Present State of Environmental Pollution in Coastal Sea Area and Measures for Protection

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A comprehensive scientific survey (about 30 parameters) over the time period of 1979 up to 1989 has been developed as well as experimental work to test the influence of the main polllutant compounds on the marine organisms.

INTRODUCTION

The Black Sea is one of the polluted World's Ocean area. The eutrophication process, as a consequence of pollution, has accelerated for twenty years when the urbanisation and industrial development began. During the last two decades there has been a clear modification in concentration or size of parameters that characterize the polluted marine zones (MIHNEA et al., 1980; MIHNEA et CUINGIOGLU, 1984 etc.). The results are here discussed in context with long term registered changes. Laboratory experiments have permitted us a new viewpoint in approaching the pollution problem.

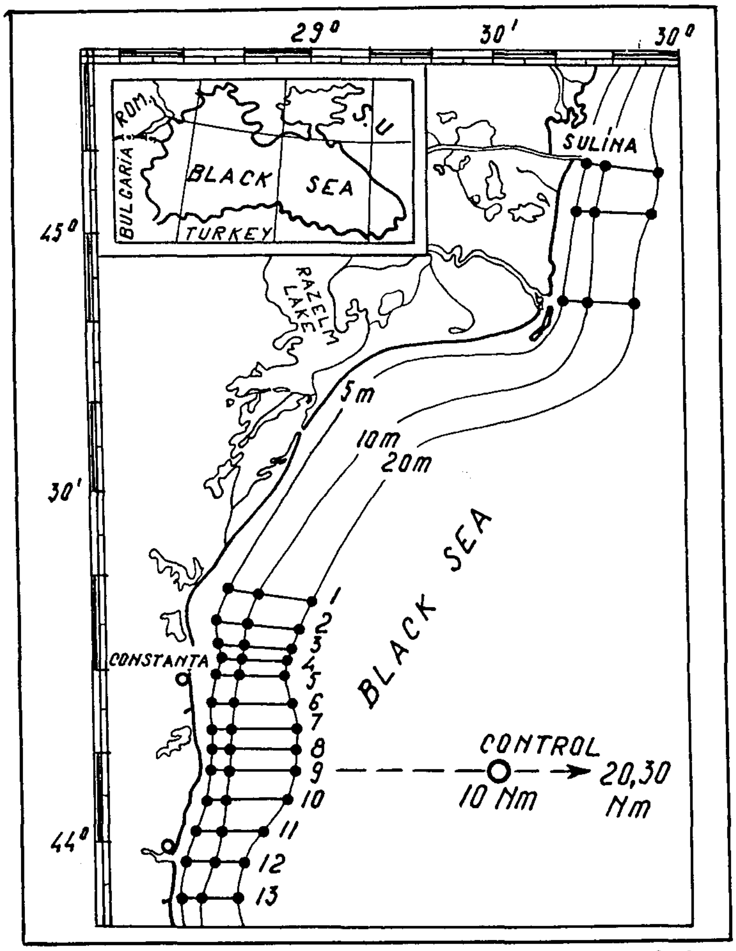

Fig.1 - The location of sampling points (1: Năvodari; 2: Casino Mamaia; 3: Romanian Marine Research Institute; 4: Ion Raţiu; 5: Modern Beach; 6: South Constanţa; 7: North Eforie; 8: South Eforie; 9: Tuzla; 10: Costineşti; 11: Neptun; 12: Mangalia; 13: Vama Veche)

SAMPLING

The sampling locations are given in Fig.1. Sampling frequency was monthly, during February-March to October. The experimented algae were isolated from inshore area and kept into standard conditions.

METHODOLOGY

The used methods are described in: SEMINA, 1978; SCOR-UNESCO, 1966; STRICKLAND 1960; 1970; STRICKLAND & PARSONS, 1972. Heavy metals were analysed in atomic absorption. Experimental conditions are given in some other papers (e.g. MIHNEA & CUINGIOGLU, 1983).

