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Biological Oceanography Cruise : LF2397

Cruise Report

(June 01 - 06)

Personnel

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Cruise Objectives

The objectives of this cruise were to study the impact of copepod grazing at the end of the spring bloom, and service the DANI moorings. Detailed objectives were to:

1. quantify phytoplankton production in two size fractions (whole and < 5.0 μm).
2. estimate copepod grazing.
3. collect samples of phytoplankton and zooplankton for species identification and enumeration.
4. collect sediment samples for the determination of sediment pigment concentration.
5. collect water samples for the determination of particulate aluminium and dissolved inorganic nutrients.
6. service the DANI moorings.

Cruise Narrative

R.V. Lough Foyle departed Belfast at 2100 h on Sunday June 01 and sailed for the process station in Liverpool Bay. (Figure 1). Process studies were initiated at 0830 on Monday June 02 and were completed by 0600 on Tuesday June 03 when the ship sailed for the DANI mooring site. The particle trap mooring was recovered and serviced during the afternoon of June 03 and process studies began at 1800. The automated sampler mooring was recovered, serviced and redeployed on Wednesday June 04 and following completion of the process work the ship sailed for Station 47 in the vicinity of Dundalk Bay. Sampling at station 47 commenced at 2100 and was completed at 1800 on Thursday June 05 at which time the ship departed for Belfast. Lough Foyle docked in Belfast at 0100 on Friday June 06.

Preliminary Results

All of the mooring work and process studies were completed.

The Irish coastal station (47) and station 38A at the DANI mooring station were thermally stratified. This was most pronounced at station 38A, where the surface to bottom difference in temperature was ≈ 3.5 °C. At the Liverpool Bay process station the water column was isothermal. A prominent feature at the DANI mooring station was the pronounced chlorophyll maximum (12 mg chlorophyll m^{-3}) at 28 m.

At the two coastal stations the copepod populations were dominated by *Temora longicornis*. In contrast there was no single dominant species at station 38A. *Calanus* spp. were more abundant than earlier in the year. There were however few adult *Pseudocalanus elongatus* or *Acartia clausi* at the offshore station. These two species were represented by large numbers of copepodite stages.

This cruise was the last in a series undertaken to follow the spring bloom in the three regions. The development of the bloom in terms of chlorophyll standing crop is shown in Figure 2. Initiation of the bloom began earlier in the two coastal sites with chlorophyll standing stock being ≈ three fold higher than at station 38A in early April. A prominent feature of the data is the high standing stock (1384 mg m^{-2}) which developed in Liverpool Bay. This was seven times the maximum standing stock observed at stations 47 and 38A.

At all three stations the proportion of standing stock in the < 5.0 μm fraction was highest at the start of the bloom. At this time the < 5.0 μm fraction represented less than 18% at the two coastal stations but represented 34% of the standing stock at station 38A. Towards the end of the bloom, the < 5.0 μm did not exceed 5% of the total chlorophyll standing crop at any of the stations.

Copepods dominated the mesozooplankton of the three regions. *Temora longicornis* and *Pseudocalanus elongatus* were the dominant species with the latter more abundant at the offshore station. *Calanus* spp. were not abundant at any time during the spring bloom period.

Acknowledgements

I wish to express my thanks to the captain, officers and crew of the R.V. Lough Foyle for their assistance during the cruise. I would also like to thank all of the scientific staff DANI and CEFAS who participated in the cruises.

R.J. Gowen

June 16, 1997

Figure 1.

A map of the Irish Sea showing the positions of the three process stations. The DANI mooring is located at station 38A

