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TRIAL OF METHODS OF MEASURING TRANSPARENCY OF SEA WATER

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FROM 3rd to 9th August 1937, a voyage was made in the "George Bligh" to determine the distribution of different kinds of water in the Southern North Sea. We made 44 stations, and worked generally at the depths of 1 m., 10 m., and near bottom. Samples were preserved for determination of salinity and the following determinations were made on the stations when conditions were suitable: temperature, salinity, phosphate, transparency with Lowestoft photometer, transmission of light to submerged photometer, transparency with Secci's disk, and colour. Data for temperature, salinity and phosphate will be published in the Bulletin Hydrographique for 1937. The remaining results are given in Table I.

In all, 19 charts were made of these results, at different depths and using averages of results at all depths, of which four charts referring to the depth of 10 metres will serve to show how the different observations fit each other. Fig. 1 shows the salinity and general topography of the area.

Looking first at the distribution of water of less than 34·0 per mille salinity, this is seen on the English side extending out from the coast of Norfolk as far as and beyond Smith's Knoll. The freshness of this water is no doubt to be ascribed mainly to the river systems of the Humber and Wash, aided no doubt by the Thames. The fresher water off the continental coast seemed to be more evenly aligned parallel with the shore. The salt water supply from the English Channel was distinguishable in the usual area between the masses of fresher water near the coasts. Salter water from the north appears as if pouring in through the Flamborough gateway and over the Dogger Bank itself.

This information became available after the salinities were titrated. It is interesting to see how much of it could have been anticipated from measurement of transparency.

In Fig. 2 are shown the results of measuring the transparency by putting the samples of water in one of the upper glasses of the Lowestoft photometer and balancing by sliding in one of the graded screens.[1]) This screen had first been calibrated to show percentage transmission of the light, by sliding it in so as to give measured differences in deflection of a galvanometer and marking the edge accordingly. Naturally, this calibration was done in harbour with the ship at rest. Comparing Fig. 1

[1]) Journ. du Conseil, XI, 2, Copenhagen, 1936.

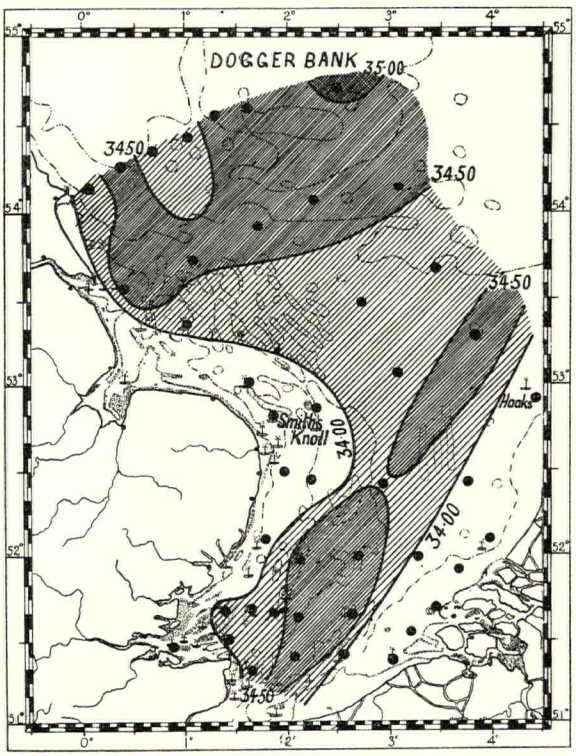

Fig. 1. Salinity.

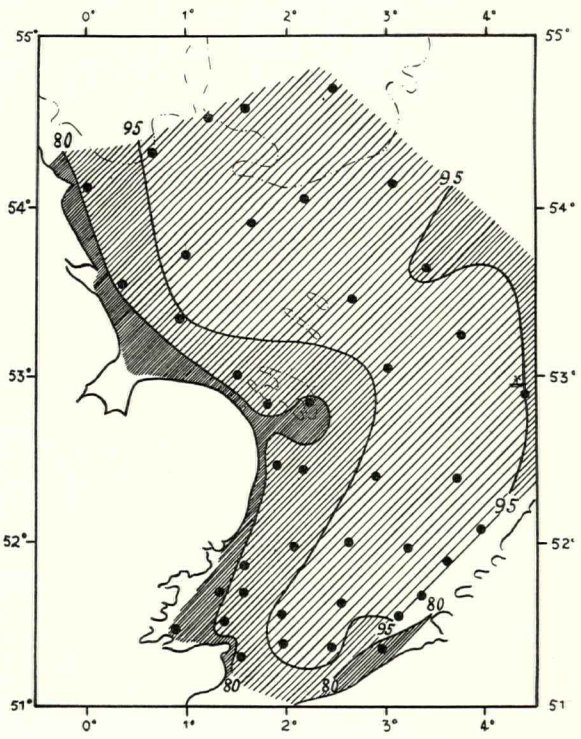

Fig. 2. Transparency by Lowestoft Photometer.

and Fig. 2, the area of distribution of the clearer, salter water from the Channel and Northern North Sea, as distinct from coastal water, is shown in both. There are, however, differences in detail and, particularly, two faults: firstly, the method is not very sensitive, so that, for example, there is generally no distinction between water of above and below salinity of 34·5 per mille. Secondly, turbidity due to local features, such as Smith's Knoll, certainly has an effect, just as the local and rather surprising clearness off the Maas would lead to the wrong idea that water from the Channel was close inshore there. This method has, however, the advantage that it can be used at night.

