IPGRI

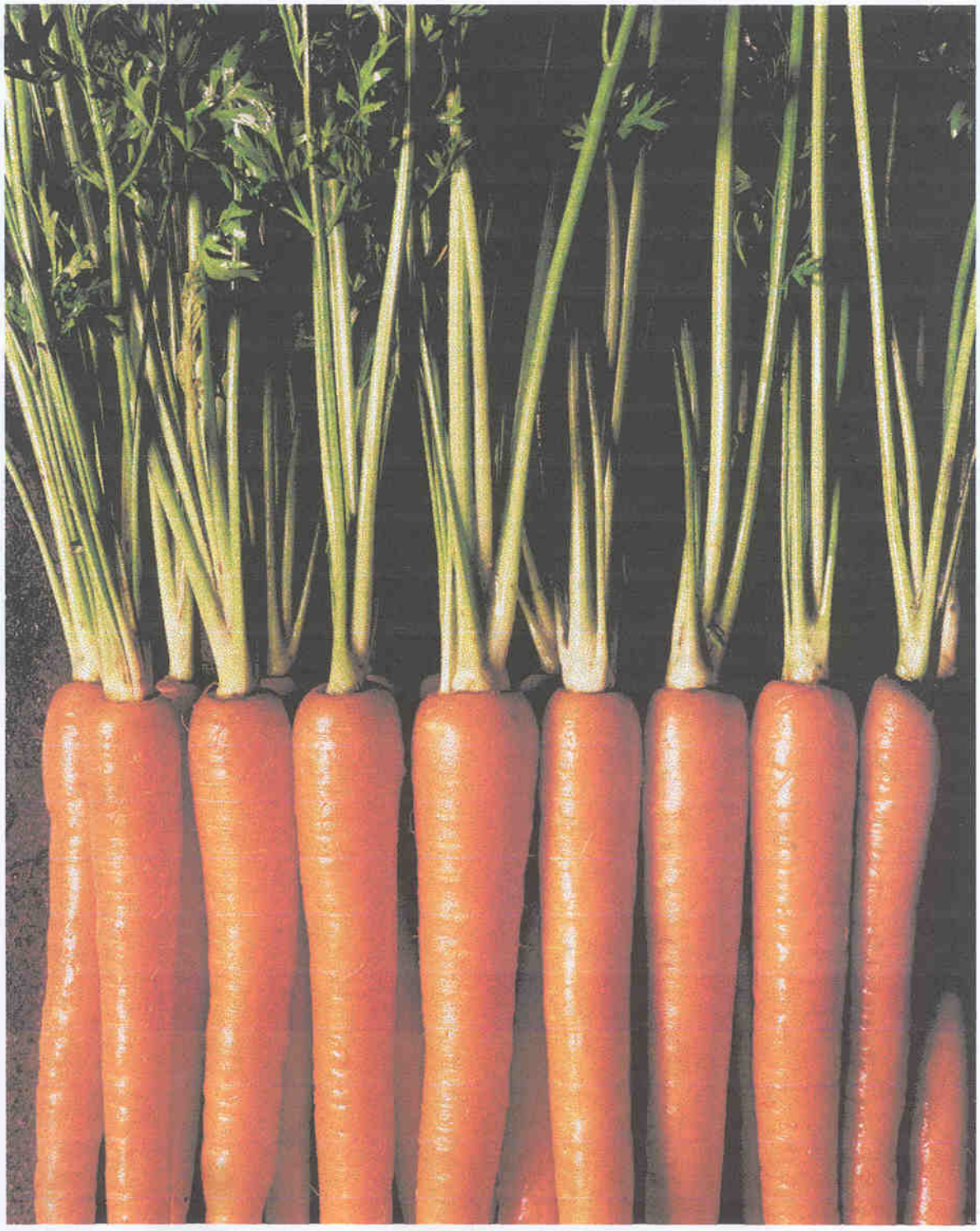
Report of a Workshop on Umbellifer crops genetic resources.

31 August 1997, Kraków, Poland

D. Astley, *compiler*

ECP/GR

European Cooperative Programme for Crop Genetic Resources Networks (ECP/GR)



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Part I. Discussion and Recommendations

Opening Session

An *ad hoc* workshop of the ECP/GR *Daucus* (Umbellifer) Group was held on 31 August 1997 in Kraków, Poland. The meeting was attended by 17 participants representing 13 European countries, IPGRI and USA. The *ad hoc* Group met in conjunction with the fifth meeting of the EUCARPIA Carrot Working Group hosted by the Department of Genetics, University of Agriculture, Kraków.

The meeting was opened by Dr Rafal Baranski, who welcomed the participants on behalf of Dr Barbara Michalik and the local organizing committee. Lorenzo Maggioni, ECP/GR Coordinator, welcomed the participants and emphasized the importance of their task to define the objectives and scope of the Group's activities, and to develop a workplan and a schedule for implementation.

Dave Astley was elected as the Chairperson for the meeting. He asked the participants to introduce themselves briefly. He then summarized the events leading up to the *ad hoc* meeting and outlined the primary objectives for the day. The draft agenda was adopted. The discussions and recommendations are summarized in the first section of the report. Individual papers are reproduced in the second part of the report.

Scope of the Group

The *ad hoc* meeting was initiated to develop a working group for carrot and *Daucus* taxa. The introductory remarks made by the participants showed that their interests represented a much broader spectrum of crops and taxa within the Apiaceae (Umbelliferae). It became evident that there was a need, and obvious benefits, to broaden the scope of the Group's activities to include other umbellifer crops. However, the Group was also very aware of the dangers of spreading their meagre resources too thinly, if the scope of the work became too wide. The ensuing discussion culminated in an agreement to limit the Group's activities to nine crops/genera within the Apiaceae, namely:

Anethum L.	dill
Apium L.	celery
Carum L.	caraway
Chaerophyllum L.	chervil
Coriandrum L.	coriander
Daucus L.	carrot
Foeniculum Miller	fennel
Pastinaca L.	parsnip
Petroselinum Hoffm.	parsley

Dave Astley agreed to write a proposal for submission to the ECP/GR Steering Committee scheduled for July 1998 in Braunschweig, recommending that the *ad hoc* Umbellifer Group be recognized formally as an ECP/GR Crop Working Group within the Vegetable Network[1].

Review of collections

The Directory of European PGR Collections[2] (Vol. 1. Holdings) was used as the basis to define what material of the nine genera existed in PGR collections. National representatives reviewed and updated the Directory information, which was subsequently collated in a table (Table 1).

European Umbellifer Database (EUDB)

The Group discussed the need to update and expand the information in the European Directory by developing a European Database of passport data for the nine umbellifer genera. The EUDB would be used to direct the activities of the Group for the management, regeneration and characterization of the collections and to coordinate collecting activities by identifying gaps in the *ex situ* genepool. Dave Astley agreed to develop and manage such a database at Horticulture Research International at Wellesbourne, UK.

Lorenzo Maggioni outlined the decisions made at the ECP/GR documentation meeting held in Budapest in October 1996. He emphasized that the standard set of passport descriptors developed should be considered as the standard format for the exchange of data between genebank curators and the central crop database. The Group agreed to accept the ECP/GR multicrop passport descriptors as the basis for data exchange and for the development of the new database. Dave Astley agreed to distribute a request for passport information to national coordinators and the genebank curators with umbellifer material as listed in the European Directory (1995). Participants at the meeting agreed to supply passport data to Dave Astley by end of December 1998.

The Group agreed that once the EUDB is established, the data should be made available to all potential users. Lorenzo Maggioni gave an overview of the Internet European Information Platform on Crop Genetic Resources and outlined the opportunities available to the crop working groups to promote their work and provide access to the European database. The potential value of the Information Platform was recognized by the Group, who agreed to develop an Umbellifer Group Web page on the Platform as soon as possible. Dave Astley agreed to liaise with Lorenzo Maggioni to establish the Umbellifer Web page before the ECP/GR Steering Committee meeting[3].

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[1] The proposal was submitted to the Steering Committee (see Appendix I) who approved the establishment of an Umbellifer Working Group during Phase VI of ECP/GR (1999-2003).

[2] Frison, E. and J. Serwinski. 1995. Directory of European institutions holding crop genetic resources collections. Fourth edition. Vol. 1 and 2. International Plant Genetic Resources Institute, Rome, Italy.

[3] The entry page to the Umbellifer database is available at:
<http://www.cgiar.org/ecpgr/platform/Crops/Umbellif.htm>

Table 1. Accessions recorded in the Directory of European PGR collections (4th edition, 1995) - updated in Kraków (1997)

Country	Institution	*Anethum*	*Apium*	*Carum*	*Chaerophyllum*	*Coriandrum*	*Daucus*		*Foeniculum*	*Pastinaca*	*Petroselinum*
							cult.	wild			
Albania	Tirana	4					1	3			6
Austria	Linz						6				4
Belgium	Genappe	x	x	x		x		x		x	x
	Merelbeke		25								10
Bulgaria	Sadovo	3				3	2				
Czech Rep.	Olomouc		30	270		5	430			15	30
	Prague		67				6				
France	Brion		77		5		386				
	Le Rheu						50				
Germany	Braunschweig	38	52	1	20	36	62	72		20	20
	Gatersleben	56	141	17	11	101	232	6		34	99
	Hannover						0	0			
	Potsdam		2								
Greece	GGB	4	14				9				10
	NAGREF	4	9								
Hungary	Tápiószele	61	71				187			35	137
Italy	IDG Bari		24				15		31		24
Lithuania	Babtai	2	10			4	110				4
REGIONAL	NGB	3	15	7			42				13
Poland	Radzików	1	8	19		1	57			3	25
	Skierniewice		10				80	2		3	47
	Poznan	1	1	1		1					
Portugal			x			20	5				48
	Vila Real		x			x					0
Slovakia	Nove Zamky	6	10	2			26			1	10
Spain	CRF Madrid					4	3			1	16
	Zaragoza		10			4	27			1	78
Switzerland	Nyon		5				47	1			4
	St.Gallen						2				1
	Wädenswil						2				
Turkey	AARI	18	6	22		17	55				80
UK	HRIGRU		25			3	735	61		20	21
	SASA		116				548				
ECP/GR Total		**201**	**728**	**339**	**36**	**199**	**3125**	**145**	**31**	**133**	**687**
USDA GRIN		81	286	36	36	150	721	55	59	73	154
Russia	VIR	335	250			342	1001			50	100

The development of a set of minimum characterization descriptors

The discussion centred on the characterization descriptors for carrot, as this is the only crop with any established formal descriptor list (UPOV, USDA, VIR and RCA-Tápiószele). There was no IPGRI standard descriptor list for carrot/*Daucus*. However, Lorenzo Maggioni informed the Group that Dr Taysir Badra was in the process of developing such a list, and that in due course a draft would be circulated as widely as possible for comment. The participants agreed to inform Lorenzo Maggioni of potential reviewers for the draft descriptor list. The Group discussed the relative merits of characters in allowing users to make constructive decisions in the selection of accessions from genetic resources collections. Although this was a constructive discussion, the choice of a minimal set of descriptors was delayed pending a formal descriptor list being agreed and published by IPGRI[4].

The Group accepted that characterization descriptors for the other umbellifer crops/genera would have to be developed by the particular crop specialists and their collaborators. The Chair encouraged all participants to consider their own interests relating to the other eight crops/genera, and to develop such minimum characterization descriptors for them.

Descriptors

The crops and wild taxa of the nine genera are utilized in many different ways, for example as vegetables, medicines, condiments and aromatics. Therefore the development of characterization and evaluation descriptors for the various crop types will necessarily differ.

Review of collecting needs and methodology

National representatives commented on the current status of collections and the need for collections and/or the development of the methods used.

Czech Republic

There are significant collections of aromatic and medicinal plants maintained by the Research Institute of Crop Production (RICP) Olomouc Gene Bank. The collection also includes landrace material of carrot, celery, parsley, parsnip and caraway. There may still be some landraces and certainly wild taxa to be collected.

France

The new national Umbellifer Network will review the need for germplasm collection and for an ecogeographic survey of wild taxa. A preliminary assessment of the collection requirements indicates the target areas as wild taxa in Brittany and southern France, landraces throughout the country and obsolete cultivars maintained by seed companies and NGOs for all crops.

[4] IPGRI. 1998. Descriptors for wild and cultivated Carrots (*Daucus carota* L.). International Plant Genetic Resources Institute, Rome, Italy.

