Influence of solar activity upon the Diatoms of Black Sea plankton

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The interest towards investigation of the interrelations in the system solar activity - magnetosphere - biosphere grew rapidly due to its possibility to serve for bioprognosis through statistical analysis of solar and geomagnetic activity upon biosphere.
Monitoring of the phytoplankton dynamics in the Bulgarian Black Sea economic zone has been performed annually since 1954 by standard expeditional scheme of up to 30-40 mile profiles in 3-month periods and 34-year repeatibility period in more than 1200 stations of up to 200 m depth. The results of more than 6000 samples have been collected in informative banks for cells number($10^6/m^3$) and biomass(mg/m^3)(6). Through the process of investigation we established 5-year cycles in the phytoplankton biomass dynamics but in our opinion these were connected with the hydrological conditions of seawater environment(4,5).
The subject of this investigation is the possible influence of solar activity upon the diatoms flora in the Black Sea plankton. The investigation of its dynamics within the period 1954-1987 completely coincides with three 11-year cycles of sun-spots : 19-21 cycle by the Zürich numeration.

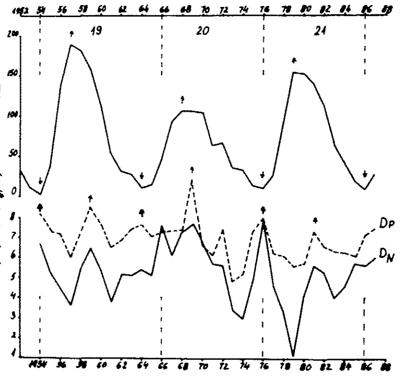

Fig. 1. Variations of the average annual parameters - cell number (N $10^6/m^3$) and biomass(P mg/m^3) of diatoms(D_N, D_P) compared to the variations of the sun-spots(Rz)

Within the temporal variations of the investigated parameters of diatom flora(fig.1) we observed peculiar dependency upon solar activity : throughout one 11-year cycle we found two clearly expessed peaks, the first being 1-2 years late in relation to the Rz sun-spots peak and the second coincides with the Rz minimum. This variation is very well expressed for a 5-year approximate period; the local diatom peaks occur at comparatively quiet conditions of solar activity as in 1972.
To confirm this period we used spectral analysis of the temporal lines in order to draw periodic amplitude graphs(1) at 3-month discrete interval. Basic periods in the interval investigated were 11,1 and 5,3 years for solar activity(2) and the periods 4,45 and 7,6 were considered to be amplitude modulation(fig.2). The analysis showed that the solar activity cycle for about 11,1 years was reflected in the dynamics of the diatoms by 10,5 - 10,8-years periods. In their temporal lines the variation of 5,5 - 5,6 years is basic while the accompanying periods T_1=6,65 and T_2=4,45-4,5 are results of amplitude modulation with modulation period of about 22 years. For its reliable detection within the spectrum we need mor data, however its presence in the solar activity is well expressed(2), especially in the solar corpuscular radiation and interplanetary magnetic field and the resulting geomagnetic field variations(3).

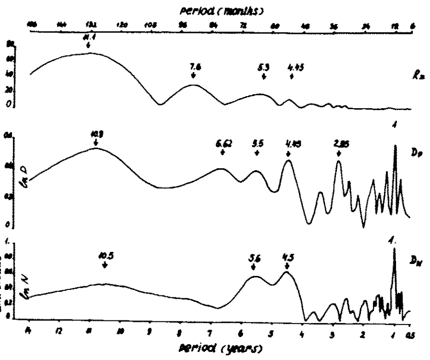

Fig. 2. Amplitude spectra of the average annual temporal lines(ln N, ln P) of diatoms(D_N, D_P) compared to the same of sunspots(Rz)

CONCLUSIONS : Solar activity influences diatom plankton flora through 5,5 - 5,6 years periods, exactly shown on fig.1 and fig.2 and through 11,1 years period(fig.2), and through 22-year period indirectly detected by complex demodulation(fig.2). The two-maximum diatoms'distribution provides possibilities for making bioprognosis about the maximums and the blooming in the following 22nd solar cycle. The Rz maximum is expected at the beginnung of 1990(7). We can expect minimal cell number and biomass in 1990 and the maximal is to be expected in 1991 - 1992.

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Approximation to Chlorophyll-a distribution in the Balearic Sea (Northern Mediterranean)

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An oceanographic project aimed at investigating hydrological conditions and production in the Western Mediterranean, which includes the so-called Balearic Sea, is in progress. Parameters directly related to phytoplankton primary production are presently being measured.

