the 200 m contour, the pelagic fishing stations and the hydrographic stations.

The survey area was divided into 20 sectors of 20 nautical miles each, and each sector into layers by the 50, 100 and 200 m isobaths. Around Cape Machichaco (3ºN) the transects were extended to 40 n.m. from the coast, beyond the limit of the continental shelf. During the rest of the cruise, the transects extended from depths of 30 m to 200 m. The transects were 10 n.m. apart. The Galician Rias were surveyed as far inshore as the 20 m isobath. 37 pelagic fishing stations and 63 hydrographic stations were occupied. The survey area is aproximately 6500 $n.m^2$. The covering index ($N\sqrt{S}$ = 21.08) is considered acceptable, and minimizes the errors in the indices of relative abundance (AGLEN, 1983).

A SIMRAD EK 400 echosounder of 38 KHz and a QD digital integrator were used during the survey. An echosounder of 120 KHz of the same model contributed to the interpretation of the ecograms. The acoustic instruments were calibrated using a standard target (a copper sphere of 60 mm of diameter, (FOOTE, 1983). The results of the calibration and the settings of the controls during the cruise are shown in Table I.

To calculate the conversion factor C the following expression was used:

$$C = \frac{3.43}{M} \text{ antilog } 0.1 \ (TS_{sph} - 20 \log_r + 10 \log_{\psi} + 30 \text{ TS/Kg})$$

(STROMME et al., 1983)

where

M = Integration value of the standard sphere = 346

T_{sph} = 33.7 dB

r = Depth of the sphere = 20.62 m

$10 \log \psi$ = Solid angle of the transducer = 18

The value of TS/Kg for the sardine was obtained from the equation:

$$TS = 20 \log L - 71.2 \quad \text{(ANON., 1983)}$$

used by the North Sea Group for the herring and from the relation:

$$W = 0.00421 \quad L^{3.1909}$$

obtained during the cruise carried out by the R.V. "Noruega" during the same season on the Portuguese part of the same stock. The result was:

$$TS/Kg_{17} = -32.10 \quad dB$$

The value of C for the cruise was:

$$C = 0.06141 \quad L \quad tons/M \text{ per } n.m^2.$$

Fishing stations were selected in accordance with acoustic traces. A pelagic net with a vertical aperture of 10 m provided with a net-sounder SIMRAD FR-500 with wire was employed. The speed during fishing ranged between 3 and 4 knots. The length distribution of each species in the catch was determined. The sex, stage of sexual maturity and visceral fat content were determined in the case of the sardines, in 10 specimen in each 0.5 cm length-class. The otoliths of these specimen were renoved for age determination.

Hydrographic observations were made with a bathythermograph (275 m maximum depth). The temperature of the surface layer was measured with a digital termometer. The direction and speed of the wind were measured at all hydrographic stations. At the end of each vertical mile, readings of the integrator were made. A daily interpretation of the ecograms, with a separation of the traces corresponding to plankton and fish was carried out.

To plot charts of the distribution of relative density, a moving mean for each consecutive 5 miles was calculated.

The abundance of sardine was estimated for each sector and layer. The biomass values were separated into length-classes according to the size distribution in the net samples. The length distributions were converted to age distributions using a length-age key constructed from the otolith samples. The sectors were grouped into geographic areas: South Galicia (sectors 20-22), North Galicia (23-28), Western Cantabria - Asturias (29-34) and Eastern Cantabria - Euskadi (35-40).

RESULTS

3.1. Estimation of abundance

Table II gives the results of the pelagic trawling. Table III show the values of M (mean mm of integration), L (mean length of the sardine), area, C as a function of length, the fishing stations occupied and the biomass for each sector and layer. Table IV gives the length distributions of sardines in each sample and Table V shows the age/length key obtained during the cruise.

Table VI shows the estimated biomass and the numerical abundance of each age-class in the whole survey area, and for each geographic area.

Fig. 2 gives the distribution of the relative abundance of biomass. In figures 2a, 2b, 2c and 2d this distribution is shown in more detail.

The total biomass estimated was 693000 tons, 76% of the biomass was in Northern Galicia, 10% in Western Cantabria-Asturias and 10% in Southern Galicia. Figure 3 shows the demographic structure of the population in the different areas and in the whole survey area.

The estimated recruitment was 6 000 000 x 10^{-3} individuals. 60% of the total (0 group) was in Southern Galicia (fig. 4).

3.2. Enviromental Conditions

During the cruise, the winds were from the NE quadrant in the eastern Cantabrian Sea. In the Western Cantabrian Sea and in North Galicia, they were weaker, and from the SW quadrant. In Southern Galicia they were again from the NE quadrant, (Table III).

Figure 5 shows the upwelling indices (Bakun, 1973; Blanton et al. 1984) of Cape Finisterre.

Temperature profiles are shown in figures 6a, 6b and 6c. Figures 7a and 7b show the spatial distribution of temperature in the surface and at 50 m.

In the eastern part of the Bay of Biscay, the thermal structure was very stable with a pronounced thermocline between 10 and 20 m.

To the west of Cape Ajo, the isotherms are parallel to the coast and rise towards it. This weakens the thermocline, although it is well marked in deeper areas. These profiles indicate upwelling entranced by capes.

This effect is intensified west of Santander, and off Cape Peñas where the 16º and 15ºC isotherm appear at the surface.

Cold water is more prominent between Cape Ortegal and La Coruña (E46). In this area almost all the surface water on the continental shelf is cooler than 15ºC.

When this profile (E-46-47-48) was repeated two weeks later, the temperature of the surface water was above 16ºC.

The most intense upwelling was detected between Cape Toriñana and Cape Finisterre where the surface temperatures were less than 13.5ºC.

An area of higher temperature (17ºC), can be seen in the mouth of the Ria de Muros, probably due to fresh water run off. In the rest of the rias temperatures were below 15ºC.

DISCUSSION

The survey was interrupted for ten days at La Coruña. The hydrographic conditions during the first and second parts of the cruise were quite different (fig. 7a, 7b).

The effect of these changes on the abundance and spatial distribution of the sardines are not known.

The total biomass estimated for Galicia (560 000 tons) is about three times that for 1982 (DIAS et al. 1983) and 1984 (PASTOR et al. 1985). The estimated biomass for the Cantabrian Sea in 1983 and 1984 (90 000 and 83 000 tons respectively) is of the same order of magnitude.

The low abundance of I age class sardines in the prospected area is in accordance with the failure of recruitment in 1982, detected in the cruise carried out that year, and has also been described by the ICES sardine WG (ANON, 1983), based in the low rate of catches of juveniles.

The estimated value of recruitment for 1983 seems to be better than those of 1982 and 1984.

Significant concentrations of juveniles were detected 15 n.m. from the coast, in surface waters above the edge of the continental shelf.

The winds observed in the eastern Cantabrian Sea are typical for the season. West of Cape Ajo, the Northwest wind enhances upwelling (MOLINA, 1972).

Upwelling is more marked west of Cape Peñas and Cape Ortegal, although the winds there were not favorable.

During the second part of the cruise, the typical august situation described by WOOSTER et al. (1976), FRAGA (1981) and DIAS et al. (1983) was found with a northerly wind component favorable to upwelling.

The situation during this cruise was similar to that described by MOLINA (1972) with warm water in the southeast part of the Bay of Biscay, and upwelling west of Cape Ajo, stronger towards Galicia. The most intensive upwelling occurs north and south of Cape Finisterre, FRAGA (1981), BLANTON et al. (1984).

The maximum concentration of sardine found coincide with this area of maximum upwelling.

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Constant (TVG) (2TL40, 2TL20)	99.1	64.60	dB
Loss transmission at depth r	22.40	22.40	dB
Attenuation TVG at depth r	77.98	43.38	dB
Gain selected	-20	-20	dB
Gain measured	-20	-20	dB
Power output	Alta	Alta	
Signal duration	1	1	m sec
Bandwidth	3.3	3.3	kHz
Echo level	0.24	1	Vp-p
20 lg V/2V2	-20.73	-9.03	dB
SL + VR	131.9	131.5	

Frequency 38 kHz

Water temperature 17ºC

Sound velocity (c) 1490 m/seg.

Sphere integration	
upper limit	11 m
lower limit	16 m
threshold	10 mV
M (mm)	905

Echosounder	EK 400-38
Transducer	30x15 ceramic
Transmitter power	HGH
TVG/Gain	20 log R/O dB
Pulse length	1.0 ms
Bandwidth	3.3 kHz
Integrator	Digital QX+QD
Gain	OdB x 100
Threshold	10 mV

TABLE I.- Calibration results of acoustic gear, and settings of controls during cruise.

