

Report of a Working Group on *Malus/Pyrus*

First meeting
15-17 May 1997
Dublin, Ireland



L. Maggioni, R. Janes, A. Hayes, T. Swinburne
and **E. Lipman**, *compilers*



Errata

Appendix I, page 91

- Descriptor 14. Status of sample
Should read:

14. Status of sample		(SAMPSTAT)
1 Wild	0	Unknown
2 Weedy		
3 Traditional cultivar/Landrace	99	Other (Elaborate in REMARKS field)
4 Breeder's line		
5 Advanced cultivar		

- Descriptor A. Plant use
Modified to:

A. Plant use		(PLANTUSE)
The character may be scored using only the global codes 1 or 2 (or 99). If more information is available, then the more detailed coding may be used (e.g. 1.1). An accession with multiple uses should be scored using the relevant codes separated by a semicolon (e.g. 1.1; 2.3).		
1 Fruit	2	Tree
1.1 Dessert	2.1	Pollinator
1.2 Cooking/Food processing	2.2	Ornamental
1.3 Juice/Cider	2.3	Stock
	2.4	Wild
99 Other (Elaborate in REMARKS field)		

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The International Plant Genetic Resources Institute (IPGRI) is an autonomous international scientific organization, supported by the Consultative Group on International Agricultural Research (CGIAR). IPGRI's mandate is to advance the conservation and use of plant genetic resources for the benefit of present and future generations. IPGRI's headquarters is based in Rome, Italy, with offices in another 14 countries worldwide. It operates through three programmes: (1) the Plant Genetic Resources Programme, (2) the CGIAR Genetic Resources Support Programme, and (3) the International Network for the Improvement of Banana and Plantain (INIBAP). The international status of IPGRI is conferred under an Establishment Agreement which, by January 1998, had been signed and ratified by the Governments of Algeria, Australia, Belgium, Benin, Bolivia, Brazil, Burkina Faso, Cameroon, Chile, China, Congo, Costa Rica, Côte d'Ivoire, Cyprus, Czech Republic, Denmark, Ecuador, Egypt, Greece, Guinea, Hungary, India, Indonesia, Iran, Israel, Italy, Jordan, Kenya, Malaysia, Mauritania, Morocco, Pakistan, Panama, Peru, Poland, Portugal, Romania, Russia, Senegal, Slovak Republic, Sudan, Switzerland, Syria, Tunisia, Turkey, Uganda and Ukraine.

Financial support for the Research Agenda of IPGRI is provided by the Governments of Australia, Austria, Belgium, Brazil, Bulgaria, Canada, China, Croatia, Cyprus, Czech Republic, Denmark, Estonia, F.R. Yugoslavia (Serbia and Montenegro), Finland, France, Germany, Greece, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Republic of Korea, Latvia, Lithuania, Luxembourg, Malta, Mexico, Monaco, the Netherlands, Norway, Pakistan, the Philippines, Poland, Portugal, Romania, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, the UK, the USA and by the Asian Development Bank, Common Fund for Commodities, Technical Centre for Agricultural and Rural Cooperation (CTA), European Union, Food and Agriculture Organization of the United Nations (FAO), International Development Research Centre (IDRC), International Fund for Agricultural Development (IFAD), International Association for the promotion of cooperation with scientists from the New Independent States of the former Soviet Union (INTAS), Interamerican Development Bank, United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP) and the World Bank.

The European Cooperative Programme for Crop Genetic Resources Networks (ECP/GR) is a collaborative programme among most European countries aimed at ensuring the long-term conservation and facilitating the increased utilization of plant genetic resources in Europe. The Programme, which is entirely financed by the participating countries and is coordinated by IPGRI, is overseen by a Steering Committee (previously Technical Consultative Committee, TCC) composed of National Coordinators nominated by the participating countries and a number of relevant international bodies. The Programme operates through ten broadly focused networks in which activities are carried out through a number of permanent working groups or through ad hoc actions. The ECP/GR networks deal with either groups of crops (cereals, forages, vegetables, grain legumes, fruit, minor crops, industrial crops and potato) or general themes related to plant genetic resources (documentation and information, *in situ* and on-farm conservation, technical cooperation). Members of the working groups and other scientists from participating countries carry out an agreed workplan with their own resources as inputs in kind to the Programme.

The geographical designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of IPGRI or the CGIAR concerning the legal status of any country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries. Similarly, the views expressed are those of the authors and do not necessarily reflect the views of these participating organizations.

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Part I. Discussion and Recommendations

Introduction

Welcoming address

Lorenzo Maggioni, ECP/GR Coordinator, welcomed all the participants and the observers to the first formal meeting of the ECP/GR Working Group on *Malus/Pyrus* on behalf of IPGRI and conveyed the greetings of the director of the Europe Group, Dr Thomas Gass. He then thanked Anita Hayes of the Seed Saver Association for the excellent organization of the meeting, in collaboration with Wye College and particularly with the help of Dr Rachel Janes. He also thanked the University College of Dublin (UCD) and the Department of Agriculture for facilitating and supporting the event. He then mentioned that contributions were received by members who were unable to attend but represent nonetheless an integral part of the Group. Representatives of FAO and ASSINSEL were also invited, but were unable to attend. In a letter addressed to IPGRI, Dr Mohamed Zehni of FAO has expressed the importance of this meeting to the Seed and Plant Genetic Resources Service (AGPS). L. Maggioni informed the Group that at the end of a Working Group meeting it is customary to elect a Chair who remains in charge until the end of the following meeting. For the time being, considering the active role taken for the organization of the Workshop on *Malus* genetic resources at Wye College in 1995 and for the coordination of the project on *Malus* genetic resources recently submitted to the EC, Dr Terry Swinburne was invited to act as Chair of the present meeting. The Group approved this suggestion.

Opening address

On behalf of the Department of Agriculture, Food and Forestry, Don Feeley extended a warm welcome to all delegates attending this conference. He wished the participants a pleasant visit to Dublin, and that there would be some time to enjoy the Guinness and perhaps the rain. D. Feeley apologized for the absence of Dr I. Byrne, National Coordinator, who was attending the FAO Commission on Genetic Resources for Food and Agriculture in Rome. He then acknowledged this as the first meeting of the *Malus/Pyrus* Working Group and wished to congratulate Ms Anita Hayes for her success in arranging to have this meeting in Dublin. The Department of Agriculture, Food and Forestry has responsibility for the conservation of genetic resources for food and agriculture and readily identifies with her work on conservation activities on *Malus* and *Pyrus*. He went on to say a few words on conservation activities in Ireland. Ireland ratified the Convention on Biological Diversity on 26 March 1996. National legislation on genetic resources is the remit of the Department of Arts, Culture and the Gaeltacht, who are responsible for the conservation of wild plants, wild animals and natural habitats, and for Special Areas of Conservation (SACs). The Department of Agriculture, Food and Forestry have responsibility for genetic resources insofar as they relate to food and agriculture only. The Minister for Agriculture, Food and Forestry set up a representative Committee on Genetic Resources for Food and Agriculture in July 1996 to advise and aid in the development and implementation of plans aimed at the conservation of genetic resources for food and agriculture. A budget has been provided to fund research

programmes approved by this Committee. One of the projects, the Lamb-Clarke Historical Apple Collection, funded in 1996 is relevant to this meeting. He mentioned that the Department of Agriculture is continuing to fund part of this work again this year and wished Professor Hennerty and Ms Hayes every success with this important work. D. Feeley mentioned also the following projects to which the Advisory Committee have provided funding for conservation activities:

- a *Lolium perenne* Core Collection project which involves a collaborative effort with 17 other European countries
- conservation of old Irish cereal varieties
- conservation of the Galway sheep breed
- conservation of Kerry cattle breed.

He pointed out that national activities of this type are fulfilling Irish obligations under the Convention on Biological Diversity and implementing the Global Plan of Action as agreed in Leipzig in 1996. The Department of Agriculture is playing an active role in protecting the environment generally and conserving threatened species of plants and animals in particular.

Before concluding, D. Feeley commented briefly on the Department of Agriculture's experience and cooperation with NGOs in Ireland in the area of conservation of genetic resources. This involvement to date with NGOs relates to the Irish Seed Saver Association and the Irish Genetic Resources Conservation Trust. He said that this experience has been a positive one, since the Seed Savers are efficient and effective, operating at low budget costs and capable of working within frameworks provided by the Department of Agriculture. He said that Prof. Hennerty, representing the University sector, may share these sentiments. In conclusion he wished all the participants a very successful conference and an enjoyable stay in Dublin.

The apple in Ireland and University College Dublin

Michael Hennerty, Head of the Department of Crop Science, Horticulture and Forestry, University College Dublin (UCD), welcomed the group to Ireland and University College Dublin and wished the participants a successful and rewarding meeting. He considered appropriate the choice of Dublin for the first meeting of the ECP/GR Working Group on *Malus/Pyrus*, because it has ancient associations with the apple. He explained that about 50 km from here is the Boyne Valley which contains enormous and mysterious monuments, such as the one at Newgrange, which were built in 5200 BC by people we know little about. Inside some of these monuments, in a prominent position, apple trees, which had been cut off at the base of the trunk, were found standing upright. Obviously the apple tree was of some significance to these people. An ancient mummified apple was recently found at Haughey's Fort in County Armagh, the major apple-producing district in Ireland. This apple has been found to be about 3000 years old. It is now being DNA-tested to determine if this was a cultivated, rather than a wild apple. If it proves to be cultivated, he said, this will be the oldest example of its type in existence. St. Patrick converted the Irish to Christianity in the 5th century and the dietary instructions he gave to his followers are still available. Apples were an important dietary component, but it is unclear if these apples were wild or cultivated. Recent research at the Viking settlement at Dublin, which is over 1000 years old, has also found evidence that apples were a major

component of the diet of the time. Again we do not know if they were cultivated. The Normans were the next invaders of Ireland and with them they brought many apple cultivars, especially cider varieties. M. Hennerty said that we know they cultivated their apples because some of their orchards are still standing. The arrival of the English added to the diversity of apples, because they also brought their cultivars with them. Thereafter an enthusiasm for apple breeding developed in Ireland which reached its climax in the last century.

M. Hennerty explained that, together with the Irish Seed Saver Association and the Armagh Orchard Trust, in UCD they are attempting to locate and conserve these old Irish cultivars before they become extinct. A report on this progress is given later (see p. 28). UCD, through its Faculty of Agriculture, has a long association with the apple. The Faculty has its roots in the Glasnevin Institute founded in 1838, which is the oldest institution of its kind in these islands. It was renamed Albert Agricultural College after the visit of Prince Albert in 1853 and in 1860 the first lecturer in Horticulture was appointed. In 1890 Dr E.C. McWeeney described the potato blight fungus, which had devastated the Irish population in the 1840s, and its control with copper sulphate and lime. It has been said that few agricultural discoveries have been so completely successful, or so widely adopted.

In 1901-03 Sir Frederick Moore laid down the first replicated apple trial in these islands, which consisted of a number of cultivars (Bramley's Seedling, Annie Elizabeth, Gascoyne's Scarlet and Golden Spire) on seedling rootstocks. The first trial with Hatton's rootstocks, which were later named Malling rootstocks, was laid down in 1926 by Dr G.O. Sherrard, the year Albert College became part of UCD. The stocks used were M1, M2, M7, M9, M13 and M16 worked with a wide range of cultivars. In 1936 it was clear that the spacing used in 1926 was too wide and a new trial with the same material was planted in 1936. In 1940 Professor E.J. Clarke published his pioneering work on the relationship between soil type and apple nutrition. Nine years later Dr J.G.D. Lamb presented his PhD thesis on the history of the apple in Ireland with descriptions of the old Irish apples he had collected. In 1980 the Faculty moved from Albert College to the main campus here at Belfield and the orchard moved here also in 1987. M. Hennerty explained that the new Lamb-Clarke Irish Historical Apple Collection, named after these two outstanding pomologists, both of whom are alive today, was planted in the UCD orchard this year and he hoped the Group could visit it during the meeting.

Anita Hayes thanked the Department of Agriculture for their support. In addition thanks were extended to Dr Michael Hennerty and the staff of University College Dublin for their hospitality and their assistance in arranging the meeting.

Terry Swinburne asked all the participants to briefly introduce themselves and to approve the agenda. He then invited everyone to actively interact in the technical discussions and asked François Laurens and Marc Lateur to help the reciprocal understanding within the Group with occasional summaries in French.

Information on ECP/GR

L. Maggioni informed the participants, a number of whom were present for the first time at an ECP/GR meeting, of the changes in the structure and mode of operation of the Programme, as decided in the meeting of the Technical

Consultative Committee (TCC) in Nitra, Slovakia in September 1995. It was also at this meeting that the constitution of a Working Group on *Malus/Pyrus* was decided. The new structure of the Programme, which is composed of crop-specific Networks and thematic Networks, was presented and the type of activities carried out within each of these was illustrated. He summarized the most recent ECP/GR events, such as the Documentation meeting in Budapest (October 1996) and the participation of non-EU countries in EU-funded projects (EC 1467/94), such as the projects on *Prunus* and on *Vitis* genetic resources. The existence of a Web site for ECP/GR was mentioned, as well as the preparation of a prototype Internet Information Platform on Crop Genetic Resources.¹ This will be the framework to interconnect and provide on-line access to the European Central Crop Databases. The imminence of the end of Phase V of ECP/GR (at the end of 1998), was mentioned, and the opportunity to formulate recommendations for the future of the *Malus/Pyrus* Working Group to the Steering Committee was emphasized. L. Maggioni informed the participants that this committee will meet during the summer of 1998 and that a first draft strategy for the implementation of the Global Plan of Action in Europe, through the activities of ECP/GR, has been circulated to members of the Steering Committee.

¹ As of June 1997 the European Information Platform on Crop Genetic Resources can be consulted at the following URL: <http://www.cgiar.org/ecpgr/platform>

European *Malus* Database and Project EC 1467/94

Project EC 1467/94

T. Swinburne, coordinator of the project proposal on *Malus* genetic resources to the EC, reported on the outcome of the submission. The proposal was unsuccessful, although it received some good comments, such as the presence of many participating countries. On the other hand, its approach was judged insufficiently scientific. It was perceived by the coordinator that work for the construction of the *Malus* database was insufficiently advanced, when compared with the status of projects successfully submitted. Another problem seemed to have been the size of the funding requested. In view of a potential resubmission of the proposal, T. Swinburne suggested that descriptor data should already be included in the database, and that a further request for funding should focus on the introduction of evaluation data. He therefore stressed the need to define a set of priority characters of common interest for evaluation during this meeting. In the discussion it was also suggested that special emphasis be placed upon the screening of genetic material, with the purpose of identifying varieties suitable for different uses such as juice extraction, as well as for pest- and disease-resistant environmentally friendly cultivation.

*The Group agreed with this interpretation of the reasons why the project was rejected and welcomed the offer of T. Swinburne to coordinate a new project proposal along the lines suggested, in view of the third call of proposals. L. Maggioni informed the Group that this call is expected for the autumn of 1997 and that a deadline for the presentation of proposals is likely to be three months after this date.² The option of also presenting a similar proposal for *Pyrus* genetic resources was taken into consideration. The Group acknowledged that a *Pyrus* project could be more appealing for EU funding, since this crop has received less attention in Europe so far and, differently from *Malus*, it does not present an overproduction problem. M.F. Tarbouriech will look into the possibility of a French institute undertaking the coordination.*

The Group recommends that ECP/GR continue the approach of facilitating the participation of non-EU countries in EU-funded projects, such as in the cases of Allium, Beta, maize, potato, Prunus and Vitis projects.

Presentation of the *Malus* Database

The CORE-STORE for *Malus* database has been developed by Horticulture Research International, Wellesbourne and Wye College, University of London under a contract from the UK Ministry of Agriculture, Fisheries and Food for use in the UK National Fruit Collection (NFC). The database was designed to meet the specific curatorial requirements of the NFC, but possesses features which will be central to the functioning of the European database.

R. Janes demonstrated the database, emphasizing both features specific to the NFC and those essential to the European database:

- Individual accessions
 - Passport data
 - Germplasm use records
 - Horticultural management records

² As of February 1998, the third call for proposals had not been announced yet.

- Cultivars
 - Parentage
 - Synonyms
- Countries
- Institutes
- Colleagues
- Multicrop Passport Descriptors List

T. Swinburne confirmed that Wye College is willing to accept the commitment of filling the CORE-STORE database with the data from the European Working Group partners, as a necessary step towards the implementation of a Malus European Database. The Group agreed to provide the agreed multicrop passport data to Wye College by November 1997 and that Wye College would make the database available as a diskette or CD-ROM and eventually on Internet. R. Janes will contact other national Malus database managers in the near future to request accessions data.

Opportunities of establishing a *Pyrus* database

*Opportunities of establishing a *Pyrus* database were discussed and the Group agreed that this would be welcome. It was considered appropriate that the same structure of the Malus database be adopted in this case. Wye College would prefer not to commit itself with the hosting of a second database, but suggested that it might be possible by negotiation to utilize the CORE-STORE structure for this purpose. Marie-France Tarbouriech explained that the French national database already includes some descriptors for *Pyrus* accessions and the Group suggested that this could be the embryo for a European *Pyrus* database. M.-F. Tarbouriech accepted to consult the French National Coordinator as to the possibility of France taking on this commitment. N. Braniste expressed the availability of his institute to assist in the task. M. Lateur mentioned that his institute may be able to become responsible for the European *Pyrus* database. He will check on the feasibility of this with the full support of the Malus/*Pyrus* Working Group.*

Multicrop Passport Descriptors List for data exchange

L. Maggioni summarized how the production of descriptors lists by IPGRI (and formerly by IBPGR) was a dynamic process in continuous evolution. He explained that this led to a situation in which some common descriptors are defined in different ways and that this is complicating the documentation, especially in cases where genebanks are dealing with multiple crops. The development of a core list of passport descriptors that would be standard for all crops was recently undertaken by IPGRI and FAO. The resulting Multicrop passport descriptors list was presented to the European database managers during the ECP/GR Documentation workshop in Budapest 1996. An agreement was reached there to adopt a slightly modified list as a standard format for data exchange.

The final version of this list was presented to the Group that decided, after some debate, to adopt it with minor modifications (see Appendix I). Two extra fields were requested entitled 'Plant Use' and 'Parentage'. These will be defined as follows:

Multicrop Passport Descriptor A - Plant Use (PLANTUSE)

The coding scheme proposed can be used at two levels of detail: either by using the global codes (1 or 2) or by using the more detailed coding (e.g. 1.1).

