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A CONTRIBUTION TO THE ASSESSMENT OF MARINE PRODUCTION BY MEANS OF NUTRIENT SALTS

PRILOG OCJENI PRODUKTIVNOSTI MORA POMOĆU HRANJIVIH SOLI

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Measurements of a year cycle of nutrient salts (nitrogen and phosphate ones) from two stations in the central Adriatic were used for marine organic production calculation.

Buljan's differential-integrational method: $P = \Sigma (\triangle \alpha)$ where $\alpha = 0_2 — O'_2$ i. e. exygen content, was used for a quantitative calculation of production.

We, however, used the content of nitrogen and phosphate salts for α assuming that the variations in these salts contents are due to the biological activity connected with the marine production.

The results obtained were also compared with the C^{14} method.

INTRODUCTION

Difficulties in the studies of organic production in the sea are due to the dynamic nature of this process. Since the organic matter producted in the sea is simultaneously consumed the investigations of organic production are not simple. Therefore new or additional method for organic production calculation is a step forward in oceanographic investigations.

QUANTITIVE CALCULATION OF PRODUCTION BY MEANS OF NUTRIENT SALTS

Chemical parameters, such as oxygen, carbon dioxide, and phosphate and nitrogen salt contents, are some of the factors by means of which marine production my be calculated.

Buljan (1968) developed a differential-integrational method which the level of production in grC/m^2 and grC/m^3 may be calculated. This method supposes dm/dt to be analysed for individual chemical parameters from a sufficient number of levels and on sufficient occasions in the course of the year.

Buljan used oxygen content in the sea water to determine the level of Adriatic production by this method. Thus Gross and Nett production as well as the dissimilar part (Diss) of produced organic matter in a water column may be calculated. All of these calculations require oxygen content data to be available.

We used phosphate and total nitrogen salts Σ N (ammonia, nitrite, nitrate) contents assuming that the variations in these parameters are due to the biological activity in the sea waters. Thus we calculated the production at two stations in the central Adriatic, the Kaštela Bay (25) and Stončica (9) for the years 1975, 1976 and 1977. The Station 25 is a coastal station of 35 m depth and Station 9 open sea station of 100 m depth (production calculated down to 50 m).

An example of the calculation of the amount of annual production by means of Σ N and phosphate is given in Tables 1 and 2.

A transformation of nitrogen and phosphates in grC/m^2 (S v e r d r u p, J o h n s t o n, F l e m i n g, 1946) is given in Tables 3 and 4.

RESULTS AND DISCUSSION

Tables 5 and 6 show Nett, Diss and Gross production at Stations 25 and 9 in the years 1975, 1976 and 1977.

As it may be seen the production calculated by the use of oxygen exceeds that calculated by the use of other two methods. This is probably due to the nature of constituents themselves since oxygen is a dissolved gas while Σ N and phosphates are dissolved salts. The values obtained are still of the same order of magnitude.

A comparison of Gross production calculated by the most common method of radioactive carbon (C^{14}) and our method is given in Table 7.

CONCLUSIONS

Our methods proved to give, on an average, lower results than the earlier ones. An advantage of the assessment of biological production by this method is in that it may be applied retroactively for any oceanographical station for which there are sufficient data on nitrogen and phosphorus salts.

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KRATAK SADRŽAJ

U ovom radu iskorišteno je mjerenje jednogodišnjeg ciklusa hranjivih soli (dušikovih i fosfatnih) na dvije postaje u srednjem Jadranu za izračunavanje organske produkcije u moru.

Za kvantitativno izračunavanje produkcije uzeta je Buljanova diferencijsko-integracijska metoda: $P = \Sigma (\Delta\alpha)$ gdje je $\alpha = 0_2 — 0'_2$ tj. sadržaj kisika.

U ovom slučaju za α je uzet sadržaj dušikovih i fosfatnih soli uz pretpostavku da su kolebanja sadržaja ovih soli posljedica biološke aktivnosti koja se odnosi na produkciju mora.

Dobiveni rezultati uspoređeni su i s C^{14} metodom.