DATE	TIME	STATION Nº	GEAR	DEPTH (m) BOTTOM	DEPTH (m) GEAR	POSITION (START) LAT.N	POSITION (START) LONG.W	CATCH TOTAL	DOMINANT SPECIES	WEIGHT (Kg) P/HOUR	WEIGHT (Kg) %
05/08	20h21m	1	PT	89	18	43º 23'	1º 59'	14.1	Trachurus trachurus	7.8	55
									Micromesistius poutassou	3.0	21
									Merluccius merluccius	1.8	13
									Scomber scombrus	1.3	9
05/08	22h41m	2	PT	90	16	43º 24'	1º 54'	91.5	Trachurus trachurus	159.9	87
06/08	07h34m	3	PT	116	29	43º 23'	2º 28'	36.7	Polybius henslowi	35.7	97
06/08	15h28m	4	PT	327	10	43º 37'	2º 41'	15.0	Polybius henslowi	11.0	71
									Micromesistius poutassou	2.0	15
06/08	19h30m	5	PT	80	28	43º 29'	2º 46'	239.2	Sardina pilchardus	159.9	67
									Trachurus trachurus	65.2	27
06/08	21h39m	6	PT	178	16	43º 32'	2º 54'	158.4	Trachurus trachurus	84.6	53
									Sardina pilchardus	44.4	28
									Polybius henslowi	26.5	17
07/08	19h56m	7	PT	96	16	43º 31'	3º 48'	56.8	Trachurus trachurus	53.3	94
									Polybius henslowi	2.1	4
									Sardina pilchardus	1.2	2
08/08	07h26m	8	PT	47	16	43º 26'	4º 18'	43.9	Polybius henslowi	43.9	100
08/08	08h43m	9	PT	55	16	43º 27'	4º 21'	10.7	Polybius henslowi	10.7	100
08/08	19h12m	10	PT	88	30	43º 36'	4º 58'	14.0	Trachurus trachurus	6.0	43
									Polybius henslowi	4.7	33
									Sardina pilchardus	2.4	17
08/08	22h08m	11	PT	52	23	43º 31'	5º 12'	20.6	Polybius henslowi	17.1	83
									Micromesistius poutassou	1.1	5
									Trachurus trachurus	0.8	4
									Sardina pilchardus	0.5	3
09/08	07h00m	12	PT	70	30	43º 37'	5º 39'	595.0	Trachurus trachurus	508.6	85
									Micromesistius poutassou	54.8	9
									Sardina pilchardus	11.5	2
									Engraulis encrasichows	9.3	2
09/08	12h50m	13	PT	84	30	43º 40'	5º 54'	120.7	Sardina pilchardus	92.8	77
									Polybius henslowi	27.9	23
09/08	15h32m	14	PT	54	23	43º 36'	6º 05'	9.4	Sardina pilchardus	6.8	73
									Polybius henslowi	2.5	27
09/08	19h26m	15	PT	127	130	43º 46'	6º 20'	46.4	Sardina pilchardus	25.4	55
									Trachurus trachurus	18.3	39
									Polybius henslowi	1.6	3
10/08	08h43m	16	PT	137	122	43º 35'	7º 02'	96.4	Micromesistius poutassou	89.3	93
									Merluccius merluccius	3.0	3
									Trachurus trachurus	3.0	3
10/08	16h30m	17	PT	53	20	43º 38'	7º 17'	-	-	-	-
10/08	19h30m	18	PT	47	12	43º 44'	7º 36'	388.0	Sardina pilchardus	189.2	49
									Trachurus trachurus	166.2	42
									Polybius henslowi	20.5	5
									Scomber scombrus	12.1	4
11/08	07h28m	19	PT	176	156	43º 51'	8º 10'	117.1	Micromesistius poutassou	112.1	97
11/08	11h15m	20	PT	98	20	43º 39'	8º 11'	27.1	Sardina pilchardus	20.1	74
									Polybius henslowi	7.0	26
11/08	19h01m	21	PT	98	13	43º 24'	8º 29'	109.4	Sardina pilchardus	78.0	74
									Trachurus trachurus	19.7	12
									Polybius henslowi	10.7	8
									Micromesistius poutassou	7.9	6
11/08	21h09m	22	PT	56	20	43º 27'	8º 28'	529.5	Sardina pilchardus	513.9	97
									Trachurus trachurus	6.7	1
									Polybius henslowi	5.5	1
12/08	07h21m	23	PT	85	83	43º 27'	8º 31'	52.3	Trachurus trachurus	36.5	70
									Polybius henslowi	6.6	13
									Sardina pilchardus	6.5	12
13/08	16h56m	24	PT	29	26	43º 26'	8º 18'	207.6	Trachurus trachurus	111.3	54
									Sardina pilchardus	80.6	38.8
									Polybius henslowi	4.2	2.0
14/08	21h05m	25	PT	53	10	43º 18'	8º 57'	137.7	Sardina pilchardus	96.4	70
									Polybius henslowi	27.2	20
									Trachurus trachurus	7.0	5
									Scomber scombrus	6.2	5
14/08	00h14m	26	PT	27	10	43º 14'	8º 59'	76.5	Sardina pilchardus	66.9	88
									Polybius henslowi	4.2	6
									Micromesistius poutassou	2.4	3
									Trachurus trachurus	2.1	3
15/08	21h50m	28	PT	60	40	42º 42'	9º 07'	128.5	Trachurus trachurus	65.4	50.9
									Sardina pilchardus	45.6	35.5
									Micromesistius poutassou	3.6	2.8
28/08	20h47m	29	PT	105	30	43º 19'	8º 59'	82.5	Polybius henslowi	62.0	75
									Trachurus trachurus	12.3	15
									Micromesistius poutassou	6.3	8
28/08	22h33m	30	PT	170	20	43º 27'	9º 00'	243.34	Sardina pilchardus	223.8	92
									Polybius henslowi	14.2	5.
									Trachurus trachurus	5.3	2
29/08	12h10m	31	PT	190	20	42º 51'	9º 29'	2321.5	Sardina pilchardus	2318.62	99
29/08	14h52m	32	PT	150	130	42º 43'	9º 29'	8.97	Polybius henslowi	4.5	49
									Scomber scombrus	1.5	16
									Micromesistius poutassou	1.5	16
									Merluccius merluccius	0.4	4
29/08	22h30m	33	PT	190	10	42º 27'	9º 19'	55.95	Sardina pilchardus	33.1	59
									Polybius henslowi	21.8	39
									Trachurus trachurus	0.8	1
30/08	07h01m	34	PT	50	20	42º 21'	8º 53'	4.07	Sardina pilchardus	2.5	61
									Polybius henslowi	.9	22
									Scomber scombrus	.4	9
									Trachurus trachurus	.3	6
30/08	14h35m	35	PT	75	10	42º 09'	8º 56'	83.25	Sardina pilchardus	82.5	99
30/08	21h56m	36	PT	100	10	42º 02'	9º 01'	348.35	Sardina pilchardus	343.1	98
									Polybius henslowi	3.6	1

Table II.– Characteristics and results of fishing stations.

