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SPECIAL MEETING OF STACRES - NOVEMBER 1978

On the Possible Drift of Shrimp Larvae in the Davis Strait

by

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Charlottenlund, Denmark

The block labelled LEGEND in Fig. 4 and Fig. 5 of Res. Doc. 78/XI/93 should be replaced by the following:

LEGEND

0.00-0.07 m/sec

0.07-0.18 m/sec

0.18-0.29 m sec

>0.29 m/sec

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INTRODUCTION

Carlsson and Smidt (1978) state that "Larval drift by surface currents is assumed to be essential for the recruitment to certain stocks (of shrimp, author's add.)." Klimenkov, Berenboim and Lysy (1978) reported that "In August and September, large numbers of shrimp larvae (stages 4 to 6) were caught in the near-bottom layers in the Store Hellefiske Bank area ...." and, with reference to Kiilerich (1943) and Carlsson and Smidt (l.c.), that " .... the large shrimp concentrations on the offshore grounds in the Store Hellefiske Bank area are likely to be as much dependent upon the intensity and direction of larval drift from more southerly areas as on their own reproductive capacity."

Clearly enough, a very important factor in assessing shrimp stocks and fisheries - as in assessment of stocks of other species - is the question on stock/recruitment relationship. One part of this problem is the drift and fate of larvae.

The biology of shrimp in Greenland waters is fairly well described, e.g. by Horsted and Smidt (1956) and by Horsted (1978). Some data on the occurrence of shrimp larvae in the plankton in the Davis Strait are available as shown later in this paper, and the general current system is known.

However, for a closer examination of the reproductive capacity of the stock on individual shrimp grounds more detailed data are necessary. Such data, anyway in terms of physical data, have to a great extent been collected in most recent years as part of the environmental research programs connected with the technical offshore activities in connection with oil exploration off West Greenland. Data has been collected by various oil companies as well as by the Ministry for Greenland.

In the time available it has not been possibly fully to analyze and evaluate the many physical data in relation to drift of shrimp larvae. However, it may be possible in due time to develop a "shrimp larvae drift model" provided that enough data are currently collected. The present paper is a preliminary analysis of data on occurrence of shrimp larvae and recently collected data on currents in the Davis Strait.

OBSERVED DISTRIBUTION OF SHRIMP LARVAE OFF WEST GREENLAND

Larval stages of Pandalus borealis are common in plankton samples from the Davis Strait and inshore West Greenland waters. Berkeley (1930) gave detailed descriptions with figures of 6 larval stages at British Columbia, and similar stages occur in Greenland waters.

In Oslo Fjord, Hjort and Ruud (1938) found that the main hatching of Pandalus borealis ended in April, and in the middle of July they obtained many small shrimps in the first bottom stage. Therefore, they assume that the larval development takes about three months.

Data from West Greenland waters given here indicate a larval development of about four months or more. The main hatching period in the Davis Strait is March-April (Horsted, 1978), and larvae have been taken by stramin net in inshore West Greenland waters in April-October (Horsted and Smidt, 1956).

Stephensen (1935) summarized data on development stages from different surveys as shown below (stages I-V):

	MAY 29	JUN	JUL	AUG	SEP 3-7
Davis Strait 1908-09		I-II-III	II-III	IV-V	
Davis Strait 1928	I	I-II-III	I-II-III		IV-V
SW Greenland fjords			II-III-IV	IV-V	

Further details on larval stages in the Davis Strait in 1928 are given in Table 1, the stations being shown in Fig.1.

The occurrence of shrimp larvae in the upper 50 meters at the oceanographic stations in the Davis Strait (Fig.2) in summer (mainly July) in the 1970s is shown in Table 2. The relatively small numbers in 1977 and 1978 may be due to unusually big quantities of Beroe and medusae, which possibly reduced the effectivity of the stramin net in catching the larvae. A major part of the larvae possibly stayed in deeper water layers (see below).

Pandalus larvae from the standard stations have been identified to stages only in 1977 and 1978 when all larvae were in stage III and IV. Their distribution on stages was as shown below:

	No.of larvae exam.	Stage III	Stage IV
1977 July	586	55%	45%
1978 July	57	23%	77%

In August and September 1976, large number of larvae (stages IV-VI) were caught in the near-bottom layers in the Store Hellefiske Bank area (Klimenkov, Berenboim and Lysy, 1978).

Horizontal stramin net hauls at various depths in inshore waters showed that generally the larvae were most frequent in hauls deeper than 50 m (Horsted and Smidt l.c.). Also in the Davis Strait several larvae stay in deeper water layers as seen in Table 1.

