SCRIPTA MEDICA (BRNO) – 76 (5): 269–274, *November 2003*

CHRONOMICS: THE BROAD SCOPE OF MONITORING CHRONOMES.

A REVIEW

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A b s t r a c t

The aim of the present paper is to summarized the data on biological rhythms in living organisms including man and summarise data on circadian, circaseptan and other rhythms in geophysical variables. The synchronisation of both geophysical and biological activities and their oscillations are discussed.

K e y w o r d s

Chronobiology, Geophysics, Variability, Cardiovascular variables, Rhythms, Astronomy

INTRODUCTION

Opening a pharmaceutical fair has been an opportunity to plead for new humanistically as well as financially challenging disciplines. The task fits the couleur locale of this intellectually fertile region with Johann Gregor Mendel's home and abbey. Much confounding variability in plant hybridisation became a new discipline, thanks to Mendel, the botanist. But Mendel was really a meteorologist at heart, as Anna Matalova has put it, and perhaps an astronomer since, among other things, he had a telescope *(1*). Thanks to a letter, located by Dr. Matalová, concerning „terrestrial and cosmic phenomena", Mendel was also a transdisciplinary chronobiologist *(2).*

Before Mendel, Jan Evangelista Purkinje, recognised by Goethe, had left his name in both the nervous system and the heart, where international studies now record the effect of not only acute magnetic storms, but also cycles covering about five decades. This has also been reported by Jarmila Siegelová and Bohumil Fišer, the former minister of health *(3).* Chronobiological methods resolve confounding variability into cyclic and, to that extent reproducible, phenomena of interest in

their own right, as newly discovered ~21-year components in religious *(4)* and other motivations. Cost-effective health care for not only individuals, but eventually also societies, is now in sight *(5)*. But an immediate goal is the recognition of disease risk syndromes by means of monitoring the health of individuals. As opposed to conventional practice, including Nof1 trials, chronobiologists of today can go the "two extra miles of monitoring extensive time series" and, more importantly, analyse these series, so that each diagnostic and therapeutic decision is accompanied by a statement concerning its uncertainty, including P-values and 95% confidence intervals.

It took a long time to proceed from Mendel's genetics to genomics. Thanks to Jarmila Siegelová, Jiří Dušek, Bohumil Fišer and other co-workers from the Brno team, the time span to elapse from chronobiology to chronomics, i.e., mapping of time structures (chronomes), has been be much shorter.

Chronobiology

Once we have mapped rhythms and other elements of time structures, the reductionist approach is more rewarding since it allows us to relate the fruits of molecular biology to chronomes rather than to snapshots on roller coasters. There are very many rhythms. Again we do not know which are critical but, in addition to other factors, many circadian rhythms have already been shown to make or contribute to the difference between life and death. Furthermore, chronomes also contain chaos and trends. These elements all serve for a dynamic quantification of gene expression.

As a dividend from dealing with variability, more important than the clarification of otherwise unaccounted for sources of variation, the mapping of chronomes uncovers invisible cyclic solar associations on earth. These chronobiologic variations, such as human growth, natality, morbidity and mortality from, for instance, myocardial infarction or suicide, bear helio- and/or geomagnetic signatures, as do the ills of society such as homicides, in the form of about-50, 21- or 10.5-year cycles (*13*). These phenomena all show signatures that Mendel envisioned, even before a whirlwind blew through his study. Jarmila Siegelová has documented circaseptam rhythms with some weak geomagnetic ontogenetic signatures in human newborns *(6)*. These and other infradian, notably infra-annual, effects may prove to be as ubiquitous as circadians turned out to be out of phase *(15)*. If so, drastically different results will be obtained, which should be considered in any human endeavour, from molecular biology to socio-ecology and earth and cosmic physics.

Rhythms in astronomy

In physics there is a well-accepted solar bipolarity cycle of about-21 years: at every about-10.5-year sunspot minimum, the polarity of the spots, which differs on the two solar hemispheres, changes from positive to negative *(7)*. For various

time series of epidemiological data, variability is very large; period estimates converge toward 10.5, 21 and/or 50 years *(8).* Since these epidemiological data cover only a few cycles, up to a century, they are not enough to specify a generally valid precise point and interval estimate for a circadecennian, circavigintennian or circasemicentennian periodicity. In the cases reported so far, the „zero-10.5- and/or 21-year and/or 50-year amplitude" assumption can be rejected at anticipated periods.

