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# Conservation status of the rare species *Betula nana* in the peatbog Tinovul Luci (the Harghita Mountains, Romania)

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**Abstract.** The aim of the study was to assess the conservation status of the boreal relict plant species *Betula nana* in one of the southernmost site of its range - the Natura 2000 site ROSCI0246 Tinovul Luci (Harghita county, Romania). Data collected in the field were confronted with that published in 1930 and 1960. Our findings show that *Betula nana* is critically endangered (CR) in the studied site, with a high risk of becoming extinct in the near future. The main threat is the change of habitat, which may be reversed, in part, by decreasing the cover of the tree layer.

**Keywords:** *Betula nana*, biodiversity conservation, Natura 2000, peatbog.

## Introduction

*Batula nana* L. (dwarf birch) is a small shrub, up to 1m height, with circumpolar distribution and several isolated occurrences in the mountains of temperate zone. In Romania it is a glacial relict, preserved in only two peatbogs of the Eastern Carpathians (Pop, 1928; Raţiu, 1967) – Găina-Lucina (SV) and Luci (HR). It is listed in the Red Book (Dihoru and Negrean, 2009) as critically endangered (CR) at national level (IUCN, 2012). The peatbog Tinovul Luci, at 46°12' N, is at the southernmost rear edge of global range of *Betula nana*. This peatbog is laying on the place of an old volcano, located in the Harghita Mountains of Eastern Carpathians, at an altitude of 1080 m. With its 120 ha, it is one of the largest peatbogs in Romania (Pop, 1960; Şofletea and Curtu, 2008). It was declared botanical reserve in 1995 and Natura 2000 site in the year 2008 (ROSCI0246). The forests inside are managed by two forest districts, F.D. Miercurea Ciuc (190 ha) and F.D. Tălişoara (89 ha).

The state of art regarding the dwarf birch on this protected area dates from 1926-1928 (Nyárády, 1926; Pop, 1928), and the newest came from 1973 (Dihoru and Negrean, 2009).

The aim of this study is to assess the conservation status of *Betula nana* in the peatbog Tinovul Luci in order to establish the proper management measures. The objectives were: (i) to establish the population's size and range, (ii) to analyze species habitat and the main driving factors, (iii) to investigate the regeneration capabilities, (iv) to identify actual and potential threats on species and/or its habitat.

## Materials and methods

Data from forest management plans and literature (Nyárády, 1926; Pop, 1928, 1960) was processed and a map with potential habitat of *Betula nana* was created, using QGis software (www.qgis.org). The species range was mapped as grid-cells of 50x50 m.

Six field trips were carried out in 03.06, 24.06, 08.07, 16.07, 21.10, 02.11.2017. Observations were made along transects covering 377 grid-cells out of 503, i.e. 75% of the area of the peatbog.

The following habitat parameters were measured: the distance between *Betula nana* groups and the nearest water pond or stream, water temperature in the peatbog near *Betula nana*, soil temperature in the 2 forest types – pine and spruce dominated, soil reaction in the A horizon with a Hellige pH-meter, depth of watertable at 4-5 m away from *Betula nana* grups using a drill and a tape line. The temperature was read around 12 o'clock, in 2 repetitions on 3 June and 8 July, on an electronic device with 1% accuracy. The plant communities in which *Betula nana* grows were described by 2 relevés with an area of 25 $m^2$. The climate aridity was expressed through the Ellenberg quotient: $EQ=T_{VII}/P \cdot 1000$, where $T_{VII}$ is the temperature of warmest month (July) and P the annual sum of precipitations (Ellenberg, 1992). The yearly values of $T_{VII}$ and P were extracted from ROCADA grids (Dumitrescu and Bîrsan, 2015).

Population parameters were: number and height of shoots, shoots diameter at ground level, vegetative growth, capability of sexual reproduction (inflorescences, fruits and seedlings). Threats and pressures were assessed by personal observations and information gathered from local foresters. The number of individuals was not counted but inferred since we try to limit the stress upon the species, i.e. we didn't check the underground connections between stems. An individual was regarded as a bunch of shoots close enough (in a range of 1 m) to form a genet. A shoot was considered the aerial part of a plant emerging separatedly from the ground. Further, a group refers to all neighbouring individuals (as defined above) clearly distant (>10 m) from other conspecific plants.