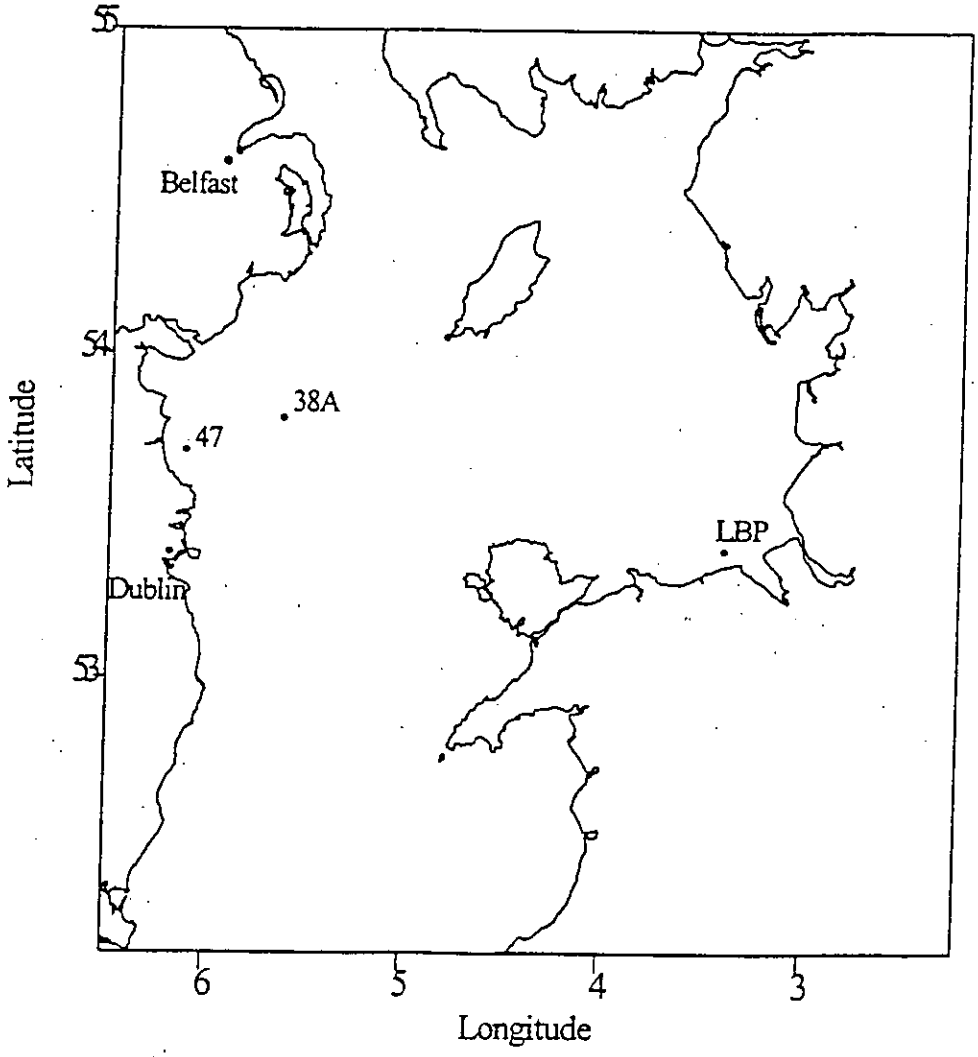
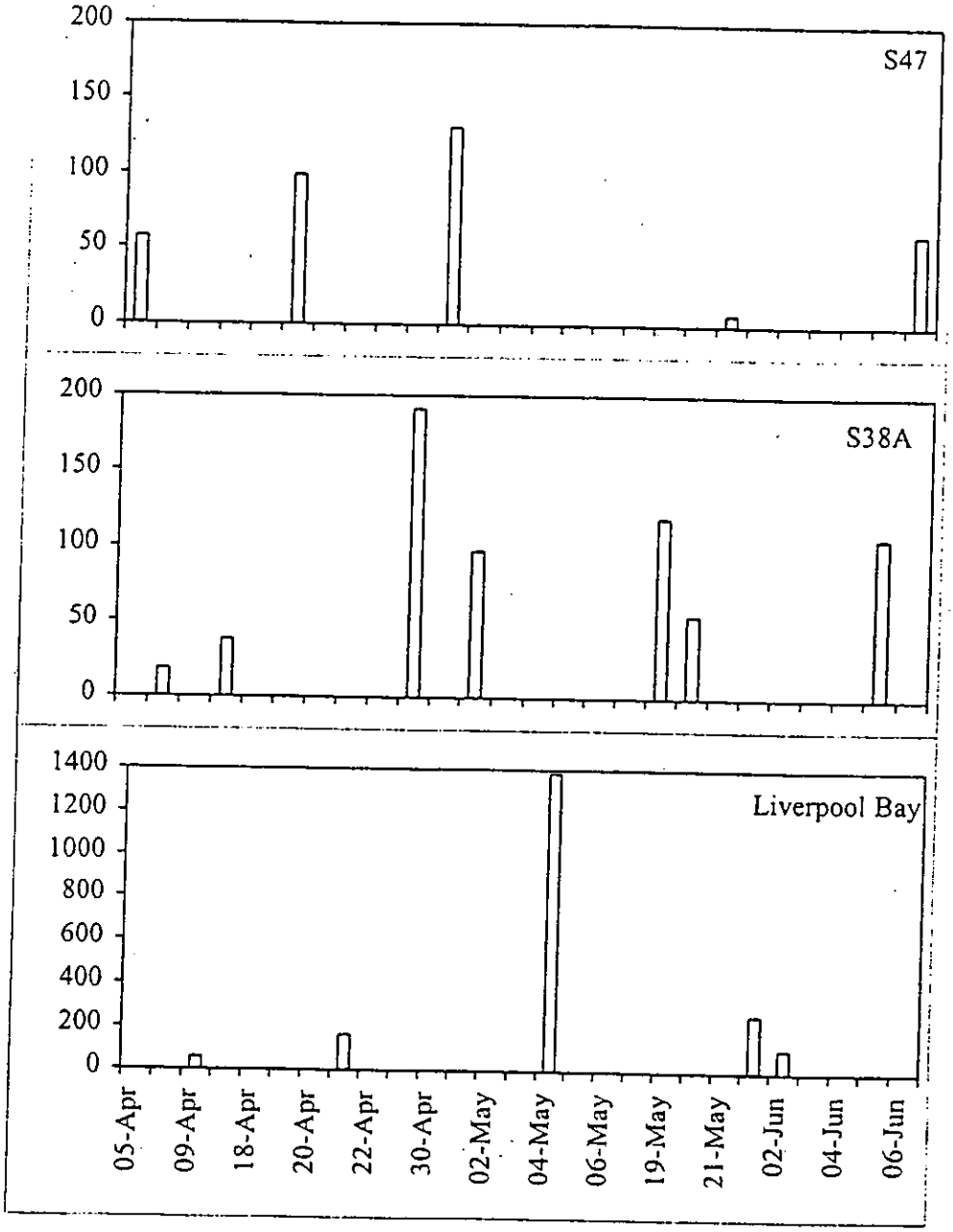


