Meddelelser om Grønland

The annual cycle of temperature, salinity, currents and water masses in Disko Bugt and adjacent waters, West Greenland

Ole G. Norden Andersen

Bioscience
5 · 1981

The annual cycle of temperature, salinity, currents and water masses in Disko Bugt and adjacent waters, West Greenland

Ole G. Norden Andersen

MEDDELELSER OM GRØNLAND, BIOSCIENCE 5 · 1981

Table of contents

Received January 1978
Accepted January 1979
ISSN 0106-1054
ISBN 87-17-02867-1
Printed by AiO Tryk as, Odense

The annual cycle of temperature, salinity, currents and water masses in Disko Bugt and adjacent waters, West Greenland

OLE G. NORDEN ANDERSEN

Andersen, Ole G. Norden 1981. The annual cycle of temperature, salinity, currents and water masses in Disko Bugt and adjacent waters, West Greenland. Meddr Grønland, Biosci. 5: 33 pp. Copenhagen 1981–08–28.*

All available data on bathymetry, temperature, salinity and currents up until and including 1975 are used in describing the seasonal changes and dynamics of the hydrography of Disko Bugt, the Vaigat and adjacent glacier and non glacier fjords. From a winter situation with well mixed ÷1.75°C cold water in the upper c. 100 m steep halo- and thermoclines develop during the summer between freshened and heated surface water leaving Disko Bugt and deeper more saline water entering from the West Greenland Current. Huge ice bergs have a decisive cooling effect upon the upper 150–200 m affecting the outflowing current as well as the inflowing water which is responsible for the high bottom temperatures and salinities (up to 3.5°C and 34–34.5‰ at 300–500 m) found the year round, and which contributes to raising the temperature in the upper 200 m in the summer, especially in the southern and eastern part of the bay and even into the Vaigat. Surface temperatures reach 12°C in the offshore waters of the bay where salinities may drop to 30‰, and inshore in the more diluted waters of Disko Fjord temperatures may even reach 14°C, whereas in the glacier fjords, where surface salinities come close to zero, 4°C is the highest temperature recorded and subzero temperatures are found even in July. An extensive upwelling of W Greenland water occurs in the northern part of the bay during the summer and fall and similar phenomena occur in Disko Fjord, driven by winds and apparently linked to tidal rhythms. Although TS diagrams show that deep Disko Bugt water and Baffin Bay water is of common origin, no water seems to enter Disko Bugt from Baffin Bay or from the Baffin Current.

Ole G. Norden Andersen, Zoological Museum, Copenhagen, Universitetsparken 15, DK–2100 Copenhagen Ø, Denmark.

*Publications from the Danish Arctic Station, No. 80.

Introduction

In previous publications on the hydrography of W Greenland information on Disko Bugt is often lacking or fragmentary. The present paper presents published and unpublished data on temperature, salinity and currents available from Disko Bugt and adjacent waters up until and including 1975. The material is dealt with on a seasonal as well as on a regional basis. Although most of the data are from July and Aug. and activity has varied with regard to both time and location, it seems justifiable to delineate the 9 offshore areas shown in Fig. 1. The Danish National Science Research Council has supported the preparation of this paper.

Material and methods

Most previous measurements were made in the summer, preferably in July, and at standard depths of 0, 10, 25, 50, 100, 150, 200, 300 m and so on and often at even greater intervals, affording little information on the very variable hydrography of the euphotic zone in the upper about 50 m.

During a 2½ year period from May 1973 to Nov. 1975 the author worked at Arctic Station at Godhavn on the island of Disko, W Greenland studying the annual cycle of meroplankton, primary production and hydrography at Godhavn and in Kangikerdlak, a small fjord arm in the Disko Fjord complex. A standard sampling program was carried out at about 8 day intervals (3–14 days) from May to Oct. at Godhavn and less frequently in Kangikerdlak and only about once a month at both locations during the winter. Similar programs were carried out at Egedesminde, Christianshåb, and N of Jakobshavn in Aug. 1974 and temperature and salinity was measured between Godhavn and Egedesminde in Aug. 1975 and at 18 locations all over the bay in Oct. 1975 (Fig. 17). Of this work only the hydrographic data on temperature and salinity are included here, whereas primary production and its relations to physical and chemical factors will be dealt with in a later paper (Andersen 1981).

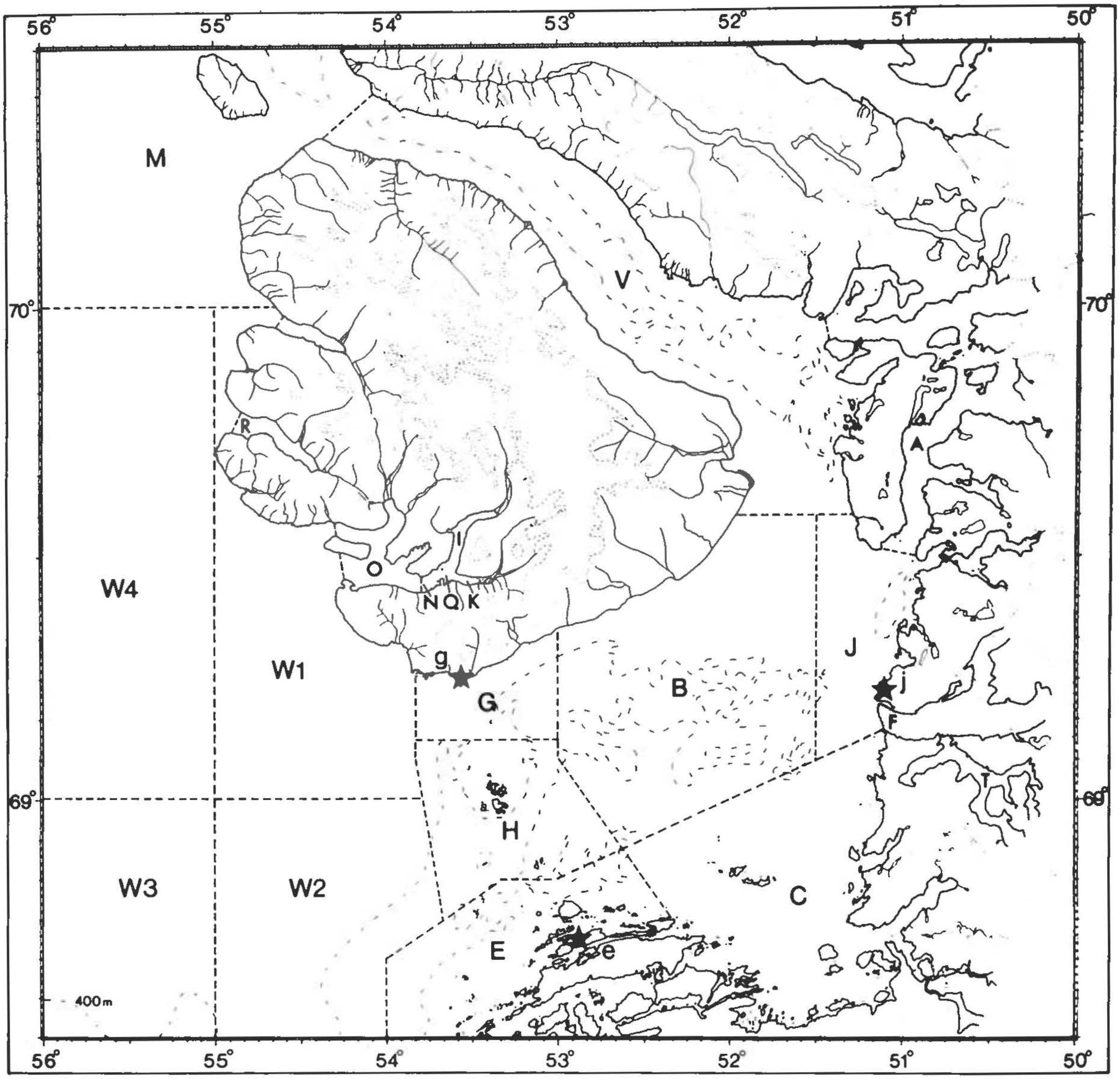


Fig. 1: Map showing the areas dealt with in the survey. The offshore areas include areas off Disko, Disko Bugt and the Vaigat (W_{1-4} and M), off Godhavn (G), around Kronprinsen Ejland and Hunde Ejland at the entrance to the bay (H), off Egedesminde (E), off Christianshåb (C), off Jakobshavn (J), the central and northern part of the bay (B) and the Vaigat (V). The glacier fjords are Tasiussaq (T) inside Jakobshavn Isfjord (F) and Atâ Sund (A). Non-glacier fjord areas are Mellemfjord (R), outer (O) and inner (I) Disko Fjord, Kangikerdlak (K) and the areas off Nãngissat (N) and off Qivítut (Q). The harbours are Godhavn (g), Egedesminde (e) and Jakobshavn (j), all marked with stars.

In 1973 all measurements were made at 0, 5, 10, 15, 20, 30, 40, 50 and occasionally also at 2.5 m (in Kangikerdlak); in 1974 and 1975 also at 0.5, 1, 2, 3, 4 and 7.5 m at both stations, and at Godhavn also at 60, 70, 80 and 90 m. The measurements made in Oct. 1975 also included the depths 120, 150, 200, 250, 300, 350 and 400 m when possible.

Temperature and salinity were usually measured with an MC5 combination thermobridge and conductivity salinometer (Electronic Switchgear), whereas at depths greater than 90 m an insulating water sampler with thermometer was used and salinity was determined with aerometers.

In the open-water period investigations were carried out from the station vessel, "Porsild", or from a small speed boat. In the period with ice the only means of travel was by foot or by dog sledge, and in this cold period it was necessary to work inside a tent heated by

Fig. 2: Bathymetric map of Disko Bugt and adjacent waters. Some critical threshold depths in metres are shown in large type. Compiled from (1): the Royal Danish Hydrographic Office maps of the Greenland west coast, (2): "Atlas Sheets", (3): unpublished data from various government ships and (4): Hydrographic Office (Washington D. C.) maps.

one or two primus stoves. The salinometer and thermobridge would not work properly at subzero air temperatures, and the water sampler had to be heated prior to use in order to prevent the formation of ice on its inner surfaces when submerged.

In order to keep the water samples from freezing a small circular catalyst stove was placed in the centre of a square piece of foam plast fitted snugly into a plywood box with 1/2 cm holes through the sides to ensure ventilation and a 15 cm hole in the lid, but partially covered so as to leave a 1 cm slit on two sides. The samples were placed in holes in the foam plast.

Bathygraphy

The map Fig. 2 shows the bathygraphic features outside fjords and harbours. N of Store Hellefiskebanke a narrow trough, up to 550 m deep, stretches from about 68°N, 58°W and ENE into the SW corner of the area

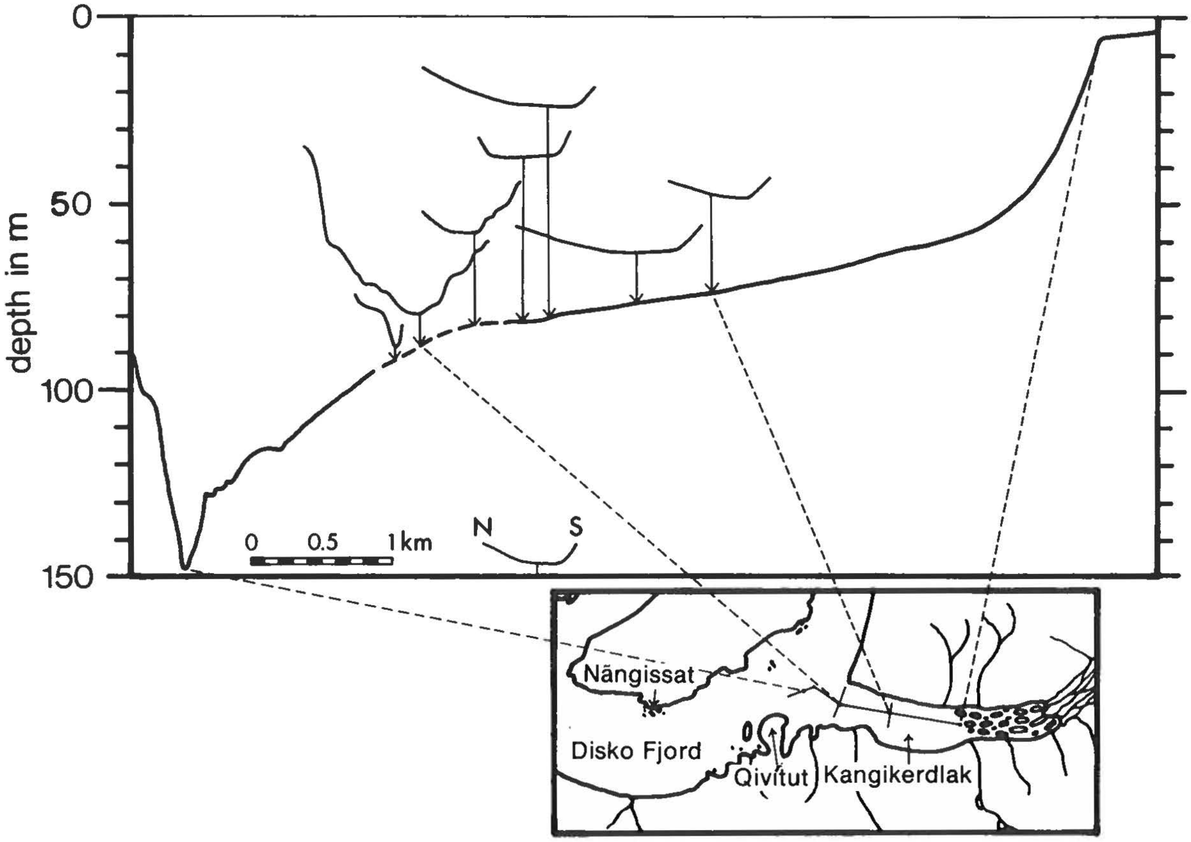


Fig. 3: A depth profile from the head af Kangikerdlak to a point off Qivítut including some cross section taken while attempting to find the deepest route out of the fjord arm. Vertical/horizontal is about 25/1.

covered by the map. The greatest depth connecting this trench to Davis Strait is about 360–370 m, while a threshold with a maximum depth of only 305 m divides it from the up to 990 m deep area just W of Egedesminde. This deep continues as an 800 m deep channel between Kronprinsen Ejland and Hunde Ejland into Disko Bugt, where a maximum depth of about 850 m is found SE of Godhavn, while depths of less than 500 m are most common. An up to 720 m deep area is also found S of Hunde Ejland, possibly separated from the main deep by a 435 m deep threshold. The maximum depth between Godhavn and Kronprinsen Ejland seems to be about 235 m and in Godhavn Rende, where a maximum depth of 375 m is reached in isolated spots, a minimum depth of little more than 200 m is found in the narrowest part near Godhavn. In the channel S of Grønne Ejland the depth barely exceeds 200 m. A maximum depth of 380 m existing over a wide area divides the central deep area of the bay from the deep found off Rodebay, thus acting as a threshold to this deep and to Atâ Sund.

A wide threshold about 245 m deep is located between the up to 650 m deep Vaigat and Disko Bugt, having a marked effect upon the hydrography of this narrow strait. Inside Hareøen a threshold with a maximum depth of about 350 m crosses the western entrance to the Vaigat, and from here a channel at least 400 m deep runs NW past Hareøen, where a maximum depth of about 150 m is found between Hareøen and the shallow area W of Disko.

Petersens data (1964) show indications of a threshold of 250–300 m located at the entrance to or inside Atâ Sund, inside which a depth of 525 m has been recorded. Hammers data (1883) show indications of a threshold existing at the entrance to Jakobshavn Isfjord at a depth of about 200 m.

Soundings at the entrance to Disko Fjord show a maximum depth of about 175 m which is the greatest depth found inside the fjord as well. Warm bottom water existing below 150 m in the outer part of the fjord indicates that no shallower threshold is found, whereas hydrographic data from no deeper than 100 m in the inner regions of the fjord complex, where 148 m measured off Qivítut (Fig. 3) is the greatest depth recorded, give no clues as to the bathygraphy. From Qivítut and outward no threshold seems to exist and depths greater than 125 m may be found all the way out.

The small fjord arm Kangikerdlak in the inner part of

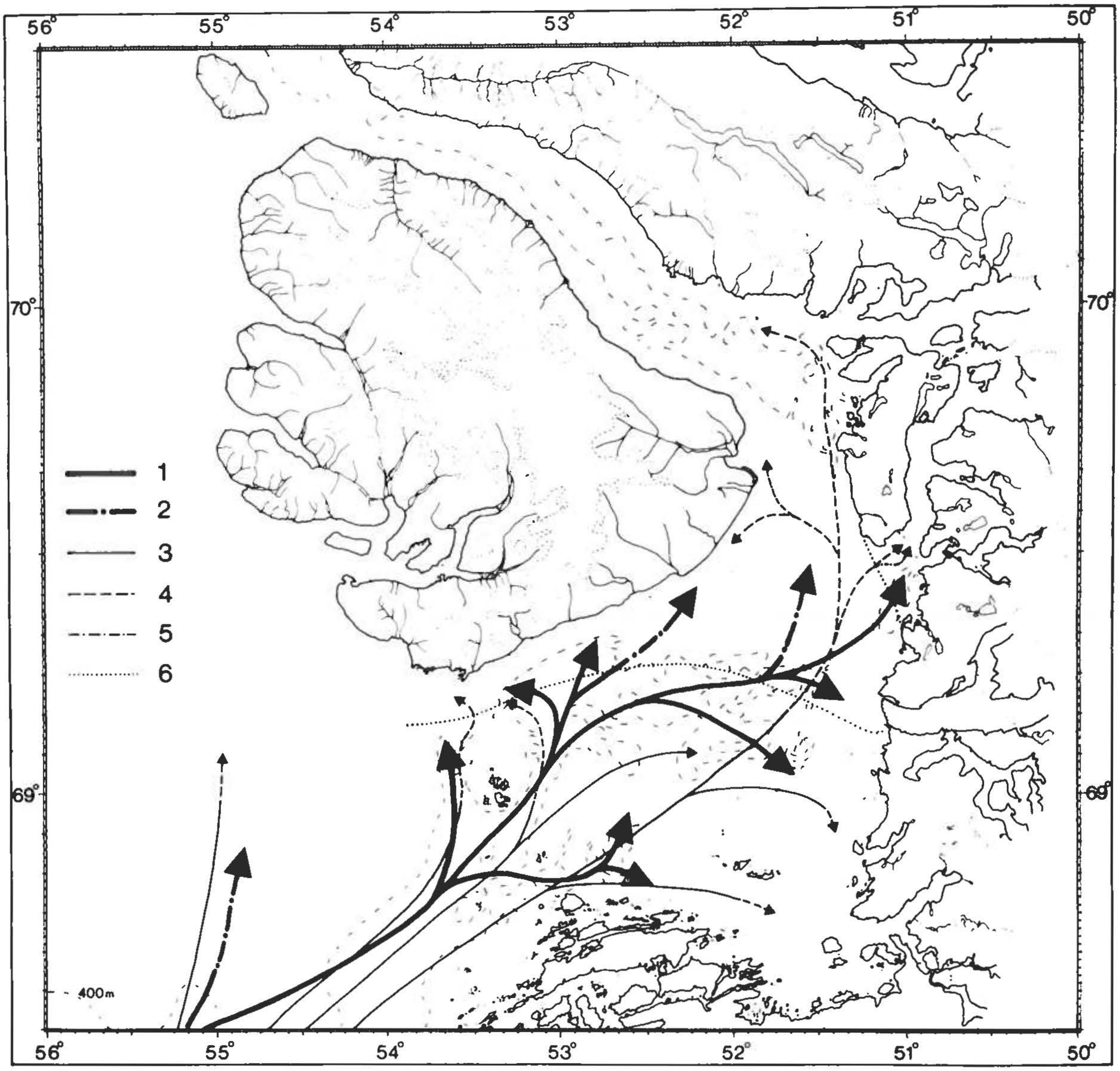


Fig. 4: The main pathways taken by W Greenland water entering and surface water leaving Disko Bugt. 1: Deep warm water from the outer slopes of Store Hellefiskebanke below 200 m. 2: Upwelling of this water. 3: Warm water from the upper 200 m of the West Greenland Current. 4: The same water passing beneath fresher surface layers. 5: Upwelling of this water. 6: The main area covered by diluted surface water leaving Disko Bugt lies to the N respective to the W of these two lines.

the fjord complex (Figs 1 & 3) has a bottom profile with a steep slope from the delta at the head of the fjord gradually levelling off to a maximum depth of about 80 m at the mouth. Cross sections show a level bottom with sides sloping more steeply to the S, where the bottom is of more coarse material and contains more rocks than the northern slope. It is uncertain whether a low threshold is found, since the wide area of level bottom appearing in the cross sections of the fjord narrows down to nearly nothing in the sections made at the mouth of the fjord. From there the bottom slopes more steeply and more irregularly to greater depth.