RECENT OBSERVATIONS ON CURRENTS OVER THE MAJOR SHRIMP GROUNDS OFF WEST GREENLAND

1. Material and methods

From the preceding section on the occurrence of shrimp larvae it seems most proper to consider currents for the period April to August/September including observations also in the deeper water layers. Current data are not available for the full period and not for all possible depths of interest. Lack of time when preparing this paper has also made it necessary to restrict the analyses to data which cover the most important shrimp grounds off West Greenland.

The data referred to in this paper were obtained partly by means of moored self recording current meters operated by the Danish Hydraulic Institute on behalf of the oil companies as well as for the Ministry for Greenland (Anon., 1977), and partly by means of droque drift buoys deployed in 1976 and followed by means of satellite. The drift buoy experiments were conducted and analyzed by the Chevron Oil Field Research Company on behalf of the oil companies (Brooks, 1976).

The moored current meters were on each of the stations normally placed somewhat below surface (normally 30 m) with another meter somewhat above bottom, and in some instances also with a meter in the middle water layer.

Some drift buoys were deployed with a drogue 15 meters long and 2 meters wide suspended from the bottom of each buoy with approximately 50 meters of rope. Other buoys were tethered to icebergs. Only results of drogue buoys are referred here.

2. Results

A. Moored current meters.

On the basis of data from the current meters, recording for periods of few days up to 13 weeks inside the July-September period, the Danish Hydraulic Institute (Anon., 1977) concluded that the general current conditions at the continental shelf along West Greenland are dominated by oscillating tidal currents superimposed by a slow northgoing net current, the West Greenland Current. Generally the speed of the net current decreases towards north with the maximum net currents occurring at the shallow banks. At Stations S, P and N (Fig.3) the maximum recorded net current 30-50 m below the surface was 0.38 m/sec., 0.26 m/sec. and 0.24 m/sec. respectively (1 m/sec. = 1.95 knots).

The Institute further states, that the differences in net currents and tidal currents throughout the area result in the following current patterns for the northern and the southern areas, respectively.

Northern Area (Station N): relatively weak northgoing net current superimposed by a relatively strong north-south dominated semidiurnal tidal current resulting in a northgoing net current with mean speed of about 0.08 m/sec. About 1% of the time the "surface" current speed exceeds 0.45 m/sec.

Southern Area (Station S): relatively strong northgoing net current superimposed by a relativele weak north-south dominated diurnal tidal current resulting in a northgoing net current with mean speed of about 0.12 m/sec. About 1% of the time the "surface" current speed exceeds 0.43 m/sec.

The most interesting feature is possibly the decrease in net current speed from south to north as illustrated in Fig.3. The figure also shows that at the northern edge of Store Hellefiske Bank the mean net current turns towards Disko Bay at the inner part of the shelf. The currents between Egedesminde and Godhavn indicate a general water flow inward at the southern side of the bay entrance and outward at the northern side.

The Institute further concludes, that in the northern part of the area the net current decreases significantly with the depth, while the net currents are of the same order near the surface and near the bottom in the southern areas.

More detailed information on the speed and direction distribution of the 24-hour mean net current is given by the current roses in Fig.4-5. The Institute points out, that southerly net currents occur very infrequently, while northerly 24-hour mean net current between 0.18-0.29 m/sec. occur 27%, 13% and 2% of the approximately 30 m below surface at locations S, P and N, respectively (Station P not shown on Fig.4-5).

B. Drogue drift buoys

Three drogue drift buoys were deployed in the area off Godthåb (Div.1D) in 1976. Records of the buoys' position were obtained several times (normally 5-9 times) in the 24-hour period, and in fact the full picture of the drift of the buoys is more complicated than shown on Fig.6 where only the last position of each day has been plotted for the period when the buoys were in the West Greenland fishing areas.

Buoy No. 1101 was deployed off Godthåb 26 June. It was caught by a trawler on 18 August in the shrimp fishing area west of Store Hellefiske Bank. The net movement of the buoy between the two dates given is about 186 nautical miles in a NNW direction, corresponding to a net speed of 0.15 knots. The buoy had lost its drogue at the time when it was caught, but it is not known when the drogue was lost. The buoy was redeployed on 8 September at 65°30'N 55°00'W, drifted north for six days (30 n.miles). Then the drift became very erratic and it turned north-northeasterly. In the next six days, it drifted 18 n.miles. No data was received after 20 September.

Buoy No.1137 was also deployed on 26 June off Godthåb (first recording 27 June), very close to buoy No.1101 but over more shallow grounds than the latter. Until 12 July it drifted in a NNW direction. By 12 July the net distance drifted was 68 n.miles, corresponding to a net mean speed of 0.19 knots. After 12 July it changed to a westward direction and later in July more southwards towards the Labrador Sea from where recording was still obtained in December.