So far we have dealt with observations at the particular level of 10 m. from the surface. Distribution of phosphate at the same depth was, on this occasion, mainly similar to the distribution of turbidity, that is, it followed the shading of Fig. 2 and the fresh water of Fig. 1. This is by no means always the case, but that is not the subject of the present paper. Temperature at the same level was not particularly informative. There seemed to be a tongue of cooler water extending east from Flamborough and grading from there to warm water on the continental coast and in the estuary of the Thames.

I am indebted to my colleague, Mr. R. S. W i m p e n n y, for arranging the apparatus for measuring the percentage of light at the surface that is transmitted to the depth of 10 m. The results are shown in Fig. 3. Here there are fewer observations available, because the work could not be done at night. The same limitation applies to the use of Secci's disk, of which the results are shown in Fig. 4. Both methods seem more sensitive than the Lowestoft photometer in distinguishing the most clear from the slightly less clear water. Both have the fault, seen already in Fig. 2, of confusing the transparency or turbidity that the water has acquired locally with that due to its origin and history. Observations on the colour observed against Secci's disk were only made in the later part of the cruise, that is, north of 52° Latitude. The results suggest that this method will not be much help in defining these water masses. The bluest water extended from the second station off Flamborough to the eastward. The yellowest water was near the coast.

The conclusion is that, from the point of view of studying the distribution of water masses in summer, there is much in favour of using Secci's disk. In winter, when most observations would be nocturnal, the Lowestoft photometer would be useful. The most promising method of all is the artificially-illuminated, submerged photometer. This is now in use.

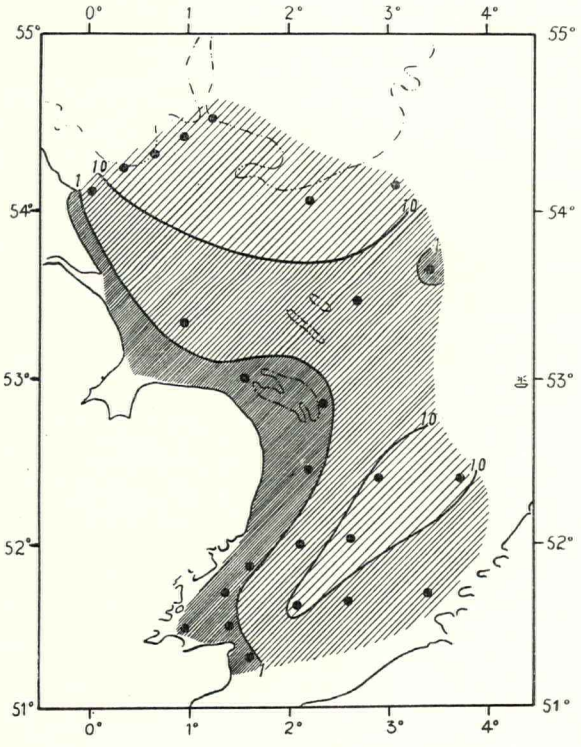

Fig. 3. Transparency by Submarine Photometer.

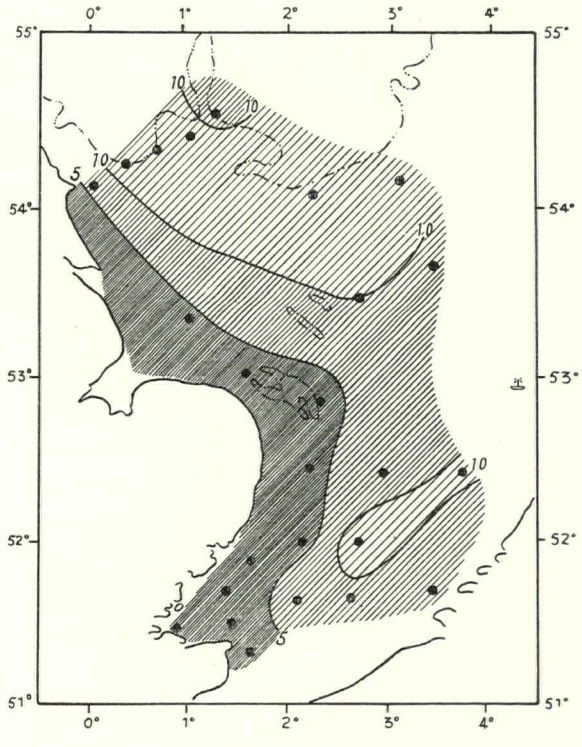

Fig. 4. Transparency by Secci's Disk.

