Oecologia Montana 1992
2, 43-47

TECHNIQUES AND STRATEGIES

Biological diversity in the Carpathians

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Abstract. The major threat to the Carpathian ecosystems in global terms is the long distance transmission of emissions (gases and pollution, acid rain) and the synergic activity of anthropogenic influences. The local causes of forest damage are grazing of domestic animals, erosion, avalanches and unregulated tourism. In recent years there have been claims made to construct new facilities for sport and tourist activities in the mountain area.

Global air pollution and acid rain needs international political measures in order to resolve and alleviate the problem. In the battle to protect nature we must constantly be kept informed about the true situation and threat to nature.

The local threat can be solved by making legislative regulations that will aid the practical management of national parks and reserves. Of utmost importance is the cooperation between local administrations, citizens and forest owners.

Key-words: Biodiversity, the Carpathians, nature protection

The dynamics of biological diversity are influenced by time which represents one of the major factors determining the existence of ecosystems,as well as temperature, water and minerals.

The development of the present ecosystems in the postglacial period *(Holocene)* depended on significant changes in climate, on the distance of refuges in which organisms could survive unfavourable conditions of the glacial period, and on the nature and development of soils. Glacial periods in the Carpathians caused the dying out of the majority of higher plants. Warming in the post-glacial period,about 10,000 years ago, created conditions for back migration of individual species from their refuges (dominantly in southern Europe), where they were protected during the glacial periods.

Changes in temperature, rainfall and original conditions (in the post glacial-period) influenced the changes of the main woody plants. In the three periods, the main woods were changed from the beginning with *Pinus* and *Corylus* then with oak *Quercus*, *Ulmus* and in the mountainous sea levels with *Picea*, and finally with *Abies* and *Fagus*.

In the post-glacial period, the number of species increased untill the neolitic period (app. 1,000 years B.C.). After the neolitic revolution, human society began to influence more noticeably the development of natural ecosystems in the lower situated warmer altitudes of Central Europe. During the formation period of neolitic agriculture, the Carpathians were almost completely covered by forests. Only high-montane and alpine rocky localities were without forest cover - i.e. rocky walls, avalanche slopes, and narrow belts of some river banks (Ložek 1973).

Agricultural man tried to stop the spreading of forests into lowlands, and he helped to preserve non-forest areas with their richness of steppe organisms. Instead of natural forests on old Pleistocene " black soils ", reserve communities, which had been devastated by domestic animal grazing were formed.

However, the significant increase of human influence on nature appeared at the end of the Bronze Age (app. 1,250 - 700 years B.C.). At that time, due to water erosion, wide valley silts were formed. In addition, the metal sickle was developed, marking it possible to cut grass twice a year. This fact influenced the creation of rich plant communities in montane and lowland areas.

The limited degree of land exploration was the main reason for biologic diversity during the pre-industrial period. At the end of the middle Ages, the major devastation of forests began, due to non-regulated grazing and exploitative mining. In the Carpathians, the Valasi population started to form their settlements. They had metal instruments and fire to destroy forests from mountain combs and from the side of valleys as well. In the 18th century a sort of organized forest economy came into existence. This type of economy ensured forest renovation by planting monocultural of (mainly spruce) forests, so the biodiversity of the forest ecosystems decreased. The intensification of soil use in the New Age deepened the differentation of cultural ecosystems (Míchal 1992).

After the Industrial Revolution (app.200 years ago), the process of revitalisation of the environment began, together with the unification of economic uses of the environment. This led to the increased appreciation of biological diversity of ecosystems of the biosphere.

In Central Europe, the greatest ecological diversity, including the richness of species, was achieved in the first half of the 19th century (Fukarek 1979). It

became clear that only the continuity of traditional economic ways could maintain the richness of species in the pre-industrial cultural region.

