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INVESTIGATION OF SOME MICROHABITATS IN BOTANICAL GARDEN "ECOPARK-VARNA" FOR "*EX SITU*" CONSERVATION PRACTICES

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Abstract: The aim of this study was to investigate abiotic conditions in some micro-habitats within the University Botanical Garden for ex situ plant conservation. Analyses aimed to determine whether environmental conditions are optimal for the breeding of the selected plants with conservation status. UBG ''Ecopark" habitats are characterized by certain differences in their abiotic conditions. For the purpose of the study three representative test sites were selected, representing typical habitats. Data on microclimate and soil samples by soil indicators were analyzed in three separate test sites by a stationary and a mobile weather station.

INTRODUCTION

"*Ex situ*" conservation is an important method to protect biodiversity and a part of the measures, included in the Rio de Janeiro Convention on Biological Diversity (UN, 1992). The specificity of the method implies a controllable environment and conditions for the preservation of threatened species, which are part of the genetic, species and ecosystems funds of the countries. This specification of the "*ex situ*" conservation method determined the Botanical gardens as the most appropriate places for such preservation activity (Cheney et al., 2000; Jackson and Sutherland, 2000).

The UBG "Ecopark", Varna is a territory with a wide variety of successful combination of natural and maintained anthropogenic habitats. That variety of

habitats is a condition for the realization of a large number preserving activities as an "*ex situ*" conservation of the threatened species of the local flora of the Black sea coast.

The basis of successful implementation of "*ex situ*" conservation is a complex assessment of abiotic characteristics of microhabitats in UBG "Ecopark" and creating a database of the values of these characteristics. Microhabitats are defined as fragmented small areas differing from others with characteristic abiotic conditions and vegetation.

Fifty two plant species of the Bulgarian flora were successfully bred in the territory of UBG "Ecopark" Varna. Of these, 37 species were grown and preserved ex situ. The ultimate aim of this work is to enrich the ex situ collection of conservation plants in order to protect, to arrange exhibition for the visitors of the garden and to train students.

An important prerequisite for the successful plant introduction are the environmental conditions and specific requirements of different plant types. Until now no studies have been conducted to determine soil conditions, microclimate and the different microhabitats in the territory of UBG "Ecopark" Varna. Data, corresponding to the area of the Varna town were generally used. These data provide some variation of the indicators observed in the territory of UBG "Ecopark".

Diverse habitats exist in the territory of UBG "Ecopark" Varna, such as open grasslands, deciduous and coniferous forests, water and near water. All of them are specific for the corresponding differences in microclimate and soil parameters. This defines the various conditions of the abiotic environment in different microhabitats.

The aim of this study is to determine the characteristic differences of soil and microclimate conditions in previously set test grounds. The results were analyzed to determine the specific conditions of each microhabitat and to identify suitable plant species for *ex situ* conservation through literature search.

Taking into account the different conditions of the terrain and surrounding vegetation study of specific habitats with typical conditions different from others will give us accurate data on microclimate and soil conditions of the area of the garden. The optimal conditions for the enrichment of the *ex situ* collection in the territory of Varna UBG "Ecopark" plants with the conservation status of the flora of Bulgaria will be determined by analyses of the results and references.

MATERIAL AND METHODS

University Botanical Garden "Ecopark", Varna "is situated near to 'St. St. Constantine and Helena' Resort, 8 km north of the city of Varna. The relief of the park is plane with altitude from 29 m to 85 m. The area is 36 ha, which are divided into 19.8 ha /55%/ – woodlands; 14.5 ha /40%/ – grasslands and 1.7 ha /5%/ – water bodies (2 streams and 3 ponds).

According to the climatic regionalization of Bulgaria (Velev, 2002) the territory is part of Continental-Mediterranean climatic region and Varna Black sea climatic province. The climatic impact of the sea is confirmed by the positive mean January temperature /up to 1°C/, comparatively small temperature amplitude and the breeze circulation.

The territory of UBG "Ecopark" Varna is part of the Carpathian-Danubian soil region; The Lower Danube sub region and East Balkan province. The soils in the "Ecopark" are gray forest soils (*Luvisols*) with light to heavy loam-sand structure (Ninov, 2002).

