REVIEW

by the official opponent

on the dissertation by Su Jiahui

submitted in fulfillment of the requirements for the degree of Candidate of Biological Sciences

on the topic: "Structural and functional characteristics of testate amoeba assemblages in terrestrial habitats of the Northern Eurasia"

Specialty: 1.5.15 – Ecology

The topic of the dissertation, devoted to the study of structural and functional characteristics of testate amoeba (testacean) communities in terrestrial ecosystems of Northern Eurasia, **is undoubtedly relevant**. Testate amoebae are key components of microbial communities in soils and peatland ecosystems, playing an important role in regulating biogeochemical cycles and maintaining food web structure. In the context of ongoing global climatic and anthropogenic changes, the study of their community structure is of particular significance for the development of reliable bioindication approaches, which are essential for monitoring changes occurring within communities and ecosystems. In this dissertation, the author attempts to move beyond a purely morphological paradigm toward a functional trait-based approach, which aligns with contemporary global trends in microbial ecology. The dissertation comprises an introduction, eight chapters, conclusions, a reference list of 196 sources, spans 157 pages, and is illustrated with 11 tables and 29 figures. The dissertation conveys a coherent and well-integrated impression.

Degree of substantiation of scientific statements, conclusions, and recommendations. The dissertation was conducted at a high methodological level and demonstrates rigorous logical structure. To address the research objectives, the author employed a comprehensive suite of modern statistical analytical methods. The core scientific statements and conclusions are well-argued and logically follow from the presented results. The author undertook substantial work in compiling and analyzing trait data for 372 of the most frequently encountered testate amoeba

species in the Northern Holarctic. Based on this dataset, seven functional groups of testate amoebae were delineated.

A particularly compelling section concerns the mechanisms of community assembly. Results obtained using SES.MPD analysis revealed differences in the deterministic processes governing the assembly of sphagnum-dwelling versus soil-dwelling communities. All scientific conclusions and recommendations formulated in the dissertation are the logical outcome of the extensive empirical research and careful data analysis performed.

Reliability of the obtained results is ensured by the use of a representative database of 1,635 samples, which were previously collected in strict accordance with established methodological standards, and by the application of modern, widely accepted statistical methods in ecology. The results have undergone peer review and have been published in leading international scientific journals, which confirms their scientific validity and recognition by the scientific community.

Scientific novelty of the work lies in the application of an integrative approach that combines taxonomic and functional perspectives in the study of testate amoebae. A system of functional traits has been proposed, and on its basis, a functional classification of testate amoebae has been constructed, specifically oriented toward elucidating their ecological roles and adaptive strategies. This approach overcomes the limitations of traditional morphological classification systems and provides a deeper understanding of the ecological significance of these microorganisms. A comparative analysis of the assembly mechanisms of soil-dwelling and sphagnum-dwelling testate amoeba communities was performed, taking into account regional specifics and latitudinal gradients. The discovered patterns of spatial distribution, including inverse latitudinal gradients of α-diversity and regional variability in community structure, reveal previously unexplored aspects of testate amoeba ecology. Collectively, these results establish a new methodological foundation and substantially expand the possibilities for studying the biodiversity, functional organization, and ecological functions of testate amoeba communities in terrestrial ecosystems.

No serious shortcomings have been identified in the dissertation under review. On the contrary, one must note the large volume of analyzed material, the advanced and appropriately applied statistical methods, and the thorough, thoughtful approach both in formulating research objectives and tasks and in writing the thesis. The candidate has obtained fundamental results that undoubtedly contribute to protistology and ecology and have clear potential for practical application. In each section, the author discusses and interprets the obtained results, proposing interesting hypotheses.

Nevertheless, several questions and remarks arose after reading the dissertation, listed below.

Theses to be defended. The work formulates four defended statements, which rather resemble conclusions. Some of them are of a rather specific nature. It would have been preferable to formulate one or two more conceptual generalizations of interest to all specialists in the field of microbial ecology. The material of the work fully allows for this.

After reading the work, a question arises regarding the functional traits. The author delineated seven functional groups based on a comprehensive morphological analysis – can these groups be given specific definitions? What exact 'functions' are referred to? The classification is based on morphology/morphometrics of 17 shell characteristics and feeding type. How can this knowledge be translated into ecological functions? This aspect is briefly mentioned in the work but deserves a more detailed description. It is understood that 'functional groups' has become a standard term in such studies, however, would it be more accurate to refer to the delineated groups as "morpho-functional groups"?

Furthermore, it is worth raising the following general point regarding the use of the "feeding type" trait. The value of the trait-based approach lies in the fact that the researcher, for the purpose of analysis (e.g., for bioindication), does not need to identify the organism (in this case, a testate amoeba) to the species level. In other words, one does not need to be a qualified taxonomist. However, to classify testate

amoebae by feeding type, the researcher must, in any case, first identify the species and then, using literature data (or a ready-made database), assign the feeding type to that species. The morphology of a fixed shell itself does not reveal the amoeba's feeding strategy. Thus, the necessity of taxonomic identification of testate amoebae complicates the application of the developed approach.

In the context of discussion, it would be interesting to know to what extent the developed approach and its underlying morphological traits are suitable for palaeoecological research. In other words, the question is whether the studied set of morphological traits (e.g., xenosomes, invagination of aperture, external spines or horns) is well preserved in subfossil testate amoebae.

The literature review mentions biotic factors influencing the composition and structure of testate amoeba communities. Biotic, interspecific interactions are referred to in defended statement No. 3 and conclusion No. 4. However, biotic interactions were not directly studied in this work. It is true that high SES.MPD values support the *hypothesis* that biotic interactions play a predominant role in community assembly; however, this is *only one of several possible explanations*. A more cautious interpretation is therefore warranted. This should be more accurately reflected in the conclusions and, in my opinion, should not be included in the defended statements at all.

In the dissertation, the term 'ecoregion' is frequently used. It would be useful to clarify what the author means by this term. Why not simply 'region', or 'ecobioregion'? How does an 'ecoregion' differ from natural zone?

The statement that "The findings and interpretations presented in this PhD thesis have been rigorously tested and validated through multiple channels of academic dissemination" is formulated in an abstract manner, without specificity. Does this refer to the scientific conferences at which the results of the work were presented, as mentioned below?

The above remarks and discussion points in no way diminish the overall positive assessment of the work. An extensive and high-quality study has been conducted, the reliability and significance of whose scientific results are beyond doubt. The dissertation candidate, Su Jiahui, is undoubtedly a highly skilled specialist in the field of ecological research on testate amoebae and possesses a broad range of research and statistical analytical methods.

The data obtained by Su Jiahui are relevant, scientifically significant, and hold promise for further development. The material in the dissertation and the abstract is presented clearly. The main findings of the work have been published and presented at scientific conferences.

The dissertation meets the requirements set by Lomonosov Moscow State University for works of this kind. The content of the dissertation corresponds to specialty 1.5.15 – Ecology, as well as to the criteria defined in paragraphs 2.1–2.5 of the Regulations on the awarding of academic degrees at Lomonosov Moscow State University. The dissertation has been prepared in accordance with the requirements of the Regulations of the Dissertation Council of Lomonosov Moscow State University.

Thus, the candidate, Su Jiahui, deserves to be awarded the degree of Candidate of Biological Sciences in specialty 1.5.15 – Ecology.

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