1 Fruit

- 1.1 Dessert
- 1.2 Cooking/Processing
- 1.3 Juice/Cider
- 1.4 Multipurpose

2 Tree

- 2.1 Pollinator
- 2.2 Ornamental
- 2.3 Root/Interstock
- 2.4 Multipurpose

99 **Other** (elaborate in Remarks field)

Multicrop Passport Descriptor B - Parentage (PARENTAGE)

- 1 Mutant - (a vegetative mutant of a known cultivar)
- 2 Open-pollinated - (only the mother is known)
- 3 Controlled cross - (both parents are known)
- 4 Seedling/unknown origin - (no information regarding parentage is known)

The opportunity to add more fields may be considered in the future. The inclusion of a field for 'Collector's name' was considered irrelevant, since this information is unknown for the majority of the accessions. It was also considered unnecessary to create a passport field to note mutant accessions (sports), since this information could be included in the parentage data. A clarification was made that, as a general guideline, the database would include modern cultivars with registered names or after passing the UPOV tests for distinctness, uniformity and stability, old varieties and wild species. Only a limited number of genetic stocks, such as breeding material under test or

breeders' lines, should be included where these have formed part of published research programmes.

Minimum Descriptors List for characterization

R. Janes presented a proposed list of Minimum Descriptors for *Malus*. This is detailed in Appendix II and was based on the following sources of information:

- Results of the European Study: a study was carried out in France, Belgium, Italy and the United Kingdom. The aim of this study was to utilize multivariate statistical techniques in identifying suitable characters for inclusion in the Minimum Descriptors List for *Malus* with the purpose of assisting the discrimination of duplicates (see Part II, Presented papers, p. 24)
- Suggestions from European colleagues (Jan Blažek, Vassiliy Djouvinov, Marc Lateur, Bronislovas Gelvonauskis and Alison Lean) - lists A and B in Appendix II
- IBPGR Descriptor List for Apple, 1982
- UPOV Guidelines for the conduct of tests for distinctness, uniformity and stability - Apple TG/14/8, 1995.

In the discussion it was concluded that the proposed list was too long. However, as fruit characters were more generally useful, and also easier to record, the number of floral characters proposed could be reduced. The following characters were then selected:

- *Season of flowering*
- *Flower bud colour*
- *Fruit harvest maturity*
- *Fruit size*
- *Fruit shape*
- *Fruit crowning at apex*
- *Fruit ground colour*
- *Fruit over colour*
- *Fruit over colour coverage and/or type.*

It was agreed that as far as possible the methods used should follow existing guidelines such as those used by UPOV. R. Janes, in consultation with M. Lateur and A. Lean, agreed to compile a set of procedures, relating to the agreed list of characters, from the existing guidelines, which will be circulated to Working Group members to be accepted by the end of 1997.

Opportunities for including evaluation data in the Database

Introduction

T. Swinburne pointed out that potential users of plant genetic resources require more information on accessions than is provided by passport data or botanical descriptors. The previous EC proposal focused on the basic components for a database, but having almost achieved this stage, the Group should now concentrate on the acquisition and inclusion of evaluation data. This work should form the basis of any future proposal to the EC programme.

The highest priority characters for evaluation to be included in the European Malus Database were the following:

- *Scab resistance*
- *Mildew resistance*
- *Canker resistance*
- *Fruit sugar/acid ratio*
- *Fruit firmness*
- *Fruit storage quality.*

Since a standardization of the procedures is essential, five subgroups accepted the task of defining draft standard protocol by the end of August 1997. This will be forwarded to the Chair and distributed to all members for a round of comments.

The subgroups for standard evaluation protocols are the following:

Canker:	<i>T. Swinburne and M. Lateur, E. Dapena de la Fuente</i>
Scab and mildew:	<i>F. Laurens and M. Lateur, in collaboration with E. Dapena de la Fuente, J. Blažek and V. Djouvinov</i>
Firmness:	<i>M. Lateur, V. Djouvinov and F. Laurens</i>
Storage quality:	<i>I. Hjalmarsson and M.F Tarbouriech</i>
Sugar/acid ratio:	<i>M. Lateur, V. Djouvinov and F. Laurens.</i>

The role of Non-Governmental Organizations in local and national conservation of *Malus* and *Pyrus* germplasm

A. Hayes described the working methodology of the Seed Savers' field research and heritage preservation in general and the unique role that NGOs can have in gathering information within rural communities. She described the history of the Native Irish Apple Project and the cooperative efforts of the Irish Seed Saver Association, The Armagh Orchard's Trust, Dr Michael Hennerty of University College Dublin and Dr Keith Lamb, a retired pomologist and the original researcher on the Irish Apple. She emphasized the role that the scientific community can play in verifying the field research work of the NGOs and bringing it forward to its full scientific and cultural potential, as well as the essential role that retired scientists can play in supporting the field efforts of NGOs.

James Choiseul described the establishment of the new Lamb-Clarke Apple collection, derived from the material relocated by the Irish NGOs, Irish Seed Savers and Armagh Orchard Trust. Cultivars were characterized using floral morphology and flowering time, supplemented with historical research. In the immediate future it is planned to determine the virus status of the accessions and describe the fruit. Medium-term plans include biomolecular characterization, production of virus-free stocks via meristem culture and disease-resistance evaluation.

Evica Mratinić informed the Group of the existence of some NGOs in F.R. Yugoslavia, mainly formed in recent years. They contribute on a voluntary basis to the conservation of the plant genetic resources.

L. Maggioni reported on the Italian experience of the NGO Association Pomona, which is collaborating with Universities and local administrations in an effort to trace old fruit tree varieties, rediscover their heritage and preserve them by transfer into private or public areas or natural parks. A project in the province of Piacenza was successful in discovering several old apple, pear and cherry varieties with local names. A large diversity was found in the surroundings of a medieval monastery in Tolla, where monks used to plant varieties with different harvesting times and storability, in order to offer fruits in every season to the pilgrims on their way to Rome.

Markus Kellerhals reported on the collation efforts between the Federal Research Station Wädenswil and the NGOs Fructus and Pro Specie Rara in Switzerland. The two NGOs are preparing data on addresses of collections and single-tree holders (on-farm conservation), passport and pomological data and site information.

R. Janes reported on a project to establish a UK Network for *Malus*. Many initiatives have been developed in recent years to address apple conservation in the UK, coordinated by either non-governmental organizations such as Common Ground or by governmental bodies such as the UK Ministry of Agriculture, Fisheries and Food (MAFF). Many botanic and heritage gardens possess extensive collections of apple species and cultivars, as do nurserymen and individual enthusiasts. However, there is no National register of collections and their holdings in the UK. This proposal is designed to redress that deficiency.

The apple collection held at Brogdale as part of the MAFF National Fruit Collections contains the largest number of authenticated cultivars on a single site

in Europe. This collection is funded by a joint research commission to Wye College, University of London, and the Brogdale Horticultural Trust and they have a national and international responsibility to ensure *Malus* germplasm conservation. However, although the collection currently contains over 2000 accessions, Wye College recognizes that these only partially span the genetic diversity contained within apple cultivars and species held in the UK as a whole. Wye College aims to set up a UK Network for *Malus* to identify the full extent of *Malus* genetic resources in Britain, and to compile a National register of collections. Hence, it would be possible to assess accurately which cultivars are rare or threatened, or indeed if enough duplicate collections exist in the UK to ensure long-term safety for apple diversity. Wye College intends that the Network complement and support the work of other apple conservation projects, and not conflicts with them. The Network will be coordinated by Wye College, with the full support of the Brogdale Horticultural Trust, Common Ground and MAFF. It is envisaged that with the increased awareness of the importance of conservation at a local level, Wye College will be increasingly supportive of *in situ* programmes in the future.

T. Swinburne asked the participants whether in their respective countries they had some relationship with non-governmental organizations. M.-F. Tarbouriech described the collaboration between formal and informal sectors in France. The communication is sometimes difficult since NGOs' interest is primarily social and cultural, while curators and breeders place the main attention on the potential use of the genetic resources. T. Swinburne confirmed the existence of the same type of conflicting priorities in the UK. These would need to be resolved by understanding mutual interests at a time when reciprocal collaboration is sought for the development of a European database. M. Lateur gave the example of his collection receiving several accessions from individuals and NGOs and reaffirmed the value and the potential of a collaborative approach, although this is not always achieved.

The Group was pleased to learn of the existence of valuable examples of collaboration between the formal plant genetic resources community and the NGOs. It was acknowledged that the advantages of looking into possible means of collaboration can be invaluable, since voluntary associations can find the time and the appropriate way to identify rare and threatened genetic material as well as its cultural and historical heritage. On the other hand NGOs can benefit from the empowerment and the assistance with long-term conservation that the formal sector can offer. An enhanced preservation and accessibility of genetic material should be the result of this interaction.

*The Group therefore recommended to actively seek to assist, help and foster this kind of useful collaboration. A step in this direction is the compilation of a list of NGOs involved in the conservation of *Malus* and *Pyrus* in each country. Members of the Working Group will prepare a national list and forward it to the ECP/GR Coordinator for inclusion in the present report by the end of September 1997 (see Appendix III).*

Safety-duplication of fruit tree accessions at European level

L. Maggioni introduced a discussion about the concept of safety-duplication, i.e. the duplication of an accession for safety reasons. He mentioned how safety-duplication is essential for ensuring sound conservation, with a minimized risk of losses and that this is also beneficial for the rationalization of collections, since accessions that are accessible and are safely duplicated once do not need to be conserved as multiple duplicates in many places. As an important criteria for safety, he quoted the conservation managed by financially stable institutions as well as the need to establish formal agreements for safety-duplication. Such agreements, preferably undertaken between different countries, would strengthen the mutual trust and the sharing of responsibilities. The formality of the agreements would ensure official recognition to the safety-duplication and also that emergency situations could be dealt with according to pre-established procedures. The Memorandum of Understanding between the Nordic Genebank and the Institute of Biology, Latvia, was presented as an example suitable for seed germplasm of safety-duplication agreement with a 'black-box' type of arrangement. In the case of fruit trees, a slightly different model of agreement should be developed, to take into account the different problems involved with the transfer of graft material and with the maintenance of bulky and demanding specimens.

The Chair asked the Group how they deal with the problem of safety-duplication. M. Hennerty reported that in Ireland three sites are dedicated to duplicating fruit trees and a fourth site is used in Northern Ireland. E. Bratberg said that NGB has made arrangements to safety-duplicate in two sites distributed within the Nordic Countries. M. Lateur reported that in Belgium only some accessions are present in more than one site. M. Kellerhals mentioned that in Switzerland they have started to multiply accessions in more than one site within the country and that *in situ* conservation is considered as a valid option. M. Fischer said that no duplicates are prepared at the moment in Germany and that an agreement with botanic gardens is foreseeable in the near future for safety-duplication. This would be badly needed, especially considering the risky low temperatures reached during the winter at Dresden-Pillnitz. T. Swinburne admitted that the UK National Collection is not formally duplicated elsewhere.

Manfred Fischer informed the Group of the current emergency situation at Maikop, Russian Federation, where the apple trees of the Vavilov collection are severely endangered and require duplication elsewhere. He also informed of the agreement under stipulation between IPGRI and the Vavilov Institute, based on which he would use US\$ 5000 of emergency funds to go and take scions of unique wild species for safety-duplication in Germany. This would be accompanied by a reciprocal duplication of German wild species at the Vavilov Institute.

During the discussion that followed, the concept of 'European collection' was generally outlined by L. Maggioni. This would be a decentralized collection comprising the apple and pear accessions that European genebanks would agree to maintain on behalf of all member countries of ECP/GR. Main objectives of this collection would be:

- to formalize the sharing of responsibilities for the conservation of European *Malus* and *Pyrus* genetic resources

- to ensure the safe conservation of these accessions
- to ensure the continued access to these accessions to all ECP/GR countries
- to reduce the workload for each country and encourage more effective and efficient conservation.

A workplan for the establishment of a European collection has been developed by the *Secale* Group and the Forages Working Group of ECP/GR and these can be taken as reference for the future by the *Malus/Pyrus* Group.

The Group agreed that the definition of European Malus and Pyrus Collections concept is reasonable and will have to be pursued. However, for the present time, considering the early stages of the Central Malus Database, it is considered too early to make decisions in terms of a practical commitment.

The Group acknowledged the validity of ensuring the safety-duplication of the accessions within framework agreements, although duplication of trees in different countries may sometimes be impractical owing to phytosanitary and climatic constraints. The Group recommended that IPGRI look into the drafting of a Memorandum of Understanding between countries specifically adapted to the transfer of fruit tree propagating material.

The estimated total number of apple accessions being 36 000, the Group considered it very important to speed up a mechanism by which the database could be used to identify accessions repeated in multiple copies and to especially highlight those unique at European level. This could be the first step towards a well-informed reduction or prioritization of the collections. In order to do that, the Group agreed to send a list of all the names and numbers of the accessions maintained to R. Janes by the end of May 1997. Cyrillic characters will have to be sent after the respective database manager has translated them into Roman characters.

Updates on country collections and recent collecting activities of *Malus* and *Pyrus*³

Belgium

Marc Lateur focused on *Pyrus* collections in Belgium, which are estimated to contain about 3580 accessions, including some 20% Belgian cultivars and 10% landraces. He indicated that problems of duplication and identification remain in most collections, and that the collecting of unique material, mostly landraces, is not yet finished.

Bulgaria

Vassiliy Djouvinov provided the following information on Bulgarian collections:

- *Malus*: 761 accessions including 43 of Bulgarian origin, 221 from USA, 86 from the former USSR, 54 from Great Britain, 37 from Germany, 32 from France, and others from Canada, China, Japan, Korea, Hungary, Poland, former Czechoslovakia, Yugoslavia etc.
- *Pyrus*: 234 accessions including 29 of Bulgarian origin; others are from France, Germany, USA, Great Britain, Italy, former USSR, Yugoslavia, China, Korea, Japan etc.

Cyprus

A message sent by Athena Della informed the group that there is no collection of local *Malus* and *Pyrus* species in Cyprus. However there is a collection of old introductions and commercial varieties in the Nursery of the Department of Agriculture, Ministry of Agriculture, Natural Resources and Environment (Saittas area). *Pyrus syriaca* Boiss. is grown from 150 to 1500 m of altitude. Sometimes it was planted or used as a stock for cultivated pears. The common pear is cultivated on a limited scale in the more elevated valleys. *Malus sylvestris* Miller, the apple, is extensively cultivated at high altitudes.

France

François Laurens explained that the conservation of apple and pear genetic resources in France is carried out by two organizations, AFCEV (French Association for the Conservation of Vegetal Species) and INRA. AFCEV is a non-governmental organization in charge of the management of fruit conservation throughout France. INRA-Angers is in charge of a collection of 1500 *Malus* and 1000 *Pyrus* accessions including wild species, rootstocks and cultivars (cider, juice and dessert apple and pear). Furthermore, BRG (Bureau des Ressources Génétiques), a governmental institution, aims to encourage various partners to manage more efficiently the genetic resources. BRG aims to develop a national agreement for the genetic resources of all species collected in France, in collaboration with different partners involved in genetic resources. A new National Database for apple and pear genetic resources is under development. It is estimated that data for about 3465 and 1202 unique accessions have been entered for apple and pear respectively. The national database will lead to an official list of accessions planted in France. The next step will be the characterization of all this material. The final step will be the selection of 100 to

³ Full papers, when available, are published in Part II.

200 accessions which represent the genetic variability of *Malus* and *Pyrus* germplasm in France.

Germany

Manfred Fischer explained that the *Malus* Genebank in Dresden-Pillnitz includes at the moment 997 cultivars and clones, 33 rootstocks and 382 species and wild-hybrids. Characterization and evaluation of wild species of *Malus* and *Pyrus* is planned to clarify taxonomic uncertainties and especially to find sources of scab, mildew and fire blight resistance. A special programme will be undertaken to evaluate *Malus sieversii* (Lodeb.) M. Roemer populations from Kazakstan, in cooperation with the Cornell University of Geneva. A list of all fruit cultivars of different institutions and NGOs in Germany is under preparation. This list at present includes 5526 accessions of 1861 apple cultivars and 687 accessions of 338 pear cultivars. It is planned to make this list available on the Internet.

Hungary

Tibor Szabó and Janos Apostol reported about the activities of the Research Station of Fruitgrowing at Újfehértó, which was commissioned by the Plant Genebank Council and the Ministry of Agriculture to maintain national field collections of apple, pear and other fruit trees. Accessions, including local varieties, improved and grown varieties, natural varieties related to cultivars, breeders lines and hybrids, are characterized for flowering and ripening time, fruit characteristics, growth habit, etc. There are plans to safety-duplicate the material and most of the pear varieties can already be found at the station of Keszthely, in western Hungary.

Ireland

James Choiseuil described the Lamb-Clarke Historical Irish Apple Collection, including 132 accessions of dessert, culinary and cider cultivars. Detail was given on the number of named cultivars, Irish and non-Irish cultivars and cultivars new to science.

Lithuania

Bronislovas Gelvonauskis presented the *Malus* collection which was initiated in 1938 at the Lithuanian Institute of Horticulture. It contains almost 600 accessions. More than 70% of them are of foreign origin, others are old local cultivars or were created at the Institute (cultivars and hybrids). The apple breeding programme aims at creating winterhardy, precocious apple cultivars, with excellent fruit quality and high storage potential. Donors of apple scab resistance have been used in breeding since the 1970s.

Netherlands

A message sent by Henk Kemp informed the group that in the Netherlands interest is increasing, in both the private and public sectors, for old apple and pear cultivars/germplasm. A list of the names of old apple and pear varieties included in the three most important collections in the Netherlands was made available to be included in the European *Malus* and *Pyrus* databases.

Poland

Zygmunt Grzyb indicated that the biggest collection of fruit trees is situated at the Research Institute of Pomology and Floriculture at Skierniewice. This field collection, which is financed by the Polish government, contains 907 accessions of *Malus* spp., 204 of *Pyrus* spp. and 154 of *Malus/Pyrus* rootstocks. It has suffered from harsh winters in the past years and in 1998 the collection will be established on a new site. The collection is partially characterized and evaluated, and data are computerized.

Another *Malus* collection is maintained in the Botanical Garden in Powsin near Warsaw. The collection is sponsored by the Ministry of Agriculture. It contains about 250 accessions, evaluated systematically according to UPOV's descriptors. The main task of the collection is to maintain the primitive autochthonous cvs. of Polish origin.

Other collections (*in situ*) have also been registered and their number is increasing, mostly in the northern part of Poland.

Romania

Nicolae Braniște described the National collection of fruit germplasm and the activities of conservation and evaluation, which are coordinated by the Ministry of Agriculture, in collaboration with the Genebank of Suceava. Currently about 1500 accessions of apple and pear have been inventoried. *Ex situ* collections of apple are located in Voinești and Bistrița, while pears are conserved at Pitești and Cluj stations.

Russian Federation

Vladimir Ponomarenko presented an overview of the collecting expeditions of VIR and illustrated with a slide show the geographic distribution of wild *Malus* and *Pyrus* species in the territory of the former Soviet Union. *Malus sieversii* (Lodeb.) M. Roemer was shown to be a species displaying a very high diversity, with fruits ranging from sweet to acid, to very bitter taste and weighing up to 200 g. The importance of focusing research on wild species and enabling access to them was stressed.

