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REVIEW OF DANISH TRAWL SURVEYS ON THE OFFSHORE WEST GREENLAND SHRIMP GROUNDS IN 1977 AND A COMPARISON WITH MATERIAL FROM PREVIOUS YEARS

by

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INTRODUCTION

Research surveys of the offshore shrimp grounds at West Greenland have shown that the most important of these are found in Divs. 1A and 1B (Carlsson and Smidt, 1976). A number of stations have been fished in this area as part of the annual research program of the Greenland Fisheries Investigations (Grønlands Fiskeriundersøgelser). These stations as well as those standard stations previously established in other parts of Subarea 1 are covered as regularly as possible by the R/V ADOLF JENSEN, maintaining as far as possible a standard trawl and a standard trawling technique.

In 1976 the research work also included a trawl survey by a commercial trawler (the Greenland trawler SISIMIUT) operating 44 stations in a stratification scheme covering the area between 66° and 69°N lat. east of 59°W and the depths between app. 150 m and 600 m (Horsted, 1976a).

The research on the offshore shrimp grounds at West Greenland in 1977 has been concentrated in Div.1B and has been based partly on trawl hauls, partly on bottom photography. The latter part of the research is reported in a separate document (Kanneworff, 1977) whereas the present document contains information of the trawl hauls. Some further hauls are likely to be made in 1977, and the material, especially the samples of shrimps, has not yet been worked up completely. The results are, therefore, more or less preliminary. The 1977 material is compared to material from previous years.

MATERIAL AND METHODS

The 1977 material has been obtained partly from hauls of the R/V ADOLF JENSEN (167 GRT, 525 BHP, side trawler) and partly from the commercial Greenland trawler SISIMIUT (722 GRT, 2000 BHP, stern trawler) on which biologists were onboard during two trips in June.

The trawl used by the R/V ADOLF JENSEN is a so-called "Alaska Balloon" trawl, cod-end mesh size app. 36 mm, ground rope (length of bobbins) 31.9 m. Speed of vessel during trawling normally 2-2½ knots. However, in May 1977 it was necessary to use a new trawl, and although this had the same dimensions as the formerly used trawls it seemed difficult to get it working properly unless the speed was increased to about 3 knots. Subsequent hauls with this trawl have, therefore, been made by this speed. This demonstrates the difficulties of maintaining standard trawling procedures even ifgears are kept as constant as possible.

The SISIMIUT uses a "Fjortoft Sputnik" otter trawl, ground rope 51 m, head line 43 m. Trawling speed 3-3½ knots. Cod-end mesh size 40 mm.

At one occasion the two vessels made trawl hauls at the same place and time in order to get a comparison of the fishing power of the two vessels.

Research hauls are normally of a duration of 1 hour whereas commercial hauls may be longer, frequently 2 hours. For analyses all hauls are converted to 1-hour hauls. The total catch per haul of the ADOLF JENSEN will normally be given by an accuracy of 95% or more, whereas the catch per haul of the SISIMIUT may be less accurate. Total catch per haul of the latter vessel is reported by the crew to the captain and reported in terms of whole boxes, each box containing about 30 kg. The captain is requested to record the catch per haul in figures rounded to hundreds of kg.

The accuracy of the positions when vessels are operating far offshore, outside radar range of the coastline, is normally not very good. Actually, in some cases the rectangle recorded by the SISIMIUT does not correspond to the recorded depth according to the nautical maps. It is the impression of the observers that the depth is correctly recorded, whereas the actual rectangle fished may be one of the neighbour rectangles to the one recorded. Many hauls will, of course, cover more than one rectangle, but the logbook entries and the adp-processing uses only one rectangle. No attempt has been made here to adjust rectangles to depths, but generally speaking there is normally good agreement between the two sets of data.

Table 1 is a list of the offshore hauls made by the ADOLF JENSEN in 1977 whereas Tables 2a and 2b illustrate the distribution and catch of the hauls by the SISIMIUT for the period when observers were onboard.

Tables 3 and 4 show the results of the hauls made since 1968 by the R/V ADOLF JENSEN on the standard stations Godthåb Deep (Div.1D) and Sukkertoppen Deep (Div. 1C) respectively.

The hauls from the two days in 1977 when comparison of the fishing power of the two vessels was made are shown in Table 5.

For some of the analyses it seems necessary to take into account the diurnal variation as was done by Horsted (l.c.) for the 1976 trawl survey by the SISIMIUT. This question is considered in the section below.

Correction for diurnal variation in catch rate

Diurnal variation in catch rate in shrimp fisheries is a well known phenomenon to fishermen and has been described by various authors, for the

Greenland fisheries for instance by Smidt (1976) and Horsted (l.c.). Conversion factors for July were given by Horsted (l.c.)

In order to take into account the diurnal variation when comparing trawl hauls the data reported by Smidt (l.c.) have been used here to get rough estimates of conversion factors. Smidt showed that the magnitude of the diurnal variation varied between the various seasons of the year, being most pronounced in the periods when the variation in light intensity is at a maximum, i.e. around equinox. It does, therefore, seem reasonable to suggest that the following grouping of months could be made, each group having its specific conversion factors.

a) November-December-January-February
b) June-July
c) May and August
d) April and September
e) March and October

Material at disposal at the time when this paper was written does not cover all months, but all five of the suggested groups are represented by data. The data contained in Smidt's Table 3 (l.c.) and in Table 2 of the present paper, i.e. the hauls by the SISIMIUT from December 1975 to October 1976 and in June 1977, are plotted in Figs. 1-6.

Quite obviously there is a great variation between hauls not only due to diurnal variation but also due to other factors. The variation is extremely pronounced in June-July 1976 (Fig.3), so much indeed that it seems somewhat hazardious to postulate a diurnal variation. On the other hand the material from December-January (Fig.2) and especially from October (Fig.6) clearly indicates a diurnal variation although there is still a great deal of variation between hauls inside each of the 2-hours periods used by Smidt.

Fitting lines (by eye) on the 1976 material (Figs. 2-6) leads to conversion factors as given in Table 6. These conversion factors are then used to convert the catches in Tables 1 and 2 for diurnal variation. Quite obviously this rough procedure could be criticized, e.g. it seems doubtful whether the extreme high catches occurring for instance in early morning in December-January (Fig.2) should be raised further, if they were to be taken as abundance indices.

It will be readily seen from Figs. 2-6 and from Table 6 that the period from April to September shows a generally higher level of catch rate than other months of the year. If this is a regular annual tendency then it is possible that conversion factors for diurnal variation ought to take into account not only the diurnal variation inside each specific period but also the variation between periods. Since fluctuations in light intensity are believed to cause the diurnal variation it seems possible, that this factor itself could cause variation in the mean catch rate between periods of the year. However, such variation may also be caused by the annual recruitment to the exploited stock of mainly female shrimp (Horsted 1976b), especially if recruitment tends to be stepwise or even knife-edge and not continuous, and of the actual exploitation itself. Also variation in distribution of the shrimp stock caused for instance by active migration or by hydrographical

variation could heavily influence the abundance of shrimp in any given area (Horsted and Smidt, 1956). It does not seem possible at present to separate the various sources of variation. For this paper conversion factors have been calculated separately for each period of the year, so that inside each such period the best 2-hours catch is given a value of 1.00. The conversion factors obtained from the 1976 material are given in Table 6.

RESULTS AND DISCUSSION

Comparison between vessels

Table 5 gives the material when the M/T SISIMIUT and the R/V ADOLF JENSEN were operating at the same date and place in May 1977. The first three ADOLF JENSEN-hauls were made by a speed of 2-2.5 knots, the other five by a speed of 3-3.5 knots, the same as the SISIMIUT. It will be seen that there is a good deal of variation in catch rate for both vessels (no correction for diurnal variation has been made). However, in all cases when trawling has been done simultaneously the catch rate of the SISIMIUT has been above that of the ADOLF JENSEN. This is to be expected simply due to the difference between the gears of the two vessels (see page 2).

The material does not seem sufficient to establish a reliable overall conversion factor between the two vessels. All eight hauls would give an average conversion factor of 3.4 to convert ADOLF JENSEN-hauls to SISIMIUT-hauls, whereas the last five hauls give a conversion factor of 2.1. As a first indication one might, therefore, estimate the SISIMIUT-hauls to give catch rates double those of the ADOLF JENSEN. However, due to the scarcity of the material, no conversion has been made in this paper, but the material has been analyzed for the two vessels separately.

Long-term trends in research hauls

Tables 3 and 4 shows the hauls of the ADOLF JENSEN at the two standard stations Godthåb Deep and Sukkertoppen Deep, respectively. The hauls are plotted in Figs. 7 and 8.

Again in this material there is great variation in catch rate between the hauls. No correction has been made for diurnal variation, but all hauls have been made at daytime and most frequently by taking two or three hauls in one day.

It is very difficult to see any clear trend if the total material is regarded. However, it must be borne in mind that the fishing power of the vessel has not been constant. A new and more efficient type of trawl was introduced in July 1971. Skippers changed in December 1968 and in March 1974. Both the skipper which served in the first years of the vessel's history (September 1967 - December 1968) and the two subsequent skippers are likely to have had a "learning time". A learning factor should, therefore, be taken into account, probably for the full period 1967-69 and again in 1974. Probably the most stable period in terms of the fishing power has been the years 1975-77. Over these three years there seems to be a clear drop-off in catch rate both in the Godthåb Deep, and in the Sukkertoppen Deep. For the latter ground this drop-off is confirmed by Greenland fishermen (pers.comm.). The Sukkertoppen

Deep was one of the more important grounds - if not the most important - in the first years of the offshore fishery by non-Greenlandic boats.

Even if fishing power were kept constant and even if exploitation had been stable over a long period one would expect to find fluctuations in abundance indices due to natural variations in the shrimp stocks, caused for instance by year-class fluctuation, migration, variation in distribution on the grounds, fluctuations in stocks of predators etc. It seems extremely difficult to analyze the material for all such possible sources of variation. However, one would have to take into account their combined effect on stocks when forming a management strategy. As stated above there seems to be a clear drop-off in abundance indices for these two grounds over the last three years.

Trends in catch rates of the commercial fishery

Table 7 gives the catch per hour of the Greenland trawlers in Div. 1B in the period October 1975 to September 1977 while in Table 8 the figures for the SISIMIUT are shown separately in order to get figures related to a fishing power which is more stable than the total pool of figures. The mean values per month in the material from the two tables is illustrated in Figs. 9 and 10, respectively. Again in these figures plots are rather scattered. The figures do not indicate any clear long-term change in the monthly average catch rates, but may probably show some annual variation when more material over a longer period becomes available. Tables 7 and 8 do, however, demonstrate that monthly means for a large area may not be good indices for analyses of fluctuations in the total stock of the area since at any given time only part of the area is covered. Horsted (l.c.) showed that fishery in 1976 had a northward displacement, possibly due to a movement of the major concentrations of shrimps. This displacement is, of course, again seen in Tables 7 and 8 for 1976, and the same or even more pronounced and further extended displacement seems to have occurred through 1977.

