

Utilization of the Borová Hora Arboretum in the education process and scientific research

IVAN LUKÁČIK¹, IVANA SARVAŠOVÁ¹ & JANA LUPTÁKOVÁ²

¹Borová Hora Arboretum of the Technical University in Zvolen, Borovianska cesta 66, 960 53 Zvolen, Slovak Republic; lukacik@tuzvo.sk, sarvasova@tuzvo.sk

²The Institute of Foreign Languages of the Technical University in Zvolen, T. G. Masaryka 24, 960 53 Zvolen, Slovak Republic; jana.luptakova@tuzvo.sk

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Abstract: The Borová Hora Arboretum is a research and educational workplace of the Technical University in Zvolen. Its collections are utilized for education, pedagogical work, and scientific research concerning especially the field of dendrology, but also other biological disciplines. In contrast to similar facilities, there are collected native autochthonous tree species growing in Slovak forests, in their wide intraspecific and geographical variability.

Teaching forestry dendrology and dendrology generally in the arboretum is aimed at the obtaining of theoretical and practical knowledge necessary for successful breeding and growing indigenous and introduced tree species significant for forest management and with respect to morphological traits, biological properties, and forest communities which they form. Special attention is paid to the intraspecific and geographic variability of species, to the importance of this research and the utilization of ecotypes.

Keywords: arboretum, education process, autochthonous dendroflora

Introduction

Arboreta and botanical gardens belong to significant dendrological facilities providing a wide range of possibilities for practical teaching students within the

main biological disciplines. Qualified teaching of specialized subjects at universities and secondary vocational schools orientated towards natural sciences (biology, forestry, and ecology) cannot do without knowledge of a wide variety of indigenous (autochthonous) and introduced (allochthonous) tree species.

In Slovakia, there are good opportunities to study the forestry tree species introduction in the Kysihýbel Forestry Arboretum and in the Botanical Garden at the Secondary Forestry School in Banská Štiavnica, horticultural introduction in the Mlyňany Arboretum of the Slovak Academy of Sciences, or in various significant historical parks. The Borová Hora Arboretum (hereafter BHA) has a special position in getting to know a wide variability of the gene pool of the Slovak dendroflora as an illustration of the assortment for creating effective compositions, horticultural and public garden arrangements and design (HRUBÍK 2000).

One of the most important tasks of the BHA is education. Specialized orientation to autochthonous dendroflora with a special focus on the Slovak tree species provides students of the Faculty of Forestry with a wide space to study many biology-based subjects (dendrology, botany, and pedology) and the students of the Faculty of Ecology and Environmental Sciences with possibilities to study the subjects such as Landscape Dendrology, Landscaping, Plant Protection, and Landscape Plants. The students utilize not only the tree species collection, but also the collection of roses and the interior collection of seeds and fruits. The BHA also provides the Faculty of Wood Sciences and Technology with a part of practical teaching the subject of morphology and tree species structure, and at the same time with possibilities to observe processes of wood degradation in the model conditions. The BHA is exploited not only by students of the Technical University in Zvolen, but also by students of other universities, especially the Slovak University of Agriculture in Nitra and Matej Bel University in Banská Bystrica.

Start of the Arboretum, building up and content focus of its collections

The first proposal to establish an arboretum in Zvolen was submitted by Ing. Jozef Pagan, the then Assistant Professor at the Institute of Dendrology and Phytocenology, the Department of Botany and Pedology at the then University of Forestry and Wood Sciences and Technology (hereafter VŠLD) in the year 1958. His proposal was accepted by the academic officials of the Faculty of Forestry at the VŠLD and he was authorised to work out more detailed materials and collect the data such as a specialized focus of the arboretum, its localization, size (area) and operational buildings.

In the course of following years, negotiations at different levels concerning solving issues of property rights, area, specialized focus, and financial means for building up the arboretum were running. The first building works started at the end of 1964 and in a short time, within less than three years, there appeared utility networks, administrative and other buildings (exhibition pavilion, operating log cabin and others), a basic road network, and also all the area (28.38 ha) was

fenced. **30th March 1965**, when the first planting was carried out, is considered as an official beginning of the **Borová Hora Arboretum** (PAGAN et al. 1985).

Later on, the proper area was expanded by the areas not used for agricultural purposes or the forest areas which were seen as suitable and needed from the viewpoint of collection focus and filling in. Thus, the area extended to 45.50 ha in 1970 and in the year 1983, to the current 47.84 ha (LABANC 1995). In the mid-90s, there appeared problems concerning the settlement of property rights relating to land parts in which the BHA is situated. Specifically, not all land was purchased from the original owners at the start of building the arboretum. At the beginning of 2005 and after long negotiations, the owner of all the BHA area became the Technical University in Zvolen (LUKÁČIK 2015).