SECTOR	STRATUM (DEPTH-m)	AREA (n.m.^{2})	$\bar{M}$	$\bar{L}$ (cm)	FISHING STA.No.	BIOMASS (Tons)
20	0-50 50-100 100-200	20.55 54.35 279.79	49 93 35	11.36 11.36 10.68	35, 36 35, 36 33	1 147.92 5 762.19 10 478.14
21	0-50 50-100 100-200	20.90 76.30 208.71	97 54 94	13.88 18.43 10.68	34 35 33	2 817.95 7 581.17 20 992.05
22	0-50 50-100 100-200	28.91 95.47 191.28	55 66 48	15.33 15.33 11.39	28 28 31, 33	2 432.78 9 640.56 10 466.84
23	0-50 50-100 100-200	28.91 49.47 155.05	56 81 13	11.16 15.53 11.36	26 28 30, 31	1 813.24 6 210.96 2 297.84
24	0-50 50-100 100-200	29.96 74.21 192.33	462 560 146	11.16 15.53 11.11	26 28 30	15 779.33 64 414.28 31 169.00
25	0-50 50-100 100-200	59.93 105.57 317.07	118 112 242	19.01 18.96 18.92	22,23,24,25 22,23,24 21	13 436.31 22 465.30 145 021.48
26	0-50 50-100 100-200	17.42 79.79 275.95	458 632 8	20.22 20.22 20.22	18, 20 18, 20 18, 20	16 116.29 101 863.11 4 459.35
27	0-50 50-100 100-200	58.53 57.49 363.41	317 44 10	20.22 20.22 20.22	18, 20 18, 20 18, 20	37 479.10 5 109.71 7 340.88
28	0-50 50-100 100-200	33.1 55.05 429.61	85 60 3	20.22 20.22 20.22	18, 20 18, 20 18, 20	5 683.27 6 672.06 2 603.44
29	0-50 50-100 100-200	24.04 64.80 363.06	38 7 9	20.86 20.86 20.86	12,13,14,15 12,13,14,15 12,13,14,15	1 909.26 948.02 6 829.16
30	0-50 50-100 100-200	18.81 94.77 134.49	- 16 10	- 20.86 20.86	- 12,13,14,15 12,13,14,15	 3 169.11 2 810.84
31	0-50 50-100 100-200	35.88 29.09 160.27	36 268 11	20.86 20.86 20.86	12,13,14,15 12,13,14,15 12,13,14,15	2 699.61 16 293.89 3 684.61
32	0-50 50-100 100-200	22.99 79.44 267.59	96 30 6	20.86 20.86 20.86	12,13,14,15 12,13,14,15 12,13,14,15	4 612.71 4 980.89 3 355.58
33	0-50 50-100 100-200	24.04 66.55 206.96	- 0.5 30	- 10.72 10.72	- 10, 11 10, 11	 35.60 6 643.42
34	0-50 50-100 100-200	26.69 43.55 157.49	29 7 55	10.72 10.72 10.72	10, 11 10, 11 10, 11	828.19 326.19 9 268.29
35	0-50 50-100 100-200	29.61 50.52 98.96	73 - 6	11.54 - 11.54	5, 6, 7 - 5, 6, 7	2 486 - 683
36	0-50 50-100 100-200	68.98 65.5 58.18	48 39 -	11.54 11.54 -	5, 6, 7 5, 6, 7 5, 6, 7	3 808 2 938 -
37	0-50 50-100 100-200	31.35 116.72 72.12	- 0.5 3	- 11.54 11.54	- 5, 6, 7 5, 6, 7	- 67 249
38	0-50 50-100 100-200	26.82 65.50 81.18	- 23 18	- 11.54 11.54	- 5, 6, 7 5, 6, 7	 1 733 1 680
39	0-50 50-100 100-200	14.28 131.01 135.54	1 4 3	11.54 11.54 11.54	5, 6, 7 5, 6, 7 5, 6, 7	- - -
40	0-50 50-100 100-200	36.58 102.09 160.97	- - -	- - -	- - -	- - -
TOTAL						643 292

TABLE III.- Values of

$\bar{M}$ (integrated in mm)

$\bar{L}$ mean length of sardines, area, C as a function of length, fishing stations and biomass for each sector and level.

l(cm)	P-3	P-5	P-6	P-7	P-10	P-11	P-12	P-13	P-14	P-15	P-18	P-20	P-21	P-22	P-23	P-24	P-25	P-26	P-28	P-30	P-31	P-33	P-34	P-35	P-36
8	–	–	–	–	–	–	–	–	–	–	–	–	–	26	–	–	3	300	–	–	–	–	–	–	697
9	–	–	–	–	7	–	–	–	–	–	–	–	–	251	–	–	2	2 343	12	–	–	–	–	–	5 287
10	–	598	671	2	57	–	–	–	–	–	–	–	–	1 135	–	–	–	120	140	2 664	3 750	312	2	–	8 405
11	–	4 425	2 093	58	90	2	–	–	–	–	–	–	–	76	–	–	–	–	314	12 790	110 846	779	9	–	2 430
12	–	3 709	671	35	45	1	–	–	–	–	–	–	–	–	–	–	–	–	12	4 263	72 880	1 285	42	–	9 439
13	–	479	40	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	266	2 357	78	30	–	2 669
14	10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11	–	349
15	4	–	–	–	–	–	–	–	–	–	–	–	–	24	–	–	–	–	–	–	–	–	4	–	74
16	2	–	–	–	–	–	–	–	1	–	–	–	–	–	–	20	–	–	–	–	–	–	–	24	9
17	1	–	–	–	–	1	–	–	4	–	–	–	39	–	–	–	20	57	16	–	–	–	–	72	–
18	1	18	–	–	–	–	–	–	4	–	75	29	395	48	4	20	409	171	148	–	–	–	3	621	–
19	1	64	–	–	–	–	14	129	4	13	597	29	494	240	10	–	513	301	278	–	–	–	6	741	–
20	–	229	3	–	–	2	43	371	30	53	822	96	138	336	8	102	292	106	163	–	–	–	7	–	–
21	–	74	–	–	–	1	14	357	17	89	697	32	79	697	18	102	143	–	32	–	–	–	2	–	–
22	–	–	9	–	–	2	14	144	23	72	273	63	–	1 058	22	327	20	8	16	–	–	–	4	–	–
23	–	–	–	–	–	1	14	85	11	36	–	4	20	673	14	653	41	6	–	–	–	–	–	–	–
24	–	–	8	–	–	–	–	15	1	8	–	4	–	264	–	61	–	–	–	–	–	–	–	–	–
25	–	–	–	–	–	1	–	–	–	4	–	–	–	48	1	–	–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20	–	–	–	–	–	–	–	–	–

TABLE IV.- Length distribution of sardines in each sample.

Length \ Age	0	I	II	III	IV	V	VI	VII	VIII	IX	X	
9												
10	9 (100)											9
11	20 (100)											20
12	21 (100)											21
13	22 (100)											22
14	12 (100)											12
15	4 (100)											4
16		3 (100)										3
17		8 (73)	3 (27)									11
18		6 (26)	12 (52)	4 (18)	1 (4)							23
19			18 (58)	8 (26)	4 (13)	1 (3)						31
20			11 (44)	9 (36)	3 (12)	2 (8)						25
21			12 (50)	5 (21)	5 (21)	1 (4)			1 (4)			24
22			1 (7)	1 (7)	4 (26)	3 (20)	3 (20)	1 (7)	2 (13)			[illegible]5
23			1 (6)		2 (12)	4 (23)	3 (18)	4 (23)	2 (12)	1 (6)		17
24							1 (9)	3 (27)	6 (55)		1 (9)	11
25										1 (50)	1 (50)	2
26												
TOTAL	88	17	58	27	19	11	7	8	11	2	2	250

TABLE V.- Length/age key obtained during cruise.

$\bar{l}$	Age	EUSKADI-CANT.OR.	CANT.OCC.-ASTURIAS	NORTH GALICIA	SOUTH GALICIA	TOTAL
10.97	0	813 461	1 192 960	465 050	3 805 850	6 277 321
17.56	I	311	6 154	202 089	29 335	237 889
19.56	II	12 362	228 682	2 561 620	111 325	2 913 989
19.7	III	7 939	133 725	1 337 000	47 569	1 526 233
20.27	IV	3 636	105 640	765 508	20 508	895 292
20.81	V	1 676	60 427	318 824	5 597	386 524
22.28	VI	167	33 111	105 173	1 073	139 524
22.70	VII	185	23 884	63 189	375	87 633
22.11	VIII	566	33 542	118 787	856	153 751
23.72	IX	-	7 335	9 187	-	16 522
24.7	X	48	4 502	4 312	-	8 862
TOTAL		840 350	1 829 956	5 950 747	4 022 492	12 643 545
BIOMASS		13 644	68 396	489 933	71 320	643 293

TABLE VI.- Numbers in each age class for whole survey area, and for each geographical sector.

