

## REVIEW

on a dissertation for obtaining the educational and scientific degree "PhD" in the professional field 4.3 Biological Sciences (Ecology and Ecosystem Conservation - Behavioral Ecology)

**Author of the dissertation work:** KATERINA TONEVA ZAREVA-SIMEONOVA, part-time PhD candidate in the Department "Ecology and Protection of the Natural Environment" at the Faculty of Biology of the Sofia University "St. Kliment Ohridski".

Scientific supervisor: Professor Daniela Marinova Nikolova, PhD

Scientific consultant: As. professor Venislava Valeriyeva Spasova, PhD

### DISSERTATION TOPIC:

**"Human and environmental influences on the behaviour of selected mammal species in captive conditions - application to zoo management and conservation"**

**Reviewer:** Professor Diana Peneva Zlatanova, PhD, Faculty of Biology of SU "St. Kliment Ohridski", member of the jury for awarding the educational and scientific degree Doctor according to Order No. RD38-140/12.03.2024 of the Rector of SU.

### General presentation of the procedure and the PhD student

The submitted set of materials on digital media complies with the requirements of the Law on Research and Development and the Regulations for its implementation, as well as the Regulations for the conditions and procedure for the acquisition of scientific degrees and occupation of academic positions at Sofia University "St. Kliment Ohridski" and includes:

1. Dissertation thesis;
2. Abstract of the dissertation thesis in Bulgarian
3. Abstract of the dissertation thesis in English;
4. Declaration of originality and authenticity;
5. Plagiarism check report and annexes;
6. Reference for compliance with the minimum national requirements for awarding PhD with a list of publications attached;
7. Reference of examinations taken and passed during the PhD training;
8. A copy of a university diploma;
9. Reference for scientific contributions;
10. CV;
11. Scientific articles published during the PhD period;

Katerina Toneva Zareva-Simeonova was born on 19 April 1974. In the period 1995-2000, she studied at the University of National and World Economy (UNWE). There, she graduated as a Bachelor of Accounting and Control with a professional qualification Economist with a thesis "Control of import, export and trade in wild fauna species through the implementation of the Washington Convention (CITES) in the Republic of Bulgaria". In 2006 she graduated from

the New Bulgarian University with a Master's degree in Ecology and Ecotoxicology, with a thesis entitled: "Study of the ornithofauna of the Osogovo Mountain". In 2019 she was enrolled as a part-time PhD student at the Department of Ecology and Environmental Protection of the Faculty of Biology / Sofia University " Kliment Ohridski ".

Katerina Zareva-Simeonova started working in 1993, first as a cashier-accountant, and from 1998 until now as an employee of the Sofia Zoo. At the Zoo she works in the Educational sector and has held various positions - zoo worker (1998 - 1999), graphic designer (2000-2008), ecologist (2008-2012) and from February 2013 to the present - head of the Ecological Scientific and Educational Centre of the Zoo. Throughout this period, Katerina has performed a variety of activities ranging from caring for the animals in the Education Centre to participating in and organizing the development and delivery of educational programs for children, working with university students, training staff, preparing information packages, brochures, posters, creating designs for educational programs, preparing educational materials, organizing workshops and events, liaising with NGOs and other organizations, projects and research, consulting and as a speaker at various events.

In the period 2000 - 2010, she was also the scriptwriter of over 100 educational and popular science films for the "Culture and Education" editorial department of the Bulgarian National Television (BNT): for the series "Eye to Eye with Animals" and the "Children's Editorial Department" of BNT - "For Animals with Love", among others. Additionally, she has participated in the development of information films about the NATURA 2000 ecological network in Bulgaria through "Svidas" and the Union for Wild Nature "Balkani".

Since 2003 Katerina Zareva has been involved in several research projects such as wolf research and conservation (project "Research of the fauna on the territory of the Osogovo State Forest Enterprise - impact of the wolf (*Canis lupus*) on game") and bear (projects "Improving the conditions for large carnivore conservation - a transfer of best practices (EXTRA)", "Impact of visitors, Environment and Environmental Enrichment on Brown Bear (*Ursus arctos*) Behaviour in Captivity", "Assessment of Brown Bear (*Ursus arctos*) Welfare in Captivity in Bulgaria", "Integrated Genetic and Ethological Studies for Long-term *In situ* and *Ex situ* Conservation of the Brown Bear *Ursus arctos*"). Additionally, she has been involved in communication projects for the Natura 2000 ecological network, consultancy in the development of action plans for dealing with invasive species, etc. Katerina has also participated in 14 international and 3 national conferences in the field of education and conservation research. She also has two publications published before the beginning of her PhD study.