Slovakia

A message sent by Eva Šidová informed the group that collecting and conservation of *Malus* and *Pyrus* genetic resources in the Slovak Republic are coordinated by the Research Institute of Plant Production, Piešťany, within the framework of the National Programme. Collections of *Malus* and *Pyrus* are concentrated in the following three research institutes, which host, under different climate conditions, local and foreign varieties, clones and breeding selections:

- Research Institute of Fruit and Decorative Trees, joint stock company Bojnice
- Herbaton Ltd., Klčov
- Slovak University of Agriculture, Nitra.

Spain

Enrique Dapena de la Fuente indicated that a repository of apple cultivars was established progressively in the Centro de Investigacion Aplicada y Tecnologia Agroalimentaria (CIATA) of Villaviciosa from 1955 onwards. Currently 370 apple

accessions are being maintained, including 207 local cultivars (148 Asturian and Basque cider apple) and 25 French and English cider apple. Exploration and collecting of local cultivars of the Cantabrian coast have been carried out and since 1986 characterization and evaluation have been intensively studied, focusing on resistance to pests and diseases, production characteristics, sensorial and technological quality.

Switzerland

Markus Kellerhals informed that mainly three organizations are involved in the conservation and characterization of *Malus* and *Pyrus* genetic resources: the Federal Research Station Wädenswil, financed by the Federal Office of Agriculture, and two private NGOs, Fructus and Pro Specie Rara. The main collections of Fructus are located at Höri (190 *Malus*, 43 *Pyrus* accessions) and Aubonne (90 apple and 94 pear accessions). Pro Specie Rara follows a decentralized approach with *in situ* conservation (on-farm) of about 500 *Malus* accessions. Fructus and Pro Specie Rara are working with coordinated databases on Filemaker including all information on collecting sites and *in situ* collection. The database of Pro Specie Rara is partly accessible in German on the Internet at the following address: <http://www.dainet.de/genres/psr/psr.htm>. The information system allows the detection of accessions which are threatened with extinction. A so-called 'red list' is being established. The Federal Research Station Wädenswil is preparing an Access database that will be connected with the other two. This is essentially being developed to test modern cultivars and includes evaluation data from field trials. After the conferences of Rio and Leipzig, the Swiss government is also increasing its commitment in the conservation of fruit genetic resources in Switzerland.

Yugoslavia (F. R.)

Evica Mratinić summarized activities carried out in Yugoslavia since the 1970s to inventory apple and pear local varieties. Several institutions are currently engaged in *ex situ* conservation, description and evaluation of autochthonous accessions, introduced varieties and wild species, such as *Malus sylvestris* Miller, *M. dasycphylla* Borkh. and *M. florentina* (Zuccagni) C. Schneider, *Pyrus communis* L., *P. amygdaliformis* Vill, *P. nivalis* Jacq. and *P. elaeagnifolia* Pall. A slide demonstration of unique local varieties was shown and she described the disruption of this field research with the onset of war within the former Yugoslavia.

Research activities⁴

A new project for the use of apple genetic resources in a breeding programme (M. Lateur)

A research project on fruit trees genetic resources and disease resistance started in 1975 at Gembloux, Belgium. Since 1990 a breeding programme has focused on apple scab polygenic resistance, using the better-performing old cultivars screened in the collection. During the last 5 years, around 80 old apple cultivars have been used as parents in different combinations with the view of testing their ability to transmit their polygenic resistance characters for scab and for mildew.

Testing for resistance in apples at the Fruit Genebank and the Fruit Breeding Institute at Dresden-Pillnitz (M. Fischer)

Resistance to scab, mildew and fire blight were studied in cross-combination programmes at Pillnitz, Germany, using various sources of resistance. PCR techniques were also used to ascertain the resistance to fire blight. To discover new sources of resistance, more than 700 cultivars were analyzed over a 4-year period, revealing that only a few varieties have not been infected by scab and mildew. The more resistant varieties will be more heavily used in future resistance breeding programmes. Studies were also conducted on the breakdown of the monogenic scab resistance of *Malus floribunda* Siebold, ex van Houtte and its progenies with a spectrum of scab races, showing that in Pillnitz race no. 3 has apparently been responsible for the contamination of otherwise resistant forms. A list of cultivars with multiple resistance is given on page 89 of this report. The durability of scab resistance of new cultivars was studied on cultivars with different genetic background.

Research activities at INRA Angers relevant to *Malus* and *Pyrus* genetic resources (F. Laurens)

Three recent studies were presented:

- characterization of allozyme diversity on apple: multidimensional analyses show a high level of polymorphism in the wild species group. Local cultivars show a tendency to pool according to their geographic origin.
- testing for resistance of old and local cultivars: (1) studies on fire blight resistance of pear showed a great variability in the resistance of the tested cultivars, and a high level of susceptibility among the old cultivars tested, (2) scab resistance screening tests were performed on apple and the first results showed a wide variability of behaviour among accessions. The few accessions showing resistance symptoms for all strains tested could be useful as durable sources of resistance in breeding programmes.
- hybridization: a recent hybridization programme has been developed in collaboration with the Conservatoire Nord Pas de Calais in the north of France. A new pear hybrid will be released in 1997, originated from a cross between Doyennée d'hiver and Doyennée du Comice. It is a late-maturing variety which could replace Passe Crassanne (better fruit quality, longer storage ability, lower susceptibility to fire blight, no secondary blossom).

⁴ Full papers are published in Part II.

Project on 'Development of the European Apple Crop, by integrating demand for high quality, disease-resistant varieties suited to regional circumstances, with advanced breeding methods' (M. Kellerhals)

This project, funded from 1993 to 1996, was a shared-cost research project under the EC Framework III programme in research and technical development for Agriculture and Agro-Industries (AIR). The activities and disciplines involved in this project ranged from basic molecular biology through genetics and breeding to all sciences related to characters selected in apple breeding, such as plant pathology, entomology, analysis of fruit quality and tree habit. In addition the project was focusing on the economic and social aspects of apple production. A major effort was devoted to the development of the Apple Store database. The aim of this database was to store genetic data, phenotypic data and analytical results and make them available in a user-friendly way to all researchers. The European Apple Project has fostered collaboration among research teams in different European countries and brought interesting results: markers for scab and mildew resistance genes, aphid resistance and further characters have been developed and will partly be applied in marker-assisted breeding. A European Apple Genetic Linkage Map was constructed.

Investigation of *Pyrus* germplasm with reference to susceptibility to *Psylla pyri* L. (V. Djouvinov)

In 1995 and 1996 the Bulgarian pear collection, over 20 years old, was violently attacked by *Psylla pyri*. In this collection each accession was represented by five trees. Susceptibility was determined using a scale from 0 (resistant) to 4 (high susceptibility). Most of the accessions were graded 3 or 4, and only a very small part from 0 to 2. In the two successive years only the cultivar Liatifa from Azerbaijan was absolutely resistant, and the local Bulgarian cultivar Karamanets and *Pyrus betulifolia* Bunge had very low susceptibility. The cultivars resistant to *P. pyri* – Liatifa and Karamanet – were included in the breeding programme for 1997.

Microsatellite markers for accession identification, pedigree analysis and assessment of allelic diversity in *Malus* genetic resources (G. King)

HRI developed and used a range of Simple Sequence Repeats markers (SSRs or microsatellites) for *Malus* which are capable of distinguishing between closely related apple varieties. The results of preliminary allele surveys based on reproducible SSR markers are presented (see page 104 for details). In example A, 46 diverse *Malus* accessions scored with two SSR markers reveal differences in level of polymorphism; in example B, a survey of 7 markers reveal 69 alleles; in example C, survey of a locus from the linkage group containing *Sd1* aphid resistance scored over 160 cultivar accessions reveals unequal distribution of six alleles. These results demonstrate that SSRs are amenable to comparison and collation of data from different laboratories.

Literature review

The Group welcomed the idea of developing a bibliographic list of references of interest for *Malus* and *Pyrus* genetic resources. Members were encouraged to compile, in collaboration with other interested institutions within their countries, a national list including especially ancient books and articles as well as grey literature, such as internal reports or other unpublished material. This list will be

forwarded to the ECP/GR Coordinator by the end of 1997 for further assembling and distribution to the Group.

Conclusion

In the evening of 14 March 1997 M. Hennerty accompanied the participants to visit the Lamb-Clarke collection at the University College of Dublin.

The participants reviewed the Section Discussion and Recommendations of the report of the meeting and accepted it after some corrections.

The meeting was seen as an important way of securing the genetic resources of *Malus* and *Pyrus* and as a good forum for the exchange of ideas. The participants strongly recommended that the Group continue to meet as frequently as ECP/GR can afford during Phase VI. The future of the collections was seen as linked to the future of this Group.

Terry Swinburne was elected to chair the Group until the end of next meeting, which was tentatively planned for late May 1999 (note: this date may be affected by the initiation of Phase VI of ECP/GR).

The new Chair also wished to thank especially Anita Hayes of the Irish Seed Savers for her tremendous work carried out in organizing the meeting and reminded the group that this task had been undertaken without the aid of stable funding arrangements. He thanked as well R. Janes and L. Maggioni for their activity in the preparation of this meeting.

Part II. Presented Papers

The use of multivariate discriminant analysis in compiling minimum descriptor lists for *Malus*

Rachel Janes and J. Iwan Jones

Wye College, University of London, United Kingdom

Introduction

An exploratory study was carried out on common *Malus* cultivars in four European countries in 1995 and 1996. The aim of this study was to pinpoint highly heritable, easily identifiable *Malus* cultivar characters, which did not widely vary between European sites, and which could be used to help compile a standard minimum list of descriptors.

Method

Collection holders in four European countries took part in the common cultivars study:

- Belgium: Marc Lateur and Christophe Wagemans
- France: Francois Laurens
- Italy: Fabrizio Grassi
- United Kingdom: Helen Case, Carol Bazeley and Rachel Janes.

The following list of cultivars common to most collections was selected, which were also known to be contained in many other collections in Europe:

- Florina
- Charden
- Melrose
- Bramley's Seedling
- Worcester Pearmain
- Ingrid Marie
- James Grieve
- Lord Lambourne.

Three lists of standard descriptors to be measured by all four participating countries were supplied by Wye College; one each for flower, leaf and fruit descriptors. Most of these were very close to the descriptors described in the IBPGR Descriptor List for Apple (1982) and the UPOV Guidelines for the conduct of tests for distinctness, uniformity and stability – Apple TG/14/8 (1995). In total, approximately 75 descriptors were assessed. The study was carried out in 1995 and again in 1996.

Results

Results were compiled in the UK and analyzed using multivariate statistical techniques. Here only preliminary results from 1996 are reported.

Some data were missing or difficult to analyze because of problems such as lack of flowering/fruit set, variation in how certain characters were measured between countries and also queries to the validity of some of the character scores

(see other contribution by R.A. Janes, Appendix II). Such data have been excluded from the analyses.

It must also be noted that this type of analysis carried out on a mixture of *scored* (i.e. state 1, 2 or 3, etc.) and *actual* (e.g. measured in mm) characters may result in the importance of the actual measures being underestimated. This is due to actual data inherently containing more variation than scored data.

Flower descriptors

A canonical correspondence analysis (CCA) of the data was carried out. This involved using forward selection to establish which of the descriptors were most important in discriminating between the cultivars, but did not involve separating out variation due to covariables, i.e. the country in which the measurement was taken.

The following descriptors were found to be important (listed below by decreasing importance):

- position of petal margin
- style position in relation to anthers
- fusion of style
- lower flower colour
- upper flower colour
- petal shape
- flower shape.

The flower results are displayed in Figure 1, which shows how the cultivars are separated when flower characters are considered. The distance between cultivars directly corresponds to how different or similar they are, i.e. the more similar they are in terms of flower characters the closer they are on the diagram. The individual characters on the diagram are in coded form, but if they are next to the cultivar name on the diagram, they are very important in separating out this cultivar in the analysis.

When covariables (i.e. country) were included in the analysis, it was apparent that the selected characters listed above were measured consistently in all countries.

Leaf descriptors

A CCA was again carried out using forward selection, but no covariables. There were, however, far fewer descriptors measured in this part of the study than in either fruit or flower and there was a lot of missing data. Therefore, no firm conclusions could be made.

Fruit descriptors

A CCA was again carried out using forward selection, but no covariables. Many of the characters measured had been found to be unreliable in the field or difficult to ascertain. Therefore characters such as those relying on russeting, lenticels or eye aperture were discarded from the analysis.

The following descriptors were found to be most important (listed below by decreasing importance):

- fruit shape
- over colour coverage
- fruit over colour
- tube size

- crowning at apex.

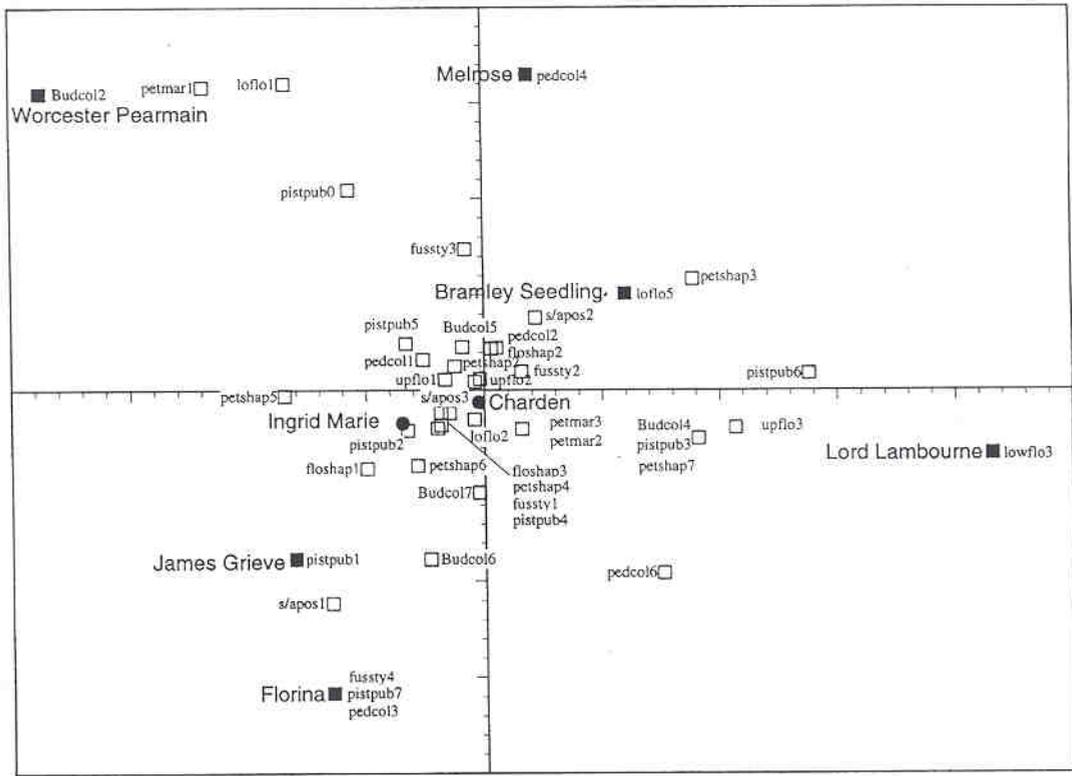


Fig. 1. Discriminant analysis of apple varieties using flower characteristics. Forward selection of characters, no geographical covariables.

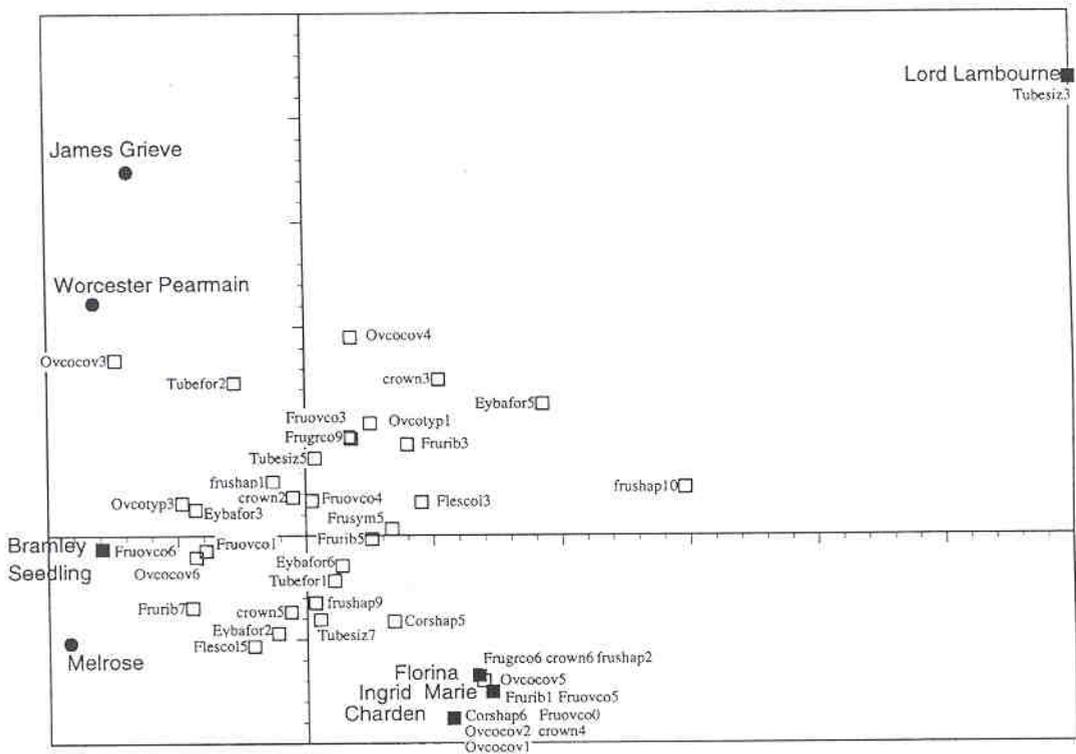


Fig. 2. Discriminant analysis of apple varieties using fruit characteristics. Forward selection of characters, no geographical covariables.

The fruit results are displayed in Figure 2. Similarity between cultivars based on their fruit characters is displayed by distance on this diagram. How near individual characters are to a cultivar on the diagram indicates how important the character is in separating out this cultivar.

Again, when covariables were included in the analysis, it was apparent that the selected characters listed above were measured consistently in all countries.

Conclusions

Multivariate analysis is a useful tool in assessing the importance of individual descriptors in discriminating between *Malus* cultivars. The descriptors which were suggested by the analyses were all consistently measured among countries, indicating that these characters meet the criteria suggested above for ideal descriptors.

