RHYTHMOBIOCHEMISTRY: ALGAL PHOTOSYNTHETIC PIGMENTS

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Utilizing biorhythmological methodology there were recorded the diurnal biorhythms of the photosynthetic pigments from the green alga *Scenedesmus quadricauda* (Turp.) Bréb. These biochemical compounds varied significantly quantitatively and qualitatively, proving the importance of certain moments which may be considered as "biochemical key times". Considering new scientific knowledge of Physics, the Rhythmobiophysics is also founded. Practically, the investigations of these biophenomena may be useful for varied domains of Biorhythmotechnology.

Key words: Rhythmobiochemistry, diurnal algal biorhythm, photosynthetic pigments, new biological concepts.

INTRODUCTION

Biorhythmological studies as new trends in scientific research are very important for all domains of Biological Sciences, which is evidenced firstly at phototrophic organism. The environmental rhythms, especially those of light, have imprinted their periodicities to beings, thus all their functions present rhythmical changes.

In a previous paper (Braiman and Xiao, 2006) I proposed the Rhythmobiochemistry foundation, as science studying the periodical transformations of the living matter components and the rhythmicity of bioprocesses. The term "biomolecules" has extended utilization at present, with the aim to differentiate these bioproducts from the other chemicals existing in nonliving matter. As new theoretical standpoint I present certain scientific reasons for the acceptance of the fact that these molecules are changing according to the biorhythmological laws.

Valuable fields and experimental investigations were accomplished concerning the aquatic organisms and their diurnal-circadian rhythms. Between these, algae represent a varied and widespread group, playing a main role in primary production in all aquatic ecosystems upon Terra.

By previous data (Apostol, 1998) I evidenced certain algal biorhythms of physiological functions at organism-cellular level, as example division or photosynthesis. The present work refers to the molecular level, regarding the biochemical rhythms, those of the photosynthetic pigments.

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MATERIALS AND METHODS

As was argued in previous works (Apostol 1994, 2001) in all the biological researches the "biological time" should be known and considered, because the biophenomena are permanently changing and thus the obtained results can be quite different. The biorhythm being one essential characteristic of the living organisms, the research methodology should be a biorhythmological one, assuring certain comparable appreciations.

For these studies concerning the diurnal rhythms of the photosynthetic pigments a pure culture of the green alga *Scenedesmus quadricauda* (Turp.) Bréb., carried out on Knop medium was used. The culture vessels were maintained under natural illumination, in day/night normal rhythms (the determinations were effectuated in August). For all durations of the experiments the light intensity was registered using a Luxmeter PU 150 and also the air temperature in laboratory was recorded.

At certain selected times algal culture was passed in tap dechlorinated water, in equal quantities, and filtered by filter paper. The pigments were extracted by an original method with glacial acetic acid and absolute ethanol in proportion 1:3. After 24 hours of extraction at each selected time, the absorbance spectra were recorded by photoelectrocolorimetry on a Spekol EK1, including its entire wavelength range (400–800nm). The records were performed regularly at intervals of 50 nm and also in blue and red spectral regions (typical for chlorophylls).

The selected times for evidence of the diurnal rhythm were: 08:15a.m., 01:15p.m.,04:00p.m. and 08:00p.m. (for extractions and records after 24 hours).

RESULTS AND DISCUSSIONS

The recorded results representing the absorbance for certain wavelengths are presented as average values in Figure 1.

It can be seen the typical general pattern as being unimodal in form, and the diurnal biorhythms of the varied photosynthetic pigments, presenting ascendant and descending phase for each wavelength considered. It is interesting the fact that the records on all wavelengths presented similar senses, the hour 04:00 p.m. seems to be a "key biological time", regarding the biochemical changes in this alga. In the previous experiments, photosynthesis appreciated by oxygen values presented also at 04:00 p.m. the typical changes of the diurnal biorhythm. Having in view that the former experiments were effectuated in laboratory standard conditions (with permanently artificial illumination) it may be appreciated that the photosynthesis rhythm is genetically programmed. The data recorded for the photosynthetic pigments biorhythms confirmed this typical pattern, although the external variations presented small amplitudes (air temperature was almost constant +250C and maximum 1000 Lx).

