ECOPHYSIOLOGICAL FEATURES OF SOME CALCIPHILE PLANT SPECIES FROM NATURA 2000 DOMOGLED-CERNA VALLEY SITE

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ABSTRACT

The calcareous substrate found in Natura 2000 Domogled-Cerna Valley site, allowed the installation of vegetation with a strong calciphile character.

The most interesting adaptation of these plants is linked to mineral nutrition, some of them having the ability to remove the excess of calcium at the leaf level due to the presence of special glandular formations.

Another adaptation is linked to water regime. The small amount of water they have available in their body is preserved due to the low intensity values of transpiration.

Photosynthesis registers a diurnal variation with a peak at noon in wetter periods and in the morning during drier periods.

INTRODUCTION

Calcium is an essential plant nutrient. As the divalent Ca^{2+}, it is required for structural roles in the cell wall and membranes, as a counter- cation for inorganic and organic anions in the vacuole, and as an intracellular messenger in the cytosol (Marschner, 1995).

Calcium deficiency is rare in nature, but excessive Ca restricts plant communities on calcareous soils. Calcium is taken up by roots from the soil solution and delivered to the shoot via the xylem. It may traverse the root either through the cytoplasm of cells linked by plasmodesmata (the symplast) or through the spaces between cells (the apoplast). The relative contributions of the apoplastic and symplastic pathways to the delivery of Ca to the xylem are unknown (White, 2001).

Calcareous soils differ from lime deficient soils in the following ways; they are usually more permeable to water and therefore warmer and drier than siliceous soils, but their primary distinction is that they contain much greater amounts of Ca^{2+} and HCO_3^-. This means calcareous soils are buffered towards a higer pH than other soils and show a weakly alkaline reaction.

Nitrogen is more rapidly mineralized in calcareous soils. P,Fe, Mn and most heavy metals are less available than in acid soils (Larcher W., 2003)

Grasslands on the calcareous soils of chalk and other limestones are among the most species-rich plant communities in Europe.

Huge losses among these grasslands and their continuing vulnerability to agricultural improvement, neglect, and the impact of climate change and pollutants have focused attention on the need for conservation of their biodiversity.

A clear understanding of the molecular mechanisms that enable calcicole species to thrive on calcareous soils is essential to enable us to predict how these plant communities and their constituent species will be affected by environmental change and how the biodiversity of these ecosystems can be sustained.
(http://www.research.lancs.ac.uk/portal/en/publications/environmental-genomics-of-calcicole calcifuge-physiology)

The calciphiles must possess an efficient mechanism to remove high concentrations of free calcium delivered into the leaf's apoplast by the transpiration stream. If the xylem sap reached the apoplast around the stomata containing even 5-10% of its free calcium, stomatal function would be disturbed. If these species are representative of calcicoles in

general, the leaf's mechanism for preventing excess calcium from reaching the stomatal guard cells may be indispensable. The capacity to remove or sequester most of the calcium delivered in the xylem may be a key factor in determining whether a plant is a calcicole or not(De Silva DLR.,Manfield T.A., 1994).

In the natura 2000 Domogled-Cerna Valley, the habitat 8210 – Rocky calcareous slopes with chasmophytic vegetation – is present on relatively compact surfaces, discontinuous on the rocky sides from Pecinisca Keys, Feregari Keys (fig.1), Tesnei Keys and Stan's Peak.

This habitat is a common presence on the limestone sharp slopes of Cerna Valley. The total surface occupied by this habitat in the community interest site is of about 90 ha.

MATERIAL AND METHODS

In order to study the physiology of the calciphyle plants, there have been studied three species that were present in that area: *Saxifraga paniculata, Geranium macrorhizum* and *Scabiosa columbaria.*

The experiences were effectuated in the Feregari Keys from Domogled-Cerna Valley site, during May – August 2016.

Fig.1. Habitat 8210 in Feregari Keys

Saxifraga paniculata - *Saxifragaceae* family- is a perennial stoloniferous herbaceous plant. It has a basal rosette of leaves, which are leathery, flat and stiff. The oblong to ovate leaves 1-3cm long, have fine margins. A lime encrusted white pore is present at the base of each leaf. The rosette produce erect flowering stems.