Figure 2. Development of the spring bloom (in terms of chlorophyll standing stock mg m^{-2}) in Dundalk Bay (S47), the central region of the western Irish Sea (S38A). Note change in scale of the y axis for Liverpool Bay.



Preliminary results from the DANI investigation of the spring bloom in the Irish Sea

Introduction

As part of DANI studies of ecosystem functioning in the Irish Sea and participation in the CEFAS JoNuS II programme, research cruises onboard the RV Lough Foyle were undertaken to investigate the dynamics of the spring phytoplankton bloom in the Irish Sea. The investigation centred on three stations (Figure 1) each of which was visited five times during March - June 1997 (Table I). CEFAS staff participated in two of these cruises. Chlorophyll and copepod abundance data (April 18-23) were collected during a RV Cirolana cruise.

Water column structure

These preliminary results are based on uncorrected temperature and salinity data. Absolute values are likely to be ± 0.1 °C and 0.2 for temperature and salinity respectively.

In contrast to the Irish coastal station 47 and the offshore station 38A, the water column at S-LBP remained isothermal (Figure 2). Furthermore, the temperature of the water was generally 0.5 °C lower than the temperature at the Irish coastal station 47. At the offshore station, the water column had begun to stratify in early April and by early June the surface to bottom difference in temperature was ≈ 3.5°C.

In general, salinity at the Liverpool Bay station was lower and vertical gradients in salinity smaller (Table II) than at the other two stations. (A comparison of absolute values can only be undertaken once the salinity data have been corrected).

Dissolved inorganic nutrients

At the time of the March survey there was little indication of increased phytoplankton biomass at station 38A and at this location concentrations of nutrients measured probably represent the winter maxima, with a near surface nitrate concentration of 8.86 mmol m^{-3}. Concentrations of nitrate were higher at the two coastal stations (9.0 and 12.38 mmol m^{-3} at stations S-47 and S-LBP respectively) although there is evidence of increased phytoplankton biomass at these two stations suggesting that the nitrate concentrations were not indicative of winter maxima. In comparison to the offshore station where near surface N:P and N:Si ratios were 9.8:1 and 1.3:1 respectively, there is an indication that the two coastal stations were enriched with nitrate relative to phosphorus and silicate. At S-47 the N:P and N:Si rations were 11.7:1 and 1.9:1 respectively and at S-LBP the ratios were 11.5:1 for N:P and 1.95:1 for N:Si.

The decline in nitrate was first observed at S-47 (Figure 3). Thus by April 05 the concentration of nitrate had fallen to 1.5 mmol m^{-3}. In contrast, there was little indication of a reduction in near surface concentrations of nitrate at station 38A in early April. At this time, concentrations of nitrate at S-LBP were ≈ 26 mmol m^{-3}, approximately double the concentration measured at this station in early March. At present there is no indication that these samples were contaminated (samples were collected from three separate CTD dips carried out over two days). However, the high nutrient concentrations coincided with the lowest salinity recorded at this station (Table II). By the end of April nitrate concentrations at S-47 and S-LBP had fallen to ≈ 0.2 and 1.0 mmol m^{-3} respectively and there was surface depletion of nitrate at S-38A.

