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The role of collection missions in gathering plant genetic resources material

Rola ekspedycji w gromadzeniu zasobów genowych

Summary. In the last 40 years, the National Center for Plant Genetic Resources (KCRZG) in Radzików has organized 67 collecting missions across the country. The main task was to secure the still existing plant genetic richness in agricultural ecosystems. Mission dates were set according to the time of seed maturation and the harvesting strategy adjusted to the collected group of plants. The collected genotypes included seeds, bulbs, grafts etc. The samples were collected mainly from local farmers or gathered directly from the field. During the collecting missions, one could clearly observe the progressive ”genetic erosion” of crop plants, visible through the disappearance of the tradition of growing local varieties, especially cereals. It is caused by the cultivation of modern varieties or the cessation of the cultivation of traditional crop plants. In the period from 1984 to 2017, a total of approximately 4700 samples were collected during 67 collection missions organized by KCRZG – Radzików. In the 90s, cereals prevailed. In the second period of the collection missions, from 1994 to 2005, vegetable and spice plants did instead. In the third period, between 2006 and 2017, ornamental plants, medicinal plants, wild plants, grasses, plants accompanying crops were the most plentiful groups of plants. The decreasing number of old cultivars and landraces in the last 40 years indicates the need for further collection of genetic resources through collecting missions and monitoring of genetic erosion of crops in Poland.

Key words: collecting missions, plant genetic resources, genetic erosion, landraces

INTRODUCTION

The need for preservation and research of local crops was discussed at the International Congress of Agricultural and Forestry in Vienna in 1890, when botanists and

breeders throughout Europe began to research in this direction [Agnolleti et al. 2009]. In 1922–1940, Nikolai and Vavilov with their team conducted numerous collecting missions in Russia and in various parts of the world, covering more than 50 countries in Asia, Africa, Central and South America, and collecting about 50,000 different plant genetic resources. Vavilov's work upon the origin and distribution of cultivated plant species has become the basis for many studies on the genetic resources of plants that are still being made to this day [IPGRI et al. 1995, Damania 2008]. The concern to preserve the abundance of nature with all its elements took the form of the Convention on Biological Diversity signed in 1992 [Podyma and Puchalski 2013]. The Convention obliges its parties to protect nature at all its levels (genetic, species and ecosystem), treating natural systems with semi-natural or anthropogenic systems equally, which means that we should protect both wild and cultivated species [Dostatny et al. 2014]. National Center for Plant Genetic Resources (KCRZG), wishing to contribute to minimizing the loss of genetic diversity of crop plants, implements trips aimed at the collecting the still existing gene resources of plants in our country. These trips have been held regularly since 1971 [Nowosielska and Podyma 1988, Dostatny and Nowosielska 2006].

The collection takes place mainly among farmers. In Poland, more than half of farms (about 54%) are the smallest ones, i.e. with an area of agricultural land up to 5 ha [GUS 2017], which slows down the disappearance of crop diversity and promotes preservation of old varieties. However, the only effective way to protect disappearing old varieties from the cultivation is their harvest during the collecting missions and their depositing in gene banks [Dostatny and Hodun 2010]. Former varieties and local populations play particularly important role in agricultural ecosystems. They are generally not susceptible to diseases, and competitive against weeds [Feledyn-Szewczyk 2011]; they are characterized by lower soil requirements, and are also adapted to cultivation in extensive, ecological and local conditions. They constitute a valuable genetic pool, which can be used as a starting material for breeding new varieties with better quality traits.

Old varieties of agricultural plants are generally better able to withstand stressful conditions, such as the period of drought, which allows harvesting even in unfavorable conditions. At the same time, preservation of old varieties means that traditional food processing methods still exist and are popular [Dostatny et al. 2014].

During the collecting mission, plants accompanying crops as well as wild related species (crop wild relatives = CWR) are also collected. Crop wild relatives are closely related to crop species, which can be a source of valuable genes in breeding new crop varieties as an excellent source of adaptive traits and resistance to disease [Fielder et al. 2015, Taylor et al. 2017]. The history of collection of plant genetic resources in Poland, their wealth, collection, valorization and protection are the purpose of this paper.

