





Monitoring of Vascular Plant Species from the Southeastern Part of Strandzha Nature Park, Bulgaria

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Abstract. The study presents data on some invasive and conservation-significant species in two protected areas of the Strandzha Nature Park – Protected Area "Marina Reka" and Protected Area "Silistar". There were monitored the protected species *Pancreatium maritimum*, *Calluna vulgaris*, *Daphne pontica*, *Ilex colchica*, *Rhododendron ponticum*, *Mespilus germanica*, and *Taxus baccata*, as well as an invasive species – *Amorpha fruticosa*, whose population borders that of *Pancreatium maritimum*. The projective coverage of species in the sample areas and the total projective coverage of the vegetation have been studied also measures for their protection have been indicated.

Key words: invasive and protected plants, Protected Area "Marina Reka", Protected Area "Silistar", Strandzha Nature Park.

Introduction

Strandzha Nature Park is one of the largest protected areas in Bulgaria. It is located in the southeastern part of the country and borders the Republic of Turkey. It was declared a national park by Order NoRD-30 from 24 January 1995, State Gazette number 15/1995. The goal is long-term conservation of the unique nature of Veleka River and Rezovska River watersheds and ensuring sustainable socio-economic development in the region (Zahariev, 2014).

The category of the park is changed in the natural park by Order NoRD-350 from 14

July 2000, State Gazette number 66/2000. In the park areas present their own status of nature conservation: 5 reserves, 19 protected areas and 7 landmarks. After twice reducing the area of the park in 2001 and 2013, its total area is 116054.21 ha.

The flora of the Nature Park is distinguished by its large number of species, which were widespread during the Tertiary (Tertiary relics) – 63 species. Among them, *Rhododendron ponticum*, *Daphne pontica*, and less often *Vaccinium arctostaphylos* are major participants and formers of plant communities

and the rest are among the species of greatest conservation importance, such as *Ilex colchica* and others (Zahariev, 2016).

The aim of the present research work is a pilot study on the status of some plant species of conservation importance in the two protected areas within the Strandzha Nature Park – “Marina Reka” and “Silistar”, as well as to identify possible threats to their conservation that would serve as a basis for further monitoring studies.

Material and Methods

The subject of the study were the species *Amorpha fruticosa* Linnaeus,

Pancratium maritimum Linnaeus, *Calluna vulgaris* (Linnaeus) Hull, *Daphne pontica* Linnaeus, *Ilex colchica* Pojark., *Rhododendron ponticum* Linnaeus, *Mespilus germanica* Linnaeus, and *Taxus baccata* Linnaeus; from the two protected localities: Silistar Protected Area, next to the road to the village of Sinemorets (*Amorpha fruticosa* and *Pancratium maritimum*) and Marina River Protected Area, on the road to the town of Malko Tarnovo, near the village of Bulgari (*Calluna vulgaris*, *Daphne pontica*, *Ilex colchica*, *Rhododendron ponticum*, *Mespilus germanica*, and *Taxus baccata*) (Fig. 1).

