THE ECOPHYSIOLOGICAL RESPONSE TO WATER STRESS OF SOME PLANT SPECIES FROM THE DOMOGLED-CERNA VALLEY PROTECTED AREA

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Abstract

Domogled-Cerna Valey is a protected area characterized by a climate with sub-Mediterranean influences. The lithological and pedological substrate, as well as the specific climate, have given a xerophilic character to the area's flora and vegetation. But even for the vegetation adapted to these conditions, climate changes with very long periods of drought have created significant physiological imbalances, which in the longer term (if those conditions are maintained) will cause changes in the structure of the habitats.

The determinations were made in Tesna-Valley Natural Reserve, and the plants studied were Genista tinctoria, Cerastium banaticum, Dianthus petraeus, Hypericum rochelii. The very low values of the photosynthesis intensities determined in 2024, low biomass accumulations, and the decrease in the growth rate, affecting also the flowering and fruiting processes. If these conditions continue to manifest in the coming years, it is possible that the number of individuals in the populations will change significantly.

Key words: protected area, habitat, drought, photosynthesis

INTRODUCTION

Domogled-Cerna Valley National Park is a protected area in southwestern Romania, covering parts of Caraș-Severin, Gorj, and Mehedinți counties. Spanning 61,211 hectares, it is located in the Southern Carpathians, primarily within the Cerna River basin. The park's terrain includes sections of the Godeanu and Cernei Massifs on the right bank, and the Vâlcan and Mehedinți Massifs on the left bank, forming part of the Retezat-Godeanu Mountain range. The park's landscape is dominated by limestone formations, including cliffs, caves, sinkholes, and gorges. It also features thermal springs and waterfalls, such as the Vânturătoarea Waterfall, making it rich in karst topography. These geological structures support diverse ecosystems, including Mediterranean and alpine vegetation. Endemic species such as the

The park was designated to preserve its natural beauty and biodiversity, with habitats ranging from beech and spruce forests to alpine meadows. It also provides critical protection for endemic and rare species. Banat Black Pine (*Pinus nigra ssp. banatica*) thrive in its unique habitats.

https://national-parks.org/romania/domogled-valea-cernei

The recent climate changes have also affected this protected area.

Average temperatures have increased over recent decades, resulting in more frequent and intense heatwaves. This contributes to prolonged drought periods, which severely impact and water resources in the region. The region has seen reduced and irregular precipitation patterns. Torrential rains, when they occur, often lead to flooding, while prolonged dry spells exacerbate drought conditions

https://www.sciencegate.app/document/10.24193/rcj2020_11

Scarcity of water is a severe environmental constraint to plant productivity. Drought-induced loss in crop

yield probably exceeds losses from all other causes, since both the severity and duration of the stress are critical (M Farook et al, 2009).

Water is necessary for every aspect of plant development, including gemination, cell division, photosynthesis and respiration. The drought stress may induce complex changes in biochemical, physiological, and morphological aspects of plants, limiting vegetative health, growth, regeneration of the plant population, the vegetative community in a region, and/or the entire ecosystem. The exact nature of impacts to vegetation depends on the drought its severity, spatial extent, seasonal timing, and persistence, and the capacity of the vegetation to adapt to disturbances, and vegetation management actions https://www.drought.gov/topics/vegetation

MATERIAL AND METHODS

The determinations were made in Tesna-Valley Natural Reserve. The Tesna is a tributary of the Cerna River and the gorges formed by its access are characterized by steep cliffs, lush forests and streams.

The area is in a region rich in karst formations, with caves, gorges and waterfalls that enhance its natural charm.

The Tesna Valley is home to a diverse flora and fauna, many species being endemic or rare.

The drought of 2024 dried up a large part of the lands present in this area. That is why the appearance of the vegetation has changed significantly.

