PANNONIAN STEPPE GRASSLANDS IN MORAVIA
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INTRODUCTION

This - already seventeenth - special edition of the Veronica magazine represents a continuous tradition of publishing monothematic treatises which are concerned with various problems of landscape and nature preservation. This edition, dedicated to one of the unique jewels of the Czech landscape, the Pannonian steppes of Moravia, has been published as a 20th anniversary of Veronica's existence present to the readers. The authors have tried - in a popular way, when possible - to sum up the knowledge about how the Moravian steppes formed and evolved, about their current state and their significance in European context.

In contrast to many other similar publications, which focus mainly on the area of South Moravia, this treatise is trying to include a wider area of Moravia, including various steppe cenoses localities in their limit occurrences. Of course, the scope of the Veronica special edition only allows a limited choice of either the significant localities or their important species. It is a pleasant duty for us to mention at least some of the naturalists who not only studied the steppe communities, but also strove to protect them.

For nature lovers, this edition of Veronica should serve as a source of information about the unique steppe cenoses, which rightly deserve their place among the most valuable natural, cultural and historical sights of our country. To preserve the Pannonian steppe grasslands of Moravia in the third millennium, passive protection only will not suffice. These memorable islands of nature's treasures in contemporary cultural landscape demand continuous active care. Such care cannot be realized without securing financial support. Therefore, the ambitious goal of our publication is to influence the public and those who are responsible for the distribution of public finances, to ensure sufficient support of steppe preservation.

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THE STEPPE BIOME

"Oh, you steppes, how beautiful you are!" the Cossack ataman Taras Bulba sighed more than once in Gogol's novel. And Russian and Ukrainian were the languages from which the term "steppe" was borrowed, first appearing in international botanical terminology in the 18th century. Before that, the East Slavic name for steppe was "wild field."

Steppes are self-sufficient grass cenoses of the temperate zone. They can be found in areas with continental climate, where the summers are warm and dry and the winters are cold. Lack of rainfall limits the growth of wood plants and prevents the development of a solid forest cover. Typical Eurasian steppes are located between 45° and 55° of northern latitude, from south Ukrainian and south Russian plains up to Mongolia and north-east China. Similar cenoses can also be found on other continents. In North America they are the prairies, in South America the pampas. In the past, the steppe biome probably also prevailed in Mesopotamia, where neolithic agriculture originated and enabled the rise of first ancient civilizations.

Eurosiberian steppe landscapes are characterised by far horizons and prevalent flat and undulated reliefs, mostly in low altitudes. Typical matrix is loess, which covers a varied geological bedrock. Loess (in some parts of Moravia pithily called "žlutice" - yellow soil) is an aeolian rock rich in calcium. In the glacial era, the wind deposited variously thick layers of loesses. In steppe areas chernozem soils developed on loesses. Chernozems - "dark soils" - are named after their characteristic dark-coloured humus horizon. This dark horizon, rich in humus, was being formed over millennia, in times when there was lack of water, from the remains of roots of grasses and herbs. Earthworms significantly contributed to the accumulation of organic matter and its spread into the deeper layers of the soil. In the digestive systems of earthworms, organic remains mixed with the soil particles. Chernozem contains an abundance of nutrients and owing to this it was and still is the most valuable agricultural soil. This is the reason why steppe biomes are so rare in the world. Most steppes had been cultivated and began to be used intensively as fields. As early as 1895, the Russian naturalist V.V.Dokuchayev summarized the results of an expedition studying south Russian and south Ukrainian steppes in these words: "Real chernozem steppes are disappearing from the Russian landscape with startling rapidity." Larger remains of steppes have been preserved only in a few nature reserves.

One of the most well-known, well-studied and largest nature reserves, where the steppe and forest-steppe biomes are preserved in their natural state, is the Central Chernozem V.V.Alyekhin Zapovednik in the Kursk and Belgorod area in Russia. Five parts of this zapovednik occupy the area of 4847 ha. This world significant nature reserve is named after the famous Russian geobotanist Vasiliy Vasiliyevich Alyekhin (1852-1946), a native of Kursk, who studied local steppe and forest-steppe landscapes as early as the beginning of the 20 th century and promoted their strict protection from agricultural exploitation. In 1935, the zapovednik was successfully established, the nature reserve was extended in 1968 and in 1979 it became a part of the worldwide network of biosphere reserves, established under the patronage of UNESCO.

A common European, looking for the beauty of nature mainly in the mountains, might consider the flat steppe landscape dull. What was it about the steppe that Taras Bulba admired, apart from the feeling of unlimited freedom? It must have been the silver of the undulating feather grasses in the height of spring, when the steppe also blooms colourful blossoms. The steppe cenoses are characterized by a wide species variety (biodiversity). The character of the steppe cenoses is determined by grasses and other species of grass-like appearance. Grasses are particularly suited for the specific ecological conditions of the steppes, because their near-ground sheaths ensure survival in the dry summers and cold continental winters. Their fasciated and deep-reaching roots regenerate quickly. Typical species of Eurasian steppes are feather grasses (Stipa sp.) with a conspicuous long and feathery spike, which undulates in the slightest breeze and functions as a flying device for spreading the seeds. The caryopsis of feather grasses has a hard tip, which serves as a drilling

device to penetrate the soil even in the thickest grass sward. Grasses and most steppe herbs belong to hemicryptophytes, which is a life form of plants the buds of which winter on the soil surface.

From the high herbs, the so-called "steppe runners" adapted best to the life in steppes. They have strong roots which reach more than a metre deep. In the autumn, after the seeds ripen, their spherical above-ground parts separate from the root and in the wind they roll over the steppe and gradually shed the fruits. In this way they spread over the steppe flatlands. The most conspicuous steppe runner is Tatarian sea kale (*Crambe tataria*). The sea kales bloom white in May and as they extend over the steppe localities, they remind the observer of grazing sheep.

In September and in the autumn wind
it runs along the steppe
runs on the horizon
the sea kale shrub, rolled by the wind
being close to murder, decapitation and evil
close to the Tatar horse,
darkness rises from the grasses and feather grass spikes...

Thus the poet Jan Skácel perceived the feather grass steppe near the south Moravian town of Pouzdřany in his poem Třmeny (Stirrup irons), which was inspired by the legend of sea kale being brought to Moravia by Tatar riders.

Some Russian researchers believe that the spherical shape and rolling movement of the steppe runners ("perekati-pole" in Russian) served the ancient steppe nations as a model for constructing the wheel. In Eurasian steppes, great bustard (*Otis tarda*) is the bird representative of steppe runners, preferring running to flying, owing to its great weight (over 15 kg). The still numerous species of ground rodents, e.g. souslik (*Citellus citellus*), are typical representatives of the steppe fauna, while in the past big herbivore ungulates (horses and oxen) also lived here.

NORTH PANNONIAN STEPPES

In Central Europe, various types of steppe grassland occur particularly in the Pannonian biogeographic province. The Pannonian province (named after the ancient Roman province Pannonia) stretches across the Carpathian Basin, consisting of depressions between mountain ranges belonging to the Alps, Dinarides and Carpathians. The core of the Pannonian province is the Great Hungarian Plain (Alföld) in the Hungarian territory. In the Pannonian province, flat and undulated reliefs prevail for which loesses and calcareous grit are typical. On these, chernozems and phaeozems have developed and the occurrence of saline and halomorphic soils is characteristic. The Pannonian landscape is distinguished by a very warm climate that is significantly influenced by continental effects from the east, and partly also by the Mediterranean climate from the south. Due to these influences, markedly thermophilic plant and animal species occur there. In the natural landscape unaffected by human activity, communities of thermophilic oak woods would prevail; however, the Pannonian province belongs to those European landscapes that have been affected by human activity for the longest time and most intensively. The whole territory was a part of primeval ecumene, continuously settled since the early Neolithic peasants had come who prevented the spreading of forests in the post-glacial period. Due to cattle grazing, beautiful communities of steppe barrens, reminiscent of continental south Ukrainian and south Russian steppes, had developed, and have been conserved to this day. Today's Pannonian landscape is mainly agricultural with prevailing fields. Characteristic features are orchards with thermophilic fruit trees (apricots and peaches), vineyards and acacia growths. Such landscape character is exceptional in the Czech Republic. After all, the Pannonian biogeographic province takes up only 4% of the Czech territory, all of it in the southern part of Moravia. Phytogeographers include this territory in the area of thermophytics and in the Pannonian Thermophyticum phytogeographical region.

The starting point for understanding the current state of vegetation is a potential natural state of plant communities, i.e. such a state that would have developed if the landscape had not been affected by human interventions. The natural condition of the landscape defines the framework and opportunities for the landscape use and represents a comparative basis for the evaluation of all the changes brought about by human activity. In the landscape of South Moravian Pannonia, unaffected by humans, various types of thermophilic oak woods of the 1st oak vegetation zone would prevail.

Not even in the natural state would the thermophilic oak woods be quite solid, and in drier sites forest-steppe and steppe polankas (a table-land of small size) with manifold species would occur, with characteristic occurrence of photophilic and thermophilic species of Ponto-Pannonian and Mediterranean distribution.

In Europe, the landscape of the 1st oak vegetation zone is the one that has been affected by humans for the longest time and most intensively. As early as Pleistocene, Paleolithic hunters and gatherers lived there. From the 6th millennium B.C., the Neolithic peasants affected the post-glacial development of vegetation in the landscape by preventing the development of solid forest cover due to soil cultivation and livestock rearing, thereby facilitating the development of steppe and forest-steppe cenoses. Thus, in the landscape of oak vegetation zone in the post-glacial era, fields, meadows and pastures have always taken up more space than forests. The necessary prerequisite for the development and conservation of North Pannonian steppe cenoses was the grazing of livestock and grass mowing which had prevented the development of these localities towards forest cenoses in the past. Due to grazing, original cenoses, with the prevalence of perennial rootstalk grasses that regenerate quickly after the removal of the shoot by browsing and are vegetatively spread easily, formed. In the pastures also those species were spread that were not grazed by livestock such as unpalatable or poisonous species (e.g. wormwood and pasque flower) and thorny and spiny species (thistle, carline thistle, hawthorn, rose). That is why these specific cenoses are pithily called "špidláky" ("spikes").

The cenoses of steppe meadows, conserved up to now, are a monument to the immemorial way of use of dry North Pannonian hillsides. After the grazing had ceased, cenoses of post-agrarian pasture steppe barrens remained there that must be maintained by removing spontaneously spreading wood plant species and periodic mowing. Otherwise, they would be overgrown by expansive grasses, shrubs and trees. Populations of rare thermophilic animal and plant species have been conserved up to now in these localities; some of them reach the northern limit of their occurrence in Moravia. The importance of these cenoses for the preservation of biodiversity is demonstrated by their inclusion among biotopes of European significance within the EU programme NATURA 2000.

Mapa č. 2:
The main area of distribution of steppe grasslands in Moravia
Key: 1 – delimitation of Pannonian Thermophyticum (according to the Botany Institute of the Academy of Sciences of the Czech Republic 1987), 2 – the northern limit of Pannonian biogeographic province (according to M. Culk 1996), 3 – the aeolian sands area between Bzenec and Hodonín, which was called by K. Domin (1935) "Pannonian sands," 4 – significant localities of steppe grasslands in Moravia (a selection): 1. steppe meadows of the White Carpathians, 2. Boleradice Highland, 3. Bzenec sands, 4. Dunajovice Hills, 5. Pojihlaví serpentine steppes, 6. Hovorany meadows, 7. Krumlov-Rokytná conglomerates, 8. Květnice near Tišnov, 9. Milovice Slope, 10. Pavlov Hills, 11. Plumlov area, 12. Pouzdřany Steppe, 13. Stránská skála, 14. Špice, 15. Špidláky, 16. Větrníky, 17. Zimarky, 18. Znojmo heathlands

THE LANDSCAPE OF MORAVIAN STEPPE GRASSLANDS

Relief and geological bedrock

The area of the Pannonian Thermophyticum in South and Central Moravia covers exclusively young geomorphological elements, which belong to the Outer-Carpathian depressions, South Moravian and Central Moravian Carpathians and the Pannonian Basin. The basic morphological character of these elements was formed by the most recent movements of the Alpine orogeny and their formation was concluded by an extensive, predominantly alluvial (large valley floodplains and river terraces) and aeolic (the loess sedimentation and aeolian sands), activity. The main lines of the basic layout of the area are the biggest rivers of South Moravia, the Morava, the Svratka, the Dyje and the Jihlava.

The Inner-Carpathian depressions, represented by the Upper Moravian Dale (Hornomoravský úval) on the north and by the Dyje-Svratka Dale on the south-west, are interconnected by the Vyškovská brána depression. The bedrock mostly consists of Tertiary

neogene unconsolidated sea sediments of the Carpathian foredeep (clays, sands, gravels), which are covered by Quaternary alluvial and aeolic sediments. The relief consists of accumulative platforms and of erosive-accumulative and accumulative, often loess, uplands at the margins. The aggradational relief with hills at the margins is also typical for the depression of the Lower Moravian Dale (Dolnomoravský úval), which is a part of the geologically important neogene structure of the Vienna Basin. This depression is determined by tectonics and is filled with Miocene sea and lake sediments. The Vienna Basin is an important source of mineral raw materials - from energetical raw materials it is mainly crude oil and natural gas and, in smaller quantities, lignite. Flat erosive surfaces of the cryopediment type, which were formed by cryogenic processes in Pleistocene, follow the wide valley floodplains and river terraces of the Dyje and the Svratka rivers. These surfaces are typically developed in the western part of Lower Moravian Dale and in the central part of the Dyje-Svratka Dale. Accumulative processes prevail, in steeper sloping areas in unconsolidated rocks an accelerated soil erosion by water develops, landslips are less frequent.

The area of the Pannonian Thermophyticum extends in South and Central Moravia to the areas of higher altitude in South Moravian Carpathians (the Pavlov Hills) and Central Moravian Carpathians. In Central Moravian Carpathians, however, the highest areas of Chřiby, Litenčice Hills and Ždánice Forest belong to the area of the Carpathian mesophytic environment. The South and Central Moravian Carpathians form complexes of flysch rocks (sandstones, claystones, conglomerates), originating in Jurassic and Paleogene eras. The western part of Central Moravian Carpathians is also formed by folded tectonically raised unconsolidated sediments of the Carpathian foredeep. The nature of the relief is that of erosive-accumulative and erosive-denudational uplands (relative altitude division 50 - 150 m) up to flat highlands (relative altitude division 150 - 200 m). Calcareous outliers with an abundance of small erosion forms are typical for Pavlov Hills in the South Moravian Carpathians (the highest peak Děvín is 550 m high). In a more rugged relief processes of water erosion prevail, slope gravitational processes (landslides) are also characteristic.
In the east, the Pannonian Thermophyticum reaches by a prominent projection into erosive-accumulative and erosive-denudational flysch uplands and flat highlands in Moravian-Slovak Carpathians, into the west edge of Vizovice Upland. Bedrock consists of flysch rock complexes (sandstones, claystones, conglomerates) of partial flysch overlying rocks of Magura and outer flysch. Processes of accelerated water erosion, landslides and in the area of Uherský Brod also wind erosion are characteristic.

In the west the Pannonian Thermophyticum also reaches gentle margin slopes of the, often tectonically determined, Hercynian subsystem of the Bohemian-Moravian Highland (Českomoravská vrchovina). In the north-western area they are the eastern edges of Drahany Highland, consisting of culm rocks (greywacke, shales, conglomerates, siltstones). Continuing is the Bobravská Highland, with the relief on igneous intrusions of the Brno massif. The south-eastern boundary of Pannonian Thermophyticum is created by the eastern edge of Jevišovice Upland, formed by igneous intrusions of the Dyje massif and by metamorphic rocks. The marginal slope of the Bohemian-Moravian Highland is segmented by deep wide valleys (the Dyje and the Jihlava rivers), lateral tectonic depressions (Řečkovice-Kuřim trough fault) and longitudinal tectonic depressions (Boskovice groove), into which the Pannonian Thermophyticum partially reaches. For the eastern edge of the Bohemian-Moravian Highland in this area, marginal slope and often extensive gently inclined plateaus of the planed surface continuing the highland are characteristic. In river valleys inclosed meanders have developed, often with rocky slopes. River erosion prevails, there is the possibility of developing accelerated water erosion on the slanting slopes.

Climate

The area of the Pannonian Thermophyticum belongs, according to Quitt's (1971) topoclimactic types, to the warm area T4 in South and Central Moravia, to the warm area T2 at the western and eastern margins of the territory and only small fringes belong to temperate areas MT11 and MT10.

Warm area T4 is characterized by a very long summer, which is very warm and very dry, with 60-70 summer days (maximum daily temperature 25°C and above) and with average July temperatures of 19°C to 20°C. Average annual rainfall is 500-600 mm, average rainfall in the

growing season is 300-350 mm. The transitional period is very short, with warm spring and autumn, the growing season lasts 170-180 days (days with average daily temperatures of 10°C and above). Average daytime temperatures in April and October are 9-10°C. The winter is short, with 100-110 frost days, temperate (average temperatures in January -2°C to -3°C), dry to very dry with short-lasting snow cover, which is 1 to 20 cm thick and lasts 30-40 days.

Warm area T2 is characterized by a long summer, which is warm and dry, with 50-60 summer days (maximum daily temperature 25°C and above), with average July temperature of 18°C to 19°C. Average annual rainfall amounts to 550-650 mm, the average growing season rainfall is 350-400 mm. The transitional period is very short, with warm or temperate spring and autumn and with growing season lasting 160-170 days (days with average daily temperatures of 10°C and above). Average daily temperatures in April and October are 8°C to 9°C. Winter is short, with 100-110 frost days, temperate (average temperatures in January -2°C to -3°C), dry to very dry with short-lasting snow cover, which is 1 to 20 cm thick and lasts 40-50 days.

Temperate area MT 10 is characterized by a long and warm summer with 40-50 summer days (maximum daily temperature 25°C and above). Average temperature in July is 17°C to 18°C. Summer season may last up to 90 days, average temperatures are 15°C. Average annual rainfall is 550-700 mm, growing season rainfall amounts to 350-450 mm. The growing season lasts between 140 and 160 days (days with average daily temperatures of 10°C and above). The transitional period is short with temperate spring and autumn. Average daily temperatures in April and October are 7°C to 8°C. Short temperate winter has average temperatures -2°C to -3°C, with 110-130 frost days. The snow cover lasts 50-60 days.