MATERIAL AND METHODS

For over 40 years, KCRZG has been organizing the collecting mission trips to acquire new objects for collections. Trips took place mainly in Poland and were conducted jointly with the curators of particular plant groups. The basic task of trips is to secure the still existing genetic richness in rural areas. Local, old and regional varieties were collected, which did not appear in the COBORU national register. Departure dates were set

according to the time of seed maturation, and the harvest strategy was adapted to the plant group. During the trips, seeds, bulbs, and grafts were collected, interviews with farmers were conducted. Information about the samples received has been collected, e.g. how many years a given variety is grown, how it is used and where it comes from. The seeds were obtained mainly from warehouses of farmers or harvested in the field. During the collection of objects, they were given the mission numbers – standard codes were used, consisting of a three-letter state code (JSO 3166 country codes), in which the trip took place. The code consists of the first three letters of the region, two digits defining the year, and after dash – the subsequent sample number, e.g. POLPOM07-X. Information about the place of harvest was saved. In addition to the name of the country and region, the name of the village, farmer's data, geographical coordinates, altitude above the sea level were also noted. In the case of wild-type harvest, the position was described [Alercia et al. 2015]. Objects of plant species accompanying the crops and wild related crop species were also collected. Wild species have different periods of ripeness, therefore it is not possible to collect a large number of samples during a given mission. Therefore, the best form of protection for these groups of plants is to conduct *in situ* protection. In connection with this task, monitoring was carried out in various regions of Poland to observe the occurrence of these dynamic groups of plants and the assessment of genetic erosion. After returning from the collecting mission, all information was entered into the EGISET database at the National Center for Plant Genetic Resources of the IHAR in Radzików, and samples along with their passport data were forwarded to the storage room, which then sent them to individual curators, who deal with the identification, valorization and reproduction of a given plant group. Names of fruit tree varieties were in general determined after the end of the trip based on previously collected fruit samples. To identify the acquired varieties, mainly specialized literature was used, among others, the old pomology handbooks [Lauche 1882–1883, Zaliwski and Rejman 1952]. Collected objects were assigned to five groups: cereals, other agricultural plants, vegetables and spice plants, fruit trees, as well as ornamental, medicinal, wild plants, grasses, and plants accompanying the crops, hereinafter referred to as accompanying plants.

RESULTS

The subject of the study are results from the collection harvest during the 67th collecting mission in 1984–2017 carried out in 16 provinces of Poland.

In order to process data acquired during the missions, they were divided into three periods (1984–1986, 1994–2005, 2006–2017). The most frequently penetrated were areas in the eastern and south-eastern parts of the country. These areas are characterized by greater fragmentation of farms, traditional way of farming and greater number of organic farms, which results in a greater chance of finding local varieties (Fig. 1). In total, 4742 objects belonging to 5 groups of plants were collected during all trips.