By early May there was evidence of nutrient depletion at all three stations. In surface waters at stations 38A and all depths at LBP nitrate had fallen below the level of detection, although there was a small increase in early June.

Phytoplankton

Assuming that a chlorophyll concentration of 1 mg m^{-3} is indicative of the start of the spring bloom, it is clear that the bloom was well under way at S-LBP (3.2-3.6 mg chlorophyll m^{-3}) and S-47 (2.5 - 3.2 mg chlorophyll m^{-3}) in early April. At this time the near surface concentration of chlorophyll at the offshsore station was ≈ 0.6 mg m^{-3}. Development of the spring bloom (as chlorophyll standing stock, mg m^{-2}) at each of the three stations is shown in Figure 4. There are two notable features of the data; the high biomass (1384 mg chlorophyll m^{-2}) measured at S-LBP in early May and the duration of the spring bloom at the offshore station.

Over the course of the bloom and at all three stations the greatest proportion of the chlorophyll standing stock was associated with the > 5.0 µm fraction of the phytoplankton. However, at the start of the bloom the chlorophyll associated with the < 5.0 µm fraction was generally higher than during the peak and end of the bloom. For example, at S-47 the < 5.0 µm fraction represented 14.9% of the total chlorophyll standing stock in early April, compared to 4.0% at the end of the bloom. At S-38A the < 5.0 µm fraction represented 34.0% of the chlorophyll standing stock, at the start of the spring increase although this proportion had fallen to 5.4% by June 04.

At the peak of the spring increase, euphotic zone daily production was estimated as 912 mg C m^{-2} at S-38A, 1175 mg C m^{-2} at S-47 and 3157 mg C m^{-2} at S-LBP. These estimates are within the range of published values for the Irish Sea.

Identification and enumeration of preserved phytoplankton samples remains to be carried out. However, casual observations suggest that in Liverpool Bay the colonial flagellate *Phaeocystis pouchetii* was abundant throughout the spring bloom and was probably the cause of the high chlorophyll standing stock in early May.

Zooplankton

As expected the meso-zooplankton was dominated by planktonic copepods. In general, *Pseudocalanus elongatus* was the dominant species at the offshore station and *Temora longisima* dominated at the two coastal stations. Adult and juvenile stages of the two calanoid copepods *Calanus finmarchicus* and *Calanus helgolandicus* did not contribute more than 11% to total copepod abundance during the spring bloom period. Copepods were most abundant at the offshore station (Figure 5) and reached a peak of 549.47 x10^3 ind m^{-2} towards the end of May. Copepod abundance was lowest (maximum of 48.29 x10^3 ind m^{-2}) at the process station in Liverpool Bay. At each station however, development of the copepod population appeared to be closely associated with the spring bloom of phytoplankton. For example, at station 38A maximum copepod abundance followed the peak in phytoplankton standing stock (Figure 6).

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Table I. Sampling dates for the three Irish Sea process stations

Date Visited	Station 47	38A	LBP
Mar 03		✓	
Mar 04	✓		✓
Apr 05	✓		
Apr 07		✓	
Apr 09			✓
Apr 30	✓		
May 01		✓	
May 05			✓
May 19		✓	
May 20	✓		
May 22			✓
Jun 02			✓
Jun 04		✓	
Jun 05	✓		

Table II. Uncorrected estimates of near surface (3 m) salinity and the near surface to bottom difference (Δs) in salinity at the three Irish Sea stations during March-June 1997.

Date	Station S-47 Near surface salinity	Δs	S38A Near surface salinity	Δs	S-LBP Near surface salinity	Δs
Mar 03-4	34.23	0.17	34.13	0.14	33.77	0.12
Apr 05-09	34.14	0.05	34.23	0.18	32.01	0.04
Apr 29 May 04	33.40	0.55	34.15	0.24	32.59	0.12
May 19-23	33.80	0.21	34.10	0.25	32.87	0.01
Jun 02-05	33.70	0.39	34.09	0.19	32.64	0.16

Figure 1.