Temperate area MT 11 is characterized by a long summer, which is dry and warm, with 40-50 summer days (maximum daily temperature 25°C and above) and average July temperature 17°C to 18°C. Average annual rainfall is 550-650 mm, growing season rainfall amounts to 350-400 mm. The growing season lasts between 140 and 160 days (days with average daily temperatures of 10°C and above). The transitional period is short, with temperate spring and autumn. Average daily temperatures in April and October are 7°C to 8°C. Short temperate winter has average temperatures -2°C to -3°C, with 110-130 frost days. It is very dry, with the snow cover 1 do 20 cm thick and lasting 40-50 days.

The Pannonian steppe and dry grassland localities can be found predominantly in warm area T4, the warmest topoclimactic type in the Czech Republic. The climatic stations data confirm the climate to be warm and dry. Average annual temperature exceeds 9°C (Hustopeče and Podivín 9.2 ^{o}C, Drnholec 9.3 ^{o}C, Hodonín 9.5 ^{o}C). Average annual rainfall values range around 500 mm (Drnholec 493 mm, Čejč 509 mm, Podivín 516 mm, Mutěnice 533 mm). Pannonian steppe grasslands appear in one of the driest areas in the Czech Republic. Dry, arid climate, typical for Pannonian territory, is also confirmed by very low values of Lang rain factor (the ratio of annual rainfall to temperatures), which range from 50 to 60 (Drnholec 53, Podivín 56, Mutěnice 57, Hustopeče 61).

Hydrological conditions

If we consider underground water regions, the Pannonian Thermophyticum belongs to the area with the lowest average specific run-off of shallow underground water (less than 0.3 l in a second per one km²). Average level of underground water-table and yield of the springs are highest from March to April and lowest in October and November.

The axis of the Pannonian Thermophyticum consists of middle and lower courses of big Moravian rivers - the Svratka, the Jihlava, the Dyje and the Morava. Considering surface water, however, the landscape of Pannonian Thermophyticum belongs, due to the warm and dry climate, to the least watery area, with a very low runoff (0-3 litres in a second per one km²), with low water retaining capacity and a very low run-off coefficient. The most watery months are February and March. There are large areas without permanent streams in Pannonian Thermophyticum, owing to the low run-off of surface waters. Hollows - dry valleys with flat water-free floors - belong to the distinctive features of the landscape. It is their steep slopes many steppe grassland localities can be found on.

Soils

One of the characteristics of the Pannonian Thermophyticum landscape is the prevalence of chernozem soils, which were formed at the beginning of the post-glacial period in the natural steppe and forest steppe conditions of that time. Main types found here are carbonate chernozems and typical chernozems (with their humus horizons poor on calcium carbonate), which were formed on loesses, deposited by wind in the glacial ages. The loess blankets were deposited in layers up to 30 cm thick. Loesses are characterized by a high amount of calcium carbonate, which creates whitish lime blooms, fibrous branching veins or is precipitated into typical lime nodules, called loess dolls. In some places, solonchak chernozems, characterized by high amount of salts in the soil, can be found. On marly clay and marl and their deluvia pelitic chernozems with coarse grains were formed. On carbonate sandstones and sands arenaceous chernozems with fine grains prevail. Chernozems have good physical properties, crumb structure, are often medium soils, without soil skeleton, with neutral reaction and a high amount of humus and nutrients. The dark humus horizon usually reaches the depth of 60-80 cm.

Chernozems belong to the best cultivable and most nutrient-rich agricultural soils. In South Moravia, they have been used for agriculture for more than 7000 years, since the time of the beginnings of neolithic agriculture in the post-glacial era. Chernozems are sensitive to wind and water erosion. Water erosion of the soil is very much influenced by the choice of crops and also by the way the land is managed. It is, for example, not in effect on steep slopes which are covered by grass communities or forest growth. Erosion is most extensive on fields which are tilled along the lines perpendicular to the contour, especially where long continuous slopes are tilled. Development of whole systems of erosion rills, formed by the concentration of water flow, can be observed, especially in spring. Long-term erosion activity is documented by the light colour of the soil surface on the convex upper parts of the slopes, where the dark humus horizon of chernozems had been washed away. Many South Moravian steppe grasslands are now located on this type of chernozems.

Current state of landscape

Current state of landscape is determined by the use of the soil. To evaluate the intensity of human interference in a region, the coefficient of ecological stability - the ratio of the area of permanent cultures (forests, meadows, pastures, gardens, orchards, vineyards, water areas) to the area of short-term cultures and technical objects (arable land, building area) - is used. The average value of the coefficient of ecological stability in the Czech Republic is 1.24. In the biogeographical regions belonging to the Pannonian Thermophyticum, the coefficient of ecological stability values are significantly lower (Lechovice region 0.2, Hustopeče region 0.2, Mikulov region 0.8). These values show that these regions belong to areas which are exploited above average, with fully anthropogenized landscape, completely transformed by humans. Care of all permanent vegetation formations, which contribute to the increase of ecological stability, is essential in this type of landscape.

The low value of the coefficient of ecological stability in Pannonian Thermophyticum is determined by the dominance of fields in the landscape, with arable land covering 62% of the area. Large blocks of arable land, created by land consolidation in the second half of the 20th century, prevail. Permanent grass covers - meadows and pastures - have almost disappeared, they now take up only 2.7% of the area. Gardens and orchards cover 4% of the area, with prevailing apricot, peach and walnut trees, in some cases even almond trees. Characteristic element of the landscape are the vineyards, which also take up 4% of the area. They are mainly situated in the sunniest and warmest parts of the southern slopes. The forested area is very small, taking up only 13% of the whole area. The largest areas of forests can be found in the valley floodplains of the Morava, the Dyje and the Svratka rivers, which had not been used - due to the floods - for agriculture in the past.

The prevalent landscape of Pannonian Thermophyticum then consists of fields, with occasional orchards and vineyards. The preserved localities of Pannonian steppe grasslands represent isolated islands of biodiversity, threatened by various influences from their surroundings.

THE HISTORY OF MORAVIAN STEPPE LOCALITIES USE

The history of Pannonian dry grasslands use is difficult to trace into further past. It is certain that this type of plant community has been, since the second half of the 19th century, constrained when possible, due to its low crop productivity. Therefore, all the remnants of the steppe grasslands that have been preserved up to present day are located in areas which are difficult to access and cultivate, and which, in South Moravia, are almost exclusively primarily steep non-forest slopes of the local hills (of the larger of these areas, besides the slopes of Pavlov Hills, those preserved up to present day are e.g. Pouzdřany Steppe, Čejč and Čejkovice Špidláky, Větrníky near Lysovice in Vyškov region, Visengrunty near Bošovice, Rašov Fault and Ševy near Mouřínov in Bučovice region etc.).

We can only speculate about the use of these steep slopes in the Middle Ages. If we use later periods for analogy, we can assume that they were used as extensive pastures and made up, which we can say with great certainty, a part of a larger pasture territory. The first written sources, in which we can find how the particular locality was being used, are the Teresian and - more accurate in the cadastre description - Josephian cadastres. These documents (the former was being drawn in Moravia at the end of the 1740s and later was rectified several times, the latter, for various reasons only valid for a year, was drawn in the years 1785-1788) mapped the state of field tenure and homesteads of the villages, with the purpose of devising a more strict and, in the case of the Josephian cadastre, more just taxation. These documents report the division of individual village cadastres into field lines, which are then more or less carefully described. From these descriptions we find out place-names of the individual localities and also how they were exploited. And indeed, everywhere where the remnants of Pannonian dry grasslands are today, the cadastres show pastures.

We have even better records from the first half of the 19th century. At that time, precise cadastre maps - the so-called indication sketches (in Moravia in 1820s) - were first produced for all the villages of the Habsburg monarchy as bases for determining net proceeds from the land. Using these maps, the so-called evaluative cadastral records, which calculated the net proceeds from every homestead, were produced for individual villages. An integral part of these cadastral records was a very detailed description of the village, the cadastre and the soil management there. The authors of the cadastral records divided all the managed soil of the individual cadastres according to individual field and forest cultures into classes, based on the soil lair. In this document, we can find concrete places and the manner of their cultivation. Judging from what we can find in these documents, most estates with Pannonian grasslands were defined as pastures of the second and third lair classes (the authors of the cadastral records usually divided the soil into three classes, with the first class comprising exclusively flat floodplains surrounding rivers), which, for example in the case of the Čejč and Čejkovice Špidláky, were marked, in accordance with contemporary knowledge, as sandy clay soil, offering only a "poor grazing-ground."

As the authors of the cadastral records, advocating rational field management, complained, these estates were not being maintained in any way, they were at most subject to "spring cleaning," which consisted in removing seeding. The cadastral records also speak of the practice of the peasants, who, in wet years and in accessible localities, mowed the grass once a year. People who remember the era of interwar private peasant farming also confirm this practice. Where mowing was expected, the authors of the cadastral records claim, the peasants made spring preparations by burning or raking up the dry grass.

There were, of course, many more pastures of the second and third class in the first half of the 19th century. In the Hodonín area, in villages like Čejč, Mutěnice and Čejkovice, where there still are remains of steppe grasslands today, pastures of these classes spread on the total area of 1170 ha! We can then presume that Pannonian grasslands represented a significant part of this area. However, where conditions permitted, these grasslands began to be cultivated, especially after servitude was abolished in 1848, which brought the rise of free peasant farming. And the *ownership factor* was without a doubt the most important of the factors that brought about the exploitation of the pastures.

The pastures of villages located on the plains usually belonged to the common ownership of the particular manor, village and individual peasants. This joint tenancy ensured the right of the manor to let its herds graze on the pastures, that the village had enough grazing-ground for its cattle and it also ensured the right of individual farms to use the pastures for grazing (in many places,

however, the pastures were only used by the manor and the village). After servitude was abolished, the pastures were mostly divided into thirds, one for each subject. Individual peasants usually did not divide the pasture among themselves and continued to use their third together, paying rent for feeding on the village pasture. The pastures owned by villages were often sold or rented on long lease, thereby bringing profit to the villages, which, in 1848, gained more freedom to decide what to do with their possessions. The pastures were often sold or rented to the landless, who used them almost exclusively for crop growing.

Another important factor that contributed to gradual decrease in pasture area was the *cessation of sheep breeding*. In the first half of the 19th century, manors in particular still bred big flocks of sheep, which required large amounts of feed to survive. For example, in the three Hodonín area villages mentioned above, at the time of the drawing of the cadastral records, a total of 9167 sheep were bred in the manor and peasant stock. The decline in sheep breeding was connected mainly with the decrease in wool prices, caused by the entrance of cheap Australian and South American wool on European markets.

In the wake of the cessation of non-pastoral sheep breeding on the plains came, in the last third of the 19th century, a gradual *transition to crop rotation*, which left little space for cattle grazing. Growing fodder plants enabled stall feeding and the increasing amount of litter became to be used as lea fertilizer. Big estate farmers in particular were ceasing their use of pastures at this time. Great demand for soil in the economic depression of the 1930s contributed to selling and fragmentation of the remaining village pastures and, together with the increase in artificial fertilizer use, brought about the definitive wane of the common grazing-grounds in the plain areas of Moravia.

Thus, only pasture enclaves, limited to places described at the beginning of this chapter, remained in the village cadastres. The disappearance of the plains pastures thus cannot be, surprisingly, blamed on the communist agriculture collectivization - it only completed the process. The pasture enclaves were, together with balks, hollows, road ditches or river banks, grazed by cattle that belonged to farming metal workers, who lacked fodder plants which would enable permanent stabling of their stock. For this reason these plots were mowed far more often than in the past. Among the farming metal workers goat breeding prevailed, they owned only small numbers of beef cattle. But goats, while grazing, cleared the pasture lands perfectly of shrub seeding, eliminating the necessity of "spring cleaning."

The graze located in the rest of the sloping pasture enclaves of the plains of Moravia completely disappeared around the end of the 1960s and the beginning of the 1970s, together with the cessation of domestic cattle breeding as a consequence of the intensification of agricultural production and an increasing standard of life. Around that time the individual sloping pasture areas with Pannonian dry grasslands began to be declared natural reserves. A lot of them, however, fell victim to the so-called substitute recultivations - terracing of the grasslands - in the 1970s and 80s. The remaining localities, although strictly protected, will hardly escape gradual deterioration without regular grazing or mowing (which, it has to be said, happen in some places thanks to state support or non-governmental organizations).

VEGETATION AND FLORA OF SOUTH MORAVIAN STEPPES

Ecological differences between localities are reflected in the variability of the South Moravian steppe grasslands vegetation. The variability depends mainly on the humidity gradient, which is influenced by, for example, slope steepness or the cardinal point orientation, but it also depends on the diversity of the geological substrates - main types here are soft Tertiary sediments (sandstones, marlstones), loesses, limestones, crystallic rocks and sands; in some of these rocks we can also distinguish acidic and ultrabasic types. A significant factor is also the location of the steppe locality in relation to the core of the area - the localities at the margins are almost invariably impoverished. These days, the favoured explanation for this gradient is that the margin localities succumbed more easily to spontaneous changes in the course of the vegetation development in the post-glacial era, rather than that the steppe species involved never migrated that far.

On the shallow soils, which dry out particularly easily, especially in the southern and western quadrant orientation, typical rock steppe develops. In the core it is the primary vegetation,

however, human exploitation activities in the past have, without a doubt, benefited the vegetation. It consists mainly of smaller tufted grass - especially some species of fescue - the species composition of which contains a diversity of various conspicuously blooming species.

On limestones, this vegetation is denoted as *Seslerio-Festucion pallentis* alliance. Typical rock steppe species are grey fescue (*Festuca pallens*), Valesian fescue (*Festuca valesiaca*), Baden's bluegrass (*Poa badensis*), crested hair-grass (*Koeleria macrantha*), blue sesleria (*Sesleria caerulea*), from blooming monocotyledons they are, for example, pygmy iris (*Iris pumila*) and *Iris humilis* subsp. *arenaria*, from dicotyledon perennials and semishrubs mountain germander (*Teucrium montanum*), *Fumana procumbens*, *Medicago prostrata*, the *Veronica prostrata* speedwell and Spanish catchfly (*Silene otites*). Orpine family plants are also typical, for example white stonecrop (*Sedum album*), biting stonecrop (*Sedum acre*) and the *Jovibarba globifera* houseleek. From alliaceous plants we can find especially small yellow onion (*Allium flavum*) here. In the spring, a whole range of specific annuals with a very short development period appear in this vegetation. Among them are, for example, *Holosteum umbellatum*, little mouse chickweed (*Cerastium semidecandrum*), rue-leaved saxifrage (*Saxifraga tridactylites*), the *Arabis auriculata* wall cress, the *Erophila spathulata* whitlow grass and the *Veronica praecox* speedwell.

In hard limestone rock crevasses vegetation of the *Diantho lumnitzeri-Seslerion* alliance with a set of mountain, also called dealpine, species can be found. They are, for example, the *Arenaria grandiflora* sandwort, grass pink (*Dianthus lumnitzeri*), lifelong saxifrage (*Saxifraga paniculata*), blue sesleria (*Sesleria caerulea*) and *Biscutella laevigata*; the endemic Moravian pink (*Dianthus moravicus*) also grows in a few places at the eastern edge of the Bohemian Massif.

Similar vegetation on acidic rocks belongs to the *Festucion valesiacae* alliance. We can find grey fescue (*Festuca pallens*), Valesian fescue (*Festuca valesiaca*) and crested hair-grass (*Koeleria macrantha*) here, too. The species composition of shrublets is different - for acidic rocks, especially hairy greenweed (*Genista pilosa*) is typical. The species composition of ephemerons is completely different. On acidic rocks, whitlow grass (*Erophila verna*), thale cress (*Arabidopsis thaliana*), *Cerastium glutinosum*, *Myosotis stricta*, the *Androsace elongata* rock-jasmine, spring speedwell (*Veronica verna*) and Dillen's speedwell (*Veronica dillenii*) grow. From alliaceous plants, Bohemian gagea (*Gagea bohemica*) is typical.

On the sunniest sites of the southern quadrant, which form on deeper soils on Tertiary sediments or on loesses, different types of the *Festucion valesiacae* alliance vegetation appear. As a rule, they take up small areas and are often bound to clear-cut slope edges, where they can even represent primary vegetation, in which most steppe species were able to survive the strongest attacks of forests. Besides the small tufty Valesian fescue (*Festuca valesiaca*) and dwarf sedge (*Carex humilis*), the stout feather grasses (*Stipa*) markedly add to the species composition - in South Moravia, a total of five species of these grasses can be found. Species diversity of feather grass cover is usually slightly lower. From dicotyledonous plants, the *Astragalus onobrychis* milk-vetch, Austrian milk-vetch (*Astragalus austriacus*) and *Jurinea mollis* are frequent, less frequent are Tatarian sea kale (*Crambe tataria*), the *Seseli pallasii* moon carrot, *Chamaecytisus austriacus*, honeywort (*Trinia glauca*) and other species. Short steppe bushes continue this vegetation in some places, where we can find, for example, dwarf almond tree (*Prunus tenella*), steppe cherry (*Prunus fruticosa*) and burnet rose (*Rosa spinosissima*).

On slightly deeper basic soils on slopes of the remaining orientations, vegetation of the so-called broad-leaved dry grasslands, which belongs to the *Bromion erecti* alliance, appears. The largest areas of steppe grasslands in our territory belong to this alliance; it is altogether a secondary, semi-natural vegetation, which has spontaneously set up only after deforestation. This vegetation is very species-diverse in many localities; most of the flowery meadows - which are considered to be one of the most species-rich types of grass-herb vegetation in the whole of Europe - in the so-called steppe White Carpathians belong here. From the grasses, mainly tor grass (*Brachypodium pinnatum*) appears in the species composition, sometimes also *Bromus erectus*, *Koeleria pyramidata* and the *Festuca rupicola* fescue, from sedges especially mountain sedge (*Carex montana*). From dicotyledonous herbs mainly mountain clover (*Trifolium montanum*), the *Polygala comosa* milkwort, dropwort (*Filipendula vulgaris*), greater knapweed (*Centaurea scabiosa*), hoary plantain (*Plantago media*), meadow clary (*Salvia pratensis*), the *Prunella grandiflora* self heal and

many more are characteristic.

Vegetation of the *Koelerio-Phleion phleoidis* alliance is physiognomically similar to, but very different in species composition from the previous type. This vegetation is bound to acidic growth media and it is typically formed at the easternmost margins of the Bohemian Massif. In contrast to the previous vegetation, it consists of a mix of acid-tolerant and markedly acidophilic species. The former are for example the *Festuca rupicola* fescue, dwarf sedge (*Carex humilis*), squinancy woodruff (*Asperula cynanchica*), the *Pseudolysimachion spicatum* speedwell, from acidophilic species, for example, sheep's fescue (*Festuca ovina*), German catchfly (*Lychnis viscaria*) and field sorrel (*Rumex acetosella*) can be found in this type of vegetation.