The species names follow Sârbu *et al.* (2013) for vascular species and Frey *et al.* (2006) for bryophytes.

## Results and discussions

There were identified 6 groups of *Betula nana* spread within only three grid-cells (Fig. 1). The biggest distance between groups is 220 m. There were counted 139 shoots with a range of 8-47 shoots/group. We assume that were encountered no more than 20-22 individuals. The height of *Betula nana* shoots varies between 5 and 65 cm; the diameter of shoots at the ground level is at most 1.5 cm.

Soil temperature under pine stand reaches 11-12 °C during summer; it exceeds by 2-3 °C that of spruce stand and by 4-5 °C that of the neighbouring stream. The peatbog is very strong acidic, with pH=3.5-4.3.

The water table was at 40-50 cm depth during summer.

The vegetation around *Betula nana* is a Bog woodland (91D0*), a priority Natura 2000 habitat (Gafta and Mountford, 2008). It may be classified into the association *Vaccinio uliginosi-Pinetum sylvestris* Kleist 1929 em. Matusz. 1962 (Coldea and Plămadă, 1989; Coldea *et al.*, 2015). The canopy is dominated by *Pinus sylvestris*, with scarce admixture of *Picea abies* or *Betula pubescens*. On the herb layer prevail *Vaccinium myrtillus* and *V. vitis-idaea*. The moss layer is a continuous and thick blanket of *Sphagnum* species. Overall, the floristic composition is typical for the habitat, free of non-native, ruderal or invasive species. Among characteristic species are *Andromeda polifolia, Betula pubescens, Empetrum nigrum, Eriophorum vaginatum, Polytrichum strictum, Sphagnum capillifolium, S. fallax, S. fuscum, S. magellanicum*.

Relevé 1 – Altitude 1080 m, Slope 0°, Area 25 m$^2$; Tree layer (40%): *Pinus sylvestris* 3, Shrub layer (2%): *Betula nana* +, *Pinus sylvestris* (juv.) +, *Picea abies* (juv.) +, *Betula pubescens* (juv.) +, Herb layer (40%): *Vaccinium myrtillus* 2, *Vaccinium vitis-idaea* 2, *Andromeda polifolia* +, *Eriophorum vaginatum* +, Moss layer (100%): *Sphagnum capillifolium* 5, *Polytrichum strictum* 1, *Sphagnum girgensohnii* 1, *Pleurozium schreberi* 1, *Dicranum scoparium* +, *Sphagnum magellanicum* +, *Sphagnum angustifolium* +.

Relevé 2 – Altitude 1080 m, Slope 0°, Area 25 m$^2$; Tree layer (40%): *Pinus sylvestris* 3, *Picea abies* 1; Shrub layer (5%): *Picea abies* 1, *Betula nana* 1; Herb layer (60%): *Vaccinium myrtillus* 3, *Vaccinium vitis-idaea* 3, *Eriophorum vaginatum* 1, Moss layer (95%): *Sphagnum angustifolium* 3, *Sphagnum capillifolium* 2, *Sphagnum girgensohnii* 1, *Sphagnum magellanicum* 1, *Polytrichum strictum* 1, *Pleurozium schreberi* 1, *Dicranum scoparium* +.

The previous descriptions of *dwarf birch* on Luci mentioned large bushes and frequent fruit production (Nyárády, 1926; Pop, 1928, 1960). Later on, vegetation surveys from 1976 of Coldea and Plămadă (1989) reveals a lower frequency for this species.

During our survey in 2017, only a few individuals of *Betula nana* were identified, without inflorescences or fruits. Probably the population ceased the sexual reproduction, being exposed to low genetic diversity. The main cause of species decline may be the change of habitat conditions. As a light demanding, hygrophilous, pioneer species (Ellenberg, 1992; De Groot, 1997; Sârbu *et al.*, 2013; Drzymulska, 2014) it may suffer in a shady forested peatbog. One argument is given by species physiology. *Betula nana* requires at least 2300 lux during summer to achieve the photosynthetic compensation point (photosynthesis greater than respiration); comparatively, the Scots Pine, a light demanding species too, can reach this point at only 1000 lux (Ellenberg, 1992). Moreover, the importance of light on *Betula nana* survival is confirmed by past observations on Luci and the current state at Găina-Lucina where *Betula nana* is in better conditions, as the habitat is more open – 7110* Active raised bogs (Pop, 1928; Ursu *et al.*, 2017). During interwar time the Luci peatbog had patches without or with very low cover of trees, where *Betula nana* was most abundant; on the contrary, the species grew seldom, as disperse, isolated stems under the pine canopy (Pop, 1960).