Figs. 11 and 12 illustrate the distribution of the effort in terms of number of hauls of the Greenland trawlers in 1976 and 1977. (Hauls from the 1976 and 1977 SISIMIUT-surveys are included in the figures but account for relatively very small parts of the total number of hauls - 44 of 1099 hauls in 1976 and 24 of 2617 hauls in 1977). It will be seen that, whereas there is a rather great area between 67°N and 68°N around 57°W where intensive fishing took place in both years, the 1977 fishery tended to occupy areas not covered in 1976. This is especially the case to the northwest of the common area. Also more deeper parts of the slope of the bank seem to have been fished in 1977 than in 1976.

The important question regarding the northwards annual displacement of the fishery is whether it is actually reflecting just a movement of shrimp concentrations or whether it is moving due to changes in catch rates caused by the fishery itself. If only the latter is the case one would not expect to see the phenomenon of small areas (rectangles) giving at one time of the year a remarkable high catch rate and at other times of the year hardly any catch at all (Horsted l.c.). It is, therefore, likely that some movement of the shrimp concentrations themselves does occur. The picture is, however,

also influenced by the fact that the Labrador drift ice will prevent fishing in at least part of the major shrimp area at certain times of the year. However, although stock movements do occur one could not exclude the possibility that the gradual northwards displacement of the fishery is also the effect of the fishery itself causing a decrease of stock in one area and then gradually leaving for new areas where the initial abundance is better until the effect of fihing is also felt there. Anyway, although the general picture for the two years is the same, in nearly any given month of 1977 the fishing extended further north that it did in the same month of 1976 and 1975.

Estimates of biomass in 1977 compared to the estimates for 1976

Horsted (l.c., Table 2) gave biomass estimates by strata for Div. 1B in July 1976 based on the swept area method applied to hauls by the SISIMIUT at pre-selected stations.

In June 1977, when observers were onboard, this vessel again made some hauls outside the commercially fished area, although a specific survey like the one in 1976 was not made. It is, therefore, not possible to make a comparison between the two years for the total area covered by the survey in 1976, but probably for some of the strata .

Table 9 gives a comparison between the two years. The 1977 material corresponds to the material in Table 2b. Figs. 13 and 14 show the stratification of the area and the stations in the 1976 survey. For the comparison some of the strata are broken down by smaller areas to ensure that comparison is made between such areas which were covered both in 1976 and 1977. It will be seen, for instance, that in the northernmost part (Fig.13) the sampling in 1977 is so scarce that it seems impossible to extrapolate the few hauls to the 1976-strata . However, all three stations sampled north of 68°15'N in 1977 showed much less catch per hour than any of the ten stations north of the same latitude in 1976. Catches of the ADOLF JENSEN in the deep north of St.Hellefiskebanke were also very low in May 1977, but somewhat higher in July-August (Table 1).

On the deeper part of the slopes west of St.Hellefiskebanke (Strata 9 and 10) there is not much material for comparison between the two years, and the same applies to the more shallow part. The two hauls made here gave widely different results, viz. 610 kg/hour (corrected) at a depth of 189 m, 56 kg/hour (corrected) at a depth of 140 m. This together with the hauls of the ADOLF JENSEN on relatively shallow water (Table 1), indicates that the 150 m contour line seems a proper border line for the distribution of the stocks.

The best comparison between the two years is obtained in the Strata 4-8.

The sum of the 1977 biomass estimates for Strata 4, 5 and 6 is 13721 tons while the figures obtained by the 1976 material for the same strata add up to 10925 tons. For the same combined area the estimate when averaging all of the 1976-stations as was done previously is 10731 tons but for a somewhat wider area of 3665 km^2 against the present 3430 km^2 (a part east of Stratum 5 not included in the new figure). This could indicate that the biomass by June 1977 was somewhat higher in this important area than by July 1976.

Also for Strata 7 and 8 comparison can be made between the two years. The sum of the 1977-estimates is 4409 tons, while the 1976-material applied to the same strata gives a figure of 5196 tons. The figure obtained from the 1976 material averaged for the two strata combined was 4658 tons. Thus, in this area which is also a very important one, there seems to be less shrimps in June 1977 than by July 1976.

These trends for the important part of the grounds in Div. 1B also point to a northward displacement of the most dense part of the stocks.

As said about, due to lack of data for the vast area between 68°N and 69°N, it is not possible to make a complete comparison between the two years for the whole area surveyed in 1976. The said area accounted for roughly 40% of the total biomass estimate for the area surveyed in 1976.

For the important grounds south of 68°N the figures would suggest that apart from the tendency to a displacement of the concentrations the biomass by June 1977 was about the same as by July 1976. Making this comparison it should be remembered that (at present) the theory applied in the assessment models is a very high natural mortality for the female group of shrimps, and that the high level of exploitation has only been seen for a couple of years. Baring in mind at the same time that the fishery exploits mainly the female group and that these are about 4 years old one would not yet expect to see the possible influence of the fishery on the stock.

The limitations of the swept area method has been discussed previously by the ICNAF Subcommittee on Assessment. In a random stratification scheme it would normally give minimum figures for biomass estimates although the correction for diurnal variation will diminish the degree of underestimation.

REFERENCES

Carlsson, D.M. and E.Smidt, 1976. Pandalus borealis stocks at Greenland. Biology, exploitation and possible protective measures. Int.Comm. Northw.Atl.Fish., Res.Doc. 76/VI/16.

Horsted, Sv.Aa., 1976a. A trawl survey of the offshore shrimp grounds of ICNAF Div. 1B and an estimate of the shrimp biomass. Ibid. 76/XII/150.

" 1976b. The life cycle of the shrimp (Pandalus borealis Kr.) in Greenland waters discussed in relation to the potential yield of the stocks. Ibid. 76/XII/154.

" and E.Smidt, 1956. The Deep Sea Prawn (Pandalus borealis Kr.) in Greenland Waters. Medd.Danm.Fiskeri- og Havunders., N.S. I, 11.

Hoydal, K. 1976. An assessment of the deep sea shrimp (Pandalus borealis) in West Greenland waters (Subarea 1) based on Faroese catch/effort data and information on fishing areas from the Faroese fishery. Int.Comm.Northw.Atl.Fish., Res.Doc. 76/VI/15.

Kanneworff, P., 1977. Estimated density of shrimp (Pandalus borealis) in Greenland waters 1975-77 and calculation of biomass on the offshore fishing grounds, Divs. 1A-1B based on bottom photography. Ibid. 77/XI/

Smidt, E., 1976. Diurnal variations in shrimp catches on the offshore grounds of ICNAF Div. 1B. Ibid. 76/XII/149.

TABLE 1. Offshore bottom trawl hauls by the R/V ADOLF JENSEN, 1977. Hauls arranged from North to South. For rectangle codes see map fig. . All hauls have been sampled but for some hauls the material is not yet worked up to give a mean size of shrimps. Two or more sets of catch figures when two or more hauls were made.

Div.	Locality and rectangle code		Depth range (m)	Date	Catch of shrimp per hour (kg)	Corrected catch per hour (kg)	Mean size of shrimp (No.per kg)
1A	West of Disko	LP440	347	9VIII	46	46	
	" " "	LK006	219-24	8VIII	207	457	
1B	N.of St.Hellefiskebanke	KZ012	344	24VII	167	175	
	" " " " "	KX005	403-20	6VIII	210	273	
	NW of St. " "	KX438	344	6VIII	60	60	
	N.of St.Hellefiskebanke	KX012	441-73	14V	24-42-97	26-42-102	118
	W.of St.Hellefiskebanke	KT001	351	25VII	100	118	
	" " " " "	KS004	290	22VII	93	96	
	" " " " "	KR438	390	26VII	1260	1273	
	" " " " "	KR006	169-75	22VII	4	4	
	" " " " "	KP440	273-80	25VII	470	494	
	" " " " "	KP004	210	27VII	360	385	
	" " " " "	KN002	228-40	13V	450-580	851-632	136-124
	" " " " "	KN003	240-57	12V	280	619	148
	" " " " "	KN004	225-30	12V	1070-378	1263-835	149-144
	" " " " "	KM004	224-29	27VII	0	0	-
	" " " " "	KL005	235	12V	56-100	57-100	93
	" " " " "	KK005	260-85	12V	45	53	
	" " " " "	KJ007	169-220	21VII	1	1	
	" " " " "	KF006	536-74	4VIII	57	108	
	W.of Hbg. Deep	KB006	468-74	4VIII	gear somewhat damaged.Few shrimps	-	
1C	Hbg. Deep	KA011	206-25	16V	120-70-102	142-116-285	158-146
	" "	KA011	213-28	28VII	22	27	
1C	Sukkertoppen Deep	JF020	500-25	3II	12-15	12-17	111
	" " "	JF020	485-540	22IV	25-10	33-10	102
	" " "	JF-JG021	534-43	31V	7	15	
	" " "	JF020	525	4X	5-4-5	7-4-5	74-73
1D	Godthåb Deep	JB023	290-306	6-10I	95-75-116	96-84-118	126
	" "	JB023	300-304	28III	153-143-207	153-154-261	144
	" "	JB023	300-310	22IX	66-34-64	68-34-74	154-136
1E	Off Frh. Isblink	HJ-HK031	216-38	14IV	121-7-0	138-7-0	128
	" " "	HJ-HK031	215-34	13X	70-36-30	74-36-30	188-416

TABLE 2a. Distribution and results of hauls by the Greenland trawler SISIMIUT on the offshore shrimp grounds of Div.1B in the period 15-26 June 1977. For rectangle codes see Fig.

a) Catch of shrimp per hour (kg)
b) Effective Fishing time (hours)
c) Number of hauls
d) Depth range (m)
e) Mean size of shrimps(spec.per kg)

Rect-angle		1	2	3	4	5	6	7	8	9/10	11	12
KZ	a					50						40
	b-c					1-1						1-1
	d					302						425
	e					-						-
KX	a						30					
	b-c						1-1					
	d						340					
	e						-					
KV	a						76				126	240
	b-c						0.9-1				1.6-1	1.7-1
	d						270				245	245
	e						-				-	-
KT	a				343				150			
	b-c				6.4-3				2-1			
	d				264				245			
	e				140-164				-			
KS	a						521					
	b-c						14.6-7					
	d						219-253					
	e						142-190					
KR	a		500	618	1029	1142						
	b-c		2-1	5.7-3	20.4-10	6.9-3						
	d		264	256-302	212-245	250-284						
	e		-	159-166	162-185	164						
KP	a				525							
	b-c				9.3-4							
	d				208-266							
	e				153							
KN	a			415								
	b-c			2.2-1								
	d			245								
	e			-								
KM	a	60	200	171	200							
	b-c	1-1	1-1	1.8-1	1-1							
	d	491	378	255	283							
	e	-	-	-	-							
KL	a				576	624						
	b-c				8.3-4	12.5-6						
	d				226-237	220-226						
	e				109-121	117-138						
KK	a							500	50			
	b-c							1-1	1-1			
	d							189	140			
	e							-	107-160			
KJ	a						300					
	b-c						1-1					
	d						226					
	e						-					

TABLE 2b. Catch of shrimps (kg) per hour of the M/T SISIMIUT 15-26 June 1977 corrected for diurnal variation. For information about actual catch and effort see Table 2a.