STATION No	DATE 1982	GMT	POSITION LAT.N	LNG.W	DEPTH (m)	WIND Dir.	Vel. (Knots)	SEA TEMPERATURE (ºC) 0m	25m	50m	100m
1	Aug. 6	2 40	43º 30.5'	2º 15.7'	200	Calm		22	14.2	12.8	12.1
2	6	3 50	43 25	2 13.2	120	N	3	22.2	13.5	12.4	12
3	6	4 40	43 19.7	2 13.1	50	N	3	22.1	13.3	-	-
4	6	17 46	43 32.7	2 41.7	181	N	10	22.1	13.5	12.3	11.8
5	6	18 10	43 30.1	2 41	106	N	10	22.3	14.0	12.2	-
6	6	18 55	43 27.2	2 42.6	32	N	10	22.6	13.7	-	-
7	7	6 30	43 33.4	3 07.8	160			21.8	14	12.2	11.9
8	7	7 30	43 27.8	3 09.1	80			21.8	14	12	-
9	7	8 10	43 23.9	3 08.7	31			21.4	12.5	-	-
10	7	17 05	43 34.6	3 33.4	200	NE	10	21.8	12.4	11.9	11.5
11	7	17 40	43 33.6	3 33.4	111	NE	10	21.6	12.3	11.8	-
12	7	18 30	43 30	3 35.4	40	NE	10	19.8	11.8	-	-
13	7	23 45	43 34.1	4 04	200	E	12	19.5	12.7	12.1	11.8
15	8	1 00	43 27.3	4 04.5	33	E	12	18.3	12	-	-
16	8	12 50	43 31.3	4 31.1	300	NNE	4	19.5	12.6	12.1	11.8
17	8	13 27	43 28.4	4 32.1	225	NNE	4	19	12.5	11.9	11.4
18	8	13 57	43 25.3	4 31.2	41	NNE	4	18.2	11.5	-	-
19	8	18 45	43 37.2	4 58	200	W	4	17	12.8	12.3	11.7
21	8	20 55	43 29	4 58.4	42	W	4	16.8	12.1	-	-
22	9	2 46	43 52	5 25.8	193	WSW	5	20.8	16	12.3	12
23	9	4 18	43 41.5	5 27.8	140	WSW	5	17.2	12.7	12.1	11.4
24	9	5 22	43 34.9	5 26.8	44	WSW	5	16.6	12.5	-	-
25	9	10 51	43 52.4	5 53.1	300	W	6	20.2	15.6	13	12.2
26	9	11 59	43 44.3	5 53.5	115	W	6	19.1	12.7	11.9	11.6
27	9	12 45	43 39.2	5 54.8	41	W	6	14.5	12	-	-
28	9	18 45	43 46.1	6 20.5	212	W	6	19.1	13.3	12.4	12.1
29	9	21 30	43 40.4	6 20.7	90	W	6	17.5	13	12.2	-
30	9	22 15	43 35	6 20.3	50	W	6	15.8	13	-	-
31	10	3 20	43 55	6 48.2	124	W	10	17.8	13.7	12.8	11.8
32	10	4 40	43 46	6 48	120	W	8	17.2	15.2	12	11.4
33	10	6 08	43 36.7	6 47.9	37	W	4	14.2	13.1	-	-
34	10	12 32	44 05.3	7 16.2	200	W	8	19.3	14.3	12.7	12
35	10	14 25	43 51.4	7 16.7	151	W	10	17.6	14.5	12.4	11.5
36	10	16 18	43 38.5	7 16.5	24	W	10	16.1	-	-	-
37	10	23 52	44 03.2	7 41.2	181	W	7	18.7	16	12.5	12.1
38	11	1 01	43 53.8	7 44.6	131	W	10	17.6	16	13	-
39	11	1 57	43 48.2	7 45.9	58	W/SW	4	15.2	13.4	12.5	-
40	11	6 15	43 57.1	8 11.1	209	W/SW	4	18.6	15.2	12.8	12.1
41	11	9 14	43 49	8 08	124	W/SW	8	15.2	13.2	12.5	12.1
42	11	10 10	43 43.2	8 04.7	65	SW	3	14.2	14.2	12.7	-
43	11	15 05	43 45	8 32	200	SW	8	17.3	16.0	13.0	12.2
44	11	16 15	43 39	8 26	150	SW	5	14.9	13.3	12.4	12
45	11	16 55	43 34.7	8 20.5	50	SW	3	18	13.7	-	-
46	12	3 42	43 35	8 52	200	-	-	15.6	14	12.7	12
47	12	5 08	43 28	8 47	148	-	-	14.8	14	12.8	12.2
48	12	6 20	43 22	8 42	100	-	-	14.3	14	12.5	-
46 bis	28	16 41	43 35.7	8 52.2	200	N	15	18.7	17	15	12.4
47 bis	28	18 15	43 27.2	8 45	137	N	15	17.5	15	13	12
48 bis	28	19 10	43 23	8 42.7	103	N	15	16.9	14	12.8	-
49	29	1 11	43 22.4	9 14.5	190	NE	4	17	15	12.9	12.2
50	29	2 03	43 16.4	9 13.7	111	NE	4	16.5	14.2	12.8	-
51	29	2 58	43 13.8	9 7.5	79	NE	6	15.1	13	12.4	-
52	29	7 45	43 2.9	9 30.2	197	NE	8	15.8	15.3	13.6	12.6
53	29	8 55	43 03	9 25.9	152	NE	16	15.3	14.8	13.4	12.3
54	29	9 55	43 2.9	9 20	62	NE	16	13.1	13	12.3	-
55	29	14 35	42 42.2	9 30.5	183	NE	16	15.1	14.6	12.7	12.4
56	29	17 10	42 43.2	9 17.9	132	NE	12	16.4	13	12.5	-
57	29	18 29	42 42.9	9 6.2	57	NE	6	16.5	13.3	12.1	-
58	30	0 30	42 23.1	9 14.6	200	NE	6	16.7	14.3	13.1	12.4
59	30	1 21	42 23.2	9 07.5	125	NE	5	16.6	13.7	12.6	12.1
60	30	2 19	42 22.8	8 58.6	70	NE	5	16.2	12.5	12.1	-
61	30	19 30	42 3.3	9 20.2	200	S	6	17.8	15.3	13.8	12.7
62	30	21 00	42 2.5	9 5.5	130	S	6	16.9	13.8	13.3	12.7
63	30	23 20	42 1.5	8 55.9	50	S	6	14.6	12.6	-	-

TABLE VII.- Thermal characteristics of stations, winds observed, and mean temperatures.

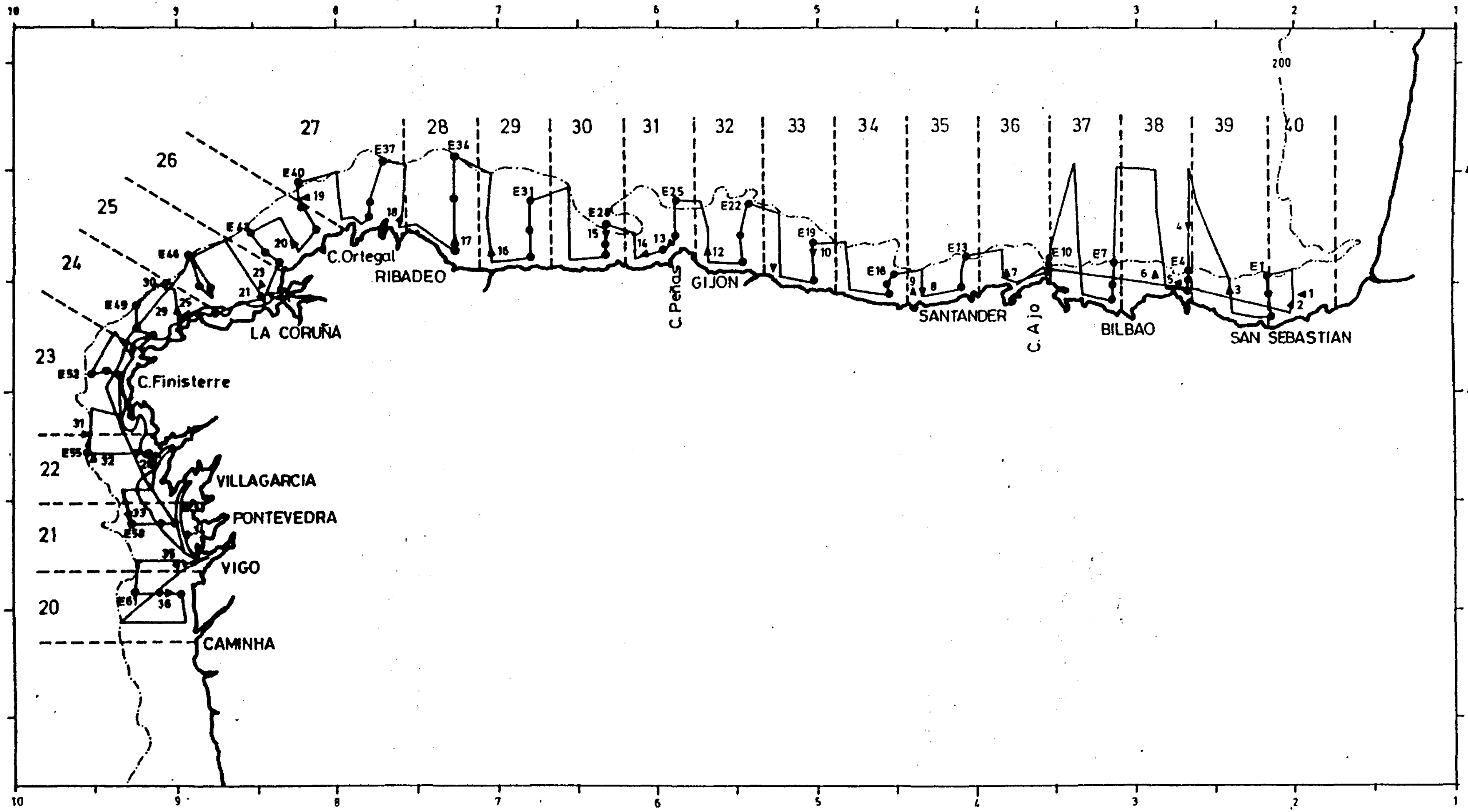


FIGURE 1.- Area surveyed showing cruise track, geographical sectors, 200 m contour, and fishing and hydrographic stations.

