András Bankovics & Orsolya Mile

The LIFE-Project "Conservation of the Pannon endemic *Dianthus diutinus* (2006-2011)"

Abstract

The LIFE-Nature project 'Conservation of the pannon endemic *Dianthus diutinus*' started in 2006 in order to stabilize the wild populations of *Dianthus diutinus* in its most important sites.
The natural habitats of the species are mosaics of open perennial grasslands and clusters of native trees, where *Dianthus diutinus* mostly occurs in the open grasslands. These habitats have been fragmented in the past 50 years mainly due to forestry activity, and recently most of them are classified as forests. The species is present in two priority habitat types of Community interest: Pannonic inland sand dune thicket (*Junipero-Populetum albae*) (91N0) and Pannonic sand steppes (6260) listed in Annex I of Habitat Directive.
Conservation measures have been implemented on the 3 most important sites of *Dianthus diutinus* (Bodoglár, Bócsa, Csévharaszt) for the enlargement and unification of its present habitats. Habitat reconstructions took place in tree plantations of non-indigenous species with high canopy cover. 27 hectares of European Black Pine plantations have been thinned at Bodoglár, and 17 hectares were cut to create glades. Altogether 46 hectares of Black Locust forests were cut in Bócsa and Csévharaszt to convert these sites into habitats with clusters of native tree species. As a result, the potential area beneficial for *Dianthus diutinus* at the three sites had reached 455 hectares.
Monitoring results show that the surface area of grassland has increased at Bodoglár after Black Pine thinning, while native poplar shoots appeared in Bócsa where soil conditions are better. In the meanwhile, counting of *Dianthus diutinus* individuals has been done continuously throughout the 5 years of the project. According to the results, the total number of endemic plant individuals has significantly increased, from 20 thousand in 2007 to more than 97 thousand by 2011.
Additionally, as part of the *ex situ*-conservation, 19 thousand young plants were reared at the Botanic Garden of the University of Szeged, which had further strengthened the natural populations after outplanting. However, there are still important actions to be carried out in the future. Shoots of *Robinia pseudoacacia* have to be treated with mechanical and chemical methods for several years, together with the significantly reduced stands of *Asclepias syriaca* in the project sites.

Das LIFE-Projekt „Schutz des Pannonischen Endemiten *Dianthus diutinus* (2006–2011)"

Zusammenfassung

Das LIFE-Natur-Projekt „Schutz des Pannonischen Endemiten *Dianthus diutinus*" (2006–2011) hatte die Stabilisierung der Wild-Populationen von *Dianthus diutinus* an ihren wichtigsten Wuchsorten zum Ziel. Die natürlichen Habitate der Art sind Mosaike aus offenen Dauergrasländern und Gruppen einheimischer Gehölze, wobei *Dianthus diutinus* vor allem in den offenen Grasländern vorkommt. Diese Habitate wurden in den letzten 50 Jahren besonders durch forstliche Aktivitäten stark fragmentiert und aktuell werden die meisten von ihnen als Wald eingestuft. Die Art kommt in zwei Habitat-Typen vor, die von gemeinschaftlichem Interesse sind: Pannonische Inland-Sanddünen-Gebüsche (*Junipero-Populetum albae*) (91N0) und Pannonische Sandsteppen (6260) (Anhang I der FFH-Richtlinie).
Schutzmaßnahmen zur Vergrößerung und Vereinheitlichung der bestehenden Habitate wurden an den drei wichtigsten Fundorten (Bodoglár, Bócsa, Csévharaszt) von *Dianthus diutinus* durchgeführt. Habitat-Rekonstruktionen fanden in drei Anpflanzungen nicht-einheimischer Gehölzarten mit hoher Kronendichte statt. In Bodoglár wurden 27 ha Schwarzkiefer-Anpflanzungen ausgelichtet und 17 ha gerodet, um Lichtungen zu schaffen. In Bócsa und Csévharaszt wurden 39 ha Robinienforst gefällt, um diese Flächen in Habitate mit Gruppen einheimischer Gehölze umzuwandeln. Im Ergebnis dieser Maßnahmen konnte die potentiell durch *Dianthus diutinus* zu besiedelnde Fläche auf 455 ha vergrößert werden. Das Monitoring zeigte, dass sich die Ausdehnung der Grasland-Flächen in Bodoglár nach der Auslichtung der Schwarzkiefern vergrößert hat. In Bócsa, wo die Bodenbedingungen besser sind, wuchsen hingegen zahlreiche einheimische Pappeln auf. Während der Laufzeit des Projektes wurden die Individuen von *Dianthus diutinus* jährlich gezählt. Ihre Gesamtzahl stieg von 20.000 im Jahr 2007 auf 95.000 im Jahr 2011. Zusätzlich wurden als *ex situ*-Maßnahme im Botanischen Garten der Universität Szeged 19.000 Jungpflanzen angezogen und später zur Stabilisierung der Bestände in den natürlichen Populationen ausgepflanzt. Aufgaben, die in den Projektgebieten auch zukünftig fortgeführt werden müssen, sind die Behandlung der Robinien-Schößlinge sowie der – signifikant reduzierten – Bestände von *Asclepias syriaca* mit mechanischen und chemischen Methoden.