Greece

There is an urgent need to collect wild taxa and landraces throughout the country. The Greek Gene Bank staff members have monitored genetic erosion in the landraces of all crops. The local selections of vegetables appeared to be maintained by householders and on small-scale farms. However, it is becoming evident that this situation is changing as the social structure in agriculture changes and highly bred varieties become widely available, and therefore the landraces of vegetables are increasingly under threat.

Germany

Certainly wild taxa of the genera should be collected. It may also be possible to locate relic populations of parsnip, which is not a common crop in Germany.

Hungary

There are 160 accessions in the carrot collection, 30% collected in the 1960s. There seems little possibility to collect more cultivated carrot in Hungary. There is the possibility in Transylvania. There are still wild taxa and some landraces of the minor umbellifers crops that require collection.

Italy

The priority for collection is the landrace material maintained in traditional agriculture, but also local cultivars selected and marketed in specific regions and sold in local markets. Changes in the seed laws and umbrella varieties may have serious consequences on the maintenance of many local selections.

Nordic Gene Bank (NGB)

There is a need to assess what material of Nordic origin exists in other collections, for example in Europe and the United States. The NGB will try to acquire a sample of such material for storage. The EUDB will assist greatly in this regard. Collection will concentrate on wild taxa and landraces.

Poland

Priority will be given to the collection of landraces and the local knowledge associated with the germplasm, especially horticultural practices, medicinal and aromatic uses. It will also be important to collect obsolete and current Polish cultivars from local seed companies.

Russia

The N.I. Vavilov Research Institute of Plant Industry (VIR) maintains a significant collection of these umbellifer crops, of which many accessions are landraces. However, Tatyana Khmelinskaya informed the Group that some of this unique material faces an uncertain future where accessions are of either low seed weight and/or low viability because of the lack of resources for regeneration. She requested assistance from the Group in the regeneration of specific material. The Group agreed to assist VIR where possible within the limitations of national/institutional programmes. Teresa Kotlińska and Dave Astley offered to liaise with Tatyana

Khmelinskaya and coordinate the Group's efforts. With reference to collecting germplasm, it may be possible still to find landraces of parsnip in certain regions.

UK

There is a need to collect wild taxa of *Daucus* covering the ecogeographic range of each taxon. This may be achieved in cooperation with the new Royal Botanical Garden Kew Millenium Seed Bank Project, one objective of which is to collect wild taxa in the UK. The Horticultural Research International Genetic Resources Unit (HRIGRU) carrot / *Daucus* collection includes the material transferred from the Centre for Genetic Resources, The Netherlands (CGN), which contains many Plant Introduction accessions from the United States Department of Agriculture (USDA). There is a need to clarify the current status of this material within the USDA collection of Ames, Iowa. There is a need to collect more cultivated and wild parsnip material.

Taxonomy

The participants all agreed that there is a significant requirement for curators to identify taxonomists willing to act as advisors for the validation of material in the collections. Individuals agreed to notify the group of any umbellifer taxonomist within their national system.

Safety-duplication of collections

IPGRI is keen to promote the safety-duplication of collections in a second country governed under formal bilateral agreements. Copies of the agreement between NGB and Lithuania were circulated as a working example of a bilateral agreement. Several representatives confirmed that their institutions had storage space available and could offer 'black box' safety-duplication. However, all agreed to investigate the types of (bilateral) agreements used currently within their institutions. The institutes offering facilities included:

- Nordic Gene Bank (NGB) in the Svalbard Island (Norway), at -3^{0}C
- Centre for Plant Genetic Resources (IHAR), in Radzików, Poland, at -20^{0}C
- Research Institute for Crop Production (RICP) in Prague, Czech Republic, at -20^{0}C
- Greek Gene Bank in Thessaloniki, Greece
- Horticultural Research International Genetic Resources Unit (HRIGRU) in Wellesbourne, UK.

Opportunities for collaboration

The Group agreed there were areas of work that required a collaborative approach in order to maximize the resources available to the Group and to minimize duplication of effort.

There is already considerable molecular work taking place in the University of Wisconsin. Phil Simon will be pleased to collaborate with members of the European Group on molecular characterization. Individuals from Poland, France and Sweden had a very productive time with Phil in the University of Wisconsin in the Summer of 1998.

Rafal Baranski is keen to collaborate on the screening of carrot material for resistance to *Erwinia*. He offered to screen material on behalf of the Group, if any members had interesting candidate material.

Phil Simon also announced plans to collaborate with Group members on the collection of *Daucus* material in Europe and the Near East in 1999. Plans have been finalized and collecting will be carried out in Greece, Poland, Syria.

The proposal to develop a EC 1467/94 GENRES proposal for carrot was taken forward and has been successful. The project is currently under final negotiation with DG VI, but hopefully will start in June or July 1999. There are project partners from France, Germany, Greece, Italy, Nordic Gene Bank and the UK[5].

Election of Chairperson and closing remarks

Dave Astley agreed to remain Chairperson for the group until the next meeting. He thanked Prof. Barbara Michalik, Dr Rafal Baranski and the staff of the Department of Genetics for the excellent organization of the meeting and their warm hospitality.

[5] As a result of the third call for proposals for the EU programme EC 1467/94 on the conservation, characterization, collection and utilization of genetic resources in agriculture, Project GENRES 105 on "The future of European carrot: a programme to conserve, characterize, evaluate and collect carrot and wild relatives" was under consideration for funding on the 1999 budget line. The project is coordinated by Dr Dave Astley, Horticulture Research International, Wellesbourne, UK.

Part II. National collections and research activities

Workshop participants sent their reports on the status of Umbellifer genetic resources in their countries for inclusion in this report.

Umbellifer genetic resources in France

Mathilde Briard
ENSH-ENITP, Angers, France

France adopted a national strategy for genetic resources management for animals, plants and microorganisms. The strategy is coordinated by the Bureau des Ressources Génétiques (BRG). The general principles of the strategy are:

- to provide a better integration of the conservation process and the use of resources, especially through better characterization of the material;
- to conserve for the long term the maximum variability in PGR collections through the minimum number of accessions;
- to use the best methods of conservation - *ex situ* (cultivated species), *in situ*, or association of both techniques (wild species such as forests, grasslands or wild relatives of cultivated species); and
- to develop a dynamic process of conservation in order to integrate genetic progress without loss of variability and to keep the natural adaptability of the species (pilot species, e.g. wheat, *Cichorium*).

For all species, activities are organized in national networks. Each network has a general coordinator and a steering committee who share the work for conservation, multiplication and evaluation. The work is organized through the coordination of public institutions (INRA, high schools, etc.), botanical gardens and private companies (seed producers, breeders, etc.). In May 1997 there were 27 well-organized networks in existence and new ones, such as Umbellifers (mainly carrot), were being initiated.

The Umbellifer Network

There has been a concerted effort to organize individual programmes and projects into a formal collaborative programme in order to prevent the duplication of material and activities, and incomplete collections with subsequent loss of resources. Participants in the Umbellifer Network include:

- carrot breeders (Clause, Vilmorin, Sandoz Seeds) - varietal creation
- botanical gardens (Mulhouse, Angers) - educational demonstration
- GEVES (Group for the study and control of varieties and seeds) - registration of new varieties
- INRA (National institute for agronomical research) - research
- ENSH-ENITHP - High school for horticulture and landscape

(General coordinator of the future network: Mathilde Briard) - research and education.

Collections

- 70 entries of old local varieties ('Jaune du Doubs', 'Parisienne', 'Merveille', etc.),
- 515 current varieties (95% 'Nantaise' type),
- 26 different *Daucus,*
- 125 Umbellifers including 80 species used as food, and
- approximately 20 *Chaerophyllum bulbosum*.

Morphological characterization.
Biochemical characterization (RAPD).

Conservation and utilization of selected Apiaceae collections in Germany

L. Frese[1], K. Hammer[2], T. Nothnagel[1], M. Rauber[3] and F. Ebner[4] with a contribution from U. Reinhard[5]

[1] Federal Centre for Breeding Research on Cultivated Plants (BAZ), Braunschweig, Germany
[2] Institute of Plant Genetics and Crop Plant Research (IPK), Gatersleben, Germany
[3] Breeding company Sperling, Lüneburg, Germany
[4] Breeding company Hild, Marbach, Germany
[5] Verein zur Erhaltung der Nutzpflanzenvielfalt (VEN) (Association for the conservation of diversity of crops), Schandelah, Germany

Introduction

This report deals with genetic resources collections of nine genera of the Apiaceae family held by the Federal Centre for Breeding Research on Cultivated Plants (BAZ) and the Institute of Plant Genetics and Crop Plant Research (IPK). The various crop species have been collected to sustain breeding of vegetables, spices and crops suitable for non-food applications. The IPK and BAZ genebanks maintain a total of 1825 accessions distributed over 16 species. Information is also presented on breeding research and activities of breeding companies as well as non-governmental organizations (NGOs).

Collection

A summary of the nine Apiaceae genera is presented in Table 1. Details on species names, geographic origin, variety names and other passport data can be searched on-line either on the ZADI-Information Centre for Genetic Resources (<http://www.dainet.de/genres/>) or on the IPK (<http://www.ipk-gatersleben.de/>) homepages.

Table 1. Number of species, number of accessions and availability of seed samples by genus and holding.

Genus	BAZ			IPK		
	No. of species	No. of accessions	Availability (%)[1]	No. of species	No. of accessions	Availability (%)[1]
Anethum	1	49	18	1	138	92
Apium	1	77	53	3	168	91
Chaerophyllum				3	11	90
Coriandrum	1	49	27	1	416	96
Carum	2	17	35	1	44	94
Daucus	1	169	38	6	301	92
Foeniculum	1	80	31	1	85	87
Pastinaca				1	40	89
Petroselinum	1	24	42	1	157	97

[1] sufficient amounts of viable seeds are available for seed exchange

Both genebanks regenerate the mainly outcrossing germplasm in small isolation greenhouses or under spatial isolation. Each year a few accessions per species are selected from the holdings and fed into the routine regeneration programme. A priority list generated by the seed stock management databases, that uses the critical threshold values for the number of viable rest seeds, serves as the basis for decision-making.

Safety-duplicates of the IPK collection are stored for those materials which have been obtained from joint collecting missions in the genebanks of the countries of origin. None of the germplasm held by the BAZ genebank has been safety-duplicated elsewhere.

Characterization and evaluation

While the characterization of accessions is mainly conducted by genebanks, the evaluation of germplasm requires specific expertise and technical equipment. Disease resistance and yield components have been evaluated by BAZ institutes or breeding companies. Table 2 provides an overview of the availability of characterization and evaluation data in the BAZ and IPK documentation system. Descriptors without data have not been considered in the table. In the case of the BAZ genebank the amount of available characterization and evaluation data is very limited.

Table 2. Number of descriptors used.

Genus	No. of descriptors used	
	BAZ	IPK
Anethum		14
Apium		22
Chaerophyllum		8
Coriandrum	27	45
Carum		10
Daucus	3	22
Foeniculum	7	17
Pastinaca		12
Petroselinum		10

Research

This chapter provides an overview of past and ongoing research activities. Relevant literature references are listed at the end of this paper. *Chaerophyllum* and *Pastinaca* are not investigated scientifically in Germany at present. A limited number of investigations dealt with collection management aspects. Pollination ecology of *Coriandrum* and *Daucus* have been studied to improve seed production. Using different pollinator insects, outcrossing rates in *Daucus* grown in isolation cages have been determined. Extensive characterization and evaluation work in *Coriandrum* has been carried out at the IPK genebank. This work resulted in a comprehensive description of morphologically distinct *Coriandrum* groups available in the IPK collection. It is considered as an example of how the management, access and use of

genetic diversity in collections can be improved through investigations of the variation patterns.

Breeding of *Coriandrum* for resistance to *Pseudomonas syringae* and high content of petroselinic acid is being conducted by the Institute of Plant Pathology and Plant Protection, University of Göttingen. The classification of Apiaceae collections with respect to chemotypes variation is a main research topic of the Institute of Quality Analysis (BAZ, Quedlinburg). Studies on seed oil content and composition are being conducted in cooperation with various BAZ working groups in *Apium graveolens, Carum carvi, Coriandrum sativum, Foeniculum vulgare* and *Petroselinum* sp. Currently, the Institute of Breeding of Vegetables, Medicinal and Aromatic Plants (BAZ, Quedlinburg) is screening *Petroselinum crispum* against eight disease agents with an emphasis on *Septoria petroselini*.