Table 1. Quantitative calculation of production by means of Σ N (μg—at/1) at Station 9 in 1976

	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
0	2.07	2.11	1.81	1.69	1.87	1.90	3.04	1.67	1.64	1.76	1.86	3.28	1.39
10	1.88	1.67	1.61	1.71	1.55	1.87	1.25	1.51	1.80	2.30	1.52	2.07	1.59
20	2.07	1.78	2.33	2.33	2.10	2.18	1.03	1.79	1.90	1.91	1.58	2.19	1.26
30	2.40	2.29	1.86	2.74	1.90	1.88	1.24	1.84	2.25	1.39	1.60	1.91	2.84
50	2.22	3.54	1.46	2.78	1.86	1.99	1.41	1.28	1.68	1.33	1.78	2.65	2.12
		+0.04	−0.30	−0.12	+0.13	+0.03	+1.14	−1.37	−0.03	+0.12	+0.10	+1.42	−1.89
		−0.21	−0.06	+0.10	−0.16	+0.32	+0.62	+0.26	+0.29	+0.50	−0.78	+0.55	−0.48
		−0.29	+0.55	±0.00	−0.23	+0.08	−1.15	+0.76	+0.11	+0.01	−0.33	+0.61	−0.93
		−0.11	−0.43	+0.88	−0.84	−0.02	−0.64	+0.60	+0.41	−0.86	+0.21	+0.31	+0.93
		+1.32	−2.08	+1.32	−0.92	+0.13	−0.58	−0.13	+0.40	−0.35	+0.45	+0.87	−0.53
Nett+		13.00	4.20	27.20	0.50	3.40	5.20	16.80	13.90	5.60	5.00	32.10	7.40
Diss-		4.50	39.70	0.30	25.20	0.00	31.20	6.40	0.00	15.50	9.40	0.00	23.80
Gross		17.50	43.90	27.50	25.70	5.20	34.60	23.20	13.90	21.10	14.40	32.10	31.20

Table 2. Quantitative calculation of production by means of PO_4 — P (μg—at/1) at Station 9 in 1976

	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
0	0.072	0.051	0.060	0.043	0.060	0.043	0.060	0.068	0.068	0.043	0.055	0.043	0.047
10	0.073	0.047	0.060	0.072	0.068	0.060	0.060	0.081	0.073	0.034	0.047	0.051	0.051
20	0.094	0.051	0.060	0.055	0.051	0.068	0.060	0.085	0.085	0.034	0.051	0.051	0.055
30	0.073	0.051	0.073	0.043	0.051	0.068	0.060	0.068	0.090	0.018	0.043	0.068	0.060
50	0.072	0.051	0.068	0.051	0.055	0.068	0.064	0.068	0.081	0.043	0.051	0.055	0.064
		−0.021	+0.009	−0.005	+0.005	−0.008	+0.017	+0.008	±0.000	−0.025	+0.012	−0.012	+0.004
		−0.026	+0.013	+0.012	−0.004	−0.017	+0.000	+0.021	−0.008	−0.039	+0.013	+0.004	±0.000
		−0.043	+0.009	−0.005	−0.004	+0.017	−0.008	+0.025	±0.000	−0.051	+0.017	±0.000	+0.004
		−0.022	+0.022	−0.030	+0.008	+0.017	−0008	+0.008	+0.022	−0.072	+0.025	+0.025	−0.008
		−0.021	+0.017	−0.017	+0.004	+0.013	−0.004	+0.004	+0.013	−0.038	+0.008	+0.004	+0.009
Nett+		0.00	0.80	0.10	0.20	0.50	0.10	0.70	0.50	0.00	1.00	0.40	0.10
Diss—		1.30	0.00	0.70	0.10	0.10	0.20	0.00	0.10	2.50	0.00	0.10	0.10
Gross		1.30	0.80	0.80	0.30	0.60	0.30	0.70	0.60	2.50	1.00	0.50	0.20

Table 3. A transformation of nitrogen in grC/m² and grC/m³

	Σ N			grC/m²			grC/m³		
	Nett+	Diss—	Gross	Nett+	Diss—	Gross	Nett+	Diss—	Gross
I	13.00	4.50	17.50	1.00	0.40	1.40	0.02	0.01	0.03
II	4.20	39.70	43.90	0.30	3.20	3.50	0.01	0.06	0.07
III	27.20	0.30	27.50	2.20	0.00	2.20	0.04	0.00	0.04
IV	0.50	25.20	25.70	0.00	2.00	2.00	0.00	0.04	0.04
V	5.20	0.00	5.20	0.40	0.00	0.40	0.01	0.00	0.01
VI	3.40	31.20	34.60	0.30	2.50	2.80	0.01	0.05	0.06
VII	16.80	6.40	23.20	1.30	0.50	1.80	0.03	0.01	0.04
VIII	13.90	0.00	13.90	1.10	0.00	1.10	0.02	0.00	0.02
IX	5.60	15.50	21.10	0.40	1.20	1.60	0.01	0.02	0.03
X	5.00	9.40	14.40	0.40	0.80	1.20	0.01	0.02	0.03
XI	32.10	0.00	32.10	2.60	0.00	2.60	0.05	0.00	0.05
XII	7.40	23.80	31.20	0.60	1.90	2.50	0.01	0.04	0.05
	134.30	156.00	290.30	10.60	12.50	23.10	0.22	0.25	0.47