A general trend in the development of biodiversity nowadays is the decrease of the variety and revitalization of vegetation types, where competitively weak species with specific requirements are replaced by widely adaptable species. In our century the functioning of ecosystems and the entire biosphere, has been influenced by two historical processes (Michal 1992):

- Elimitation of barriers. Isolated biogeographic regions have been assessed by transport networks and regular overseas trips since the 16th century.
- Rapid acceleration of the extinction of animals and plants of the highest degree from about 1950.

In comparison with the present catastrophe, characterized by reduced biodiversity, species richness has also been increased due to human activity. In human activity, there are and there were destructive and creative tendencies, but there is no doubt of the possibility of a positive influence on nature by man due to certain historical facts.

Biodiversity and stability of ecosystems

The key problem of present day ecology is the stability of ecosystems. The traditional vision of a simple positive correlation between diversity and stability is not considered as correct today. From the viewpoint of the ecosystem, the plant community forms a functional unit representing more than just a summary of individual components. The most important feature of this functional unit is the ability of autoregulation, i.e. the ability to regulate the numbers of individual species populations by excluding certain species, even if they are able to exist on the given ecotope. The natural plant community in that way more or less influences or limits representation of certain species and also limits influences of certain effects from outside.

The hypothesis of species saturation of the community, due to which the natural community increases its reserve of biomass to the maximum achievable limit of the given ecotope, has sense only in relation to the set of species inside the region. Biological diversity decreases with the harshness of the geographic situation, i.e. it is smaller at the poles and greater at the equator. The influence of the thermogradient is indicated by the fact, that normally, under the same conditions, biological diversity decreases with the altitude, i.e. in the lowlands it is greater in comparison with mountain regions. As an example, the number of vascular plant species in Europe according various authors as follows: Italy, Yugoslavia 4,750 - 4,900; Greece 3,950 - 4,100; Bulgaria, Romania 3,300 - 3,400; Germany, Switzerland 2,600 - 2,750; Bohemia and Moravia 1,910, Slovakia 2,250; Norway, Sweden 1,250 - 1,500; Finland 1,230 (Michal 1992).

At this time, the general opinion is that ecological stability may be achieved for great species diversity with specialized outlined requirements of cenosis members, and for small species diversity where the species requirements (ecologic valences) are wide and little outlined as well. Ecosystem diversity, according to present experience, is not considered to be a usable criterion for the evaluation of stability. Stability, the natural ability to absorb changes and to maintain the state of plants and animals in case of disruption, is responsible for diversity.

The nature of ecosystem stability is not expressed in its unchangable state, but in its ability to maintain a dynamic balance, i.e. to maintain itself by modification of inner processes without any relevant changes of structure, or to return itself to the starting point-balanced state, as soon as the activation of the stimulus which evokes this state terminates. Therefore, at the present time, we consider the protection of nature from the standpoint of enhancing ecosystem stability. Protection of biodiversity is a natural conseguence of ecosystem stability .

General physico-geographical and floristic description of the Carpathians

Every mountain system is characterized by a specific geographical situs, by specific geologic and geomorphologic conditions, and by climate. This is also valid for the Carpathians, which after the Alps are the second largest chain of mountains in Central Europe, and from the point of view of Central Europe, the most important.

The Carpathians spread from the Danube, in the northwest from Bratislava (Slovakia) to the Iron Gate of the Danube in the southeast. The length of the Carpathian chain is about 1,500 km. Its width in the northwestern region is 240 km and in the southeast it is 340 km. In the Ukrainian Carpathians, the width of the mountains is about 100-120 km. In the southern part, the Carpathians border the Danube lowlands. On the northern part, the Carpathians cross into Poland and the Ukraine (Polish and Ukrainian Carpathians) and then continue to the Polish and Ukrainian lowlands.

The Carpathians are cited as early as the 2nd century in manuscripts of the Roman writer, Claudius Ptolemaios. Favourable climatic conditions of the lowland Podunajska, Potiská, and Pridnestrovská enabled the formation of settlements in the Carpathians from the Middle Ages (Stojko *et al.* 1991).