1 *Dianthus diutinus* and its habitat

Dianthus diutinus Kit. is a very rare character species (Fig. 1) of the native plant association *Festucetum vaginatae* Rapaics ex Soó 1929 of the plains in Hungary. *D. diutinus* is endemic to the Pannonian biogeographical region. It is strictly protected by Hungarian law and is a priority species with community interest, listed in Annex II of the Habitat directive.

D. diutinus populations occur in the mosaic-like habitat of two priority habitat types of community interest: Pannonic sand steppes (6260) and Pannonic inland sand dune thicket (*Junipero-Populetum albae*) (91N0) (Fig. 2) listed in Annex I of the Habitat Directive.
This plant species was scientifically described by Hungarian botanist Pál Kitaibel, soon after he found it in the vicinity of Csévharaszt during his field trip crossing the Great Hungarian Plain in the early 1800s.

D. diutinus were found at several places in the Sandridge area of the Danube-Tisza Interfluve Region and the Hills of Gödöllő after the species have been found and described. However, by the end of the 19th century former localities of the species had been significantly reduced.
Currently there are only 10 populations, consisting of smaller subpopulations with different densities, which have evidently survived until now (Vidéki & Máté 2003, 2011) (Fig. 3).
Due to the very few recent occurrences of the endemic species and the uncertain survival chances of some populations, it became obvious for conservation experts that actions, both *in situ* and *ex situ*, had to be taken in order to improve the conservational status of *Dianthus diutinus* at its most important populations (Molnár 2003, Vidéki & Máté 2003).

Fig. 1:
Dianthus diutinus Kit.

Fig. 2:
Habitat of
Dianthus diutinus.

Fig. 3:
Recent occurrences of *Dianthus diutinus* in Hungary.

2 Main threatening factors of the species

2.1 Habitat fragmentation

Attempts have been made to halt the shifting sand of the Danube-Tisza Interfluve region since the 19th century. They became more intensive from the 1950s with the intensification of viniculture and afforestation. These days, shifting sand dunes practically do not exist due to the decrease of grazing animal stocks and the increased area of tree plantations. Remnants of the former *D. diutinus* populations could have survived only in patches, in between *Robinia pseudoacacia* (Fig. 4) and *Pinus nigra* plantations, on the slopes of the sand dunes, which could not be cultivated economically. Fragmentation of *D. diutinus* habitats and their enclosure by forests severely threatens the survival of small populations of the species.

Fig. 4 (left): *Robinia pseudoacacia* is spreading invasively.

Fig. 5 (right): The spreading *Asclepias syriaca* settles in native grasslands.

2.2 Habitat degradation

The Milkweed (*Asclepias syriaca*) was introduced to Hungary for economical reasons. It thrives in sandy soils and spreads aggressively in the degraded grasslands, however, it also settles in native grasslands. This plant is very efficient in spreading, and it has covered several thousands of hectares in the country. Its dense populations can even suppress the natural vegetation (Fig. 5), hence it is a real threat for *D. diutinus* and its habitat.

3 Objectives of the LIFE project

The main goal of the LIFE project 'Conservation of the Pannon endemic *Dianthus diutinus*' was to stabilize the natural *Dianthus diutinus* populations through the proper implementation of conservation measures at the most important known stands of this rare plant species. Project sites were identified and delineated to include the most important populations of *D. diutinus*, which included those at Bodoglár, in the vicinity of Kiskunmajsa town, at Bócsa and at Csévharaszt (Fig. 3). Large proportions of all three project sites are registered as forests. The existent natural habitat patches of *D. diutinus* are isolated by large non-indigenous tree plantations of different species, Black Pine forests at Bodoglár and Black Locust stands at Bócsa and Csévharaszt. The LIFE project aimed to improve habitat conditions at the three project sites on a total 455 ha area. The isolated *D. diutinus* habitats were expected to be interconnected as the non-indigenous tree plantations were thinned or cut entirely and displaced by the glades created. Inside the interconnected habitat network, natural regeneration processes are helped by recurring management, thus the populations of the species could be stabilized (Bankovics & Mile 2011).