The Botanical garden is part of West coastal sub province of Euxinian province, part of the European Broadleaved forest region, according to geobotanical regionalization (Bondev, 2002). It is observed that the natural vegetation of the UBG "Ecopark" is transitional between *Q. cerris-Q. frainetto* forests and xerothermic grasslands.

The complex abiotic assessment of the climate and soil condition was made for three typical habitats in "Ecopark", Varna. The three sample plots (SP) in grassland, woodland and riverside habitat were chosen so that to be look like natural habitats of certain "*ex situ*" conservation plants (Peev, 2011; BDA, 2007): *Astracantha arnacantha* (M. Bieb.) Podlech subsp. *aitosensis* (Ivanisch.) Réer & Podlech, *Astracantha thracica* (Griseb.) Podl., *Pancratium maritimum* L., *Fritillaria pontica* Wahl. and *Rhododendron ponticum* L. Floristic description was made in the sample plots to determine the specific habitat type according to the classification of EUNIS (Davies et al., 2004). Information of temperature, humidity and luminance in the three sample plots was made.

The first sample plot (SP1) is in a grassland nearby Roman tomb in the University Botanical Garden. The relief is plane with slight slope (1-2°C) and Southeast exposure. The soil is slightly loam-sandy with neutral to slightly basic pH (7-7.1 pH). The predominant plants of the SP1 are species from Poaceae family: *Poa bulbosa* L., *Cynodon dactylon* (L.)Pers., *Dactylis glomerata* L., *Bromus scoparius* L., *Cynosurus echinatus* L. and species *Petroragia prolifera* (L.) R.S.Ball et. Heyw., *Astragalus onobrychis* L., *Trifolium purpureum* Lois., *Trifolium echinatum* M.B. The species composition determines the described habitat as E1.61 Mediterranean subnitrophilous grass communities.

The second sample plot (SP2) is located in rare oak forest (0.4-0.5 coverage) part of habitat G1.7A1 Euro-Siberian steppe (*Quercus*) woods near to the mean entrance of the Botanical Garden. The SP2 is a slope plot with incline from 5 to 10°C and Southeast exposure. The soil is basic (7.2-7.3 pH) with rough loam-sandy structure. Tree and shrubs with greatest abundance are: *Quercus cerris* L., *Q. robur* L., *Acer campestre* L., *Cotinus coggygria* Scop., *Cornus sanguinea* L., and grasses: *Dactylis glomerata* L., *Geum urbanum* L., *Lathyrus niger* (L.)Bernh., *Trifolium campestre* Schreb. and *Crocus flavus* Weston.

The third plot (SP3) is situated on one of the floodplain terraces of Kajnak dere between the wooden bridges in UBG "Ecopark", Varna. The soil is waterlogged, loam-sandy soil with basic reaction (7.3-7.5 pH). The vegetation is riverside type, part of habitat G1.31 Mediterranean riparian *Populus* forests and it is presented by *Populus alba* L., *Salix alba* L., *Salix fragilis* L., *Quercus robur* L., *Ulmus minor* L., *Cornus sanguinea* L., *Viburnum opulus* L., *Calystegia sepium* (L.) R.Br.

Field data for temperature and humidity, strength and speed were reported by the team with one stationary and one mobile weather station. Data is downloaded to each of the sample sites for 10 days. The data collected are daily by sampling in 10 minutes and averaged for the day automatically from the station. Data on precipitation amount are only for one site which is open and accurate. Due to the proximity of points, rainfall are the same for trial sites.

Field studies related to indicators of temperature and soil moisture in two soil layers of 0-10 cm and 10-20 cm and were made in the collection of data from automatic weather stations or 10 days in three consecutive single measurements. The data were recorded in the field diary and averaged monthly for the period.

Soil samples for laboratory analysis were collected in September (09.19.2014) Their analysis is carried out in the Laboratory of Soil Science of the Technical University of Varna by standardized methods. The soil samples were six for each layer representatively sampled received from 3 samplings in the test site. Laboratory analyzes were carried out in three repetitions as the data provided were averaged for the studied indicators.

