FISKERIDIREKTORATETS SKRIFTER
Serie Havundersøkelser
(Report on Norwegian Fishery and Marine Investigations Vol. IV, No. 6)

Published by the Director of Fisheries

A Norwegian Fat-Herring Fjord

An Oceanographical Study of the Eidsfjord

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Introduction.

The pelagic fish fry and their food are under the sway of the movements of the water containing them, and in the case of the fry this lasts until they reach their bottom stage or begin to acquire independent movement. The physical conditions such as temperature salinity and currents, are also very important to the movements of the adult fish and their food f. inst. the inward movement of herrings into fjords. This makes the study of currents a matter of prime importance in fishery research of to-day.

In 1932 an oceanographical cruise was made between 15. October and 9. November as part of the routine work of the Norwegian Fishery Invegistations in the m/c Johan Hjort, along the coast from Bergen to Lofoten and Vesteraalen. Like previous autumn cruises this one was also conducted according to the plans laid down by Mr. Oscar Sund only with the difference that the renowned herring-fjord Eidsfjorden was covered by a somewhat denser net of stations than had been the case on earlier occasions.

Eidsfjorden had previously been examined by the Fisheries Directorate and in the summers of 1898 and 1899 by H. H. Gran (1900). He concluded that saline and warm water had entered the fjord along the bottom between the beginning of July 1899 and the 24th–25th of the same month, pushing the cold winter water upwards and outwards. The longitudinal section was reiterated on August 26th—28th without disclosing any important change of the situation in the deeper layers.

Our plan in the autumn of 1932 was to undertake a more detailed survey of the oceanography of the fjord and the coastal bank outside of it in order to obtain a more complete picture of the exchange of water between these two areas.

On the coastal bank five stations were placed, and inside the fjord, four, as seen from the chart fig. 1. The following elements were

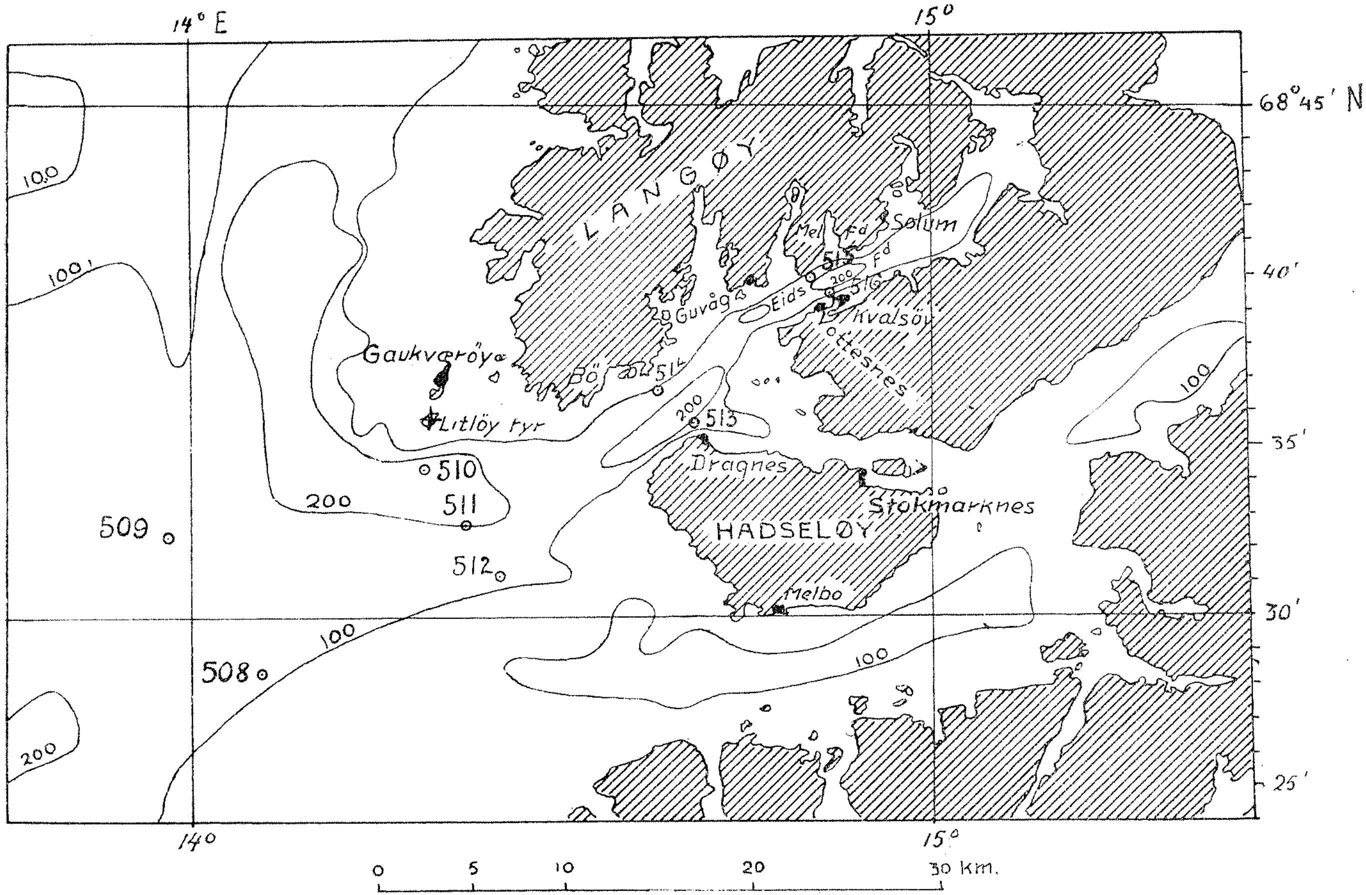

Fig. 1. ⊙ Stations. 100 = Isobaths.

observed: temperature, salinity, oxygen, p_H and phosphate contents. Besides a number of plankton hauls were made.

Oxygen was determined according to Winkler, phosphate according to Atkins, and for this as well as for the p_H-determinations (with phenolphthaleine) the Sund colorimeter was used (1931). All determinations were made on board the ship except those of salinity which were carried out in Bergen after the end of the cruise. Mr. Kr. Wilhelmsen being responsible for the salinity and oxygen determinations and the author for those of phosfate and p_H.