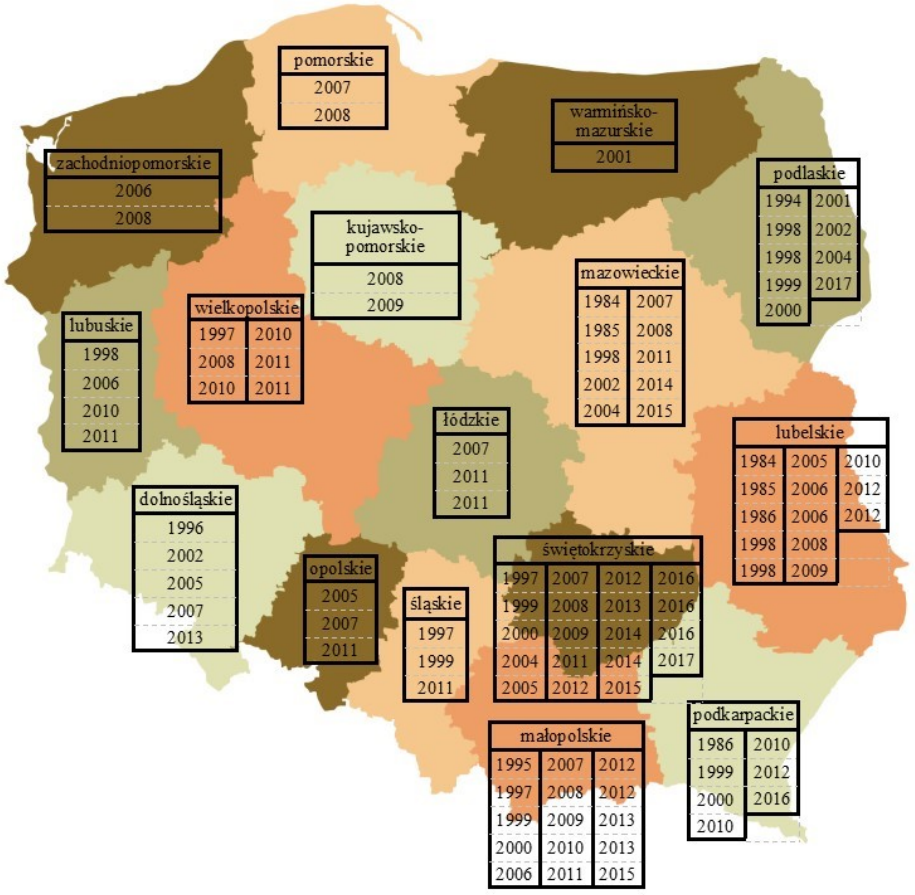

Fig. 1. Collecting missions carried out in individual provinces in 1986–2017

In all the years of harvesting, i.e. between 1984 and 2017, objects from the group of vegetables and spices (36.1%) dominated among the objects acquired. Most objects were collected in the podlaskie (560) and lubelskie (465) provinces. The second most numerous group (30.7%) consisted of ornamental, medicinal, wild plants, grasses and accompanying plants. Most objects from this group were collected in the following provinces: małopolskie (576), świãtokrzyskie (322), lubelskie (179). Relatively numerous to the remaining groups were fruit tree harvests (22.2%); the largest number of objects were collected in the following provinces: podkarpackie (163), dolnośląskie (157), świętokrzyskie (136), małopolskie (132), podlaskie (127), and wielkopolskie (104). Cereals accounted for only 6.5%, while the largest number of objects were collected in the following provinces: lubelskie (91), podkarpackie (58), świętokrzyskie (54) and podlaskie (41). The least numerous group in terms of the collection in the period 1984–2017 were other agricultural crops, which accounted for 4.5% of the harvest, the most were collected in the following provinces: podlaskie (76) and lubelskie (64) (Fig. 2, 3).

During the harvest period 1984–1986, during three trips, among 202 objects collected (Tab. 1) in individual groups of plants, the most numerous were cereals (40.6%) and vegetables and spices (31.2%). In the group of cereals, *Triticum aestivum* L. (34 objects) and *Secale cereale* L. (20) were collected the most frequently, while in the group of vegetables and spice plants, the most numerous plants of *Phaseolus* L. genus (39) were collected. Group of other agricultural and fodder plants accounted for 15.8%, while ornamental, wild, medicinal plants, grasses and accompanying plants – 12.4%. In the period described, no object of fruit trees was collected, because during this period they were not included in the harvest range during the collecting mission.

In the period 1994–2005, 2636 objects were collected (Tab. 1). The largest group was made up of vegetable and spicing plants (45.6%), the largest in this group were objects of *Phaseolus* L. (329) and *Allium* L. genera (193, including both onions and garlic). In the second, the most numerous (23.1%) group of ornamental, wild fodder plants, grasses, medicinal and accompanying plants, *Trifolium* L. (59) were collected. The third group in terms of number in the collection were fruit trees (19.8%), the most numerous objects of *Malus* L. (272), *Pyrus* L. (50) and *Prunus* L. (41) genera were collected. The group of plants including other agricultural crops was characterized by much smaller share (6.3%), there were most often the objects *Camelina sativa* L. (13), *Linum usitatissimum* L. (8) and *Lens culinaris* Medik. (7). The least numerous group were cereals (5.2%), in which the following species dominated: *Secale cereale* L. (25), *Avena sativa* L. (22), *Zea mays* L. (17), and *Triticum aestivum* L. (13).

