Collecting by the Institute of Plant Genetics and Crop Plant Research (IPK) at Gatersleben

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Introduction

There is a long tradition of plant germplasm collecting at Gatersleben. H. Stubbe, the first director, collected in the Balkans in 1941–42, shortly before the foundation of the Institute of Cultivated Plant Research in 1943. Soon after the war, he encouraged further collecting work, for example in southern Italy (Maly *et al.*, 1987) and China. An intensive, systematic collecting programme was started in the 1970s (Table 39.1). The central parts of Europe were the first targets of this effort. In eastern Germany, where the Gatersleben institute is situated, genetic erosion was already so high at that time that it was not feasible to mount a conventional expedition. Instead, a series of articles was published in newspapers and popular gardeners' journals asking for samples of relic crops and rare cultivars (Hammer *et al.*, 1977). This approach was successful with garden plants (vegetables, herbs, fruit trees), but few accessions of field crops (cereals, pulses, oil crops) were obtained. Similar tactics were also later used in western Germany (Dambroth and Hondelmann, 1981).

The mountainous regions of Czechoslovakia (as it then was) and Poland were collected next. Here what was to become the standard Gatersleben collecting approach matured. This involves mounting multi-species missions for crops and their wild relatives, on the basis of ecogeographical and ethnobotanical data, in close cooperation with specialists in the host country, consulting local experts in the collecting areas. Each sample collected is shared among participating organizations. Other important aspects of the approach are:

- splitting of variable populations into phenotypically different lines when collecting;

Table 39.1 Collecting missions conducted by Gatersleben staff (1974–92) and accessions collected (after Hammer *et al.*,1994.

Collecting area (years)	Number of accessions
Czechoslovakia (1974, 1977, 1981)	1,153
Eastern Germany (1975–84)	694
Poland (1976, 1978, 1984)	442
Spain (1978)	344
Italy (1980–92)	2,414
Libya (1981–83)	468
Georgia, former USSR (1981–90)	2,873
Austria (1982, 1983, 1985, 1986)	265
Ethiopia (1983, 1984)	186
Korean DPR (1984–89)	530
Mongolia (1985, 1987)	67
China (1986, 1988)	67
Iraq (1986)	141
Cuba (1986–92)	661
Central Asia, former USSR (1987, 1988)	141
Colombia (1988)	112
Peru (1988)	37
Total	10,595

- the collecting of herbarium material, if possible during the missions, or at least from the first multiplication of the accessions in the Gatersleben experimental fields;
- preparation by the collectors of comprehensive collection lists, with preliminary botanical characterization, before the transfer of the material to the gene bank;
- preparation of the material for multiplication according to a specific standard (Lehmann and Mansfeld, 1957);
- botanical verification by the collectors in the multiplication fields;
- characterization and evaluation carried out jointly by the participating scientists and published in the form of catalogues, e.g. Kühn *et al.* (1976) on the collecting mission in Czechoslovakia in 1974;
- compilation of the information in checklists of cultivated plant species (Hammer, 1991; Hammer *et al.*, 1992).

In the following years, collecting was extended to the classical Vavilovian gene centres, first the Mediterranean area and then the Near East, Ethiopia, East Asia and Latin America. The funding for some missions was provided by the International Board for Plant Genetic Resources (IBPGR). Most, however, were financed and organized by agreements between the former Academy of Sciences of the German Democratic Republic (GDR) and the equivalent academies or societies in other countries. From a total of nearly 100 missions (Hammer *et al.*, 1994), a few examples are described in the rest of this chapter to illustrate specific aspects of the Gatersleben collecting approach. The explorations of Italy, Georgia and Cuba are discussed first. The fourth example is the investigation of the genus *Allium*, carried out by the Department of Taxonomy, which illustrates some of the problems of collecting wild relatives of crop plants.

The Gatersleben gene bank is not only active in collecting, regeneration, maintenance, characterization and evaluation of plant genetic resources. It also encourages and stimulates use of the material in breeding programmes by other institutes (Hammer, 1993). In the collecting, determination and characterization work, the gene bank is strongly supported by the Department of Taxonomy and Evolution of the Institute of Plant Genetics and Crop Plant Research (IPK), which includes a herbarium housing the reference collection of the gene bank. The close connection between gene bank staff and taxonomists has been a strong factor in the development of the Gatersleben collecting approach.

Italy

Italy is part of Vavilov's Mediterranean gene centre (e.g. Vavilov, 1987). Agriculture was introduced into the peninsula from the eastern Mediterranean and the Near East about 5000–4000 BC (Zohary and Hopf, 1993). Extensive variation in the early crops has developed. Later, several new crops were domesticated in the area (Hammer *et al.*, 1992). Cultivated plants have also been introduced from most other centres of diversity (Hammer *et al.*, 1992). Crops from east Asia (after AD 1000) and from the New World (after AD 1500) play a particularly important role in Italian agriculture and horticulture, and in many cases have developed high levels of diversity. Italy has also been an important bridge between the Mediterranean and central and western Europe.