After 2000, they accomplished repairing and reinforcing approach roads in the arboretum, also carrying out the overhaul of the fence, conducting the development project "Innovation of reproduction greenhouse", and building up the public conveniences for visitors to the arboretum. In the years 2006 – 2007, the development of nursery operation of the University Forestry Enterprise and the irrigation system were completed and consequently, greater reconstruction jobs in the administration building as well as in garages and workshops were carried out. In 2010, the ABH was connected to the node of SANET network by the optical cable and thus the conditions have been essentially changed and greater possibilities of using the Internet for all arboretum staff have been opened.

Specialized and content focus of the collections and the arboretum activity have been the most important tasks since the submission of the first proposal to build the arboretum. However, these were differently changed during preparatory work. It was evident that first of all the arboretum should serve the needs of education of forestry engineering students and the subsequent scientific research should be focused on the needs of forestry practices. In the original proposal it was expected that the arboretum would have two parts. The former one was to be formed by public garden arrangements with an irregular nature-landscape planting tree species. Their arrangements were to lie on a systematic principle and result from demands for environmental conditions of individual tree species respecting also their aesthetic values. The latter, "forestry part" occurring in the adjacent stands managed by the University Forest Enterprise was planned to serve especially for checking up production capacities of introduced tree species which were to be sown into the existing stands in variously large groups.

The opinions concerning specialized and content orientation of the collections were unified in 1964, after Professor Pravdomil Svoboda's coming to the Faculty of Forestry at the VŠLD. He proposed to build up the arboretum on the plant system principle and, in contrast with other arboreta, "to concentrate especially varieties of indigenous dendroflora, namely the material collected with the strict knowledge of origin that will be possible further to be monitored, evaluated and thus to demonstrate its morphological and geographical variability" (Authors' team 1964 ex PAGAN 1995). The proposal was accepted by the university

management and to give this idea its present form, especially Professor Pagan, holding a post of the director of the arboretum in the years 1970 – 1990, has taken a great credit.

Collections of the Borová Hora Arboretum

The collections of the arboretum comprise 3 fundamental groups – a collection of tree species, a collection of roses, and a collection of cacti and succulents. **The collection of tree species** has been built gradually and despite images and often also enormous efforts of founders to plant only the verified material, especially at the beginning a material of various genetic values was used in planting. A great part has been purchased from different gardening organisations and specialized institutions. A substantial part of this material, however, was very valuable as they were of various known origins, e. g. *Picea abies* (L.) Karst and *Pinus sylvestris* L. which have been preserved in the BHA until now and they serve as an illustration for the study of geographical variability. Other significant populations and valuable rare forms of autochthonous tree species have been procured gradually and still they are being obtained by their own or mediated collecting directly in the forests of Slovakia or also in a broader area within their natural dispersal.

The most valuable job of the arboretum lies in the fact that individual populations and precious forms of autochthonous tree species are propagated by seed and vegetatively and consequently they are archived as a rare gene pool. They are not only protected and endangered taxa, but also the populations in extreme and uncommon sites, various peripheral populations, various morphological deviations and mutations which differ a given individual from individuals of a certain genus. Preserving such individuals is significant not only from the viewpoint of studying species variability, conserving their biological diversity, but also a possibility of their applying in the following breeding (LUKÁČIK et al. 2005).

In 1981, as an acknowledgement of the collections' great value, the BHA was declared a protected area "to protect the sample of genetic riches of tree species composition in the Slovak forests, a great individual variability of tree species genera, for research, instructive, and cultural and educational purposes".

A range of morphological deviations obtained from natural localities is varied. Many of them are used in landscaping or in planting in the urban environment. The importance of the collection lies also in preserving peripheral populations of which many have not occurred in the original localities any more, as well as in a possibility of observing the biological manifestations of taxa in the changed environment conditions.

Since 1981, protected and endangered species have been recorded and archived in the collections. The aim of preserving the endangered species of the Slovakia's dendroflora is their translocation to equal or partially treated conditions in the BHA. By their consequent reintroducing in autochthonous communities a higher ecological landscape stability can be reached.

According to the arboretum register toward 1st January 2015, there was a record of 4, 660 taxonomic (registered) units containing 127 genera, 484 species (with no species of genus *Rosa* sp.), 1, 029 forms and cultivars of tree species, and 1, 501 origins (with no clear habitual deviations – geographical variability), altogether 14, 053 individuals of registered tree species.

