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NITROGEN SALTS IN THE CENTRAL AND SOUTHERN ADRIATIC (1970-1971)

DUŠIKOVE SOLI U SREDNJEM I JUŽNOM JADRANU (1970-1971)

LAMBE STOJANOSKI

SPLIT 1975

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Lambe Stojanoski

Institute of Oceanography and Fisheries, Split, Yugoslavia

INTRODUCTION

The first researches into phosphates were made by Ercegović (1934), and then by Nüman (1941). From that period also the works by the research workers Vatova (1934), and by Vatova & Picotti (1942) are well known. Later on the phosphates were examined by Buljan (1953a), Buljan & Marinković (1956), Buljan & Zore-Armanda (1966), Faganelli (1959, 1961), Picotti (1960), McGill (1965), Scaccini-Cicatelli (1967, 1969), Vatova (1962), and Ilić & Božić (1969).

Among the nitrogen salts in the eastern Adriatic only the nitrates have been examined. There are data by Nüman (op. cit.) for the northern Adriatic, by Buljan and Marinković (op. cit.), and Buljan & Zore-Armanda (op. cit.), for the central Adriatic. The nitrogen salts, except the phosphates, have not yet been fully examined.

This paper deals with all the forms of inorganic nitrogen in the sea.

We are grateful to Prof. Dr M. Buljan who helped us in our work on this paper.

We also thank Dr T. Pucher-Petković who supplied us with data on phytoplankton.

1. DESCRIPTION OF THE AREA

Observations were carried out at five stations (Fig. 1). Four of them (25, 8, 9, 3) are in the central Adriatic, and one in the southern Adriatic (15). The stations include several productional zones of this area, i. e. A, C, and D, according Buljan (Buljan, 1969b).

Examinations were conducted from July 1970 to June 1971. At the stations 25, 8 and 9 samples were collected every month, and at the stations 3 and 15 four times a year, i. e. every season.

In addition to the nitrogen salts also phosphates and other standard oceanographic parameters were determined (oxygen, temperature, salinity).

2. METHOD

The samples collected for analysis were cooled on board and analysed in the laboratory.

The nitrites were determined according Strickland-Parsons (1968).

The nitrates were determined by having reduced them to nitrites (Strickland-Parsons, op. cit.).

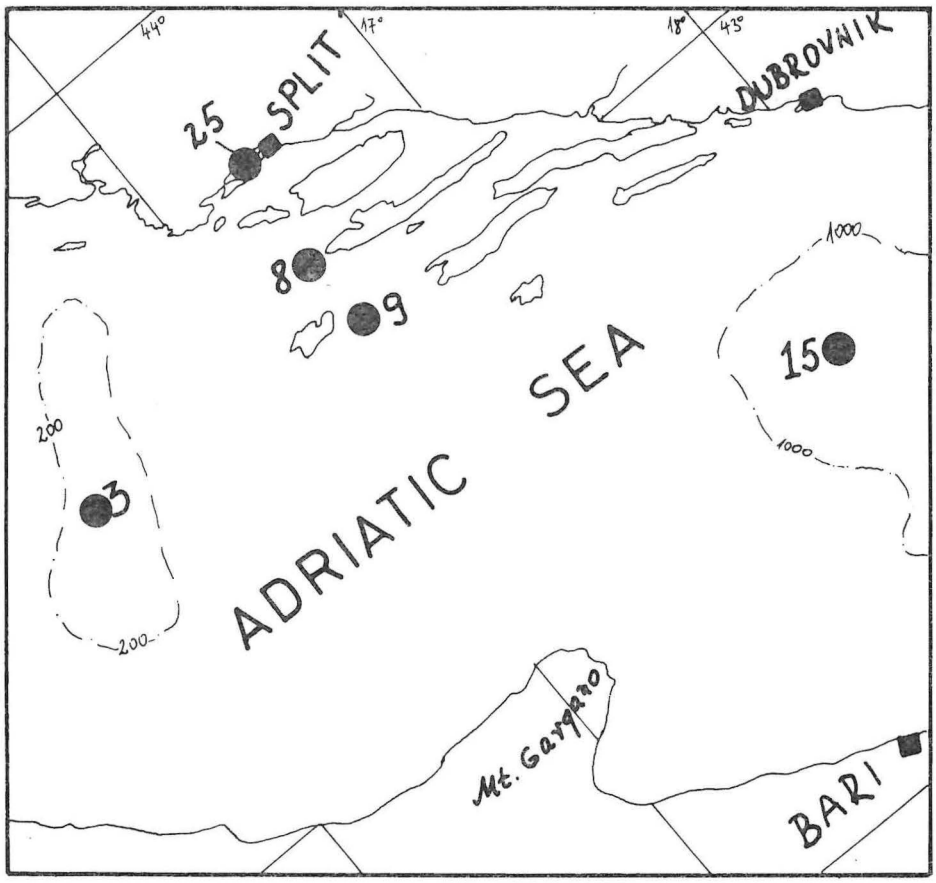

Fig. 1. Area of investigation with location of stations: Kaštela Bay (St. 25), Pelegrin (St. 8), Stončica (St. 9), Jabuka Pit (St. 3) and South Adriatic Pit (St. 15).

Stations	Coordinates	Depths (m)
Kaštela Bay (25)	43° 31' N 16° 22' E	0, 10, 20. 35
Pelegrin (8)	43° 12' N 16° 19' E	0, 10, 20, 30, 50, 75
Stončica (9)	43° 00' E 16° 20' E	0, 10, 20, 30, 50, 75, 100
Jabuka Pit (3)	43° 04' N 15° 06' E	0, 20, 50, 100, 200, 260
South Adriatic Pit (15)	42° 05' N 17° 37' E	0, 20, 50, 100, 300, 500, 1000, 1190

No satisfactory and fully developed method for determining ammonia in the sea exists for the time being, which affects the results and their comparison. Therefore the results of the quantity of ammonia should be taken with a certain reservation. We have chosen the method of direct determination of ammonia in the sea water by oxidation with hypobromite in an alkaline

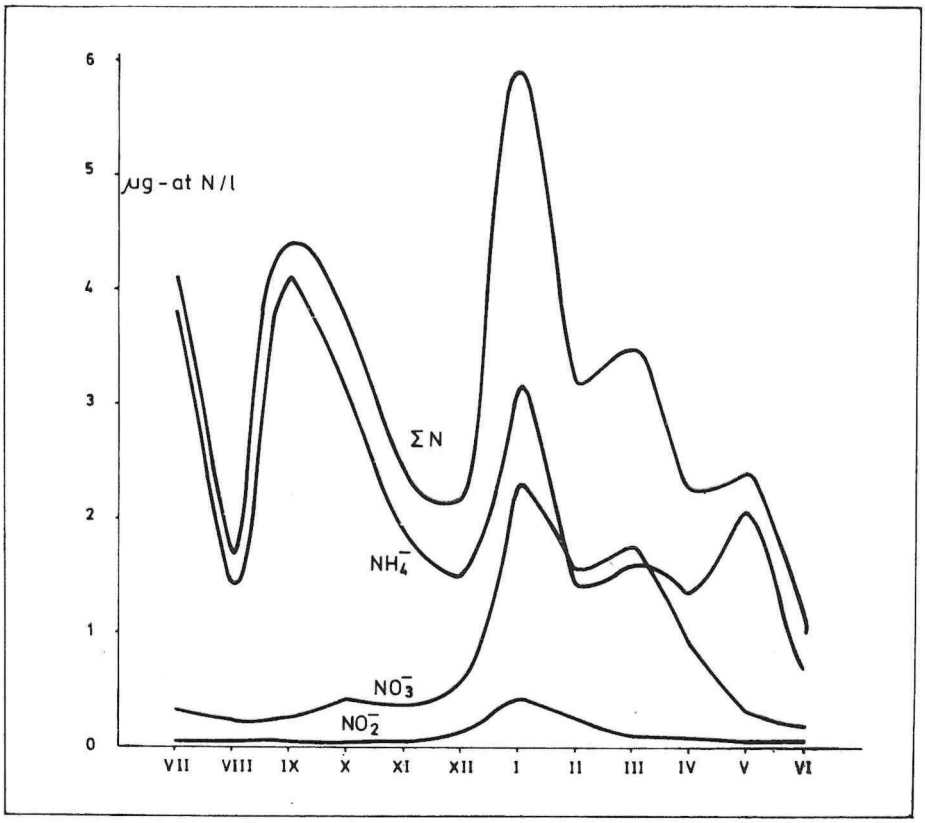

Fig. 2. Seasonal variations of nitrogen salts in Kaštela Bay.