The Institute of Applied Genetics (University of Hanover) and the Institute for Breeding Methods in Vegetables (BAZ, Quedlinburg) are cooperating in the mapping of economically important traits of *Daucus carota* subsp. *sativus* as a basis for marker-assisted selection within the framework of a GFP-funded (Association for the Promoting of German Private Plant Breeding) project. Evaluation of wild carrot lines for resistance to *Alternaria dauci* and investigations of the genetic background of resistance is done by BAZ within the same project. The use of wild species for development of new sources of cytoplasmic male sterility (cms) for carrot hybrid breeding is also investigated. Alloplasmic cms-lines are used in a DFG-funded (German Research Association) project at the Institute of Genetics of the Humboldt-University in Berlin. The project's aim is to analyze the interaction between the nucleus and cytoplasm and its significance on the expression of flower genes. Furthermore, in three projects of BAZ institutes, quality traits of carrots such as carotene, sugar and flavour as well as resistance of *Daucus* germplasm to *Meloidogyne hapla* are being investigated.

Commercial breeding and NGO activities

This chapter mainly deals with carrot, celeriac and parsley breeding. The remaining six genera are considered as a source of potentially valuable crops. However, their economic importance is still limited. A small number of accessions of obsolete varieties or provenances of the nine crop species are being maintained by German NGOs (*Anethum* - 2 accessions, *Apium* - 5, *Chaerophyllum* - 1, *Coriandrum* - 3, *Carum* - 2, *Daucus* - 13, *Foeniculum* - 2, *Pastinaca* - 5, *Petroselinum* - 6). These collections are mildly selected to keep or even improve the specific characters, such as in the case of *Chaerophyllum* for tuber yield, shape and size.

Production of carrots, celeriac and parsley

In 1997, 295 000 t carrots were produced on 4000 hectares in Germany with a decreasing tendency. The crop has the second highest production after cabbage. Amongst *A. graveolens* var. *dulce,* var. *secalinum* and var. *rapaceum*, only the latter is of economic importance in Germany. Approximately 50 000 t are produced on about

1500 hectares. The majority is used by the processing industry while a smaller part is produced for the fresh market. Leaf parsley (*P. crispum* subsp. *crispum*) is one of the most important aromatic plants grown in the world. Root parsley (*P. crispum* subsp. *tuberosum*) is of minor importance as a vegetable. Data with respect to the other Apiaceae species were not readily available.

Commercial breeding of carrots, celeriac and parsley

Carrot breeding is implemented by the Wagner (Heidelberg) and Carl Sperling (Lüneburg) companies, and celeriac by the Hild (Marbach) and Wagner companies. Parsley is selected by many breeding companies at a low input level. There is a large number of landraces reproduced all over the world. Several companies maintain their own defined selections. The only active parsley breeder in Germany, the Hild company, is competing with Bejo in the Netherlands and the Limagrain group in France.

Three main carrot types are grown for use in the food industry: 'Pariser Markt', 'Amsterdamer', 'Flakeer', 'Late Berlikumer', and 'Imperator', whereas 'Amsterdamer', 'Nantaise' and 'Berlikumer' types are produced for the fresh market. Open-pollinated carrot varieties have largely been replaced by F_1 hybrids. Umbrella varieties ('Pariser Markt', 'Amsterdamer', 'Nantaise', 'Berlikumer', 'Flakeer', 'Chantenay', 'Imperator') are always open-pollinated varieties and are being maintained by several breeding companies as family selections.

The leading celeriac variety with more than 50% market share in Europe is 'Monarch' due to its excellent processing quality. 'Monarch' yields a high percentage of stainless flesh of mild taste. Older varieties with the typical strong and severe taste have almost completely been replaced by 'Monarch' and very few other varieties similar to it.

There is a very large number of parsley varieties maintained and sold by numerous companies. In northern Europe finely curled varieties are preferred, while in southern Europe plain-leafed types are mainly used.

Main breeding aims for carrot, celeriac and parsley

Carrot breeding aims depend on the production method and the intended use. Breeders select for high carotene, low nitrogen content, long cylindrical shape, shape of crown, good inner and outer colour, smooth skin, days to maturity, yield, tenderness, attractive green colour of the leaves, leaf length, and storage ability. Disease resistance (*Alternaria* and *Pythium*) also plays an important role. The seed price determined by the seed yield can also be of importance.

The main breeding aims in celeriac are yield, white flesh, resistance against *Septoria*, bolting resistance, and high content of etheric oils for essence production. The development of hybrid breeding systems is an important field of activity.

The main breeding aims in parsley are dark green leaves, yield, fine curling and in the long run the development of hybrid varieties.

Need for genetic resources

There seems to be no urgent need for using cultivars held by genebanks in carrot breeding programmes. Breeders themselves maintain working collections of obsolete, open-pollinated varieties. Wild carrots are mainly of interest as a source of resistances and new cytoplasms.

In celeriac, the genetic basis of varieties grown today is very narrow due to the extremely strong market share of 'Monarch' and its derived varieties. Many of the older varieties only maintained in genebanks have tolerance to the main celeriac diseases due to their high content of etheric oils. Further breeding progress will strongly depend on this obsolete germplasm.

Due to the relative low breeding intensity in parsley, the genetic diversity of today's varieties is rather broad. For special breeding projects like the development of hybrid varieties, breeders will also have to screen outside the commercially available genepool.

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Daucus genetic resources in Greece

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Greece is rich in indigenous wild *Daucus* germplasm. Early botanical surveys report seven species and three subspecies of *Daucus* on its territory:

1. *Daucus pumilus* Ball (*Caucalis pumila* Gou, *D. maritimus* Gaertn.). In coastal sites in Macedonia, Attica, Argolis, Ionian islands, Cyclads, Crete.
2. *Daucus Broteri* Ten (*D. ponticus* Vel.). In farmland and coastal sites on Zakynthos, Syros and Crete islands.
3. *Daucus muricatus* L. In seaside sites in Macedonia (northern Greece).
4. *Daucus involucratus* SS. On barren land in Macedonia, Thessaly, Aetolia, Attica, the Peloponnese, Cyclads and Crete.
5. *Daucus guttatus* SS (*D. setulosus* Guss., *D. speciosus* Ces.). On barren land in Thrace, Macedonia, Thessaly, Attica, Euboia, the Peloponnese, Ionian islands, Cyclads and Crete.
6. *Daucus gummifer* Lam (*D. gingidium* Vis, *D. mauritanicus* Gandg.)
   Daucus gummifer var. *hispanicus* Hay (*D. hispanicus* Gau.). Occurring in sandy and seashore rocky sites in Macedonia and on Lefkas and Crete islands.
7. *Daucus carota* L.
   Daucus carota var. *maximus* Car.
   Daucus carota var. *sativus* D.D.
   Occurring throughout Greece.

As regards cultivated carrots, the germplasm collection of the Greek Gene Bank is very poor and far from representative of the existing variability in the country. It contains only eight accessions collected in 1982 and 1983 from only two administrative departments of the country.

In the past germplasm collections in Greece focused on certain priority crops. Vegetable crops received no attention, because they were considered less threatened. However the rate of genetic erosion has proven much higher and more extensive than expected. In order to rescue as much germplasm as possible, including carrot, the highest priority must be given to collecting expeditions.

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Possibilities for collecting wild species of the family Umbelliferae in Hungary

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Of the genera targeted by the Working Group, the following wild species can be found in Hungary:

- *Daucus carota* L.

Common weed and grassland species throughout the country.

- *Pastinaca sativa* L. subsp. *pratensis* (Pers) Čelak.

Common weed and grassland species throughout the country.

- *Chaerophyllum aromaticum, C. hirsutum* L. , *C. aureum* L., *C. temulum* L., *C. bulbosum* L.

Occur in certain moist forested spots in the mountains of Vértes, Sopron, Mecsek.

- *Apium repens* (Jack.) Lacaita.
  Occurs in flood areas of the rivers Danube and Dráva.

We succesfully located a botanist who kindly agreed to contribute to taxonomic identification of problematic accessions in Umbelliferae. He is also an expert on wild *Allium* species native to Hungary. His contact details are:

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Notes on conservation and uses of the Apiaceae germplasm in Italy

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Introduction: species and growing areas

Four species of the Apiaceae family: carrot, fennel, celery and parsley, are of major horticultural interest in Italy, as well as in most other European countries. Many others are grown in more restricted areas as condiment plants or potherbs, or are also exploited from wild stands.

A preliminary overview of the four major species' current production and cultivation areas (Istituto Nazionale di Statistica 1996) helps understand the importance of their germplasm exploitation and possible conservation.

Carrot

Carrot is presently cultivated on more than 10 000 hectares. Due to its need for coarse textured soils, its commercial cultivation is concentrated in five main production areas (Siviero and Donelli 1997):

- in the north, the Chioggia (Veneto region) and Ferrara (Emilia-Romagna) areas, for summer production;
- in the centre-south, the Fucino area (Abruzzo region), a highland plain that produces in late summer and autumn, and the Fiumicino and Sabaudia coastal plains (Lazio region), for winter and summer production;
- in the south, the Ragusa and Siracusa coastal plains (Sicilia region), and the coastal sandy soils of northern Puglia, for winter and early spring production.

Cultivation is almost totally for the fresh market, both for internal consumption or for export. Cultivation for industry is virtually absent, after the failure of a state-assisted enterprise for β-carotene extraction during the 1960s. Glasshouse cultivation is of very minor importance and, when present, it does not make use of special varieties. Because of this situation, the interest of growers is presently concentrated on medium-early to medium-late cultivars, suitable for open-field production.

Fennel

Fennel is a typical Mediterranean crop. Italy still maintains a leading position for its production, despite the growing importance of France. Total area amounts to about 19 000 hectares. The central-southern regions of Puglia, Campania, Calabria, Sicilia and Lazio are the leading production areas of the typical winter crop, whereas in the centre-north only the Marche region is planted with comparable areas. In northern Italy, where fennel is grown as a spring or autumn crop, because of its frost sensitivity, the wider areas are in the Emilia-Romagna region. The whole production is directed to the fresh market, both for internal consumption and export.

Celery

In Italy, only var. *dulce* (true celery) is an important crop, cultivated on approximately 4500 hectares, whereas var. *rapaceum* (celeriac) is almost unknown. The Puglia region, in the south, accounts for half the total area. However, important celery crops are also present in the north, with the Piemonte region occupying the leading position. Other relevant areas are in Emilia-Romagna and Veneto (north), Lazio (centre-south), Sicilia and Sardegna (south). Celeriac is grown on restricted areas in the north. Cutting celery (var. *secalinum*) is grown as a condiment plant.

Parsley

The cultivation of parsley is spread everywhere, including small plots and in family gardens. The total area amounts to about 1300 hectares, with only Puglia (south) occupying a leading position. Normal-leafed varieties are almost exclusively used for internal consumption, whereas curled-leafed types are cultivated for export. Root parsley is almost unknown in Italy.

Other species

Parsnip (*Pastinaca sativa* L.), dill (*Anethum graveolens* L.), coriander (*Coriandrum sativum* L.), lovage (*Levisticum officinale* L.) and many others are grown on small areas as condiment plants by specialized farmers or in family gardens.

The recent facts of variety certification

The four major Apiaceae species, plus chervil, adhere to the same rules as all major vegetables with respect to varietal certification in the European Union.

The common European register was established in the early 1970s. At the time, many traditional varieties, although being well known and having an established market position, were commercialized by several companies, none of which was officially appointed for maintenance breeding of base material. These varieties represented the basis for the production of most vegetable crops; consequently they could not simply be excluded from commercialization by a simple administrative act. Therefore, the special category of *standard* varieties was created to allow their official registration in the national or European catalogues. *Standard* varieties do not need *a priori* official certification of the varietal characteristics that are guaranteed by the seed producers, and are only subject to post-controls by the certification bodies.