Origins of the water masses of Disko Bugt

Apart from the effect which the freezing and melting of the surface layers exert upon the hydrography of Disko Bugt, there are 3 main constituents which contribute to the making of the water masses in Disko Bugt. The comparatively warm West Greenland Current reaches the bay from the south; counterclockwise eddies from the cold and comparatively fresh Baffin Current mix with the West Greenland Current off Disko Bugt and especially to the S in the narrow part of Davis Strait; and surface currents made up primarily of cold low salinity water driven by an admixture of fresh water from great quantities of ice bergs as well as from rain, snow and sea ice flow out of the bay passing W along Disko and past Godhavn and N through the Vaigat. Counteracting this outflow of lighter surface water there is a general influx of W Greenland water, especially into the deeper portions, where it contributes to an upwelling primarily along the S coast of Disko, and into the eastern parts of the bay, reaching into the fjords found there and into the Vaigat (Fig. 4).

The hydrography of the West Greenland Current has been thoroughly described by various authors (Hamberg 1884, Wandel 1893, Nielsen 1928, Baggesgaard-Rasmussen & Jacobsen 1930, Smith et al. 1937, Riis-Carstensen 1936, Kiilerich 1939 & 1943, Dunbar 1951, Hansen & Hermann 1953, Hachey et al. 1954), but only Nielsen (1928) and Kiilerich (1943) have attempted a more thorough description of Disko Bugt. These are, however, in rather general terms.

The West Greenland Current from Kap Farvel and N along the W coast of Greenland right up to Thule is at its start made up of 2 distinct water masses of different origin. One is a continuation of the East Greenland Current which after rounding Kap Farvel keeps to the surface and close to shore as a cold and fresh current which eventually reaches Disko Bugt, as shown by drift bottles (Lee 1968). The other is part of the warm and saline Irminger Current, a branch of the Gulf Stream, which extends from below the polar current close to shore to the surface farther off shore. Although these 2 water masses to some extent mix on their way N, they can still be distinguished W of Egedesminde on the S side of the entrance to Disko Bugt. Here the Atlantic water constitutes a relatively warm and saline current found below 200–300 m hugging the outer and northern slopes of Store Hellefiskebanke, where it is wedged between and beneath the colder near-shore part of the West Greenland Current and the Baffin Current.

Off S Greenland the centre of the Atlantic water is found at 100–200 m with temperatures of 4–7.3°C and salinities close to 35‰ (upper point of a in Fig. 5). On its way N the centre of this warm section of the current is found at increasing depths. Some water is lost to the S going Baffin Current and there is an admixture of water from this current and from the cold near-shore part of the West Greenland Current itself, lowering both salinity and temperature. Just S of the narrowest part of Davis Strait, where a 700 m deep ridge crosses between Greenland and Baffin Island, the warm centre is located at about 600 m and summer temperatures are about 4.5°C and salinities are still above 34.9‰. Off Store Hellefiskebanke the N going Atlantic water is centred at 300–600 m and has maximum temperatures of 2.5–3.5°C at 300–400 m and maximum salinities of only 34.5–34.8‰ at 400–600 m. N of Store Hellefiskebanke the remaining Atlantic water splits up. Some of it continues N past Disko, where it is found at 400–500 m, and some is deflected W from the shallow areas W of Disko, while the remainder flows via the trough stretching SW from Egedesminde just N of Store Hellefiskebanke and across the threshold only 305 m deep into the deeper parts of Disko Bugt (Fig. 4).

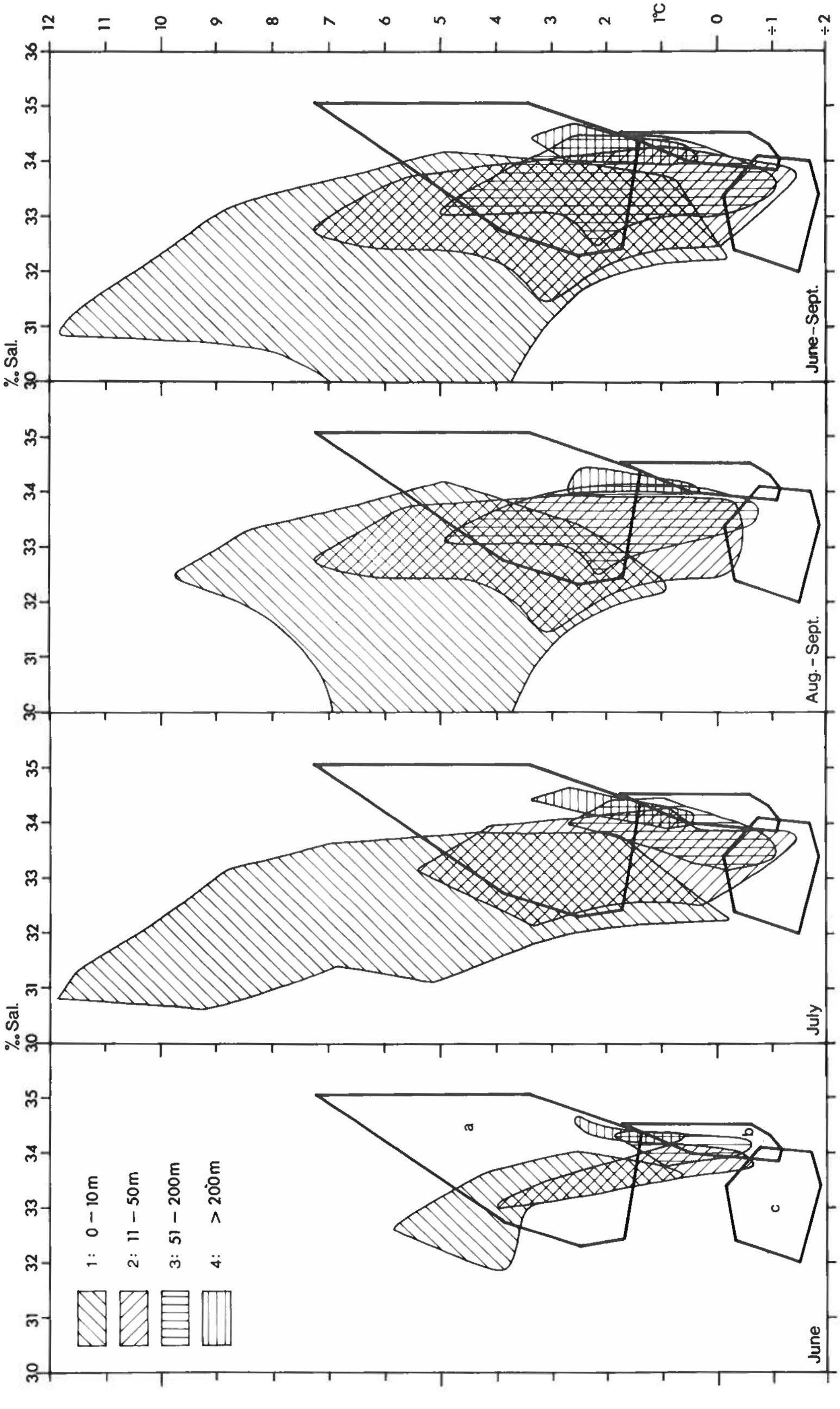
Because of this threshold, the central, most saline portion of the Atlantic water does not generally enter Disko Bugt, where salinities rarely reach 34.5‰, whereas at this point the warmest deep water is found closer to threshold depth and more readily enters the bay. As shown in Fig. 5 the highest temperature of the deep water of the bay is only 4°C less than the highest found off S Greenland and it can be as high as off Store Hellefiskebanke, whereas the highest salinities are always lower. The highest temperatures in the deep water have been found off Godhavn (Fig. 6) indicating a direct inflow of deep water from the West Greenland Current and the highest salinities are found in the deep centre of the bay entrance which also indicates the presence of deep W Greenland water.

The continuation of the cold East Greenland Current flowing N over the top of and inside the W Greenland banks to some extent mixes with the Atlantic water and during the summer it receives a sizeable efflux of fresher cold surface water from the many long and deep W Greenland fjords. Grann (1929) found that in Aug. this near-shore part of the West Greenland Current S of Store Hellefiskebanke contained neritic species of diatoms of southern origin, fewest in number close to shore. In passing over Store Hellefiskebanke the southerly species gradually disappeared and were completely lacking in the upper 50 m N of the bank and inside Disko Bugt, where only Arctic neritic species were found. W of Egedesminde the West Greenland Current moves very slowly and the part which has passed over the banks consists of a well mixed and especially during the summer and early fall a relatively warm upper layer from where temperatures gradually drop to a minimum at about 200 m.

Inside the bay (June–Sept.), however, temperatures in general drop several degrees below the lowest temperatures found below 50 m in the West Greenland Current, and while salinities are not altogether lower, they are not as high as the highest salinities found in the West Greenland Current due to the 305 m threshold mentioned above.

There are no indications of an admixture of deep Baffin Bay water (below 300 m) to the deep water found in Disko Bugt. Here temperatures are generally higher than in Baffin Bugt, but similar salinities in the two areas suggest a common origin of their deep water masses. The existence of cooler water at a shallower depth just below 200 m could imply that an admixture of deep Baffin Bay water does occur. The lowest minimum temperatures in the Disko Bugt area are, however, found over the deep parts of the Vaigat and of area B and off Godhavn, while minimum temperatures

Fig. 5: TS diagrams including all offshore temperature + salinity series from June to Sept. are shown. Diagrams a–c are from Dunbar (1951, Fig. 3) showing TS conditions in Aug.–Sept. in (a): West Greenland S of Disko (below 50 m) (data from Smith et al. (1937) and Kiilerich (1939)), (b): deep Baffin Bay (below 300 m) (data from Kiilerich (1939) and Smith (1941)) and (c): Arctic or polar water of Baffin Bay (50–250 m) and the Baffin Current (data as for c).



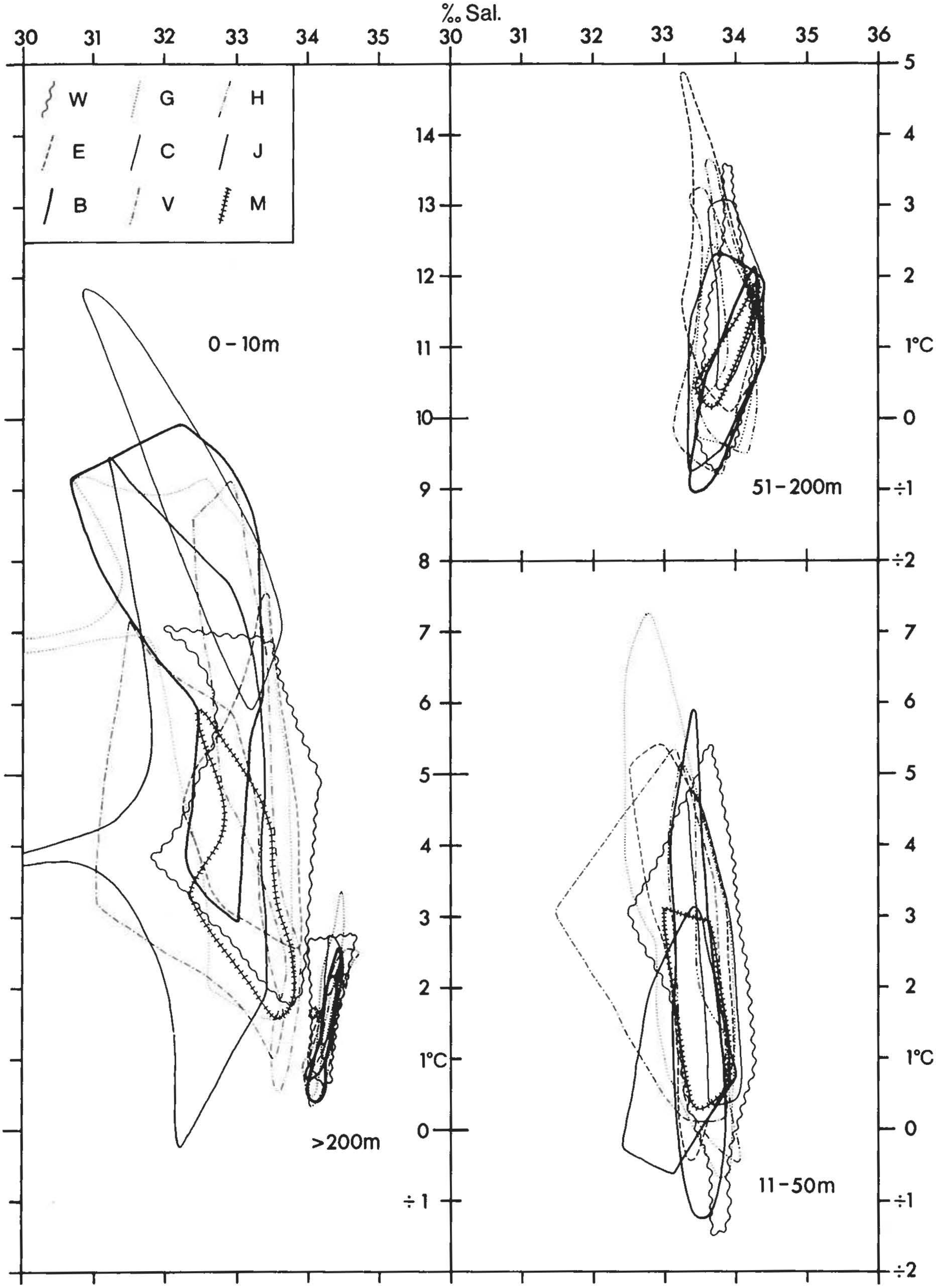


Fig. 6: TS diagrams for the period June to Sept. showing the regional variations in the 4 depth intervals used in Fig. 5. Capitals in the legend refer to the offshore areas shown in Fig. 1.

are progressively higher in areas J, E, H and C indicating that the coldest water is cooled locally (Fig. 6).

The summer TS diagrams seem to indicate that Baffin Current water (c in Fig. 5) mixes with W Greenland water entering Disko Bugt. The temperature of the 51–200 m water in the bay (3 in Fig. 5), however, rises during the summer due to an influx of W Greenland water, and as shown in Fig. 6 the cold water in area W is separated by this warmer water from the cold water in areas B, J and V. So even though Baffin Current water mixes with W Greenland water off Disko Bugt and S thereof, this warm current efficiently excludes pure Baffin Current water from the bay. Furthermore Grann (1929) found no floristic evidence of Baffin Current water reaching Disko Bugt.

As a result of the inflow of warm W Greenland water in the upper 200 m, the TS diagrams for 51–200 m (Fig. 6) clearly show highest temperatures at Egedesminde followed by areas H, W, V and C. The waters nearest to Jakobshavn Isfjord (J) and off Godhavn (G) have lower maximum temperatures at these depths due to cooling by ice bergs as well as to upwelling, whereas the TS diagram for area B resembles conditions found below 200 m elsewhere, indicating an upwelling of cold water followed by warmer and more saline water. Since the ice bergs also have a cooling effect here, the lowest temperatures are reached here followed by areas V and J.

It is in the upper 50 m that surface heating and fresh water from land, sea ice and the more than 14 km³ of ice bergs emitted each year into the bay exert their greatest influence. The highest temperatures are reached in the most stable surface layers of low salinity, and it is off Godhavn, where these layers attain their greatest magnitude, that the highest temperatures are reached at 11–50 m followed by area B, where higher salinities indicate conditions of upwelling, just as the very low temperatures measured there. The very low temperatures of area W are due to the nearness of the Baffin Current and/or a continuation of the ice berg laden current leaving Disko Bugt, being constantly cooled by the ice bergs.