Physical and physico-chemical indicators like bulk density, mechanical composition, water resistance of the structural units, content of organic matter (humus) soil and chemical reaction were examined by the following methods:

– Determination of bulk density by the method of Kaczynski with standardized soil sample;

– Water resistance of the structural units by the method of Andreanov;

– Determination of the mechanical composition by the method of Rutkowska;

– Determination of the content of organic matter (humus) in the soil by the method of Turin;

– Determination of the reaction of the soil solution (pH) with a calibrated pH meter.

Chemical indicators related to the amount of the main plants for soil nutrients – nitrogen, potassium and fosrfor were examined by the following methods:

– Content of ammonium (NH_4-N) and nitrate nitrogen (NO_3-N) - photometry;

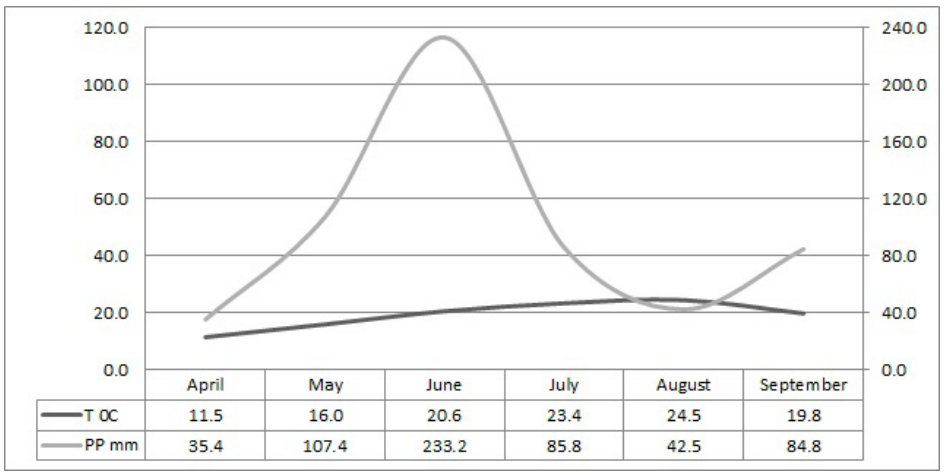
– Content of phosphorus (P) by a double-lactate method Egner-Rheem (ISO 11263);

– Content of potassium (K) by a double-lactate method Egner-Rheem (ISO 11263).

RESULTS AND DISCUSSION

The microclimate studies of the sample plots show similarities in the values of air temperature and precipitation as well as among themselves and with those throughout the UBG "Ecopark" discussed below. The characteristics, which differ in the sample plots are luminance and the wind strength. The grass habitat has highest luminance (5770 lx) and the strongest wind. The second place is for the sample plot in a rare oak forest and the third place is for the most shadow plot near to the stream with luminance 1325 lx, where the wind is insignificant. The air humidity is in the range of about 70-75% as for the SP3 it is with the highest humidity (>85%) for the investigated period.

The analysis of the climate elements – temperature and precipitation were prepared by Walter-Gaussen diagrams. The ombrothermic diagram for the vegetation season of UBG "Ecopark", Varna shows drought period in August, which is correspondent with the period of fruiting and dissemination of *Astracantha* spp. and with the period of senile vegetation of the *Fritillaria pontica* and *Rhodendron ponticum*.



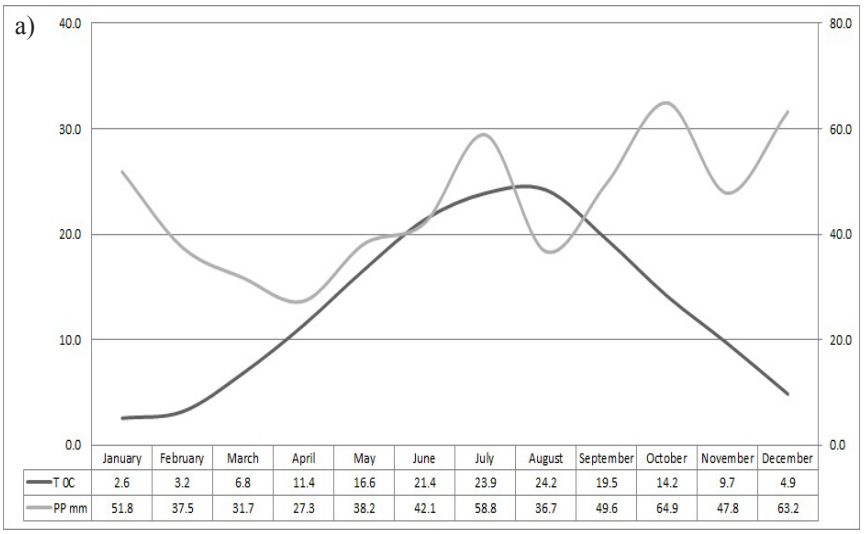
	April	May	June	July	August	September
T 0C	11.5	16.0	20.6	23.4	24.5	19.8
PP mm	35.4	107.4	233.2	85.8	42.5	84.8

