

ARISTOTELIAN GOAL-DRIVEN CAUSE AND BIOLOGICAL MODELING

Sergei N. GRINCHENKO

ABSTRACT. *The notion of animate nature is introduced to consider how the hierarchical self-controlling system works. Hierarchical mechanism of search optimization (of goal criteria by energy character on adaptive random search algorithms) is a necessary element of this system. Consequently, it is necessary to use a goal-directed approach for the adequate modeling of biological systems. Thus, being formalized through cybernetic language, – “energy-search optimization” of animate nature actually corresponds with Aristotle’s realistic goal-driven cause – causa Finalis.*

KEYWORDS: *biological modeling, cybernetic models, hierarchic self-controlling system, goal-directed approach, adaptive random search, causa Finalis*

A mathematical model is an aggregate of functional dependences, connecting the variable quantities (“causes”) with their functions (“consequences” or “effects”). It is supported by the possibility of cause-and-effect relationships between first and second. This is usually considered as a default capability. But such possibility is only for rather simple modeled entities.

In animate nature “simple” can be referred to objects, functioning on time intervals, but which not correspond to exceeding “characteristic times”. Characteristic times is typical for system times amendment (of oscillatory or relaxation types). In longer time intervals, during the initial stages, the cause-and-effect relations cannot describe processes of adaptive evolutionary behaviour of animate nature objects.

To obtain a good modeling it is necessary to use a goal-directed approach. In turn, hierarchic mechanisms of the *self-control cybernetic model* (search optimization of goal criteria by energy character on adaptive random search algorithms) form the basis of this approach (Grinchenko and Zaguskin 1989; Grinchenko 2004, 2007, 2010) – see fig. 1. It’s toolkit realizes a permanent change of a feedback sign in a contour of control. It is alternative to “homeostatic” toolkit, basing only on a negative feedback, and thus realizing only the *stability* of complex systems, but not their *development*.

The animate nature in total should be regarded as hierarchic self-controlling system. Therein, the processes form the hierarchic optimizational contours – the closed chains of cause-effect relations. Tiering the contour (into research aims) in this or that place – really or virtually – we can treat these or those relations as “cause-effect”. In general, the animate nature (on each tiers of its hierarchy) permanently strives to obtain energetically optimal states. This demonstrates its cybernetic purposeful model.

In a hierarchical contour, on each temporary step of optimization process, all elements of N-th tier actively “behave”, i.e. to generate certain vector (“cluster”) of search and, thus, to influence on the (N+1)-th tiers’ element. The last tier reacts with

quite determined *inertia*, generating respective alteration of the goal criterion. Hence, it influences on all elements, its components and signals, such as "comfort"- "discomfort" (of energy character). And if the signal "comfort" is given – of the previous activity of each of N-th elements – the whole process can be continued "in the same strain", thus realizing special controlling influences 'from above'. But if the signal "discomfort" is given – similar influence *initiates* change of a direction and intensity of the search activity of each of N-th tier elements.

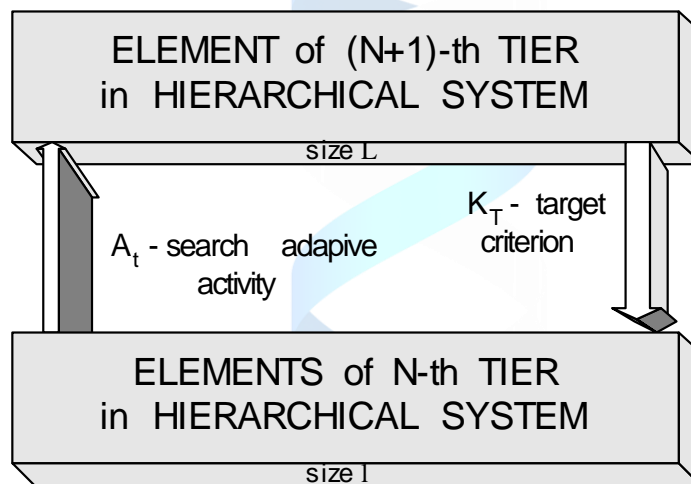


Fig. 1. Elementary (ultimate degenerated) diagram of the hierarchical search optimization mechanism.

The general notes: a) arrows directed upwards, have structure (reflect the relation) «many - to one», directed downwards - «one - to many»;
 b) A_t - search adaptive activities; K_T - target criteria of search optimization;
 $T \gg t$ - moments of time, $L \gg l$ - sizes.

