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RV *Dana* (Danish Institute for Fisheries Research)

Cruise 06/97 (Marine Laboratory Aberdeen cruise 0197H)

Collaborative cruise between Danish Fisheries Research Institute (DFU) and FRS Marine Laboratory, Aberdeen

REPORT

4-19 April 1997

Personnel

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Objectives

1. To assess latitudinal variations in the timing of emergence of *Calanus finmarchicus* from diapause in the NE Atlantic.

2. To determine the locations where overwintered *Calanus finmarchicus* are first carried onto the shelf regions around Faeroe, and southeast Iceland.

3. To map the distribution of primary production, *Calanus finmarchicus* grazing and egg production rates along the Iceland Scotland Ridge.

Scientific background

The cruise formed part of the EU funded Trans-Atlantic Study of Calanus (TASC) and had the specific role of testing a model of the emergence of *Calanus* from overwintering diapause at depths of 400-1,500 m in the Atlantic and Norwegian Sea and subsequent invasion of the shelf regions. An earlier cruise (*Dana* 15/96, November/December 1996) had mapped the distribution of overwintering *Calanus* over a wide are of the NE Atlantic. These data were used in the model to predict the distribution that would be expected in April based on the ocean

Hydrographic and chlorophyll conditions

The sub-polar front was the dominant hydrographic feature of the survey region, running parallel and to the north of the Iceland-Scotland Ridge. North of the front, surface water temperatures in the Norwegian Sea were less than 2°C (minimum 0.8°C) whilst south of the front temperatures were typical of Atlantic waters (8°C). Chlorophyll concentrations were low in the oceanic waters (<1 $mg.m^{-3}$) with highest values in the cold surface waters north of the sub-polar front, and in the extreme south of the survey area where thermal stratification was just beginning to develop. Significantly higher concentrations (>1 $mg.m^{-3}$) were found in the shelf waters around the Faeroe Islands and on Faeroe Bank.

Calanus distribution and abundance

As in *Dana* cruise 15/96 the OPC proved to be an excellent remote sensing device for *Calanus* in the oceanic water where contamination from inert particulate matter was minimal. Vertical distributions of particles in the size range 1,200-1,400 microns diameter correlated well with the distributions of animals estimated from ARIES net samples. The OPC data were extensively used for near-real time mapping of *Calanus* distribution and survey planning (Figure 3).

In November/December, the highest overall abundances of overwintering *Calanus finmarchicus* were found in the deep, cold Norwegian Sea Deep Water (NSDW) below 600 m in the Faeroe-Shetland Channel. Elsewhere, in the Norwegian Sea, overwintering animals were found at depths of 400-600 m, and between 600 and 1,500 m in the Atlantic south of Iceland. By April, a high proportion of the animals in the Norwegian Sea (eg station 60) had ascended to the upper 400 m of the water column and matured to stage VI males and females. The abundance below 400 m was substantially less than in November/December. In contrast, in the Atlantic region south of the Iceland-Scotland Ridge, a high proportion of animals were still present as stage V at depths of 500-1,500 m. A latitudinal gradient of emergence state was present in the Faeroe-Shetland Channel. In the north (eg station 128), some stage V animals were present as a layer at 600 m, with large numbers of males at 400 m and females in the upper 300 m. At the southern extreme (eg station 124), in the Faeroe Bank Channel, a dense layer of diapause stage V animals persisted at 600 m, with a lower concentration of males and females in the upper 400 m. The OPC data showed these differences in vertical distribution very clearly, even resolving the differences in size composition of animals in the various layers (Figure 4).

In the upper 400 m there was some evidence that stage VI female animals were undergoing a diel vertical migration between the surface at night and a layer at 300 m depth during daytime. The average concentration of particles in the *Calanus* size range (1,200-1,400 microns) showed highest values in the northern Faeroe-Shetland Channel and in a band along the Iceland-Faeroe Ridge as predicted before the cruise by the model (Figure 5). Exceptionally high concentrations of particles in this size category were located on the northern side of the Faeroe Bank, again as predicted by the model under certain wind conditions.

