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Circulation of waters in the ICNAF Area in 1973-1974

by

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Abstract

Four charts of the dynamic topography of separate parts of the ICNAF area compiled on the basis of observations of the PINRO research vessels in 1973-1974 are presented in this paper. The mean curve of the annual values of the Labrador Current transport across section 4-A is compiled from the Ice Patrol and PINRO many years' data. There were determined anomalies of the current transport across standard sections for 1973-1974. Negative anomalies of the intensity of the Labrador Current predominated in the Newfoundland area in the spring-summer period of 1974.

Introduction

Five research vessels of PINRO performed comprehensive hydrological observations in ICNAF area from June 1973 to August 1974.

Materials of the hydrological surveys were treated by the dynamic method. The dynamic charts and values of the Labrador Current water transport, obtained as the result of treatment, characterize peculiarities of water circulation in the fishing areas for the survey period.

Spatial changes in geostrophic circulation

The geostrophic circulation in the Davis Strait and Labrador areas in September-October 1973 is shown in Fig.1. It is seen from the figure that in the autumn of 1973 the pattern of water circulation in the strait (ICNAF Divisions IB-ID, Baffin Land area) was close to type I, when the alongshore streams are subdivided in the central part of the strait by a trough of the low sea level (Alekseev A.P.; B.P.Kudlo et al., 1972). The circulation of the first type was observed in 1969 and 1971 (Kudlo B.P., 1975). But in 1973, like in 1969, a sharp change in the direction of the stream lines of the West Greenland Current in the westerly and south-westerly direction in the Banan and Lille-Hellefiske areas was registered. A vast anticyclonic water cycle with its center on the parallel of 65°N, that transported water from the central part of the strait to the Store-Hellefiske Banke area, was formed over the Canadian-Greenland Threshold. Local vortices were observed in the Baffin Land Current off the Cumberland Peninsula (See Fig.1). These circumstances were apparently responsible for a comparatively low resultive transport of water (50% of the mean one) in southerly direction across section 9-A in September 1973 (Table 1). The transport of the West Greenland Current was rather high while that of the Baffin Land Current was about "norm". As a whole, the circulation intensity was higher than usual in the Davis Strait in September-October 1973. As for the area, adjacent to the Hudson Bay, and Labrador (Divisions 2G-2J), they were not carefully investigated (Fig.1). It can be supposed that the main stream of the Labrador waters flowed round the Hamilton Bank outside the isobath of 200 m, while weak flows were observed in the bank area in early November 1973.

Three dynamic charts (Fig.2-4) are constructed for the Newfoundland area (Divisions 3K-3P).

Thorough survey of the Newfoundland area was carried out in June-August 1973. Hydrological observations on each station

were made at all standard depths and therefore they are well suited for the dynamic treatment. The dynamic chart constructed on the basis of those data is presented in Fig.2. Comparison between this chart and that for April-June 1973 (Kudlo B.P., 1974) makes it possible to consider changes in the pattern of horizontal circulation of waters in the Newfoundland area from April-June to June-August 1973.

Main changes occurred : in the Ritu Bank area where a crest of an increased level with the anticyclonic circulation on the bank was formed; on the eastern slopes of the Newfoundland Grand Bank and Flemish Cap Bank where circulation acquired a regular typical pattern.

An analysis of the charts mentioned above shows that in the case of more frequent stations in the observation area (See Fig.2), a greater number of rather small elements of water cycles appear on the chart. It is likely that those water cycles always existed in the area along with the clockwise general water circulation on the banks.

Dynamic charts constructed from data of two successive hydrological surveys conducted in April-May and May-July 1974 are shown in Fig.3 and 4. The second survey (Fig.4), during which there was registered a rare phenomenon, is of a particular interest. As it is seen from the chart, in the second half of June 1974 the Labrador Current waters found to be very weak on the south-eastern slope of the Grand Bank. The stream lines had a tendency to deflect in easterly and southeasterly directions. A clock-wise general water circulation is distinctly pronounced on the Grand Bank.

Changes in the Labrador Current transport

The Labrador Current transport on standard sections calculated by the dynamic method is shown in Table 2. Values of norms and anomalies of transport at the date of observations were determined by the mean curves of the annual values of transport which were constructed by us earlier (Kudlo B.P.,

1975,1974). The mean curve of the annual values of transport on section 4-A is shown in Fig.5. To construct it the results of calculations of transport by the dynamic method for 72 observations on the section from 1934 to 1974 were used. Calculation of the water transport followed the method given by Zubov to get a homogenious set both from the Ice Patrol data for 1955-1964 and from the PINRO data for 1960-1974 (Zubov N.N. and Mamayev O.I.,1956);calculations were made for the layer from the surface to the bottom at shallow stations and for the 0-1000 m layer for deep stations in the range from 1 to 12 standard station (from 46°20'N 49°05'W to 45°20'N 47°22'W).