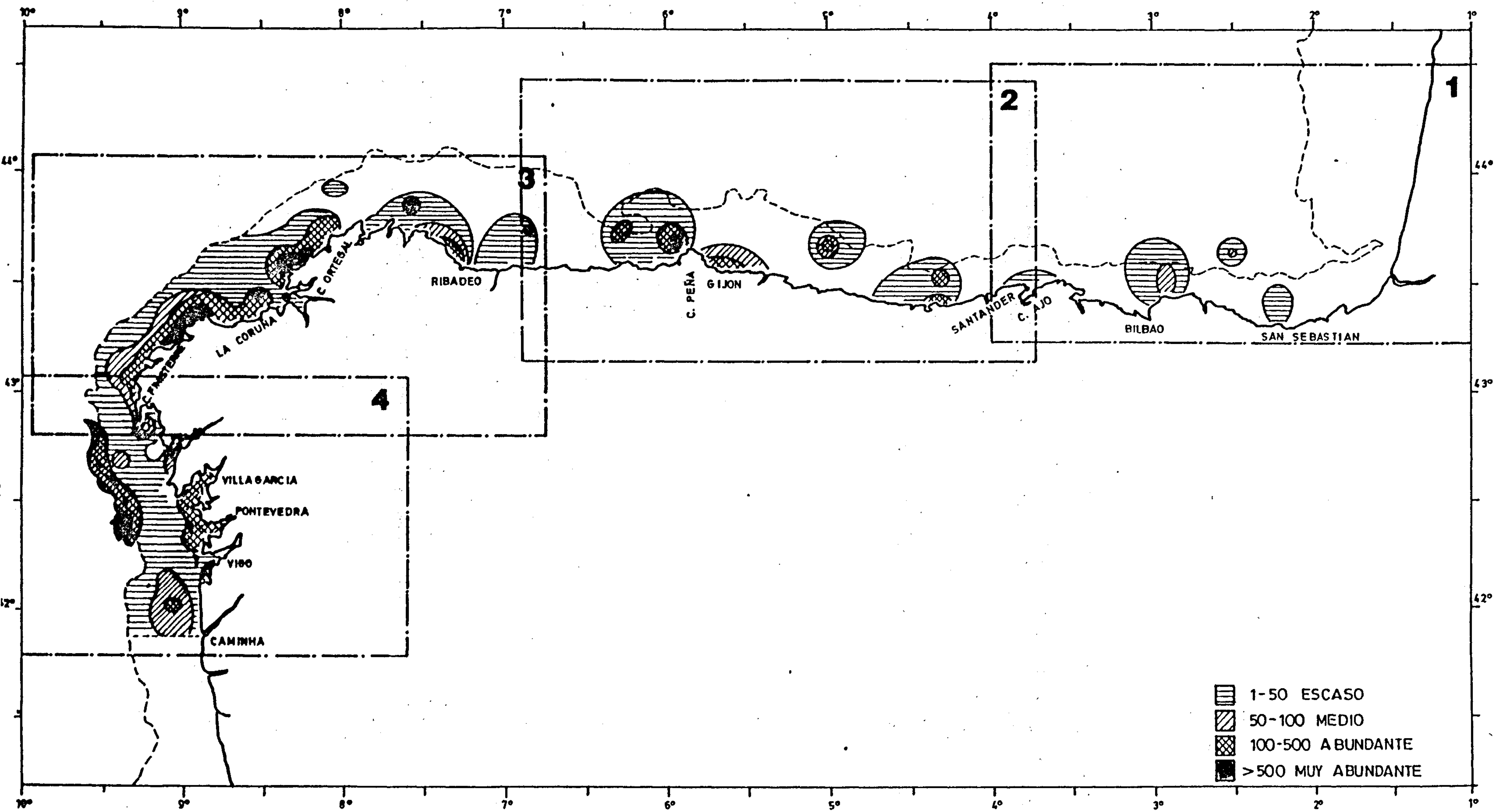


FIGURE 2.- Relative abundance of biomass in survey area.

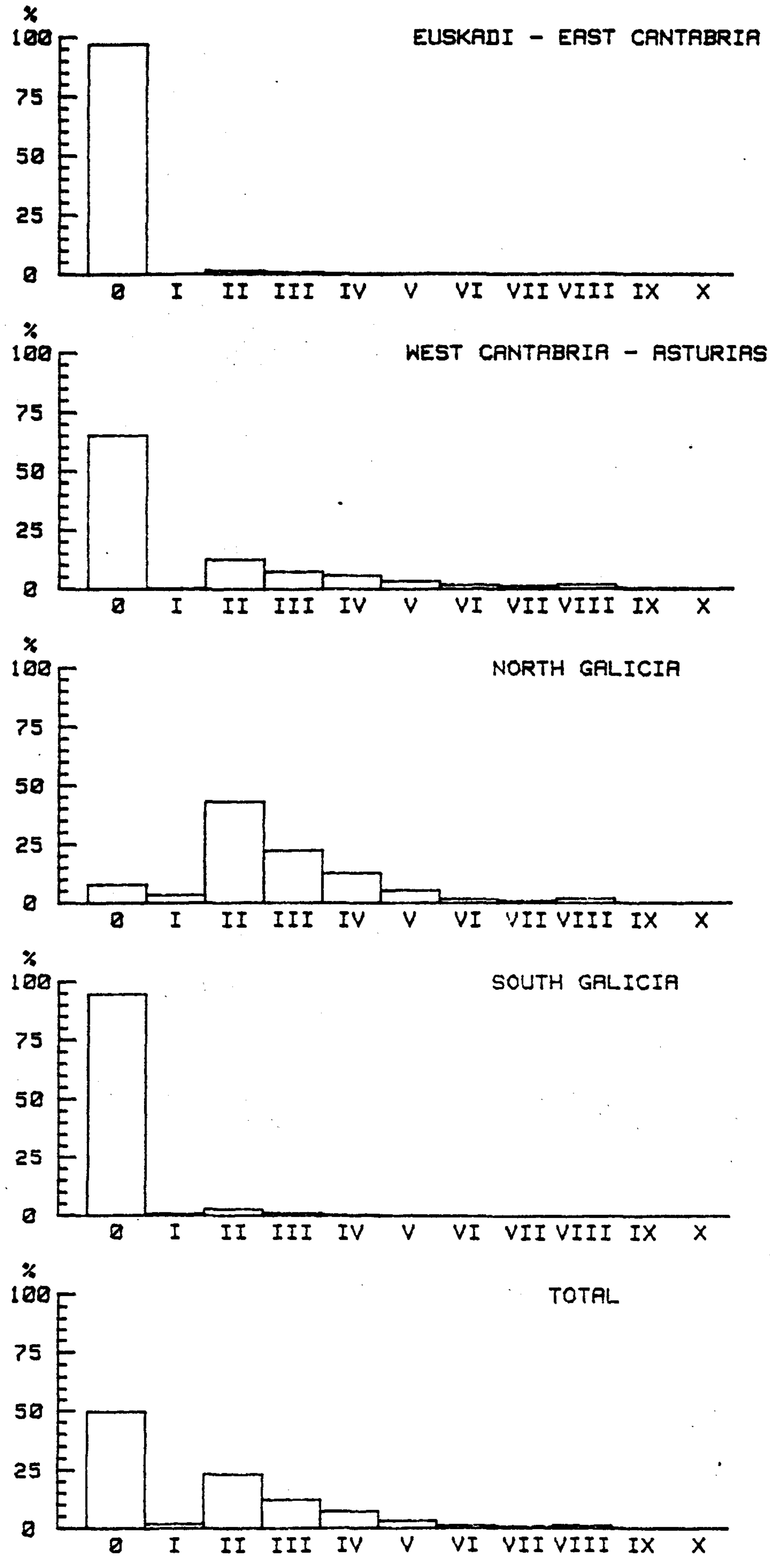


FIGURE 3.- Demographic structure of sardine population in each sector.