4 Habitat reconstruction

At Bócsa and Csévharaszt sites, the most abundant arboreal invasive species were Black Locust (*Robinia pseudoacacia*) and Tree of Heaven (*Ailanthus altissima*). In the project, a total of 18 ha Robinia stands were cleared at Bócsa, while special attention was paid not to cause any damage in the grasslands and clusters of white poplars. Moving of cut wood was done by hand and by quad bike to deposits, where it was chipped by a chipper purchased by the project. At Csévharaszt, 28 ha Robinia forest was cut in several patches.
Robinia trees were treated with chemicals well in advance before cutting in order to reduce their sprouting vigour. Stems were drilled and chemicals were injected in between August and October (Fig. 6). Withered leaves had fallen after ten days, and the trees were cut in winter (Fig. 7).

Fig. 6 (left):
Stem injection is the most effective pre-treatment method to eliminate Black Locust.

Fig. 7 (right):
To avoid soil damage, forestry quads were used for wood material transport at Bócsa project site.

As a result of this preventive treatment, the number of sprouts was significantly reduced. Hence, post treatment methods were applied just 2-3 times annually and the total treatment area of sprouts was 16 and 30 ha at Bócsa and Csévharaszt respectively.
Forest compartment borders were modified in the new forest management plans according to conservational management guidelines and most cut area were described as glades.

Black Pine (*Pinus nigra*) plantations appeared in the landscape of Bodoglár in the second half of the last century causing habitat fragmentation. Native species, like the endemic *D. diutinus*, survived only in the undisturbed areas, however, populations have been isolated from each other. In order to interconnect these native habitat fragments, 27.5 ha Black Pine plantations were thinned in 2008 in the project area, and a further 17 ha were cut in 2011 (Fig. 8). All cut wood material was removed from the area, tree branches and leaves were chopped and transported as wood-chips (Fig. 9).

Fig. 8 (left):
Black pine plantations were cut in order to interconnect native grasslands.

Fig. 9 (right):
A chipper was used and wood-chips transported away.

Besides the reconstruction of open perennial grasslands, recreation of clusters of native trees was also started in the autumn of 2010. Saplings of White Poplar (*Populus alba*) and in the depressions Pedunculate Oak (*Quercus robur*) were planted in the sparse black pine plantations on a total area of 2 ha. Most of the young trees survived the first winter but many withered due to the extreme drought of 2011.
Glades and clusters of native poplar trees took over the place of former pine plantations, which are also indicated on the forest compartment sheets of the new forest management plan.

5 Grassland restoration

Common Milkweed (*Asclepias syriaca*) is an aggressively spreading weed, which originates from North-America. It arrived in Hungary as an ornamental plant, and was later recognised as an important nectar source for bees and it was planted widely. Its seeds are attached to long, white hairs and encased in a 10 cm long follicle. The follicles ripen and split open and the seeds are blown by the wind to nearby areas. Seeds buried in the soil can lie dormant for several years before germinating. Since it is a heat tolerant species, it thrives in the sandy soils of Hungary and spreads efficiently both by its seeds and by its several metre long root-system. In recent years, milkweed has become the most common invasive plant species in the sandy areas of *D. diutinus* habitats. It spreads not just in the trampled, degraded areas but settles also in the natural, valuable grasslands as well. These dense milkweed populations significantly alter and degrade the existing natural habitats since they can supplant the natural vegetation, hence they are a real threat for *D. diutinus*.

Fig. 10 (left):
Milkweed plants were treated with chemicals individually by brush.

Fig. 11 (right):
The dense, heavily invaded areas of *A. syriaca* were sprayed.

Several attempts have been made to eliminate the species from the natural grasslands in the last few decades. As a result, we knew that mechanical methods alone are insufficient for the elimination. However, together with the precise application of chemical treatments, fairly good results could be achieved. Naturally, on the Natura 2000 sites, special attention had to be paid not to cause any damage in the native vegetation, hence the treatment method was selected according to the density of the milkweed stands and the natural status of the vegetation. In high nature value areas with few milkweed plants, the leaves were treated with chemicals individually by brush (Fig. 10), while the dense, heavily invaded areas were sprayed (Fig. 11). Treatments were applied 2-3 times annually and resulted in a 90% decrease of the invaded area compared to 2007. In the meantime, the density of surviving populations has also significantly been reduced (Bankovics & Mile 2011). Although these are good results, the treated areas have to be regularly checked and monitored in the future, since the milkweed can appear again from the seed bank in the soil and from the neighbouring areas.

