ANADOLU ÜNİVERSİTESİ BİLİM VE TEKNOLOJİ DERGİSİ –C
Yaşam Bilimleri ve Biyoteknoloji

ANADOLU UNIVERSITY JOURNAL OF SCIENCE AND TECHNOLOGY –C
Life Sciences and Biotechnology
Cilt/Vol.:3-Sayı/No: 1 : 15-21 (2013)

ARAŞTIRMA MAKALESİ/**RESEARCH ARTICLE**

SEED GERMINATION BEHAVIOUR OF THREE ALPINE SPECIES FROM ULUDAĞ MOUNT, TURKEY

Serap KIRMIZI[1*], Gürcan GÜLERYÜZ[2], Hülya ARSLAN[2],

ABSTRACT

In this study, the germination requirements of three species from alpine belt of Uludağ Mount; *Gypsophila olympica* Boiss., *Matthiola montana* Boiss. and *Silene rhynchocarpa* Boiss. We tested the germination under (20 °C) dark, (20 °C) continuous light, and photoperiod 20/10 °C (12/12h) with distilled water. Different germination behaviour was found for these three species from closely related habitat conditions. *G. olympica* showed similar germination percentages in dark, light and photoperiod, and germinated faster in light (3.9 days). *S. rhyncocarpa* germinated 100 % at all the three conditions but faster in dark with 2.0 days. *M. montana* seeds were found to require light for germination. The germination was 27.2 % at dark, whereas the seeds were germinated 90 % under photoperiod. The results can be useful for both in situ and ex situ conservation of these plant species.

Key Words: Alpine plants, Germination, *Gypsophila olympica, Matthiola montana, Silene rhynchocarpa,* Endemic

ULUDAĞ'DA YETİŞEN ÜÇ ALPİN TÜRÜNÜN TOHUM ÇİMLENME DAVRANIŞLARI

ÖZ

Bu çalışmada, Uludağ alpin bölgesinde yetişen *Gypsophila olympica* Boiss., *Matthiola montana* Boiss. ve S*ilene rhynchocarpa* Boiss. türlerinin çimlenme gereksinimleri araştırılmıştır. Çimlenme üç farklı ortamda ve saf su ortamında test edilmiştir: Karanlık (20 °C), ışık (20 °C), fotoperiyot 20/10 °C (12/12 saat). *G. olympica* türünün her üç ortamda da benzer çimlenme yüzdeleri gösterdiği, fakat ışıkta daha hızlı çimlendiği bulunmuştur (3.9 gün). *S. rhynchocarpa* her üç durumda da % 100 oranında çimlenmiş fakat karanlıkta daha çabuk çimlenmiştir (2.0 gün). M. montana tohumlarında ışık ihtiyacı tespit edilmiştir. Karanlıkta % 27.2 ve fotoperiyotta % 90 oranında çimlenme bulunmuştur. Elde ettiğimiz bu veriler, bir tanesi tehlike altında olan bu türlerin ileride muhtemel ex situ veya in situ olarak korunmalarına kaynak oluşturabilir.

Anahtar Kelimeler :Alpin bitkiler, Çimlenme, *Gypsophila olympica, Matthiola montana, Silene rhynchocarpa,* Endemik

1 * Corresponding author: skirmizi@uludag.edu.tr
Gemlik Asım Kocabıyık Graduate Vocational School, Horticulture Programme, Uludağ University, 16600, Gemlik/Bursa, Turkey
2 Faculty of Science and Arts, Department of Biology, Uludağ University, 16059, Görükle/Bursa, Turkey

Received: 06 April 2012; **Revised:** 19 June 2012; **Accepted:** 08 January 2013

1.INTRODUCTION

Seed germination and subsequent seedling establishment is one of the critical stages of any plant and it influences the persistence of its populations (Grubb 1977; Harper 1977. Bu et al. 2008). It is known that physiological and environmental factors such as temperature and light interact to regulate dormancy release as well as speed of germination (Allen et al. 2007; Finch-Savage and Leubner-Metzger 2006). There is a large number of endemic species found in alpine habitats (Väre et al. 2003), and most alpine species have dormant seeds, exhibiting mainly physiological dormancy (Billings and Mooney 1968; Baskin and Baskin 2004).

