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Review

PhD Thesis of **Berika Beridze** entitled:

“Evolutionary history and conservation genetics of *Castanea sativa* Mill. in the South Caucasus”

The sweet chestnut (*Castanea sativa*), member of the beech family (Fagaceae), which is the focus of this doctoral dissertation, is scientifically one of the most interesting tree species in Europe and neighboring areas. Even though this tree species plays a relatively important economic role locally in some regions (especially in the Mediterranean), its main importance for botany, biogeography and forest science lies in the fact that it is a relict species. The relict character of the tree also explains the sensitivity of this species to man-made global changes, deforestation, habitat destruction and, last but not least, recent climatic changes. In addition, its disjunct distribution, so typical of relict trees, provides an exciting opportunity for numerous research directions and modern methods that have been used extensively in this dissertation.

The choice of the study area is also very suitable for the scientific questions of this PhD thesis. The Caucasus, and even more so the South Caucasus (also called Transcaucasia) with Colchis, is undoubtedly a strong point of this study. The Caucasus ecoregion is not only one of the biodiversity hotspots on our planet, but also one of the most important refugia for relict trees. This is particularly important for Europe, which has a very impoverished dendroflora after the last ice ages. Therefore, exploring and understanding the historical biogeography of *Castanea sativa* in Southern Caucasus is of great importance for assessing the impact of human activities on forest trees and ultimately for effective conservation efforts for the most valuable trees of European forests.

For these reasons, I was very much looking forward to reviewing this work, but also had correspondingly high expectations. My expectations, as I can already say at the very beginning, were not disappointed. The doctoral thesis consists of 3 high-quality publications that have already been published in renowned peer-reviewed journals. The first one published in *Annals of Botany Plants* deals with evolutionary history of *Castanea sativa* in the South Caucasus region, based on genetics, niche modelling as well as on palaeobotanical records. The second paper was published in *Ecology and Evolution* and adds the conservation component by defining the prioritization in South Caucasus based on genetics and ecology of the priority taxon. And finally, the third contribution, published in *Dendrobiology*, enlarges the perspective on the whole natural distribution area, from the Iberian Peninsula to the South Caucasus. The main aim of this work was to investigate the possibility of using niche modelling to guide *Castanea sativa* management, especially within the *assisted gene flow* (AGF) approach.

These three publications (as well as the entire doctoral thesis) were conceived, carried out and published under the direction of the renowned researcher in this field, Dr hab. Monika Dering. In addition, MSc Beridze was able to benefit from the collaboration with other well-known researchers in the field of genetics and modelling of woody plants, who appear as co-authors on the publications. On the one hand we find well-known researchers from Poland, Great Britain, or Germany, on the other hand researchers from Transcaucasia (Georgia and Azerbaijan). For this reason, these 3 publications, the most important part in the PhD thesis of MSc Beridze, are very well conceived, well written, with faultless methodology, very professional layout of the graphics, etc. They were peer-reviewed, and I will therefore not evaluate these 3 publications in detail, but mainly discuss the first synthetic/introductory part of the present PhD dissertation.

Not to be forgotten are other publications in which Berika Beridze has contributed as a co-author (4 peer-reviewed papers, listed at the end of the introduction section). These include papers published in renowned journals such as *Scientific Reports* or *Regional Environmental Change*. These papers also deal with genetics and modelling of tree species (e.g., *Abies cilicica* or *Cupressus atlantica*). This shows that MSc Beridze's expertise goes beyond his PhD work. At the same time however, it shows that the candidate does not get lost with many topics, but deepens his expertise in the field of rare, endangered and relict woody species.

MSc Beridze also did not shy away from demonstrating his knowledge in popular science articles. In my opinion, it shows even more clearly the candidate's interest in the sweet chestnut, in the South Caucasus as a biodiversity hotspot and in the importance of trees in general.

Now, going back to the synthetic introductory part of the thesis. This separately written section enhances the quality of the PhD thesis and is a valuable addition to the three published papers presented at the end of the printed version. It consists of almost 50 pages. It includes a summary, the introduction about the Caucasus and the sweet chestnut, presents the aims of the thesis and hypotheses, the methodological pipeline, and particularly valuable and well elaborated outcomes of the whole work. This introduction and synthesis section ends with a conclusion of the whole PhD thesis and with an impressive bibliography of 130 references. Although generally very well-written, I would like below to add some remarks chapter by chapter.

The introductory part starts with a Summary, which is in my opinion too general. It is very superficial and only provides very general information. Normally, such a summary should be structured more like an abstract of a publication. After a brief introduction of the problem, the most important methods, concrete results and at the end concrete conclusions should be presented. However, this summary only gives a superficial idea of what was investigated... but not what was found. Some sentences say for example: "...The ecological and historical drivers of population genetic structure have been identified...". The reader of this summary unfortunately does not learn which drivers were actually identified.