The about-21-year cyclicity constitutes evidence suggesting that the cyclicity of solar bipolarity has far reaching associations on terra firma. It can be postulated, but as yet not proved, that electric power blackouts that accompany some (not all) magnetic storms, as well as excess myocardial infarctions and suicides associated with some (but not all) such storms, may all be dependent upon the stage of decadal cycles. Furthermore, in the physiological range, much more subtle effects can be recorded in osseous, heart and brain tissues *(8).*

Biological rhythms in humans

The data for meta-analyses have been collected from various regions of the globe, such as Minnesota (USA), Denmark, Alma Ata (Kazakstan) and Moscow (Russia). In human neonatal body length and weight (Denmark) we found statistically significant about-21-year components that were more prominent in their amplitude than about-yearly rhythms. In period length they corresponded very roughly to a similar component in the birth weight of Minnesotan newborns. The about-21-year birth weight components were out of phase with each other, and contrasted with a circadecennian component in birth weights in Moscow *(9*).

We also found similar components in other variables from century-long neonatal anthropometry. A few of the series are based on millions of individuals over one cycle, some samples are smaller but cover a century. The frequency with which these changes recur in about-21-years is, as noted above, a solar magnetic signature; however, we do not know to what extent differences in rhythm phase are geomagnetic, sociologic or other in origin *(8).* Confounding „secular", i.e., unaccounted for, variability may well be removed to study other effects. Solar signatures, visible or invisible, circadian, circavigintennian and other rhythms represent a substantial part of a „noise"-term in any epidemiological study.

Inter-relationsship between rhythms in geophysics and chronobiology

The authors are involved in the world-wide monitoring of physiological data that reveal signatures of magnetic disturbance and they possess a corresponding data bank for the study of mechanisms underlying invisible solar effects; they have also developed computer programmes for isolating cycles with their uncertainties. They welcome cooperation in the international project on the Biosphere and the Cosmos, briefly BIOCOS, and can provide automatic

instrumentation for ambulatory blood pressure and heart rate monitoring with a 90% reduction in cost *(11, 12, 14).* In mutually accepted projects, they can further offer analyses based on an extensive reference data base. The international data base in Minnesota has available standards for long-term blood pressure and heart rate monitoring data that are related to gender, age and ethnicity (Caucassian, Asians and others).

The analytic programmes serve in particular for the screening of novel disease risk syndromes and assessment of non-drug and drug treatment effects. The industries are now challenged to close the loop between the present-day devices for long-term monitoring and the future need for better and cheaper minimal invasive instrumentation, treatment devices, such as drug pumps, or electrical appliances, such as pacemaker-cardioverter-defibrillators *(10*). The tools available can serve immediately for prevention of stroke or other life-threatening diseases, as already implemented by Dr. Kuniaki Otsuka in Urausu, Japan. Even with good-quality environments, such as clean air, clean water and clean and safe streets, there will still be a need for cardiovascular health monitored and chronobiologically interpreted with the help of the Minnesota data base. Specialists interested in cooperation are invited to communicate with us at corne001@tc.umn.edu.

A c k n o w l e d g e m e n t

The study was supported by the U.S. Public Health Service (GM-13981; FH); Dr. h.c. Dr. h.c. Earl Bakken Fund (FH, GC); the University of Minnesota Supercomputing Institute (FH, GC); and the Ministry of Education, Youth and Sports of the Czech Republic.(MSM141100004).

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NAUKA O CHRONOMECH, ŠIROKÉM SPEKTRU MONITOROVÁNÍ ČASOVÝCH STRUKTUR

S o u h r n

Cílem předložené studie je shrnutí dat o biologických rytmech v živých organismech a u člověka a data o rytmech cirkadiánním, cirkaseptánním a a ostatních rytmech, které se vyskytují v biofyzikálních veličinách. Nezodpovězenou zůstává otázka synchronizace geofyzikálních a biologických aktivit a jejich oscilací.

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