All of the above contributed to this PhD student's considerable prior experience in collecting and analysing data related to environmental protection, as well as building on her knowledge of ecology and ethology necessary for the development of this dissertation topic.

### **General characteristics of the dissertation - volume and structure.**

The dissertation contains a **total of 176 pages**, including 15 tables, 19 figures, 33 photographs and 3 appendices. I believe that it was appropriate to group the photographs and figures under a common numbering as **scientific figures**. Additionally, the lack of a list of figures and

tables at the beginning of the thesis with a reference to their place in the thesis makes it difficult to keep track of them. Such a list should be given after the table of contents, with the page of the relevant figure and table indicated.

The dissertation is presented **according to an established model** including Acknowledgements (one page), Table of Contents (two pages), Abbreviations used (one page), Introduction (two pages), Aim and Objectives (two pages), Literature Review (17 pages), Exposition in four parts (95 pages), each part containing Materials and Methods, Results and Discussion; Research Ethics (one page), Conclusions (one page), Contributions (one page), Recommendations (two pages), References (21 pages) and 3 Appendices (10 pages). The list of cited literature includes 297 sources, of which 277 are foreign and 20 Bulgarian publications.

**The main body text includes:**

- **Part 1** *Influence of sound and odour stimuli on the behavioural repertoire of the brown bear* (31 pages), including Material and methods (10 pages), Results (16 pages), Discussion (nine pages);
- **Part 2** *Stereotypic behaviour in two captive-bred female brown bears, focusing on the abnormal behaviour of "non-nutritive suckling"* (12 pages), of which Material and Methods (two pages), Results (seven pages) and Discussion (three pages);
- **Part 3** *Assessment of the welfare of captive brown bears in Bulgaria* (32 pages), including Material and methods (eight pages), Results (14 pages), Discussion (10 pages);
- **Part 4** *Rearing, behaviour and activity of the European ground squirrel *Spermophilus citellus* in zoo conditions* (20 pages), of which Material and methods (10 pages), Results (five pages), Discussion (five pages)

Here again, I must point out my recommendation from the approbation, which is not reflected in the final version in the body of the thesis - it is not clear enough where the literature review ends and where the statement of results begins, as there is no introduction to the Results chapter. Further confusion arises from the fact that there is no delineated Materials and Methods chapter for the whole thesis, and each part of the study has its Material and Methods, Results and Discussion chapters in the Results Statement.

**Relevance of the issues**

The dissertation thesis submitted to me for a review addresses an extremely understudied problem not only in our country but also in other countries, namely: how humans and the environment influence the behaviour of two target mammalian species when kept in captivity. Zoos around the world have evolved over the last century from entertainment institutions to ones with important contributions to the study and conservation of threatened species. Unfortunately, efforts to study these species in captivity are still relatively few and focused mainly on solving management problems, such as dealing with conflicts in groups or with increased stereotypic behaviour. The focus is mostly on exotic species, while not enough attention is paid to native species. Therefore, I believe that the PhD student and her research

supervisors have chosen very correctly the target objects - one of which is a species that is very often captive-bred in our country, even under inappropriate conditions (the brown bear). The second species (the European ground squirrel), despite being an attractive species, is not present in the collections of other zoos in the country, except for the Sofia Zoo, although its study in captivity is important for its conservation in the wild. The study of its behaviour for the first time in zoo conditions is done in this thesis, which shows its important and contributory nature.

The results of the present study have important scientific and applied implications, and may also contribute to better captive breeding of these two species, further supporting the importance of this thesis.

### **Characteristics and evaluation of the thesis**

#### *Knowledge of the problem, goals and objectives*

Katerina Zareva-Simeonova shows a very good knowledge of the available published information in Bulgaria and abroad related to the behaviour of the brown bear, the use of different sound and smell stimuli as environmental enrichment in different captive species, as well as the biology and behaviour of the ground squirrel as a species. She is also well-versed in modern methods for studying behaviour in rodents. I believe that the literature review included in the thesis and the sources cited are consistent in topic with the research presented later and the results obtained. Here I have one remark about a typical mistake made by a still insufficiently experienced scientist - the literature review is limited to listing sources and referring to the studies already done, lacking a critical analysis of what has been published. The literature review, in addition to identifying the available sources of information, should point to the gaps in the available knowledge that necessitate the development of this thesis and thus argue for the need for the research conducted. This will allow a fuller appreciation of the contribution of the results obtained.

