

ENDANGERMENT OF THERMOPHILOUS FLORA EVEN UNDER CONDITIONS OF INCREASING ENVIRONMENTAL TEMPERATURES

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Abstract

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As mentioned earlier, it is not true that some bulbous species from the family *Orchidaceae* are able to survive only mycotrophically, i. e. without formation of stalk. Our observations, especially of *Ophrys apifera*, have demonstrated (in the Czech Republic) that the durability of adult plants is very short so that their numbers are fluctuating. The dying can be caused by several factors. Frost damages followed by rotting of underground parts (roots and bulbs) are relatively frequent. The leaf rosette, which is the most resistant, dies as the last, usually later in the spring of the following year. This means that the frost damage is often not identified during the cursory visually control in the spring. We observed very extensive damaging and dying of the *Orchidaceae* after the winter of 2002/03 - on the turn of November and December 2002, there was a rapid onset of very strong black frost after a long, wet and relatively mild autumn. Consequently 80% of population perished. None specimens of *Ophrys apifera* and/or *Himantoglossum adriaticum* came into blossom in 2003 and other species were strongly damaged. Our observations document that the general increase in air temperatures need not result in the occurrence of generally expected better growing conditions for some thermophilous species. It is very probable that the extremes climatic conditions could show greater effects than the general increase in average temperatures. Such phenomena are well-known but in practice they are not noticed and/or are explained in a different way. Such risks can exist in the whole Central European region. Negative effects of frosts in winter 2002/03 were further intensified by long and extreme droughts in the growing season of the year 2003. Combination of these extremes was crucial for the species *Gentianella bohemica*: In average, 95% of specimens in each population perished. If the fluctuations in climatic conditions will be more frequent, some species can become extinct irreversibly very quickly.

Orchidaceae, Ophrys, Gentianella, frost damage, freezing of bulbs, endangered species of plants

Authors of this paper have for many years studied biologically and ecologically complicated species (e. g. mycorrhizic, semi-parasitic etc.), which are therefore rare and rather endangered. Unfortunately, it is not possible to perform any experiments with these species. However, long-term studies on populations and/or individual plants, observations on small

beds in the localities etc. enabled us to learn about the whole developmental cycle, phenological rules, response of individual species in individual localities to climatic/environmental changes and causes and sources of their endangerment.

As mentioned earlier (Růžička, 2001), it is not true that some species of bulbous *Orchidaceae* are able to

survive in soil only in a mycotrophic way, i. e. without formation of stalk. Such a situation can occur only after the removal of stalk bud or of already growing aboveground part because the bulb is not able to form a new stem bud. In such a case it is only possible to found under the soil surface a new (i. e. daughter) bulb but this cannot be classified as a natural phenomenon resulting from internal properties of these species. In the Czech Republic, there are only several thermophilous, rare species from the family *Orchidaceae*, which form their leaf rosette already in the autumn (species of genus *Ophrys*, *Himantoglossum adriaticum*, and a few species of the genus *Orchis*). In these plants the frequency of flowering is rather fluctuating in individual years and for that reason they are erroneously considered as living underground in some years.

Our observations, especially of *Ophrys apifera* (Ondrová et Růžička, 2001) demonstrated that in the Czech Republic the durability of plants maturing to the stage of flowering is very short and that it is not longer than 3 years (and in average even shorter). The existence of each population is dependent on the possibility to pass through a stage of regular and intensive rejuvenation so that its abundance is rather fluctuating in individual years. If the dying off is massive, it can be caused by several factors and it seems that the most frequent are damages caused by frost and subsequent rotting of roots and bulbs (in the Czech Republic, this concerns also other species which produce leaf rosettes as late as in the following spring).

The visual observation of dying caused by frost has an interesting cause (Růžička, not published). Roots are very sensitive and the actively growing zone with hyphas dies as the first and the rotting progresses thereafter up towards the bulb. The interface between the top of the bulb and the stem base suffers from damage and rotting. Later the bulb is growing soft or rotting. The leaf rosette, which is the most resistant, dies as the last, usually later in the spring of the following year. This rosette remains to be green for a relatively long period, till the total extinction of roots and the bulb and it is even possible that the stem with buds continues in elongation growth. This means that the frost damage is often not identified during the cursory control performed in the spring. Only very experienced observer is capable to notice a kind of greying of leaves, loss of gleam and, sometimes, also slight wilting. It is not possible to see that the plants have either damaged or completely rotten underground parts. Thereafter it is possible to see a sooner drying of stalks (especially during the drier periods) and a lower number of flowering individuals and/or absence of flowering plants. The further fate of individual plants is dependent on the extent of underground damage and on the capability of the original bulb to produce a new bulb.

