Digitization of the flora of Kazakhstan

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Abstract. This study focuses on the possibilities of digitalization of plant herbariums in Kazakhstani Universities. In this paper, theoretical and practical aspects of herbarium collections digitalization according to the international standards and how this can be achieved are explained with visuals and steps of the process. First, the valid taxonomic approaches to herbarium layout should be determined jointly with the international and Kazakh herbarium experts and put forward by a common decision. In line with these decisions, the taxonomic categories of plant specimens, the repair of herbarium cardboards and changing its taxonomic histories and current valid names should also be introduced into the system. The features of some important virtual herbariums in Asia and Europe on the web have been examined and appropriate additional features have been developed. In addition to the features in other virtual herbariums, the feasibility of measuring digital images on the web page has been demonstrated with fidelity. It was also proven that a certain area of small organs of plants can be magnified by up to 60 times (by increasing dpi) with the scanner.

1 Introduction

It is an indisputable fact that plants are essential for life, as they constitute a fundamental part of life on Earth and provide breathable oxygen, habitat, food, fuel, medicine and many other benefits for living things. It is necessary to understand the importance of plants in order to increase agricultural productivity and sustainability. To discover new pharmaceuticals, to reduce the negative effects of climate change, in short, to better understand life as a whole. It is for these reasons that since the first years of life, scientists have tried to observe and recognize plants. Taking notes on plants, drawing pictures of them and tending to identify them. These flora studies, which have survived and continued since then, are important in terms of creating valuable resource for biology, medicine, agriculture, cosmetology, food and many other branches of science. In this context, researchers continue to collect plant specimens and archive them in herbariums [1, 2].

Plant samples collected from the field for floristic studies are dried for preservation. Being stored in special systems of cabinets or storage containers in specific buildings and departments collected in the light of necessary scientific knowledge, dried according to certain rules, systematically stored, cataloged and arranged, they are unified under the general name “herbarium”. Herbariums also contain plant specimens preserved in different solutions. In

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short, herbariums are places where plant collections are stored for long-term scientific studies. Herbariums are not only places where plant samples are stored, but also places where botanical studies are carried out [3-5].

A collection like this is a vital reference when we need to identify a plant, as it provides us with information on location of plants, chemicals they contain, flowering status, seed structure and lots more. In herbariums specimens are usually organized systematically by family, genus, species, and subspecific categories and listed according to alphabetical or phylogenetic classification [7-16]. In addition, samples of related taxa are found close to each other, making comparisons easier. Therefore, herbariums are of invaluable importance for botanical science [6]. Lucca Ghini (1490-1566) was the first to practice sticking and storing plants in dry samples on cardboard. Ghini's technique was spread throughout Europe by his students. Until the time of Linnaeus, the cardboard on which the plants were glued was bound and stored vertically on shelves. Linnaeus initiated the method of storing cardboard on which plants were glued, one by one and horizontally [4].

Current study aims to draw attention to the importance of the procedures that need to be carried out before digitizing Kazakhstani herbariums, which have a rich plant collection and are currently dried up due to their long storage. The intention of these valuable collections is to assist everyone, especially botanists, in the fields of biodiversity, ethnobotany, and conservation, systematic and sustainable development.

2 Materials and Methods

In our study we used cardboards containing plant specimens collected and named according to the scientific rules in the herbariums of Kazakhstani flora. For digitalization of herbarium collection, we have developed the Mattarama apparatus and a powerful (high dpi) scanner. After the display system of the plants used in the herbarium is determined, as the 1st step, plant taxon samples should be examined. Plant sample carton will be placed one by one in the herbarium cabinets according to their taxonomic order. As a 2nd step, the scientific names of the taxa will be written in the rows of the first column of the labels on the herbarium specimens using Excel. Common features of all taxa required for digital herbarium will be written in the first lines of other columns. The label information of each taxon must be written next to the line where the scientific name of each taxon is written. During the 3rd step, the materials on the plant cartons will be repaired if necessary. During the 4th step, digital QR codes will be pasted on the original objective and image on the plant samples in the herbarium. During the 5th step, plants will be scanned from the Mattarama device and digital (TIFF, BMP, PNG or JPG) format file images will be transferred to computer. During the 6th step, the images of the plant samples transferred to the computer and their label information will be transferred to the web page (server) with the help of the system prepared by the computer software developers. As the 7th step, all this prepared data should be placed in a digital system software that will work online. Habitat pictures of plant samples, photographs, scanner images, unique label information of each plant sample constitute database information. Considering the number of cartons of plant specimens in herbariums in Kazakhstan, it can be estimated how many years it will take to complete.

3 Results and Discussion

The aim of the study was to digitally transfer the examined and restored herbarium specimens to the digital environment with the help of high-resolution scanners (Fig. 1-4).