Taken overall, the distribution data confirm the paramount importance of the Faeroe-Shetland Channel and the deep water circulation therein for the *Calanus* stock in the whole Iceland-Scotland region. By far the bulk of the stock resides in the Channel during the winter and is

Table 1. *Dana* 0697 - record of sampling at each station

Station	Sampling carried out
148 (60°55.00'N, 000°30.00'W)	ARIES
149 (61°30.00'N, 000°45.00'W)	ARIES
140 (62°05.09'N, 000°59.89'W)	CTD + vertical net + ARIES
130 (62°24.29'N, 001°49.82'W)	ARIES
120 (62°43.49'N, 002°39.74'W)	CTD + vertical net + ARIES
110 (63°02.69'N, 003°29.67'W)	ARIES
100 (63°21.89'N, 004°19.59'W)	CTD + vertical net + ARIES + MIKT
80 (64°00.28'N, 005°59.44'W)	CTD + vertical net + ARIES
60 (64°38.68'N, 007°39.29'W)	CTD + vertical net + ARIES
40 (65°17.08'N, 009°14.19'W)	CTD + vertical net + ARIES
30 (65°36.27'N, 010°09.07'W)	ARIES
19 (65°32.42'N, 011°40.57'W)	CTD + vertical net + ARIES
18 (65°09.37'N, 012°22.15'W)	ARIES
17 (64°46.31'N, 013°03.72'W)	CTD + vertical net + ARIES
16 (64°23.26'N, 013°45.30'W)	ARIES
15 (64°00.21'N, 014°26.88'W)	CTD + vertical net + ARIES
14 (63°37.16'N, 015°08.45'W)	CTD + vertical net
13 (63°14.10'N, 015°50.03'W)	CTD + vertical net + ARIES
12 (61°51.05'N, 016°31.61'W)	ARIES
32 (62°12.65'N, 014°51.76'W)	CTD + vertical net + ARIES
33 (62°35.71'N, 014°10.18'W)	ARIES
34 (62°58.76'N, 013°28.60'W)	CTD + vertical net + ARIES
35 (63°21.81'N, 012°47.03'W)	ARIES
36 (63°44.87'N, 012°05.45'W)	CTD + vertical net + ARIES + MIKT
37 (64°07.92'N, 011°23.87'W)	ARIES
38 (64°30.97'N, 010°42.30'W)	CTD + vertical net + ARIES
49 (64°34.83'N, 009°10.79'W)	ARIES
58 (63°52.57'N, 009°02.45'W)	CTD + vertical net + ARIES + MIKT
57 (63°29.52'N, 009°44.02'W)	ARIES
56 (63°06.47'N, 010°25.60'W)	CTD + vertical net + ARIES
55 (62°43.42'N, 011°07.18'W)	ARIES
54 (62°20.36'N, 011°48.76'W)	CTD + vertical net + ARIES
53 (61°57.31'N, 012°30.33'W)	ARIES
52 (61°34.26'N, 013°11.91'W)	CTD + vertical net + ARIES + MIKT
72 (60°55.86'N, 011°32.06'W)	CTD + vertical net + ARIES
73 (61°18.91'N, 010°50.48'W)	ARIES
74 (61°41.97'N, 010°08.91'W)	CTD + vertical net + ARIES
75 (62°05.02'N, 009°27.33'W)	ARIES

Station	Sampling carried out
76 (62°28.07'N, 008°45.75'W)	CTD + vertical net + ARIES
77 (62°51.13'N, 008°04.17'W)	ARIES
78 (63°14.18'N, 007°22.60'W)	CTD + vertical net + ARIES
88 (62°54.98'N, 006°32.67'W)	ARIES
98 (62°35.78'N, 005°42.75'W)	CTD + vertical net + ARIES
108 (62°16.58'N, 004°52.82'W)	ARIES
118 (61°57.39'N, 004°02.90'W)	CTD + vertical net + ARIES
128 (61°39.19'N, 003°12.97'W)	ARIES
126 (60°52.08'N, 004°36.13'W)	CTD + vertical net + ARIES + MIKT
116 (61°11.28'N, 005°26.05'W)	ARIES
106 (61°30.48'N, 006°15.98'W)	CTD + vertical net + ARIES
96 (61°49.68'N, 007°05.90'W)	CTD + vertical net + ARIES
95 (61°26.62'N, 007°47.48'W)	CTD + vertical net + ARIES
105 (61°07.43'N, 006°57.55'W)	ARIES
115 (60°48.23'N, 006°07.63'W)	CTD + vertical net + ARIES
125 (60°29.03'N, 005°17.70'W)	ARIES
124 (60°05.98'N, 005°59.28'W)	CTD + vertical net + ARIES
114 (60°25.17'N, 006°49.21'W)	ARIES
104 (60°44.37'N, 007°39.13'W)	CTD + vertical net + ARIES
94 (61°03.57'N, 008°29.06'W)	ARIES
93 (60°40.52'N, 009°10.63'W)	CTD + vertical net + ARIES
102 (59°58.27'N, 009°02.28'W)	ARIES
112 (59°39.07'N, 008°12.36'W)	CTD + vertical net + ARIES
122 (59°19.87'N, 007°22.43'W)	ARIES + MIKT