The sub-surface samples were obtained by means of Nansen water-bottles, each fitted with two thermometres from Franz Schmidt, Berlin, controlled by the Physikalisch-Technische Reichanstalt, Charlottenburg. The thermometres have also been controlled afterwards. As the readings were made with a proper reading-lens, the temperatures may be considered accurate within a hundredth of a degree Celsius. The maximum depths of observation were controlled by an unprotected thermometre on the lowest waterbottle in conjunction with an instrument of the ordinary construction.

I desire to express my sincere thanks to Mr. Oscar Sund who has assisted me in various ways and translated the paper and to Professor Dr. H. U. Sverdrup who has freely given me valuable advice.

Topography.

The Eidsfjord runs from the central portion of the island of Langøya in a south-westerly direction towards the open ocean. The continental shelf is very narrow in this area, the slope being only 54 km distant from Litløy lighthouse in the direction N 32° W. The fjord is deep, everywhere more than 150 m as far in as Solum. The greatest depth (230 m) is found where the Melfjord enters. Depths over 200 m are also found South of Guvaag and in a greater area between Hadseløya and Bö. The 100 m and 200 m lines are shown in the chart fig. 1. If the land were raised only 20 m the islands Hadseløya and Langøya would join. From an oceanographical point of view it is therefore natural to put the outer limit of Eidsfjorden at the line Bø—Hadseløya. A trough with depths of 150 to 260 m runs more or less parallel to the coast from the outside of Unstad to Hovden where it takes a north-westerly direction and runs across the shelf towards the slope, with shallows of less than 100 m on both sides, thus providing a direct deep connection between the deep area just mentioned and the deep water outside the slope. The treshold west of Kvalsøy is 157 m and thus constitutes only an imperfect barrier against watercommunication between the Eidsfjord and the shelf.

Currents.

Outside the slope the Atlantic current is running northwards. The greatest velocity is near the steeper part of the slope connecting the shelf and the deep basin of the Norwegian Sea. The Atlantic water intrudes like a wedge under the coastal water on the bank. This water is, according to the definition by Helland-Hansen and Nansen, characterised by a salinity of 35 ‰ or more whatever the temperature may be. The coastal water is less saline generally between 33 and 35 ‰. It is a mixture of Atlantic water and of less saline water which partly originates from the Baltic current and partly from precipitation and from discharge of rivers from the whole of the Norwegian coast farther south, and, lastly, water from the North Sea. The coastal current carrying these water-masses northwards runs mainly parallelly to the coast (Helland-Hansen and Nansen, 1909).

To get a picture of the currents in the area under consideration the sp. vol. in situ (compression considered) has been calculated for the standard isobar surfaces, and the dynamic depths have been calculated between these and the surface of the sea. In table V the values of the dynamic depth and of sp. vol. are given as anomalies, i. e. differences between the actual values and the values which would have been found if the temperature had been 0° C and the salinity 35 ‰ at all depths. If the actual values are required, the figures in col. 10 and 11 of tab. V are to be added to the standard values given in cols. A and B resp. in the table below.

Table I.

a desibar	A $10^5 \alpha$	B $10^4 D$
0	97 264	0
10	260	97 262
25	253	243 147
50	242	486 266
75	230	729 355
100	219	972 417
125	208	1 215 450
150	197	1 458 457
175	185	1 701 434
200	174	1 944 384
250	152	2 430 199

The charts figs. 2, 3 and 4 show the dynamic topography of the isobaric surfaces 10, 75 and 150 decibar relatively to the isobaric surface 175 decibar, chosen because it is lying so near to the bottom as possible. The dynamic isobaths have been drawn for every 2·5 dyn. millimetre on charts 2 and 3 and for every half dyn. mm on chart 4. Chart fig. 2 shows the local variations of the thickness of the water-layer between 10 and 175 db. expressed in dyn. mm. The curves drawn represent stream lines for the current in 10 m relatively to the current in 175 m, and the relative velocity of the current is inversely proportional to the distances between the curves supposing that the conditions are stationary and the accelerating force due to friction is negligible. If $\triangle D_1 - \triangle D_2$ is the interval in dynamic decimeters between two curves, and L the distance in metres we have

$$v - v_0 = \frac{\triangle D_1 - \triangle D_2}{2 \omega \sin \varphi L}$$

where $\omega = 0{\cdot}729 \cdot 10^{-4}$ and φ the latitude. The formula gives the velocity in metres per second. If the velocity in 175 m is negligible, the curves represent actual stream lines and from the chart the absolute current in 10 m can be derived. According to the chart a relatively strong current runs outside the Eidsfjord towards NNE (the coastal current). Near the shallows outside Litløy and Gaukværøy it turns a little, taking a more Northerly course. In the area south of Litløy and inwards to beyond Dragnes an anticyclonic whirl is formed. A smaller whirl is also indicated between Melfjord and Kvalsøy, the rotation is clockwise as in the first case.

Chart fig. 3 shows that the current on the bank is considerably weaker in 75 than in 10 m but of the same direction. Outside the fjord a curl movement is seen in this depth also and inside Dragnes a strong current up the fjord is apparent.

Chart fig. 4 shows that on the bank the current is very weak in 150 m and of the same direction as in the two other depths mentioned. Inside Dragnes the current is opposite to that in 75 m, running out of the fjord. In the area S of Litløy there is also an indication of the whirl seen in charts 2 and 3.

Bearing this horizontal current system in mind as observed at three levels we shall now proceed to a study of the current distribution by means of vertical sections. In general the component of the relative currents at right angles to a vertical section through two stations can be computed by means of the above formula if $\triangle D_1 - \triangle D_2$ represents the difference in the dynamic distance between two isobaric surfaces at two stations and L the distance between the stations.