The distribution of temperatures in the upper 10 m

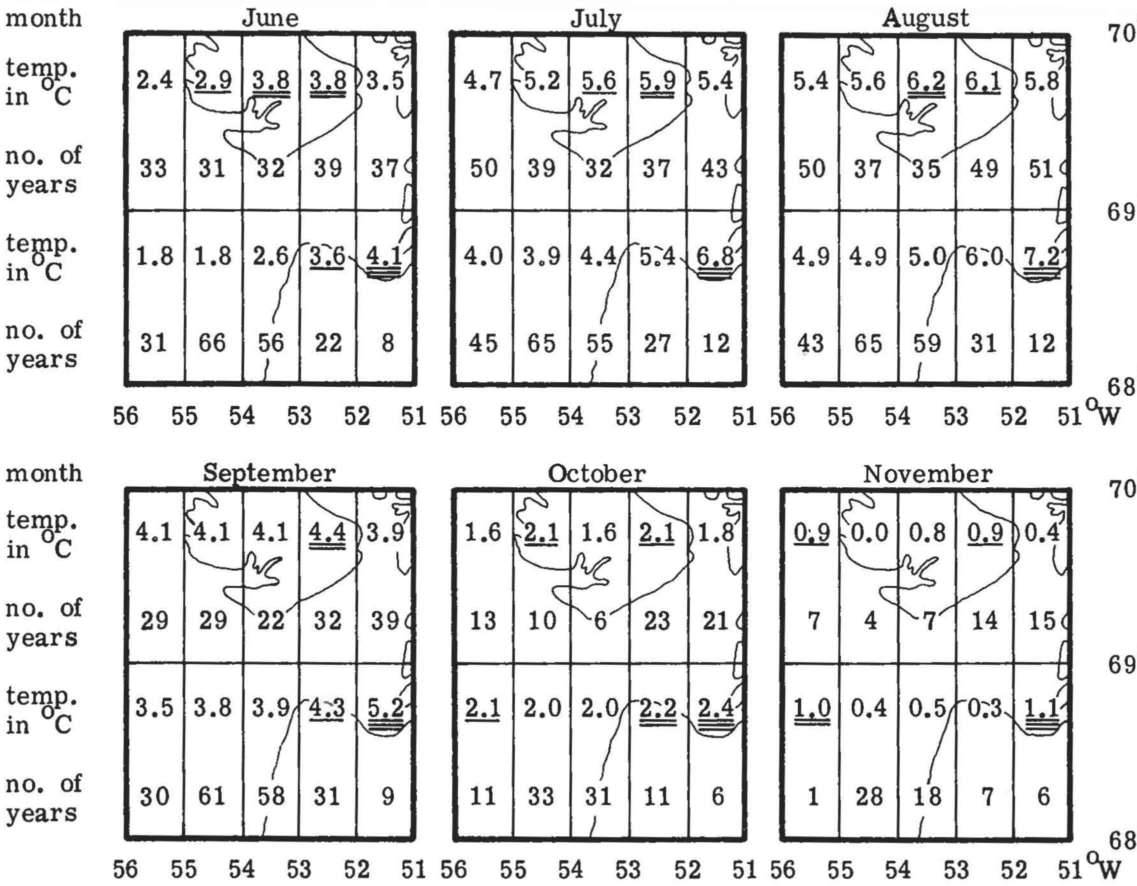


Fig. 7: Means of the monthly means of surface temperatures published in "Nautical meteorological annual" and "Monthly surface temperatures of the North Atlantic" up until 1971 are shown for each month in the open water period from June to Nov. The 1st, 2nd and 3rd warmest area(s) in each month are indicated by underlining.

(Fig. 6) quite naturally resembles that of the surface temperatures. These show (Fig. 7) that area C has the highest average surface temperatures from June to Nov., closely followed by areas B and G until about Oct., when the West Greenland Current affords relatively high temperatures to the Disko Banke area W off the bay. In the upper 10 m maximum temperatures are highest in area C due to a combination of high temperature inflow and local heating of diluted surface water. Gradually cooler are areas B, J, G and H. The lowest temperatures are reached in the very variable surface layers of area J followed by areas H, V and G. The stable surface waters in area C are least cooled followed by surface waters in area B which are stabilized in a shallower surface layer, and by the well mixed water off Egedesminde.

The annual cycle in temperature, salinity, currents and water masses

Offshore areas

In Figs 8–11 all known temperature and salinity series are compiled month by month as described in Table 1 for each of the offshore areas shown in Fig. 1. Salinity values are amply demonstrated, whereas the temperature profiles often are more irregular than can be shown in a composite figure. Therefore some critical temperature data are summarized in Table 2.

The dynamic treatment of the hydrographical observation material of the "Godthåb" and "Marion" expeditions 1928 (Kiilerich 1939, Smith et al. 1937) comprise, with all its limitations (Parr 1938), the only attempts to describe quantitatively the currents entering

Table 1: In Figs 8–11 and 22–24 composite profiles summarize all data on temperature and salinity from each of the areas (offshore, fjords and harbours) shown in Fig. 1. For each month numbered from 1 to 12 the data are shown either as single series – when only 1 or 2 series exist from the area and month in question – or by hatched or open (only Godhavn harbour) areas bound by curves representing the highest and lowest values found at each depth. The lettering used in Fig. 1 is retained in the profiles and the corresponding list of data below. t and s stand for temperature and salinity respectively. Area W is in July and Aug. divided into 4 sectors as shown in Fig. 1 (Fig. 8). The voluminous data from area G and from Disko Fjord has made it necessary to split it up into 2–3 profiles (Figs 9 & 23) with the July data represented twice. A Sept. series from Mellemfjord (R) is indiscernible from the Kangikerdlak data from this month in Fig. 23.

area	month	J	F	M	A	M	J	J	A	S	O	N	D
	nos in Fig.	1	2	3	4	5	6	7	8	9	10	11	12
W_t	no. of series						3	29	14	9	1		
	monthly dates						15+28	12–31	1–30	9–27	21		
W_s	no. of series						3	23	10		1		
	monthly dates						15+28	12–31	1–30		21		
$W1_t$	no. of series							8	8				
	monthly dates							12–31	1–26				
$W1_s$	no. of series							8	4				
	monthly dates							12–31	1–13				
$W2_{ts}$	no. of series							5	2				
	monthly dates							22–28	30				
$W3_t$	no. of series							4	1				
	monthly dates							19–29	30				
$W3_s$	no. of series							3	1				
	monthly dates							19–27	30				
$W4_t$	no. of series							12	3				
	monthly dates							13–31	13–26				
$W4_s$	no. of series							7	3				
	monthly dates							13–31	8–26				
G_t	no. of series	1	1	1	1	7	8	24	16	11	7	2	2
	monthly dates	10	6	20	15	7–31	6–29	1–29	7–31	3–24	4–31	1+5	5+18
G_s	no. of series	1	1	1	1	5	7	12	9	8	6	2	2
	monthly dates	10	6	20	15	14–29	6–29	2–29	7–31	3–20	4–18	1+5	5+18
H_t	no. of series						3	9	6	2	5		
	monthly dates						5–29	2–24	7–20	6+9	14+15		
H_s	no. of series						3	4	6	1	5		
	monthly dates						5–29	6–11	7–31	9	14+15		
E_t	no. of series						1	5	6	3	2		
	monthly dates						22	2–30	8–20	6–11	15		
E_s	no. of series						1	4	4	2	2		
	monthly dates						22	6–30	7–20	9+11	15		

area	months nos in Figs	J 1	F 2	M 3	A 4	M 5	J 6	J 7	A 8	S 9	O 10	N 11	D 12
C_t	no. of series						1	20	9	6	5		
	monthly dates						28	1–30	1–30	5–22	16–25		
C_s	no. of series							5	2		1		
	monthly dates							9–29	11–30		16		
J_t	no. of series						3	19	7	5	3	2	
	monthly dates						16–30	15–31	4–23	10–21	16–21	3+10	
J_s	no. of series						1	7	2		1	2	
	monthly dates						25	15–31	8+13		16	3+10	
B_t	no. of series							18	10	2	6		
	monthly dates							5–29	1–30	6+14	17–24		
B_s	no. of series							12	5		5		
	monthly dates							2–29	8–15		14–24		
V_t	no. of series						1	28	6	11	1		
	monthly dates						30	9–31	10–19	6–17	17		
V_s	no. of series						1	26	6	9	1		
	monthly dates						30	11–31	11–27	6–17	17		
M_t	no. of series							6	4	2			
	monthly dates							12–16	2–26	13+19			
M_s	no. of series							6	4				
	monthly dates							7–15	10–26				
T_{ts}	no. of series				1	2							
	monthly dates				24	8+9							
A_{ts}	no. of series							1	8				
	monthly dates							27	3–22				
F_{ts}	no. of series											2	
	monthly dates											6+8	
K_{ts}	no. of series	1	1	2	1		3	6	16	2	3	1	1
	monthly dates	23	12	11+25	17		9–28	6–27	9–29	12+23	2–23	11	28
Q_{ts}	no. of series			1				1	1 (in K)	1	1		
	monthly dates			16				9	10	20	10		
N_{ts}	no. of series					1			1 (in K)				
	monthly dates					26			10				
I_{ts}	no. of series							1					
	monthly dates							8					
O_{ts}	no. of series								2 (in K)	4	1	1	
	monthly dates								1+10	18+26	10	26	
R_t	no. of series									3 (in K_t)			
	monthly dates									6–15			
g_{ts}	no. of series				1	3	3	3	3	4			
	monthly dates				5	11–31	12–27	14–19	6–26	1–28			
e_{ts}	no. of series								1	1			
	monthly dates								6	12			
j_{ts}	no. of series									1			
	monthly dates									16			

and leaving Disko Bugt at different times of the year. Kiilerich showed that of the weak current flowing N past Disko Bugt in the upper 200 m in July only a minor part entered the bay through the S half of the entrance, while the major flow of water between Godhavn and Egedesminde was out of the bay, the greatest velocities occurring off Godhavn. Smith et al. showed that of the mass of water constituting the West Greenland Current passing Egedesminde in Aug., about $^1/_3$ entered the bay, while $^2/_3$ of the remainder along with water from Baffin Bay entered into a counterclockwise eddy found in the deep basin which extends SW from the entrance to Disko Bugt; the rest flowed across the mouth of Disko Bugt joining the bay discharge there and continued N into Baffin Bay. At this time of the year the flow of water into Disko Bugt was found to be equal to the amount leaving the bay through the N part of the entrance. Finally Kiilerich found a strong current flowing

Table 2: A summary of temperature characteristica as indicated at the top of the table

	dates		total			surface temperatures						sub-surface minimum temperatures									sub-surface		
						total		minimum		maximum		upper			principal			lower			upper		
areas	months	days	no. of series	depth in m	temperature in °C	no.	temperature in °C	no.	temperature in °C	no.	temperature in °C	no.	depth in m	temperature in °C	no.	depth in m	temperature in °C	no.	depth in m	temperature in °C	no.	depth in m	temperature in °C
W1	6	15 28	3	65 375	÷0.1 3.9	3	1.9 3.9	0		3	1.9 3.9	0			2	24 75	÷0.1 0.7	1	150	0.7	0		
W1	7	12 31	10	90 245	÷0.1 7.0	9	2.7 7.0	0		8	2.7 7.0	0			3	75 150	÷0.1 1.0	0			0		
W2	7	20 28	7	170 295	÷0.3 5.7	6	3.1 5.7	0		5	3.1 5.7	0			6	75 188	÷0.3 1.6	0			0		
W3	7	19 29	5	245 510	÷1.7 5.6	5	3.1 5.6	0		4	3.1 5.6	1	20	3.3	4	50 188	÷1.7 1.8	0			1	30	3.4
W4	7	13 31	13	70 240	÷1.6 7.9	12	3.1 7.9	3	3.8 4.2	9	3.1 7.9	0			9	50 140	÷1.6 0.8	0			3	5 10	4.2 4.7
W1	8	1 14	7	30 150	÷0.5 7.5	7	3.4 7.5	2	5.3 5.5	5	3.4 7.5	0			3	40 80	÷0.7 ÷0.2	0			2	10 20	5.4 5.7
W2	8	30	2	175 490	0.3 6.0	2	5.0 6.0	0		2	5.0 6.0	0			2	75 200	0.3 2.5	0			1	10	5.8
W3	8	30	1	250	1.3 5.0	1	5.0	0		1	5.0	1	10	4.8	1	200	1.3	0			1	25	4.9
W4	8	13 26	3	125 180	÷0.5 6.6	3	5.2 6.6	1	5.2	2	5.8 6.6	0			3	30 100	÷0.5 0.4	0			1	20	5.6
W1	9	9 27	9	24 125	÷0.4 5.3	9	3.9 5.3	4	3.9 4.3	5	3.9 5.3												
W4	9	25	1	137	0.7 5.9	1	5.9	0		1	5.9												
W1	10	21	1	220	0.5 2.3	1	1.8	0		1	1.8	1	20 25	1.8	0			0			1	50 90	2.3
G	1	8	1	90	÷1.7 ÷0.9	1	÷1.7	1	÷1.7	0		0			0			0			0		
G	2	6 28	2	50 90	÷1.7 ÷0.8	2	÷1.7	2	÷1.7	0		0			0			0			0		
G	3	20	1	90	÷1.7 ÷0.3	1	÷1.7	1	÷1.7	0		0			0			0			0		
G	4	15	1	90	÷1.6 ÷0.1	1	÷1.6	1	÷1.6	0		0			0			0			0		
G	5	7 31	7	90 350	÷1.4 3.3	7	÷1.4 3.3	3	÷1.4 2.0	4	0.4 3.3	0			6	20 60	÷1.2 0.1	1	200	0.4	2	2 4	2.0 2.4
G	6	6 29	8	50 250	÷0.7 5.7	8	2.0 5.7	3	2.0 4.0	5	3.6 5.7	2	1 7.5	2.4 5.0	6	30 80	÷0.7 0.9	0			5	4 10	2.4 5.3
G	7	1 29	27	50 450	÷1.2 9.8	27	3.8 9.8	2	6.0 6.4	25	÷1.2 9.8	5	10 75	÷0.2 2.0	17	50 150	÷1.2 1.0	5	200 350	0.8 3.3	4	3 20	2.1 8.8
G	8	7 30	16	50 400	0.0 9.1	16	3.7 8.8	7	6.2 8.8	9	3.7 8.2	2	5 30	1.8 4.6	8	75 180	0.0 0.9	0			9	3 50	2.0 9.1
G	9	3 24	12	50 400	1.0 7.0	11	3.7 6.8	5	3.9 6.5	6	3.7 6.8	2	10 20	3.7 4.3	4	73 200	1.0 1.9	1	200	1.2	6	5 30	3.4 7.0
G	10	4 31	8	50 400	1.0 3.4	8	1.2 2.9	7	1.2 2.9	1	2.6	5	10 60	1.8 2.8	3	150 200	1.0 1.3	0			7	10 80	1.8 3.4

are listed month by month for each of the offshore areas shown on the map Fig. 1.

maximum temperatures						thermoclines								isothermal layers <1°/100 m						below principal minimum		
						negative				positive												
intermediate			lower			upper		lower		upper		lower		surface			sub-surface					
no.	depth in m	temperature in °C	no.	depth in m	temperature in °C	no. >1°/25 m	depth range in m	no. >1°/25 m	depth range in m	no. >1°/25 m	depth range in m	no. >1°/50 m	depth range in m	no.	depth in m	temperature in °C	no.	depth in m	temperature in °C	no.	depth range in m	temperature in °C
1	50	0.9	1	200	0.8	3	0–8 10–50	0		0		0		1	8	2.6	0			2	24 375	÷0.1 0.9
0			0			8	0–20 20–75	0		0		1	100 120	2	20	3.2 4.3	0			2	75 245	1.0 1.3
0			0			6	0–10 20–50	0		0		1	100 150	0			0			6	150 340	0.5 2.6
0			0			3	0 18–50	0		0		0		0			0			5	50 510	÷1.7 3.0
0			0			10	0–10 20–75	0		1	0 10	3	75 100–150	1	3	3.6	2	10 20	3.3 4.1	10	50 240	÷1.4 2.6
0			0			7	0–25 20–60	0		0		1	80 100	3	10–25	3.3 5.6	0			4	30 150	÷0.5 1.1
0			1	300	2.7	2	10–25 25–75	0		1	0 10	1	75 100	1	10	6.0				2	75 490	0.3 2.6
0			0			1	25 50	0		0		0		1	25	4.9	0			1	200 250	1.3 1.5
1	75	1.1	0			2	0–20 50–60	0		0		0		0			0			2	75 180	÷0.5 1.1
0			0			0		0		0		0		1	15	1.8	0			0		
0			0			0		0		1	80 90	0		1	80	÷1.5	0			0		
0			0			0		0		1	80 90	0		1	70	÷1.7	0			0		
0			0			0		0		1	70 80	0		1	40	÷1.6	0			0		
0			0			0		0		0		0		0			0			0		
1	150	0.5	1	300	1.9	6	0–30 10–50	0		2	0 2–4	0		1	15	÷0.4	0			1	200 350	0.4 1.9
0			0			8	0–15 25–60	0		4	0–2 4–5	0		0			0			6	30 250	÷0.7 1.9
5	150 250	0.9 2.6	1	300	3.4	24	0–15 15–50	0		3	0–2 3–5	5	55–75 100	2	10	5.3 7.9	0			19	50 450	÷1.2 3.5
0			0			16	0–20 15–75	0		5	0–15 1–20	1	75 100	1	10	3.7	3	10–40 20–50	1.7 4.1	8	75 400	0.0 2.3
2	86 150	1.9 2.0	1	300	1.8	11	5–40 10–100	0		0		0		5	5–15	3.7 6.8	4	10–15 20–40	3.5 4.8	3	150 400	1.0 2.0
0			0			1	75 100	0		0		0		2	1–15	2.0	0			3	150 400	1.0 2.4