The role of Non-Governmental Organizations in local and national conservation of *Malus* and *Pyrus* germplasm

The Irish Seed Saver Association



The Irish Seed Saver Association is a voluntary organization dedicated to the location and preservation of heritage varieties of fruit, grain and vegetables. The Association maintains a seed bank for the distribution of these non-commercially available vegetables and potatoes. We pass the various seed materials on so that others can learn to save them and in this way ensure a living agricultural legacy. One of the goals of the Irish Seed Saver Association is to bring Ireland's cultural and genetic heritage into the hands of ordinary people. One of the unique aspects of seed-saving networks, which exist all over the world, is the opportunity to share in the responsibility and joy of conserving the planet's diminishing genetic resources in a real and practical manner.

The Irish Seed Savers Native Apple Project grew out of this ethos. When we began the project 4 years ago, there was no official governmental or academic programme dedicated to native apple conservation in Ireland. Recognizing that time was of the essence with regard to the age of the people with traditional knowledge, we began our work without any formal support of any kind. We were, however, very fortunate to have as a resource the wisdom and knowledge of Dr Keith Lamb, a retired pomologist who had performed the only field research on the native apple nearly 50 years ago.

Our work began in a very systematic but simple manner. Through various publications and posters, a copy of which is supplied here, we attempted to reach the older rural populations who might remember the names and locations of the apples they stole as children (an honoured children's pastime long ago). Slowly, but surely, individuals contacted us with information that led to the location of native apple varieties that were thought to be extinct. Several individuals became inspired to work on the project, within their own communities. This method of gathering information brought us into forgotten byroads and mountain villages all over Ireland. When we located something of interest, apples were collected and brought to Dr Lamb who was able to confirm or deny their identity.

Once we realized that this work could indeed prove fruitful, we began to search for a collaborative partner within the scientific community. We were very fortunate to form this with Dr Michael Hennerty, Head of the Department of Horticulture at University College Dublin and a pomologist himself. As we continued our field work, Dr Hennerty was able to work through the Department of Agriculture to re-introduce apple material that was restricted for importation into Ireland through normal channels. His ability to provide the expertise and proper isolation conditions convinced the Department of Agriculture to allow us to reintroduce 27 native varieties that were held at the Brogdale National Fruit

Collection. Many of these cultivars were sent to Brogdale by Dr Lamb in the 1940s and 1950s.

Peadar MacNeice of the Armagh Orchard's Trust, another non-governmental organization, was doing similar work in rural communities in Northern Ireland. He has also contributed many Ireland apple varieties to the National Apple Collection which is now housed at University College Dublin. This cooperation of North and South, young and old, scientific and NGO has resulted in a successful national collection, now recognized and supported by the Department of Agriculture and launched at its official opening by President Mary Robinson in February of 1996.

What struck me most deeply, doing the field research, was that the people who held this precious local knowledge were mostly very elderly and very surprised that anyone would travel far to listen to their stories of how life used to be long ago. It took many many hours, cups of teas and rainy afternoons to locate perhaps the last tree of its kind, long neglected in the back garden. Many older people were embarrassed to even show me these old trees, because of their state of decline. If I had not come to them without an introduction from a respected local neighbour, there would have been very little chance that I would have been invited into their homes and lives. This very fine thread between preservation and extinction was demonstrated to me again and again.

Another lesson that was demonstrated to me time and time again was the pool of knowledge that goes untapped among the elders of our communities. Horticultural and cultural knowledge of great depth was revealed to me in the simplest of settings. I also was reminded that we forget to ask the elders in our scientific communities as well as lay communities for their experience, advice and support, all to the detriment of our efforts at conservation.

NGOs have very real skills to offer to the conservation efforts worldwide. We have time to work within our own communities in ways that "outsiders" cannot and a deep passion for our work that is motivated by a desire to preserve a cultural legacy as well as a botanical one. We NGOs need scientific support to assist us in our field work, test our findings and bring our work to its full potential benefit. I think as well that the scientific communities need our freedom of investigation, to go forward where the conservation need is great, but where a policy or economic decision has prohibited academic investigation. The areas that might divide us need to be explored and lessened through open communication. Our children and our children's children demand no less from us .

Native-Irish-Apple-Project



IRISH APPLES

• LOST •

Abraham
 Aherne Beauty
 April Queen
 Blood of the Boyne
 Burlington
 Buttermilk Russet
 Clack-Melon
 Coccagee
 Codrun Seedling
 Davy Apple
 Dunkitt
 Farrell
 George
 Green Sweet
 Honey Ball
 Irish Pitcher
 Kilkenny Codlin
 Killeagh Seedling
 Lady's Beauty
 Leixlip
 Madame Gorge
 Osborne
 Red Kane
 Siberian Russet
 Sovereign
 Stripped Brandy
 Striped Sax
 Sweet William
 Tom Chestnut
 Tommy
 Tullaroan Brandy
 Valentine
 White Crofton
 White Moss
 Widow's Friend
 Wine Apple



• FOUND •

Ard Cairn Russet Brogdale Horticultural Trust
 Ballinora Armagh Orchards Trust
 Ballyfatten Brogdale Horticultural Trust
 Ballyvaughn -
 Seedling Genvieve Tenthorne
 Barnhill Pippin Brogdale Horticultural Trust
 Bloody Butcher Brogdale Horticultural Trust
 Brown Crofton Brogdale Horticultural Trust
 Clearheart Sonairte National Ecological Center
 Dockney Brogdale Horticultural Trust
 Ecklinville Seedling Brogdale Horticultural Trust
 Eight Square or Kill Brogdale Horticultural Trust
 Gibbon's Russet Brogdale Horticultural Trust
 Gibby's Apple Armagh Orchards Trust
 Golden Royal Brogdale Horticultural Trust
 Greasy Pippin Brogdale Horticultural Trust
 Green Chusel G.G. Fayers
 Irish Peach Commercial Variety
 Irish Russet or
 Sam Young Brogdale Horticultural Trust
 Keegan's Crab Armagh Orchards Trust
 Kemp or May Bloom Brogdale Horticultural Trust
 Kerry Pippin Brogdale Horticultural Trust
 Kilkenny Pearmain Brogdale Horticultural Trust
 Lady's Finger of
 Offaly Brogdale Horticultural Trust
 Maiden's Blush G.G. Fayers
 Martin's Seedling or
 No Surrender Armagh Orchards Trust
 Munster Tulip Brogdale Horticultural Trust
 Red Brandy Joy Daniels
 Reid's Seedling Brogdale Horticultural Trust
 Richardson Brogdale Horticultural Trust
 Ross Nonpareil Brogdale Horticultural Trust
 Scarlet Crofton Brogdale Horticultural Trust
 Smeller or
 Thompson's Apple Brogdale Horticultural Trust
 Strippy Brogdale Horticultural Trust
 Summer John Brogdale Horticultural Trust
 White Russet Armagh Orchards Trust
 Winston Sport Brogdale Horticultural Trust
 Yellow Pitcher Brogdale Horticultural Trust



You · too · can · help · to · find · these · lost · treasures

contact: Irish Seed Saver Association,



The Native Irish Apple Project

J.G.D. Lamb

In a time of increasing standardization we realize how true it is that variety is the spice of life. It is being realized also that there are sound reasons for preserving variation in living things, for scientists are concerned at the loss of local breeds of domestic animals and local varieties of food crops. This concern arises from the loss of potentially valuable genetic characteristics, so that we may have too small a genetic base for the future breeding of animals and plants.

Half a century ago we were still largely self-sufficient in fruit and vegetables. In those days if you did not grow your own apples you maybe did without. This led to the development of cultivars of purely local fame, only some of which became more widely known.

It was well-nigh 50 years ago that I undertook a survey of local Irish apples, with the encouragement of Professor G.O. Sherrard, Ireland's first professor of horticulture. In those days there was a country-wide network of county advisers in horticulture, many of whom had extensive local knowledge. Valuable sources of historical information were the Statistical Surveys of the Counties, published in the opening years of the 19th century. Several of these listed the apples grown in those days.

With this information and assistance, visits were paid to old orchards up and down the country. When the same name was applied by the owners to an apple in different locations this was taken as a strong indication that the name was correct, especially if it was recorded in the appropriate Statistical Survey. In addition, a few early accounts of Irish apple were traced, e.g. that sent to the Horticultural Society of London by John Robertson of Kilkenny in 1820.

In all, some 70 apples of Irish origin were found as living trees. Today, with the advent of the chain saw, how many survive? Should they be preserved? To mention one aspect alone, it was noted that many of them appeared to be disease resistant. In those days, there was none of the "spray it with..." philosophy, so a cultivar subject to disease just was not grown. My survey results, with full descriptions of the apples, were published in Vol. 4 (1951), Economic Proc. of the Royal Dublin Society.

Although fruit collections in Northern Ireland, England and the Republic contain some Irish varieties, there has been to date no comprehensive reference collection of the native apple. The Irish Seed Saver Association, working in cooperation with the Armagh Orchards Trust, are attempting to locate, identify and conserve what native varieties remain. This work is happening at a crucial moment in Irish history. In a time of massive, sweeping social and cultural change, it is of critical importance to record the irreplaceable local knowledge of the older persons in our communities. Working from the named varieties and locations recorded by Dr Lamb, Irish Seed Saver members have been working in their communities to relocate these valuable varieties. The Red Brandy, a scab-resistant Kilkenny variety, was recently relocated by Joy Daniels and the Ballyvaughn Seedling, a once common Clare apple, was relocated by Genevieve Tenthorney.

Our efforts have many purposes, to conserve genetic material, preserve local history and to bring biodiversity back into our own lives in a practical way. This is work that will not wait and this work can only be accomplished through our

cooperative efforts. If you would like to help, please contact us for information on how you can participate in the Native Apple Project.

The ancient laws of Ireland, the Brehon Laws, classified the apple as a sacred tree, with a fine of five cows for cutting one down.

Description of the Irish Apple Germplasm Conservation Project (Lamb-Clarke Collection)

James W. Choiseul, Project Coordinator

Dept. Horticulture, Faculty of Agriculture, University College Dublin, Ireland

My association with the Lamb-Clarke Collection began in March 1997 when I was invited to do a Post-Doctorate on the apple cultivars currently housed at UCD. The objective of the project is to update J.G.D. Lamb's thesis (1949) entitled 'The Apple in Ireland; Its History and Varieties', and incorporate into it old Irish cultivars located since its publication.

I would firstly like to describe the procedure we follow when we receive a new cultivar for the collection. Scion wood, from whatever source, is upon receipt at UCD refrigerated at 4°C. If we consider the cultivar to be a desirable addition to the collection, it is grafted onto M9 rootstock. A desirable cultivar is one which is recorded as being of Irish origin or potentially of Irish origin owing to its absence from the standard lists of cultivar names. However, the Lamb-Clarke Collection contains a number of foreign cultivars, mostly from England, which are included because they are rare in an Irish context and may, in the future, be useful for comparative or cross-reference purposes with other collections. The use of the word 'rare' is not based on any national survey of apple cultivar frequency as no such work exists. Rather, it is based on the expertise of pomologists and individuals working in the apple industry.

After grafting, the plants are potted up and placed in a glasshouse. We have found that the glasshouse environment leads to a higher percentage of successful graft unions and also produces stronger, more vigorous plants, than planting in a nursery. In the year following grafting, accessions are planted out into the nursery area or if strong enough, into the orchard proper. We conserve three specimens of each cultivar at UCD, the remaining plants being used to establish a sister orchard in Co. Clare in the west of Ireland. The accessions are labelled with the year of planting, rootstock and name (and synonyms) of the cultivar. The year and location of the earliest written record for the cultivar are also included. This latter information is included as it is felt that the general public should have access to the collection and therefore there is a requirement for some information to be available *in situ*.

There are currently 132 accessions in the Lamb-Clarke Collection, 47 planted in the orchard, 56 in pots in the glasshouse and the remainder in the nursery. Some of these cultivars are widely distributed, such as Irish Peach and Ecklinville Seedling, whereas many, such as Ballyvaughan Cooker and Cavan Wine, have never been recorded before.

As the plants in the orchard are only 1 year old, there are limitations on their usefulness for scientific evaluation. Assessments for disease resistance for example, based on immature trees are of little use. Similarly any measurements which are destructive by nature are not possible. We have therefore limited our initial evaluation to observations on the flowering time and floral structure of the plants. The floral characters which were found most useful included style pubescence, style fusion, relative lengths of style and stamen, length and shape of pedicel, petal shape and petal attachment.

A second aspect of the project involves historical research on the cultivars in the collection. There are three principal sources of information. Firstly, sources such as horticultural texts and journals have been the primary source of information on the origin of the cultivars. Secondly, UCD houses the National Folklore Archive which has also been examined for information on apples. Unfortunately this source has not yielded significant quantities of information. Lastly, miscellaneous sources such as ordinance surveys, nursery catalogues and travel logs provide some information on old cultivars, their distribution and use.

The remainder of 1997 will be dedicated to completing two tasks. The first of these will be to establish the virus status of the Lamb-Clarke Collection with the intention of producing virus-free stock at a later date. The virus status will be established using double-stranded RNA analysis. The second objective for 1997 will be to make botanical descriptions of the fruit of the apple cultivars. This will confirm the identity of the cultivars against existing records, eliminate from the collection duplicated cultivars and allow heretofore unknown cultivars to be described for the first time.

In the long term, it will be a priority to propagate virus-free stock using meristem culture. Fortunately the Dept. Horticulture at UCD has a long-established expertise in this area.

It is also our intention to characterize the cultivars in the collection using biomolecular methods such as isozyme analysis and/or RAPDs. Finally we would hope to commence some cultivar disease assessments, possibly using innovative *in vitro* methods.

The informal sector in Italy in the area of research and conservation of fruit germplasm, and of apple in particular

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Research and informal conservation is a very heterogeneous field, which cannot always be easily defined. There are different levels, roles, interests and reasons for involvement in this sector. There is unfortunately also division and poor coordination among the different initiatives and there are only few examples of collaboration between the informal and formal sectors. In the past, efforts were made to set up a coordination network, all of which failed because of organizational problems and lack of funds.

The data provided in this report are also the outcome of independent, voluntary collection of data carried out by Dr M. Rosaria Perna and partly by Dr Stefano Tellarini.

However, even a simple inventory of germplasm collected and conserved and of the large amount of data available throughout Italy as a result of the different activities, would be extremely useful for this sector to identify possible areas of collaboration between the two sectors. It is possible to identify and group together the various people and institutions from the informal sector who carry out research and conservation activities in the fruit growing sector. For each group that tends to be more or less homogeneous, I have identified one or more focal points, i.e. associations, agencies, corporate organizations, consortia, that could be useful for a future collection of data with a wider scope. There should, however, be a single point of reference for the data collected and this role could perhaps be played by IPGRI.

Traditional farmers

Some older farmers, particularly those working in marginal hilly and mountainous areas, still conserve local varieties for sentimental reasons, even though these plants are no longer of economic importance. These farmers keep their old plants, but do not reproduce them because they themselves have grown old and their children do not work in the family business. Moreover, they are the last to know the traditional customs and uses, but they have no one to pass their knowledge on to.

To map out, region by region, the individual farms that conserve genetic material, one must rely on corporate organizations, regional and suburban agricultural offices or on extension workers in agricultural development agencies. In certain regions, such as Veneto, Emilia, Marches and Latium, there are already technicians who are aware of this need.

Regulation 2078/92 promotes the cultivation of varieties threatened by genetic erosion. Unfortunately, however, it has only been implemented in a few regions and does not directly support the conservation of stock plants on the individual farms. Some farmers have made an official request to receive funds for the cultivation of trees threatened with genetic erosion. This may be considered a good starting point for *in situ* conservation and the reintroduction of local varieties. In this case, data can be easily accessed by referring to the implementation of Regulation 2078/92.

Associations and consortia of organic and biodynamic farmers

Organic and biodynamic farmers are now open to the conservation of biodiversity and cultivation of local varieties, but often they are farmers new to the job or foreigners that in any case know little about the traditions and the local varieties. Others have started farming too late to inherit the old local varieties and knowledge about them. The following is a partial list of these associations:

- **La terra e il cielo, Senigallia, Ancona.** This is a consortium of organic farmers who have reproduced and conserved certain varieties of apple and vine, as well as cereals and some vegetable varieties.
- **Coordinamento per l'Agricoltura biologica di Lecco,** offered to the Mountain Community of Triangolo Lariano to establish for them a nursery for the reproduction of old fruit tree varieties.
- **L'albero della vita, Triest,** reproduces cereal and vegetable seed with biodynamic methods and even have some fruit tree species and varieties.
- **Agrinova Soc. Coop., Catania** is relaunching traditional apple varieties resistant to scab (Mela dell'Etna, Gelato cola and Cola).
- **Nuova Ricerca Cooperative Borgo Tossignano, Bologna** is a large cooperative which for a number of years has been researching and working on varieties of maize and pulses, but also on fruit tree varieties.

Local and regional institutes

As these do not fall exactly within the informal sector, they are not considered to be part of the official network. They could, however, be considered a bridge between the formal sector and the farmers because of their even distribution throughout the country.

In recent years, some development agencies, such as **Ente di Sviluppo Agricolo delle Marche**, have started research and conservation activities. Thanks to the presence of technicians working on the subject of conservation of genetic resources, since 1984 this particular agency has collected numerous apple accessions (Rosa marchigiana, Rosa stellata, Verdone, etc.). It is also very active in popularizing productive cultivation of some of these varieties for the market.

Other development agencies, mentioned below, popularize the conservation of agricultural biodiversity:

- **Ente di Sviluppo Agricolo del Veneto**
- **Agenzia Regionale per lo Sviluppo e l'Innovazione in Agricoltura del Lazio.**

Another interesting event is the research activities being carried out by some of the mountain communities who hold fruit tree collections (apple and pear).

- **Comunità Montana Valli Gesso Vermenagna Pesio, Robilante, Cuneo** has a rich collection of approximately 50 varieties of apple and pear.
- **Comunità Montana della Carnia, Tolmezzo, Udine** has carried out research on apple germplasm and also on the popular knowledge and traditions. It holds a rich collection of apples and they propagate the varieties for distribution among the local farmers.
- **Comunità Montana Canal del Ferro Val Canale, Udine** has carried out research on apple and maintains a small collection.
- **Comunità Montana Valle Esa, Biella** has carried out research on apple and holds a collection.
- **Comunità Montana Alto Chiascio, Gubbio, Perugia** has carried out a research and conservation project on old fruit tree varieties (apple, pear,

plum, cherry and fig) in the context of the European Community Leader programme. It has a collection of local material found in the area, including 15 varieties of apple, 8 of pear, 5 of cherry and 5 varieties of plum. These are also tested in small field trials on different rootstocks and they are compared with standard varieties.

The work that could be and is carried out by the professional agricultural institutes also must not be underestimated, e.g. **Istituto Tecnico Agrario di Spilimbergo, Pordenone, Istituto Professionale Agrario di Cussanio, Cuneo, Istituto Professionale per l'Agricoltura e l'Ambiente di Pieve S. Stefano, Arezzo**, who all have collections of various fruit tree varieties and who actively disseminate information regarding the conservation of genetic resources.

