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OPINION

by Prof. Dr. Diana Zlatanova, Faculty of Biology, Sofia University “St. Kliment Ohridski”,

regarding the dissertation for obtaining the educational and scientific degree "Doctor" entitled: "**Hibernation patterns of cave-dwelling bat species in Bulgaria in the context of global climate change**"

by **Niya Lyubenova Toshkova**, full-time doctoral student at IBER, in the scientific specialty "Ecology and ecosystem conservation" with scientific advisor Prof. Dr. Vasil Popov.

General overview: This opinion has been prepared pursuant to Order No. 29/04.04.2025 of the Director of IBER - BAS, in connection with the procedure for defence of a dissertation for obtaining the educational and scientific degree “Doctor” in professional field 4.3. Biological Sciences, scientific specialty: 02.22.01 “Ecology and ecosystem conservation”.

Documents presented for the public defense:

The PhD candidate has submitted all required documents in electronic format in accordance with the “Regulations on the terms and procedures for acquiring scientific degrees and for holding academic positions at IBER-BAS”, and the “Requirements for dissertations for obtaining the degree of 'Doctor'” as applied at IBER–BAS, namely:

- Three published articles – two in the Biodiversity Data Journal (Q2 ranking and impact factor, each contributing 20 points) and one in Historia Naturalis Bulgarica (Q4). In all three, the PhD candidate is the first author. The dissertation also includes a draft, a preprint, and a methodology – all high-quality manuscripts. Additionally, five more published articles are included in the defence documentation, with the candidate being first author in two of them. Despite exceeding the required publication threshold (50 points versus the required 30), I consider that the review paper 'Bat responses to climate change: a systematic review' (https://doi.org/10.1111/brv.12893) is also relevant to the dissertation topic, further proving that Niya Toshkova is an established young scientist;
- Documents certifying participation in international and national scientific forums (three oral presentations and two posters), as well as information about six scientific exchanges;
- Certificates and other documents proving the accumulation of 296 credits, exceeding the minimum required 250;
- Administrative documents (CV, diplomas, etc.) required by the regulations for acquiring scientific degrees and academic positions at IBER-BAS;

The submitted documents and publications meet and even exceed the necessary criteria for obtaining the educational and scientific degree 'Doctor'.

General impression of the dissertation:

The hibernation of sensitive species such as bats is an important subject of fundamental scientific research. In this context, the present dissertation constitutes a timely, thorough, interdisciplinary, and methodologically precise study that clarifies key aspects of the hibernation of cave-dwelling bats in Bulgaria in the context of global climate change. Several key points stand out: 1) The study focuses on the effects of climate change on winter activity, physiology, and health status of bats—one of the most vulnerable and understudied groups of mammals, not only in Bulgaria but also globally. In this sense, the work fills an important gap in knowledge about the Balkan region, and especially Bulgaria. 2) The dissertation combines ecology, physiology, anatomical pathology, molecular biology, and bioinformatics, leading to a multidimensional assessment of bat hibernation, including acoustic monitoring, analyses of feeding activity and dietary spectrum (including metagenomic methods), health biomarkers (oxidative stress, body mass, wing damage), and methodological innovations for monitoring in relation to temperature fluctuations. 3) A substantial amount of field and laboratory data was collected from six caves across Bulgaria, with over 700 individuals studied, more than 11,000 sound recordings, and hundreds of samples for molecular analysis. This gives the dissertation high evidential value and credibility. 4) Beyond scientific findings, the work has direct applications in conservation practices—proposing a methodology for national monitoring to assess the impact of climate change on bats, identifying key risk factors, and documenting pathogenic parasites. The proposed methods, such as assessing wing membrane damage, are particularly useful for evaluating population health. 5) Most parts of the dissertation are published in high-ranking peer-reviewed journals, with data available through platforms like Figshare and ChiroVox, reflecting a high standard of scientific ethics and transparency.

The dissertation is presented in a format and volume consistent with the requirements for doctoral dissertations at IBER–BAS. It consists of text supported by **three attached publications**, one methodological preprint, one unpublished manuscript, and one practical-methodological study. The work concludes with a summary of results, main conclusions, future research directions, and contributions. The dissertation is 148 pages in total. The submitted documents include an resume in Bulgarian and a short summary in English. In my opinion, the references should not be included in the body of the abstract.

Assessment of the significance and credibility of the results, interpretations, and conclusions, and the nature of scientific contributions:

- *Degree of familiarity with the topic:* The candidate demonstrates excellent knowledge of the subject through her publications. However, the body of the dissertation lacks a true literature review, making part of Chapter III's title misleading. A brief but

critical review highlighting well-studied topics and research gaps would help readers better appreciate the contribution of the work.

- *Objectives, tasks, hypotheses, and research methods – alignment of the chosen methodology with the aims of the dissertation:* The objectives and tasks are clearly and correctly defined, supported by working hypotheses (for which both the candidate and supervisor deserve commendation), and the methods are appropriate for answering the questions set. Analytical methods are well-chosen, clearly explained, and the collected data is sufficient for drawing conclusions.

- *Discussion of results and literature used:* The results are clearly presented and well-supported by relevant literature in the associated publications. The discussion is logical and coherent.

- *Conclusions and future research directions:* The dissertation outlines 19 conclusions summarizing the obtained results. Conclusion 17 could be shortened, as it contains excessive details. The chapter on limitations and future research directions is particularly valuable, offering a critical view of challenges in bat studies in Bulgaria.

- *Scientific contributions:* Eight contributions are identified (though not specified as fundamental or applied) along with four applied contributions. Contribution 3 lacks clarification on whether it is original or confirmatory. I accept all contributions, some of which are of great importance for the advancement of bat research in Bulgaria.

- *Evaluation of the candidate's personal contribution*: I have known Niya since her undergraduate studies, when she was my thesis student at the Faculty of Biology, Sofia University. She has always been diligent, hardworking, curious, and open to new ideas—qualities that form a strong foundation for a promising researcher. I believe the analyses presented are original and not derived from other work. The fact that the candidate is the first author of almost all submitted publications and manuscripts confirms her original personal contribution to the topic.

- *Assessment of the quality of scientific output and citations:* The results are of fundamental importance and have already led to the first citation of a work included in this dissertation. Furthermore, Niya has many other citations (according to Scopus – 23 publications, over 150 citations, and an h-index 5), indicating that she is already an established researcher.

Comments on the dissertation:

Although most of my remarks from the pre-defence review were addressed, some minor technical issues remain. For example, on page 131, second paragraph, parts of the text repeat the 'Materials and Methods' section of a publication, which should not be reiterated in the 'Summary of Results'. Additionally, mentions like trap relocation are introduced without clear relevance to the results. Similar issues appear in the following paragraphs.

Motivated conclusion:

The comments and technical notes above do not diminish the value of this dissertation. The clearly defined goals and hypotheses, interdisciplinary methods, and significant findings and conclusions with both fundamental and applied relevance form a dissertation fully compliant with the Law on the Development of Academic Staff in the Republic of Bulgaria and its implementing regulations. Based on the above, I evaluate the work positively and recommend that Niya Lyubenova Toshkova be awarded the educational and scientific degree "Doctor" in the scientific specialty "Ecology and ecosystem conservation".

Date: 11.06.2025 Prepared by:……

Sofia Prof. Diana Zlatanova