A map of the Irish Sea showing the positions of the three process stations. The DANI mooring is located at station 38A

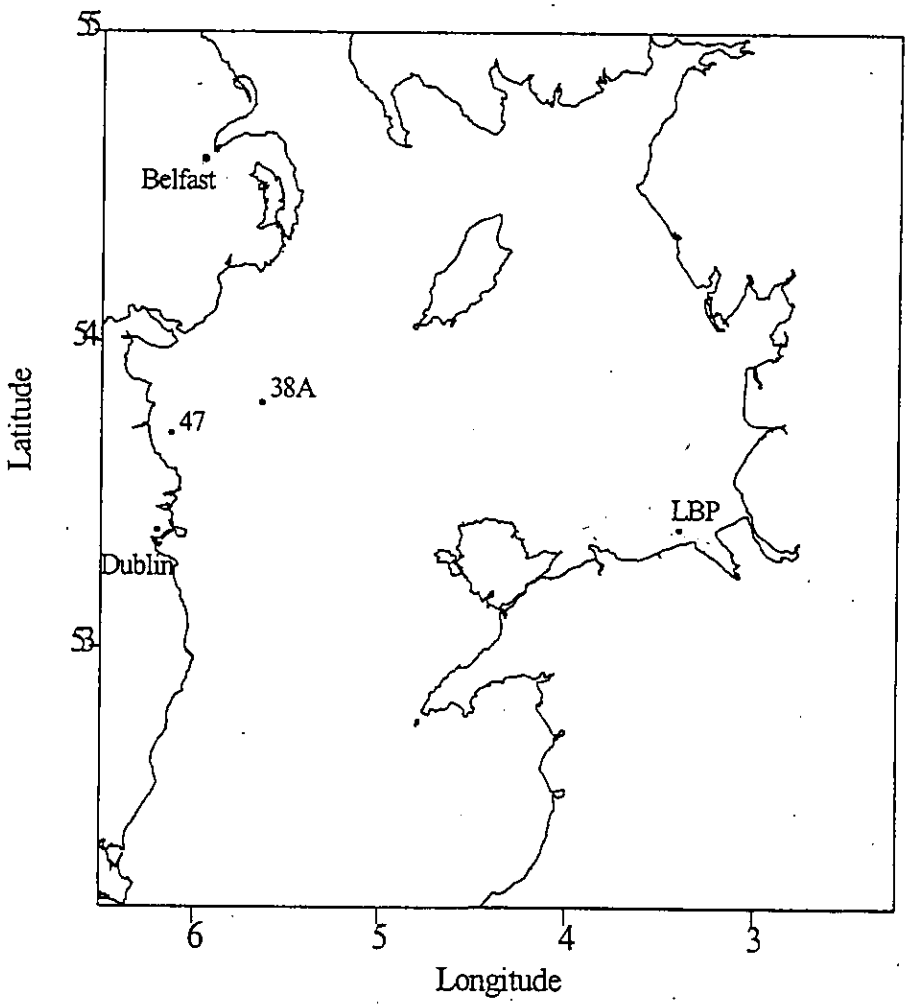

Figure 2. Temperature structure of the water column at the three process stations during March - early June 1997. A, station 38A; B, station 47; C, station LBP.

