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New data on *Edraianthus serbicus* (K e r n.) P e t r o v i c in Bulgaria

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Abstract. The limited distribution of *Edraianthus serbicus* is related to the low competitiveness of the species and low germinating capacity of its seeds. Its spatial population structure is unhomogeneous. Its reproductive capacity is high, but unfulfilled spontaneously. Afforestation campaigns in the areas of its distribution have a particularly adverse effect on the existence and development of populations of *Edraianthus serbicus*.

Key words: *Edraianthus serbicus* (K e r n.) P e t r o v i c, rare species, population structure, reproduction.

Introduction

Edraianthus serbicus is a species endemic to West Bulgaria and East Serbia. It occupies a rather limited area, which makes it ecologically vulnerable on an European scale. Besides the taxonomical (B e c k 1893; W e t t s t e i n 1887; J a n c h e n 1910) data on the species and the caryological (K u z m a n o v 1973, 1993; K u z m a n o v & al.1992) data on the genus, the research into the ecological and biological specificities of *Edraianthus serbicus* is chiefly limited to a monograph by L a k u s i c (1973). No special studies into this species have been so far conducted in Bulgaria.

In 1990, in one of the localities of this species, Mt Golo Burdo, a plot was mapped out in order to establish the spatial structure and to trace out the destiny of that population in the course of time. Along with this some new biological and ecological characteristics of *Edraianthus serbicus* have been observed in three different points within its area in the country. This article presents the results of that study, which hopefully shall throw new light on the knowledge of this rare species.

Methods and object of study

Distribution of *Edraianthus serbicus* in Bulgaria is limited to the calcareous frontier mountains of the country (Fig.1). Populations of *Edraianthus serbicus* located in the Golo Burdo, Chepun and Konyavska mountains were object of study. The number of reproductive shoots and of flowers in an inflorescence were registered in all three localities. In 1990 an area in Golo Burdo, lying at 42°33'6" N and 23°3'13" E, and totalling 703 m^2 was mapped out. The mapping was made by a network of 1×1 m squares outlined on the terrain with the help of ropes, measuring roulette and durable markers. The data were plotted on graph paper.

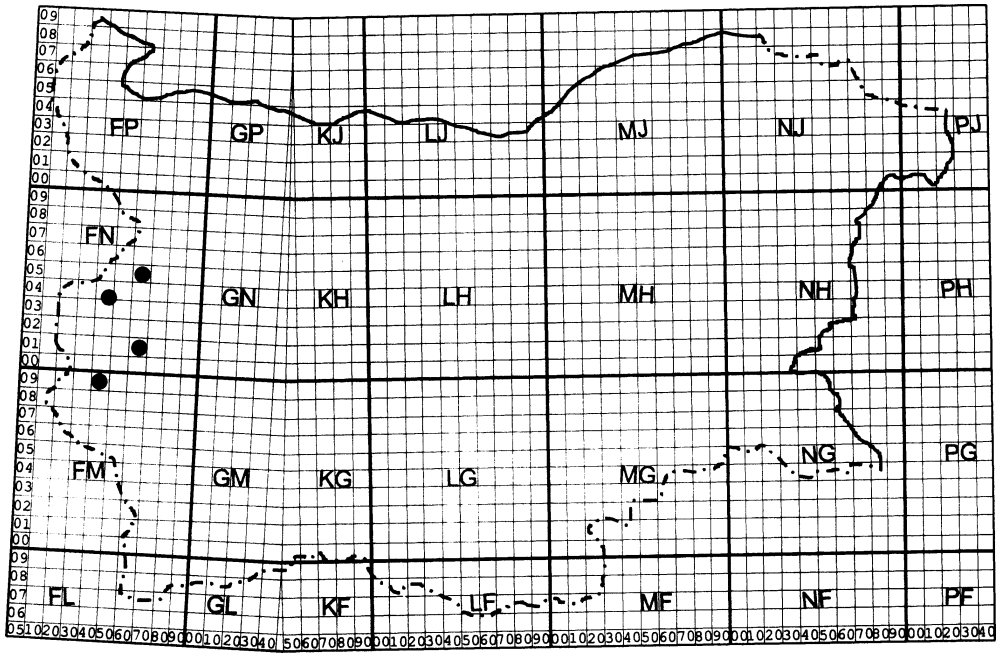

Fig.1. Distribution of *Edraianthus serbicus* (K e r n.) P e t r o v i c in Bulgaria

In the region of Mt Golo Burdo 60 specimens were durably marked (with plastic labels) so as to trace out the number of developed flowers in the different years.

