Seasonal Changes in the Nitrite Content of Sea-Water.

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Brandt (1927) has summarised and reviewed our knowledge of the nitrogen compounds existing in sea-water, including nitrites. In general, estimations of nitrite in sea-water have been made colorimetrically, using the Griess-Ilosvay reagent, which has also been used in the present work. Usually the amount of nitrite found, recorded as milligrams of nitrogen per cubic metre, was small. Raben's results have been grouped by Brandt as follows, 0 mg., 48 cases ; under 1 mg., 53 cases ; 1–4 mg., 21 cases ; 5–9 mg., 6 cases. Orr (1926) in the Clyde Area, found from under 1 mg. to about 10 mg. in June 1925, the deeper water having more than the upper layers. Harvey (1926) states that, " in a number of water samples from the English Channel, examined either on board ship or immediately after landing, no definitely detectable traces of nitrites could be found either by the Griess-Ilosvay reagent or with the strychnine reagent without sulphuric acid, except in the case of inshore water subject to pollution. After storage an appreciable quantity of nitrite has been detected in several instances. In water from 830 metres in the Bay of Biscay, preserved with mercuric chloride when collected, and in water at various depths up to 3000 metres, similarly preserved, collected by the R.R.S. *Discovery* some 200 miles west of Portugal, no nitrite could be definitely detected."

It may be added that dilute standard solutions of nitrite lose strength by the production of nitrate from nitrite, so the same process must take place in sea-water on storing, as well as the converse.

As is well known, ammonium salts are converted to nitrites by bacterial action, and the latter is oxidised to nitrate by another micro-organism or by air. It seemed probable, therefore, that when ammonium salts were being converted into nitrite, a considerable amount of nitrite must exist temporarily in the sea. Harvey (1928) showed that at International Hydrographic Station E1 there was a rapid production of nitrate* in early

* The reduced strychnine reagent used by Harvey reacts both with nitrites and nitrates. The values have been referred to as nitrate for brevity, since that is normally the major constituent.

autumn, which accompanies the phosphate regeneration found by the writer to take place at E1 simultaneously. The analyses shown in Table I make it clear that this nitrate production is preceded and accompanied by nitrite production. The nitrite test is easier to carry out than is that for nitrate on account of the difficulty of preparing the reduced strychnine reagent required for the latter. The presence of nitrite, moreover, indicates, in sea-water, that nitrate is being produced. Whereas by the nitrate test alone it would require two consecutive samples to establish this. Furthermore, the absence of nitrite in the deep oceanic samples examined by Harvey shows that nitrification has, in them, run its full course to nitrate. Table I contains analyses for E1, E2 mid-Channel, and E3 off Ushant. The dates of analysis are shown opposite A in the bottom line of the table. The values found for the surface waters, even in the warmest period of the year, show conclusively that there has been no significant error due to storage.

TABLE I

NITRITE NITROGEN AS MG. PER CUBIC METRE AT STATIONS E1, E2, E3 DURING 1928–1929.

	Aug. 16	Aug. 16	Aug. 17	Aug. 29	Sept. 18	Oct. 2	Nov. 30	Jan. 2	Mar. 4	Mar. 26	Mar. 26	Mar. 27
m.	E1	E2	E3	E1	E1	E1	E1	E1	E1	E1	E2	E3
0	0·2	0·2	0·2	0·0	<1	13·3	1·4	3·1	11·0	2·7	4·3	3·2
5	—	—	—	0·0	—	12·8	—	—	—	—	—	—
10	—	0·2	—	0·0	—	—	—	—	—	—	—	—
15	0·2	—	0·2	4·3	<1	—	1·4	—	—	—	—	—
20	0·2	—	0·2	38·9	2·0	—	—	—	—	—	—	—
25	38·3	—	0·2	—	14·6	14·2	—	3·4	—	—	—	—
30	—	—	—	—	13·6	—	—	—	—	—	—	—
40	—	—	—	28·9	—	—	—	—	—	—	—	—
50	23·5	—	0·2	—	—	—	—	—	—	—	—	—
60	—	5·6	—	—	—	—	—	—	—	—	—	—
70	31·0	—	—	37·4	16·1	15·6	1·4	3·9	8·9	3·1	—	—
80	*	—	—	*	*	*	*	*	*	*	—	—
85		5·4	—								4·0	—
90		*	—								*	—
100			0·2									—
105			*									3·1
A	20/8	20/8	20/8	30/8	19/9	4/10	1/12	3/1	6/3	28/3	28/3	28/3

