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International Council for the Exploration of the Sea

CM 1982 / H : 38
Pelagic Fish Committee

Herring larval surveys in the Celtic Sea in 1981/82

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Abstract

The distributions of herring larvae sampled on ten cruises off the south coast of Ireland during the 1981/82 spawning season are described. A new larval abundance index, which is based on the abundances of <10mm larvae prior to 15 December and on <11mm larvae afterwards, has been calculated for the last four seasons. This index shows an increase each year since 1978/79 indicating that the spawning stock biomass has also increased.

Introduction

Surveys for herring larvae spawned by autumn and winter-spawning herring have been conducted between October and February each season since 1978/79 (Grainger 1979, 1980; Grainger and Cullen 1981). Indices of larval abundance have been calculated as outlined in the 1981 Herring Larval Working Group Report (CM 1981/H:3). Briefly, the areas under the straight lines joining <10mm larval abundance estimates plotted on time were found for each of the periods before and after 1 Janaury. Each index for the latter period was multiplied by 1.465* and added to the corresponding autumn index to produce an index of total larval production for the whole season. These indices for the last four seasons were examined by the 1982 Herring Assessment Working Group (CM 1982/Assess 7) in relation to the estimates of spawning stock biomass derived from the VPA runs, but no relationship was found irrespective of input F. Some members of the Group made suggestions as to how the larval data could be re-analysed and some of these have been incorporated into the calculation of new larval indices as described below. The purpose of the exericse was to use the larval data to indicate which input F for VPA was most realistic.

A major suspicion surrounded the index for winter larvae which seemed to be seriously underestimated. This was particularly true in 1981/82 when the winter larval index accounted for only about 0.1% of the total whereas catches of winter spawners accounted for over 50% of the total catches, with no major change in effort occurring. Traditionally, the term "autumn-spawners" has referred to fish spawning (and being caught) in October and November, and "winter-spawners" to those spawning in December and January. However, as Figure 1 shows, there is no clear distinction between autumn and winter spawners, at least in terms of vertebral counts, but rather a gradual change. Fecundity may also show a gradual change throughout the season, but it has been determined at only two times (during October and in early January) from samples of adequate size (Molloy, 1979) and once from a small mid-season sample. Hitherto, larvae taken up to 31 December have been considered autumn larvae and, because incubation times in December are about 14 days, this means that fish spawning as late as mid-December are taken as autumn spawners. Fish spawning in December have vertebral counts very similar to those spawning in January and February, and so it was decided to take 1 December as the beginning of winter spawning and

/larvae

* to allow for differences in fecundity

larvae taken from 15 December onwards were thus considered as winter larvae.

Another possible reason for underestimation of winter larvae is that they hatch out at a larger size. It is difficult to tell from the size distributions of larvae taken whether there is such a difference and a special study of hatching larvae will be required. Examination of the average size of all larvae <11mm in length during the last three seasons showed larvae taken from 15 December onwards were somewhat larger (length in mm):

	1979/80		1980/81		1981/82	
	$\bar{l}$	S(l)	$\bar{l}$	S(l)	$\bar{l}$	S(l)
Autumn	9.29	0.68	8.68	1.38	9.00	1.05
Winter	9.62	0.65	9.50	0.77	9.23	1.44
Difference	0.34		0.81		0.23	

Larvae from the Downs herring stock which hatch out in December and January are slightly longer than those which hatch out earlier in the central and northern North Sea, and so the length class used for assessment purposes is <11mm (Anon., 1973). A similar size class was adopted for this study for larvae taken from 15 December onwards.

Methods

The sampling procedure in 1981/82 was the same as in the previous season (Grainger and Cullen, 1981). Stations were positioned 8 nautical miles apart in a grid formation along the south coast of Ireland. At each station two double-oblique tows were made with a Dutch-modified Gulf III sampler with 275 µm mesh from a vessel travelling at 5 knots. No real-time depth monitoring system was used but the depressor which hung 3m below the sampler was generally shined on the bottom. However, on rough ground a depth recorder showed that sampling was only within 8m of the bottom. Each 10m depth interval was sampled overall for about 2 minutes. The volume of water sampled was measured with a pre-calibrated flowmeter. Samples were fixed following the method of Nichols and Wood (1978) immediately after the tow. Later herring larvae were identified by reference to Saville (1964) and measured for total length.

For each cruise the total abundance of <10mm larvae (prior to 15 December) or <11mm larvae (after 15 December) was calculated by raising the numbers per m^2 by the area represented by each station. The mean abundance of <10mm larvae in October and November gave the autumn index. The mean abundance of <11mm larvae in December-February gave the winter index which was then multiplied by 1.465 and added to the autumn index to give a single index for the whole season.

Ten such cruises were conducted and the sampling grid was the same as for the 1981/82 survey resulting in good overall coverage.

Larval indices for the previous seasons were recalculated using the same procedure as outlined above. In the course of recalcualting the new indices an error was discovered in the original calcualtion of the winter index for 1978/79 which was much too high.

Results and Discussion

The distributions of larvae in the three size categories on each cruise are shown in Figures 2-10 where stations sampled but at which no larvae in the particular size category were recorded are marked with a dot.

The distribution of small larvae in the autumn was generally more widespread than in previous years when it was mainly restricted to probable spawning areas off Cork Harbour and in Baginbun Bay. However winter larval abundance was very low.

The larval abundances estimated for the last four seasons using the new size classes after 15 December are shown in Tables 1-4. The larval indices calculated from these data are as follows:

	Autumn	Winter x 1.465	Total
1978/79	7163 (3)*	122 (3)*	7284*
1979/80	9503 (5)	3374 (5)	12877
1980/81	7601 (4)	8932 (4)	16533
1981/82	16285 (5)	1510 (5)	17795

* monthly cruises only - not good estimates.

These new indices were tested for correlation with the spawning stock biomass for the Celtic Sea herring for the corresponding seasons which were estimated by the 1982 Herring Working Group (Anon, 1982) using Virtual Popualtion Analysis with input Fs of 0.4, 0.6 and 0.8. The results are as follows:

Input F	1981/82	0.4	0.6	0.8
SSB at	1978/79	12700	11300	10700
Spawning time	1979/80	16900	14300	13100
(tonnes)	1980/81	21200	16700	14500
	1981/82	25600	20000	13800
r		0.960	0.957	0.950
P		<0.05	<0.05	=0.05

The spawning stock biomasses are plotted with the larval indices in Figure 11. The correlations are all significant but the coefficients (r) do increase with lower input F suggesting that F was somewhere between 0.4 and 0.6 in 1981/82. Thus it would appear that the spawning stock biomass in the Celtic Sea has increased each year since 1978/79. It is hoped that with one or two more season's data it will be possible to use a regression of spawning stock biomass on larval indices to determine the former.

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Table 1 : Larval abundances in the 1978/79 season.