Germination was monitored under laboratory conditions, in Petri dishes, under temperature 18-20°C, both under 24-hour lighting and under permanent darkness. Another experiment was set for observing the effect of acidity on germination in gradient values: pH 5.5, 6, 7 (with the addition of sodium), 7 (with the addition of sodium and potassium), 8 and 9. For the purposes of statistical repetition 100 seeds were used for each experimental version. The seeds were collected in August 1990 and the experiment was set in 1991.

Morisita's Index (G r e i g - S m i t h 1964) was calculated by the formula

$I=q\Sigma n_i(n_i-1)/N(N-1)$,

where q is the total number of the used plots; n_i is the number of specimens in the respective plot, while N is the total number of specimens. Accodring to the interpretation of this index, values above 1 proved the unhomogeneous spatial structure of the population, while the degree was expressed by the abosolute value of the obtained coefficient.

Results and discussion

In all visited habitats the species occupied open rocky terrains, with southern exposition or exposition with a southern component. In this parameter our studies differed from that characteristic of species mentioned by L a k u s i c (1973),

who maintained that it had western or eastern composition, seldom with a southern or a northern component. Rock base was calcareous in all locations. Within the limits of its distribution *Edraianthus serbicus* inhabited mainly rock crevices or terrains with large outcrops of the base rock, which was characteristic of its not very competitive nature.

In all three points of observation *Edraianthus serbicus* participated in open-structured, xerothermic plant communities of calciphytes. In none of these had it a dominating role. These communities were characteristic with a rich species composition. The phytocoenotic characteristic of the communities with the participation of *Edraianthus serbicus* was studied by V e l c h e v (1962) and V a s i l e v (unpublished data).

Population density was as follows: on Mt Konyavska (in the region of peak Viden, established in 1992) - 21.36 specimens/m^2; on Mt Golo Burdo (on the territory of the mapped plot, established in 1990) - 0.42 specimens/m^2; on Mt Chepun (on the southern slopes, above Dragoman, established in 1992) - 0.35 specimens/m^2. These values featured the population on Mt Konyavska as densest and most abundant.

The spatial structure of the investigated populations was unhomogeneous. This became particularly clear from the values of Morisita's Index, which varied between 2.42 (Mt Konyavska) and 4.03 (Mt Golo Burdo). The spatial structure of the mapped population is presented in Fig. 2. At the beginning of the studies the mapped plot neighboured on an area afforested with Black Pine about 5 years ago. For the purposes of afforestation some trenches for tree planting were dug out in that region, including on the territory of population of *Edraianthus serbicus*. They seemed to have provided a good environment for the investigated species, which lacked the strong competitiveness of the local species, which in turn were probably affected by the digging activities. Moreover, not all trenches were planted with young seedlings of Black Pine (*Pinus nigra*).

In the course of 9 years the seedlings of Black Pine grew and began to close their canopy. This development of the forest gradually began to reduce the space and numbers of the population of *Edraianthus serbicus*. Finally, of the 294 specimens registered in 1990 in that area 61 specimens were established in 1998. The entire area to the southwest of the 15th meter on the map is virtually covered with a young Black Pine forest now, and *Edraianthus serbicus* is missing. This means that 80% of the population has died out. An evidence that the specimens of investigated species were inhibited was the fact that the average number of reproductive shoots per specimen has dropped from 4.38 in 1990 to 1.6 in 1998. If this tendency retains, a slow dying out of the population could be anticipated. In our opinion, the main reason for this was the encroachment of Black Pine. In his monograph on the species L a k u s i c (1974) emphasized that there were no forest species among the representatives of the genus.

