Taking stock of biodiversity

Nature's Vast Variety

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The term "biodiversity" has recently risen to the fore, not only in science but also in economics and politics. Maintaining biodiversity has become a universally recognized priority of environmental protection

Among the more highly-developed forms of life, no two specimens are identical, even if a species' numbers run into the billions (setting wholly special cases aside). This fact alone demonstrates that biodiversity is an especially important factor in the logic of life, the logic according to which living things have developed over nearly 4 billion years - from simple non-cellular forms up to very complex and extremely diverse organisms.

This diversity is evident in the estimated number of plant and animal species alive today. Scientists generally agree that this number is likely to be at least 10 million; others speak of 30 million, and still others of 100 million. Even 10 million seems vast when compared to the only 1.8 million species we have managed to identify in more than 250 years of modern classification work. The pace of discovery, however, is very uneven across both taxonomic groups and geographical space. Also uneven is

The mountain landscapes, like here in the Beskid Sądecki Mountains, encompass an extraordinary variety of natural and semi-natural biotopes

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the scope of species variety (one of the most frequently employed measures of biodiversity) within various taxonomic groups. As far as plants are concerned, the flowering plants are the best studied, but generally not the richest in terms of species - although the variety of certain flowering plant families is indeed impressive (such as the orchid family with some 40,000 species or the grass family with some 15,000). Geographical unevenness is also easy to see in terms of endemic species, the most unique elements of biodiversity, which are limited to small regions and which serve as excellent descriptions of the natural identity of specific biogeographical units. Certain areas are completely devoid of such endemic species due to their history, e.g. the "young" regions of Europe (including most of Poland's territory) where the Pleistocene continental ice-sheet eradicated the old Tertiary flora. The oldest such ice-sheet covered all the lowlands in Poland, with old endemic species only surviving in the Tatra Mountains. The diversity of flora also varies across climatic zones, polar regions being extremely poor and tropical zones being extremely rich.

In philosophy and economics

Saying that biodiversity is an emanation of life itself makes biodiversity a catchword for all the biological sciences - or even a paradigm for our whole way of thinking about biological life, on par with the theory of evolution. Since biodiversity is an emanation of life and the product of its evolution, and life itself in all its variety is today (formally at least) a specially cherished value, it therefore comes as no surprise that biodiversity has also become the measure of sustainable development. This is a notion cited in many international and national documents, including the Polish Constitution, as the only acceptable form of civilizational advance. A milestone in promoting awareness of how significant biodiversity is for our planet came with the International Convention on Biological Diversity signed at the Earth Summit in Rio de Janeiro (1992), and the subsequently emerging Global Strategy for Plant Conservation. Maintaining biodiversity, which is now under threat worldwide as a result of vast changes in the natural environment, has also become a universally recognized priority of environmental protection.

Biodiversity now not only draws together important fields of the natural sciences, it also offers a platform for their integration with such domains as economics or ethics. All of these fields, after all, strive to describe various aspects of the phenomenon of life. Biodiversity has also

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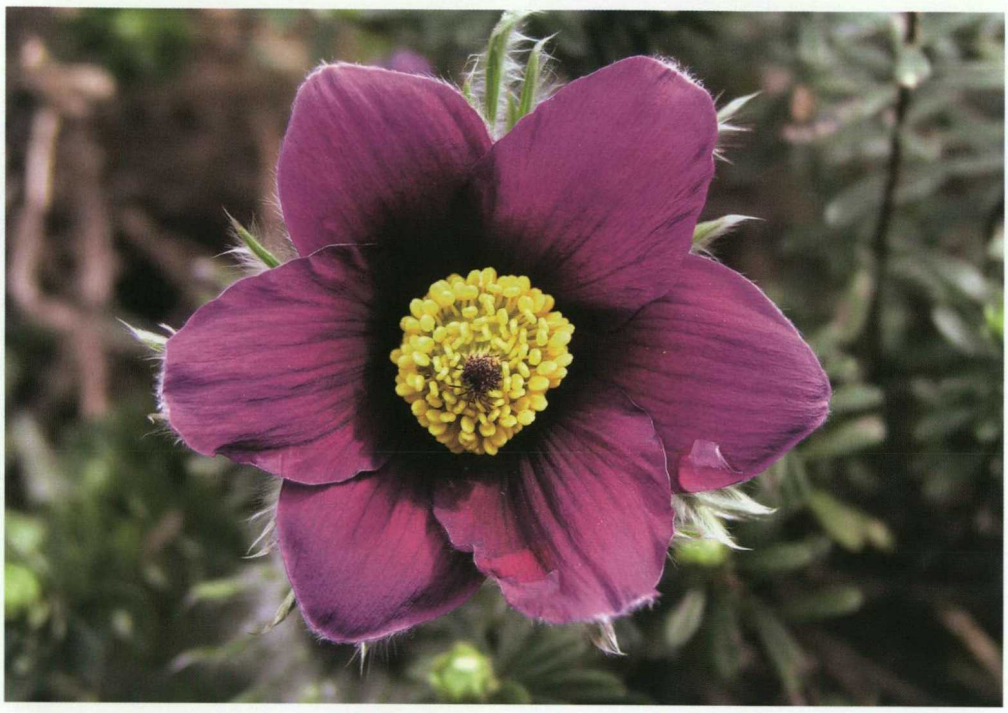
Two charming high mountain species: the Spring Gentian and the Mountain Houseleek. Their individuals and populations originating from various regions differ significantly at the genetic level