The Introduction section starting at the page 14 is well-written. Here just some very minor and very technical points that would need improvement. In some places the multiple references are not given in an alphabetical (nor chronological) order. This could be improved and unified across the whole manuscript. Also at the end, in the References section, there are several references which are not in an alphabetical order (e.g., Manafzadeh et al.; Sekiewicz et al.). Another detail: in the legend of the Figure 2, the author talks about a church from IV BC. Is this 6th century BC? If yes than we should not use the term church but rather temple, I suppose. More generally, the centuries in English should not be written using roman letters (also on the page 22, 18th century). Additionally, some figures are composed of several photos, so the author should write at the end

“Photos:”. In the Figure 3, the author is writing about a “tree mutilated by local inhabitants”. I am not sure if the word *mutilation* is appropriate here. Most likely it is a tree that was used for wood or fodder for animals and is not a result of an act of vandalism. Use of branches and cutting in various forms is very common in the Caucasus.

The chapter on Caucasian ecoregion is very well-structured and written. In contrary, in the chapter on *Castanea sativa* I am missing several specifications. For example, there is no global view on distribution of this species. A reader will discover this later in the publications (also in the figure 4 which is not cited at the beginning), but it could be described in more detail here when introducing the species. Also briefly explain where the other refugia are in the Mediterranean, etc.

The phylogenetic position of *Castanea sativa* is even less described. To which family does it belong? how many species are there in the genus? which species are phylogenetically closely related to *C. sativa*? Etc. This is only presented in a very brief and partial way on page 21. *A propos* the cited literature has wrong year (Lang et al. 2007 and not 2006).

Two next chapters are the most important and valuable parts of the introductory part of the PhD-thesis. All research hypotheses (seven) are correctly formulated in the chapter Research Objectives, and MSc Beridze delivers convincing confirmations (or partial confirmation or rejections) of them in the next chapter Major Outcomes.

I actually only have one important remark/complaint about the concept and methodology of the entire PhD thesis. The whole thesis (but especially the paper 1 and 2) is based namely almost exclusively on ca. 20 populations collected nearly exclusively in Georgia (see for example Fig. 1, Fig. 7, with only very few exceptions, either in Macedonia or in Azerbaijan). The main point/criticism is therefore, that the Hyrcanian refugium is not represented at all. Even if there are only 4 known populations in Iran/Hyrcania, this could influence the final conclusions. The strong genetic differentiation of the Azeri population EGC4 might be already a signal, that other isolated and unstudied populations from Armenia, Azerbaijan, but especially from Iran, might change the outcome and interpretation of the analyses. The strong differentiation between western and eastern part of the Transcaucasian taxa was observed in several relict trees of this region with similar disjunct distribution (e.g., *Zelkova carpinifolia*, *Pterocarya fraxinifolia*, etc.). MSc Beridze is not hiding this problem, he is explicitly explaining it for example on the page 32. BUT

there are several text fragments (both in Research Objectives and in the Major Outcomes), that could be misleading to an inattentive reader, since the author is often presenting the results as if they applied to the entire Caucasus ecoregion. And that is not quite true, since Hyrcanian refugium was not sampled. Of course, I know how time-consuming and complex field work and the collection of plant material is. Nevertheless, this geographically limited sampling is strongly influencing the final conclusions and the author should mention it more clearly and frequently.

In summary, and despite the rather small areas for improvement, I think this PhD thesis is excellent. Thus, I conclude that the reviewed doctoral dissertation of Berika Beridze, M.Sc., meets the conditions specified in Article 187 of the Act of July 20, 2018 Law on Higher Education and Science (i.e., Journal of Laws of 2023, item 742, as amended), and I request the Scientific Council of the Institute of Dendrology of the Polish Academy of Sciences to admit M.Sc. Berika Beridze to further stages of the proceedings for the conferment of the doctoral degree

(Polish version of the last text fragment: Stwierdzam, że recenzowana rozprawa doktorska mgr. Beriki Beridze spełnia warunki określone w art. 187 ustawy z dnia 20 lipca 2018 r. Prawo o szkolnictwie wyższym i nauce (t.j. Dz. U. z 2023 r. poz. 742 z późn. zm.) i wnioskuję do Rady Naukowej Instytutu Dendrologii Polskiej Akademii Nauk o dopuszczeniu mgr. Beriki Beridze do dalszych etapów postępowania w sprawie nadania stopnia doktora).



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