Another important fact is that some of these “old” varieties were so widespread that great within-type variability accumulated over time, since they were cultivated in different nations and their seed produced by several companies, each one probably practising some kind of selection. Therefore, the common name of one variety often indicated a group of different genotypes, often so heterogeneous that they could not meet the standards for acceptance in the EU register. The great diffusion of many of these varieties meant that it was not possible to exclude them from commercialization. Therefore, the *umbrella* programme was launched containing the following stages:

- identification of the *umbrella* varieties, intended as very heterogeneous and internally differentiated types, whose description was too broad to allow the renewal of their acceptance in the catalogues;
- definition of derived varieties, by the examination of the diversity within each *umbrella* variety; and
- naming of the derived varieties.

The last relevant fact is that, starting from 1999, any variety, either standard or officially certified, will no longer be accepted in the national and European registers without an official body responsible for maintenance breeding.

In summary, the present situation of commercial Apiaceae germplasm (and other vegetable crops) is the following:

1. selected varieties registered as *certified* varieties;
2. selected varieties registered as *standard* varieties;
3. *umbrella* varieties and their recently individuated derivatives, presently registered as *standard* varieties;
4. old varieties (not of the *umbrella* type), of more local interest, but with an official body responsible for maintenance breeding;
5. old varieties without an official body responsible for maintenance breeding, that will be cancelled from registers.

Varieties of categories 1 and 2 tend to be more important for professional, wide-scale horticulture, that however still makes use of varieties in category 3. Categories 3, 4 and 5 are of major interest in germplasm conservation.

Situation of Apiaceae germplasm in Italy

Genebanks

The accessions of the four major Apiaceae held by genebanks are reported in Table 1. The relatively low number of samples indicates that the collection of Apiaceae germplasm has not been a priority for the Italian genebanks and breeding institutes.

The material held by the major genebank, the Institute for Germplasm, of the National Research Council in Bari, is provided with standard passport data, but has not yet been subject to evaluation. All Italian samples were collected on-farm in southern Italy.

Other samples of bitter fennel are present as living collections at the Departments of Agronomy of the Universities of Bologna and Bari.

Collecting missions

Missions aimed at germplasm surveying and collecting were carried out during recent years in marginal agricultural areas.

The Institute of Germplasm in Bari, in cooperation with the Academy of Science of the former DDR, did rather detailed surveys in southern Italy and Sicily, especially during the 1980s. The results of these surveys have been reported in several papers and summarized in a final report (Hammer *et al.* 1992).

During these surveys most of the material reported in Table 1 was collected. Minor species of the genera *Ammi*, *Anethum*, *Anthriscus*, *Carum*, *Chaerophyllum*, *Coriandrum*,

Crithmum, *Cuminum*, *Pastinaca*, *Pimpinella*, *Sium*, *Smyrnium* were observed and partially sampled as well.

An important part of the material held by the Istituto di Orticoltura e Floricoltura at the University of Catania consists of accessions sampled during collecting missions in Sicily (Branca, personal communication).

The situation of local germplasm in two marginal areas of the Toscana region was surveyed by the Department of Agronomy of the University of Firenze, within a programme funded by the region. A report on these activities was published (Nota *et al.* 1991). Collecting missions of the former Institute of Plant Breeding of the University of Torino, during which the above reported material was sampled, were carried out with particular focus on the Piemonte region.

Table 1. Accessions of the four major Apiaceae vegetables held by some Italian institutions.

Country of origin	Carrot	Fennel	Celery	Parsley
Istituto del Germoplasma, CNR, Bari				
Italy	15	31	24	24
Egypt	6	7	2	3
Japan	5	1	2	1
Albania	3	2	--	6
Libya	3	--	--	2
Algeria	--	--	--	1
China	--	--	1	--
Ethiopia	--	2	--	--
Istituto di Orticoltura e Floricoltura, University of Catania				
Italy	2	7+11 (wild)	7	15
DIVAPRA, sez. Miglioramento genetico e produzione sementi, University of Torino				
Italy	--	--	3	--
Istituto di Miglioramento genetico, University of Perugia				
Italy	--	(3, bitter)	--	1
Dipartimento di Agronomia, University of Firenze				
Italy	--	--	3	2

No relevant local type of the four major species was found during preliminary investigations carried out in northern Italy (D'Antuono, unpublished). It is very likely that a certain degree of variability exists in the area, especially for parsley and possibly celery. Similar surveys in central Italy (D'Antuono and Bacchetta 1990) brought out the survival of a once renowned local type of anise (*Pimpinella anisum* L.) on 2-3 hectares in the provinces of Macerata and Ascoli Piceno (Marche region).

Commercial material and germplasm held by seed companies

The present situation of commercial material of the four major species is hereafter summarized. In the following tables, *a-types* refer to genotypes registered either as *certified* or *standard* varieties; *b-types* to *standard* varieties.

Carrot

Varieties 412 and 35 (synonyms excluded) are registered in the European and Italian catalogues. The varieties exclusive of the Italian catalogue are reported in Table 2, together with the types belonging to the officially individuated derivatives of the *umbrella* varieties presently registered in Italy.

All varieties are medium or medium-late types, with a conical or cylindrical root, suitable for open-field production. None is of the short-rooted, early type. Despite the uncertainty of the origin of many of them, the types more likely derived from selection of locally adapted populations are: 'Fiumicino' (*a-type*), whose name, already known since prior to World War II derives from one of the typical production areas; 'Albenga' (from the Albenga plain, Liguria); 'Fucino' (name from the Fucino plain, Abruzzi); and 'Lunga cilindrica d'Ingegnoli'. 'Albenga' will be cancelled from the register because no application for maintenance breeding responsibility was submitted.

Missing among the *umbrella* varieties, are the 'Amsterdam' types that are bred but not conserved by several Italian companies. Three types of 'Nantes ameliorée' out of six are maintained by Italian firms. The preliminary evaluation of standard varieties was commenced by the Bologna office of the National organization for seed certification (Ente Nazionale Sementi Elette). Variability of some characters was found within variety (e.g. 'Nantes 2, 3, 5'; 'Chantenay 3' etc.), as well as among homologous types provided by different seed firms. The next step, that will begin in 1998 will be the correct identification and attribution to the standard recognized types of the samples provided by individual seed companies, in order to judge the acceptability of applications for maintenance breeding.

Table 2. Carrot varieties exclusive of the Italian catalogues and *umbrella-type* varieties (approved EU name in parentheses) registered in the Italian catalogue.

a-types	***b-types***	***umbrella* (all *b-types*)**
Birka (a2)	Albenga (b4)	Berlicum 2 (u1,)
Cartago (a2)	Fucino (b3)	(Berlicumer 2)
Cindy (a3)	Lunga cilindrica d'Ingegnoli (b3)	Chantenay Royal 2 (u1)
Delo (a2)	Nantes prima (b3)	Chantenay à coeur rouge 3 (u1)
Efeso (a2)	Nantes robur (b3)	(Chantenay 2 and 3)
Fiumicino (a1)	Ortolana (b1)	Flakkée 2 (u1,u3)
Lady (a1)	Rubrovitamina (b3)	(De Colmar 2)
Luxor (a3)		Nantese 2 (u1,u2,u3)
Rinascita (a2)		Nantese 3 (u1,u2,u3)
Scorpion (a2)		Nantese 5 (u1)
Spider (a2)		(Nantaise ameliorée 2, 3, 5)
Sundor (a3)		
Tosca (a3)		

Legend:
a1, b1, u1: Italian responsible for maintenance breeding
a2, b2: Italy-based foreign company responsible for maintenance breeding
a3, u3: foreign company responsible for maintenance breeding
b3: application for maintenance breeding responsibility submitted in Italy
b4: application for maintenance breeding responsibility not submitted in Italy

Fennel

Varieties 43 and 26 are registered in the European and Italian catalogues. Unlike carrot, Italy plays a major role in the European Union for seed certification. The fennel varieties registered exclusively in Italy are reported in Table 3, according to the same criteria used for carrot. Applications for maintenance breeding responsibility were submitted for all the *b-type* varieties currently without an official body responsible. If all applications are accepted, none of these varieties, many of which are of local origin, will be cancelled.

The only fennel *umbrella* variety ('di Firenze') has many synonyms in the European catalogue and also a Dutch body responsible for maintenance breeding. This demonstrates the importance of Italy as the origin of the fennel germplasm which is currently available.

Table 3. Fennel varieties exclusive of the Italian catalogue and *umbrella-type* varieties (approved EU name in parentheses) registered in the Italian catalogue.

a-types	***b-types***	***umbrella* (all *b-types*)**
Brino (a2)	Bianco perfezione (b1)	di Firenze (u1,u2)
Cervino (a1)	Cristallo (b1)	(di Firenze)
Chiarino (a1)	di Napoli (b3)	
Conero (a2)	di Sicilia (b3)	
Everest (a1)	Mantovano (b3)	
Fedro (a1)	Montebianco (b1)	
Marco (a1)	Romanesco (b3)	
Riace (a2)	Sirio (b2)	
Ronny (a1)	Wadenromen (b3)	
Tarquinio (a1)		
Tiber (a2)		
Tusco (a2)		

Legend: see Table 2

Celery and celeriac

There are 74 celery cultivars registered in the European catalogue, 23 of which are present in the Italian register. The situation of this species differs slightly from that of carrot and fennel (Table 4). In fact, *b-type* varieties prevail over *a-types*. Among *b-types*, most of the currently registered cultivars still do not have a body responsible for maintenance breeding. Many of them are probably of local origin ('del Valdarno', 'Dorato d'Asti', 'Gigante di Romagna', 'Rosso di Torino', 'Verde a coste piene d'estate'). All will remain on the Italian register. No application for maintenance breeding responsibility was submitted for 'Verde di Perpignano'.

The situation of celeriac is rather simple. Only two varieties are registered in the national catalogue, out of a total of 50 in the European list. Both are *b-types*. The 'di Verona' cultivar is probably selected from local material, currently without a body responsible for maintenance breeding, for which an application has been submitted. No application for 'Gigante friulano' was submitted; this variety will therefore be cancelled, but will probably remain in the Spanish register.

Parsley

Varieties 39 and 6 are registered in the Italian and European catalogues. All the varieties in Italy (Table 5) are exclusive of the national catalogue, except for the two belonging to *umbrella* types. 'Genovese' and 'Gigante di Napoli' are two renowned cultivars of local origin. No application for maintenance breeding responsibility was submitted for 'Paramount'.

Table 4. Celery varieties exclusive of the Italian catalogue and *umbrella-type* varieties (approved EU name in parentheses) registered in the Italian catalogue.

a-types	*b-types*	*umbrella (***all *b-types)***
Costa d'oro (a1)	del Valdarno (b3)	Gigante dorato 2 (u1)
Golden boy (a2)	Dorato d'Asti (b3)	(Golden self blanching 2)
Salbo (a1)	Florigreen (b2)	
Selendor (a1)	Fordhook (b3)	
Sigfrido (a1)	Gigante di Romagna (b3)	
	Lusia (b1)	
	Nicolaus invernale (b3)	
	Peros Rendy (b3)	
	Rosso di Torino (b3)	
	Verde a coste piene d'estate (b3)	
	Verde di Perpignano (b4)	

Legend: see Table 2

Table 5. Parsley varieties exclusive of the Italian catalogue and *umbrella-type* varieties (approved EU name in parentheses) registered in the Italian catalogue.

a-types	*b-types*	*umbrella (***all *b-types)***
----	Aromatico a costa rossa (b1)	Comune 2 (u1)
	Genovese (b3)	(Commun 2)
	Gigante di Napoli (b3)	Nano ricciuto (u1)
	Paramount (b4)	(Mooskrause 2)

Legend: see Table 2

Traditional uses and potential new interests

Several species of the Apiaceae family are Old World famous vegetable or condiment plants. Traditional uses of many of them therefore developed in many places. The present interest in traditional ways of life may play a role for the resumption of the use of old germplasm or the development of new small-scale selection activities.

The exploitation of a local purple carrot type in the Viterbo area (Lazio region), was reported in the 1930s (TCI 1931) and perhaps was still in course until about 20 years ago (Arieti 1985). Its roots were boiled, sliced, dried, stored and, according to need, re-hydrated and seasoned with vinegar, sugar and spices and used as a dressing for boiled meat. Seeds were preserved for a long time by a local family and by the nuns of a local convent. Recent surveys did not recover any seed of that type. Purple carrot types were sampled in southern Italy (Hammer *et al.* 1991). Interest in new purple types for niche markets has recently been documented (Simon *et al.* 1997).

