Dimitar R. Peev

Studies on the biology of threatened plants of the Bulgarian flora

Abstract

Peev, D. R.: Studies on the biology of threatened plants of the Bulgarian flora. – Bocconea 5: 137-142. 1996. – ISSN 1120-4060.

More than 700 species of the Bulgarian vascular flora belong to the threatened or rare category, and 330 are protected by law. A classification according to 9 main criteria is presented, which shows that herbaceous perennials, cross-pollinated plants, those flowering in spring, etc., predominate. Detailed case histories are given for 6 species with very peculiar biological characteristics, and 10 further model cases of note are more briefly presented . Although 31 taxa appear to have become extinct in Bulgaria, the state of those surviving is generally satisfactory, except for a few growing in "hot spot" areas that are being closely monitored.

An overview of the present knowledge: the main sources

Information on the biology of Bulgarian threatened plants has increased in parallel with the production of the *Flora of Bulgaria* (Jordanov 1963-1989), in which more than 100 families have so far been treated.

In a few other works, mainly of a more or less ecological nature, fragmentary data on the biology of some species can be found (Gančev 1950; Jordanov & Peev 1966; Velčev & al. 1971, 1975; Mešinev 1975; Velčev & Vasilev 1976; Velčev & Bondev 1975).

For the last decade the main source of information has been the Bulgarian Plant red data book (Velčev & al. 1984) which includes specific information on the subject treated here.

Notes on higher plant biodiversity and on the number of threatened species

In spite of its small territory Bulgaria houses a rich vascular flora, with a higher number of species than much larger countries such as Poland and England. This flora comprises 130 families with 872 genera, 3534 species , 847 subspecies, and c. 2000 varieties; or, by principal groups: 58 species of pteridophytes, 16 species of gymnosperms, and 3460 species of angiosperms.

In the *Plant red data book for Bulgaria* (Velčev & al. 1984) it is noted that during the last 50 years 31 species of higher plants have become extinct in Bulgaria, 150 species are threatened with extinction, and 574 are qualified as rare, all of which are of great scientific and practical interest. 330 species are protected by the Bulgarian Law for the Protection of Nature (State Newspaper No. 56, of 21 July 1989).

Seven hundred Bulgarian threatened species as "standard" biological models

The "standard" category includes 700 species that exhibit biological features that are widely spread in different plant families, and in which no highly specific structures and functions can be observed. They can be classified according to 9 basic criteria, as follows:

Biological type. – Among the threatened plants in Bulgaria there are 568 species of herbaceous perennials, 127 annuals, 122 biennials, 12 subshrubs, 47 shrubs, and 18 trees. Because of the fact that several species belong in two (or more) different categories (for example, shrubs and small trees), the sum of the above figures exceeds 700. This also applies, by analogy, to the other criteria that follow.

Root system. – The species with axial root system (420) are most numerous. A significant number have bulbs (33) or tubers (23), which reflects a Mediterranean tendency. All other species (274) have different root systems.

Ecological type. – The threatened plant species that are xerophytes number 355. Nearly the same number are mesophytes (345). Threatened plants grow mainly on rocks, dry mountain slopes, and meadows, less frequently wetlands. Among the total one finds 14 free-floating and 11 rooted aquatics; 88 are strict chasmophytes and 25, strict psammophytes.

Soil. – Nearly half the species grow on calcareous ground or limestone rocks (332), 184 prefer siliceous soil. Another significant specialist group are the halophytes with about 20 species.

Pollination. – An analysis of pollination types shows that most threatened plants (530 species) have panmictic populations in which cross pollination prevails; 125 species are self-pollinating.

Flowering. – 584 species have their flowering peak from April to June. For 486 species it lies between July and September. In the trimesters January to March and October to December only 20 species can be seen in flower.

Fruiting. – 486 species ripe their fruits between July and August, 205 between May and June, and 347 between September and October. From March to April and in November or December only 20 species can be found bearing ripe fruits.

Reproduction. – 538 species reproduce mainly by seed, in 100 vegetative reproduction prevails, and in about 100, both types of reproduction are about balanced. These data are somewhat uncertain because of the occurrence of mixed reproduction types in some species.