The exploration of plant genetic resources in Italy was much influenced by Vavilov. As his special interest was wheats, early Italian activities in the field mainly involved cereals (Strampelli, 1932). A first comprehensive exploration was carried out in parts of southern Italy and Sicily in 1950 (Maly *et al.*, 1987). The material collected is being maintained by the Gatersleben gene bank. The Laboratorio del Germoplasma (later Istituto del Germoplasma) was founded in 1969 within Italy's Consiglio Nazionale per la Ricerca (CNR). It started a comprehensive programme of collecting and evaluating indigenous plant genetic resources. In the first years, this concentrated on *Triticum*, but later the scope of activities was widened. In 1980, the Istituto del Germoplasma established a cooperative programme with the gene bank of the Gatersleben institute, within the framework of an agreement between the CNR and the Academy of Sciences of the GDR. Annual joint multi-species collecting missions have since been carried out in Italy. The material is recent years, mainly due to agricultural development. They are critical witnesses of the process of genetic erosion and were able to explain, for example, the decline of the famous endemic cultivated Georgian wheat species (*Triticum timopheevii*, *T. zhukovskyi* and *T. macha*) after the Second World War. Various socioeconomic developments have contributed to crop genetic erosion: the organization of agricultural cooperatives after the war; the shift in focus towards animal husbandry in mountainous areas such as Svanetia, Tushetia and Khevsuretia during the last 15–20 years; and population movements caused by the abandonment of high mountain villages and resettling in the lowlands or by the politically motivated expulsion of national minorities during wartime. All these factors had to be considered during the collecting missions in order to understand the situation in the fields and gardens.

Collections were made directly from fields and gardens and in markets, but more often from recently harvested material and from farmers' seed stores. Variable seed samples, especially of grain legumes and cereals, were divided into phenotypic lines (e.g. Hanelt and Beridze, 1991; Table 39.3).

Cuba

The plant genetic resources of Cuba are described in detail in the various papers in Hammer *et al.* (1992–94), from which the material presented here is drawn. Cuba is well known for its mosaic of ethnic groups and cultures and also for its rich wild flora comprising about 6700 species of higher plants, about 50% of which are endemic. However, the flora of cultivated plants was largely neglected until the 1980s, with only a few exceptions (e.g. Roig, 1975). Even Vavilov, who spent a few days in Cuba, characterized the country as lacking any interesting plant genetic resources (Díaz Barreiro, 1977). A new perspective developed as a result of work with traditional root and tuber crops (Rodríguez Nodals, 1984) and from the cooperation between the Instituto de Investigaciones Fundamentales en Agricultura Tropical (INIFAT) in Santiago de las Vegas and the Gatersleben gene bank. A number of joint collecting missions were carried out (e.g. Esquivel *et al.*, 1987), resulting in a large collection, including very diverse material of beans, paprikas, pumpkins and tomatoes and some accessions of rare and neglected crops. This material is maintained in the gene bank of INIFAT. Selected samples are also duplicated at Gatersleben (Table 39.1). It has proved valuable in evolutionary and taxonomic studies (e.g. Castiñeiras *et al.*, 1991).

After seven years of exploration, it is clear that Cuba is extremely rich in crops, with more than 1000 species cultivated. (Ornamental plants and forest trees have not yet been considered at this stage of the study.) There are also many wild and weedy relatives of crop plants, wild medicinal plants, etc. (Hammer *et al.*, 1992–94). Exploration for plant genetic resources was combined with ethnographic, taxonomic and other

Table 39.3 Accessions collected during the joint missions in the Republic of Georgia (1981 to 1990). Further separations have been done during multiplication and evaluation at Gatersleben (Beridze *et al.*, 1987).