Hellerman climatological mean wind stress. Predicted distribution of Calanus at 1 April

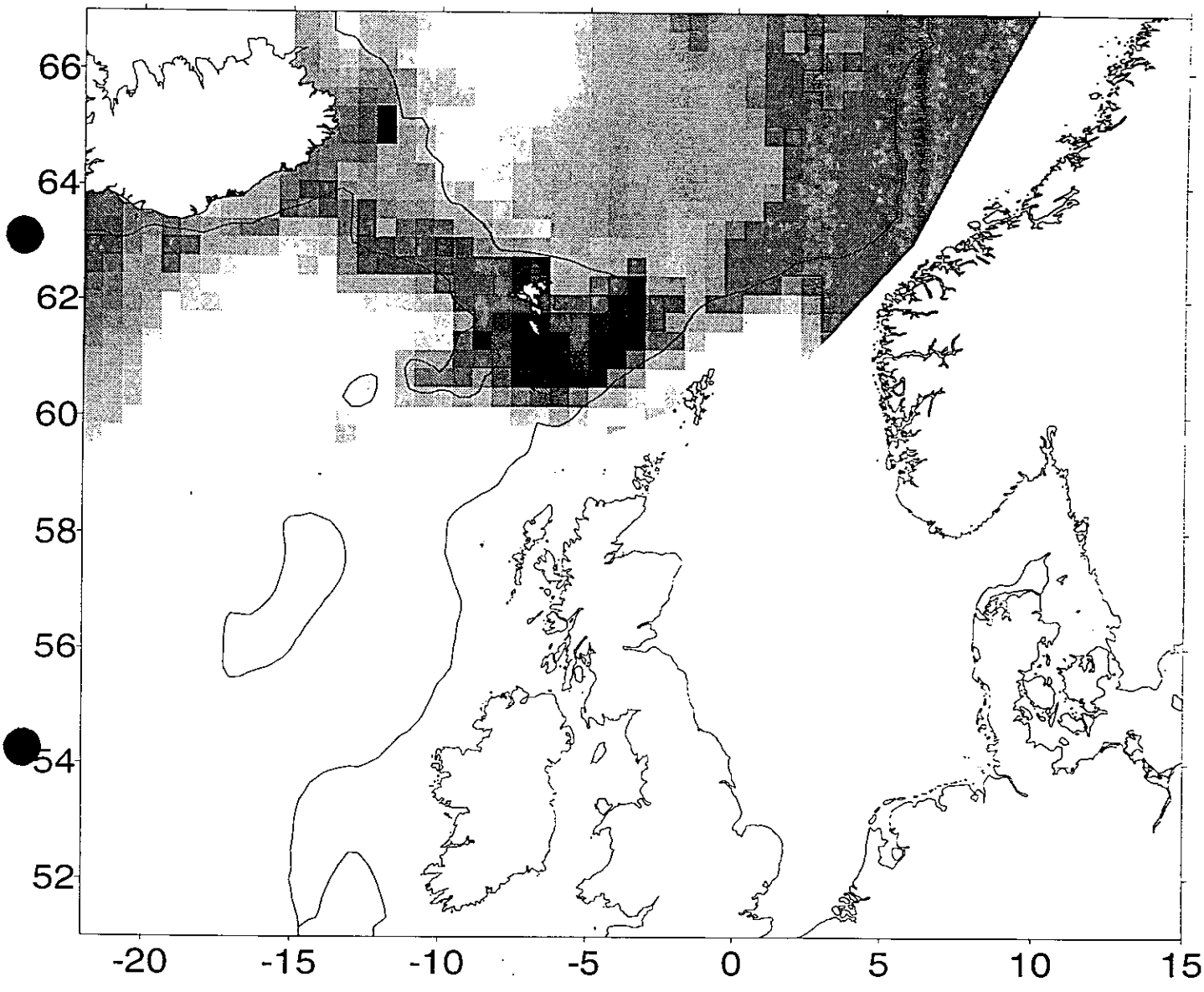

Figure 1. Model prediction of the distribution of *Calanus* in the surface waters on 1 April under climatological mean wind conditions. Inputs to the model were data from the cruise *Dana* 15/96 in December 1996, and data from a water circulation model of the North Atlantic.