In 2006–2007, 1904 objects were collected (Tab. 1). The period was characterized by the most numerous collection of ornamental, wild, medicinal, and accompanying plants (43.1%). They were mainly plants of genera: *Trifolium* L. (36), *Festuca* L. (27), *Dactylis* L. (13), *Agrostemma* L. (12), *Valerianella* Mill. (12). The second group in terms of the number of objects collected during the mission were fruit trees (27.9%), among which one genus dominated, *Malus* L. (334). Among the group of vegetables and spice plants (23.5%), the following types were collected the most: *Phaseolus* L. (130), *Cucurbita* L. (77), *Allium* L. (30). The share of cereals was much smaller (4.6%), and the crops included mainly such species as: *Secale cereale* L. (39), *Avena strigosa* Schreb. (14), *Zea mays* L. (13). Plants from the group of other agricultural and fodder plants accounted for only 0.8%.

Data presented below take into account the number of objects collected in individual provinces. Lubelskie province – 849 objects were collected. The group of vegetables and spice plants (465) was the most numerous. There were plants of the genus *Phaseolus* L. (156), *Cucurbita* L. (50) and a group of ornamental, wild, grasses, medicinal and accompanying plants (179); this group was characterized by large diversity of species.

Dolnośląskie province – 256 objects were collected; the most numerous group consisted of fruit trees (157), in which the most numerous samples of *Malus* L. (78) and a group of vegetables and spicing plants (75) were collected, most of which were of the genus *Phaseolus* L. (33).

Podkarpackie province – 409 objects were collected, mainly from the group of fruit tree plants (163), in which genus *Malus* L. (96) dominated, and from the group of vegetables and spicing plants (144) such as *Phaseolus* L. (54), *Allium* L. (14).