Buoy No.0576 was deployed on 9 September off Sukkertoppen (ICNAF Div. 1C). Until 26 September it drifted northwards, net distance 107 n.miles, net mean speed 0.25 knots. Then it suddenly changed direction towards south with nearly the double mean speed. Records were obtained from the Labrador Sea in December.

For the latter two buoys it is not known whether the drogue was lost, but this was possibly the case for buoy No.0576 and the reason for the sudden change of its drift and speed.

The Chevron Oil Field Research Company (Brooks, 1976) has concluded from these experiments (and from data obtained from buoys tethered to icebergs) that, in general, the drift patterns of the buoys confirmed the current patterns reported in oceanographic atlases for the Davis Strait. Further, the results illustrate both temporal and areal changes. However, the uncertainties as to how long the drogue remained attached (or how long other buoys remained tethered to their icebergs) preclude firm conclusions.

DISCUSSION

Although the observations of currents do not cover the first months when shrimp larvae occur in the plankton it may nevertheless be concluded that at least for Divisions 1D, 1C and southern part of 1B the net drift of larvae is likely to be northwards. It may be doubtful whether the net transport in the April-June period is the same as that indicated by the July-September currents, because in the first period the Div. 1B shrimp grounds are frequently covered by the Labrador drift ice. The material here presented does not show the influence of the Labrador Current at that time, but probably the net northwards currents on the shrimp grounds in Div. 1B are weaker in the first part of the larval period than later, and there may even be some transportation back southwards at the western part of the grounds.

If the net currents observed in July-September were taken to be representative also for the first larval period, then the larvae may well be transported more than 240 n.miles (equalling 0.1 knots through 100 days) or even more (300-400 n.miles) through the approximately 4 months larval period. This would indicate that the progeny from hatching in Div. 1C-1E could be of importance for the recruitment to the stock in the northern part of Div. 1B.

It is assumed here, that the larvae could be considered as a water mass. They may be able to undertake some active movement, but to what extent and whether such movement is directed in relation to the current is not known.

It is, however, most important to note the conclusion that the net current decreases from south to north and also that, in the northern area the net current decreases significantly with the depth. Considering at the same time the possibility that current gyres occur in the shrimp area northwest of Store Hellefiske Bank it seems very likely that the stock in this area is recruited not only from more southerly stocks but possibly to a much greater extent by its own larvae. It may also well be so that the recruitment to the stock in the Disko Bay is to a great extent dependant upon drift of larvae from the offshore grounds in Div. 1B. Larvae hatched in the Disko Bay may partly contribute to the stock there but some of them may well drift (through the Vaigat northeast of Disko) to more northerly offshore grounds.

These ideas can, of course, not be fully proved, anyway not at present, but the likelihood that the stock in the main shrimp area in the northern part of Div. 1B is to a great extent sustained by its own spawning and hatching should be born in mind when discussing possible management strategies although for this species as for many others the stock-recruitment relationship is not well enough known.

ACKNOWLEDGEMENTS

Chevron Petroleum Company of Greenland has kindly permitted the data in Brooks (1976) to be quoted.

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Table 1. Shrimp larvae (stages I-V) taken by the Godthaab Expedition 1928. Numbers per 30 min. stramin net haul, 2 m ring diameter. For station numbers see Fig. 1.

Station no.	Date	m wire	Stages
5	29.5.	300	1 I
14	6.6.	35	1 I, 3 II
		100	12 I+II
		300	1 II
18	11.6.	35	1 II
		100	1 I, 1 II
		400	1 I
20	12.6.	35	2 II
27	16.6.	35	2 III
30	18.6.	100	8 II+III
31	18.6.	45	3 II
32	19.6.	35	8 II+III
43	6.7.	100	300-400 I+II, few III
47	13.7.	100	1 III
140	3.9.	80	1 IV
146	4.9.	250	1 IV, 6 V
			6 IV+V
148	6.9.	350	3 V
153	7.9.	50	2 IV
		350	1 IV, 9 V

Table 2. Shrimp larvae (number per 30 min.) taken by 2 m stramin net in the upper water layers (max. depth ca. 50 m) at the oceanographic standard stations in the Davis Strait (Fig. 2). Mean temperatures (°C) are given for the depth intervals 0-50 m and 0-500 m at Station 4, Godthåb section.