Rect-angle	1	2	3	4	5	6	7	8	9/10	11	12
KZ					66						49
KX						42					
KV						81				202	300
KT				463				152			
KS						667					
KR		535	729	1215	1197						
KP				617							
KN			456								
KM	85	300	173	325							
KL				636	828						
KK							610	56			
KJ						423					

TABLE 3. Hauls with shrimp trawl by the R/V ADOLF JENSEN on the standard station Godthåb Deep. Position around 63°56'N,52°20'W, ICNAF Div. 1 D. Depth range 260-310 m.

Year	Date	Ref.no.	Number of hauls	Catch of shrimps per hour (kg)	Mean size of shrimps (No. per kg)
1968	1IV	3941	2	13-60	132
"	1-2V	3964	2	40-70	
1969	8-9I	4142	3	60-34-90	259
"	4-5III	4168	2	120-125	191
"	7-8V	4213	3	90-100-65	-
"	15-16VIII	4276	2	219-285	247
1970	4-5VI	4376	3	315-156-105	213-168-153
"	24VII	4422	1	584	204
1971	17-21I	4512	3	125-194-165	120-130-125
"	13-14V	4530	3	216-168-201	115-118-113
"	18-19VIII	4582	3	122-90-325	173-189
1972	26V	4626	2	126-104	145-150
"	2VI	4627	1	304	150
"	13VII	4669	3	269-480-512	179-195-152
1973	6II	4718	3	1456-702-1438	124-112-120
"	17-18IV	4738	3	86-144-178	118-124-124
"	22VI	4754	2	67-236	121-140
"	23X	4865	2	195-323	139-152
1974	8I	4876	1	120	124
"	21I	4877	2	240-290	149-121
"	10-11VI	4913	3	82-172-238	163-170-144
"	12-13VII	4943	3	90-95-61	139-132-121
"	27XI 3XII	5002	3	345-184-308	170-153-180
1975	9-16I	5016	3	81-293-425	179-183-248
"	23-24IV	5031	3	148-142-118	171-187-178
"	18-19VI	5043	3	250-434-168	152-239-181
"	19-20VIII	5110	3	179-131-115	153-153-182
"	7X	5134	1	252	-
"	10-11XI	5158	2	392-328	166
1976	20-21I	5176	3	158-129-79	123
"	27IV	5186	3	68-43-73	107-118
"	2VI	5206	2	85-55	113-90
"	8VI	5209	1	230	-
"	20IX	5321	1	53	-
"	25-27X	5327	3	138-377-307	144-146
"	30XI 1-2XII	5336	3	86-54-84	-
1977	6-10I	5342	3	95-75-116	126
"	28III	5369	3	153-143-207	144
"	22IX	5488	3	66-34-64	154-136

TABLE 4. Hauls with shrimp trawl by the R/V ADOLF JENSEN on the standard station Sukkertoppen Deep. Position around 64°20'N 53°00'W, ICNAF Div. 1C. Depth range 480-550 m.

YEAR	DATE	REF.NO.	NO.OF HAULS	CATCH OF SHRIMP PER HOUR (KG)	MEAN SIZE OF SHRIMP (NO. PER KG)
1968	7 VIII	4058	1	135	158
1969	15-16 I	4144	4	16-90-82-60	127
"	15 IV	4188	2	50-205	168
1970	1 VI	4375	1	46	124
"	22 VII	4420	3	250-190-170	103-112-112
1971	26-28 V	4532	1	55	109
"	4 VI	4539	1	42	112
"	20 VIII	4583	3	38-39-81	113-109-113
1972	14 IV	4621	1	65	114
"	14 VI	4637	2	no info. - 62	122-159
1973	13 II	4719	1	93	99
"	12 III	4726	1	14	104
"	28 VI	4759	1	128	99
1974	24-25 I	4879	2	11-8	99
"	16-17 IV	4913	3	82-177-238	163-170-144
"	18 VI	4916	1	53	107
"	23 VII	4951	1	9	84
"	4 XII	5003	2	7-7	129-112
1975	24 VI	5047	2	213-134	100-91
"	21 VIII	5112	1	48	87
1976	14 I	5175	2	92-79	129
"	30 IV	5187	2	39-32	136
"	9-10 VI	5215	3	24-29-37	96-99
1977	3 II	5354	2	12-15	111
"	22 IV	5384	2	25-10	102
"	31 V	5411	1	7	-
"	4 X	5490	3	5-4-5	74-73

TABLE 5. Comparison between simultaneous trawl catches of the commercial trawler SISIMIUT (SIS) and the research vessel ADOLF JENSEN (AJ) in Div. 1B, May 1977. The first three AJ trawlings were carried out with a speed of 2-2.5 knots, the following trawlings with a speed of 3-3.5 knots.

Rect-angle	Hour	SIS St.No.	AJ St.No.	SIS Catch/hour	AJ Catch/hour	SIS/AJ
KH005	0045	1	-	282	-	
KH005	0225	2	-	700	-	
KJ005	0455	3	5397	52	45	1.16
KK005	0745	4	-	600	-	
KL005	0945	5	5398/1	457	56	8.16
KM003	1200	6	5398/2	700	100	7.00
KN003	1430	7	-	2229	-	
KN003	1610	8	5399	1333	1070	1.25
KN003	1805	9	-	655	-	
KN003	2025	10	5400	825	378	2.18
KN003	2220	11	5401	1309	280	4.68
KN003	0045	1	-	600	-	
KN003	0245	2	5402	650	450	1.44
KN003	0525	3	-	1200	-	
KN003	0750	4	5403	629	580	1.08
KN003	1005	5	-	1418	-	

TABLE 6. Catch per hour and conversion factors for diurnal variation of shrimp catches as obtained from trawl hauls by the M/T SISIMIUT December 1975 - October 1976. The basic material is given by Smidt, 1976 and illustrated in Figs. 1-6.

Time of day (hrs)		0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24
	c.p.h	250	350	450	540	610	670	660	600	500	300	230	210
NOV-FEB (Fig.2)	conv.	2.68	1.91	1.49	1.24	1.10	1.00	1.02	1.12	1.34	2.23	2.91	3.19
	c.p.h.	690	740	810	880	970	1030	1040	990	940	850	740	640
JUN-JUL (Fig.3)	conv.	1.51	1.41	1.28	1.18	1.07	1.01	1.00	1.05	1.11	1.22	1.41	1.63
	c.p.h.	350	540	800	950	1050	1110	1125	1070	950	770	510	350
MAY, AUG (Fig.4)	conv.	3.21	2.08	1.41	1.18	1.07	1.01	1.00	1.05	1.18	1.46	2.21	3.21
	c.p.h.	260	400	610	800	940	1030	1060	1050	910	700	420	200
APR, SEP (Fig.5)	conv.	4.08	2.65	1.74	1.33	1.13	1.03	1.00	1.01	1.16	1.51	2.52	5.30
	c.p.h.	190	200	280	400	540	650	690	680	560	325	200	180
MAR, OCT (Fig.6)	conv.	3.63	3.45	2.46	1.73	1.28	1.06	1.00	1.01	1.23	2.12	3.45	3.83

Table 7. Commercial trawlers' catch per hour, Div. 1B, 1975-1977. Areas and months with less than 10 hours' trawling are excluded.

Rect-angle	7510	7511	7512	Mean 1975	7601	7602	7606	7607	7608	7609	7610	7611	7612	Mean 1976	7701	7702	7703	7704	7705	7706	7707	7708	7709	Mean 1977
KV																			597					597
KS											531			531						915	546	407	454	592
KR											357			357						815	541	649	452	550
KP										572	348			428	169					402	735	499	434	476
KN		550		550						444	366	452		397	389				735	888	685	525	353	660
KM	290	518	488	472			1233		784	643	325	495		705	1716				553	606	769	451	362	602
KL		609	373	496			870	1138	692	719	180			726	1163			1056	787	474	616	418		801
KK			282	282			885	812			249			774	922			702	450			270		517
KJ							998	673						733		115		666	360					407
KH								544						544		1394			564					970
KG							573						72	310		547								547
KF							643							643		547		317						477
KE																933		395						575
KD							892							892			821	738						761
KB					502		375						459	434			767	432						677
KA					440								360	380		721	228	215						611
JZ					639	620								637	762	457		180						545
JX															474									474
MEAN	290	545	417	481	620	620	867	733	769	605	350	477	333	609	851	684	718	576	596	684	686	496	434	613

TABLE 8. SISIMIUT catch per hour, Div. 1B, 1975-77. Areas and months with less than 10 hours' trawling are excluded.

Rect-angle	7511	7512	MEAN 1975	7601	7605	7606	7607	7608	7609	7610	7612	MEAN 1976	7701	7702	7703	7704	7705	7706	7707	7708	7709	MEAN 1977
KS										531		531						660	546	493	448	558
KR										357		357						815	541	589	460	571
KP									633	347		439						402	735	592	524	553
KN	549		549						456	327		392					748	915	771	660	351	749
KM	527	488	514			1233		784	682	320		751					599	551	659	494		565
KL	609	373	496			870	1138	692	719	52		767	1344			1056	1168	525	616	434		948
KK		282	282			885	812					855	922			702	425					594
KJ						998	673					756		115		666	287					401
KH							544					544		1394								1394
KG						573						573										
KF					347	643						533				327						327
KE														933		457						676
KD						892						892			827	718						754
KB				502		375					459	434			841	352						749
MEAN	559	417	504	502	347	867	733	769	632	346	459	657	1246	889	837	631	676	669	685	556	472	673

TABLE 9. Comparison between biomass estimates obtained in 1977 and from the 1976-material applied to strata used in 1977. Strata and the 1976-stations are shown on Figs. 13 and 14. Details of the 1977 material are found in Tables 2a and 2b.