Table 4. A transformation of nitrogen in grC/m² and grC/m³

	Σ N			grC/m²			grC/m³		
	Nett+	Diss—	Gross	Nett+	Diss—	Gross	Nett+	Diss—	Gross
I	0.00	1.30	1.30	0.00	1.70	1.70	0.00	0.03	0.03
II	0.80	0.00	0.80	1.00	0.00	1.00	0.02	0.00	0.02
III	0.10	0.70	0.80	0.10	0.90	1.00	0.00	0.02	0.02
IV	0.20	0.10	0.30	0.30	0.10	0.40	0.01	0.00	0.01
V	0.50	0.10	0.60	0.60	0.10	0.70	0.01	0.00	0.01
VI	0.10	0.20	0.30	0.10	0.30	0.40	0.00	0.01	0.01
VII	0.70	0.00	0.70	0.90	0.00	0.90	0.02	0.00	0.02
VIII	0.50	0.10	0.60	0.60	0.10	0.70	0.01	0.00	0.01
IX	0.00	2.50	2.50	0.00	3.20	3.20	0.00	0.06	0.06
X	1.00	0.00	1.00	1.30	0.00	1.30	0.03	0.00	0.03
XI	0.40	0.10	0.50	0.50	0.10	0.60	0.01	0.00	0.01
XII	0.10	0.10	0.20	0.10	0.10	0.20	0.00	0.00	0.00
	4.40	5.20	9.60	5.50	6.60	12.10	0.11	0.12	0.23

Table 5. Production at Station 25

		grC/m²/year			grC/m³/year		
Method	Yaers	Nett+	Diss—	Gross	Nett+	Diss—	Gross
O_2	1975	29.20	17.40	46.60	0.84	0.49	1.34
	1976	26.00	30.40	56.40	0.76	0,86	1.62
	1977	36.50	60.00	97.10	1.05	1.74	2.79
Σ N	1975	5.50	6.30	11.80	0.17	0.18	0.35
	1976	13.90	12.40	26.30	0.41	0.35	0.76
	1977	9.20	3.50	12.70	0.29	0.10	0.39
PO_4—P	1975	5.60	5.70	11.30	0.17	0.16	0.33
	1976	3.90	5.30	9.20	0.10	0.15	0.25
	1977	3.70	3.50	7.20	0.11	0.09	0.20

Table 6. Production at Station 9

Method	Yaers	grC/m²/year Nett+	Diss—	Gross	grC/m³/year Nett+	Diss—	Gross
	1975	53.80	36.60	90.40	1.08	0.73	1.81
O_2	1976	29.20	36.90	66.10	0.58	0.73	1.31
	1977	53.50	52.30	105.80	1.04	1.05	2.09
	1975	10.60	7.20	17.80	0.21	0.14	0.35
Σ N	1976	10.60	12.50	23.10	0.22	0.25	0.47
	1977	17.00	8.10	25.10	0.34	0.16	0.50
	1975	8.00	8.00	16.00	0.17	0.17	0.34
PO_4—P	1976	5.50	6.60	12.10	0.11	0.12	0.23
	1977	5.50	4.90	10.40	0.11	0.10	0.21

Table 7. A comparison between the results on Gross production obtained by different methods and parameters

	(25) Bay of Kaštela						(9) Stončica					
	grC/m²/year			grC/m³/year			grC/m²/year			grC/m³/year		
Method	1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977
C^{14}	196.30	226.80	186.50	5.61	6.48	5.33	45.40	67.60	65.00	0.65	0.97	0.93
O_2	46.60	56.40	97.10	1.34	1.62	2.79	90.40	66.10	105.80	1.80	1.31	2.09
Σ N	11.80	26.30	12.70	0.35	0.76	0.39	17.80	23.10	25.10	0.35	0.47	0.50
PO_4—P	11.30	9.20	7.20	0.33	0.25	0.20	16.00	12.10	10.40	0.34	0.23	0.21