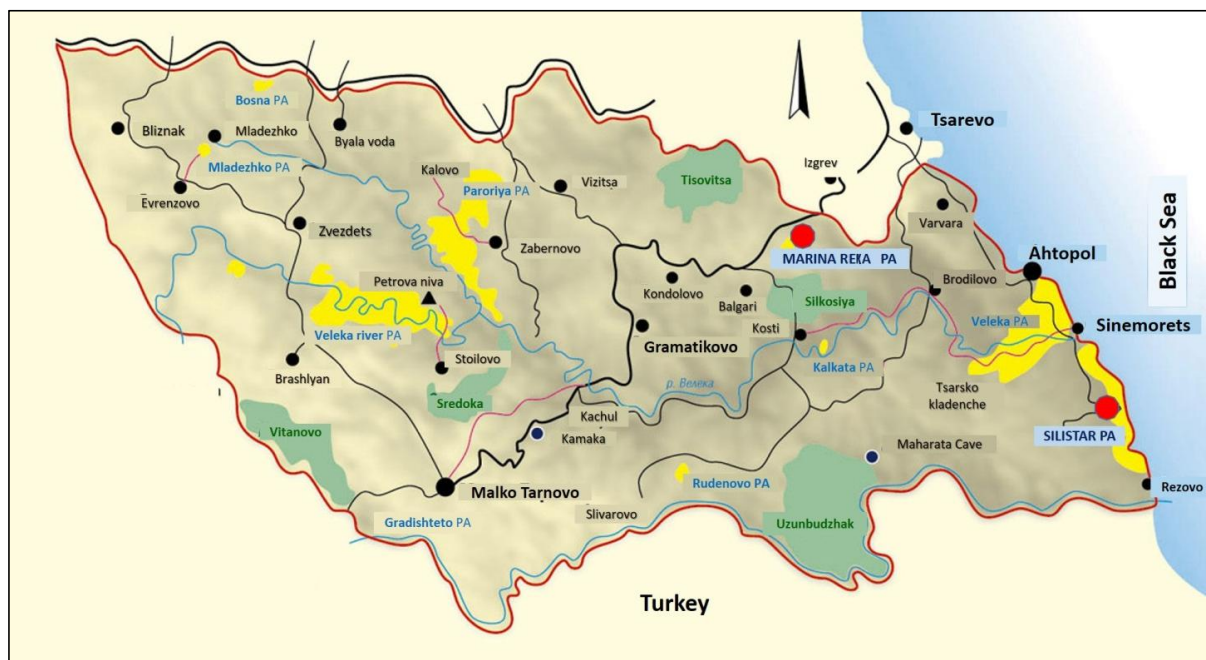


Fig. 1. Map of the study area in Strandzha Nature Park, SE Bulgaria.

The monitoring of higher plants followed the National biodiversity monitoring system, Environmental Executive Agency, Ministry of Environment and Water, Bulgaria (Gusev & Bancheva, 2016). The following parameters were defined for each population: Location and floristic region; Sampling plot of the local population; GPS coordinates of the sampling plot of the local population with portable GPS receiver GARMIN 530; Different number of sampling sites will be defined depend on the

size of the local population. Sampling sites will be approximately 20x20 m. When the total area of the studied habitat is small, then the size of the sampling sites will be smaller; In order to study the major part of the population and to receive reliable data, the sampling sites will be marked uniformly, at about 20 m intervals; Population density will be estimated as a number of individuals per m².

Inventory of the plants was carried out in 2021. The collected materials were

identified at the Department of Botany and Biological education of Plovdiv University "Paisii Hilendarski" using a stereo magnifying glass and identification keys. Nomenclature was according to Delipavlov & Cheshmedjiev (2011).

Results and Discussion

Eight plant species in the area of Strandzha Nature Park were studied. Table

1 presents data on the geographical coordinates of the localities in which the plant species studied were found.

Amorpha fruticosa is an invasive species; *Pancratium maritimum*, *Calluna vulgaris*, *Daphne pontica*, *Ilex colchica*, *Rhododendron ponticum*, *Mespilus germanica* and *Taxus baccata* are species with conservation status (Table 2). Here is a brief description of each of the species.

Table 1. List of studied taxa and localities of their establishment.

Species	Locality (latitude/longitude and altitude)	Floristic region and year of sampling
<i>Amorpha fruticosa</i> L.	N 42°01'26.4"; E 028°00'35.1" / 12 m	Black Sea coast (Southern), 2021
<i>Calluna vulgaris</i> L.	N 42°07'00.9"; E 027°45'57.5" / 246 m	Strandzha, 2021
<i>Daphne pontica</i> L.	N 42°07'05.8"; E 027°45'59.5" / 235 m	Strandzha, 2021
<i>Ilex colchica</i> Pojark.	N 42°06'43.4"; E 027°45'51.9" / 180 m	Strandzha, 2021
<i>Mespilus germanica</i> L.	N 42°07'05.8"; E 027°45'59.5" / 235 m	Strandzha, 2021
<i>Pancratium maritimum</i> L.	N 42°01'24.6"; E 028°00'36.9" / 3 m N 42°01'22.0"; E 028°00'37.4" / 3 m N 42°07'00.4"; E 027°45'57.5" / 240 m	Black Sea coast (Southern), 2021
<i>Rhododendron ponticum</i> L.	N 42°06'50.9"; E 027°45'57.5" / 240 m N 42°06'45.9"; E 027°51'23.1" / 240 m N 42°06'45.9"; E 027°45'53.0" / 240 m	Strandzha, 2021
<i>Taxus baccata</i> L.	N 42°06'43.4"; E 027°45'51.9" / 185 m	Strandzha, 2021

Table 2. List of studied taxa and their conservation status. *Legend:* BDA (Biological Diversity Act), EN (Endangered), IUCN (IUCN Red List of Threatened Plants), VU (Vulnerable), RLBVP (Red List of Bulgarian vascular plants), LC (Least Concern), RB (Red Book of the Republic of Bulgaria), MPA (Medicinal Plants Act).