Type of population (or clone). – Concerning the spatial structure of the populations, 171 species show a mosaic pattern, 48 have dispersed populations, 117, dense populations, and 478 occur as single individuals.

Six case histories of highly peculiar Bulgarian threatened plants

Each of the six species presented under this heading has its unique, very specific array of biological mechanisms. Many of their structures and functions occur comparatively rarely in other plants. I made this selection on the basis of the relative level of effective adaptation, although this assessment is admittedly subjective in some respects.

An "archaic" model: Isoetes setacea *Lam.* (Isoetaceae). – In Bulgaria this species is found only in small lakes on Mt Pirin, from 1200 to 2500 m a.s.l., submerged in shallow water. Its geographical distribution includes N. and Central Europe, W. Siberia and N. America. The stem is about 2.5 cm high, the leaves are trophosporophylls with specific trabeculae bearing the micro- and macrosporangia. The microsporangia are situated on the basal part of the inner leaves, the macrosporangia on the outer leaves. This structure and function is typical for the early evolutionary stage in primitive *Selaginellales, Lycopodiales* and *Psilophytales,* as in the Cretacean *Lycostrobus* thought to be ancestral to the recent *Isoetes. I. setacea* forms dense colonies in almost all Pirin lakes but is considered a rare species, being protected in the Pirin National Park.

Hygro-xerophytes: what kind of phenomenon? Haberlea rhodopensis *Friv.* (Gesneriaceae), *and anabiosis.* – This is a perennial, herbaceous plant, found in the central Stara planina and central to eastern Rhodopes, on silicate and limestone rocks, from 250 to 1400 m a.s.l. It is a Balkan endemic, extending to N. Greece. Reproduction in this cross-pollinated species, which forms dense populations, is both by seeds and vegetative. The following experimental data were obtained by Gančev (1950): (1) fully dry plants can be stored for a period of 31 months in the herbarium but when moistened they turn to life again; (2) dry plants survive at 71°C for 50 minutes in a thermostatic oven, where fresh plants also survive at 66°C for 56 minutes; (3) 22 hours after being moistened and exposed to normal light, the cells of the leaves begin functioning again; (4) dried plants have the ability to absorbe atmospheric moisture; (5) the paradox is that the anatomical structure of the leaves clearly pertains to a hygrophyte. The contradiction between hygromorphic structure and anabiotic function seems to result from an ancestral adaptation to the warm and wet Tertiary climate that has assumed a new function under the progressive drought of the Quaternary period. Biochemical investigations by Velčev & al. (1971) have shown that in the process of drying the activity of the alkaline phosphatase and the quantity of total proteins, sulphydril and disulphide groups increase considerably. A similar anabiotic capacity is observed in *R. serbica* Panč., of the same family.

Species or puzzle: Quercus thracica *Stef. & Nedjalkov* (Fagaceae). – An evergreen tree, of which but a single individual is known in the eastern Rhodopes, at 450 m a.s.l., on siliceous ground. It resembles *Q. coccifera* L. According to Stefanov (1969) it sets normal fruits. This phenomenon has caused puzzle, and means either that the tree is self-pollinating (which is not what one would normally expect in an anemophilous species), or that fertlization is effected by pollen from other species. Bondev (1966) supposes that

the tree itself is an old hybrid between *Q. troyana* Webb and *Q. coccifera* L., neither of which is presently found in this area, while Stefanov assumes that it results from abrupt mutation of *Q. cerris* L. Experimentally raised progeny shows clear hybrid segregation, with some plants coming very near to *Q. troyana* and others to *Q. coccifera*. Up to now the problem of the origin of *Q. thracica* is unsolved.

Life in the stony desert: Astragalus aitosensis *Ivan.* – A dwarf shrub confined to the Aitos area in eastern Stara planina, where it grows on silicate and limestone soil between 50 and 550 m a.s.l., covering a surface of about 1500 ha. The population density is considerable (megapopulation) due to successful generative and vegetative reproduction. The ecological characteristics of the locality can be considered as extreme. Over the last 50 years there have been more than 30 very dry periods of more than 20 days each. Throughout summer time (June-August) the absolute temperature maxima are about 45°C, and in winter (December-February) the absolute minima reach –21°C. According to Stefanov (1969) *A. aitosensis* can survive thanks to its very ample and deep root system. Velčev & Bondev (1975) state that the xeromorphic structure of the roots and leaves (some transformed into prickles and pricklets) as well as the dense indumentum also contribute to the successful development. In certain periods 40-80 young plants have been counted on an area of 100 m^2. Vegetative reproduction takes place only in relatively wet years. *A. aitosensis* is a Tertiary relic, included in the European list of threatened plants as a rare species.