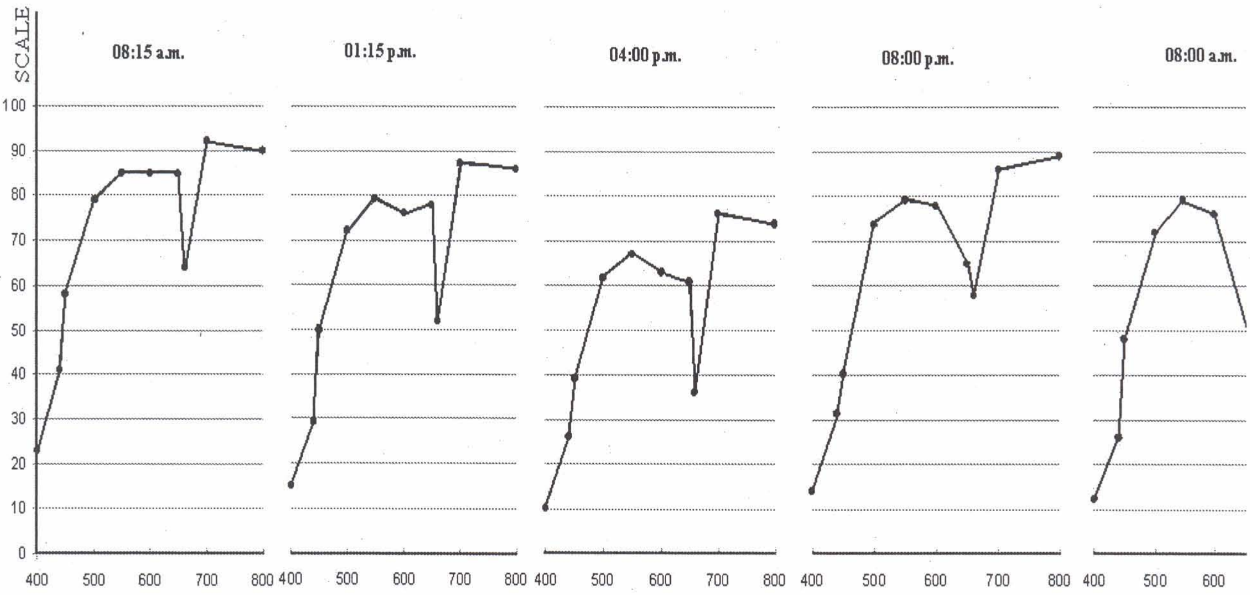

Fig. 1. Diurnal biorhythm of photosynthetic pigments absorption.

DISCUSSION

Nowadays it is unanimously recognized that as a rule there exist periodical transformations of the components in all the biosystems, at each level of their organization. Thus, in biological investigations the time represents one important parameter, regarded as biological time, and this is not only different from the physical and chemical times, but representing the advanced step in the matter evolution upon Terra, it included the others.

In recent years the concept of "time scales" has received attention (Gamon 2007, Pearcy 2007) and it was proved that oscillation signals in the cell present oscillatory phases changing periodically in time (Knoke *et al.*, 2007). The vibrational spectral analysis has been also developed recently (Braiman and Xiao, 2006, Hasegawa *et al.,* 2006). I think that the Rhythmobiophysics may be founded by the investigations on the atomic or even subatomic levels. These researches will utilize other time scales, having in view that photosynthetic electron transport processes have shorter times (Kovalenko and Riznichenko, 2007).

Regarding the applied importance, this new knowledge may be of interest mainly for the standardization of methods, for Biorhythmotechnology knowing the importance of bioactive phytochemicals (Cseke *et al.*, 2006).