Continuing this vegetation are sometimes growths with dominant shrublets ("Znojmo heathlands" and similar vegetation types), which were formed at the contact of Pannonian and Central European flora and represent a phytogeographical speciality of this territory. They belong to the *Euphorbio-Callunion* alliance. These growths are secondary, they were formed after the felling of the thermophilic acidophilic oak groves and the following degradation of soil cover. Shrublets are dominant, especially hairy greenweed (*Genista pilosa*) and ling (*Calluna vulgaris*). The herb composition is very similar to the previous vegetation type. We can find mainly sheep's fescue (*Festuca ovina*), the *Agrostis vinealis* bent and meadow oat (*Avenula pratensis*), in rare cases wavy hair-grass (*Avenella flexuosa*) and common matgrass (*Nardus stricta*) can be found, too. Other plants that appear in the species composition are for example mouse-ear hawkweed (*Hieracium pilosella*), Klamath weed (*Hypericum perforatum*), Ponteder pink (*Dianthus pontederae*), but also more pronounced acidophytes, for example the *Jasione montana* sheep's bit and the *Scleranthus perennis* knawel. Numerous lichens of the *Cladonia* and *Cetraria* genera point to acidic substrate, too.

The growths of open sands represent a completely different Pannonian steppe vegetation. They are also for the most part secondary and, like in the above mentioned acidophilic steppe grasslands, there is a mix of Pannonian species and Atlantic migrants in their species composition. The vegetation of South Moravian sands (together with the vegetation on the sands of the neighbouring Záhorie Plain) is very different from other types of vegetation on the sands of the Pannonian Plain, because local sands, in contrast to sands in the Danube river basin, lack grains of basic rocks. The sands vegetation consists of many communities. In the least closed stands on the recently disturbed surfaces we can find, for example, sand plantain (*Plantago arenaria*) or rat's tail fescue (*Vulpia myuros*). In the advanced stages of succession usually grey hair-grass (*Corynephorus canescens*) and wild thyme (*Thymus serpyllum*) dominate, together with the annuals slender cudweed (*Filago minima*), *Spergula morisonii*, Dillen's speedwell (*Veronica dillenii*), rarely also *Spergula pentandra*. Most of the above mentioned species are typical Subatlantic species and they have not much in common with Pannonia. Only in the vegetation of successively advanced surfaces with a thin layer of humus can we find a marked representation of Pannonian elements. There, the core of the vegetation is formed by tufty grasses, either *Festuca vaginata* subsp. *dominii*, or the *Stipa borysthenica* feather grass, from the Pannonian elements we can also find white sticky catchfly (*Silene viscosa*), Spanish catchfly (*Silene otites*), *Erysimum diffusum*, *Carex stenophylla*, *Carex supina* and *Linaria genistifolia* here.

We have to perceive the flora of South Moravian steppe localities in connection with the fact that it is the north-western projection of Pannonia. Local landscape, open in the south-eastern direction, enabled many species to penetrate here from south-east. But the species composition rules in these localities are not by far trivial. Professor Podpěra, who laid the foundations of phytogeographical research in South Moravia, was already aware of the fact that the steppe elements do not decrease in numbers with the increasing distance from the core of Pannonia. What is this caused by? Mainly by the complex geological, geomorphological and climatic character of Central Europe. The complicated relief creates a high diversity of sites, which are differentiated by exposure differences. Moreover, the slope inclination can amplify or reduce the influence of slope orientation. Climate also has a complex, mosaic-like character - the mountain ranges form windward and leeward positions, relative continentality also has quite a distinct influence in places where the föhn effect of the air masses descending from the higher hills to the plains, where the air

masses get warmer and drier, is in effect. Therefore the seeming illogicality of the increase of rainfall in South Moravia along the Znojmo - Hustopeče - Bílé Karpaty line, is not surprising.

From the differences in the range shape also the different histories of the steppe plants in South Moravia follow. The climate was changing considerably in last 10 000 years, the existing natural conditions influenced the preferences of certain flora and vegetation elements greatly. It is obvious that the continental Eurosiberian species reached their peak in the time of cold steppes at the end of the glacial period and in early post-glacial period and after that they were pushed out to various extreme sites. These species often have the characteristics of glacial relicts. We can recognize them by the insular range, characteristic by large gaps, and also by their concentration in sites unusual in the particular landscape. Some halophitic elements definitely belong to them, e.g. black saltwort (*Glaux maritima*), but also the conspicuous Chenopodiaceae shrublet *Kochia prostrata*, which in the Central European area characteristically accompanied the transition from salt marshes to steppes.

We can find many limit elements - species which reach their partial or absolute range limit here - in South Moravia. A whole range of typical thermophilic grassland species belong to them. The most well-known include *Pulsatilla grandis*, pygmy iris (*Iris pumila*), *Iris humilis* subsp. *arenaria*, *Iris graminea*, *Echium maculatum*, *Hesperis tristis*, *Scorzonera austriaca*, *Inula ensifolia*, *Inula oculus-christi*, honeywort (*Trinia glauca*), *Seseli pallasii*, *Euphorbia epithymoides*, Tatarian sea kale (*Crambe tataria*), *Euphorbia salicifolia*, ground broom (*Cytisus procumbens*), white broom (*Chamaecytisus albus*), *Taraxacum serotinum*, dwarf almond tree (*Prunus tenella*) and other. On the other hand, there are very few endemic species here. The only endemic species of Pannonia, which reaches South Moravia, is the very rare Pančić's wormwood (*Artemisia pancicii*). Most of its localities are in Austria, one is in Serbia and three sites have been found in South Moravia. The closest relatives of Pančić's wormwood are the Central Asian species of wormwood from the group of *Artemisia laciniata* relatives. This group consists of a few independent isolated species in Central Europe; *Artemisia insipida* from the south-western Alps and *Artemisia oelandica* from the Swedish island of Öland belong to it, too.

Other species of thermophilic grasslands reach further north to the warm areas of Central and North Bohemia and very often even to Central Germany, where the islands of thermophilic flora are known in the Rhine river basin and in the continental south-eastern foothills of the Harz mountain in the central part of the country on the boundary between Thuringia, Saxony-Anhalt and Saxony. Among such species we can find dwarf sedge (*Carex humilis*), the sedges *Carex supina* and *Carex michelii*, Baden's bluegrass (*Poa badensis*), the *Dictamnus albus* dittany, viper's grass (*Scorzonera hispanica*), *Dorycnium germanicum*, *Seseli osseum*, horse fennel (*Seseli hippomarathrum*), goldilocks (*Aster linosyris*), *Inula germanica*, *Scabiosa canescens* and the *Pulsatila pratensis* pasque flower.

Three different elements meet in the flora of South Moravian thermophilic grasslands. First of them are the Submediterranean species, which have the distribution core in the Mediterranean countries. These species are the real thermophytes, with high demands on temperature. Some of them reach their absolute northern range limit in our territory. These species include, for example, wall germander (*Teucrium chamaedrys*) and the *Stipa eriocaulis* feather grass.

The second element are the Ponto-Pannonian species, the ranges of which reach our territory from the south-east, from the Balkans and the surroundings of the Black Sea. In their ecological demands resistance to cold appears, somewhat compensated by the relationship to lower rainfall. These species often reach the north-western limit of their range in South Moravia. Representatives of these species are *Inula ensifolia*, baby's breath (*Gypsophila paniculata*), *Polygala major*, *Ranunculus illyricus* and *Cruciata pedemontana*.

The third group of species are the envoys from continental steppes of the Eurasian area. Their thermophily is rather a substitute for xerophily in Central Europe - some of them reach the Polar circle in the high continental parts of Siberia, while in Europe they are bound to the warmest sites. These typical steppe species are often absent from the core of Pannonian plains and they can be paradoxically found in their southern range limit in our territory. Among the typical continental steppe species we can find Austrian milk-vetch (*Astragalus austriacus*), purple milk-vetch (*Astragalus danicus*), *Peucedanum alsaticum*, snowdrop anemone (*Anemone sylvestris*), from

feather grasses *Stipa capillata*, *Stipa tirsa* and *Stipa dasyphylla*, from fescues Valesian fescue (*Festuca valesiaca*) and *Festuca rupicola*, but also *Potentilla arenaria* and *Chamaecytisus ratisbonensis*.

SIGNIFICANT PLANT SPECIES

Kochia prostrata

This low shrub from the Chenopod family is one of the most typical steppe plants of South Moravia. Here it was mostly found on high loess slopes, but it might have grown on the steppe margins of salt marshes in the past. Its habitats were gradually disappearing, and when, in the second half of the 1970s, the last known colony was destroyed while a road in the orchards at Stará hora near Újezd u Brna was being extended, it was classified as an extinct species of our flora for a short time. However, after a few years, a new population was discovered on the slopes of a railway cutting, only a few hundred meters away from the extinct locality. The shrubs were doing well there, but nowadays the locality, which is still not included in the protected area, is overgrown by wood plant seeding, with grasses like *Stipa capillata* spreading here too. In 2006, only a few shrubs were to be found. Right beyond the border, in Austria, not far from the Hatě border crossing, vast populations survive even today.

Gr

Purple mullein (*Verbascum phoeniceum*)

The only completely perennial species of mullein is characterized by conspicuous dark purple flowers. It grows on sands, limestones, on loess slopes and also on acidic crystalline basement; these sites, however, all dry out very easily. Occasionally it creates hybrids with other, yellow-flowered, mullein species - the flowers of the resulting hybrid are then yellow-orange. Hybridization, however, is limited by differences in phenology - purple mullein is the earliest of all our species, so the possibility of being pollinated by other mullein species is minimal.

Gr

Echium maculatum

The blood-red flowers of *Echium maculatum* represent an exotic ornament of the steppe slopes in the central nad eastern parts of the warm South Moravia. This stout plant reaches its western range limit here. It mostly grows a rosette for a few years and dies after fading, although it is apparent that sometimes a daughter shoot can save it from dying. *Echium maculatum* is rightly included in the list of significant European species. These days its populations only survive in about 10 habitats in Moravia, the numbers of the flowering plants, however, change considerably from year to year. Irregular blooming and the rather complicated life-cycle renders the plant fairly vulnerable.

Gr

Spring adonis (*Adonis vernalis*)

It is impossible to imagine the beginning of spring in the steppe grasslands without the bright yellow flowers of spring adonis, blazing above the greyness of the old grasses during April. This perennial herb belongs to the differentiation species of thermophyticum, not only of the Pannonian one - its occurrence reaches even the warmest parts of Bohemia. It prefers calcareous substrates, besides limestone especially loesses and calcareous flysch. There are dozens of spring adonis habitats in South Moravia. We can find the most numerous population of this area at the margins of the Milovice forest in the Protected Landscape Area Pálava. For example, in the Milovice Slope Nature Reserve, almost five thousand tufts of this beautiful protected plant were found by young nature enthusiasts while prospecting. The increase in the spring adonis population after regular mowing and removal of the wood plant seeding in Šéry near Bučovice Nature Reserve is a nice example of a successful management in a specially protected area.

La

Aster amellus

This perennial usually concludes the "flower clock" of the steppe grasslands. Its beautiful purple-blue flowers only open in late summer and often keep blooming until the end of October, when the first stronger frost comes. It is considered to be a Ponto-South Siberian floroelement, a species which has its centre of occurrence in the steppes and forest-steppes of south-eastern Europe and South Siberia. Like most steppe species, *Aster amellus* is also bound mainly to overlaps of loesses. Owing to that it also likes growing in abandoned loam pits of brickworks. We can even find large populations on an abandoned Vratislav-Vienna highway north of Brno, the construction of which took place in the 1940s.

La

Moravian pink (*Dianthus moravicus*)

The only "purebred" endemic species of Moravian rocks and rock steppes only grows in 6 localities in the south-western Moravia. Its bedrock can be Permian-Carboniferous conglomerate, granite, gneiss or amphibolite, but it always is a naturally relict nonstocked forest land. It was identified as late as 1982, up to that time the plant had been thought to be cheddar pink (*Dianthus gratianopolitanus*), which can be found in many habitats in Central Bohemia. In fact, cheddar pink is not much related to Moravian pink, which is closer to the types of grass pink (*Dianthus lumnitzeri*), which grow on isolated spots at the margins of the Alps and western Carpathians and which also include populations of Pavlov Hills.

Gr

Tatarian sea kale (*Crambe tataria*)

Tatarian sea kale the steppe runner is a very conspicuous, so to speak "flag plant" of the South Moravian steppes. Here it reaches its absolute limit of occurrence in the north-west, but it is remarkable that it is much rarer in the neighbouring countries (Austria, Slovakia and Hungary) than in South Moravia. Even today it can be found in more than 10 localities. It is also a model example for another reason - like a proper steppe plant, it is able to react quickly and spread to newly formed areas. This proves that steppe species often have a hidden potential of dynamic distribution.

Gr

Feather grass (*Stipa*)

Feather grasses are typical xerophilic tufted grasses, the covers of which give the impression of a real steppe. Up to now, we know of 7 species of feather grass growing in South Moravia. *Stipa capillata* is the only one of them which does not have a feathery spike. It is very xerophilic, grows on loesses and in sandy and rocky steppe growths, in the driest parts of South Moravia and it does not grow east of the Morava river at all. Feather grasses with feathery spikes are very similar to each other, they differ to a certain extent in occurrence, ecological demands and also phenology. The most frequent of feather grasses is probably European feather grass (*Stipa pennata*), which reaches the farthest to the north and to the west in Moravia. On deeper loess soils it is accompanied by the stout *Stipa pulcherrima*. The most known locality of this species is the Pouzdřany Steppe, where it is the dominant species of the steppe vegetation. On the other hand, in Pálava it only grows on loess pockets. *Stipa dasyphylla*, easily distinguishable by its markedly downy leaves, also creates robust tufts. This species is typical for the serpentines in the Jihlava river basin (Pojihlaví); it is dominant in some parts of the Mohelno Serpentine Steppe, for example. It seems to avoid limestones: it is completely absent from Pálava and is also very rare on the hills between the Dyje river and Ždánice Forest. It belongs to the continental species and South Moravia lies practically at the southern margin of its range. The gentle *Stipa tirsa* is characterized by a belated date of blooming - it blooms about four weeks later than the other species. It can be sporadically found at the edges of the Bohemian Massif, for example around Moravský Krumlov or in Pojihlaví. Like the previous species, it cannot be found in Pálava, but is quite numerous in the remnants of steppes between Brno and Bučovice. It also used to dominate the driest types of White Carpathians steppe vegetations - but the times when the Carpathian hills were white with the downy spikes of feather grasses are long gone... The remaining 2 species are very rare. *Stipa eriocaulis* was discovered only recently in the rocky steppe of Svatý Kopeček near Mikulov, while *Stipa borysthenica* is bound to a

few sand-banks in the Hodonín area and in the confluence area of the Dyje and the Morava rivers.

Gr

Pulsatilla grandis

This is a typical Pannonian plant, which reaches its north-western range limit in South Moravia, but its margin localities can already be found in the typical Bohemian-Moravian Highland in the Třebíč and Náměšť area. It grows in various types of short-blade vegetation; in taller growths of broad-leaved steppe grasslands it is rare and its populations are suppressed by bigger plants there. It does not prefer any of the dominant geological substrates - it grows on limestone, flysch, on aeolian loess, but also on various acidic crystalline basements; it avoids only sands. In the neighbouring areas it smoothly passes into related species - in Austria into pasque anemone (*Pulsatilla vulgaris*), in Slovakia into Slovak pasque flower (*Pulsatilla slavica*). We cannot find such species in Moravia, but, if we are lucky, we can find its hybrid with *Pulsatilla pratensis*. The *Pulsatilla grandis* pasque flower has significantly decreased in numbers in last decades - the main reason is the destruction of its habitats as a result of building activity or restoration of agricultural land, the second important reason is plant succession caused by the cessation of the traditional management and also by the increase in nutrient amount. Despite that, more than 100 populations exist, with the most numerous still probably the one in Kamenný vrch over Brno-Nový Lískovec.

Gr

Pygmy iris (*Iris pumila*)

Pygmy iris is one of the most typical species of South Moravian steppe vegetation. Its multicoloured flowers in various shades from purple through blue to pink, but also yellow, are one of the symbols of the awaking spring. It belongs to species of the Ponto-Pannonian range and here in South Moravia it reaches the north-western range limit. Its habitats were first found only during the 20 th century in Bohemia on the Říp and in Šárka near Prague and they probably come from planting. Pygmy iris grows mainly in the vegetation of calcaerous rocky steppes in Pavlov Hills, but it can also be found in turfy grasslands on soft Tertiary sediments and on loess substrates, exceptionally also on other substrates (granite, Permian-Carboniferous or culm conglomerates). A total of 40 localities remains and these localities delimit the Pannonian range very well. They rarely reach outside the range, other localities include Velký Hornek in the Říčka river valley in the southern part of Moravian Karst. The Děvín populations in the Pálava Protected Landscape Area belong, without a doubt, to the largest in Central Europe and when they bloom, they attract the attention of thousands of visitors.

Gr

Iris humilis* subsp. *arenaria

Iris humilis subsp. *arenaria* is a real rarity of South Moravian steppes. Its range extends north of the Black Sea and reaches the Pannonian plains on the north-west, where it includes South Moravia. Today we know of 8 localities here, one half of which lie in Pálava and the other in the surroundings of Miroslav. Another group of habitats is located in Austria, right beyond our border south of the Podyjí National Park. This species prefers arid rocky steppes on shallow soils, with low free-growing vegetation, regardless of substrates, which can be limestone, granulite, gneiss or granite, in Slovakia and Hungary it prefers calcareous sands. It blooms about 5 to 7 days later than pygmy iris and its flowers are only open for one day. This is also one of the reasons why a common visitor rarely encounters it.

Gr

Globularia bisnagarica

A tufty herb with a rosette of spatulate leaves and a leaved stalk, tipped with a spherical truss of small, gently blue flowers. We can find it mainly in the central part of South Moravian Thermophyticum, it prefers deeper loess soils. For example, it is quite sparse in Pálava, at the margin of the Bohemian Massif it only grows on Miroslav Hills. Apart from one exception, the surroundings of Horní Němčí, it does not grow east of the Morava river. It belongs to species with

Submediterranean distribution, in calcaerous areas of the Alps and the Carpathians it ascends to quite high altitudes in the mountains.

Gr

Dwarf almond tree (*Prunus tenella*)

This steppe shrublet with big, conspicuously pink flowers reaches in South Moravia farthest to the west. A few small populations were found in the past near Popice in the Břeclav area, on Dunajovice Hills, and the westernmost occurrence is near a former settlement Ječmeniště in the Znojmo area. The habitats of this species are usually higher loess balks. Dwarf almond tree can withstand ruderalization, but near Popice some populations were destroyed by the expansive invasive boxthorn (*Lycium barbarum*). Dwarf almond tree is very decorative and, especially in the villages with former German population, it has been grown in the gardens since long ago. It seems that in the localities mentioned above it is indigenous.