solution (Gillbrichts, 1961), which is based on Buljan's method of determining ammonia (1951).

The phosphates were determined by extraction method according Strickland-Parsons (op. cit.).

3. RESULTS AND DISCUSSION

3. 1. Monthly distribution

The obtained data are given in the Tables at the end of this paper.

Figures 2, 3, 4, 5, and 6, and Table 7 give the movement of the monthly means for ammonia, nitrite and nitrate at individual stations.

Kaštela Bay (St. 25)

The quantity of ammonia varied greatly, i. e. from 0.78 to 4.48 µg-at/1 (Fig. 2). Distinct maxima occurred in July, September, and January, and the minima in August, December, and June.

The quantity of the nitrates varied from 0.27 to 2.31 µg-at/1. In the colder part of the year (Dec.-April) more nitrates were found than in the warmer one (May-November).

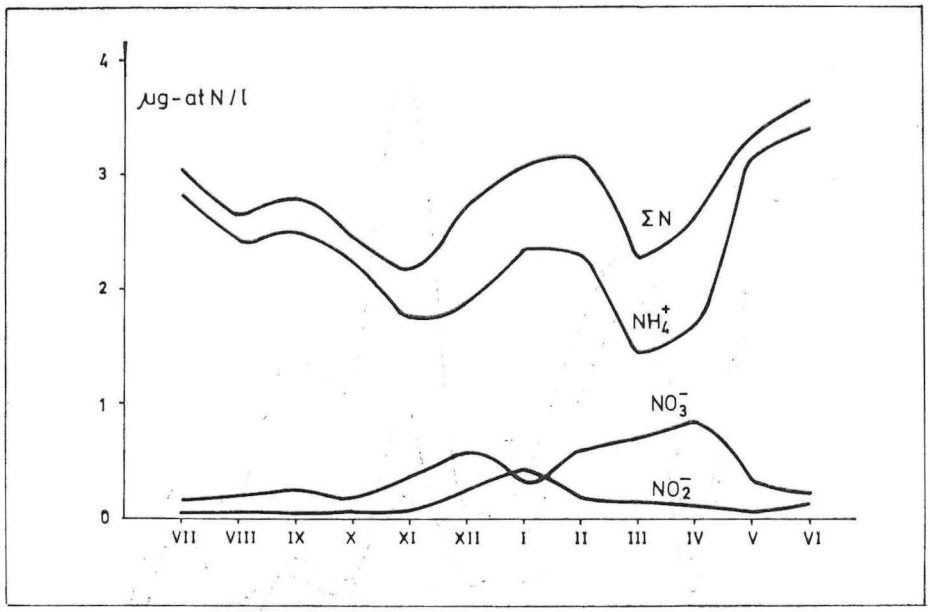

Fig. 3. Seasonal variations of nitrogen salts at Pelegrin.

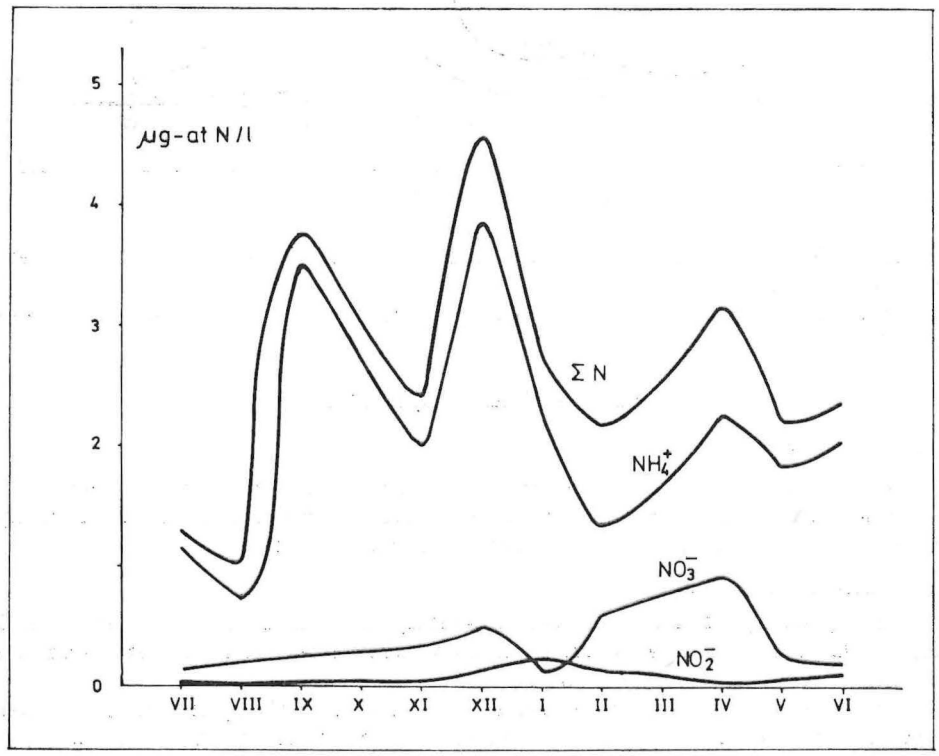

Fig. 4. Seasonal variations of nitrogen salts at Stončica.