The rivers of the Carpathian mountains lead to the Danube into the Black Sea, and to the Visla into the Baltic Sea. Climate and orographic structure is varied. The Carpathians are divided into the Western, Eastern, and Southern Carpathians.

Western Carpathians. The Western Carpathians spread over the territory of Bohemia, Slovakia, Poland and Hungary (Bukk and Tokay). The High Tatras are situated in the middle of the range (Slovakia and Poland), where the highest peak on the Slovak side is Gerlach at 2,655 m a.s.l. Here glacial activity is especially evident. The dominant mineral is granite but there are also small amounts of chalk, dolomite and sand. There are more than 100 glacial lakes in the High Tatras. In reference to plant life, there are plant species of arctic-alpine, e.g. *Salix herbacea*, *Oxyria digina*, *Saxifraga oppositifolia*, and others. Endemic plants of the High Tatras include *Primula halleri* ssp. *platyphylla*,*Oxytropis campestris* ssp *tatrae*, *Poa*

nobilis, Euphrasia exaristata and others.

East of the High Tatras are the Pieniny Mountains, which are built of chalk minerals. Some endemic plants of the Pieniny include *Taraxacum pieninicum, Centaurea triumfettii* ssp. *pieninica, Erysimum pieninicum, Dentranthema zawadskii* and others.

In the sand area of the Western Carpathians, the highest peak Babia Hora, reaches 1,725 m a.s.l. South of the High Tatras, stretch the Low Tatras; its highest peak is Ďumbier at 2,044 m a.s.l. A second range of mountains spreads out from the southern end of the High Tatras, the Veľká Fatra, whose highest peak is Ostredok at 1,592 m a.s.l. Here in the Veľká Fatra there exists the biggest source of *Taxus baccata* in Europe (about 160,000 trees on an area of 2,0000 ha). West of the High Tatras spread the mountains of the Malá Fatra whose highest peak, Veľký Fatranský Kriváň stand 1,709 m a.s.l. Another massif, Slovenské Rudohorie, stretches from the town of Zvolen to Košice, with a length of about 200 km. Important karst formations (caves, abysses) with special flora and fauna are to be found in Slovak Karst (the biggest chalk and karst territory in the Central Europe), in Muránska Planina and in Slovak Paradise. Valuable forms of volcanic relief are seen in Poľana, Vihorlat, Štiavnické vrchy (the richest area of ore mines in Central Europe), and on Vtáčnik.

Eastern Carpathians. The Eastern Carpathians stretch from the valley of Laborec and Oslava (Slovakia - Poland) to the mountain massif of Bucegi in Romania, where they terminate in the saddle Predeal (1,033 m) and in the valley of the Prahova river. The largest area of this part of the Carpathians is in the Ukraine. The length of the Ukrainian Carpathians is 280 km with a width of about 100 km. The total area is about 37,000 km. As for geology, the main minerals are sands; crystalic minerals are less represented (granite, ores, etc.), as well as chalk minerals (dolomits and chalks), and volcanites (andesites). The Eastern Carpathians are divided into several mountainous groups:

Beskydy, Gorgany, Pokutsko-Bukovinské Carpathians, Poloninsko-Černohorské Carpathians, and Vihorlatsko-Gutinské mountains. The highest Ukrainian peak is a sand peak, Hoverla (2,061 m a.s.l.). Flora in the Eastern Carpathians is represented by many Carpathian endemic species. For example, *Syringa josikaea, Antennaria carpatica, Astragalus krajinae, Narcissus angustifolius, Veronica baumgartenii, Poa deylii, Hedysarum hedisaroides*, and others. Forest species of relict character include *Pinus cembra, Larix polonica*, and *Betula pendula* and *Pinus sylvestris*. In the Eastern Carpathians there are the largest beech and beech-fir primeval forests in Central Europe. On the upper border of the forest, on the sand area, there is to be seen *Pinus mugo, Alnus viridis (Duschekia viridis), Juniperus sibirica, Rhododendron kotchii*, and others (Stojko *et al.* 1991).

