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REVIEW

by Assoc. Prof. Dr. Kremena Blagovestova Stefanov, IO-BAS, Varna

of dissertation work on Monica Atanasova Subeva on topic: " Zooplankton as a bioindicator of ecological status of standing water bodies " presented for acquisition on educational and scientific doctor degree in professional direction 4.3. Biologically sciences , scientific specialty : 06.01.11 Hydrobiology

Supervisors: Assoc . Prof. Dr. Vessela Evtimova
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The present review is prepared in execution on Order No. 31 /1 1 .0 4 .2025 of the Director of IBER-BAS on the basis of Art. 4, para. 2 and Art. 9, para. 1 of the Law on the Development of the Academic Staff in the Republic of Bulgaria (LDASRB), Art. 2, para. 2, and Art. 30, para. 3 of the Regulations for the Implementation of the LAADRB (RILDASRB) , paragraph 1, item 3 of The additional provisions to the RILDASRB and Art. 6 and Art. 9 of the Regulations on the conditions and procedure for acquiring scientific degrees and for occupying academic positions at the Institute of Biodiversity and Ecosystem Studies at the Bulgarian Academy of Sciences (IBER-BAS), and in connection with the Decision of the Scientific Council of IBER-BAS, Protocol No. 41/04.04.2025, item 3.

Personal data of the PhD

Monika Atanasova Sabeva was born on September 1, 1990 in the town of Ihtiman. She graduated with a bachelor's degree in Biology at Sofia University "St. Kliment Ohridski" in 2013, after which she continued her education in the master's program in Applied Hydrobiology and Aquaculture at the same university. In 2015, she also completed a postgraduate qualification as a biology teacher. Since 2016, she has been a doctoral student at the Institute of Biodiversity and Ecosystem Studies at the Bulgarian Academy of Sciences.

Her professional path is closely related to hydrobiology. Monika has participated in 16 scientific projects related to the monitoring and research of freshwater and marine ecosystems in Bulgaria and the polar regions. She works as an expert in the field of zooplankton, phytoplankton and macrozoobenthos . She has experience in field research, sampling and laboratory analysis of water samples.

1. **General characteristics of the dissertation work**

The dissertation contains 121 pages, of which 99 are main explanatory text including four publications on the topic, 3 tables and 18 figures, as well as 6 pages of appendices. The work is structured in ten chapters, following the established format for scientific research: introduction , literary overview, formulation on objectives and hypothesis, materials and methods, results and discussion, conclusions and contributions. The dissertation work has been prepared in the principle of joint publications and contains all necessary components relevant to this type of presentation.

The topic is relevant, well-grounded, and refers to the improvement of the methods for assessment of the ecological status of standing water bodies within the context of the European legislation and environmental monitoring. The dissertation is written on clear scientific language, with accurate terminology and logical consistency .

The aim of the dissertation is well formulated, and the tasks are logically sequenced lead to achieve the main goal. The working hypothesis is clearly and appropriately defined and successfully proven in the presented work.

The abstract meets the generally accepted requirements, is presented in 35 pages, follows the basic structure of the dissertation and summarizes the key elements of the work. It shows systematicity and originality.

2. **Literary awareness and theoretical preparation of the candidate**

The author demonstrates a thorough knowledge of the contemporary scientific literature in the field of hydrobiology and biodiversity. The literature review is up-to-date and well-structured, including 152 references, of which 39 in Cyrillic and 113 in Latin script.

Particularly impressive is the candidate's ability to analyze and compare different approaches to ecological assessment, including classical biotic and saprobic indices and modern multimetric methodologies. The author does not limit himself to passive citation, but uses the literature to build his own argumentation related to the working hypothesis.

3. **Methodology of the research conducted**

Eigth model reservoirs with varying trophic conditions and geographical location are examened, falling under the jurisdiction of three basin directorates:

- Danube Region (BDDR): Gorni Dabnik, Telish, Sopot, Bebresh,
- West Aegean Region (BDZBR): Pchelina,

- East Aegean Region (BDIBR): Sinyata Reka, Konush, and the Chetiridesette izvora.

The reservoirs were selected to represent different typological categories (HMWB and AWB) and a variety of ecological conditions, which ensures a high representativeness of the results. The dissertation is notable for the large amount of field work condacted by the student. More then 300 samples were collected and analyzed, including: zooplankton (littoral and pelagic), macrozoobenthos, physicochemical parameters, chlorophyll a, nutrients (N, P). The research was conducted across three seasons (spring, summer, autumn) over two years (2016–2017), which allows for seasonal and interannual comparison.

The analytical methods and software used in Monika Sabeva's research (PAST 4.15, PRIMER-e 6, Canoco 4.5) are fully adequate and widely accepted in modern ecological science. The selection and combination of these programs provide a solid statistical basis for processing biological data, allowing for various types of analyses (structural, multivariate, functional), thereby ensuring high scientific value of the results. The methods and software used are not only appropriate, but also representative of good practice in ecological status assessment of aquatic ecosystems.

4. **Significance and conviction of the results, interpretations and conclusions obtained**

The results are presented clearly and systematically, well visualized with tables, graphs and figures. The dissertation presents a detailed analysis of zooplankton communities, their seasonal and spatial dynamics, and their relationship with the physicochemical characteristics of the water bodies.