Crops	Number of accessions
Cereals	570
Zea mays	320
Triticum spp.	90
Hordeum vulgare	75
Secale cereale	31
Avena sativa	14
Legumes	1172
Phaseolus vulgaris	923
Pisum sativum	58
Vegetables	780
Allium spp.	264
Cucurbita spp.	138
Cucumis spp.	47
Beta vulgaris	41
Brassica spp.	63
Lycopersicon esculentum	37
Raphanus sativus	36
Spice plants and others	318
Anethum graveolens	25
Apium graveolens	28
Coriandrum sativum	43
Petroselinum crispum	34
Ocimum basilicum	33
Total	2873

studies. This integrated approach allowed a thorough characterization of the history of Cuban crops, using taxonomic, historical and ethnobotanical information from both the literature and the field (Hammer *et al.*, 1992–94):

1. Pre-Columbian period (e.g. *Manihot esculenta*, *Nicotiana tabacum*, *Capsicum frutescens*, *Phaseolus vulgaris*, *Ph. lunatus*).
2. Early introductions – the Spanish influence (e.g. *Allium cepa*, *A. sativum*, *Artemisia abrotanum*, *Brassica oleracea*, *Coriandrum sativum*, *Mentha spicata*, *Origanum majorana*, *Ruta graveolens*).
3. African influence (e.g. *Abelmoschus esculentus*, *Solanum melongena*, *Elaeis guineensis*, *Sesamum orientale*, *Coffea arabica*).
4. East Asiatic influence (e.g. *Benincasa hispida*, *Allium tuberosum*, *Diospyros kaki*, *Raphanus sativus*, *Vigna umbellata*).
5. Latecomers, mostly introduced from the USA (e.g. *Glycine max*, many temperate fruit trees and vegetables).

6. 'Mysterious immigrants', i.e. plants for which at the moment it is impossible to trace the provenance (e.g. *Allium* aff. *glandulosum*).

Several crops can be put in more than one group. An example is *Allium fistulosum*. Types introduced early from the Mediterranean (group 2) never flower in Cuba, while an east Asiatic type introduced later (group 4) flowers occasionally. Another example is *Brassica juncea*, which includes both material introduced from Africa with the slave trade (group 3), and now found mainly as a weed, and also an east Asiatic type introduced fairly late, possibly from the USA (group 5).

Another result of the integrated, multidisciplinary collecting approach has been the development of a method for the study of the typical Cuban home garden, the 'conuco' (Esquivel and Hammer, 1988). It has revealed them as places of active evolution, supporting high levels of variation within crops as well as related wild and weedy species. The 'conucos' can be considered as focal points for the *in situ* conservation of diversity (Esquivel and Hammer, 1992). A relatively small number of selected crops with high infraspecific variation can be conserved *ex situ* in the Cuban gene bank. The majority of the hundreds of crops grown in Cuba will have to be conserved 'on farm', using the traditional horticultural system of the 'conuco'. The monitoring of this system must be developed and will be a topic of further investigation.

Collecting wild *Allium* species in central Asia

Allium is a large genus of more than 700 species, including many useful plants. Onion (*A. cepa*) and garlic (*A. sativum*) are well-known crops throughout the world. Others are important in more restricted areas, such as leek (*A. porrum*) in Europe, or only locally, such as *A. hookeri* in Asia. The Department of Taxonomy of the Gatersleben institute has been investigating the taxonomy of *Allium* for more than ten years (Hanelt *et al.*, 1992). George Don, the 1827 monographer of *Allium*, wrote that 'the genus *Allium* can only be studied satisfactorily from living specimens'. An attempt has therefore been made in the last decade to take into cultivation at Gatersleben as many species as possible, representing all subgenera and sections, to give taxonomic research a sound basis. Some material has been donated by botanical gardens. However, only about 70 species could be obtained in this way, and there was much misnamed material. Collecting missions in areas rich in critical *Allium* species have been the main source for the Gatersleben *Allium* collection, which now comprises nearly 300 species (Fritsch, 1990; Fritsch *et al.*, 1994).

The genus is distributed in the wild almost exclusively in the northern hemisphere, with a centre of diversity in southwest and central Asia. Contacts were made with the botanical institutions of the former Soviet Academy of Sciences in the now independent central Asian republics of Tadzhikistan, Uzbekistan and Kazakhstan. These countries are in Vavilov's central Asian gene centre, where the wild ancestors of onion and garlic occur. Despite its rich flora, botanical exploration of this region began only in the second half of the last century. There have been advances, especially in the last 60 years, but much of the region is still insufficiently explored. It consists for the most part of rugged mountains and desert-like steppes. The lower alluvial regions are mostly under irrigation and planted with cotton. They are more densely populated. Onions and garlic form an essential ingredient of most local dishes and are extensively cultivated throughout the region. Several wild species are also regularly collected from the wild and used as vegetables or seasonings, or preserved (Fritsch, 1990). These are well known to local people, who can distinguish among them and have vernacular names for many.

Collecting missions were organized on the basis of continuing, long-term scientific cooperation. Each sample was divided into duplicates, one of which remained in the country of origin. Collections were established in Dushanbe, Tashkent and Alma-Ata. The support of local institutions was invaluable to the Gatersleben staff for various reasons. The available Floras of the Central Asian republics are partly out of date (Vvedensky, 1971). However, herbarium specimens, the results of botanical surveys of local areas and other unpublished data are available at local scientific institutions. Together with the knowledge of local botanists, these allow much sounder conclusions about where, when and how to collect. Also, though communication in the field with adult men is usually possible in Russian, young people and women mostly speak only local languages. Contact with local people is important not only in documenting germplasm samples but also to obtain information on roads, accommodation and sources of good water in an area where there are few detailed maps available.

