CORRELATION BETWEEN CALCIUM BIORHYTHMS AND HELIO-GEOPHYSICAL FACTORS

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A correct understanding of processes taking place in the living organism and the discovery of their connection with external environmental factors would be impossible without a study of biorhythms [1]. We know that calcium plays an important physiological role in the living organism, including as a participant in immunologic processes, maintaining intercellular interactions during immunogenesis [4], and for that reason the discovery and study of the laws governing spontaneous fluctuations of this parameter are extremely necessary.

The aim of this investigation was to determine reliable parameters of the hierarchy of monthly rhythms of the serum calcium concentration in rabbits under normal conditions and during immunization, and also to study correlation between calcium biorhythms and monthly rhythms of changes in atmospheric pressure and solar activity (Wolf numbers and solar radiation at a frequency of 2800 MHz).

EXPERIMENTAL METHOD

Experiments were carried out on six mature male chinchilla rabbits weighing 3.8-4.2 kg, kept under standard animal house conditions. Daily for 64 days (from March 29 to May 31,

TABLE 1. Phase Correlation of Rhythms of Helio-geophysical Factors and Biorhythms of Blood Serum Calcium of Rabbits under Normal Conditions and after a Single Immunization (March 29– May 31, 1977, $M \pm m^2$)

Dimension of rhytm	Parameter of rhythm	Factor				
		calcium, mM		Wolf number, relative units	solar radiation at 2800 MHz	atmospheric pressure, GPA
		normal	immunization			
	G	3,57±0,06	3,60±0,05	15,48±7,92	76,6±8,9	996,4±2,7
1 month	T	27,0±0,9	25,7±0,9	28,5±0,9	28,5±0,9	28,4±1,8
	A	0,15±0,03	0,11±0,05	8,08±0,58	3,67±0,06	2,40±0,30
	φ	334±27	332±44	224±15	239±10	94±18
3 weeks	T	20,4±0,9	20,7±1,4	19,8±0,6	21,0	
	A	0,17±0,07	0,12±0,04	6,30±1,15	2,03	—
	φ	205±79	32±33	32±15	335	
2 weeks	T	13,5±0,9	13,3±0,7	14,4±0,5	15,7	13,8±0,9
	A	0,16±0,04	0,14±0,05	4,99±0,50	1,72	7,21±1,04
	φ	241±27	101±56	100±12	41	232±70
1½ weeks	T	10,7±0,6	10,0±0,6	—	9,0	9,9±0,5
	A	0,15±0,03	0,14±0,05		1,81	4,56±0,53
	φ	304±42	180±93		325	90±34
1 week	T	5,7±0,8	6,2±0,8			5,6±0,1
	A	0,12±0,02	0,12±0,06	—	—	2,92±0,53
	φ	248±33	328±53			239±33
½ weeks	T	2,93±0,45	3,22±0,45			
	A	0,11±0,02	0,11±0,03	—	—	—
	φ	295±62	294±78			

Legend. —) No rhythm discovered. G) Mean statistical value of parameter. Phase:

March 29, 1977 — normal, April 30, 1977 — immunization.

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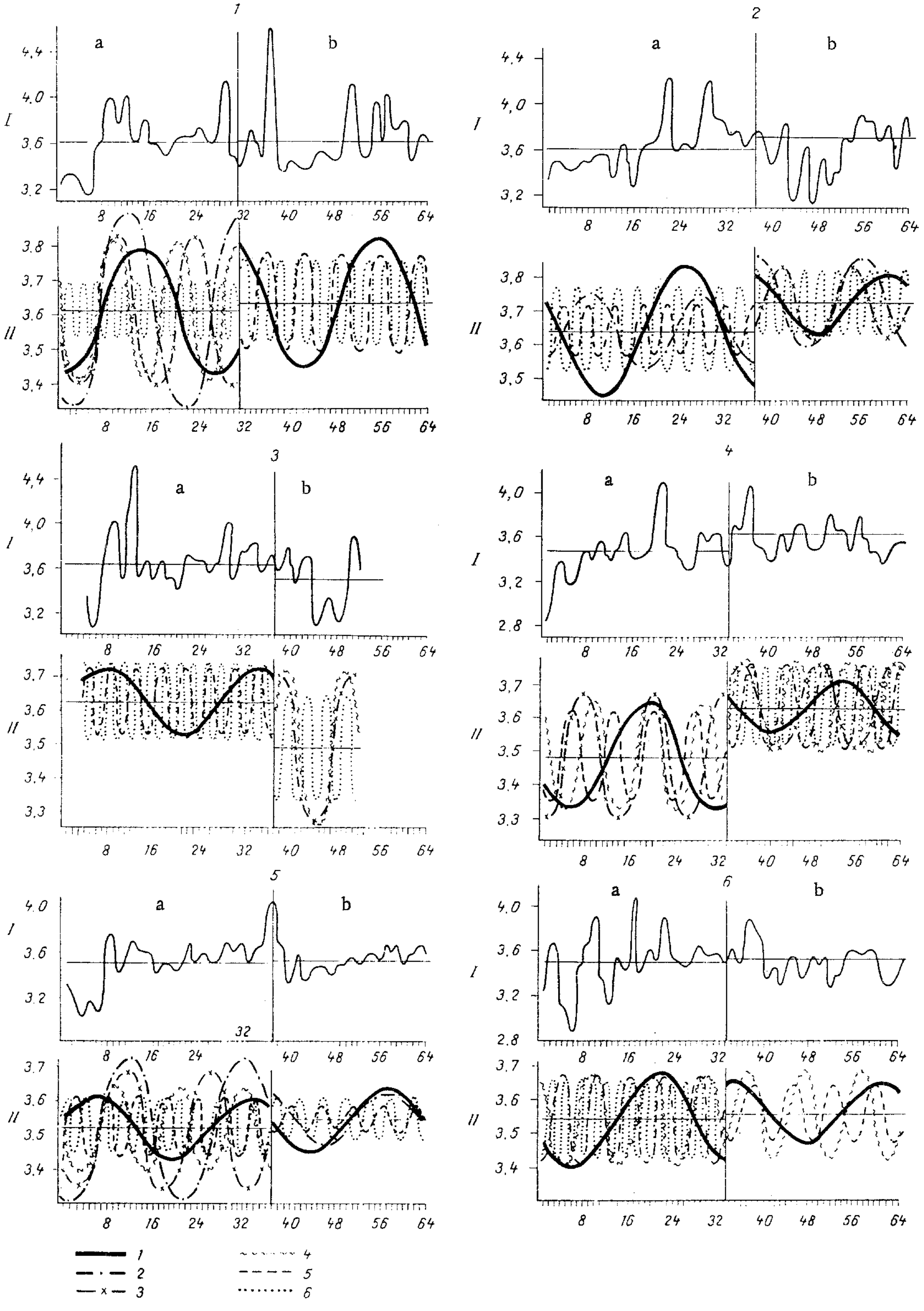