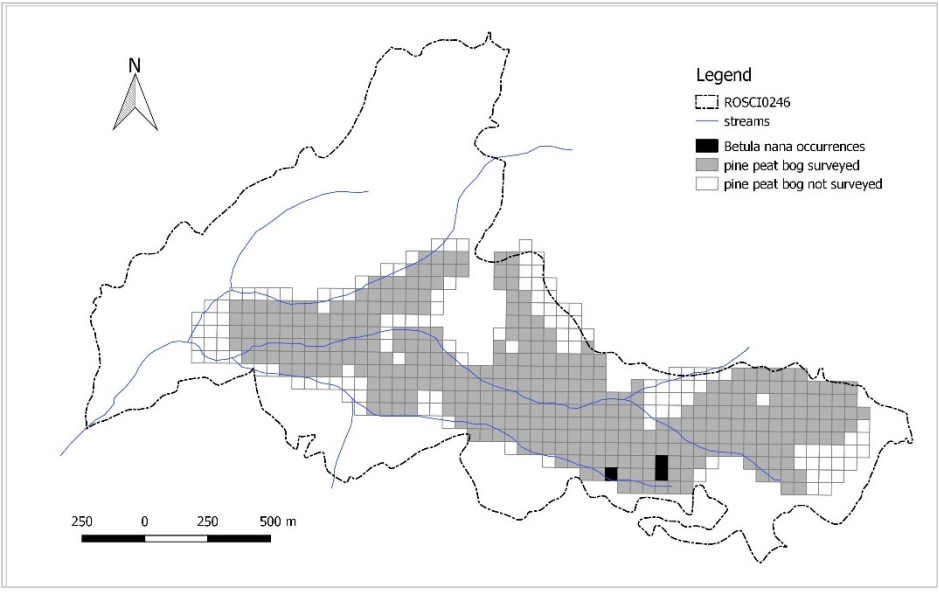


**Figure 1.** The occurence of *Betula nana* and its potential habitat, peatbog with *Pinus sylvestris*, in Tinovul Luci Natura 2000 site (ROSCI0246)

Nowadays, the light availability on the ground level decreases as pine trees' height and crown increase. On its subarctic range *Betula nana* can grow inside forests, but at lower latitudes the shading effect is more severe as the daylight during growing season is smaller. In former times, the forest gaps inside Luci bogland could have had secondary, man-made origins. At that time, the peat was used as bed for livestock; the forest was felled; sometimes fires were started by local villagers or shepherds in order to run away the bears. Obviously, the peat removal had a negative impact on all plants, but later on *Betula nana* was favored by reduced competition stress of pine, spruce and bilberry. Nowadays, the light regime and competition became unfavourable for the dwarf birch as disturbances diminish and the pine grows. Indirect effects may be on development of *Sphagnum* layer and evapotranspiration.

The time series of aridity index at Luci area for 1961-2013 shows occurrences of drought (EQ>30) on the last 25 years (Fig. 2). Comparatively, at Găina-Lucina the ombrothermic regime is more favorable and could maintain the habitat open. It is known that in the sub-continental climate of Eastern Europe the precipitation amount is usually insufficient to prevent peat bogs afforestation (Ellenberg, 1992). Therefore, in such sub-optimal conditions the favorability for trees may be rapidly shifted either by disturbances or by small climatic changes/ fluctuations. It is challenging to know if the passive preservation regime (non-intervention) in Tinovul Luci counted for such changes on *Betula nana*, i.e. favouring the natural succession toward bog woodland. Analysis of long-term vegetation dynamic in Luci area reveals the role of human impact in the modern age: the increase of pine is related with a sharp decline of beech (Tanţău *et al.*, 2003).