In the dissertation presented, the formulated aim, although relevant to the research, is not sufficiently summarised, is too long and is wastefully described in 7 lines. Concise presentation of research material is an important quality that every scholar should strive for. In this case, the emphases related to the assessment of stereotyped behaviours, the influence of various stimuli, and the assessment of the level of well-being could have only been stated in the tasks as they answer the question "How?" as a way of reaching the goal. In the objective, it is only appropriate to answer the question "What is being aimed for?" in 2-3 lines, making the connection with the title of the thesis indicating the influence of the person and the environment. That is, it is to establish the influence of man and the environment on the behaviour of two conservation-relevant captive-bred species.

#### *Methodical approach*

The methodological approach is clear and well-chosen, but some details are missing in the data collection. For example, in Part Influence of sound and odour stimuli on the brown bear's behavioural repertoire - *Experiment 1 - Presentation of sound by conspecific*, there is no information on the origin of the sound. It has been found that individual subspecies, even local populations, have "dialects" in sound production and the use of a sound that is not

sufficiently recognizable to the animals can lead to error in interpreting the results. Therefore, the origin of the animal making the sound, even the context in which that sound was recorded, is important from a behavioural perspective. If that sound is from another population or subspecies, then the results and discussion should clearly and honestly state and discuss the possible implications of the results obtained.

The data analysis and statistical treatment of the data are clearly and thoroughly described, for which I congratulate the PhD student and her supervisor and advisor.

#### *Significance and cogency of the results, interpretations and conclusions*

The results obtained in the captive brown bear study are presented, well described and illustrated with photographs, figures and tables - both in the bear and ground squirrel studies. They are properly interpreted and discussed, in the context of other studies in the published literature. However, it should be borne in mind, especially for future studies, that such a small sample size (number of animals) may present a serious skewing of the data, depending on the individuality of the animals studied. A much larger number of individuals studied is needed for completeness in the study, as well as a longer study duration.

An important aspect of this thesis is the assessment of the welfare level of captive brown bears in Bulgaria. Such a study using a scientific approach is being done for the first time in our country and is of exceptional applied value - for example, Table 11 contains a very important analysis of the problems identified and the best practices found in captive bears. Equally important is the discussion on what is an important reference point for improving the management of this species in captivity.

Also clearly presented and interpreted are the results obtained from the captive study of the loon using three approaches, the Open Field and New Object Study tests, and the camera trap observation in an exposition enclosure. Here again, I should point out that the very small sample of individuals studied (n=7) must be considered, but as with bears - there is no discussion on the possible effect of the small sample on the results obtained. However, these are the first results on captive animals and therefore have their value.

#### *Conclusions*

The conclusions are well formulated as a consequence of the well-structured results. Some of the conclusions could have been presented **in a little more detail** by listing the behaviours identified. Additionally, hibernation of a captive ground squirrel was recorded for the first time to my knowledge and the results of this could even be framed as a separate conclusion.

#### **Nature of scientific contributions**

This work is the first dissertation focused entirely on assessing the behaviour of two conservation-dependent captive species, the bear and the ground squirrel. The contributions are original and they are entirely a product of the PhD student's work being in line with the results obtained. But some of them are not well enough formulated - for example Scientific Contributions 1 and 3.

- Contribution 1 "The behavioural response of the brown bear *U. arctos* to natural sound and odour stimuli in captivity builds on the knowledge of the species' behaviour to such

stimuli and their effectiveness in reducing the occurrence of stereotypic behaviour." - there is an ambiguity here: *in this case, it is the recording and analyses of the behavioural response as a result of sound and odour stimuli (i.e. conducting the scientific study) that builds on the knowledge*, not the response itself, which exists but has not been studied before.

- Contribution 3 "The pilot activities carried out for the breeding and study of the behaviour and activity of the European ground squirrel *S. citellus* in zoo conditions mark the beginning of ex situ conservation activities for the species in Bulgaria" - in this case, the scientific contribution *is the conduct of a study on the behaviour and activity of the salamander in zoo conditions, which* is the first time in Bulgaria, but in the text, the emphasis is placed on the beginning of *ex-situ* conservation activities for the species in Bulgaria, which is of applied, not scientific value.