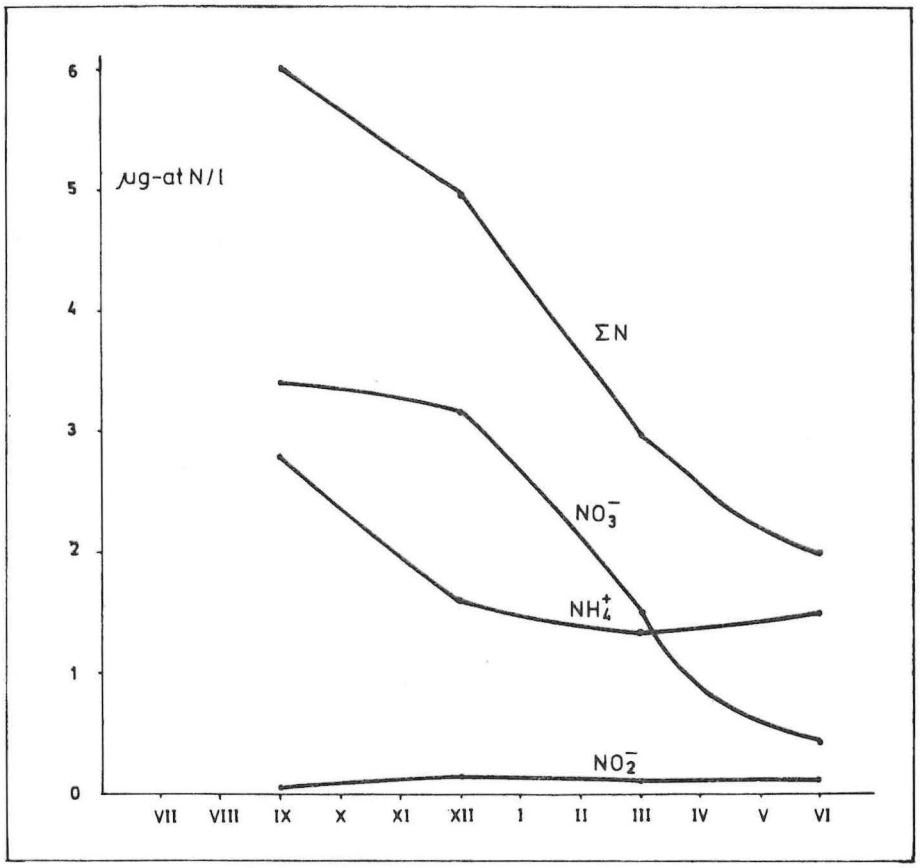

Fig. 5. Seasonal variations of nitrogen salts at Jabuka Pit.

The nitrites showed a distinct maximum in January and absence of more significant oscillations in other months.

Pelegrin (St. 8)

The amplitude of fluctuation of ammonia was considerably smaller, from 1.47 to 3.43 µg-at/1 (Fig. 3). The maxima occurred in July, June and January, and the minima in November and March.

The quantity of the nitrates varied from 0.14 to 0.92 µg-at/. They were found more in the colder part of the year than in the warmer one.

The nitrites had the same path as at the Station 25.

Stončica (St. 9)

The quantity of ammonia varied within the wide range of from 0.77 to 3.91 µg-at/1 (Fig. 4), like in Kaštela Bay. Distinct maxima occurred in September, December, and April, and minima in August, November, and February.

The nitrates and nitrites behaved like on Pelegrin (St. 8).

Jabuka Pit and South Adriatic Pit (St. 3 and St. 15)

The movement of the quantity of the nitrogen salts at these two offshore stations was analogous (Fig. 5 and 6).

The quantity of ammonia decreased from September to March, and then it increased slowly again.

The nitrates had their maximum in September and December and then they dropped greatly in March and June.

There were no significant fluctuations in the movement of the nitrites.

The quantity of the nitrates in the waters of these stations were exceptionally great. The cause might be found in the inflow of the Mediterranean waters. The exceptionally high values of salinity (38.98°/00) also speak in favour of the above said. They were found in the same period although they

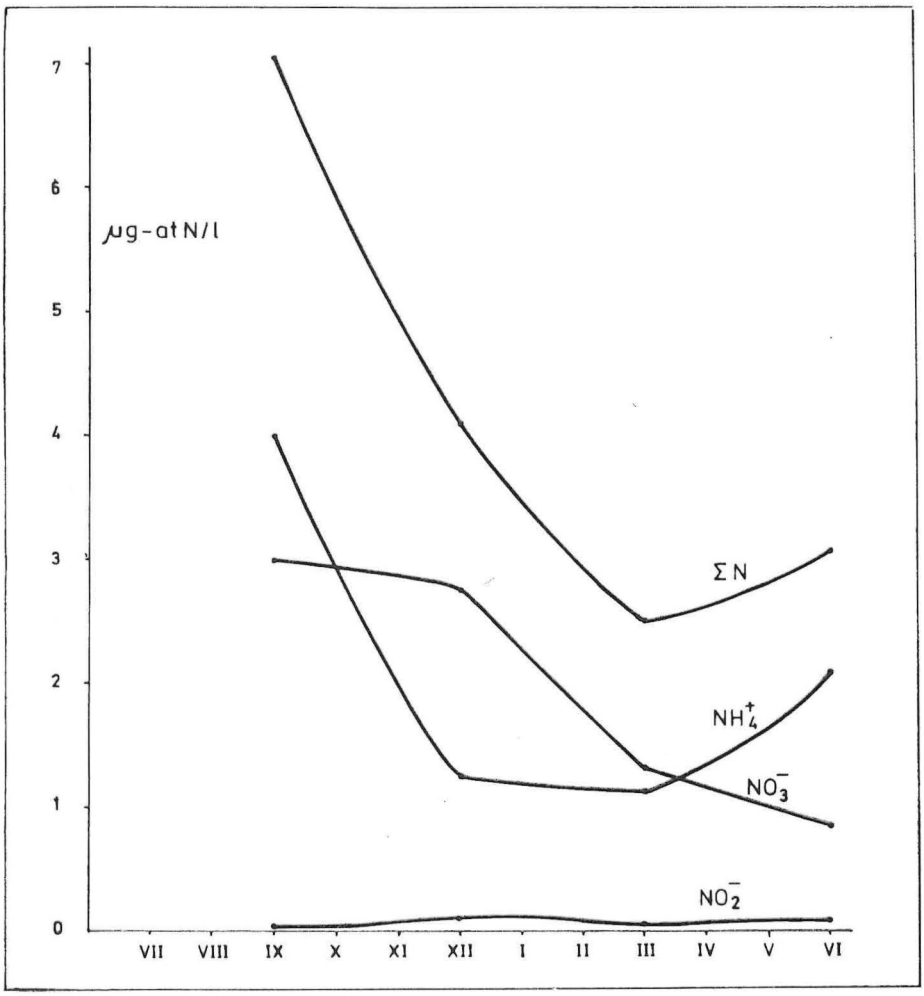

Fig. 6. Seasonal variations of nitrogen salts in South Adriatic Pit.

are not characteristic for the Adriatic. It is possible that the shallow north Adriatic waters enrich the Jabuka Station.

3. 2. Vertical distribution

Figures 7, 8, 9, 10 and 11, and Tables 8 and 9 give the vertical distribution of the nitrogen salts for the examined period.

The vertical distribution of the nitrogen salts at the inshore stations is almost analogous (Fig. 7, 8, 9). In the surface layers the ammonia increases, and the nitrates and nitrites do not show any significant changes with depth, except in Kaštela Bay where they decrease with depth.

At the offshore stations of the Adriatic the ammonia has the highest values at 100 and 300 m (Fig. 10, 11).

At these stations the nitrates showed an increase with depth, and at Jabuka they attained the maximally recorded values. These values on the bottom of Jabuka are explained by a bad circulation of the sea water in that pit, which has been proved by the reserarches in the dynamics of the water masses (Zore-Armanda, 1963). The great amounts of the nitrates in the deep waters of the south Adriatic are probably due to the inflow of the Mediterranean waters which are richer in the nutrient salts enriching thus the Adriatic waters (McGill, 1965). In some years this influx is stronger, i. e. during the ingression the waters from the eastern Mediterranean enter the Adriatic via the intermediary layer (Buljan, 1953b).

We can thus conclude that the high contents of the nitrates are characteristic for the deep Adriatic. The deep Adriatic represents also an important source of the nutrient salts for the central and southern Adriatic. They are conveyed to the upper layers by circulation.

3. 3. Nitrogen-phytoplankton relation

In Figures 12, 13 and 14 we compared the movement of phytoplankton (cells/litre), as the biological factor that is directly connected with nutrient salts, with the sum of nitrogen salts.

In Kaštela Bay the minimum of nitrogen corresponds to the maximum of phytoplankton (Fig. 12). The later movement is also alternating to some degree, except that in August no dependence between these two factors exists.

