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## **SOLAR-TERRESTRIAL EFFECTS REVEALED THROUGH LONG-TERM OBSERVATION ON BIORHYTHMS IN PLANTS AND EXPERIMENTAL RANDOM EVENTS OCCURRENCE**

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### **Abstract**

The comparative long-term observation of vascular *Marantha leoconeura* plant circadian biorhythms and some random processes in the mechanical and in electronic systems were carried out throughout winter and autumn months at the current year. The winter periods with relatively quiet Solar state were characterized by circaseptan and circasemiseptan multi-diurnal cycles in multi-diurnal time-course in plant leaves daily movement, and in deviation of obtained random numbers and coins toss counts from theoretically expected values. Solar active days at August and at September correlated with accumulated deviation of expected probability of random processes, and resulted in 5 days cycles prevalence in multi-diurnal time-course for both systems. The revealed discrepancy in seasonal dynamics observed is presumably caused by solar and cosmophysical driving agents the physical nature of which is badly expected to be unraveled.

### **Introduction**

Solar-terrestrial links were always intriguing cross-field of synthetic intellectual interactions and attracted researchers with various scientific approaches. To explore the question the both biological and nonliving systems were studied simultaneously, their comparative long-term observe was carried out under lab indoor conditions during the some months of the current year. The highly environment sensitive vascular decorative plants *Marantha leoconeura*, var. "Facinator" cultivated under lab controlled conditions were used. The leaf-petiole changeable angles of leaf blades in these genera species are susceptible to change of atmosphere pressure, humidity etc. and presumably to cosmic weather also. The species are widely considered as "living biological barometer" due to their important properties to response on abrupt atmospheric pressure and humidity changes via special baro-sensitive cells in the leaf blade – petiole conjunction. In the results of the time-course of plant leaf-petiole angle change measurements the presence of circaseptan and circasemiseptan cycles in the multi-diurnal dynamics of plant blades movement have been demonstrated earlier [1].

But it isn't simple task to identify what namely a kind of factors might be responsible for unusual plant behavior at any time elsewhere. To select the cosmophysical factors and to detect the cosmic influence, S.E. Shnol' and colleagues used the radioactive decay long-term counts [2]. For the same aim we did attempts here to explore the long-term monitoring of random events on the base of simple mechanical and electronic systems simultaneously with biological systems to detect the plausible effects of cosmic factors.

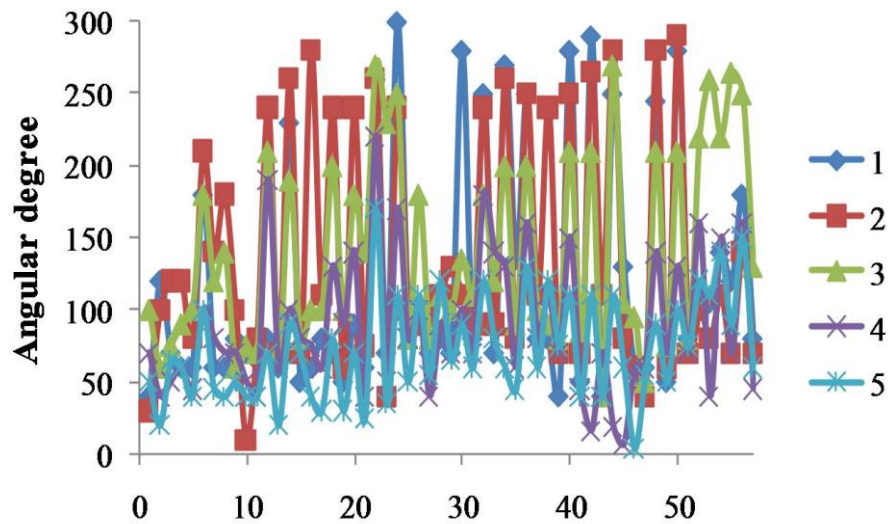
### **Biological objects and methods**

The vascular decorative plants *Marantha leoconeura* "Facinator" cultivated under lab controlled conditions were used as a sensitive biological indicator of external environment fluctuations and cosmic influence. The leaf-petiole changeable angles of their leaf blades (N=10) were measured twice daily during noon and evening hours. The mechanical and electronic systems produced random digital output, namely random number generation and coins toss were used also. The ten random numbers with nine random digits were generated twice daily, firstly about noon and 12 h afterwards with portative generator "CITIZEN" SRP-285II. The deviation from most probable value for generation of either first 5 to 7 consequent various digits were obtained for every experiment. For example, expected probability P for the generation of 5 consequent different digits should be as  $P = 0,3024$  [3], i.e. one expects that every three of any ten numbers generated would include 5 different digits under ordinary normal conditions. As a mechanical model the coin cohorts in 100 coins each of three different denominations toss were used. The coins of each denomination were tossed daily with 5 repeats at noon and 12 h afterwards at the horizontal surface the strictly fixed high level off with following evaluation the degree of deviation from most probable cross or pile distribution.