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Survey track and station positions

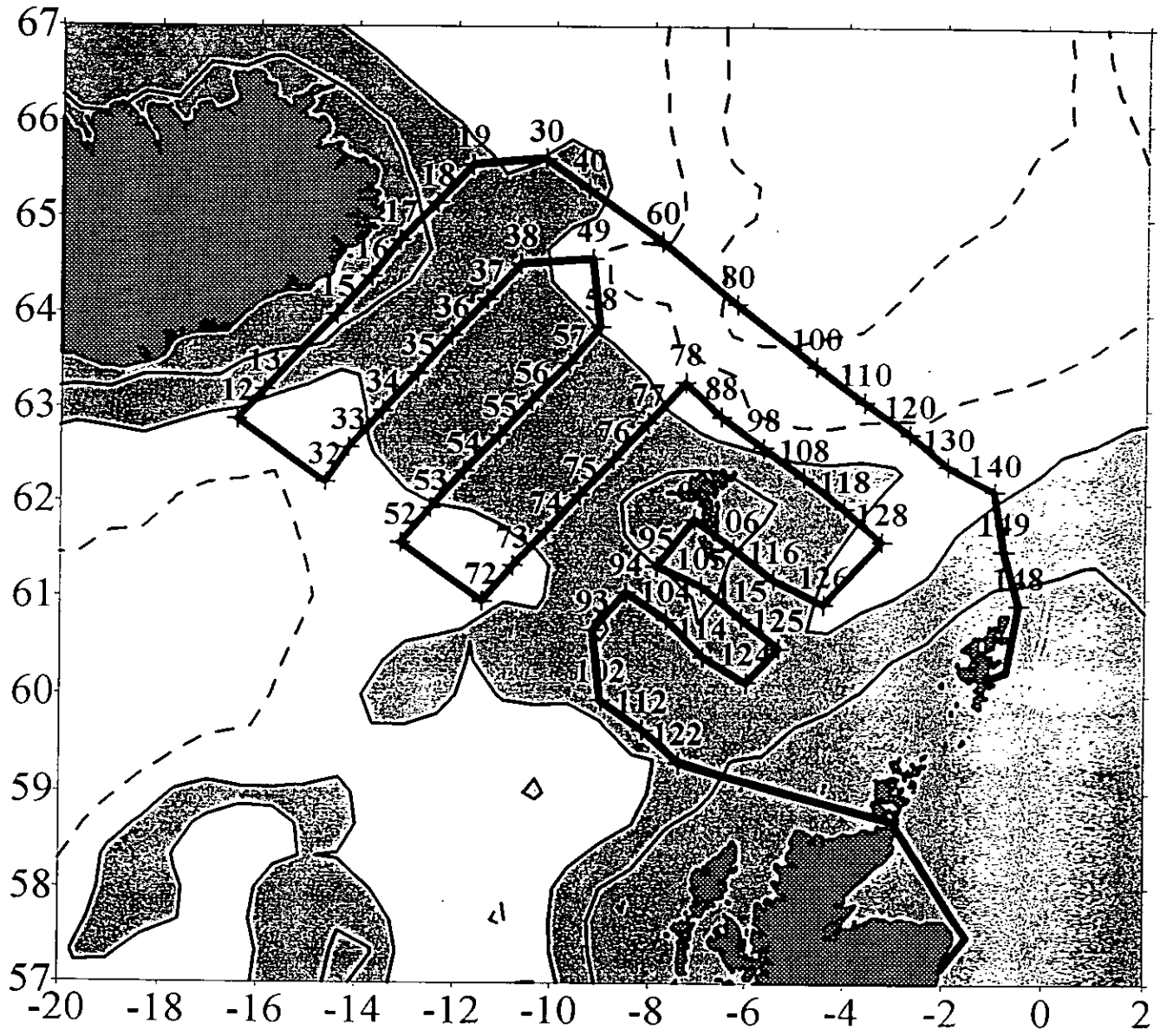
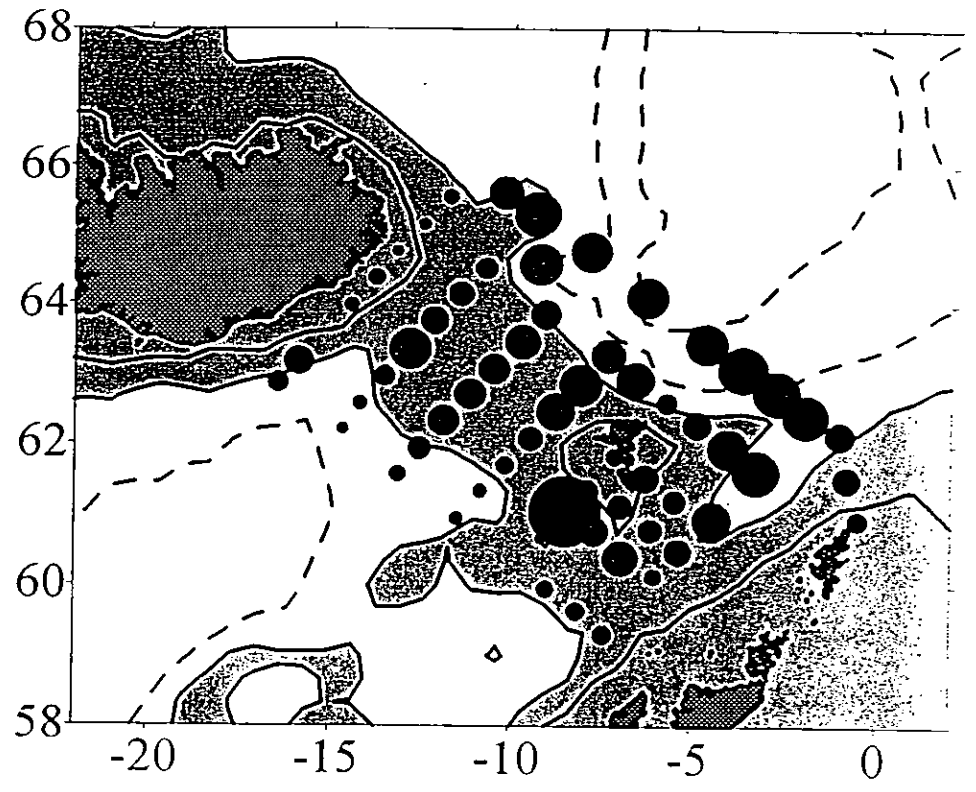