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Representatives of buttercup family, such as this protected Pasque-flower, are among the most beautiful flowers often planted in rock gardens

become a subject of wider reflection in such fields as ecophilosophy, ecotheology, and bioethics. Perceived as a harmonious balance in the composition of the natural landscape, biodiversity constitutes a contemplative realm and the best setting for human spiritual development. Economics, in turn, sees biodiversity a source of food, raw materials, and medications. And so, without studying, describing, and taking stock of biodiversity, it is hard to imagine any sort of spatial planning or environmental management at all, not to mention environmental protection.

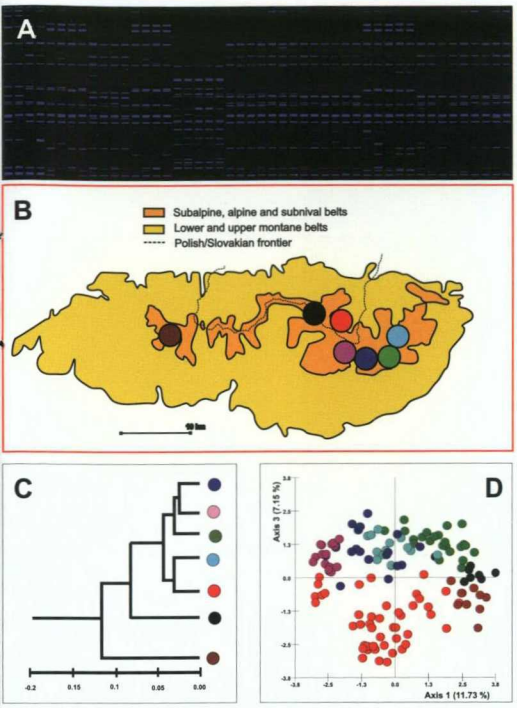
Different tiers

Biodiversity is manifest on various levels of how life is organized. The Convention on Biological Diversity lists the following tiers: the genetic, species, ecosystem and landscape levels. The species level is the most frequently considered, although the genetic (intraspecific) level is also of increasing interest and is now being investigated using state-of-the-art molecular techniques.

Moving on to the ecosystem level, which in our case represents the plant communities that are described as characteristic combinations of species, we observe a very clear dependency of biodiversity on the environment, similar to that seen on lower levels (as well as on the higher landscape level). There is no arbitrariness here: "choice" is always made by the environment, which determines the ultimate shape of biodiversity on each of its tiers of organization. Indeed, the environment is exceedingly "choosy." For example, if we ask how many distinct 50-species combinations can be generated from among the 2,500 flowering plant species growing in Poland, the outcome is 1.6×10^{105} (a number 25 order higher than the supposed number of atoms in the Universe). Yet no more than 800 such systems actually occur, a figure that is practically equal to zero if viewed from the theoretical standpoint. This is of course the consequence of the limited variety of habitats themselves, and strong variety in terms of the habitat requirements of the species themselves, rendering many of these combinations impossible.

Biodiversity center

In view of the significance nowadays attached to biodiversity, each country generally maintains numerous centers researching biological variation. Alongside the once-numerous regional institutions, countries now usually have central institutions specially set up to handle documen-