Stratum	1976 St.No.	1977 Rect-angle	Area (km^2)	Catch per hour (kg) 1976	Catch per hour (kg) 1977	Biomass estimates (tons) 1976	Biomass estimates (tons) 1977
1	3	KZ5	830	66	333	328	1655
2	1	KZ12	680	49	108	200	440
3	5	KX6	330	42	153	83	302
4	11, 15	KV6	720	81			
		KT4		463			
		KS6		667			
		Mean		377	406	1625	1750
5	-	KV11	220	202			
		KV12		300			
		KT8		152			
		Mean		218	(489)	287	(645)
6	20, 21	KR2	2490	535			
		KR3		729			
		KR4		1215			
		KR5		1197			
		KP4		617			
		KN3		456			
		Mean		792	572	11809	8530
7	23	KM3	1140	173			
		KM4		325			
		KL4		636			
		KL5		828			
		Mean		490	626	3345	4273
8	27	KJ6	420	423	367	1064	923
9	24	KM1	300	85	85	153	153
10	-	KM2	450	300	-	808	(2546)
11	28	KK7	450	610	24	1644	65

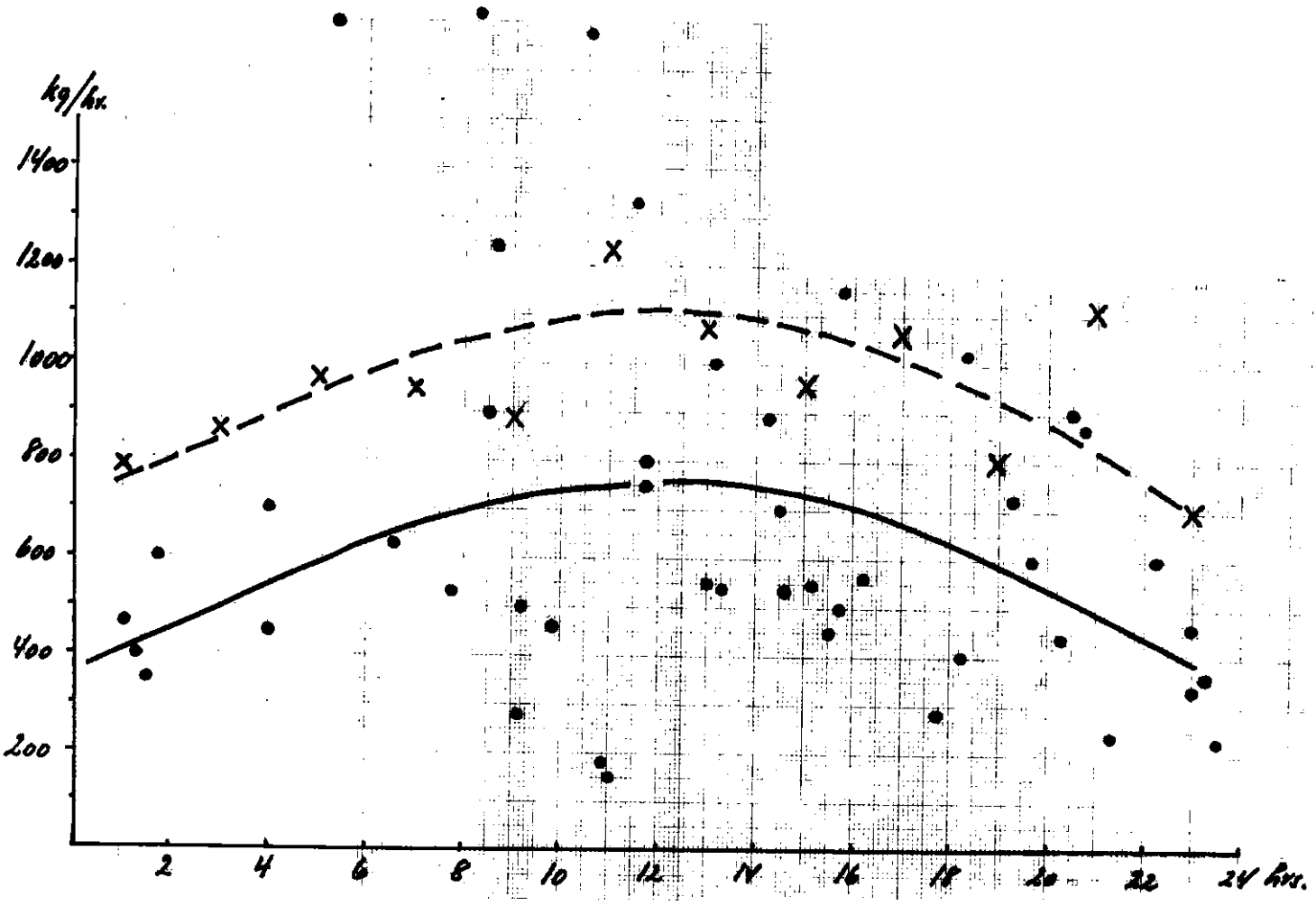

Fig. 1. Catch of shrimp per hour in commercial hauls of the M/T *Sisimiut* in Div. 1B, June 1977. Each dot represents a haul. X indicates average catches for the same vessel and division in June 1976 (Smidt, 1976, Table 1). Lines fitted by eye, broken line 1976, full line 1977.

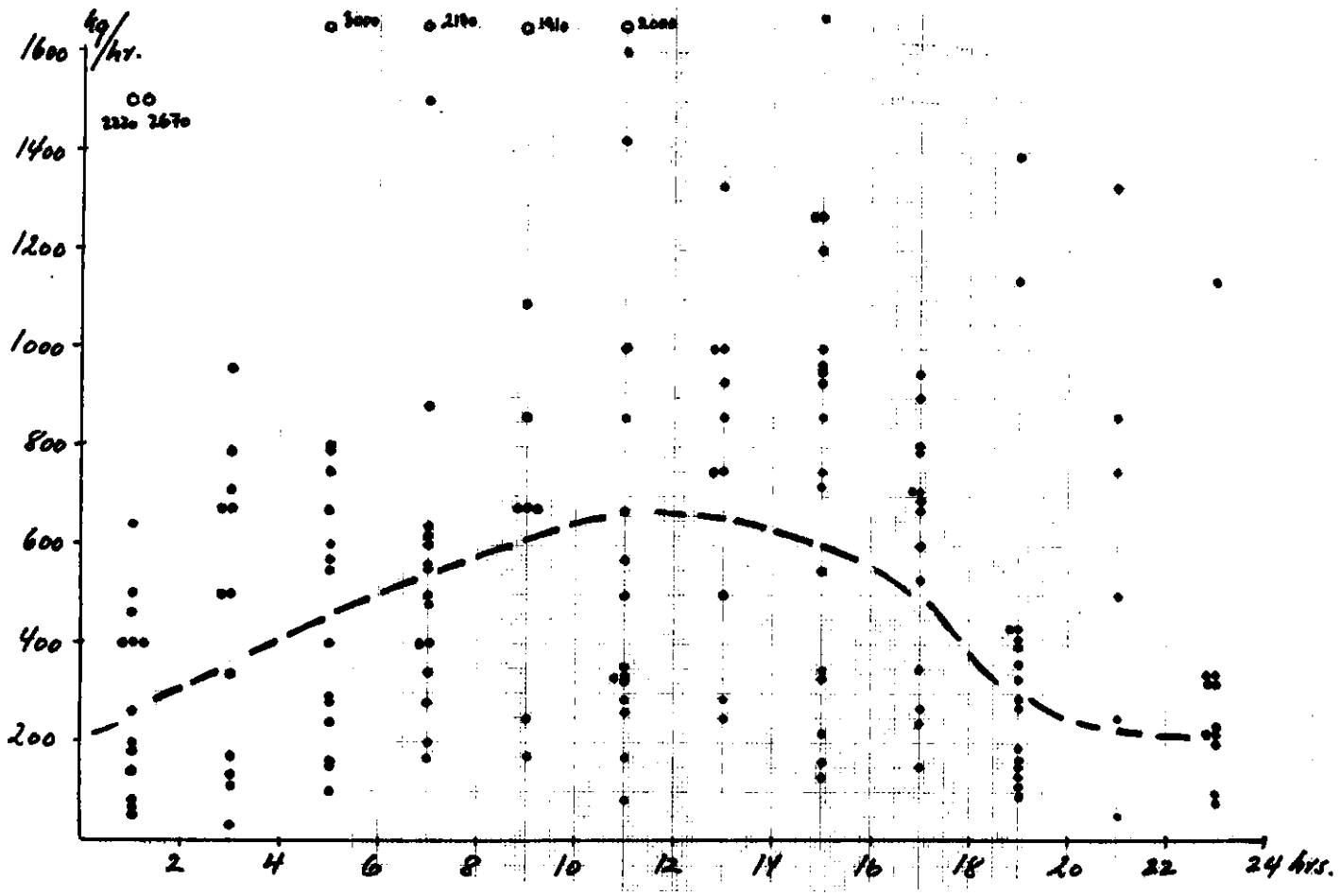

Fig. 2. Catch of shrimp per hour of the M/T *Sisimiut*: December 1975–January 1976. Each dot represents a haul. Open circles represent hauls outside the scale of the figure, and their catches are given by figures. Median line fitted by eye.

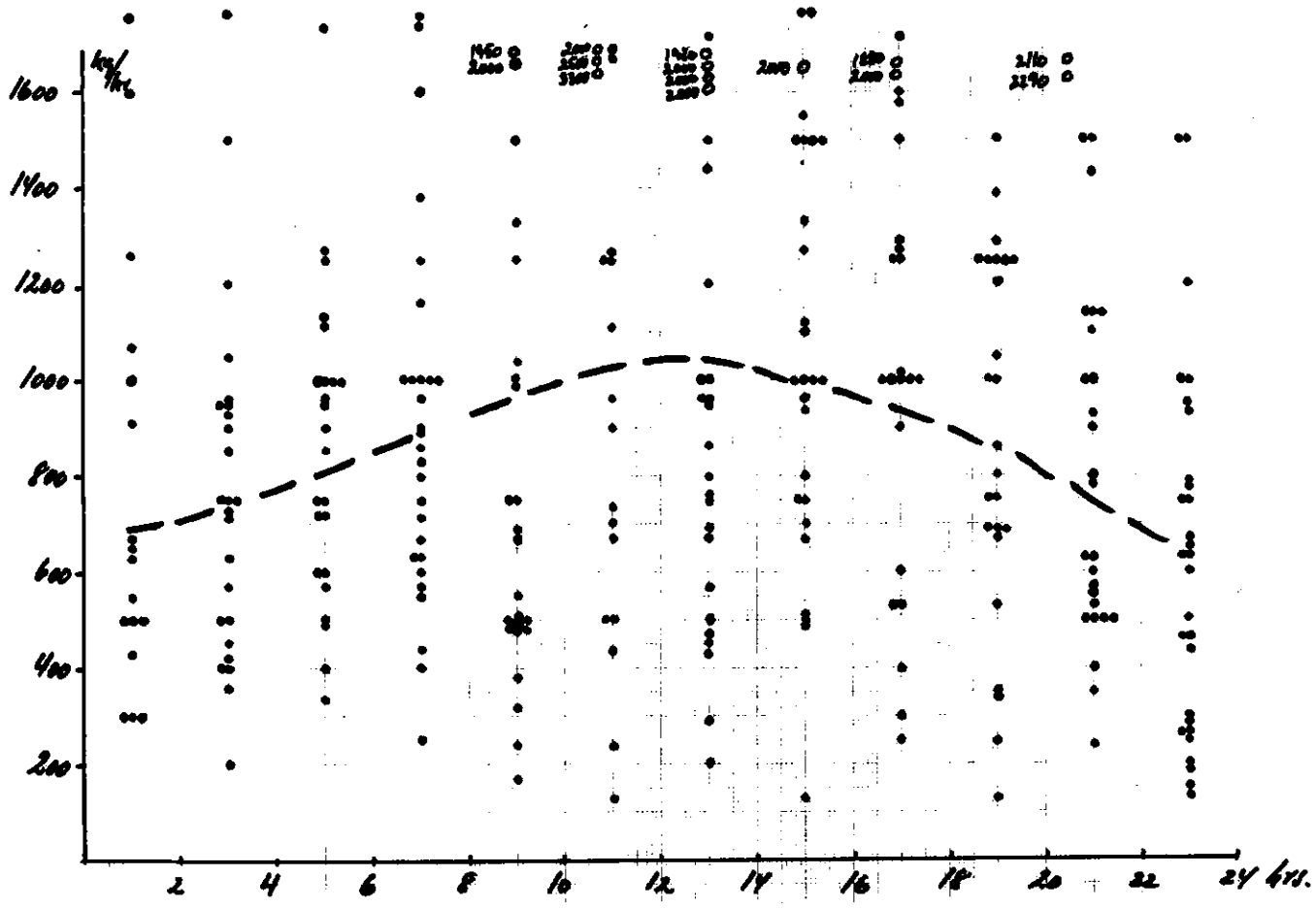

Fig. 3. Catch of shrimp per hour of the M/T *Sisimiut*: June-July 1976. Each dot represents a haul. Open circles represent hauls outside the scale of the figure, and their catches are given by figures. Median line fitted by eye.