Section	Year	Month	Station 8	7	6	5	4	3	2	1	Temperature 0-50 m	0-500 m
Egedesminde	1971	JUL					0	1	54	0		
Holsteinsborg	1971	JUL			157	80	50	20	75	1		
	1972	"			280	196	21	1	156	149		
	1977	"				139	7	0	2	6		
	1978	"				1	0	0	0	0		
Sukkertoppen	1971	JUL		28	7	93	7	19	?	8		
	1972	"				55	417	5	20	860		
	1977	"				72	0	0	4	18		
	1978	"				6	0	0	0	0		
Godthåb	1970	JUL				7	2	1	29	30	0.76	1.69
	1971	"	6	95	234	77	3	22	2	43	2.53	2.22
	1972	"				244	107	4	0	46	1.11	2.12
	1973	JUN				23	158	2	18	79	1.82	2.25
	1974	JUL				190	432	201	10	37	1.97	2.02
	1975	"				45	89	7	60	51	2.04	2.53
	1976	"				47	0	7	142	8	1.39	1.78
	1977	"				6	405	0	14	61	2.53	3.50
	1978	"				26	0	0	0	6	2.64	3.10

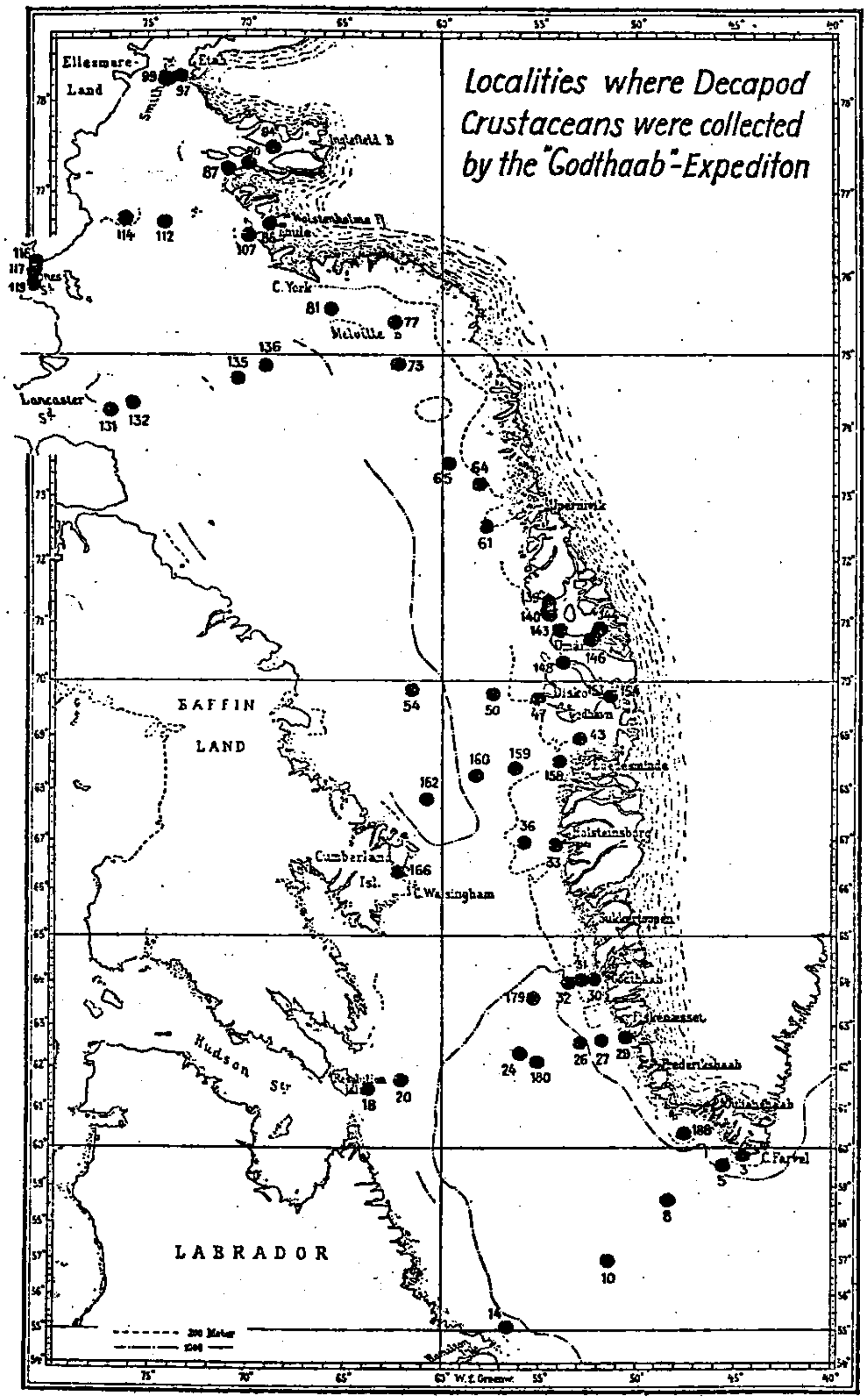

Fig. 1. Localities where decapod crustaceans were collected by the "Godthaab" Expedition.