RESULTS AND DISCUSSION

The extensive and increased nutrient input into the Black Sea over the last two decades has led to elevated nutrients concentration and to in-

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creased risk of adverse eutrophication effects (MIHNEA, 1984; 1985; 1987). There were found min. and max. values (in μg-at l^{-1}) of $N-NO_2$: 0.01-92.4; $N-NO_3$: 0.59-135.5; $N-NH_4$: 0.13-343; $P-PO_4$: 0.06-1,340 and $Si-SiO_3$: 2.84-304.92. Undetectable levels were found for all macronutrients after the maximum photosynthetic activity, but that situations were time and space

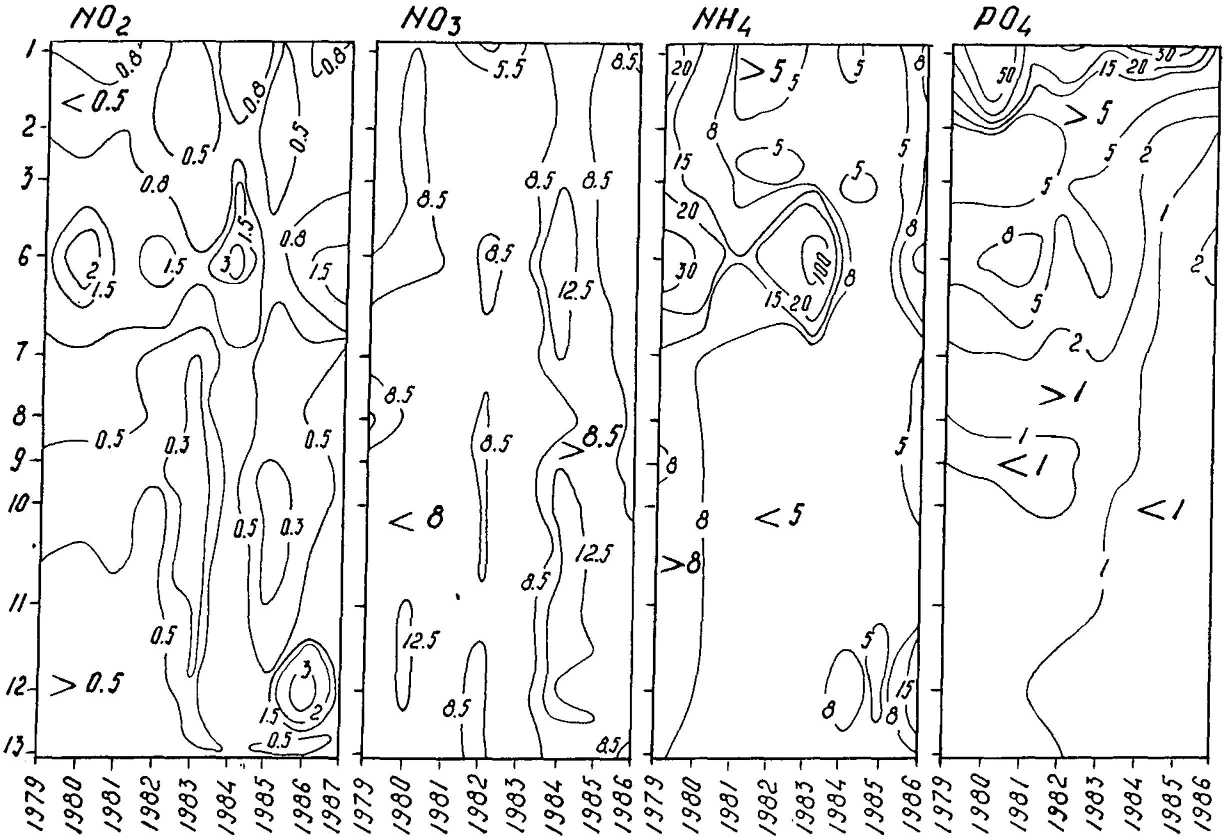

Fig.2 - Mean annual of the main macronutrients in the inshore area

limited. The highest values characterized areas situated just in front of the outfalls or into the sheltered zones. The distribution of annual macronutrients mean level has proved the high eutrophication stage (Fig.2) on account of the massive anthropogenic input. Besides these macronutrients, notable quantities of N-urea were determined; an usual variation from trace to 24.27 μg-at l^{-1} was recorded, but maximum concentrations reached from 46 to 157 μg-at l^{-1}. Silicium has had min. and max. values of 2.84 and 304.92 μg-at l^{-1}. High levels of dissolved organic matter were present during the considered