According to Meteoblue data, the very small amounts of precipitation that fell in the months of July - September (figures 1,2,3) associated with very high temperatures, accentuated the drought. https://www.meteoblue.com/en/weather/week/b%C4%83ile-herculane_romania_685796

Figure 1. Temperature and precipitation in July 2024
https://www.meteoblue.com/en/weather/historyclimate/weath RiverRerarchive/b%c4%83ile-herculane_romania_685796?fcstlength=1m&year=2024&month=7

Figure 2. Temperature and precipitation in August 2024
https://www.meteoblue.com/en/weather/historyclimate/weatherarchive/b%c4%83ile-herculane_romania_685796?fcstlength=1m&year=2024&month=8

Figure 3. Temperature and precipitation in September 2024
https://www.meteoblue.com/en/weather/historyclimate/weatherarchive/b%c4%83ile-herculane_romania_685796?fcstlength=1m&year=2024&month=9

In the study, plants belonging to the species were taken *Genista tinctoria, Cerastium banaticum, Dianthus petraeus* and *Hypericum rochelii.*

Genista tinctoria- is a low-growing, green-stemmed, deciduous shrub of the Fabaceae family. It is native to meadows and pastures from Europe to Siberia. Shrubs feature elliptic-oblong to oblong-lanceolate, hairy-margined, rich green leaves. Golden yellow pea-like flowers bloom in erect terminal racemes in June often with sporadic continued bloom extending throughout summer into September. Flowers are followed by 8-12 seeded narrow-oblong pods. Seeds ripen from August to October.

https://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?taxonid=280361

Because it is not a sensitive species and that in some regions it even has an invasive character, its behavior was followed in the constantly changing conditions of the environment in the researched area.

Cerastium banaticum ssp banaticum – Caryiophyllaceae family is endemic for the Balkans (Flora Europaea) and has a special phytogeographic value being considered a rare species since its discovery (Rochel, 1828). The native range of this species is Albania, Bulgaria, Greece, Romania, Turkey,Yugoslavia https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:152092-1

In Romania, it can be found only in the south-west region, sporadically of oak and beech rocky areas (Sârbu et al., 2013). This species was considered as rare in two Romanian Red Lists (Dihoru and Dihoru, 1994; Oltean et al., 1994), while Oprea (2005) cites it as a rare species which may become threatened in the future. The plant has two types of stems, one is radicant, caespitose and repent, while the other one is floriferous, reaching approximately 40 cm in height. The inflorescence shows wide pubescent silver bracts with white petals (Cristea Victoria et al, 2019).

Dianthus petraeus ssp.- Caryiophyllaceae family. The leaves are narrow, stiff and taper to a fine tip. The 10-15 cm leafless stems bear solitary flowers, 8-10 mm in diameter, white or pale pink, sometimes bearded and with toothed petals. Native to the rocky areas of the Balkan peninsula. Grows easily from seed, thrives in sunny, stony soil.

http://encyclopaedia.alpinegardensociety.net/plants/Dianthus/petraeus

Hypericum rochelii – Hypericaceae family.

Perennial herb 0.15–0.5 m tall, erect to ascending, sometimes rooting, few-stemmed, unbranched below inflorescence. Stems with internodes 13–30 mm, usually shorter than the leaves. Leaves sessile to subamplexicaule, triangular-lanceolate or upper triangular-ovate, paler beneath. Inflorescence with 3–25 flowers from 1–3 nodes, rather lax, without lower branches or rarely with one to many flowering branches. The flowers are 20 mm in diameter, stellate; buds broadly ellipsoid, rounded. Sepals 5, subequal, not or very shortly united, oblong-elliptic to lanceolate, subacute, glandular-fimbriate; Seeds orange-brown, 1.3 mm

https://hypericum.myspecies.info/taxonomy/term/794

The intensity of the photosynthesis and transpiration processes was determined with the Lci portable device that measures the respective parameter with great precision and also has the advantage that the leaves of the analyzed plants can be kept on the plant, so that at intervals of time, new determinations can be made on the same leaves. In this way, graphs can be made regarding the diurnal dynamics, but also the seasonal dynamics of this physiological process. In addition, the device also measures the temperature in the assimilation chamber, as well as the amount of water vapor and light intensity, factors that influence all the vital processes of the plants.