Figure 1. Walter-Gaussen diagram for the vegetation period of 2014 year (UBG Varna).

The drought period without rains and with high temperature above 20°C for 2014 year starts from July 26 to August 15 and its duration is 20 days and nights. That is a significant duration since the norm of drought is 10 days and nights without rainfall.

The ombrothermic diagrams for the ten years average climate data for the region of the city of Varna have a similar characteristic curve as this for the territory of the UBG "Ecopark". It is seen that the period of occurrence of various weather phenomena (dry or wet period) are dislocated to each other in the Walter-Gaussen diagrams for the ten year period and vegetation period of 2014 year.

These differences are in the spring drought period, which occurred earlier (April-May) for 2014 and otherwise it is in the second half of May and beginning of June. A further difference is observed at the peak of the rainfalls, which is during June of 2014 and during the end of June and the beginning of the July for the studied ten year period (2004-2013).



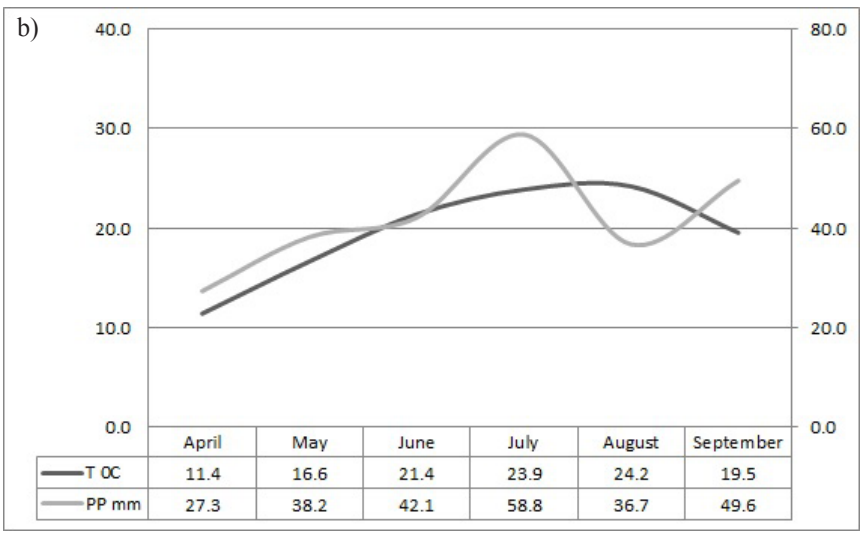


Figure 2. Walter-Gaussen diagrams: a) average data from 10 years period; b) average data for the vegetation period of 10 years period.

The analysis for each year of the ten year period shows differences between the times of occurrence of the weather phenomena. However, 6 from 10 years is characterized with summer drought in August, 2 years have a drought period in July and only one year throughout June. The 2004 year doesn't have summer drought period. The spring drought period is poorly presented through the 2014 year, but in 6 from 10 years, it is in May, for 3 years it is in April and for 1 year in June. 2010 and 2012 like 2014 are years without drought periods because their curves of temperature and precipitation doesn't cross. 2007 year is the driest year, followed by 2008 and 2012. 2014 and 2004 years are the most humid from the investigated years.