Leaves of wild carrot are used in many parts of Italy as components of mixed salads. They are preferred to cultivated types for their stronger aroma and absence of pesticide contamination. To date, it would appear that no specific cultivation for this kind of product has occured. Wild carrot flowers are also used for croquettes in some places.

The use of bitter fennel *(Foeniculum vulgare* Mill. subsp. *piperitum* Ucria) as a condiment plant is extremely popular, especially in central Italy. All plant parts are used in specific recipes, but especially leaves and young seeds. The cultivation for the

production of fresh leaves and types with coloured leaves was started by some growers. This species is interesting for germplasm sampling and characterization.

Parsley is a very popular seasoning in Italy and largely grown in home gardens. Among major species, it is perhaps the one for which domestic seed production more often occurs. Therefore, germplasm variability has not yet been adequately sampled.

Many minor Apiaceae are used as condiment plants. Their use at the vegetative stage is becoming more and more popular and the cultivation of some species is increasing. Some companies are able to sell seed of these species, sometimes also practising basic selection of the main attributes (plant shape, earliness, growth habit, aptitude to regrowth, etc.). Germplasm of these species is therefore available, but not yet characterized or adequately sampled.

Many other species are used from wild stands and could be susceptible to basic domestication in the future.

Conclusions

This preliminary analysis of the current situation of the Apiaceae germplasm collection and uses in Italy has revealed the following:

- The attention of researchers involved in germplasm collection was mainly focused on the on-farm sampling in marginal areas of southern Italy. Very limited collection activity was done in the north. Germplasm held by seed firms was not collected at all by research institutions.
- The current regulation on standard seeds represents a favourable situation for the maintenance of variability. At present, quite a lot of diversity is held by seed companies, each of which made a different degree of selection in the material held. The advantages of this material over genebank accessions are: easy availability; availability in commercial quantities; and favourable characteristics for cultivation. However, according to the new regulation, all varieties without a body responsible for maintenance breeding will be excluded from certification from 1999. Therefore, there is a risk of loss of the less used varieties, for which nobody applied to take over the task.
- In the opinion of the seed companies' technical staff, *standard* varieties will be increasingly relegated to home production and non-professional growers, whereas professional horticulturists will use certified varieties and hybrids. This situation is already rather advanced for carrot and fennel and in progress for celery. As a consequence, there is no guarantee that the interest of seed companies on *standard* varieties derived from local material will be maintained in the future. As a result, much of the currently available material could be lost within 10-20 years.
- Germplasm of minor species, for which the varietal registration is not compulsory, is largely unknown and is presently in the hands of seed companies or single growers.

Strategies that could be considered, from the point of view of conservation of the Apiaceae germplasm in Italy are the following:

1. Large gaps of on-farm germplasm sampling seem to exist in northern Italy, especially with regard to parsley, celery and some minor species. Some sampling could therefore be worthwhile.
2. Seed companies played a very important role in germplasm preservation. Sampling of the germplasm presently held by seed companies may represent a priority, in view of the possible changes determined by new regulations at European level.
3. The characterization of the collected germplasm should be undertaken.
4. The study of germplasm of minor species is a completely open field.

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Status of the *Daucus* collection at the Nordic Gene Bank

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The Nordic Gene Bank (NGB) conserves plant genetic resources from the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden). NGB has a regional network of experts organized in crop working groups. The Vegetable Working Group collects and evaluates vegetable species including *Daucus*.

The collection

An inventory of Nordic carrot material includes 130 varieties. The NGB *Daucus* collection consists of 94 accessions. The status of the accessions appears in Table 1 below. Out of the 51 accessions under investigation, 33 accessions are either new or unverified varieties. Most of the material originates from Denmark (one from Sweden). All accessions have passport data and 63% are described to various extents according to the UPOV guidelines. There is no urgent need for multiplication and rejuvenation of the collection.

Table 1. *Daucus* material at the Nordic Gene Bank.

Active collection	Base collection	Under investigation	Safety-duplicate at Svalbard
94	38	51	7

Activities of the Working Group

- Four accessions are presently undergoing regeneration.
- Four accessions will be characterized during 1997.

Proposed activities for the future

- Repatriation of Nordic material from other genebanks.
- Evaluation of the material regarding nutritional quality and disease resistance.
- Further collection of data regarding origin and pedigree of the stored material.

Genetic resources of Umbelliferae vegetables in Poland

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Carrot

Carrot is an important vegetable crop in Poland. It is the third vegetable in economic importance after cabbage and onion. The total vegetable production in 1996 was estimated at 5.4 million tons, of which 5.1 million tons were ground vegetables. The area of field vegetable cultivation was 236 600 hectares. Carrot production was 794 000 tons and the area planted with carrots was 29 000 ha, with an average yield of 275 q/ha (Table 1). In 1975-78 carrot production was 14.5 kg per person, increasing to 20.8 kg in 1992-1995.

Average annual consumption of vegetable crops *per capita* in Poland during 1996 was 116 kg, of which 93% local produce. This figure is about 7% less than the *per capita* consumption in the previous few years (133.7 kg *per capita* in 1993). Carrot represents about 13% of vegetables consumption, cabbage 16%, and tomatoes 12%.

Table 1. Data on carrot production in Poland.

Year	Area (thousand ha)		Production (thousand tons)		Average carrot yield (q/ha)	Import of fresh vegetables (thousand tons)		Export of fresh vegetables (thousand tons)	
	Total GV[1]	Carrot	Total GV[1]	Carrot		Total	Carrot	Total	Carrot
1993	275.5	34.0	5875	931	274	139.9	17.0	215.3	6.7
1994	290.5	35.6	5107	786	221	118.6	4.2	244.5	22.5
1995	279.2	32.9	5643	814	247	144.1	12.6	142.2	5.8
1996	236.6	28.9	5104	794	275	110.0	8.0	177.5	7.0

[1] GV = ground vegetables

In 1995, the world production of carrot was 14.5 million tons, of which 4.6 million tons were European production. The major carrot producers in Europe are Poland (0.8 Mt = 5.6% of world carrot production), UK (0.7 Mt - 5.2%) and France (0.6 Mt - 4.4%) (Table 2).

Other umbellifers

In Poland, parsley, celery and dill belong to the group of aromatic vegetables. The average area of parsley cultivation is about 12 800 ha, yield 149 q/ha (14 900 kg/ha). Total production is about 190 000 tons. Celery is produced on 7000 ha, average yield is about 18 700 kg/ha. Total production is about 130 000 tons.

It is difficult to find detailed data about the production of parsley and celery because these vegetables are grown on smaller scales. Parsley is very commonly used in Polish kitchens.

Table 2. Carrot production in the world and in Europe.

Country	Area 1995 (thousand ha)	Yield 1995 (t/ha)	Production 1995 (thousand tons)	% of world production 1995	% of European production 1995	Production 1991-93 (kg/capita)
World	**673**	**21.5**	**14471**	**100**		**2.5**
Africa	66	12.3	804	5.6		1.1
N. America	63	30.8	1930	13.3		4.4
S. America	36	19	680	4.7		2
Asia	186	22.3	4147	28.7		1.1
Oceania	6	35.4	228	1.6		6.2
Europe	**143**	**32.5**	**4652**	**32.1**	**100**	**7.8**
France	18	36.6	641	4.4	14	9.9
Germany	8	39.4	297	2.1	6	3.1
Italy	11	43.3	468	3.2	10	8
Poland	33	24.7	814	5.6	17	21.3
Russia	100	12.5	1250	8.6	27	8.7
UK	17	44.8	751	5.2	16	13.3
The Netherlands	7	59.7	430	3	9	29.3
Spain	7	42.9	300	2.1	6	7.5
Ukraine	34	12	409	2.8	9	7.1

History

In Poland, documents recording carrot cultivation appeared in the herbarium in 1484 and in a calendar from the 17th century describing carrot cultivation in detail. In his book "Vegetables in the field" (1886), Kaczyński recommended the carrot cultivars 'Bez serca' (without heart), 'Brunszwicka long', 'Duwicka Karota', 'Holenderska' (Dutch), 'Nantejska Karota', 'Nantejska improved' and 'Paryzka'. Almost 40 years later, Brzeziński (1925) recommended the cultivars 'Karota paryska', 'Karota z Guerande', 'Półdługa nantejska' (Semi-long) and 'Długa z St.Valery' (long).

Cultivars grown in Germany in the 1950s included 'Pariser Markt', 'Duwicker', 'Londonen Markt', 'Nantaiser', 'Touchon', 'Amsterdamer Treib', 'Erstling', 'Lange rote', and others (Becker-Dillingen 1950). During the same period, the Soviet Union cultivated Russian selections of these cultivars as well as many cultivars and landraces that had originated from the Central Asian Republics such as 'Mirzoj yellow', 'Mirzoj red', 'Mszak', 'White Ukrainian', 'Greenheaded', and 'Loberichskaja' (Ejchfield 1948). Many of these cultivars are still cultivated (Sazonowa and Własowa 1990).

The cultivars that were introduced into Poland from Europe and from the Soviet Union became well-known after World War II. At that time, the carrot cultivars 'Paryska', 'Duwicka', 'Amsterdamska', 'Pierwszy Zbior', 'Nantejska', 'Lenka',

'Perfekcja', 'Amager' and 'Londyńska' were grown. They were selected on the basis of the foreign cultivars mentioned above (Niec 1949, Edelsztajn 1950, Chroboczek 1977).

The first two Polish carrot cultivars 'Selecta' (from the cross 'Nantejska' × 'Randers' made in 1941) and 'Lenka' (derived from 'Nantejska'), were bred in the 1950s. Many carrot cultivars were used for many years, though their number has been decreasing year after year. Many of the very well-known old cultivars have been lost. However, some are still maintained by breeders, farmers or in genebanks.

Some of the old Polish cultivars ('Amsterdamska', 'Pierwszy Zbiór', 'Nantejska', 'Lenka', 'Selecta', 'Perfekcja', 'Amager') are still listed in the 1996 National Register, mostly as F_1 hybrids bred during the past few years ('Kalina', 'Regulska', 'Koral', 'Dolanka', 'Karo' F_1). Unfortunately, the turnover of cultivars is so rapid that we must pay great attention in the genebank to preserving the obsolete open-pollinated cultivars and old cultivars that are not grown anymore.

In 1996 the National Register included the following cultivars:

- carrot: 14 Polish open-pollinated cultivars of which five registered in 1955 ('Amsterdamska', 'Pierwszy Zbiór', 'Lenka', 'Nantejska', 'Perfekcja') and 49 foreign cultivars, mainly F_1 hybrids, Dutch and few French, German;
- parsley: six cultivars of which four Polish (three since 1955 - 'Lenka', 'Berlinska', 'Cukrowa'), and two Dutch;
- celery: 15 root cultivars of which six Polish (one since 1955 - 'Jablkowy', one since 1975 - 'Odrzanski') and nine Dutch and German;
- parsnip: no cultivars on the list; and
- dill: two Polish cultivars since 1990 (and six native cultivars in register trials).

Genetic resources activities

Plant genetic resources play an important role in crop improvement programmes as sources of gene donors. Of special importance are landraces that are adapted to local environments and can provide useful traits for broadening the genetic base of crops. Wild relatives of crops species are also useful in plant breeding as gene sources for pest and disease resistance, and for tolerance to environmental stresses. Loss of genetic diversity implies the loss of these diverse genes. As extinction of local germplasm has recently been aggravated by an increasing adoption of hybrid cultivars and by socioeconomic changes in agriculture, collecting and preserving local germplasm becomes an urgent necessity.

Conservation of vegetable germplasm in Poland was initiated in 1982. In 1988, the Plant Genetic Resources Laboratory of the Research Institute of Vegetable Crops at Skierniewice took over the responsibility for the conservation of vegetable crops genetic resources in Poland. This task is part of a National Programme coordinated by the Centre for Plant Genetic Resources (IHAR) in Radzików. This National Programme is part of and supported by the Polish Ministry of Agriculture.

The Vegetable Germplasm Conservation Programme performs all essential functions related to genetic resources of vegetable crops, including: collecting primitive forms, landraces, old and new cultivars and wild relatives; documentation; storage;

evaluation; increases; screening for donors of important characters; services to users; exchange of material and information; and collaboration.