Meta-evolution is the special notion – meaning the process of consecutive escalating of levels/tiers of hierarchical system of «high enough» complexity. It should be mentioned that the "*meta-step*" – time of appearance of new tiers in hierarchy of meta-evolving system; and the "*meta-phase*" – evolving period between times of appearance of adjacent tiers in the hierarchy of meta-evolving system.

The *animate* nature has generated on the Earth, on 12 previous and 13 current meta-phases of meta-evolution, various forms of the system organization.

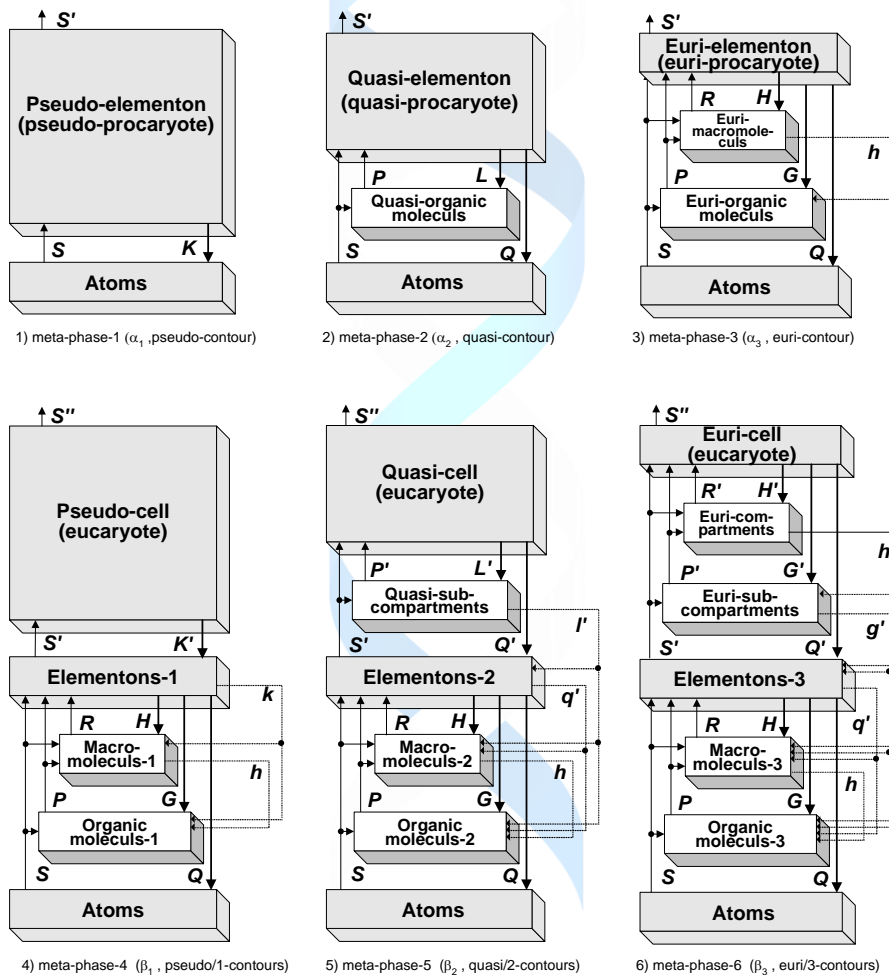
Meta-phases of animate meta-evolution make *triads*: *pseudo-*, *quasi-* and *eury-*forms, with increase of their complexity and efficiency. The simplest pseudo-meta-phase has (in its spatial hierarchy) only 2 tiers. In turn, hierarchy of a more complex quasi-meta-phase consists of 3 tiers; and hierarchy of even more difficult eury-meta-phase consists of 4 tiers.

The comparison of the specified, empirically selected periods in development of animate nature with theoretical (informatics-cybernetic) representation – on formation