period. This parameter ranged between 21 and 40 but 40-65 mg$KMnO_4$ l^{-1} values were found, too. The great load of dissolved organic matter was correlated with high levels of BOD_5. The raw values were distributed between 0.23

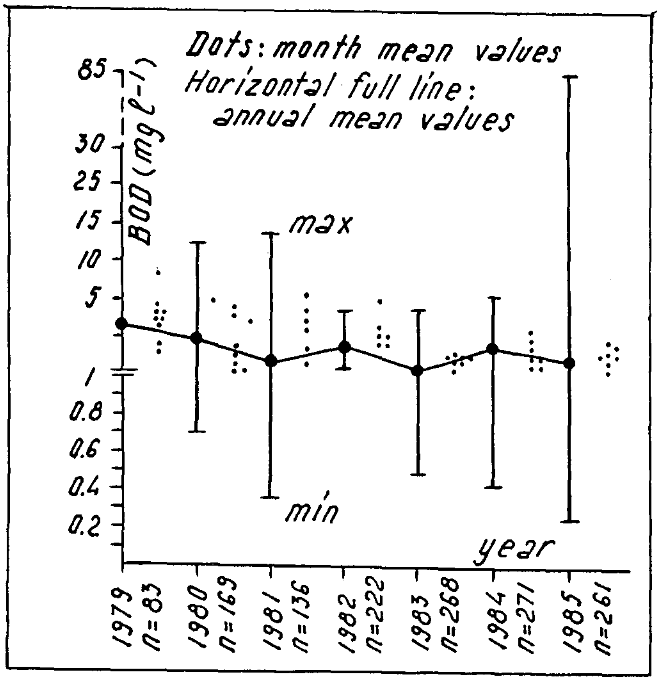

Fig.3 - BOD_5 variation: min., max., annual $\overline{X}$ and month $\overline{X}$

and 85 mg l^{-1} (Fig.3). The size class frequency (%) on a whole of the 1,521 samples was: less than 1 to 1: 2.76; 1-5: 60.68; 5-1: 30.05; 10-15: 4.86; 15-20: 1.58 and more than 20 up to 85: 0.07. The highest values were registered within the nearshore not far from discharge as well as when great phytoplanktonic blooms ceased and biomass began to be mineralized.

Heavy metals content into the sea water was determined on 10m isobate; the range of variation is listed down as $\mu g\ l^{-1}$ (Table 1).

Table 1. Heavy metals level

Heavy metal	Sampling point (min. max./X̄)				
	Năvodari	North Constanța	South Constanța	Tuzla	Mangalia
Cu	trace- 6.25 3.38	trace- 3.56 2.51	trace- 7.0 3.72	trace- 3.20 2.07	trace- 4.90 2.12
Pb	trace- 6.25 5.33	trace- 0.5	trace-4.25 2.76	trace- 2.75 1.56	trace- 4.82 2.32
Zn	2.2-91.0 28.66	6.5-46.50 18.47	1.45-44.0 16.79	1.65- 3.60 13.82	1.40-24.0 10.20
	trace- 0.70 0.48	trace- 1.00 0.55	trace- 1.32 0.56	trace- 1.60 0.70	trace- 0.95 0.48