Gr

Inula germanica

From all the species of this genus, *Inula germanica* is the rarest. It is closely bound to deeper soils on soft substrates, we cannot find it either in Pálava or in most of steppe localities of south-western Moravia. The reason for it being endangered is also, to a certain extent, genetic corrosion - it easily creates hybrids with its relative *Inula ensifolia* in common localities. The hybrid only preserves itself vegetatively, but it is very viable and it can survive even in places where the sensitive *Inula germanica* became extinct. For example, in the Pouzdřany steppe the hybrid is also more frequent than its rare parent.

Gr

Helictotrichon desertorum

The memorable *Helictotrichon desertorum* oatgrass was discovered by Professor Josef Podpěra, Nestor of South Moravian botanists, on Šibeničník near Mikulov before the First World War. It is one of the most remarkable steppe grasses - apart from the only site in South Moravia, it is located on 5 hills in the driest, most continental part of Bohemian Highland, on Hainburg Hills opposite Bratislava in the neighbouring Austria, in sporadic localities in Ukraine and more continuously in a belt at the southern margin of Siberia from Ural to Mongolia. In Central European localities, it is altogether bound to steep west-facing slopes with deeper soils. In all the localities, intensive influence of the wind, which did not allow forests to prevail, is manifested. *Helictotrichon desertorum* is probably a remnant of the steppe flora from the cold periods at the end of the glacial era.

Gr

Pančić's wormwood (*Artemisia pancicii*)

Pančić's wormwood is without a doubt one of the most remarkable steppe plants in South Moravia. It is the only typical endemic species of Pannonian steppes in our steppe flora. In North Serbia, where it was first identified, it has only one habitat, in Lower Austria and Burgenland about 13 localities exist, and 3 more are known in South Moravia. It has never been found in Slovakia or Hungary. It always occurs in steppe grasslands on deep soft substrates; in our country it can still be found on Dunajovice Hills, in the Pouzdřany Steppe and near Čejč. The population amounts to 40 individuals, but the plants rarely flower and usually spread vegetatively. Its closest relative, *Artemisia laciniata*, can be found in Austria, where it only grows in moorland meadows.

Gr

Snowdrop/wood anemone (*Anemone sylvestris*)

In contrast to the common European wood anemone, which grows in forests and meadows from plains to mountains, the snowdrop or wood anemone, also blooming white, is considerably rarer and blooms much bigger flowers. The specific name "wood" is misleading, because this anemone's centre of occurrence are the steppes of South Siberia. In South Moravia we can also

admire its May flowers mainly in various steppe grasslands. If it grows in a forest, it is only at its margins or in forest openings. It is bound mainly to calcareous substrates, avoiding the poor and acidic ones. It belongs to those thermophilic species which have many habitats not only in the Pannonian, but also in the Bohemian Thermophyticum. On calcareous substrate, its occurrence reaches outside the area of thermophilic flora and to relatively high altitudes. For example, on the interstratified bed of crystalline limestones in Sýkořská highlands north of Tišnov an isolated population of snowdrop/wood anemone grows in an altitude of almost 600 m.

La

Jurinea mollis

Jurinea mollis is also one of the plants which have their centre of occurrence in the steppes north of the Black Sea and in our territory reaches its north-western range limit. Its appearance reminds the observer of a thistle, but none of its parts is tipped with thorns. It blooms very early, usually already at the end of April or the beginning of May and it represents a conspicuous solitaire in the narrow-leaved steppe grasslands. It is a rare plant, which prefers turfy steppes on deeper basic substrates. The highest number of South Moravian localities can be found in the Hustopeče area, while in Pálava it is rare and at the steppe margin of the Bohemian Massif or in White Carpathians it does not grow at all.

Gr

Austrian dragon head (*Dracocephalum austriacum*)

It was a great surprise when the Austrian dragon head was discovered in the 1920s near Bořetice in the Hustopeče area - scientists expected it rather in the calcareous rocky steppe in Pálava, as it grows under similar conditions in the Czech or Slovak Karst. In its only South Moravian locality it grows in a close stand grassland which is, moreover, under an open stand of pine trees. Only a few shrublets survive here; when not blooming, they are difficult to distinguish from the rest of the close stand. However, long-term observation showed that the number of the plants has probably not changed significantly since the time of its discovery.

Gr

FAUNA

The fauna of Pannonian steppes and dry grasslands is plentiful. It consists of widespread, eurytopic species on the one hand and of less demanding species of non-forest localities or exclusive species on the other hand. A close link to this particular environment can be caused by many factors. The overall microclimatic conditions can be decisive, or the major role may be played by isolated factors like temperature, low humidity, sun exposure, structure and canopy closure of the plant cover with small areas of bare soil without vegetation or the physical and chemical properties of the soil. In many cases the decisive factor is the food link, i.e. the food specialization of the phytophagous species to steppe plant species as well as the specialization of parasitoids and some predators to steppe animal species. Like in other environments, plentiful communities of interdependent species have evolved here. Moreover, in many cases the species have a significant bioindicative value and their occurrence in South Moravia is noteworthy also from the zoogeographical point of view. Many of them penetrate here from Pannonia and reach the northernmost or westernmost limit of their occurrence in Europe or in the whole range. The significance of the communities of these species is enforced by the fact that in South Moravia their optimum biotopes are small in area and are usually isolated in the midst of intensively exploited landscape and many of the species are existentially endangered. As there is a high number of them (thousands of species) we can only name the most significant ones in the following text.

The dominant part of fauna are insects and spiders, but we cannot forget to mention gastropods and some vertebrate species. There are also other specialized species of invertebrates here, like soil nematodes, bristle-footed worms, mites or springtails. Let us name at least one of them. It is an earthworm *Allolobophora hrabei*. It lives in xerothermous non-forest biotopes with deeper soils. It can be up to 50 cm long and is betrayed by little heaps of cylindrical excrements around 3 cm high and 10 cm wide.

Gastropods (Gastropoda)

The amount of gastropods living in open sites is significantly lower than in the case of forest biotopes. In our fauna only about a quarter from the total of 163 species of land gastropods commonly occurs on completely open sites. Other factors that determine species richness are the amounts of accessible calcium and humidity. The land gastropods in particular prefer places with high amount of calcium, which they need especially for building their shells. Similarly, most of the species are sensitive to desiccation, which is the reason for higher numbers of species in wet sites. From this we can conclude that dry steppe sites are in general not very rich in gastropods. In this case there is a great difference between calcareous rocky steppes and localities situated on non-calcareous bedrock. On well-preserved calcareous steppes we can find 10 to 15 species of gastropods, if there are rockeries and eventually wet shrubs present, the number of gastropod species increases rapidly. In spite of the low species richness, there are some gastropods which are strictly bound to warm steppe localities on calcareous bedrock. From such species we can mention *Granaria frumentum*, which has the largest populations in South Moravian steppes. Some other steppe species are significant especially from the historical point of view, because they represent the remnants from glacial eras - of the steppe, dry, but also very calcareous environment - or remnants from the beginning of Holocene. From such species we can mention the critically endangered *Helicopsis striata*, a significant element of glacial loess steppes. In the last 50 years, this gastropod became practically extinct (abandonment of the traditional utilization of our land = the end of extensive small pastures, acacia overgrowing steppes). In the past, it was found in the Pálava steppes and in the Hustopeče surroundings; the longest surviving population in a small steppe in the Šibeničník pod Mikulovem reserve belongs to the past, too. *Chondrula tridens* also belongs to significant species of the early Holocene steppes. It decreased in numbers in the last years, but the decrease is not that dramatic. This species also lives in non-calcareous steppes and is also able to live in substitute habitats (dry and regularly mowed banks along the roads etc.). The serally primary character of the site is important - *Chondrula tridens* is sensitive to overgrowing. Among the species that form the backbone of the steppe malacofauna are those which demand open sites. We can also find them in abundance in other, often completely artificial, open sites. They are mainly lovely grass snail (*Vallonia pulchella*) and ribbed grass snail (*V. costata*), crested vertigo (*Vertigo pygmaea*) and *Truncatellina cylindrica*. In all these cases the species are small, their shell size does not exceed 3 mm. However, we can also find more conspicuous species of gastropods in steppes. The characteristic plain steppe species is without a doubt *Cepaea vindobonensis*. Slightly smaller *Xerolenta obvia* also has stripes on its shell, which is markedly flatter and has a wide perforate (the opening in the middle of the bottom half). This species has a strong population especially in steppes rich on calcium.

Spiders (Araneae)

Around 30 out of more than 850 species of spiders known in the Czech Republic are limited in occurrence to South Moravian steppe barrens and rocky steppes. Especially in rocky steppes we can find a lot of species, often rare and narrowly site specialized ones. They are, for example *Dysdera ninnii*, *Neottiura suaveolens*, *Meioneta simplicitarsis*, *Alopecosa mariae*, *A. solitaria*, *A. striatipes*, *Archaeodictynna minutissima*, *Phrurolithus pullatus*, *P. szilyi*, *Cryptodrassus hungaricus*, *Zelotes atrocaeruleus*, leaflitter crab spiders *Ozyptila pullata* and *Xysticus embriki*, jumping spiders *Chalcoscirtus brevicymbialis*, *Pellenes tripunctatus* and *Pseudeuophrys obsoleta*. Some species can be found not only in rocky steppes but also in loess steppes, or in sand banks. Among these are mainly *Euryopis saukea*, *Drassyllus vinealis*, *Sitticus dzieduszyckii* and *Synageles hilarulus*. From the denuded aeolian sands species we have to mention *Alopecosa psammophila*, which was first identified in the Bzenec aeolian sands, and *Titanoeca psammophila*. The first information about the occurrence of *Eresus ruficapillus* and *Mecynargus foveatus* in our territory also came from the Bzenec aeolian sands. For the xerothermic non-forest areas, the members of the Atypus genus are characteristic, but only *Atypus muralis* is typical exclusively for fescue steppes, the others have lower demands on temperature.

Orthopterans (Orthoptera) and some other small insect orders

From approximately 27 500 species of insects known in our territory, the most important inhabitants of Pannonian steppes include many orthopterans (Orthoptera), true bugs (Heteroptera), butterflies and moths (Lepidoptera), beetles (Coleoptera), dipterans (Diptera) and hymenopterans (Hymenoptera); other orders appearing here include some of the cockroaches (Blattodea), earwigs (Dermaptera), mantises (Mantodea), cicadas (Cicadomorpha), Sternorrhyncha, thrips (Thysanoptera), lacewings (Neuroptera) and twisted-wing parasites (Strepsiptera).

One of the most well-known species here is the common European mantis (*Mantis religiosa*). Until recently it represented a great rarity, but in the last decades of the 20th century its habitats expanded to the north. These days we can find it in most of the Moravian territory, it has also penetrated to Bohemia and it is common in non-forest xerothermic localities of the southern half of Moravia. Probably the most important species of orthopterans is matriarchal katydid (*Saga pedo*), the biggest species of long-horned grasshoppers in our territory, reaching the length of 7.5 cm. It belongs to the wingless species of grasshoppers and it is usually of bright green colour. It is also interesting because in Central Europe it reproduces parthenogenetically - a male has not yet been seen. It was found in Pavlov Hills, Pouzdřany Steppe, in the surroundings of Kurdějov and older occurrence data come also from the vicinity of Znojmo. Matriarchal katydid, like the majority of other long-horned grasshopper species, prefers localities with taller herb vegetation and dispersed shrubs, and forest fringes. From the characteristic grasshopper species of steppe and forest-steppe localities of South Moravia a stout, predominantly light green bushcricket *Ephippiger ephippiger* is worth mentioning. Its vertex is black, the front and back carapace edge is often widely fringed in rusty-brown and the side edges are yellow. The very short wings are red-brown. It can be sometimes found in the surroundings of Znojmo, Kurdějov and Brno; it spread as far as Mohelno through the Jihlavka valley. Light green long-horned grasshopper *Poecilimon intermedius* with dense spotting is up to 20 mm long. It also reproduces parthenogenetically and it is found at Kamenný vrch near Kurdějov and in a few places in White Carpathians. A very rare long-horned grasshopper *Platycleis montana* is grey-green and it was found in the Čejč area, in the surroundings of Kobylí, Bzenec and Hodonín. Over 2 cm long, brown or grey long-horned grasshopper *Platycleis vittata* was found in Pouzdřany Steppe and a few similar localities. Beside the still frequent balm-cricket (*Gryllus campestris*), the South Moravian steppe barrens and rocky steppes are a home to some rare species of crickets, especially *Modicogryllus frontalis* and *Eumodicogryllus bordigalensis*. While the former has already been registered in many localities in the north up to Brno, the latter has only been found in Pálava. In places with taller vegetation, in late summer evenings and nights we can hear the characteristic melodic singing of the *Oecanthus pellucens* tree cricket. It may be only 1.5 cm long, but its singing can be heard dozens of metres away. It is ochre coloured and it folds its shiny transparent wings flat on its abdomen.

We can recognize long-horned grasshoppers and crickets by their long feelers and conspicuous ovipositors of the females. Short-horned grasshoppers, in contrast, have short feelers and the females do not have ovipositors. Long-horned grasshoppers create their songs by rubbing their wings against each other, while short-horned grasshoppers rub their wings with their hind legs. Short-horned grasshoppers prefer places with short vegetation, some species even require free growth with spots of bare soil, rubble or rockeries. We can mention the brown to yellow-brown short-horned grasshopper *Omocestus petraeus*, a short-horned grasshopper *Dociostaurus brevicollis* which is grey-brown with dark and light patches, and a green, green-brown to brown short-horned grasshopper *Chorthippus dichrous* as examples of species bound to xerothermic non-forest land of the Pannonian area. We have records of the occurrence of two rare species of short-horned grasshoppers, *Celes variabilis* and *Arcyptera microptera*, from the past, but they have not been confirmed recently.

We know cockroaches predominantly as unwanted synanthropic species, but we can find some of them in natural environments and also in steppe and forest-steppe sites. They are mainly the *Ectobius erythronotus*, *Phyllodromica megerlei* and *P. maculata* species. They usually run around fast in the dry vegetation, on the ground surface, less frequently on taller herbs and shrubs. From seven species of earwigs native to our country, one also belongs to the inhabitants of

xerothermic non-forest land. It is *Anechura bipunctata*. It is up to 2.5 cm long, brown-black with red-black head and legs. In the middle of each elytron it has a light spot. It can be sometimes found, for example, in the Pavlov Hills and Pouzdřany Steppe.

From the lacewings (Neuroptera) the most significant are European mantispid (*Mantispa styriaca*), ant-lion *Distoleon tetragrammicus* and owl-fly (*Libelloides macaronius*). These three species inhabit loess and rocky steppes and they prefer places with shrub cover or warm forest fringes.

True bugs (Heteroptera)

True bugs (Heteroptera) contain around 40 000 described species worldwide; majority of them live in tropical and subtropical areas of the world. Therefore it is not surprising that also in the conditions of Central Europe the majority of true bugs prefer warmer areas. We can use the numbers of true bug species found so far in Hrubý Jeseník - 180 species - and in Pálava Protected Landscape Area (including the area proposed for extension of the PLA) - 500 species - as an example. This species richness of Pálava, or even the whole Pannonian area of South Moravia, is caused by the thermophilic and xerophilic species, which inhabit various types of steppe grasslands - from rocky steppes with sparse vegetation to closed stands of grassland steppes. Many rare thermophilic true bugs also live in South Moravian aeolian sands and remnants of salt marshes, we will, however, skip these in the following account. In the Czech Republic, 853 species of true bugs have been found so far, 260 of which have been included in the red list of invertebrates of the Czech Republic. The species bound to steppe vegetation are represented quite significantly in this red list. From the zoographical and nature protection point of view, the most valuable species are those which reach the northern or western limit of their occurrence in South Moravia. The first group contains species with the centre of occurrence around the Mediterranean Sea, the second (considerably less numerous) consists of species inhabiting the steppes of Eastern Europe and Central Asia, from where they reach into the Pannonian Plain, while they do not occur in the Mediterranean. *Vilpianus galii*, which is characterized by an almost spherical body, is found in many steppe localities in the whole of the Pannonian Plain, in the north up to the surroundings of Tišnov. This species, living on bedstraws (*Galium* spp.), is a typical example of a species which reaches its northern occurrence limit in South Moravia. In the same localities *Staria lunata* can be found, too. Probably the highest number of rare steppe true bugs can be found in Pavlov Hills - we can name *Copium teucrii* and *Hyalochiton komaroffi* as representatives - they are strictly bound to mountain germander (*Teucrium montanum*) which grows here in rocky steppes. The Mediterranean *Lygaeosoma sardeum* only lives in rocky steppes of Pálava and near Moravský Krumlov. Its relative *Lygaeosoma sibiricum* is, in contrast, an example of a species reaching South Moravia in a steppe belt from as far as Central Asia. Another nice steppe true bug is *Melanocoyrphus alboacuminatus*, which only lives in National Park Podyjí at present.

