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Some Considerations on the Significance of Larval Drift for the Recruitment of West Greenland Cod

by

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ABSTRACT

The geographical distribution of young cod off West Greenland is described and trajectories of satellite-tracked drifting buoys deployed off East Greenland are analysed with the intention to evaluate the influence of larval drift on year class strength of West Greenland cod. The trajectories of the drifters confirm larval drift from Southwest Iceland to East Greenland and from Southeast to Southwest Greenland. The latter is reflected by the distribution of the 1985 year class which was observed with highest densities off Southwest Greenland (Div. 1F and 1E). By contrast, the 1984 year class was much more abundant further north off West Greenland (Div. 1D and 1B+C). Considering additionally the high abundance of larvae in 1984 and the very low larval abundance in 1985 at West Greenland it appears that the 1984 year class have originated to a considerable extent from West Greenland spawning areas whereas the 1985 year class was formed predominantly by larval drift from Southeast to Southwest Greenland.

INTRODUCTION

In 1984 and 1985 strong year classes of cod occurred in Greenland waters after several years of poor recruitment. Direct current measurements off Greenland are scarce, but based on the general current patterns it has been assumed that, especially in 1984, this good recruitment was related to the drift of considerable numbers of larvae from Iceland to East Greenland and further to the southern part of West Greenland (Anon. 1989). It is supposed that these year classes will disappear to a considerable extent from West Greenland at time of maturation remigrating to their original spawning grounds. This is based on the observation that such spawning migrations seem to be especially pronounced for year classes which originate from the spawning sites at East Greenland and at Iceland (Horsted 1989), whereas the amount of emigrants from year classes of western origin should be much lower.

In this paper recent trajectories of satellite-tracked drift buoys are analysed in order to describe possible drift paths of cod larvae and the distribution of the 1984 and the 1985 year classes off West Greenland is presented, discussing their origin.

MATERIALS AND METHODS

The results of the autumn groundfish surveys 1984-1988 by RV "Walther Herwig" (Institut für Seefischerei Hamburg) were used for describing the geographical distribution of the 1984 and 1985 year class of cod off West Greenland (Anon. 1989). The density of these two year classes as expressed in number per square nautical mile was calculated for age 0 to age 3 from the survey abundance estimates and the division areas. Although the absolute abundance of small cod is significantly underestimated due to incomplete availability to the survey gear and to gear selection (Anon. 1986) the tracking of the year classes over 4 years should allow a comparison of the results obtained for the different NAFO divisions.

Within the framework of a research program on the warm water sphere of the Atlantic (SFB 133, Institut für Meereskunde Kiel) a couple of satellite-tracked drifting buoys were deployed in the areas southeast of Greenland, the Irminger Sea and the Denmark Strait from RV "Poseidon" in May 1988. The drifters consisted of a surface buoy containing a transmitter for satellite tracking connected to a window-shaded 16.8 m^2 drogue at 100 m depth. The buoys were monitored by the ARGOS system. The raw data consists of 6 - 8 satellite fixes per day with an accuracy of about 2 km. These data were submitted to a probability check to exclude those drifters which have lost their drogue or which have been trapped by ice. The remaining data were interpolated by a three point Lagrangrian scheme to obtain eight buoy positions of equal distance per day. For the purpose of this paper the trajectories of four drifters which had been released close to the spawning grounds of East Greenland and Iceland cod were chosen.

RESULTS

In Fig. 1 the densities of the 1984 and the 1985 year class is illustrated in the different divisions off West Greenland from age 0 to age 3. For both year classes the increase in abundance with age reflects the incomplete availability of the first age groups to the survey gear. However, from a comparison of the different areas it is apparent that the 1984 year class was found with highest densities mostly in division 1D through age 0 to age 3. But considerable densities were also observed in the remaining areas, especially in division 1B+C at age 1 and in division 1 E for age 1 to age 3. By contrast, the 1985 year class showed a much more pronounced southern distribution. About 70 % of the 0-group was localized off Southwest Greenland (Div. 1F and 1E). Subsequently this year class remained with highest densities in that area until age 3, which was concentrated in division 1D.