Flowering stems have reduced and scattered leaves which terminate in a somewhat elongated cluster. The flowers are white, approximately 1 cm across and have dots which are either purplish or red. The flowers themselves have five petals, two styles, one inferior ovary and two-beaked seed capsule.

Scabiosa columbaria- Caprifoliaceae family is a perrenial plant growing to 0.8 m (2ft 7in) by 0.8 m (2ft 7in) at a medium rate. It is in flower from July to September. The flowers are hermaphrodite and are pollinated by lepidopters. Suitable for light(sandy), medium(loamy) and can grow in very alkaline soils. It cannot grow in the shade. It prefers dry or moist soil.(http://www.pfaf.org/user/Plant.aspx?LatinName=Scabiosa+columbaria).

Geranium macrorrhizum - *Geraniaceae* family is a species of hardy flowering herbaceous perennial plant in the genus *Geranium.*

It is native to the South east Alps and the Balkans. Its common names include bigroot geranium, bulgarian geranium, and rock crane's-bill.

It has five-lobed (palmate) leaves that are aromatic when crushed, with pale pink flowers in summer.

On the biological matterial were determined: the intensity of leaf transpiration, the intensity of photosynthesis, the content of assimilatory pigments and the water content.

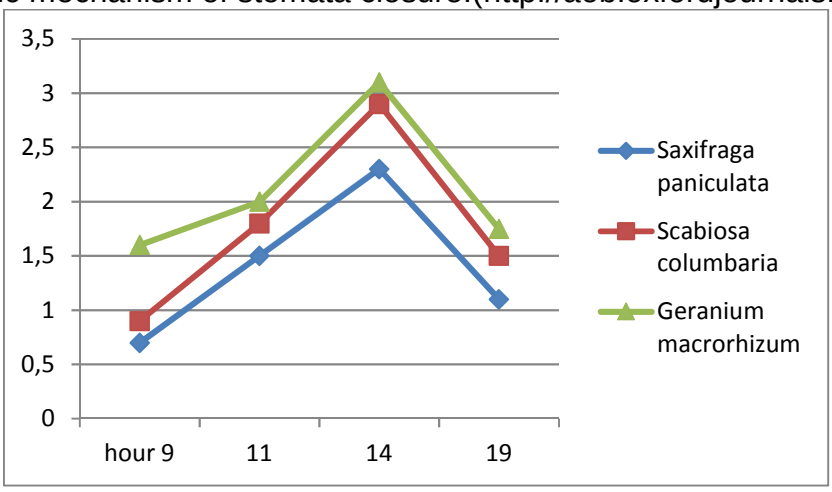
Transpiration, photosynthesis and respiration in leaves were determined using LCi portable device.

The chlorophyll content of leaves was determined with the Minolta portable chlorophyll meter (SPAD units).