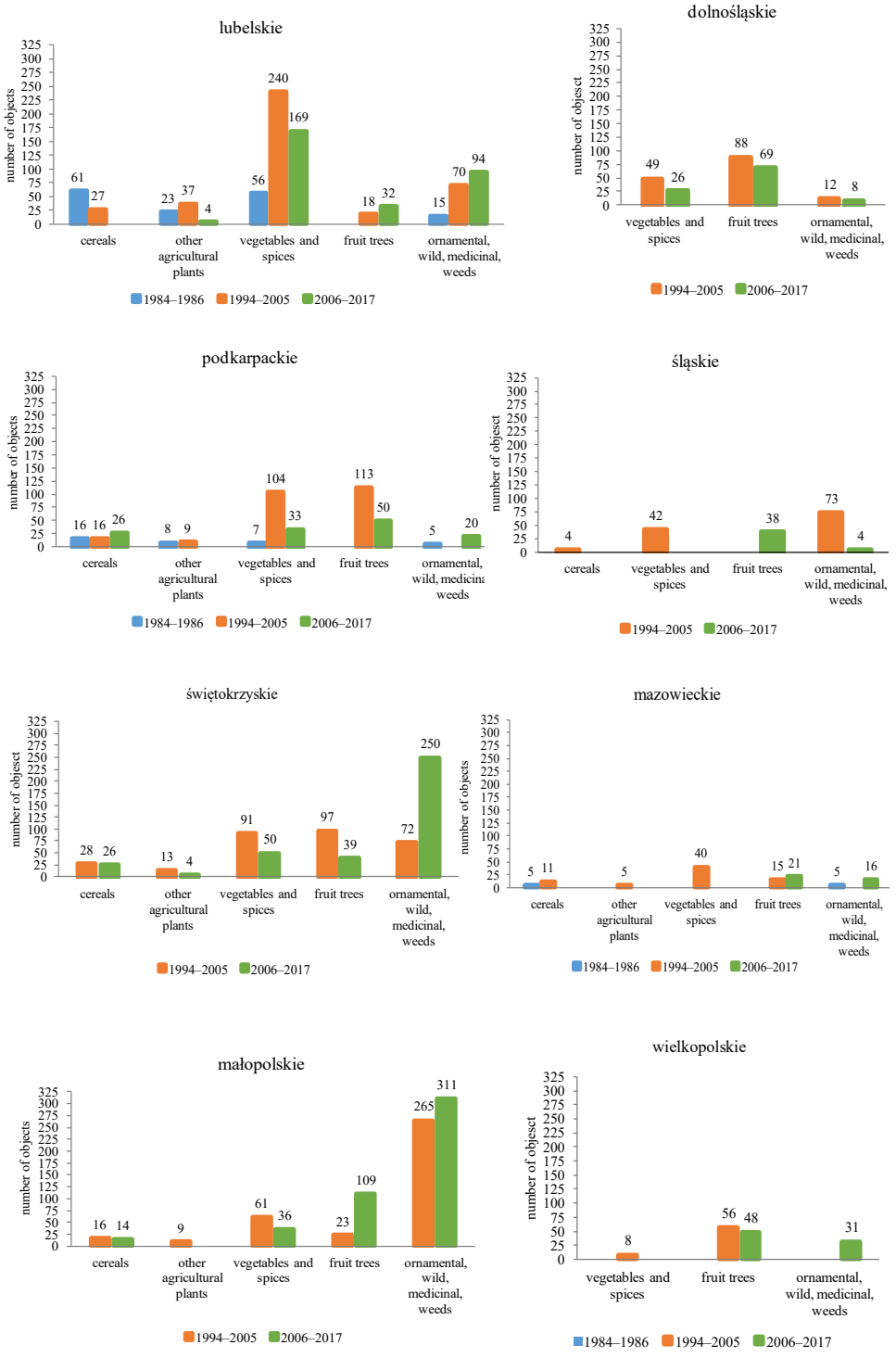

Fig. 2. The number of objects collected in individual provinces in three periods

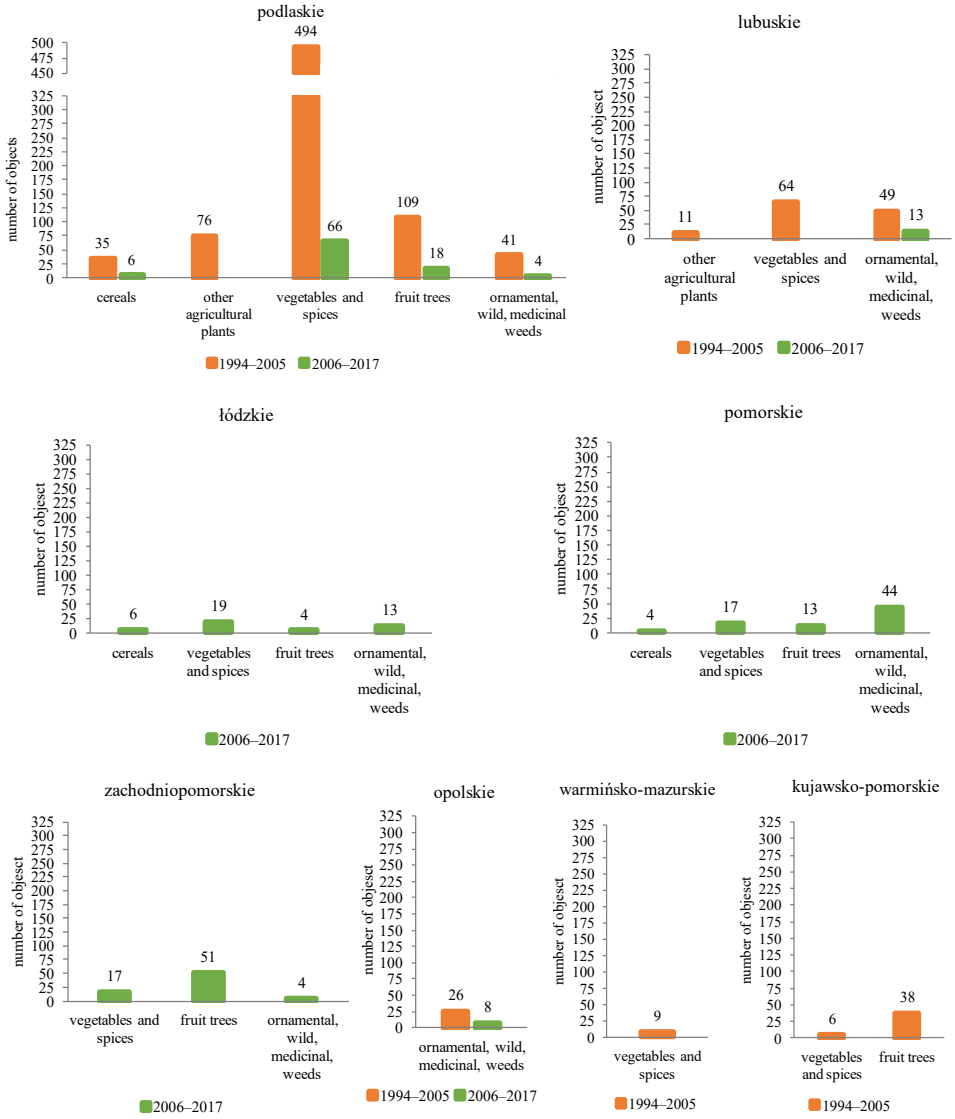

Fig. 3. Number of objects collected in individual provinces in three periods

Śląskie province – 166 objects were collected, mainly from ornamental, wild, medicinal and weed groups (77), most from the *Trifolium* L. genus (10), from the group of vegetables and spicing plants (44), mainly *Phaseolus* L. (19), *Allium* L. (11), and from the group of fruit trees (39) – *Malus* L. (34).

Świętokrzyskie province – 670 objects were collected, mainly from the group of ornamental, wild, grasses, medicinal plants and weeds (322), such as *Agrostemma* L. (12), *Valerianella* Mill. (10), from the group of vegetables and spice plants (141): all types of

Phaseolus L. (39), *Allium* L. (20), *Cucurbita* L. (9), and fruit trees (136) were mainly collected from the genus *Malus* L. (51), *Prunus* L. (26).

Mazowieckie province – 120 objects were collected, mainly from the group of vegetables and spicing plants (41), such as *Allium* L. (12), *Phaseolus* L. (10) and from the group of fruit trees (36) from genera *Malus* L. (32) and *Pyrus* L. (7).

Małopolskie province – 845 objects were collected, mainly from the group of ornamental, wild, medicinal and accompanying plants (576), mainly of the genera *Trifolium* L. (75), *Festuca* L. (27), and from the group of fruit trees (132) – mainly genus *Malus* L. (71).

Wielkopolskie province – 148 objects were collected, most of the group of fruit trees (104) – mainly *Malus* L. (62) and *Prunus* L. (9).

