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REVIEW

by

Assoc. Prof. Tihomir Stefanov,

National Museum of Natural History – BAS

for a PhD thesis by Kristina Rashkova Panova – PhD student in the Institute of Biodiversity and Ecosystem Research – BAS, entitled: „Passive acoustic monitoring of birds in beech forests influenced by various degrees of human activity" for awarding the educational and scientific degree "Doctor" in the professional field "4.3. Biological Sciences", scientific specialty "Ecology and Ecosystem Protection"

This review examines the dissertation work of Kristina Rashkova Panova, submitted for the defense of the scientific and educational degree "doctor" in the nomenclature specialty "Ecology and Ecosystem Conservation" (code 02.22.01). The work was developed independently in the Department of "Animal Diversity and Resources" of the Institute of Biodiversity and Ecosystem Research at the Bulgarian Academy of Sciences under the scientific supervision of Assoc. Prof. Dr. Boris Nikolov (IBER-BAS). The candidate's documents have been prepared, deposited and checked according to the adopted requirements of the Scientific Council of IBEI-BAS. This review also follows the recommendations of this council.

General characteristics of the PhD thesis – volume and structure

The structure, format and volume of the dissertation work correspond to the generally accepted requirements for such works. It contains a total of 52 standard pages and is designed as bound publications. The work includes an introduction (3 pages), aim and objectives (2 pages), materials and methods (5 pages), results and discussion, presented in two published articles (30 pages), conclusion (6 pages) and a list of cited literature (6 pages), containing a total of 56 references, all in Latin.

The topic of the dissertation work is interesting and formulated correctly. Scientific and applied results have been achieved, which have been published in two scientific articles. The sustained, concise language and style used by the author in shaping the body of the thesis make an extremely good impression.

The purpose of the dissertation is clearly formulated, and the tasks for its implementation are well defined. Kristina has set herself an ambitious goal in the field of ornithology, related to the use of acoustic indices to characterize ornithofauna in different types of beech forests, which shows her very good theoretical preparation on the topic and her aspiration for scientific development. The research is entirely the personal work of the PhD student and was conducted on the territory of Belasitsa Mountain. The selected scientific methods are adequate and allow for the collection, processing, synthesis and analysis of the data necessary to derive appropriate results.

The results themselves, as well as the discussion, are presented in depth within two separate scientific articles. The conclusion summarizes the main conclusions and contributions of the study, emphasizing its applied aspect.

Literary awareness and theoretical preparation of the candidate

The candidate demonstrates excellent literary awareness. Many of the cited references are used analytically, in support of some or rejection of other statements. Kristina Panova demonstrates excellent theoretical preparation. She handles scientific literature and terminology freely and correctly and is well informed in the issues of the issues under consideration and the methodological approaches in studying the vocal activity of birds.

Methodology

The methodological part is very well described by the candidate and suitable for the performance of the specified tasks. The use of automatic sound recording devices for collecting acoustic data and their analysis with the help of software for generating sonograms and editing sound allows the identification of most vocalizing bird species in the studied area, as well as establishing the frequency of vocal activity. This is very well conducted by the PhD student, and at this stage of the work the role of the scientific supervisor and the scientific consultant is also clearly visible. The very well-done work in terms of the analysis and interpretation of the collected data demonstrates the exceptional continuity between the supervisors and the doctoral student.

The use of the four selected acoustic indices (Acoustic Complexity Index, Acoustic Diversity Index, Acoustic Evenness Index and Bioacoustic Index) for passive acoustic monitoring is innovative and has a number of advantages over traditional methods – it reduces disturbance from human presence, increases the temporal and spatial scope (multiple locations can be studied simultaneously for long periods of time), significantly reduces the subjectivity of observations, and provides continuous recordings that can be listened to repeatedly by different experts.

The study was conducted in three types of beech forests on the territory of Belasitsa (unaffected old, managed old and managed young), which allows tracking the impact of different forestry practices on the local avifauna. This allows the author to analyze silvicultural activities in order to reduce the anthropogenic impact on birds in the area.

Significance and persuasiveness of the obtained results, interpretations and conclusions

The results obtained, based on the large set of analyzed data from the study, are completely convincing. All data and their statistical processing have been correctly used to formulate the relevant conclusions by the author.