Depending on the target area and species, collecting took place at different times of the year between April and August. Collecting at different times imposes different restrictions and offers different opportunities to collectors. These are summarized in Table 39.4.

Joint collecting missions and visits to research stations have taken place nearly every year since 1983. The routes are shown in Fig. 39.1, where important collecting sites are also marked. Though *Allium* was the main target, whenever possible other plants of interest to the collaborating gene banks were also collected (Table 39.5).

Table 39.4 Collecting restrictions and opportunities in central Asia.

Spring (April to May)	The leaves of all *Allium* species are still developing; taxa can be distinguished only by leaves, sometimes also by young scapes	Bulbs must be kept moist in plastic bags for several days, dry after the leaves wither. Rhizomatous species must be kept moderately moist. Many species do not flower in the following year	Plants can only be collected in markets if seeds, bulbs or fruits of last harvest are being sold
Early summer (May to early June)	Leaves of early-flowering *Allium* species begin to wither, but can still be used for differentiation. Flower and scape characters are observable. Leaves of late flowering species are fully developed, their scapes only partly	Bulbs should be held rather dry, rhizomatous species moderately moist. Most species will flower in the next year. Best time to collect	In June, young bulbs of onions and garlic start to be sold in markets
Late summer (July to August)	Early flowering *Allium* species difficult to recognize. Only scape and capsule fragments remain, often dislocated. Some late-flowering species still in flower or bear capsules. May be possible to reconstruct leaf shape. Best time to collect them	Bulbs should be kept dry, rhizomatous taxa slightly moist. Most will flower in the next year	Onions, garlic, etc. can be bought in the market. Best time to collect them there

Table 39.5 Accessions collected in central Asia (1983–93).

	Tadzhikistan	Uzbekistan	Kazakhstan
Allium spp.	318	100	124
Cultivated plants and wild relatives	134	14	10
Ornamental and other plants	153	45	41

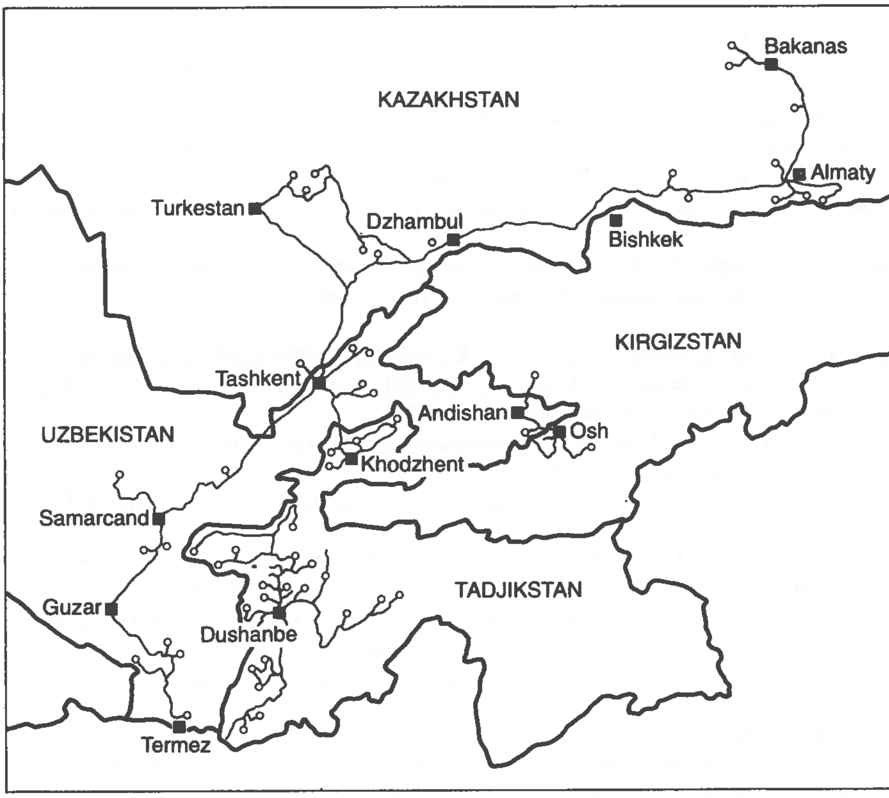

Fig. 39.1. Map of the collecting missions for *Allium* in central Asia (1983-93).

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