At the Stončica Station the situation is similar, i. e. the maximum of one component coincides with the minimum of the other (Fig. 14).

The Pelegrin Station shows no causative connection like the other two stations do (Fig. 13). A probable cause of this is a different composition of phytoplankton at this station (Pucher-Petković, 1966). This deviation is quite understandable because Pelegrin is a channel station under the influence of the Neretva (river) and the open sea.

3. 4. Nitrogen-phosphorus ratio

The nitrogen-phosphorus ratio in the ocean and sea organisms is constant. In the ocean this ratio expressed in atoms at all the levels is 15:1, while in the inshore seas it changes throughout the year (Riley-Chester, 1971). The calculated ratios of the means of our stations are shown in Tables 10 and 11.

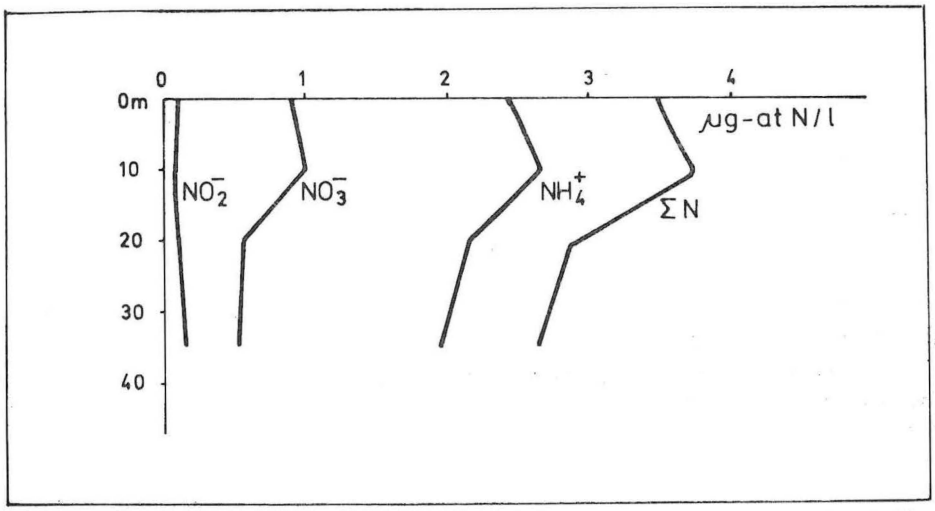

Fig. 7. Vertical distribution of nitrogen salts in Kaštela Bay.

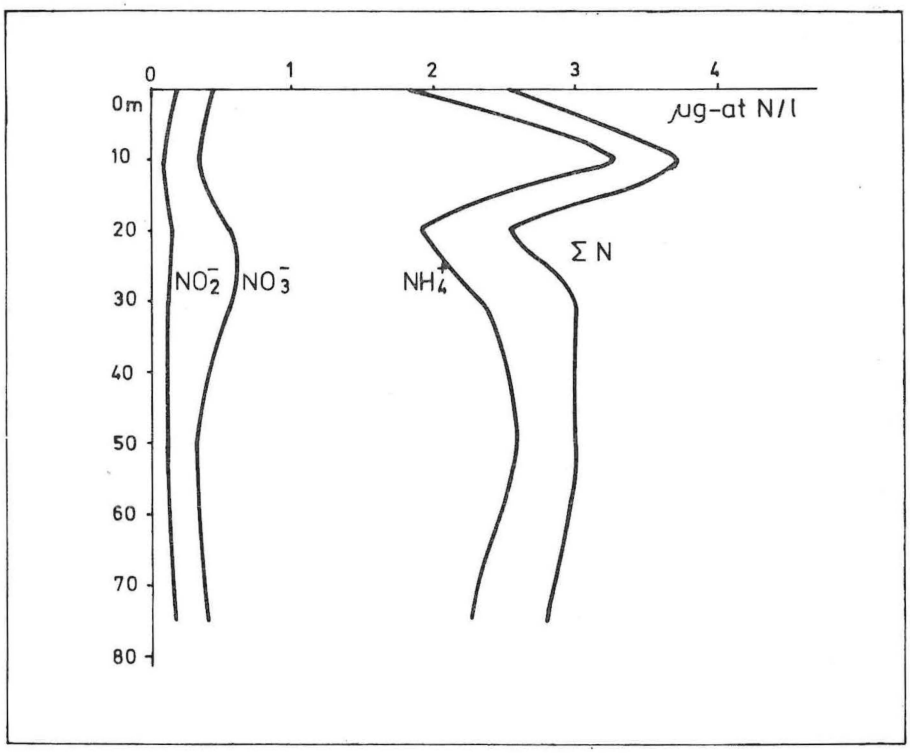

Fig. 8. Vertical distribution of nitrogen salts at Pelegrin.

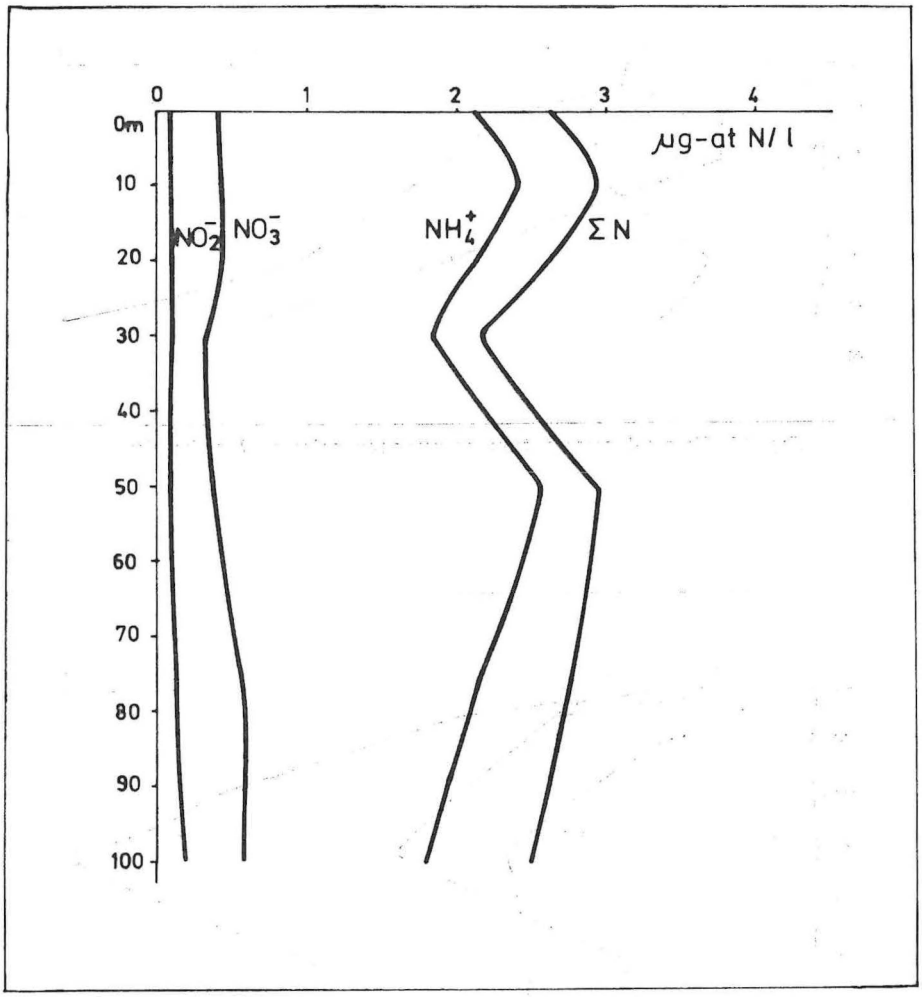

Fig. 9. Vertical distribution of nitrogen salts at Stončica.