6 *Ex situ*-conservation

The long-term conservation of *D. diutinus* may primarily be guaranteed by the protection and improvement of its natural habitats. However a better result can be obtained in case this *in situ*-conservation is supported and complemented by other methods, among them *ex situ*-solutions, like artificial propagation of plants in botanical gardens and planting of grown seedlings (Standovár & Primack 2011). This activity can efficiently contribute to the strengthening of natural populations.

Fig. 12 (left):
Dianthus diutinus seedlings grown from seeds collected in wild populations.

Fig. 13 (right):
Seedlings grown in the Botanical Garden of Szeged were planted out in their original environment.

Results of investigations that have been carried out for several years in the Botanical Garden of Szeged show that *D. diutinus* can be reproduced from seeds in artificial circumstances (Mihalik 2000, Mihalik & Németh 2002a, 2002b, Németh & Mihalik 2004, 2007, Németh & Makra 2011). In the project period there have been almost 20,000 *D. diutinus* seedlings grown from seeds collected in wild populations of the endemic plant (Fig. 12). DNA analyses have been carried out concerning several wild populations of *D. diutinus*, but no significant difference could be detected between the isolated populations (Németh & Makra 2011). However, genetic patterns characteristic to particular populations were found, hence seedlings cultivated in the Botanical Garden were planted in their original environment. Good quality open perennial grasslands have been identified as potential areas for planting (Fig. 13). According to our experience, the best time for the planting of *D. diutinus* seedlings is October, since this cooler and rainy period helps the survival of the young plants (Gál 2011, Németh & Makra 2011). The best survival results were shown for those groups which were planted in open grasslands with partial shading by trees. Vitality surveys carried out on some planted indi-

viduals indicated that individuals planted in denser grassland with some shade had a higher survival rate in the first year (Gál 2011). However, in the long run the more open grassland patches with just partial shading proved to be more beneficial for the planted seedlings, which is in line with the pioneer nature of the species. In the whole project period, 20,000 *D. diutinus* individuals were planted out, 70% of which survived. Most of the planted seedlings have already produced flowers and seeds, and in many cases their offspring could also be observed around adult individuals (Gál 2011).

7 Monitoring

Dianthus diutinus individuals were monitored at all known stands of the species. Data was collected using a high accuracy GPS system (Trimble ProXT Receiver, Recon Handheld, ArcPad 7.0.1 and GPSCorrect 2.11) and every individual has been registered (Gál 2011). In order to facilitate precise recording, every plant was marked with a stick during the counting. Registered GPS data are stored in geo-database in the GIS laboratory of the Kiskunság National Park. The obtained data can be projected on maps and are suitable to plan nature conservation management in the field, and to evaluate the data for scientific purposes. The results of the monitoring between 2007 and 2011 show that the world population of *Dianthus diutinus* has increased significantly (Tab. 1). The growth is partly due to the increase in the number of individuals of the previously known populations, which is considered as a result of favourable weather conditions and the implementation of habitat improvement measures. On the other hand, the growth is also a result of the intensive fieldwork to discover new populations and to check possible occurrences based on literature data. In the project period, four new populations have been found including a huge one, numbering more than 10,000 individuals.

Tab. 1: Population change of *Dianthus diutinus* in the LIFE project period.

Site / Year	**2007**	**2008**	**2009**	**2010**	**2011**
Ásotthalom	101	103	233	228	306
Bodoglár	5,007	8,590	12,906	16,928	27,614
Bócsa	1,753	1,845	3,791	5,710	8,848
Csévharaszt TT	1,500	1,138	1,782	1,744	2243
Csévharaszt village	1,769	1,353	5,803	5,900	6,672
Harkakötöny	7,255	8,483	9,036	10,080	34,159
Nagykőrös, Strázsa-hegy	90	68	25	31	143
Nagykőrös, Száraz-dűlő	1,046	704	988	1,196	2,290
Ócsa	508	556	1,386	1,156	2,074
Nemesnádudvar	-	-	10,495	15,262	13,152
Pusztavacs	-	-	15	72	66
Jakabszállás	-	-	-	-	171
Total	**19,029**	**22,840**	**46,460**	**58,307**	**97,738**

