RHYTHMOBIOCHEMISTRY: MODIFICATIONS IN PHOTOASSIMILATING PIGMENTS RHYTHMS BY POLLUTION

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The diurnal biorhythms of the photoassimilating pigments from the green alga *Scenedesmus quadricauda* (Turp.) Bréb. and their modifications produced by lacticum acid in laboratory experiments were recorded. The results confirmed the hypothesis of the "biochemical key times" existence, and as a new biological concept is proposed the "biological times hierarchy" in biosystems. Rhythmobiochemical knowledge may explain certain aspects presenting a main importance for the Ecochronotoxicology development.

Key words: Rhythmobiochemistry, algal photoassimilating pigments, new biological concepts, Aquatic Ecochronotoxicology.

INTRODUCTION

Founding the Rhythmobiochemistry (4), I considered as theoretical standpoint that knowledge regarding the transition and transformation of physico-chemical rhythms in biological ones is very important for understanding the biophenomena display.

In a previous work (5) there were registered certain main temporal transitions and connections by records of the algal photoassimilating pigments diurnal biorhythms on an extended spectral scale.

Taking into consideration the extensive state of pollution in the Terra's aquatic ecosystems, I think that it should be useful to improve the present knowledge about this danger for humanity with new scientific data, verified by laboratory experiments.

MATERIALS AND METHODS

Laboratory experiments were performed according to the biorhythmological methodology, the hour being the chronobiological unit. The experimental times (to start and finish the experiments after 24 hours) were distanced at intervals of 4 hours in the day time. The experimental model was similar with that considered as control, presented in a previous work (5) performed in the same environmental conditions.

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As test-organism was utilised the same green alga *Scenedesmus quadricauda* (Turp.) Bréb. grown as pure culture on Knop solution maintained in normal environmental rhythms.

Taking into consideration that external factors can modify the biorhythms patterns, I have utilised for this study a chemical pollutant, lacticum acid, because in previous biotests I remarked an algicide action of this acid. The selected concentration was one non-acutely lethal of 0.2‰.

The absorbance spectra of the bioactive phytochemicals were recorded photoelectrocolorimetrically for the entire wavelengths range (400–800 nm) on the Spekol EK_1.

RESULTS

The recorded data revealed certain significant modifications in the typical pattern of the absorbance spectra, although the pH of water (7.0) was slightly modified, being 6.5. The quantitative and qualitative changes recorded in the frame of the diurnal biorhythms are illustratively presented in Figs. 1–3.

As a rule, the diurnal rhythm pattern of the algal photoassimilating pigments absorptions was similar to that recorded in the control experiments, thus, confirming the previously published results. For the reason that these series of experiments were effectuated concomitantly, the recorded data are comparable.

As can be seen in Figure 1, along the day time, the absorbance spectrum presented certain temporal particularities, these being recorded also at 04:00 p.m., as for control experiments.

The pollutants, as other external factors, may have different actions at varied times in the diurnal biocycles. Analysing each temporal variant, one may notice the fact that in many cases the absorbance was stimulated by lacticum acid, but in the tests accomplished at 04:00 p.m. were recorded statistical significant reductions, depassing 10% at certain wavelengths (Fig. 2).

Taking into consideration the variation of information existing in the speciality literature regarding the absorbance spectrum of photoassimilating pigments, I appreciated that the representation of average data recorded in the typical zones of the spectrum should be useful to prove and characterise this biophenomenon.

As can be seen from Figure 3, the greatest modifications in the diurnal biochemical rhythm regarding the absorbance capacity were produced at a certain hour, this being 04:00 p.m., including the characteristic zones of the absorbance spectrum for the photoassimilating pigments.

