Symmetry of STRUCTURE

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Abstracts

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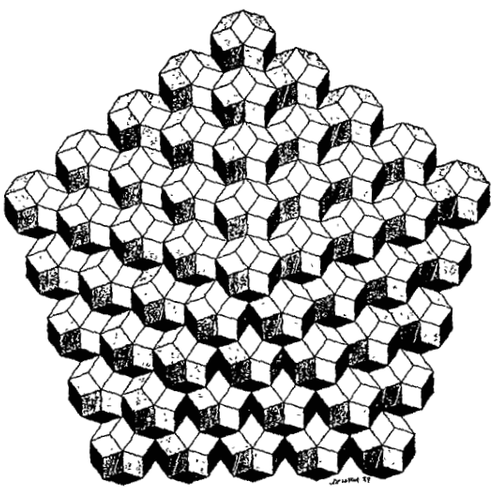

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SYMMETRY AND THE ORGANIZATION OF THE "SPACE" OF CARDIAC CYCLE STRUCTURES IN MAMMALS

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The symmetry principle acquires more and more methodological signification in modern biology (Urmantsev, 1974, Urmantsev, 1986). In this connection a exposure of invariants and transformation laws of biological objects is of great importance since only existence of a certain group of transformations and simultaneously the conservation of certain ratios during these transformations enables one to reveal symmetry.

The "space" of cardiac cycle structures for different species of mammals under exercise has been used as a biological object for the symmetry investigation. The heart performs its function due to change of the contrary and mutually complementary activity states of myocard such as tention (systole) and weaking (diastole). Every structure of the cardiac cycle (SCC) can be considered as a system including systolic and diastolic values of some cardiac activity j-parameter and their sun.

The temporal, volumetrical, mechanical and coronary-flow SCC's representing the most considerable biophysical parameters of the cardiac activity have been analyzed (Tsvetkov, 1984,1985). The temporal SCC consists of durations of systole, diastole and the cardiac cycle. The volumetrical SCC includes the volume of the expulsed blood, the volume blood retained in the ventricles and the end diastolic volume of the ventricles. The mechanical SCC represents the mean systolic and mean diastolic pressures in the aorta refering to the duration of the cardiac cycle and the mean pressure. The coronary-flow SCC includes the mean systolic and mean diastolic coronary flows refering to the duration of the cardiac cycle and the mean coronary flow. The "space" of SCC's is totality of the temporal, mechanical, volumetrical and coronary-flow SCC's for different species of mammals under exercise.

Generalized composition of the SCC's "space" (Tsvetkov,1985) is:

$$0.382(\sqrt{\delta})^{K_j+1} a_j W_i^{\beta_j} + 0.618(\sqrt{\delta})^{K_j-1} a_j W_i^{\beta_j} \cong (\sqrt{\delta})^{K_j} a_j W_i^{\beta_j}, \quad (1)$$

where on the left the systolic and diastolic values and on the right the summary value are presented.

On the algebraic expression (1) W_i is weight of some i-animal, k_j, a_j, b_j are the constants for different species in mammals corresponding to the j-parameter. The value δ presents changes of blood supply of an organism at some level of exercise with respect to the "golden" regime of that one approximately corresponding to the organism at rest. For any animal $\delta = \overline{Q(\nu)}/\overline{Q(\nu_{gs})}$ where $\overline{Q(\nu_{gs})}$ is the heart output at the "golden" heart rate ν_{gs} when the ratios of the durations of systole, diastole and the cardiac cycle is analogous to the proportion of the golden section. $\overline{Q(\nu)}$ is the heart output at heart rate ν corresponding to the fixed level of an exercise. For all animals δ =1-4 when the exercise varies from the state of rest to the maximal exercise value.

In the law (1) the influence of weight W and levels of relative blood supply of organism δ on the cardiac cycle structures is presented and the role of the golden section ("golden" numbers 0.382 and 0.618) in the organization of the SCC's "space" is reflected as well.

The structure of cardiac cycle representing the j-parameter of cardiac activity will be designated as j-SCC. In the law (1) has been the symmetry of j-SCC's series in mammals some level of relative blood supply of organism (e.g. δ =1.8) that is analogous for all animals. It is obviously that every level of relative blood supply δ has their "own" structural invariants for j-SCC

$$n_{ST}(\delta) = 0.382\sqrt{\delta}, \tag{2}$$

$$n_{DT}(\delta) = 0.618/\sqrt{\delta}, \tag{3}$$

where $n_{ST}(\delta)$, $n_{DT}(\delta)$ are ratios of systolic and diastolic values of j-parameter to their summary value at the level of relative blood supply organism δ, respectively.

The symmetrical transformation of individual j-SCC's of i-animal into the analogous SCC's of other animals within $W_{min} \leq W \leq W_{max}$ and $1 \leq \delta \leq 4$ follows the law

$$C_j = (W/W_i)^{\beta_j}. \tag{4}$$

Proceeding from the laws (1), (2), (3) and (4) the invariance in the j-SCC's composition of the multitude of mammals in limits the exercise variation ($1 \leq \delta \leq 4$) is obvious.

The "evolution" of the compositions of the temporal, mechanical, and coronary-blood SCC's in mammals with exercise variation is connected with "evolution" of invariants $n_{sT}(\delta)$ and $n_{DT}(\delta)$. These invariants are connected with "golden" number 0.382, 0.618 and the values δ are analogous for all considered kind of SCC's (Fig.1).

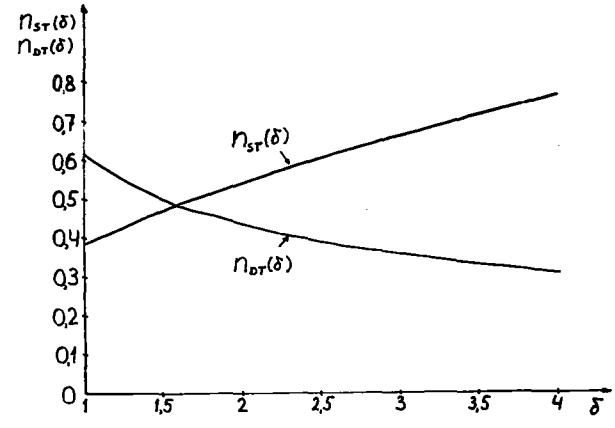

FIG. 1. The invariants of SCC's in mammals under exercise

This phenomen indicates that these invariants are universal. Thus, the golden section is a kind of "technological recipe" of SCC's composition. The properties of the golden section have found extensive applications in the sphere of Nature organization and in the sphere of the creative activity of the men: architecture, painting, music, mathematics, technique etc. (Bochkov, 1974; Petukhov, 1981; Stakhov, 1984; Soroko, 1984; Dubrov, 1987). Hence, there is no doubt about the existence of series of symmetrical objects in the Nature and the art the foundation for the invariance of which is formed by the golden section and its properties.

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