Additionally, as well as for the conclusions, an important fundamental contribution is the study of the hibernation of the ground squirrel in captivity, which is also omitted to be included here.

I fully accept the applied contributions.

### **The scientific works, reflecting the dissertation research**

The dissertation is accompanied by three publications in English on the topic of the dissertation, two of which appear in the dissertation as results, presented in the text. In both publications, the PhD student Katerina Zareva-Simeonova is the first author in co-authorship with a Bulgarian team.

- One of the publications (2022) is in the refereed Bulgarian journal *Acta zoologica bulgarica* (Q4 = 12 pts.) and is a behavioural study of two captive female brown bears, focusing on the abnormal behaviour "non-nutritive suckling" (Part 2 of the results presented in the thesis).
- The second publication (2023) is in the refereed journal *Applied Animal Behaviour Science* (Q1 = 25 items) and examines the influence of sound and odour stimuli on the behavioural repertoire of brown bears (Part 1 of the results presented in this thesis).

Thus, the recommended additional criteria for SB degrees **have been met (a total of 37 pts out of the required 30 pts)**.

The third publication, although it includes one of the target species, does not include research on the topic of this dissertation.

### **Technical notes**

- Fig. 7 is redundant as it carries minimal information that can be presented in the text;
- the term "*diet*" is a directly translated foreign word and should be replaced by the word *nutrition*;
- on pages 120-121 some texts should not be in the Discussion section but in the Results section, as they are themselves the results of the study;

- presence of some spelling and technical errors;
- in some places, there is a use of popular language (e.g. “peg” pose, etc.)
- it is accepted that the recommendations should be presented after the conclusions as they are an immediate result of them. Currently, the Contributions break the text into what should be the Conclusions and Recommendations chapter;

### **Personal participation**

I have known Katerina Zareva-Simeonova since 1998 when she started working as my employee at the Ecological Scientific and Educational Centre of the Sofia Zoo. We had the opportunity to work together for about 15 years and I have watched her grow from a graduate student to an active erudite scientist and teacher at the Zoo's Education Centre. I highly appreciate Katerina's personal involvement in the preparation of this dissertation, as in my observations the data collection, processing and analysis are entirely her own. This is evidenced by her place as first author in the published results, some of which are in a high-ranking journal (Q1).

### **Thesis abstract**

The abstract corresponds to the content of the thesis, reflecting the main points of the study. I can point out two remarks to it:

- 1) it is still too extensive, even though a note was already made at the approbation about its length - it should not be more than 40 pages, and it is currently 58. Some of the large tables - such as Table 7 of the abstract could have been omitted as they are less important;
- 2) the graphs and figures in the abstract should have been presented with the original numbering from the thesis - there is currently a discrepancy in this numbering between the thesis and the abstract - for example, Table 7 in the abstract is Table 10 from the thesis.

### **I have the following questions for the PhD student:**

1. In your opinion, which of the two factors - the human factor (the constant presence of people in the vicinity) or the environment (often small, unfurnished or unstimulated enclosures) are most often the cause of the stereotypic behaviour of captive bears in Bulgaria?
2. What do you think are the most appropriate measures or types of environmental enrichment to address the stereotypical behaviour of bears in captivity?
3. Is it possible that keepers' direct contact with the animals to reduce the stereotypical behaviour of the bears, or do you think a more natural solution should be sought?

### **Conclusion**

Despite the remarks made and the weaknesses pointed out (which are often the result of inexperience), **Katerina Zareva-Simeonova's** dissertation represents an important and contemporary scientific study which contains scientifically applied results with original scientific contributions. The doctoral candidate shows a good command of methods, a good knowledge of the literature and the ability to interpret the results obtained. On this basis, I

believe she has acquired the necessary practical and theoretical knowledge in the professional field of Ecology and Ecosystem Conservation.

Based on this conclusion, **I propose the Honorable Scientific Jury** to award **Katerina Zareva-Simeonova** the educational and scientific degree of “**Doctor**” in the professional field - 4.3. "Biological Sciences", scientific speciality Ecology and Conservation of Ecosystems.

25.5.2024 г.

Reviewer:

(Prof. Diana Zlatanova, PhD)