The information obtained is of great importance, both for modern knowledge of the Bulgarian avifauna and its conservation, and for the development of ecoacoustics and the application of passive acoustic monitoring in the country. It is also important in terms of improving forestry practices and sustainable forest management in Bulgaria, demonstrating the importance of old forests for biodiversity. This emphasizes the practical application of the results obtained and their interdisciplinary scientific and conservation value.

The reliability of the results obtained and the conclusions drawn is also evidenced by the fact that they have been summarized in two scientific articles published in peer reviewed journals with an impact factor.

Critical notes on the PhD thesis

Despite the overall excellent impression that the dissertation leaves, I have the following critical remarks about it, which are not ranked in order of importance:

1. It is not clear on what principle and according to what criteria the Semicollared flycatcher (*Ficedula semitorquata*) was chosen as a model species in the PhD thesis and the object of special focus and attention. It is a rare species for Bulgaria, attached to old forests, but in

the study area there are other similar species such as the White-backed woodpecker (*Dendrocopos leucotos*), for example.

2. The study is limited to only one geographical area (Belasitsa), where all 12 experimental sites are located. Adding at least one more area to the study (the beech forests in Strandzha, for example) will increase the representativeness of the results and will allow for more complete testing of the acoustic indices. This will also allow for more detailed ecological analyses, adding altitude as an additional factor in the studies.
3. The methodology using passive acoustic monitoring has not been control tested and compared with some of the standard monitoring methodologies in similar habitats, part of the National Biodiversity Monitoring System (Methodology for monitoring of breeding bird species; Methodology for monitoring of common bird species). This would allow the comparison and calibration of this innovative method with the already established and widely used methods for monitoring the status of individual bird species and collecting information for reporting under Art. 12 of the Bird Directive. As a recommendation to the PhD student, I would suggest that this can be carried out in future studies in different regions of the country.
4. Despite the great practical application of the obtained results in terms of improving forestry practices and sustainable forest management, the dissertation does not provide specific recommendations aimed at the forestry community in the country.

Scientific contributions of the PhD thesis

The contributions are divided by the author into "scientific" and "scientific-applied". I accept the contributions formulated in this way and consider them to be well-founded.

In the thesis, four acoustic indices have been validated for the first time as indicators of the species richness of bird fauna in beech forests, which is a significant contribution to the development of ecoacoustics as a research method in the country.

The conclusions drawn are important in terms of sustainable forest management and improvement of forestry practices.

The results obtained for the beech forests in Belasitsa using this method allow comparison with similar forest ecosystems in other parts of Europe, which is the basis for future similar studies in other parts of the country.

An important conclusion is the demonstration of the significance and reliability of passive acoustic monitoring as an effective tool for long-term monitoring of birds in remote places.

Assessment of the quality of scientific papers reflecting the dissertation research

Kristina Panova presents two scientific articles on the topic of her PhD thesis. Both are written in English and have been published in scientific publications, referenced in Scopus and Web of Sciences. One article was published in the journal of the Spanish Ornithological Society – Ardeola, and the other in the journal of IBER-BAS – Acta Zoologica Bulgarica. Both publications are co-authored with two other co-authors. Both works present results of research on the dissertation topic and are prepared at the required high level.

The dissertation study as the personal work of the PhD student

The results and conclusions of the study are contained in the attached articles, as well as in the main text of the dissertation. The dissertation work is entirely done by Kristina Panova in terms of conception, development and execution. The high level of its execution is clearly contributed by both the scientific supervisor Assoc. Prof. Boris Nikolov and the scientific consultant Prof. Tsvetan Zlatanov, who are co-authors in the two published articles part of the PhD thesis.

Conclusion

The thesis represents a well-planned and excellently executed independent research of the author. This places Kristina Panova as an established ornithologist with a great future in terms of implementing new methods for studying birds in the country. The presented work is an excellent finale to the entire training process during the doctoral studies and demonstrates the excellent preparation of the doctoral student and the role of the scientific supervisors.

In her report on the credits received in the course of her studies as a PhD student, K. Panova has collected 226 points. According to the requirements of the Bulgarian Academy of Sciences, a minimum of 200 points is set, i.e. the doctoral student exceeds this minimum.

Based on the above, I confirm that Kristina Panova's work fully complies with the academic legislation and I recommend that the esteemed Scientific Council of IBER - BAS award the scientific and educational degree "doctor" (scientific specialty "02.22.01 - "Ecology and protection of ecosystems"), which according to the results shown, she fully deserves.

25.03.2025

Sofia

Reviewer:

(Assoc. Prof. Dr. Tihomir Stefanov)