Thermal influence of thermoelectric power station "Varna" on Varna Lake ecosystem and ecological impact.

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Varna lake is a brackish lake (mean salinity 16‰) with intensive water exchange with the sea through two channels. As an area where the greatest portion of the industrial and sewage waste waters of Varna region are discharged, it is the main source responsible for the high level of eutrophication and pollution of Varna Bay with strong ecological impact on the marine biota. (MONCHEVA, 1991).

The operational phase of the Thermoelectric Power Station (ThPS) "Varna" situated on north Varna lake coast started in 1967. The once-through cooling circuit is based on deep layers cold water intake by pumps and discharge back to Varna lake system through two channels (Fig.l). At full power the cooling water temperature in the circuit is about 40°-46°C and depending on the season at the discharge points between 27° and 20°C. The investigations are focused on ThPS "Varna" temperature pattern influence assessment and its ecological impact.

The parameters taken into consideration are temperature, salinity, current speed and direction, phytoplankton analyses in qualitative and quantitative terms, (abundance and biomass, chlorophyll "a" and phaeophytin) seasonally during 1990 - 1991 and detail investigations in May 1991.

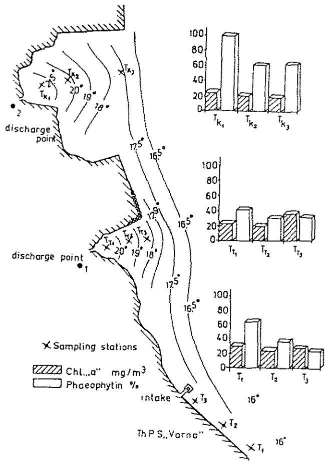

Fig.1. Trends in temperature, chl. "a" and phaeophytin distribution from the closed to discharge points areas.

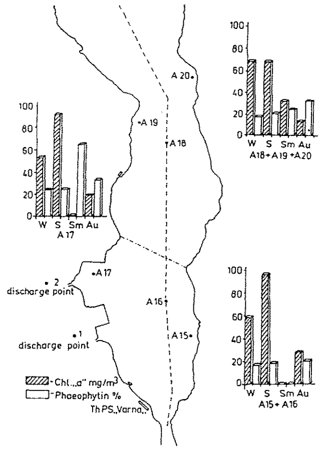

Fig.2. Seasonal pattern of chl."a" and phaeophytin distribution in Varna lake: w - winter; s - spring; sm - summer; au - autumn.

The data reveal that the thermal plume influences an area of 9.2×10^5 m² (e.g. 1/4 of the total surface of Varna lake) down to 5m depth, resulting in a local temperature water mass gradient varying between 6 and 10°C (depending on the season) - fig.1.

The discharged water impact includes both oceanographic and biological perturbations of the ecosystem (although restricted mainly to its western part) :

- the temperature gradient induced changes in the stratification of the basin affect water mass circulation and density, resulting in the formation of a horizontal pressure gradient and water mass dynamic processes activation in the area of concern (especially in winter, spring and autumn).

- perturbation in the pattern of development of phytoplankton: significant differences in quantitative terms between the impact (st. A17, A16, A15) and relatively distant areas (st. A18, A19, A20) while the taxonomic structure is almost the same - the main trend being a shift in both chl."a" and phaeophytin in the area of concern (fig.2). As it is known t° increase influences phytoplankton development in several ways: stimulates colonization rate, determines to a greater extent in excystment, generation time and life cycle duration (EPPLEY, 1972, STEIDINGER and HADDAD 1981).

Probably the induced increase in the temperature of closed area waters may serve as a potential initiation factor responsible for high phytoplankton biomass maintenance and conditioning phytoplankton blooms inoculating the whole area through dynamical processes under the high eutrophication level of the environment.