The drifters 6939 and 6940 were deployed off Southwest Iceland and on Dohrn Bank (Fig.2). Drifter 6939 went northward with the Irminger current with velocities of about 20 cm/s and entered the East Greenland current in the middle of July. It turned southward with increasing speed reaching maximum values of 50 - 70 cm/s after passing Kap Farvel between August, 20th and September, 10th. Drifter 6940 was directly launched in the East Greenland current and moved southwestward with velocities of about 10 - 20 cm/s. When rounding Kap Farvel in the end of october the velocity increased up to 80 cm/s. Off West Greenland the northward drift of the buoys continued to 64°30'N and 65°30'N respectively, before they turned westward.

The drifters 6922 and 6943 were deployed in the southern part of the East Green-

land current (Fig.3). Drifter 6922 had already rounded the southern tip of Greenland in May/June with a speed of about 50 - 70 cm/s, whereas buoy 6943 passed Kap Farvel in July/August with velocities of 40 - 50 cm/s. As before, the velocity maxima occurred off Southwest Greenland. Earlier than drifter 6939 and 6940, which passed that region in autumn, they adopted a westward course at 62°45'N and 61°45'N respectively. Drifter 6922, which was launched closer to the coast than drifter 6943, arrived in Div. 1E in the end of June whereas the other was first observed there in August.

DISCUSSION

Although the information base on the offshore distribution of young cod at West Greenland is not very accurate it can be concluded that the 1985 year class was initially concentrated off Southwest Greenland, whereas the 1984 year class showed a more pronounced northwestern distribution. Based on the distribution of the younger age groups (age 1 to age 3) Smidt (unpubl., presented in Hansen and Buch 1986) has evaluated the origin of a couple of former year classes. Year classes thought of as being of western origin showed a northwestern distribution (i.e. year classes 1953, -57 and -60) and were found in years of high larval abundance on the banks off West Greenland. In contrast, year classes occurring predominantly off South Greenland were classified as "easterners" (i.e. year classes 1956, -61,-63 and -73) and had been observed in years of low larval abundance off West Greenland (Hansen and Buch 1985). Preliminary results of the routine sampling of cod eggs and larvae off West Greenland (Div. 1D and further north) conducted by the Greenland Fisheries Research Institute show extraordinarily high numbers of cod larvae in 1984 (Smidt 1985) and an extremely low larval abundance in 1985 (Lehmann 1986).

Direct measurements of the surface currents in the area in question are scarce. Observations on Dohrn Bank off East Greenland indicate a mostly westward flow with a speed of about 30 cm/s at 156 m depth (Stein 1974). Current meter recordings at 100 m depth in the East Greenland current and in the Irminger current south off Kap Farvel illustrate a steady flow to the west with mean velocities of about 30 cm/s and 10 cm/s respectively (Clarke 1984). At West Greenland mostly northward currents with velocities of about 20 cm/s have been reported based on drift bottle experiments (Hermann and Thomsen 1946) and current meter data (Buch 1982). Indirect determinations of the current velocity using geostrophic calculations show that the West Greenland current is most intense in spring and autumn, whereas during summer the current is considerably reduced (Alekseev et al. 1972, Buch 1984, Myers et al. 1989, Soule et al. 1963). Furthermore, a more pronounced westward circulation south off Fyllas Bank in early summer has been reported (Alekseev et al. 1972). In general, the drifter trajectories given in this paper are in accordance with these findings, representing a possible drift of cod larvae from Southeast to Southwest Greenland and from Iceland to East Greenland. The latter has been well documented by the results of O-group surveys covering the Icelandic-East Greenland area (Helgason and Sveinsbjörnsson 1987). Although the drifters might not have been deployed precisely in the spawning centers because they were originally not intended to track aggregations of cod eggs or larvae and interannual variations of the currents can occur (Alekseev et al. 1972, Myers et al. 1989), a more extended drift of the larval stages from Iceland to the banks off West Greenland seems

rather unlikely. But the remarkably high current strength off South Greenland may cause some subsequent displacement of juvenile cod towards West Greenland. However, it appears that the extraordinary numerous cod larvae found on the banks off West Greenland in 1984 (Smidt 1985) did not originate from the East Greenland and Icelandic spawning grounds since they have been observed there already in summer.