The interpretations are convincingly supported by literature data and substantiated by reliable statistical tests. Several key thematic areas stand out clearly, on which the candidate demonstrates solid theoretical preparation, such as:

- the role of zooplankton in pelagic food chains and the functional ecology of water bodies,
- assessment of trophic and saprobic status using established methods and the ability to critically select appropriate indicators,
- the indicator potential of zooplankton, a well-founded and theoretically developed section, referring to leading publications (e.g. Caroni & Irvine 2010, Almeida and al . 2020), with clearly distinguished taxonomic and functional approaches,
- comparison of biological quality elements (BQEs) - the analysis demonstrates an understanding of both normative and ecological rationale for using phytoplankton,

macrozoobenthos and fish, and provides well-argued reason for inclusion of zooplankton as an additional BQE.

The conclusions are logically sound and aligned with the working hypothesis. The author consistently and argumentatively proves that the structure of zooplankton communities is closely related to key ecological characteristics of water bodies – such as their trophic state, level of organic pollution (saprobicity) and overall ecological potential. An important emphasis in the conclusions is placed on the clearly outlined seasonal and spatial dynamics in the distribution and abundance of the main zooplankton groups (Rotifera, Cladocera and Copepoda). This shows the candidate's good understanding of the biological cycles and ecosystem specificity of each of the studied reservoirs. Particularly significant is the result that demonstrates a strong positive correlation between the proposed zooplankton index RCC and the classical trophic index TSI, indicating the reliability and applicability of zooplankton as a bioindicator for ecological assessment, including in cases where other BQEs are lacking or of limited applicability.

5. Critical notes on the dissertation

Despite the high scientific and applied level of the dissertation, I would like to make the following remarks, which do not diminish the significance of the work: 1) It would be useful to present in more detail the limnological characteristics of each of the studied reservoirs, especially in terms of water exchange and anthropogenic pressure; 2) Some of the graphic materials are in small font or low contrast and make visual perception difficult; 3) In some cases, the interpretations of the correlation dependencies can be further developed by adding information about cause-and-effect relationships.

6. **Evaluation of scientific contributions**

The contributions in Monika Sabeva's dissertation are clearly formulated, empirically supported, and demonstrate both theoretical rigor and practical relevance. They can be divided into two main categories.

Scientific contributions

The work introduces several original findings that provide new data on the composition and status of zooplankton and macrozoobenthos communities in specific water bodies. For the first time, zooplankton communities in four lowland reservoirs – Gorni Dabnik, Telish, Konush and Sinyata Reka – have been studied and described. This includes both the qualitative composition and

quantitative parameters, which makes the data valuable for future monitoring and comparative studies. Additionally, for the first time, a description of the macrozoobenthos in the reservoirs Cheridesette Izvora and Sinyata Reka has been made – data that has so far been missing in the scientific literature. Based on the analysis of ecological factors, it was established that conductivity and total phosphorus are the most significant variables influencing the composition of zooplankton, while temperature, chlorophyll a and transparency have an indirect effect. Particularly significant is the contribution related to the conduct of a saprobological assessment of standing water bodies, which used indicator species from both zooplankton and macrozoobenthos.

Applied contributions

The applicability of the RCC zooplankton index has been confirmed as a reliable tool for assessing the trophic state of standing water bodies– particularly valuable in the context of the need for new BQCs, complementing the existing regulatory framework. Indicator zooplankton taxa has also been defined that can be linked to specific trophic levels and/or ecological potential, and which serve as a practical tool for assessing HMWBs (Heavily Modified Water Bodies) in the country. This contribution has direct implication for management and monitoring practices, especially in the context of the WFD and Regulation H-4. Furthermore, the newly developed multimetric index BMMI shows higher sensitivity than the classical Biotic Index (BI) for assessing ecological potential based on macrozoobenthos . This is a valuable recommendation for practice and holds the potential to influence future regulatory revisions and adaptations in the ecological monitoring of water bodies in Bulgaria.

The research is distinguished by originality, interdisciplinary approaches and a high degree of applicability.

7. Assessment of the quality of the scientific publications reflecting the dissertation research

The PhD student has published five scientific articles, 4 of which are included in the dissertation. It is important to emphasize that Monika Sabeva is the first author on all of them. The topics of the publications correspond directly to the dissertation work and confirm the consistent development of the research. The quality of the publications is high, and their results have been appropriately integrated into the dissertation text.

8. **Motivated answer on the question how much the research by the dissertation are mainly personally case on doctoral student**;

The submitted dissertation clearly demonstrates the candidate's independent work, coherent structure, well-justified methodology, original results and logical derived conclusions. The PhD student demonstrates independence in science thinking and mastery on methodological tools. Undoubtedly the scientific supervisors have their leading role, but the core research, analyses and interpretation are case on the author herself.

9. Reasoned conclusion

The dissertation by Monica Subeva possesses high **scientific, applied and ecological importance**, reflecting the scope, depth and contribution of the research. This emphasizes not only the analytical strength, but also the applied value of the work, making it higly relevant and useful in the context of national and European water management policies. Based on the analysis, I believe that the dissertation work of Monika Atanasova Sabeva fully meets the requirements for awarding the educational and scientific degree of "Doctor". The proposed scientific contributions are significant, the results are original, and the methodology is scientifically well-founded. The dissertation represents a complete academic work that complies on all requirements on the law for development on academic staff in the Republic of Bulgaria, as well as the specific requirements of the Regulations for the implementation of application of the LDASRB of IBER-BAS. It contains both scientific and applied contributions and serves as a reliable basis for future fundamental and practice-oriented research.

Therefore, I would like strongly recommend that the members on the esteemed Scientific Jury award Monika Atanasova Sabeva the scientific and educational degree "Doctor in the field of higher education 4. Natural sciences, mathematics and informatics', scientific field 4.3. Biologically sciences, doctoral program " Hydrobiology ".

30.06.2025

Reviewer:
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