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SOME REGULARITIES IN SESSILE PROTISTS EVOLUTION

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The attached mode of life is rather common among protists. There are sessile pecies in heliozoans, foraminifers, radiolarians, heterortophic and autotrophic flagellates and infusoria. There are two main morphotypes of sessile protists: stalked and flattened on substrate.

From papers of N.R.Silvester et al. (1985) and other it appears that attachment while giving to protists some benefits, subjects them to the problems of a counteraction to specific hydrodynamic loads. These specificity is determined by the sessile protists location within the hydrodynamic boundary layer limits. The our investigation of some species of sessile infusoria variability [2] has shown that this variability depends on the distribution of hydrodynamic loadsin different sites of a boundary layer. We arrived to the idea that the boundary layer has a determinated spatial structure; the conditions are different in the different parts of this layer.

Shear stress, hydrodynamic velocity pressure (integrated force) and other hydrodynamic loads should be mentioned as the most important abiotic factors influencing organisms in a boundary layer. The conventional factors such as temperature, concentration of oxygen, dissolved organic matter, etc are essential too. The action of all these factors is different in various parts of boundary layer being conditioned by the spatial structure of the layer [3,4].

The morphological adaptations of sessile protists can be classified in groups related to the various hydrodynamic factors or to different sites of a boundary layer. The boundary layer represents a complex of potential habitats for protists. On such a basis we have formulated the concept of fluid boundary layer as an adaptive zone for these organisms.

But it inevitably leads to the following question: how the mastering of the adaptive zone by protists has happened? The attempt to answer this question is the purpose of the present paper.

The adhesive organelles of sessile protists (in particular infusoria) and these organelles derivatives, such as loricas attract our attention first of all. It is possible to observe a different degree of such structures development in varios taxa that can be seen in the example of suctorian ciliates. We believe that such structures form the evolutionary rows.

The different degree of adhesive structures (stalks) development connected with hydrodynamic loads might also be observed in case of intraspecific variability. In our opinion it allows to consider the evolution of organelles as the process of adaptation to the hydrodynamic factors.

Obviously the first problem for the ancestors of sessile protists was that of the attachment to a substratum. They were subjected to action of shear stress that operates upon the base of an attached organism. Under these conditions various secretory organelles (for example scopula and scopuloid in infusoria) have been appeared and developed at the expense of the amplification of their functions.

Besides from the sticky substances secretion the increase of contact area with a substratum is necessary for a counteraction to shear stress. Hence forms with the extended body base or with cell basal protuberances gained the selective advantage.

The particularity of this stage was that attached organisms were located within the limits of the diffusal boundary layer where only the molecular diffusion is possible. Correspondingly the uprise above this layer moves the animals into the area of a much faster convection diffusion and gives the protists essential benefits in feeding. In this connection some forms evolved adaptations to raising their body above a substratum. They formed stalks thus adding the function of zooid rise over substratum to the function of attachment. However, this uprise has subjected the organisms to the additional load of the hydrodynamic velocity pressure.

During adaptation to the latter in protists (especially in infusoria) the greatest number of structures were generated. The value of a hydrodynamic velocity pressure increase together with the body rise over substratum [2] as well as with increase of the body diameter [5]. The latter is especially impor tant for sessile protists. Among them the tendency of the progressive increase of bodly size is characteristic. For example in suctorians the most primitive podophriids have the size of a cell up tp 50 μ, in acinetids up to 150 μ, in ephelotids and stalked discophryids up to 300 μ. Accordingly action of an integrated force should sharply increase in the zone of junction between stalk and body. Therefore practically all adaptation to this factor ensure strengthening of this junction. These are formed at the sacrifice of apical allometric growth of stalk. Some types of attached protists loricas probably also were generated by the same way [3].

The origin of the spasmoneme in peritrichous ciliates was probably also connected with the necessity to strengthen the stalk-body junction. In this case the evolution probably went in direction of allometry of the basal part of bell with a penetration of the cell protuberance into the stalk. This also increased the strength of the junction. Thus, together with the basal part of cell, structures ensuring zooid contraction (filaments and the cisterns of endoplasmic reticulum) has moved inside the stalk too. As a result, such stalks have also gained the ability to contraction.

Thus the stages of the adhesive organelles evolution in different protists taxa were similar: 1) facultative attachments (thygmotaxis); 2) secretion of sticky substances; 3) increases of the attachment area; 4) rise of the body above substratum with the formation of the adhesive organelles (pedicles and stalks); 5) formations of structures protecting a zone of stalk and body connection [3].

I is necessary to mention that not all attached protists evolved structures to rise of the body above substratum. The amplification of the function of counteraction to shear stress in some groups mostly went by means of flattened body formation and increase of the body size in order to increase the area of its contact with a substratum. In the area of a conventional diffusion only feeding organelles were mounted. In such a way the characteristic outlines of suctorians heliophyids and trichophryids, peritrichs lagenophryids and others were probably generated.

The transition to the sessile mode of life has probably required also the amplification of functions of the feeding organelles. This aim is achieved by the formation and polimerization of specialized structures such as tentacles, cell protuberances, collars and special peristomal ciliature. Thus in flagellates and infusoria ciliature or flagella lost their locomotory function but retained the feeding function.

The predatory protists also evolved specialized means of prey capture. This evolution went on not by the amplification of function of the already existing organelles but by the substitution of organelles. In such a way axopodians were probably derived in heliozoans and tentacles in suctorians. This gave these protists possibility to feed on prey equalling or even exceeding the predator in size. The feeding function was also intensified thanks to the organelles polymerization. Unlike the filter feeders, trofonts of the predators have lost locomotory organelles.

In autotrophic organisms flagella do not carry out the trophic function. Accordingly in the unicellular (gemimonad) algae the transition to an attachment was followed by the reduction of this structure.

Apparently the evolution of feeding organelles in sessile protists went on by way of amplification of functions by means of polimerization of structures that already existed in free-swimming ancestors. The substitution of functions also took place. In organisms with different types of nutrition these processes went on differently.

In contrast to sessile multicellular organisms the evolution of sessile protists had progressive, not regressive (katamorphic) character.

The progressive evolution of protists is often associated with the increase of body size. Such increase may cause the drop of the effectiveness of cell organelles or organelle systems functioning. This drop might be avoided either by the increase of organelle size or by the organelle number multiplication. The second way (polymerization) has been realized by protists much more often, as was noted already by V.A.Dogiel [1].

As follows from the examples discussed above, the transition to a sessile mode of life in protists is also usually associated with the body size increase and amplification of functions of organelles by polymerization. The latter in turn creates conditions for the separation of functions [4].

In the course of the transition to the sessile mode of life in protists also the change of functions has happened: the locomotor structure lost the motility function but saved the feeding one. The reduction of structures responsible for swimming took place only in predatory forms, where feeding organelles were generated by the substitution of organelles. Accordingly, in the protists the majority of organelles was not lost during the transition to a sessile mode of life. The variety of conditions in a boundary layer lead to the development of additional structures (in particular attachment organelles). The progressive character of sessile protists evolution is connected with these particularities.

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OTURAQ HƏYAT TƏRZLİ İBTİDAİLƏRİN TƏKAMÜLÜNDƏ BƏ'Zİ QANUNAUYĞUNLUQLAR

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