The De Martonne Aridity index shows similar results as the ombrothermic diagrams. In 2014 dry months are April (19.8) and August (14.8) with values of the index below 20. June is the most moisture month – 91.4. The De Martonne Aridity index for the 10 year period show that 8 of the 10 years have spring dry periods through April, May or June and in 7 from 10 years have a rough drought through August and September. The summer drought period (August) is with value of the index 5.5 and through April, May and June it is higher among 11-14. The duration of the spring dry periods is 5-15 days on average. The summer dry periods always are above 10 days and often exceed 20-25 days.

According to the collected climate data the winds in UBG "Ecopark", Varna are East through the day and West-Northwest through the nights. The average speed of the wind gusts is 1.5-3.3 m/s, slightly higher than the average speed for Varna region. The average monthly total solar radiation for the vegetation period in the territory of UBG "Ecopark" Varna is 15.08 ccal/cm^2 and for July it is 19.50 ccal/cm^2. This high solar radiation is accompanied by a large number of clear (without clouds) days because of breeze circulation, which is characteristic for the region (near to the sea).

The research of the soil in the three sample plots showed that the soils within the UBG "Ecopark" are slightly basic with loam-sandy structure and high degree of tightness. The course of soil moisture during the months of the vegetation period of plants shows similarity to the course of precipitation. This relationship is most clearly presented in the course of soil moisture of the soil layer of 0-10 cm of grass habitat and weakest in riparian forest communities where soil humidity is constantly high (about 17%). Due to the nature of the clay soil the investigated soil layer (10-20 cm) is characterized by low humidity against to the layer 0-10 cm. However, the soil humidity rarely falls below 5%, which limit wilting of most plants.

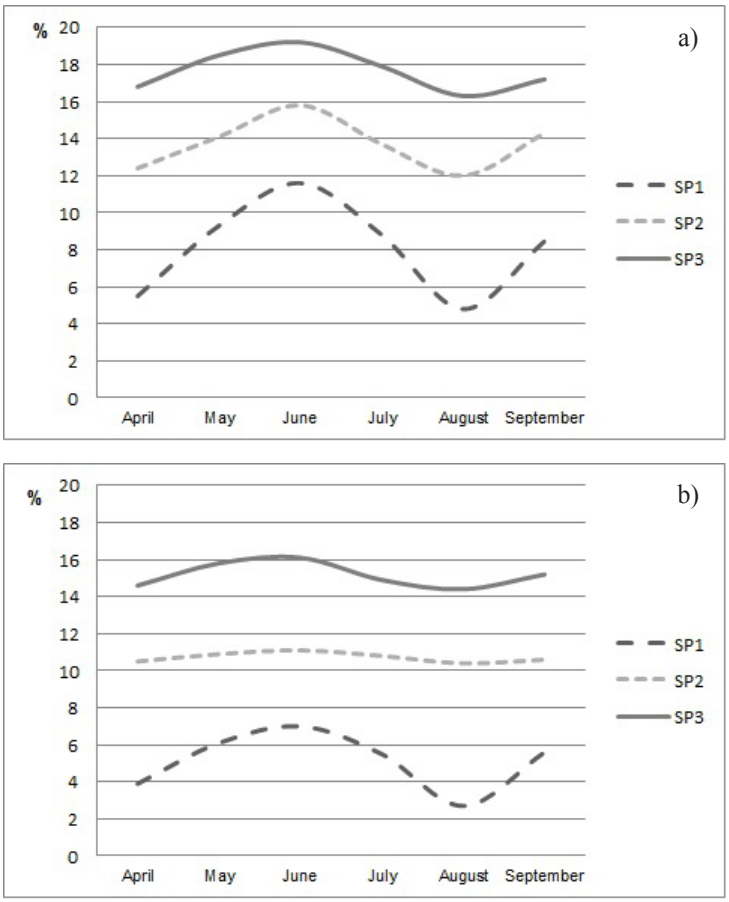


Figure 3. Soil moisture: a) 0-10 cm layer; b) 10-20 cm layer.