Umbelliferae germplasm in Poland

The Polish germplasm collection consists of:

- carrot: 80 accessions (39 cultivars, 33 landraces, eight breeding lines) that are readily available for distribution, and 30 additional accessions that are not yet included in the collection, but will be after regeneration;
- parsley: 47 accessions (15 cultivars, 32 landraces);
- celery: 10 accessions (six cultivars, four landraces);
- parsnip: three accessions (one cultivar, two landraces);
- dill: 45 accessions (three cultivars, 42 landraces).

Number, type and origin of accessions maintained are shown in Tables 3 and 4 below.

Table 3. Number of accessions in the genebank.

Origin	Number of accessions				
	Carrot	Parsley	Celery	Parsnip	Dill
Albania	1	1			
China	1		1		
Denmark		5			
France		3			
Germany	2				
Hungary				1	
Japan	20		2		
Kirgizistan	1				
The Netherlands	2	3			
Poland	**27**	**20**	**5**	**1**	**29**
Russia	3	1		1	1
Slovakia	8	5			4
USA.	4				
Ukraine	4	9	2		11
Uzbekistan	7				
Total	**80**	**47**	**10**	**3**	**45**

Table 4. Type and origin of accessions.

Origin	Advanced cultivars					Landraces					Breeding lines	Old cvs.
	Carrot	Parsley	Celery	Parsnip	Dill	Carrot	Parsley	Celery	Parsnip	Dill	Carrot	Carrot
Albania						1	1					
China						1		1				
Denmark		5										
Germany	2											
France		3										
Japan	20		2									
Kirgizistan						1						
Poland	**9**	**3**	**4**		**2**	**10**	**17**	**1**	**1**	**27**	**7**	
Russia	2	1		1	1						1	1
Slovakia						8	5			4		
Holland	2	3										
U.S.A.	3					1						
Ukraine						4	9	2		11		
Uzbekistan						7						
Hungary									1			
Total	**38**	**15**	**6**	**1**	**3**	**33**	**32**	**4**	**2**	**42**	**8**	**1**

Characterization and evaluation

Passport data for the accessions are nearly complete although for some accessions of foreign origin some characters are not yet known.

Ten accessions of carrot from the genebank have been characterized at PlantiCo Szymanów, for 15 morphological and economical traits, following descriptor lists partly established by UPOV and partly developed by the Institute of Vegetable Crops in collaboration with breeders (Araj *et al.* 1994).

In 1995, in collaboration with the PGR Laboratory and PHRO-Krzeszowice (Production and Breeding of Horticultural Plants Ltd.), a germplasm collecting plan was established with the objective of evaluating accessions for characteristics important to breeders and processors, and for disease resistance. At present, this collection includes 55 accessions from the genebank. During 1996, 39 accessions of this group were characterized for 38 traits of leaves and roots. In addition, the chemical composition of six components was evaluated. Part of the material has been screened for resistance to *Erwinia carotovora* and *Alternaria* sp. Results of these evaluations have partly been included in the electronic database.

The accessions of parsley, celery and dill were partly evaluated during multiplication according to descriptors used by breeders.

Regeneration

The first seeds of Polish advanced cultivars of carrot, celery and parsley were deposited in the genebank in 1982 for storage. Dill and parsnip were deposited in 1992. Most of these cultivars are still used in production. The accessions which are taken from storage for evaluation are also regenerated. These accessions are not duplicated elsewhere.

Storage

The collected material is stored at the Central Gene Bank in Radzików. Seeds are dried to 5-7% moisture content and stored in screw-type glass jars at -4^{0}C for short-term storage or at -18^{0}C for long-term storage.

Collecting explorations

Explorations within Poland are organized each year to collect indigenous germplasm. This includes visits to local markets and small isolated villages, particularly in the southern, eastern, and northern regions of Poland where farmers still maintain local cultivars of various vegetables (including umbellifer vegetables) in small quantities for home use. When no seeds were available, we asked the farmers to save some for us from their next seed production. Carrot, parsley, celery and parsnip landraces are becoming very rare. Our explorations between 1988 and 1996 have resulted in collecting 38 accessions of carrot, 32 of parsley, three of celery, 42 of dill (Table 5). The collecting regions of the accessions mentioned above are shown on Figure 1. Each seed sample collected is split in two parts: one part is added into the base collection; the other is used for regeneration and preliminary evaluation.

Figure 1. Collecting sites of umbellifers in Poland, 1988-1996
(coloured areas = regions of cultivation and breeding; coloured squares = collecting sites)

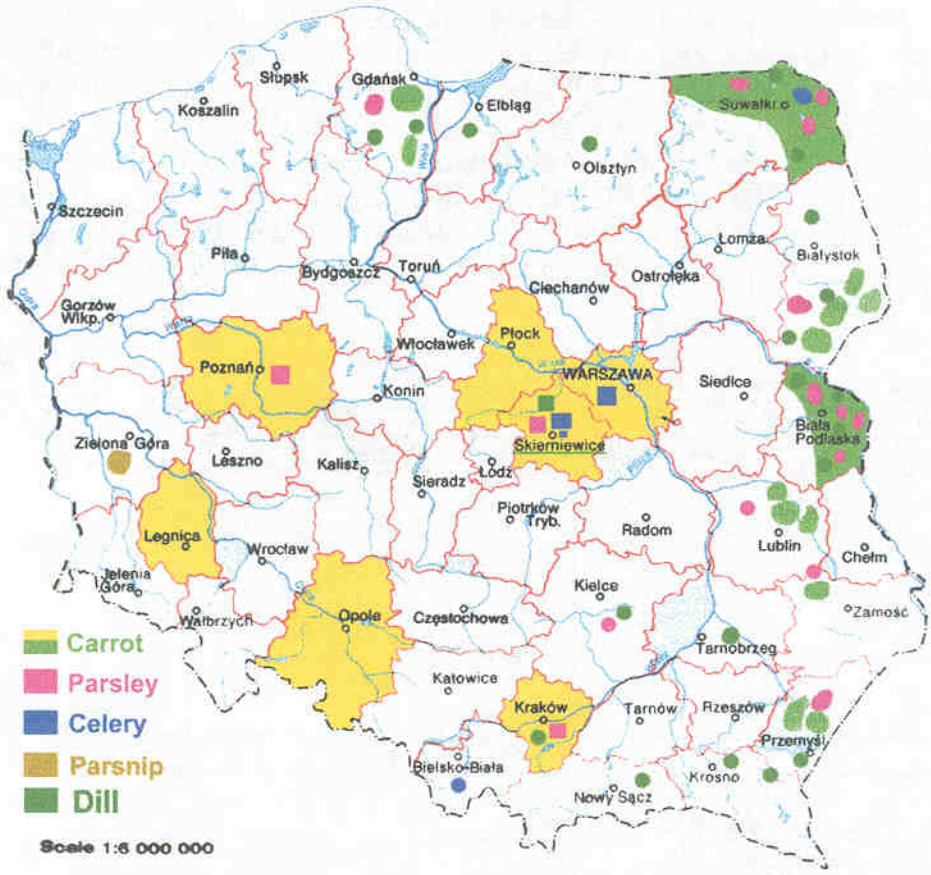

Table 5. Accessions collected during missions organized since 1988.

Year	Organization	Area	Number of accessions			
			carrot	parsley	celery	dill
1988	VIR-Petersburg	Uzbekistan, Kazakstan, Tajikstan, Kirgyzstan	2			
1989	VIR-Petersburg, USDA-USA	Uzbekistan, Kazakstan, Tajikstan, Kirgyzstan, Turkmenistan	8			
1990	VIR-Petersburg, POLSKV-Skierniewice	West Siberia, Altaj mountains	2			
1991	MAFF-Japan, POLSKV	around south/east/north parts of Poland	6	5		7
1993	POLSKV	Provinces: Przemysl, Krosno, Nowy Sacz	1	1		4
1993	POLSKV	Provinces: Kielce, Tarnobrzeg, Przemysl	1			2
1994	Albania	POLIHAR, Radzików		1		
1994	POLSKV, POLIHAR	Province Suwalki	1	4	1	5
1995	POLSKV	Province Biala Podlaska	5	7		9
1996	POLIHAR-Radzików	Ukraine, Slovakia, Poland	12	14	2	15
		Total	**38**	**32**	**3**	**42**

Utilization and perspectives

Between 1990 and 1997, the following were introduced in the genebank: from the country, eight accessions of carrot, one parsley, five celery, 10 dill; and from abroad, 40 carrot, 11 parsley, two celery and one dill seed samples (Table 6). We distributed 138 carrot, 59 parsley, five celery and 51 dill seed samples to breeders and scientists in the country and 35 samples of carrot, three of parsley, six of celery and four of dill to users abroad (Table 7). Accessions made available to breeding companies (PlantiCo Szymanów, PlantiCo Golebiew, POLAN-Kraków, Spójna Nochow, and PHRO-Krzeszowice, PHNO-Snowidza, Agricultural University Kraków) were screened for resistance to *Erwinia carotovora* and *Alternaria* sp., and for potential sources of carotene, and as pattern cultivars.

Table 6. Number of accessions introduced in the genebank.

Year	Breeding comp., Inst., Univ.				Abroad			
	carrot	parsley	celery	dill	carrot	parsley	celery	dill
1990								
1991	1		2	2	5	8		
1992		1			12			
1993				6				
1994	7		2	2	4	2	2	
1995			1		14			
1996					2	1		1
1997(I-V)					3			
Total	**8**	**1**	**5**	**10**	**40**	**11**	**2**	**1**

Table 7. Number of accessions distributed since 1990.

Year	Breed. comp., Inst., Univ.				Abroad			
	carrot	parsley	celery	dill	carrot	parsley	celery	dill
1990	23				16			
1991	34	8		6				
1992	12							
1993					4	3	3	1
1994					7		3	3
1995	18	4	2	5				
1996	11	14		10				
1997(I-V)	40	33	3	30	8			
Total	**138**	**59**	**5**	**51**	**35**	**3**	**6**	**4**

Additional accessions were distributed to breeders for inclusion in their breeding programmes as a new source of traits that might contribute to genetic variability for broadening the genetic base.

The most requested materials are those providing new sources of resistance to diseases, pests and environmental stress tolerance. The breeders often prefer these sources in cultivars rather than in wild or primitive populations. Users often look for

foreign carrot and parsley cultivars that are used as standards for various economic traits.

We have directed our research in plant genetic resources towards improving the availability of useful germplasm. Our objectives are: to accumulate data on important characteristics of conserved germplasm; to develop further the database management system; to publish the catalogues; and to expand the exchange of germplasm and information. We believe that this approach will serve the breeders and all other users more effectively.

The following additional recommendations can further improve the utilization of germplasm:

- Place the working collection in the hands of breeders for inclusion in their ongoing programmes. Morphological and economic evaluation of variability must be supplemented by newer techniques like isozyme electrophoresis, and the application of molecular markers. It will also help identify duplicates within the collected material, search, and classify the marker genes for beneficial characters.
- Expand collaboration with research laboratories at agricultural universities (e.g. Kraków Agricultural University) and breeding companies, where facilities and expertise for specialized analyses are available.
- Decide whether or not native F_1 hybrids ought to be preserved in the Gene Bank.
- For carrot cultivars and wild relatives that are deposited in the Gene Bank, prepare descriptors compatible with the international system (IPGRI), and make them available to breeders.
- Develop international collaboration with other networks, institutions and non-governmental organizations.
- Enlarge the genepool of existing native Polish landraces by collecting as many as possible.
- In order to help protect the breeding possessions for the future, obligate or commit Polish breeders to provide the Gene Bank with representative samples of their cultivars immediately after deletion from the National Register, as well as any valuable breeding material that they have at their disposal

Conclusions

In spite of budgetary limitations, every effort is made to build up the carrot Gene Bank in Poland. Explorations are organized every year to collect and preserve indigenous germplasm, identify, search for economic traits including resistance to pests and pathogens, tolerance to environmental stresses, and carotene content. The collection is growing and the material is available to breeders and scientists in Poland and abroad. Collaboration with research centres at universities and other non-governmental organizations in Poland and abroad will speed up identifying important characteristics and duplicates within the collected material, and classify marker genes for useful characters.

