

THE BOTANICAL VAULT

For over half a century, the seed bank of the Polish Academy of Sciences (PAS) in Powsin has been protecting the diversity of the plant world – from various forms of rye to endangered, endemic, and declining species of flora native to Poland and Central Asia. It is an ark of survival for many taxa on the brink of extinction.

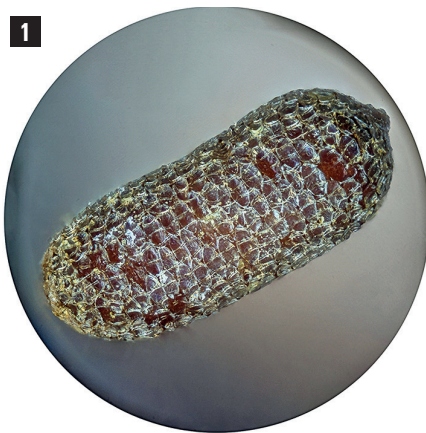


Photo 1

Seeds of *Hypericum elegans* Stephan ex Willd. (Elegant St. John's-wort), family *Hypericaceae*, a legally protected steppe relict specie. In Poland, it is an extremely rare species, known from only two sites on the Lublin Upland. It is listed as Endangered (EN) in the Polish Red Data Book of Plants and as Critically Endangered (CR) on the Red List of Plants and Fungi of Poland. It occurs in dry, sun-exposed, xerothermic grasslands and on slopes with infertile soil

Photo 2

Seeds of *Apium repens* (Jacq.) (creeping marshwort). The seed is oblong, with distinct ribs running along the fruit. This species is one of the rarest representatives of the Apiaceae family in Poland. It occurs only at a few sites, is strictly protected, and is listed as a species of high conservation status

Photo 3

Seeds of *Campanula sibirica* (L.) (Siberian bellflower). The seed is small, ellipsoidal, light brown, with a smooth surface. This species belongs to exceptionally rare components of Poland's flora. It occurs on isolated sites, is legally protected, and is listed on national Red Lists as threatened with extinction

Photo 4

Seeds of *Saxifraga hirculus* (L.) (marsh saxifrage), family *Saxifragaceae*. A relict species with a circumpolar distribution. In Poland, it was formerly recorded at over 200 sites and is currently highly threatened with extinction. In Poland, populations in the Rospuda Valley are particularly well known and represent some of the best-preserved stands of this plant in Central Europe

Photo 5

Spherical capsules of *Tozzia carpatica* Woloszczak seeds (Carpathian tocia, syn. *Tozzia alpina* subsp. *carpathica*) family *Orobanchaceae*. A mountain species with a restricted range occurring in the Carpathians and the Balkans. In Poland, it is known from approximately 20 sites in the Western Bieszczady Mountains and the Silesian Beskids. It is included in the European Red List of Vascular Plants and on the IUCN Red List. In Poland, it is classified as NT (Near Threatened). Its populations are threatened mainly by natural processes (stream freshets) as well as tourist pressure

Photo 6

Seeds of *Ligularia sibirica* (L.) Cass. (Siberian ligularia; syn. *Senecio sibiricus*, *Senecio ligularia*, *Cineraria sibirica*) family *Asteraceae*. A relict species that is strictly protected and classified as endangered (EN) in Poland; it is listed in the Polish Red Data Book of Plants and the Red List of Plants and Fungi of Poland. In Poland, it is known from only a few sites in the central and southern parts of the country. The species is associated with carbonate peat bogs, damp meadows, and stream banks. It is threatened primarily by habitat drainage and overgrowth, and formerly also by harvesting for ornamental purposes

Photo 7

Seeds of *Veratrum nigrum* L. (black false hellebore), family *Melanthiaceae*. The species is strictly protected in Poland and is classified as Critically Endangered (CR). In Poland, it occurs in isolated populations on the Lublin Upland and in the Roztocze region, where it is associated with xerothermic grasslands and light oak forests. It is a steppe relict, preserved

in Ukraine and Russia, and also known from a few locations in Central and Western Europe. The plant grows up to 180 cm tall and is distinguished by its large, parallel-veined leaves and long, burgundy-black inflorescences. The species is threatened by habitat loss resulting from forest stand shading and anthropogenic pressure. All parts of the black false hellebore are highly toxic

Photo 8

Seed of *Ostericum palustre* Bess. (syn. *Angelica palustris*; marsh angelica), family *Apiaceae*. A relict species under strict legal protection, classified as Vulnerable (VU) in the Polish Red Data Book of Plants and as Near Threatened (NT) on the National Red List. The species is threatened by the drainage of wetlands for agriculture, agricultural intensification, and meadow overgrowth resulting from land abandonment