An unusual initiative was carried out by **E.C.A.P. (Ente Confederale Addestramento Professionale), Ravenna**, which, in collaboration with **Comune di Casola Valsenio, Ravenna**, set up a project entitled "Rediscovering forgotten fruits". It is a territorial development project for the rediscovery and exploitation of resources and marginal agricultural cultivation in hilly areas. By "forgotten fruits", they mean medlar, sorb-apple, arbutus berry, cornelian cherry, pomegranate and also Mela della rosa and Pera volpina. They have produced a large quantity of information sheets and in October the annual trade fair dedicated to forgotten fruits will be held in Casola Valsenio.

Private associations and amateur groups

Many small and large initiatives fall within this sector which moreover should be well sustained because in many cases they have made up for the shortcomings of the public sector and they have often worked without financial aid.

- **Associazione Archeologia Arborea, S. Lorenzo di Lerchi-Città di Castello, Perugia** was started in collaboration with **Centro delle Tradizioni Popolari di Città di Castello, Perugia** and has carried out three years of research, first in the area of the Alta Valle del Tevere, between Tuscany, Umbria, Emilia Romagna and Marches regions, and later in the area of Gubbio and Gualdo Tadino.
It has set up a large collection of fruit tree trees in a private farm. The association is fundamentally supported by private funds and by the membership fees of those who join the association and adopt one of the plants in the collection. The Association also disseminates information on the knowledge and reintroduction of old fruit tree species.
- **Associazione Pomona, Milan** was founded for the spreading of old fruit tree varieties and has and still carries out projects on the conservation and reintroduction of old fruit tree varieties, in collaboration with universities and research centres. It also organizes pomological exhibitions and other initiatives together with centres for research on fruit culture, in particular the CRPV in Cesena.
- **Il Frutto permesso di Dario Martina, Verzuolo, Cuneo** has established a large collection of apple cultivated on their own roots and left with natural shape.
- **Mr Pietro Felice, Ovaro, Padova** has established a collection of approximately 50 varieties of apple and 20 pear varieties.
- **Dr Angelini, Servigliano, Ascoli Piceno** owns a collection of approximately 600 plants of Mela rosa and other ecotypes.

Nurserymen

A few years ago, nurserymen started producing old varieties of fruit plants for selling. In some cases they have a collection of interesting material, even though they often follow market trends rather than favour the conservation of genetic material.

- **Vivai Dal Monte, via Casse, 9, 48013 Brisighella, Ravenna** has a production line called the “Antico pomario” in which they produce many varieties of apple, pear, cherry and apricot of Romagna region. For a certain period they also kept an organic nursery.
- **Monti Vivai Picciorana per Tempagno, Lucca** have reproduced many varieties of apple, pear, plum and peach discovered in the Garfagnana and Tuscan Appenine areas.
- **Bassi Vivai, via Pavese, 7, Cuneo**, offer numerous varieties of apple, pear, prune, apricot, peach and cherry, many of which are typical of the Piedmont region.
- **Omezzolli Vivai, via Brione, 9, Riva del Garda, Trento** have carried out extensive research and reproduction of old fruit tree varieties, above all on apple and pear, using organic and biodynamic methods.
- **Cooperativa C.R.E.A., via 25 Aprile, Cibeno di Carpi, Modena** is a forestry nursery and also works with autochthonous hedge species. In recent years they have set up the production of many old varieties of apple and pear discovered in a large part of the Tuscan Emilian appenine area.
- **Flora 2000 Vivai, via Zenzalino Sud 19/a, Budrio, Bologna** produce “old” varieties for apple, pear, peach, plum, cherry and apricot.

Status of national collections

Review of the present status of the *Pyrus communis* L. collections in Belgium: A first estimation

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The first amateur pear breeder in Belgium was Nicolas Hardenpont (1705-1774). He was a priest in the city of Mons and sowed pear seeds extensively around 1730-1740 with the view to obtaining new pears of superior quality. He is reputed to have been the first to make actual crosses between pear varieties, his aim being to produce new pears of the *beurré* type. Before his time a majority of pear varieties were either crisp – like apples – or hard-fleshed and fit only for cooking. Around 1760, Hardenpont released a dozen new pear cultivars, of which six at least were soft-fleshed, melting dessert pears. This was a revolutionary improvement at the time. The best-known cultivars from his historical work are Beurré d'Hardenpont (syn. Glou Morceau), a melting winter pear of first rate quality, especially when grafted on a seedling, and Passe Colmar, both of which were later grown on a large scale in the USA.

How did Hardenpont obtain his superior pears? It seems that he was a pioneer in the controlled pollination of pears, long before Knight (1759-1838) who is reputed to have been the first to practise controlled breeding of apples.

Hardenpont soon had many imitators in Belgium and elsewhere in Europe. One of the most famous was a Belgian pharmacist and physician, Van Mons (1767-1842), who produced over 400 new pear varieties. In 1874, the pomologist Gilbert recorded 146 Belgian amateur breeders who had bred more than 1100 pear cultivars during the 18th and 19th centuries but he made no reference to the numerous pear landraces which existed on farms (Gilbert 1874).

The great American pomologist U.P. Hedrick wrote in 1921: "The pear was improved more in one century in Belgium than in all the centuries that had past", and further: "Now, mostly owing to the work of the Belgians, the buttery pears predominate". Populer (1979) made a review on the Belgian pears and apples that he had collected in Belgium.

In fact, Belgium may be considered as an important secondary centre of diversification for the cultivated pears and an astounding number of varieties bred in other countries have Belgian pears among their ancestors.

A rapid survey of Belgian pear collections shows there is presently a lack of information on duplications and identification problems in most collections. Many of the identification errors in old collections come from inaccurate synonyms, mis-spelling, mis-labelling or from the interstock having overgrown the variety. Most curators have no time for evaluation or characterization. The data presented in Table 1 are therefore a first approximation which should be revised in the future.

The collecting work of unique material, mostly landraces, is not yet finished at the Station de Phytopathologie but proceeds at a slower pace, as an increasing amount of time is devoted to the management and evaluation of the collections

and to development activities in the commercial nursery and fruit-growing area, in connection with the old fruit varieties re-injected in the trade by the Station.

Table 1. *Pyrus communis* collections in Belgium – a first estimation

Institutions	No. of accessions	No. (or %) of different cvs.	No. of Belgian cvs.	No. of 'landraces'
Formal Sector				
State Plant Pathol. Stn., Gembloux	865	732	561	272 [†]
Research Centre, Gorseme	41	41	10	5
State Fruit Growing Stn., Gembloux	24	24	8	3
Technical Horticultural Schools				
Anderlecht	± 50	–	–	few
Gembloux	± 80	–	–	few
La Hestre	± 50	–	–	few
Leuven	± 110	–	–	few
Liège	± 40	–	–	few
Melle	± 110	–	–	few
Mechelen	± 60	–	–	few
Tournai	± 30	–	–	few
Vilvoorde	± 130	–	–	few
Informal Sector				
Nationale Boomgaarden Stichting (Association)	± 1070	± 70-90% ?	± 690% ?	± 390% ?
Flore et Pomone (Association)	250-300	–	–	few
Private collection [†]	650	–	–	few
Other private collections, not yet investigated	–	–	–	–
Total estimation	± 3580	± 25%	± 20%	± 10%

[†] Mostly of Belgian origin, but also from The Netherlands and the north of France.

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Update on *Malus* and *Pyrus* genetic resources management in France

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² Conservatoire National Alpin de Gap-Charance, Gap, France

Conservation of apple and pear genetic resources in France is carried out by two organizations (Laurens 1996):

- AFCEV (French Association for the Conservation of Vegetal Species) is a non-governmental organization in charge of the management of fruit conservation throughout France. *Malus* and *Pyrus* genetic resources are collected in France by associations of amateurs for the most part, and by regional or national repositories.
- INRA Angers is in charge of a collection of 1500 *Malus* and 1000 *Pyrus* accessions including wild species, rootstocks and cultivars (cider, juice and dessert apple and pear). The main activities of the apple and pear laboratories at INRA Angers are genetic studies and breeding. The main selection objectives are fruit quality and pest and disease resistance.

Furthermore, BRG (Bureau des Ressources Génétiques), a governmental institution, aims to incite various partners to manage genetic resources more efficiently, and to develop, in collaboration with the different partners involved, a national agreement for the genetic resources of all species collected in France. No specific funds have been allocated to achieve this task. BRG asked M.-F. Tarbouriech to manage the apple and pear network.

For apple and pear, the principal short-term objectives are:

- to create and manage a national database
- to develop a policy for material exchange
- to achieve a more efficient management, i.e. detect accessions planted in too many sites, duplicate unique accessions.

Two different databases have already been developed:

- one database contains INRA's accessions (Informix Unix)
- the other, for AFCEV's data, has been developed by the 'Conservatoire National de Gap Charance' (Hyperfile software).

Descriptors entered in the database are essentially the accession name, the accession code and the code of the donor institute. AFCEV and INRA proposed a list of 90 characterization descriptors including flowering time, picking time, fruit characterization (attractiveness, taste), tree habit, vigour, resistance/susceptibility to major pests and diseases.⁵

To facilitate the exporting of data to the European database, INRA and AFCEV are developing a new database which will be the National Database for apple and pear genetic resources. It is being developed under Access in collaboration with A. Zanetto (INRA Bordeaux), manager of the European *Prunus* Database.

The structure of the *Malus* and *Pyrus* Database is shown in Figure 1. It illustrates the relations between the different objects: one object "genotype"

⁵ Full list available from author.

includes passport data and descriptors common to apple and pear; one object for apple-specific characterization descriptors; and one for pear-specific descriptors.

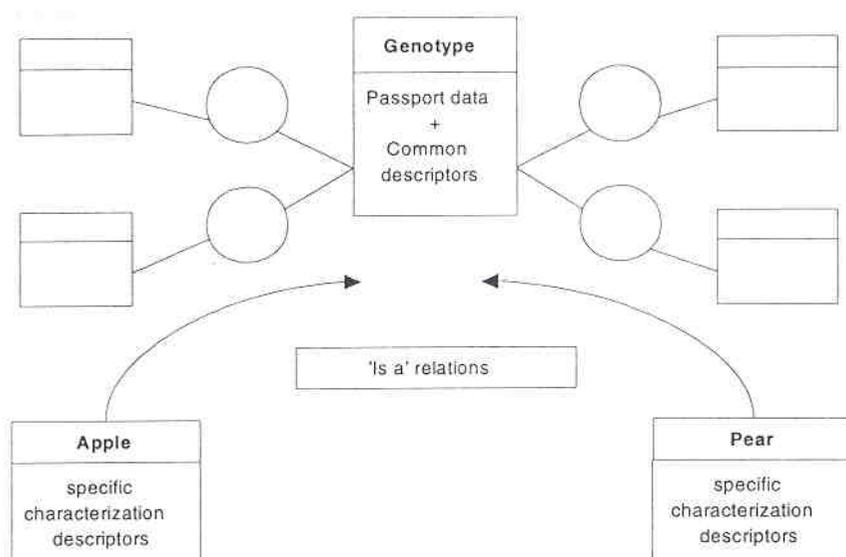
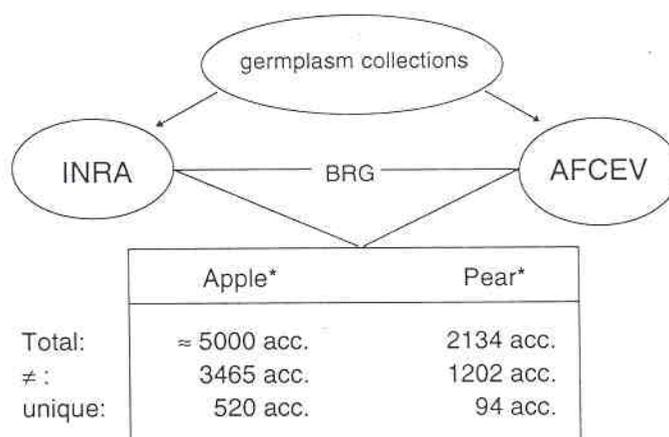


Fig. 1. Structure of the *Malus/Pyrus* database, showing relationship between objects.

The passport descriptors are the Multicrop Passport Descriptors List developed jointly by IPGRI and FAO (Box 1). The AFCEV-INRA descriptor list described above is very informative but too long: people in charge of collections did not take time to check, note and enter all these data in the database. So, in the new database a minimum list of 19 easily assessed descriptors has been provided (Boxes 2 and 3). Characterization descriptors for pear have not yet been defined. This database will also be open to other descriptors: ECP/GR characterization or evaluation descriptors (pest and disease assessment).

At this moment, for the 20 sites which entered data in the database (about 80% of the cultivars conserved in France), a list of about 5000 cultivars of apple and 2134 cultivars of pear has been computerized (see below). The list includes duplicated clones and synonyms. We estimated that, from these total numbers, 3465 distinct accessions have been entered for apple and 1202 for pear. We consider that 520 apple accessions and 94 pear accessions are not safely-duplicated. Very few passport data and characterization descriptors have been completed: 50 for apple, 250 for pear.



* No. of accessions on 20 sites (= 80% of the conserved accessions).

Box 1. Multicrop passport descriptors

Order number (unique identifier)
 Accession number
 Accession name
 Institute code
 Status of sample
 Genus
 Species (for wild species)
 Subtaxa (for wild species)
 Country of origin
 Donor Institute code
 Donor code
 Collecting source

Box 2. *Malus / Pyrus* minimum common descriptors

Plant use
 Fruit use
 Viral condition
 Identity check
 National collection (Y/N)

Box 3. *Malus /Pyrus* common minimum characterization descriptors

Flowering time
 Picking time
 Fruit shape
 Fruit size
 Russet
 Fruit ground colour
 Over colour
 Type of over colour
 Amount of over colour
 Fruit firmness
 Sugar/Acid ratio
 Flavour intensity
 Storage ability

Conclusion and perspectives

AFCEV, INRA and all partners involved in conservation of *Malus* and *Pyrus* are working together to manage genetic resources more efficiently. The first step of this work is currently being implemented: a national database is being designed. It will lead to an official list of accessions planted in France. The next step will be the characterization of all this material with the minimum list of descriptors mentioned above, and its management. The final step will be the selection of 100 to 200 accessions representing the genetic variability of *Malus* and *Pyrus* germplasm in France to create a core collection. But all partners, whether working in governmental or non-governmental organizations, or amateurs, encounter the same major problem: finding funds.

Reference

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Current activities of the Fruit Genebank Dresden-Pillnitz in the evaluation of *Malus* species and cultivar accessions

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The current collection of the *Malus* Genebank in Dresden-Pillnitz includes 997 cultivars and clones, 33 rootstocks and 382 species and wild-hybrids. According to the nomenclature of Way *et al.* (1990), the group of *Malus* species in the German Genebank can be classified in:

- 18 primary species
- 12 secondary species
- 52 ornamental cultivars (crosses of different species)
- 300 others.

The cultivar collection comprises

- 195 actual cultivars
- 28 actual Pillnitz cultivars
- 96 old German cultivars
- 106 local cultivars
- 173 mutations, breeding clones and donors for special characteristics
- 399 others.

The further evaluation of wild species of *Malus* and *Pyrus* will include:

- morphology and phenology for clarification of last taxonomic problems,
- time and density of flowering (yearly)
- fruit set
- presence and percentage of apomixis
- finding of different sources of scab and mildew resistance donors by evaluation of the natural infection without fungicide spraying
- finding of fire blight resistance sources by artificial inoculation tests
- support of the scab resistance selection in apple breeding by collecting and analysis of the races spectrum of the scab fungi population in the field of the *Malus* species collection.

For the cultivars the following will be evaluated:

- phenology
- morphology
- time and density of flowering (yearly)
- fruit set and yield (yearly)
- fruit quality and storability
- scab and mildew infection (yearly) - this year without fungicide spraying, normally under a very low fungicide spraying programme to find donors for polygenic resistance
- other damages, this year winter frost injury and spring frost damages.

A special programme will be carried out for the evaluation of populations of *Malus sieversii* (Lodeb.) M. Roemer from Kazakstan, in cooperation with the

Cornell University of Geneva, NY, USA. For the evaluation we use the special form which was presented at the ECP/GR workshop on European *Malus* germplasm held at Wye College, UK, in June 1995.

All passport data and the evaluation data for morphological, phenological and agronomical characteristics will be computerized within the framework of the German EVA project.⁶ This constitutes a good source for a further project for an international *Malus* database.

At present we are preparing an accession list of all fruit cultivars of different institutions and NGOs of Germany. This list contains so far 10 131 accessions of 4373 fruit cultivars, including 5526 accessions of 1861 apple cultivars and 687 accessions of 338 pear cultivars. We plan to make this list available on the Internet.

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⁶ EVA: Informationssystem für Evaluierungsdaten pflanzengenetischer Ressourcen.

Progress report on the Hungarian genebank for apple and pear species

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Preservation of natural genetic material and individual plants having special or valuable biological and agronomic traits for future plant breeding can be carried out only in suitable genebanks. The material of collections can fulfil that function only temporarily. In fact collections are maintained in order to store cultivars suitable for current cultivation while genebanks have to be maintained for new aims of plant breeding. Genebanks include local varieties, improved and cultivated varieties, natural varieties related to cultivars, different breeders' lines and hybrids.

Detailed data are recorded for each accession to allow their identification, central recording and availability for native and foreign researchers, lecturers, breeders and other inquirers.

In Hungary the Plant Genebank Council and the Ministry of Agriculture commissioned the Research Station at Újfehértó to establish and maintain apple, pear, quince and medlar vegetative field collections for long-term germplasm conservation.

Species

Table 1 lists the species which can be found at the Research Station of Újfehértó. It can be noted that most of the varieties are in the genebank.

Table 1. Summary of the species of the Genebank and collections at Újfehértó, 1 January 1997 (varietas, convarietas, hybrid, etc.)

Fruit species	Genebank	Collection	Total
Apple	673	201	874
Pear	480	–	480
Quince	57	27	84
Medlar	28	7	35
Sour cherry	–	59	59
Gooseberry	–	61	61
Total	1238	355	1593

Types of material

Material maintained in the genebank is listed in Table 2.

Table 2. Sample types by species, Genebank Újfehértó, 1 January 1997

Sample types	Apple	Pear	Quince	Medlar	Total
Cultural variety	7	12	5	2	26
Superseded variety	9	4	–	–	13
Assortment variety	409	226	7	–	642
Collected local variety	191	185	43	26	445
Collected wild variety	5	20	1	–	26
Hybrid	52	33	1	–	86
Total	673	480	57	28	1238

Data acquisition

Data recording for each item found in the genebank is started in the first year of fruit production (see below for list of characters recorded). Knowledge of the date of flowering, ripening, characteristics of the fruit and growth characteristics of the tree allows identification of varieties and duplications. The identification of accessions is difficult because of shortage of funds and staff. We think that it is necessary to preserve accessions in two sites. We have already taken steps to implement this in the case of pear. Most of the pear varieties can also be found in the west of Hungary, at Keszthely.