Beetles (Coleoptera)

From about 6 100 species of beetles known in the Czech Republic, a few hundred species are closely bound to Pannonian steppes. Among local species, we can find predators as well as phytophagous species evolving on underground or above-ground parts of plants. The most significant of the big species of ground beetles is indisputably the stout, black-coloured, only slightly shiny Hungarian ground beetle (*Carabus hungaricus*). A green, copper shiny tiger beetle *Cicindela soluta* lives on bare sandy soils with open stand. The rare Kent Carabus (*Callistus lunatus*) lives in steppe localities, but also in abandoned quarries and dry forest fringes. The black-coloured, flat *Licinus cassideus* is a predator specialized on gastropods, with mouth organs perfectly adapted to reach into the gastropod's shell. In the steppe localities, but also in salt marshes, a tiny, only about 3.5 mm long, black-coloured carabidan *Amblystomus niger* sometimes appears. In dry biotopes with sandy or calcareous substrates we can sometimes find the *Masoreus wetterhallii* carabidan. Up to 11 mm long, metallic blue carabidan *Cymindis miliaris* prefers rocky steppes. From the scarabaeid beetles, the small, only 4-6 mm long, beetle *Ochodaeus chrysomeloides* seeks dry warm sites. It evolves on underground fungi. A real rarity is the 1 cm long, rusty-brown beetle *Bolbelasmus unicornis*, also bound to underground fungi. A rare species of the dry loess and rocky

steppes is also *Euheptaulacus porcellus*. In this context it is necessary to mention the clear-cut beetle fauna of the European rabbit (*Oryctolagus cuniculus*) burrows. The most significant of the many species initiated from the rabbit droppings are *Trox everesmannii* and *Aphodius citellorum*. Rabbits also influence the opening of the plant cover and they enable the existence of species which need bare soil and open stand vegetation. The recent decrease in their numbers leads to overgrowing and decrease in species diversity of the steppe barrens insects. A quite conspicuous, up to 12 mm long *Sisyphus schaefferi* has unusually long hind legs and is similar to exotic scarabaeids. It is also interesting because, like flower beetle, it flies with closed elytra. The disappearing horned dung beetle (*Copris lunaris*) is dependent on the pastures of sheep, but also of cattle or other animal species. The 2 cm long, matt green flower beetle *Netocia ungarica* also belongs to this family. We can in rare cases find imagos in anthodia of teasels and thistles. Although buprestidans are bound mainly to various wood plant species and only fly to steppe biotopes in the imago stage, some species also evolve here. Larva of the buprestidan *Sphenoptera substriata* lives in the roots of pinks (*Dianthus* spp.), buprestidan *Coraebus rubi* evolves in the roots of blackberry (*Rubus* spp.) at the edges of steppes and finally larva of the tiny buprestidan *Habroloma nanum* eats out corridors (mines) in the leaves of bloody cranesbill (*Geranium sanguineum*). The black-coloured click beetle *Prosternon chrysocomum*, which can grow up to the length of 15 mm is also, together with a few of its relatives, characteristic for the steppe biotopes. The red-black *Trichodes favarius* checkered beetle evolves in the nests of solitary bees. Some of the tenebrionid (Tenebrionidae) species, for example the 7-9 mm long *Podonta nigrita*, also belong to the steppe species. We can encounter the conspicuous, cylindrical, orange-red coloured, 10-16 mm long bladder-fern *Mylabris variabilis* in the summer on the flowers of some plants. Its ontogenesis takes place in the egg cases of short-horned grasshoppers. Meloid beetles (*Meloe* spp.) are also typical inhabitants of the steppe biotopes, with some species quite widespread and others being great rarities. Meloid beetle *Meloe violaceus* is a more frequent species, although it disappeared from many sites in the last decades. The rare species are, for example, meloid beetles *Meloe uralensis*, *M. decorus* and *M. brevicollis*. Longhorn beetles, like the already mentioned buprestidans, evolve in wood. Only in a few cases the larvae consume roots or live inside the stalks of herbs. A few species of long-horned beetles of the *Dorcadion* genus evolve on the grass roots. *Dorcadion pedestre* is almost all black, with a lengthwise white stripe where the elytra meet. Slightly bigger *Dorcadion fulvum* is all light brown and the rarest *Dorcadion aethiops* is black. The larva of *Agapanthia cynarae* lives in the stalk of aconites (*Aconitum*). The steppe biotopes are more frequently inhabited by the species of long-horned beetles of the *Phytoecia* genus, for example long-horned beetles *Phytoecia argus* and *P. rubropuncta* evolve in meadow saxifrage (*Seseli* spp.), long-horned beetle *P. nigripes* in many Apiaceae species and long-horned beetle *P. coerulea* in some steppe Brassicaceae. From the species-rich family of chrysomelid beetles (Chrysomelidae), two of the species of the *Crioceris* genus bound to asparagus (*Asparagus officinalis*) are worth mentioning, namely *C. quatuordecimpunctata* and *C. quinquepunctata*. In the steppe biotopes, we can find our biggest leaf beetle *Cassida canaliculata*, the *Chrysolina eurina* species and species related to cryptocephalus species *Coptocephala chalybaea* and *Tituboea macropus*. Bare surfaces with free-growing vegetation are the favourites of *Pachnephorus villosus*, which evolves on teasels (*Cirsium* spp.).

Moths and butterflies (Lepidoptera)

The butterfly fauna of dry Pannonian grasslands is species-rich, too. From the 3390 species known in our territory, about 160 markedly prefer these biotopes and approximately 60 of them do not cross the boundaries of Pannonicum (Pannonian province). Many of these 60 species reach their northernmost European limit in South Moravia, in the area of Pavlov Hills, Pouzdřany and Židlochovice hills or even Hády near Brno. At Hády near Brno itself as many as 25 of these species live. From the steppe species of moths and butterflies the first to attract our attention are the big and conspicuously-coloured ones, which we can encounter during the day; more remarkable species, however, often live hidden, are active at night and usually escape the attention of a common visitor. From the day butterflies, some of the skippers, blues and satyrids are typical for these sites. The tiny red underwing skipper (*Spialia sertorius*) has the top part of wings black with white speckles and differs from similar species by the cinnamon-coloured reverse of underwings. Its caterpillar eats the

leaves of salad burnet (*Sanguisorba minor*). Markedly bigger, dark-coloured large chequered skipper (*Heteropterus morpheus*) inhabits sites with taller grass vegetation, flies in June and July and it can be instantly recognized by the characteristic jumpy flight. From satyrids, we have to mention the big, brown-black dryad (*Minois dryas*) and the smaller false grayling (*Arethusana arethusa*), which has grey-brown wings with a yellow-orange stripe and a few eyelets. Caterpillars of both the species live on grasses and the adult butterflies appear at the height of summer, the former mostly in tall grass growth, the latter, on the contrary, on the sunniest surfaces with low free-growing vegetation. *Hipparchia statilinus* is a critically endangered or maybe even already extinct species of the South Moravian aeolian sands. We can find two prominent species of blues, Chapman's blue (*Polyommatus thersites*) and damon blue (*P. damon*), in the sainfoin growths. While the former still appears almost everywhere in sainfoin steppe localities, the latter can only be found in a few sites now, it is rapidly disappearing and belongs to the most endangered butterfly species of our republic. Turquoise blue (*Polyommatus dorylas*) has probably already disappeared from the steppe biotopes of South Moravia, adonis blue (*Polyommatus bellargus*) is quite numerous in some places and chalk-hill blue (*P. coridon*) is in some years plentiful in the steppe localities. Some of the red-black burnets also belong to the conspicuous steppe species. We can find them on flowers in the summer, they are usually not timid, so we can have a good look at them. The typical and in some years very numerous burnet of the South Moravian steppes is *Zygaena carniolica*. The red spots on its front wing are usually yellow-rimmed and it has a red belt on the abdomen - these characteristics easily distinguish it from other species. A much rarer species is bloodword burnet (*Zygaena laeta*), which has the front-wing red spots interconnected and its back of the head and the back half of the abdomen are strikingly red. *Zygaena punctum* burnet, which has the red pattern relatively indistinct, is a real rarity. The first of these species evolves on bird's foot trefoil, sainfoin and other fabaceous plants, the host plant of the other two species is field eryngo (*Eryngium campestre*). The bright golden-green *Jordanita chloros* belongs to close relatives of burnets. It has disappeared from many sites, but we can still exceptionally find it even in close proximity of Brno.

The smallest butterflies, with a wing-span of only 3–10 mm, are the members of the Trifurcula genus. Their caterpillars eat out little corridors in leaves or stems of plants. We can name *Trifurcula josefklimeschi* and *T. corothamni* as characteristic species of the South Moravian steppes. The former evolves in stems of *Dorycnium* spp., the latter, which was first identified in South Moravia, in stems of ground broom (*Cytisus procumbens*). Even among moths, which we know mainly as unpleasant inhabitants of our homes, we can find some steppe species, for example the whitish *Ateliotum hungaricellum*. The caterpillars of its relatives bagworms build portable cases, like the water caddis. In dry grasslands of the southernmost parts of Moravia, the tiny bagworm *Acentra subvestalis* sometimes appears, a more common species is the slightly bigger *Taleporia politella*. *Minetia crinita* - about 15 mm long - from the Oecophoridae family, can be found only in a few sites in South Moravia. Its caterpillar eats dead parts of grasses. A family with a high number of species represented here is the casebearer moths (Coleophoridae). The caterpillars of casebearer moths create portable cases and feed on leaves or seeds of plants. Most species are narrowly food specialized, which, together with strict environment demands, severely limits their occurrence. In South Moravian steppes, around 25 ecologically narrowly specialized species were found. For example, on the *Astragalus onobrychis* milk-vetch, they are casebearers *Coleophora onybrychiella*, *C. astragalella* and *C. stramentella*, on *Dorycnium* spp. *Coleophora squamella*, *C. congeriella*, *C. medelichensis*, *C. oriolella* and *C. acrisella* live, on sainfoin (*Onobrychis* spp.) *C. dignella* and *C. vulpecula*, on goldilocks (*Aster linosyris*) *C. pseudolinosyris* and *C. galatellae* and on *Aster amellus* *C. asterifoliella*, *C. amellivora* and *C. obscenella*. From the tiny, inconspicuous Scythrididae the most significant are *Scythris bengtssoni*, *S. flavidella* and *S. vittella*. From the species-rich family of the not easily discernible gelechid moths we can name at least the species *Ptocheuusa abnormella*, *Caulastrocecis furfurella* and *Megacraspedus imparellus*. The first one is trophically bound to *Inula ensifolia* and we can sometimes find it in the growths of this plant; the caterpillar of the second one feeds on the stems of goldilocks (*Aster linosyris*); the third one probably evolves on steppe grass species. *Parahypopta caestrum* belongs to bigger and more conspicuous moth species and it very rarely appears for example in some sites of Pavlov Hills or Pouzdřany Steppe. Its front wings are greyish-white with a brown-black pattern in the middle, the

back wings are grey. Its caterpillar evolves in the roots of asparagus (*Asparagus officinalis*). Some of the clearwing moth species, reminiscent of hymenoptera, are also typical inhabitants of Pannonian steppes. They are especially Turkish clearwing (*Chamaesphecia colpiformis*), *Ch. crassicornis* clearwing and Moravian clearwing (*Ch. astatiformis*). The caterpillars of these species evolve in the roots of steppe plants, the first in wood sage (*Salvia nemorosa*), the second in Waldstein's spurge (*Euphorbia waldsteinii*) and the third in leafy spurge (*E. esula*). Apart from the host plant, all three species require an extremely xerothermic habitat. The species mentioned appear in South Moravia the farthest to the north and to the west of their range, which to the east covers the steppe zone and reaches into Kazakhstan. The species-rich family of leaf-rollers (Tortricidae) is also represented here by many species. The caterpillars of leaf-rollers have diverse ontogeneses, some species feed on leaves, others on flowers, stems or roots of the host plants. The *Cochylimorpha elongana* leaf-roller caterpillar eats stems of wormwoods (*Artemisia* spp.) and some other related plants, the *Aethes nefandana* leaf-roller probably evolves on eryngos (*Eryngium*), the *Thiodia trochilana* leaf-roller on some of dead-nettles (Lamiaceae), the caterpillar of the *Eucosma cumulana* leaf-roller feeds on the leaves of the inula species (*Inula* spp.) and the caterpillar of the *Dichrorampha cinerascens* leaf-roller consumes the root of yarrow (*Achillea* spp.). The bionomics and host plants of some rare species are still unknown, like those of the *Cydia intexta* leaf-roller. The very rare *Wheeleria obsoleta* plume moth evolves on horehound (*Marrubium* spp.). Its imagos have, like other plume moths, wings that are divided into individual feathery lobes. From the many species of leaf-folders, an example of a significant species is the *Synaphe antennalis* leaf-folder. It probably evolves on the steppe grass species, but its bionomics is not known yet. In South Moravia, it can be found in the Pouzdřany Steppe and in a few other sites.

Geometrid moths (Geometridae) and owlet moths (Noctuidae) are very numerous in species in Pannonian steppes, therefore we can only mention the most significant examples. The small light green Etruscan emerald (*Chlorissa etruscaria*) evolves on Apiaceae. From many species of the small members of the *Idaea* genus, the most remarkable are *Idaea filicata*, *I. politaria*, *I. rubraria* and satin wave (*I. subsericeata*). The caterpillars of *Cataclysme riguata* feed on some species of bedstraws (*Galium* spp.). The slightly bigger *Scotopteryx coarctaria* flies also during the day, unlike most other species of geometrid moths, and its caterpillar feeds on the leaves of brooms, most often ground broom (*Cytisus procumbens*). *Synopsia sociaria* and *Selidosema plumaria* are not very particular as to their host plants and evolve on many steppe plant species. Little chess-board (*Narraga fasciolaria*) and lesser treble-bar (*Aplocera efformata*) are typical for aeolian sands. *Lygephila ludicra* already belongs to owlet moths and is also characterized by day activity. Its caterpillar most often feeds on the leaves of sainfoin (*Onobrychis* spp.). The tiny *Phyllophila obliterata* can only be found in the steppe wormwood (*Artemisia* spp.) species covers, its northernmost occurrence is in the Židlochovice Hills. Its relative *Odice arcuinna* has not been seen in South Moravia for a few years. Two tiny species, *Schinia cardui* and *S. cognata*, can be found in the flowers of their host plants during the day. A characteristic species of the early spring is *Perigrapha i-cinctum*. Butterflies and moths often appear as early as the beginning of March, we can attract them to the light or find them with a flashlight sitting on the dry anthodia of knapweeds. Significant noctuid species found in aeolian sands are *Eublemma minutatum*, *Actinotia radiosa*, malachite moth (*Staurophora celsia*) and archer's dart (*Agrotis vestigialis*).

Dipterans (Diptera)

Dipterans include almost 7700 species in the area of Czech Republic and thus they represent our most numerous order of insects. From the total number at least 40% of the species live in the northern part of the Pannonian province. The Pavlov Hills fauna was studied in the most detail, we only have scarce information about other dry sites. The following data support the claim that our part of the Pannonian province is unique if we consider the occurrence of diptera: the number of dipteran species, which only appear in the Czech part of the Pannonian province is estimated at minimum 350 species, while 34 taxons were identified and labelled directly in this area. Even though these numbers reflect the standard of fauna research rather than the real endemism, they are at least documenting the occurrence of many thermophilic species, which reach the northernmost limit of their distribution here. This claim also includes the thermophilic species living in steppes.

The characteristic species of the remarkable natural phenomenon that Pavlov Hills, with the grass and shrub sites and occasionally exposed calcareous bedrock, indisputably are, are, for example, the extremely thermophilic species of the soldier-flies (Stratiomyidae), snipe flies (Rhagionidae), robber-flies (Asilidae), bee flies (Bombyliidae), stiletto flies (Therevidae), dance flies (Empididae), hybotid dance flies (Hybotidae), thick-headed flies (Conopidae) and some other families. We can name soldier-flies of the *Lasiopa* genus and *Chloromyia speciosa* species, the saprophagous larvae of which evolve among the plant remnants and in the soil. The *Symphoromyia immaculata* snipe fly might be common around most of Europe, but it prefers xerothermic sites and was regularly observed in Děvín and Tabulová hora.

We can find many thermophilic species, which like to bask in the sun on the dry slopes and in the road and forest fringes vegetation, among the robber-flies. They are mostly agile flyers, which hunt other insects. The conspicuous *Stenopogon sabaudus*, which reaches its northern limit of distribution in our country, is clearly thermophilic, just like three species of the *Holopogon* genus, the species *Dioctria wiedemanni* and *Laphria aurea* are also only known in South Moravia and nowhere else in the Czech Republic. On the south-facing slopes with steppe vegetation, thermophilic bee fly species *Phthiria gaedei*, *P. pulicaria*, *Lomatia lachesis*, *L. lateralis*, *Conophorus virescens*, *Bombylius cinerascens*, *B. fulvescens* and *B. venosus* regularly appear. Their larvae live as parasites in wasp and solitary bee nests, in caterpillars and cocoons of butterflies and in oothecas of orthopterans.

From dance flies, the truly steppe species are *Empis opaca* and *E. strigata*, *E. maculata* reaches the northern limit of its distribution at Pohansko near Břeclav, *Rhaphomyia hungarica* can be found in Pavlov Hills. From the related hybotid dance flies family we can name a higher number of plain and thermophilic species, which are of Southern European origin. *Platypalpus palavensis* was identified in Pavlov Hills and later also found in steppe localities in Central Bohemia and in South Slovakia.

The larvae of the thick-headed flies family are endoparasites of stinging hymenoptera (in rare cases also of orthopterans) and imagos are often seen near wasp, bee and bumble-bee nests. A few of our species are probably of Mediterranean origin and reach the northern limit of their distribution in South Moravia. Although most representatives of the long-legged flies (Dolichopodidae) family live along rivers and lakes, there are some species bound to xerothermic sites, e.g. *Sciapus bellus*, *S. euzonus* and *S. heteropygus*.

Phytophagous species, which are bound directly to xerophilic grasses and some other herbs, are also very numerous on steppe slopes. Members of the frit flies (Chloropidae) family appear most frequently, some gall midges (Cecidomyiidae) and fruit flies (Tephritidae) create galls. Among frit flies, bound to grasses for ontogenesis, we can find mainly members of the *Chlorops*, *Meromyza* and *Oscinella* genera. The *Pseudonapomyza palavae* leaf-miner was identified in Pálava, its host plant, however, is not known yet. Some leaf-miners of the *Phytomyza* genus evolve directly in grasses. From gall midges we can mention, for example, the *Rhopalomyia pseudofoliorum* species identified and labelled by Vimmer at Svatý Kopeček near Mikulov as early as 1924. Its larvae create galls on the stems and leaves of field wormwood. The larvae of fruit flies appear in receptacles, fruits, leaves and stems of plants. The Submediterranean species *Acinia biflexa* evolves in inula species, *Chaetorellia acrolophi* is only known in Pavlov Hills in our country, its larvae evolve in knapweeds.

Some other species of the many families also exhibit a narrow link to steppe sites. The reasons for this can be very diverse. We will mention a few examples. For example, larvae of the *Chamaemyia* genus (Chamaemyiidae family) feed on coccids living on the grasses, the larvae of *Pherbellia limbata* and *P. cinerella* species (Sciomyzidae family) parasitize in the tiny xerothermophilic gastropod species, like *Granaria frumentum*; some rare thermophilic cluster flies of the *Pollenia* genus (Calliphoridae) (e.g. *P. atramentaria*, *P. dasypoda*, *P. mayeri* and *P. tenuiforceps*) attack earthworms in the soil, when they are in the larval stage. Lesser housefly *Fannia krimensis* (Fanniidae) exhibits Ponto-Submediterranean type of distribution and its saprophagous larvae live in the soil; root-maggot flies (Anthomyiidae) of the *Eustalomyia* and *Leucophora* species live in solitary bee nests as larvae, tachinid flies from the Phasiinae (Tachinidae) subfamily, which often appear on the flowers of Apiaceae, have larvae which live as

parasitoids in stink bugs (Pantatomidae, Heteroptera).