Species	Criteria for selection
<i>Amorpha fruticosa</i>	Invasive
<i>Calluna vulgaris</i>	BDA; RLBVP [VU]
<i>Daphne pontica</i>	BDA; RLBVP [EN]; RB [EN]
<i>Ilex colchica</i>	BDA; RLBVP [EN]; RB [EN]
<i>Mespilus germanica</i>	IUCN [LC]; RLBVP [LC]
<i>Pancratium maritimum</i>	BDA; RLBVP [EN]; RB [EN]
<i>Rhododendron ponticum</i>	BDA; RLBVP [VU]
<i>Taxus baccata</i>	BDA; IUCN [LC]; RLBVP [EN]; RB [EN]; MPA

***Amorpha fruticosa* L. (Fabaceae) (Fig. 2)**

Global distribution: The origin is from southeastern parts of North America (Petrova et al., 2013). It is naturalized in Europe and temperate parts of Asia. In

Europe it was brought for the first time as an ornamental plant in England in 1724.

Distribution in Bulgaria: It is found throughout the country, from sea level to 1200 (1500) m asl. It was introduced in

culture in the early 19th century decorative and anti-erosion purposes. The first evidence of spontaneous distribution in natural habitats in the country was since 1898 (Petrova et al., 2013).

Morphology: Shrub up to 6m. Leaflets 5-12 pairs, 15-40 x 8-20 mm, ovate or elliptical, pubescent or subglabrous, glandular-punctate. Inflorescence 7-15 cm. Standart c. 6 mm, blue or purplish. Legume 7-9 mm, glandular-punctate (Tutin et al., 1980).

Population analysis: A population in an area of 500 m² was reported. The projective vegetation cover in the sample area is 95%, of which 90% are represented by the studied species, and 5% consist of the species *Cyonura erecta*, *Periploca graeca*, *Silene euxina*, *Melilotus alba*, *Salix* sp., *Fraxinus* sp. The invasive nature of the species requires control of the area of its population because it is located near the sandy strip along which *Pancratium maritimum* grows.

***Pancratium maritimum* L.**
(Amaryllidaceae) (Fig. 3)

Global distribution: Mediterranean region, Black Sea coast of Bulgaria, Turkey, Western Caucasus.



Fig. 2. General view of *Amorpha fruticosa*.

Distribution in Bulgaria: Southern Black Sea coast.

Morphology: Bulb very large, deeply sunk, tapered to a long neck. Leaves up to 50 cm x 20 mm, lorate, glaucous, appearing before anthesis. Scape stout compressed. Spathe 4-7 cm. Pedicels 5-10 mm, shorter than ovary. Hypanthial tube 60-80 mm, very slender. Perianth-segments 30-50 mm, linear-lanceolate, erecto-patent to patent. Corona c. 2/3 as long as perianth-segments; margin with 12 triangular teeth. Free part of filament about equaling anther. Flowering in mid-summer (Tutin et al., 1980).

Population analysis: A population in an area of 200 m² was reported, including four sites of reporting - A, B, C, and D (Fig. 4). The projective vegetation cover in the sample area is 20%, of which 10% are represented by the studied species, while 10% comprise the species *Anchusa leptophylla*, *Elymus* sp., *Silene euxina*, *Eryngium maritimum*, *Galilea mucronata*, *Medicago marina*, *Periploca graeca*. Threats: the locality is close to a camping site and a beach strip; the presence of competing plant species: *Silene euxina*, *Eryngium maritimum*, *Medicago marina*, *Periploca graeca*.



Fig. 3. General view of *Pancratium maritimum*.