Chlorophyll-a levels were determined by spectrophotometric methods, using acetone as solvent. Concentrations were estimated with Jeffrey & Humphrey's (1975) equations. Preliminary results on measurements of primary production (ESTRADA, 1981) are also included.

This contribution discusses preliminary results on abundance and evolution of phytoplankton biomass expressed as mg chl-a/m3 of the photic layer (0-100m). Data are based on three samplings (March, May and September 1987) which correspond to clearly differentiated hydrographic situations. For each sampling a total of 30 stations were visited.

Variations observed in the distribution profile of the mean concentration of pigments for all stations in the three annual periods studied are represented in Fig.1.

The descent of the maximum of chlorophyll-a over time is a consequence of the stratification process, which results in an impoverishement of the layers above the thermocline. This phenomenon had been previously described (ESTRADA, 1985).

In March, prior to the formation of the thermocline, chl-a maxima are found between 30 and 50 m. When determining primary production a reduction of photosynthetic efficiency below the stated depths (Fig.2) is noticed, which is due either to the accumulation of biomass from above or as a result of low light intensity. As values for the ratio D430/D664 throughout the water column are similar, the second alternative is more probable. We should also point out that this increment in chl-a concentration may represent an increment in the concentration per cell rather than that of phytoplankton biomass.

Pigment distribution exhibits a marked seasonality imposed by the alternation of stratification and mixing periods. This variation in the distribution profile is quantitative as well as qualitative. Fig.3 represents increment in quantity of chl-a with increasing depth of the water column. Slope variations of the curve represent variations in the cumulative gradient of pigment distribution as a result of discontinuities of factors limiting production and phytoplankton biomass.

Variations observed in the distribution of weighted averages of chlorophyll concentration for a column of water between 0 and 75 m depth in the three annual periods studied (Fig.4), are a function of the vertical distribution of the limiting factors, which are themselves related to the season of the year, to the hidrographic situation of the different masses of water and to their thermohaline cycling.

As a result of the stabilization of the surface layers a displacement of maxima of chlorophyll abundance towards the SW of the Balearic archipelago can be observed, as well as a generalized impoverishment with reduction in chlorophyll related levels.

The slight increase in summer biomass values in this area may be attributed to the presence of waters of Atlantic origin which penetrate along the channels between the islands (FONT, 1986).

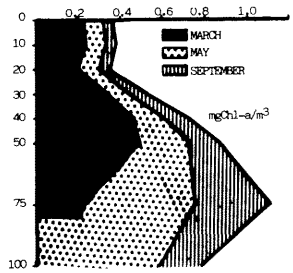

Fig.1. Distribution profile of the mean concentration of pigments (mg Chl-a/m^3).

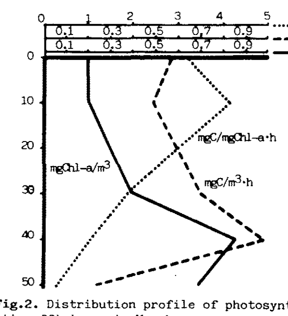

Fig.2. Distribution profile of photosynthetic efficiency in March.

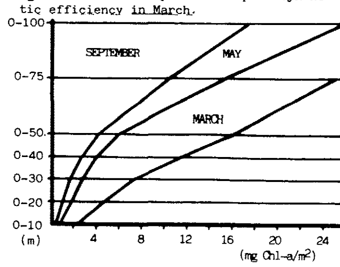

Fig.3. Increment in quantity of Chl-a with increasing depth (mg Chl-a/m^2) of the water column.

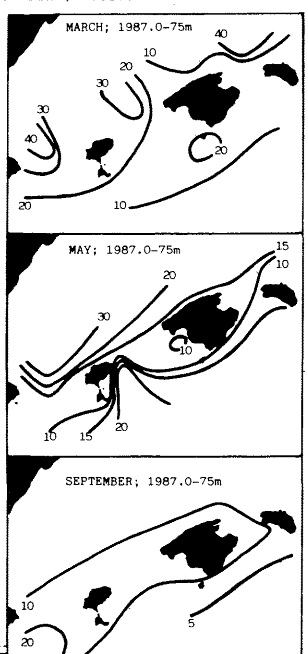

Fig.4. Distribution over time and space of pigment levels, expressed as mgChl-a/m^2 (0-75 m).

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