Transport values on section T (the latter corresponds to section 4-A adopted at PINRO) adduced in the Ice Patrol Bulletins are used for the period from 1934 to 1940 (Bulletins, 1938-1942).

An analysis of the data showed that use of the latest observations enabled one to improve the curve of the seasonal transport changes that was earlier constructed by Soule et al. (Soul et al.,1961) (See Fig.5). Comparison between the obtained curve and transport curve for section 3-A (Kudlo B.P.,1975) reveals their fairly close analogy.

Division 2J. On section 8-A changes in the Labrador Current transport are indicative of its weakening from 1973 to 1974 : positive anomalies of transport in the previous year changed for a considerable negative value in July of the succeeding year (See Table 2). In August 1974 the intensity of the current increased again,and it was slightly higher than its mean value.

In Division 3L,that is characterized by section 6-A,changeability in the intensity of the Labrador Current in 1973-1974 was less pronounced. As a whole,weakening of the circulation intensity relative to the long-term mean one is noted. Anomalies of transport for the two years vary in the ranges from +0.6 to -1.6×10^6 m^3/sec.

On the south-eastern slope of the Grand Newfoundland Bank, in Division 3N, transport of the Labrador Current was calculated for the two standard sections : 4-A and 3-A.

It is seen from Table 2 that positive anomalies of transport still kept in the area in May 1973, as well as upstream in April. The intensity of the current proved to be lower than normal on section 3-A in July. In the spring of 1974 (April-May) the intensity of the current was below normal on either sections.

On the whole, it can be stated that the intensity of the Labrador Current in the areas investigated in April-August 1974 was decreased. Only in early May on section 6-A along 47°N and in August on section 8-A slight positive anomalies of transport (+0.5 x 10^6 m^3/sec.)were registered across the Hamilton Bank.

References

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Table 1

Water transport on section 9-A across the Davis Strait in September-October, 10^6 m^3/sec.

Date of observations	Transport northwards	Transport southwards (+)	Resultive transport	Transport ratio south : north
25-26.X.1971	-2,62	+1,63	-0,99	1 : 1,6
Average for 1962, 1964, 1967 and 1971	-1,90	+3,22	+1,32	1,7 : 1
27-28.IX.1973	-2,44	+3,07	+0,63	1,3 : 1

Table 2

Transport of the Labrador Current, its norms and anomalies on standard sections in 1973–1974

Section, sector, layer	Vessel, cruise	Date of observations	Transport 10^6 m^3/sec.		
			Observed	Norm	Anomaly
8–A(ABC)	"Protsion" II th cruise	22–24 June I973	7,09	4,3	+2,8
0–2000m	"Artemida" 6th cruise	0I–02 November I973	9,I3	4,9	+4,2
Division 2J	"Gemma" 9 cruise	04–06 July I974	0,I7	4,3	–4,I
	"Perseus III" I2 th cruise	I9–20 August I974	5,08	4,6	+0,5
6–A(H_1GH_2)	"Protsion" IIth cruise	26–27 April I973	3,75	3,I	+0,6
0–bottom	"Protsion" IIth cruise	24–25 May I973	2,29	3,2	–0,9
Division 3L	"Perseus III" IIth cruise	I2–I3 July I973	2,32	3,4	–I,I
	"Gemma" 9th cruise	02–03 May I974	3,6I	3,I	+0,5
	"Gemma" 9th cruise	26–27 May I974	I,62	3,2	–I,6
	"Perseus III" I2th cruise	24–25 July I974	3,29	3,4	–0,I
4–A (I–I< stations)	"Protsion" 11cruise	I8–20 May I973	8,08	4,I	+4,0
0–I000m	"Gemma" 9th cruise	26–28 April I974	2,35	4,5	–2,I
Division 3N	"Gemma" 9th cruise	2I–22 May I974	2,32	4,0	–I,7
3–A (4–I0st.)	"Protsion" IIth cruise	I5–I6 May I973	6,66	4,2	+2,5
0–2000m	"Perseus III" IIth cruise	II–I2 July I973	0,44	2,6	–2,2
	"Gemma" 9th cruise	24–25 April I974	3,85	4,9	–I,0
Division 3N	"Gemma" 9 th cruise	I7–I8 May I974	3,07	4,I	–I,0