The detailed map of phaeophytin distribution investigation reveals very high values (between 75 - 93 %) at the very close to the discharge points zone slightly decreasing towards the 16° isotherm (fig.1). The high phaeophytin % can not be related to the direct temperature impact (the summer temperature exceeds 26°C). As the temperature of the water in contact with the condensors is 40 - 46°C, it is high enough to cause the death of the living plankton cells to which the mechanical treatment contributes a lot. Taking into account that the mean year phytoplankton biomass is 24.9 mg/l, each pump capacity (250 m³/h) and average phaeophytin (77 %) it is estimated that the input of fresh - dead phytobiomass amounts to 12kg per fortnight, e.g. 4.4 t per year. The dead matter if not utilized through the food web sinks directly to the bottom.

The excess of phytobiomass produced as a result of the high eutrophication level of Varna Lake (ROJDESTVENSKI, 1991), and the high input dead matter rate induced by the thermal operating cycle of the station create conditions leading to the deterioration of benthic cenoces through a decrease of water transparency, a mechanical overlapping and an oxygen deficiency. As established the benthic cenoces at st. A17 are totally dead and seriously damaged at st. A16, A15 (KONSULOVA, 1991).

The results of the complex investigations give ground to consider the thermal influence of ThPS "Varna" on Varna Lake system as a thermal pollution with strongly expressed indirect negative ecological impact although it is not the only reason responsible of the ecological disaster of the basin.

REFERENCES

EPPLEY H.W., 1972.- *Fishery Bulletin* , 70: 1083-1085.

KONSULOVA Tz., 1991.- Conference "Varna Region Environmental Ecological problems", Varna, 31 oct.- 1 nov. (in print).

MONCHEVA S., 1991.- Ph. D. Thesis 10- BAS.

ROJDESTVENSKI A., 1991.- *Oceanology*, 26 (in print).

STEIDINGER K.A. and HADDAD K., 1981.- Biological and Hydrographic Aspects of Red Tides. *Bioscience*, 31: 814-819.

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Relationships between physico-chemical characteristics and planktonic communities in the Bay of Alcudia (Majorca)

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The physico-chemical characteristics and planktonic communities of the Alcudia Bay have been monitored throughout 1991. Monthly samples were taken from seven stations located along a radius starting from the innermost part, adjoining the coastal marsh *Albufera de Mallorca*, to the outer bay (four stations), with three stations along the coast. Samples were taken from surface to bottom, with 5 m intervals. Results show that there are significant relationships between physicochemical characteristics (salinity, N/P ratio), phytoplankton biomass expressed as chlorophyll *a* and particulate matter, basically zooplankton, collected with a 100 µm mesh net.

The Bay of Alcudia has an input of brackish water from the *Albufera de Mallorca*. This coastal aquatic habitat exports part of the nutrients it takes in from tourist and agricultural activities (MARTINEZ TABERNER *et al.*, 1990). The lower density water arriving in the bay stays at the surface and creates an inverse salinity and nutrient gradient in the water column. The intensity of this gradient and its incidence in the outer bay depend on the water flow from the *Albufera*, water density, nutrient load and S and SE wind action; all these parameters may vary over the year.

Nutrient concentrations display great temporal and spatial heterogeneity (horizontal and vertical). Nitrate values are always high at the surface in the area near the *Albufera*. In the rest of the Bay values are high at certain moments of the year. Phosphorus concentrations are generally low, with very localized peaks in both time and space. Due to this variability N/P values are greatly dispersed around the 16/1 quotient considered optimum for phytoplankton growth (GOLDMAN *et al.*, 1979).

Chlorophyll *a* concentrations exhibit a pattern of variation dependent on the N/P ratio. Maximum values of chlorophyll *a* coincide with ratios above 16/1, while minimal concentrations of chlorophyll are associated with very low N/P ratios. This behaviour suggests that at certain moments of the annual cycle and at certain points in the bay, N and/or P are limiting factors for phytoplankton growth. The annual phytoplankton dynamics is modified by the entry into the bay of brackish water rich in nutrients. This surface enrichment is the cause of significant phytoplankton development, fundamentally of small flagellates (Cryptophyceae and Chrysophyceae) during spring and autumn.