RESULTS AND DISCUSSIONS

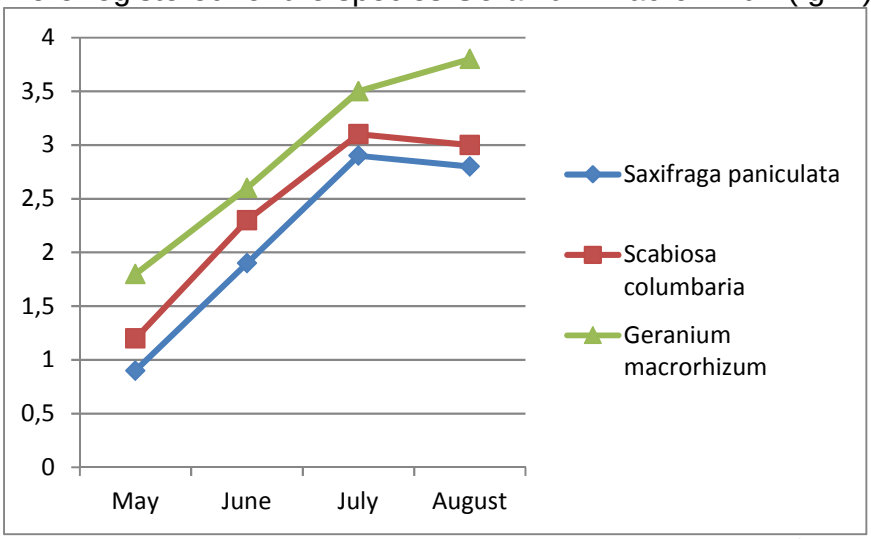
1. Water elimination

The plants which have been taken into study presented low values of the transpiration intensity. A slightly intensification of the transpiration process was recorded during noon, when the higher temperature causes an intensification in the process of water absorption and the high light values favor the opening of the stomata(gr.1). The data obtained is in concordance with the specialty literature data, which states that at calciphyle plants, the values of transpiration intensity are very low. Researchers conclude that this element can directly act upon stomatal cells, being involved, together with the potassium, in the physiologic mechanism of stomata closure.(http://aob.oxfordjournals.org/content).



Gr. 1.The diurnal variation of transpiration (mmol/m^2/s)

Regarding the seasonal variation of transpiration, at all three species taken into study in 2016, it was recorded a maximum at the end of July, beginning of August. The highest values were registered for the species *Geranium macrorhizum*(gr.2).



Gr.2. The seasonal variation of transpiration (mmol/m^2/s)

2. Photosynthesis

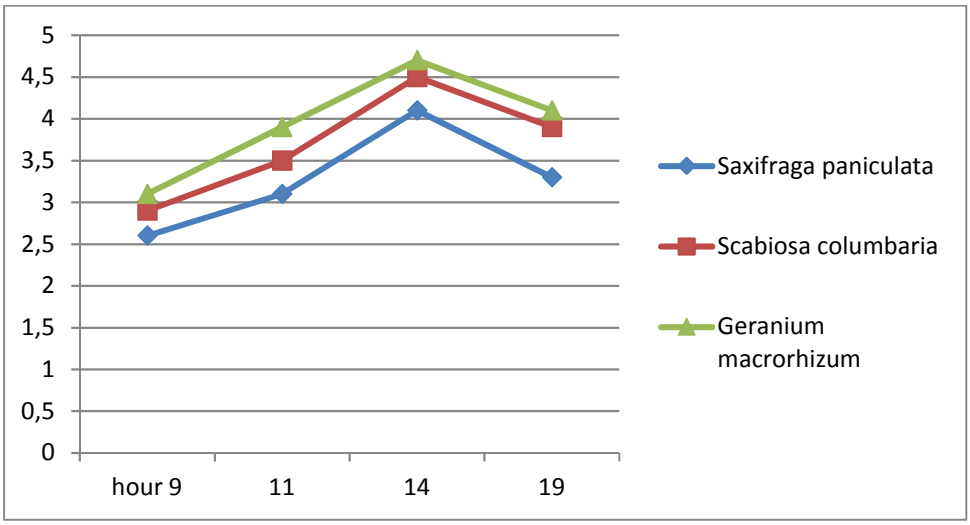
The process of photosynthesis is determined both by external factors (light, temperature, water, carbon dioxide concentration) and internal factors, a very important role being played by the functioning of the stomata. These epidermal formations represent the pathways for water removal, but also the paths that let the carbon dioxide, which is necessary for photosynthesis, penetrate the cell. That is why a reduction in transpiration intensity is generally correlated with a reduction of the photosynthesis intensity.

The diurnal variation of photosynthesis intensity presented a maximum at noon and a minimum in the morning, around 8 o'clock (graphic 3), and the seasonal variation indicated a maximum in June, the month during which plants flowered (graphic 4).