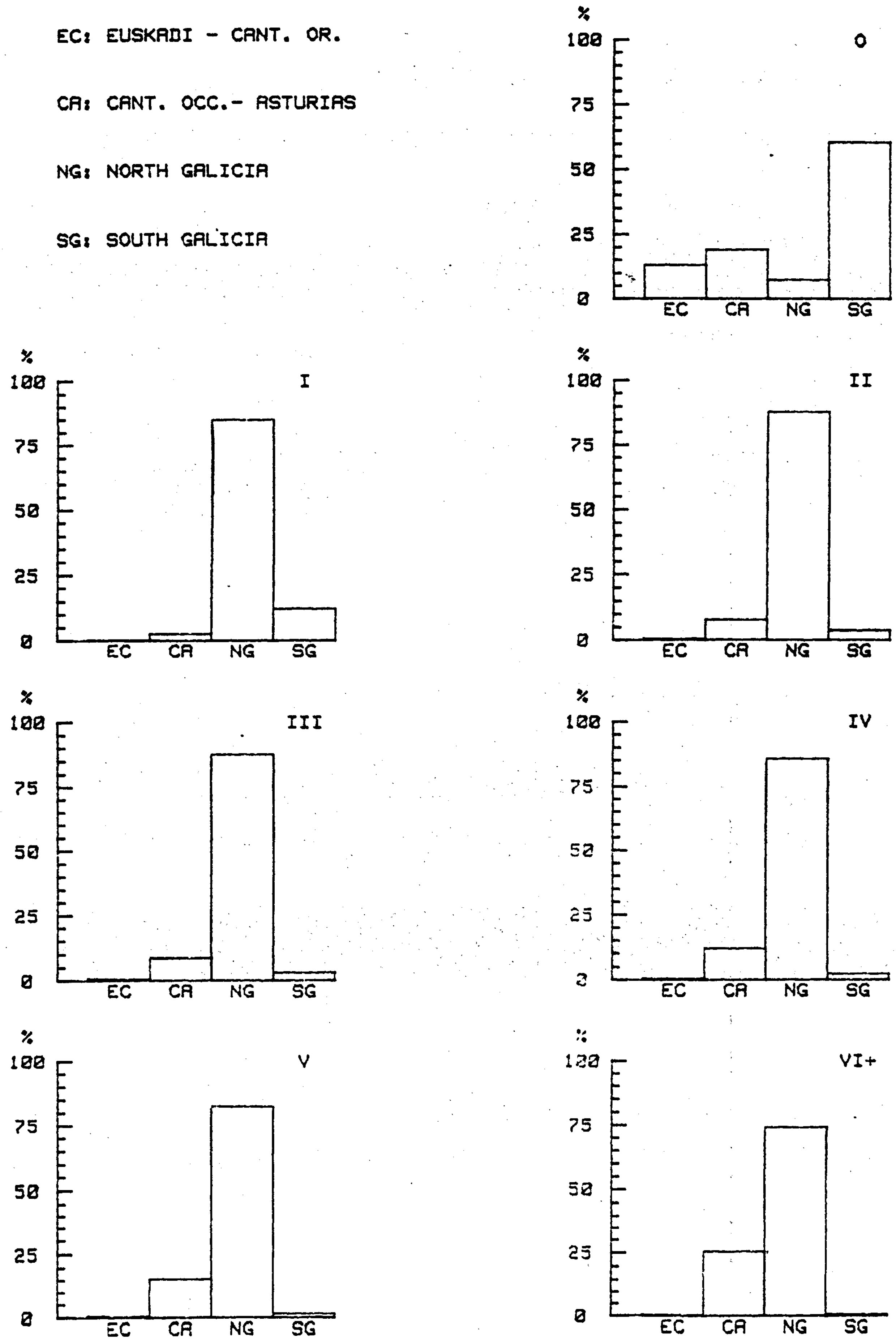


FIGURE 4.- Age-class abundance (percentages) in each sector and in whole survey area.

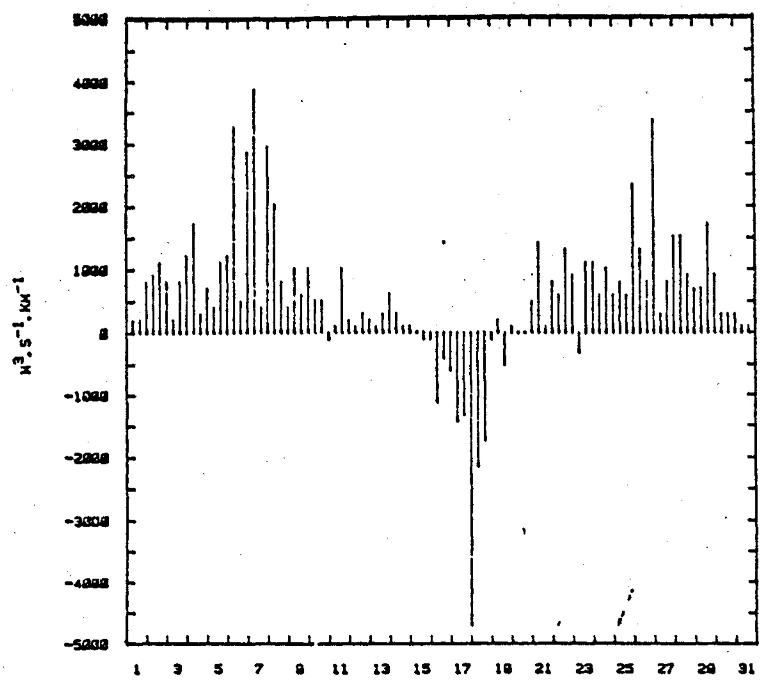
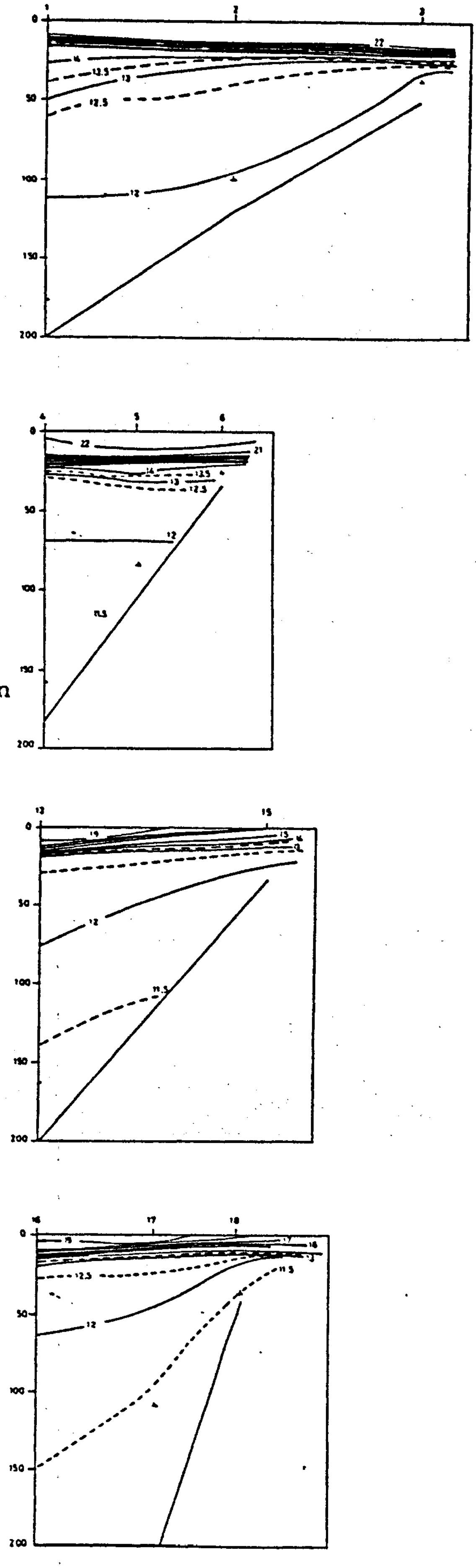


FIGURE 5.- Daily upwelling indices on Galician Coast, in 43ºN, 11ºW, for August 1983.