Podlaskie province – 850 objects were collected, mainly from the group of vegetables and spice plants (850), such as *Phaseolus* L. (121), *Allium* L. (120), *Cucumis* L. (24), *Lycopersicon* Mill. (19) and from the group of fruit trees (127) – above all the genus *Malus* L. (82) and *Pyrus* L. (22).

Lubuskie province – 141 objects were collected mainly from the group of vegetables and spicing plants (64): most of genus *Phaseolus* L. (25) and from the group of ornamental, wild, grass, medicinal and accompanying plants (62) – this group was characterized by a large diversity of species.

Łódzkie province – 42 objects were collected, mainly from the group of vegetables and spicing plants (19) – most of genus *Phaseolus* L. (7) and from the group of ornamental, wild, grass, medicinal and accompanying plants (13) – mainly *Trifolium* L. (5).

Pomorskie province – 78 objects were collected, mainly from the group of ornamental, wild, grasses, medicinal plants and weeds (44).

Zachodniopomorskie province – 74 objects were collected, mainly fruit trees (51) *Malus* L. (29), *Pyrus* L. (14).

Warmińsko-mazurskie province – 12 objects were collected, the most from the group of vegetables and spice plants. It should be noted that the collections did not cover the area of the entire province.

Opolskie province – 38 objects were collected; the most from the group of grasses, ornamental, wild, medicinal and accompanying plants (34).

Kujawsko-pomorskie province – 44 objects were collected – the most numerous group of fruit trees (38), mainly *Malus* L. (33).

