ABSTRACT

The frozen plasticity theory is a punctuationalist theory of adaptive evolution. It states that long periods of stasis, during which populations respond to selection pressures only by elastic change in the frequency of already present alleles, alternate in the evolution of sexual species with short periods of plastic evolution, during which alleles can get fixed or eliminated by directed selection. Asexual species are not expected to maintain such high genetic polymorphism in the long term. They should, however, be able to plastically respond to selection pressures throughout their whole existence. This difference between the evolutionary dynamics of sexual and asexual clades has a number of ecological and macroevolutionary implications. Concerning ecology, we could expect different environmental preferences of sexual and asexual species. Accordingly, in our first work that was based on a comparative study, we statistically significantly supported the hypothesis that (ancient) asexual groups of (eukaryotes) inhabit more stable and homogeneous habitats than their related sexual controls. Focusing on actually experienced, i.e. subjective, heterogeneity of the environment turned out to be the crucial factor of this type of research. From the viewpoint of macroevolutionary implications of the frozen plasticity theory, it is essential that irreversibly polymorphic alleles and further unchangeable elements of the genotype-phenotype map accumulate effectively irreversibly in the course of the existence of evolutionary lineages. As we argue in our second, theoretical, work, this "macroevolutionary freezing" is an important factor in the evolution of evolvability of sexual lineages. This process results in easier adaptation, modular organization and increased robustness of organisms. At the same time, however, it manifests as the reduction of macroevolutionary potential, i.e. the probability of producing major evolutionary innovations. This results, among other things, in decreasing variability of evolutionary lineages or their interspecific and intraspecific disparity. Macroevolutionary freezing is the result of stability-based sorting – a universal process of preferential accumulation of elements that are less likely to disappear or change to other elements. Theoretical analysis of this phenomenon, its relation to natural selection and macroevolutionary consequences was the topic of our third work. It is shown that even species selection based on the highest remaining macroevolutionary potential probably cannot stop macroevolutionary freezing in relatively small populations of eukaryotic organisms. In the following fourth, also theoretical, work, we argue that alternatives to freezing modular genetic architecture are not frequent in terrestrial evolution and that macroevolutionary freezing cannot be entirely prevented even by occasional combinations of several considerably frozen traits, rare “thawings” of such elements of body function and organization, heterochronic changes, or radical simplifications of development. The only effective way to restore macroevolutionary potential thus remains a transition to a higher level of hierarchical organization. However, macroevolutionary freezing proceeds also at the higher level, whereas the only way from this “dead end” remains to be a transition to an even higher level of hierarchical complexity. Macroevolutionary freezing, or stability-based sorting, therefore propose the ultimate explanation for the trend of increasing hierarchical complexity

during the existence of life on Earth and its accompanying phenomena such as the modular organization of organisms, increasing diversity between elements at an immediately lower level, simplification of elements at this level and lower levels, gradual acceleration of the trend with two large boosts in the Neoproterozoic and Cambrian, its typicality for eukaryotes and especially their complex representatives, the difference of pre-Neoproterozoic (and especially Precambrian) evolution from post-Neoproterozoic (and mainly Phanerozoic) evolution, or the different character of prokaryotic and eukaryotic evolution. At the very end of this thesis I mutually contextualize ecological and macroevolutionary implications of frozen plasticity theory and show that they are not only coherent but also allow us to outline a schedule of events that could lead from a biosphere consisting of relatively simple asexual prokaryotic organisms to the contemporary biosphere characterized by the presence of complex and increasingly complicated eukaryotic organisms with a multi-level genotype-phenotype map.

Keywords: Frozen plasticity theory, frozen evolution theory, sexual reproduction, evolvability, complexity, macroevolutionary potential