In alpine regions, different localities can reflect some microtopographical differences and change sharply (Billings and Bliss, 1959; Miller 1982; Körner 1999). In accordance with the environmental conditions, alpine plants show high variations in the germination behaviour. Thus, the germination timing has a critical importance in alpine habitats because the growing period is short (Bliss 1971; Urbanska and Shütz 1986, Chambers 1989). It is believed that no universal mechanism for alpine species germination (Gimenez-Benavides et al. 2005). Furthermore, the alpine plants generally have some dormancy mechanisms to protect germinated seedlings from the unfavourable conditions of winter (Körner 1999).

Baskin and Baskin (2004) defined dormant seed as, the one that does not have the germination ability in a certain time period under normal environmental factors that encouraging for germination in other circumstances. The germination features have undergone development among the species in a different way for adaptation to the environment, so the germination occurs when conditions are suitable for a new generation (Finch-Savage and Leubner-Metzger 2006). Dormancy properties are often similar for closely related taxa (Karlsson and Milberg 2007), but can be different within a family even among neighbouring species (Karlsson et al. 2008).

Investigations of the germination ecology of alpine plants are scarce; and the factors and mechanisms regulating the germination in alpine habitats are poorly known (Baskin and Baskin 1998; Kırmızı et al. 2011; Güleryüz et al. 2011; Arslan et al. 2011). In this study, we aimed to obtain the basic information on germination preferences of three species *Gypsophila olympica* Boiss. (Endemic and endangered), *Silene rynchocarpa* Boiss. (Caryophyllaceae), and *Mathiola montana* Boiss. (Brassicaceae) (Endemic) growing on alpine site of Uludağ Mount. Gypsophila olympica is known only from a single locality in Turkey (Uludağ Mount) and is represented by about 1000 individuals. In addition, its habitat subjected to construction of ski runs and overgrazing. The germination requirements of those species were not previously studied.

2. MATERIAL and METHODS

2.1. Species Descriptions

Matthiola montana Boiss. (Brassicaceae) is a perennial herb with stout stems. Lower leaves are very narrowly oblanceolate, white tomentose to subglabrous. Flowers are brownish to yellowish. Fruit is silique and erect, narrowly oblong. Species is endemic and grown on stony slopes up to 2300 m. This species is distributed on south and west Anatolia. The flowering time is on May and July (Davis 1965).

Gypsophila olympica Boiss. (Caryophyllaceae) is a caespitose perennial species with woody rhizomes. Stems are numerous, unbranched, 3-15 cm, glabrous. Leaves are linear, triquetrous, acute, scabrid at margins and mostly congested at base. Flower clusters are single (rarely two), terminal. Species is endemic and known from Uludağ Mount. Flowering time is on July to August. It grows on limestone rocks. Its altitudinal range varies between 2000 and 2500 m. (Davis 1967).

Silene rhynchocarpa Boiss. (Caryophyllaceae) is a perennial herb with erect stems; leaves have silky hairs, mainly glandular and sticky hairs at above. The basic leaves are linear, very narrow lanceolate. Stem leaves were narrow elliptic to oblanceolate, smaller than basic leaves mostly have silky hairs. Flowers white and have ovoid capsules. It grows on rocky slopes and screes between 1500 and 3600 m (Davis 1967). Species widespread on throughout Anatolia such as Bursa Uludağ Mt (A2) Amasya Ak Mt (A5), Sivas Yıldız Mt (A6), Izmir: Boz Mt (B2), Konya Sultan Mt (B3), Antalya: Elmali Mt (C2), Isparta Dedegöl Mt (C3) Hakkari Kara Mt (C9) etc.