Using otolith characteristics Rätz (1989) has shown that in 1985 and in 1986 juvenile cod (age 1 and age 2) migrated from East to West Greenland. For the 1984 year class the proportion of imigrants amounted to 33 % at age 1 and 38 % at age 2, but the 1985 year class consisted of only 15 % imigrants at age 1. Due to the otolith sampling strategy applied in that study it is not possible to adjoin these imigrants to the different divisions off West Greenland. However, it seems reasonable to assume that the high densities of the 1984 year class observed off Southwest Greenland in 1985 and in 1986 resulted mainly from this imigration.

In summary it can be stated that there is some evidence that the 1984 year class originated to a considerable extent from West Greenland spawning grounds and an imigration occurred additionally during the following years, whereas the 1985 year class was formed predominantly by larval drift from Southeast to Southwest Greenland. Nonetheless, more reliable information on the drift of cod larvae and on the distribution of young cod off West Greenland appears highly desirable for future work.

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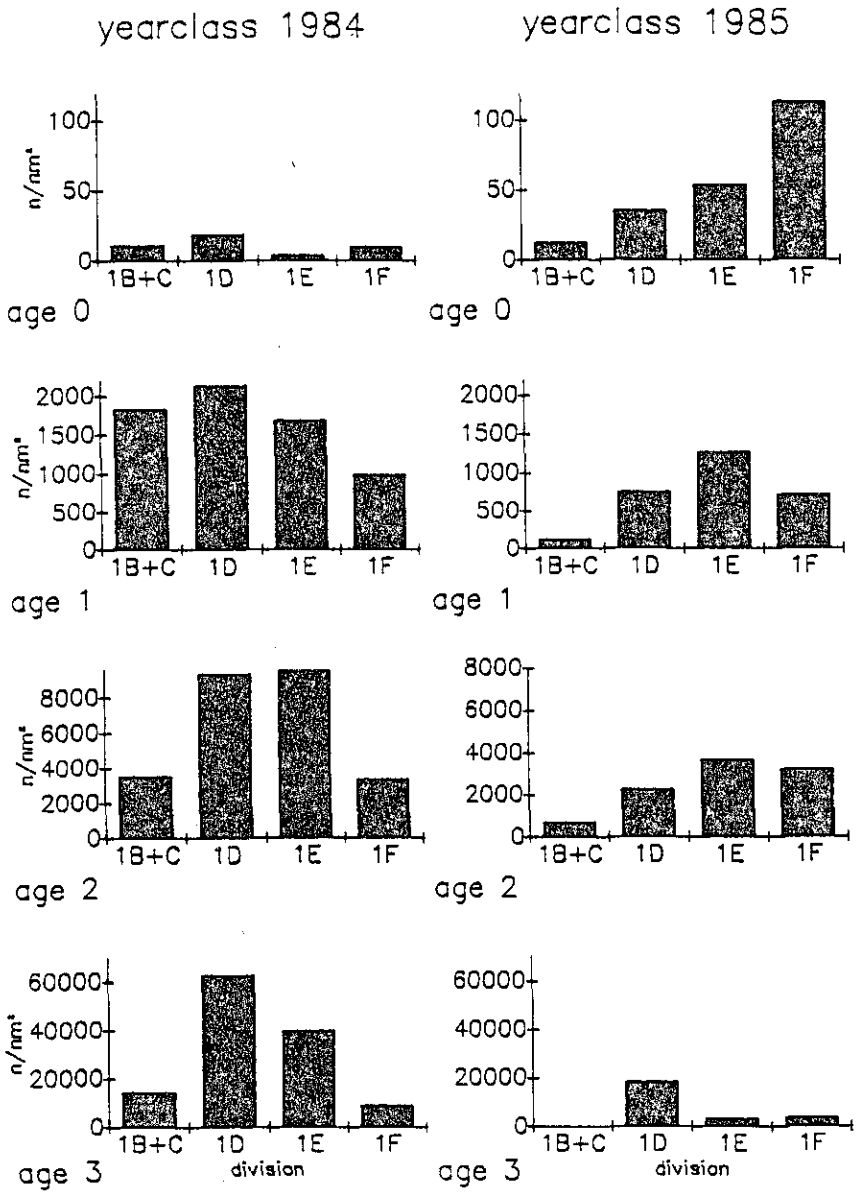