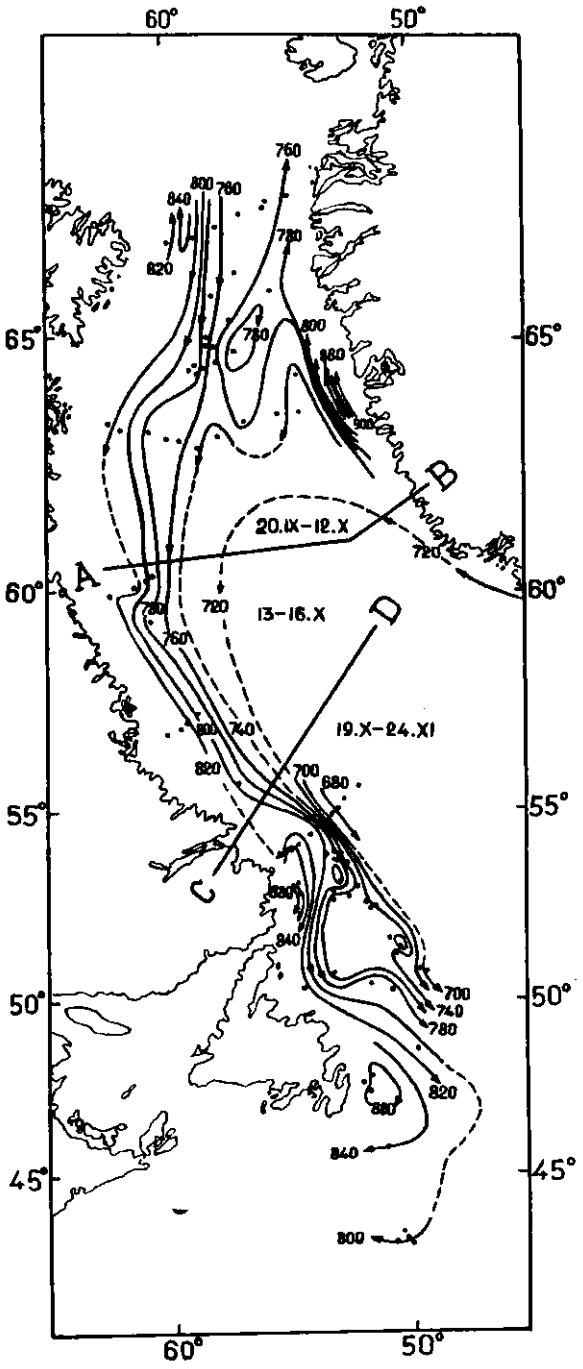

Fig. 1. Geostrophic circulation in the Davis Strait, Labrador and Newfoundland areas in September-November 1973, 0-200 db, R/V *Artemida*.

