

## REVIEW

by **Dr. Tsenka Georgieva Tchasovnikarova**

Associate Professor at the Institute of Biodiversity and Ecosystem Research, BAS

of a PhD thesis for awarding the educational and scientific degree "Doctor"

Field of higher education: **4. Natural sciences, mathematics, and informatics,**

Professional area: **4.3. Biological Sciences,** Science Major: **Ecology and Ecosystem**

**Conservation - Behavioural Ecology**

Author: **Katerina Toneva Zareva-Simeonova**

Topic: **Influence of human and environment on the behavior of selected mammal species in captivity- application in zoos and conservation**

Scientific supervisor: **Prof. Daniela Simeonovska-Nikolova, PhD** Sofia University "St. Kliment Ohridski"

Scientific consultant: **Assist. Prof. Venislava Spasova, PhD,** Sofia University "St. Kliment Ohridski"

### **1. General description of the presented materials**

By Order No. RD-38-140 of 12. 03. 2024 of the Rector of Sofia University "St. Kliment Ohridski"

I have been appointed as a member of the scientific jury for providing the procedure for the defense of the PhD thesis entitled "Influence of human and environment on the behavior of selected mammal species in captivity - application in zoos and conservation", in the field of higher

education **4. Natural Sciences, Mathematics, and Informatics**, professional area **4.3. Biological Sciences**, Science Major Ecology and Environmental Protection - Behavioral Ecology. The author of the PhD thesis is Katerina Toneva Zareva-Simeonova, a part-time PhD student at the Department of Ecology and Environmental Protection of Sofia University "St. Kl. Ohridski".

The set of materials submitted by Katerina Zareva is under the Academic Staff Development Act in the Republic of Bulgaria and the Regulations for its implementation, as well as the Rules and Regulations for Scientific Degrees at Sofia University. The candidate has attached a list containing two scientific publications, as follows: one in a journal with quartile Q<sub>4</sub> and impact factor 0.5 - *Acta zoologica bulgarica* and one in a journal with quartile Q<sub>1</sub> with impact factor 2.3 - *Applied Animal Behaviour Science*. Based on the presented publications, the candidate fulfills the national requirements according to the Academic Staff Development Act in the Republic of Bulgaria and the Rules and Regulations for Scientific Degrees at Sofia University at Sofia University "St. Kliment Ohridski."

## **2. Brief biographical data of the PhD student**

Katerina Zareva graduated from the University of National and World Economy in 2000 and New Bulgarian University in 2006 with a Master of Ecology, specialty "Ecology and Ecotoxicology". She defended his master's thesis on "Study of the ornithofauna of the Osogovo Mountain" with scientific supervisor Prof. D. Nankinov. In 2019, she was enrolled as a part-time PhD student at the Department of Ecology and Environmental Protection at Sofia University. Katerina Zareva's overall professional activity is related to active work in nature conservation, conservation biology, and environmental education. Her career development is closely connected with the Sofia Zoo. She has been working at the Zoo since 1998 and is the head of the Ecological Science and

Education Center. Katerina Zareva shows remarkable organizational skills in managing and organizing the zoo's educational activities. The PhD student actively participates in 11 scientific research projects on large carnivores and small mammals: two international projects (Live+ and Wikimedia Foundation, USA), one by the National Science Foundation fund, three by the PhD Students and Thematic Research Projects Support Programme of Sofia University "St. Kliment Ohridski" fund, two from the Natura 2000 ecological network and two are funded by the Ministry of Environment. Katerina Zareva has participated in 15 international and three national conferences, mainly related to the European Association of Zoos. She participated in several environmental conferences and Kliment's Days of Sofia University. Apart from the publications related to her thesis, K. Zareva is the author of 3 other publications in international journals. The overall professional, scientific research and educational activity of the PhD student is dedicated to the study of ecology, behavior, and conservation biology of large carnivores in the wild and in captive conditions and reflects her formation as an accomplished specialist in these areas.

### **3. Topic relevance and appropriateness of goals and tasks**

K. Zareva's doctoral thesis is a contemporary study of the behavior of two species of mammals kept in captivity for the purposes of zookeeping and conservation biology. The study of animal behavior is an essential component of zoo research, as it is fundamental to the application of an evidence-based approach to animal husbandry and population management in the wild. It is of the utmost importance to determine the care of animals in captivity based on evidence-based decisions, as this is essential for their development and welfare, not just for their survival in zoos. The observation of animal behavior and subsequent interpretation allows for the comparison between the behavior of animals in captivity and in the wild. This contributes to the understanding of their

behavioral needs and preferences, which in turn can be used to increase their reproductive success and welfare. Modifying the environmental conditions to align with behavioral responses enables the expression of a broader range of behavioral displays. The observation of animal behavior provides insight into the characteristics of an enclosure that are important to the animals and that would minimize the impact of stressors in captive conditions. Over time, the scope and type of research conducted in zoos has expanded, yet the study of animal behavior remains a constant focus for methodological development and improvement of housing conditions. The study on the behavior of the two species of conservation concern, the brown bear, and the European ground squirrel, in captive conditions is scarce. Furthermore, the brown bear lacks a comprehensive scientific assessment of its welfare level. In this context, the study area of this thesis is highly pertinent, as it addresses a significant gap in the existing knowledge on the behavioral ecology of these species.