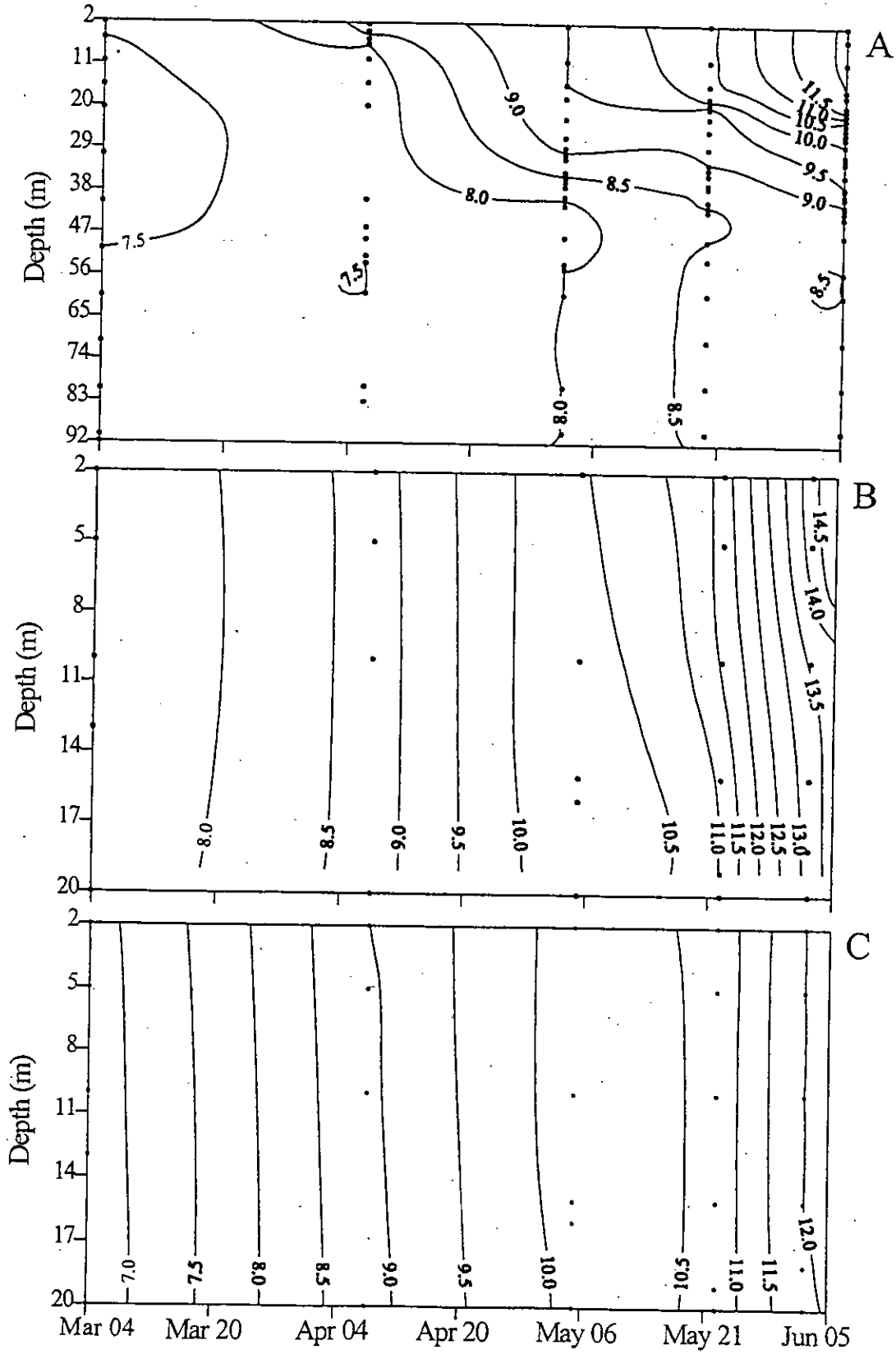

Figure 3. Changes in nitrate concentration (mmol m-3) a the three process stations during spring 1997. A, station 38A; B, station 47; C, station LBP.