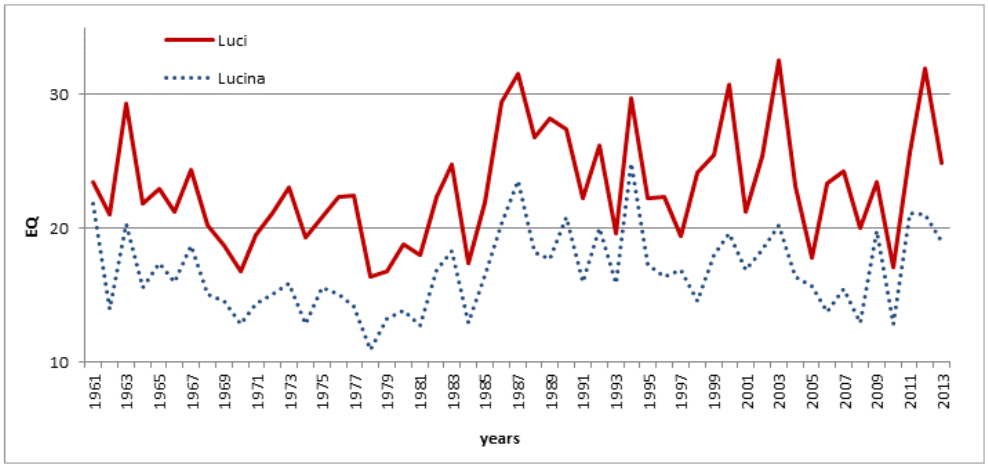


**Figure 2.** Variations of aridity Ellenberg quotient (EQ) during 1961-2013 for the neighbouring of Luci (HR) and Găina-Lucina (SV) peatbogs

Some human pressures upon reserve are encountered nowadays. The most obvious is the berry harvesting, that leads to trampling, brushing and, the worst of all, accumulation of plastic waste. Accidentally, livestock passage can occur, without significant impact. The effect of these pressures upon the dwarf birch may be inferred only, since no direct relationship was observed. The use of combs for berries harvesting may cause injuries to branches, leaves or twigs of *Betula nana.* Nevertheless, this pressure may not have a significant impact, since the species is resistant/resilient to tearing or grazing (De Groot *et al.*, 1997).

Overall, the conservation status of *Betula nana* on the Natura 2000 site Tinovul Luci was assessed as unfavourable bad (Tab. 1).

The following management measures are recommended:

- monitoring the population every year, due to its severe scarcity.

- improving habitat condition by decreasing canopy cover and creating small gaps in the pine stands around *Betula nana*; although the pine forest is a priority habitat, 91D0*, the EU regulations allow or even recommend to remove trees in order to restore the true raised bogs of type 7110*, 7130*, 7140* (Gafta and Mountford, 2008).

- planting saplings of dwarf birch obtained from seeds collected from other sites; the aim is to diminish genetic decline of local population.

- conducting controlled fertilization in order to increase shoots meristematic activity of dwarf birch (Bret-Harte *et al.*, 2001).

- regulating berries harvesting inside the protected area, harmonized with the objectives of Natura 2000; being a traditional activity it can't be simply banned, but it may be bind with conservation awareness.

**Table 1.** Assessment of the conservation status of *Betula nana* on Luci peatbog

| **Parameter** | **Description** | **Assessment** |
|---|---|---|
| Area of ocuppancy | 7500 $m^2$ | unfavourable bad |
| Area trend | decreasing | |
| Population size | < 25 indiv. | unfavourable bad |
| Population trend | decreasing | |
| Habitat area | 125 ha | unfavourable bad |
| Habitat quality | poor, in terms of light conditions | |
| Habitat trend | stable | |
| Threats | competition for light; low genetic diversity | unfavourable bad |
| Overall | | unfavourable bad |

To the above assessment it should be add that the Luci's population of dwarf birch is geographically and genetically isolated. The nearest known conspecific population is more than 155 km away, at Găina-Lucina. Thus, *Betula nana* is facing an extremely high risk of extinction at the site level, corresponding to the IUCN category critically endangered (CR) (IUCN, 2012).

## Conclusions

The dwarf birch in Luci peatbog is in a severe decline, having a very small, isolated population, with limited area of occupancy, habitat favourability and amphimixis. At site level this species is critically endangered (CR) and dedicated management actions are urgent. The current absence of a conservation strategy may be explained by the lack of a custodian and the division of forest management between two forest districts.

This study aimed to point out the vulnerability of a relict species and the related unfavourable effects of non-intervention strategy. As a key species of the Luci peatbog ecosystem, the dwarf birch deserves special attention and pertinent planning of protective actions.

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