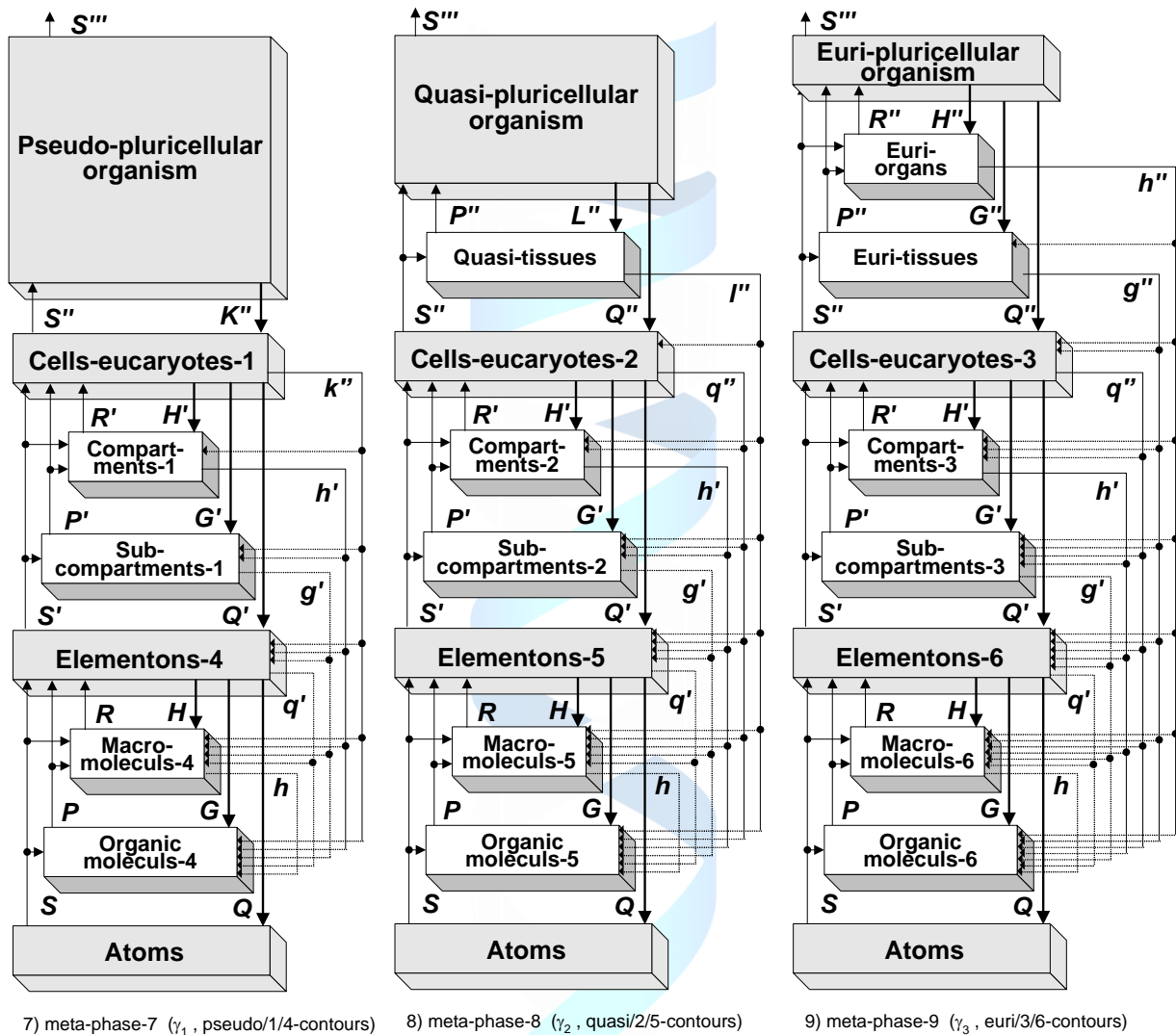
of new hierarchical tiers – allows to lead the following parallels between of animate meta-evolution and *eons*:

- ◆ from atoms up to "elementon" (procaryote units) = Katarchaeon (Hadean);
- ◆ from "elementon" (procaryote units) up to eukaryote cells = Archaean;
- ◆ from eukaryote cells up to pluricellular organism = bottom Proterozoic;
- ◆ from pluricellular organism up to biogeocenosis = top Proterozoic;
- ◆ from biogeocenosis up to Biogeosphere (its current condition and further) = Phanerozoe (Grinchenko 2004).

In Fig. 2 (1–13) the simplified circuits of basic meta-steps of animate nature meta-evolution are shown. It demonstrates, that the occurrence of *alive system memory* – mechanism of reproduction (and account) of the last experience about a course of process of hierarchical search optimization in system (for more details refer to Fig. 2) – is the most characteristic difference between alive and lifeless, on each tier in hierarchy.



Thus, Biosphere is the (self-)erection of several layers of self-optimizing contours of this natural system (process). Each of these contours strives to obtain their own goals – of optimal energetic existence.



The hierarchical structures (generated on various meta-steps of alive meta-evolution) exist synchronously and autonomous, in parallel realms. For instance, the existence of procaryotes and single-celled eukaryotes, or pluricellular organisms and biogeocenoses are evolutionary quite successful.