#### **4. Knowledge of the problem**

In the chapter entitled "Literature Review," the PhD student exhibits an impressive knowledge of the scientific literature pertinent to the research problem. The reference list comprises 297 sources of literature, 20 of which are in Cyrillic and 277 in Latin. The known results have been reviewed systematically and logically, and an analytical analysis of the literature sources has been carried out. This provides a solid foundation for interpreting the results obtained in the dissertation. The comprehensiveness and analytical nature of the literature review demonstrate the PhD student's good theoretical background in research problems. They are a prerequisite for the competent interpretation of the results obtained.

## **5. Research methodology**

An integrated approach was used in the study, including different methods of investigation of the behavioral repertoire of brown bears: influence of sound and olfactory stimuli (35 individuals studied), stereotypic behavior of female brown bears with emphasis on the abnormal behavior "non-nutritive suckling" (2 individuals studied), assessment of the level of welfare of brown bears in captivity in Bulgaria (47 individuals studied). The studied samples are of sufficient size and well distributed by sex, ensuring the results' reliability and significance. The individuals of the European ground squirrel (7 individuals) were subjected to the standard behavioral tests "open field" and "exploration of a novel object", the daily and seasonal activity of the ground squirrels in an exposure cage was also studied. All results were processed with appropriate, modern, and well-chosen statistical methods. The use of modern and adequate methods for the set goals and objectives contributes to the objective analysis of the study and sets the standards for similar studies in Bulgarian ethological studies of captive animals. I highly appreciate the methodological basis and research approaches used.

## **6. Characterization and evaluation of the thesis**

The dissertation is structured in 13 sections, in accordance with the traditional requirements for the type and organization of the individual chapters. These include an introduction (2 pages), aims and objectives (1 page), and a literature review (18 pages). The remaining chapters are organized as sub-units with relevant material and methods, results, and discussion: "Influence of sound and odor stimuli on the brown bear behavioral repertoire" (24 pages), "Stereotypic behavior in two captive female brown bears, with emphasis on the abnormal behavior 'non-nutritive suckling'" (10 pages), " Welfare Assessment of brown bears in captivity in Bulgaria" (21 pages), "Husbandry,

behavior and activity of the European Ground Squirrel *Spermophilus citellus* in zoo conditions" - 15 p., "Research Ethics" - 1 p., "Conclusions" - 1 p., "Contributions" - 1 p., "Recommendations" - 2 p., "References" - 22 p., "Appendices" - 25 p. The proportion of the chapters is commensurate with the study's nature, aims, and objectives and is in line with standard practice. The thesis is 176 pages long and includes 19 figures, 16 tables, and 33 photographs, with an additional table and 31 photographs in the Appendix chapter. The dissertation is well written in a scholarly style with attention to detail. I appreciate the manner of layout and technical precision. The enumerated metric characteristics of the thesis, the quantity of research conducted, the quantity of data obtained, and the appropriate methodologies employed for data evaluation and analysis ensure the reliability and robust scientific foundation of the conclusions and contributions drawn.

## **7. Contributions and significance of the thesis for science and practice**

The thesis represents one of the first comprehensive and large-scale studies of the behavioral repertoires of the conservation-important species Brown Bear and European Ground Squirrel in Bulgaria. It makes a significant contribution to both fundamental and applied scientific knowledge. The dissertation is based on a substantial quantity of research work, which ensures the reliability, comprehensiveness, and significance of the results.

### **Basic scientific contributions**

#### ***Original***

- ✓ This study presents a previously unreported form of stereotypic behavior in female brown bears, designated as "non-nutritive suckling". This expands the knowledge base regarding

abnormal behavior in the species. The causes of this phenomenon and potential mitigation strategies are elucidated.

- ✓ A preliminary initiative has been initiated regarding ex-situ conservation activities for the European ground squirrel in Bulgaria. The patterns observed in the species' behavioral repertoire under zoo conditions represent a pioneering contribution to the field of behavioral research.

### *Affirmative*

- ✓ The knowledge base regarding brown bear behavior in response to natural sound and odor stimuli in captive conditions has been expanded and enriched. These methods have been demonstrated to reduce the occurrence of stereotypical behaviors.
- ✓ The scientific-applied contributions include the formulation of recommendations and proposals for changes in the regulatory framework for the minimum requirements and conditions for the captive breeding of brown bears in Bulgaria. The recommendations are based on a comprehensive assessment of the welfare of the species in captivity.