The researches concerning the normal relationships between the rhythms of the living and non-living systems should be intensified having in view their possible modifications. Ecological studies (Wanink *et al.,* 2007) yet stated that the climate change prolongs phytoplankton growing season, thus the seasonal rhythms are changed.

For a better understanding of biophenomena essential aspects, new scientific terminolgy and concepts are formulated, interesting many activity domains.

CONCLUSIONS

One can conclude that in the biochemical rhythms there are certain typical "key times". The "biochemical time scales" are varied and varying and should be known also the "physical times scales" included in the display of each rhythmical biophenomenon. Being included in one biosystem, the biophysical and biochemical times" are changing according to the biorhythmological laws.

REFERENCES

1. Apostol S., 1994, *Biological Monitoring*: Comment, SILNEWS, 14, pp. 1-2.
2. Apostol S., 1998, *Biorhythmotechnology in Algar Cultures*, Roum. Biotechnol. Lett., **3**, *3*, pp.267-269.
3. Apostol S., 2001, *Rhythmobiochemistry: Photosynthesis*, Academia Româna – Memoriile Secţiilor Stiinţifice, Seria IV, XXI, pp. 189-195.
4. Braiman M.S., Xiao Y.W., 2006, Step-Scan Time-Resolved FT-IR Spectroscopy of Biopolymers. In: Gregoriou V.G., Braiman M.S. Editors, *Vibrational Spectroscopy of Biological and Polymeric Materials*, Taylor and Francis, London, pp. 354-418.
5. Cseke L.J., Lu C.R., Kornfeld A., Kaufman P.B., Kirakosyan A., 2006, How and why these Compounds are Synthesized by Plants. In: Cseke L.J., Kirakosyan A., Kaufman P.B., Warber S.L., Duke J.A., Brielmann H.L. Editors, *Natural products from plants*, CRC Press, London, pp. 52-100.
6. Cseke L.J., Setzer W.N., Vogler B., Kirakosyan A., Kaufman P.B., 2006, Traditional, Analytical and Preparative Separations of Natural Products, In: Cseke L.J., Kirakosyan A., Kaufman P.B., Warber S.L., Duke J.A., Brielmann H.L. Editors, *Natural Products from Plants*, CRC Press, London, pp. 264-317.
7. Gamon J.A., Qiu H.L., Sanchez - Azofeifa A., 2007, Ecological Applications of Remote Sensing at Multiple Scales, In: Pugnaire F.I., Valladares F., Editors, *Functional Plant Ecology*, CRC Press, pp. 655-683.
8. Hasegawa T., Konka V., Leblanc R.M., 2006, FT-IR Spectroscopy of Ultrathin Materials. In: Gregoriou V.G., Braiman M.S. Editors, *Vibrational Spectroscopy of Biological and Polymeric Materials*. Taylor and Francis, London, pp.99-162.
9. Knoke B., Marhl M., Schuster S., 2007, Selective Regulation of Protein Activity by Complex Ca^{2+} Oscillations: a Theoretical Study, In: Deutsch A., Brusch L., Byrne H., De Vries G., Herzel H. Editors, *Mathematical Modeling of Biological Systems*, vol. I, Birkhäuser, Berlin, pp. 11-22.

10. Kovalenko I.B., Riznichenko G.Y., 2007, Multiparticle Direct Simulation of Photosynthetic Electron Transport Process. In: Deutsch A., Brusch L., Byrne H., De Vries G., Hezel H. Editors, *Mathematical Modeling of Biological Systems*, vol. I, Birkhäuser Berlin, pp. 3-9.
11. Pearcy R.W., 2007, Responses of Plants to Heterogeneous Light Environments. In: Pugnaire F.I., Valladares F., Editors. *Functional Plant Ecology*, CRC Press, pp. 213-257.
12. Wanink J.H., Van Dam H., Classen T.H.L., 2007, Climate Change Prolongs Phytoplankton Growing Season in Shallow Frisian Lakes, the Netherlands, SILNEWS, 51, p. 10.