The winner of the sea shore sands: Pancratium maritimum *L.* – This is a herbaceous perennial and strict psammophyte, growing in Bulgaria on sands and dunes along the southern Black Sea coast. Its geographical distribution comprises the Mediterranean area and western Caucasia. Good seed set and vegetative reproduction result in considerable population densities. According to Velčev & Vasilev (1976), the typical habitat of *P. maritimum* is very deep sand. Every season the contractile roots drag the bulbs a bit deeper, down to depths of about 140-160 cm, at a level where sea water soaks the sand. In this way, and in spite of the very dry and warm sand surface, the plant has a secure water supply. From mid-July to mid-August surface temperatures may reach 52°C (Peev, unpubl.) and the high osmotic pressure of the cell sap enables the plants to pump sea water. The very hydrophilic seed testa imbibes itself with rain water and so assists in the germination process, but when dry the seeds are very light and are dispersed by wind over long distances. In Bulgaria *P. maritimum* L. is considered an endangered species.

Has God really created this species, Primula deorum *Vel.?* – This herbaceous perennial is found only in Bulgaria, on Mt Rila, from 2000 to 2900 m a.s.l., on siliceous ground. The seasonal growth of *P. deorum* starts at the end of April, still under the snow. The first leaves form a very dense cone covered by a jelly-like substance, protecting them from freezing. Cross sections of the roots and leaves show that some cells are filled with that gelatinous substance (probably polysaccharids). Under experimental conditions the plants die at temperatures of –41°C. Reproduction by seed and vegetative reproduction are both successful, and the populations of *P. deorum* are very dense. *P. deorum* has no close relatives in the European flora. It occupies an intermediate position between the *Primula* groups *"Revolutae fariniferae"*, *"Revolutae efariniferae"*, and *"Involutae"*. According Jordanov & Peev (1966) it established itself

in its present habitats during the initial stages of the post-glacial period, immediately after the withdrawal of the Würm glaciers from the mountains of S.E. Europe. In the *Red data book of Bulgaria* (Velčev & al. 1984) this species is rated as rare.

Ten further specific model cases

Cercis siliquastrum L. *(Fabaceae)* shows cauliflory, a phenomenon typically found in the tropical forests. It occurs in the Mediterranean region and S.W. Asia.

Dracunculus vulgaris Schott is a typical representative of the *Araceae,* with a well developed, large red spathe, smelling very bad for people and very pleasantly for its pollinators. Its geographical distribution comprises S. Europe and Asia Minor.

Verbascum juruk Stef. *(Scrophulariaceae)* is a local endemic and probably arose from a mutation of *V. humile* Janka.

Lathraea rhodopaea Dingler *(Scrophulariaceae),* a root parasite on *Corylus, Alnus, Fagus,* and *Picea,* is widely distributed in Bulgaria, just extending to N. Greece.

Utricularia minor L., *U. vulgaris* L., and *U. neglecta* Lehm. *(Lentibulariaceae)* are carnivorous, endangered species of bogs and lakes. *U. minor* occurs in S. Central Europe, *U. vulgaris* extends to Siberia and N. America, and *U. neglecta* is European.

Heptaptera triquetra (Vent.) Tutin *(Apiaceae)* has a triangular stem and is endemic to Bulgaria and Turkey-in-Europe.

Eryngium maritimum L. *(Apiaceae)* is a well known example of a tumble weed, found along the coasts of Europe, Asia Minor, and N. Africa.

Trapa natans L. *(Trapaceae)* is a hydrophyte noteworthy for its cleistogamy and the specialized, submerged development of its seedlings. It ranges from the W. Mediterranean through S.W. Asia to Japan and China.