The collection of roses started to be built simultaneously with the collection of tree species and its base was the collection coming from the Arboretum Peklov and the Botanical garden of Průhonice. The initial intention and main idea was to concentrate and archive especially resistant park roses with the aim of their use in landscape practice. Later on, this proposal was completed by a new important idea – to archive the rose varieties which were bred in the territory of the former Czechoslovak Republic, i. e. in the territory of the Czech Republic, Moravia, and Slovakia, which closely corresponded with the a general conception of building the arboretum. In accordance with possibilities, the collection is completed also nowadays, especially by old rose varieties and botanical roses which are being gradually on the wane both in other collections and in great outdoors, though they are very decorative and usable in public gardening and they are a valuable base for further observing and evaluation. The present collection of roses concentrates more than 800 cultivated rose varieties, including almost 250 varieties from the Czech and Slovak breeders. The highest number is represented by old rose varieties from the Czech breeders such as Jan Böhm, Josef Urban, and the world-renowned rose-breeder Rudolf Geschwind. The collection of roses also includes over 80 varieties of botanical roses, in total there are almost 900 taxonomic units of the genus *Rosa* sp. in the arboretum, i. e. up to 4, 000 bushes altogether.

The collection of cacti and succulents focused mainly on the family of Cactaceae was founded especially as a study collection as well as for purposes of the development of cultural and educational work. With regard to a special orientation of the tree species collection, also the collection of cacti has been created to point to a variability of individual species. At present, the collection is represented by 74 cactus genera with 550 taxa and 47 succulents with 150 taxa. Altogether the collection of the arboretum includes 1, 500 growing individuals of xerophilous flora especially from Mexico, North and South Americas, with the main emphasis on the endangered plants registered in the CITES.

Educational process and scientific research

Apart from solving tasks resulting from the fundamental conception of building up the collection, the activity of the BHA is also focused on creating conditions for utilization of the concentrated gene pool in the pedagogical process and solving research tasks in co-operation with the faculties of the Technical University in Zvolen as well as other universities and research workplaces. The utilization of the BHA for these purposes is constantly increasing similarly as its utilization by the general expert and lay public.

Apart from the students of the Technical University in Zvolen, the BHA is utilized also by the students of other Slovak universities. The collections are

a significant source of additional technical knowledge especially of tree species morphology and ecology also for students of secondary schools and pupils of primary schools.

Pedagogical influence of the arboretum is intensified also through students' seminar assignments and diploma theses. So far the arboretum material has been a base for working out 2 doctoral theses, 64 master's and 23 bachelor's theses, and others have been in the process of elaborating. Their topics were focused not only on observing and evaluating tree species variability, but also on ornitofauna, mykoflora, torrent control, vegetation modifications, and others. The pedagogical process is closely connected with scientific research, most of doctoral, master's theses or seminar assignments are connected with research tasks. These in the BHA are focused especially on study of variability of rare tree species of the autochthonous dendroflora.

In 2002, the arboretum was granted the first independent project in the scientific grant agency VEGA. This project with the title *Preserving and research into the gene pool of autochthonous tree species of Slovakia in the Borová Hora Arboretum at the Technical University in Zvolen* was solved in the years 2003 – 2005. It was followed by another VEGA project named *Research into the gene pool of autochthonous tree species of Slovakia from the viewpoint of its preserving and following utilization* solved in the years 2006 – 2008.

To get more complex knowledge of tree species and forest ecosystems in general as well as of gene pool of tree species in the BHA and its utilization in the education process at different levels, the KEGA project with the name of *Modernization of the information system, education process and activities in the Borová Hora Arboretum* was solved in the arboretum in the years 2012 – 2013. Within this project, a nature trail with the information panels documenting a mission and activities of the arboretum and orientation of its gene pool collections has been built up.

The present and perspectives

As it was mentioned above, with its focus the BHA has a specific position among arboreta and botanical gardens not only in Slovakia, but also abroad. The orientation towards preserving and conserving autochthonous dendroflora of Slovakia is really original, unique and each time more pressing also at present. Therefore, the main present trends as well as future activity of the arboretum follow this conception.

Within the educational work, approximately 8, 000 "studentclasses", i. e. an institute's share in the total faculty's pedagogical performances (an hour measurement of a subject multiplied by a number of students enrolled for the subject and a coefficient of study level), of practical teaching per year on average have been recently taught, 2 – 3 bachelor's and master's theses are worked out on average. Moreover, a part of operational practices for students of the first year at the Faculty of Forestry is run here.

Research work is focused especially on observation of growth biology, further development and reproduction of the material having been concentrated until

now and on its detailed assessment, on the analysis of growth processes, and the development of selected tree species in relation to supposed climatic changes and air-pollution load, on assessment and classification of morphological differences among autochthonous tree species with a possibility of use for their taxonomic assessment. The arboretum collections and facilities are utilized also by other staff of the Technical University in Zvolen in solving 9 – 10 research tasks or scientific projects.