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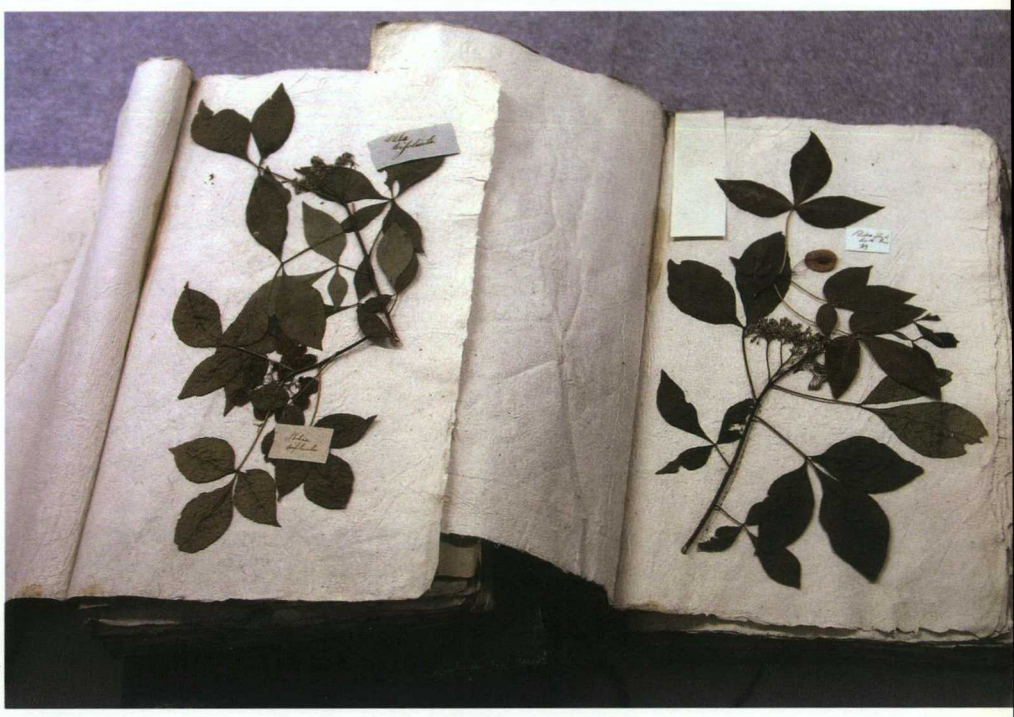

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An analysis of plant DNA diversity (A) helps researchers to identify differences and kinships (C and D) between populations inhabiting various regions – here, valleys in the Tatra Mountains (B)

tation and collection work and to promote biodiversity awareness within the given country. The Institute of Botany of the Polish Academy of Sciences is just such an institution in Poland for the realm of botany: the field of science that studies the traditionally understood "plant world" (which is now divided into at least two large kingdoms: plants and fungi). Headquartered in Kraków, the Institute maintains Poland's largest botanical collections, encompassing more than 1.6 million specimens from all the systematic groups of contemporary and fossil plants (flowering plants, ferns, mosses, liverworts, algae, lichens, slime molds, and fungi). The Institute's fossil collection is one of the five largest such collections in Europe, and its *iconotheca* of more than 400,000 items is one of only two of such size and quality in the world.

The Institute maintains central databases and publishes source materials on biodiversity in Poland: its "Flora" series covering various groups of plants and fungi throughout the country, now encompassing more than 70 volumes, plus its iconographies, bibliographies, distribution atlases, and large synthetic studies. The Institute likewise publishes *Acta Palaebotanica*, one of the world's most important journals addressing the biodiversity of fossil plants, as well as *Polish Botanical Journal* – the only Polish journal of international scope devoted entirely to the diversity of the plant world (carrying articles about more than 1,000 newly discovered species and genera over the past 15 years).

In print

Particularly worthy of note is the Institute's publication of an in-depth monograph based on isopollen maps, tracing the historical development of biodiversity in Poland's landscapes over the past 14,000 years, since the end of the last glacial period to the present day. The *Biodiversity of Poland* series, produced by the Institute over the past three years in connection with its 50th anniversary, brings together – for the first time – all the species of flowering plants, ferns, mosses, liverworts, algae, lichens, slime molds, and fungi ever found in Polish territory, giving Polish and Latin nomenclature. The Institute's published iconography of vascular plants has been recognized as one of the best of its kind in the world. Likewise noteworthy are other comprehensive works of national scope describing threats to floral biodiversity and its protection, authored or published by the Institute – such as the *Red List* and *Red Data Book* and the monu-

On its more than 10 kilometers of shelves, the Institute of Botany has gathered precious collections of plants and fungi – including some real treasures, like this herbarium from the late 17th and early 18th centuries

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The ecosystems in agricultural areas are a rich reservoir of biodiversity

mental *Atlas of Protected Plants*, presenting the current state of knowledge about the Polish flora species most threatened with extinction and methods of protecting them. The book on *Invasive Plants and Fungi in Poland*, now being prepared under the patronage of the Institute, will be an important work addressing one of the most important threats to biodiversity, covering both plants and fungi.

Some of the several dozen volumes the Institute produces annually are the outcome of cooperation with similar research institutes in the world and demonstrate its commitment to studying biodiversity on other continents, i.e. South America, Africa, Asia, various parts of Europe, and the polar regions. Good examples in recent years have been the large monographs describing Antarctic liverworts or the macrofungi of North Korea. More research of this sort has recently been pursued under large consortia or international networks; projects currently underway address such issues as the biodiversity of semi-natural ecosystems in Europe's pastoral and hayfield regions, as well as the biodiversity and florogenesis of our continent's mountain regions. The latter issues are being investigated via a wide range of methods and molecular techniques, at the Institute's excellently equipped laboratories. Such modern technology also makes it possible to analyze older herbarium materials, up until now often considered nothing more than "historical documents." This marks a true breakthrough in research and opens up vast potential and prospects for the future. ■

Further reading:

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