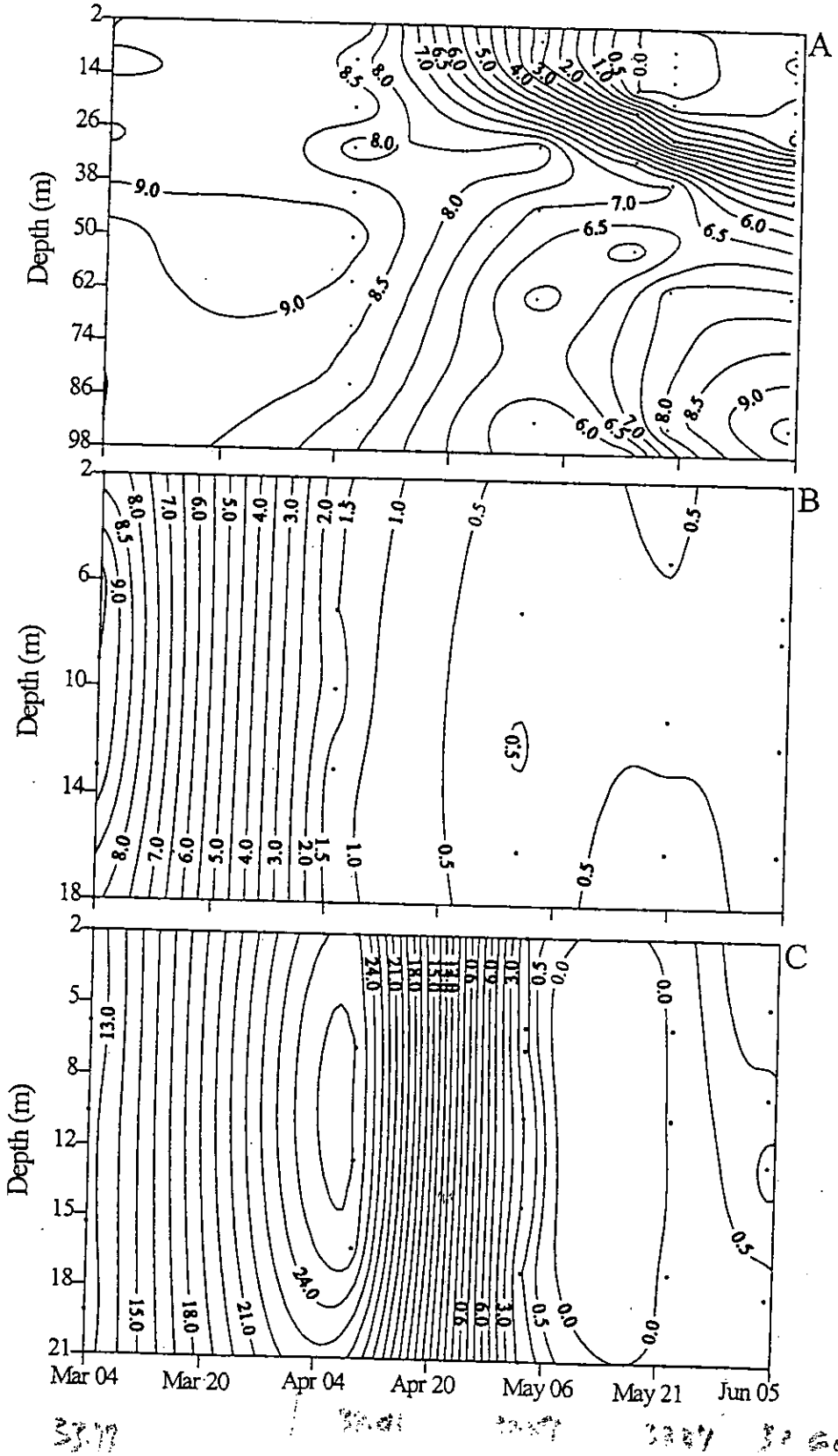

Figure 4. Development of the spring bloom (in terms of chlorophyll standing stock mg m^{-2}) in Dundalk Bay (S47), the central region of the western Irish Sea (S38A). Note change in scale of the y axis for Liverpool Bay.