### **Results and discussion**

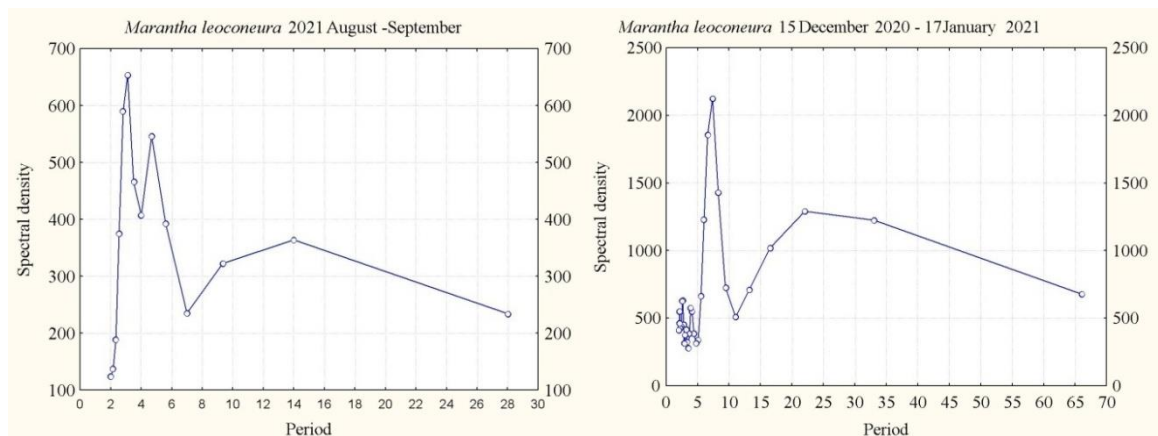
The important peculiarity of *Marantha* genera plants the presence of eigen circadian biorhythms of folia dynamics under background normal conditions. Meanwhile it is widely known that cosmic and geophysical factor capable to influence such rhythms among plethora of living organisms of microbiotic ones [4] to humans [7]. Because of that

we conducted daily diurnal and nocturnal angles measurements, the results for some of which presented here, fig. 1. First of all, the much higher blade deviations in nocturnal hours as compared to diurnal ones were revealed. For the demonstration of plausible cosmic effects, the September 2021<sup>st</sup>, a month with periods of elevated solar activity intermitted by quiet days, was selected. The 12 h temporal gaps since 28 August to 26 September at abscissa and the 5 leaf blades angles deviation dynamics, respectively, are presented. The folea run show explicit difference between the solar quiet days at 15-18 at September, and days marked high solar activity, which were as follows: 8-12 and 22-24 September. During the quiet periods the plant blades show robust circadian rhythm which abruptly disturbed by solar activity characterized by C type flares. The elevation for maximal amplitude in nocturnal position for 4-5 blades on the eve of 9<sup>th</sup> September maximum and their follow smooth decrease are found also.



**Figure 1.** The 12 h temporal gaps since 28 August to 26 September at abscissa and the 5 different leaf blades angles deviation dynamics for *Marantha*.

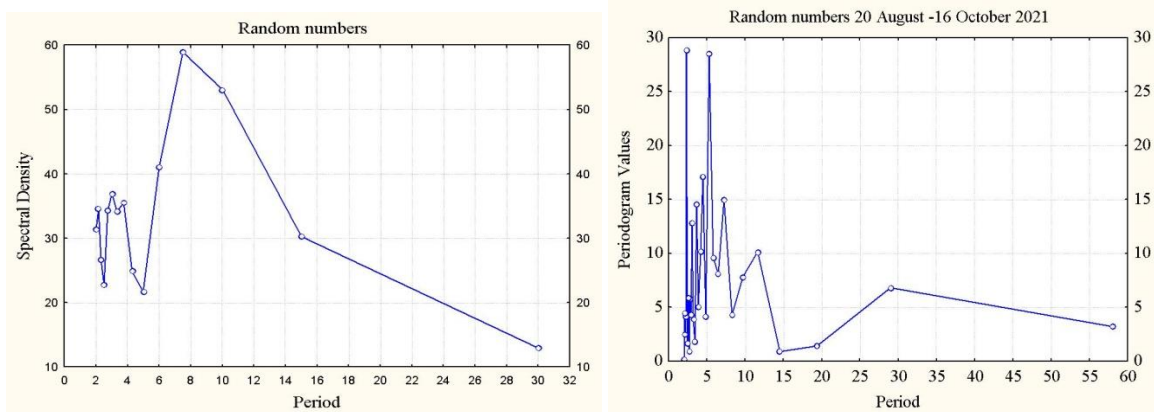
The September rise in solar activity have induced the change in multi-diurnal dynamics of plant blades also, the respective temporal spectra show the presence of circasemiseptan (half week length) and 5 days cycles, meanwhile during the quite winter months the circaseptan (week length) cycles were prevailed, fig.2.