In the years 2015 – 2016, the BHA staff are solving the KEGA project *“Utilization of autochthonous ecosystems at reconstruction of the tree species collections for their application in progressive educational activities in the Borová Hora Arboretum”* focused on reconstruction of the tree species collection and completing the information network in less visited parts of the arboretum presenting illustrative examples of natural tree species communities and connected flora.

Besides, the BHA participate in solving the international project of the Vysegrad Fund V4 programme and other two VEGA projects.

Other activities are directed to the expected trends relating to the public interest. Carrying out of various educational and popularizing programmes for the general public with a special respect to youth and children categories are trendy, their accomplishments are real. The arboretum staff provide more than 50 specialized excursions a year for home as well as foreign visitors.

It is, however, necessary to see a resulting effect in a wider context. In the future, it will be inevitable to find ways and possibilities of financing such buildings and facilities which cannot be sufficiently financially saturated for development programmes though they have a multi-source model of financing, including subsidy and grant means, institution’s own income, or various single sponsorships. Fundraising is necessary to be oriented also to the existing sources within the different EU programmes at more levels – regional, national, and multinational. Starting trends in operating the botanical gardens and arboreta are directed to their wider functional utilisation, and therefore their mission and relevance should be judged at the given levels.

Conclusion

With the focus of its collections the Borová Hora Arboretum at the Technical University in Zvolen considerably contributes to conservation and preserving autochthonous dendroflora in its extensive intraspecific and geographical changeability. By its location in the vicinity of the town of Zvolen, it gives an attractive area to carry out activities of natural sciences-oriented pedagogy as a part of environmental education for the general public and residents of the town. The thematic approach of the BHA and a way of solving the outside predestine it to present information in the form of experiential activities directly in the area of the facility and for all target groups of visitors. Main activities of the arboretum are specialized excursions with a tour guide service and educational work with pupils and students of vocational schools.

The rightness of the mentioned activities is confirmed by the fact that attendance in the arboretum is on the increase (Fig. 1). In 2014, the collections of the BHA were attended by over 8,500 visitors, including 6,400 students of universities and secondary schools, pupils of primary schools, and children at preschool age, which represents a double increase in attendance as compared with the year 2005.

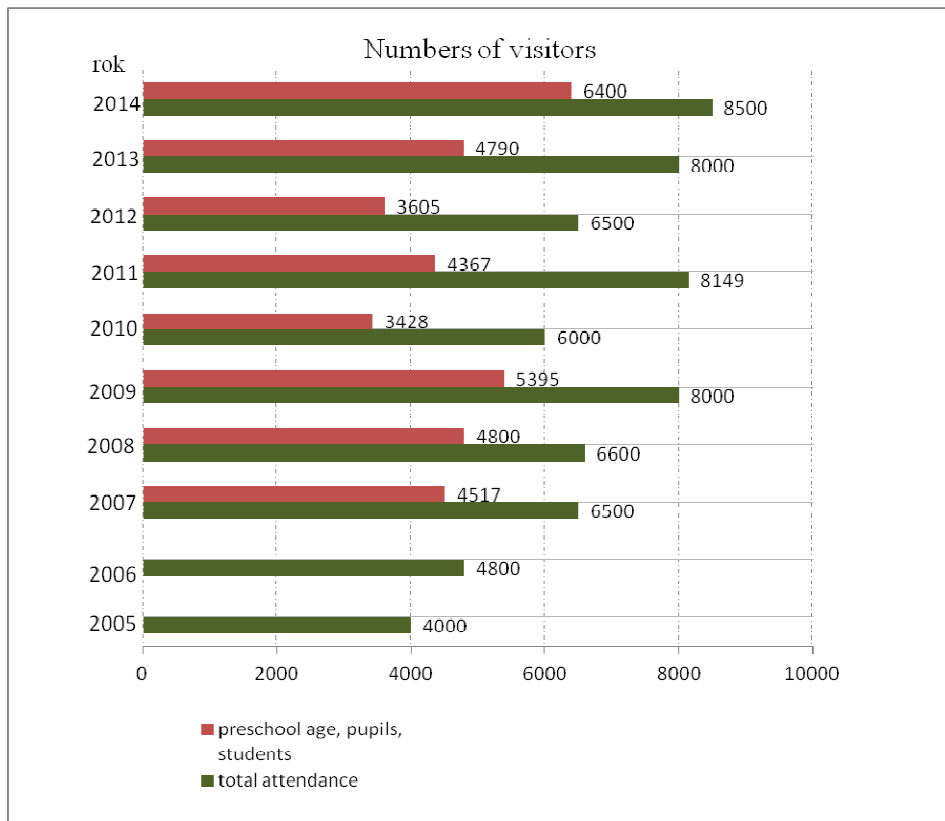


Fig. 1. Attendance figures in the Borová Hora Arboretum in the period of 2005 – 2014

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