Larval Abundance ($x10^{-6}$)

Cruise	Mid-date	<10mm	10-15mm	>15mm
0478	21. 9.78	362	0	0
0578	18.10.78	15826	17575	0
0678	28.11.78	5301	13188	1621
		<11mm	11-16mm	>16mm
0778	17.12.78	0	728	1716
0279	24. 1.79	0	0	839
0379	15. 2.79	250	7670	0
[0479	21. 3.79	0	497	0]*

* not included in assessment - too late in the season.

Table 2 : Larval abundances in the 1979/80 season.

Larval Abundance ($x10^{-6}$)

Cruise	Mid-date	<10mm	10-15mm	>15mm
1079	2.10.79	273	0	0
1179	16.10.79	9490	19713	2106
1279	31.10.79	31201	35431	3487
1379	13.11.79	5023	26712	8746
1479	5.12.79	1526	12966	26573
		< 11mm	11-16mm	>16mm
0180	3. 1.80	6827	8680	7159
0280	16. 1.80	2379	9218	4630
0380	5. 2.80	1379	1540	150
0480	13. 2.80	296	3113	2509
0580	27. 2.80	635	535	3243

Table 3 : Larval abundances in the 1980/81 season.

Larval Abundance ($\times10^{-6}$)

Cruise	Mid-date	<10mm	10-15mm	>15mm
1080	8.10.80	1325	234	308
1180	22.10.80	9944	7388	220
1280	4.11.80	15137	17683	714
1380	26.11.80	4000	6582	857
		<11mm	11-16mm	>16mm
1480	16.12.80	19066	6732	1000
0181	14. 1.81	1958	5268	4523
0281	4. 2.81	3364	33147	9698
0381	24. 2.81	0	19958	40710

Table 4 : Larval abundance in the 1981/82 season.

Larval Abundance ($x10^{-6}$)

Cruise	Mid-date	<10mm	10-15mm	>15mm
1181	13.10.81	8852	5023	0
1381	28.10.81	8051	16471	1242
1581	11.11.81	30895	31331	5261
1681	25.11.81	6349	44707	7537
1781	9.12.81	27280	40784	6513
		<11mm	11-16mm	>16mm
1881	22.12.81	3351	15452	8545
0182	5. 1.82	429	1925	2246
0282	21. 1.82	0	252	1447
0382	7. 2.82	0	0	0
0482	17. 2.82	1374	19144	0