2.2. Seed Collection

Mature seeds of G. olympica, S. rhynchocarpa and M. montana were collected from alpine belt of Uludağ Mountain between 2100-2300 m altitudes on September 2008. Seed collection was made from about 100 ha area. Seeds of each species were collected at least 30-50 randomly selected individuals. Seeds were air-dried immediately upon collection, for one week, and then stored dry in a paper bag at room temperature for about 1 month (18-20 ºC) until they were used in the germination tests.

2.3. Germination Tests

The germination experiments were conducted under (20 °C) continuous dark, (20 °C) continuous light, and photoperiod 20/10 °C (12/12h) with distilled water. Four replications of 25 seeds per Petri dish were sown on sterile plastic 9 cm Petri dishes. Seeds were checked for germination daily. Seeds were regarded germinated when the radicle emerged from the testa. For application of dark treatment, Petri dishes were wrapped with aluminium foil. Seeds incubated in dark treatments were checked under dimmed laboratory conditions. Final germination percentage and mean germination time (MGT) were determined according to Kırmızı et al. (2011).

3. Results and Discussion

Seed dormancy and germination patterns of a plant can be affected by various components like local environmaental conditions, climate, soil quality and the position of seed in mother plant (Karlsson et al. 2008). In this study, none of the studied plant species exhibited dormancy. Final germination percentage and mean germination times of *Gypsophila olympica*, *Silene rhynchocarpa*, and *Matthiola montana* seeds for different treatment series were given in Table 1.

Gypsophila olympica was germinated at similar percentages at three different treatments. The highest germination was 94 % at photoperiod conditions (Fig. 1A). But seeds faster germinated in continuous light conditions with 3.9 days of MGT. (Fig. 2A). Dormancy pattern is often similar for closely related taxa but may differ within a family even within co occurring neighboring species. Kırmızı et al. (2011) also found different germination patterns for three endemic co-existing Asteraceae species. Moruno et al. (2011), studied germination ecology of two *Gypsophila* species (*Gypsophila tomentosa* and *Gypsophila struthium*) from Mediterranean habitats and found opportunistic germination behaviour and non dormancy status of both species suggests that this germination behaviour makes them highly competitive in colonizing available and adequate soils.

Silene rhynchocarpa showed almost the same germination percentages in all treatments as 100 % (Fig.1B). The faster germination was in dark with 2 days MGT (Fig.2B). Thompson (1970), reported germination of *Silene secundifolia* was restricted to a narrow temperature range between 7- 16 °C and after ripening was slightly extended the temperature range.

Table 1.Final germination (% G) and mean germination times (MGT; days) of Gypsophila olympica, Silene rhynchocarpa, and Matthiola montana seeds for different treatment series. [Values are means followed by standard deviation (n = 4)]

		% G ±SD	MGT±SD
PHOTOPERIOD	*G. olympica*	94.0± 4.0	6.6 ± 0.5
	S.rhynchocarpa	100.0 ± 0.0	6.0 ± 0.1
	M. montana	90.0 ± 5.7	9.01 ± 0.7
DARKNESS	*G. olympica*	90.0 ± 3.7	5.8 ± 0.2
	S. rhynchocarpa	100.0 ± 0.0	2.0 ± 0.2
	M. montana	27.2± 9.9	5.5 ± 2.1
LIGHT	*G. olympica*	89.6 ± 6.5	3.9 ± 0.2
	S. rhynchocarpa	100.0 ± 0.0	2.5 ± 0.5
	M. montana	76.4 ± 3.6	5.4 ± 0.9

Matthiola montana seems to prefer light conditions for germination. Its germination percentage low was 27.2± 9.9 in dark (Table 1), in contrast, it germinated 90 % under photoperiod (Fig.1C). Further, the faster germination occurred in continuous light with 5.4 days MGT (Fig. 2C). Thanos et al. (1994) reported previously on germination of *Matthiola tricuspidata* that nearly full germination at 15- 25 °C range and, germination was suppressed in light. Ellis et al. (1985) found different germination requirements for *Matthiola incana* and *Matthiola longipetala* as prechilling, potassium nitrate and light. They suggested that, the photoinhibition of Matthiola tricuspidata seeds could be related to an unknown substance in seed coat (Thanos et al. 1994).