Data acquisition

Accession name:

Collecting site:

Cultivation date of accession:

Fruit-buds opening

Start of flowering

Full flowering

End of flowering

Flower density

Fruit density

Harvesting or maturation time

Maturity

Size

Fruit gathered (kg)

Fruit fallen (kg)

Stalk length

Stalk thickness

Fruit size

Fruit length (mm)

Fruit width (mm)

Fruit thickness (mm)

Fruit surface

Attractiveness

Base colour of skin

Cover colour of skin

Cover of skin

Thickness of skin

Cover colour ratio (%)

Lenticel colour

Density of lenticels

Flesh colour

Firmness of flesh

Taste of flesh

Smell of flesh

Juiciness of flesh

Marble pattern of flesh

Putrescibility of flesh

Openness of ovary

Inside of ovary

Shape of ovary

Number of seeds

Trunk circumference (cm)

Details on accessions contained in the Lamb-Clarke Historical Irish Apple Collection ⁷

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There are currently 132 accessions contained in the Lamb-Clarke Collection. Of these, 52 are dessert cultivars, 32 are culinary cultivars and two are cider cultivars. Records exist for only 82 of the accessions. Of the remaining 49 cultivars, 15 do not possess proper names. Thirty-nine of the 83 recorded cultivars were mentioned in Lamb's thesis as being of Irish origin.

There are multiple copies of several accessions in the collection. This is because the information which accompanied the scion wood for each was inconsistent and it was decided to retain each in order to establish if they were distinct cultivars.

The accessions now planted in the orchard are divided into dessert and culinary cultivars. Non-Irish cultivars are also planted at the same location but are grouped together away from the Irish cultivars.

⁷ See also by same author 'Description of the Irish Apple Germplasm Conservation Project (Lamb-Clarke Collection), p. 29, this report.

Malus and Pyrus germplasm in Italy

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Introduction

This report will try to give an update with respect to the article presented in 1995 at the European *Malus* germplasm workshop (Grassie *et al.* 1996), and an inventory of the *Pyrus* germplasm present in *ex situ* collections in Italy. In addition, the subsequent work on the evaluation, utilization and valorization of old fashioned Italian cultivars will be discussed.

At present, Italy does not have a formal national conservation strategy for fruit tree germplasm, even though the Istituto Sperimentale per la Frutticoltura (ISF), belonging to the Ministero per le Politiche Agricole, since 1993 has begun an informal coordination activity on deciduous fruit tree germplasm including *Malus* and *Pyrus*. The ISF carried out in 1993 an inventory of all the fruit tree germplasm present in Italy. The document was published by the Institute and is still available upon request. The accessions included not only Italian cultivars, but also foreign ones. In this report, it was considered appropriate to discuss mainly the material reported to be of Italian genetic origin. Furthermore, traits of particular interest, like quality, disease and pest resistance have been reported for some of the most interesting obsolete and old cultivars.

Italy's apple production, like that of the rest of the world, is based on two cultivars, Delicious and its sports and Golden Delicious with recent expansion based on their seedlings Gala, Mutsu, Jonagold from Golden Delicious and Empire and Fuji from Delicious (Hokanson *et al.* 1997).

Nonetheless, certain territories still base their production on old local cultivars. Two examples of this tendency are the ancient apple cultivars Annurca and Decio. The first was cited by Plinio, in the Imperial Rome, with the Latin name *Orbiculata* and locally called *Orcola*. It is still commonly grown in the Campania region (south Italy), and it is particularly appreciated for its peculiar flavour and crispy flesh. The second was grown in Roman times and was probably singled out in the gardens belonging to the Decio noble family, in the Latium region.

Considering the pear industry, the number of cultivars grown commercially is very limited and breeding programmes throughout the world have not changed substantially the pear cultivar scenario, which is still based upon few and very old cultivars. An example of an old pear cultivar still very appreciated is Spina Carpi, described by the pomologist Gallesio (1800), which corresponds to the ancient pear Picena dei Romani (Morico *et al.* 1997). This cultivar is used in breeding programme projects for its resistance to *Psylla pyri* and for its good quality.

Present situation of the apple and pear industry in Italy

Regarding apple, both the total production (2 017 000 t in 1996) and the cultivated area slightly decreased in recent years (Table 1).

Table 1. The apple and pear industry in Italy (area and total production)

Year	Apple		Pear	
	Area (ha)	Production ('000 t)	Area (ha)	Production ('000 t)
1991	77 544	1830	44 571	706
1992	75 460	2361	44 905	1131
1993	73 621	2143	44 930	916
1994	71 244	2233	45 171	929
1995	67 115	1940	44 167	913
1996	64 199	2017	44 902	999

Source: ISTAT (Istituto Nazionale di Statistica).

An important aspect of the new orchards is that some of the cultivars used are resistant to apple scab. Up to now, the most-used cultivar resistant to *Venturia inaequalis* (Cke.) Wint. is Florina, bred in France, but Golden Lasa introduced by the ISF, Section of Trento, will be one of the most-planted cultivars in Trento district to replace Golden Delicious.

The percentage of the apple production of the main cultivars is reported in Figure 1. It is interesting to see how the old cultivar Annurca still represents 4.5% of the total Italian apple production.

The pear industry seems to be more stable than the apple one and the total production in 1996 has been 999 000 t (Table 1). The varieties grown are mainly of foreign origin, the few Italian cultivars significantly grown commercially are Coscia, Spadona Estiva and Santa Maria (Fig. 2).

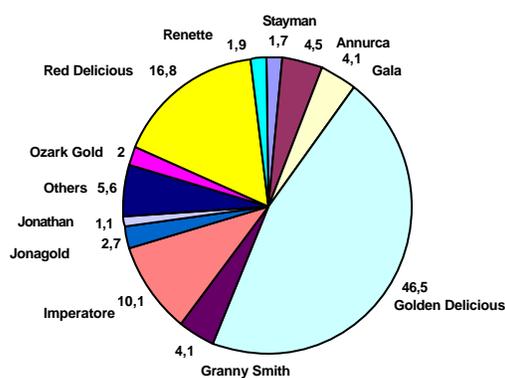


Fig. 1. Distribution of production (% of total) of the main apple cultivars. Source: ISTAT and COO.

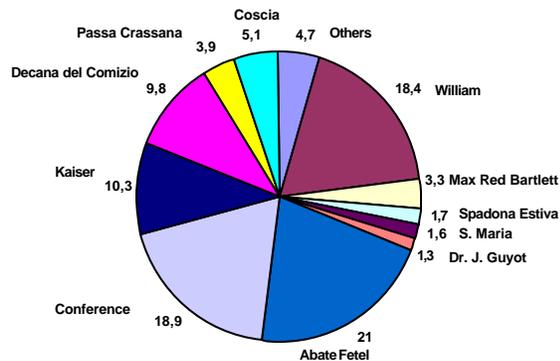


Fig. 2. Distribution of production (% of total) of the main pear cultivars. Source: ISTAT and COO.

Evaluation, utilization and valorization of the old Italian apple and pear cultivars from the scientific world to the productive and amateur world

The first National Congress on fruit tree germplasm, held in Alghero (Sardegna) in 1992 at the conclusion of a 10-year-old project funded by the National Research

Council (CNR), aimed at recovering, collecting, inventorying and conserving the main fruit tree species.

From then on, the activity on the conservation and valorization of the indigenous apple and pear cultivars, performed by the various research institutions, has steadily increased.

The results of such activity can be easily seen throughout the country by consulting the nursery catalogues and the promotional commercial activities linked with obsolete apple and pear germplasm, adapted to specific pedoclimatic regions.

All of the Research Institutions that took part in the project, collected, evaluated and described the local regional material. Particular attention was paid to the selection of this material for horticultural traits such as quality, spur and compact habit, wildness, pest and disease resistance and fruit shelf life (Table 2).

Table 2. Some old Italian apple and pear cultivars resistant or tolerant to the main diseases

Apple		Pear	
<i>Venturia inaequalis</i>	<i>Podosphaera leucotricha</i>	<i>Venturia pyrina</i>	<i>Cacopsylla pyri</i>
Decio	Abbondanza	Madernassa	Mangarola
Democrat	Decio	Mangarola	Mora di Faenza
Dunizza Giallo Rosa	Democrat	Mora di Faenza	Spina Carpi
Durello di Ferrara	Dunizza Giallo Rosa	Volpina	Volpina
Durello di Forlì	Fior di Cassia		
Modenese	Francesca		
Morello	Limoncella		
Renetta Grigia di Torriana	Pomella Verde Brisca		
Renetta Ruggine	Renetta Grigia di Torriana		
Runsè	Rosa D'Osta		
	Rosa di Caldaro		

Sources: Quadretti *et al.* 1996; Bellini and Nin 1997; Tabanetti 1997.

The aim of this exercise was to identify cultivars that could satisfy several main categories of utilization:

1. Single out particular positive horticultural traits that can be useful in breeding programmes.
2. Study the possibility of using successfully modern orchard management techniques on obsolete cultivars, to overcome the inconveniences manifested by these cultivars, such as late bearing, small fruit size, alternate bearing, short shelf life, etc.
3. Cultivars that can satisfy consumers' requests for home garden production and for ornamental purposes (weeping, compact and dwarf habit, flowering trees, green edges, etc.). An example of this is the double-purpose pear cultivar Scipiona, of the Emilia-Romagna hills, used both as a garden hedgerow and for its production.
4. Cultivars suitable for integrated pest or biological control management, thus reducing both the environmental impact and the production costs, objectives that cannot be easily achieved by growing modern and homogeneous bred cultivars. In fact, the wildness (less susceptibility to biotic and abiotic stresses) that belongs to most of these cultivars has been the main reason for their diffusion in ancient times.

Table 3. Operative units involved in the updating of the *Malus* and *Pyrus* germplasm inventory coordinated by the ISF of Rome, total number of accessions, those of Italian origin and the Italian accessions considered at risk of extinction

Institution	Administration	Accessions			Italian cvs. at risk
		Total	Italian	%	
Apple					
Centro Sperimentazione Agraria e Forestale, Laimburg	Regional	433	30	6.9	3
Dipartimento Biotecnologie Agrarie ed Ambientali, Ancona	University	145	133	91.7	133
Dipartimento Coltivazione e Difesa Specie Legnose, Pisa	University	460	25	5.4	13
Dipartimento Colture Arboree, Bologna	University	1643	455	27.7	40
Dipartimento Colture Arboree, Torino	University	160	130	81.2	126
Centro Ricerche Produzioni Vegetali, Cesena	Regional	143	30	20.9	0
Istituto Colture Arboree Mediterraneo, Sassari	Nat. Res. Council	36	30	83.3	30
Istituto Colture Arboree, Napoli	University	15	15	100.0	15
Istituto Colture Arboree, Padova	University	88	88	100.0	0
Istituto Ortofloroarboricoltura, Viterbo	University	60	51	85.0	27
Istituto Sperimentale per la Frutticoltura (Trento, Forlì)	Ministry of Agriculture	1211	283	23.4	190
Istituto Sperimentale di Frutticoltura, Verona	Provincial	165	30	18.2	25
Total		4559	1300	28.5	602
Pear					
Dipartimento Biotecnologie Agrarie ed Ambientali, Ancona	University	33	9	27.3	9
Dipartimento Coltivazione e Difesa Specie Legnose, Pisa	University	49	16	32.6	2
Dipartimento Colture Arboree, Torino	University	140	88	62.8	68
Centro Ricerche Produzioni Vegetali, Cesena	Regional	185	118	63.8	0
Istituto Colture Arboree Mediterraneo, Sassari	Nat. Res. Council	108	104	96.3	104
Istituto Ortofloroarboricoltura, Viterbo	University	34	30	88.2	13
Istituto Sperimentale per la Frutticoltura (Forlì)	Ministry of Agriculture	288	65	22.6	49
Istituto Sperimentale di Frutticoltura, Verona	Provincial	50	10	20.0	8
Total		887	440	49.6	253

Source: Istituto Sperimentale per la Frutticoltura - Roma.

The institutions that contributed to the updating of the inventory of apple germplasm are listed in Table 3. The total number of apple cultivars present in *ex situ* field collections is 4559. The cultivars of Italian origin account for 1300

(28.5%), 602 of which are considered at risk of extinction. The numbers reported do not take into account the duplicate accessions present, so it is reasonable to consider the number of distinct accessions to be certainly smaller. In fact in the census made in 1993 the total number of distinct apple and pear accessions accounted respectively to 1438 and 718 (Morico *et al.* 1993).

The data collected on pear germplasm show that nearly 50% of the total accessions are of Italian origin. The total pear accessions are 887 (Table 3). The production is based on very few old cultivars introduced between 1700 and 1800. This phenomenon has largely contributed to the loss of unique local cultivars. A survey carried out in Italy reported that 285 pear cultivars (most of which of local origin) have already disappeared, and with them many precious characters (Bellini and Scaramuzzi 1976).

Because of the extremely slow evolution of the varietal assortment and the market need to have uniform products, production has concentrated on a few old common cultivars, thus causing a progressive and uncontrolled loss of Italian pear germplasm.

The main cause of apple genetic erosion, on the other hand, is the ever-increasing varietal turnover and to the market need to have a standardized and uniform product.

Conclusion

Collecting, characterization, evaluation and utilization of old local cultivars, adapted to difficult and different environments characterizing the Italian peninsula, can potentially provide a rich and useful genetic variability, especially for resistance and quality traits. Furthermore, this genetic variability also allows us to diversify the production to meet the consumers' increasing demand for a healthier and better-quality product. In accordance with the worldwide accepted concept of a more 'friendly agriculture', Italian ancient cultivars can contribute to a more ecological way of production.

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***Malus* germplasm status and utilization in Lithuania**

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In 1938 a *Malus* collection was initiated at the Lithuanian Institute of Horticulture. About 1700 accessions were investigated in 1946-90. Observations and measurements were made on the following characters: phenology; morphology of woodcuttings, buds, flowers and fruits; tree habitus; yield; winterhardiness; scab resistance; canker resistance (230 cultivars investigated); apple blotch resistance (30 cultivars investigated).

The *Malus* collection contains almost 600 accessions (Table 1). More than 70% of them are of foreign origin, others are old local cultivars or were created at the Institute (cultivars and hybrids). There are 38 cultivars resistant to apple scab (genes *Vf*, *Vm*) and 49 accessions with columnar habitus in the apple collection.

Table 1. Status of the apple collection, 1996

Status	No. of accessions
Assortment cultivars	15
Old local cultivars	12
Institute cultivars	16
Landraces	22
Hybrids	91
<i>Malus</i> species	14
Introduced cultivars	422
Total	592

During the 1950s and 1960s the main purpose of the introduction and cultivar evaluation was finding cultivars for commercial cultivation. The main purpose of the apple breeding programme was to create winterhardy, precocious apple cultivars, with excellent fruit quality and high storage potential. Donors of apple scab resistance have been used in breeding since the 1970s. Besides the above-mentioned traits the new apple cultivars are distinguished by dwarfness or semi-dwarfness and a compact crown. The donors of these traits started to be introduced and used in the apple breeding programme.

Status and policy of *Malus/Pyrus* collection maintained in Poland

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The Plant Breeding and Acclimatization Institute and Centre for Plant Genetic Resources at Radzików near Warsaw, was commissioned by the Ministry of Agriculture to establish the conservation of plant genetic resources, in this case also Fruit Germplasm Collection.

The biggest collection of fruit trees (*ex situ*) is situated at the Research Institute of Pomology and Floriculture at Skierniewice (central part of Poland). The old collection existed since the end of the 1920s. Before the Second World War, it contained several hundreds of apple and pear cultivars and species of Polish (autochthonous) and foreign origin.

The *Malus/Pyrus* genebank field collection maintained at the Research Institute of Pomology and Floriculture at Skierniewice:

Species	Accessions
<i>Malus</i> sp.	907
<i>Pyrus</i> sp.	204
<i>Malus/Pyrus</i> rootstocks	154

The field collection is managed by Mr G. Hodun under the coordination of Mr Z.S. Grzyb. Each accession is represented by two trees for apples and three trees for pears. The establishment and maintenance of the collection is financed by the Polish government.

The area of the living collection is about 3 ha for *Malus* and 0.90 ha for *Pyrus*. Apple cultivars and species are grafted on M26 rootstocks; pear cultivars and species are grafted on *Pyrus caucasica* seedlings. Fruit trees are grown at a distance of 2.5 m within the row and 4.5 m between rows. The apple collection has been in place for 12 years in some places. During that period several hard winters occurred, and several trees and rootstocks were injured by low temperatures.

The collection of *Malus/Pyrus* rootstocks propagated vegetatively contains 154 genotypes and covers about 0.54 ha. Many plants were injured by low temperatures during the severe winter of 1996/97 (with no snow) and they need regeneration. So in 1998 the collection will be planted on a new site.

In 1997, as in previous years, the following observations were made on the *Malus* and *Pyrus* collection: time and intensity of blooming, fruit ripening of different cvs., their productivity, fruit quality, shapes of fruit and skin colours were recorded. The growth of trees and shape of canopy was also determined. In this year, 20 apple cvs. were described according to the UPOV descriptors. Collected data were included in a computerized database.

In the last few years, 100 accessions of apple and 30 accessions of pear were evaluated and data were included in the database. After regeneration, the trees in the new pear collection have not started to bear fruit. The list of apple cultivars and species was sent to the European *Malus* Database at Wye College, University of London, UK in 1997.

National programmes

National programme activities related to *Malus/Pyrus* have been carried out since 1980 with a short break at the beginning of last decade, when existing collections were not well financed by the Ministry of Agriculture. Besides apple and pear collections, held in good conditions at the Research Institute of Pomology and Floriculture, there is a *Malus* collection (*in situ*) in the Botanical Garden in Powsin near Warsaw. The collection is sponsored by the Ministry of Agriculture. It contains about 250 accessions, which are evaluated systematically according to UPOV descriptors. The main task of the collection is to maintain the primitive autochthonous cultivars of Polish origin.

Other collections (*ex situ*) existing in Agricultural Academies in Poland have not been financed and they are not developing now. Collections (*in situ*) within the ecological community have also been registered and their number increases constantly, mostly in the northern part of Poland, depending on the financial support.

Evaluation and utilization

We record the blossoming and ripening date every year. Crop productivity of trees and quality of fruit are also measured. In addition, the growth of trees, shape of canopy and occasionally the resistance to main pests and diseases is evaluated. Some accessions are used in the special breeding programme conducted at the Research Institute of Pomology at Skierniewice.

Data management

Data management includes the European *Malus/Pyrus* Database. In the apple collection, 40% of passport data have already been completed and 80% of accessions have photograph documentation of the fruit. *Malus* and *Pyrus* sp. evaluation has systematically been completed.

The national programme for fruit species genetic resources in Romania

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Romania, by its geographical location in Europe and thanks to its temperate-continental climate which is favourable to the cultivation of many fruit species, owns a rich genetic fund created both by natural selection and by the introduction of foreign cultivars. The first concern for identification, description and classification of local and foreign genetic resources goes back to 1877 when 1075 cultivars were described and collected in a farm near Cenad (Arad district) by Maté Bereczki.