Fig. 1. Experimental time course (I) and spectrum of significant biorhythms (II) of rabbit serum calcium level under normal conditions (a) and after a single immunization (b). Abscissa, time (in days); ordinate, calcium concentration (in mM). 1-6) Serial Nos. of rabbits. Vertical line on graph indicates time of immunization. Here and in Fig. 2: 1-6) 1 month and 3, 2, $1\frac{1}{2}$, 1, and $\frac{1}{2}$ week biorhythms, respectively.

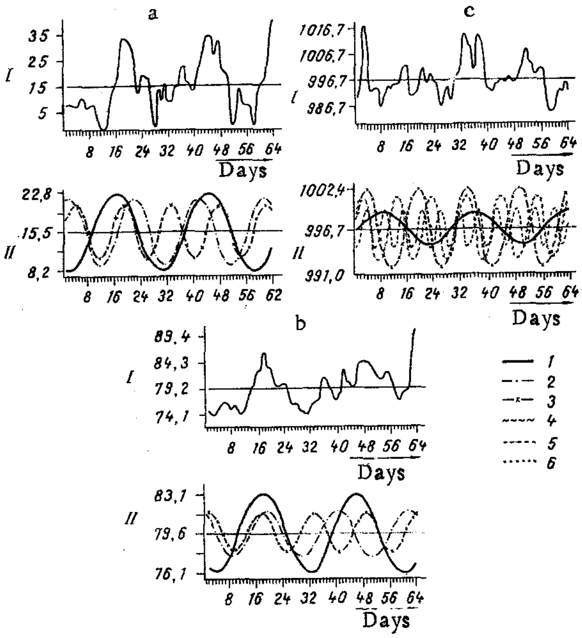

Fig. 2. Long-term (64 days) time course (I) and spectrum of significant rhythms (II) of Wolf numbers (a), solar radiation at 2800 MHz (b), and atmospheric pressure (c). Abscissa, time (in days); ordinate, units of measurement.

1977) 1 ml of blood was withdrawn from the marginal vein of the ear of each animal at 9 a.m., and the calcium concentration in the serum was determined by a complexonometric method with trilon B [3]. On the 32nd day after the beginning of the experiments each intact rabbit was immunized once with human antimeasles γ-globulin (in a dose of 0.05 g/kg body weight). By means of an original algorithm [2] significant rhythms were discovered and their parameters determined in the individual time course of the serum calcium level of the rabbits and also in the time course of changes in Wolf numbers and solar radiation at a frequency of 2800 MHz and atmospheric pressure (from March 29 through May 31, 1977).

EXPERIMENTAL RESULTS

Daily measurements of the blood serum calcium level of the rabbits revealed an individual time course of this parameter for each animal (Fig. 1). Mathematical analysis of the complex structure of the experimental curve, undertaken by means of a computer, revealed a significant ($p \leq 0.05$) individual spectrum of biorhythms (Fig. 1, IIa, b) and their parameters in each rabbit under normal conditions and after immunization: the length of the period (T, in days), amplitudes (A, in mM), and shift of the cosinusoid (φ) relative to the beginning of the experiment or the 1st day after immunization.