Hymenoptera (Hymenoptera)

Many species of the very numerous hymenoptera order - at present we know of 6400 species in our territory - are an integral part of the steppe fauna. Various species of bees and also many other hymenoptera, for example ruby wasps, velvet ants, digger wasps and also some ants and wasps, live in the steppes. Some bee species are narrowly specialized to certain types of steppe flora. Steppe bees usually nest in the ground, but there are species which nest in cavities (haulms, twigs, dead wood, rock crevasses etc.). Many species of the small, primitive, usually black members of *Hylaeus* spp. live here, e.g. *Hylaeus cardioscapus*, *H. cornutus*, *H. duckei*, *H. euryscapus*, *H. imparilis* and *H. leptocephalus*. The *Colletes* spp. genus is a morphologically and biologically diverse group. With only small exceptions they are thermophilic species, we can include the *Colletes collaris*, *C. graeffei*, *C. hylaeiformis* and *C. punctatus* species in the Pannonian eremophilic fauna. Andrenid bees (*Andrena* spp.) are also numerous, with more than 100 species found in the Czech Republic. Members of this genus have various ecological valence, those belonging to Pannonian steppe species are *Andrena aeneiventris*, *A. curvana*, *A. fuscosa*, *A. limata*, *A. mocsaryi*, *A. mucida*, *A. oralis*, *A. paucisquama*, *A. transitoria* and *A. trimmerana*. Halictid bees of the *Halictus* genus and some of the *Lasioglossum* genus, for example *Lasioglossum aeratum* and *L. bluethgeni*, are numerous here. Kleptoparasitic *Sphecodes* spp. parasitize on many other bee species, most often on halictid bees. Their valence is dependent on the host and most of them are thermophilic. Those living in steppe sites of South Moravia are for example *Sphecodes cristatus*, *S. intermedius* and *S. majalis*. Other xerothermophilic species of Pannonian steppes include, for example, *Ceylalictus variegatus*, *Nomiapis femoralis*, *Rhophitoides canus*, *Systropha planidens*, *Dufourea halictula*, *Melitta dimidiata*, *Dasypoda argentata* or wood-boring bee *Lithurgus chrysurus*. Other Pannonian steppe species of bees can be found among blue orchard bees, upholsterer bees, gall-making aphids and in many other genera.

The stout, metallic-purple carpenter bees (*Xylocopa* spp.) fly to steppe communities to feed. There are three species living in the Czech Republic, but only one of them, *Xylocopa iris*, is limited in occurrence only to the South Moravian Pannonian steppe region. *Nomada* spp. are kleptoparasitic bees; there are about 100 species of them in the Czech territory. They parasitize mainly on andrenid bees, and also on other bee genera. Eucera bees, e.g. *Eucera caspica* and *E. cineraria*, and Tetralonia bees, e.g. *Tetralonia inulae*, with the obligatory link to some inula (*Inula* spp.) species are also typical inhabitants of steppe sites. The males of those species have conspicuously long feelers and the females are to a great extent responsible for steppe flora pollination. The mason bees (*Anthophora* spp.) and their kleptoparasitic *Melecta* spp. and cuckoo bees (*Thyreus* spp.) also create a steppe group of bees. These bees fly conspicuously fast, some of them are able to stop mid-flight for a short time and flap at one place while sucking nectar from long-tubed flowers. Although they are markedly smaller, they are often mistaken for bumble-bees because of their thick ciliation.

The conspicuously metallic shiny green, blue or partially red ruby wasps evolve as parasitoids in the larvae of digger wasps and other hymenoptera. In the South Moravian Pannonian steppes we can find many species which do not live anywhere else in the Czech Republic. The most significant of them are ruby wasps *Notozus sanzii*, *Stilbum cyanurum*, *Euchroeus purpuratus*, *Chrysis comparata* and *Ch. splendidula*. From wingless velvet ants we can mention the species *Dasylabris regalis*, *D. maura*, *Smicromyrme triangularis* and *Physetopoda daghestanica*. A whole range of digger wasps species live in loess and sand sites. Their larvae evolve in paralysed individuals of spiders and orthopterans, in caterpillars of butterflies and in other insects. The most significant of digger wasps are *Sphex funerarius*, *Ammophila terminata*, *Sceliphron destillatorium*, *Spilomena mocsaryi*, *Dryudella lineata*, *Bembecinus hungaricus*, *Astata rufipes* and *Didineis wuestneii*, *Palarus variegatus* is only known from aeolian sands. From potter wasps we have to mention the species *Eumenus sareptanus insolatus*, *Alastor biegelebeni pannonicus* and *Odynerus poecilus*. We can also find species which prefer steppe sites or appear exclusively there among ants. They are, for example, harvesting ant (*Messor muticus*), pavement ant (*Tetramorium caespitum*), *Tapinoma erraticum*, *Lasius psammophilus*, *Plagiolepis tauricus* and *P. xene*.

Vertebrata (Vertebrata)

All the species of land vertebrates living in Central Europe are - in contrast to the vast majority of invertebrates - of considerable size and weight. Therefore they require sufficiently large territories of suitable environment, in this case the steppe environment. The decisive factor for the possible occurrence of steppe vertebrates in Central Europe is the time in which and the extent to which the steppe environment existed in this area in the post-glacial era. This is true especially for forms with low spontaneous vagility (ability to move from place to place, overcoming obstacles) - mainly some species of mammals, to a lower extent amphibians and reptiles. In the case of mammals, cheiropterans are an exception, because, like birds, they are able to cross vast distances in a short time and create permanent or temporary populations in favourable environment enclaves in distances of hundreds of kilometres. But mammals, sometimes even the smaller-sized species, can also spread unexpectedly fast.

The "steppe" vertebrate species penetrated into Central Europe as early as Boreal age and later in Neolithic Age - after the formation of secondary non-forest areas, the cultural steppe. Even this cultural steppe, however, was changing: in connection with the increasing settlement density and changes in soil management the non-forest area was growing and it was being reshaped. The basic elements of the agricultural landscape up to the 18th century were croplands, barrens and permanent grass covers - meadows and pastures. In the wake of the intensification of agriculture, first the barrens disappeared and then gradually up to the 20 th century pastures and meadows were diminished to a great extent. For the steppe species, pastures in particular represented an environment most similar to the steppe environment.

The boundary of the Palaearctic steppe Eremial only reaches the Danube delta in the west and the whole Pannonian district is separated from it by the Carpathian Mountains. The late formation of the pasture steppe and the isolation in the Inner Carpathian Basin probably resulted in local fauna being poor and lacking various typical steppe species which lived or still live in south Ukrainian steppes. These include, from mammals, great jerboa *Allactaga jaculus*, gray marmot *Marmota baibacina* or saiga *Saiga tatarica*. The mole rat *Spalax leucodon* occurrence is limited to the Great Hungarian Plain, the southern birch mouse *Sicista subtilis* occurrence reaches into Small Hungarian Plain. Steppe polecat (*Mustela eversmanni*), European ground squirrel (*Spermophilus citellus*) and European hamster (*Cricetus cricetus*) have spread further to the west to Austria and Bohemia. Particularly the last one became a notorious inhabitant of the fields as far as Western Europe. Mound-building mouse (*Mus spicilegus*) is also limited to Pannonia, but it probably spread as a result of adaptation to cultural agricultural landscapes. Similarly, some other species not originally living in steppes but utilizing open spaces and eventually gradually adapting to them, spread into the cultural steppe. Common vole (*Microtus arvalis*) and European mole (*Talpa europaea*) are examples of such species. Until recently, these sites have been home to numerous populations of European rabbit (*Oryctolagus cuniculus*), which has a significant influence on the loess steppe formation in particular, as we mentioned in the text on coprophagous beetle species. The spread of forest-steppe and forest animals into the open country still continues today, as we can see in the cases of European roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), red fox (*Vulpes vulpes*) or even European badger (*Meles meles*). A wider shift of the quasi-steppe range limits is also still apparent, but it rather concerns the thermophilic forms native to open landscape mainly from south-east, like recently jackal (*Canis aureus*), which has appeared as far as South Slovakia. In contrast, the ranges of real steppe species in the regression phases of their distribution move back to the south-east. This move is apparent, for example, in the cases of European ground squirrel and steppe polecat. The adaptation of mammals to life in the steppes is often connected with using underground burrows, with hibernation or with gathering reserves. From amphibians, only European green toad (*Bufo viridis*) regularly penetrates into these biotopes, but its reproduction takes place elsewhere. From reptiles, European green lizard (*Lacerta viridis*) and smooth snake (*Coronella austriaca*) live here, although both these species have a high site valence and particularly the latter has a much wider distribution in our territory and also inhabits other environments.

The question of the indigenousness of steppe species in Central Europe is even more complex in the case of birds, not only because of their migration abilities, but also because of their

ability to use elements in environments not typical for steppes. Apart from that, their stay in the steppes is for some species limited to the non-reproductive season - the migration or winter period. Among the nesting species of Central European open landscape, great bustard (*Otis tarda*) and the already extinct little bustard (*Tetrax tetrax*) are regarded to be the main steppe elements, others include red-footed falcon (*Falco vespertinus*), stone curlew (*Burhinus oedicnemus*) and tawny pipit (*Anthus campestris*). These species, however, can also be found further west in Europe and they inhabit environments different from typical steppes - barrens, fields, alluvial deposits and river and lake shores. Hoopoe (*Upupa epops*), common European roller (*Coracias garrulus*) and lesser grey shrike (*Lanius minor*) are similar in this respect. All the species mentioned are currently in the regression phase of distribution and they retreat south-west. The north-western limit of the Central European range of European bee-eater (*Merops apiaster*) pulsates permanently. Of course, the usual species of open landscape - grey partridge (*Perdix perdix*), skylark (*Alauda arvensis*) and others - live in the whole area. Most of the common species probably settled in the South Moravian steppe biotopes immediately or shortly after their formation, but we can still document considerable differences using concrete cases; crested lark (*Galerida cristata*) was found in the territory of Czech Republic as early as 14th century, but, for example, European bee-eater only appeared as a nesting species of South Moravia in the second half of the 20 th century.

In closing we have to point out that most of the steppe fauna species are sensitive to overgrowing and eventual eutrophication of these sites. We have to realize that the presence of steppe localities in our nature is, with only small exceptions, connected with human activity. If the traditional use/maintenance ceases, the character of the site rapidly changes - and if we want to preserve the steppes here, such change clearly represents a degradation. Care of steppe sites has to include the care of both the plant and the animal component. The only difference is that the animal component requires a much more sensitive treatment. In other words, the same resulting state of phytocenose can be achieved by various regulatory measures, but only those which threaten the animal populations the least are acceptable. The treatment which brings optimum species composition and physiognomy of the plant communities, thereby also creating a suitable environment for the existence of steppe-specialized animal species, would be unnecessary and counter-productive, if the same animal species were exterminated in the course of the treatment.

SIGNIFICANT LOCALITIES OF MORAVIAN STEPPE GRASSLANDS (A SELECTION)

Steppe meadows of the White Carpathians

The famous non-forest vegetation of the White Carpathians is known to be one of the most species-rich plant communities of the European continent. At a closer look, this diversity is surprising - in this case it is substitute, semi-natural vegetation, formed after deforestation and we can find it growing under conditions where there is no apparent influence of geomorphology, preserving various islands of non-forest on rocks and debris. This species diversity has not been satisfactorily explained yet. It was the variety of the thermophilic grasslands in the Radějov, Lipov and Velká nad Veličkou areas that has attracted naturalists here since the establishment of the first Czechoslovak Republic. But a long time had to pass until the most valuable parts of these meadow steppes, as they were called by the Nestor of Brno botany Professor Podpěra, became nature reserves and parts of a Protected Landscape Area. In some cases it was too late - the complexes in the Hájová hill or below Kobylí hlava near Blatnička were beyond recovery, because they were first intensively fertilized and then ploughed. The steppe of the White Carpathians lies on the boundary of the Pannonian influence and contains not only Pannonian but also numerous continental, Submediterranean and mountain elements. It is a great shame that we will never again see the undulating cover of the *Stipa tirsa* feather grass, that only individual plants of even the *Echium maculatum* or spring adonis (*Adonis vernalis*) survive. The significance of the White Carpathians has, however, shifted from the typical steppe vegetation to meadows - slightly more mesophilic types of thermophilic grasslands still occupy quite large areas in some localities and they are home to numerous populations of orchids and other rare species of plants and animals.

The National Nature Reserve Zahrady pod Hájem with the area of 163 ha and National Nature Reserve Čertoryje (325 ha), both protected since 1987, belong to the most significant

protected localities of the flower meadows of the White Carpathians. A fragment of an impoverished feather grass steppe with *Echium maculatum* has been protected since 1998 in Natural Monument Kobylí hlava (3,38 ha).

Gr

Boleradice Upland (Boleradická vrchovina)

The flat upland in the southern part of Ždánice forest is formed by flysch claystones, sandstones and conglomerates. The widely rounded distributing ridges are separated by widely open valleys, mean altitude is 255 m, the highest point is the peak of Přední kout (410 m altitude). In the North Pannonian province, it represents a unique complex of agricultural-forest landscape with natural thermophilic oak groves, oak-hornbeam coppices (exceptionally also beech groves), with contact steppe and forest-steppe communities in polankas and at the forest fringes and communities of post-agrarian steppe barrens. Thanks to the well-preserved range of types of natural and near-natural vegetation, we can find various evolution stages of steppe grasslands here. In steppe polankas, for example *Echium maculatum*, pygmy iris (*Iris pumila*) and *Globularia bisnagarica* grow. The most interesting localities of post-agrarian steppes are, for example, as of yet not protected steppe barrens in Plunarské terasy, where feather grasses (*Stipa capillata* and *S. pennata*), asters (*Aster linosyris*, *A. amellus*), milk-vetch *Astragalus onobrychis*, burnet rose (*Rosa spinosissima*) and steppe cherry (*Prunus fruticosa*) grow.

Various types of steppe grasslands have been protected since 1956 in Natural Monument Kamenný vrch (steppe barrens with feather grasses, spring adonis, *Echium maculatum*, *Pulsatilla pratensis* and snowdrop anemone, area of 6 ha); Nature Reserve Hrádek (dogwood oak groves and forest-steppe polankas, with *Echium maculatum* and pygmy iris and an area of 11.8 ha), Nature Reserve Nosperk (dogwood oak groves, oak-hornbeam groves and contact steppe communities, the area is 10.88 ha) and Nature Reserve Zázmoníky (dogwood oak groves with dittany and steppe barrens with Austrian dragonhead, the area is 4.85 ha) have been protected since 1986.

Bu

Bzenec Sands (Bzenecké písky)

The area of aeolian sands between Hodonín, Kyjov and Bzenec is a very peculiar steppe vegetation locality. Most of it is covered by the Dúbrava (or Doubrava) forest and it is sometimes called Moravian Sahara. In the past, an intensive forest pasture took place here, which caused soil degradation, opening of the forest and renewal of the sand dune movement. At the end of the 18th and the beginning of the 19th century the situation was critical, the sands threatened the agricultural cultures in the surroundings and forestation was begun. We would have probably lost the open sands completely, if the Northern track of Emperor Ferdinand was not planned to run through there. A wide fire belt had to be maintained because of the steam locomotives; requests to create army training grounds for garrisons in Hodonín and Bzenec were added. These are the localities where the sandy steppe with a dynamic vegetation and many unique animal species was preserved in a larger continuous area. The steppe here combines the reach of Pannonian migration with a very acidic environment of the siliceous substrate and is very different from most sands in the Danube river basin (Podunají); the most similar sands can be found in the neighbouring Slovakia's Záhorie Plain. In the species composition, migrants from south-east meet oceanic species of Western Europe, but some boreal species, which reach their absolute southern range limit here, are also a peculiarity. A plant example is the typical wild thyme (*Thymus serpyllum*). The biota of aeolian sands requires disturbing. If we do not let the wind do its work, humans have to come and disturb. Ploughing of the sands by travel of track vehicles is surprisingly more beneficial than letting it be and overgrow with pine trees.

The vegetation of aeolian sands has been protected in National Natural Monument Váté písky (99.8 ha) since 1992 and in Natural Monument Bzenec army training ground (36.8 ha) since 1994.

Gr

Dunajovice Hills (Dunajovické kopce)

To the west of the attractive Pálava lies the ridge of Dunajovice Hills. Their geological constitution is completely different - it is formed by Tertiary sediments, particularly gravels. The historical development led to early deforestation, resulting in the viable steppe alternately taking over the periodically abandoned agricultural lands. Changes in agricultural cultures, barrens and permanent steppe spots were still observable quite recently here. Dunajovice Hills are a wonderful example of the dynamics of steppe biota. At the time of collectivization, meadows were destroyed in many places and the Slunečná hill was terraced into a likeness of a step pyramid. The special substrate, however, caused the planted cultures to fail to take root. In the end, a reserve was established here on quite a large area, including the above mentioned Slunečná. The reserve protects especially the succession areas of barrens, which are home to one of the richest populations of Tatarian sea kale (*Crambe tataria*) in Central Europe, although we can also find remnants of not very disturbed steppe turf, where the very rare Pannonian endemic species Pančić's wormwood (*Artemisia pancicii*), the attractive dwarf almond tree (*Prunus tenella*), pygmy iris (*Iris pumila*) or the exotic steppe parasite grey broomrape (*Orobanche caesia*) grow.

A part of Dunajovice Hills has been protected since 1990, today the National Natural Monument has the area of 107 ha.

Gr

Serpentine steppes of Pojihlaví

The specific and complex geology of the eastern margin of the Bohemian Massif was uncovered by deep incised valleys of west Moravian rivers. The section chosen by the Jihlava river has a substrate in which granulites and serpentines alternate. Serpentine rocks belong to the most remarkable substrates - in their chemism the bivalent calcium is substituted by the bivalent magnesium, with an increased content of heavy metals. Serpentines evidently have mutagenic effects, there are serpentine endemic species found all over the world. The soil on serpentines is poisonous for many plants, the substrates of serpentines are therefore completely different from the surrounding ones, because the competitive relationships in the vegetation are also always completely different. If, furthermore, the dark serpentine rock is facing south, it is warmed more than the neighbouring light granulite, so the serpentine localities seem more thermophilic, more steppe-like. The famous locality of the Jihlava valley is Mohelno Serpentine Steppe (Mohelenská hadcová step), but serpentine outcrops can also be found around Lhánice, Templštejn, below Biskoupky and near Hrubšice. They are characterized by a plenitude of feather grasses, especially *Stipa dasyphylla* and short fescues, sea thrift *Armeria maritima* subsp. *serpentini* is only bound to these localities, near Mohelno the Mediterranean *Notholaena marantae* grows in the northernmost area of its distribution. Serpentine localities also belong to the most significant habitats of thermophilic insects. In the past these steppes were grazed, these days the succession of shrubs, and in Mohelno also of wood plants like the Banks pine (*Pinus banksiana*), represents a problem.