The content of chlorophyll pigments was determined directly on plant leaves with the Minolta portable apparatus, which

measures and expresses this parameter in SPAD units.

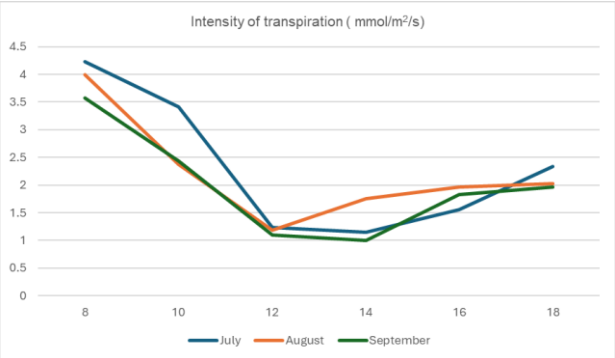
The water content of the leaves was determined by the gravimetric method, after drying the plant material in an oven at 105 degrees Celsius.

RESULTS AND DISCUSSIONS

The intensity of transpiration

The diurnal variation in the intensity of transpiration indicated a reduction in the middle of the day in *Genista tinctoria* plants, the highest values being recorded in the morning around 9 o'clock (graph 1). During the three months, the transpiration intensity values decreased as the pedological drought settled. This decrease in transpiration has protective effects because it can contribute to saving water, but at the same time, it prevents the formation of the suction force, which ensures the absorption and ascent of water in the plant body. from this point of view, the reduction of sweating also reduced the amount of water absorbed.

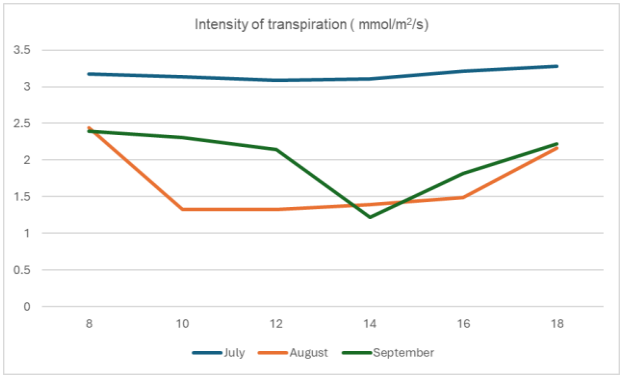
In *Cerastium banaticum*, in July the transpiration remained at almost constant values during the days, but as in the case of the *Genista tinctoria* species, in August the values decreased, so that in September it reached the minimum value of 1.33. mmol/m^2/s (graph 2).



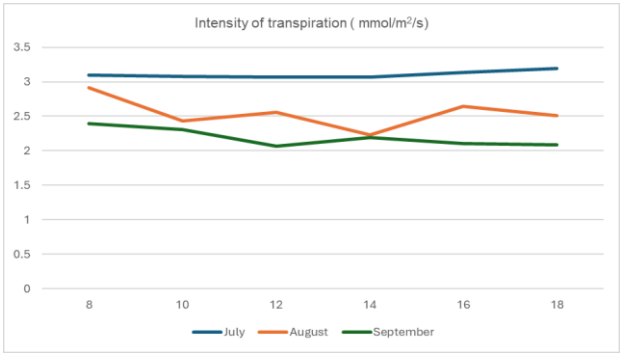
Graph 1. Diurnal variation of transpiration intensity (mmol/m^2/s) in *Genista tinctoria* over the three months of determinations

Adapted to drought conditions, the *Dianthus petraeus* species was not significantly affected, although the recorded values were slightly lower, especially in September (graph 3).