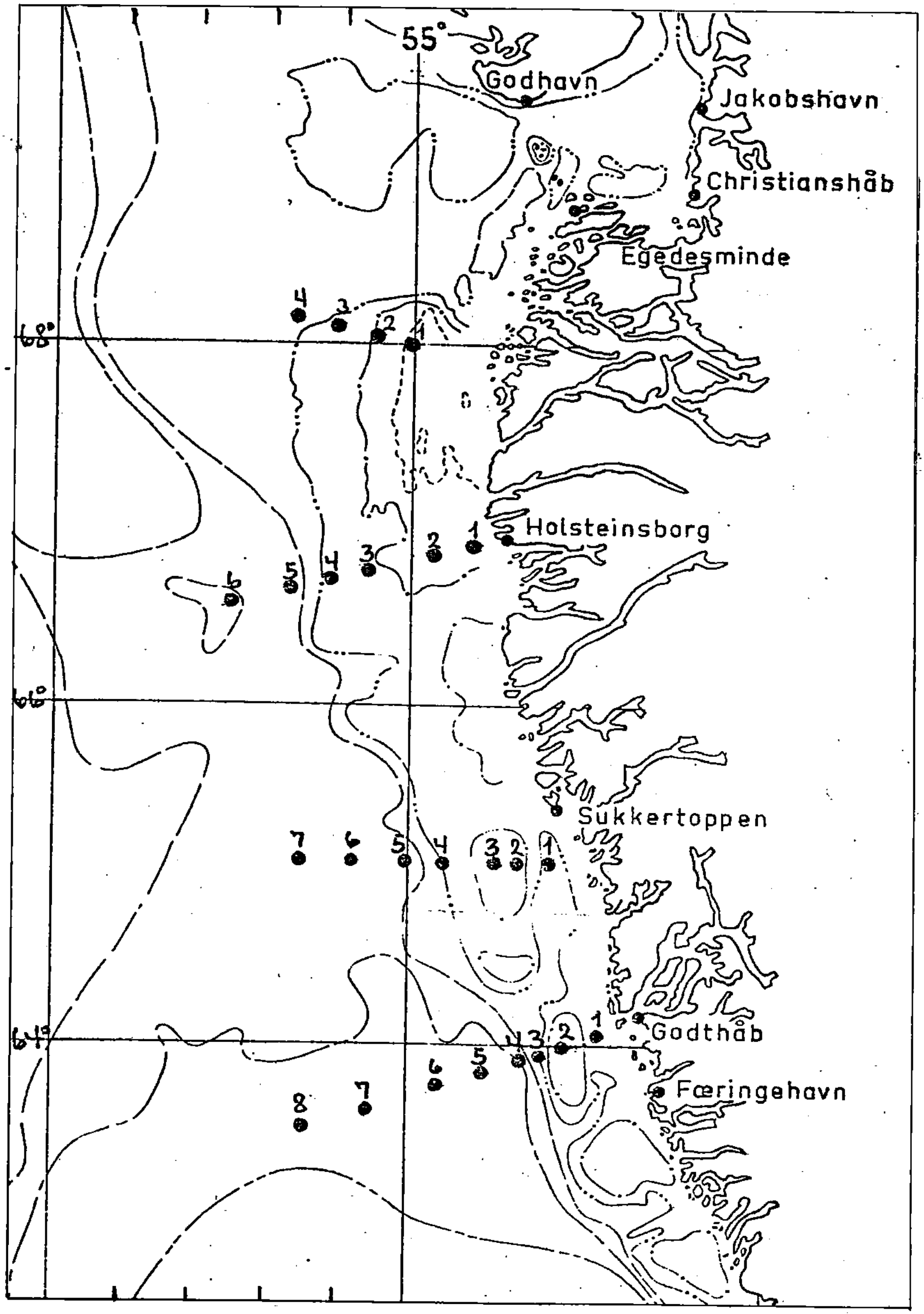

Fig. 2. The oceanographic standard stations

C 10

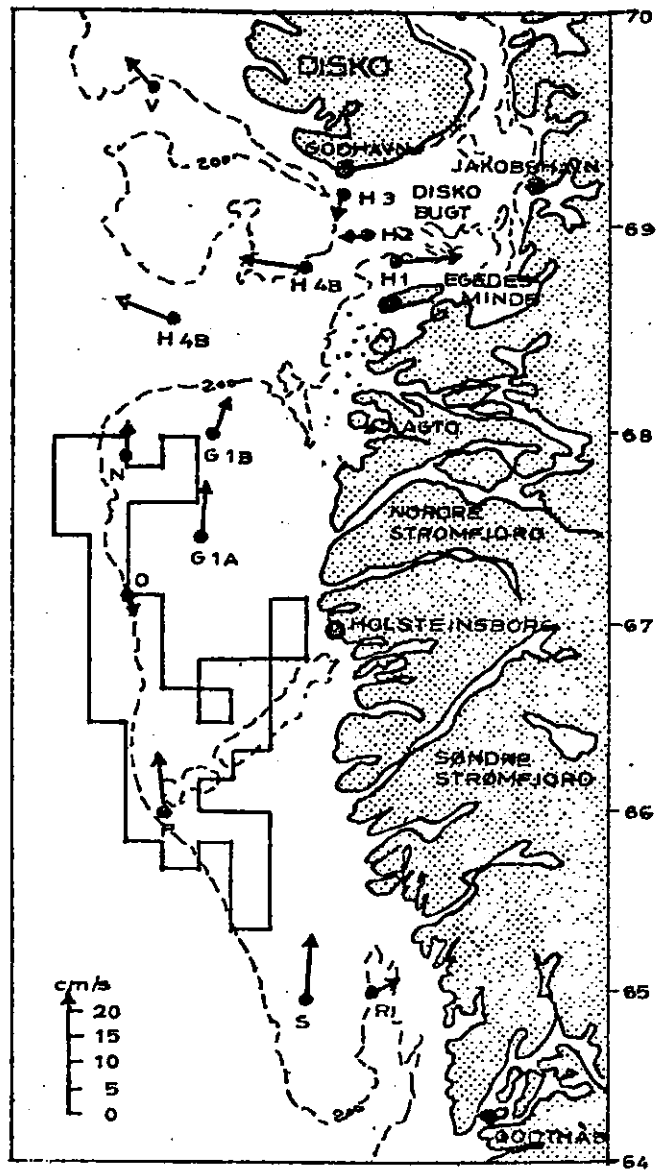

Fig.3. The mean net current off West Greenland based upon observations in July-September 1976.

The straight lines show the concession areas.

Observations and drawing of figure bu The Danish Hydraulic Institute (Anon.,1977).