Figure 2. Map of station positions and survey track.



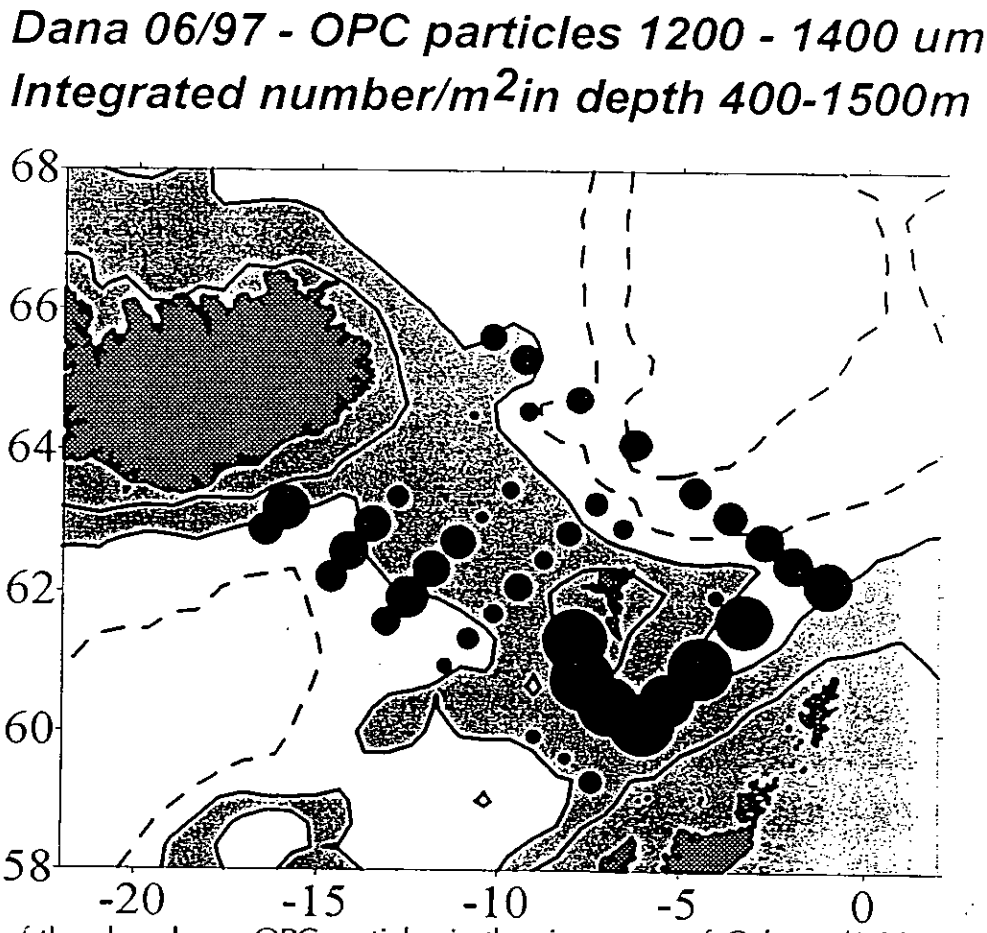


Figure 3. Maps of the abundance OPC particles in the size range of *Calanus* (1,200-1,400 microns) integrated over two depth layers.