The Mohelno Serpentine Steppe has been protected since 1933, the current National Nature Reserve takes up the area of 48 ha. The Biskoupice Serpentine Steppe has been protected since 1979, the current Natural Monument area is 2.2 ha.

Gr

Hovorany Meadows

In the intensively agriculturally exploited vineyard-field landscape of the Kyjov upland, on the slopes of the Karlák hill near Hovorany on the bedrock of flysch calcareous grit, partly covered by loesses with chernozem soils, a complex of steppe and meadow communities has surprisingly survived. In the dry steppe grasslands communities with dominant Valesian fescue (*Festuca valesiaca*), many rare and significant species grow, for example *Echium maculatum*, Tatarian sea kale (*Crambe tataria*), European feather grass (*Stipa pennata*), the *Pulsatilla grandis* pasque flower, Austrian milk-vetch (*Astragalus austriacus*), the *Astragalus onobrychis* milk-vetch and goldilocks (*Aster linosyris*). The rare steppe communities are threatened by invasive wood plants overgrowing, particularly by false acacia (*Robinia pseudoacacia*), but also tree of heaven (*Ailanthus glandulosa*) and boxthorn (*Lycium barbarum*).

The Hovorany Meadows Nature Reserve has been protected since 1992, its area is 10.6 ha.

Bu

Květnice near Tišnov

The name Květnice - related to flowers - symbolizes the species composition of the extreme margin of the north-western projection of the thermophilic flora area. The Ostrovní hora hill (470 m), rising steeply above the floodplain of the Svratka river at the border of Boskovice trough and Bohemian-Moravian Highland, accepted many thermophilic floroelements on its calcareous southern slopes at the time of post-glacial vegetation formation. From the plants which could not migrate further into the interior of Bohemian-Moravian Highland, we can mention at least the feather grasses *Stipa capillata* and *Stipa pulcherrima*, *Euphorbia epithymoides*, *Campanula boloniensis*, *Inula oculus-christi* and *Thymus praecox* in the free growth of downy oak (*Quercus pubescens*) and cornelian cherry dogwood (*Cornus mas*). Květnice is a textbook example of various communities on minerally poor and acidic quartzites and minerally rich limestones, which are much more species-rich. Even today there is a remarkable contrast of the natural dogwood oak groves on the southern slopes and beech groves on the northern slopes. Many thermophilic species of insects are also bound to forest-steppe polankas of southern calcareous slopes. Since 1994 common European mantis (*Mantis religiosa*) has become quite common, species that are considerably more extraordinary were discovered here even earlier by the prominent Moravian entomologist P. Lauterer, including some of the cicadas - their next closest habitats can be found as far as southern Italy.

Květnice, which was declared a state nature reserve in 1950 (in 1992 it became a Natural Monument, comprising an area of 127 ha), is also a typical example of protection management. The development of wood plant seeding is periodically regulated on the forest-steppe polankas; acacia is being completely destroyed. Gradually the withering European black pine is also felled - its artificial growths should be substituted by spontaneously developing various types of thermophilic oak groves.

La

Komentář k obrázku:
Anthropogenic influences undoubtedly contributed to the development of steppe and forest-steppe vegetation. Bare southern slopes, deforested as a result of pasture and rare ore mining, are clearly visible on a veduta of Tišnov from the first third of the 18th century. At the end of the 19th century, these slopes were forested by the allochthonous European black pine, which is withering at present.

Milovice Slope (Milovická stráň)

This is probably the most plentiful locality of spring adonis (*Adonis vernalis*) in South Moravia, continuing the edge of the Milovice village in the Pálava Protected Landscape Area. In the 1980 census the members of the Brontosaurus movement found almost 5000 tufts of this significant and beautiful species. The most numerous population of spring adonis is on the steep southern slope above the local football field. Adonis and other photophilic steppe species are threatened here by overgrowing of the post-agrarian pasture steppe barrens by wood plants, particularly by false acacia (*Robinia pseudacacia*). Contacts between the steppe and the forest vegetation are also very valuable, especially small natural forest-steppe polankas, where adonis also grows. Polankas with steppe species formed on steep southern slopes, where the extreme ecological conditions enabled the opening of the dwarfed dogwood oak groves. Milovice polankas in South Moravia represent a unique evidence of natural refugia of steppe species in forest landscape.

This long-known and admired habitat of spring adonis has only been protected since 1994 as the Nature Reserve Milovická stráň (88.35 ha).

Bu

Conglomerates of Moravský Krumlov

In the valley of the Rokytná river near Moravský Krumlov, very interesting non-forest sites can be found on outcrops of Permian-Carboniferous conglomerates. The river has eroded a deep valley, on the steep, sometimes rocky, slopes of which a specific vegetation asserts itself. Its

specificity consists mainly in the geochemical character of the matrix. Cobbles of rocks are glued together by calcareous cement with high amount of iron - that is the reason for the conspicuously rusty colour of the conglomerates. This iron causes the local acidification and as a result, species with a completely opposite relationship to soil reaction can coexist here. For example, we can find the acidophilic forked spleenwort (*Asplenium septentrionale*) right next to the calciphilic wall-rue (*A. ruta-muraria*). There is a variegated mosaic of vegetation types and a high diversity of plant and animal species on the complex of rocky amphitheatres and forested gullies. It is this locality where the endemic Moravian pink (*Dianthus moravicus*) was identified and we can find 5 species of feather grasses here.

No one ever doubted the scientific significance of this area, it is therefore past comprehension that from the first proposal to establish a natural reserve to the actual establishing an incredible 40 years had to pass. The National Nature Reserve Krumlov-Rokytná conglomerates was only established in 2005, on an area of 86.6 ha.

Gr

Pavlov Hills (Pavlovské vrchy)

Pálava has an exclusive position when we consider the South Moravian steppe biota. It is the only area where the large-area Pannonian rocky steppe appears on limestone bedrock - similar type of biotopes can be found in Hainburg Hills in Austria, at the edges of Small Carpathians in Slovakia and in many sites in northern Hungary. The peculiar geology, in connection with the dramatic geomorphology of the outlier, and climatic specificity - all these factors predetermine the specific flora nad fauna. In Pálava, the contact between forest and non-forest land is very tight. Although it is apparent that many deforested areas used to be forested in the past, these forests were very sparse in many cases and probably had the character of an open stand with numerous non-forest enclaves. The immediate rock edges were, of course, non-forest - they undoubtedly represented a refuge for the vegetation of present rocky steppes. The turfy steppe in most of Pálava is an artefact which was formed with the assistance of humans. Deforestation and subsequent erosion significantly extended the non-forest area. Where this happened a long time ago, the rocky steppe spread from the above mentioned refugia and remained quite stable until now. The areas of turfy steppes covers are, in contrast, less stable, and they are turning into mesophilic meadows at present. The naturalist research of Pálava began as early as 19th century and the area is now well examined, so we can easily evaluate the changes that took place. Quarrying has had an effect in some localities; it caused the extinction of unique grikes and also of some rare plant species in Turold. There were times when gardeners were the biggest enemies of the Pálava reserves, nowadays it is rather the omnipresent eutrophication.

Pavlov Hills are a part of the Pálava Protected Landscape Area; the calcareous outliers have been protected since 1946 in the Děvín-Kotel-Soutěska National Nature Reserve (383 ha) and Svatý Kopeček Nature Reserve (57.06 ha); current National Nature Reserve Tabulová, Růžový vrch and Kočičí kámen (47.4 ha) has been protected since 1951.

Gr

The Plumlov area

West of Prostějov in the surroundings of Plumlov, many small hills, consisting of culm shale and greywacke, rise on the border of Drahany Hills and Haná. In the landscape, which is predominantly ploughed and very poor in species, the unexpected richness of plant life and butterflies bound to them seems literally like a miracle. Many rare thermophilic herbs bloom in the acidic dry grasslands here, often in their limit area in Moravia. In most localities here pasque flower *Pulsatilla grandis*, purple mullein (*Verbascum phoeniceum*), speedwell *Pseudolysimachion spicatum* and *Armeria vulgaris* ssp. *vulgaris* grow. In some localities we can find, for example, yellow flax (*Linum flavum*), snowdrop anemone (*Anemone sylvestris*), speedwel *Veronica teucrium*, purple cow-wheat (*Melampyrum arvense*), steppe cherry (*Prunus fruticosa*), *Aster amellus*, and others. The first small-scale protected areas were created here more than half a century ago, more followed in the course of the 1980s. These areas include: Natural Monument Dolní vinohrádky (0.38 ha, 1952), Natural Monument Čubernice (1.20 ha, 1952), Natural Monument Brániska (1.43

ha, 1953), Natural Monument Za hrnčířkou (0.96 ha, 1953), Natural Monument Hamerská stráň (0.57 ha, 1987), Natural Monument Kozí horka (0.87 ha, 1989) and Nature Reserve Kněží hora (8.47 ha, 1989). Most steppe grasslands in these protected areas experience exemplary care - regulated grazing of goats and sheep and partly also mowing take place here. However, other "little Plumlov hills" located amidst the fields still await proper protection and care.

La

Pouzdřany Steppe (Pouzdřanská step)

One of the most famous localities of thermophilic steppe vegetation extends on the slopes of the Strážná hill above Pouzdřany. The dominant vegetation type here is the continuous cover of the *Stipa pulcherrima* feather grass, with numerous populations of Tatarian sea kale (*Crambe tataria*). The core of Pouzdřany Steppe is probably created by a primary non-forest land, which was, however, extended to its present area in the past, after the adjacent thermophilic oak woods were cut down. Until the half of the 20th century the area was used for grazing and growing fruit trees, grape-vine and licorice cultures, the upper edge was traditionally occupied by fields. Significant factors influencing this locality in the long-term were fires and the periodically growing and shrinking colonies of wild rabbits. Due to its accessibility, the locality was a favourite of naturalists from Brno, thus it was thoroughly researched both botanically and entomologically. From the point of view of botany, there seem to be no qualitative changes, but the entomologists report species losses. Management here is, however, still experimental - some time ago, a radical action against acacias was necessary, at present sheep grazing has been under way for a number of seasons. Its influence on the biotopes will have to be regularly evaluated.

The Pouzdřany Steppe National Nature Reserve has been protected since 1956 and its area is 47 ha.

Gr

Stránská skála

An island of Jurassic limestones at the eastern edge of Brno rises conspicuously from the flat upland. Traces of settlement from the Paleolithic and Neolithic Ages testify to the long-term human activity in this area. Various communities of post-agrarian pasture barrens create a unique landscape character in Stránská skála, documenting the thousand-year tradition of landscape cultivation. In these steppe grasslands, the large population of the *Pulsatilla grandis* pasque flower is significant, other important species include, for example, European feather grass (*Stipa pennata*), purple milk-vetch (*Astragalus danicus*), Austrian milk-vetch (*Astragalus austriacus*) and *Aster amellus*. Common European mantis (*Mantis religiosa*) represents the characteristic insect species. Apart from steppe grasslands, grasslands with growths of blue sesleria (*Sesleria caerulea*) and an interesting vegetation of calcareous rocks appear on the northern slopes. Stránská skála is surrounded by urban landscape nowadays, the area is therefore frequently visited throughout the whole year, resulting in occasional trampling of rare communities.

The Stránská skála National Natural Monument takes up an area of 16.6 ha and it has been protected since 1978.

Bu

Špice

The proximity of Brno is without a doubt one of the reasons why there are so many historical records about Stará hora near Újezd u Brna (older scientists meticulously wrote "near Sokolnice"). Even today the locality is wonderful - it is probably the northernmost habitat of Tatarian sea kale (*Crambe tataria*); pygmy iris (*Iris pumila*) and many species of broomrapes grow here and it is also one of the 2 localities of the stout *Euphorbia salicifolia* found in the Czech Republic. The occurrence of *Gypsophila fastigiata* is also a rarity, as it almost always grows exclusively on sands. It is a south-facing slope, which had probably long been used as a mosaic of pastures, mowed areas, orchards, vineyards and small fields. Even today we can see an abundance of species, although it is paradoxical that at present, some of the most significant species only grow outside the protected areas. This is true especially for the memorable *Kochia prostrata*, which in

Central Europe regularly appears in steppes originating in salt marshes.

Nature Reserve Špice has been protected since 1956 and it has an area of only 1.02 ha.

Gr

Špidláky

Surprisingly, the Čejč area was one of the earliest thermophilic flora regions to be explored in Moravia. A few records about local vegetation appeared in Vienna naturalist magazines as early as 1850s. The great representatives of Brno natural sciences - Podpěra, Šmarda and others - were often travelling to the surroundings of Čejč to explore. The brackish Čejč lakes disappeared 150 years ago, some of the elements of saline Pannonian steppes, for example milk-vetch *Astragalus asper*, were still found here at the beginning of the 20 th century. The steppe slopes, which inspired the term "špidlák" (a steep, horizontally structured slope with alternating convex and concave parts, to which a primary non-forest was probably bound in the past), remained outside protection until the beginning of the 1990s, without significant losses among the plant species. These localities were not suitable even for the megalomaniacal agricultural projects. Only the Žleby (also Luka) complex in the Kobylí territory was disturbed by building narrow terraces; despite that, as late as 1990s sensitive species like dark-winged orchid (*Orchis ustulata*) or garland flower (*Daphne cneorum*) could be found there, not to mention the typical steppe species. Recent research proved the existence of Pančić's wormwood (*Artemisia pancicii*), the population of which has been lost for many years. The localities complex between Čejč and Čejkovice still belongs to the most significant steppe localities in the Czech Republic - here we can find many species that cannot be found in the near (and very similar) Pouzdřany Steppe.

Nature Reserve Špidláky, protecting three separate steppe grassland localities in the Čejč area, was established in 1992 on an area of 20.9 ha.

Gr

Větrníky

The largest steppe locality in the area between Bučovice, Rousínov and Vyškov is Větrníky, a complex of steppe slopes quite far away from the nearest villages. If we add the fact that it is an area of active landslides, it is clear why there was no interest in using this locality in any other way than a pasture or a meadow. The distance from forests caused that, although unmanaged, Větrníky were not overgrown by wood plants as intensively as other similar localities. However, significant changes in vegetation were caused by rain wash - running down from the surrounding agricultural cultures - below the upper edges of the slopes. The present reserve consists of areas which were being declared protected areas gradually. The added areas were invariably abandoned barrens. In the core of the area, quality steppe vegetation with many significant species (5 species of steppe feather grasses still grow here) was preserved, but the margin areas are partly overgrown by shrubs and partly by bushgrass (*Calamagrostis epigejos*) and on the landslides also by reeds. We know that in the past meadows - from brackish to boggy - used to extend on the foot of the hills, but at present there are only minute fragments of them left.

The present Větrníky National Nature Reserve has an area of 24.46 ha and it has been protected since 1951.

Gr

Zimarky

This unique island of Pannonian loess steppe grasslands on chernozems is situated on a hill north of Velké Bílovice in the middle of a large complex of terraced vineyards. A surprisingly large population of Tatarian sea kale (*Crambe tataria*) has been preserved here, feather grasses (*Stipa capillata* and *S. pulcherrima*) and a whole range of significant South Moravian steppe species, like spring adonis (*Adonis vernalis*), pygmy iris (*Iris pumila*), *Jurinea mollis*, goldilocks (*Aster linosyris*), *Aster amellus*, *Campanula sibirica*, Austrian milk-vetch (*Astragalus austriacus*) and burnet rose (*Rosa spinosissima*), grow here.

This remnant of steppe vegetation, taking up a few hectares of the predominantly agrarian landscape, has been saved from destruction by local nature lovers, as it is not yet protected by law.

Bu

Znojmo Heathlands

In the easternmost projections of the Bohemian Massif south of Znojmo we can find very unusual steppe localities. On Kraví hora, in the surroundings of Konice, Popice, Havraníky and Hnanice, grass-herb and shrublet communities grow. In their species composition, Pannonian species and typical acidophilic species - their core of occurrence lies in the oceanic parts of Europe and represents Hercynian elements in our territory - mix. The acidic granite bedrock, complemented by pockets filled with calcareous loess, the very warm and dry climate, location at the crossroads of migration paths - all of these are contrastive characteristics of an environment which does not have many analogues in the Pannonian area. Many species in their range limit occurrence meet in this territory - pygmy iris (*Iris pumila*) in the western range limit, reflexed stonecrop (*Sedum reflexum*) in the eastern one; similarly the acidophilic ling (*Calluna vulgaris*) meets the basophilic steppe ground broom (*Cytisus procumbens*) here. This vegetation probably represents a blocked seral stage after cutting down of dry acidophilic oak groves, where there was additional erosion of the shallow soil cover. The heathlands were used mainly as extensive pastures until the 19th century. In the years 1992-1994, the accumulation of immission fallout of nutrients in the short covers of narrow-leaved fescues enabled the rapid spread of oat grass (*Arrhenatherum elatius*), which now obliterates the steppe physiognomy of these localities by its enormous production of biomass. There had been many attempts at fighting the oat grass, the most effective seems to be extensive sheep grazing.

The heathlands complex with steppe species is protected in the first zone of the Podyjí National Park.

Gr

SIGNIFICANT RESEARCHERS AND PROTECTORS

Jaroslav Horák (born 1919)

He was born in Hodonín and after finishing his studies at the Faculty of Forestry of the University of Agriculture in Brno, he worked in Lesprojekt in Brno in the years 1949-1956, where he was engaged in typological research and in mapping the forests of South Moravian dales. He became interested in contact communities of steppe and forest-steppe polankas. In 1956, he became a scientist in the scientific laboratory of biocenology and typology of forests of the University of Agriculture in Brno. From here he transferred to the Department of Forestry Botany and Phytocenology, where he worked until he retired. His monography on forest types of the Pavlov Hills and a compendium of studies of thermophilic oak woods and their contact geobiocenoses undoubtedly belong to the classic works on geobiocenological forest typology. He also studied the steppe and forest-steppe polankas in the reservations of Masaryk Forest, a training forest enterprise of the Mendel University of Agriculture and Forestry in Brno; he is currently preparing a collective monography on this topic. Jaroslav Horák has been a passionate advocate to nature since the beginning of his professional career. For example, for years, he tirelessly kept promoting the cancellation of the game-preserve in the Pálava Protected Landscape Area, where the vast numbers of hoofed game were devastating (and still do) his beloved thermophilic oak woods including steppe and forest-steppe polankas with rare plant species.