For conservation of the threatened or endangered species, propagation from seed is an efficient and inexpensive way (Cerabolini et al. 2004; Gimenez-Benavides et al. 2005).Furthermore, developing ex situ conservation protocols for threatened species, is the main objective of the European conservation strategies (European Council and Planta Europa, 2002). The habitat of these species is at risk due to land use changes and overgrazing and tourism activities in the Uludağ Mountain (Arslan et al. 1999; Güleryüz et al., 1998; Güleryüz et al. 2005). These factors can influence the seed production of these endemic plant species.

4. CONCLUSIONS

Consequently, we found different germination requirements of these three alpine species; *Silene rhynchocarpa* seeds fully germinated at three different treatments, *Gypsophila olympica* seeds were also germinated at similar percentages in all three treatments, *Matthiola montana* seeds found to require light for germination stimulation.

In addition, the data on germination conditions of these two endemic species could be used in ex situ conservation management because seed germination is a part of ex situ conservation, especially for monitoring viability and to ensure germplasm regeneration (Bewley and Black 1994). Seed germination data for *Silene rynchocarpa* which is is neither endemic nor threatened species could be useful for revegetation or land management studies of its habitat.

Acknowledgements

This study was supported by Turkish Scientific Research Council (Project No:107T494)

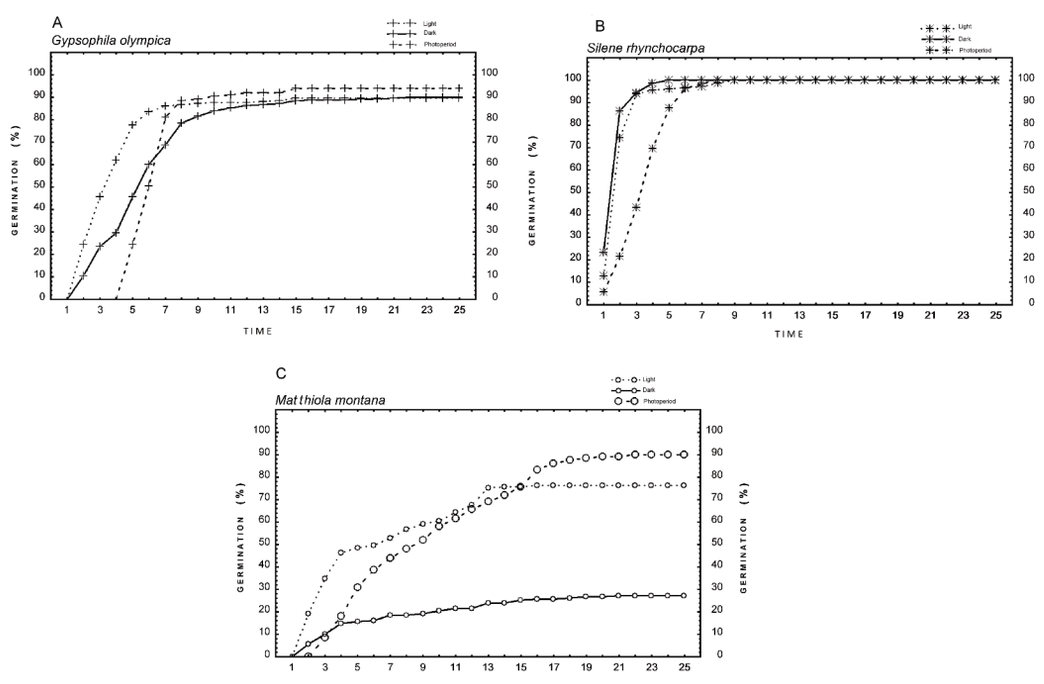

Figure 1. Cumulative germination percentages of *Gypsophila olympica* (A), *Silene rhynchocarpa* (B) and *Matthiola montana* (C) seeds in different treatments