* Denotes that the bottom has been reached before the depth indicated.

From the analyses it may be judged that there is a rapid nitrification in the hypothalassa during August at E1, a less rapid production at E2, and very little at E3. The blank estimation with the reagents usually amounted to only 0·1 mg. per m^3. According to Harvey's (1926, 1928) values for nitrate at E3 for July 1925 and 1926, the available supplies had been depleted to a greater extent at E1 than at E3, E2 being intermediate.

In October at E1 nitrite production was rapid, but by November 30th nitrite had almost all been converted, as shown by the small amount found and Harvey's high nitrate values for this season. Following, apparently, a late autumn or early winter plankton outburst, the existence of which is quite in keeping with Harvey's 1926 nitrate figures, we find a prolonged nitrite production in early spring, with a peak early in March.

It remains to be considered to what extent the nitrite values found are affected by the discharge of sewage from Plymouth, 22 miles N.W. of E1, or from the coast generally. Table II shows clearly that such an effect is negligible or non-existent, inasmuch as not even at L1, which is only about 300 metres from a large sewage outfall and less than 500 m. from the main outfall, are values found at all as high as at E1 during August. We may conclude, therefore, that, as in the case of phosphate and nitrate, the nitrite content of E1 is due to the operation of cyclic processes occurring at that spot.

TABLE II.

NITRITE NITROGEN AS MG. PER M.^{3}, IN SURFACE SAMPLES, 1928–1929. STATION L1, BELOW LABORATORY IN PLYMOUTH SOUND; L2, AT BREAKWATER; L3, OFF RAME HEAD; L4, HALF-WAY TO EDDYSTONE; L5, AT EDDYSTONE; L6, 5 MILES S.W. OF EDDYSTONE, VIZ. MIDWAY BETWEEN L5 AND E1.

Station.	Sept. 18.	Nov. 30.	Jan. 2.	Mar. 1.	Mar. 26.
L1	3·1	6·0	9·5	9·1	4·8
L2	3·0	3·9	9·5	7·2	—
L3	3·5	3·3	9·2	6·0	3·4
L4	0·0	3·3	7·7	7·9	—
L5	1·0	—	5·6	7·3	—
L6	0·0	1·3	3·5	9·1	—
E1	0·0	1·4	3·1	11·0	2·7
A	19/9	1/12	3/1	6/3	28/3

SUMMARY.

1. The nitrite content of sea-water is a useful indication of the rapid transformation of ammonium salts into nitrates.

2. In August the upper 20 m. of water at Station E1, in the English Channel, were devoid of nitrite, from 0·0 to 0·2 mg. of nitrite nitrogen per m.^{3} being found. At and below 25 m. as much as 38 mg. per m.^{3} was found; off Ushant, at E3, the whole water column was devoid of nitrite.

3. In October at E1 the whole water column contained about 14 mg. per m.^{3}, which had fallen to 1·4 mg. by the end of November. From January to March from 3–11 mg. per m.^{3} was found at E1, and at E3 on March 27th 3 mg. was recorded for the whole isothermal water column.

4. The values given for nitrite nitrogen are unaffected by transport from the shore, since inshore waters and even Plymouth Sound are poorer in nitrite than the lower layers at E1 in August, and the shore effect ceases to be appreciable beyond the Eddystone Lighthouse at the most, usually nearer shore.

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