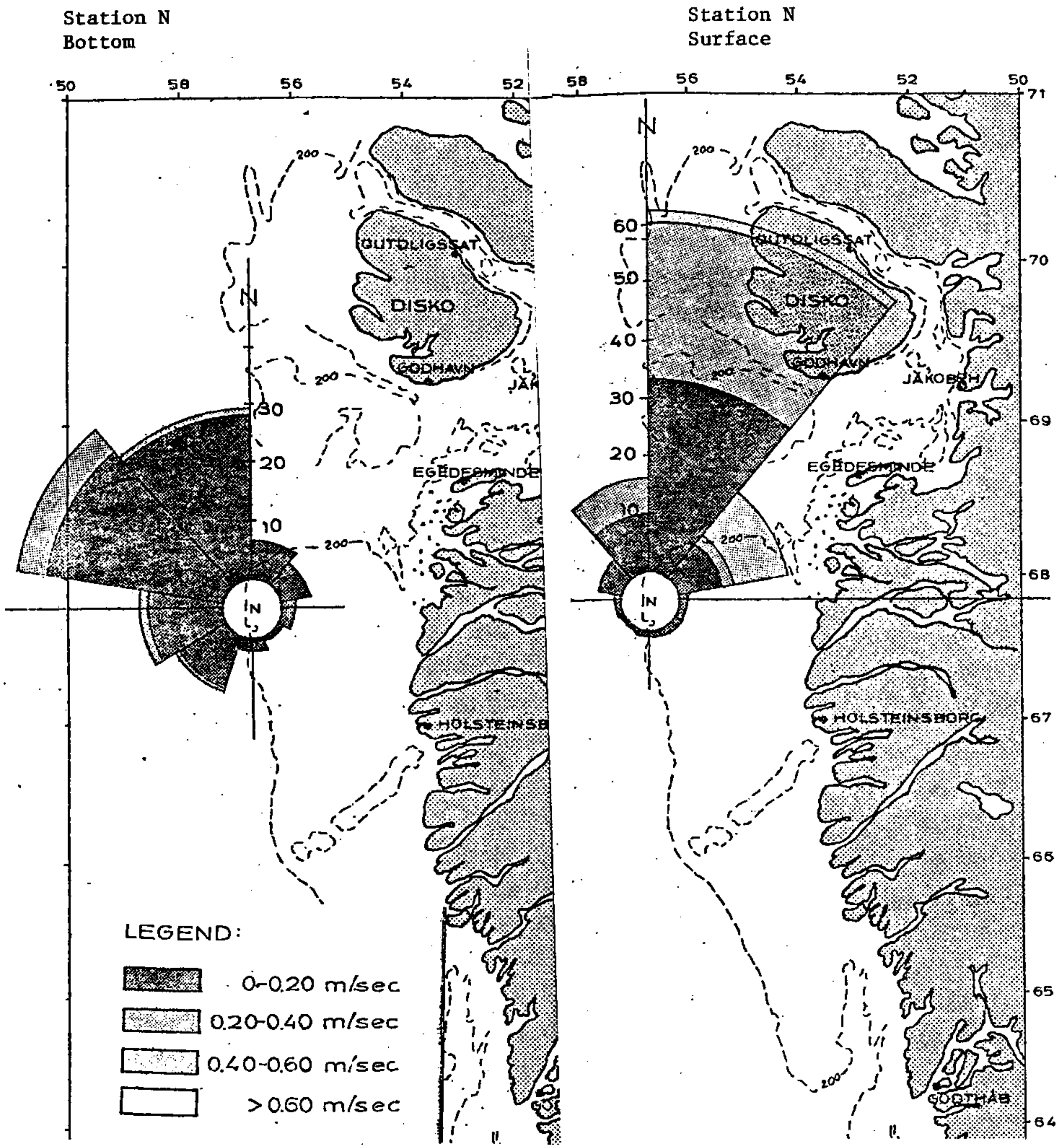

Fig. 4. Current roses of net drift, July-September 1976, at the Station N (See Fig. 3).
Water depth 180 m. Recording: Surface = 30 m., Bottom = 175 m.
Observations and drawing by the Danish Hydraulic Institute (Anon., 1977)

Station S
Bottom

