Tverdislov, symmetries and dynamic complexity

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Твердислов, симметрия и динамическая сложность

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Abstract. Research by Tverdislov et al. has presented findings explaining the steady, successive levels of development of living beings through chiral switching ensuring stability throughout the stages leading to their ultimate complexity. These hypotheses form a useful complementary approach to the present author's mosaic theory of natural complexity, providing a mechanism that could explain the principle of integration underlying the mosaic theory. The dynamic development of symmetrical forms as argued by Tverdislov et al. may be seen as one of a number of processes involved in the integration of successive stages in the evolution of a living being and in the emergence of complexity.

Keywords**:** Chirality, Complexity, Enantiomorph, Living being, Evolution, Integration.

Резюме. В работе Твердислова и др. представлены результаты, объясняющие устойчивые, последовательные уровни развития живых существ посредством хирального переключения, обеспечивающего их устойчивость на всех эволюционных этапах; и что приводит к их предельной сложности. Эти гипотезы формируют полезный взаимодополняющий подход к современной авторской мозаической теории естественной сложности, обеспечивая механизм, который мог бы объяснить принцип интеграции, лежащий в основе мозаической теории. Динамическое развитие симметричных форм, как утверждают Твердислов и др., можно рассматривать как один из целого ряда процессов, вовлекающих интеграцию последовательных стадий в эволюцию живого существа и в возникновение сложности.

Ключевые слова: хиральность, сложность, энантиоморф, живое существо, эволюция, интеграция.

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Content

Содержание

Introduction

The concept of natural selection, covering variations such as sexual selection, dates back to Darwin, but the basic question raised since Darwin is whether natural selection can account for *all* the dynamics of evolution. This gives rise to two major arguments, one being that natural selection can explain all the findings observed in the evolution of living species [Dawkins, 1976; Williams, 1966], and the other and opposite argument being the existence of more general processes in parallel with natural selection to account for the evolutionary development of living beings tending towards complexity. For example, the American biologist Stephen Jay Gould postulated that Darwinian selection left scope for relatively long phases of equilibrium with very little change occurring in species, but which were punctuated by more abrupt phases of speciation [Gould, 2002]. Many researchers have taken this further than Gould, arguing for what is called *orthogenesis*; an excellent chronological review of orthogenesis has been published by Igor Popov [Popov, 2018]. To quote Popov, orthogenesis means that "organisms are predisposed to vary in certain directions" (p.1). Disregarding extreme arguments presented by certain proponents of orthogenesis who reject Darwin's theory of evolution, orthogenetic processes are not incompatible with Darwin's natural selection, although they clearly go *beyond* natural selection [Chapouthier, 2019].

1. Complexity in mosaic form

Based on anatomical observations of animals, the present author developed a thesis [Chapouthier, 2018] that is clearly in line with the second approach described here, making it possible to look beyond processes of natural selection and include more general processes contributing to the complexity of living beings. In other words, this is "Darwinism beyond Darwin" [Chapouthier 2014].

The mosaic theory of complexity can be summarised as follows. The basic idea is that all and any complex living structure has been produced through two basic principles that are compatible with, but different from, Darwinian selection: the *principle of juxtaposition* of similar elements, followed by the *principle of integration* where similar elements integrate with one another to form an entity of greater complexity in which the original elements then stand as component parts. For example, individual cells can juxtapose and then integrate to form organs; living organisms can juxtapose and then integrate to establish a society of animals. The same process applies to a mosaic art work, being formed as a unit in which the component parts have a certain degree of autonomy, and where the overall visual image of a mosaic does not cancel the autonomy of form, colour or sheen of the tesserae comprising it. And so the operation can be repeated, with entities thus formed as component elements being subsequently juxtaposed one against the other and ultimately integrated to form entities at an even greater degree of complexity, as entities comprised of entities. Ever increasing levels of complexity thus appear, developing from cellular organelles into communities of animals, having covered intermediate stages, for example, as cells, organs and individual organisms.

One important clarification is needed here. While all the arguments contributing to the mosaic theory are based on anatomical data from living beings with their complexity as observed, there are at present no further arguments to support any hypotheses on what exact processes might be involved and what causes could make it possible for integration to occur at a given stage.

2. The work of Vsevolod Tverdislov et al.

Research by Vsevolod Tverdislov et al. has hypothesised one of a number of processes to explain the way a system shifts towards complexity, and which could be behind integration in the mosaic theory. This is therefore an interesting approach to examine.