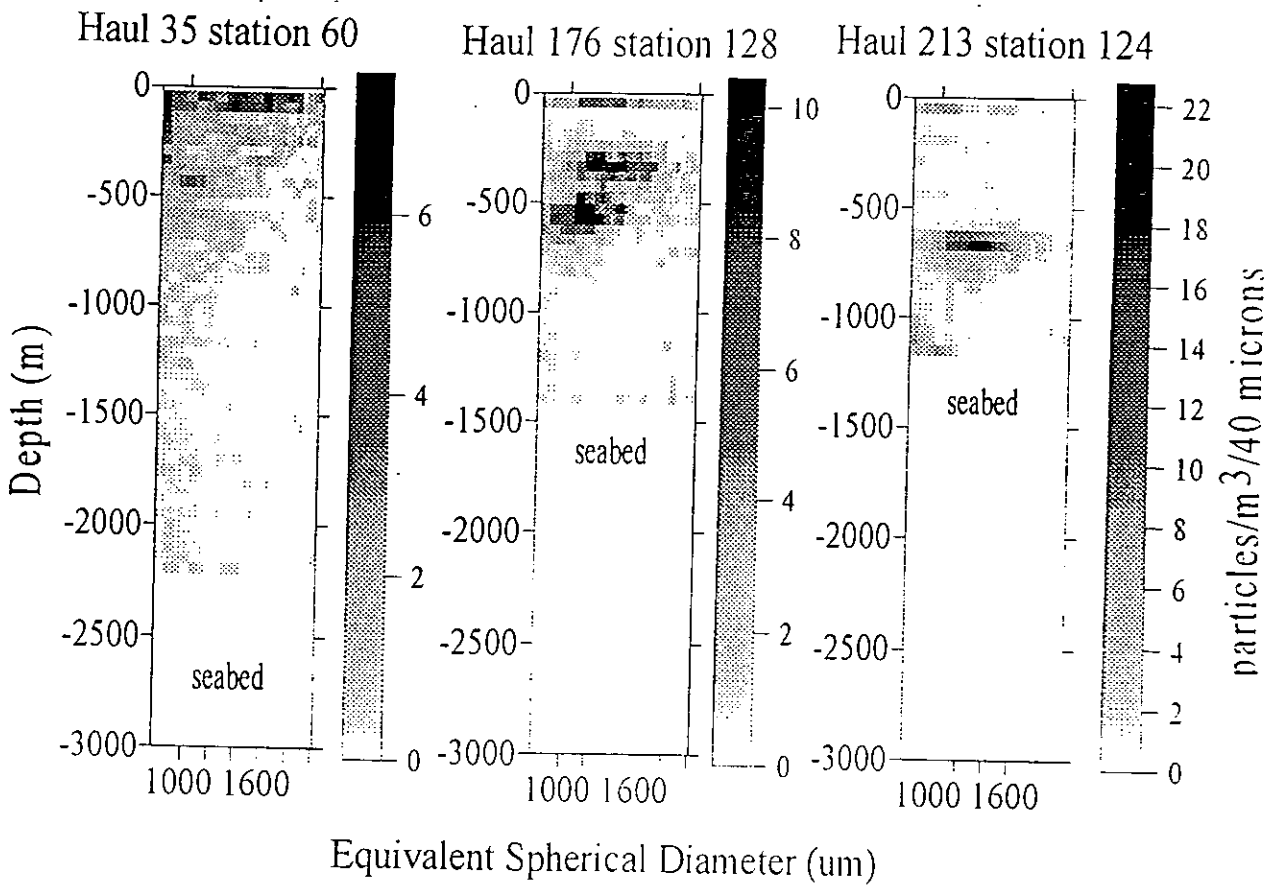


Figure 4. Vertical profiles of particle size composition at stations 60, 128 and 124 showing the latitudinal trend in emergence state of *Calanus*. In the north (station 60) the majority of the population was present as males and females in the surface waters, whilst in the south (station 124) the majority were present as stage V animals.