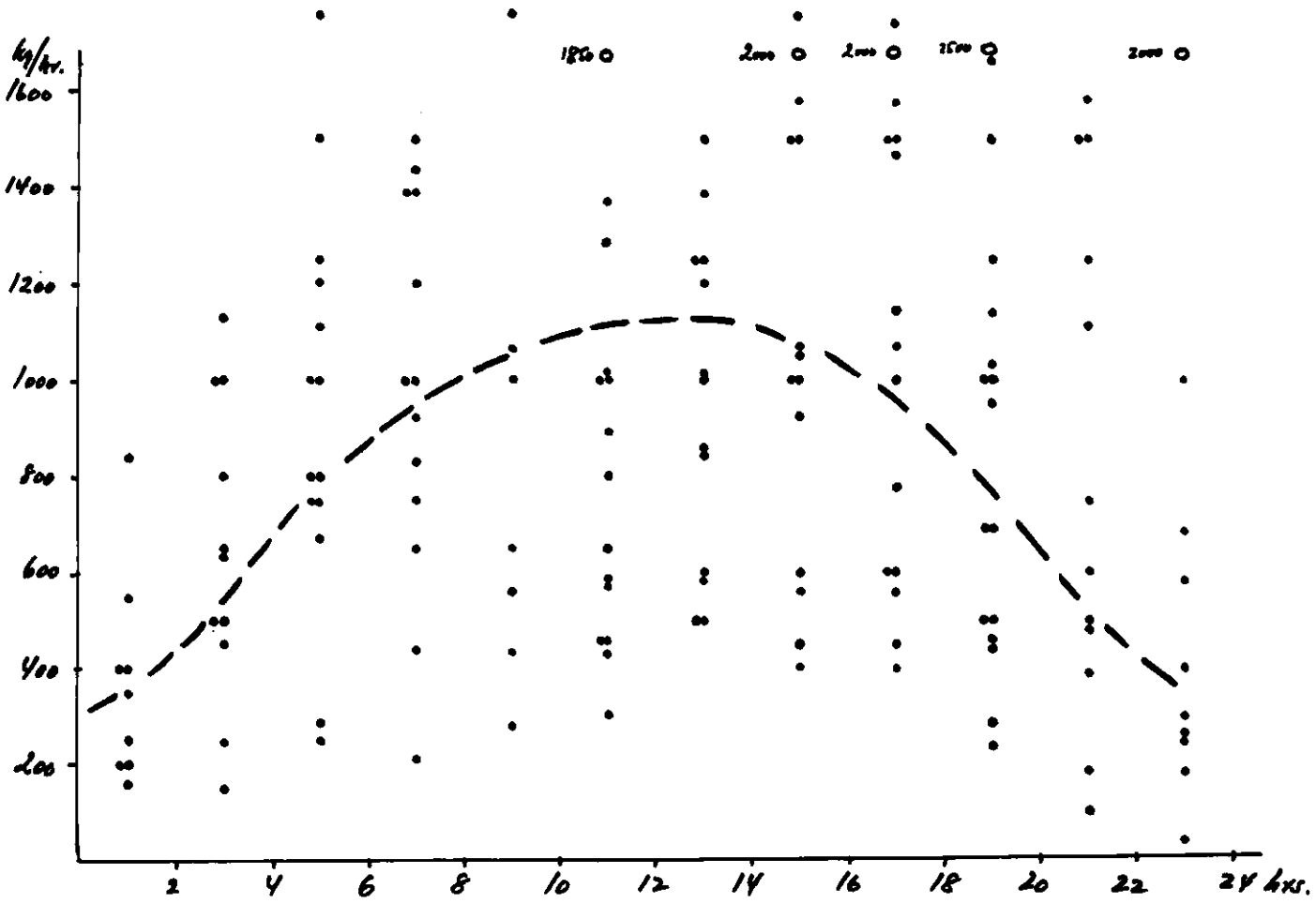

Fig. 4. Catch of shrimp per hour of the M/T *Sisimiut*: August 1976. Each dot represents a haul. Open circles represent hauls outside the scale of the figure, and their catches are given by figures. Median line fitted by eye.

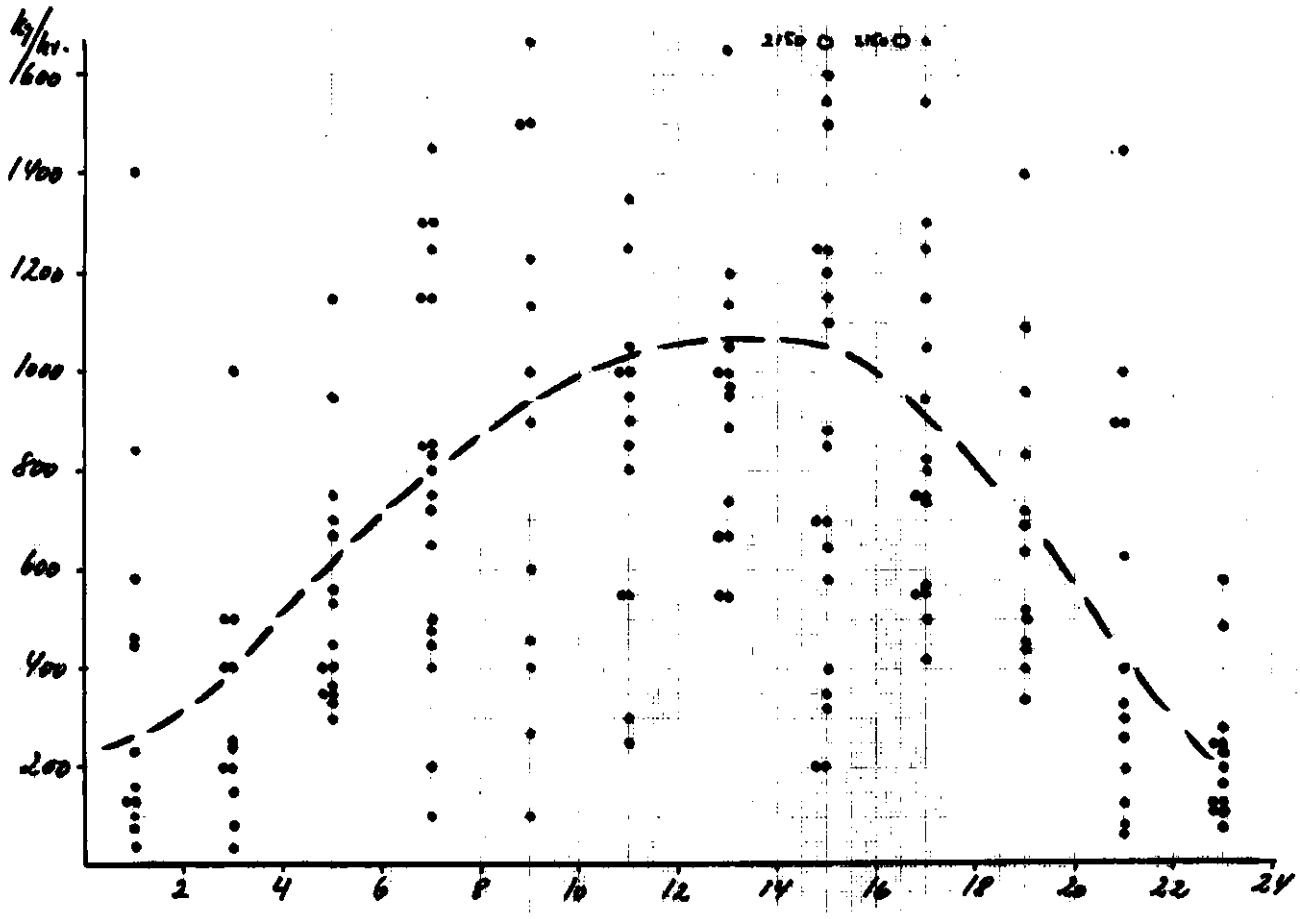

Fig. 5. Catch of shrimp per hour of the M/T *Sisimiut*: September 1976. Each dot represents a haul. Open circles represent hauls outside the scale of the figure, and their catches are given by figures. Median line fitted by eye.