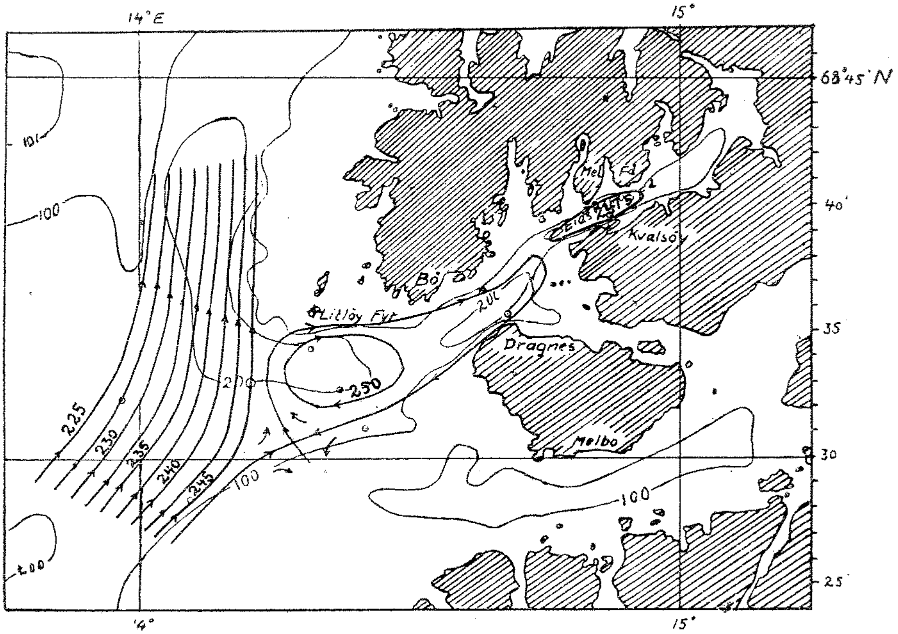

Fig. 2. The dynamic Topography of the Isobaric Surface 10 db relatively to 175 db. Lines of equal dynamic Depth in mm (Approx. Streamlines in 10 m).

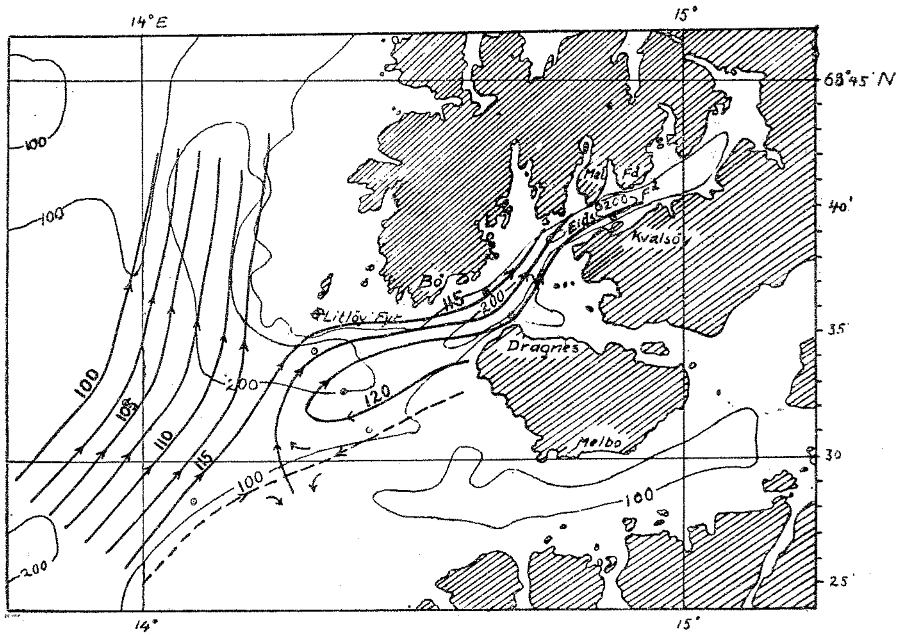

Fig. 3. The dynamic Topography of the Isobaric Surface 75 db relatively to 175 db. Lines of equal dynamic Depth in mm (Approx. Streamlines in 75 m).

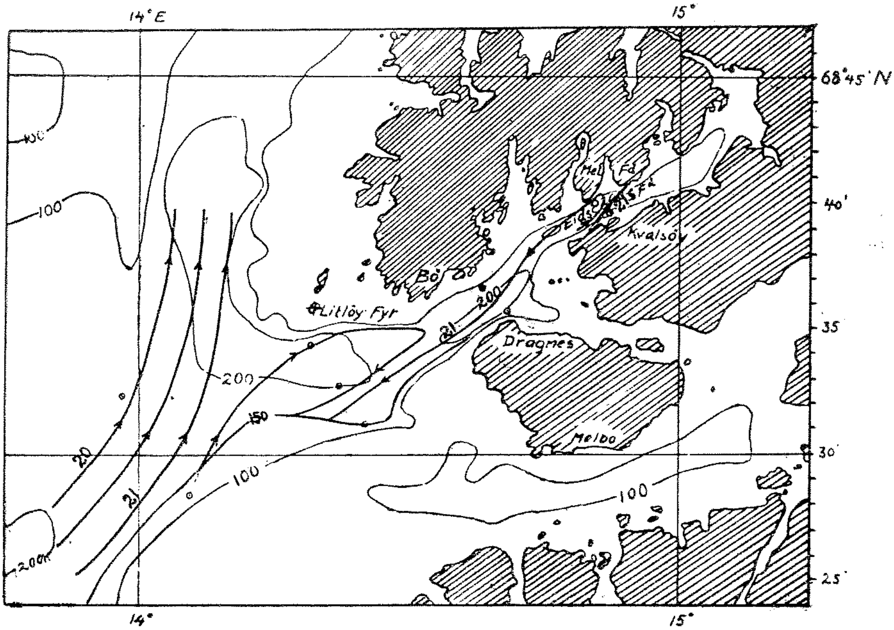

Fig. 4. The dynamic Topography of the Isobaric Surface 150 db relatively to 175 db. Lines of equal dynamic Depth in mm (Approx. Streamlines in 150 m).

The above formula is derived by means of Bjerknes theorem of circulation.