Table 10 shows that all through the year a significant seasonal fluctuation exists. The minimal ratio 11:1 was found at Stončica (August), and the maximal 212:1 at Pelegrin (June).

Fluctuation in relation to dept is considerably smaller (Table 11), only in the greater depths of the offshore stations greater values are found, because the increase of the phosphorus salts is not adequate to the increase of the nitrogen salts.

As the 15—20: 1 ratio is considered to be the most favourable for biological activity, i. e. productivity, we may conclude that the inshore stations are more suitable in this respect. If some extremely high ratios are neglected then Kaštela Bay and Stončica are characterized by the most favourable conditions for production.

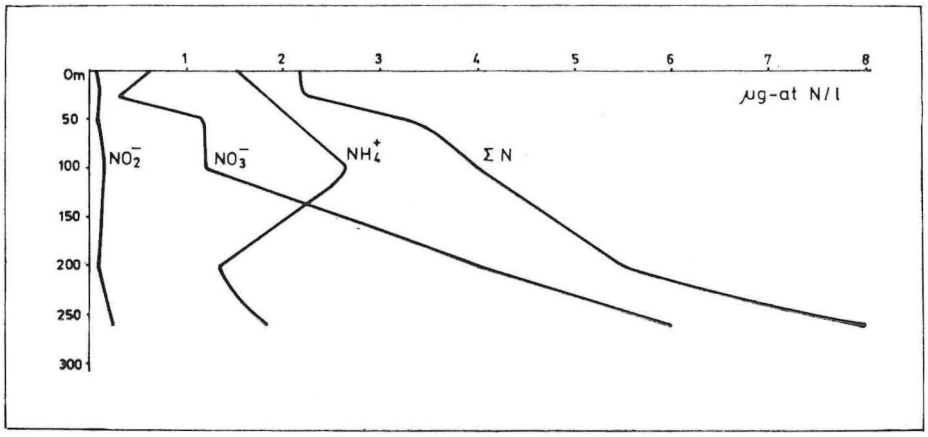

Fig. 10. Vertical distribution of nitrogen salts at Jabuka Pit.

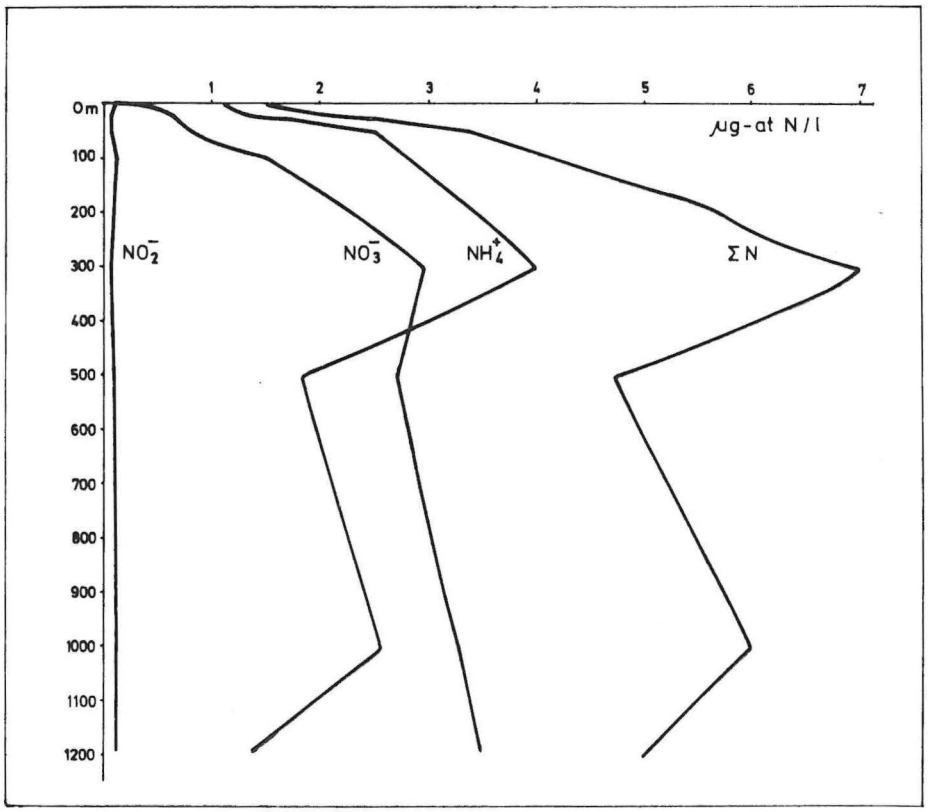

Fig. 11. Vertical distribution of nitrogen salts in South Adriatic Pit.

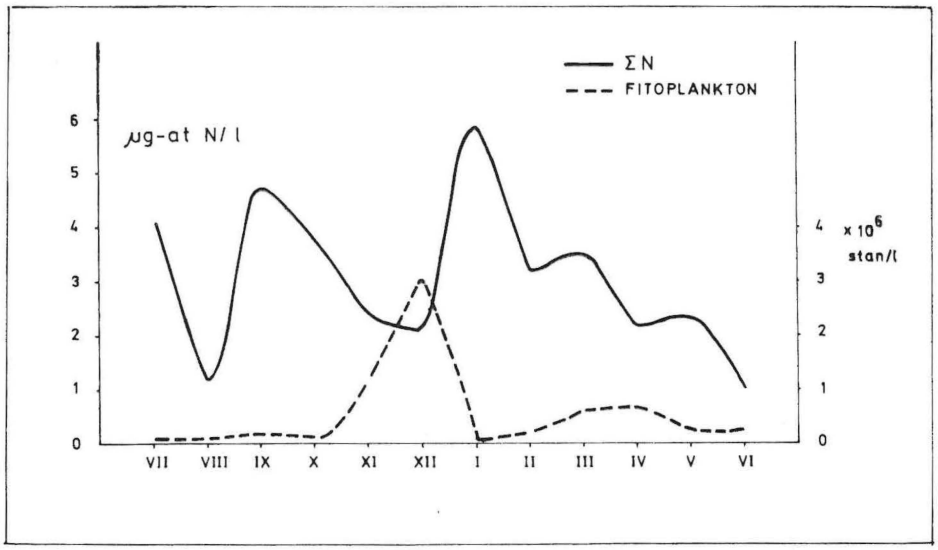

Fig. 12. Seasonal variations of nitrogen and phytoplankton in Kaštela Bay.

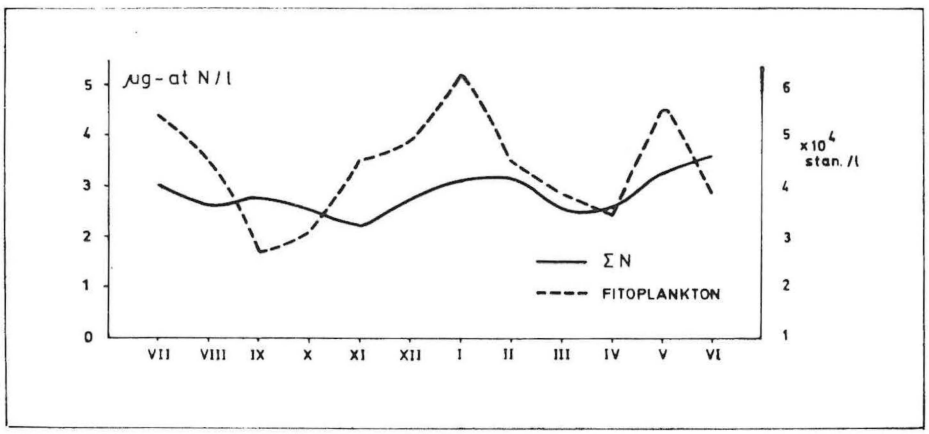

Fig. 13. Seasonal variations of nitrogen and phytoplankton at Pelegrin.