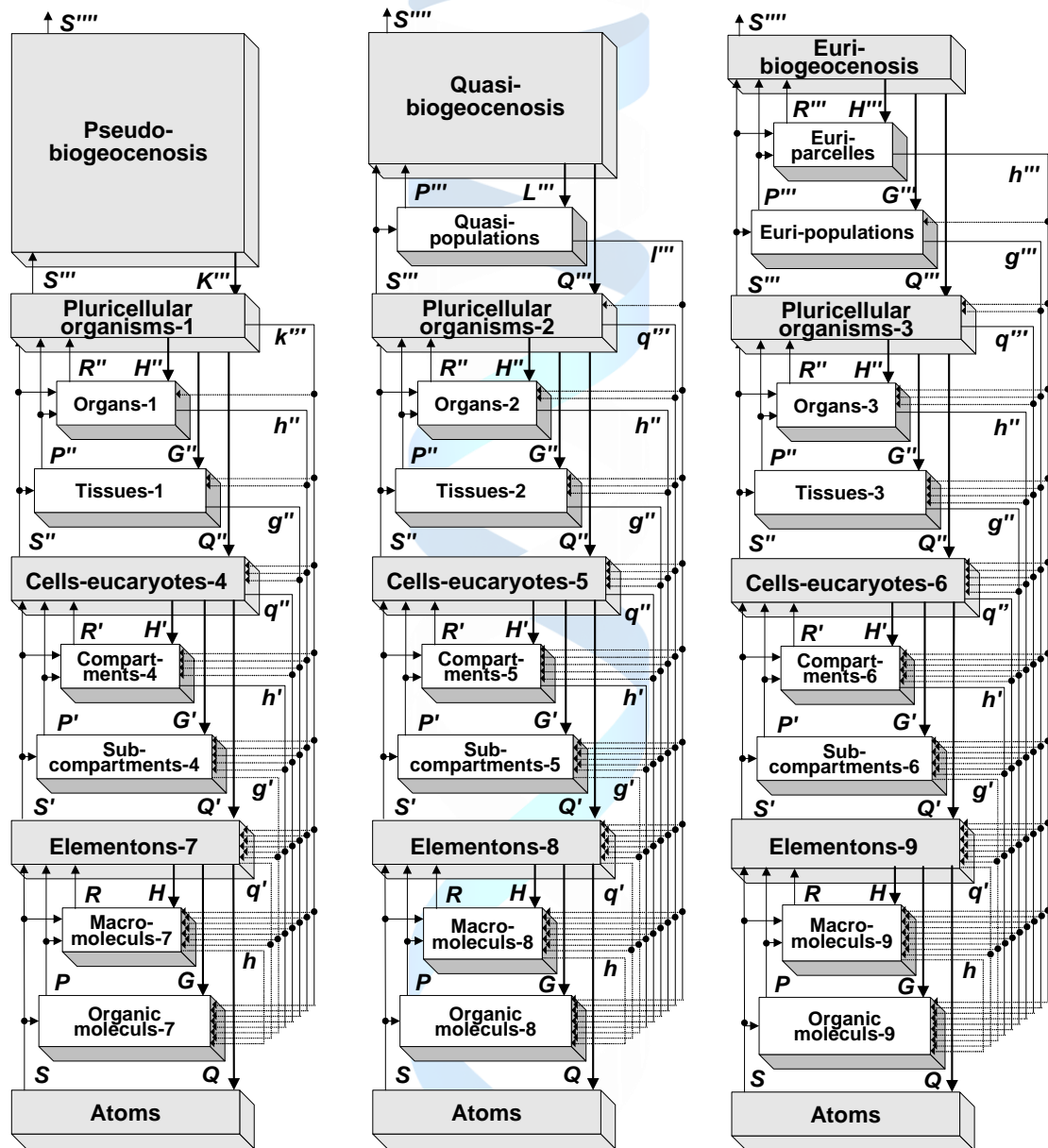
Duration of a triad (according to the empirical data) is about 1, 01 billion years. Calculated durations of the specified forms is about 944 million, 62 million and 4 million years respectively.

The tendency of the complication of structures which are taking place "inside" such (complicating in hierarchy) structural forms is monotonous.

It is evident that we are to represent the world basic structural elements as active, permanently striving to achieve their own goals (i.e. their energetically optimal conditions). This is a kind of transition (in our thinking) of the basic structures from a *passive* and "ossified" position and relation to the world, influenced totally 'from without' – into the mainly inherent and active ('from within') living and functioning, thus purposefully obtaining their energetically optimal conditions.