Ophrys cornuta Steven *(Orchidaceae)* is known for its pollination through pseudocopulation, the labellum of its flowers mimicking the females of *Gorites mistaceus* and *Enera tuberculata (Muscidae).* It is an E. Mediterranean taxon, ranging from the Balkan Peninsula through the Crimea and Asia Minor to the Caucasus.

Cyclamen coum Mill. *(Primulaceae)* has peculiar, spirally contracting pedicels that place the capsules at ground level, thus facilitating seed dispersal by ants. Its range comprises the areas bordering the Black Sea.

Discussion and conclusions

Most of the threatened species form panmict populations, indicative of the existence of effective gene exchange, perhaps dating back to the Tertiary period.

A majority are xerophytes, and one may hypothesize that drought stress has triggered active microevolutionary processes.

A considerable number of threatened plants survive in small, disjunct populations or in small numbers of individuals.

Among Bulgarian threatened plants, very specific biological model cases can be found, thought to represent adaptations at the peak of the evolutionary process.

Generally, the discussed species grow in protected areas and nature reserves, sheltered from the direct impact of Man.

So far environmental degradation has not drained the gene pools or impaired the biological functionality of the species here discussed. Some exceptional depletions that have been observed are of an oscillatory type and can be imputed to the normal range of population fluctuations.

A real decline and concomitant negative changes have been observed in plant species occurring in so-called hot-spot areas. They are under close and constant scrutiny by the Bulgarian Phytomonitoring System.

In general terms, however, the adaptability, plasticity and resilience of the taxa that, taken together, make up the Bulgarian genetic heritage is considerable, and good hope exists for their survival.

Let plants live as they have been created, and everything will once again be included in the great homoeostasis.

References

Bondev, I. & Kočev, H. 1961: Vărhu biologijata na pokălvane na semenata na njakoi višokoplaninski trevisti rastenija. – Izv. Bot. Inst. (Sofija). **8:** 117-128.

Gančev, I. 1950: Anabiotična suhoustojčivost i drugi biologični osobenosti na *Haberlea rhodopensis* Friv. – Izv. Bot. Inst. (Sofija) **1:** 191-213.

Jordanov, D. (ed.) 1963-1989: Flora na Narodna Republika Bălgarija, **1-9.** – Sofjia.

– & Peev, D. 1966: Opit za cjalostno proučvane na rilskata iglika *Primula deorum* Vel. – Izv. Bot. Inst. (Sofija). **16:** 5-28.

Mešinev, T. 1975: Germination of *Potentilla fruticosa* L. seed under natural and experimental condition. – Pp. 185-191 in: Anonymous (ed.), V čest na Akademik Daki Jordanov. – Sofija.

Stefanov, B. 1969: Strange forms in plants. – Sofija.

Velčev, V. & Bondev, I. 1975: Razprostranenie, ekologo-biologični osobenosti i fitocenologična harakteristika na *Astragalus aitosensis* Ivanisch. – Pp. 121-159 in: Anonymous (ed.), V čest na Akademik Daki Jordanov. – Sofija.

– , Gančev, S. & Vasilev, P. 1975: Ekologo-biologično proučvane na *Ramonda serbica* Panč. i *Haberlea rhodopensis* Friv. – Pp. 175-184 in: Anonymous (ed.), V čest na Akademik Daki Jordanov. – Sofija.

– , Kožuharov, S., Bondev, I., Kuzmanov, B., Markova, M. & Velev, V. (ed.) 1984: Červena kniga na NR Bălgarija, **1.** – Sofija.

– , Rašev, Z. & Vasilev, P. 1971: Njakoi biohimični proučvanija na *Ramonda serbica* Panč. i *Haberlea rhodopensis* Friv. văv vrăzka s izjasnjavane na ekologo-biologičnite im osobenosti. – Izv. Bot. Inst. (Sofija) **21:** 69-76.

– & Vasilev, P. 1976: Ekologo-biologično i fitocenologično proučvane na pjasačnata lilija (*Pancratium maritimum* L.) v rajona Sozopol. – Fitologija **5:** 3-20.

Address of the author:
Dimitar R. Peev, Institute of Botany, Bulgarian Academy of Sciences, Acad. G. Bončev str., BG-1113 Sofija, Bulgaria.