If C is the circulation in a closed curve, then its acceleration $\frac{dC}{dt}$ is a function of the number of solenoids ($\int \alpha\, dp$) formed by the intersection of isobars and isosteres within the curve and of the variation of the projection S of the curve area on the equatorial plane. Disregarding friction the theorem gives.

$$\frac{dC}{dt} = -\int \alpha\, dp - 2\,\omega \frac{ds}{dt} \quad \ldots\ldots\ldots\ldots \quad (1)$$

where α is sp. vol., p pressure and ω the angular velocity of the Earth.

Helland-Hansen and Sandstrøm (1905) have shown how this formula may be used for the calculation of the vertical velocities under stationary conditions.

Let a closed curve be limited by two verticals (stations A and B) and by two isobars in the depths z_0 and z_1 the curve being at right angles to the direction of the current. Then the mean relative current between A and B at the two levels (z_0 and z_1) is:

$$C_0 - C_1 = \frac{1}{2\,\omega L \sin\varphi}\left[\left(\int_{p_0}^{p_1} \alpha\, dp\right)_A - \left(\int_{p_0}^{p_1} \alpha\, dp\right)_B\right] \quad \ldots\ldots \quad (2)$$

The expression within the angular brackets gives the number of solenoids within the curve. p_0 and p_1 are the pressures in z_0 and z_1 L is the distance in km between A and B and φ is latitude.

In stead of sp. vol. its anomaly $\triangle \alpha$ may be introduced. As $\triangle \alpha = \alpha - \alpha_{35, 0, p}$ (Bjerknes 1911) the formula becomes.

$$C_0 - C_1 = \frac{1}{2 \omega L \sin \varphi} \left[\int_{p_0}^{p_1} (\triangle \alpha \, dp)_A - \int_{p_0}^{p_1} (\triangle \alpha \, dp)_B \right]$$

When the $\triangle \alpha$ have been found by means of Sund's oceanographical Slide Rule, based on Hesselberg and Sverdrup's tables (1915), the two integrals are easily found by means of calculating machine. The integrals represent the anomalies $\triangle$ D which are given in table V, column 11, if z_0 represents the surface.

The formula can therefore be written

$$C_0 - C_1 = \frac{\triangle D_A - \triangle D_B}{2 \omega L \sin \varphi}$$

If the line connecting these stations forms an angle β with the direction of the current the values given by the formula have to be divided by sin β.

The table below gives the currents relative to the current at 175 m between stations 508 and 509, 30 km W of Melbo. The direct computed values have been divided by sin β, the value $\beta = 68°$ being determined from the charts.

Table II.

Depth in m	0	10	25	50	75	100	125	150	175
Velocity, cm/sec	16·2	15·3	14·7	12·9	9·8	5·8	2·7	1·3	0·0
do. km/day	14·0	13·2	12·7	11·1	8·5	5·0	2·3	1·1	0·0

It is seen that the velocity decreases much between 75 and 100 m, exactly at the transition between the surface layer which have been cooled during the autumn and the heavier deep water. This Sprungschicht is not quite horizontal, therefore one finds in the depths corresponding to it a considerable variation of $\triangle$D in the same level and consequently a relatively strong current.

The corresponding currents between some of the other stations are represented in fig. 5. From this it is seen that the current is directet towards WSW in all dephts between sts. 512 and 511. It is strongest in 50 m. On the N side of the trough between sts. 510 and 511 the current conditions are considerably different, an in-going current is present in the intermediary layer, with maximum strength in 75 m, and outgoing currents at the bottom and at the surface. Between Dragnes and Bø the in-going current is stronger, having similarily its maximum at 75 m. At the surface and at the bottom weak currents

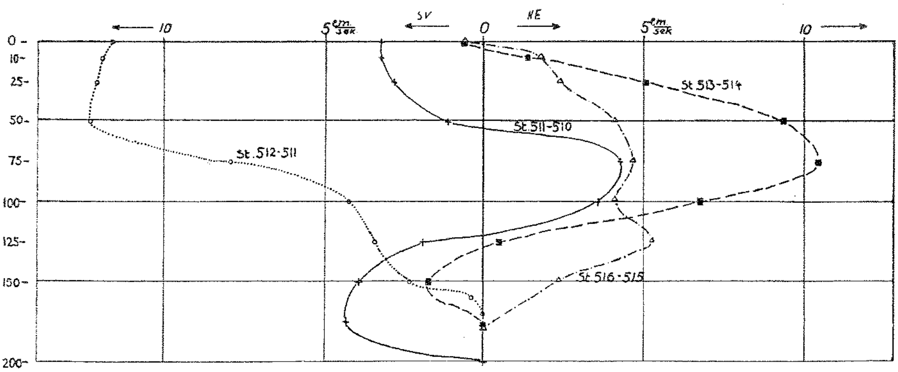

Fig. 5. The vertical Distribution of velocity between Stations 511 and 510, 513 and 514, 516 and 515 and between 512 and 511.

run out. Between Kvalsøy and Melfjord the in-going current has dived somewhat deeper while decreasing in strength. Here also a weak outgoing current is apparent at the surface while no indication of such a current is observed near the bottom.

According to fig. 5 it would appear that more water flowed into the fjord than out again. Some water may, of course, be flowing out between our stations and the shore, though not much as they are very close to the shore. As the bottom of the fjord is uneven som bottom water may have escaped the calculations and as this probably would be flowing out like the bottom water in the outer area, the outflow will be somewhat larger than what might be gathered from our calculations. The assumption of zero velocity at 175 m is, perhaps, not quite justified. At this level the current may flow out and our calculation may, therefore, give a too small outflow. The oxygen diagram also shows (fig. 10 p. 16) the presence of an outflowing bottom current. The hatched area corresponds to a saturation of less than 90 % and this bottom water, relatively poor in oxygen, wedges into the more strongly oxygenated water on the bank, in about 150 m. The wind plays a certain part for the outflowing current in the upper layers. During the period of observation the winds were NNW to NE at an average velocity of 3 Beaufort. Such a strength will cause a current of about 6 cm/sec (E. Palmén, 1931) out of the fjord, and as the fjord is rather narrow the rotation of the Earth will only to a small degree produce a solenoid field corresponding to this wind action. The residual wind current is therefore added to the weak outgoing surface current found by direct calculation. This reasoning is corroboratet by fig. 11 showing phosphate contents in a section from the bank to the innermost station opposite the Melfjord. In the uppermost 100 m the phosphate iso-lines rise rather strongly in the fjord, like the isotherms and the isohalines (see fig. 8). This seems to indicate a movement towards the surface, which is a necessary result if the wind drives the surface water out from the shore and from the fjord.