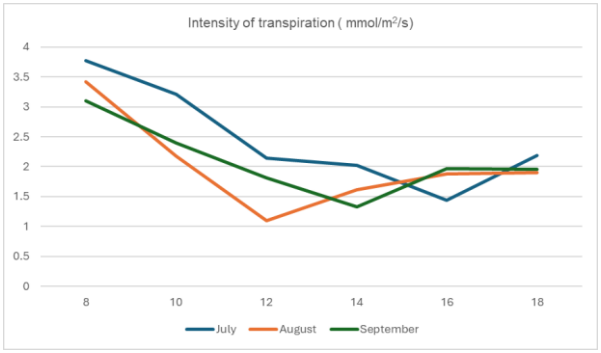
Hypericum rochelii had an evolution of the transpiration process like the *Genista tinctoria* species, but with lower values than in its case (graph 4).



Graph 2. Diurnal variation of transpiration intensity (mmol/m2/s) in *Cerastium banaticum* over the three months of determinations



Graph 3. Diurnal variation of transpiration intensity (mmol/m2/s) in *Dianthus petraeus* during the three months of determinations



Graph 4. Diurnal variation of transpiration intensity (mmol/m2/s) in *Hypericum rochelii* during the three months of determinations

The intensity of photosynthesis

Because it is dependent on the degree of opening of the stomata, photosynthesis had an evolution like the transpiration

process, with differences determined by the stronger influence of light intensity.

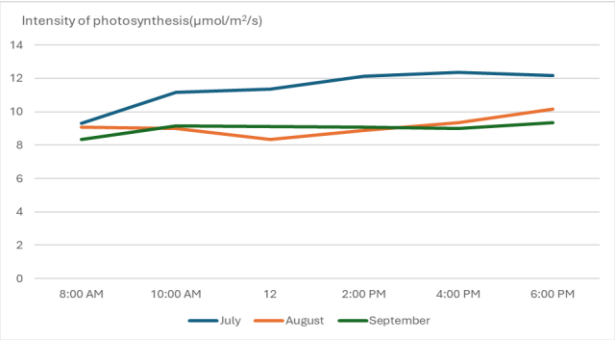
At *Genista tinctoria,* the highest value of photosynthesis (12.37 µmol/m^2/s) was recorded at 4 pm in July, being also influenced by the high intensity of light (graph 5)

In *Cerastium banaticum,* the maximum value (11.21 µmol/m^2/s) was recorded in July at 2 pm (graph 6). Although it is better adapted to drought conditions, the small amount of water in the soil significantly influenced the process in this species as well.

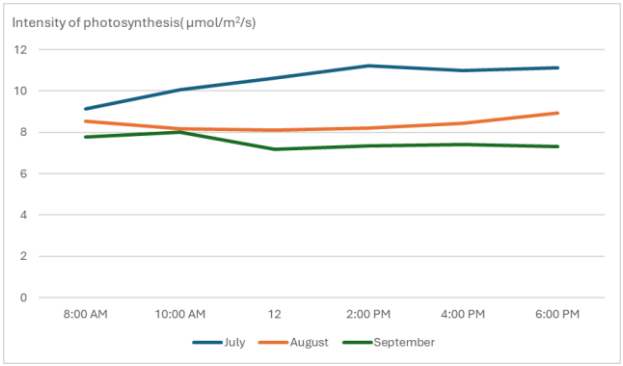
Dianthus petraeus had lower photosynthesis values (graph 7), which are also a characteristic of the species, but the process was not significantly influenced by the amount of water in the soil.

Hypericum rochelii was the most strongly affected, having very low values of photosynthesis both in August and September (graph 8).