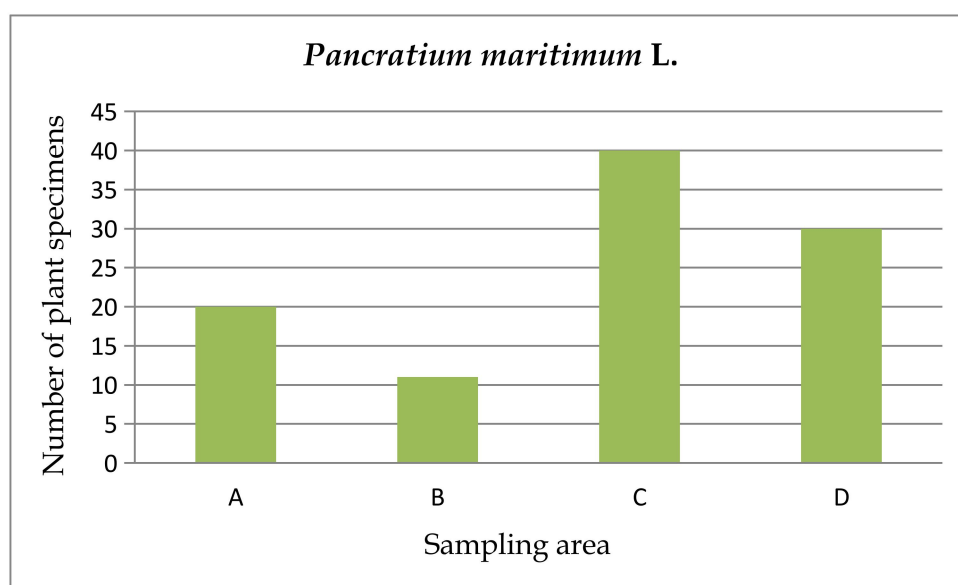


Fig. 4. Number of plant specimens in the sample areas.

***Calluna vulgaris* (L.) Hull (Ericaceae)**
(Fig. 5)

Global distribution: Mainly in Europe.

Distribution in Bulgaria: Strandzha Mountain.

Morphology: Subglabrous to densely grey-pubescent. Stems 15-80(-150) cm, erect, freely branched. Leaves 2,5-3,5 mm (including auricles), closely appressed, widely spaced on leading shoots but densely imbricate on lateral, non-flowering branches, oblong-lanceolate, concave on adaxial, keeled on abaxial surface, amplexicaul, with proximally directed auricles. Flowers shortly pedicellate, in narrow racemes which are sometimes grouped into panicles; bracteoles usually 6-8, crowded together beneath the flower, the upper 4 simulating sepals. Sepals 3-4 mm, oblong, pinkish-lilac; corolla lobed nearly to the base, its lobes like the sepals but smaller; anthers included (Tutin et al., 1972).

Population analysis. A population in an area of 10 m² was reported. The projective cover of the vegetation in the sample area is 90%; only single specimens of the species (5 semi-shrubs) have been registered. The tree species *Quercus polycarpa*, *Fagus orientalis*,

and *Sorbus aucuparia* predominate. Threats: growing species of the genus *Quercus polycarpa*, near a hiking trail.

***Daphne pontica* L. (Thymelaeaceae)** (Fig. 6)

Global distribution: Eastern Europe (Bulgaria, Turkey), Southwest Asia (along the Black Sea coast), Caucasus.

Distribution in Bulgaria: Strandzha Mountain; from 50 to 700 m asl. (Black Sea coast).

Morphology: Evergreen shrub with suberect branches; 50-100 cm or more, erect; leaves obovate, 2-2,5 times as long as wide; flowers in pairs on a common peduncle, arising from the axils of reduced, bract-like leaves at the base of the current year's growth; hypanthium 8-10 mm, slender; sepals pale yellow, almost as long as the hypanthium (Tutin et al., 1968).

Population analysis. A population of 10 m² was reported. The projective vegetation cover in the sample area is 50%, of which 40% are represented by the studied species, and 10% consist of the species *Quercus polycarpa*, *Fagus orientalis*, *Sorbus aucuparia*, *Crataegus monogina*, *Rubus* sp., *Pteridium aquilinum*, *Pyracantha coccinea*. Threats: near a hiking trail.



Fig. 5. General view of *Calluna vulgaris*.



Fig. 6. General view of *Daphne pontica*.

***Mespilus germanica* L. (Rosaceae) (Fig. 7)**

Global distribution: It is found across Southern Europe where it is generally rare

Distribution in Bulgaria: Strandzha Mountain.

Morphology: Shrub to small tree up to 6 m. Leaves 5-12 cm, lanceolate or oblanceolate to obovate, pubescent, but sometimes glabrous above, entire or serrulate towards the apex. Flowers 3-4 cm in diameter. Sepals 10-16 mm, linear-triangular. Petals white. Fruit 2-3 cm, brown, pyriform to depressed-globose. Cultivated for the fruit, which after incipient decay becomes soft and edible (Tutin et al., 1968).