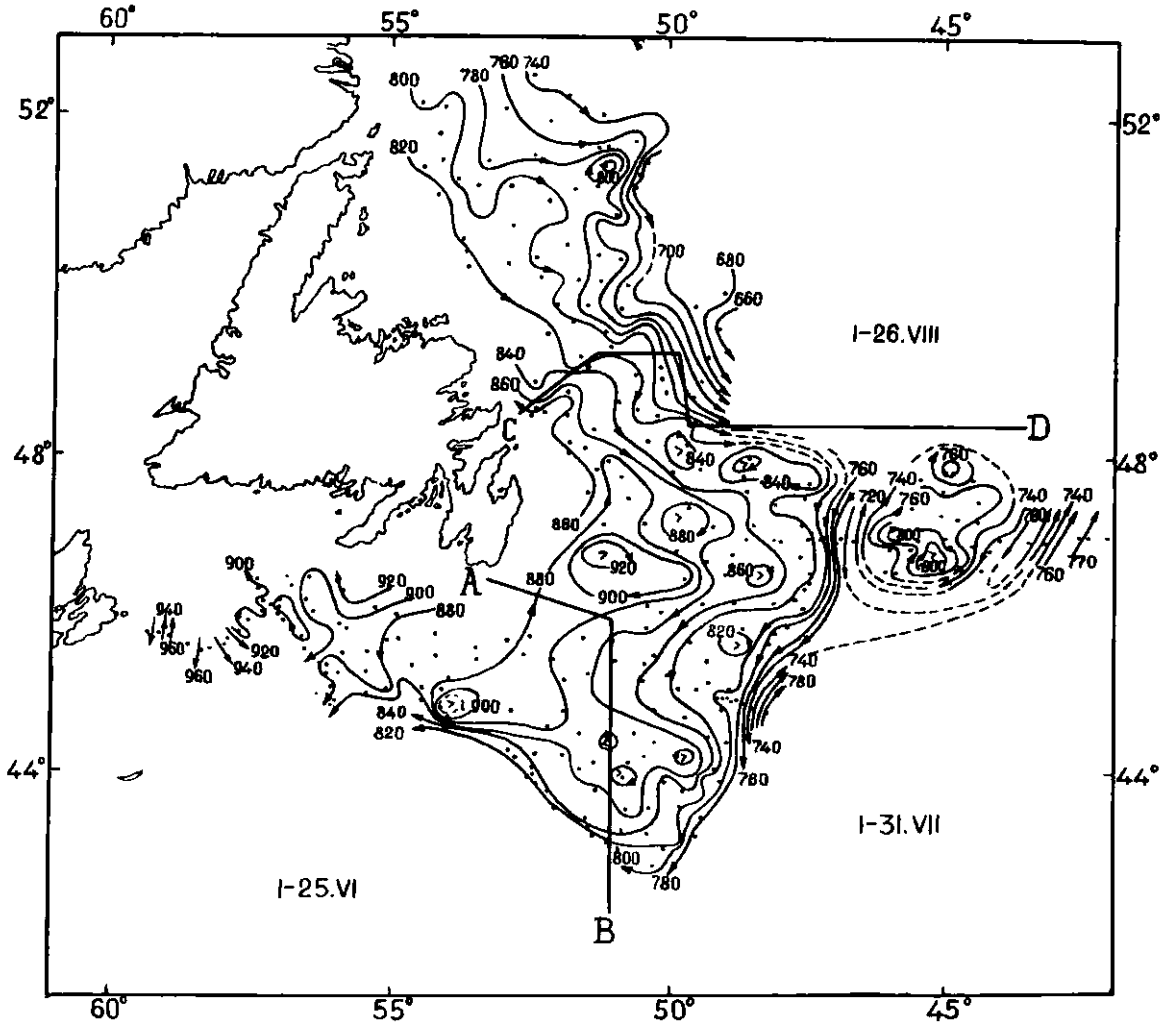

Fig. 2. Geostrophic circulation in the Newfoundland area in June-August 1973, 0-200 db, R/V *Perseus III*.

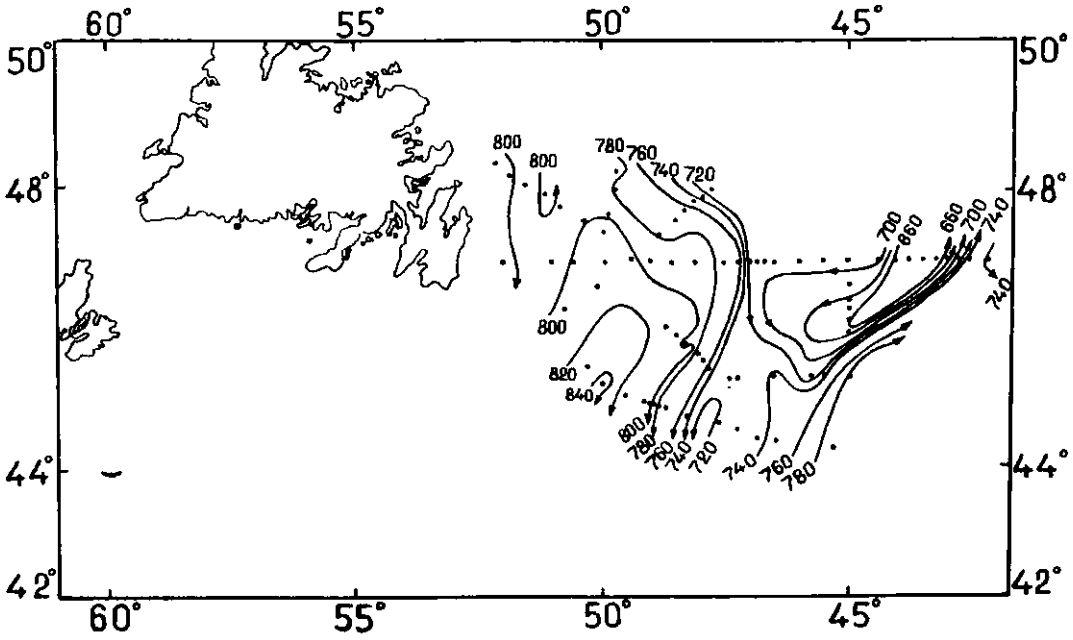

Fig. 3. Geostrophic circulation in the Newfoundland area, 21 April–9 May 1974, 0–200 db, R/V *Gemma* (1st survey).