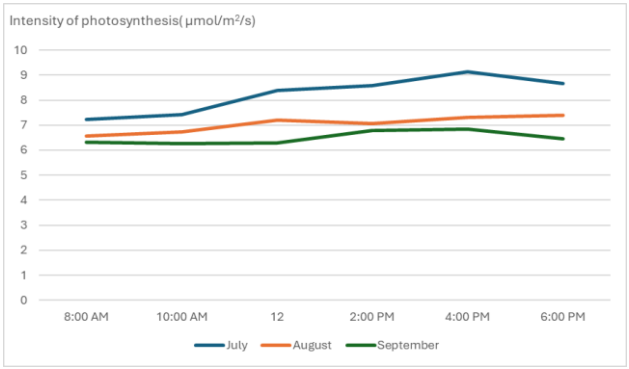
The reduced values of photosynthesis in all plants in the climatic conditions of July, August and September affected productivity and biomass accumulation.



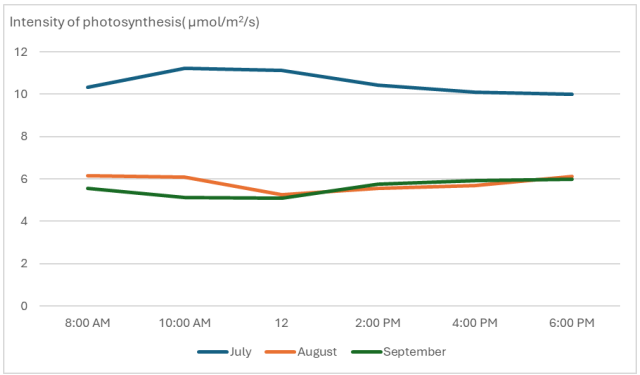
Graph 5. Diurnal variation of photosynthesis intensity (µmol/m^2/s) in *Genista tinctoria* over the three months of determinations



Graph 6. Diurnal variation of photosynthesis intensity (µmol/m^2/s) in *Cerastium banaticum* during the three months of determinations



Graph 7. Diurnal variation of photosynthesis intensity (µmol/m^2/s) in *Dianthus petraeus* during the three months of determinations



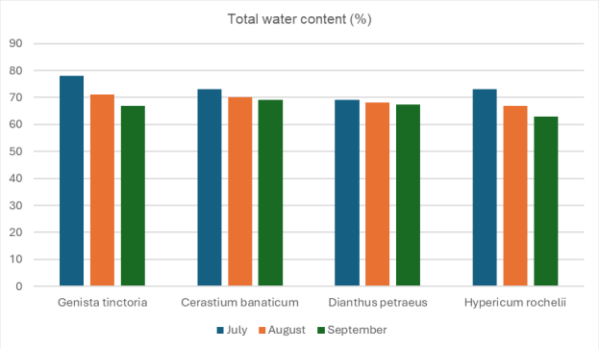
Graph 8. Diurnal variation of photosynthesis intensity (µmol/m^2/s) in *Hypericum rochelii* during the three months of determinations

The total water content of the leaves

The amount of water in the body of plants varies depending on several internal and external factors. Among the external factors, air temperature and available soil water are the most important.

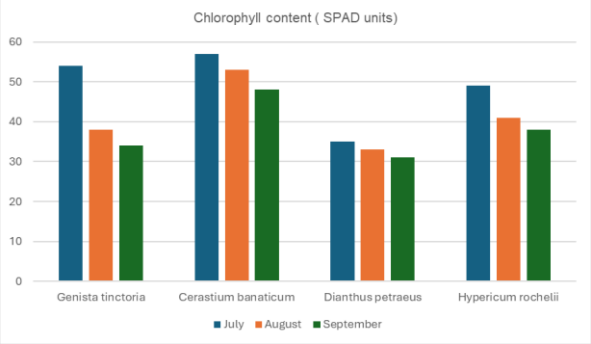
The biggest variations in water content were recorded in *Hypericum rochelii.* Significant differences were also observed in *Genista tinctoria.* The smallest differences were found in the

leaves of the species *Dianthus petraeus* (graph 9).