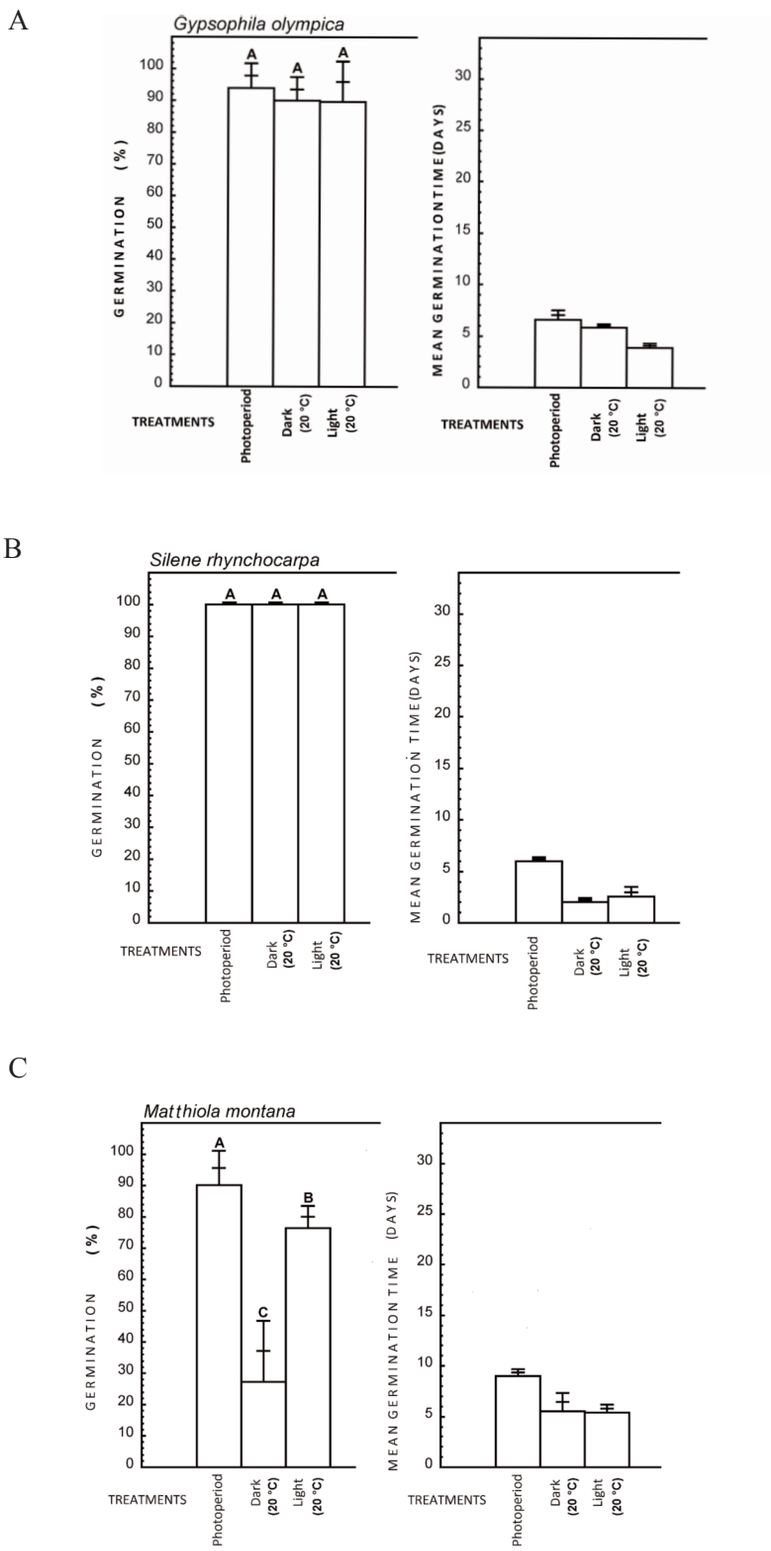

Figure 2. The mean Final germination percentages and Mean Germination Times (MGT) of *Gypsophila olympica* (A), *Silene rhynchocarpa* (B), and *Matthiola montana* (C) seeds in different treatments

5. REFERENCES

Arslan, H., Güleryüz, G., Gökçeoğlu, M. and Rehder, H. (1999). Vegetation mosaic around the second center of tourism development in the Uludağ Mountain, Bursa, Turkey. *Turkish Journal of Botany* 23, 233-239.

Arslan H., Kırmızı S., Güleryüz G. and Sakar F.S. (2011). Germination characteristics of *Androsacea villosa* L. (Primulaceae) seeds. *Acta Biologica Cracoviensia Series Botanica* 53, 32-36.

Baskin, C.C. and Baskin, J.M. (1998). *Seeds*. Academic Press, London.

Baskin, C.C. and Baskin, J.M. (2004). A classification system for seed dormancy. *Seed Science Research* 14, 1-16.

Bewley, J.D. and Black, M. (1994). *Seeds. Physiology of development and germination*. Plenum Press, New York

Billings, W.D. and Bliss, J.M. (1959). An alpine snowbank environment and its effects on vegetation, plant development and productivity. *Ecology* 40, 388-397.

Billings, W.D. and Mooney, H.A. (1968). The Ecology of Arctic and Alpine Plants. *Biological Reviews* 43, 481-529.

Bliss, L.C. (1971). Arctic and alpine plant life cycles. Annual Review of Ecology and Systematics 2, 405-438.

Bu, H., Du, G., Chen, X., Xu, X., Liu, K. and Wen, S. (2008). Community wide germination strategies in alpine meadow on the eastern Qinghai-Tibet plateau: phylogenetic and life history correlates. *Plant Ecology* 195, 87-98.