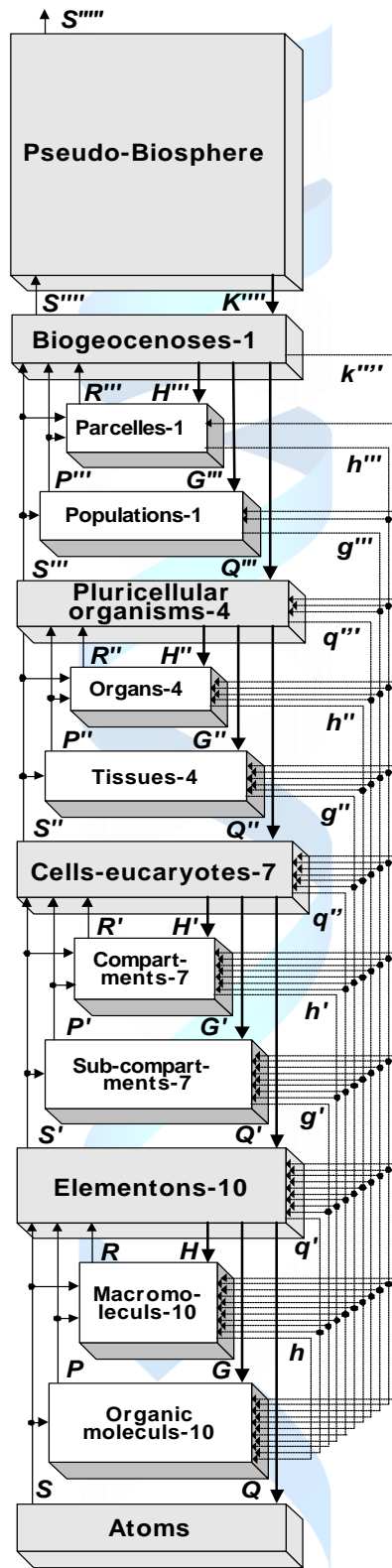
In this sense it is possible to speak about some analogue of the "freedom of will" manifestation – i.e. the specified structures emergence in the process of their adaptive

behaviour. Forrester (1971) defines this basis as the "counterintuitive" behaviour of complex systems.



10) meta-phase-10 (δ_1 , pseudo/1/4/7-contours) 11) meta-phase-11 (δ_2 , quasi/2/5/8-contours) 12) meta-phase-12 (δ_3 , euri/3/6/9-contours)

Thus, formalized by means of cybernetic language, the “energetic-search optimizationality” attribute of animate nature actually corresponds with the Aristotelian realistic goal-driven cause – *causa Finalis* [Aristotle ... 1907; Essential ... 2012]. This returns *causa Finalis* from the periphery – to the forefront of modern scientific activity, restoring its unity with the three other Aristotelian cosmic causes (forces): material – *causa Materialis*, formative – *causa Formalis*, and producing – *causa Efficiens*, but giving the leading role to goal-driven causes.



13) meta-phase-13 (ϵ_1 , pseudo/1/4/7/10-contours)

Fig. 2 (1–13). Meta-phases of evolution of animate nature.

References

- Aristotle on his Predecessors; Being the First Book of his Metaphysics. – Chicago, Open Court, 1907; tr. from the text edition of W.Christ, with introd. and notes by A.E.Taylor. URL:
http://www.classicpersuasion.org/pw/aristotle/metaphysics1.htm?pleaseget=C-3#_ednref49
- Essential Propositions of the Biocosmological Development, 2012. URL:
<http://en.biocosmology.ru/the-biocosmological-association---bca/essential-propositions-of-the-biocosmological-development>
- Forrester J.W. Counterintuitive Behavior of Social Systems // Technology Review, 1971, Vol. 73, No. 3, pp. 53–68.
- Grinchenko S.N., Zaguskin S.L. Mechanisms of Living Cell: Algorithmic Model. – M.: Nauka, 1989. – 232 p. – in Russian.
- Grinchenko S.N. System Memory of Life (as the Basis its Meta-evolution and Periodic Structure). – M.: IPIRAN, Mir, 2004. – 512 p. URL:
<http://www.ipiran.ru/publications/publications/grinchenko/> – in Russian.
- Grinchenko S.N. Meta-evolution (of Inanimate, Animate and Social-Technological Nature Systems). – M.: IPIRAN, 2007. – 456 p. URL:
http://www.ipiran.ru/publications/publications/grinchenko/book_2/ – in Russian.
- Grinchenko S.N. Teleological approach to modeling the Universe// Bio-cosmology – neo-Aristotelism. Vol.1, No.1 (Winter 2010), pp. 44–61.
<http://www.biocosmology.ru/elektronnyj-zurnal-biokosmologia-biocosmology-neo-aristotelism/postupivsie-stati/vol-1-no-1-winter>