### *Scientific and applied contributions*

- ✓ Recommendations have been formulated and proposals for changes in the regulatory framework for the minimum requirements and conditions for keeping the brown bears in zoos in Bulgaria have been prepared based on a comprehensive assessment of the welfare of the species in captivity.
- ✓ A catalog of suitable forms of enrichment for the brown bear habitat, applicable in the current conditions of Bulgarian zoos, has been compiled.

- ✓ The inaugural European ground squirrel exhibit in Bulgaria was established in Sofia Zoo for educational and scientific purposes.

In conclusion, this study represents a significant contribution to animal behavior research. It sets a new standard for studying captive animals, employing cutting-edge methodological approaches. I hope that this study will be continued in the future.

## **8. Assessment of dissertation publications**

In presenting the competition materials, I undertook a review of the research papers submitted by the Ph.D. candidates. Both papers were published in refereed journals, with quartiles Q<sub>1</sub> and Q<sub>4</sub>. This is a compelling demonstration of the caliber of research presented in the dissertation, as evidenced by the quality of the research papers. In both publications, the doctoral student is the first author, which evidences his pivotal role in the conceptualization, organization, and execution of the research. The two co-authors exemplify the collective nature of the work and the doctoral student's ability to work in a team and to draw knowledge and experience from collaboration. I hope that the presented results will resonate broadly among the scientific community due to their significance.

## **9. Personal participation of the doctoral student**

The dissertation represents the personal work of the doctoral candidate. She successfully performs a complex analysis of the developed problem, which she interprets and discusses analytically. Katerina Zareva is a fully developed and prepared researcher at the contemporary level in the fields of conservation biology and ethology. Throughout the development of her dissertation, she has demonstrated exemplary diligence, discipline, consistency, and innovation.

## **10. Abstract**

The abstract presents the developed dissertation's methodological, scientific-theoretical, and scientific-applied achievements. The dissertation was prepared according to the requirements outlined in the Regulations for the Development of the Academic Staff of the Sofia University "St. Kliment Ohridski" and the Law on Academic Staff Development in Bulgaria.

## **11. Critical remarks and recommendations**

- ✓ It would be beneficial to more clearly articulate the relevance of the topic under development in the introduction of the work. The PhD student could have more effectively highlighted the innovative nature of the research, particularly in the context of the description of novel forms of stereotypical behavior in the brown bear. This contributes to the expansion of the concepts surrounding the abnormal behavior of the species.
- ✓ The division of the exposition into separate chapters according to the research method has advantages and disadvantages. The inclusion of a multitude of methods, results, and discussions somewhat compromises the clarity of the text. I think an overall presentation of a chapter on the brown bear would improve comprehension of the results and lead to a more complex description of the species' behavioral repertoire.
- ✓ The presentation of a summary figure of the experimental design of brown bear studies would enhance the assessment of the results in terms of complexity.
- ✓ It is standard practice to begin the presentation of statistical methods by analyzing the presence or absence of a normal distribution of the data, which justifies the statistical methods then used. It is not possible to explain this at the end of the methods used, as it is meaningless.

- ✓ In Figures 1 and 2, the term "behavioral diversity" should be followed by the index on which it is based, or alternatively, an explanation should be provided after the text of the figures. It is generally preferable to utilize box plots (whisker-box plots) in the graphs to provide an insight into the mean/median and range of change of the variables. Table 6 presents the mean, minimum, and maximum values, but lacks the standard deviation, which is an indicator of the nature of the variability of the variables.

I have the following clarifying questions for the PhD student:

- ✓ It would be beneficial to ascertain whether it is possible to assess the conditions for the captive breeding and maintenance of brown bears in zoos in Bulgaria in comparison with European and global standards.
- ✓ It would be beneficial to ascertain whether there are compelling reasons to integrate the brown bear and the European ground squirrel within a single study.
- ✓ It would be beneficial to ascertain whether there are objective criteria by which the so-called "individuality" of brown bears can be determined.

## CONCLUSION

The current thesis is a study carried out at an excellent scientific level, with theoretical and applied achievements in behavioral ecology and conservation biology of captive species in Bulgaria. It has an original scientific contribution and meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Regulations for the Implementation of the law, and the relevant Regulations of the Sofia University "St. Kliment Ohridski". The dissertation work shows that the doctoral student **Katerina Toneva Zareva-Simeonova** possesses theoretical knowledge and professional skills in the scientific field "**Ecology and Ecosystem Conservation**

- **Behavioural Ecology**" by demonstrating qualities and skills for conducting independent scientific research. Due to the above, I give my positive assessment of the conducted research, presented by the above-reviewed dissertation work, abstract, achieved results and contributions, and offer to the honorable scientific jury to **award the educational and scientific degree "doctor"** on **Katerina Toneva Zareva-Simeonova** in the field of higher education:**4. Natural sciences, mathematics, informatics**, professional direction **4.3. Biological Sciences**, PhD program **Ecology and Ecosystem Conservation - Behavioural Ecology**.

23.05. 2024

Reviewer: .....

(Signature)

Assoc. Prof. Dr. Ts. Tchasovnikarova