Table 2:

	dates		total			surface temperatures						sub-surface minimum temperatures									sub-surface		
						total		minimum		maximum		upper			principal			lower			upper		
areas	months	days	no. of series	depth in m	temperature in °C	no.	temperature in °C	no.	temperature in °C	no.	temperature in °C	no.	depth in m	temperature in °C	no.	depth in m	temperature in °C	no.	depth in m	temperature in °C	no.	depth in m	temperature in °C
G	11	1 5	2	50	1.1 1.9	2	1.1 1.6	2	1.1 1.6	0		2	4 40	1.5 1.7	0			0			2	2 15	1.6 1.8
G	12	5 18	2	90	÷1.1 1.2	2	÷1.1 0.0	0		2	÷1.1 0.1	3	20 70	÷1.1 ÷0.1	0			0			1	50	÷0.9
H	6	5 29	3	100 380	÷0.5 5.7	3	1.3 5.7	0		3	1.3 5.7	0			3	50 75	÷0.5 0.6	0			0		
H	7	2 24	9	150 500	÷0.3 9.0	9	4.3 9.0	0		9	4.3 9.0	0			9	50 100	÷0.3 1.5	0			0		
H	8	7 31	7	30 500	6.5 8.2	7	5.0 7.9	2	5.0 7.9	5	5.9 7.4	1	5	5.8	3	80 200	0.7 0.8	1	300	1.2	3	1 7.5	5.6 8.2
H	9	9	1	165	5.4	1	5.4	0		1	5.4	0			0			0			0		
H	10	14 15	5	90 400	1.0 2.4	5	2.0 2.1	5	2.0 2.1	0		0			1	200	1.0	0			5	50 80	2.2 2.4
E	6	22	1	500	0.8 2.7	1	2.7	0		1	2.7	0			1	100	0.8	0			0		
E	7	2 30	5	50 500	÷0.4 7.7	5	3.5 7.5	1	7.5	4	3.5 4.5	0			4	75 100	÷0.4 0.6	0			1	10	7.7
E	8	8 20	5	90 500	0.5 7.1	5	3.5 6.7	2	4.6 6.7	4	3.5 5.9	0			3	200 250	0.5 1.5	0			2	3 15	4.8 7.1
E	9	6 11	3	500 575	0.6 5.4	3	3.4 5.0	2	3.4 4.5	1	5.0	0			3	200 350	0.6 1.3	0			2	30 50	4.2 5.4
E	10	15	2	90 400	1.3 2.5	2	2.2 2.3	2	2.2 2.3	0		0			1	200	1.3	0			1	50 90	2.5
C	6	28	1	300	1.0 8.4	1	8.4	0		1	8.4	1	25	1.2	1	100	1.0	0			1	50	1.4
C	7	1 30	20	140 375	÷0.5 11.8	20	3.8 11.8	2	3.8 6.2	18	5.1 11.8	3	30 50	0.1 3.1	20	50 200	÷0.5 2.1	0			5	10 75	0.9 6.2
C	8	1 30	9	90 375	0.2 11.2	9	6.6 11.2	2	6.6 8.1	7	6.8 11.2	2	10 50	1.2 2.5	8	100 200	0.2 1.7	0			3	4 20	2.7 8.5
C	9	5 22	6	300 375	0.5 4.9	5	3.8 4.9	0		5	3.8 4.9	0			4	200 275	0.5 1.1	0			0		
C	10	16 25	5	225 360	0.7 3.4	5	0.7 2.8	4	0.7 2.4	1	2.8	1	50	2.7	5	150 200	0.8 1.4	0			5	50 100	2.6 3.4
J	6	25 30	2	300 400	0.0 6.7	2	5.8 6.7	0		2	5.8 6.7	0			2	50	0.0 0.8	0			0		
J	7	15 31	20	200 400	÷0.8 9.5	18	0.6 9.5	1	0.6	17	÷0.1 9.5	9	10 100	÷0.5 1.1	20	20 200	÷0.8 1.6	1	300	1.4	6	13 75	÷0.3 3.8
J	8	4 23	7	90 375	÷0.4 6.6	6	÷0.2 6.6	0		6	÷0.2 6.6	7	20 40	÷0.4 1.7	4	150 300	0.1 1.4	0			5	50 100	1.1 2.8
J	9	10 21	5	300 375	0.5 4.2	3	1.2 1.5	2	1.2 1.5	1	1.5	3	10 100	0.8 3.5	3	200 275	0.5 1.6	0			2	40 50	3.7 4.2
J	10	16 21	3	290 400	0.7 3.2	3	0.7 1.4	3	0.7 1.4	0		0			3	250	1.0 1.4	0			3	90 100	3.0 3.2
J	11	3 10	2	308 460	÷2.4 2.0	2	÷2.4 0.0	2	÷2.4 0.0	0		0			2	130 140	0.4 0.7	1	365	0.7	2	75	1.1 2.0

continued

maximum temperatures						thermoclines								isothermal layers < 1°/100 m						below principal minimum		
						negative				positive												
intermediate			lower			upper		lower		upper		lower		surface			sub-surface					
no.	depth in m	temperature in °C	no.	depth in m	temperature in °C	no. > 1°/25 m	depth range in m	no. > 1°/25 m	depth range in m	no. > 1°/25 m	depth range in m	no. > 1°/50 m	depth range in m	no.	depth in m	temperature in °C	no.	depth in m	temperature in °C	no.	depth range in m	temperature in °C
0			0			0		0		2	0 2	0		0			2	2 50	1.5 1.7	0		
0			0			0		0		2	70 80–90	0		2	60–70	÷1.1 0.0	0			0		
0			0			6	0–10 25	0		0		1	150 200	1	10	2.5	0			3	50 380	÷0.5 2.4
0			0			9	0–10 10–50	0		0		0		0			0			9	50 500	÷0.3 3.4
0			0			6	1–10 30–60	1	30 50	2	0–1 1–2	0		3	1–3	5.9 7.9	3	2–25 4–30	3.5 8.1	3	80 500	0.7 2.5
0			0			1	50 70	0		0		0		1	10	5.4	0			0		
0			0			0		0		0		0		5	5–30	2.0 2.1	0			1	200 400	1.0 1.8
0			0			1	0 25	0		0		0		0			0			1	100 500	0.8 2.5
0			0			4	0–10 25–50	0		0		0		0			0			4	50 500	÷0.4 2.4
0			0			4	0–10 15–75	1	30 50	1	0 3	0		1	2	4.6	2	3–15 4–20	3.5 4.5	3	200 500	0.5 2.2
0			0			1	30 40	0		2	0 10–30	0		1	75	5.0	0			3	200 500	0.6 2.1
			1	250	1.8	0		0		0		0		2	20–30	2.2 2.3	3	25–50 50–90	2.4 2.5	1	200 400	1.3 2.2
0			0			1	0 25	0		0		0		0			0			1	100 300	1.0 1.7
1	200	1.9	3	300	2.0 2.7	20	0–10 10–50	1	50 75	2	0–30 10–40	1	150 200	1	10	6.2	0			20	50 375	÷0.5 3.4
1	100	1.2	0			9	0–20 10–50	0		2	0–10 4–20	0		0			0			8	100 375	0.2 2.3
0			1	350	3.0	0		0		0		1	275 300	2	50	3.8 3.9	2	10–40 50	4.0	4	200 375	0.8 2.0
0			0			0		1	100 150	1	0 50	0		4	0 50–100	2.5	0			5	150 360	0.8 1.9
0			1	300	2.1	2	0 25	0		0		0		0			0			2	50 400	0.0 2.1
3	100 150	0.8 1.7	3	250 350	0.9 1.9	17	0 10–56	1	25 50	3	10–50 25–75	0		1	10	0.9	0			19	20 400	÷0.2 2.3
0			0			6	0–2 4–10	0		3	20–30 50–60	0		0			0			5	150 375	0.1 2.3
3	50 150	1.7 3.9	0			2	0–50 10–100	1	125 150	3	0–25 20–50	1	275 300	0			0			5	200 375	0.5 2.6
			1	350	1.3	1	90 150	0		3	0–5 20–50	0		1	5	0.7	0			3	250 400	1.0 1.9
1	190	1.1	0			0		0		2	0–40 20–60	0		0			0			2	130 460	0.4 2.0

Table 2:

	dates		total			surface temperatures						sub-surface minimum temperatures									sub-surface		
						total		minimum		maximum		upper			principal			lower			upper		
areas	months	days	no. of series	depth in m	temperature in °C	no.	temperature in °C	no.	temperature in °C	no.	temperature in °C	no.	depth in m	temperature in °C	no.	depth in m	temperature in °C	no.	depth in m	temperature in °C	no.	depth in m	temperature in °C
B	7	5 29	18	300 500	÷1.1 11.1	18	3.9 11.1	2	7.0 7.1	14	5.0 11.1	1	75	0.0	18	50 100	÷1.1 0.7	0			2	10	7.1
B	8	1 3	9	280 525	÷0.6 9.6	9	6.4 9.6	0		9	3.7 9.6	0			9	50 100	÷0.1 0.8	4	240 300	1.0 1.6	0		
B	9	6 14	2	390 750	0.5 4.7	2	4.0 4.7	1	4.0	1	4.7	0			2	100 150	0.5 1.0	0			1	30	4.4
B	10	17 24	6	240 430	0.4 3.1	6	0.7 2.0	5	0.7 1.6	1	2.0	0			6	200 250	0.4 1.0	0			0		
V	7	9 31	32	115 640	÷0.9 7.1	32	2.8 7.1	2	3.8 5.3	30	2.8 7.1	8	10 100	0.2 2.5	30	50 164	÷0.9 0.8	3	250 300	1.1 1.6	7	10 75	0.7 5.4
V	8	10 27	10	125 475	÷0.1 4.8	10	2.4 4.8	4	2.5 3.1	6	2.4 4.8	0			10	75 200	÷0.1 2.7	0			4	10 40	2.6 4.4
V	9	6 17	11	25 515	0.3 6.1	11	1.7 6.1	8	1.7 5.2	3	3.4 6.1	6	20 50	1.9 2.9	8	200 350	0.3 0.7	0			13	10 75	2.0 5.7
V	10	17	1	400	0.8 2.8	1	2.2	0		1	2.2	1	25	2.1	1	250	0.8	0			1	70	2.8
M	7	12 15	6	100 250	0.4 5.9	6	2.2 5.9	0		6	2.2 5.9	2	50 75	0.6 1.1	3	50 100	0.4 0.8	2	150	0.8 1.2	0		
M	8	2 26	4	90 265	0.2 4.4	4	1.4 4.4	0		3	1.4 3.3	1	75	0.5	2	100 140	0.4 0.6	0			0		
M	9	13 19	2	240 250	0.2 3.9	1	3.9	0		1	3.9	0			1	150	3.9	0			0		

into the bay in Sept. through the entire entrance but virtually no water flowing out past Godhavn. At the same time a swift current flowed W through the Vaigat. This increase in the amount of water entering the bay from June to Sept. seems to be in accordance with the mass of observations on temperature and salinity from the bay. The inflow of W Greenland water is, however, by no means confined to late summer and fall, but occurs all year round and can clearly be seen to affect ice conditions during the winter, especially in the E part of the bay from Egedesminde to Jakobshavn. The outflow past Godhavn also occurs throughout the year and does not seem to lessen till late in the fall, judging from the passage of ice bergs.

There are, however, great fluctuations caused by wind and tides. Off Godhavn, where the mean tidal amplitude is 1.4 m (0.3 m–2.8 m), the rising tides regularly halt out-going currents which are forced back into the bay or towards Kronprinsen Ejland. The huge ice bergs drifting out past Godhavn are also slowed down and are often turned back into the bay or they are forced into the bays and inlets along the S coast of Disko, where they are often grounded. These ice bergs are emitted from Jakobshavn Isfjord in greatest numbers during the spring tides and the pattern of springs and neaps regulate the dislodging and grounding of ice bergs on their way past Godhavn. The bimonthly variations in the swift tidal currents occurring off Godhavn probably contribute as a major factor to the very variable hydrography of this comparatively shallow area, where the West Greenland Current meets with the less saline surface current leaving the bay between Godhavn and Kronprinsen Ejland. Although hydrographic measurements do not reveal any clear relationship between spring and neap tides and hydrographic variations at Godhavn, there does seem to be a connection between the monthly highest spring tides and the intrusion of W Greenland water and the upwelling of this off Godhavn.

Inside Disko Bugt decreasing insolation and air temperature in Sept. initiate cooling of the upper layers; during the following c. 4 months further cooling and mixing lowers the temperature until an ice cover is formed. At Godhavn, where the only winter measurements have been made (Fig. 9), isothermal conditions continued

maximum temperatures						thermoclines								isothermal layers < 1°/100 m						below principal minimum		
						negative				positive												
intermediate			lower			upper		lower		upper		lower		surface			sub-surface					
no.	depth in m	temperature in °C	no.	depth in m	temperature in °C	no. >1°/25 m	depth range in m	no. >1°/25 m	depth range in m	no. >1°/25 m	depth range in m	no. >1°/50 m	depth range in m	no.	depth in m	temperature in °C	no.	depth in m	temperature in °C	no.	depth range in m	temperature in °C
1	70	1.1	1	300	1.8	17	0–10 25–56	0		0		0		1	10	7.1	0			17	50 500	÷1.1 3.1
4	200	1.1 1.7	0			9	0–10 25–50	0		0		0		1	10	6.6	0			9	50 525	÷0.6 2.4
0			0			2	20–30 50	0		0		0		2	10–20	4.0 4.6	0			2	100 500	0.5 2.2
0			0			1	120 150	0		3	10–40 20–50	0		5	2–20	0.7 1.7	0			6	100 430	0.8 2.0
3	200 250	1.3 1.8	0			33	0–10 10–50	0		1	30 40	0		1	10	5.3	1	10 30	1.7	33	50 640	÷0.9 2.4
0			0			10	0–20 25–40	0		1	0 20	1	150 200	3	10–20	2.3 3.2	0			10	75 475	÷0.1 2.2
0			0			7	10–25 25–75	0		4	0–20 10–30	0		6	10	1.7 6.1	0			8	200 515	0.3 1.3
0			0			1	50 60	0		0		0		1	20	2.2	0			1	250 400	0.8 0.9
2	100	1.0 1.2	0			6	0–30 10–50	0		0		0		0			1	10 30	1.4	5	50 250	0.4 2.2
1	100	0.7	0			2	10–25 25–50	0		0		0		2	25–30	1.2 3.2	0			1	140 265	0.6 1.7
0			0			0		0		0		0		0			0			1	150 250	0.2 1.4

are ultimately reached in the upper 80–90 m. Meanwhile a reduction in run-off from land, in effluents from the glacier fjords, and in melting of ice bergs reduce the outflow of water past Godhavn, where surface salinities rise and isohaline conditions are established also in the upper 80–90 m. Soon after the formation of ice in Dec.–Jan. further cooling is inhibited, whereas salinity still rises a little, probably due to the increasing influence of the relatively salt West Greenland Current. From Feb. to May the West Greenland Current and increasing solar heating cause a regular positive thermocline to gradually rise to the undersurface of the ice, while salinity remains uniform in the upper 10–20 m at Godhavn, where the only measurements from the period with ice cover have been made. In the E part of the bay, from Egedesminde to Jakobshavn, and W of Disko Bugt the West Greenland Current probably maintains somewhat higher surface temperatures, since the ice there usually is not as thick as in the W part of the bay and large stretches of open water can be found there already in Mar.

As soon as the sea ice leaves in Apr.–May surface temperatures rise quickly and continue to do so through July. Meanwhile the melting of sea ice and ice bergs, run-off from land and effluents from the glacier fjords lower surface salinities and create a stable upper layer, especially off Jakobshavn Isfjord, from where great amounts of fresh surface water are emitted and a 7 km wide glacier front produces 14 km³ of ice bergs each year. This surface water flows N into the Vaigat, primarily keeping to the northern shore on its way to Baffin Bay, and W along the S coast of Disko, where a number of streams add to the freshening of surface layers, finally to pass Godhavn on its way out of the bay.

Water from the upper c. 200 m of the West Greenland Current which has been heated and mixed over the W Greenland banks flows past Egedesminde (Figs 10 & 11) into the E part of the bay and continues N, gradually raising sub-surface temperatures there from May and well into Sept., whereas surface cooling and mixing set in already by late Aug. This late vertical mixing also contributes to rising sub-surface temperatures in some areas later to reach other areas as subsurface currents.

Thus off Christianshåb (Figs 10 & 11) the freshened

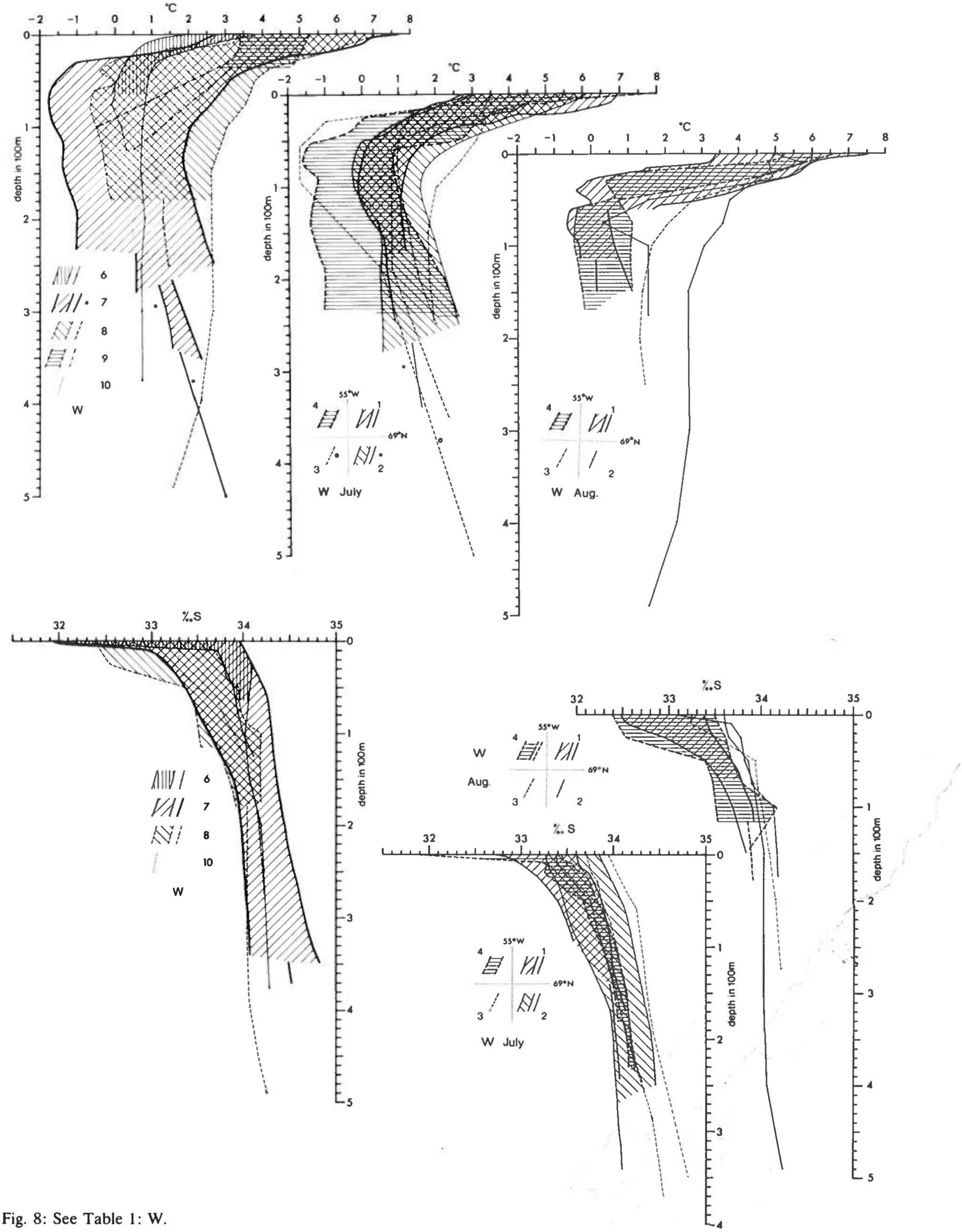


Fig. 8: See Table 1: W.