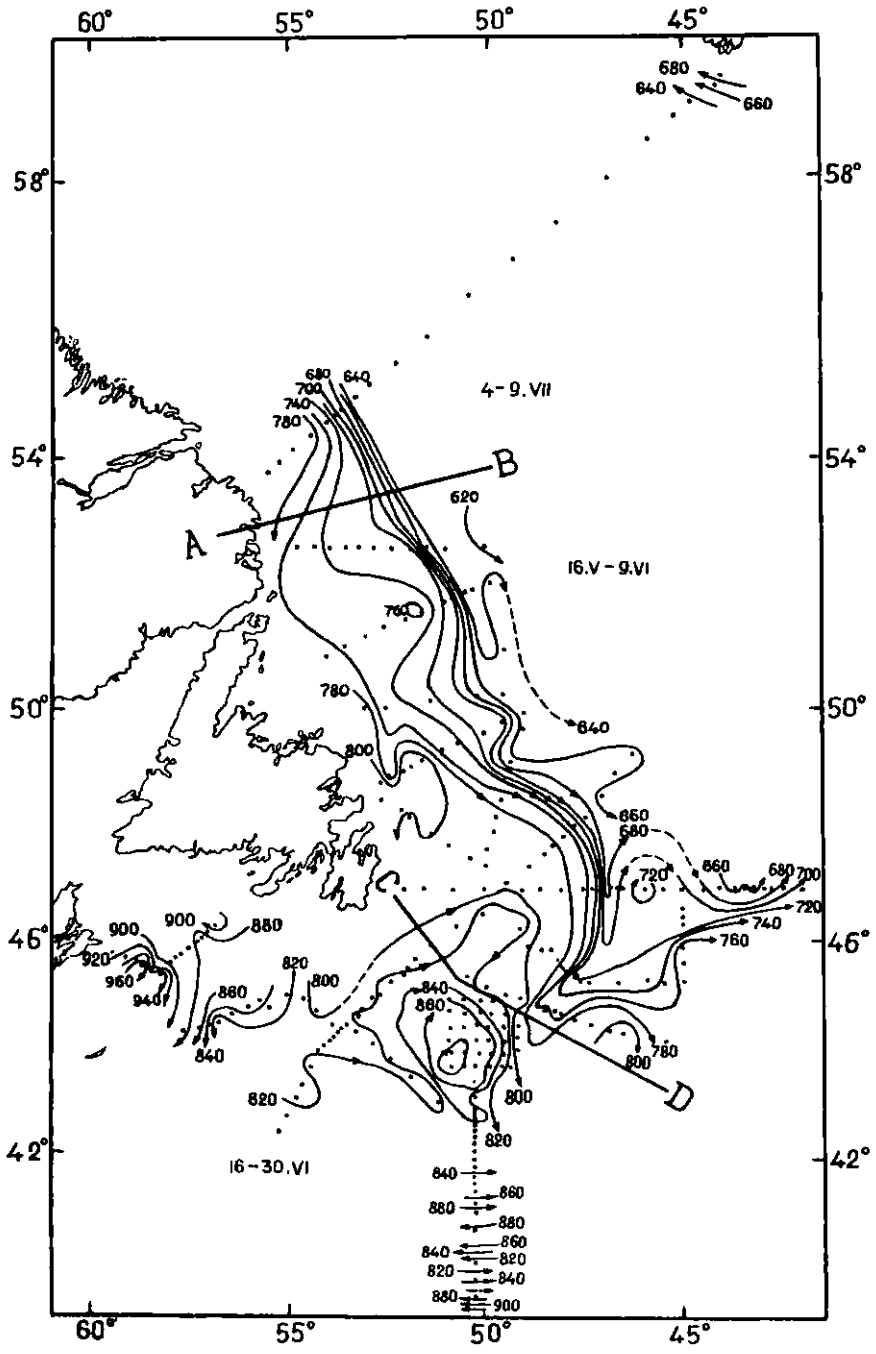

Fig. 4. Geostrophic circulation in the South Labrador and Newfoundland areas in May-June 1974, 0-200 db, R/V *Gemma* (2nd survey).