Sample areas have been delineated in order to observe the regeneration of the native vegetation after habitat improvement measures were implemented, and were checked on an annual basis (Aradi 2011). On the open soil surfaces created by Black Pine cutting, regeneration processes of the native grasslands started soon after the decay of needle litter. However this natural process has to be monitored since invasive species, most importantly the common milkweed, can also appear and settle on the disturbed soil surfaces. In case of Black Locust cutting, the regeneration process by native plant species takes much longer since the nutrient rich soil is preferred by weeds and Robinia shoots can appear even after several years of cutting (Aradi 2011, Bankovics & Mile 2011, Kovács & Sipos 2011).

References

Aradi, E. (2011): Élőhely-rekonstrukciós munkálatok hatásai a növényzetre. Rosalia 6. A Duna-Ipoly Nemzeti Park Igazgatóság tanulmánykötetei. pp. 279–290.

Bankovics, A. & Mile, O. (2011): Élőhelyfejlesztések a Tartós szegfű LIFE project keretében. Rosalia 6. A Duna-Ipoly Nemzeti Park Igazgatóság tanulmánykötetei. pp. 225–239.

Gál, A. (2011): A tartós szegfű (*Dianthus diutinus* Kit.) felmérése a Kiskunsági és a Duna-Ipoly Nemzeti Park Igazgatóságok területén. Rosalia **6**. A Duna-Ipoly Nemzeti Park Igazgatóság tanulmánykötetei. pp. 269–277.

Kovács, É. & Sipos, F. (2011): Homoki élőhelyek monitorozása a Kiskunsági Nemzeti Park Igazgatóság működési területén. Rosalia 6. A Duna-Ipoly Nemzeti Park Igazgatóság tanulmánykötetei. pp. 473–521.

Mihalik, E. (2000): A *Dianthus diutinus* virágzási dinamikája és reproduktív potenciálja. Összefoglalók, Aktuális Fóra és Vegetációkutatások Magyarországon IV., Jósvafő, 2000.

– & Németh, A. (2002a): Contribution to the revealing of the biology of *Dianthus diutinus*. Abstracts of the 3rd conference of restoration ecology: pp. 138–139.

– & Németh, A. (2002b): A *Dianthus diutinus* szaporodásbiológiája: adatok a visszatelepítés biológiai hátterének feltárásához. Abstrakt, I. Magyar Természetvédelmi Biológiai Konferencia. A veszélyeztetett fajok védelme: pp. 87–88.

Molnár, Zs. (Ed.) (2003): A Kiskunság száraz homoki növényzete. Sanddunes in Hungary (Kiskunság). TermészetBúvár Kiadó. Budapest: pp. 159.

Németh, A. & Makra, O. (2011): A tartós szegfű (*Dianthus diutinus*) ex situ védelme – esettanulmány. Rosalia 6. A Duna-Ipoly Nemzeti Park Igazgatóság tanulmánykötetei. pp. 353–380.

Németh, A. & Mihalik, E. (2004): Különböző termőhelyről származó magvakból fejlődő *Dianthus diutinus* egyedek reproduktív sajátságai. Előadások és poszterek (összefoglaló kötet), Aktuális Fóra és Vegetációkutatások Magyarországon VI., Keszthely, 2004. p. 108.

Németh, A. & Mihalik, E. (2007): Egy *Dianthus diutinus* populáció pollen és magprodukciója. (Pollen and seed production in a *Dianthus diutinus* population). Kitaibelia **13** (1): 121.

Standovár, T & Primack, R. B. (2011): A természetvédelmi biológia alapjai. Nemzeti Tankönyvkiadó, Budapest, 542 pp.

Vidéki, R. & Máté, A. (2003): A tartós szegfű (*Dianthus diutinus* Kit. ex Schult.) fajvédelmi programja. Doronicum Kft, Sopron-Kecskemét

Vidéki, R. & Máté, A. (2011): A tartós szegfű (*Dianthus diutinus* Kit.) archív adatainak feldolgozása. Rosalia 6. A Duna-Ipoly Nemzeti Park Igazgatóság tanulmánykötetei. pp. 241–268.

Address of authors

András Bankovics
Orsolya Mile
Kiskunság National Park Directorate
Liszt F. u. 19.
6000 Kecskemét
HUNGARY

E-Mail: bankovicsa@knp.hu