In the area investigated two current systems may be discerned, one on a bank, the coastal current, and another inside of this. While the current on the bank is of one direction in all depths, viz NNE, the current system inshore is very complicated. In the area south of Litløy to Dragnes a clockwise whirl is established while in the Eidsfjord a strong current in the intermediate water layer (60—125 m) runs into the fjord while an outflow takes place at the bottom and in the surface layers.

The oxygen distribution indicates that the outflow along the bottom is quite a typical phenomenon and that the inflow in the intermediate strata is not only due to the effects of a pure wind drift in the upper layers. This may also be gathered from tab. III. On the other hand, the wind will influence the thickness of the inflowing water. A strong and persistent northerly wind pushing much surface water out of the fjord must cause an increase of the inflow inducing a broader branch of the coastal current to enter the fjord. Such a situation must be considered very favorable for the approach of herring into the fjord if herrings are present in the coastal water outside on the bank. In this connection it may be mentioned that three days before and during the inflow of herrings into the Eidsfjord (August 1933), northeasterly winds at an average velocity of 4·5 Beaufort were blowing.

When flowing into the fjord the warm intermediate water mixes with the bottom layer which is colder and more saline. It will also produce a reaction current, the weak bottom flow. The outcome of this is that the bottom water gets well aired and gets a lower salinity along with a higher temperature as the autumn proceeds. The table below will show this. The three stations were near to Vottesnes while the fourth (25 oct. 1932) was situated only one mile farther up the fjord.

It is seen that the temperature in the deep layer increased and the salinity diminished considerably between $^{7}/_{7}$ and $^{8}/_{12}$ 1928. During that time a considerable change of the water has taken place. The heavy deep water with relatively low temperature and high salinity has been replaced with lighter water of lower salinity and higher temperature The same was the case in 1932 but in a lower degree. In that year, however, the period between the two observations ($^{14}/_{7}$—$^{25}/_{10}$) was shorter, 104 days as against 155 in 1928.

Table III. *Observations at Vottesnes, Eidsfjord.*

Depth	Salinity				Temperature				$10^5\Delta\alpha$ = sp.vol.anomali			
	1928		1932		1928		1932		1928		1932	
	7/7	8/12	14/7	26/10	7/7	8/12	14/7	26/10	7/7	8/12	14/7	26/10
0	32·92	32·36	33·24	32·92	11·48	2·90	12·48	6·56	288	220	283	215
10	33·04	33·19	·29	·95	·22	4·51	11·67	·99	280	173	264	218
25	·64	·31	·68	33·06	5·83	·89	7·30	7·34	153	167	168	215
50	·85	·36	·76	·65	·08	5·10	5·48	8·75	129	166	140	191
75	·87	·36	·86	·92	4·70	·14	4·72	·65	123	166	124	170
100	34·46	·38	34·54	34·15	5·61	·15	6·02	·36	90	166	88	149
125	·64	34·07	·80	·50	·90	6·88	·53	7·60	80	135	76	113
150	·68	·54	·90	·70	·99	7·03	·61	·03	78	102	70	91
175	·72	·70	—	·81	6·03	6·94	—	6·98	77	90	—	82
200			·95				·65				66	

Temperature and Salinity.

Fig. 6 shows the distribution of temperature and salinity from the bank and up the fjord. The varmest layer, keeping some of the summer heat, is found between 50 and 100 m with a temperature of 8·30—8·96 and maximum in 75 m. To this depth the autumn cooling has reached. The temperature is lower within the fjord than outside, the difference being most conspicuous in 25 m. and the isohalines follow the isotherms in this layer. The following table shows the average temperatures and salinity in the upper 25 metres:

Table IV.

Station no.	509	511	514	515
Temperature	8·27	7·72	6·46	6·85
Salinity	33·44	33·22	32·83	32·93

The fact that S and T are higher in the Eidsfjord (at st. 515) than in the fjord mouth near Dragnes (st. 514) must be caused by a vertical motion of the water towards the surface under the influence of wind blowing the surface water out of the fjord. For more details on this point see p. 11.

Only in the deepest portion of the bank some Atlantic water is found close to the bottom. Nothing of this however, enters the fjord

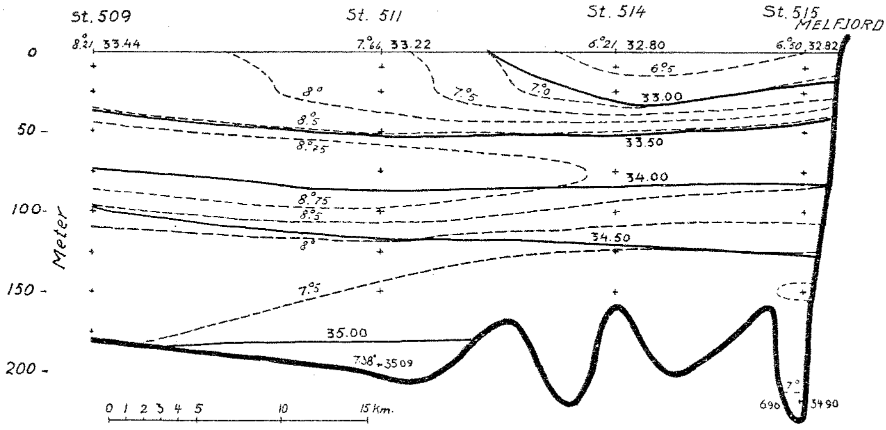

Fig. 6. Vertical Section, showing Temperature and Salinity.

