BORIS V. PREOBRAZHENSKY

MORPHOGENESIS IN CORALS: METHODOLOGICAL ASPECT

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Teleologic approach to the coral morphogenetic studies shows no promise. The knowledge of coral growth physiology enables the use of its major characters for modelling the growth process in an experiment based on the fundamental principles of Pierre Currie's Symmetry Theory. Light is a major morphogenetic factor for hermatypic colonial corals.

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Boris V. Preobrazhensky, Laboratory of Tropical Seas, Institute of Marine Biology, Far East Science Center, USSR Academy of Sciences, 690022 Vladivostok, USSR.
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The basic knowledge on the systematics, phylogenetics, physiology and genetics is inevitably associated with the analysis of the morphological manifestations in constitution of various parts of biological objects studied. A study of morphogenesis in corals is particularly significant for its long history; and many theoretical conclusions have been made and are to be drawn on the basis of the morphogenetic analysis of these animals.

An attempt to work out some explanations of form formation at the level of life-forms in the colonial corals from the standpoint of determinative approach in terms of the system-structural analysis is a goal of this paper. Colonial corals are well known to vary greatly in their corallum structure. In general terms, colonial shape is to some extent connected with the environment. A direct relation of colony shape to the water depth and to its position on the reef profile is accepted as a veracious fact. Besides, we must admit a number of possible relations of the depth to various factors. Some resulting statements seem to be rightful: "the shape is connected to the hydrodynamics", "... to the pressure", "... to the light flow", — i.e. to the quality and quantity of the light energy which "plant-animal complex of hermatype coral would consume", and what not. A most popular approach is to associate the colony shape with water turbulence rather than with anything else. Without going into any details, different hydrodynamic factors have their impact upon the colony. We believe that a compact colony withstands crushing wave swips better and thus this shape is more advantageous under the conditions of an active hydrodynamic regime. Therefore the coral forms inhabiting the most shallow sites are transformed into flat durable structures which ensures a higher survival rate. Somewhat deeper massive hemispheric and spheric corals occur, while within the greatest and thus protective depths as well as within the reef lagoons, fragile ramose colonies settle safely. Thus, according to this concept, the colony adjust its shape to the hydrodynamics. Such an explanation with a disguised teleological background satisfies the majority of workers and is believed to be quite a proved fact. However, a significant par of curious facts lies idle: in the shallows, there are abundant thin-branched fragile colonies. They break under the wave attacks and rapidly regenerate. Though uncrushable colonies are also present there, the upper turbulent levels of reef terraces are thick with the ramose fragile representatives of the same genera which are often prevailing. From this it follows that the distribution of the most significant life-forms of corals is completely reverse to that shown in the above "classical" scheme. The most shallow are ramose branching colonies and the deepest are uncrushable and leaf-shaped (folious) forms, which might seem quite illogical from the standpoint of "hydrodynamic usefullness". No reasonable explanation can be applied from such a position to the fact that all the above types of life-forms settle jointly within an uppermost shoal of the Great Barrier Reef. The "tendency" of acroporids to flat-forms at great depths is inexplicable while at the shallows they develop convex (almost spherical) bushy colonies. If we strip a teleological shell from the hydrodynamic explanation of colony form, what will be left is a bare fact that the coral morphogenesis does display a relationship with hydrodynamics. The range of that relation remains obscure, for it is quite unknown by which of its factors a water flow influence a coral and what part of it; and in which way the agitation would be transmitted into some sensorial centers operating the vegetative growth in the colony, whether it will activate or suppress them. further questions are: how these agitations affect the form-formation processes, why some of zooids increase their growth while others terminate it, and how such an amazing geometrical equilibrium of corallum forms could be achieved?

An example which was discussed shows clearly that a mere change of accents can transform an established and seemingly self-evident truth into a serious general morphological problem with a number of unsolved partial problems, the whole approach to which one still has to work out. Even such a trivial thesis as "the given feature has arisen because it provides the organism with higher survival in its struggle for life, and its absence would lead to failure", cannot be accepted. For it is but in our consciousness that a victory in the life-struggle is necessary to the organism, and it is capable to take necessary measures to warrant for itself such a prospect by proper self-reconstruction.

It is expedient to study the general laws of form-generation in terms of Theory of Symmetry. A law of generation of form under the influence of environment is known under the name of the Second (General) Principle of Symmetry by Pierre Curie. It affirms that the symmetry of a generative environment acts so as to overlap the symmetry of the body created within it. A resulting body shape preserves only those elements of its symmetry that correspond to the environmental symmetry elements (Shafranovsky 1968). In his time, A. Humboldt applied the term "life-form" to the plants having observed a conformity of their habitus with the environment. In the corals, the notion "life-form" implies the manifestations associated with the corallum shape ("habitus", "growth form") wholly resulting from the spatial distribution of centers of vegetative propagation in the colony (Preobrazhensky 1971, 1974, 1975; Krasnov and Preobrazhensky 1972).

Bearing in mind all the above, one can regard a coral colony as a result of symmetrically regular combination of a finite number of uniform original parts. The presence of several levels of complication within the coral colony is to be noted. They signify special structural levels, differing from one another by the characters of their elements and by the mode of their spatial combination. The element and the law of its combination are the inner elements of Symmetry in coral colony, they manifest themselves through the spatial arrangement of corallites and through the arrangement of the centers of the vegetative propagation. A symmetrical and topological variety of colonial forms can be computerized and predicted. But one must keep in mind the limitations of environmental Symmetry which makes it possible to achieve a superpositional result (i.e. life-form). It consists in compulsory preservation of only those inner elements of colonial Symmetry which correspond to the environmental elements of Symmetry.

A proper understanding of the interaction between the colony and its environment is impossible without operating a single system of physical units. Thus we are to find some ~~physical process~~ that can be observed in a colony and thus may serve as a tool for simulating the interaction between an organism and environment. A simulation, however, might be executed only according to the principle of "black box". This step is evidently the most complicated both methodologically and logically, for it implies the presentation of both the coral colony and an environmental factor as abstract geometrical bodies fitting to the superposition. Where those abstract bodies cross, we expect some resulting figure reflecting the outline of a real body of colonial structure (Murakhvery and Preobrazhensky 1980).

The hermatypic corals are known to activate their physiology, and skeleton development under insolation and to diminish it in darkness. Too strong light inhibits the skeleton formation (Goreau-Yonge-Barnes). Experiments made by the author using the aquarian of the Australian Institute of Marine Science (Townsville) and the Lizard Island Research Station, have demonstrated that colonial parts which get too strong insolation have almost no skeletal growth. Parts under optimum lighting conditions show maximal growth. The parts completely protected from light action demonstrate a termination in skeletal development. A straight directed light flow has a "blowe off" effect. The zone of active skeleton formation shifts towards the comparatively protected area. Straight directed light dominates the colonial symmetry and brings it to the linear light flow symmetry. It expands a colony along the light beam. The experiment leads to the conclusions that there is a possibility for the direct visualisation of superimposing the environmental symmetry upon the colonial here originated. The data thus obtained allow direct measurements of light inducing a maximum growth rate in a colony. Now we can plot the optimum coral growth conditions as a hollow spherical body of small and big diameters which show respectively a minimum and a maximum illumination limits terminating the skeletal growth. Thus plotted, a colony undergoes a superposition with a cumulative light body measured directly on the reef. A resulting figure displays a real geometrical shape, which we expect rightfully for a real coral (Murakhvery and Preobrazhensky 1980). The mode of plotting presented here my be used also for any other environmental factor.

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