During the Middle Ages, important trade routes were developed through the mountain passes. In 896, the Hungarian tribes crossed the Verecké pass and descended into the Danube lowlands.

Southern Carpathians. The Southern Carpathians are situated in Romania, between the Predeal pass and the Iron Gate on the Danube. They represent 1/3 of the Carpathians. The highest peaks are Moldoveanu (2,543 m a.s.l.) and Negoiu (2,544 m), which are composed of crystalic minerals. In the sub-mountane part, there are submeridional floristic elements to be found. For example *Carpinus orientalis, Ostrya carpinifolia*, and *Syringa josikaea*. The endemic species are as follows: *Centaurea retezatensis, Festuca bucegiensis, Poa nyaradiana, Sorbus borbasii, Sorbus dacica, Sorbus umbellata* ssp. *banatica*, and others.

The Transylvanian plate also belongs in the Carpathians (250-800 m) as well as the Western Romanian Mountains (the highest peak Bihar - 1,849 m a.s.l.) which are called Biharian Mountains.

The massif of the Carpathians is situated in the Atlantic continental climatic region, where western climatic systems are prevalent, as well as an anticyclonal pattern of weather; in some places a continental climate is more prevalent. The minimum temperature in the Carpathians occurs in January and the maximum in July. In the foothills of the Western Carpathians the medium July air temperature is 19°C and in the Southern Carpathians it is 22°C. In the southwestern part,for every 100 meters increase in altitude the temperature decreases by 0.81°C, in the southeastern part it decreases by 0.50°C. Annual rainfall is about 600-2,000 mm. The growth of woody plants in the Carpathians is affected by climate, soil, and organic conditions. Due to these factors, there are the following forest vegetation stages: -oak, *Fagus-Quercus* (300-500 m); oak-beech, *Quercus-Fagus* (400-600 m); beech, *Fagus* (550-750 m); fir-beech, *Abies-Fagus* (700-1,000 m); spruce-fir-beech, *Picea-Fagus-Abies* (950-1,300 m); spruce, *Picea* (1,250-1,550 m); subalpine, *Pinus mugo* ssp.*pumilio* (1,500-1,850 m); alpine-without woody plants (1,850-2,250 m); subnival - higher plants rare (over 2,250 m), more than 130 species of higher plants can be found here.

The geographic position of Central Europe and the favourable ecologic conditions created a rich variety of plants and animals in the post-glacial period, thus influencing biodiversity. In this area more then 2,700 species of higher (vascular) plants grow, which represents more then 1/4 of European flora. Of special importance is the Carpathian endemic species which form about 12 % of the total flora.

From the zoological point of view, the Carpathians also represent an important part of Europe. There are to be found many endemic and relict species of various systematic groups. Here would like to mention *Ursus arctos, Triturus alpestris, Triturus montandoni, Tetrao urogallus, Strix uralensis, Picoides leucotos, Aquila chrysaetos, Sorex alpinus, Chionomys nivalis, Rupicapra rupicapra* ssp. *tatrica*, and others.

Owing to one hundred years of breeding in the Carpathians, the upper climatic forest border is artificially lowered about 150-200 m. Today it reaches a level of 1,300-1,550 m. In the High Tatras, in places with a more continental climate, the upper forest border is formed by *Pinus cembra, Larix decidua, Picea abies*, and *Sorbus aucuparia*.

Protection of Carpathian nature and biodiversity

A special feature of nature protection is a differentiated and at the same time complex protection of the chosen ecosystem and species with their environment.

From the original conservative attitude, after the Second World War, the tendency changed to the protection of basic ecologic conditions and relations. In accordance with the world strategy for the protection of nature, the aim is focused on the protection of ecosystems in its total width of differentiation and characterisation for a given region, on the protection of a variety and diversity of nature, and on a permanent, maintainable and socially acceptable use of natural resources.