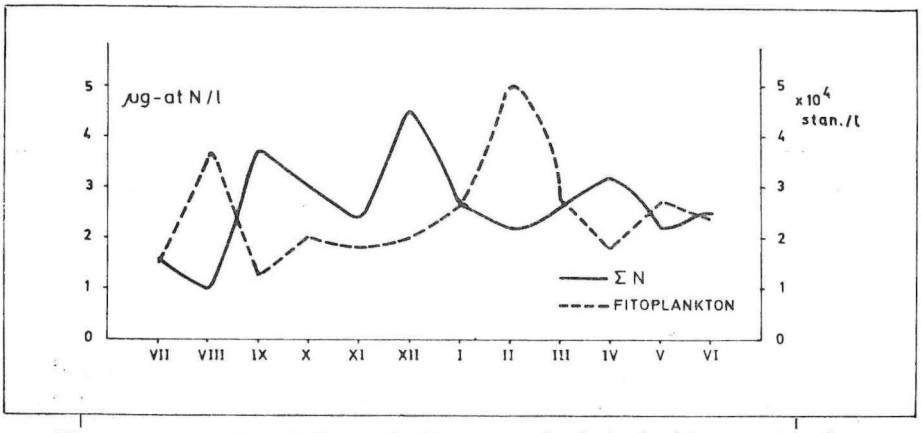

Fig. 14. Seasonal variations of nitrogen and phytoplankton at Stončica.

4. CONCLUSION

The examinations of the quantities of the nitrogen salts (ammonia, nitrites, nitrates) were conducted at the stations of the central and southern Adriatic during one year's period (June 1970-July 1971). At the same time also the phosphates and standard oceanographic parameters were determined (oxygen, temperature, salinity).

The seasonal distribution of these salts shows that the quantities of ammonia are considerable during the year at all the stations, and at the inshore stations it represents the dominant form. The nitrates are better represented in the colder period of the year. During the year the nitrites are present in very small quantities except in January when they attain somewhat higher values at the inshore stations.

The analysis of the vertical distribution shows that at all the stations ammonia is better rapresented in the surface layers, while at the offshore stations of the Adriatic the nitrates have a characteristic increase with depth.

This increase is explained by the inflow of the Mediterranean and the north Adriatic waters, which are richer in nutrient salts. It follows that the deep waters of the Adriatic are one of the sources of the nutrient salts for the rest of the Adriatic.

The nitrites do not show any greater changes with depth.

The relation of nitrogen to phytoplankton has also been studied at three stations, and certain regularities have been found (alternation of the maximum of one component with the minimum of the other).

The nitrogen-phosphorus ratios have been calculated. In general, the values are higher than the constant ratio 15:1 found in the ocean is. The reason for the greater ratios lies in the fact that nitrogen is always found in greater quantities than phosphorus is. It follows that phosphorus is a factor that restricts productivity in this region.

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DUŠIKOVE SOLI U SREDNJEM I JUŽNOM JADRANU (1970—1971)

Lambe Stojanoski

Institut za oceanografiju i ribarstvo, Split

KRATAK SADRŽAJ

U ovom radu po prvi put su ispitivane sve forme anorganskog dušika (amonijak, nitrit, nitrat) u toku jedne godine (VII. 70—VI. 71) na području srednjeg i južnog Jadrana.

Uzorci su uzimani na pet postaja (Kaštelanski zaljev, Pelegrin, Stončica, Jabuka, južni Jadran) koje obuhvaćaju više zona produkcije i to zone A, C i D po Buljanu (Buljan 1969, b).

U diskusiji razmatrana je mjesečna i vertikalna distribucija pojedinih formi dušika na svim postajama, odnos između dušika i fitoplanktona na postajama bližim kopnu (Kaštelanski zaljev, Pelegrin, Stončica) i omjer dušika i fosfora.

Rezultati su pokazali da su duboke vode južnog Jadrana bogatije na hranjivim solima i da su te vode jedan od izvora hranjivih soli za ostali dio Jadrana.

Omjer dušika prema fosforu je pokazao da je fosfor faktor koji ograničava produktivnost na tom području.

TABLES

Table 1. Data on nitrogen salts in Kaštela Bay

		1970					1971						
	m	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
	0	4.94	0.50	6.61	4.60	0.25	2.40	3.56	1.14	0.00	4.20	0.43	0.07
NH_3-N	10	3.00	2.96	4.65	4.00	2.90	0.07	—	0.69	3.43	0.16	4.75	2.80
μg-at/l	20	3.72	1.07	2.76	2.11	4.50	1.57	1.46	2.12	3.80	1.00	1.93	0.00
	35	3.58	1.18	3.90	2.22	0.07	4.00	4.46	1.71	1.20	0.16	1.14	0.25
	0	0.35	0.36	0.23	0.38	0.40	0.77	3.30	1.32	3.34	0.82	0.18	0.22
NO_3-N	10	0.33	0.50	0.33	0.72	0.38	0.00	3.50	1.48	3.35	0.76	0.27	0.37
μg-at/l	20	0.33	0.29	0.24	0.30	0.42	0.11	1.44	1.66	0.83	0.84	0.31	0.24
	35	0.35	0.00	0.28	0.50	0.44	1.20	1.00	1.60	0.00	1.00	0.28	0.13
	0	0.000	0.007	0.064	0.081	0.011	0.264	0.433	0.232	0.175	0.000	0.059	0.200
NO_2-N	10	0.000	0.000	0.000	0.021	0.006	0.000	0.418	0.280	0.070	0.000	0.038	0.181
μg-at/l	20	0.000	0.016	0.054	0.000	0.006	0.250	0.457	0.300	0.000	0.067	0.062	0.110
	35	0.000	0.070	0.054	0.005	0.057	0.008	0.601	0.352	0.047	0.121	0.048	0.214