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Current state of research activities on carrots at the Department of Genetics, Plant Breeding and Seed Science, Kraków Agricultural University

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Research on carrot at Kraków Agricultural University has been carried out for about 30 years. It mainly deals with methodological studies on breeding and seed production of F_1 hybrids. The following studies have been carried out over the last five years:

- Analysis of male sterility molecular mechanisms by study on mitochondrial DNA.
- Development of molecular markers (RAPD) useful for cultivar identification, F_1 hybrid seed purity test, analysis of genetic diversity.
- Resistance breeding to *Erwinia carotovora*: development of a laboratory slice test to assess resistance to *Erwinia*; evaluation of collections of carotene carrot type cultivars; search for resistance genes within progenies of several crosses between cultivated carrot and wild subspecies; application of *in vitro* selection in callus cultures in the presence of a crude bacterial culture filtrate.
- Attempts to use selection *in vitro* for resistance to *Alternaria* have recently begun.
- Genetic differences in nutritional composition of carrot roots (sugar, carotene, heavy metals, nitrates).
- Assessment of combining ability for important traits.
- Evaluation of morphological traits in a collection of breeding lines, cultivars and F_1 hybrids.

In addition, several other studies were done in the past including:

- Genetic studies on the male sterility source from cultivar 'Selecta'.
- Cytological investigations on microsporogenesis in male sterile plants.
- Acceleration of the generative stage development.
- Habit of seed plants, yield and quality of seeds.
- Heterosis in seed yield and quality.
- Fungal flora of seeds.
- Pollen viability of partially fertile plants.

The Department maintains breeding lines of carotene type and several breeding materials from crosses between local varieties from Asia and wild carrot subspecies.

In 1997 the Department organized the 5th Meeting of the EUCARPIA Carrot Working Group. The meeting was an opportunity for the evaluation of a collection of 100 F_1 and open-pollinated cultivars from eight countries.

The Department cooperates closely with Polish carrot breeding companies.

Collection of *Daucus carota* L. at the N.I. Vavilov Institute

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The collection of carrot (*Daucus carota* L.) dates back to 1925 when the first accessions of cultivated carrot were registered at the Institute of Plant Industry. These accessions were the seed samples shipped by various breeding companies from the United States, United Kingdom, France, Germany, Austria, as well as local landraces from Afghanistan, Iran, Uzbekistan, Turkey, etc. The carrot collection at VIR currently comprises 1001 accessions originated from 60 countries.

This collection represents all known intraspecific diversity of cultivated carrot which, according to the classification of Sechkarev (1971) and Sazonova (1990), includes three subspecies, four varietal groups and 11 varieties (Table 1).

Table 1. Intraspecific classification of *Daucus carota* L. and number of accessions in the VIR collection.

Taxonomic names	No. of accessions
A. subsp. *gingidium* (L.) Small	1
B. subsp. *carota*	
I. convar. *carota*	10
II. convar. *sativus* (Hoffm.) Setch.	
1. var. *sativus*	23
2. var. *sulfureus Alef.*	22
3. var. *atrorubrus* Alef.	1
4. var. *aurantuus* Alef.	865
C. subsp. *orientalis* (Rubasch.) Setch.	
III. convar. *orientalis*	11
IV. convar. *afghanicus*	
5. var. *afghanicus*	2
6. var. *shavrovii* Mazk.	25
7. var. *setcharevii* Sazon.	1
8. var. *zhukowskii* (Mazk.) Setch.	21
9. var. *roseus* Mazk.	1
10. var. *boissierii* (Schweinf) Mazk.	10
11. var. *vavilovii* Mazk.	8

The basic part of the collection consists of a diverse range of European carotene carrot cultivars represented by such varietal types as 'Amager' ('Flakker'), 'Valery', 'Guerande', 'Chantenay', 'Amsterdam', 'Berlicumer', 'Nantes', 'Grelo', 'Karotter'. Each of these varietal types is characterized by a comparatively stable set of morphological traits in leaf and root.

Extremely great variability is observed in commercial biological characters of cultivars, which have been conditioned by different geographic and ecological

cultivation environments. Central Asian yellow, pink and orange carrot forms are characterized by high levels of earliness, drought resistance and cold hardiness. There is a group of high-yielding cultivars for different regions of Russia and the republics of the Community of Independent States (CIS). There are non-boltering varieties adapted to long days.

In Russia carrots are reported to be afflicted by 26 forms of fungal, bacterial and viral diseases, five species of insects and five species of nematodes. The most harmful carrot diseases are bacteriosis (*Erwinia carotovora* (Jon.) Holl.), storage rot (*Sclerotinia sclerotiniorum* (Lib.) *et* By.), black rot (*Alternaria radicinia* M.D. *et* E.), grey rot (*Botritis cinerea* Pers.) and phomosis (*Phoma rostupii* Saer).

In northwest Russia carrots are subject to considerable attacks from the carrot leaf hopper (*Trioza viridula*) and rust-fly (*Psylla rosae* F.). Cultivars manifest strong differentiation in their reaction to fungal and bacterial diseases. No carrot forms with high resistance to pests have been identified.

Carrot cultivars also show high differentiation in the content of chemical components: dry matter, 10-13%; total sugars, 5-6.5%; ascorbic acid, 1-11 mg/100 g; carotene, from 0 to 20-25 mg/100g.

Carrot cultivars capable of preserving commercial quality of root with up to 90% carotene content reaching 15-17 mg/100 g after 200-250 days of cold storage have been identified.

The carrot collection is preserved in viable conditions at the National Genebank in cold rooms. Seed regeneration is performed at the Institute's Experiment Stations in Pushkin near St. Petersburg, Moscow Province, Volgograd, Maikop and Krymsk. Active collections are stored in St. Petersburg at the Department of Vegetable Crops and Cucurbits. They have been widely used in comprehensive studies, for the exchange of seed samples with foreign institutions, and also to supply plant breeding centres with basic breeding materials.

Carrot genetic diversity is studied not only at the above-mentioned sites, but also in Murmansk Province at the Polar Experiment Station. All accumulated germplasm undergoes quarantine tests according to conventional international standards.

The comprehensive study of the worldwide diversity of carrot cultivars covers all morphological, biological, commercial, biochemical and immunological traits in the major agricultural areas of Russia. The analysis of experimental data helps identify genetic sources for further breeding by individual traits and by complex sets of such traits.

The Vavilov Institute works in close cooperation with various breeding institutions of Russia and former republics of the ex-USSR.

In the period from 1995 to 1997 VIR sent out 77 samples of carrot accessions, thus satisfying requests received from The Netherlands, USA, India, Vietnam, Poland, Peru,

Bolivia and other countries. In exchange the Institute received 27 carrot samples from abroad.

Over 20 cultivars and hybrids have been bred and commercialized in Russia using genetic sources from the carrot collection of VIR.

VIR's challenges for the near future are:

- to finalize the development of the passport database on carrot germplasm;
- to continue regeneration of collection accessions; and
- to create an evaluation database on the basis of experimental research results.

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Carrot and other Umbellifers in the United Kingdom

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Horticulture Research International Genetic Resources Unit (HRIGRU)

The Genetic Resources Unit's main umbellifer collection is *Daucus*, including carrot and wild taxa. Other smaller collections of umbels are maintained (Table 1). The seed material is packed in foil laminate pouches and maintained under long-term storage conditions at 5% seed moisture content and -20^0C. Accessions are regenerated in isolation compartments using flies as the pollination agent. Data relating to the collections are stored in dBase in passport, stock and characterization files. An MS-Access database will be commissioned shortly for the whole HRIGRU documentation system. The characterization of the carrot collection has used a modified UPOV descriptor list following discussions with Jonathan Davey in SASA. In future any material grown for characterization will be used to capture a series of images relating to various aspects of the growth cycle including whole plant, leaf morphology, umbel and root characteristics. The images will be associated with the HRIGRU documentation system in due course.

The European Umbellifer Database (EUDB) is under development by Dave Astley. Currently the EUDB contains 3018 accessions representing the nine umbellifer genera including crops and wild taxa from seven institutions in six countries. The ECP/GR Umbellifer Working Group has a page on the ECP/GR Information Platform. In the near future this will be linked to a downloadable version of the EUDB at HRI.

Horticulture Research International carrot evaluation

The primary traits for evaluation are carrot fly attack (*Psylla rosae*) and the soilborne disease cavity spot (*Pythium* sp.). Both are major limiting factors in European Union carrot production and require high chemical inputs for adequate control. Genetic variation is known for both traits, but is poorly documented within genetic resource collections. HRI has a specialized facility for carrot fly research and access to known documented sites where cavity spot is prevalent. Laboratory inoculation is possible for the evaluation of cavity spot resistance and is used to supplement field data, if necessary, but results correlate only moderately with field performance

Evaluation of both traits needs production of mature roots and as a secondary objective the following traits are assessed: tendency to annual/biennial habit, foliage glabrous/pubescent, foliage persistence, root yield, shape, percentage of splitting, percentage of dry matter, skin and core colour, and general acceptability for current market requirements.

Scottish Agricultural Science Agency (SASA), East Craigs

Jonathan Davey has responsibility for the statutory variety testing for a number of vegetable crops including carrot. He maintains a reference collection of carrot including obsolete cultivars and some traditional selections (Table 1). His work involves the routine characterization of candidate varieties and the development of "tools" for the work, which includes developments in documentation and image analysis.

Table 1. Umbellifer accessions maintained in the UK.

Institution	*Daucus*		*Apium*	*Coriandrum*	*Pastinaca*	*Petroselinum*
	cultivated	wild				
HRIGRU	735	61	36	3	20	21
SASA	548		116			

University of Reading

Steven Jury is a taxonomist working on umbellifers including *Daucus*. He is currently collaborating on a revision of the book "The Umbels of Great Britain".

Royal Botanic Garden Edinburgh

Mark Watson is a taxonomist working on the Apiaceae mainly of China and the Himalaya. He is collaborating with Stephen Downie, University of Illinois on the molecular systematics of the Apiaceae.

The Henry Doubleday Research Association (HDRA), Ryton-on-Dunsmore

The HDRA is an NGO that maintains and distributes a vegetable heritage collection for use by its members. The collection includes traditional varieties no longer available commercially on the Common Catalogue, and current cultivars identified as suitable for organic production and use by amateur growers.

A network approach to the conservation of *Daucus* genetic resources

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This paper is a plagiarized version of a presentation I gave on networks for *Allium* conservation at the International Symposium on Alliums for the Tropics in Bangkok in 1993. The objective was to consider the pros and cons of the "network approach" to the conservation of *Daucus* genetic resources using the European Cooperative Programme for Crop Genetic Resources Networks (ECP/GR) as a discussion model. However, in a meeting of the members of the *ad hoc Daucus* group a decision was taken to broaden the remit of the group to Umbellifers encompassing the following nine genera: *Anethum* (dill); *Apium* (celery); *Carum* (caraway); *Chaerophyllum* (chervil); *Coriandrum* (coriander); *Daucus* (carrot); *Foeniculum* (fennel); *Pastinaca* (parsnip); and *Petroselinum* (parsley). Therefore comments referring to carrot and *Daucus* in the text are relevant to taxa in all nine genera.

In a multidisciplinary science programme where the "target" genus or crop are as taxonomically complex as *Daucus* or as widely spread geographically as carrot, it is difficult for an individual scientist or institute to cope with more than a small proportion of the total work. It follows then that individuals can work in isolation or can share the workload, to whatever degree, with colleagues having mutual interests. For the conservation of plant genetic resources this ethic of shared responsibility is considered to be a basic working principle with the resulting germplasm and information being for the benefit of mankind. It is increasingly important that scientific practice meets the demands of this moral principle.

In the development of a genetic resources programme for *Daucus*, irrespective of its scope (national, regional or global), there are clear objectives that can be identified.

1. A focal point - a network programme needs the stability provided by both a secretariat and a scientific coordinator. Once either is in place, the primary step is to identify all parties interested in *Daucus* work and nominate a group of experts representing all geopolitical areas and scientific disciplines to act as an executive coordinating and technical advisory body for the wider network.
2. What exists in collections? – to identify all collections containing *Daucus* germplasm and develop a database of passport data as a management tool.
3. Define the technical requirements and working practices for the maintenance of seed collections (short- and long-term conservation, regeneration, etc.) based on the IPGRI/FAO base/active/working collection principles:
   - base: the sum of all unique material which should be maintained under long-term storage conditions;
   - active: a collection containing accessions of sufficient size and quality that they are available to users;
   - working: a collection held for a specific use.

Ascertain in detail the working practice of individual collections (base / active / working) and the current status of each accession (seed weight / viability).

Identify institutes with the necessary expertise and capability (resources and financial) willing to act as a base or active conservation centres for seed.