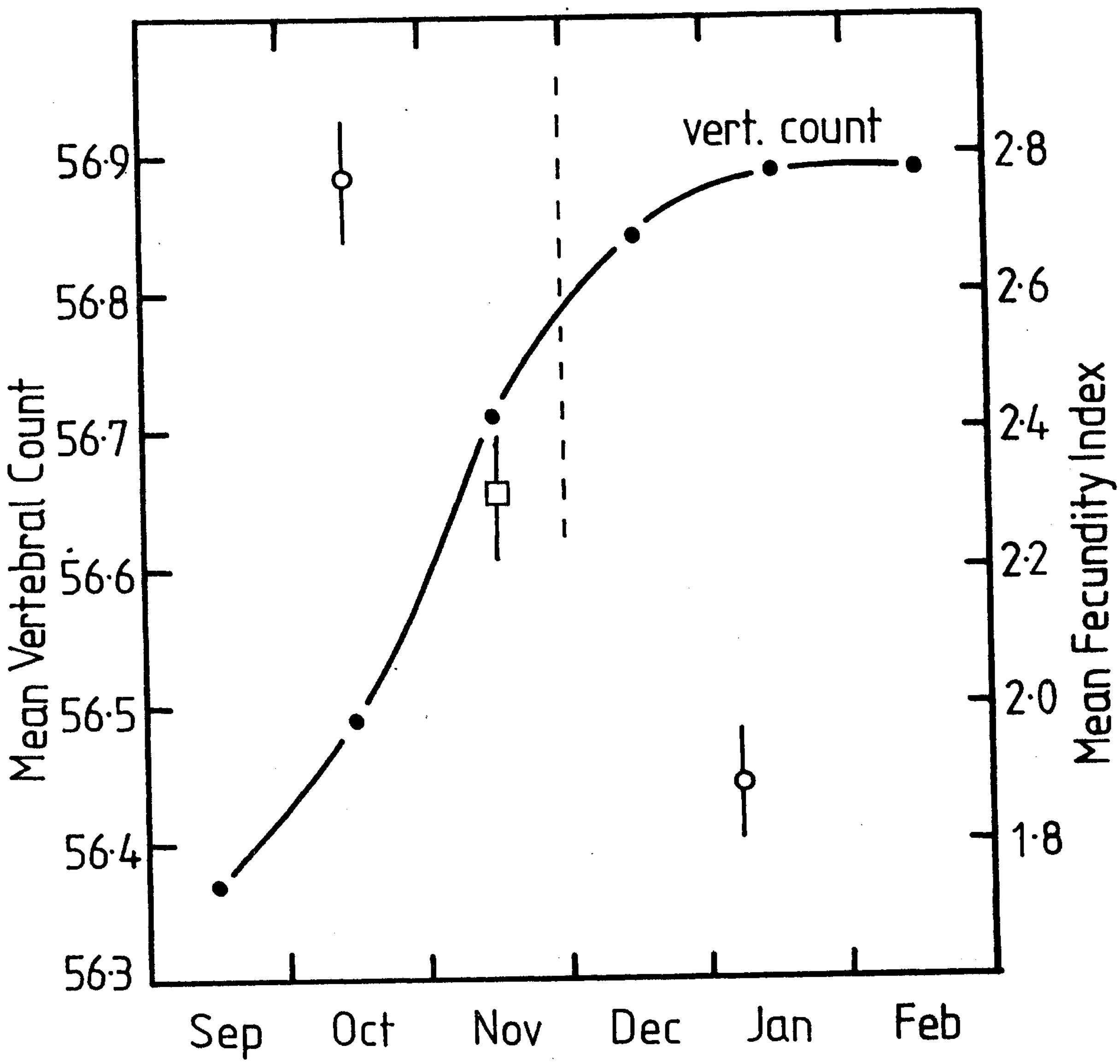
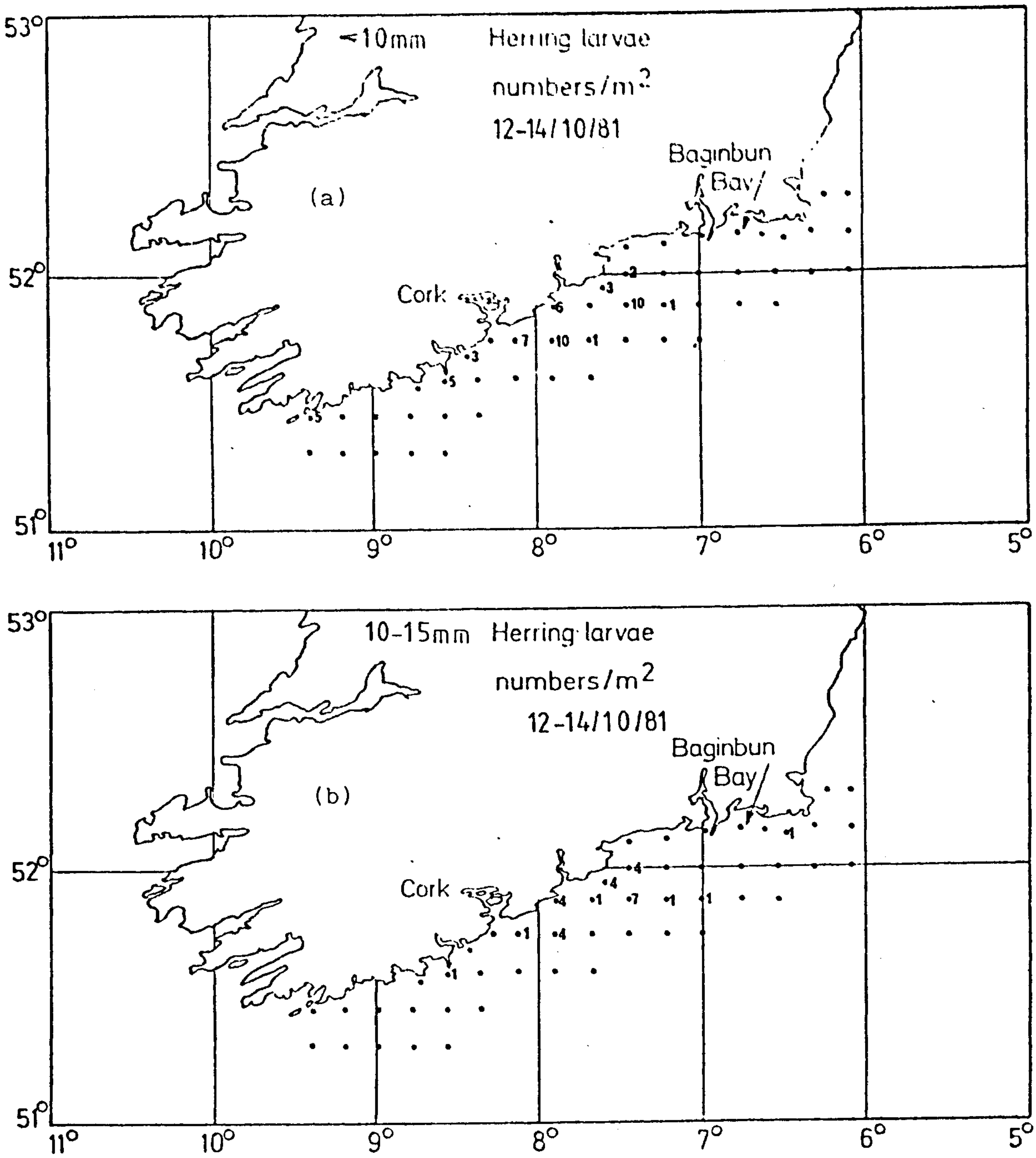
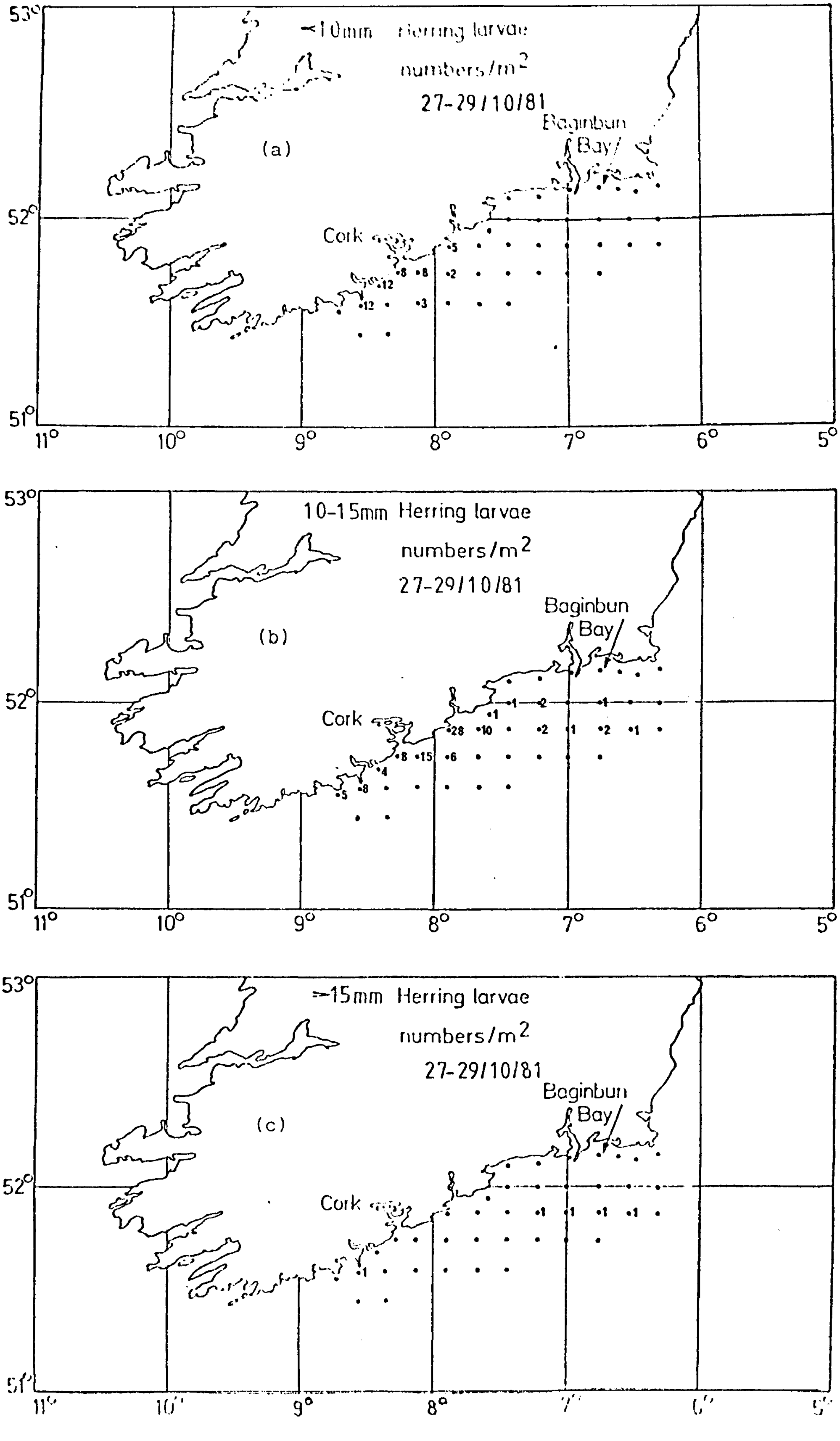


Figure 1 : Mean vertebral counts on Celtic Sea herring of maturity stage VI, 1960/61 - 1978/79, in relation to mean fecundity indices (fecundity/length^3) on stage V fish plotted on time of sampling (open circles are from Molloy (1979) and open square a 1981 sample of 10 fish; bars represent 1 standard error in each direction.)