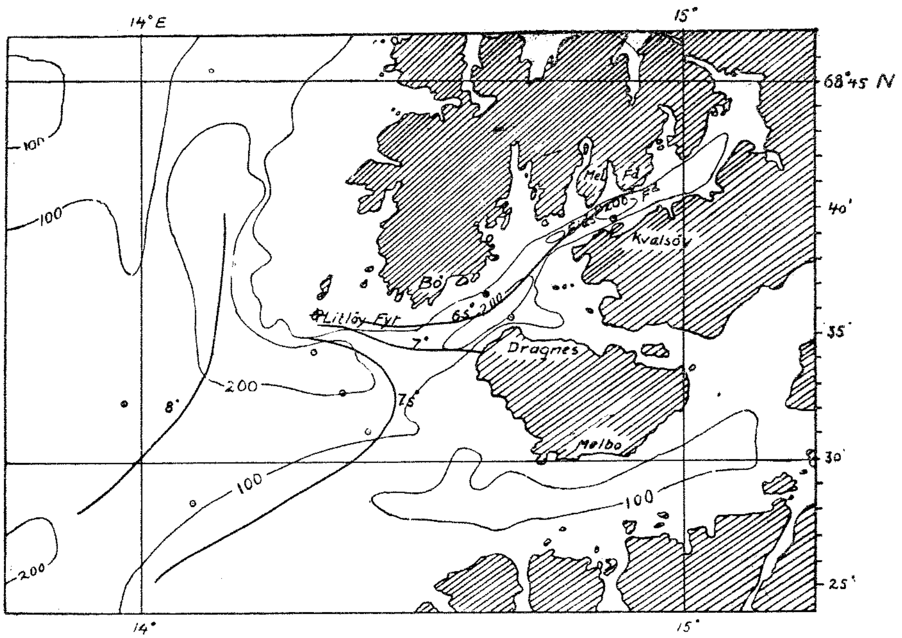

Fig. 7. Surface Temperature.

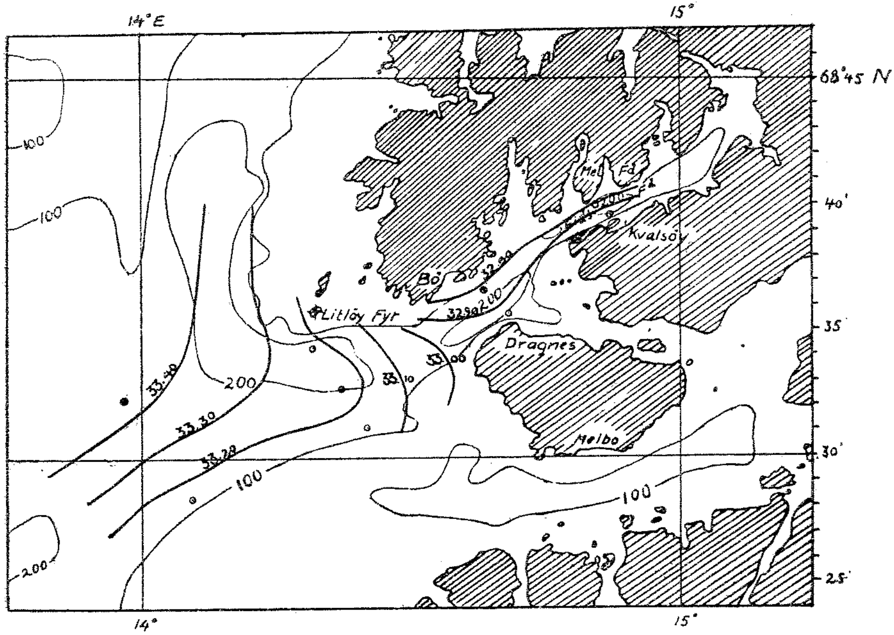

Fig. 8. Surface Salinity.

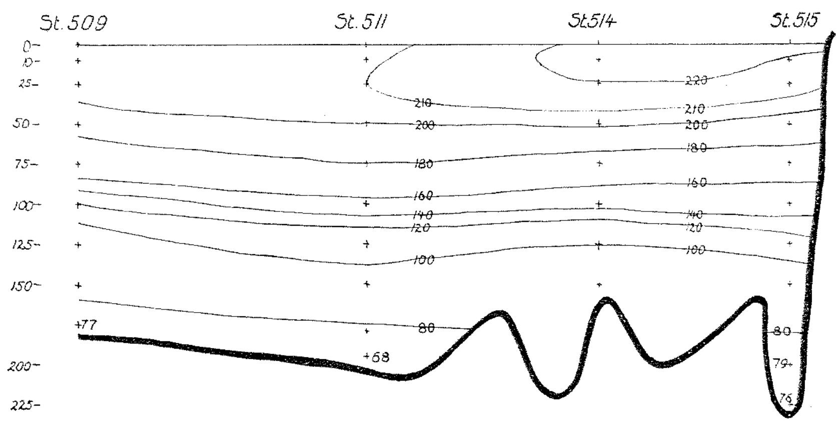

Fig. 9. Vertical Section, showing Specific Volum Anomali.

as the treshold depth of 165 m S of Dragnes bars it from entering. At the innermost station (515) the salinity is 34·90 at the bottom (225). The lowest temperature (6.96) is also found here. This is most evident from table V. In fig.s 7 and 8 it is seen how the surface temperature and salinity decrease from the bank inwards. Inside Dragnes the isolines run lengthwise along the fjord, the lowest values being found on the right side which is influenced by the greatest drainage area. The greater amount of freshwater will at this season lower both temperature and salinity. The cooling will, however, be predominant to that extent that the density of the water will also be lowered. The rotation of the Earth will furthermore help in keeping the outflowing water to the right.

The Oxygen Contents.

