



Mini Review

Multifunctionality of Cells – A Condition for Evolutionary Success or a Consequence of the Transition to Parasitism

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Abstract

The assumption that the evolutionary success of parasitic worms is due to the multifunctionality of their cells, acquired during the transition to a parasitic lifestyle, is discussed.

In a *Critical comment*, Wright [1] correctly noted that a condition of successful evolution of any group of animals is dynamism of cellular populations and, consequently, tissue capacity for remodeling and restoration by migration to them and/or by division of the constituting cells. Such dynamism of cell composition, characteristic of many groups of highly organized animals, facilitates adaptive responses to “evolutionary pressures”, which results in the evolutionary progress of species. However, as is known, some invertebrates are distinguished by the constancy of their cellular composition (the so-called euthelia, and renewal of cellular populations in such animals is either absent or carried out within certain limits (i.e., until maturity). Nematodes, at least those that are parasitic and soil-dwelling [2], are one of the most successful evolutionary groups, based on both species number and number of individuals, and are referred to those animals. The question arises of how those nematodes manage to adapt to diverse life conditions, including parasitism, and if their mechanisms of cellular population replenishment and/or renewal are restricted or completely absent throughout the majority of ontogenesis?

Wright suggested that the “evolutionary success” of parasitic nematodes can be mainly attributed to the multifunctionality of their cells. As an example, he mentioned some tissue and organ systems, the function of which had changed in the

process of nematodes’ evolution from free-living to parasitic lifestyle: epidermis of the body wall, digestive system, and somatic musculature. In this *Critical comment*, I will stop on the epidermis.

The nematodes, which are paucicellular in free-living forms, have an epidermis, which is organized as a syncytium in many parasitic forms, particularly in older larval and adult individuals [3]. According to Wright, syncytial construction provides physiological uniformity of tissue and excludes intercellular junctions, which are locations of possible infiltrations. Functions of such epidermis, as Wright considered, include synthesis, secretion, and regeneration of cuticle, in addition to reserving of necessary materials, body wall permeability regulation, and osmotic regulation of an organism’s internal environment. Two aspects should be given special attention. First, listed functions are obviously characteristic of the cellular forms of epidermis and, thus, should not be considered as unique, inherent exclusively to the cover syncytial tissue, and just of parasite organisms. On the contrary, that functional spectrum underlines the multifunctionality of *any* dermic epithelium caused exclusively by its border location. However, one should not exclude the possibility of other functional peculiarities that are exclusive to the syncytial cover of nematodes.

The second aspect mentioned by Wright was that there is a tendency of cellular epidermis to transform into a single structure, which is directly associated with the conversion of animals to a parasitic lifestyle. Compared with nematodes, this trait is more obvious in parasitic flatworms, and the epidermis (tegument) is multifunctional, which reflects their way of life. In particular, the cestode tegument has “standard” functions (e.g., protective, skeletal) that are characteristic of free-living animal cellular epidermises, and carries out several atypical functions (e.g., digestion, absorption of necessary materials, enzyme synthesis and secretion, and metabolite excretion) [4]. Trematode tegument possesses the same diverse functions [5]. Such multifunctionality is one reason why the epidermis of those parasitic worms is considered a unique tissue and therefore called “tegument”. Owing to the diversity of its functions, the tegument is an organ, though it represents a multinuclear cell in form. Functionally, flatworm tegument is similar to the acanthocephalan epidermis; therefore, despite some morphological differences from the cover of Plathelminthes (acanthocephalans have symplastic, flange worms – syncytial tegument), the acanthocephalan epidermis is also named as tegument [6,7].

Another clear example of cellular multifunctionality among flatworms and acanthocephalans rarely attracts the attention of experts. Muscular cells in these animals are usually referred to as nonstriated muscle cells; however, they substantially differ from typical smooth muscle cells, which latter based on morphological and functional peculiarities. Muscle cells in flatworms and acanthocephalans are involved in contractile function, a considerable portion of basal plate synthesis, and intercellular material synthesis [8]. Recent studies have shown that the muscle elements that make up the internal organs of acanthocephalans, or more precisely, their walls, such as the ligament, as well as the organs of the female and male reproductive systems, are characterized by intensive synthesis of intercellular material in the form of bundles of filaments [9–11]. To some degree, that peculiarities are similar to the known ability of typical smooth muscle cells to synthesize intercellular matrix [12], but they may be more expressed in worms that lack typical connective tissue. For this reason, as well as because it is observed in free-living turbellarians [13], such multifunctionality of muscle cells can hardly be due to the transition to parasitism.