Table 2. Data on nitrogen salts at Pelegrin

		1970					1971						
	m	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
	0	2.57	1.57	2.11	1.49	2.32	3.50	0.00	2.68	0.14	0.00	2.50	2.66
	10	3.57	3.43	3.54	6.71	4.50	1.93	2.47	0.28	3.30	0.07	3.43	6.15
NH_3-N	20	1.57	2.28	4.75	1.29	0.89	0.54	0.00	3.36	2.50	0.89	2.00	2.66
μg-at/l	30	3.43	3.04	0.85	2.68	0.16	3.04	3.43	4.11	0.25	3.32	0.71	3.04
	50	3.86	2.68	0.85	0.07	1.40	0.07	1.57	0.70	2.20	3.81	7.80	5.90
	75	2.07	1.65	3.08	1.47	1.40	2.32	6.84	2.86	0.43	2.11	2.80	0.18
	0	—	0.45	0.23	0.00	0.37	0.27	1.00	0.59	0.53	1.10	0.31	0.21
	10	0.14	0.15	0.23	0.00	0.29	0.32	0.06	0.68	0.86	0.95	0.34	0.18
NO_3-N	20	0.05	0.16	0.20	0.16	0.30	1.86	0.38	0.74	1.26	0.98	0.42	0.23
μg-at/l	30	0.14	0.03	0.20	0.18	0.32	0.76	0.39	0.57	0.00	0.88	0.41	0.23
	50	0.22	0.18	0.25	0.07	0.34	0.32	0.00	0.63	0.49	0.84	0.43	0.29
	75	0.28	0.00	0.36	0.47	0.69	0.28	0.00	0.62	1.27	0.77	0.36	0.19
	0	0.053	0.007	0.010	0.054	0.006	0.384	0.390	0.173	0.065	0.055	0.000	0.210
	10	0.029	0.016	0.010	0.049	0.006	0.032	0.444	0.160	0.070	0.068	0.031	0.171
NO_2-N	20	0.029	0.000	0.065	0.038	0.011	0.512	0.410	0.180	0.000	0.000	0.038	0.091
μg-at/l	30	0.053	0.170	0.032	0.043	0.064	0.136	0.384	0.180	0.091	0.000	0.038	0.160
	50	0.000	0.000	0.038	0.022	0.034	0.256	0.450	0.182	0.100	0.036	0.034	0.120
	75	0.071	0.120	0.060	0.014	0.064	0.213	0.544	0.231	0.240	0.163	0.070	0.203

Table 3. Data on nitrogen salts at Stončica

		1970					1971						
	m	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
	0	1.21	1.75	2.11	0.32	1.00	5.70	5.86	1.30	0.90	1.80	0.00	3.04
	10	1.78	0.14	2.68	3.58	1.36	4.08	2.70	0.00	1.30	3.80	4.30	2.96
	20	0.70	1.25	3.54	2.80	3.08	5.05	1.36	0.43	0.00	1.18	0.00	6.55
NH_3-N	30	0.35	0.87	3.54	3.08	2.58	3.30	0.00	0.07	2.04	4.75	1.47	0.07
μg-at/l	50	1.78	1.00	4.75	5.90	2.50	5.50	2.22	4.11	1.57	0.00	1.30	0.18
	75	0.86	0.14	2.68	1.57	1.60	3.72	0.00	2.80	4.20	4.47	3.60	0.07
	100	1.14	0.28	5.00	1.50	1.75	0.07	3.90	1.11	2.04	0.00	2.40	1.63
	0	0.17	0.21	0.44	0.35	0.32	0.12	0.84	0.72	0.00	1.08	0.33	0.18
	10	0.17	—	0.22	0.00	0.17	0.38	0.23	0.84	0.84	0.99	0.62	0.06
	20	0.10	—	0.28	0.33	0.35	0.35	0.26	0.48	1.44	0.86	0.08	0.11
NO_3-N	30	0.07	0.13	0.17	0.32	0.20	0.17	0.09	0.73	0.76	0.79	0.11	0.09
μg-at/l	50	0.33	0.26	0.17	0.28	0.34	0.37	0.13	0.57	0.35	0.91	0.24	0.24
	75	—	0.28	0.27	0.37	0.53	1.03	0.11	0.73	1.07	0.79	0.26	0.46
	100	—	0.28	—	0.51	0.72	1.36	0.00	0.54	0.77	0.95	0.28	0.20
	0	0.000	0.024	0.060	0.000	0.011	0.144	0.473	0.102	0.000	0.000	0.010	0.052
	10	0.000	0.020	0.081	0.044	0.006	0.080	0.240	0.146	0.193	—	0.051	0.140
	20	0.000	0.008	0.000	0.000	0.009	0.160	0.088	0.142	0.280	—	0.041	0.090
NO_2-N	30	0.000	0.000	0.047	0.033	0.000	0.240	0.176	0.170	0.213	—	0.070	0.105
μg-at/l	50	0.000	0.000	0.034	0.033	0.012	0.170	0.300	0.130	0.200	0.024	0.059	0.090
	75	0.082	0.024	0.054	0.056	—	0.056	0.360	0.146	0.070	0.010	0.024	0.160
	100	0.035	0.016	0.170	0.135	—	0.160	0.360	0.223	0.123	—	0.160	0.230

Table 4. Data on phosphates (μg-at/l) at Stončica, Pelegrin and Kaštela Bay

		1970					1971						
	m	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
	0	0.048	0.064	0.158	0.045	0.054	0.080	0.061	0.045	0.065	0.103	0.119	0.051
	10	0.025	0.119	0.000	0.070	0.077	0.022	0.070	0.048	0.246	—	0.106	0.051
	20	0.035	—	0.138	—	0.116	0.045	0.080	0.032	0.103	—	0.087	0.022
Stončica	30	0.009	0.058	0.038	0.064	—	0.080	0.051	0.058	0.222	—	0.158	0.039
	50	0.100	0.100	0.048	0.054	0.093	0.070	0.070	0.025	0.180	0.145	0.094	0.000
	75	0.070	0.103	0.109	0.064	0.051	0.061	0.058	0.006	0.129	0.097	0.174	0.032
	100	0.116	0.100	0.070	0.093	0.132	0.080	0.070	0.003	0.155	—	0.113	0.013
	0	—	—	—	—	0.093	0.048	0.051	0.064	0.113	0.107	0.097	0.003
	10	—	—	—	—	0.087	0.038	0.080	0.006	0.100	0.081	0.087	0.009
	20	—	—	—	—	0.148	0.035	0.058	0.019	0.177	0.090	0.061	0.035
Pelegrin	30	—	—	—	—	0.038	0.025	0.061	0.038	0.197	0.090	0.084	0.042
	50	—	—	—	—	0.109	0.054	0.106	0.045	0.087	0.071	0.081	0.000
	75	—	—	—	—	0.106	0.051	0.064	0.054	0.087	0.122	0.110	0.016
	0	0.012	0.074	0.083	0.041	0.129	0.103	0.135	0.019	0.126	0.126	0.342	0.074
Kaštela	10	0.025	0.087	0.016	0.058	0.106	0.077	0.112	0.016	0.081	0.094	0.246	0.055
Bay	20	0.009	0.080	0.041	0.029	0.122	0.035	0.087	0.022	0.216	0.103	0.116	0.058
	35	0.035	0.177	0.064	0.054	0.203	0.074	0.109	0.012	0.113	0.071	0.052	0.055

Table 5. Data on nitrogen salts and phosphates at Jabuka Pit

		1970		1971	
	m	IX	XII	III	VI
	0	4.15	1.46	0.00	0.43
	20	3.26	2.92	0.14	0.43
NH_3-N	50	3.44	0.00	2.75	2.04
μg-at/1	100	1.18	2.97	2.75	3.62
	200	4.00	0.25	1.10	0.07
	260	1.00	2.68	1.10	2.62
	0	0.35	0.81	0.88	0.28
	20	0.26	0.12	0.82	0.04
NO_3-N	50	2.10	0.71	1.24	0.75
μg-at/1	100	2.10	1.20	1.30	0.10
	200	6.15	6.60	2.62	0.69
	260	9.80	10.00	2.61	0.80
	0	0.021	0.130	0.000	0.000
	20	0.021	0.312	0.021	0.133
NO_2-N	50	0.027	0.250	0.000	0.110
μg-at/1	100	0.124	0.200	0.021	0.167
	200	0.016	0.170	0.000	0.140
	260	0.005	0.152	0.865	0.034
	0	0.096	0.064	0.071	0.048
	20	0.135	0.087	0.116	0.035
PO_4-P	50	0.135	0.045	0.139	0.000
μg-at/1	100	0.109	0.129	0.48	0.119
	200	0.096	0.064	0.175	0.068
	260	—	0.080	0.277	0.055