All data obtained on the number of flower-bearing shoots per specimen are summarized in Table 1. The specimens formed a different number of reproductive shoots in the different years, but no conformity with any specific law could be claimed (Table 2).

Specimens on which no reproductive shoots developed varied from 1.6 % to 11.7 % in the years under observation. Development of flower-bearing shoots by the

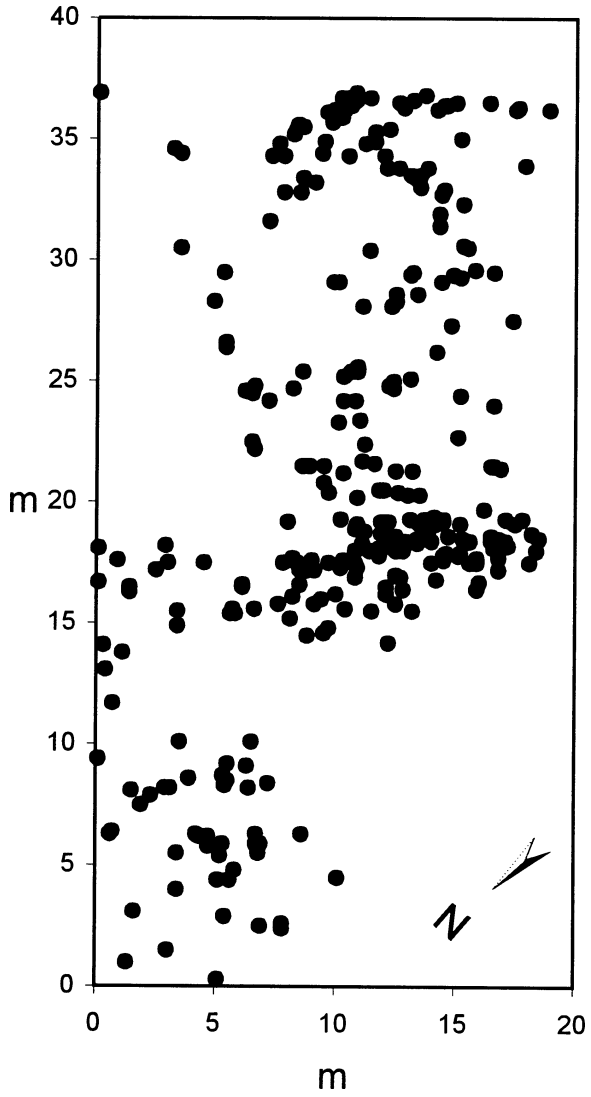

Fig.2. Scheme of the spatial distribution of *Edraianthus serbicus* population in Golo Burdo Mt.

different specimens slightly varied in the three localities. Irrespective of their high numbers and density, or probably just because of that, the specimens from Mt Konyavska formed a lesser number of reproductive shoots. Plants with 1 flower-bearing shoot occured with the highest degree of probability there as compared to Mt Golo Burdo, where their number was 4 and Chepun, where it was 3.

Each shoot developed between 1 and 10 flowers. Distribution of values by that parameter was very close to normal, which was corroborated by the low symmetry index values on the skewness curve (Table 3). Thus the mean values were sufficiently informative and showed that the number of flowers per one inflorescence was a rather conservative characteristic of the species, which retained its values irrespective of locality.

Table 1. Statistical data on the values of flower-bearing shoots in the different localities

Locality	Mean	Confidence level (95%)	Median	Mode	Standard deviation	Sample variance	Skewness	Max.	Min.	Count
Golo Burdo Mt	4.00	0.49	4	4	2.47	6.10	1.64	16	1	100
Konyavska Mt	2.83	0.35	2	1	1.95	3.82	1.43	10	1	125
Chepun Mt	3.24	0.54	3	3	2.33	5.43	1.95	13	1	75

In order to get an idea of the reproductive capacities of the species, we counted the number of seeds per pod. The results showed (Table 4) between 6 and 53 seeds in a pod. Considering the fact that typically 12 seeds form per flower, it could be stated that the mean seed output per plant was about 216 seeds. Related to the number of specimens per 1 m^2, this accounted for a significant seed output (from about 76 to 4614 seeds per 1m^2 in the different localities) which, judging by the total number of adult specimens, indicated a very low germination and high mortality of the young plants.