<10mm
Herring larvae
numbers/m2
12-14/10/81
Baginbun
Bay
(a)
Cork
10-15mm
Herring larvae
numbers/m2
12-14/10/81
Baginbun
Bay
(b)
Cork
53°
52°
51°
11°
10°
9°
8°
7°
6°
5°

Figure 2



53°
52°
51°
11°
10°
9°
8°
7°
6°
5°
<10mm Herring larvae
numbers/m2
27-29/10/81
(a)
Baginbun
Bay
Cork
5
12
8
8
2
12
3
10-15mm Herring larvae
numbers/m2
27-29/10/81
(b)
Baginbun
Bay
Cork
1
2
1
1
28
10
2
1
2
1
8
15
6
4
5
8
>15mm Herring larvae
numbers/m2
27-29/10/81
(c)
Baginbun
Bay
Cork
1
1
1
1
1

Figure 3

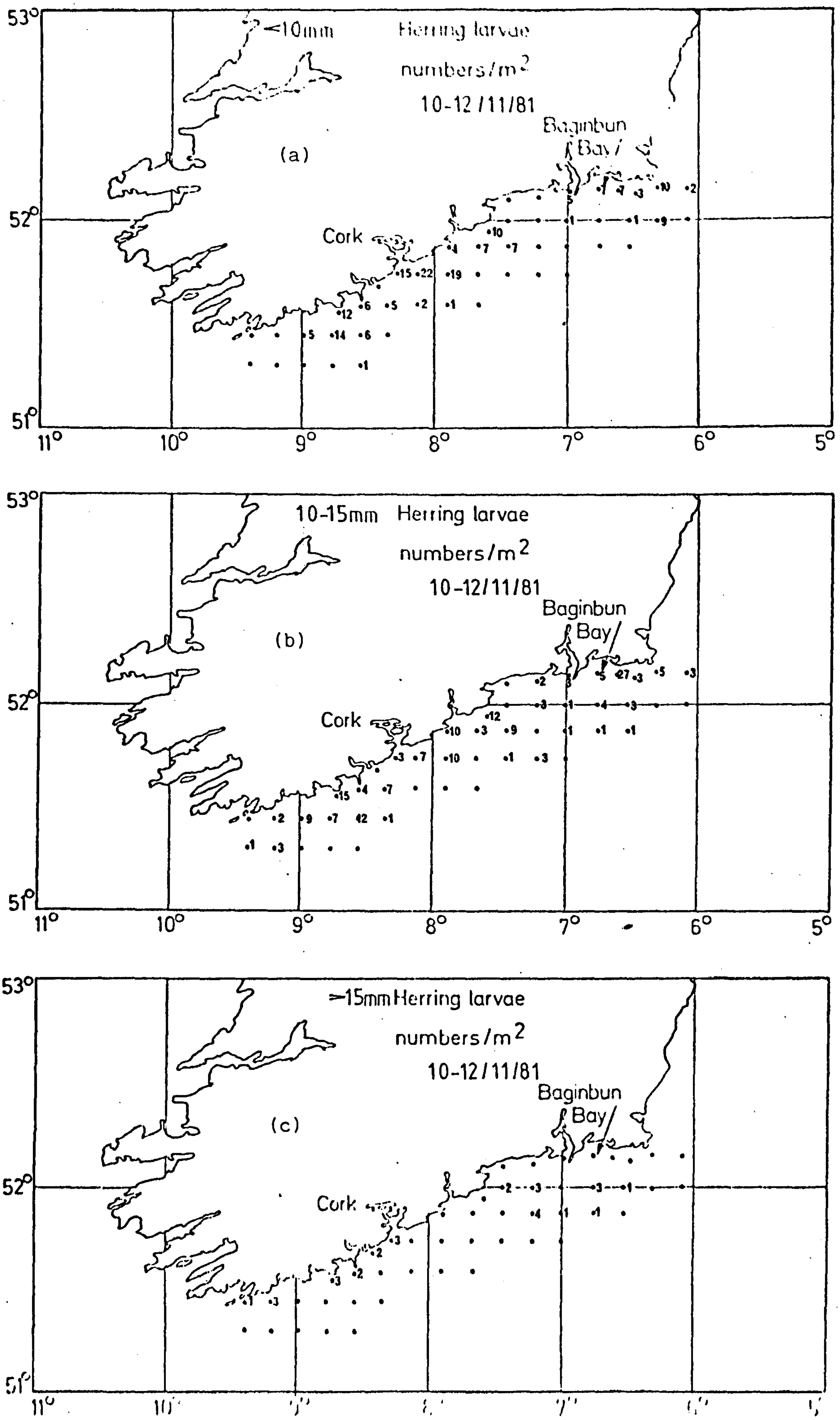
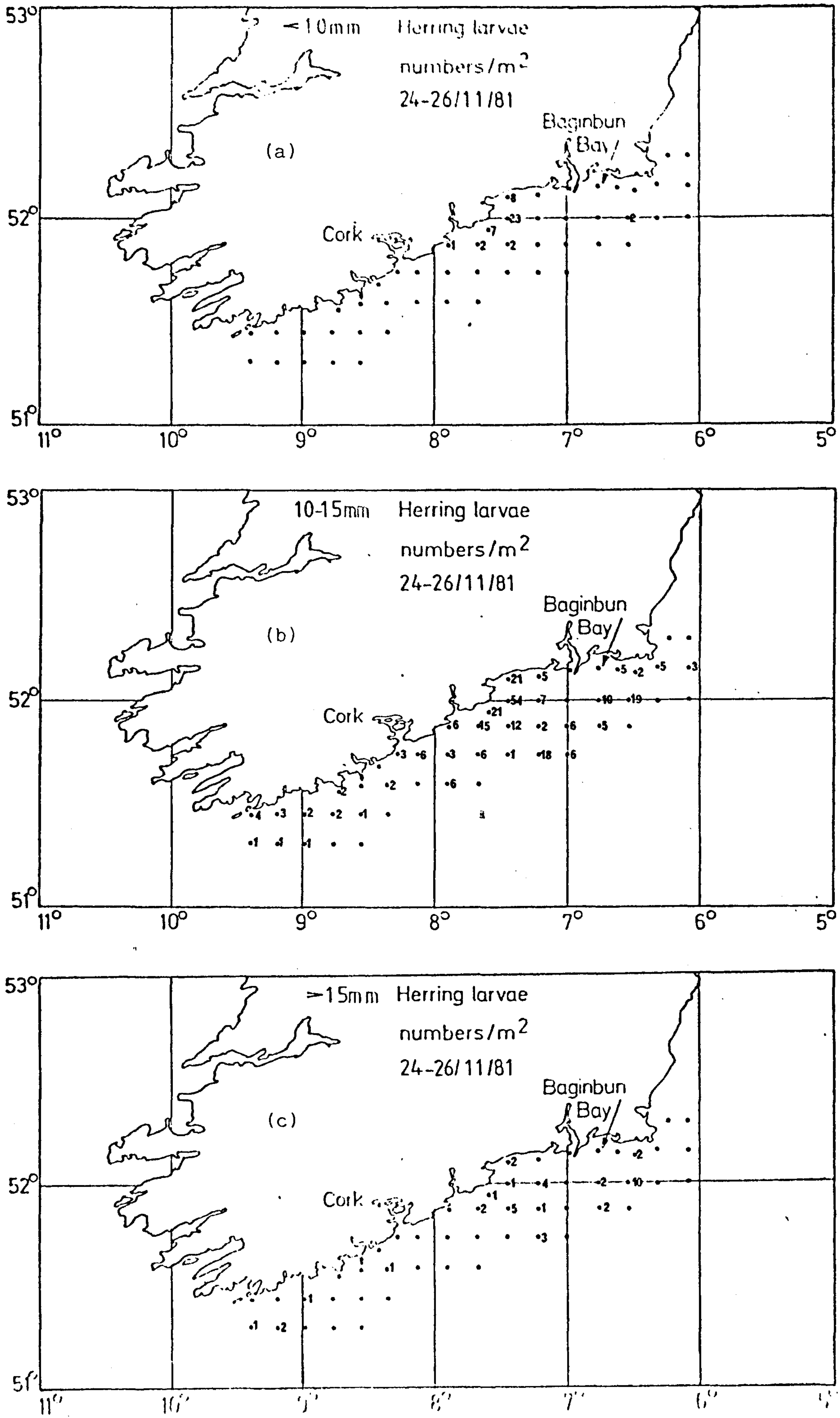
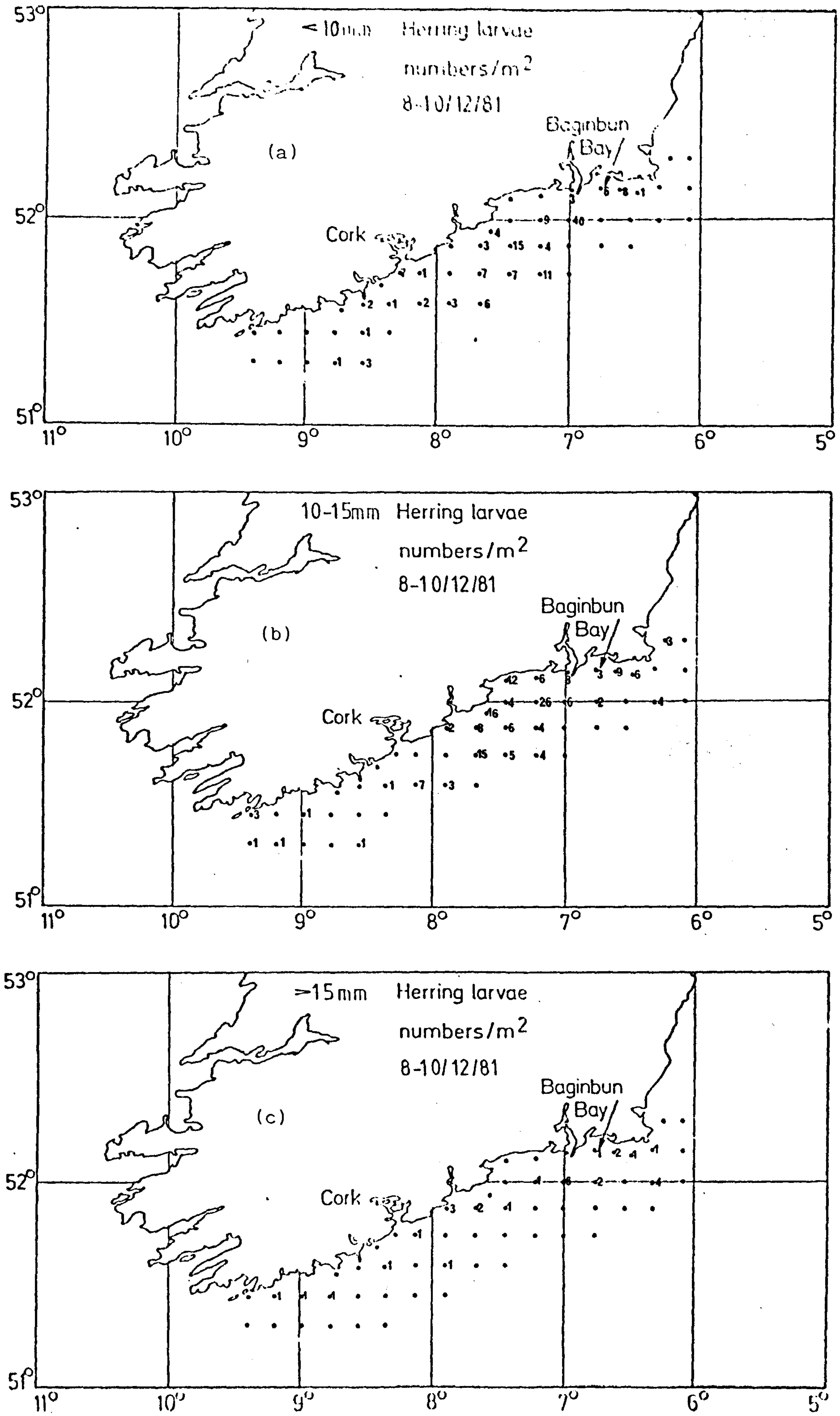