Table 6. Data on nitrogen salts and phosphates in South Adriatic Pit

		1970		1971	
	m	IX	XII	III	VI
	0	2.97	0.07	1.82	0.07
	20	4.65	0.00	0.07	1.07
	50	3.32	4.30	0.70	1.83
NH_3-N	100	4.00	0.00	1.29	2.68
μg-at/1	300	5.72	2.97	2.58	4.86
	500	5.33	0.07	1.46	0.46
	1000	4.58	1.93	0.82	2.88
	1190	3.72	0.89	0.00	0.78
	0	0.21	0.38	0.87	0.40
	20	0.27	1.46	0.82	0.42
	50	2.30	0.50	0.75	0.63
NO_3-N	100	3.94	1.31	0.78	0.67
	300	4.67	5.20	1.23	0.80
μg-at/1	500	4.53	3.73	1.38	1.24
	1000	4.70	4.91	2.42	1.24
	1190	4.94	4.91	2.54	1.57
	0	0.047	0.135	0.150	0.110
	20	0.021	0.273	0.000	0.095
	50	0.058	0.152	0.060	0.039
NO_2-N	100	0.037	0.240	0.045	0.095
μg-at/1	300	0.000	0.135	0.000	0.024
	500	0.016	0.192	0.143	0.133
	1000	0.037	0.160	0.084	0.181
	1190	0.000	0.250	0.000	0.034
	0	0.006	0.000	0.250	0.016
	20	0.054	0.064	0.197	0.016
	50	0.129	0.045	0.278	0.045
PO_4-P	100	0.100	0.096	0.297	0.049
μg-at/1	300	0.145	0.183	0.090	0.052
	500	0.112	0.151	0.370	0.023
	1000	0.158	0.093	0.097	0.000
	1190	0.154	0.093	0.151	0.019

Table 7. Monthly means of nitrogen salts and phosphates for all the stations

		1970				1971							
		VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
NH_3-N μg-at/1	Stončica	1.12	0.77	3.47	2.67	1.98	3.91	2.29	1.40	1.72	2.28	1.86	2.10
	Pelegrin	2.84	2.44	2.53	2.28	1.77	1.90	2.38	2.33	1.47	1.70	3.20	3.43
	Kaštela Bay	3.81	1.42	4.48	3.23	1.93	1.47	3.16	1.41	2.10	1.38	2.06	0.78
	South Adriatic Pit			4.28			1.27			1.09			1.82
	Jabuka Pit			2.83			1.71			1.30			1.53
NO_2-N μg-at/1	Stončica	0.031	0.013	0.046	0.043	0.070	0.144	0.285	0.151	0.154	0.011	0.059	0.123
	Pelegrin	0.039	0.052	0.035	0.036	0.030	0.255	0.437	0.184	0.094	0.053	0.053	0.159
	Kaštela Bay	0.000	0.023	0.043	0.026	0.020	0.130	0.477	0.278	0.073	0.047	0.051	0.176
	South Adriatic Pit			0.027			0.192			0.060			0.088
	Jabuka Pit			0.035			0.202			0.151			0.097
NO_3-N μg-at/1	Stončica	0.16	0.23	0.25	0.30	0.37	0.54	0.13	0.65	0.74	0.91	0.27	0.19
	Pelegrin	0.16	0.16	0.24	0.14	0.38	0.63	0.30	0.63	0.73	0.92	0.38	0.22
	Kaštela Bay	0.34	0.28	0.27	0.47	0.41	0.52	2.31	1.51	1.88	0.85	0.26	0.24
	South Adriatic Pit			3.19			2.80			1.35			0.87
	Jabuka Pit			3.46			3.24			1.50			0.44
PO_4-P μg-at/1	Stončica	0.057	0.090	0.080	0.065	0.087	0.062	0.065	0.031	0.158	0.116	0.121	0.030
	Pelegrin	—	—	—	—	0.096	0.041	0.070	0.037	0.126	0.094	0.087	0.018
	Kaštela Bay	0.020	0.104	0.051	0.045	0.140	0.072	0.110	0.017	0.134	0.098	0.188	0.061
	South Adriatic Pit			0.108			0.090			0.218			0.027
	Jabuka Pit			0.134			0.094			0.154			0.054

Table 8. Means with depth of nitrogen salts and phosphates at Stončica, Pelegrin and in Kaštela Bay

		0	10	20	30	50	75	100 m
	Stončica	2.08	2.39	2.16	1.84	2.56	2.14	1.74
NH_3-N	Pelegrin	1.79	3.28	1.89	2.33	2.57	2.26	
μg-at/l	Kaštela Bay	2.39	2.67	2.17	1.98			
	Stončica	0.073	0.091	0.074	0.095	0.087	0.103	0.178
NO_2-N	Pelegrin	0.117	0.090	0.114	0.112	0.106	0.175	
μg-at/l	Kaštela Bay	0.127	0.084	0.110	0.127			
	Stončica	0.39	0.41	0.43	0.30	0.34	0.53	0.53
NO_3-N	Pelegrin	0.46	0.35	0.56	0.34	0.34	0.44	
μg-at/l	Kaštela Bay	0.97	1.00	0.58	0.57			
	Stončica	0.074	0.076	0.073	0.078	0.082	0.079	0.086
PO_4-P	Pelegrin	0.072	0.061	0.078	0.072	0.069	0.076	
μg-at/l	Kaštela Bay	0.105	0.082	0.076	0.085			

Table 9. Means with depth of nitrogen salts and phosphates in South Adriatic Pit and Jabuka Pit

		0	20	50	100	300*	500**	1000	1190 m
NH_3-N	South Adriatic Pit	1.23	1.44	2.53	1.99	4.03	1.86	2.55	1.34
μg-at/l	Jabuka Pit	1.51	1.68	2.05	2.63	1.35	1.85		
NO_2-N	South Adriatic Pit	0.110	0.097	0.077	0.104	0.039	0.121	0.115	0.071
μg-at/l	Jabuka Pit	0.037	0.121	0.096	0.128	0.081	0.264		
NO_3-N	South Adriatic Pit	0.46	0.74	1.04	1.67	2.97	2.72	3.31	3.49
μg-at/l	Jabuka Pit	0.58	0.31	1.20	1.17	4.01	5.80		
PO_4-P	South Adriatic Pit	0.068	0.083	0.124	0.135	0.117	0.164	0.087	0.104
μg-at/l	Jabuka Pit	0.070	0.093	0.080	0.126	0.151	0.137		

* At Jabuka Pit this is the depth of 200 m.
** At Jabuka Pit this is the depth of 260 m.

Table 10. Ratio N/P (atoms)

	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
Kaštela Bay	210	17	94	83	17	29	54	19	30	23	13	20
Pelegrin					23	68	45	85	18	28	42	212
Stončica	23	11	47	46	28	74	42	71	17	28	18	80
Jabuka Pit			47			55			30			38
South Adriatic Pit			75			47			11			103

Table 11. Ratio N/P (atoms)

	0	10	20	30	50	75	100 m	
Kaštela Bay	33	46	38	32				
Pelegrin	33	61	33	39	44	38		
Stončica	34	38	36	29	36	35	29	
	0	20	50	100	300*	500**	1000	1190 m
Jabuka Pit	30	23	42	31	36	58		
South Adriatic Pit	26	27	29	28	60	29	69	47

* At Jabuka Pit this is the depth of 200 m.
** At Jabuka Pit this is the depth of 260 m.