Photo 9

Seeds of *Carlina onopordifolia* Basser (carline thistle, syn. *Carlina acanthifolia* ssp. *onopordifolia*) family *Asteraceae*. A strictly protected species, endemic to Poland and Ukraine, of high conservation concern in the EU. In Poland, it occurs at only about a dozen sites in the xerothermic grasslands of the Lesser Poland Upland and the Lublin-Lviv Upland. The species is threatened by grassland overgrowth and illegal harvesting of individuals. The seeds are achenes, which facilitates dispersal. *Carlina onopordifolia* is a symbol of the Polish Botanical Society, appearing on its seal and on the cover of the journal *Acta Societatis Botanicorum Poloniae*

Photo 10

Stipa joannis (syn. *Stipa pennata* subsp. *joannis*) is a grass species in the family *Poaceae*, naturally occurring in Central and Eastern Europe, including Poland. It is a steppe plant, characteristic of dry grasslands and xerothermic communities and is an important component of steppe and xerothermic habitats with high conservation value. In Poland, it is protected and considered rare due to land use changes and plant succession

Photo 11

A seedling of *Agrimonia pilosa* Ledeb. (hairy agrimony) obtained from seed germination tests. This test is part of the evaluation of the viability of seed material intended for storage in the seed bank. Germination tests allow determination of the seeds' capacity to develop, providing a basis for assessing the quality and value of the accumulated resources

Photo 12

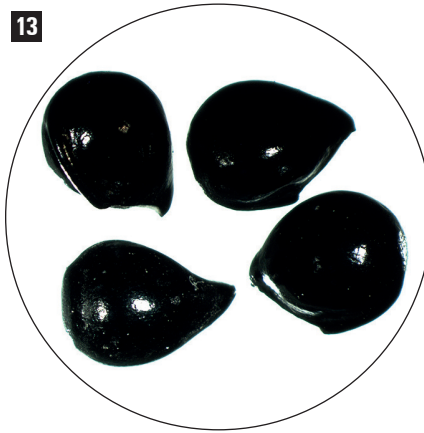
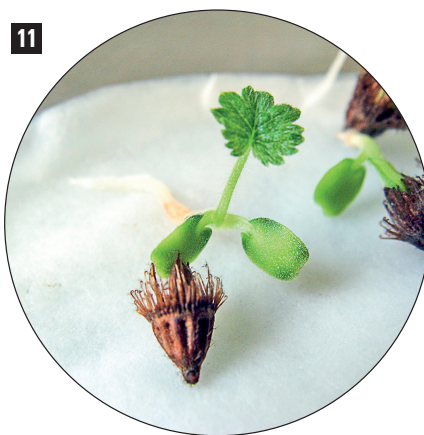
Ranunculus arvensis (L.), an annual herbaceous plant of the family *Ranunculaceae*, naturally occurring naturally in Europe, West Asia, and North Africa. It is found mainly in croplands and along field margins, roadsides, and ruderal sites. The species prefers clayey, calcium-rich soils. Formerly a common field weed, it is now rare due to agricultural intensification and herbicides use. In Poland, it is under partial protection as a species threatened with extinction

Photo 13

Dictamnus albus (L.) (dittany; colloquially called burning bush) is a perennial herbaceous plant of the family *Rutaceae*, naturally occurring in Europe, Asia, and the Middle East. In Poland, it is a rare species under legal protection. The plant exhibits explosive seed capsules: under dry conditions, the fruits burst, dispersing the seeds up to several meters away through autochory

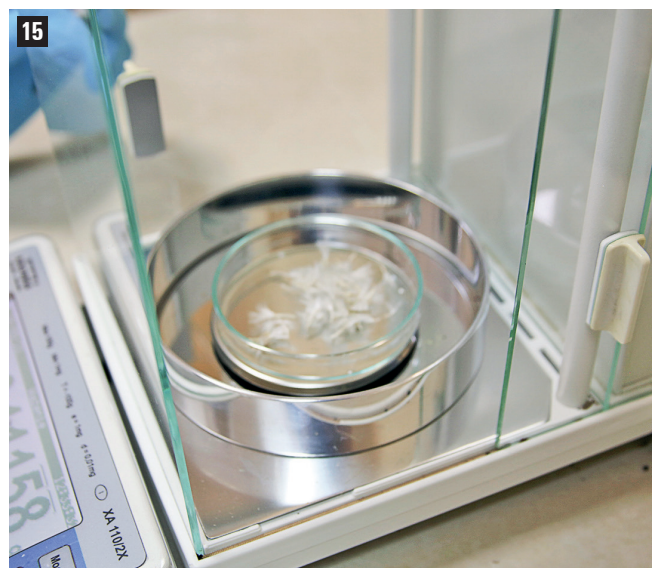


sugerują "Vulnerable" i "Near Threatened"





Fot. 14
Preparation of seeds for storage in the seed bank – the process of cleaning and screening seed material prior to deposition in cryogenic conditions