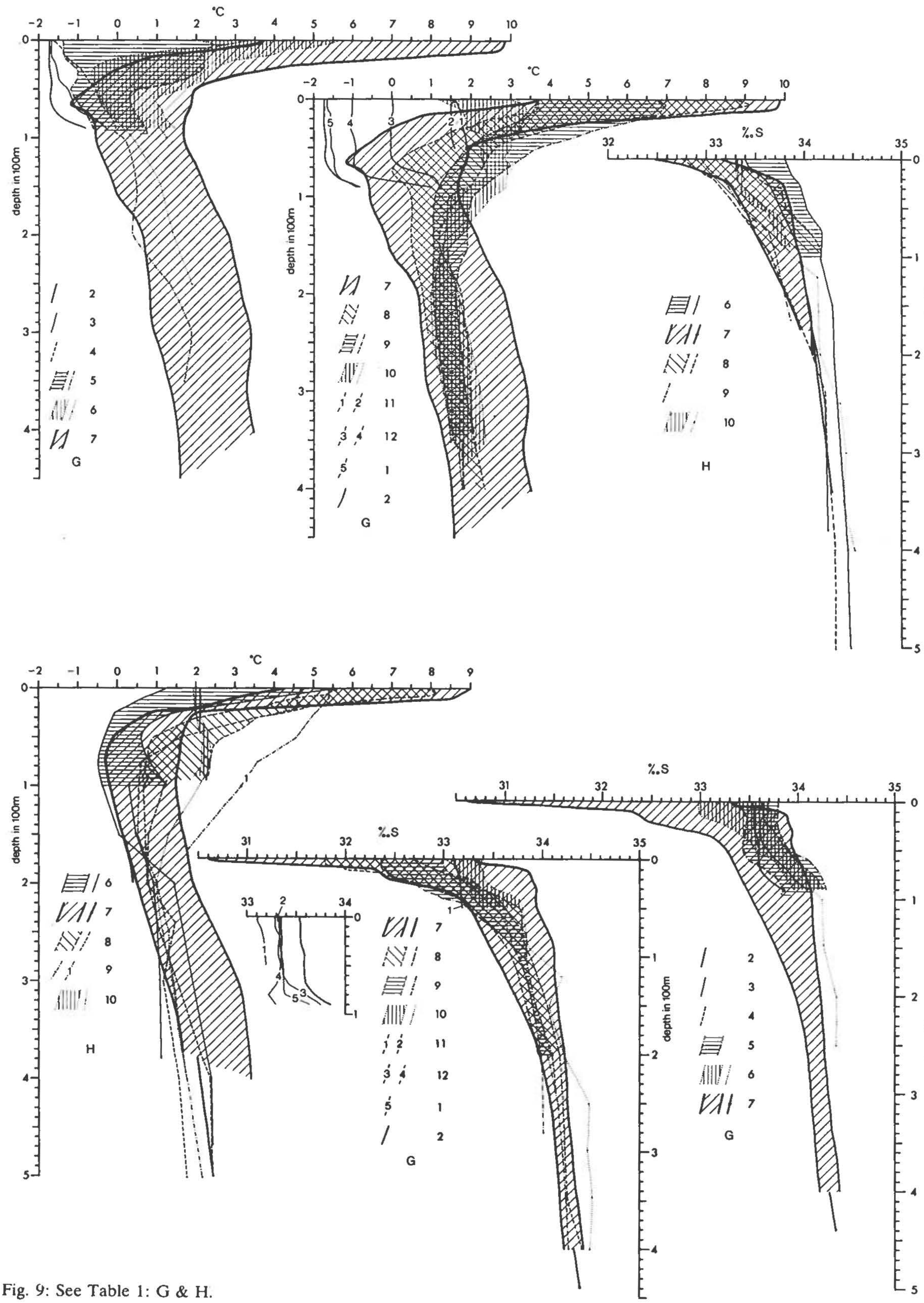


Fig. 9: See Table 1: G & H.

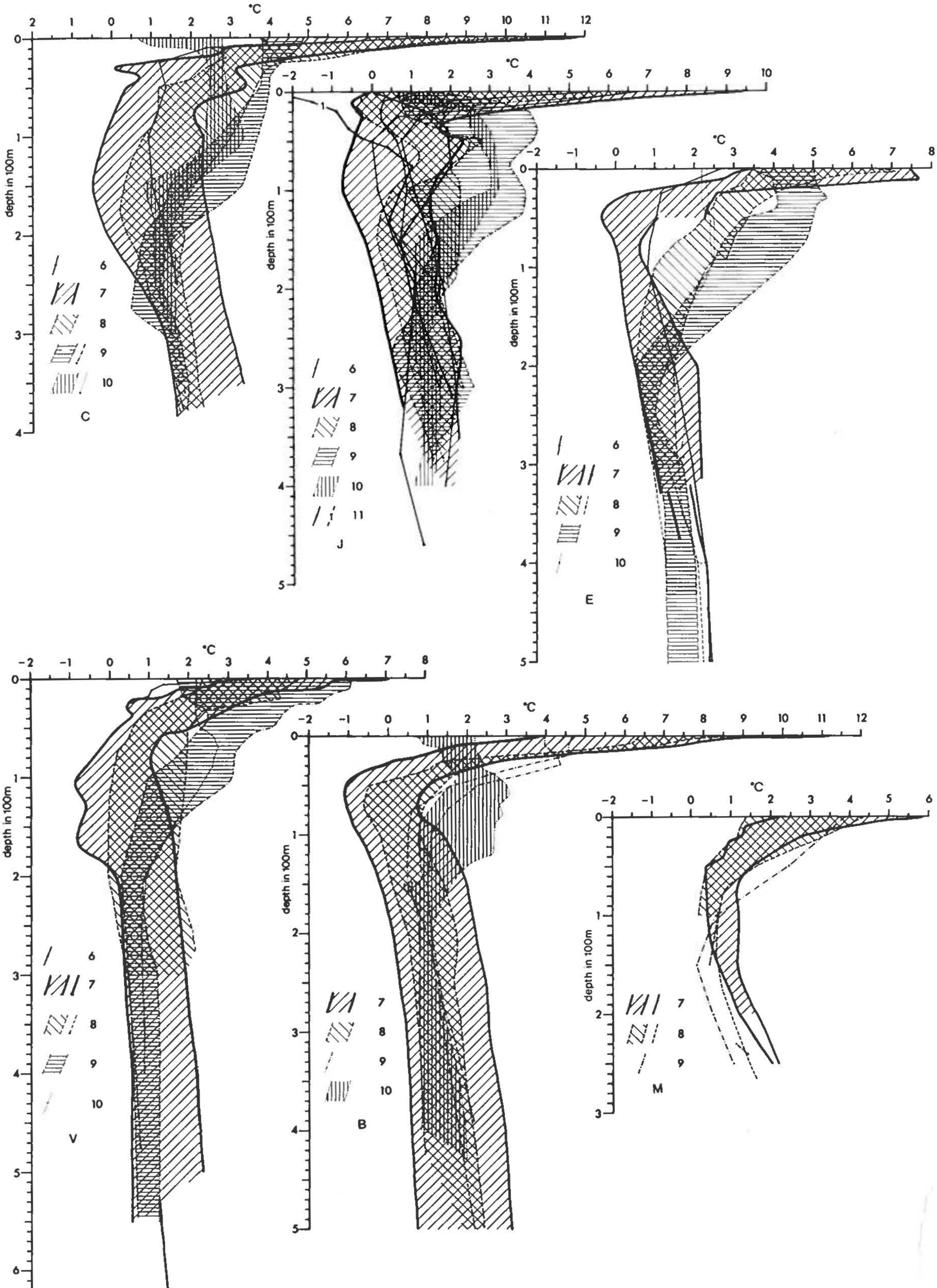


Fig. 10: See Table 1: E_t, C_t, J_t, B_t, V_t & M_t.

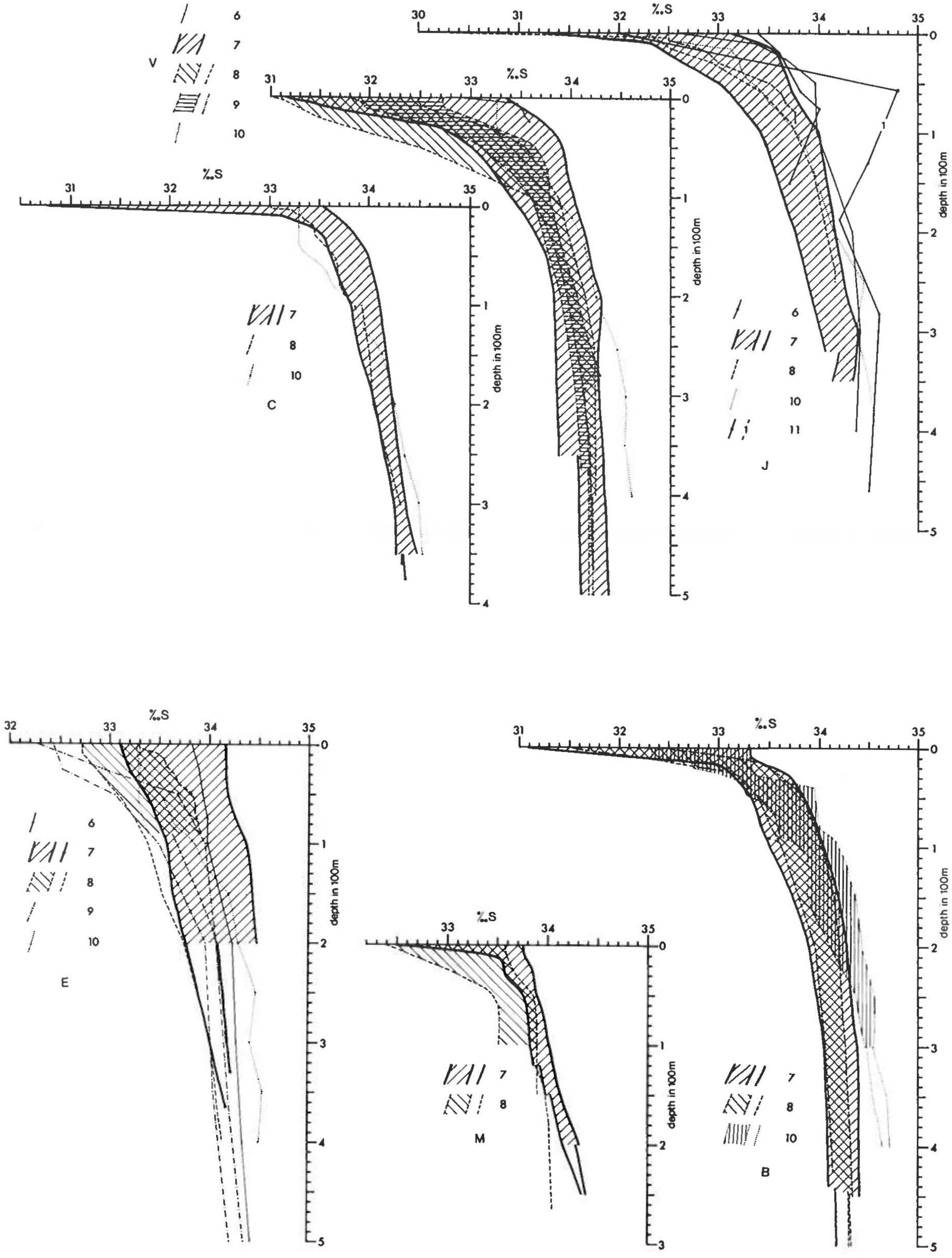


Fig. 11: See Table 1: E_s, C_s, J_s, B_s, V_s & M_s.

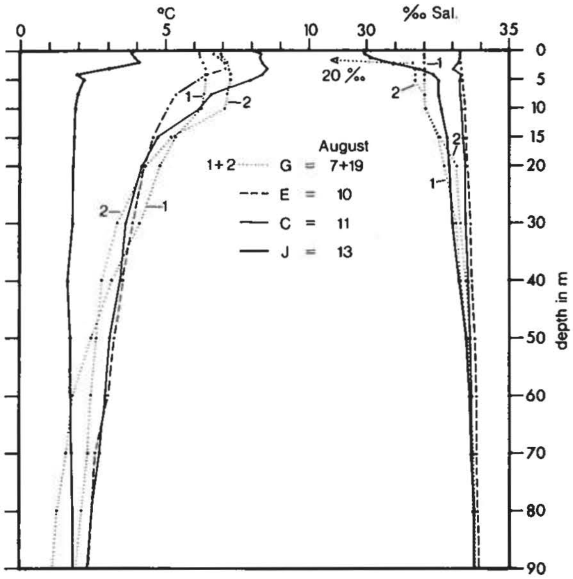


Fig. 12: Temperature and salinity profiles from the upper 90 m at Godhavn on 7 (1) and 19 (2) Aug., at Egedesminde on 10 Aug., at Christianshåb on 11 Aug. and off Atâ Sund on 13 Aug. 1974 (circles marked G, E, C and J in Fig. 17).

surface layers partially mix with the inflowing water initially creating a steep negative thermocline which tapers off towards 100–200 m, while to the N, off Jakobshavn, the warm water flows beneath an extensive fresh and cold surface layer cooled by ice bergs from the ice fjord and heated atmospherically in a thin surface layer only. Here the influx of warm water and the presence of ice bergs create very irregular temperature profiles (Fig. 10), but a deeper, winter cooled layer found in the upper 200 m is eventually obliterated, and the warm water penetrates the glacier fjords beneath their cold, fresh surface layers (Hammer 1883), even reaching into Atâ Sund (Dunbar 1951, Petersen 1964). Only the upper c. 100 m of this warm mass of water can, however, be traced as a distinct layer moving N into the Vaigat, also keeping to the E and N shore below the fresher surface layer. Here it gradually mixes with the cold layers creating a steep negative upper thermocline. At the entrance to the Vaigat a minor part of this warm subsurface current turns W along Disko.

To the NE, off Atâ Sund (J in Figs 12 & 17), the hydrography of the upper 90 m is characteristic of waters carrying newly emitted ice bergs. Cold, though not subzero, fresh meltwater from these rises towards the surface, as described by Petersen (1964), until a state of equilibrium is reached through mixing with the surrounding salt water. This creates roughly isothermal conditions (1.7–2.16°C at 5–90 m) along a sloping halocline. The temperature is surprisingly high in spite of the cooling effect of the ice bergs; this must be due to deep warm water (rich in nutrients) being drawn toward the surface with the rising water and air bubbles from the melting ice bergs.

The situation at Godhavn seems to constitute a continuation of this melting process, at least in part (Fig. 12). The water below 75–90 m has remained at a low temperature or has even cooled, while temperatures nearer the surface have risen considerably, and a marked thermocline has evolved along with a further development of the halocline, through surface heating and mixing and further melting of ice bergs, additions of fresh water from land and from precipitation. This creates highly stable conditions in the upper c. 100 m. Figs 13 & 14 illustrate the marked difference in the stratification of the upper layers found in Aug. between

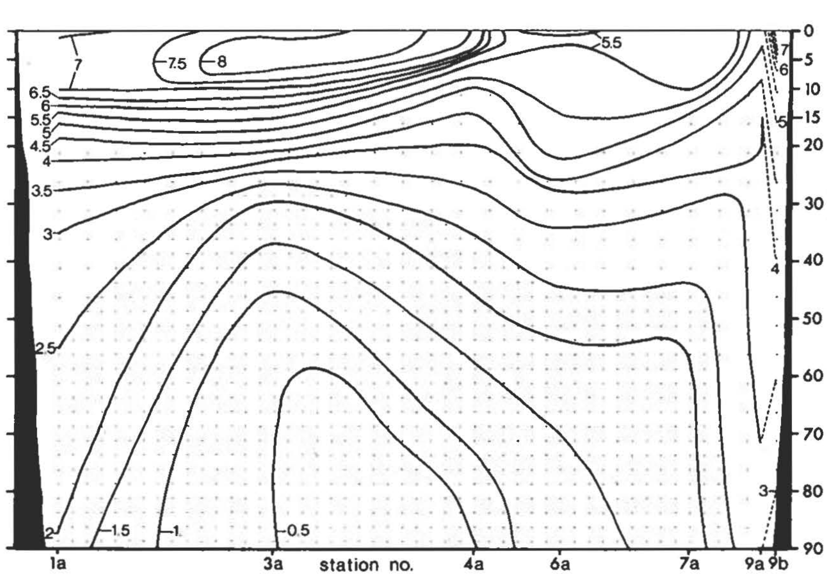


Fig. 13: Temperature section (°C) between Godhavn and Egedesminde from 20 Aug. 1975 (1a – 9a) and from 10 Aug. 1974 (9b) as indicated on the map Fig. 17.

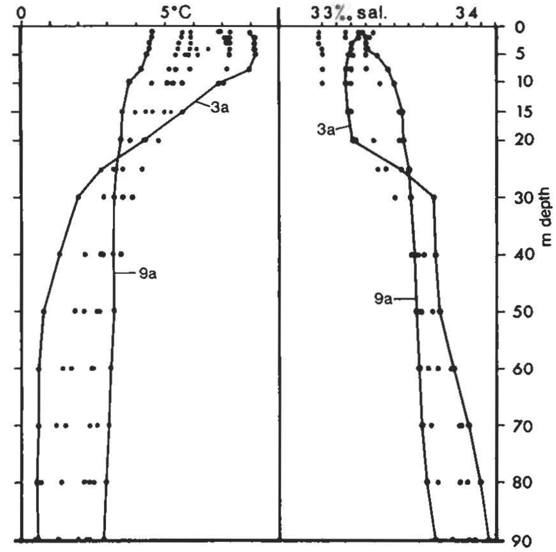


Fig. 14: Each measurement and 2 characteristic temperature and salinity profiles from Fig. 13 are shown.

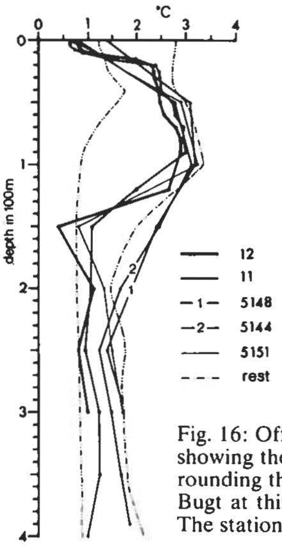


Fig. 16: Offshore temperatures in Oct. 1975 showing the cold water at about 150 m surrounding the warmest water found in Disko Bugt at this depth in the W part of area J. The stations are plotted on the map Fig. 17.

area	B	J	J	J	C	GHECBV
no. of series	1	1	1	1	1	23
dates in Oct.	16	16	21	17	23	14–24
station nos.	12	11	5148	5144	5151	others

the well mixed relatively warm water flowing into the bay past Egedesminde and that flowing out past Godhavn, where the upper 20–40 m have been further heated and freshened and the deeper water has become colder and more saline due to cooling by ice bergs and to upwelling (stations marked a in Fig. 17).

In Sept., when the warm layer is most extensive inside the bay and has reached its highest temperature, surface cooling creates a thin cold surface layer covering the warm water in area J and along the E and N shores of the Vaigat. The surface current crossing area B from J to G seems too great to permit the intruding warm water to remain as a distinct layer of any appreciable thickness above the minimum layer in area B even in Sept. A persistent layer of initially winter cooled water kept cold by passing ice bergs and insulated till late in the year against heating from above by steep surface halo- and thermoclines and surface turbidity is thus

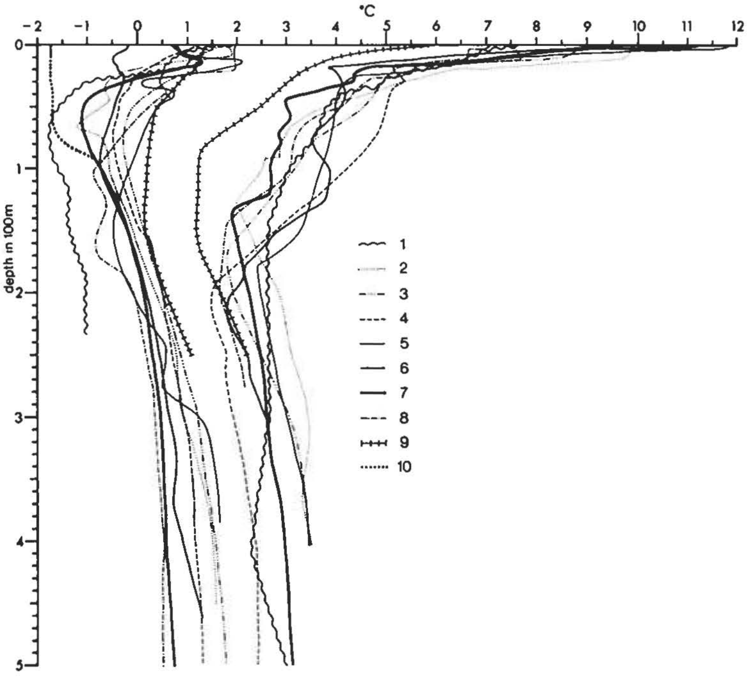


Fig. 15: 2 curves from each of the offshore areas show temperature extremes encountered from June or July to Sept. or Oct. The curve to the right in each pair also represent the highest temperatures measured and perhaps the highest generally to be reached, except maybe in area W, from where only shallow or isolated deep measurements are available from Sept. 1: W (3 June–21 Oct.); 2: G (6 June–18 Oct.); 3: H (22 June–15 Oct.); 4: E (5 June–15 Oct.); 5: C (28 June–25 Oct.); 6: J (25 June–21 Oct.); 7: B (5 July–24 Oct.); 8: V (9 July–17 Oct.); 9: M (12 July–19 Oct.); 10: G (6 Febr., 1975 – the coldest series known from Disko Bugt).