(a)
<10mm Herring larvae
numbers/m2
10-12/11/81
Baginbun Bay
Cork
(b)
10-15mm Herring larvae
numbers/m2
10-12/11/81
Baginbun Bay
Cork
(c)
>15mm Herring larvae
numbers/m2
10-12/11/81
Baginbun Bay
Cork
53°
52°
51°
11°
10°
9°
8°
7°
6°
5°

Figure 4



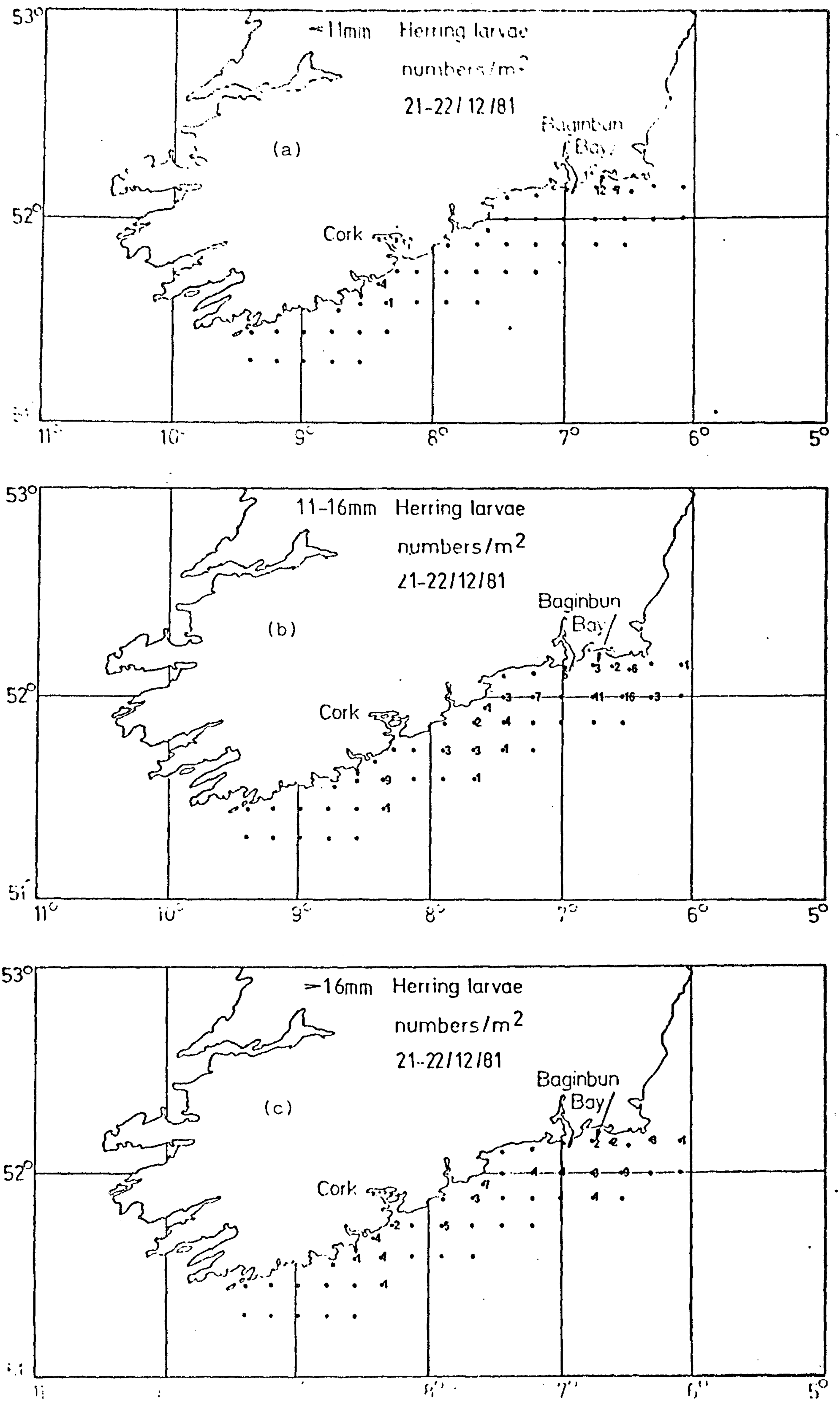
<10mm Herring larvae
numbers/m2
24-26/11/81
(a)
Baginbun
Bay
Cork
10-15mm Herring larvae
numbers/m2
24-26/11/81
(b)
Baginbun
Bay
Cork
>15mm Herring larvae
numbers/m2
24-26/11/81
(c)
Baginbun
Bay
Cork
53°
52°
51°
11°
10°
9°
8°
7°
6°
5°

Figure 5



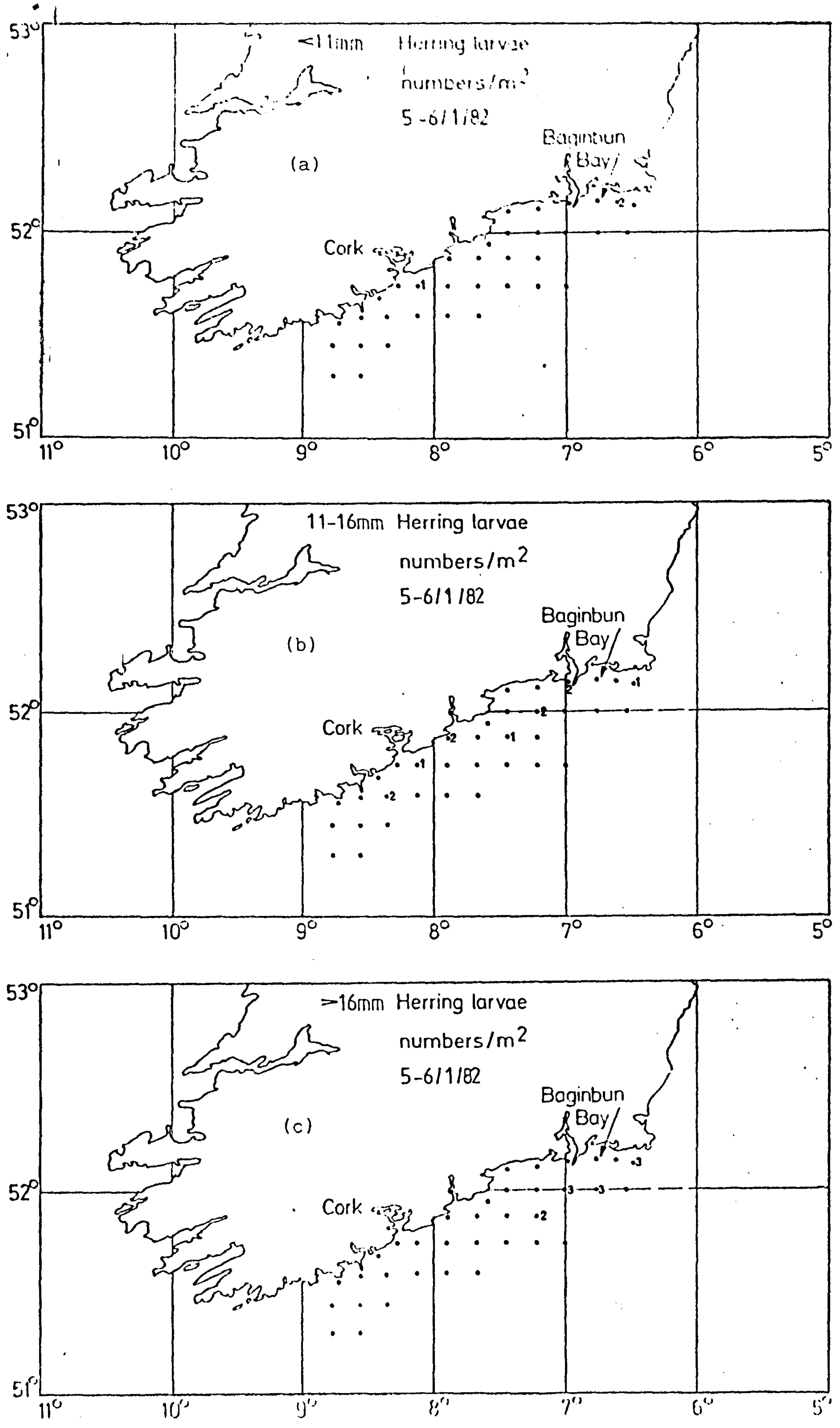
<10mm Herring larvae
numbers/m2
8-10/12/81
(a)
10-15mm Herring larvae
numbers/m2
8-10/12/81
(b)
>15mm Herring larvae
numbers/m2
8-10/12/81
(c)
Cork
Baginbun Bay
53°
52°
51°
11°
10°
9°
8°
7°
6°
5°