On the other hand, in the same cestodes, transformations of myocytes of the suckers are described, for example, the complication of their contractile apparatus, according to the author, due to the unique, parasitic lifestyle [14] and, undoubtedly, expanding the range of functions performed by myocytes. Thus, it can be assumed that the complication of tissues, at least in helminths, in some cases may be a consequence of the transition to parasitism, in others, it may be more general and reflect the natural process of evolution.

In conclusion, I highlight that Wright [1] addressed a fundamental, but little-discussed problem of tissue organization in lower multicellular animals. A study of ways and mechanisms of tissue transformation caused by the unique parasitic lifestyle, especially in endoparasitic animals, will undoubtedly facilitate a more comprehensive understanding of the unique phenomenon of parasitism.

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References

1. Wright KA. Cellular multifunctionality: a capacity facilitating evolutionary change in the paucicellular nematodes. *J Parasitol.* 1990;76:143-144. Available from: <https://www.cabidigitallibrary.org/doi/full/10.5555/19900863886>
2. Rusin LY, Malakhov VV. Free-living marine nematodes possess no eelworm. *Doklady Biological Sciences.* 1998;361:331-333. Available from: https://www.researchgate.net/publication/288808476_Free_living_marine_nematodes_have_no_eutely
3. Malakhov VV. Nematodes. Structure, development, classification, phylogeny. Hope WD, editor. Washington and London: Smithsonian Institution Press; 1994. Available from: <https://archive.org/details/nematodesstructu0000mala>
4. Kuperman BI. Functional morphology of lower cestodes: ontogenetic and evolutionary aspects. L.: Nauka; 1988;167. Available from: <https://www.cabidigitallibrary.org/doi/full/10.5555/19900864969>
5. Threadgold LT. Parasitic Platyhelminthes. In: Bereiter-Hahn J, Matoltsy AG, Richards RS, editors. *Biology of the Integument. Invertebrates.* Berlin and Heidelberg: Springer-Verlag; 1984.
6. Miller DM, Dunagan TT. Functional morphology. In: Crompton DWT, Nickol BB, editors. *Biology of the Acanthocephala.* Cambridge: Cambridge University Press; 1985.
7. Taraschewski H. Host-parasite interactions in Acanthocephala: morphological approach. *Advances in Parasitology.* 2000;46:1-179. Available from: [https://doi.org/10.1016/S0065-308X\(00\)46008-2](https://doi.org/10.1016/S0065-308X(00)46008-2)
8. Nikishin VP. Subsurface musculature of spiny-headed worms (Acanthocephala) and its role in the formation of the intercellular matrix. *Biology Bulletin.* 2004;31:598-612. Available from: <https://link.springer.com/article/10.1023/B:BIBU.0000049733.16236.79>
9. Kusenkov KV, Nikishin VP. Organization of ligament of acanthocephalan *Neoechinorhynchus beringianus* Mikhailova et Atrashkevich, 2008 (Acanthocephala, Eoacanthocephala). *Inland Water Biology.* 2017;10:140–144. Available from: <https://link.springer.com/article/10.1134/S1995082917020080>
10. Davydenko TV, Nikishin VP. Features of tissue organization in the female reproductive system of *Acanthocephalus tenuirostris* (Palaeacanthocephala, Echinorhynchida). *Biology Bulletin.* 2022;50:1556–1566. Available from: <https://link.springer.com/article/10.1134/S106235902307004X>
11. Davydenko TV, Nikishin VP. Tissue organization of the male reproductive system of *Acanthocephalus tenuirostris* (Palaeacanthocephala, Echinorhynchida). *Biology Bulletin.* 2024;51:1974–1983. Available from: <https://link.springer.com/article/10.1134/S1062359024700493>
12. Ham AW, Cormack DH. *Histology.* 8th ed. Philadelphia and Toronto: J.B. Lippincott Company; 1979. Available from: <https://archive.org/details/hamshistology0000hama>
13. Hori I. Structure and regeneration of the planarian basal lamina: an ultrastructural study. *Tissue Cell.* 1979;11:611–621. Available from: [https://doi.org/10.1016/0040-8166\(79\)90018-1](https://doi.org/10.1016/0040-8166(79)90018-1)
14. Korneva ZhV. Tissue adaptation and morphogenesis in cestodes. Moscow: Nauka; 2007;187. Available from: <http://dx.doi.org/10.13140/RG.2.1.1478.3202>