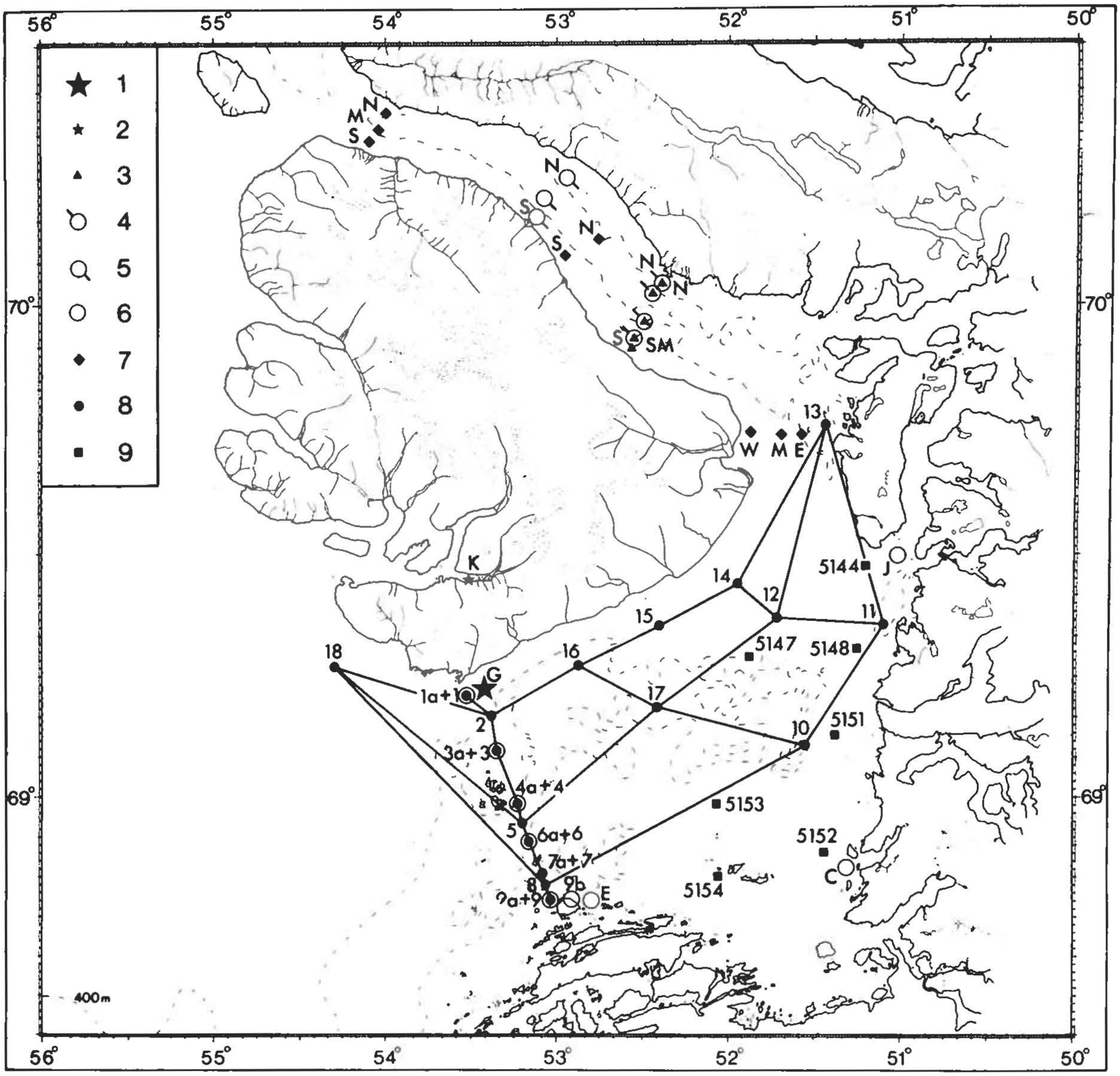


Fig. 17: Temperature and salinity stations (1–8) and temperature stations (9) mentioned in the text. 1: Own year round station at Godhavn (G); 2: Same in Kangikerdlak (K); 3: July 1949 (B.H. 1954) (see Fig. 21); 4: Same in Aug. 1949; 5: Aug. 1928 (Smith et al. 1937) (see Fig. 21); 6: Own in Aug. 1974 and 1975 (see Figs 12–14); 7: Sept. 1928 (Kiilerich 1939) (see Fig. 21); 8: Own in Oct. 1975 (see Figs 16 & 18–20); 9: Greenland Fisheries Investigations in Oct. 1975 (see Fig. 16).

drawn toward the surface in area B followed by upwelling of deeper, warmer and more saline water (Figs 10 & 11).

Data obtained in Oct. 1975 are plotted on the map Fig. 17, and in part shown as isopleths in Figs 19 & 20, as vertical profiles in Fig. 16, and as TS diagrams in Fig. 18. Better than any other set of data they show the course and fate of inflowing and locally heated water in the upper 200 m and the outflowing fresher surface current generating an upwelling of cool water in the NW part of the bay, as well as the cooling effect of ice bergs leaving the bay. The marked freshening of the upper 10–20 m is essential for attaining and sustaining the relatively high temperatures, most pronounced at about 50–100 m, in the N part of the bay, in spite of the intense surface cooling at this time of the year. The lowest temperature measured beneath the summer heated layer was at 150 m at st. 12 in the middle of the N part of the bay. Progressively warmer are the less marked minima at sts 15, 17 and 16 brought about by upwelling of cool, more saline water as well as by cooling by ice bergs from Jakobshavn Isfjord. They trace the

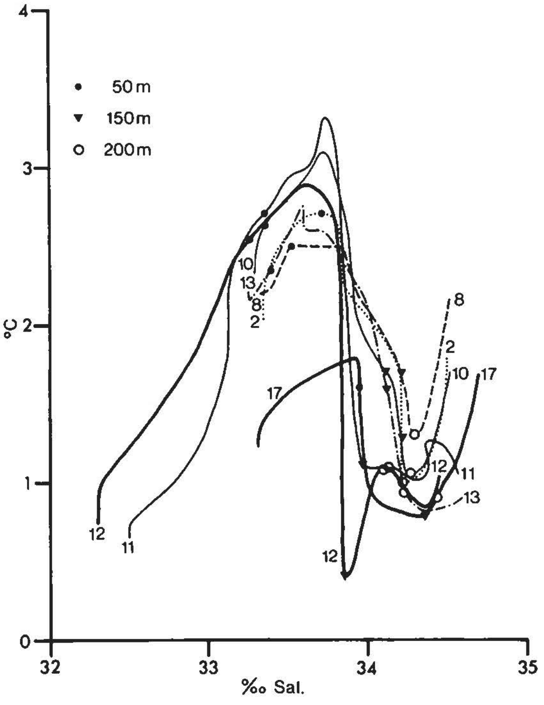


Fig. 18: TS diagrams of some of the characteristic offshore stations in Oct. 1975 plotted on the map Fig. 17.

area	G	E	C	J	B	V	B
dates in Oct.	14	15	15	16	24	17	16
max. depth in m	400	400	350	400	300	400	400
station nos	2	8	10	11	12	13	17

approximate course of ice bergs drifting towards the N part of the bay entrance between Godhavn and Kronprinsen Ejland. Close to the E shore near Jakobshavn (st. 5151) a marked minimum at 150 m is as low as that at sts 15–17, and temperatures are also very low at 150 m at st. 11. Between these two nearshore stations and the offshore stations mentioned above, however, a warm mass of water extends from the S part of the bay (sts 5154 & 5152) via sts 5153, 10, 5148 and 5144 to the Vaigat (st. 13) and around to the E coast of Disko off Flakkerhuk (st. 14). The highest temperatures are registered close to shore at about 100 m at st. 5152 and st. 5151 followed by sts 5144, 5148 and 14, but also at 60–80 m at sts 11–19 temperatures are still quite high due to the insulating effect of the marked surface halocline. It is between the cold nearshore water to the E (sts 5151 & 11) and the cold water of the central part of the bay (sts. 12 & 15–17) that the warm water reaches its greatest thickness (sts 5148 & 5144 in Figs 16 & 17) and here the temperature at 150 m is 2°C warmer than at st. 12. From there the warm layer becomes thinner on its way into the Vaigat (st. 13) and W along Disko (sts 14–17) due to upwelling and erosion from the top by the surface current leaving the bay. The TS diagrams (Fig. 18) show that whereas the low temperatures at 150 m at stations 11 and 12 occur at relatively low salinities (33.86–33.98‰) indicating a cooling by ice bergs, the low temperatures at 150 m at st. 17 (just as at sts 15 and 16 and less at st. 14) is associated with salinities as high as or higher than found at 200 m in any other part of the bay, indicating conditions of upwelling. Off Godhavn upwelling is less apparent and the surface waters can be even fresher than in Sept.

The warm bottom water of Atlantic origin is apparent below 250 m off Christianshåb and Jakobshavn (Figs 10 & 11), and in some years it reaches the Vaigat by crossing the 245 m deep threshold found at the S entrance, raising the temperature below threshold depth by as much as 2°C in extreme years. In the well mixed water of areas G, H, E and B the warm bottom water is hardly discernible as a distinct layer of higher temperatures. In the N parts of the bay (sts 11–17 in Fig. 17) this deep water is generally more saline than further S and is generally colder by 0.5–1.0°C. In the deep trough W of Egedesminde and in various depressions inside the bay off Christianshåb, Claushavn, Jakobshavn and Rodebay as well as in the Vaigat and in Atâ Sund colder water (only tenths of a degree) is sometimes found beneath the warm bottom water. This shows that there is a variation over the year in the character and /or the extent of intrusion of warm deep water and presumably in the temperature of this water. The warmest water probably enters late in the year, presumably in Oct. or even later.

In the Vaigat investigations made in July and Aug. 1949 (3 & 4 in Fig. 17) (B.H. 1950) and in Aug. (5 in Fig. 17) (Smith et al. 1937) and Sept. 1928 (7 in Fig. 17) (Kiilerich 1939) – all included in Fig. 21 – reveal features characteristic of the swift ice berg laden current flowing out through this narrow strait. These features are most likely to pertain to the current passing Godhavn as well, in spite of differences caused by wind, tides and the nearness of the West Greenland Current. The TS diagrams (Fig. 21) show that the inflowing current primarily keeps to the N shore with lowest temperatures and salinities in the upper 50–100 m, above the warmest water flowing in from Disko Bugt. Rising temperatures from July to Aug. (Fig. 21 right) are most apparent below c. 50 m due to the inflow of water heated in Disko Bugt, whereas the surface water above c. 50 m in fact is cooled and freshened by passing ice bergs which also contribute to the cooling of deeper water. From Aug. to Sept. the inflow of warm Disko Bugt water is intensified, still keeping to the N shore, and the depth of minimum temperatures is lowered from c. 100 m to c. 200 m (Fig. 21 left). This Fig. also shows that in passing through the Vaigat the cooling and freshening effect of melting ice bergs lowers the temperatures in the upper 20–30 m to less than Aug. values and brings surface salinities down to Aug. levels. The cooled and freshened surface layer thickens and spreads so that the surface temperatures along the S shore drop as much as 2.25°C from the S entrance to the N outlet

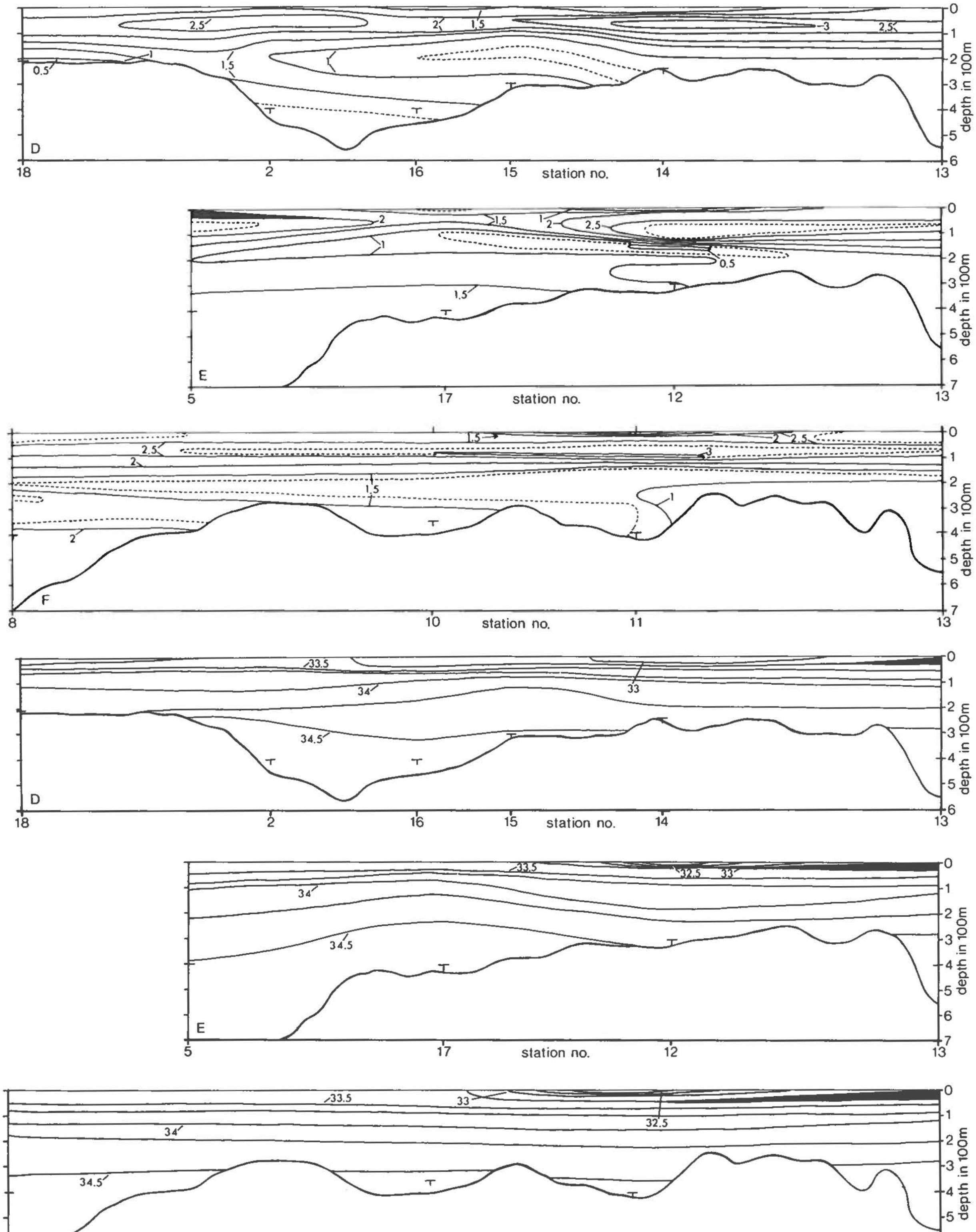


Fig. 19: Temperature and salinity sections through Disko Bugt as indicated on the map Fig. 17. T = deepest sample.

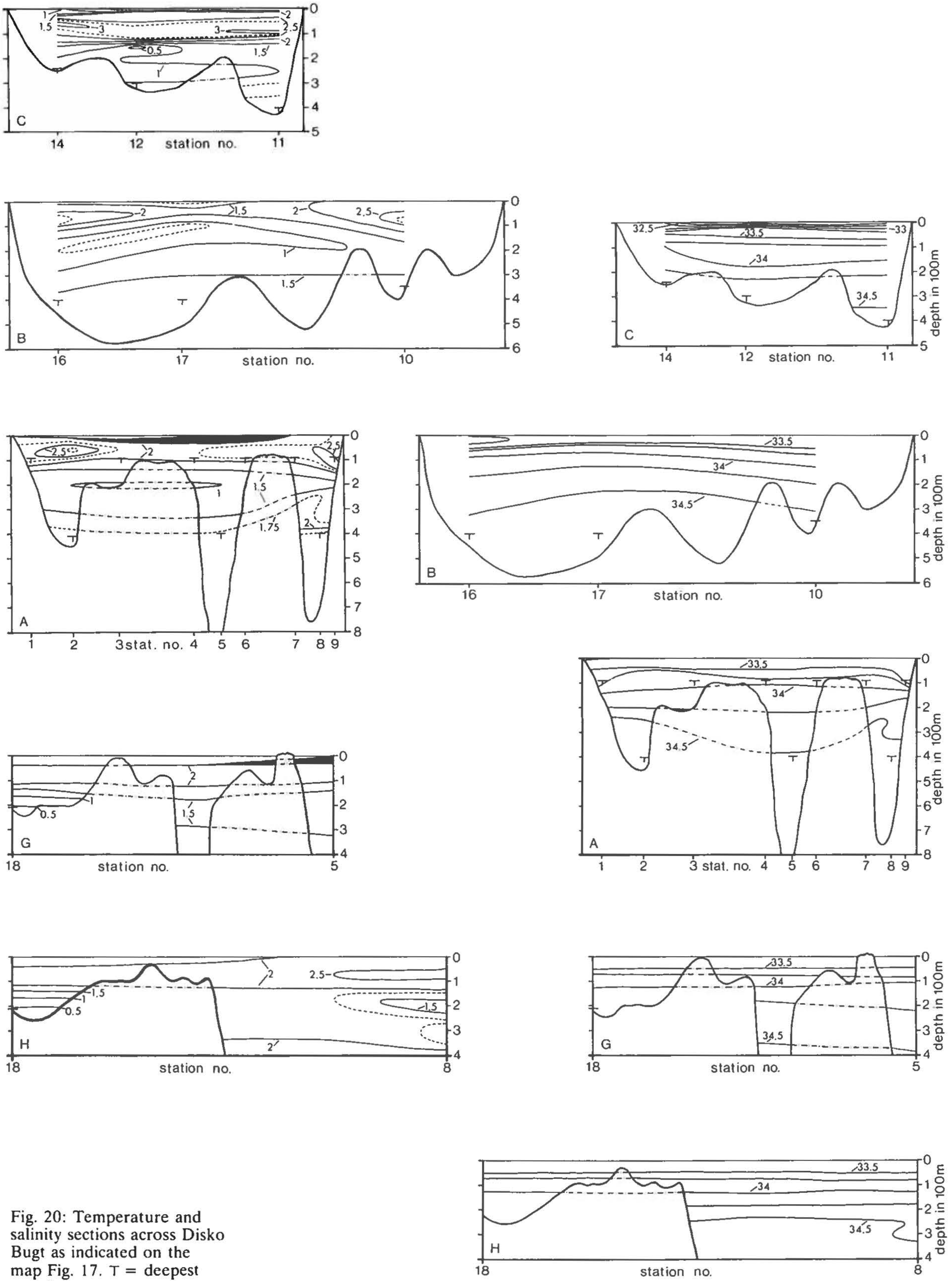


Fig. 20: Temperature and salinity sections across Disko Bugt as indicated on the map Fig. 17. ⊤ = deepest sample.