Graph 9. The total water content of the leaves during the three months of determinations (%)

The chlorophyll content of the leaves was determined in the middle of each month and indicated a reduction according to the reduction of the amount of water in the environment (graph 10). This can also explain the much lower values of photosynthesis recorded in all four species studied.



Graph 10. The chlorophyll content of the leaves in the three months of determinations (SPAD units)

CONCLUSIONS

-Drought affects nearly every aspect of plant physiology, from water transport and photosynthesis to growth and stress signalling. Plants adopt a combination of physiological and biochemical strategies to survive, often at the expense of growth and productivity

-The very low amount of precipitation in the studied area limited the soil moisture, reducing the water available for absorption by plant roots.

-To minimize water loss, the stomata closed during drought, reducing transpiration but also limiting gas exchange.

-The photosynthesis process, being dependent on water, recorded important seasonal variations, but also diurnal variations

- In the climatic conditions of the summer of 2024, the water content of the leaves decreased progressively, this parameter also influencing other important processes, such as growth, flowering and fruiting.

REFERENCES

Ciocârlan V. 2009, Flora ilustrată a României – Pteridophyta si Spermatophyta. Editura Ceres, Bucureşti

Cristea,V.,Besenyei,E, Jarda, L.,Farkas, A.,Marcu,D.,Clapa,Dhalmagyi, A., Butiuc-Keul, A., 2019, *In situ genetic variability and micropropagation of Cerastium banaticum (Rochel) Heuff- A rare and endemic species from Romania* , Acta Biologica Cracoviensia, series Botanica https://rearchgate.net/publication/335973823_in_situ_genetic_variability_and_micropropagation_of_cerastium_banaticum_rochel_heuff_caryophyllaceae-_a_rare_and_endemic_species_from_romania/link/5d87cc94458515cbd1b3a373/download?_tp=eyjjb250zxh0ijp7imzpcnn0ugfnzsi6inb1ymxpy2f0aw9uiiwicgfnzsi6inb1ymxpy2f0aw9uin19

Dihoru G, and Dihoru A. 1994. Plante rare, periclitate şi endemice în Flora României – Lista roşie. Acta Horti Botanici Bucurestiensis 173–199

Farook, M, Wahid,A., Kobayashi, N., Fujita, D., Basra, S.M., 2009, *Plant Drought Stress: Effects, Mechanisms and Management,*p153-188 https://link.springer.com/chapter/10.1007/978-90-481-2666-8_12#auth-M_-Farooq

Oltean M, Negrean G, Popescu A, Roman N, Dihoru G, Sanda V, and Mihăilescu S., 1994. Lista Roşie a plantelor superioare din România, Studii Sinteze Documentaţii de Ecologie 1: 1–52.

Oprea A. 2005. Lista critică a plantelor vasculare din România. Editura Universităţii Alexandru Ioan Cuza Iaşi.

Sârbu I, Ştefan N, Oprea A. 2013. Plante vasculare din România, determinator ilustrat de teren. Editura Victor B. Victor, Bucureşti

https://eunis.eea.europa.eu/references/1780/species

http://encyclopaedia.alpinegardensociety.net/plants/dianthus/petraeus

https://national-parks.org/romania/domogled-valea-cernei

https://www.sciencegate.app/document/10.24193/rcj2020_11

https://www.drought.gov/topics/vegetation

https://www.meteoblue.com/en/weather/week/b%c4%83ile-herculane_romania_685796

https://www.meteoblue.com/en/weather/historyclimate/weatherarchive/b%c4%83ile-herculane_romania_685796?fcstlength=1m&year=2024&month=7

https://www.meteoblue.com/en/weather/historyclimate/weatherarchive/b%c4%83ile-herculane_romania_685796?fcstlength=1m&year=2024&month=8

https://www.meteoblue.com/en/weather/historyclimate/weatherarchive/b%c4%83ile-herculane_romania_685796?fcstlength=1m&year=2024&month=9

https://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?taxonid=280361

https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:152092-1

https://hypericum.myspecies.info/taxonomy/term/794