The starting point of the hypotheses developed by Tverdislov is *chirality*, i.e. the existence of right/left organisational symmetry in living beings, one feature being a morphological mirror image of the other, as with the left hand and the right hand. The etymology of the term "chiral" is the Greek word for "hand". At a molecular level, such symmetrical forms are optical isomers. "They form mirror isomers – enantiomers possessing optical activity – ability to rotate the light polarization plane (L – left, D – right)" [Tverdislov *et al.*, 2012, p 121]. But mirror-image morphological features or symmetrical "enantiomorphs" can also be observed macroscopically; e.g. a snail may have a shell that spirals in the opposite direction to most snail shells; a human heart can be on the right (*situs inversus*), and the brain of a left-handed person can be the mirror image of the brain of a right-handed person (although this is not always the case). Whether at a microscopic or macroscopic level, and unlike mineral formations, at any given stage in a living system, there is an overwhelming majority of entities with one enantiomorph, i.e. right or left, and there is almost invariably an imbalance in relation to the other enantiomorph.

Working then on the hypothesis that the initial state is unstable, that the two enantiomorphic forms (left and right) are found in equal proportions, the development to a majority occurrence of one of the two forms could therefore be seen as the achievement of a higher level with greater thermodynamic stability. Development with one enantiomorph prevailing over the other could be a partial adaptation for greater stability. But for Tverdislov et al., in general in living units a shift through successive stages where integration can occur (stages of formation which they refer to as strata or stratification) is not a shift from a stage without chirality to one with a given type of chirality, but rather from *one chirality to another*, as if alternating in what is described as *switching the chirality sign*: "Switching the chirality sign of macroscopic objects provides irreversibility of stratification. The known chirality of biological structures at different levels suggests that the chiral L/D stratification should be universal and the hierarchical paths are stable and determined" [Tverdislov *et al.*, 2012, p. 120]. For the mosaic theory of natural complexity, the establishment of a steady stage of a certain form of chirality, either left or right, could be one of the processes involved in integration and which is henceforth irreversible, precluding any possibility of reverting to lower-level entities. For Tverdislov et al. the attainment of stability with a new form of chirality is not necessarily a stage of greater complexity, but the irreversibility and inherent stability involved for new stages means such greater complexity can occur. "The structural complexity grows (…) upon stable stratification of the system. Complexity rises inside one level, and is fixed upon formation of the next one and its gaining stability." [Tverdislov *et al.*, 2012, p. 126]. For Tverdislov et al., chirality shifting between levels could thus be one of the key elements behind the dynamic complexification of biological systems. For the mosaic theory, chirality shifting would be one of the processes of integration in living beings.

3. Validation

Tverdislov et al. conducted experiments to validate their theses, testing both artificial macromolecules [Zlenko *et al.*, 2020] and natural macromolecules [Sidorova *et al.*, 2019]. The artificial macromolecules were from N-trifluoroacetylated α-aminoalcohols (TFAAAs) and were "able to form quasi-one-dimensional supramolecular fibers (strings) when chirally pure" [Zlenko *et al.*, 2020]. The formation of strings produced tension, i.e. a type of molecular motor not found before the string fibres were formed, and thus gave rise to what could be called a new stage of integration. The analysis of natural macromolecules focused on the chiral features of proteins and nucleic acids. With proteins, for example, a number of levels of complexity can be identified, starting with amino acids as the primary structures, helices as secondary structures, then distortions and spatial arrangements of the helices as third and fourth-level structures. Going through these different stages as reported for demonstrations presented by the authors, successive inversions of chirality, i.e. symmetry switches, can be observed, showing that stability has been achieved at each of the new levels of complexity.

The analyses of experiments and the conclusions made by the authors obviously only apply to macromolecules and have not been extended to the wide range of anatomical structures of complex organisms as described in the mosaic theory of complexity [Chapouthier and Maurel, 2021]. With that reservation, Tverdislov's approach still stands as an interesting example of what may be a process of integration and complexification unrelated to, yet compatible with, Darwinian selection.

Conclusion

Tverdislov et al. have presented theses on the successive stages of complexity explained by chirality switching. Such original theses provide complementary arguments supporting the mosaic theory of complexity when taken as a mechanism to explain the principle of integration in the mosaic theory. The dynamic evolutionary development of symmetries as argued by Tverdislov et al. could be one of a number of processes facilitating integration in successive stages of developing life forms.

As the validation of the model only concerned molecular structures, either artificial or natural, there is obviously no answer yet to the broader question of macroscopic structures as with multicellular organisms. Only further research can lead to conclusions on the validity of the processes as theorised by Tverdislov et al. to apply them in a broader context to the countless forms of animal morphology.

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