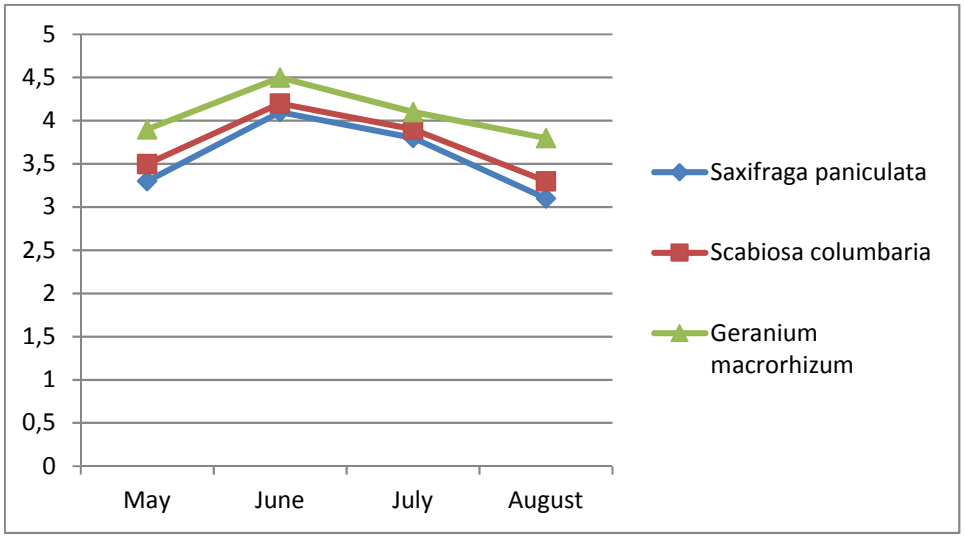
The highest values of photosynthesis intensity were recorded at *Geranium macrorhizum.*

3. The content of chlorophyllian pigments

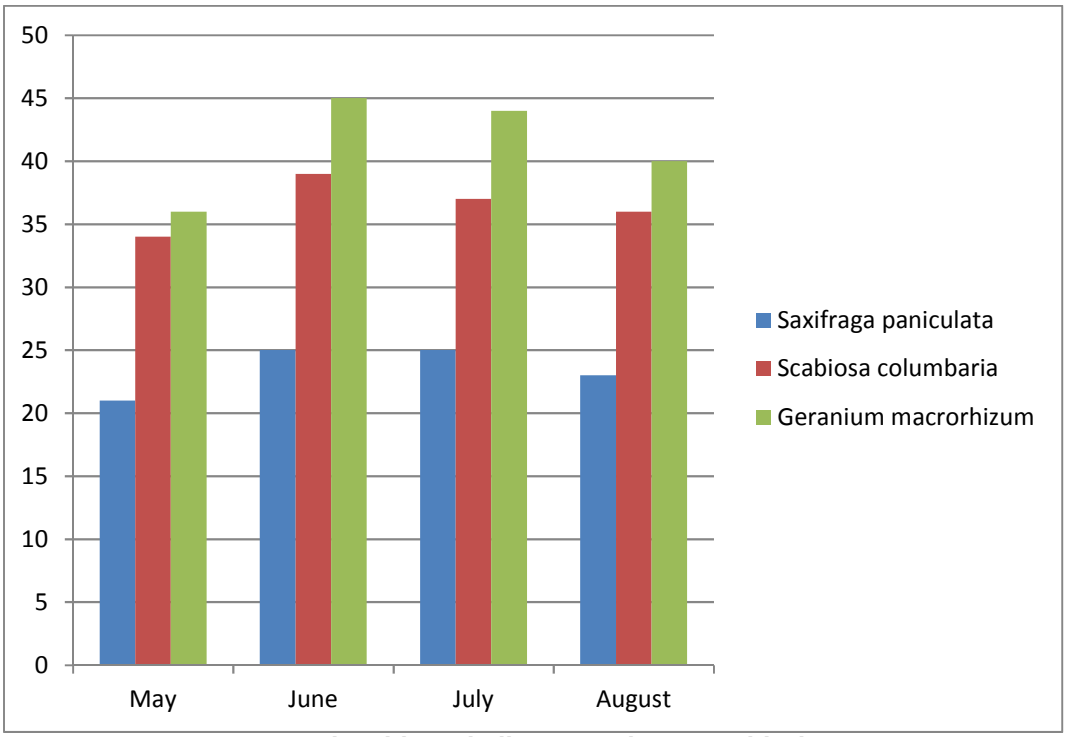
The average content in chlorophyllian pigments has presented a seasonal variation, with a maximum in August and a minimum in April. Choosing from the three species which were taken into study, *Geranium macrorhizum* presented a higher content of pigments (gr.5).