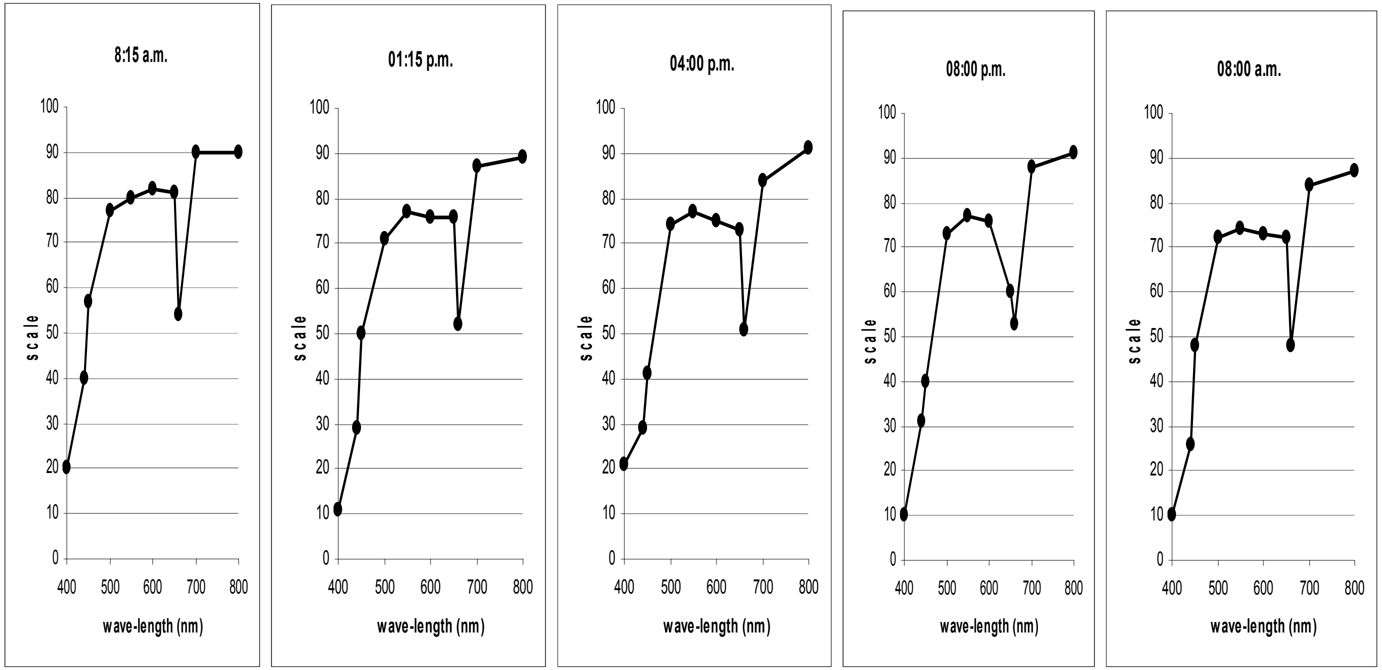


Fig. 1. Diurnal biorhythm of photoassimilating pigments absorptions under the action of lacticum acid.