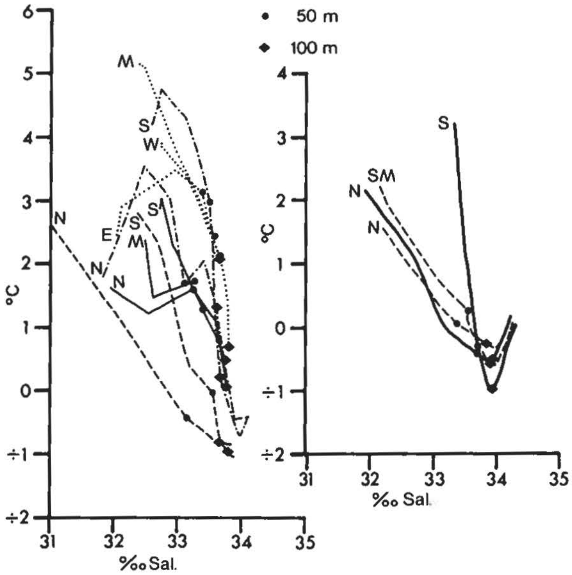


Fig. 21: TS diagrams from stations in the Vaigat marked with capitals on the map Fig. 17. Right: 11 & 12 July (—) and 27 Aug. (- - -), 1949; Left: 11 Aug. (- - -) and 6 & 7 Sept. in the western end (—), in the middle (-·-·-) and in the eastern end (·····). Several deep samples have been omitted due to their great similarity.

compared to a drop of less than 1°C along the N shore. The shore to shore difference in temperature drops from 2.7 to 1.2°C at the surface and from about 1 to 0.5°C at 50 and 100 m.

Glacier fjords

Only few hydrographic measurements have been made in the glacier fjords bordering the E coast of Disko Bugt (Fig. 22). The early measurements performed by Hammer (1883) in Jakobshavn Isfjord and Tasiussaq, indicating the presence of warm (up to 1.6°C) and saline (well above 34‰) Atlantic water are probably unreliable, at least with regard to the salinity which is the highest measured in the bay. The relatively high temperatures (up to 1°C at 100 m) below the surface layers in Atâ Sund off the glaciers Eqip sermia and Kangilerngata sermia compared to temperatures off and inside Jakobshavn Isfjord indicate an influx of subsurface water flowing N from beneath the cold surface layers found in Disko Bugt off Jakobshavn Isfjord (see J in Figs 12 & 17).

Non-glacier fjords

The only major fjord is Disko Fjord (Figs 2, 3 & 17), where conditions differ greatly from those found in

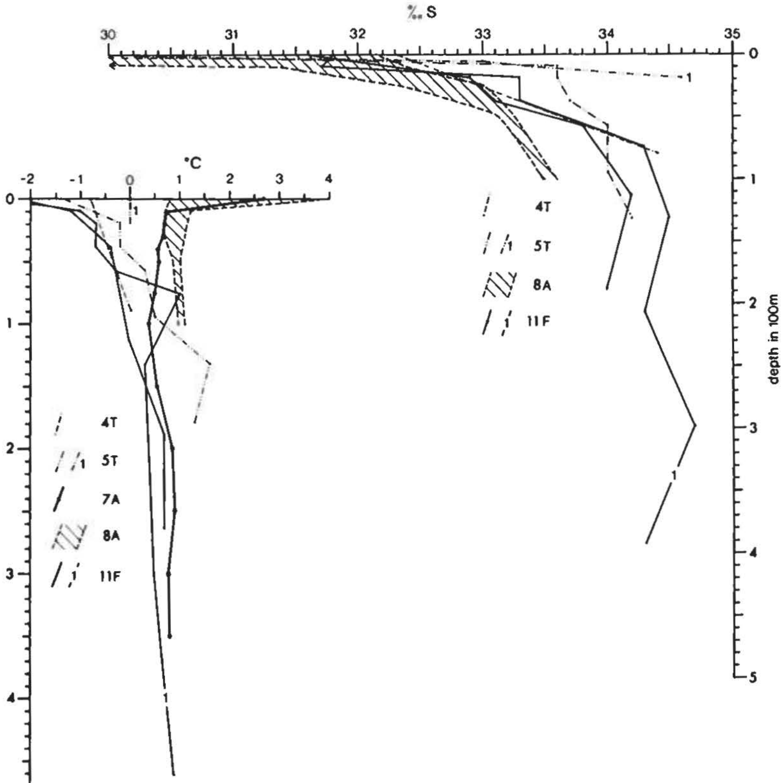


Fig. 22: See Table 1: T, A & F.

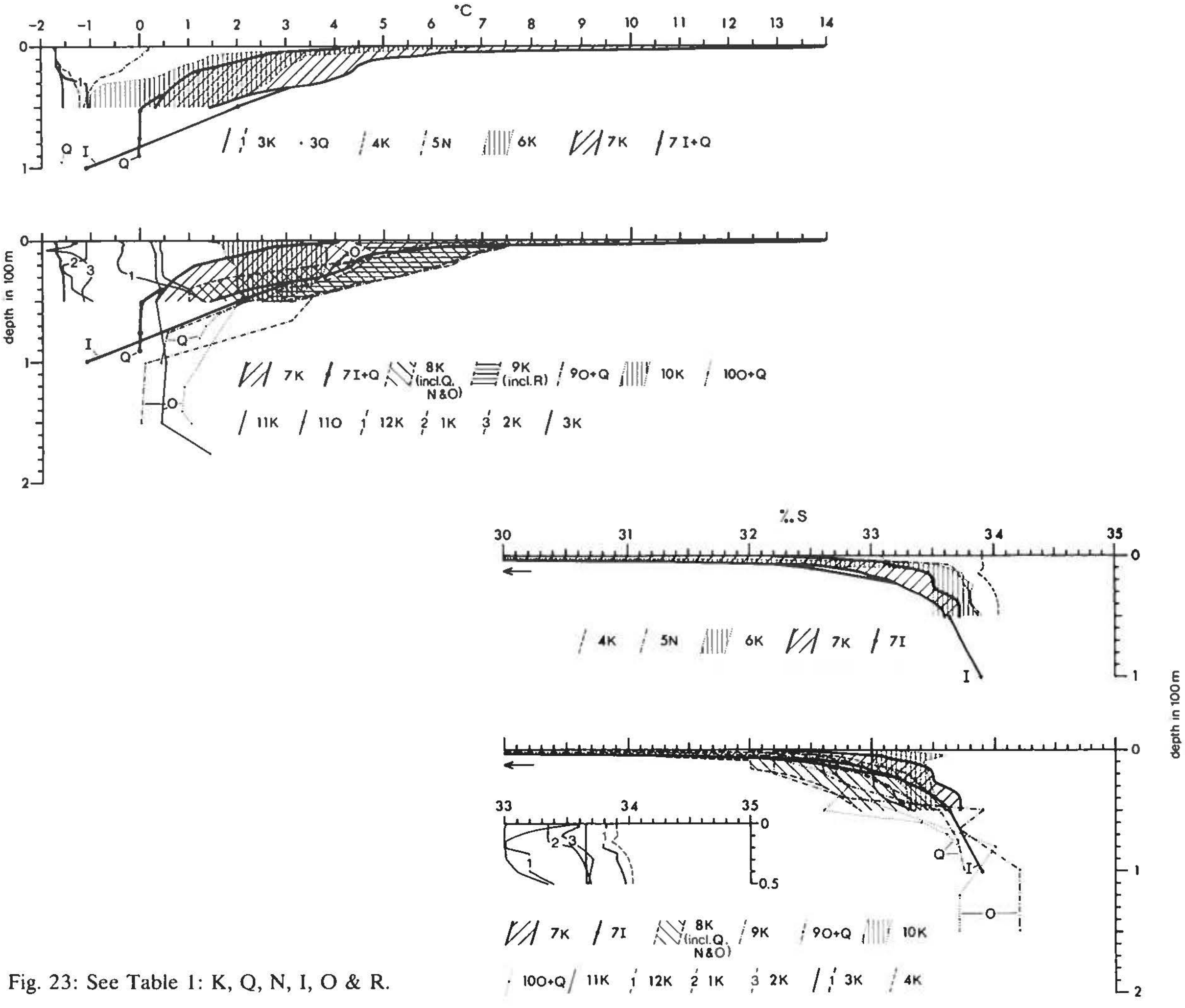


Fig. 23: See Table 1: K, Q, N, I, O & R.

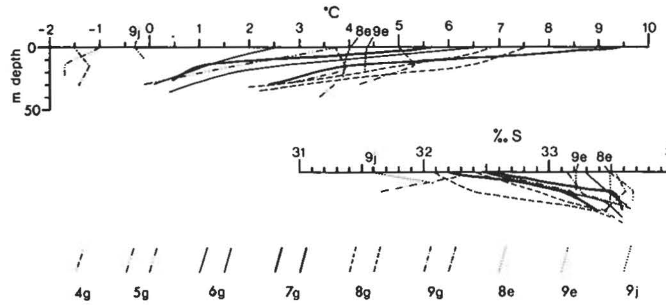
glacier fjords (Fig. 23). The fast ice leaves 2–3 weeks later than off Godhavn, in late May to early June. During most of the summer fresh, turbid surface water flows outward, while the stratified, ice berg laden surface current leaving Disko Bugt to some degree enters the fjord and the more saline water from the West Greenland Current reaches far into the fjord complex as a deep current. Prevailing winds are active in regulating the outflow of surface water and thereby also an upwelling of deep water, the Atlantic character of which seems greatest in the monthly periods with the highest spring tides.

In Disko Fjord surface-near temperatures are much higher during the summer than in glacier fjords, but at depths, where, in the glacier fjords, warmer water from the West Greenland Current intrudes, much colder water is found. This is due, not to the lack of glaciers, but to the cold current flowing out of Disko Bugt and past the mouth of Disko Fjord. In the still colder Baffin Current eddy found over the relatively shallow areas W of Disko, temperatures in July are even lower than inside the fjord. Since no threshold exists at the entrance to the fjord, warmer water has, however, been found in Oct. and Nov. below 140–150 m in the outer parts, and in Nov. temperatures at all depths here are above zero. This is not the case in Jakobshavn Isfjord. In the inner parts of the fjord measurements go no deeper than to 100 m and subzero temperatures have been recorded from below 50 m even in July, while in Nov. temperatures here also are above zero down to the deepest measurement at 50 m (Fig. 23).

In an attempt to get a picture of the summer circulation inside Disko Fjord and especially in the small fjord arm Kangikerdlak (Fig. 3), temperature and salinity was measured on 9 and 10 Aug. with 2 hour intervals at 0, 0.5, 1, 2, 3, 4, 7.5, 10, 15, 20, 25, 30, 35, 40 and 50 m in the fjord arm followed by 3 stations going out of the fjord as indicated in Fig. 25.

In Kangikerdlak the major surface halocline was found to be located in the upper 5–10 m, whereas in the

Fig. 24: See Table 1: g, e & j.



outer part of Disko Fjord it was somewhat shallower. A major negative thermocline existed in the upper 5 m of the fjord arm followed by c. 10 m of roughly isothermal water, below which a weaker thermocline reached to a depth of 30–40 m. In the outer part of the fjord the surface thermocline was shallower and less pronounced and below this the temperature dropped slowly, and there was no distinct intermediate isothermal layer or a deeper thermocline, just as the water was c. 1°C warmer at 50 m than in the inner parts of the fjord. There was also a marked drop in turbidity in the surface layers.

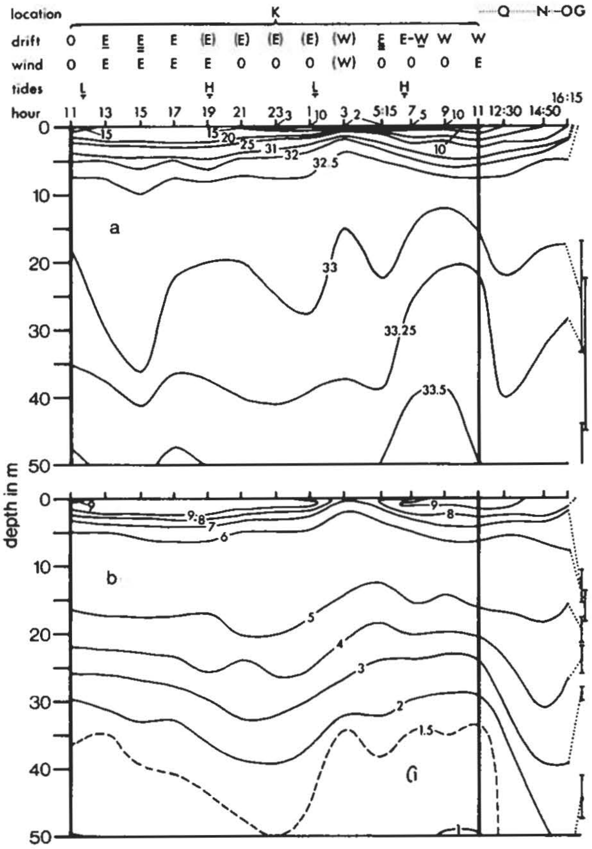


Fig. 25: Isopleth diagrams showing a 24 hour cycle from 9 to 10 Aug, 1973 in Kangikerdlak (K) and series from Qivítut (Q), Nângissat (N) and outer Disko Fjord (O) on 10 Aug. and from Godhavn (G) on 7 and 16 Aug. (shown as vertical lines joining the measurements from these two dates). The difference in speed of drift of the vessel east (E) and west (W) is roughly indicated by degree of underlining and virtually no drift is shown by bracketing. Very slight wind is also shown by bracketing. Tides are deduced from tables from the Danish Farvandsdirektorat. a: Salinity (‰); b: Temperature (°C).

Tides were not measured, but highs and lows have been extracted from published tables, and beneath the surface halocline they seem to have a semidiurnal effect upon temperature and salinity in such a way that high tides with a time lag were associated with a rise in both salinity and temperature. Winds blowing into the fjord arm halted the outflow of surface water, whereas a fresh turbid layer quickly covered the fjord in calm weather irrespective of the tides. During periods with rising tides and outgoing winds greatest amounts of surface water were swept out of the fjord arm causing an upwelling of deep water as at 3 am on 10 Aug. The long term effect is a net influx of subhalocline water, the upper layers of which in a more or less freshened state leave the fjord arm as part of the outgoing surface current. This mechanism acts as a trap to more or less stenohaline plankton organisms entering the fjord with the deep water and probably demonstrates, on a small scale, what is happening in Disko Bugt itself.

2 series of 2 measurements each taken in Sept. in Mellemfjord show that temperatures here are similar to those found in outer Disko Fjord.

Harbours

The characteristic low temperature and steep surface halocline measured in Jakobshavn harbour in Sept. 1924 clearly shows that this harbour received cold water from the ice fjord, while much higher temperatures and salinities resembling offshore conditions are recorded from the well mixed water found in Egedesminde harbour in Aug. and Sept. (Fig. 24). The diluted upper layers gradually spreading over the greater part of Disko Bugt and flowing from the bay especially past Godhavn and through the Vaigat are also encountered off Egedesminde in Aug. and especially in Sept., but they do not reach the inshore waters at Egedesminde, where salinities are higher.

At the entrance to Godhavn harbour (Petersen 1964 and own data) conditions much resemble those found offshore. Surface temperatures are, however, generally higher and in the early spring bottom temperatures at about 30 m are lower than outside the harbour and especially in the spring surface salinities are lower. In Apr. a characteristic temperature and salinity maximum also encountered offshore at various depths is found at 15 m, probably due to refreezing of rising fresh water from melting ice bergs.

References

Andersen, O. G. Norden 1981. The annual cycle of marine phytoplankton production and hydrography in the Disko Bugt area, West Greenland. – Meddr Grønland, Biosci. 6: 65 pp.

Baggesgaard-Rasmussen, & Jakobsen, J. P. 1930. Contribu- the year 1925. – Meddr Kommn Havunders., Ser. Hydrografi, 2 (10): 24 pp.

B. H. 1954 = Bull. hydrogr. Cons. perm. int. Explor. Mer. 1954. Copenhagen.

Carpenter, W. B. 1877. Report on the physical investigations carried on by P. H. Carpenter, B. A., in H. M. S. Valarous during her return voyage from Disko Island in August 1875. – Proc. R. Soc. 25 (25): 230–237.

Dunbar, M. J. 1946. The state of the West Greenland Current up to 1944. – J. Fish. Res. Bd Can. 6 (7): 460–471.

– 1951. Eastern Arctic waters. – Bull. Fish. Res. Bd Can. 88: 131 pp.

Grann, H. H. 1929. Quantitative plankton investigations carried out during the expedition with the "Michael Sars", July–September, 1924. – Rap. P.–v. Réun. Cons. perm. int. Explor. Mer. 56 (5): 50 pp.

Hachey, H. B., Hermann, F. & Bailey, W. B. 1954. The waters of the ICNAF Convention area. – A. Proc. int. Comn NW. Atlant. Fish. 4 (1953–54): 38 pp.

Hamberg, A. 1884. Hydrografisk – kemiska iagttagelser under den svenska expedition till Grønland, 1883. 1. Bih. K. svenska Vetensk. Akad. Handl. 9 (16): 65 pp.

Hammer, R. R. J. 1883. Undersøgelser ved Jakobshavns Isfjord og nærmeste omegn i vinteren 1879–80. – Meddr Grønland 4 (1): 67 pp.

Hansen, P. M. & Hermann, F. 1953. Fisken og havet ved Grønland. – Skr. Danm. Fisk.- og Havunders. 15: 128 pp.

Hartley, C. H. & Dunbar, M. J. 1937–38. On the Hydrographic mechanisms of the so-called brown zones associated with tidal glaciers. – J. Mar. Res. 1: 305–311.

Kiilerich, A. B. 1939. A theoretical treatment of the hydrographical observation material, the Godthaab Expedition, 1928. – Meddr Grønland, 78 (5):149 pp.

– 1943. The hydrography of the West Greenland fishing banks. – Meddr Kommn Danm. Fisk.- og Havunders., Ser. Hydrografi 3 (3): 45 pp.

Knudsen, M. 1923. Dr. T. Wulff's hydrographical investigations in the waters west of Greenland. Den 2. Thule Expedition til Grønlands nordkyst, 1916–18. – Meddr Grønland 64: 92–100.