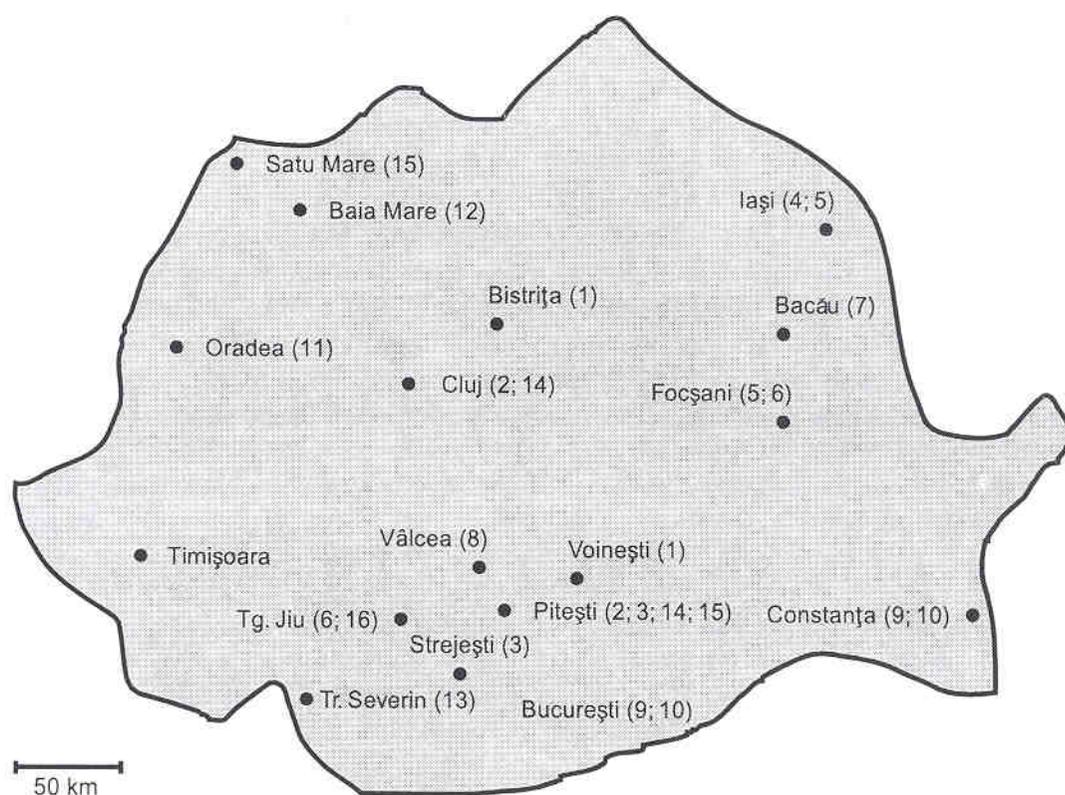
Presently, fruit germplasm conserved *in situ* or *ex situ* comprises nearly 6000 accessions as follows:

Fruit	No. of accessions	Fruit	No. of accessions
apple	879	strawberry	322
pear	585	black currant	144
quince	45	red currant	41
plum	641	white currant	7
apricot	660	gooseberry	22
peach	1025	raspberry	92
almond	179	blueberry	33
sweet cherry	527	blackberry	26
sour cherry	177	sea buckthorn	7
walnut	76	corneal	59
filbert	42	hip rose	21
chestnut	38	other species	11

The National Collections for each genus and species can be found in one or two outstanding locations which have favourable climatic conditions for growing and highlighting the specific traits of cultivars (Fig. 1). The total area of *ex situ* collections is 65 ha but this will be reduced because of low financial support. The same is true for the plant material in the botanical gardens or that identified *in situ*.

At the national level, there is a Committee for Plant Genetic Resources at the Ministry of Agriculture, which together with the Gene Bank Suceava coordinates the activity for preservation and evaluation of fruit germplasm in Romania. Fruit genetic resources are managed by 15 research stations and they are included in the national research project which at present is poorly financed.

The organization on a scientific basis of the national collections was initiated in 1970 and has continued ever since, involving the genetic resources in the breeding programmes. Simultaneously, the cultivars were evaluated using UPOV European descriptors so that after 1990, more than half of accessions were computerized in a database. The utilization of some cultivars present in the collections as parents gave more than 200 new valuable cultivars and rootstocks, grown commercially. To highlight the activity in this field, international symposia on plant genetic resources were organized at Suceava in 1993 and 1996.



- | | |
|----------------|------------------------------|
| 1 Apple | 9 Apricot |
| 2 Pear | 10 Peach |
| 3 Plum | 11 Almond |
| 4 Sweet cherry | 12 Chestnut |
| 5 Sour cherry | 13 Fig |
| 6 Quince | 14 Black currant, Gooseberry |
| 7 Seabuckthorn | 15 Strawberry |
| 8 Hazelnut | 16 Walnut |

Fig. 1. Location of *Malus/Pyrus* collections in Romania.

Nevertheless, there is still more to be done, such as:

1. Collecting new genotypes to increase the genetic variability and include a higher number of useful traits in breeding.
2. Evaluating local populations and drawing zonal maps of the fruit genetic patrimony.
3. Active participation to exchange of plants to enrich the genetic diversity and cooperation with new governmental organizations involved in environmental protection.
4. Finding new financial opportunities to preserve the present collections and to evaluate all accessions which will be registered in the database.

Apple genetic resources in the Cantabrian coast and their use in a cider apple breeding programme

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Introduction

The favourable ecological and climatic conditions linked to the quick introduction in the Cantabrian coast of *Malus domestica* Borkh. and its hybridization with *Malus sylvestris* Miller on one hand, and the mode of multiplication of apple (sexual and vegetative) on the other hand, have led to the appearance of a large number of varieties that are suitable for cider and other apple by-products. The major part of these varieties have a local distribution, although some of them, which are interesting as dessert apples, are more widely spread.

The National Apple Germplasm Bank (CIATA Asturias) and the Regional Apple Germplasm Repository (Galician, Vizcaya, Guipúzcoa, Navarra y Zaragoza) are located in the north of Spain. Among the regions of the Cantabrian coast, Asturias has the higher diversity of genetic resources of apple, and it can be considered as a secondary centre of genetic variation. These genetic resources are of great interest for breeding, particularly now that the race 6 of *Venturia inaequalis* (Cke.) Wint. has overcome the resistance of the Vf system (which has been used during the last 45 years in breeding programmes). This fact strengthens the interest to associate a polygenic resistance character (which is already present in 39.5% of the Asturian apple varieties studied) with major genes, such as Vf or Va genes.

The CIATA of Villaviciosa has carried out exploration and collection of local cultivars of the Cantabrian coast, mainly the Asturian ones. Since 1986, intensive work on characterization and evaluation, focused on the selection of apples of interest, has been developed. The main objectives considered were:

- resistance to diseases and pests
- production: precocious, high and regular bearing
- organoleptic and technological quality.

Apple genetic resources in the germplasm bank

A repository of apple cultivars was established progressively in the CIATA of the Villaviciosa from 1955 onwards. Currently 370 apple accessions are being maintained, including 207 local cultivars (148 Asturian and Basque cider apple) and 25 French and English cider apple.

Current research

A new exploration was initiated in Asturias from 1994 on the basis of a preliminary evaluation *in situ*, considering: susceptibility to *Venturia inaequalis*, *Nectria galligena* Bres. and *Podosphaera leucotricha* (Ell. & Ev.) E. Salomon; production; organoleptic and technological analysis. In February-March 1997, 424 cultivars were collected.

Characterization studies focus on the morphological characters of tree, shoot, flower, leaf and fruit.

Evaluation of *Malus* accessions includes:

- phenology
- screening for resistance to:
 - Venturia inaequalis*
 - Nectria galligena*
 - Podosphaera leucotricha*
 - Monilia fructigena*
 - Dysaphis plantaginea*
 - Panonychus ulmi*
 - Erwinia amylovora* (INRA Angers): 15 cultivars
- analysis of branching habit and type of fruit bearing, and relation with regular or biennial production
- yield
- ripening study
- organoleptic and technological characters.

Cider apple breeding programme

Since 1989, the CIATA has been developing a genetic improvement programme of cider apple varieties, through the crossing of Asturian cider apple varieties of agronomic and technological interest with some varieties or hybrids possessing important characteristics such as *Vf* scab resistance character, high fire blight resistance, relatively late ripening, and one fruit per inflorescence (kindly provided by INRA Angers, France) (Table 1).

Table 1. Crosses carried out during the period 1989-97

	Florina	Priscilla	H232	H2310	H3131	H3248	H6419
Carrio	x						
Coloradona						x	x
Collaos	x		x				
De la Riega	x					x	
Meana	x		x				
Obdulina	x						
Paraguas	x				x		
Perico	x		x		x		
Raxao	x	x	x				x
Rein. Verde							x
Reineta Encarnada				x			

The main breeding aims are:

- resistance to scab + tolerance to mildew, canker, fire blight and rosy apple aphid + technological characters
- regular bearing (good tree habit) + resistance to scab + technological characters
- resistance to scab + tolerance to fire blight and rosy apple aphid + fruit quality (eating apple).

In addition, for the improvement of scab polygenic resistance and technological characters a programme of crosses between Asturian cider apple varieties is being carried out (Table 2).

Table 2. Crosses between Asturian cider apple varieties

	Blanquina	Clara	Coloradona	Coloradona	L.Montes	Paraguas	Perezosa	Perico	Teorica	Verdialona	Xuanina
Blanquina	-	-	-	-	-	-	-	-	x	x	-
Coloradona	-	-	-	-	-	-	x	-	-	-	-
Collaos	-	-	-	-	-	x	-	-	-	-	-
Duron Arroes	-	x	x	-	-	-	-	-	-	-	-
Paraguas	-	-	-	x	-	-	-	-	-	-	x
Perezosa	-	-	x	-	-	-	-	-	-	-	-
Perico	-	-	-	x	x	-	-	-	-	-	-
Raxao	-	-	-	-	x	-	-	x	-	-	-
Teorica	x	-	-	-	-	-	-	-	-	x	-
Xuanina	-	-	-	x	-	-	-	-	-	-	-

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The management of Swiss *Malus* and *Pyrus* genetic resources

A. Update on Swiss *Malus* and *Pyrus* collections

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In Switzerland there are mainly three organizations involved in the conservation and characterization of *Malus* and *Pyrus* genetic resources: the Federal Research Station Wädenswil, financed by the Federal Office of Agriculture, and two private NGOs: Fructus and Pro Specie Rara (Fig. 1). The main collections of Fructus are located at Höri (190 *Malus*, 43 *Pyrus* accessions) and Aubonne (90 *Malus* and 94 *Pyrus* accessions). Pro Specie Rara follows a decentralized approach with *in situ* conservation (on-farm) of about 500 *Malus* accessions. Regional associations are keeping further collections with a considerable number of accessions (e.g. Rétropomme: 49 apple accessions, 77 pear).

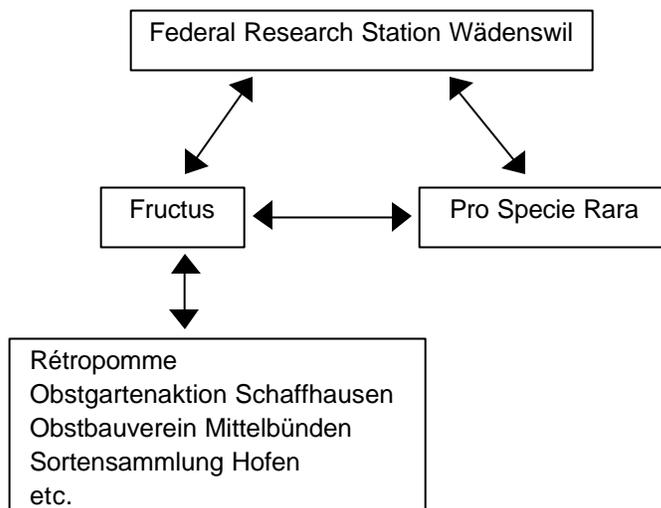


Fig. 1. Swiss organizations involved in the conservation and characterization of *Malus* and *Pyrus* genetic resources.

The rather decentralized approach of variety conservation requires good data management. Fructus and Pro Specie Rara are working with coordinated databases on Filemaker including all information on collecting sites and *in situ* collection (see below, part B).

Red list

The information system allows detection of accessions which are threatened with extinction. A so-called 'red list' is being established with the following categories:

- accession on less than 5 sites → threatened accession → red list
- accession on 6 to 30 sites → rare accession
- accession on more than 30 sites → safe accession.

Actually two red lists of the apple and pear varieties exist: one for original Swiss accessions and one for all known accessions. The Swiss accessions on the red list are now being multiplied with highest priority and subsequently distributed to collections or collaborating farmers.

Characterization

Based on several national and regional fruit exhibitions, it was possible to photograph and describe a considerable number of apple and pear accessions, mainly through the activity of Fructus. At the moment pomological description of about 500 apple and 300 pear accessions is completed and most of these descriptions are already included in the database.

CD-ROM

Fructus and Pro Specie Rara are jointly preparing a CD-ROM with pictures and pomological descriptions of about 500 apple and 300 pear accessions. It should be ready for the next common fruit variety exhibition which will take place in October 1998 in Burgdorf near Bern.

Input from the government

Until now the Swiss government was almost not involved in the conservation of fruit genetic resources in Switzerland. Private activity was predominant. However, following the conferences of Rio and Leipzig, there are initiatives to increase the government's commitments in the conservation of plant genetic resources. A report was recently prepared which gives a good summary of the current situation concerning plant genetic resources in Switzerland, targeting gaps and proposing solutions to fill these gaps. It is obvious that in the area of fruit genetic resources there are still considerable gaps to fill, mainly in respect to stone fruit. We hope that decisions will be taken during this year.

Value for apple and pear breeding

The Research Stations of Wädenswil and Changins are closely collaborating with Fructus and Pro Specie Rara. These stations are involved in apple and pear breeding programmes respectively. As there are no official government-funded genebanks for fruit species this collaboration is very important. It is hoped that through the progress in the characterization of the fruit genetic resources they can be considered more frequently in the breeding programmes. A broader genetic base is required in many modern fruit breeding programmes and it is obvious that in this context the fruit genetic resources play an important role.

B. Swiss Fruit Tree Databases for Apples and Pears

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Filemaker databases

Both NGOs are working with Filemaker 2.1 and 3.0 databases. These databases include three main parts:

- addresses of collections and single-tree holders (on-farm conservation)
- passport and pomological data that also can be used for determining varieties
- site information: quality and security of the site, age of the tree, number of trees.

Access database

This relational database is being established at the Federal Research Station Wädenswil on MS-Access. It will be connected to the Fructus and Pro Specie Rara Databases. This database is essentially developed for testing modern cultivars. However, the pomological descriptions of fruit genetic resources will also be included.

Levels of data entry

- annual evaluation data from field trials.
The characters on this level can be defined individually with the help of a mask for different character types. All the defined characters of the variety descriptions are also included.
- variety descriptions based on different sources:
 - * literature (mainly older varieties or very new ones)
 - * results of our own trials

The characters in the variety description have been fixed. Apart from biological and genetic information such as parents, resistances, ploidy level, virus status, they consist of pomological characters, of measured characters such as sugar content, acidity and firmness and characters related to tree performance. For the daily use there are also data about breeders, partners of experimental contracts, date of importation, variety rights and variety protection.

The results of our own field trials can be automatically read into the variety description sheet. The possibility of manual correction is provided.

Regular meetings with the partner institutions are envisaged for discussion and adjustment of data.

Dimensions of characters

Most of the characters are evaluated as ratings. Two rating scales can be used: either 1-9 or 0-100. The results can be shown on either scale.

Some characters are evaluated by a choice of descriptive adjectives. Others consist of measured values.

Searching possibilities

It is possible to search for any defined character of the variety description.

Presentation of data

Presentation forms are not yet finalized. A star diagram and a time diagram for a choice of key characters of one or several varieties together are already available.

Languages

The database is designed for use in four languages. The translations, however, have not yet been made.

Import and export facilities

Import facilities for data being gathered on other programmes:

- *Addresses* are already dealt with on a Filemaker database.
- One partner (Fructus) was already using Filemaker for *variety description of old varieties*. So it was a condition to provide regular importation of these data.
- For *field data* we use a programme called Widas (compatible with Excel).
- *Calibration data* are also entered from Widas via Excel.

Outlook

In the future, networking with other institutions worldwide and data exchange are envisaged.

National conservation of *Malus/Pyrus* germplasm in the Federal Republic of Yugoslavia

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Collection-oriented investigations of *Malus* and *Pyrus*

Investigations were performed on apple and pear varieties and their wild relatives. During the period 1976-79, T. Van der Zwet of the United States carried out the project Studies of Autochthonous Varieties of Pear in the Territory of the Balkan Peninsula. With the help of researchers from Yugoslavia (Stanković, Ristevski, Paunović, Jovancević), Romania, Bulgaria, and Hungary, he inventoried 279 varieties, including 225 varieties from the territory of former Yugoslavia (Serbia, Montenegro, and Macedonia). These varieties can be found in collections in the United States today.

Bell and Stuart (1990) subsequently carried out further investigations of the mentioned varieties and concluded that the following autochthonous varieties of pear from the territories of Serbia and Montenegro were highly resistant to *Psylla piricola* Först.: Jeribasma, Karamanka, Smokvarka, Mednik, Običan vodenjak and Zelenika. During this research, they established that Smokvarka was in fact a hybrid of *Pyrus communis* L. and *Pyrus elaeagnifolia* Pall.

During the period 1985-88, the Belgrade Faculty of Agriculture, led by Evica Mratinić independently began the project Inventory of Autochthonous Varieties of Apple and Pear in the area of Mt. Kopaonik. Research was carried out with financial assistance from agricultural organizations of this area. On that occasion, researchers recorded, marked and described 90 varieties of apple and 53 varieties of pear in *in situ* conditions.

In 1987, the S.F.R. Yugoslav government financed a study of the possibilities for setting up a bank of Yugoslav plant genes, as a federal institution. Within this study, in the period 1989-91, the S.F.R. Yugoslav government financed the project 'The Setting up of a Bank of Plant Genes of Yugoslavia' and within this 'The Setting up of a Bank of Fruit Tree Genes of Yugoslavia'. This project was implemented with the participation of 18 institutions (institutes, faculties) from all over former Yugoslavia, and 137 scientific researchers. Investigations were carried out on 13 varieties of fruit trees.

To study and isolate genotypes of fruit trees *in situ*, the corrected or supplemented descriptor list of the IBPGR was used for apple, pear, plum, apricot, cherry, sour cherry, almond and olive, and a new descriptor list established according to the IPGRI (IBPGR) method for myrobolan, vineyard peach, walnut, hazelnut and raspberry. On that occasion, 145 varieties of apple and 134 varieties of pear were studied.