Fot. 15
Samples, after purification, are precisely weighed on an analytical balance to determine their mass and prepare them for further processing, such as drying, packaging, and long-term storage under controlled conditions



Fot. 16
Cryogenic storage of seeds in the seed bank. Seed samples, placed in cryogenic containers and deposited in cassettes stored in liquid nitrogen (-196°C), are conserved using a long-term method that maintains high viability and genetic integrity for decades, minimizing the rate of aging processes



Seed banks play a key role in the conservation of biodiversity. There are about 1,800 of them worldwide, and they constitute a kind of plant survival ark in which seeds of cultivated and wild plants, as well as protected or threatened species, are stored. In Poland, a pioneering role in this field has been played by the seed bank at the PAS Botanical Garden – Center for Biological Diversity Conservation in Powsin, founded by Prof. Jerzy Puchalski.

Although the beginnings of this facility were linked to research on the genetics and storage of cultivated varieties and wild forms of rye (*Secale* spp.), as early as the 1980s, an idea emerged to create a separate seed bank for protected and threatened plants in response to the alarming decline of numerous populations of native Polish flora. This bank was based on innovative cryopreservation methods, that is, the storage of seeds in liquid nitrogen. This technique – which consists of decelerating the biological aging processes of seeds at ultra-low temperatures (ranging from -160 to -196°C) – allows the long-term conservation of plant viability.

Seed conservation is a complex process, ranging from monitoring natural populations during flowering, through selective seed collection, to their physiological preparation for ultra-low temperatures, viability assessment, and germination tests. For seeds of many species, it is necessary to break dormancy beforehand, often using specialized methods such as stratification or scarification.

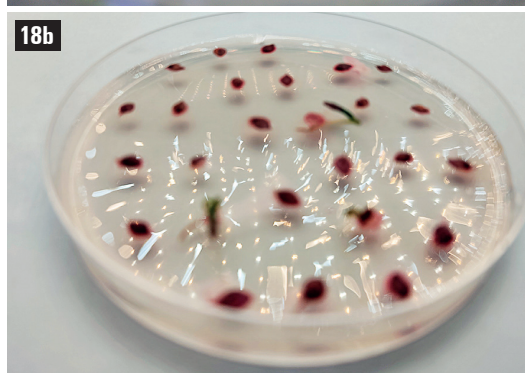
Over more than three decades of operation, the seed bank has accumulated over 1,000 samples representing 315 taxa of Polish flora, including several dozen species listed on the Red List and protected under the Bern Convention and the Habitats Directive. The bank has also secured approximately 150 taxa of Central Asian flora, a region considered



17



18a



18b

a global biodiversity hotspot. This term refers to an area characterized by exceptional species richness, including many endemic and rare taxa, and simultaneously particularly vulnerable to the loss of natural resources.

Unlike many European institutions, the PAS seed bank does not limit itself to passive seed storage. Its activities include active monitoring of natural populations, selective seed collection while maintaining genetic representativeness, viability testing, optimization of germination conditions, and research on seed resistance to extreme conditions. A tangible result of applying the acquired knowledge and stored seed material can be seen in the reintroduction of populations of Polish species of high conservation value to their natural sites, such as *Ligularia sibirica* in the Upper Pilica Valley (in cooperation with The Nature and Human Foundation) and *Adenophora liliifolia* in Kampinos National Park. Additionally, since 2023 the unit has operated a DNA bank, storing genomic DNA of threatened plant species at -80°C , which provides significant support for genotyping and taxonomic identification projects, restoration programs, and sequence databases.

In an era of global climate change, habitat pressure, and the decline of natural populations, seed banks and gene banks are becoming the last line of defense against the irreversible loss of species. The seed bank in Powsin functions not only as a repository of genetic resources but also as a place that demonstrates that nature, if properly protected, has a chance to survive and be restored. It is a place where science meets concern for the future of biodiversity and future generations.

ANNA RUCIŃSKA, PHD
PROF. ARKADIUSZ NOWAK
 PAS BOTANICAL GARDEN IN POWSIN

Fot. 17

Preparation of plant DNA samples secured in the seed bank for storage at ultra-low temperatures. The isolated genetic material is placed in specialized tubes and prepared for long-term storage at temperature of -80°C , which preserves its integrity

Fot. 18

Testing the viability of seeds under controlled conditions. Seed samples are subjected to germination tests to assess their capacity to develop into seedlings. The results form the basis for determining the quality of seed material collected in the seed bank and its suitability for long-term storage

Fot. 19

Cryotanks and freezers for long-term seed storage in the seed bank. Seed material is hermetically protected in aluminum bags or cryovials and stored at low temperatures (-20°C) or in liquid nitrogen and its vapors (-160°C to -196°C), inhibiting metabolic processes and preserving high seed viability for decades



19a



19b