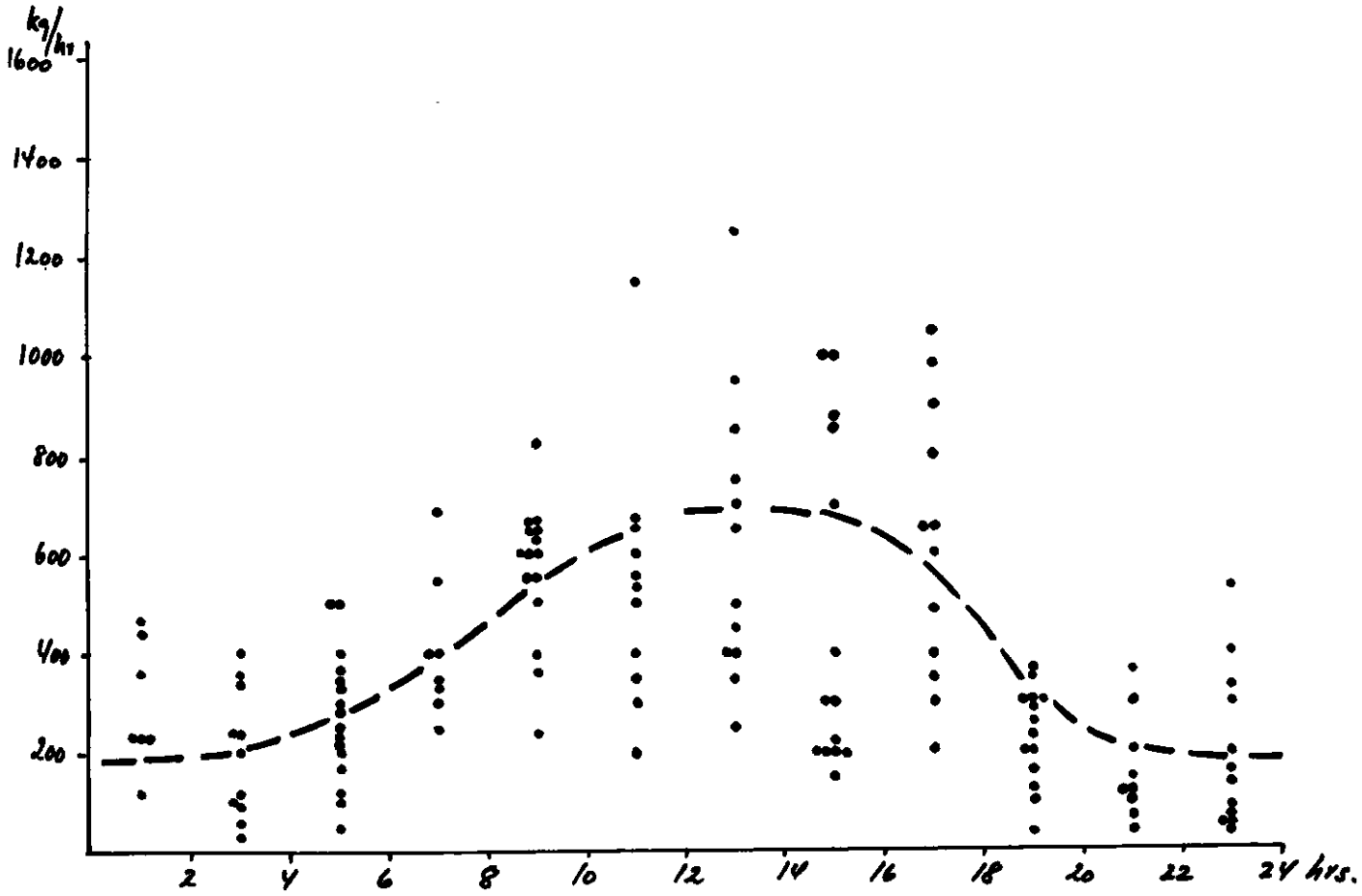

Fig. 6. Catch of shrimp per hour of the M/T *Sisimiut*: October 1976. Each dot represents a haul. Median line fitted by eye.

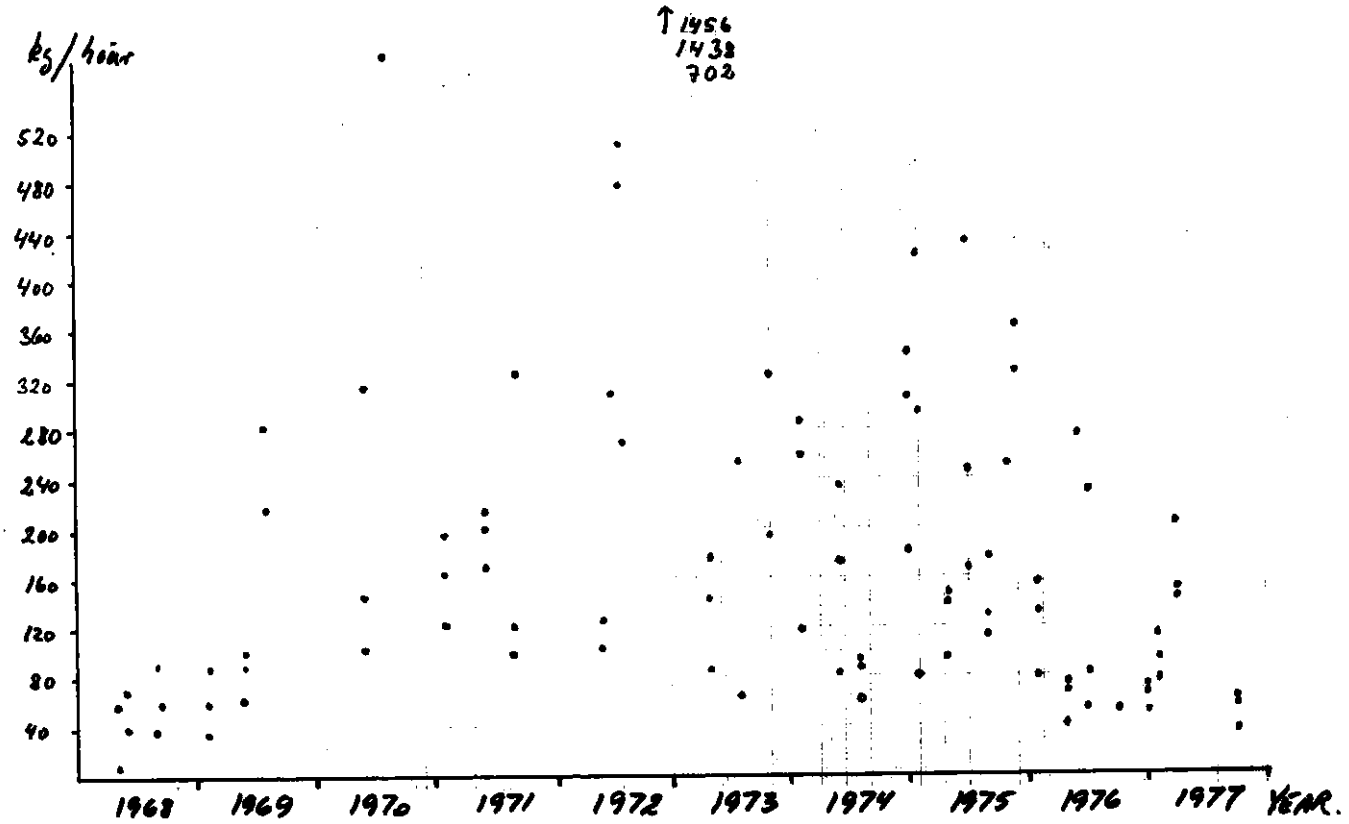

Fig. 7. Catch per hour's trawling, 1968-77 in Godthaab Deep, Div. 1D, of the Research Vessel *Adolf Jensen*. The figure corresponds to Table 3.

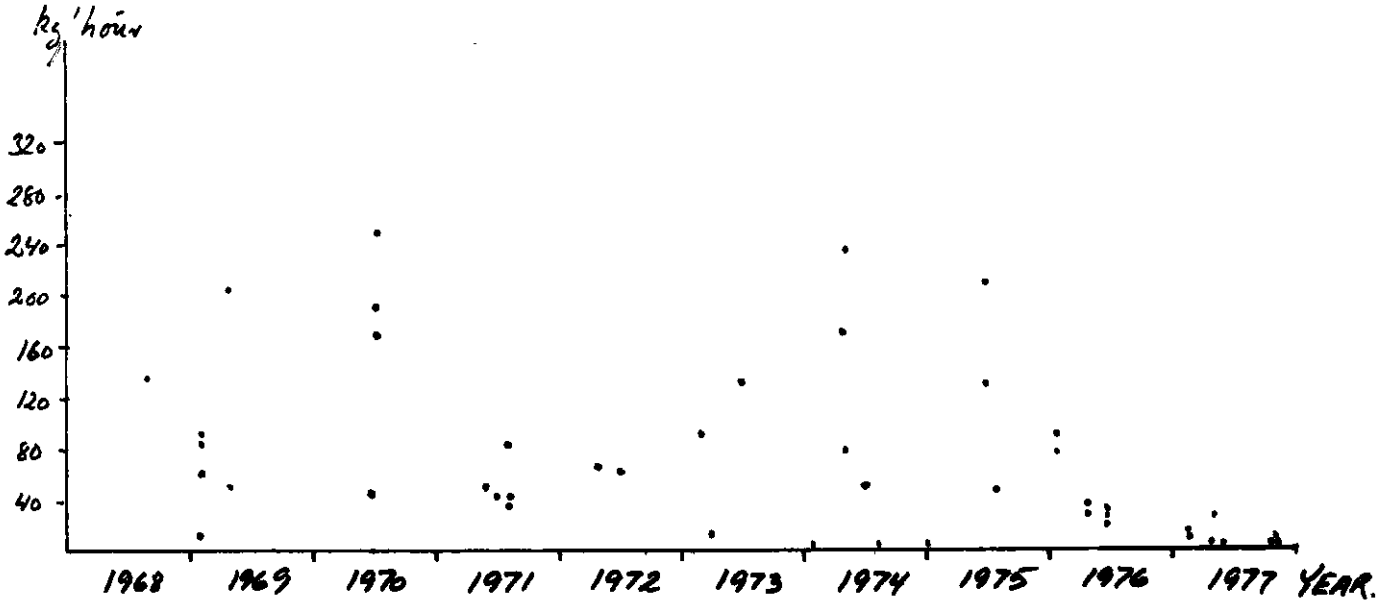

Fig. 8. Catch per hour's trawling, 1968-77 in Sukkertoppen Deep, Div. 1C, of the Research Vessel *Adolf Jensen*. The figure corresponds to Table 4.