Due to the rules concerning the protection of nature in the countries where the Carpathians are situated, since the 1950s there has been a differentiation between the regional (territorial) protection of nature to big-area (national parks and protected landscapes) and small-area (natural reserves and natural sites), and also to exceptional natural phenomena (natural protected formations), and eventually to the protection of natural historical sites (protected monuments). A special proup was formed to protect parks and gardens. The protection of species is aimed at the protection of threatened, valuable and rare organisms (plants and animals), including their environment.

When chosing regions or areas for special protection, the criteria for selection are based on the nature and unigueness of the ecosystems (national parks) and on the relatively small, degree of human influence (reserves). Present biodiversity is reflected not only as the result of natural evolutionary processes, but also as the result of human activities in past centuries. The transition from conservative principles to modern care principles concerning original and secondary ecosystems has been made in present day Slovakia. Special plans have been implemented to care for national parks, chosen protected landscapes, special natural reserves, and plant and animal species (Vološčuk, 1991).

Protection of biodiversity is important in the context of the current negative human influence on nature and landscapes. For example, in the agricultural regions with so called " mass-area ways of economy " and in those of modified landscape (recultivation, drying, etc.), the protected places also play a role in refuges for natural biocoenoses and their species in the given region. Protection of biodiversity is ensured also by rivers, often meandering in wider valleys with dendroflora on the banks. Such rivers are often declared as protected nature formations or nature reserves.

Protection of nature in the Carpathians in the form of protected landscapes has a long tradition and goes as far back as the end of the 19th century. On Slovak territory, two forest reserves were created in 1895 - Dobročský primeval forest and Šalkovský les forest. The first national park in the South Carpathians, Retezat was created in 1935 in Romania. After World War II the network of national parks enlarged, as well as the network of reserves and protected landscapes. For example, in Slovakia all important mountainous ecosystems are protected. Nowadays, there are 5 national parks in Slovakia, 5 in Poland, 2 in Hungary, 2 national parks and 1 reserve-zapovednik in Ukrainae and 1 national park in Romania. In addition there also exist 14 protected landscapes and more than 200 reserves in Slovakia.

In order to improve cooperation and coordination of the protection of nature, due to the initiative of the Tatra National Park, the Association of the Carpathian National Parks and Reserves was created in 1990. This Association connects 15 Carpathian national parks. The Association has its Statutes and Working Plan. It organizes international seminars, conferences, and symposia. It also organizes the exchange of specialists and professional materials, and creates conditions for the protection of Carpathian biodiversity. These are the goals of the Association:

- Preparation of the Red List and Red Books of plants and animals of the national parks and reserves. This is to be followed by the preparation of the Red Book of plants and animals of the Carpathians.
- Reintroduction (returning species to the original localities) of animals, e.g. *Marmota marmota* from the High Tatras to the Ukrainian Carpathians (the first activity in 1991).
- Organization of professional expeditions to study the structure of the Ukrainian primeval forests, comparing results found there to the results obtained in other European regions. The goal of this activity is to elaborate the further use and exploration of the Carpathian forests.
- Unification of methods for monitoring nature in the national parks and reserves, with the goal of ensuring the stability and biodiversity of the protected Carpathian ecosystems.
- Support to strengthen and enlarge the network for the protected areas of various categories in order to protect biodiversity in the Carpathians.
- Mutual cooperation in exchanging experience concerning the problems of forest reprivatisation. This issue is very critical in the East European countries at this time.
- Mutual cooperation in exchanging experience for improving programs to maintain national parks and protecting endangered plant and animal species.
- Exchange of experience concerning management of national parks and protected areas, especially in the maintenance of forests, meadows, and watercourses.
- Support for international cooperation in the field of frontier national parks and the formation of a trilateral protected area on the borders of Poland, Slovakia and Ukrainae.
- Exchange of experience concerning cooperation with the inhabitants of national parks, in the case for ecologically acceptable tourism, or so called sustainable tourism and recreation.
- Creation of a Pro Carpathi Foundation with the aim to continually improve the equipment in order to fulfill all the tasks assigned by the Association, and to organize conferences, seminars, language courses and lecture courses for managers of national parks.