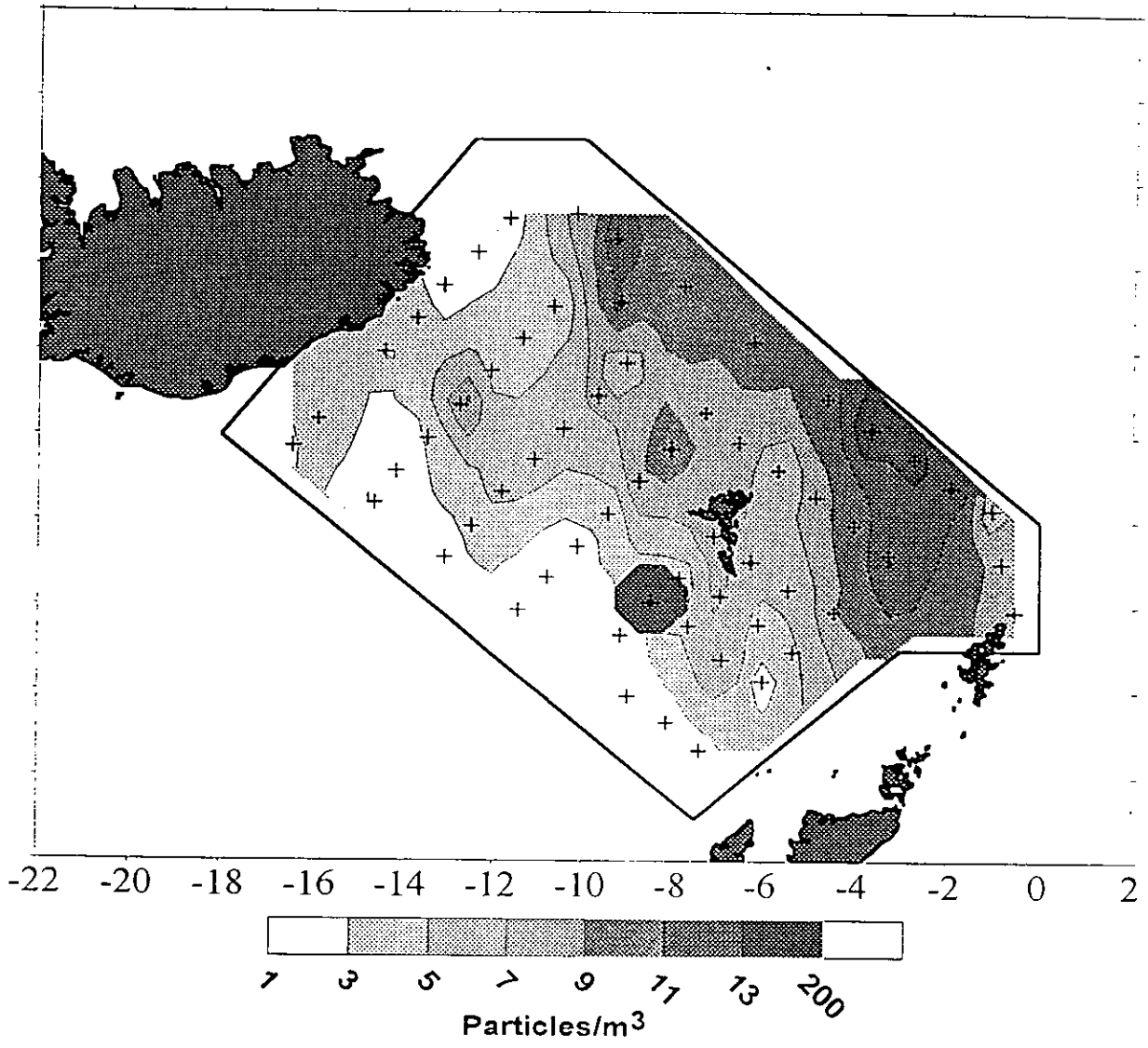


Figure 5. Map of average particle concentration (number.m^{-3}) in the upper 400 m, in the *Calanus* size range.

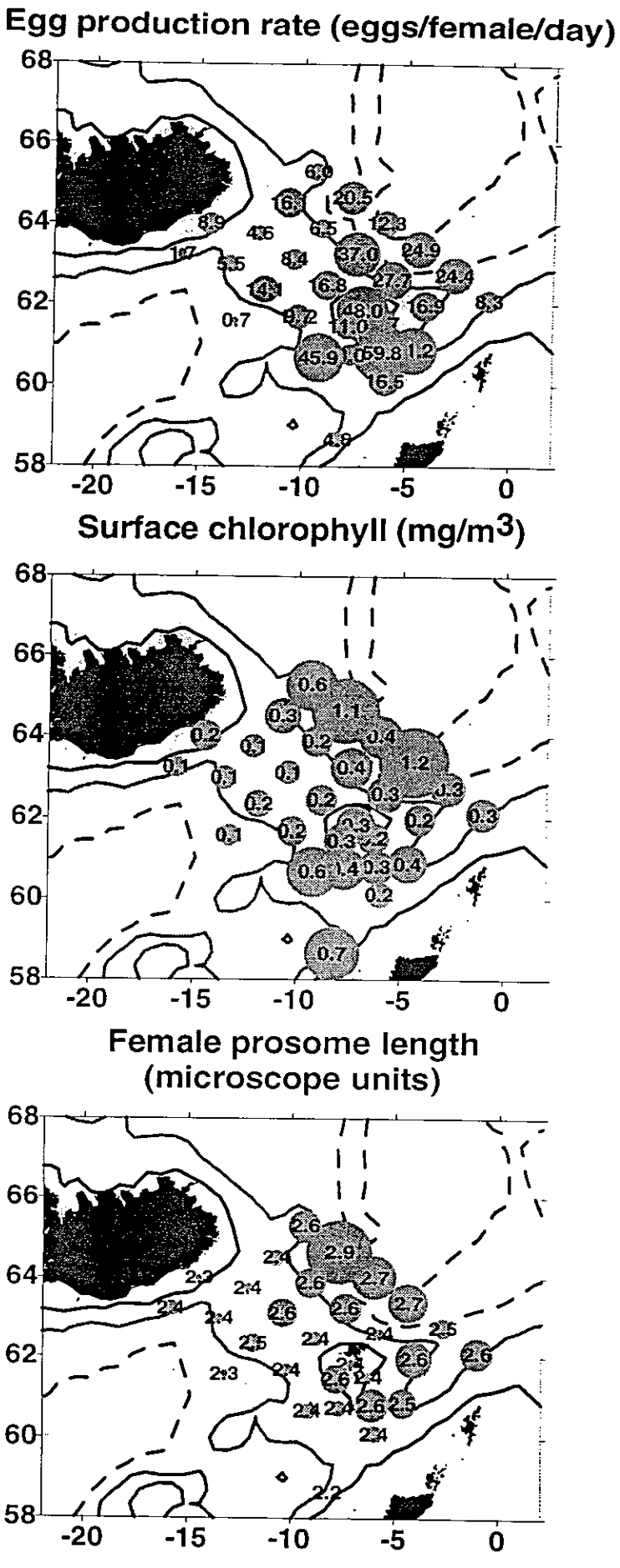


Figure 6. a) Data on egg production rates by female *Calanus;* b) Surface chlorophyll concentrations at stations where *Calanus* egg production was measured; and c) Data on the body size of female *Calanus.*