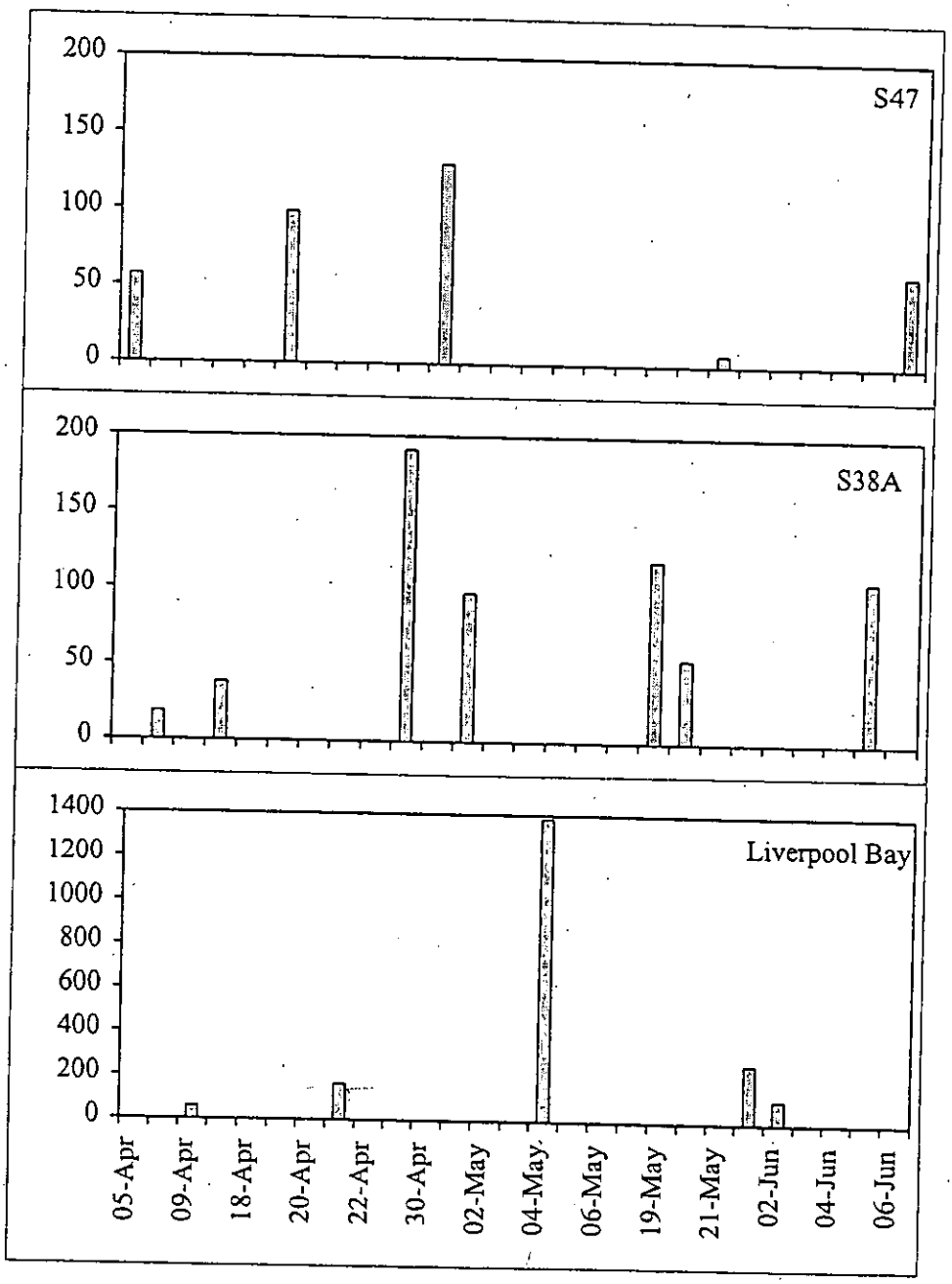

Figure 5. Changes in total copepod abundance (x10^3 ind m^{-2}) at the three process stations in the Irish Sea during March-June 1997.

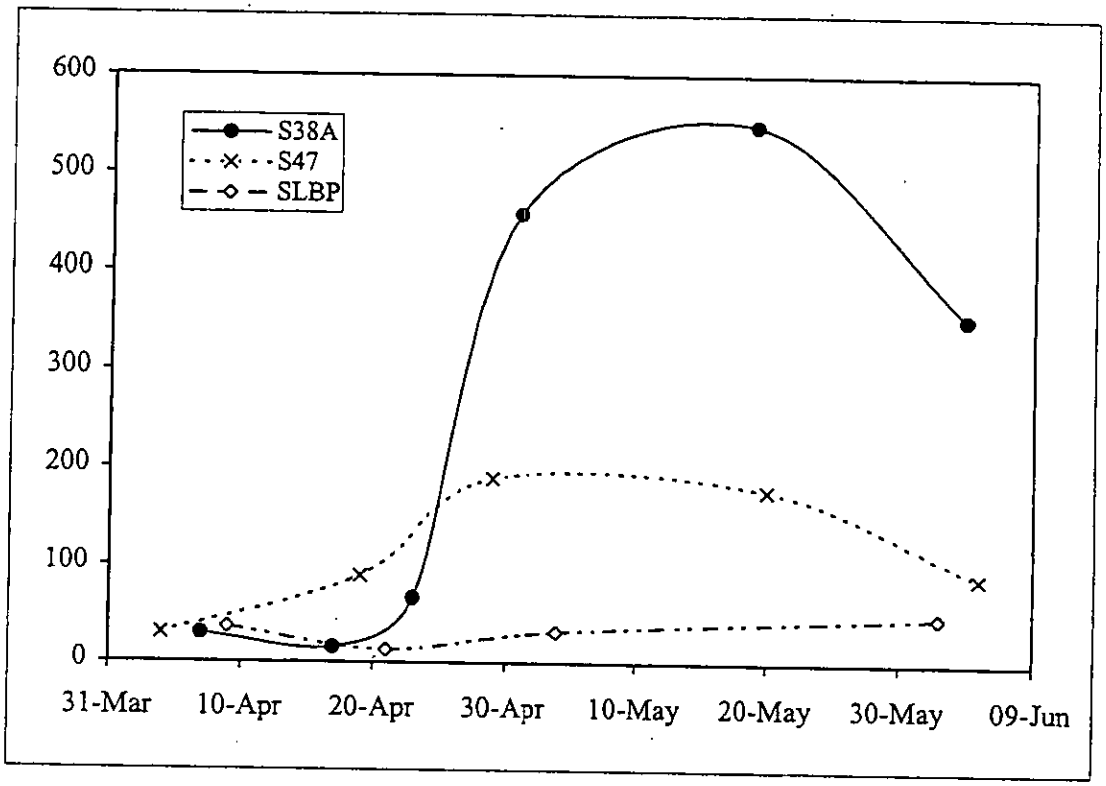

Figure 6. Development of the copepod population in relationship to the spring bloom of phytoplankton at station 38A in the western Irish Sea.