Table 2. Phytoplankton cell densities (no.cell $l^{-1}x10^{-6}$)

Year	No. of samples	Annual X̄ value	Maximum value
1979	143	5.642	62.995
1980	141	7.607	65.562
1981	132	13.474	161.015
1982	374	5.483	91.041
1983	405	.911	40.735
1984	320	12.311	108.079
1985	218	1.495	56.324
1986	175	5.963	51.548

Table 3. The frequence (%) of Chryso-Cryptophyta

Year/ Month	1979	1980	1982
III	0 -22.69	0.17-34.09	0 -33.03
IV	0.05-88.76	0 -13.33	0.01 -25.65
V	0 -16.04	0.05- 4.58	0 -81.88
VI	0.34-26.78	0.62-18.08	0 -69.66
VII	2.04-33.29	0.09-58.04	0.002-30.00
VIII	0.11-96.16	0.43-68.06	0 -58.04
IX	-	3.38-81.79	0 -17.39

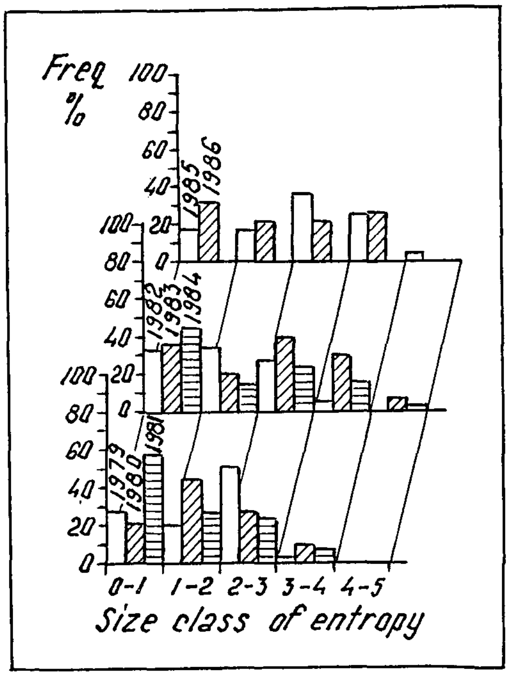

Fig.4 - The variation of phytoplankton entropy

Phytoplankton community usually developed high quantities of individuals on volume unit (Table 2),showed the tendency to produce peacheness of high cell no. densities, temporaly developed significant quantities of Chryso-Cryptophyta representatives (Table 3),and had a very low entropy (Fig.4). The entropy as Shannon Wiener H' is a biological indicator which integrates information on the kinds and numbers of organisms present in a community, in a single datum, which can be treated heuristicaly like another environmental parameter.

Entropy or diversity index is a measure for assesing the disorderliness of the environment under consideration: not all species develop at the same levels,but only 1-3 species are strongly dominants.This index provides an insight into eutrophication process complementing that provided by standing crop data: they both will reflect the net balance between increases in primary production and crop losses, e.g. - grazing. Reduced values means: high productivity produced by a few dominants and an inefficient consumption. Big standing