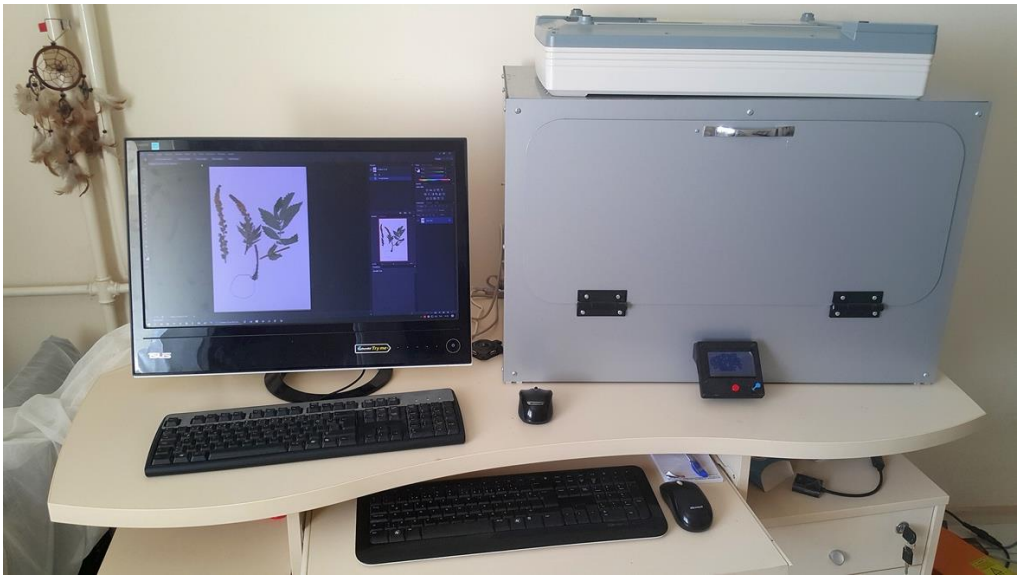

Fig. 1. Mattarama automatic apparatus and the scanner that can scan with high dpi values [17].

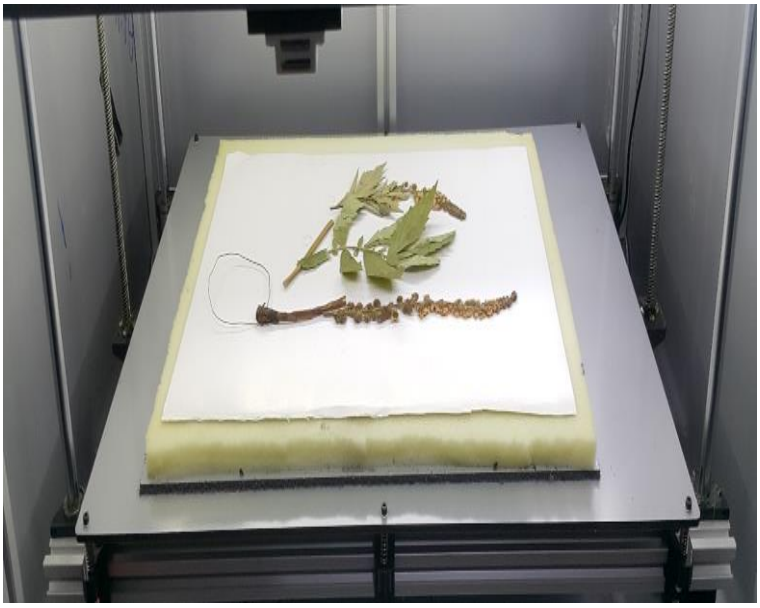

Fig. 2. Mattarama with automatic apparatus and plant sample tray [18].

Fig. 3. 60 times magnified view of flower organs of *Agrimonia eupatoria* L. species [19].

Fig. 4. View of the hairs on the pedicel of *Agrimonia eupatoria* L. species, x60.

All these samples will be made available to the entire scientific world dealing with plant systematics on Kazakhstani website, without expecting any material or moral compensation (Fig. 5).

