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### Evaluation

of the doctoral dissertation of Mr. Berika Beridze, M.A., titled Evolutionary history and conservation genetics of *Castanea sativa* Mill. in the South Caucasus (Historia ewolucyjna i genetyka konserwatorska *Castanea sativa* Mill. w Kaukazie Południowym) completed at the Institute of Dendrology, Polish Academy of Sciences, Department of Biogeography and Plant Systematics.

Supervisor - dr hab. Monika Dering; Co-supervisor - dr Katarzyna Sękwicz

#### *Form of work and place of its implementation*

The dissertation submitted to me for assessment is a series of three articles published in journals from the JCR database:

**Beridze, B.**, Sękwicz, K., Walas, Ł., Thomas, P.A., Danelia, I., Kvartskhava, G., Farzaliyev, V., Bruch, A.A. and Dering, M. 2023. Evolutionary history of *Castanea sativa* Mill. in the Caucasus driven by Middle and Late Pleistocene palaeoenvironmental changes. *AoB Plants*, 15: plad059. <https://doi.org/10.1093/aobpla/plad059> IF: 2.9; CiteScore2022: 5.4; MNiE: 100

**Beridze, B.**, Sękwicz, K., Walas, Ł., Thomas, P.A., Danelia, I., Fazaliyev, V., Kvartskhava, G., Sós, J. and Dering, M. 2023. Biodiversity protection against anthropogenic climate change: Conservation prioritization of *Castanea sativa* in the South Caucasus based on genetic and ecological metrics. *Ecology and Evolution*, 13: e10068. <https://doi.org/10.1002/ece3.10068> IF: 2.6; CiteScore2022: 4.6; MNiE: 100

**Beridze, B.**, Sękiewicz, K., Walas, Ł., Danelia, I., Farzaliyev, V., Kvartskhava, G., Szmyt, J. and Dering, M. 2023. Niche modelling suggests low feasibility of assisted gene flow for a Neogene relict tree, *Castanea sativa* Mill. *Dendrobiology*, 90:58-75. <https://doi.org/10.12657/denbio.090.005> IF: 0.9; CiteScore2022: 1.4; MNiE: 100

The PhD student is the first author in all articles, yet in none of them he is a non-corresponding author. The attached statements from the co-authors of the publications clearly indicate that the authors of the research concept in one of the articles were the supervisor and the co-supervisor, whereas in the other two one can assume that it was the Ph.D. student. The study was supported by the National Science Centre project: "*Reconstruction of the evolutionary history of the Caucasian forests: comparative phylogeography of six forest tree species*" (grant no 2017/26/E/NZ8/01049). The presented articles are thematically consistent and present results that fit into the research stream of plant ecology, evolutionary ecology, population genetics and conservation genetics.

In addition to the attached articles, the doctoral student prepared a description of his achievements and a summary in Polish. This description has been prepared very meticulously and is supplemented with photographs and diagrams. One of them, marked as Fig. 5, deserves singling out. It shows in a simple, yet very accurate way the methodological approaches used in the studies. Congratulations on the graphic and synthetic thinking skills. I also wanted to congratulate the doctoral student on a very appropriate choice of a motto: "*The beauty of the universe consists not only of unity in variety, but also of variety in unity.*" (Umberto Eco, *The Name of the Rose*). This proves that the science doctoral student also has a capability of combining science with art and an ability to philosophically reflect on biodiversity.

#### *Problem and aim of research*

The doctoral student undertook the task of explaining the evolutionary history of one of the relic tree species that constitute the biodiversity of the Caucasus. One might wonder, why this task is important. The Caucasus is one of 36 places on Earth that can be described as the so-called diversity hot spot. This is where many endemic species can be found. Not all species are taxonomically identified, their biology is not known and, as a result, their function in the ecosystems of the Caucasus is also not known. Currently, in the Anthropocene, our activity is destroying and reducing biodiversity. More and more species are becoming extinct, which causes disruption and/or disregulation of the connections between remaining species in ecosystems. As a result, NATURE's network of symbiotic interactions does not function efficiently. Symbiotic interactions are defined today as the source (mechanism, cause) of evolutionary innovations (solutions) in organisms that led to the development of species'

diversity in the biosphere. Therefore, their interruption often leads to disasters. Hence each species and its evolutionary history is important. By examining the evolutionary history of a species, one can provide facts that are valuable in preparing an effective strategy for its protection. The primary goal of the PhD student's research, conducted in the team of the Supervisor dr hab. Monika Dering, was to investigate the evolutionary history of one of the Caucasus tree species - *Castanea sativa* Mill. and its genetic diversity.

### *Tested hypotheses*

The doctoral student tested as many as seven hypotheses (presented below). I think it would be possible to combine and limit them to three, as some of them are repetitive. What deserves a special mention is the presentation of the assumptions on which the hypotheses are based.

1. The divergence time between the Caucasian and European populations of *Castanea sativa* was initiated by Pleistocene glaciations.
2. Populations of *Castanea sativa* from the West Caucasus have higher levels of genetic diversity than populations from the East Caucasus.
3. The population structure of *Castanea sativa* in the Caucasus reflects survival in isolated glacial refugia in the Caucasus.
4. Genetic diversity and differentiation in *Castanea sativa* in the Caucasus are driven by the heterogenic landscape and climatic present in the region.
5. The natural range of *Castanea sativa* in the Caucasus will be reduced due to climate change leading to loss of genetic diversity.
6. The highest conservation priority is given to the populations from the West Caucasus.
7. There is a climatic compatibility between the Caucasian and European populations of *Castanea sativa* for Assisted Gene Flow conservation management.

### *Results*

The author's most important results include:

1. Reconstructions of the evolutionary history of the species and providing an explanation of how it influenced the current genetic structure of Caucasian and European populations.
2. Identification of ecological and historical factors that influence the genetic structure of the chestnut population in the Caucasus.

3. Prediction of the future distribution of the species in the Caucasus, in response to ongoing climate changes.
4. Preparation of an *in-situ* and *ex-situ* conservation strategy for *Castanea sativa* in the Caucasus using niche modeling methods, genetic structure parameters and conservation genetics tools.

This achievement was made possible thanks to (1) a large number of samples of material collected for research from the natural range of *Castanea sativa* in the Caucasus and the European population, as well as (2) the use of various tools in the field of evolutionary ecology, population and conservation genetics, biogeography, niche modeling and computational analyses based on bayesian methods. **At this point**, I pose a question for the PhD student: what data regarding the biology of *Castanea sativa* (and probably each species) could/should be taken into account to make the prediction models of the species' distribution more precise?

**To sum up**, the work of Mr. Berika Beridze, M.A., contains (1) a current scientific problem, the solution of which is important for the protection of biological diversity, not only in the Caucasus, (2) provides new facts about the evolutionary history of a relic tree species - *Castanea sativa* and (3) presents a modern strategy for the *in-situ* and *ex-situ* protection of *Castanea sativa* in the Caucasus. I believe that **the PhD student has fully mastered the research skills** necessary to solve problems in the field of sciences and natural sciences, in the discipline of biological sciences, and is methodologically prepared to solve interdisciplinary research tasks.

I certify that the reviewed doctoral dissertation by Berika Beridze, M.A., meets the conditions specified in Art. 187 of the Act of July 20, 2018, Law on Higher Education and Science (consolidated text: Journal of Laws of 2023, item 742, as amended). I apply to the Scientific Council of the Institute of Dendrology of the Polish Academy of Sciences for admission to M.A. Berika Beridze to the next stages of the procedure for awarding him a doctoral degree.

(*prof. dr hab. Marlena Lembicz*)