**Figure 2.** Power spectra for the multi-diurnal leaf blade run in *Marantha* plant at winter months and at August-September 2021<sup>st</sup>.

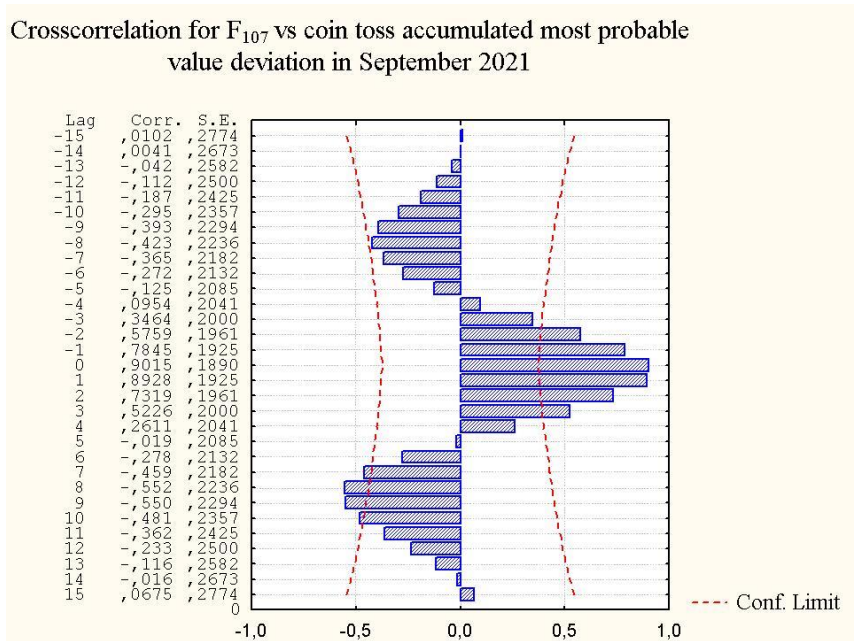
The difference in dynamics between winter and autumn seasons found can be provoked by increasing of solar activity. It is widely known the difference and temporal signature of solar activity dynamics in quiet and active years [5, 6].

The analogous difference in parameters of multi-diurnal cyclicality was obtained for daily generation of random numbers. Thus, at 2020-2021 yr winter months the explicit circaseptan cycles in dynamics temporal spectra were prevailed, fig. 4, meanwhile in follow August-September days run the 5 days cycles were prevailed.



**Figure 3.** Power spectra for the multi-diurnal random number count deviations from expected values for the winter months (left) and for August-September.

The change in multi-diurnal dynamics for the results of coins toss deviation was found also. Moreover the high correlation between accumulated count sum deviation of most probable, theoretically expected values and the main solar activity parameters were found. The cross-correlation between solar emission of 10.7 cm radio flux and accumulated deviation, i.e. algebraic sum of consequent tosses count results have showed significant direct and about a week time shifted correlation, fig. 4. The analogous significant correlation were observed for daily Wolf Numbers run at these months as well for total solar square of sunspots.



**Figure 4.** Cross-correlation for 10.7 cm solar radio flux time-course and accumulated coin toss counts.

The revealed discrepancy in time-course pattern and cycles length in power spectra between quiet winter and solar active autumn seasons suggests the solar and cosmic effects on the both systems considered. The effects were appeared as plant circadian rhythm disturbance, as different temporal pattern, the specific for solar activity 5 days etc. or for quiet state circaseptan, circasemiseptan cycles presence, and as either direct or postponed correlation of accumulated random coin toss counts with solar activity parameters.

The considered seasonal recurrent changes in plant folea circadian rhythms, results of experiments with random number generation, and coin toss counts suggest its exogenous, presumably solar and cosmic provenance/ And also

cosmophysical agents rhythms driving. The results obtained are in accordance with [5] that the recurrent changes of physical agents responsible for solar-terrestrial links most expected during the quiet solar years. The circaseptan and circasemiceptan cycles found might be driven either environmental terrestrial factors or cosmic ones also [6, 7]. The results suggest the presence of driving pace-makers of exogenous cosmic provenance which are able to modulate daily rhythms and control multi-diurnal dynamics of living and mechanical or electronic systems.

The advanced changes in the amplitude of *Marantha* leaves daily movement circadian cycles on the eve of large-scale solar disturbance allow one to consider and possibly to use these plant species as a sensitive short-term living predictor for abrupt changes in solar activity.

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