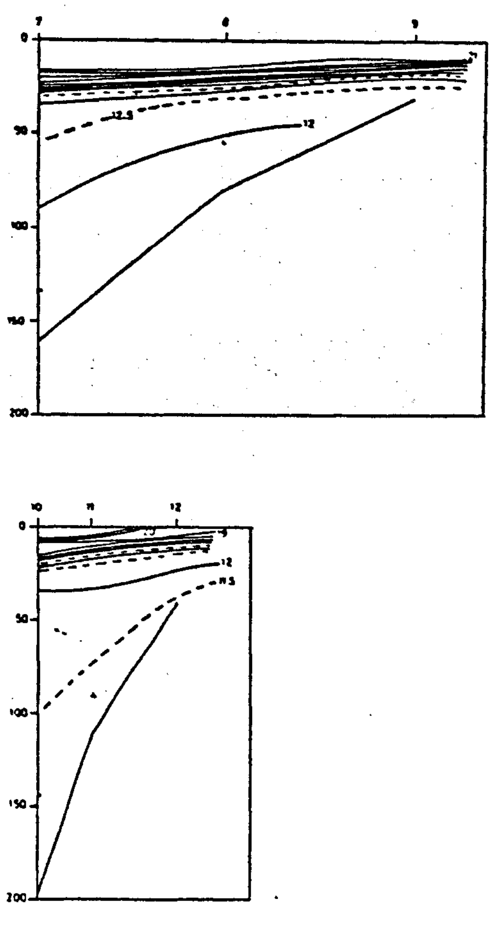


FIGURE 6.- Vertical temperature structure.

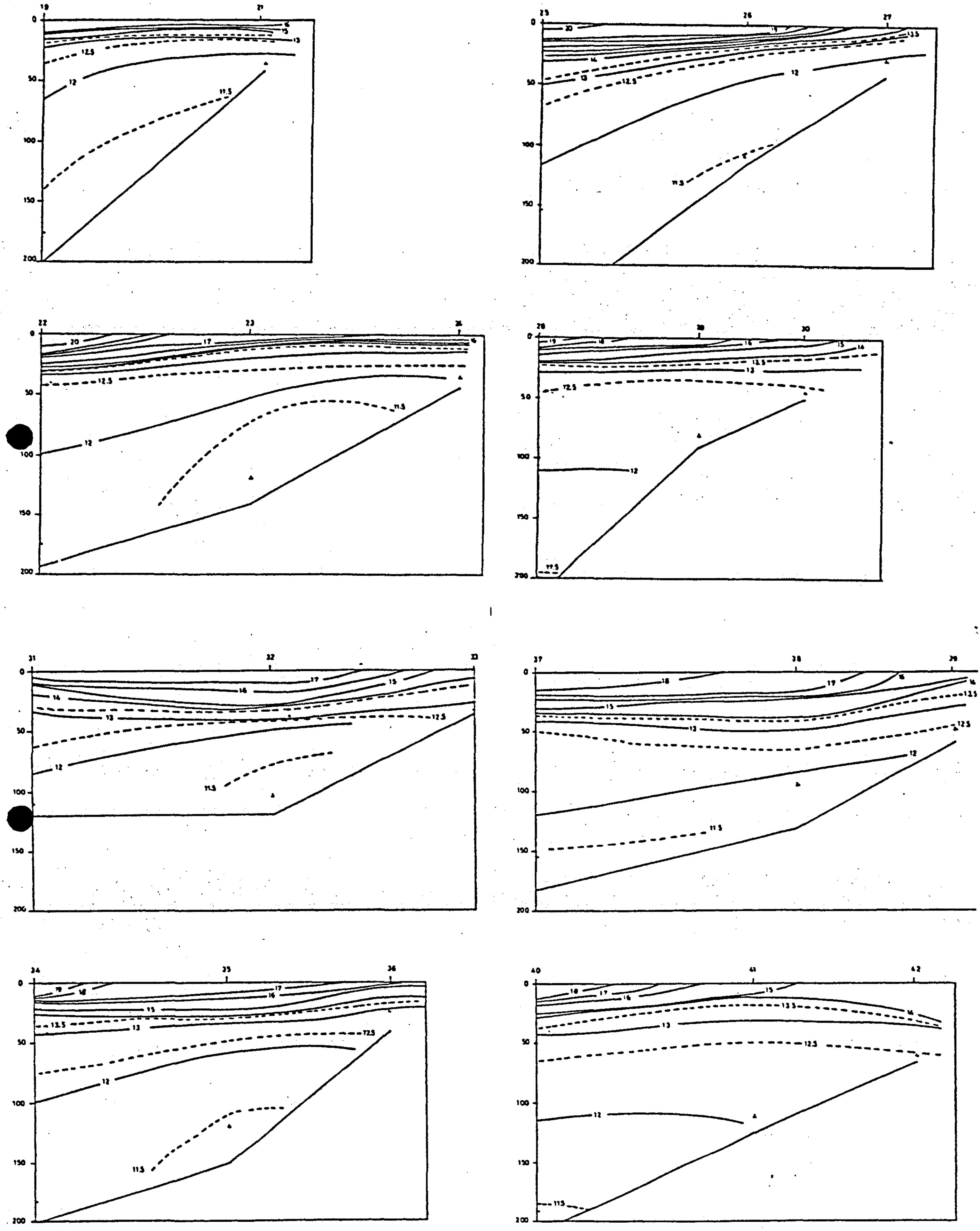


FIGURE 6 (Cont.)

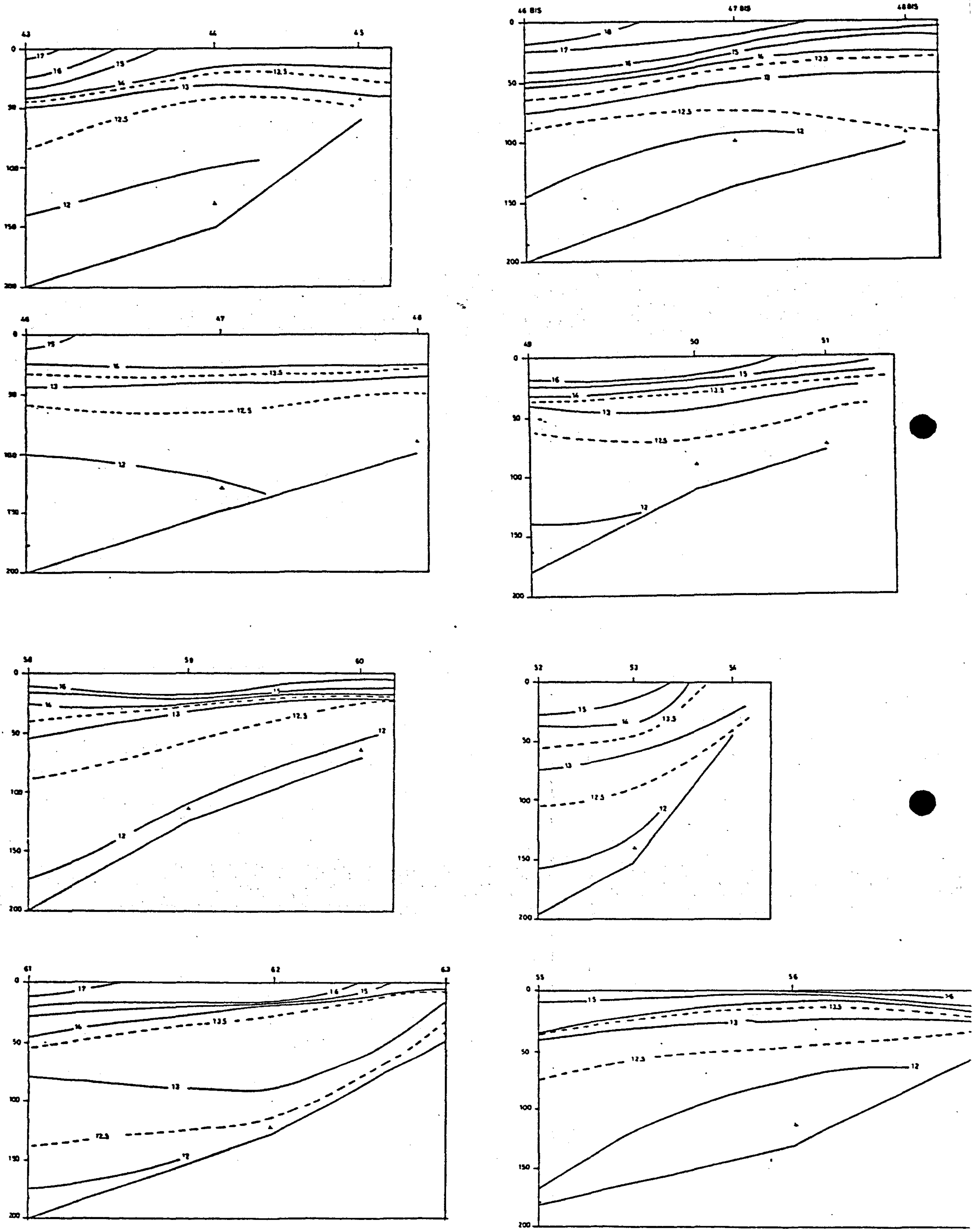


FIGURE 6 (Cont.)