Considering the well known for a number of species necessity to have a period of dormancy before starting the process of germination, seeds collected in the preceding year have been used in the experiments. So it was impossible to say how long was the period of dormancy of seeds of *Edraianthus serbicus*, if any, but apparently in the spirng next year they fulfiled their germinating capacity. The conducted laboratory experiments proved that *Edraianthus serbicus* had low seed germination. Of a total of 200 seeds set in a thermostat under 38°C none germinated whatsoever. Under 24 h of lighting and room temperature of 18-20°C (an experiment carried out from 2 IV 1991 to 2 VII 1991) germination showed 14% of positive results. In an experimental version kept permanently in the dark germination was 15%, which testified that light did not have any significant influence on the germination of seeds. Changes in the acidity also did not reflect tangibly on germination:

pH	5.5	6	7 Na	7 Na+K	8	9
Percentage of germinated seeds	4%	6%	9%	8%	2%	7%

Conclusion

Edraianthus serbicus is a rare species for the Bulgarian flora, with a relatively limited area. The reproductive capacity of the species spontaneously is not fulfilled to the full, because a very small percentage of its seed output leads to formation of adult flowering and fruit-bearing specimens. One reason for that is the low germination of seeds. The question of how vital are the seeds of *Edraianthus serbicus* remains open. The poor competitiveness of this species accounts for its distribution chiefly in rock crevices and rocky, eroded terrains and open communities.

As a representative of ancient species of its genus (L a k u s i c 1973),

Table 2. Nubmer of reproductive shoots recorded in Mt Golo Burdo in the 1990-1992 period

Specimen No	1990	1991	1992
1	0	5	2
2	2	5	2
3	7	7	5
4	6	6	4
5	0	5	3
6	6	5	2
7	4	6	3
8	4	6	1
9	9	7	4
10	11	6	7
11	8	13	3
12	11	10	4
13	0	2	1
14	5	5	1
15	3	3	3
16	11	6	0
17	6	6	2
18	7	5	1
19	4	4	2
20	5	4	Dead
21	3	6	2
22	3	5	1
23	6	1	4
24	4	2	1
25	6	3	Dead
26	3	1	Dead
27	1	0	Dead
28	5	2	3
29	1	1	Dead
30	0	4	0
31	3	4	0
32	10	4	1
33	7	5	2
34	7	5	Dead
35	13	11	1
36	1	6	2
37	0	2	Dead
38	3	5	5
39	10	1	2
40	2	2	0

Edraianthus serbicus favours in particular the open and sunny habitats typical of this species. Along these lines, anthropogenic impact in the regions of its distribution has an adverse effect on the species caused by afforestation campaigns and can strongly limit the spatial borders of its populations. The only area in Bulgaria where *Edraianthus serbicus* is protected is the Ostritsa Natural Reserve on Mt Golo Burdo.

Table 3. Statistical data on the nubmer of flowers per inflorescence in the different localities

Locality	Mean	Confidence level (95%)	Median	Mode	Standard deviation	Sample variance	Skewness	Max.	Min.	Count
Golo Burdo Mt	6.39	0.17	7	7	1.50	1.50	-0.63	9	2	303
Konyavska Mt	6.42	0.31	6	6	1.41	1.41	-0.32	9	2	81
Chepun Mt	6.09	0.38	6	6	2.18	2.18	-0.51	10	1	128

Table 4. Statistical data on the nubmer of seeds per pod of combained samples

Mean	17.5
Median	14
Mode	12
Standard deviation	9.34
Sample variance	87.24
Skewness	1.61
Count	50
Max.	53
Min.	6
Confidence level(95.0%)	2.65

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