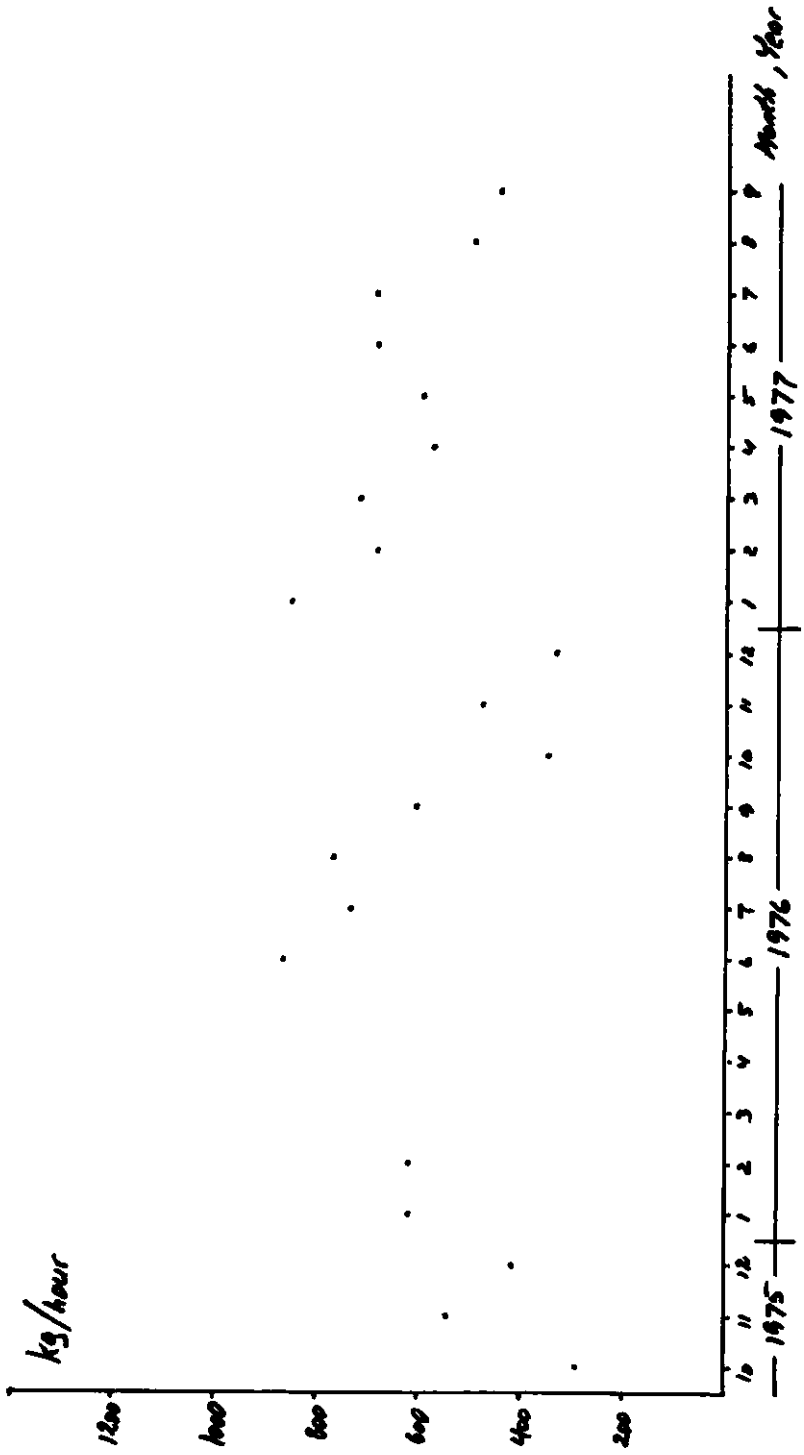

Fig. 9. Catch per hour's trawling, 1975-77 in Div. 1B by commercial trawlers. The values correspond to the mean values in Table 7.

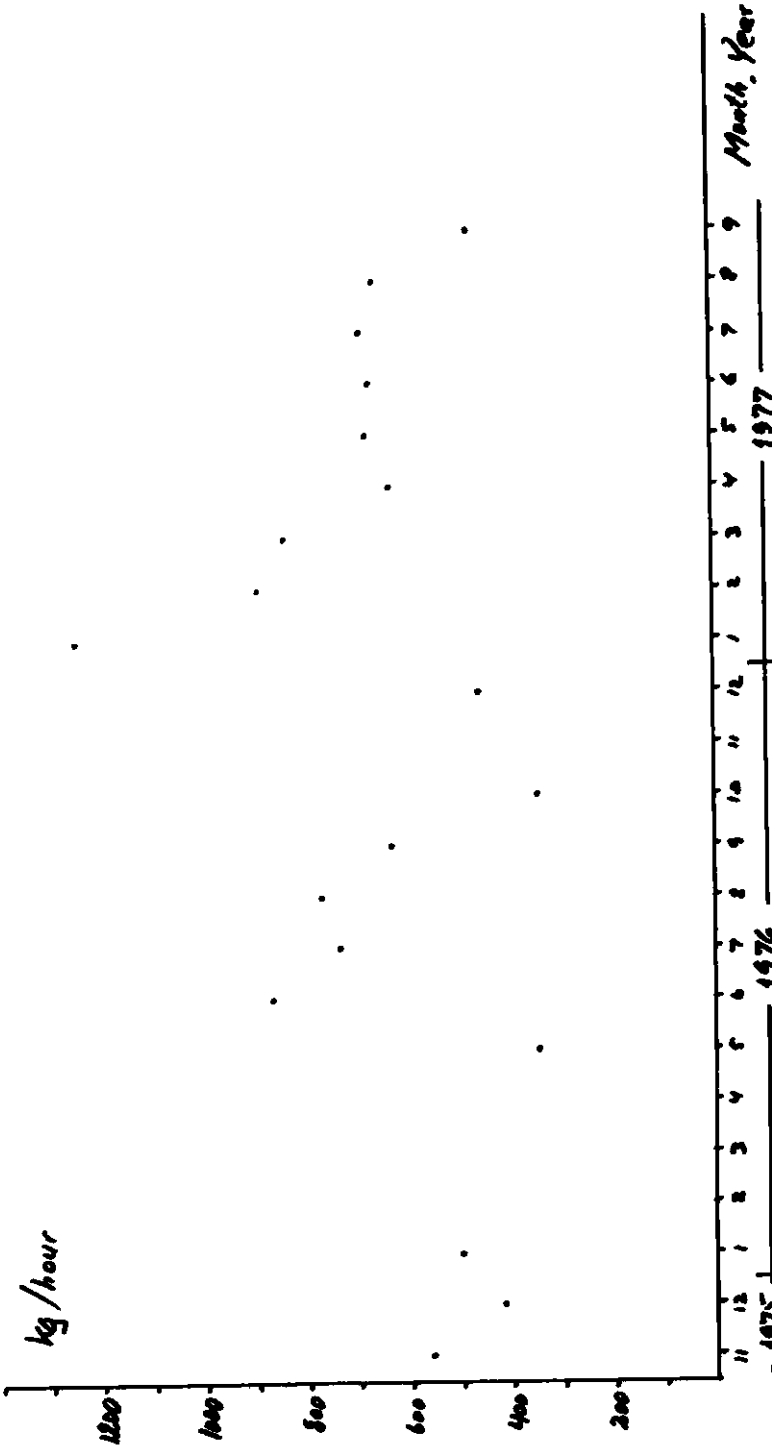

Fig. 10. Catch per hour's trawling, 1975-77 in Div. 1B of the commercial trawler *Sisimiut*. The values correspond to the mean values in Table 8.

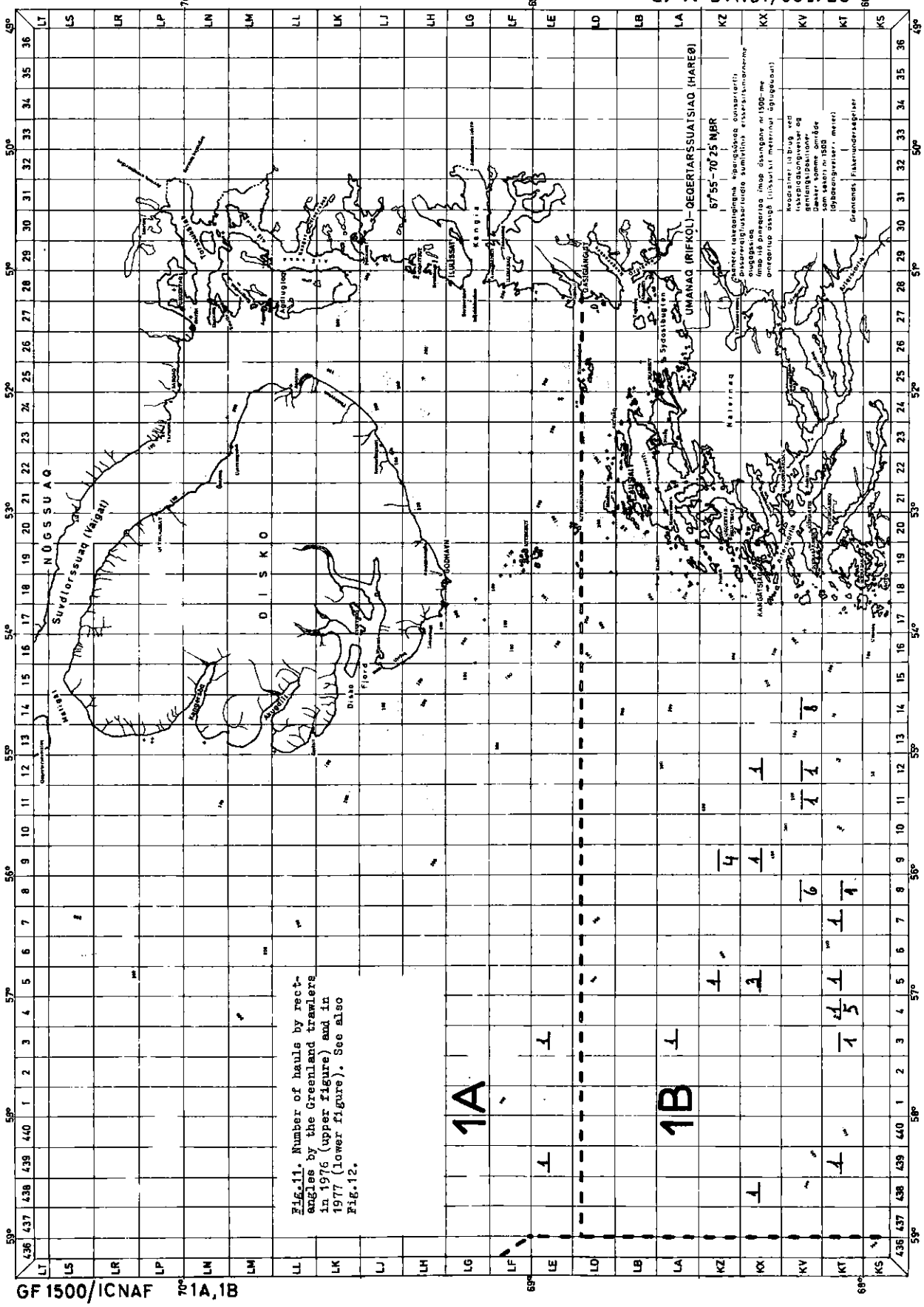

Fig.11. Number of hauls by rectangles by the Greenland trawlers in 1976 (upper figure) and in 1977 (lower figure). See also Fig.12.