Fig.1: Density of the 1984 and the 1985 year class by age group and division

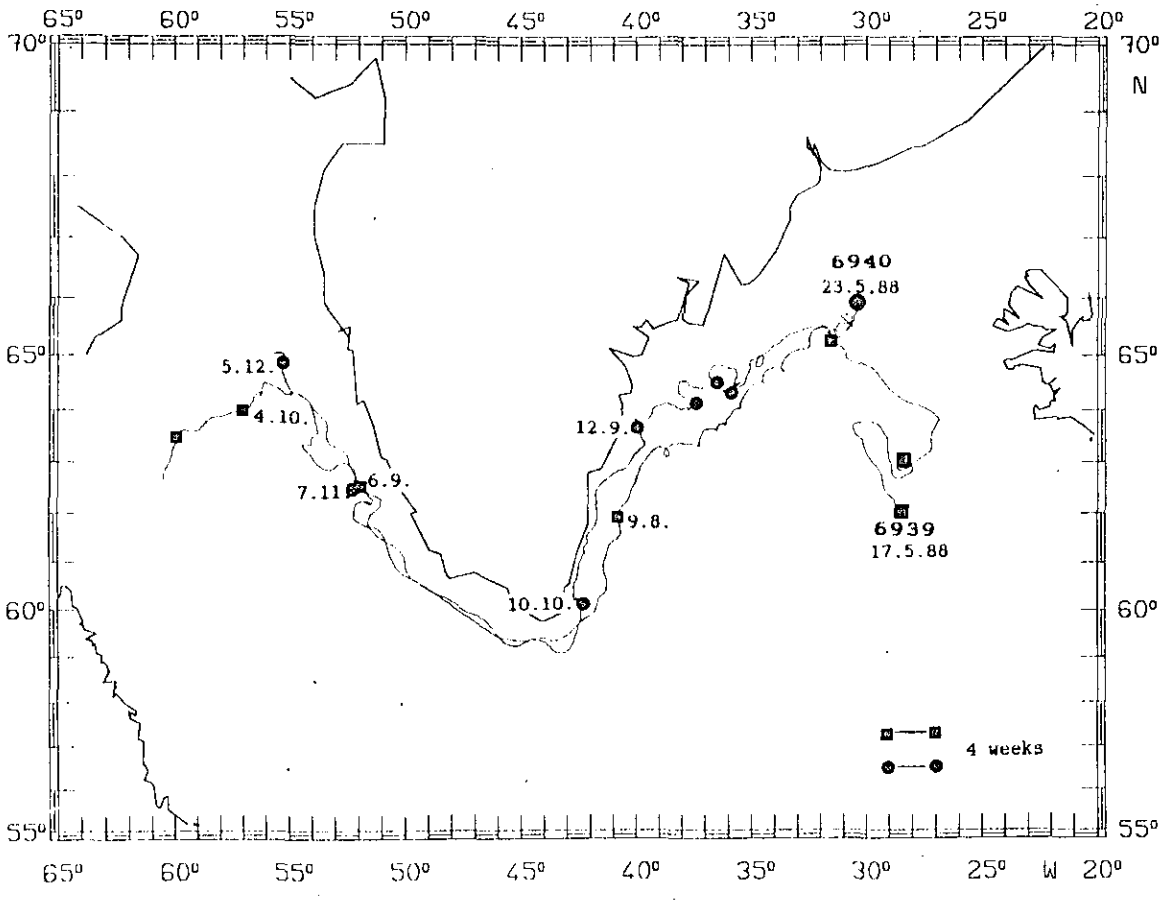

Fig.2: Trajectories of drifters