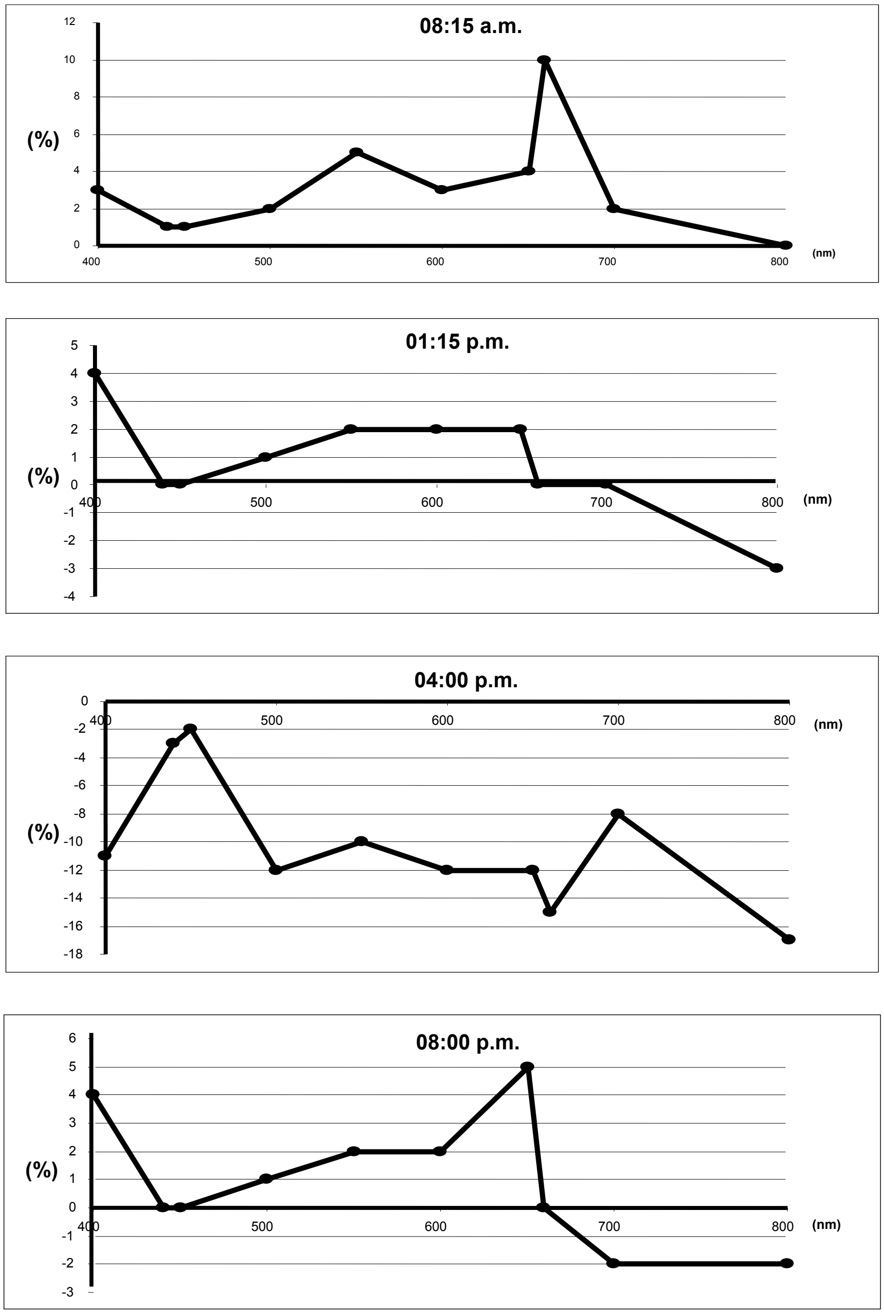


Fig. 2

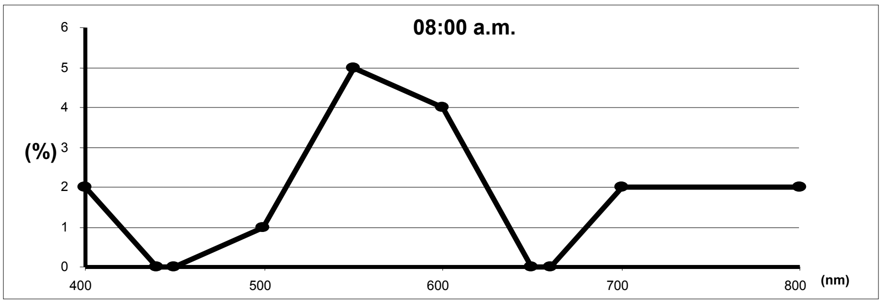


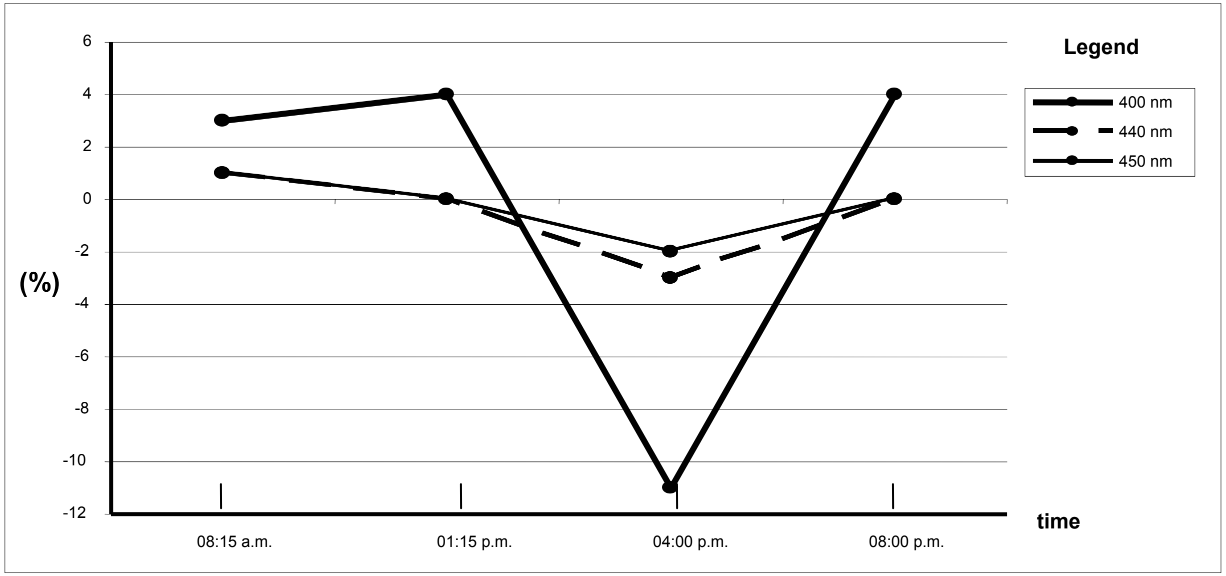
Fig. 2. Absorbance compared to the control experiments records.

DISCUSSION

Taking into consideration that laboratory temperature was almost constant (+25°C) and the illuminance diurnal rhythm presented one peak of only 1000 lx, this reduction in algal photoassimilating pigments capacity is not the photoinhibition resulting by photooxidative destruction of their photosynthetic apparatus (8, 9).

It is reasonable to consider that the biochemical rhythms are produced step-by-step in a certain order, genetically stated. As is known, the duration of periods in physical and chemical processes is small, the changes occurring on a shorter time scale (within minutes or hours), thus in a 24 hours cycle a great and varied number of biochemical oscillations being produced. One may certainly assert that in the temporal structure of each biosystem there is a well stated "biological time's hierarchy", reflecting the matter evolution. The energy and information are changing according to certain laws, depending on the time. The fact that in the biophenomena display there are certain "biochemical key times" (5) was confirmed experimentally again as being 04:00 p.m. for algal photoassimilating pigments (at all the wavelengths were recorded reductions of absorbance at this hour). Also, a certain tendency to decrease the absorbance in the afternoon time was registered 4 hours before and 4 hours after this "key time" at the 700–800 nm wavelengths. As is known, there is one specific absorbance distribution, the chlorophyll absorbs well in the visible (particularly the blue and red regions) but not in the infrared (red edge at 700 nm). I remarked modifications not only in the visible, but even in the infrared and near-infrared regions (> 700 nm), thus it can be supposed that varied cell compounds are rhythmically changed. Certainly, the spectrum is modified according to the rhythmobiological laws, and these modifications may change other chains of reactions.

From the toxicological point of view, a paradoxical situation is revealed and the question is the difficulty to characterize the action of this chemical agent considering these reverse patterns, and to state the allowable concentration.