From fig. 10 it is seen that the water is richer in oxygen on the bank than inside the fjord, except in the intermediate layer 100—125 m where the saturation is about the same along the entire section. The maximum is found right south of Litløy at 50—75 m where the saturation reaches 98 %. This high percentage must at least for a great deal be caused by the phytoplankton which was most abundantly present here, and just in hauls 75—0 m (st. 510). Attention is drawn to the fact that this station is situated near to the centre of the whirl which according to our representation was present directly outside of Eidsfjorden. The water poorest in oxygen is the bottom water in the fjord. The hatched area corresponds to saturation below 90 %. Oppo-

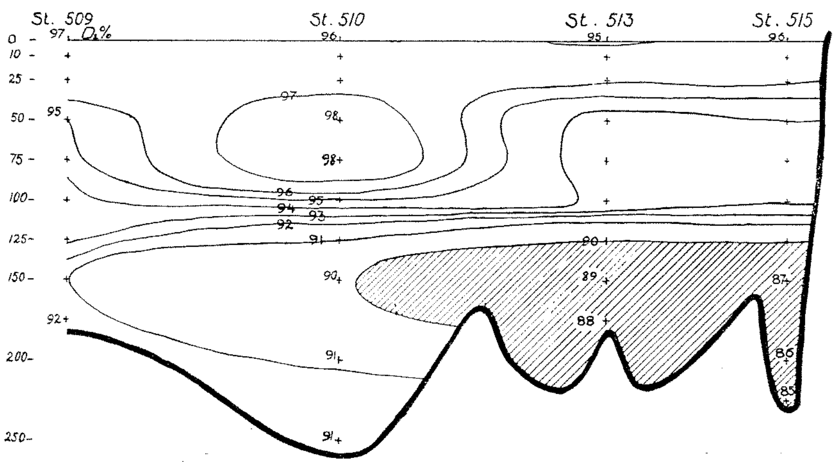

Fig. 10. Vertical Section, showing Oxygen-Saturation in %.

site the Melfjord an oxygen minimum of 85 % is found at 225 m. The oxygen distribution corresponds well with the current system as calculated from density data. From fig. 10 it appears how the bottom water relatively poor i oxygen wedges into the more oxygenated water on the bank. And at the intermediate depths where a small branch of the coastal stream enters the fjord the saturation is nearly uniform all along.

It is seen that the water in the upper layers is not saturated. According to T. Gårder (1915) this must be ascribed to the cooling being so swift at this season that the vertical circulation brings the water down before it can absorb more oxygen than it held before the cooling.

The Phosphate Contents.

(Fig. 11).

In the upper strata where a vertical circulation takes place, the amount of phosphate is relatively uniform. From a depth of 100 m it increases strongly down to 125 m like salinity and density while oxygen saturation decreases (fig. 6, p. 19). In this layer the phosphate valuas are nearly the same on the bank as in the fjord (compare the oxygen distribution) while the bank water is richer in the upper 100 m. The isolines rise at Melfjord and, as mentioned above, this can be attributed to an upward movement of the water caused by the wind current. The highest value, 109 mg pr. cub.m is found at the bottom inside the treshold. Here oxygen is at its minimum, 85 %. Both factors indicate that the treshold at 157 m forms a barrier to the renewal of the bottom water.

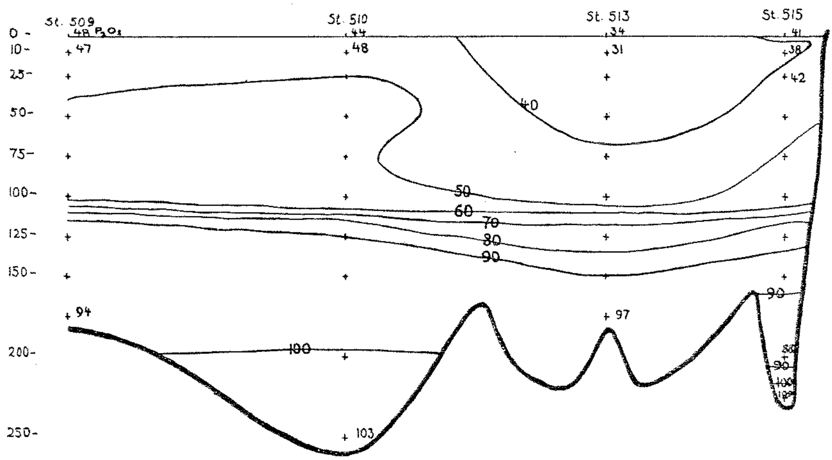

Fig. 11. Vertical Section, showing P_2O_5 mg/m³.

Explanation of table V.

At each station number, date, position and sounding is given.

Column
1, T.: Hour of observations in mean European time (MET).
2, a: Geometrical depth (m) if referred to cols. 3—9 and decibar if referred to cols. 10 and 11.
3, t°C: Temperature in centigrade degrees.
4, S ‰: Salinity in per mille.
5, σt: $\sigma t = (\rho - 1) \cdot 1000$, where ρ is the sp. gravity at a pressure of 1 bar.
6, $\frac{\Delta \alpha'}{\Delta a}$: An expression of the stability. α = sp. vol.
7, O_2 %: Oxygen saturation in per cent.
8, pH: Hydrogen ion consentration.
9, P_2O_5: Phosphate contents as mg pentoxide per cub.m.
10, $10^5 \Delta \alpha$: *Difference between the sp. vol. in situ (pressure considered) at the isobaric* surface *a* decibars and the value found if the salinity had been 35 ‰ and the temperature 0 °C throughout the water mass. The observed values of t, S and σt in *a* metres have also been regarded as representative of the depths with a pressure of *a* decibars.
„ 11, $10^4 \Delta D$: Difference between the real dynamic depth from the sea-surface to the isobaric surface *a* decibars and the dynamic depth corresponding to a water mass of 35 ‰ and 0 °C throughout.

Table V.

T.	a	t °C	S ‰	σt	$10^7 \frac{\Delta \alpha'}{\Delta a}$	O_2 %	pH	P_2O_5	$10^5 \Delta \alpha$	$10^4 \Delta D$
			St. 508. 25 October, 1932. 68° 28·1′ N, 14° 06′0′ E, 145 m.							
	0	7·69	33·08	25·84		—	—	39	217	0
0944	10	·85	·23	·93	80	—	—	39	09	214
„	25	·88	·28	·97	20	—	—	44	06	521
„	50	8·88	·54	26·02	20	—	—	47	01	1030
„	75	·85	·83	·25	84	—	—	59	180	1505
„	100	·45	34·23	·63	140	—	—	60	145	1913
0943	125	7·75	·76	27·14	196	—	—	70	96	2212
„	135	·62	·77	·17	20	—	—	90	94	2307
			St. 509. 25 October, 1932. 68° 32·0′ N, 13° 58·0′ E, 180 m.							
1040	0	8·21	33·44	26·04		97	8·10	48	198	0
1045	10	·27	·42	·02	− 30	97	·12	47	201	200
„	25	·32	·38	25·98	− 20	97	·11	43	204	503
„	50	·83	·75	26·19	76	95	·10	55	185	991
„	75	·95	34·02	·38	68	95	·09	56	168	1431
„	100	·41	·56	·89	192	94	·07	58	120	1793
„	125	7·62	·80	27·19	116	93	·07	94	91	2056
„	150	·63	·91	·28	32	91	·05	94	83	2274
„	175	·54	·98	·35	24	92	·05	94	77	2473

Table V (continued).