On the turn of November and December 2002, there was a rapid onset of very strong black frost after a long, wet and relatively mild autumn in the whole territory of the Central and Southern Moravia (and, maybe, also in a much larger territory but we did not control the total extent of this phenomenon). The period of black frosts lasted for a number of days and temperatures decreased below -15°C . In the foothills of the Bílé Karpaty (White Carpathians) Mountains, where we performed the major part of our observations, such a situation did not occur for many years. Quite on the contrary, for the species *Ophrys apifera*, which is the major subject of our observations, the last ca 15 years were very favourable and the period of flowering took place approximately by 2 weeks earlier (Růžička, 2003). At the same time were found further localities, some of them significantly new (Ondrová, 2003). The new localities were recorded westwards from the foothills of White Carpathians and the recent finding was reported in the Hustopeče Hills; it was found by Kopeček in 2002 (Šmiták, 2003).

After the aforementioned black frosts in the year 2003, no flowering specimen of *Ophrys apifera* was found out in this territory (this is a report of our colleagues because we personally control only one half of these localities); the same could be said about *O. holosericea* (we control 3 localities) and *Himantoglossum adriaticum* (1 locality, which is the only one that exists in the Czech Republic). In general, only one specimen of *O. apifera* and one of *H. adriaticum* created stems with buds and thereafter died off prior to flowering (see above).

In recent years, the condition of flowering population was relatively stable in the locality with *Ophrys apifera* (Dolní Němčí), where we follow all plants in detail (Ondrová et Růžička, 2001; Ondrová, 2003). In 2002, the number of young plants increased so that we could record altogether 105 young, undamaged plants in the autumn of 2002 and it can be said that, under normal conditions, these plants could overwinter mostly without any problems. However, after the winter 2002/03 practically all plants were damaged by frost. Regarding the fact that this species has a practically the same life cycle and similar properties as both species mentioned above it is possible to generalise these observations with a high degree of probability. As early as at the beginning of spring season, the majority of plants were completely destroyed (Fig. 1 – drying leaves, rotting of stalk and bulbs or completely rotted underground organs). Damaged plants are presented in Fig. 2: The roots are rotted and this process continues, there are no hyphas on roots and bulbs, bulbs are soft and dark and the thickened root (a rudiment of a new bulb) is only at the beginning of growth. In this part of the year, normal plants should be growing, undamaged and with a network of

Ophrys apifera from the locality Dolní Němčí, 26 April 2003



1: Completely destroyed plants



2: Seriously damaged and dying plants



3: Normal plant, undamaged by frost (this plant was protected during winter period against frost)

All pictures: Vladimír Růžička

hyphas (Fig. 3) and the daughter bulb (also with hyphas) should be visible and obviously growing. The period of black frosts came quickly and was very intensive so that also the leaves were damaged. As mentioned above, this was not usual. We observed also an earlier end of growing season and stalks of only 13 plants survived till the beginning of summer. In the autumn of 2003 only 33 plants (mostly very small) were found in this locality and only 20 of them belonged to the population of 105 plants recorded there in 2002. No underground remnants were found in places where the remaining 85 plants were recorded in the preceding year. This means that only less than 20 % of (very enfeebled) specimens survived.

In addition to species mentioned above, which were not in blossom in 2003, we have followed also flowering of some other species, especially in White Carpathians and in the Brno neighbourhood. In this study we present an only rough but relatively qualified average estimation. We have found that the most damaged were the following species: *Orchis ustulata* subsp. *aestivalis*, *O. mascula*, *O. pallens* and *Dactylorhiza sambucina* (numbers of flowering plants decreased to 40 – 50 %; the species *O. ustulata* was damaged at most while *D. sambucina* at least). Flowering of *Cephalanthera damasonium* and *C. longifolia* was also reduced, as well as of *Gymnadenia conopsea* and *Dactylorhiza majalis*. *Platanthera bifolia* and *P. chlorantha* flowered without any changes. A little higher number of flowering plants was observed in 2003 in the populations of *Dactylorhiza incarnata* and *Gymnadenia densiflora*. These observations corresponded with the fact that the less damaged species were more resistant/hardy and/or that they occurred in ecologically more protected localities (i. e. with more litter, in marshes, species with deeper situated bulbs etc.).

Our observations document a relative contradistinction, viz. that the general increase in air temperatures need not result in the occurrence of generally expected better growing conditions for some thermophilous species. If the period of increasing temperatures will be associated also with the occurrence of climatic fluctuations, it is very probable that these extremes will show greater effects than the general increase in average temperatures. In ecology, such phenomena are well known but in practice they are not noticed and/or are explained in a different way. Such a striking example as this one can occur only rarely and even by species which are very important from the view of protection of nature. Results of these observations may be interesting not only for the territory of the Czech Republic but also for the whole Central European region. After the winter of 2002/03, the effects of frosts were further intensified by changing climatic conditions of the growing season of the year 2003 when a favourable spring season was followed by long and extreme droughts.