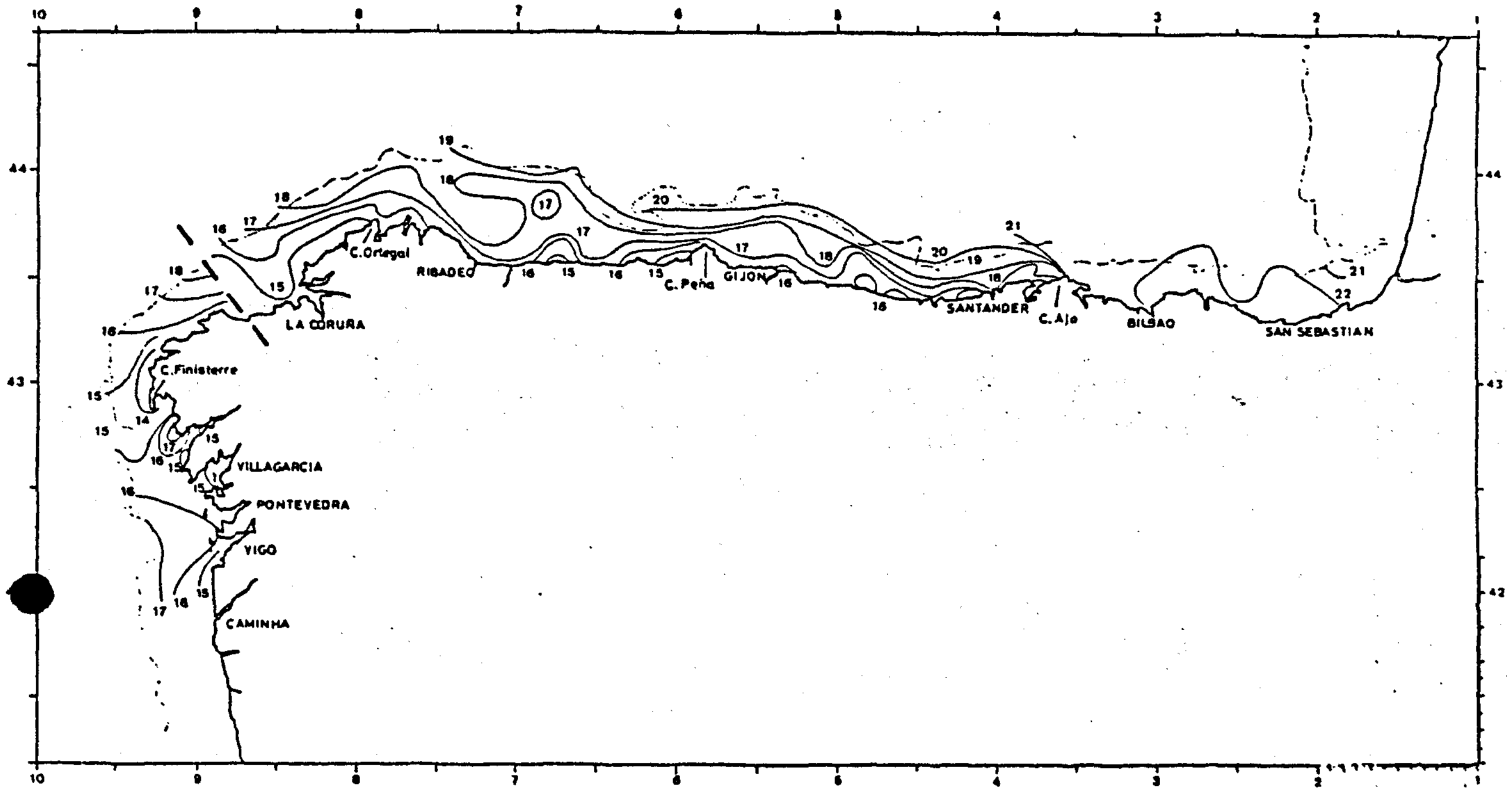


FIGURE 7a.- Distribution of surface temperature.

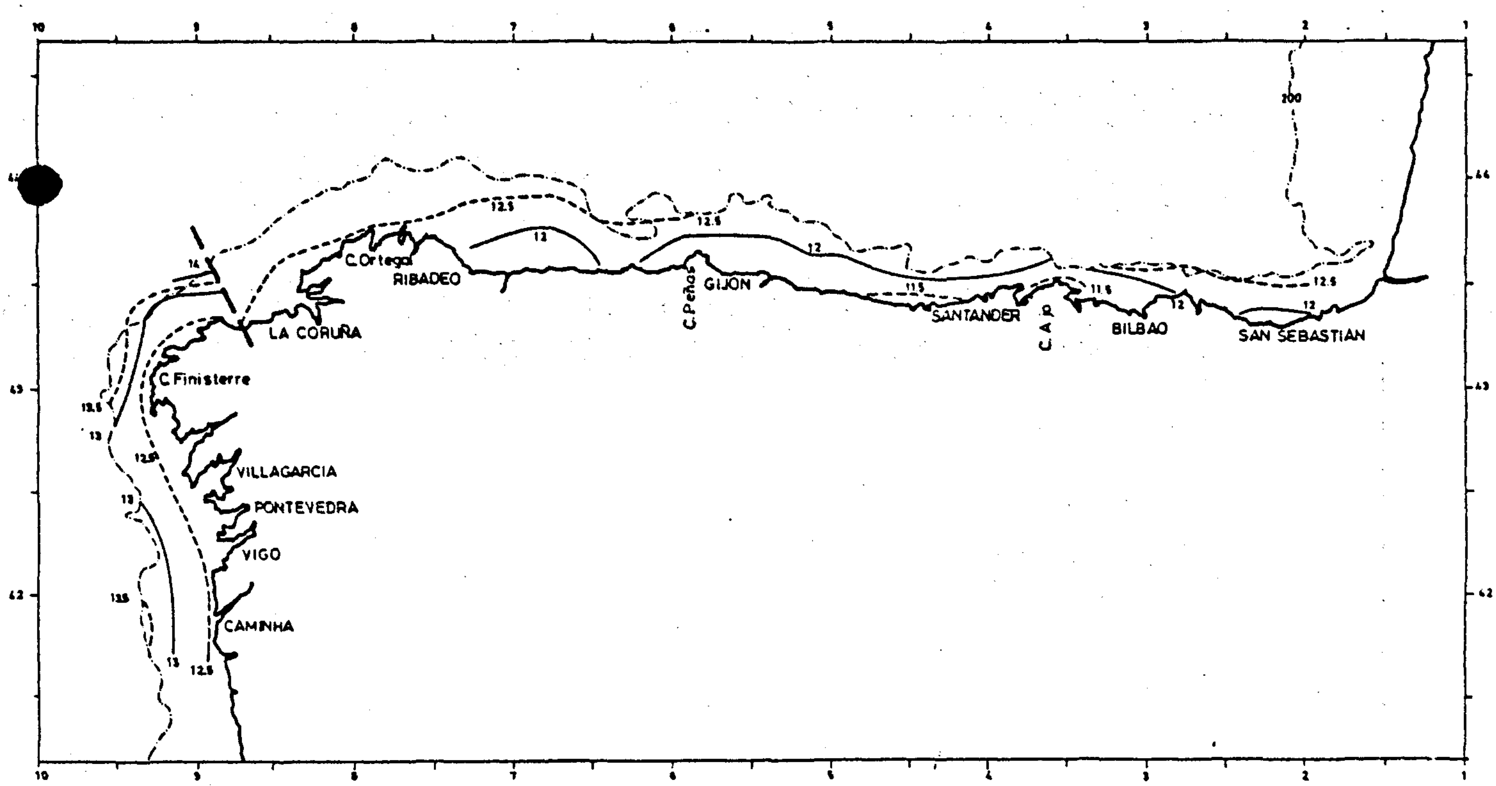


FIGURE 7b.- Distribution of temperature at 10 m.