Station S
Surface

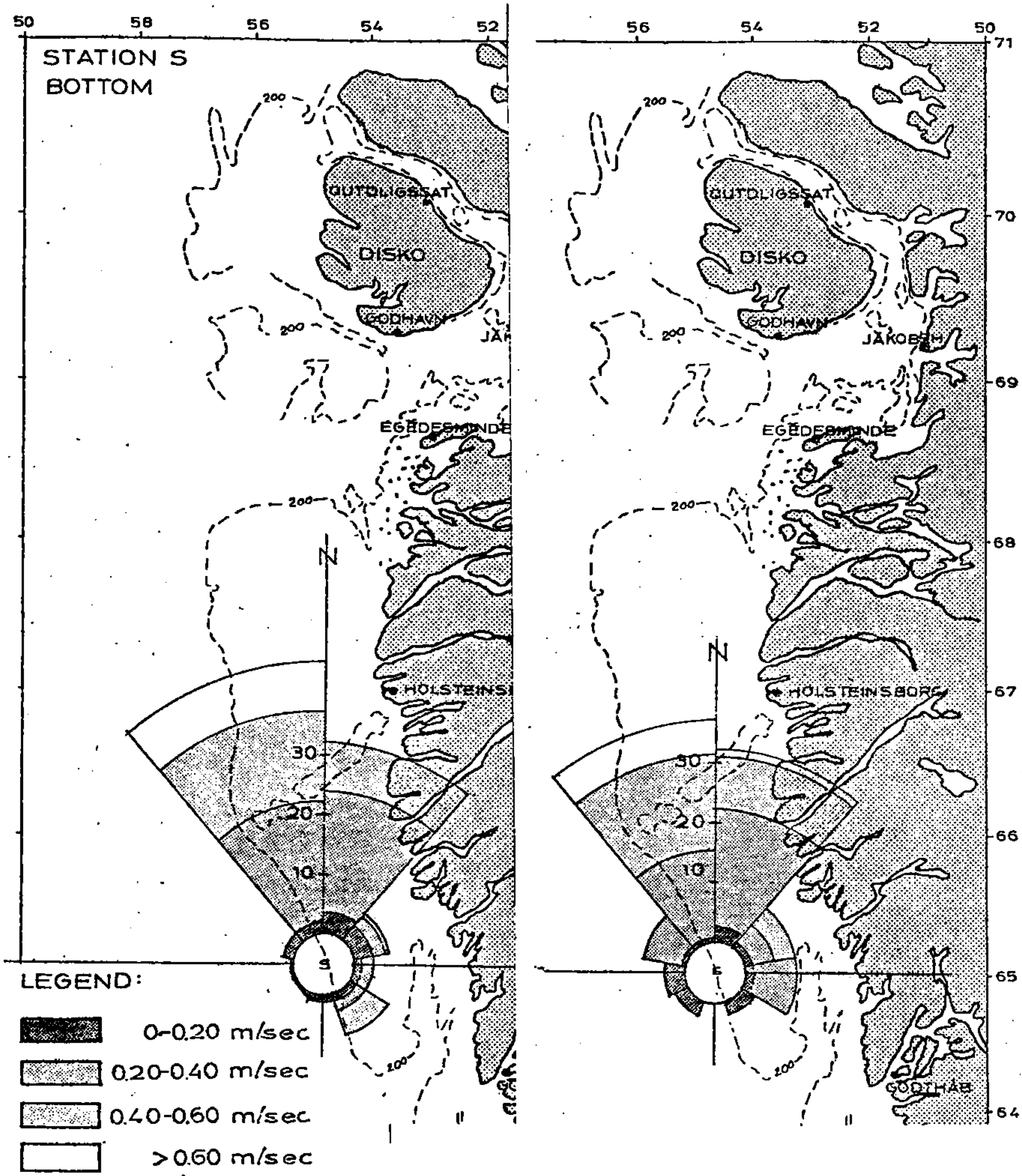

Fig. 5. Current roses of net drift, July-September 1976, at the Station S (See Fig. 3).
Water depth 200 m. Recording: Surface = 50 m., Bottom = 120 m
Observations and drawing by the Danish Hydraulic Institute (Anon., 1977).