The same algorithm was used to determine the spectrum of significant (p 0.01) rhythms in the time course of the helio-geophysical parameters recorded during the period of the experiment (Fig. 2).

Six dimensions of rhythms were identified in monthly series of blood serum calcium biorhythms for individual animals and rhythms of change in external environmental factors: 1) 1-month or 4-week (31-24 days), 2) 3/4 month or 3 week (23-18 days), 3) $\frac{1}{2}$ month or 2 week (17-12 days), 4) 1/3 month or $1\frac{1}{2}$ week (11-8 days), 5) 1/4 month or 1 week (8-4.5 days), and 6) 1/8 - 1/10 month or $\frac{1}{2}$ week (4.4-2 days). This spectrum of rhythms revealed by an original program approximately coincided with the classification of biorhythms suggested by Halberg and Katinas [5]. Not the whole set of the above-mentioned rhythms of the monthly complex, but only some of them could be identified significantly ($p \leq 0.05$) in the time course of the serum calcium levels in individual animals under normal conditions and after immunization, and also in the time course of the external environmental factors (only in one animal under normal conditions were all six dimensions of rhythms discovered).

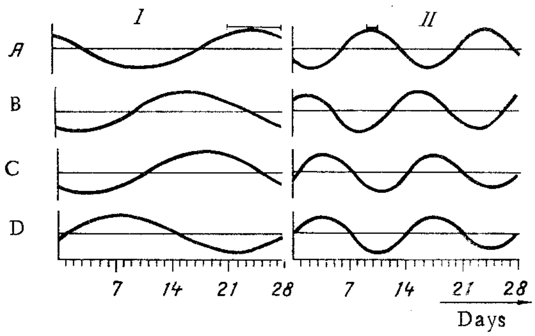

Fig. 3. Scheme showing correlation between calcium biorhythms under normal conditions and rhythms of helio-geophysical factors. Abscissa, time (in days); ordinate, amplitude in arbitrary units. I) One-month rhythm, II) two-week rhythm. A) Calcium, B) Wolf number, C) solar radiation at 2800 MHz, D) atmospheric pressure.

Statistical analysis of the individual parameters of the homonymous calcium biorhythms included calculation of the average characteristics of lengths of periods, phases, and amplitudes, relating to the hierarchy of the monthly complex of rhythms of this parameter for the whole group of rabbits under normal conditions and after immunization (Table 1).

A single immunization of the animal with γ-globulin caused no significant change in the mean calcium level or in the length of period and amplitude of the monthly complex of biorhythms whether in individual rabbits or in the population as a whole. Meanwhile immune conflict led to a significant shift of phases in some of the dimensions of rhythms. The most vulnerable was the $1\frac{1}{2}$ week or 1/3 month rhythm, for each phase was reversed in nearly all rabbits.

To discover correlation between the rhythms of helio-geophysical factors and biorhythms of the changes in the serum calcium concentration of the rabbits, it was necessary to discover what was common both to the calcium biorhythms and to the exogenous rhythms, and also to attempt to discover the rules governing their correlation.

Analysis of the group parameters of calcium biorhythms showed that the length of the period of rhythms of the corresponding dimensions was common for the calcium biorhythms and rhythms of helio-geophysical factors. For example, it was shown that fluctuations of the 1-month component of the calcium biorhythms had approximately the same period both under normal conditions and after immunization, namely 27-28 days (allowing for the region of "drift" of individual periods), i.e., a period characteristic of the velocity of rotation of the sun around its own axis. Regular correlation also was found beteen phases of individual calcium biorhythms under normal conditions and phases of rhythms of the corresponding dimension for external environmental factors (Fig. 3). The acrophases of 1-month and $\frac{1}{2}$-month calcium biorhythms were opposite in phase to the corresponding rhythms of variation of atmospheric pressure. Relative to the solar factors the acrophase of the 1-month calcium biorhythm was delayed by 7.7 and 6.3 days, respectively, behind the acrophase of the 1-month rhythm of Wolf numbers and of solar radiation at 2800 MHz. The $\frac{1}{2}$-month calcium biorhythms under normal conditions were opposite in phase to the $\frac{1}{2}$-month rhythms of these factors of solar activity.

Only analysis of phase correlation of individual components of the monthly complex of biorhythms and the homonymous rhythms of external environmental factors can thus enable their correlation to be judged and can encourage the hope that diagnostic criteria for long-term prediction of the trend of biochemical parameters will be obtained on the bais of known rhythms of helio-geophysical factors.

LITERATURE CITED

1. F. I. Komarov, Sov. Med., No. 6, 3 (1983).
2. Yu. M. Nikitin, É. N. Chirkova, and V. V. Nemov, Dokl. Akad. Nauk SSSR, 290, No. 6, 1347 (1986).
3. I. Todorov, Clinical Laboratory Investigations in Pediatrics [Russian translation], Sofia (1968).
4. A. M. Chernukh, Inflammation [in Russian], Moscow (1979).
5. F. Halberg and G. S. Katinas, Int. J. Chronobiol., 1, 31 (1973).