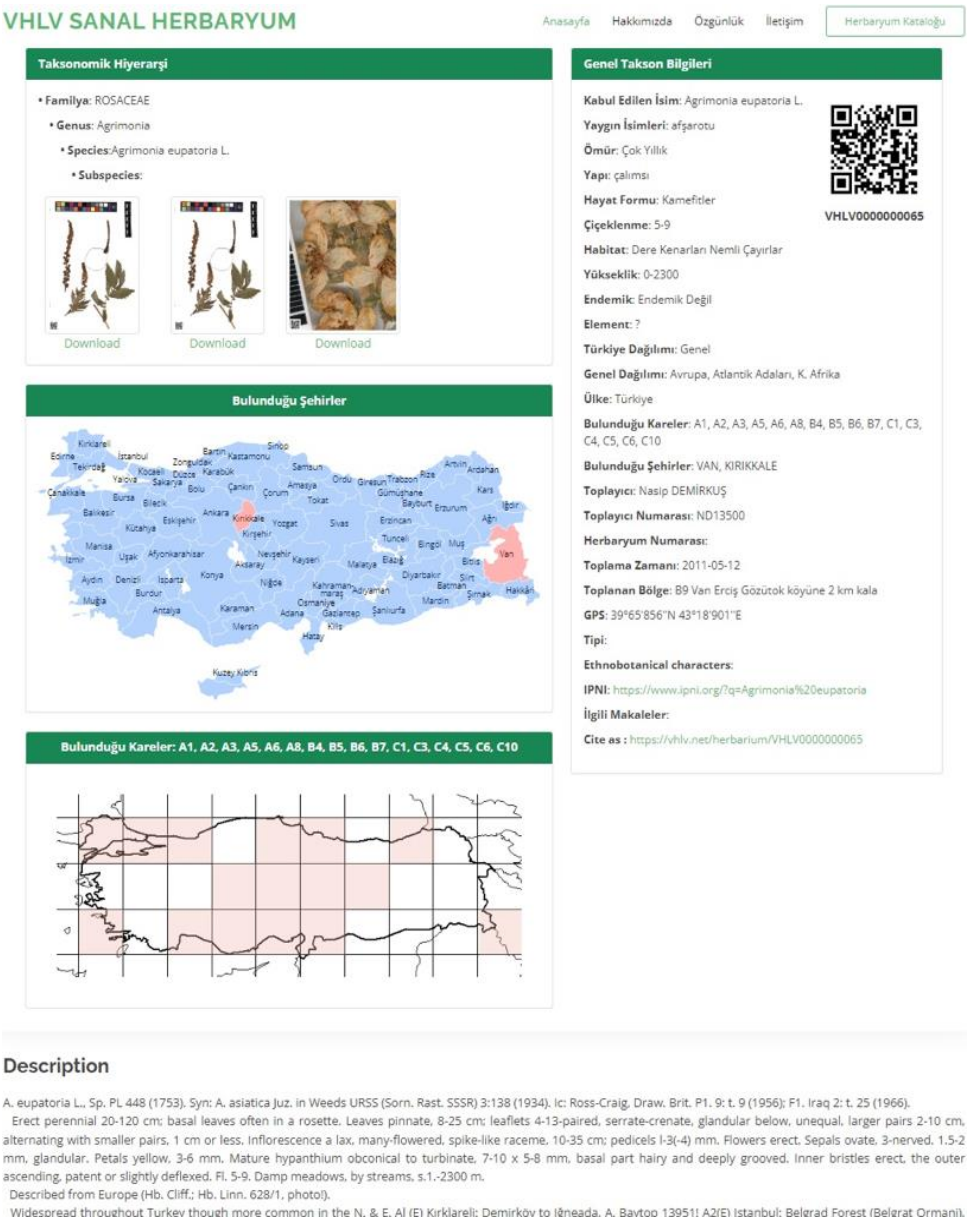

Fig. 5. Description of *Agrimonia eupatoria* L. species and image of label information [17].

It is very important that the description and label information of plants (species) are transferred to the digital environment perfectly, clearly and completely and can be changed when necessary.

4 Conclusion

During the study, The Kew Herbarium Catalogue/KEW [7], Royal Botanic Garden Edinburgh Herbarium Catalogue [8], Moscow Digital Herbarium /MV [9], The Linnaean Herbarium [10], Turkish Plants Data Service /TUBIVES [11], the content and features of digital herbariums such as the Virtual Herbarium of Lake Van Basin/VHLV/[12] and the Virtual Herbarium of

Berolinense/Bo [13] were carefully examined. As a result, we did not encounter digital measurements and up to 60 times magnified view of flower organs any virtual herbariums in the world. In the light of this information, digital measurements and magnified views of flower organs offered on the Internet on the digital herbarium web pages prepared because of long efforts. The VANF Herbarium Catalogue/VANF [14] and the Virtual Herbarium of Lake Van Basin /VHLV/under construction [15, 16]. These features are very important. Because in the identification of plants, the qualitative and quantitative characteristics can generally be identified on the Internet without being damaged their object parts. A certain area can be magnified up to 60 times with a scanner (by increasing. dpi) [18]. This means that images of small plant organs suitable for diagnosis magnified with a scanner without using a magnifying glass or microscope. This knowledge has been shared with doctoral students. It is aimed to put this information into practice together with Kazakhstani scientists.

The important advantages of advanced digital herbariums are: A- It partially enables taxon identification on the web, B- It saves on transportation and other costs, C-It prevents the objective plant material in the herbarium from being worn out repeatedly for identification, D-It provides all the information about taxa in an organized manner

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Authors' contribution

Methodology – Murat Ünal and Nasip Demirkuş. Article writing, editing, preparation, examination, research of digital herbarium web pages, invention of Mattarama and enlargement by 60 times with the browser were carried out by Nasip Demirkuş. Ms. Kurmanbayeva Meruert is the one who sent doctoral students from Kazakhstan, directed us to this study, helped us compile our knowledge on this subject, motivated us to write articles and invited us to the conference. Serbest Ziyanak prepared system software, digital measurement and web page [15, 16].

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