Lee, A. J. 1968. Physical oceanography. Environmental surveys – Norwestlant 1–3, 1963. Spec. Publs int. Comn NW. Atlant. Fish. 7 (1): 31–54.

Martens, E. 1929. Hydrographical investigations during the "Michael Sars" Expedition, 1924. – Rap. P.–v. Réun. Cons. perm. int. Explor. Mer. 56 (11): 29 pp.

Monthly surface temperatures of the northern Atlantic, 50°–80°N, 0°–60°W. – Publner danske met. Inst., Årbøger.

Naut.-met. Aarb., Danske meteorologisk Institut, Kjøbenhavn.

Nielsen, J. N. 1928. The waters round Greenland. – Greenland 1: 185–230.

Parr, A. E. 1938. On the validity of the dynamic topographic method for the determination of ocean trajectories. – J. Mar. Res. 1 (2): 119–132.

Petersen, G. H. 1964. The hydrography, primary production, bathymetry and "tagsaq" of Disko Bugt, West Greenland. – Meddr Grønland 159 (10): 45 pp.

Riis-Carstensen, E. 1936. The Godthaab Expedition, 1928. The hydrographic work and material. – Meddr Grønland 78 (3): 101 pp.

Smith, E. H. 1941. U.S. Coast Guard cutter "Northlands" ice and oceanographic observation cruise to Baffin Bay and Davis Strait, autumn of 1940. – Amer. Geophys. Union. Trans. Pt. 3: 788–792.

Smith, E. H., Soule, F. M. & Mosby, O. 1937. The "Marion" and "General Greene" Expeditions to Davis Strait and Labrador Sea; under the direction of the U.S. Coast Guard, 1928–1931–1933–1934–1935. Scientific results pt. 2: Physical oceanography. – U.S. Treasury Dept. Coast Guard Bull. 19.

Wandel, C. F. 1891. Om de hydrografiske forhold i Davisstrædet. – Meddr Grønland 7 (3): 57–103.

Meddelelser om Grønland, Bioscience

1979

1. Erik L. B. Smidt:
»Annual cycles of primary production and of zooplankton at Southwest Grenland«. 53 pp.

Annual hydrographic observations, measurements of primary production, and samplings of zooplankton were undertaken in Southwest Greenland waters in the 1950s and –60s. In the coastal area and at the entrance to Godthåbsfjord winter cooling normally extends to the bottom, resulting in a vertical mixing of the water and an effective replenishment of nutrients at the surface. The subsequent production rate is, therefore, high with an average annual gross production calculated to about $160\,\mathrm{g\,C\,m^{-2}}$. In the inner fjord regions the stratification is normally much more stable with persisting warm bottom water, and the production is, therefore, lower here than in the coastal area. The seasonal variation in the relations between daylight, primary production, phosphate, and quantity of zooplankton is, presumably, representative of the coastal waters at SW Greenland. A maximum in primary production in spring is normally followed by another maximum in late summer. The number of animals in the microplankton samples from the upper 30 m (the productive layer) is at its maximum simultaneously with the second maximum of the primary production, while the maximum of the macroplankton biomass (taken by stramin net) extends until late autumn in the coastal and outer fjord regions.

A maximum of the macroplankton biomass during winter in the deep water layers in the inner Godthåbsfjord, caused by inflow of warm bottom water, stable stratification and cooled outflowing surface water acting as a barrier to the ascent of the animals, is assumed to be normal to the open, non-threshold, W Greenland fjords.

Seasonal vertical migration of the zooplankton is indicated by Hensen net hauls from different depths. There is a concentration of zooplankton in the upper water layers in April–September and a deeper concentration from autumn to spring.

Annual cycles of various animal groups are described for holoplankton and meroplankton, separately. Holoplankters are normally dominant, copepods being the most numerous group. Meroplankters, especially bottom invertebrate larvae, are relatively numerous in the microplankton in spring and summer with *Balanus* nauplii dominant in spring and lamellibranch larvae in the following months. In a special section on fish eggs and larvae it is shown *I.a.* that cod eggs and larvae are normally concentrated in the upper 50 m, where they are much exposed to temperature variations, while eggs and larvae of American plaice occur also in deeper water. This may partly explain why the cod stock is more vulnerable to low temperatures.

It is shown that the epipelagic plankton fauna in the survey area in terms of growth and mode of development is more similar to the arctic than to the boreal fauna. It could therefore be termed subarctic, which also corresponds to the environmental conditions in the area.

1980

2. Jean Just:
»Amphipoda (Crustacea) of the Thule area, Northwest Greenland: Faunistics and Taxonomy«. 61 pp.

The material reported on was collected in the Thule area, NW Greenland, in 1968 and includes 105 species. Four of these, *Aceroides goesi, Bathymedon antennarius, Monoculodes vibei* and *Parametopa crassicornis,* are new to science. An additional 6 species are new to Greenland, while 9 species have previously been found in E Greenland but not in W Greenland. Four genera, *Lembos, Arrhinopsis, Arctopleustes* and *Parametopa,* are recorded from Greenland for the first time.

Specimens belonging to 15 additional taxa are for various reasons not referred to species. Major taxonomic problems, warranting broadly based revisions, are outlined in the genera *Byblis, Gitanopsis, Ischyrocerus, Tmetonyx, Monoculodes* and *Stenula.* Three different forms of *Paroediceros lynceus* are discussed.

All known amphipod species from the Thule area are included in an annotated list. Forty-nine taxa are discussed and figured.

1980

3. H. Meltofte, M. Elander and C. Hjort:
»Ornithological observations in Northeast Greenland between 74°30′ and 76°00′ N. lat. 1976« 53 pp.

The results of one summer's work in central Northeast Greenland are presented. The avifauna in the country traversed on several extensive survey trips is described. More intensive studies were made in an 18.2 km² census area on southernmost Hochstetter Forland. Here the populations were followed throughout the breeding season, and information on arrival, pre-laying period, population densities, habitat and nest site selection, breeding schedule, clutch size, hatching success, re-nesting, non-breeders, moult, post-breeding activities and departure is given. Special attention is given to *Clangula hyemalis, Somateria spectabilis, Anser brachyrhynchus, Arenaria interpres, Calidris maritima, Calidris alpina, Calidris alba, Phalaropus fulicarius* and *Stercorarius longicaudus*. An extremely high predation pressure was caused by *Alopex lagopus*, and this is discussed in relation to lemming abundance and environmental conditions.

1981

4. Peter Milan Petersen:
»Variation of the population structure of Polygonum viviparum L. in relation to certain environmental conditions«. 19 pp.

Populations of *Polygonum viviparum* L. have been studied at Godhavn in Greenland (69° 14′ N, 53° 31′ W), at 30 sites within an investigation area of approx. six km². At each site, the age structure of the population was described after the individuals had been classified on the basis of the morphology of the rhizome. Other population parameters investigated are the total number of individuals (1 – 2,860 per m²), number of recently established individuals (0 – 1,720 per m²), number of flowering individuals (0 – 850 per m²), number of bulbils produced (0 – 17,870 per m²), and dry weight of standing crop (0.6 – 281 g per m²); the numbers in the brackets give the total range for the 30 sites. The flowering individuals have been characterized by the age class in which flowering first occurs, the mean dry weight of the vegetative parts (0.06 – 0.94 g) and the mean number of bulbils (9± 4 – 114 ± 46). – The environmental parameters studied include height above sea level, slope and direction of slope, soil water content, loss on ignition, bulk density, pH, exchangeable K, 0.2 N H_2SO_4-soluble P, C/N, soil temperature, time of disappearance of the snow, soil movement, and degree of cover of the vegetation. The sites have been assigned to six groups which are defined with emphasis on those factors which are assumed to be limiting: 1. Sites with soil movement, 2. Sites where the snow is late in disappearing, 3. Sites with waterlogged soil, 4. Well-drained sites on level or slightly sloping ground, 5. Steep slopes, exposed to the sun, and 6. Sites where competition for light is an important factor. Within each of the groups, the sites show a number of common features, especially as regards relative values referring to the population structure, and various features characterizing the plants. It is suggested that the large variation in the population parameters mentioned above occurs mainly because individuals of *Polygonum viviparum* of a different age are in a different way and to a different degree influenced by the environmental conditions. At the same time, the bulbil gain from and loss to the surroundings is stressed as important for the size of a population.

Meddelelser om Grønland, Man & Society

1980

1. Isi Foighel:
»Home Rule in Greenland«. 18 pp.

By Danish Act of 29 November, 1978, Home Rule was established in Greenland within the Unity of the Danish Realm. The Act was prepared by a Danish-Greenlandic Commission.

The Act on Home Rule is discussed with special reference to the historical and political background.

By the establishing of Home Rule, powers which hitherto had been vested in the Danish Government and Parliament were transferred to the Greenlandic authorities. The scope of these powers and their legal characteristics are outlined.

Home Rule makes no changes in the international competence or in the relationship between Greenland and the international or interregional organizations. Greenland's membership of the EEC creates some special problems.

The question of ownership of the natural resources was of great importance in the debate in the Home Rule Commission. The Act contains a solution which seeks to give the Danish Government as well as the Greenlanders equal rights in the decision-making procedure, in the administration, and in the sharing of the revenue.

Furthermore, the financing of the Home Rule system, the language problem, the organizing of fishing and trade are being dealt with.

1981

2. H. O. Bang & Jørn Dyerberg:
»The Lipid Metabolism in Greenlanders.« 18 pp.

In the years 1970, 1972 and 1976 the blood lipids in Greenlanders living in the Umanaĸ district and the composition of their food, especially that of their dietary fat were examined in an attempt to explain the rarity of ischaemic heart disease in Greenlanders.

Decreased concentrations of serum cholesterol, triglycerides, low density and very low density lipoproteins and increased concentration of high density lipoprotein in male Eskimos were found. The fatty acid pattern of the serum lipids was different from that of Danes. Especially remarkable was the high concentration of eicosapentaenoic and low concentration of arachidonic acids compared with Danes. The serum lipids of Greenlanders living in Denmark were found similar to that of Danes.

The Eskimo food was found rich in protein and poor in carbohydrate. The fatty acid pattern of the dietary fat was similar to that found in their blood.

We could show – by in-vitro experiments – that eicosapentaenoic acid can act as precursor for thrombocyte active prostaglandins in stead of arachidonic acid in Europeans, giving rise to an anti-aggregatory prostaglandin, probably PGI_3, but to no pro-aggregatory thromboxane. This causes a shift in the balance towards the anti-aggregatory – and consequently anti-thrombotic – side.

During a fourth expedition in 1978 to the Umanaĸ district our theory from the in-vitro experiments was confirmed by in-vivo observations in the Eskimos. We found decreased platelet aggregability and increased bleeding time.

The rare incidence of ischaemic heart disease and other thrombotic diseases in Greenlanders can be explained by their low serum lipids, their high content of α-lipoprotein and – probably most important – by their special serum fatty acid pattern giving rise to a decreased platelet aggregability and consequently a decreased tendency to thrombosis.

1981

3. Jens C. Hansen:
»A survey of human exposure to mercury, cadmium and lead in Greenland.« 36 pp.

Analyses of lead, mercury and cadmium in tissues from seal and fish have shown high concentrations of mercury and cadmium. A toxicological evaluation of the actual concentrations has revealed that in some districts of Greenland, the population may exceed the provisionally tolerable weekly intake (WHO, 1977) of cadmium with from 2 to 20 times and of mercury with from 2 to 40 times. Lead intake was below the provisionally tolerable weekly intake. As these high dietary intakes might have adverse health effects in the consumers, an investigation was undertaken in order to evaluate the human exposure as reflected in blood and hair concentrations. Five districts in Greenland and a control group of Greenlanders living in Denmark have been examined.

A total of 144 persons (including the control group) have participated.

Samples were taken in September and October 1979.

Mercury. Strong evidence was found for a connection between mercury exposure and seal-eating. The mercury levels found indicate that the exposure calculated from food analyses is overestimated, but still the most highly exposed groups are on an exposure level where subclinical effects may be anticipated.

Cadmium. In general the blood cadmium concentrations are higher in Greenland than in Denmark, but the groups in Greenland were found to be very similar. In hair concentrations no differences between the groups were observed. Separation of data on blood cadmium between smokers and non-smokers showed the differences between the mean values to be highly significant. In spite of the presumably higher dietary intake, no influence on blood concentrations could be observed. Contrary to blood, hair reflected dietary intake but not smoking. The results indicate that neither blood nor hair as only parameter reflects total cadmium exposure.

A positively significant correlation was demonstrated between lead and cadmium concentrations in hair, but not in blood.

Lead. Blood concentrations were found to be at the same level as found in Western European countries, but all to be below the limit of 35 µg/100 ml which is the upper individual limit in the EEC-countries.

The highest blood-values were found in the two northern districts, where the level is significantly higher than the level in the two southern districts. The difference was found to be related to varying eating habits, also smoking habits were found to be reflected in blood and hair. Blood was found to be a better index medium than hair for evaluating lead exposure.

Selenium. A potentially toxicity-modifying micronutrient selenium was determined in a limited number of hairsamples. No evidence of a high selenium intake could be provided.

Further research is needed especially concerning mercury exposure. Concerning lead and cadmium, the levels found are well below what is regarded a critical level. As, however, the concentrations are on the same level as those found in industrialized countries, follow-up studies seem to be needed in order to observe trends of exposure.

Meddelelser om Grønland

The series *Meddelelser om Grønland* started in 1879 and has since then brought results from all fields of research in Greenland. It has now been split into three separate series:

- *Bioscience*
- *Geoscience*
- *Man & Society*

The series should be registered as *Meddelelser om Grønland, Bioscience (Geoscience, Man & Society)* followed by the number of the paper. Example: *Meddr Grønland, Biosci.* 1, 1979.

The new series are issued by Kommissionen for Videnskabelige Undersøgelser i Grønland (The Commission for Scientific Research in Greenland).

Correspondence
All correspondence and manuscripts should be sent to the Secretary, Kommissionen for Videnskabelige Undersøgelser i Grønland, Øster Voldgade 10, DK-1350 Copenhagen K. Questions concerning subscription to all three series should be directed to the agent.

Agent
Nyt Nordisk Forlag – Arnold Busck A/S, Købmagergade 49, DK-1150 Copenhagen K. Tlf. +45.1.111103.

Meddelelser om Grønland, Bioscience

Meddelelser om Grønland, Bioscience invites papers which contribute significantly to the study of flora and fauna and of ecological problems pertaining to all Greenland environments. Papers primarily concerned with other areas in the Arctic or Atlantic region may be accepted, if the work actually covers Greenland or is of direct importance to the continued research in Greenland. Papers dealing with environmental problems and other borderline studies may be referred to either of the series *Bioscience, Geoscience* or *Man & Society* according to emphasis and editorial policy.

Editor
Jean Just, Zoological Museum, Universitetsparken 15, DK-2100 Copenhagen Ø. Telephone: +45.1.354111.

Instructions to authors. – See page 3 of cover.

Instructions to authors

Manuscripts will be forwarded to referees for evaluation. Authors will be notified as quickly as possible about acceptance, rejection, or desired alterations. The final decision rests with the editor. Authors receive two page proofs. Prompt return to the editor is requested.

Alterations against the ms. will be charged to the author(s). Twenty five offprints are supplied free. Order form, quoting price, for additional copies accompanies 2nd proof. Manuscripts (including illustrations) are not returned to the author(s) after printing unless especially requested.

Manuscript

General. – Manuscripts corresponding to less than 16 printed pages (of 6100 type units), incl. illustrations, are not accepted. Two copies of the ms. (original and one good quality copy), each complete with illustrations should be sent to the Secretary.

All Greenland place names in text and illustrations must be those authorized. Therefore sketch-maps with all the required names should be forwarded to the Secretary for checking before the ms. is submitted.

Language. – Manuscripts should be in English (preferred language), French, or German. When appropriate, the language of the ms. must be revised before submission.

Title. – Titles should be kept as short as possible and with emphasis on words useful for indexing and information retrieval.

Abstract. – An English abstract should accompany the ms. It should be short, outline main features, and stress novel information and conclusions.

Typescript. – Page 1 should contain: (1) title, (2) name(s) of author(s), (3) abstract, and (4) author's full postal address(es). Large mss. should be accompanied by a Table of contents, typed on separate sheet(s). The text should start on p. 2. Consult a recent issue of the series for general lay-out.

Double space throughout and leave a 4 cm left margin. Footnotes should be avoided. Desired position of illustrations and tables should be indicated with pencil in left margin.

Underlining should only be used in generic and species names. The use of italics in other connections is indicated by wavy line in pencil under appropriate words. The editor undertakes all other type selection.

Use three or fewer grades of headings, but do not underline. Avoid long headings.

References. – Reference to figures and tables in the text should have this form: Fig. 1; Figs 2–4, Table 3. Bibliographic references in the text are given as: Shergold (1975: 16) and (Jago & Daily 1974b).

In the list of references the following usage is adopted:

Journal: Macpherson, A. H. 1965. The origin of diversity in mammals of the Canadian arctic tundra. – System. Zool. 14: 153–173.

Book: Marsden, W. 1964. The lemming year. – Chatto & Windus, London: xxx pp.

Chapter (part): Wolfe, J. A. & Hopkins, D. M. 1967. Climatic changes recorded by Tertiary landfloras in northwestern North America. – In: Hatai, K. (ed.), Tertiary correlations and climatic changes in the Pacific. – 11th Pacific Sci. Congr. Tokyo 1966, Symp.: 67–76.

Title of journals should be abbreviated according to the last (4th) edition of the World List of Scientific Periodicals (1960) and supplementary lists issued by BUCOP (British Union-Catalogue of Periodicals). If in doubt, give the title in full.

Meddelelser om Grønland, Bioscience should be registered under *Meddelelser om Grønland.* Example (with authorized abbreviations): *Meddr Grønland, Biosci.* 1, 1979.

Illustrations

General. – Submit two copies of each graph, map, photograph, etc., all marked with number and author's name. Normally all illustrations will be placed within the text; this also applies to composite figures.

All figures (incl. line drawings) must be submitted as glossy photographic prints suitable for direct reproduction, i.e. having the format of the final figure. Do not submit original artwork. Where appropriate the scale should be indicated in the caption or in the illustration.

The size of the smallest letters in illustrations should not be less than 1.3 mm. Intricate tables are sometimes more easily reproduced from line drawings than by type-setting.

Colour plates may be included at the author's expense, but the editor should be consulted before such illustrations are submitted.

Size. – The width of figures must be that of a column (76.5 mm), 1½ column (117 mm) or of a page (157 mm). Remember to allow space for captions below full page figures. Maximum height of figures (incl. captions) is 217 mm. Horizontal figures are preferred.

If at all possible, fold-out figures and tables should be avoided.

Caption. – Captions (two copies) to figures should be typed on separate sheets.

Meddelelser om Grønland

Bioscience 5 · 1981

1981

Meddelelser om Grønland

Bioscience
Geoscience
Man & Society

Published by
The Commission
for Scientific
Research
in Greenland

AiO Tryk as, Odense