Among cereals, the largest number of collected objects was represented by: *Triticum aestivum* L., *Secale cereale* L., *Avena sativa* L. In earlier periods, the old varieties could be found in the fields as single-variety crops. In recent years, old varieties of *Triticum aestivum* L. can still be found in mixtures with *Hordeum vulgare* L. or *Avena sativa* L. This material is used by farmers as a good animal feed, and "without additional money, they keep their local seeding material". Other local varieties of cereals, which can also be found are varieties of *Secale cereale* L. These are tall ones, that compete well with weeds and cannot be bought in seed centers. In recent years, the population varieties of *Zea mays* L. have also been harvested to protect the remains of the local genetic resource, but their status requires verification. The oldest varieties of it can be found practically only in the gene bank.

Tab. 1. List of collected objects in three collecting mission periods

Collecting period	Number of collected objects	Utility group									
		cereals		other agricultural plants		vegetable and spice plants		fruit trees		ornamental, wild, medicinal, accompanying plants, grasses	
		number	%	number	%	number	%	number	%	number	%
1984–1986	202	82	40.6	32	15.8	63	31.2	0	0.0	25	12.4
1994–2005	2636	138	5.2	166	6.3	1202	45.6	521	19.8	609	23.1
2006–2017	1904	88	4.6	16	0.8	448	23.5	532	27.9	820	43.1

The share of collected genotypes of old or local varieties of other agricultural plants, such as *Linum usitatissimum* L., *Pisum sativum* L. Medik., *Camelina sativa* L., *Brassica napus* L., was very small – below 5%.

Genetic resources of local vegetable and spice cultivars can still be found in some regions of Poland, first of all they are annual vegetables that are easier to reproduce and grow, as well as plants from the *Allium* L. genus. From interviews with farmers, it appears that local varieties of *Allium* L. are more resistant to diseases and more aromatic, therefore they are still often used. Old varieties of fruit trees can be found as individual objects in mountainous and hilly regions, where it is more difficult to establish modern orchards or in old backyard orchards.

DISCUSSION

Over the period of forty years, the area of searching for plant genetic resources has been increased, which was the result of both increasing the range of sought-after plant groups and limited possibilities of finding the old or local species and varieties of useful plants [Dostatny et al. 2014]. Collection results during the collecting missions pointed to the progressive genetic erosion of crops, as well as the disappearance of whole agrocenoses along with the accompanying species, which required to intensify the work and broaden their scope.

From 1984 to 2017, during 67 trips organized by KCRZG – Radzików, a total of 4742 objects were collected, including about 300 objects of old and local varieties of cereals. However, during two years, i.e. 1984–1985, a total of 150 objects were collected during three trips and almost half of them were old and/or local cereal varieties. The share of acquired grain plant genotypes in all previous trips to around the mid-nineties, always accounted for about 50% of the collected materials [Kulpa and Górski 1986, Kulpa and Jastrzębski 1986]. However, the share of cereals in the collected material after 1995 was always below 6% [Dostatny et al. 2014].

A noticeable decrease in the share of old cereal varieties in the collection, especially *Triticum aestivum* L. species, is caused, among others, by the use of seed material of new varieties that are more efficient and easier to grow, especially with the use of plant protection products. A large share of *Secale cereale* L., primarily in the third period of trips, results from the orientation of the collection to this species.

The collecting missions carried out show that vegetables and spices (36%) predominated among the objects acquired. This is due to the presence of a large number of farms, that only have home gardens, where mainly vegetable crops for own use are grown as well as a great diversity of local varieties appearing. However, results of this work show that the share of vegetables in the number of objects acquired is also decreasing. Old varieties of the genus *Allium* L. (onions or garlic) or annual plants can be also found. Local varieties of biennial species have almost completely disappeared. The main reason for this is the ever easier access and attractive valuable seeds of vegetable plants, as well as a giving up the tradition of acquiring and preserving the own collections [Dostatny et al. 2014].