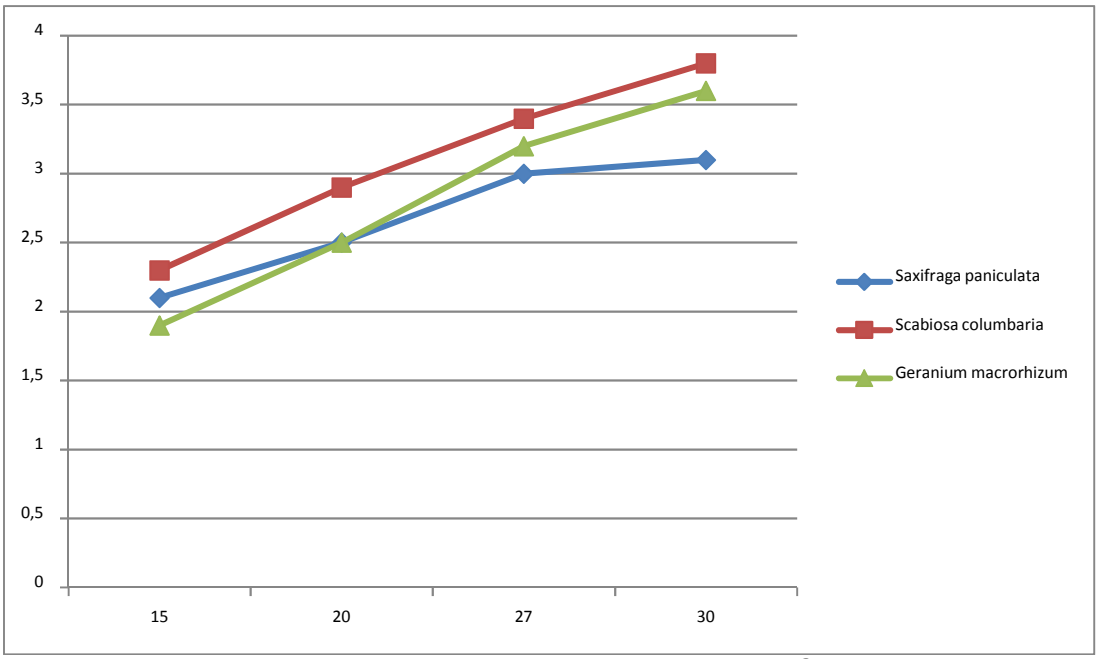
Gr.3. The diurnal variation of photosynthesis (µmol/m²/s)



Gr.4. The seasonal variation of photosynthesis (µmol/m²/s)



Gr.5.The chlorophyll content (SPAD unities)



Gr.6. The intensity of respiration ((µmol/m^2/s)

4 Respiration

The knowledge of the values of respiration intensity presents a great importance because this process represents a catabolic side of the metabolism. As it is known, the calcium excess in vegetal organisms generates a premature senescence condition; this can also intensify the process of transpiration.

Because of the fact that in the operation of determining the apparent photosynthesis we do not take into account the loss caused by the respiration process, the low values of

photosynthesis which were recorded at the plants taken into study can be the consequence of a very intense respiration.

For the determination of the transpiration, the assimilation room of the Lci machine was covered with a tinfoil paper so that the penetration of light was stopped and, from this, the realization of the photosynthesis.

According to data submitted in the graph 5, at a temperature of 15, 20, 27,30^0 C, the values of respiration intensity varied between 2,1 – 3,8 µmol/m^2/s, more intensively breathing the leaves from *Scabiosa columbaria* and less intensively those of *Saxifraga paniculata* (gr.6).

CONCLUSIONS

- Calciphile plants and calcicole plants live in mediums where there are many calcium cations, but, in fact, they do not need large quantities from this element, but a neutral or slightly acidic medium that forms in the soils that are rich in carbonates. On these soils, decomposition of mineral substances is more active, that is why biocoenosis developed on calcareous substrate have a richer floral structure than those which form on acidic soils.
- The reduction of transpiration intensity at plants from the *Saxifragaceae* family is generally correlated with the reduction of the photosynthesis intensity
- The calcium excess from vegetal organisms accelerates the process of senescence, fact noticed by measuring the high values of the respiration intensity.

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