Cerabolini B., De Andreis, R., Cerian,i R.M., Pierce, S. and Raimondi, B. (2004). Seed germination and conservation of endangered species From the Italian Alps: *Physoplexis comosa* and *Primula glaucescens*. *Biological Conservation* 117, 351 – 356.

Chambers, J.C. (1989). Seed viability of alpine Species: Variability within and among years. Journal of Range Management 42, 304-308.

Davis, P.H. (1965). *Flora of Turkey and East Aegean Islands*, Vol. 1, Edinburgh University Press, Edinburgh.

Davis, P.H. (1967). *Flora of Turkey and East Aegean Islands*, Vol. 2, Edinburgh University Press, Edinburgh.

Ellis, R.H., Hong, T.D. and Roberts, E.H. (1985). Handbook of seed technology for genebanks Volume II Compendum of specific germination information and test recommendations. Roma:International boar for plant genetic resources

European Council and Planta Europa (2002). European plant conservation strategies. Conference of the Parties to the Convention on Biological Diversity, 6th meeting. The Hague Apr 7–19. UNEP/CBD/COP/6/INF/22.

Gimenez-Benavides, L., Escudero, A. and Perez-Garcia, F. (2005). Seed germination of high mountain Mediterranean species: altitudinal, interpopulation and interannual variability. *Ecological Research* 20, 433-444.

Grime, J.P.G., Mason, A.V., Curtis, J., Rodman, S.R., Band, M.A.G. ,Mowforth, A.M., Neal and Shaw, S. (1981). A comparative study of germination characteristics in a local flora. Journal of Ecol.ogy 69, 017–1059.