The annual variation of zooplankton, expressed as mg organic matter m^{-2}, is closely linked with changes in phytoplankton biomass as mg chlorophyll *a* m^{-2}. The zooplankton biomass/chlorophyll *a* concentration ratio ranges from 12.03 to 53.67, with a mean of 28.77 and standard deviation of 13.76. Maximum values correspond to situations where the phytoplankton is mainly made up of nanoplankton species (small flagellates) with low chlorophyll *a* concentration per cell. As in similar latitudes (NASSOGNE, 1972; FERNANDEZ DE PUELLES & GARCIA BRAUN, 1989) in these cases the nauplii of copepods found were dominant in the zooplankton.

The minimum, maximum, mean and standard deviation (in brackets) shown in the table express the range of variation of the parameters discussed in this contribution. Salinity: extreme values for all levels sampled. N/P ratio: integrated means for each station. Chlorophyll *a* concentrations: total chlorophyll *a* per unit surface for each station. And zooplankton biomass (> 100 µm): as organic matter concentration per unit surface in any station.

	SALINITY °/oo	N/P	Chl *a* mg m^{-2}	ZOOPLANK (>100 µm) mg m^{-2}
JANUARY	24.65-37.22	7.14-35.83 16.77 (9.05)	1.39-7.09 3.17 (2.00)	-
FEBRUARY	8.52-37.20	8.53-46.40 27.58 (12.89)	3.31-15.20 8.14 (4.04)	47.10-153.75 113.31 (47.20)
MARCH	32.56-37.31	1.38-21.89 8.74 (7.05)	0.55-4.08 2.12 (1.08)	9.75-291.00 83.16 (120.03)
APRIL	17.10-37.44	3.05-48.00 20.04 (14.81)	1.63-4.53 2.64 (1.01)	65.50-270.00 141.70 (76.94)
MAY	7.71-37.29	3.40-196.75 47.79 (64.48)	1.41-5.38 3.60 (1.29)	14.50-368.00 159.22 (129.36)
JUNE	12.46-37.41	3.14-51.80 21.22 (17.22)	1.93-3.33 2.61 (0.47)	16.70-143.80 86.65 (47.00)
JULY/10	26.22-37.34	2.16-81.00 26.17 (28.17)	0.83-4.18 2.21 (0.93)	15.00-98.60 45.30 (31.75)
JULY/24	29.87-37.35	1.11-334.38 50.21 (116.01)	3.38-6.03 4.88 (1.50)	33.35-176.00 79.51 (56.45)
AUGUST	23.50-37.50	2.93-88.63 24.06 (28.19)	1.85-3.35 2.51 (0.85)	-
SEPTEMBER	36.50-37.50	2.20-174.20 41.09 (57.01)	0.65-7.33 3.64 (2.85)	-
OCTOBER	21.40-37.29	3.20-51.30 21.43 (18.57)	0.97-9.58 4.66 (3.06)	17.95-170.80 83.64 (55.20)
NOVEMBER	24.03-37.41	63.58-207.50 115.88 (45.87)	0.63-6.13 3.13 (1.80)	17.60-63.20 37.65 (18.59)
DECEMBER	29.87-37.35	2.63-97.60 32.82 (33.73)	0.78-5.50 3.28 (1.74)	24.10-275.00 120.30 (95.50)

REFERENCES

GOLDMAN J.C., McCARTHY J.J. & PEAVEY D.G., 1979.- Growth rate influence on the chemical composition of phytoplankton in oceanic waters. *Nature* 279: 210-215.

MARTINEZ TABERNER A., MOYA G., RAMON G. & FORTEZA V., 1990.- Chemical hydrology and macrophyte vegetation ln the canals of a Mediterranean coastal marsh. *Arch. Hydrobiol.*, 120 (1): 67-87.

NASSOGNE A., 1972.- *Etudes préliminaires sur le rôle du zooplancton dans la constitution et le transport de la matière* organique *au sein de la chaîne alimentaire marine en Mer Ligure*. Thesis Univ. Amsterdam Publ. n BI O 187. 238 pp.

FERNANDEZ DE PUELLES M.L. & GARCIA BRAUN J.A., 1989.- Dinamica de las comunidades planctonicas en una zona del Atlàntico Subtropical (Isla de Tenerife). *Bol. Inst. Esp. Oceanogr.*, 5(2): 87-100.