4. Base and active collection curators to identify material to be included in the base collections, and coordinate the transfer of seed and associated data to the base centres.
5. Identify institutes with the necessary expertise and capability (resources and financial) willing to be active in the seed regeneration programmes.
6. Based on the accumulated knowledge from network experts (genebankers, breeders, taxonomists, other scientists, NGOs and amateur growers), identify: (i) gaps in the base collections and plan a campaign to collect the relevant germplasm through national programmes, bi- and multilateral associations; (ii) the presence of duplicate accessions within the various collections using the database.
7. Coordinate the characterization of the various collections; encourage evaluation, utilization and the return of relevant data to the database(s).
8. Ensure the security of collections through the development of security duplicate collections stored under long-term conditions, and observance of international agreements.
9. Collaborative research programmes on conservation techniques and utilization throughout the global network will enhance the efficiency and the value of the germplasm collections.

The responsibility for a network is governed by the interests and commitment of its constituent members. Therefore the degree of direct involvement of the network members in evaluation and utilization will reflect their own interests.

Astley (1992) discussed the success of these "actions" in the development of the ECP / GR *Allium* Working Group based on feedback from the network membership. I will review the main points discussed in relation to the numbered points above and then outline some options for the future conservation of *Daucus* genetic resources.

Network initiation

In 1995 the ECP / GR Technical Advisory Committee recommended the provision of financial support for secretariat assistance and a preliminary meeting in the development of the ECP / GR *Daucus* Working Group based on a proposal from Horticulture Research International, United Kingdom. Each national representative has the responsibility to act as an informal national *Daucus* coordinator to extend the network into all aspects of national programmes. Individuals interested in establishing a *Daucus* network are aware of the benefits that accrue from the coordination and shared responsibility of a network system; and that a formal Secretariat offers distinct advantages in the coordination of group activities. The loss of support at any level (Secretariat, meetings, inputs-in-kind from governments for conservation, collection, documentation, etc.) would result in serious consequences for the network activities leading to genetic erosion, duplication of effort and a reduction in economic efficiency.

Database development

The scientific community will benefit from the development of a *Daucus* database permitting a coordinated approach to collection, taxonomy, conservation, characterization and evaluation. The Directory of European PGR collections[6] lists 4822 *Daucus* accessions in 33 collections in 20 countries. In a wider context there is a paucity of knowledge on the existence and content of *Daucus* collections outside the ECP/GR and USDA.

Base/active collections

The IPGRI/FAO Seed Storage Committee recommended technical standards for the long-term conservation of collections. All collections included in the Directory should accept the responsibility: (i) to provide samples to the nominated base collections; (ii) to prioritize the regeneration of material originating within their national territory; (iii) to distribute material on request; and (iv) to characterize accessions, and obtain meaningful data from users returning both data sets to the central database. The status of individual accessions in active collections should be determined by the curators with each accession tagged as being available or not.

There have been few, if any, *in situ* conservation programmes directly targeting wild *Daucus* taxa, although many wild populations do benefit by existing within conservation areas. There is a clear need for all *Daucus* workers to promote *in situ* conservation for wild taxa in their spheres of influence.

Base collections

These designations have been partly successful with the base collections receiving duplicate samples from a number of the active collections, although there is still a proportion of material in the active collections not represented in the base collections. In addition, characterization is progressing at differing rates within the various national programmes.

Regeneration

One of the major gaps in the system is the lack of a coordinated network of institutes for seed regeneration. Some national programmes do not have the resources to regenerate large numbers of accessions under controlled pollination conditions. Therefore germplasm accessions regenerated by the base store curators are subjected to selection pressures under environmental conditions away from their area of origin. It is essential to develop a coordinated approach to the problem of regeneration.

Identify gaps and duplicates

The group is meeting in tandem with the EUCARPIA *Daucus* symposium providing the opportunity for consultation with a broad spectrum of scientists. Such discussion

[6] Frison, E. and J. Serwinski. 1995. Directory of European institutions holding crop genetic resources collections. Fourth edition. Vol. 1 and 2. International Plant Genetic Resources Institute, Rome, Italy.

fora allow the group members to update their thinking and develop recommendations on *Daucus* taxonomy, collection strategies etc. in specific areas, e.g. need to collect landraces and specific wild taxa. The responsibility for collection of germplasm has been devolved to national programmes.

Evaluation and selection work is in progress to improve the quality and performance of carrot crops. Research workers utilizing carrot have to be very conscious that relatively few local landraces still exist and should promote the collection and conservation of this material. The "green revolution" and changes in traditional agriculture have led to the rapid genetic erosion of landraces in many crops including carrot. National genebanks and research workers have to be encouraged through participation in networks to collect and conserve landrace germplasm, and fully document its culture, uses and value in the local community.

One problem faced by curators, who have limited experience in taxonomy, is how to deal with wild taxa, many accessions of which are of dubious taxonomic identification and have little if any provenance data. In order to reduce these problems the group agreed to identify individuals willing to advise on taxonomic problems for *Daucus*.

The duplication (multiple occurrence) of accessions in collections was not considered significant taking account of the small size of total European holdings, the breeding system in *Daucus,* genotype × environment interaction and the possibility of accessions having the same name in different collections representing different genotypes. As the methods for routine screening of molecular markers become cheaper, simpler to use and faster, there will be a more pragmatic approach to the question of screening genotype duplication.

Characterization and minimal evaluation

Individual curators should have the responsibility to characterize their own collections and forward the information to the central database. In order to standardize the characters scored, a list of minimal characterization descriptors has to be defined and agreed for carrot and wild taxa. The choice of minimal descriptors should reflect their practical value in selecting material from genetic resources collections.

It is unlikely that any genetic resources curator would go beyond scoring minimal characterization descriptors. However, it is important that the curators and network national representatives advertize the availability of collections to users. The database should be available via the Internet and via national programmes and international organizations.

Safety-duplication

Various genebanks have been recorded in IPGRI literature as agreeing to act as base collections and safety-duplicate centres for *Daucus*. It is important that a ‘black-box’ type of safety-duplication is available to all collection curators wishing to deposit such security collections of *Daucus* genetic resources. Accessions in active collections that are not represented in base collections and those of low-seed weight in base stores are at risk. One of the objectives of a network is to minimize these risks. However, a

majority of national genetic resources programmes and the international collaborative initiatives are under-funded for the broad spectrum of work that is expected of them.

Research

The value of collections can be enhanced significantly through utilization and research. There is a need for research inputs in several areas, including: seed storage techniques (ultra-low seed moisture contents (Ellis *et al.* 1996), genetic / physiological damage in storage), disease indexing, molecular and biochemical studies on genetic diversity enhancing the efficiency of collection management, utilization and taxonomic studies.

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Appendix I. Proposal submitted to the ECP/GR Steering Comittee meeting in Braunschweig, June 1998, recommending to establish an Umbellifer Working Group

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Background

An *ad hoc* group of workers interested in carrot/*Daucus* corresponded both within Europe (ECP/GR) and with other scientists in USA and Japan. The European scientists presented a case to the ECP/GR Steering Committee in Nitra for the establishment of a *Daucus* Crop Working Group. The Steering Committee agreed to support an *ad hoc* meeting of the Group within the Vegetable Network of ECP/GR.

The Group met in August 1997 in conjunction with the 5th meeting of the EUCARPIA Carrot Working Group hosted by the Dept. of Genetics, University of Agriculture, Kraków, Poland. There was broad interest in the *ad hoc* meeting with 17 participants from 13 ECP/GR countries plus a representative from the USDA Root and Bulb Advisory Group.

Ad hoc meeting of the Group

The discussions led to the realization that within the Group and national programmes there was a broader interest in umbelliferous crops, in addition to carrot/*Daucus*. Also many participants declared multiple interests in umbelliferous crops. The Group decided it would be logical and more efficient to combine all these interests into an Umbellifer Crops Working Group. However, with such a potentially large number of genera within the Umbelliferae, a decision was taken to limit interest and activities to nine genera including *Anethum* (dill), *Apium* (celery), *Carum* (caraway), *Chaerophyllum* (chervil), *Coriandrum* (coriander), *Daucus* (carrot), *Foeniculum* (fennel), *Pastinaca* (parsnip) and *Petroselinum* (parsley). **The Group concluded that a recommendation be forwarded to the ECP/GR Steering Committee seeking a formal endorsement of the Umbellifer Working Group within the ECP/GR Vegetable Network.**

There has been no coordinated effort in Europe, or indeed elsewhere, to collect, conserve, document and make available to users the genetic resources of these umbelliferous crops and their wild relatives. The Group discussed all the aspects of genetic resources conservation for these genera, highlighting specific areas requiring immediate action. The formalization of a list of action points has led already to some significant developments within the Group. A European Umbellifer Database is under development by the Genetic Resources Unit at Horticulture Research International (HRI), Wellesbourne, UK. Initially this will be limited to passport data stored in the IPGRI/FAO Multicrop Passport Descriptor format. Currently there are no agreed ECP/GR minimal characterization descriptors for these crops. Sub-groups with

specific interests in the various crops will develop the necessary characterization and evaluation descriptors in due course. The Group was very aware of the value of a database in identifying gaps in existing collections and directing future characterization, evaluation and collecting programmes.

Members of the Group are resubmitting a carrot genetic resources proposal to the third call of the EC 1467/94 GENRES programme. This project encompasses all aspects of genetic resources work for this important crop including documentation, characterization, regeneration, evaluation, core collection development and the collection of material to fill gaps. A successful GENRES project would give tremendous impetus to the overall work of this Working Group.

Tatyana Khmelinskaya, the curator of the *Daucus* collection at the N.I. Vavilov Institute of Plant Industry (VIR) outlined the status of that collection and the requirement for immediate action in the regeneration of some accessions. Several institutes offered to assist VIR, particularly for the regeneration of landraces of carrot. This collaboration has been initiated with four national programmes having received accessions from VIR, regeneration will be initiated in the 1998/99 season.

Dr Phil Simon described the USDA carrot programme and invited collaboration with the European Group in a number of areas. The USDA will organize collecting expeditions in southeastern Europe in 1999/2000. Various members in the Group have been in contact with Phil Simon to plan joint exploration missions. In addition, members of the Group will visit Dr Simon this current year to develop collaboration on the molecular characterization of carrot and related wild *Daucus* taxa.

The Group recognized that the taxonomy of the various genera, and in particular *Daucus*, poses problems for collection curators in both the management of collections and the distribution of unvalidated material. A list of taxonomic experts has been drawn up and these contacts will hopefully assist in studies of the taxonomic problems associated with genetic resources collections.

The importance of the safety-duplication of accessions in existing collections was recognized. The participants felt that the establishment of the European database would provide a better basis for the coordination of this important task.

Finally the Group recognized the value of such a meeting to discuss their mutual interests and problems. They were appreciative of the encouragement and support of the ECP/GR Steering Committee and looked forward to a productive collaboration within the Umbellifer Group.

Appendix II. Agenda

ECP/GR Workshop on *Daucus* Genetic Resources

Kraków, Poland, 31 August 1997

1. Opening statement and election of Chairman for the day

2. Brief overview of ECP/GR and crop Working Group philosophy

3. Definition of the scope of the Group (carrot/*Daucus* or Umbelliferae/crops)

4. Review of collections (what exists where - Directory of European PGR collections - additional info)

5. Opportunities to create a European *Daucus* (Umbelliferae) Database

6. Discussion on standard passport descriptors (based on the Multicrop passport descriptors list adopted in Budapest - October 1996)

7. Opportunities to develop a minimal list of characterization and evaluation descriptors

8. Review on collecting needs and methodology (including opportunities for ecogeographical surveys and local knowledge/utilization)

9. Taxonomy (creation of a roster of experts in Europe)

10. Opportunities for safety-duplication (bilateral agreements, 'black-box' arrangements)

11. The future of the *Daucus*/Umbelliferae Group
    - Workplans
    - *Daucus* within ECP/GR
    - Collaborative projects for the enhancement of *Daucus* (umbellifer) genetic resources, i.e. description/study of the genetic variation of some species, evaluation/screening, etc.
    - Listings of genealogies for recent cultivars, reference list of old varieties, bibliographic list of references of interest for carrot/Umbelliferae genetic resources
    - Other sources of money (re-submission of project proposals - EC 1467/94, etc.)

12. Election of the Chairperson until the next meeting and closing remarks.

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