deployed off Southwest Iceland and on Dohrn Bank

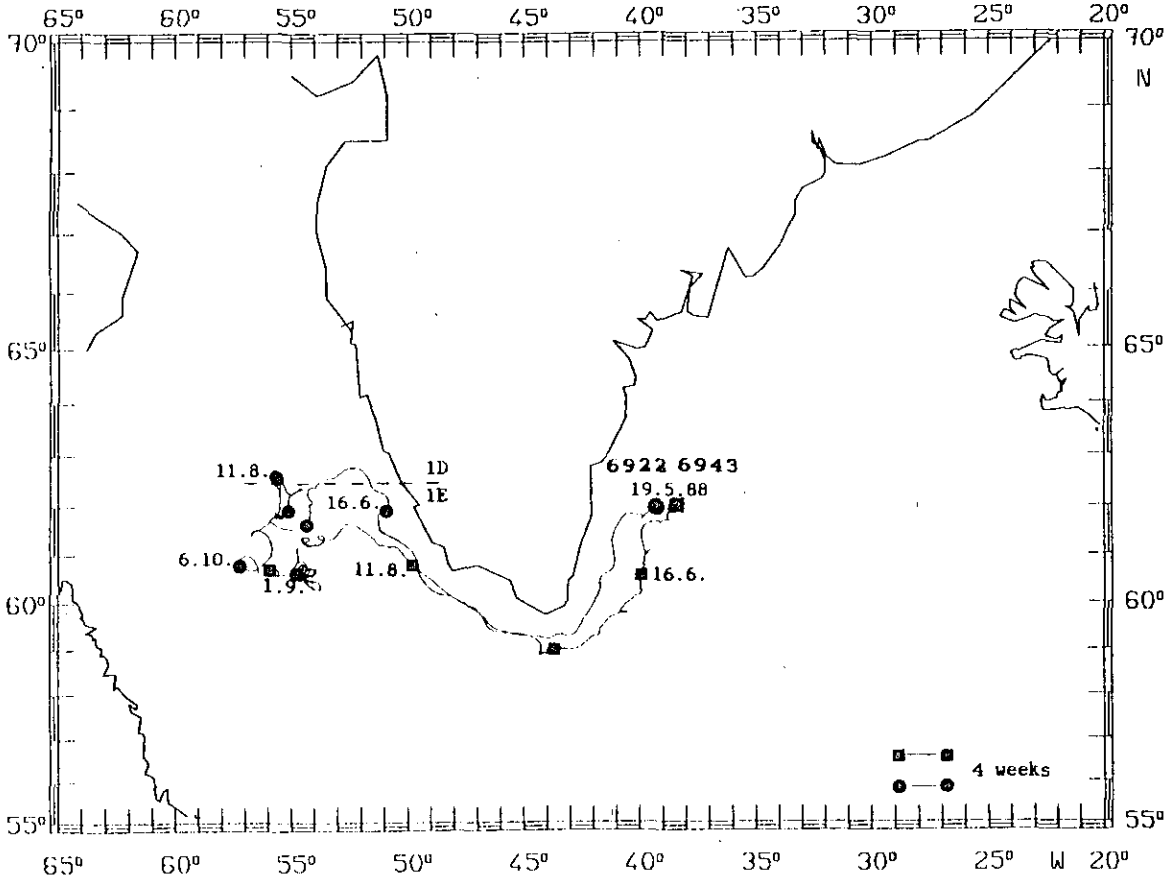

Fig.3: Trajectories of drifters deployed off Southeast Greenland