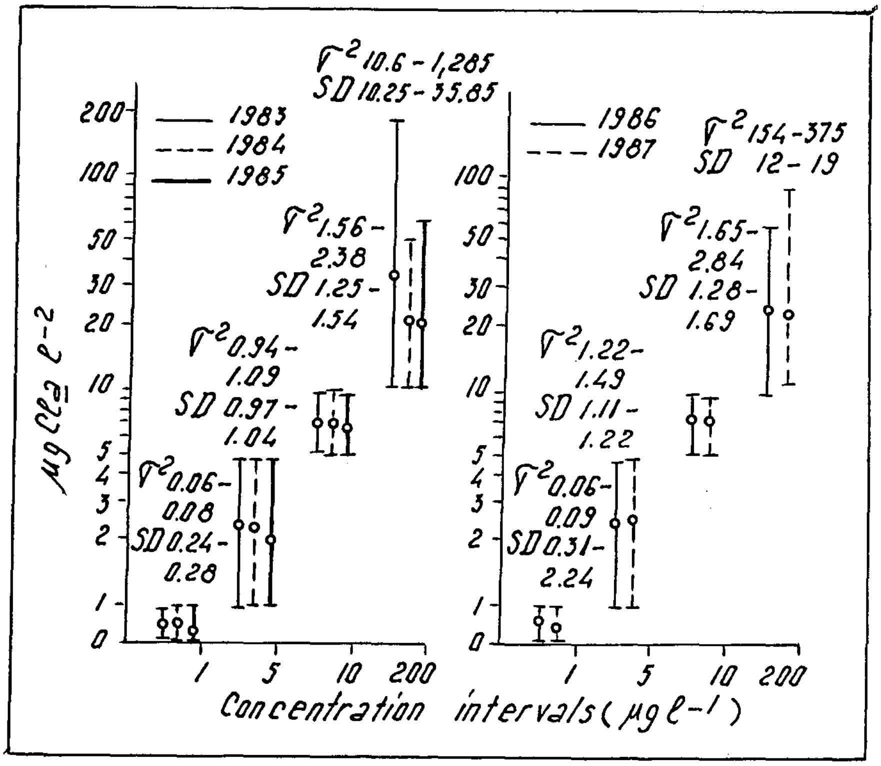

Fig.5 - Mean value and variation range of the chlorophyll a concentrations during 1983-1987

crop leads to high concentrations of chlorophyll a. During 1983-1987 from the whole of 1,126 samples 67.3% contained from less than 1 up to 5 µg l^{-1}, but 32.7 % reached more than 5 up to 185 µg l^{-1} (Fig.5). High levels of standing crop and implicitly those of chlorophyll a, determined important negative modifications of water colour and transparency (MIHNEA, 1984). The final point of all these changes was suboxia, marine organisms mortality and the decrease of landed quantities of fish as well as the disappearance of some vertebrates species (MIHNEA, 1987).

The experimental approach of the pollution is absolutely necessary, since its consequence consists in an increase of mineral and organic compounds. The input of organic matter generates, by mineralization, different compounds. As for instance in the English Channel marine area, glucose was determined at a level of 0.4-5.7 µg l^{-1} (ANDREWS & WILLIAMS, 1971), and in the Black Sea water some aminoacids (µg l^{-1}) there were identified: arginine (0 - 1.4); lysine + hystidine (trace - 14.5); asparagine (trace-16.7); glutamic acid (0-12.6) etc. (STARIKOVA & KORJIKOVA, 1969). The tests performed on these or related compounds emphasised a stimulation of maximum division rate (K max.) of unicellular algae, as these compounds were experimented separately or in different combination (for all examples control is MS culture medium lacked by experimented compounds) as it can be seen below (Table 4):

Table 4. The effects of some aminoacids on algae division rate

Species	Experimented combination	K(max.)
Rhodomonas tenuis		
Control (C)		1.23
All aminoacids		1.40
Arginine-Lysine+hystidine		1.30
Glutamic acid + asparagine		1.55
Chlamydomonas sp.		
Control		0.78
All aminoacids		0.93
Arginine+Lysine+hystidine		1.06
Glutamic acid + asparagine		1.12

Rhodomonas species were stimulated by all variants but glutamic acid and aspartate were best utilised: K max. was greater than control: 82 % for Rhodomonas lens and only 26.5 % for Rhodomonas tenuis.