Population analysis: A population of 10 m² was reported. The projective cover of the vegetation in the sample area is 90%; a single specimen of the species is registered. The area is represented by *Quercus polycarpa*. Threats: near a hiking trail, mass development of *Quercus polycarpa*.

***Rhododendron ponticum* L. (Ericaceae) (Fig. 8)**

Global distribution: Bulgaria, Georgia, Spain, Portugal, Lebanon

Distribution in Bulgaria: Strandzha Mts.

Morphology: Erect, evergreen shrub 2-5(-8) m, with spreading branches. Leaves 8-25 cm, entire, coriaceous, dark shining green above, paler beneath, glabrous. Racemes with 8-15 flowers; pedicels 2-6 cm. Calyx 1-2 mm; lobes rounded. Corolla 40-60 mm, campanulate, violet-purple; tube somewhat shorter than lobes. Stamens 10. Ovary glabrous (Tutin et al., 1972).

Population analysis: A population in an area of 100 m² was reported, including 5 sites of reporting. The projective vegetation cover in the sample area is 90%, of which 80% are represented by the studied species, while 20% comprise the species *Quercus polycarpa*, *Fagus orientalis*. Threats: near a hiking trail.

***Taxus baccata* L. (Taxaceae) (Fig. 9)**

Global distribution: In almost all Europe and in the mountains of the Mediterranean region, Southwest and Central Asia (Caucasus, Asia Minor) and North Africa.

Distribution in Bulgaria: Western and Central Stara Planina, Vitosha, Slavyanka, Pirin, Rila, Rhodopes and Strandzha Mts.

Morphology: Shrub or tree up to 20 m, with a wide, pyramidal crown. Leaves 10-30 mm, the margins recurved, dark, glossy green

above, with 2 pale green stomatal bands beneath. Seeds 6-7 mm. (Tutin et al., 1964).

Population analysis. A population of 10 m² was reported. The projective cover of the vegetation in the sample area is 80%; a single specimen of the species, about 500 years old, is registered. Among the tree species, *Fagus orientalis* predominates, and in herbaceous - *Asplenium scolopendrium* Threats: near a hiking trail.

***Ilex colchica* Pojark. (Aquifoliaceae) (Fig. 10)**

Global distribution: Balkan Peninsula, Southwest Asia and the Caucasus.

Distribution in Bulgaria: Strandzha Mts.

Morphology: Shrub 1-3 m, glabrous except for puberulent young shoots and inflorescences; bark pale grey. Leaves oblong, c. 2,5 times as long as wide, all spinose-serrate and only slightly undulate, turning black on drying; petiole with a narrower and deeper groove (Tutin et al., 1968).

Population analysis. A population of 10 m² was reported. The projective cover of the vegetation in the sample area is 60%; two specimens of the species have been registered. Among the tree species, *Fagus orientalis* and *Laurocerasus officinalis* predominate. Threats: near a hiking trail.



Fig. 7. General view of *Mespilus germanica*.



Fig. 8. General view of *Rhododendron ponticum*

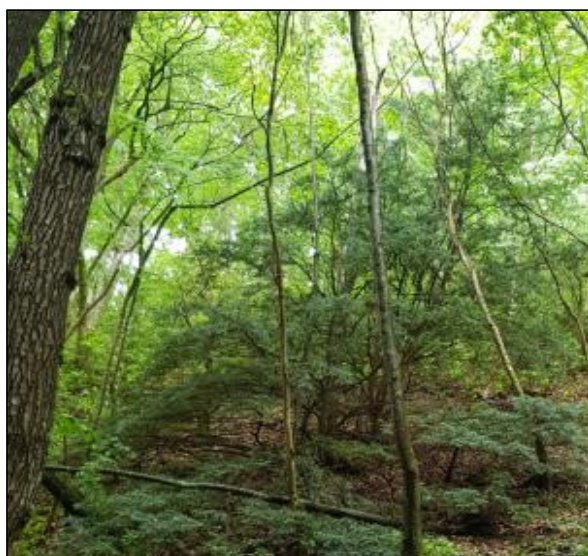


Fig. 9. General view of *Taxus baccata*.