Table 1.

Transparency with Lowestoft Photometer, Transparency with Secci's Disk, Transmission of Daylight, and Colour according to Forel's Scale.
S.S. "George Bligh", Cruise L 1934.

S. Reading of Secci's disk.
P. Transmission of daylight as a percentage of that just above sea surface. Measured with a submerged photo-cell, compared with one on the bridge.
Ty. Transparency measured by light transmitted through the 10″ tube of the Lowestoft photometer, expressed as a percentage of that transmitted through distilled water.
F. Colour according to Forel's scale. For example, No. 3 might be called "greenish blue" and No. 9 "yellowish green".
Positions, temperatures, salinities and phosphates will be published in the "Bulletin Hydrographique" for 1937

Station	Date, 1937	Time	S.	F.	Depth	P.	Ty.
1	3. VIII	1943			1		96
		1947			10		94
		1951			25		93
2	„ „	2312			1		
		2316			10		
		2320			20		
3	4. VIII	0329			1		86
		0333			10		88
		0337			18		86
4	„ „	0633	2·5		1		88
		0637			10	0·3	86
		0641			15		79
5	„ „	0835	2·4		1		84
		0839			10	0·3	75
6	„ „	1347	1·1		1		65
		1351			10	0·0	71
		1355			18		72
7	„ „	1646	2·5		1		83
		1650			10	0·4	83
8	„ „	1832	2·3		1		80
		1836			10		82
		1838			15		82
9	„ „	2057			1		97
		2103			10		96
		2107			30		96
10	„ „	2317			1		98
		2320			10		98
		2323			25		98
11	5. VIII	0125			1		65
		0129			10		65
12	„ „	0318			1		100
		0321			10		100
		0324			20		100
13	„ „	0521	6·5		1		100
		0524			10	2·8	100
		0527			20		100
14	„ „	0853	9·5		1		100
		0856			10	8·0	100
		0859			30		100
15	„ „	1210	8·3		1		97
		1212			10	10·9	100
		1214			45		100
16	„ „	1440	3·8		1		92
		1443			10	1·4	92
		1446			25		92
17	„ „	1733	11·0		1		100
		1736			10	13·0	100
		1740			35		100
18	5. VIII	2023			1		100
		2025			10		98
		2027			25		98
19	„ „	2236			1		100
		2238			10		100
		2240			20		100
20	6. VIII	0054			1		90
		0058			10		100
		0102			15		100
21	„ „	0334			1		100
		0338			10		90
22	„ „	0640	10·0		1		100
		0642			10	12·0	100
		0645			20		100
23	„ „	1040	8·3		1		100
		1044			10	11·2	100
		1048			40		100
24	„ „	1422	4·5	9	1		90
		1425			10	0·4	85
		1429			30		80
25	„ „	1712	4·0	7	1		80
		1714			10	0·5	80
		1718			35		80
26	„ „	2118			1		100
		2121			10		100
		2125			25		100
27	7. VIII	0107			1		100
		0111			10		100
		0115			20		100
28	„ „	0443	9·0	5	1		100
		0447			10	9·4	90
		0451			35		90
29	„ „	0834	10·0	6	1		100
		0837			10	6·5	100
		0839			25		100
30	„ „	1406	12·0	4	1		100
		1409			10	14·9	100
		1412			25		100
31	„ „	1825	14·0	3	1		100
		1828			10	17·2	100
		1832			65		90
32	„ „	2130			1		100
		2132			10		100
		2137			25		100
33	8. VIII	0041			1		100
		0044			10		100
		0048			20		100

Station	Date, 1937	Time	S.	F.	Depth	P.	Ty.
34	8. VIII	0357			1		90
		0400			10		90
		0404			15		90
35	„ „	0923	5·5	8	1		90
		0925			10	4·9	90
		0928			20		
		0931			30		
		0934			40		90
36	„ „	1145	15·5	3	1		
		1147			10	17·1	
		1149			20		
		1153			30		
		1155			40		
		1158			50		
37	„ „	1400	17·0	5	1		100
		1404			10	19·2	90
		1408			20		
		1412			30		
		1416			40		
		1420			50		100

Station	Date, 1937	Time	S.	F.	Depth	P.	Ty.
38	8. VIII	1634	13·0	5	1		
		1637			10	17·3	
		1640			20		
		1643			30		
		1646			40		
39	„ „	1908	9·5	6	1		100
		1912			10	10·2	100
		1916			20		
		1920			30		100
40	„ „	2110			1		100
		2114			10		100
41	9. VIII	0127			1		100
		0129			10		100
		0132			15		100
42	„ „	1332	4·2	9	1		95
		1334			10	1·6	95
43	„ „	1917	3·7	9	1		95
		1920			10	0·7	95
		1924			20		90
44	„ „	2030			1		90
		2033			10		80
		2037			30		90