Saccharose stimulated Chlamydomonas sp. (K max. 1.07) and was utilised by Cryptomonas sp. and Eutreptia lanowii, too. All experimented organic compounds entailed the increase of max. division rate up to 4.6-37.42 % e.g. Eutreptia l., or 552-987 % e.g. Cryptomonas sp. Sewage additioned to sea water in 5,10 and 20 % stimulated Rhodomonas l. division rate as well as heterotrophic bacteria. They both were involved in BOD_5 variation (MIHNEA and CUINGIOGLU, 1983). An increase of N-urea up to 1,000 µg l^{-1} stimulated K max. of Thalassiosira parva (control: 0.79; variant: 1.43), Chloromonas paradoxa (control: 0.42; variant: 1) and Prorocentrum cordatum (control:

0.71; variant: 1.71). The presence of heavy metals as Zn, Cu or Cd into the sea water in sublethal concentration has a significant rôle for unicellular algae, contributing to an increament of their division rate; some examples are given down (concentration in $\mu g\ l^{-1}$) (Table 5):

Table 5. Zinc, copper and cadmium effect on algae division rate

Skeletonema costatum		Chloromonas paradoxa					
Zn	K max.	Zn	K max.	Cu	K max.	Cd	K max.
0.5	1.43	0.5	3.16	15	1.98	0.04	1.82
2.0	1.54	2.0	3.92	30	2.10	0.10	1.95
5.0	2.10	5.0	2.30	46	2.48	0.20	3.54
10.0	3.18	10.0	2.40	-	-	0.50	2.07
50.0	2.22	50.0	1.50	-	-	1.00	2.01
C 0.1	1.35	0.1	1.65	1.2	1.90	0	1.60

In conclusion, ecotoxicology that concerns with the toxic effects of chemical and physical agents on living organisms has to include all the parent chemical compounds or breakdown products that may affect the natural environment. We need to understand and to predict the behaviour and pathways of all pollutants if we are to protect natural resources.The monitoring of physical and chemical factors must run parallel with ecotoxicology in its enlarged concept. This is an integrated approach that will bring water pollution abatement. For an environment in which the pertinent receiving capacity appears to be at least temporarily surpassed, the only realistic alternative is to cutt off all bioactive inputs from land - based sources.But this measure is everywhere declined. An improvement could be obtained by: (1) filtration through sand bads, filtration through fabrics (microstrainers), irrigation over grass plots and retention in maturation ponds; these systems basically remove residual biological solids from the effluent and thereby also reduce the remaining BOD5 concentration; (2) advanced treatment of sewage and industrial wastes that will remove almost all phosphorus by precipitations; (3) developing of new treatment technology to remove nitrogen compounds and heavy metals.

REFERENCES

ANDREWS, P. and WILLIAMS, P.J., 1971 - J.Mar.Biol.Ass.U.K., 51: 111 - 125.

MIHNEA, P.E., 1984 - Cercet.Mar., IRCM, 17: 47 - 61.

MIHNEA, P.E., 1985 - Rapp.Comm.int.Mer Médit., 29, 9: 85 - 88.

MIHNEA, P.E., 1987 - Rev.Roum.Biol.-Biol.Anim., 32, 2: 149 - 155.

MIHNEA, P.E., CUINGIOGLU, E. et BILAL, I., 1980 - Ves Journées Etud. Pollutions, Cagliari, CIESM: 869 - 876.

MIHNEA, P.E. and CUINGIOGLU, E., 1983 - Cercet.Mar.IRCM, 16: 271 - 284.

MIHNEA, P.E. et CUINGIOGLU,E.,1984 - VIIes Journées Etud.Pollutions,Lucerne, CIESM: 417 - 422.

SCOR-UNESCO, 1966 - Publ.by United Nations, Montreuil: 1 - 69.

STARIKOVA, N.D. and KORJIKOVA, L.I., 1969 - Okeanologiya, 9, 4: 625 - 636.

STRICKLAND, J.D.H., 1960 - Bull.Fish.Res.Bd.Canada, 125: 1 - 172.

STRICKLAND, J.D.H., (ed), 1970 - The ecology of the plankton off La Jolla, California in the period April through September,Univ.Calif.Press Berkeley: 1 - 103.

STRICKLAND, J.D.H. and PARSONS, T.R., 1972 - Bull.Fish.Res.Bd.Canada, 167: 310 p.