Figure 6



<11mm Herring larvae
numbers/m²
21-22/12/81
(a)
Cork
Baginbun Bay
11-16mm Herring larvae
numbers/m²
21-22/12/81
(b)
Cork
Baginbun Bay
>16mm Herring larvae
numbers/m²
21-22/12/81
(c)
Cork
Baginbun Bay
53°
52°
11°
10°
9°
8°
7°
6°
5°

Figure 7



<11mm Herring larvae
numbers/m2
5-6/1/82
(a)
Baginbun Bay
Cork
11-16mm Herring larvae
numbers/m2
5-6/1/82
(b)
Baginbun Bay
Cork
>16mm Herring larvae
numbers/m2
5-6/1/82
(c)
Baginbun Bay
Cork
53°
52°
51°
11°
10°
9°
8°
7°
6°
5°

Figure 8

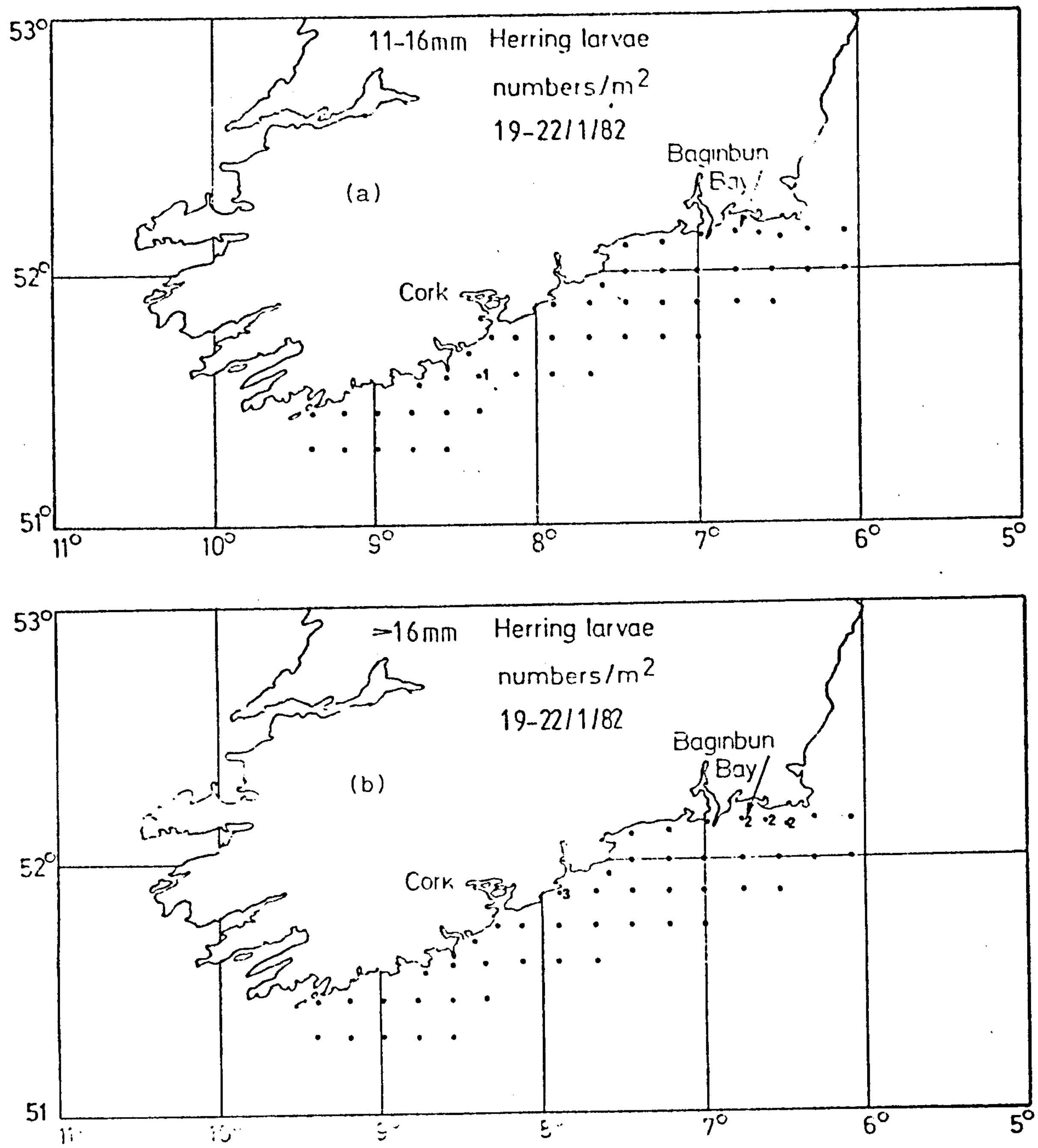
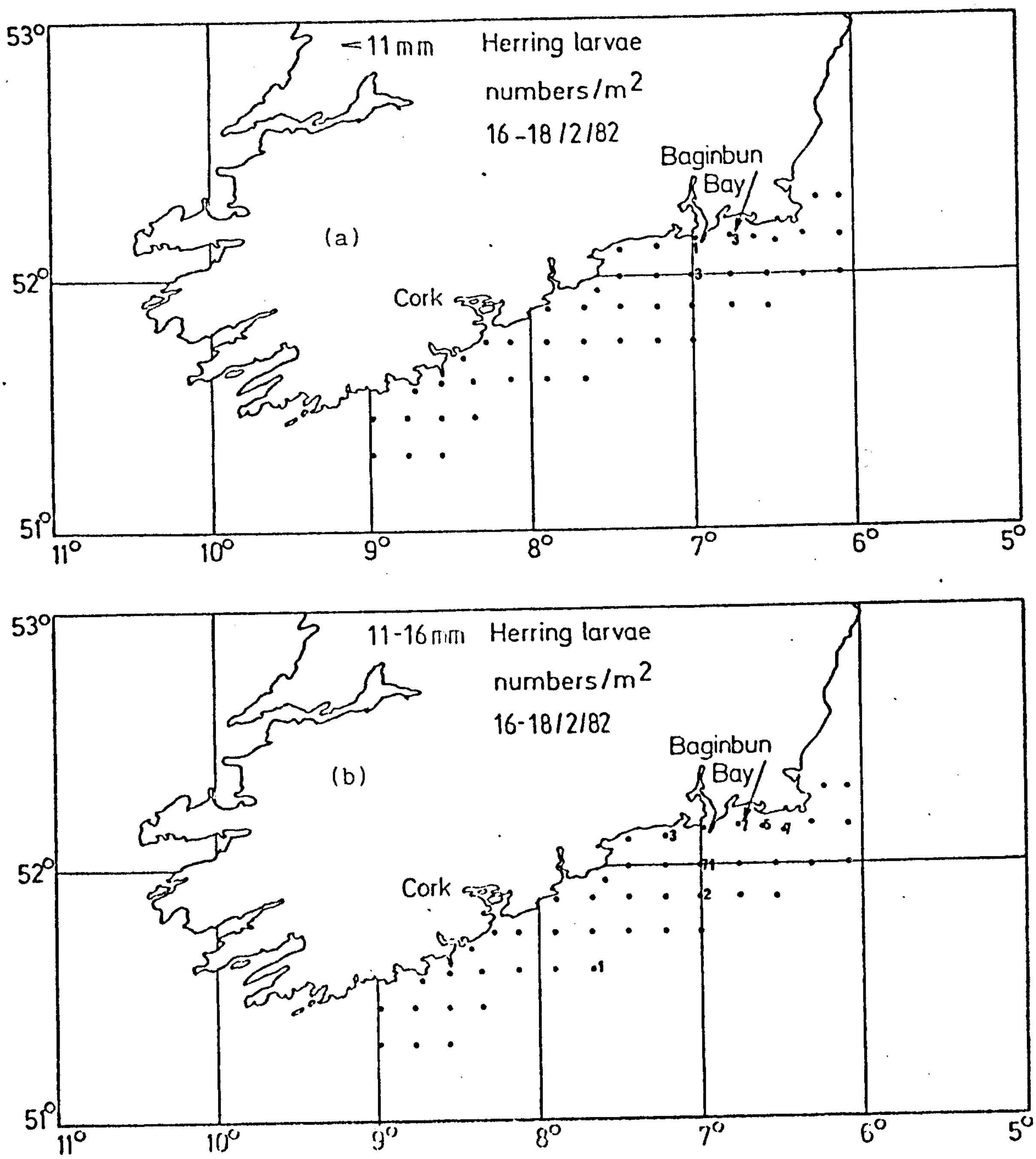