Bu

Anežka Hrabětová-Uhrová (1900–1981)

Born in Lomnice near Tišnov, she finished her studies of natural history and geography at Masaryk University and stayed to work there tirelessly for almost the rest of her life. She was concerned with morphology and taxonomy and she gave lectures, beside other subjects, also on Landscape and Nature Protection. She invested much energy into organizing the social life of Brno naturalists, she was an indefatigable functionary of the Moravian Naturalist Society and after that of the Naturalist Club; she mainly organized lectures and excursions. She had a close relationship not only to the area surrounding her native village, but also to the Hustopeče area, Pálava, the surroundings of Ivančice and the Vranov Dam. She used her field experience also at the time when

naturalists began speaking against the destruction of natural values. She fought for saving Turold from limestone quarrying without success, but on the other hand, she successfully initiated the establishing of many preserves of thermophilic flora. The review of the history of botanical research in Moravia, which she was meticulously processing mainly after she retired, did not lose any of its topicality over the years.

Gr

Josef Podpěra (1875–1954)

A native from Jílové u Prahy, he worked as a secondary school teacher in Olomouc (from 1903) and Brno (from 1908), after graduating the Charles University. In 1921, he became the first professor of general and systematic botany at Masaryk University in Brno, where he worked until the end of his life. He was also a leading figure of the Naturalist clubs in Prostějov and Brno. As early as 1921 he published "The Flora of Haná," in which he stressed the importance of the Moravian dales for the penetration of Pannonian flora from the Danube river basin further north. His three-part treatise "The Flora of Moravia in the Systematic and Geobotanical Relationships" (1924-1928), which remained unfinished, was unique in many ways. He devoted special studies to the thermophilic flora of the Pavlov Hills and Pouzdřany Steppe (1928). It is not uninteresting that it was Professor Podpěra who derived the name of White Carpathians from the undulating surges of the albescently downy feather grasses, which he had the chance to admire there at the beginning of last century. Professor Josef Podpěra raised many enthusiastic and protection-oriented botanists - for example his successor docent J. Šmarda.

La

Valentin Pospíšil (1912–1999)

He came from the Přerov area, graduated from the Academy of Education and worked as a teacher in the interwar years. During the war, he became a conservationist of Nature Protection in Vsetín, where he was teaching at the time, and after the year 1945 he began working as the head of the Department of the State Nature Protection in the Institute for the Preservation of Historical Monuments in Moravia and Silesia, located in Brno. He stayed in the State Nature Protection until 1959, when he transferred to Moravian Museum. From that time his main professional interest was bryology. The significance of Valentin Pospíšil's work lies mainly in the creation of a net of collaborators-conservationists and in his contribution to preparation and establishment of many protected areas in the 1950s. We can mention Pouzdřany Steppe, Kamenný vrch near Kurdějov, Louky pod Kumstátem, Velké Družďavy and some of the Pálava reserves as examples. As a bryologist, he studied the problems of the endangerment of bryophytes and he created the first red lists of endangered bryophytes of the Czech Republic.

Gr

Jan Šmarda (1904–1968)

A botanist of wide insight and scientific scope came from Třebíč. From 1923 he worked as a teacher in Tišnov and its surroundings. At the same time he studied at the Faculty of Science of Masaryk University in Brno, which he graduated from in 1938. Influenced by his teacher, Professor Josef Podpěra, he was mainly engaged in research of the distribution of thermophilic plants, some of which reach the north-western limit of their partial or even whole ranges in the Tišnov area. But he was also an outstanding bryologist and lichenologist, studying not only the taller plants, but also bryophytes and lichens and, with his brother František, also fungi. From May 1945 he worked as the head of the Botany Department and then as the director of the Moravian Museum in Brno. He obtained the position of docent in 1946 and in 1954 he became the successor of Professor Podpěra in the Botany Department at Masaryk University, where he raised many other excellent botanists. The peak of his his scientific career was the work in the Institute of Geography of the Academy of Sciences of Czechoslovakia in Brno, where he published his treatise "Distribution of xerothermic plants in Moravia and Silesia" in 1963.

Docent J. Šmarda was dedicated to protection of nature and landscape with as much tenacity as he put into his scientific research. At the beginning of the 1930s he initiated the protection of

Květnice and Čebínka near Tišnov and in 1948 he published an extensive proposal of nature and landscape reserves in Moravia. He earned renown as a courageous protagonist of the resistance against the technocratic scheme of water management modifications in South Moravia, he advocated the creation of geobiological landscape plans and their consistent observation at the time of human interventions. "He has fallen in the front line, full-armed, in the middle of life's struggle" - Jaromír Tomeček, a writer and a close friend of docent Šmarda, wrote in a long obituary after the unexpectedly premature death of Jan Šmarda in December 1968.

Titulek k fotografii:
Pavlov Hills belonged to favourite exploration sites of docent Jan Šmarda. Here, he liked to fraternize with artists. In a picture by Jindřich Grepl from the half of the 1960s, he teaches the poet Jan Skácel (on the right) to recognize the thermophilic flora.

THE STEPPE GRASSLANDS CARE

The protection legislation has many forms of the significant localities protection. In Act No. 114/92 Coll. about the protection of nature and landscape, various categories of protected areas are defined. The simplest legislative category is significant landscape element, which is established - and legislatively registered - by municipal offices of municipalities with extended competence, the so-called little districts. Higher level of protection is in small-scale specially protected areas - nature reserves and natural monuments, established in the past by district authorities, now by regional authorities, and the highest level is represented by national nature reserves and national natural monuments, which are established by the Ministry of Environment. The most recent category of protected areas are localities of European significance, established as a part of the Natura 2000 programme of the European Union.

In some protected areas we protect natural processes, if we want them to proceed undisturbed, and therefore human intervention is minimum or none at all. In others, we try to deliberately block this development in a particular phase, to preserve the state of these communities when they are most valuable from the biological and nature protection point of view. This is the case of most types of dry grasslands.

If we look at the original establishing documents of the oldest protected areas, we find things that, from the point of view of protection, seem incredible to us today. In the protection conditions, which state, to put it simply, what can be done and what cannot be done in the reserve, we can find things like the ban on mowing and grazing and so on. This is in direct contradiction to what we know about the formation and development of steppes today. The nature protectors needed some time to realize that passive protection of steppe reserves is not a good way to preserve them for future generations. This so-called conservationist approach was, unfortunately, short-sighted and persisted for many decades. Wood plants began to overgrow the steppe, old decomposing plant matter was accumulating, a few species of competitively strong grasses began to dominate the species composition at the expense of many competitively weak, and also rarer, plants. The species spectrum was therefore becoming poorer, some valuable species even became extinct. It was, of course, a logical and natural process, which pertained to most steppe grassland localities, not only those which were located in reserves. This development has to be seen in the historical context. The 1950s and 1960s brought a fundamental change in the style of agricultural management and consequently extremely unfavourable changes in landscape. Bad times came for the dry grasslands. Many of these sites were ploughed for the sake of the socialist agriculture. Those that remained fell victim to the cessation of grazing, when the cattle was moved from pastures to year-long stables. Sheep and goats - animals which once helped to create the character of our steppe grasslands - gradually all but disappeared from our villages.

Enlightenment and understanding came after more and more steppe localities took a visible turn for the worse. Up to now, the State Nature Protection has been trying to mend what was caused mostly by social and economical circumstances and to a lesser extent by the State Nature Protection itself.

What are the basic problems that the protectors of dry grasslands encounter at present? Mainly the overabundance of nutrients, especially nitrogen, in the soil. This is caused particularly

by the accumulation and decomposition of old biomass, when it is not removed from the plant cover in any way, for example by mowing or grazing. In last decades, this is complemented by the supply of nitrogen from the atmosphere. This includes on one hand nitrogen compounds coming from civilization sources, particularly from industry and transport, carried in the air over vast distances, and on the other hand spray drift and outwash of nitrogen fertilizers of natural and artificial origin, which are used in agriculture. The increased amount of nutrients helps the nitrophilic species, i.e. species which like nitrogen soil, to spread. These species are able to spread rapidly and they push out many valuable plants from the grassland communities. Such strategy is implemented for example by two grass species - oat grass (*Arrhenatherum elatius*) and bushgrass (*Calamagrostis epigejos*). The accumulation of old plant matter itself also has other unfavourable impacts on the plant community structure. The accumulated matter takes up space, creates shading and changes the humidity conditions. In this way the competitively weaker plants, which are dependent on propagation by seeds, are gradually pushed out from the plant cover. These plants often include many rare and endangered species.

The unstoppable wood plant overgrowth also has similar final effect in every abandoned meadow, pasture, old orchard or vineyard. This is, of course, a natural process of the so-called succession, which would lead, without our intervention, to some type of forest. This process, however, is fatal for our steppes. If the seeding of the wood plants includes our native species, for example roses, blackthorns, hawthorns, it is the better alternative. Many more problems are caused by foreign, non-native species, which are often very aggressive, spread rapidly, tenaciously resist the attempts at liquidation and are, unfortunately, widespread in South Moravia. These include, for example tree of heaven (*Ailanthus glandulosa*), boxthorn (*Lycium barbarum*), but mainly false acacia (*Robinia pseudacacia*).

Acacia spreads easily by root suckers, so in a few years, it is able to multiply the area of its growth several times. This means that what seems to us to be an acacia grove or chaparral, is often really only one plant, an organism composed of many seemingly individual “trees,” interconnected by their roots. If we add the saplings from the abundance of sprouting seeds, we see how fast this wood plant can spread. Being so aggressive, it is often able to deteriorate even very valuable vegetations, which it overgrows quickly and without any problems. An important role is played not only by the rapidity of its spread, but also by its ability to, so to speak, “clear its way.” Through its root system, it secretes chemicals which limit the growth of other plants. Therefore, a few common weeds, which can cope with the unfavourably altered chemism of the soil and shading, is all that can be found under the thick acacia cover.

By proper management - as the set of methods, measures and maintenance practices of scientifically valuable localities is summarily called - we are often able to restore the desolate areas, which used to be valuable, quite quickly, or at least steer their development in the desirable direction.

In most localities, which we subject to management, the first step is the decontaminating treatment. This includes basically the primary rough works, which are supposed to remove the most pressing causes of the problems. In this stage, it is time for saws and bush-cutters, which are used to remove the seeding of unwanted trees and shrubs. All the cut matter has to be subsequently removed from the treated area. The rough wood is driven away, the brushwood and shrubs are burnt or chopped. Most of the wood plants that are being eliminated do not, unfortunately, die out immediately, they are able to renew very quickly and readily, from stubs or from roots, which is the case of acacias. Therefore we rarely succeed without the use of herbicides, which have to be immediately applied on the stubs. This saves a lot of time, work and money, because one intervention is usually not enough and the treatment sites need to be carefully monitored and receive further treatment for a number of years. What happens to these sites next? If the removed seeding was not too thick and there were still some desired plant species in the undergrowth, then such area can usually be successfully regenerated after a couple of years of treatment by mowing or grazing. It is worse in the case of cut closed stand of acacia and other non-native wood plants. We have to opt for other solutions in these cases, for example planting of chaparrals and groups of trees and shrubs of native species, which fit the particular site. These sites also have to be, of course, further treated for a few following years. Not only continuously cutting out the shoots of the

liquidated wood plants, but also taking care of the new planted seedlings. In contrast, we do not usually interfere with continuous covers of native wood plants, unless it is necessary for the protection of particular species.

A successful result of the decontaminating management then represents the starting line for the regulating management, i.e. the following regular maintenance. Continuous regulatory maintenance only means that we try to imitate earlier ways of management. Although we use similar methods like the farmers of old, our aims are different. Our primary goal is obviously not sustaining food or gaining profit, but preserving the state of vegetation which we consider favourable. If the grass-herb covers are in good shape, the maintenance does not have to be very intensive. In the case of dry grasslands, a one-time mowing or grazing once in a few years is usually sufficient. After cutting, the hay is raked out and removed from the area. By the way, a seemingly trivial raking of hay is significant in the maintenance of thermophilic communities - it helps open the grass turf and consequently creates space for dispersion of many valuable herb species. What happens with the grass matter in case of grazing is obvious. At present, grazing is considered to be an optimal way of maintenance for most types of steppe grasslands. Unfortunately, after the long absence of grazing we have to learn to do it properly again. Grazing can be, to a great extent, compared to a lottery, the results of which can differ from year to year, because it depends on many factors, the least predictable of which, the weather, is the most important. A definite advantage of extensive grazing is the possibility of continuous regulation. Depending on the weather and the state of the plant cover, the number of animals, the composition of the flock or herd or the place and time of grazing can be altered. Selectivity is another advantage. Especially sheep prefer softer, non-blooming grasses and short shrublets, while goats are mostly specialized on the higher levels, the branches and leaves of taller wood plants and blooming grasses. Therefore the two animal species complement each other perfectly. On the other hand, the organizational and technical provision of grazing is much more complex than simply coming to the steppe with a cutting machine or a bush-cutter. Previous experience and results definitely show that we set off on a promising path. Since 1997, when sheep grazing was reintroduced in the Mohelno Serpentine Steppe, this way of management has spread to other localities, for example Větrníky, Pouzdřany Steppe, Miroslavské Hills, Dunajovice Hills, Kamenný vrch near Kurdějov and other.

There are some types of dry grasslands which require a special kind of management, or they preserve themselves by themselves, so to speak. These types include, for example, the vegetation of the so-called rocky steppe on sunny rock terraces and edges and steep rocky slopes. For them, what has been said above about the origin of dry grasslands is not valid. They are not secondary communities determined by human management, but communities of the so-called primary non-forests, which would exist even without human assistance, due only to the extreme natural conditions, which dominate in these sites. With the exception of slight decontamination of seeding, these communities demand the least maintenance. In contrast, grasslands on sands - a loose substrate extremely poor in nutrients - demand quite non-traditional ways of maintenance, for example occasional disturbing of the surface by shovelling or ploughing. For the continuous covers of feather grasses, occasional burning is favourable, but only on the surface and, at best, when the weather is frosty. The nature protectors, however, rarely find enough courage to do this, and rather rely on accidental fires, which are set unwillingly by other people... But sometimes mere raking out of old plant matter without cutting it first is sufficient.

The care of steppe areas is not random any more, we try to systematize it and set certain goals and protection priorities. In the case of localities which are already established protected areas, the methods, priorities and aims are defined by the plan of care, a document which is usually drawn for a period of 10 years and is supposed to propose ways of management - based on available knowledge of all the natural elements of the particular locality - which would ensure the existence of both plants and animals. We have to realize that many organisms, for example a number of insect or spider species, including many rare and valuable ones, are bound to herb communities of dry grasslands.

It is impossible to put measures necessary for the preservation of grass communities in protected areas into practice without financial support. In the beginning, there was no other way than organizing volunteer activities, recruiting mainly the employees of the State Nature Protection

or members of the Czech Nature Protectors Association, the Brontosaurus movement and so on. These activities were often self-financed, in better cases money from donors or sponsors were used. The misconception that nature protection comes for free originated at that time and persisted for many years. This might have been one of the reasons why systemic financial devices for ensuring the care of protected areas did not exist for a long time. New, better times came only in the 1990s. After the change in social conditions the problems of the environment became a popular issue for some time and the State Nature Protection succeeded in grounding itself as an integral part of the state administration structure, hopefully permanently.

It is worth mentioning, for illustration, the approximate expenses of the steppe localities management. For example, the extensive sheep and goats grazing or cutting with a manual cutter, scythe or bush-cutter cost ranges from 10 000 to 20 000 CZK per the area of 1 hectare, depending on the structure of the terrain, the state of the plant cover, accessibility and so on. Cutting with a tractor cutter is cheaper, ranging from 3 000 to 6 000 CZK per 1 ha, but it is impossible to use in most steppe localities. If we liquidate seeding of wood plants, we can reach 20 000 - 30 000 CZK per 1 ha. We move into an even higher finance range in the case of full-grown acacia groves, where it is necessary to use regular forestry technology and the above mentioned hectare rates cannot be applied here. We can go as high as hundreds of thousands in this case.

The new funding titles of the Ministry of Environment, introduced in the second half of the 1990s, became a blessing for the preservation of protected areas. Especially the Landscape Care Programme became the main financial source for the restoration of preservation of steppe localities. This relatively easily accessible funding programme has been functioning successfully for over 10 years now and a great number of valuable localities with steppe grasslands, beginning with the well-known national nature reserves and ending with small remnants of village pastures, were gradually restored to a desirable state using its financial sources. Nowadays this source is used to finance the planned and systematic care of the localities in national parks, protected landscape areas, national nature reserves and national natural monuments, but also in significant landscape elements and of other places. This funding is mostly received by the administrations of national parks and the Agency for Nature Conservation and Landscape Protection of the Czech Republic - these state organizations use the money to treat the areas that are in their competence - but the receivers can also be legal entities or natural persons, which make a justifiable request at the territorially responsible office of the Ministry of Environment.

The regional authorities also ensure the financing of the management of the areas in their competence, i.e. of nature reserves and natural monuments. Some municipal offices with extended competence also exhibit an obvious effort to take care of their significant landscape elements. This, however, always depends on the activity and enlightenment of the particular officials, but even more on the understanding and good-will of local political representatives.

There are still many valuable areas which have not received the necessary treatment yet. They include a number of smaller, seemingly less significant or overlooked localities, or those which are at present in an advanced stage of degradation and their biological and nature protection value is objectively lower. There is a good chance that, in near future, a really systemic device, which would be able to cover all the financial expenses even for these sites, will be invented. It seems that the proposed Operational Programme of the European Union Environment might become such a device. Let us believe that, from this point of view, our membership in the European Union will not be futile.

It is customary to summarize in the conclusion. What has been successfully achieved in the steppe grasslands care? We can claim with confidence that many neglected steppe localities regained their former beauty and value, some of them in the nick of time. Those that are in better condition only require regular care and minimum cost to be preserved. In general, we can say that a desirable and expected trend begins to materialize - from the expenses spent on care, more and more are being used for maintenance at the expense of those used for decontamination. We can illustrate this roughly on a few figures. The Brno centre of the Agency for Nature Conservation and Landscape Protection of the CR spent 1.5 mil CZK in total for care of national nature reserves and monuments of the steppe character in 2001, with 900 000 CZK spent on decontaminating and consequent work and only 600 000 CZK on regular maintenance. In 2004, the ratio was noticeably

different - less than 1 million spent on decontamination and 1.2 million on maintenance. These numbers testify not only to the fact that the South Moravian steppes are gradually being brought to a desirable state, but also to the fact that, at least at the national protection category level, the necessary finances are successfully ensured. The remaining protected areas, which are “only” nature reserves or monuments, are lucky to be located in South Moravia. Not every region in the Czech Republic is willing to finance nature protection to such an extent as the South Moravian Region. Despite this, there are still many valuable areas, which are waiting for the proper management. Let us believe that all the steppe grasslands localities will soon receive it.