In the second collection period, greater number of acquired objects of local genetic resources can be noticed. During the trips, the progressive genetic erosion of local varie-

ties of cultivated plants was clearly visible, which is caused mainly by the cultivation of modern varieties or the cessation of growing certain marginal species of utility plants. The trips were conducted mainly in the eastern and south-eastern part of the country, and this is related to greater fragmentation of farms, their traditional way of management and greater number of organic farms [Walenia 2009, Bożek and Bogocz 2012, Pałka-Łebek 2017].

Results presented by Czembor et al. [2017] do not indicate the rapid disappearance of local crop varieties, which was underlined by the authors of the present publication. The applied approach consisting in a joint discussion of crops and accompanying plants collection disregards the fact of their declining share in the periods in question.

In the last period of the collecting missions, the collections were focused on a group of wild and meadow plants, crops accompanying plants and/or old varieties of fruit trees and areas not explored so far, such as the north-western, western and south-western parts of Poland were penetrated in order to search for the aforementioned plant groups. The reason for searching for new groups of plants is the lack of old cereal varieties in Poland, a small diversification of crops and fewer local varieties of vegetable plants. During the collection of object diaspora in this type of habitat, the position was precisely described giving all or the most common plants occurring at the place of acquiring, and if necessary, the assessment of the population status of collected species was carried out.

A detailed description of individual collecting missions within the abovementioned period has been presented in several works such as: Dostatny and Nowosielska [2006] that described trips carried out in the mazowieckie and świętokrzyskie provinces; Dostatny and Hodun [2008], where trips carried out in 2005–2008 in ten provinces were described; Dostatny and Dziubiak [2010], a work presenting the results of trips in the north-western part of Poland, and Dostatny et al. [2014], where the results of collections in nine provinces for period between 2009 and 2011 were presented.

SUMMARY

Declining number of old and local varieties grown for the last 40 years indicates the special role of collecting missions in the protection of genetic resources. Due to collecting missions, unique genetic resources were acquired in the *ex situ* collections. In this way, we can at least partially mitigate the effects of progressive genetic erosion of crop plants as a result of economic changes in modern agriculture, as well as prevent the decline of genetic diversity of varieties and the cessation of the cultivation of certain marginal species of useful plants by disseminating the collected resources. Despite the small share in cultivation, local plant varieties have useful production features, and also fulfill the natural and cultural functions, hence there is the need to protect them.

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Streszczenie. W ciągu ostatnich 40 lat Krajowe Centrum Roślinnych Zasobów Genowych IHAR w Radzikowie zorganizowało 67 wyjazdów celem pozyskania obiektów do zbiorów kolekcyjnych na terenie kraju. Ich głównym zadaniem było zabezpieczenie wciąż istniejącego bogactwa genetycznego w ekosystemach rolniczych. Terminy wyjazdów były ustalane zgodnie z okresem dojrzewania nasion, a strategia zbioru dostosowana do zbieranej grupy roślin. Zbiory obejmowały nasiona, cebule, zrazy itp. Obiekty były pozyskiwane głównie z magazynów lokalnych gospodarzy lub zbierane bezpośrednio w terenie. Podczas wyjazdów wyraźnie można było zaobserwować postępującą „erozję genetyczną" roślin uprawnych, widoczną poprzez zanikanie tradycji uprawy lokalnych odmian, szczególnie zbóż. Jest ona spowodowana uprawą odmian nowoczesnych lub zaprzestaniem uprawy niektórych gatunków roślin uprawnych. W okresie od 1984 do 2017 r. podczas 67 ekspedycji zorganizowanych przez KCRZG – Radzików zebrano łącznie około 4700 obiektów. W latach 90. przeważały zboża, w drugim okresie zbiorów, tj. od 1994 do 2005 r., rośliny warzywne oraz przyprawowe, natomiast w trzecim okresie, 2006–2017 r., rośliny ozdobne, lecznicze, dzikie, trawy oraz rośliny towarzyszące uprawom. Malejąca liczba upraw dawnych i lokalnych odmian w ostatnich 40 latach wskazuje na potrzebę dalszego gromadzenia zasobów genetycznych poprzez ekspedycje i na potrzebę monitorowania erozji genetycznej w Polsce.

Słowa kluczowe: ekspedycje, zasoby genowe roślin, erozja genetyczna, lokalne odmiany roślin użytkowych

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