11-16mm Herring larvae
numbers/m2
19-22/1/82
(a)
Baginbun Bay
Cork
53°
52°
51°
11° 10° 9° 8° 7° 6° 5°
>16mm Herring larvae
numbers/m2
19-22/1/82
(b)
Baginbun Bay
Cork
53°
52°
51
7° 6° 5°

Figure 9



<11 mm
Herring larvae
numbers/m2
16-18/2/82
Baginbun
Bay
(a)
Cork
11-16 mm
Herring larvae
numbers/m2
16-18/2/82
Baginbun
Bay
(b)
Cork
53°
52°
51°
11°
10°
9°
8°
7°
6°
5°

Figure 10

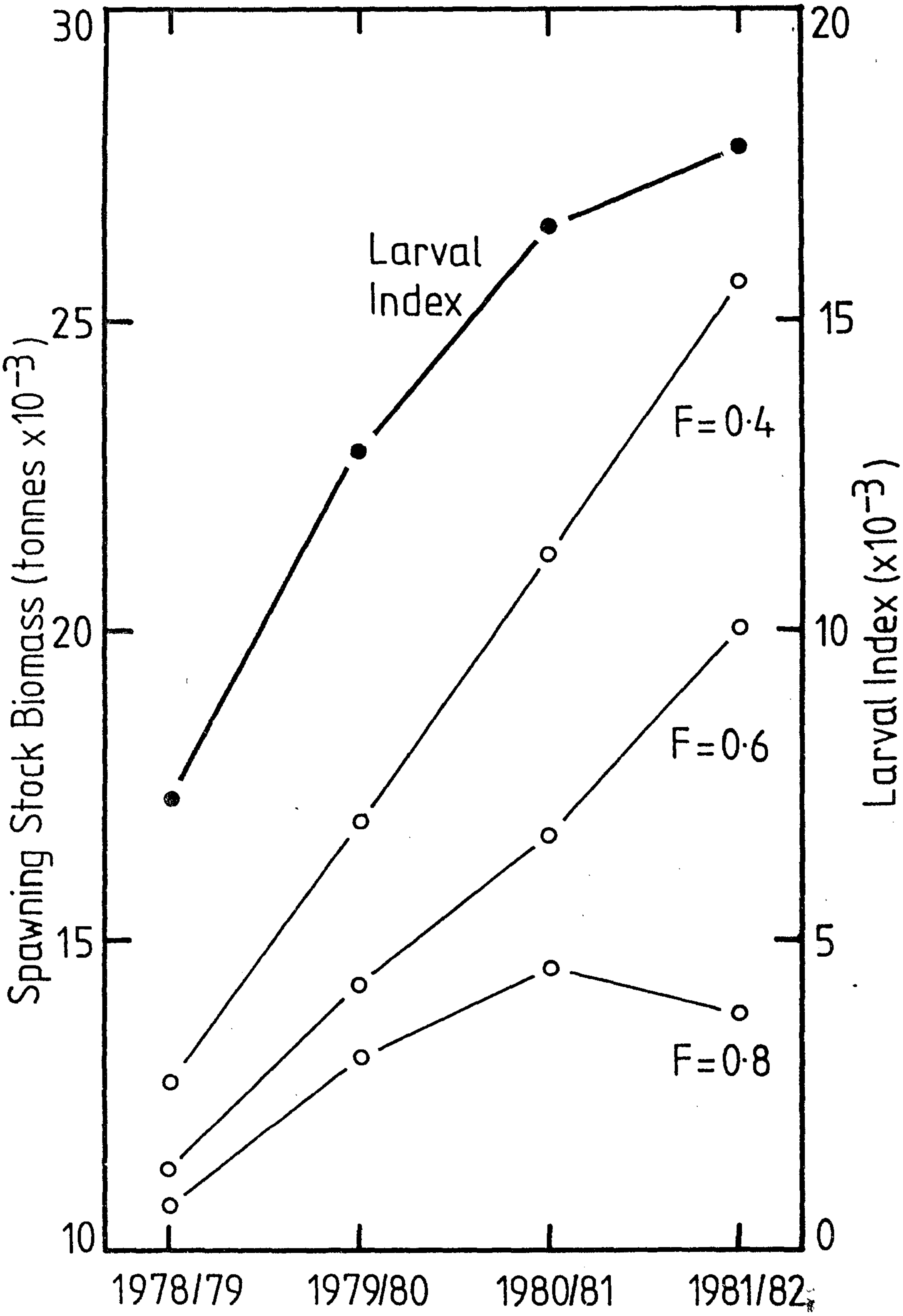


Figure 11 : Celtic Sea spawning stock biomass at spawning time assuming F in 1981/82 of 0.4, 0.6 and 0.8 in relation to larval index.