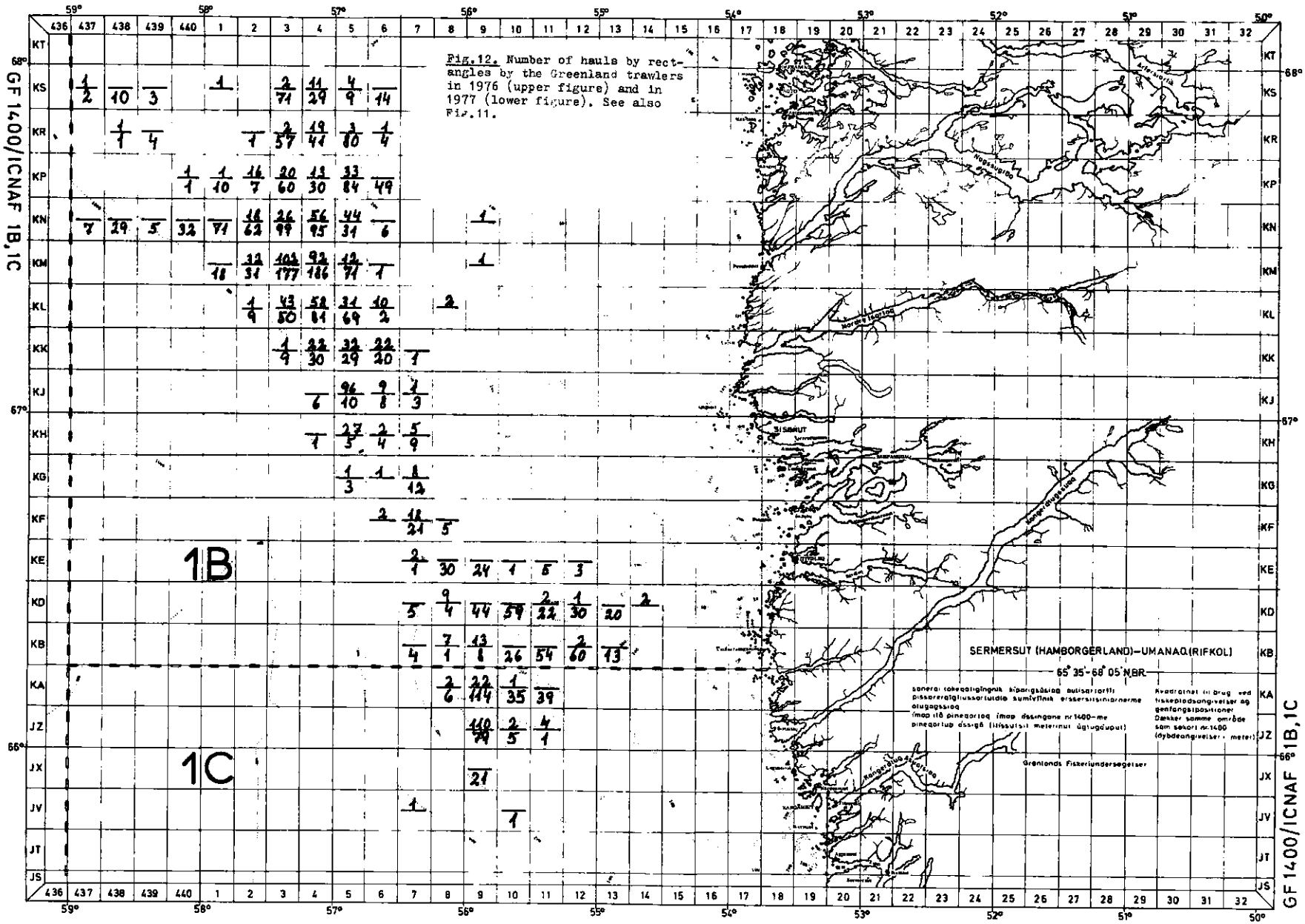

Fig.12. Number of hauls by rectangles by the Greenland trawlers in 1976 (upper figure) and in 1977 (lower figure). See also Fig.11.

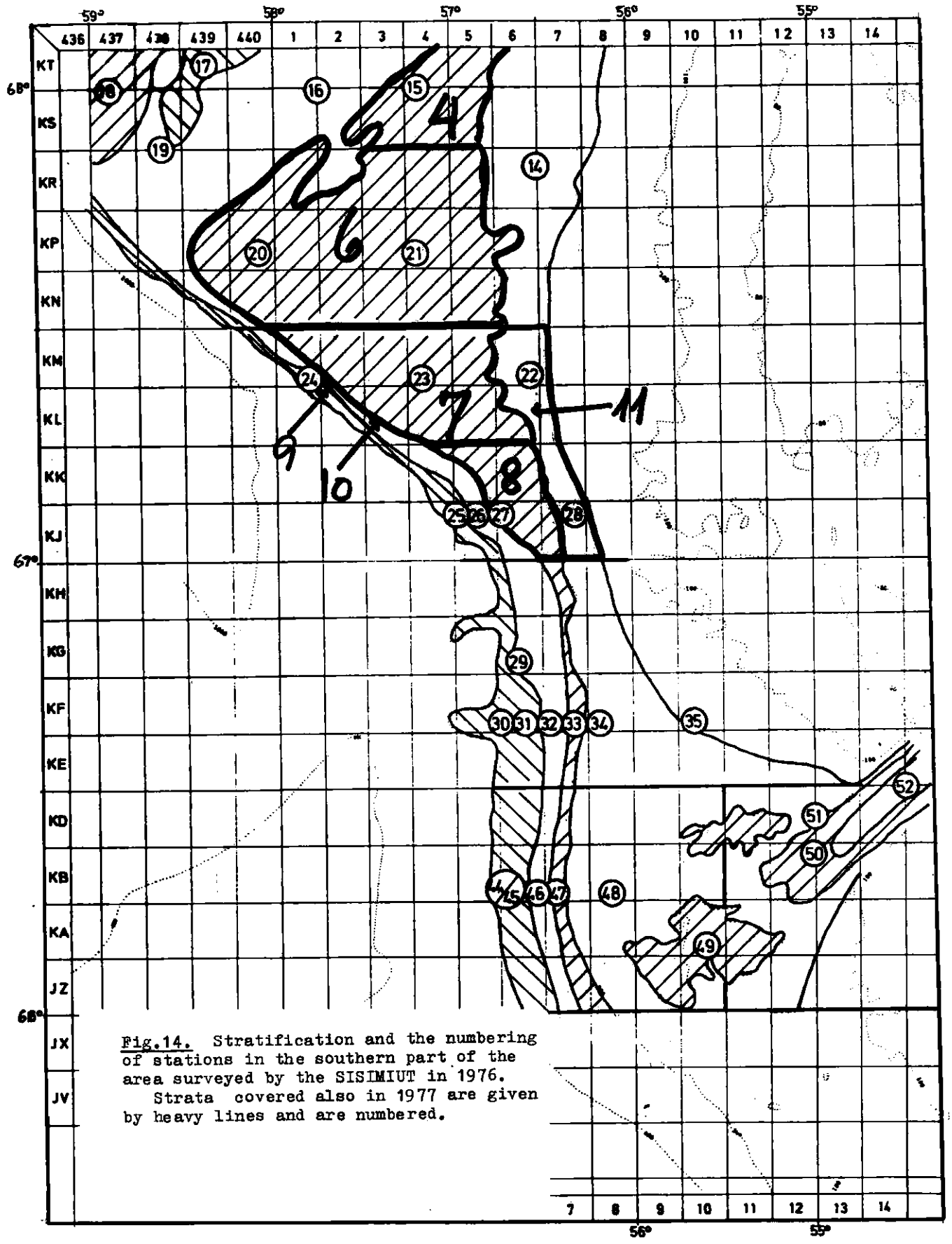

Fig.14. Stratification and the numbering of stations in the southern part of the area surveyed by the SISIMIUT in 1976.
Strata covered also in 1977 are given by heavy lines and are numbered.

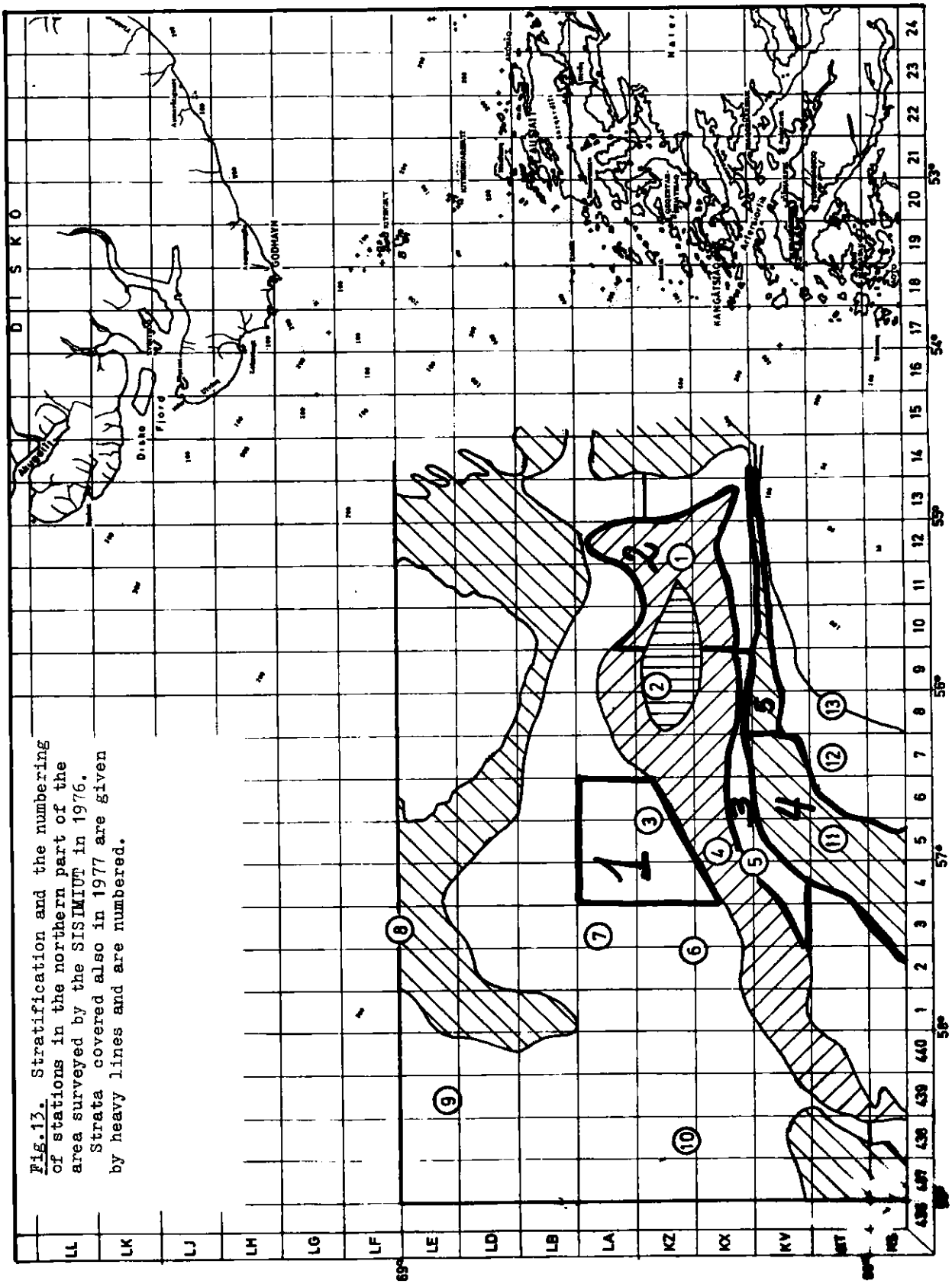

Fig.13. Stratification and the numbering of stations in the northern part of the area surveyed by the SISIMIUT in 1976. Strata covered also in 1977 are given by heavy lines and are numbered.