Basing on our experience it can be also explained why those thermophilous species of the family *Orchidaceae*, which form their leaves already in the autumn (e. g. *Ophrys apifera* or *O. holosericea*), occur in South Moravia just in the foothills of White Carpathians: this is a warm region (thermophyticum transiting to mesophyticum) but with a higher humidity and better snow conditions than in the warmest steppe and forest-steppe regions of the South Moravia. It is not difficult to imagine that there is a possibility that the occurrence of some thermophilous species which has become stabilised within the last 15 years or even widespreading, could become extinct, at first probably in those localities where they did not exist before (e. g. *Ophrys apifera* in the Hustopeče Hills).

The individual care about these endangered taxa must be oriented especially to localities with a long-term and stable frequency of occurrence. It is necessary to assure a reliable production of seeds and their transfer to the most suitable and stable places as well as their good germination and the subsequent growth of young seedlings. If these localities are maintained by mowing and/or grazing, it is recommended not to remove all organic matter from soil surface in the autumn because this material can protect young plants against winter frosts and to create conditions favouring an abundant development of soil microflora and humus production.

A lesson taken from activities focused on protection of *Gentianella bohemica* and *G. amarella* in the Českomoravská vrchovina Highland should be also mentioned (Růžicka et Zabloudil, 1996; later Růžicka et al., unpublished). Also in this case the flowering of plants in the year 2003 was very bad after a number

of years of a relative stability. It is of interest that also a part of plants of the species *G. bohemica* was damaged by frost after the winter of 2002/03; this observation was the first within a period of nearly 15 years of continuous studies. The damages were completed above all by a dry growing season of 2003 when, at its end (both species are flowering in the autumn), approximately 95 % of recorded plants were even died! Both these species (and *G. bohemica* especially) are bound more with the oceanic character of climate. If the changes in climatic conditions will be more regular, it is very probable that their populations will extinct more quickly than in case of the extinction of *Orchidaceae*, partly due to the fact that these species are very sensitive to climatic changes and partly also due to the fact that they are strictly biennial (Růžicka et Zabloudil, 1996); this means that they could irreversibly disappear from this locality within a period of a few years.

SOUHRN

Ohrožení teplomilných druhů flóry i při celkovém oteplování klimatu

Již dříve jsme zjistili, že velké výkyvy v početnosti kvetení tořiče včelonosného (*Ophrys apifera*), ale i dalších teplomilných druhů čeledi vstavačovitých, nejsou dány tím, že by rostliny přežívaly mykotrofně v hlízách pod zemí, jak bývá uváděno, ale vysokým úhynem, v České republice ponejvíce zmrzáním. Existence populací je pak zajišťována bohatým každoročním zmlazením. Mrazové poškození nemusí být vizuálně nápadné: zjistili jsme, že podzemní orgány jsou citlivější než nadzemní, které zůstávají zelené dokonce i po shnití hlíz a zasychají až později na jaře. Zcela mimořádně markantní byl efekt velmi silných holomrazů, které přišly náhle na přelomu listopadu a prosince v r. 2002. Některé populace byly silně redukovány (*Ophrys apifera* na 20 % počtu, a v r. 2003 ani jediný exemplář nekvetl - podobně další druhy vstavačovitých, které vytvářejí listové růžice už na podzim) a přeživší jedinci se budou dlouho zotavovat (byli oslabeni). K mrazovým poškozením došlo i u dalších druhů, mj. i u poměrně otužilého hořečku českého (*Gentianella bohemica*). U něj však větší vliv na redukcii populací mělo následné dlouhodobé sucho v sezoně 2003 (ve sledovaných populacích pak zaniklo dokonce 95 % jedinců). Ačkoli se tedy všeobecně předpokládá, že oteplování klimatu může vést k šíření teplomilných druhů, naše pozorování dokládají, že aspoň některé druhy mohou být ovlivněny spíše extrémními hodnotami výkyvů teplot (aj. povětrnostních podmínek), kterými mají být klimatické změny doprovázeny. To je sice skutečnost známá, jen ojediněle se však najde tak markantní doklad pronikavého účinku jediného výkyvu jako v našem případě. Pokud by se takové výkyvy opakovaly vícekrát za sebou, mohly by některé vzácné teplomilné druhy i zcela a rychle vymizet.

Orchidaceae, Ophrys, Gentianella, poškození mrazem, zmrzání hlíz, ohrožené druhy rostlin

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