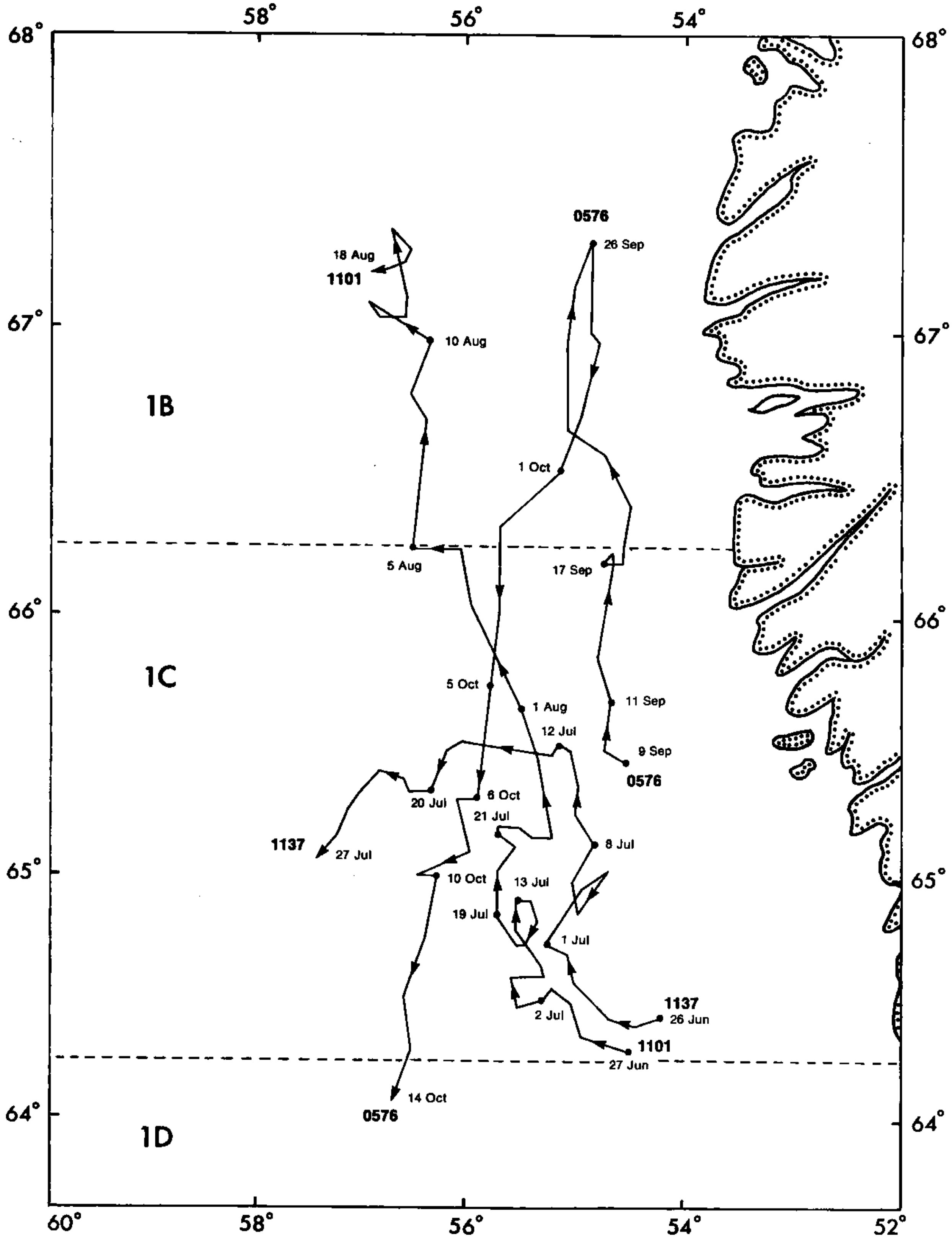

Fig. 6. Daily net drift of drogue drift buoys deployed off West Greenland in 1976 by the offshore Concessionaires. Based upon records by the Chevron Oil Field Research Company (Brooks, 1976).