Grubb, P.J. (1977). The maintenance of species-richness in plant communities: the importance of the regeneration niche. Biological Reviews 52, 107 – 145.

Güleryüz, G., Arslan, H., Gökçeoğlu, M. and Rehder, H. (1998).Vegetation mosaic around the first center of tourism development in the Uludağ Mountain, Bursa, Turkey. *Turkish Journal of Botany* 22,317-326.

Güleryüz, G., Malyer, H., Kaynak, G.and Özhatay, N. (2005). Uludağ A2 (A) Bursa. In: Özhatay N., Bayfield A., Atay S, Editors. *Important Plant Areas in Turkey,* Istanbul, Turkey.

Güleryüz, G., Kırmızı, S., Arslan H. and Sakar FS. (2011). Dormancy and germination in

Stachys germanica L. *subsp. bithynica* (Boiss.) Bhattacharjee seeds: Effects of short-time moist chilling and plant growth regulators. *Flora* 206, 943–948.

Finch-Savage, W.E., Leubner-Metzger, G. (2006). Seed dormancy and the control of germination. *New Phytologist* 171, 501–523.

Harper J.L. (1977). *Population Biology of Plants*. Academic Press, London.

Karlsson, L.M and Milberg, P. (2007). A comparative study of germination ecology of four *Papaver taxa. Annual Botany*. 99, 935–946.

Karlsson, L.M., Tamado, T. and Milberg, P. (2008). Inter-species comparison of seed dormancy and germination of six annual Asteraceae weeds in an ecological context. *Seed Science Research* 18,35-45.

Kırmızı, S., Güleryüz, G. and Arslan, H. (2011). Germination responses to GA_3 and short-time chilling of three endemic species: *Tripleurospermum pichleri*, *Cirsium leucopsis* and *Senecio olympicus* (Asteraceae). *Plant Species Biology* 26,51-57.

Körner, C. (1999). Alpine Plant Life. Springer-Verlag, Berlin. 2nd Ed.

Miller, P.C. (1982). Environmental and vegetational variation across a snow accumulation area in montane tundra in central Alaska. *Holarctic Ecology* 5, 85-98.

Moruno, F., Soriano, P., Vicente, O., Boscaiu, M. and Estrelles, E. (2011). Opportunistic Germination Behaviour of *Gypsophila* (Caryophyllaceae) in Two Priority Habitats from Semi-arid Mediterranean Steppes, *Notulae Boanicae Horti Agrobotanici Cluj*. 39,18–23.

Native Plant Working Group (2000). Native Plant Revegetation Guidelines for Alberta. H. Sinton-Gerling (ed.), Alberta Agriculture, Food and Rural Development and Alberta Environment. Edmonton, Alberta.

Nishitani, S. and Masuzawa, T. (1996). Germination characteristics of two species of *Polygonum* in relation to their altitudinal distribution on Mt. Fuji, Japan. *Arctic Alpine Research* 28, 104–110.

Thanos, C.A., Georghiou, K. and Delipetrou, P. (1994). Photoinhibition of seed germination in the maritime plant *Matthiola tricuspidata*. Annual Botany 73, 639–644.

Thompson, P.A. (1970). Changes in Germination Responses of *Silene secundiflora* in Relation to the Climate of its Habitat. *Physiologia Plantarum* 23, 739–746.

Urbanska, K.M. and Schütz, M. (1986). Reproduction by seed in alpine plants and vegetation research above timberline. *Botanica Helvetica* 96,43-60.

Väre, H., Lampine,n C., Humpries, C. and Williams, P. (2003). Taxonomic diversity of vascular plants in the European alpine areas. In: Nagy et al., (eds) Alpine Biodiversity in Europe. Ecological studies, vol. 167. Springer, Berlin Heidelberg New York, 133-148.