T.	a	t °C	S ‰	σt	$10^7 \frac{\Delta\alpha'}{\Delta a}$	O_2 %	pH	P_2O_5	$10^5\Delta\alpha$	$10^4\Delta D$
	St. 510. 25 October, 1932. 68° 34·5′ N, 14° 18·8′ E, 258 m.									
	0	7·69	33·23	25·95		96	8·13	44	206	0
1218	10	·80	·21	·92	− 40	97	·11	48	210	208
„	25	·79	·19	·91	− 7	97	·11	50	211	524
„	50	8·09	·31	·96	16	98	·14	53	207	1047
„	75	·29	·49	26·07	40	98	·12	51	197	1551
„	100	·65	34·41	·73	248	95	·11	56	135	1969
1222	125	7·69	·66	27·07	128	91	·04	90	103	2265
„	150	·44	·79	·21	56	90	·04	89	89	2506
„	200	·43	·95	·34	22	91	·04	101	78	2923
„	250	·41	35·07	·44	16	91	·04	103	70	3293
	St. 511. 25 October, 1932. 68° 32·6′ N, 14° 22·0′ E, 200 m.									
	0	7·66	33·22	25·95		—	—	—	207	0
1327	10	·74	·22	·93	− 20	—	—	—	209	208
„	25	·74	·21	·92	− 7	—	—	—	210	522
„	50	8·43	·47	26·04	40	—	—	—	200	1035
„	75	·96	·84	·24	80	—	—	—	180	1509
„	100	·74	34·15	·51	96	—	—	—	156	1931
1328	125	·79	·60	27·01	192	—	—	—	108	2258
„	150	·44	·74	·18	60	—	—	—	93	2510
„	195	·38	35·09	·45	56	—	—	—	68	2871
	St. 512. 25 October, 1932. 68° 31·0′ N, 14° 25·3′ E, 166 m.									
	0	7·53	33·18	25·94		97	—	32	208	0
1406	10	·65	·19	·92	− 10	96	—	31	209	209
„	25	·58	·17	·91	− 13	96	—	33	211	524
„	50	8·70	·59	26·08	64	94	—	33	195	1032
„	75	·65	·88	·32	88	94	—	37	173	1491
„	100	·95	34·27	·57	92	97	—	35	150	1896
1407	125	7·83	·58	27·00	160	91	—	55	110	2219
„	150	·52	·85	·25	132	90	—	81	87	2466
„	160	·43	·91	·31	70	90	—	81	80	2550
	St. 513. 25 October, 1932. 68° 35·6′ N, 14° 40·9′ E, 180 m.									
	0	6·74	32·95	25·86		95	8·10	34	215	0
1546	10	7·15	33·04	·88	10	96	·10	31	214	215
„	25	·19	.09	·91	20	96	·10	32	211	533
„	50	8·77	·58	26·06	56	94	·10	36	197	1044
„	75	·68	·88	·31	92	94	·10	41	174	1506
„	100	·59	34·16	·54	88	94	·09	44	152	1915
„	125	7·66	·56	27·00	168	90	·07	75	110	2240
„	150	·24	·82	·26	100	89	·04	87	85	2485
„	175	·16	·86	·31	16	89	·03	97	81	2693

Table V (continued).

T.	a	t°C	S ‰	σ_t	$10^7 \frac{\Delta\sigma'}{\Delta a}$	O_2 %	pH	P_2O_5	$10^5\Delta\alpha$	$10^4\Delta D$
St. 514. 25 October, 1932. 68° 36·5′ N, 14° 38·1′ E, 155 m.										
	0	6·21	32·81	25·81		—	—	—	220	0
1633	10	·43	·80	·78	- 30	—	—	—	223	222
„	25	·66	·89	·83	27	—	—	—	219	553
„	50	8·47	33·46	26·02	72	—	—	—	201	1079
„	75	·72	·89	·32	112	—	—	—	173	1545
1643	100	·35	34·22	·64	120	—	—	—	143	1941
„	125	7·50	·64	27·08	168	—	—	—	101	2244
„	150	·20	·78	·23	52	—	—	—	88	2481
St. 515. 26 October, 1932. 68° 40·1′ N; 14° 50·8′ E, 230 m.										
	0	6·50	32,82	25·79		96	8·11	41	222	0
0847	10	·80	·91	·82	30	96	·11	38	219	219
„	25	7·15	33·03	·87	27	96	·10	42	215	546
„	50	8·71	·61	26·10	84	94	·10	45	194	1058
„	75	·59	·95	·39	104	94	·09	51	168	1509
„	100	·30	34·13	·56	72	93	·08	53	150	1908
„	125	7·49	·46	·95	144	90	·06	88	114	2236
„	150	·00	·75	27·25	112	87	·05	91	86	2487
„	200	·02	·86	·33	14	86	·03	88	79	2900
„	225	6·96	·90	·37	12	85	—	109	76	3093
St. 516. 26 October, 1932. 68° 39·7′ N, 14° 52·3′ E, 190 m.										
	0	6·56	32·92	25·86		—	—	—	215	0
0833	10	·99	·95	·83	- 30	—	—	—	218	217
„	25	7·34	33·06	·87	20	—	—	—	215	541
„	50	8·75	·65	26·12	96	—	—	—	191	1050
„	75	·95	·92	·35	84	—	—	—	170	1500
„	100	·36	34·15	·58	84	—	—	—	149	1900
0835	125	7·60	·50	·96	144	—	—	—	113	2226
„	150	·03	·70	27·20	89	—	—	—	91	2482
„	180	6·98	·81	·30	30	—	—	—	82	2741

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