Fig. 10. General view of *Ilex colchica*.

Conclusions

The study presents data on monitoring of the species *Amorpha fruticosa*, *Pancratium maritimum*, *Calluna vulgaris*, *Daphne pontica*, *Ilex colchica*, *Rhododendron ponticum*, *Mespilus germanica*, and *Taxus baccata* in the two protected areas of Strandzha Nature Park – Marina River and Silistar. Relatively stable populations of the species *Pancratium maritimum* and *Rhododendron ponticum* have been found, while *Calluna vulgaris*, *Mespilus germanica*, *Ilex colchica*, and *Taxus baccata* are represented by a limited number of single specimens. For the species, it is necessary to take measures for their protection, since they are located in close proximity to tourist trails, and in some cases, their area is taken over by the young oak vegetation growing. In order to preserve the population of *Pancratium maritimum*, it is needed to control the population of the invasive species *Amorpha fruticosa* because it is located in the immediate vicinity. In our view, it is recommended urbanization along the sandy strip in this coastal zone to be limited.

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References

- Biological Diversity Act. (2002). Promulgated, *State Gazette*, 77, 09.08.2002. (In Bulgarian).
- Gusev, Ch. & Bancheva, S. (2016). National biodiversity monitoring system, Environmental Executive Agency, Ministry of Environment and Water, Bulgaria. Retrieved from eea.government.bg. (In Bulgarian)
- Delipavlov, D. & Cheshmedzhiev, I. (Eds.). (2011). *Key to the plants in Bulgaria*. Plovdiv, Bulgaria: Academic Press Agricultural University. (In Bulgarian).
- IUCN. (2021). *The IUCN Red List of Threatened Species*. Version 2021-3. Retrieved from iucnredlist.org.
- Medicinal Plants Act. 2000. Promulgated. - *State Gazette*, 29, 07.04.2000. (In Bulgarian).
- Peev, D. (Eds). 2015. *Red Data Book of the Republic of Bulgaria. Vol. 1. Plants and Fungi*. Sofia, Bulgaria: BAS & MoEW.
- Petrova, A. & Vladimirov, V. (Eds). (2009). Red List of Bulgarian vascular plants. *Phytologia Balcanica*, 15(1), 63-94.
- Petrova, A., Vladimirov, V., Georgiev, V. (2013). *Invasive alien species of vascular plants in Bulgaria*. Sofia (Bulgaria): Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences. IBER – BAS, Sofia. 320 p. ISBN 978-954-9746-30-3. (In Bulgarian).
- Tutin, T.G., Burges, N.A., Chater, A.O., Edmondson, J.R., Heywood, V.H., Moore, D.M., Valentine, D.H., Walters, S.M. & Webb, D.A. (Eds.). (1964). *Flora Europaea. Vol. 1: Psilotaceae to Platanaceae*. Cambridge (UK). Cambridge University Press.
- Tutin, T.G., Heywood, V.H., Burges, N.A., Moore, D.M., Valentine, D.H., Walters, S.M. & Webb, D.A. (Eds.). (1968). *Flora Europaea. Vol. 2: Rosaceae to Umbelliferae*. Cambridge (UK). Cambridge University Press.
- Tutin, T.G., Heywood, V.H., Burges, N.A., Moore, D.M., Valentine, D.H., Walters, S.M. & Webb, D.A. (Eds.). (1972). *Flora Europaea. Vol. 3: Diapensiaceae to Myoporaceae*. Cambridge (UK). Cambridge University Press.
- Tutin, T.G., Heywood, V.H., Burges, N.A., Moore, D.M., Valentine, D.H., Walters, S.M. & Webb, D.A. (Eds.). (1980). *Flora Europaea. Vol. 4: Gentianeae to Gramineae*. Cambridge (UK). Cambridge University Press.

- Walters, S.M. & Webb, D.A. (Eds.). (1980). *Flora Europaea. Vol. 5: Alismataceae to Orchidaceae (Monocotyledones)*. Cambridge (UK). Cambridge University Press.
- Zahariev, D. (2016). Biodiversity of relict vascular plants in Bulgaria. *International Journal of Research Studies in Biosciences*, 4(1), 38-51.
- Zahariev, D. (2014). *Invasive plant species along the major rivers in Strandzha Natural Park*, Seminar of Ecology - 2014, Proceedings, Union of scientist in Bulgaria, IBER-BAS, 148-158.

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