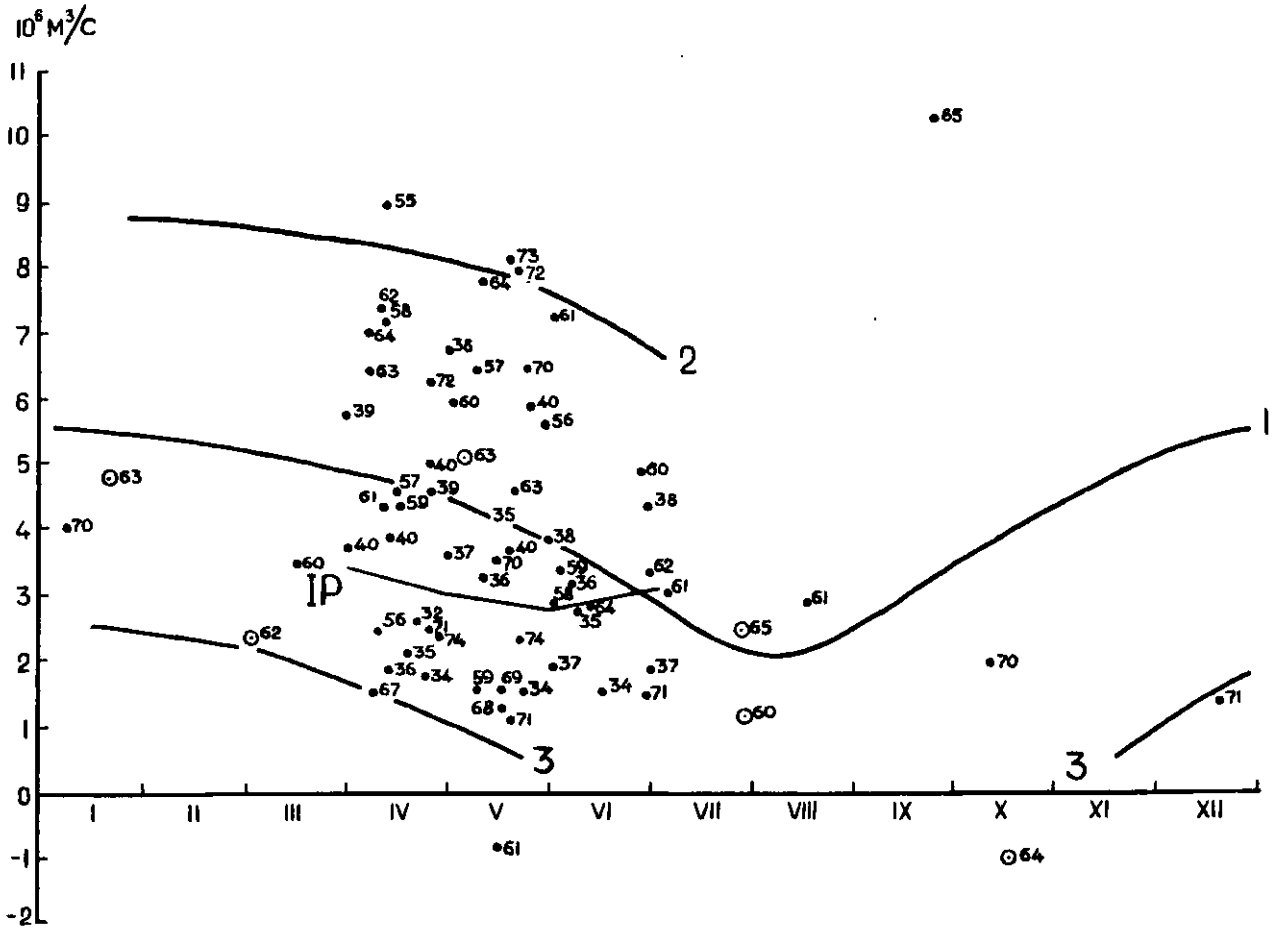

Fig. 5. Annual run of mean (1) and extreme (2, 3) values of the Labrador Current water transport on section 4-A across the southeastern slope of the Grand Bank in the 0-1000 m layer according to long-term data. Circles = maximum depth of observations, less than 1000 m. IP - seasonal curve of transport across section T after Soule *et al.*, 1961.