The results of the chemical analysis of the two soil layers (0-10 cm; 10-20 cm) reported a good nutrient preservation of soil with the studied elements (N, P, K). There is a trend of higher concentration of elements in the upper layer while at the depth values of elements concentration decrease. The amount of P in the sample plots are similar and the average values of the two soil layers are 22.46 mg/100g for the SP1, 24.67 mg/100g for the SP2 and 24.27 mg/100g for the SP3. The concentration of K is similar in the first and second plots (~20 mg/100g) and it has 4 time bigger concentrations for the third SP. This fact can be explained by the nearness of the stream and higher basic reaction of the SP. The results for N are similar to sample plots 2 and 3 with values ~3 mg/kg. In the first sample plot the concentration of N is 2 times bigger (7.4 mg/kg) than others, but that is because there is fertilization of the area near to the investigated point.

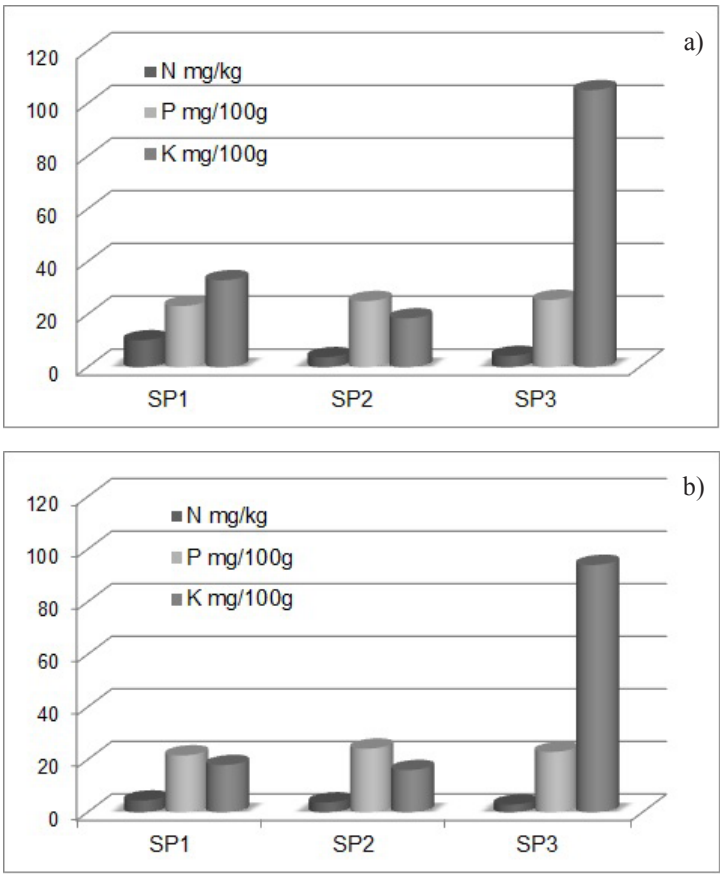


Figure 4. Concentration of nutrient elements in soil layers: a) 0-10 cm; b) 10-20 cm.

CONCLUSIONS

According to the analysis, it can be concluded that the climate of UBG "Ecopark", Varna is not significantly different from the climate, typical of the city of Varna. Anomalous weather events were not detected and climate conforms to certain climatic region.

The studied climatic and soil conditions are as close as possible to the environmental condition of the natural habitats of 5 threatened species chosen. They represent an irrevocable condition of overall "*ex situ*" conservation, which include introduction, cultivation and reproduction of these plants on the territory of UBG "Ecopark", Varna. The additional condition for successful "*ex situ*" conservation is the big area of UBG "Ecopark" which can be a place for exposition of cultivated species aiming at a wide range of people to be aware with the specifics and the problems of these plants.

According to the purpose of the study to be established on the basis of research, soil and microclimate conditions of some microhabitats in UBG Varna for ex situ conservation of plants of conservation of the flora of Bulgaria were investigated for three major botanical garden habitats, which showed a high potential in relation to the "*ex situ*" conservation. Analysis of the results shows that the territory of UBG can be successfully used for introduction of plants from the Bulgarian flora by meeting the requirements for environmental conditions close to optimal. Enrichment of the ex situ collection is essential for biodiversity conservation.

The project may be extended to other microhabitats, which are presented in UBG "Ecopark" and reveal the potential of these habitats for the needs of "*ex situ*" conservation of more plant species.

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