6
4
2
0
-2
-4
-6
-8
-10
-12
(%)
Legend
400 nm
440 nm
450 nm
time
08:15 a.m.
01:15 p.m.
04:00 p.m.
08:00 p.m.

Fig. 3

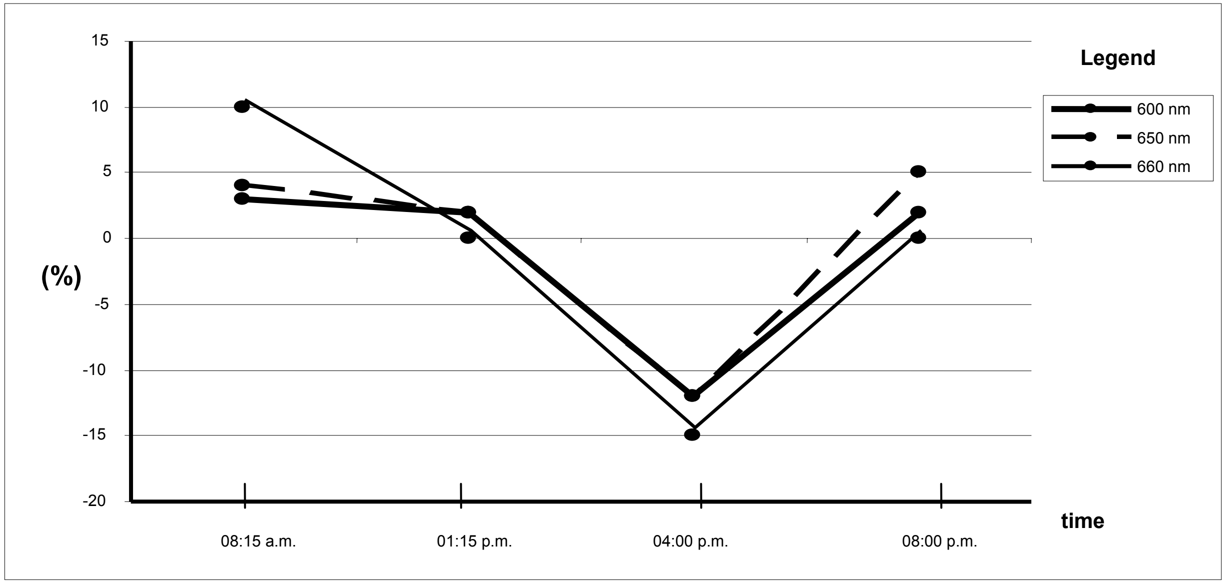


Fig. 3. Absorbance modifications recorded at varied wavelengths.

As was proved, the same concentration determined varied effects, thus is it an inhibitory or a stimulant one? It is stimulating at certain hours, without influence in other cases and very inhibiting at 04:00 p.m. A great field of investigation is opened by Ecochronotoxicology (1–3).

First of all, the biological time should be considered for correct comparative studies. This aspect becomes important to productivity estimations even at biosphere level, knowing that the phytoplankton activity is appreciated as having a contribution to about 50% fixation of CO_2 from atmosphere (6).

As theoretical point of view, considering that recently (7), it was again appreciated at world level that mathematical and computational approaches are absolutely essential for solving central problems in life sciences, I consider that new biological laws should be known and utilized.

CONCLUSIONS

1. Experimentally, there was recorded a typical pattern of photoassimilating pigments absorption in the green alga *Scenedesmus quadricauda* (Turp.) Bréb.
2. At the cell level, rhythmobiochemical studies proved the periodicity of biophenomena and the hierarchy of the physical-chemical-biological scales.
3. Paradoxical phenomena may be produced by external factors (the pollutants are nowadays included between these) because the biological processes are stimulated or inhibited according to the biological times in the biosystem.
4. Practically, the day moment utilized for record or experimentation may be decisive for appreciation of results.
5. For the development of biological sciences mathematical models founded on the biorhythmological laws should be proposed.

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