This project was to continue in the next period as well, when the already registered genotypes would be moved from *in situ* to *ex situ* conditions, and registering and studies of new genotypes would also continue. Moreover, the work undertaken on the establishment of a federal Yugoslav bank of plant genes (buildings and collection gardens) would be completed. Unfortunately, the project was interrupted by the events which took place in the territory of former Yugoslavia in 1992 and the following years.

Preservation of *Malus* and *Pyrus* germplasm in F.R. Yugoslavia

The following institutions (faculties and research institutes) contribute to the preservation of *Malus* and *Pyrus* germplasm today:

1. The Belgrade Faculty of Agriculture
 - Department of Fruit Growing / Curator: Evica Mratinić
2. The Institute for Agriculture Research Serbia of Belgrade
 - Centre for Fruit Growing and Viticulture of Čačak / Heads of the collection: Ž. Tešović and M. Nikolić
 - Department for Agricultural and Technological Investigations of Zajecar / Curator: R. Miletić
3. The Novi Sad Faculty of Agriculture
 - Department of Fruit Growing / Curators: Z. Keserović
4. The Priština Faculty of Agriculture
 - Institute of Plant Production of Peć
5. The Agricultural complex PKB INI "Agroekonomik" of Belgrade
 - Department of Fruit Growing and Viticulture / Curator: Radmila Todorović
6. The Agricultural Institute of Podgorica
 - Fruit Growing Station of Bijelo Polje / Curator: Lj. Krgović

During 3 years of work on a joint project 'Setting up a Bank of Yugoslav Plant Genes' and 'Setting up a Bank of Fruit Genes', financed by the Yugoslav federal government, the above institutions registered and described 89 autochthonous varieties of apple and 83 autochthonous varieties of pear in *in situ* conditions. About 90% of the registered *Malus* and *Pyrus* gene fund which is found *in situ* has been transferred to the *ex situ* state (active collections) over the past 5 years (without financial assistance of the government) by the researchers participating in the project. This number of genotypes, financed under the project, was determined on the basis of funds made available by the government at that time. It is just a small part of the exceptionally large number of autochthonous varieties of *Malus* and *Pyrus* in Yugoslavia.

Autochthonous varieties of *Malus* and *Pyrus* are found in Yugoslavia mostly in hilly-mountainous regions, on individual farms, where fruit growing is extensive. There is a great possibility that certain genotypes will disappear owing to the abandonment of agricultural practices and to ageing of orchards. Bearing this in mind, many researchers continued to work on registering and collecting autochthonous varieties of *Malus* and *Pyrus*, either individually or within the activities of the institutions where they were employed. These activities were conducted with the objective of preserving the existing gene fund without any financial assistance from the government. These individual investigations were carried out primarily thanks to the great enthusiasm and personal commitment of the researchers, as well as financial assistance from agricultural organizations in the field.

Table 1 presents autochthonous varieties of apple and pear whose study was financed by the government, as well as the total number of autochthonous varieties studied and collected *in situ* and *ex situ* in the Federal Republic of Yugoslavia.

Studies of introduced apple and pear varieties are carried out within a project financed by the Yugoslav federal government and the republican governments of

Serbia and Montenegro. The preservation of these varieties in *ex situ* collections is not sufficiently financed by these governments.

Table 1. Number of *Malus/Pyrus* accessions in F.R.Yugoslavia collections

Crop	No. autochthonous accessions studied	Autochthonous accessions <i>in situ</i>	Collection of accessions <i>ex situ</i>		
			Autochthonous	Mostly foreign cvs.	Hybrids or selections
Apple	89	333	188	562	128
Pear	83	240	194	533	42

In addition to the collecting of autochthonous and introduced varieties of apple and pear in Yugoslavia by the Faculty of Agriculture of Belgrade, work has also begun on the rich populations of wild species of apple and pear. *Malus* species found in this area in natural populations have been determined, as well as their distribution. They are: *Malus sylvestris* Miller, *M. dasyphylla* Borkh. and *M. florentina* (Zuccagni) C. Schneider. *Malus florentina* is especially interesting as a species endemic to the Balkans. It is found in Yugoslavia (southern Serbia), Macedonia, Greece, Albania, and southern Italy.

The following species of *Pyrus* are found in natural populations in Yugoslavia: *Pyrus communis* L., *P. amygdaliformis* Vill, *P. nivalis* Jacq., and *P. elaeagnifolia* Pall.

Work continues on selection, *in situ* investigations, and collecting of the economically most interesting genotypes. This research is also being carried out without any financial assistance from the Yugoslav government.

Evaluation and utilization

Genotypes in active collections are evaluated according to the most important phenotypic and pomological characteristics in order to determine their importance for horticulture and breeding.

Each genotype (accession) in the collection is represented by five trees and its characteristics are evaluated according to the IPGRI descriptors list. The following characters are evaluated in apple genotypes: trunk thickness, time of blossoming, time of maturation of fruit, productivity, fruit size, basic and additional colour of epidermis, firmness of fruit, fruit quality, resistance to the pathogens *Podosphaera leucotricha* (Ell. & Ev.) E. Salmon and *Venturia inaequalis* (Cke.) Wint., and ecological factors (frost and drought).

The following are evaluated in pear genotypes: trunk thickness, time of blossoming, parthenocarpia, time of fruit ripening, productivity, fruit size, epidermis colour, fruit quality, resistance to the pathogens *Psylla pyri* L., *Venturia pirina* Aderh., *Psylla piricola*, and *Erwinia amylovora* (Burril) Winslow *et al.*, and to ecological factors (frost and drought).

All these apple and pear genotypes are interesting for different purposes:

- to create new varieties
- for commercial cultivation
- for cultivation in gardens
- for ornamental use or for revegetation of bare mountainous areas
- as rootstocks
- for fresh consumption
- for processing.

Reference

Bell, R.L. and L.C. Stuart. 1990. Resistance in Eastern European *Pyrus* germplasm to pear *Psylla* nymphal feeding. HortScience 25(7):789-791.

Research activities

New project for the use of apple genetic resources in a breeding programme

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Introduction

In 1975 a research project on fruit trees genetic resources and disease resistance began. A collection of old fruit tree cultivars has been set up progressively and has now reached 2550 accessions of which 1250 are apples. The material is continuously evaluated for disease resistance and agronomic characters in experimental orchards (Lateur and Populer 1996).

The first few crosses were made in 1988 with the initial aim of studying the pollen intercompatibility (Lateur 1996). Since 1990 started a breeding programme has focused on apple scab polygenic resistance, using the better-performing old cultivars screened out of our collection. Thanks to new funding, the programme has been operational since the beginning of 1996 (Lateur and Wagemans 1996; Lateur *et al.* 1997). It is the second way of valorization of our genetic resources, after the direct re-introduction of some old fruit cultivars through commercial nurseries (Lateur and Populer 1996).

Strategy of the apple breeding programme at Gembloux

1. Selecting from the evaluation of our genetic resources :
 - new sources of polygenic scab resistance, mildew resistance and *Nectria* canker resistance
 - sources of fruit quality (taste, firmness, conservation, etc.) and hardiness
2. Selecting the parents with the best combinations of good diseases resistance and good agronomic characters.
3. Developing specific methods for testing the polygenic scab resistance of young seedlings by:
 - standardizing all parameters: soils, inoculum, quantitative inoculation, temperature, RH, etc.
 - developing a quantitative assessment key
 - controlling the consistency between the greenhouse scab test and the plant resistance in the field.
4. Selecting the best parents which transmit their good characters to a sufficiently large proportion of their offsprings.

Apple breeding work at Gembloux

The general crossing scheme is given below. During the last 5 years, around 80 old apple cultivars have been used as parents in different combinations to test their ability to transmit their polygenic resistance characters for scab and for mildew.

General crossing scheme for durable scab resistance

<u>Polyg x Polyg</u>	<u>Polyg x Vf</u>	<u>Polyg x commercial cvs</u>
± 30%	± 30%	± 30%

Figure 1 summarizes our breeding activities during the period 1990-96 on crosses and on open-pollinated flowers from selected cultivars.

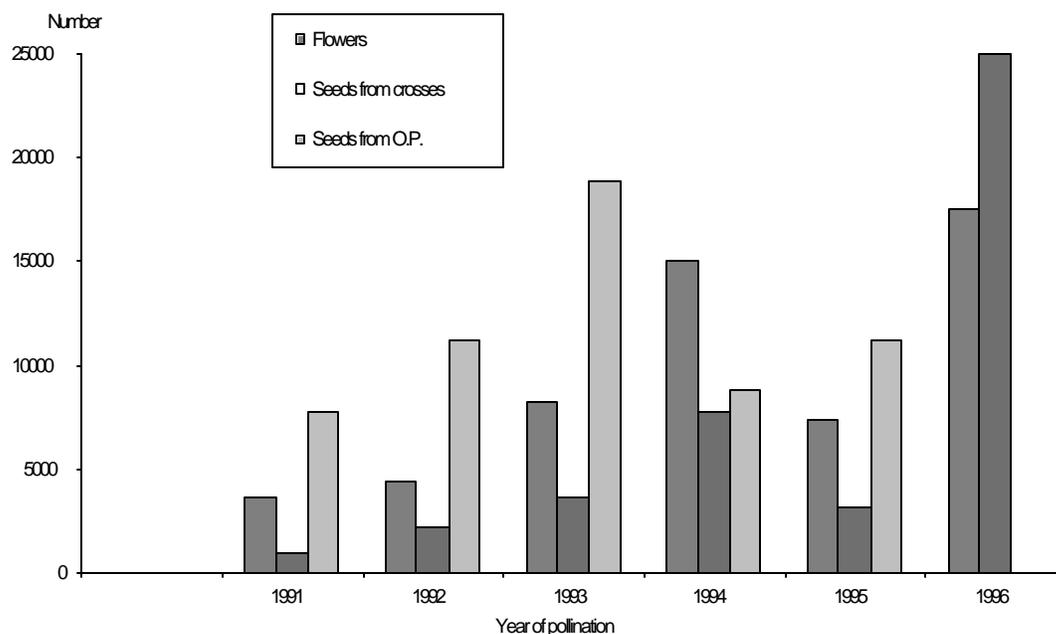


Fig. 1. Number of pollinated flowers and number of seeds raised from crosses and from open-pollination (O.P.) at the Plant Pathology Station from 1991 onward.

Table 1 shows the average cycle of selection based on preliminary results.

Table 1. Average cycle of selection of the breeding programme, 1990-96

Time	Steps	Selection pressure	Polyg. parents	No. of seedlings		
				Vf parents	O.P. [†]	Total
Year 0	Crosses					
Year 1	Sowing		5000	2100	10000	17100
		Greenhouse scab test				
Years 2-3	Nursery		1200 (24%)	860 (41%)	1300 (13%)	3360 (20%)
		Scab, mildew and canker susceptibility				
Year 3 or 4	Grafting on M9		480 (10%)	252 (12%)	450 (4%)	1182 (7%)
		Agronomic characters				

[†] O.P. = open-pollination.

Through the preservation, evaluation and utilization of the existing genetic diversity, fruit breeders have promising chances to develop new cultivars adapted to the future conditions of fruit growing.

Acknowledgements

The apple breeding project has been funded since December 1995 by the Belgian Ministry of Middle Classes and Agriculture, Department of Research and Development, which we acknowledge for their financial support.

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Testing for resistance in apples at the Fruit Genebank and the Fruit Breeding Institute at Dresden-Pillnitz

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Fruit breeding is heavily dependent on the constant use of old and new varieties as well as on the use of different wild species. This is especially important for the introduction of disease and pest resistance, as well as of stress tolerance. Besides the collecting and conservation of fruit collections, their evaluation for later use in breeding work is of great importance. Therefore we give priority to the collecting and conservation of varieties and species which show significant properties and express them under different ecological conditions.

For each kind of cultivated plant, related wild species are an important genetic source. These sources contain genetic information – in this case especially resistance traits – that can be transferred to the cultivated form. The genetic pool of wild species collections reveals what is actually possible with regard to resistance. This means that a certain completeness of a collection of wild species should be aimed at. An analysis of the resistance features supplies information for evaluation of the manifold plant forms. This means that high demands have to be placed on the quality of these analyses if they are to correctly convey the genetic resistance background. Without going into further details, we would like to point out the difficulties encountered in analyzing resistance features that are dependent on environmental conditions.

Resistance to scab, mildew and fire blight plays a major role in the breeding of apples today. Table 1 shows the scab and mildew resistance of our *Malus* wild species collection.

For breeding purposes it is a distinct advantage that, with the exception of apomictic polyploids, wild species of apples can be crossed with cultivated apples without limitations. This means that to determine the genetic background, resistance carriers can be combined with cultivated varieties at all stages. In cross-combination programmes at Pillnitz the following species and cultivars were used:

- as sources for scab resistance: in the first step Steinantonovka (Va), in the next steps *Malus* × *floribunda* Siebold ex van Houtte (Vf), *M.* × *micromalus* Makino (Vm), *M.* × *atrosanguinea* (Späth) Schneid. (Vf ?), *M. pumila* Mill. (Vr) and the cultivars James Grieve, Cox Orange, Duchess of Oldenburg and others;
- as sources for mildew resistance *M.* × *zumi* Calocarpa (Matsun) Rehd., *M.* × *robusta* Persicifolia (Carriere) Rehd., *M.* × *floribunda*, *M.* × *micromalus* and the cultivars Dülmener Rosen, James Grieve, Helios, Alkmene, Lord Lambourne, Worcester Permain and others;
- as sources for fire blight resistance *M.* × *robusta* Persicifolia, *M.* × *sublobata* (Dipp.) Rehd., *M.* × *floribunda*, *M. prunifolia* (Willd.) Borkh., *M. fusca* (Raf.) Schneid. and the cultivars Remo, Rewena and Reanda.

Table 1. Potential of scab and mildew resistance in 270 accessions of *Malus* wild species at Dresden-Pillnitz

	Scab	Mildew	Both
No symptoms	6%	12%	4%
Only slight symptoms	24%	24%	15%
Significant symptoms	70%	65%	53%

Following initial information about a possible breakdown of the monogenic *M. floribunda* scab resistance, it became necessary to consider further sources of resistance. Since 1994, 18 highly scab-resistant *Malus* species have been crossed with cultivated apples and subjected to an early selection in a prebreeding programme with the Institut for Fruit Breeding Dresden-Pillnitz. Likewise, it was attempted to transfer the good mildew resistance of *Malus sylvestris* Miller to cultivars. The results will be evaluated in the coming years.

A valuable aid in identifying sources of resistance has been the marking of the resistance genes by PCR techniques. To ascertain the resistance to fire blight, numerous *Malus* species were screened in cooperation with the Phytopathological Institute in Aschersleben, Germany. The results revealed that the northwestern American species *Malus fusca* possesses complete resistance.

The evaluation of the apple cultivars of the Fruit Genebank is also a decisive help in discovering new sources of resistance within this collection. The discovery of carriers of polygenic resistance that are decisive for the stability of resistance in the field is of prime importance. By crossing these varieties a limitation of the genetic diversity in apple populations can be avoided. In the last few years it had been feared that this could occur because only a few high-quality apple cultivars had been used in breeding programmes. An analysis of more than 700 cultivars over a 4-year period revealed that only a few varieties remain that have not been infected by scab and mildew. The varieties not affected by these pests were Alkmene, Hiberna, Kardinal Bea, Remo, Rote Sternrenette, Roter Eiserapfel, Peasgoods Nonsuch and Schlesischer Lehmäpfel. The cultivars Boskoop, Rewena and Discovery showed only slight damages due to mildew in one year. These varieties will be more heavily involved in future resistance breeding programmes, especially since their fruit quality is considered to be quite unproblematical.

In recent years there have been numerous indications of the breakdown of the monogenic scab resistance of *Malus floribunda* and its progenies. For 3 years now, usually unaffected *M. floribunda* origins in our assortment of wild species have also been diseased by scab. The spectrum of races has been investigated and it was discovered that in Pillnitz the scab race no. 3 has apparently been responsible for the contamination of otherwise resistant forms. As a result of this research and in order to permit a considerably tougher selection process, all seedlings from the scab resistance programme of the Breeding Institute will also be infected with this aggressive racial spectrum stemming from the Fruit Genebank since 1996.

The rate of susceptibility in the populations is higher than by using the natural scab inoculum as before.

In the first step of the resistance breeding work in Pillnitz, the selected cultivars possess only one resistance source. It is important to note that the first varieties of the Re-series include cultivars with different bases of scab resistance:

<i>Vf</i>	Remo, Retina, Rewena, Rene, Reanda, Relinda, Releika, Resi, Rebella, Regine, Renora
<i>Vr</i>	Realka, Releta, Remura, Regia, Reka
<i>Va</i>	Reglindis.

In the following steps the first high-quality clones with two scab resistance sources are in the last field testing:

<i>Va</i> + <i>Vf</i>	17 breeding clones
<i>Va</i> + <i>Vr</i>	3 breeding clones
<i>Vr</i> + <i>Vf</i>	6 breeding clones
<i>Vf</i> + <i>Vf</i>	4 breeding clones.

Some scab-resistant cultivars, especially with the *Vf* gene, proved to be mildew resistant. These are Remo, Rewena, Reanda, Rebella and Resi. Other named cultivars are only weakly susceptible to different degrees. We found this in the *Vr*-cultivars, a few of which were susceptible to mildew. The same problems with mildew in the field were found in Jonafree, Freedom, Liberty, Florina and Priscilla.

Commercial trials carried out over 12 years without fungicidal sprays have demonstrated that the Pillnitz resistant cultivars (*Vf*, *Va* and *Vr*) have up to now a durable resistance to scab and sufficient levels of resistance to mildew. Fungicides can be reduced by at least 80% for these cultivars. It was very encouraging to note that diseases caused by other fungi were also absent in these trials.

Breeding material with mildew resistance obtained from both oligogenic and polygenic sources (*M. × robusta* Persicifolia, *M. × zumi* Calocarpa, cultivars) are being tested in the field.

Fire blight resistance is very important because there are no efficient bactericides registered for use in orchards. Donors of alleles for resistance have been found in progenies involving *M. × floribunda* and some cultivars. Progenies of Clivia, Golden Delicious, Alkmene and Pi-A 44,14 produce a good percentage of seedlings with a high level of resistance. Varieties resistant to fire blight are Remo, Rewena, Rene, Rebella, Reanda and Realka.

The cultivars Remo, Rewena, Rebella and Reanda possess triple resistance to scab, mildew and fire blight. Parents with triple resistance transmit a high degree of resistance to their progenies. The best combination, Pi-AS 44,14 × Rewena produced on average one triple-resistant plant for every seven seedlings tested.

The resistance levels of different Pillnitz Re-cultivars[®] are listed in Table 2.

The following investigations were carried out to examine the durability of scab resistance of new cultivars. The tested cultivars were chosen out of a number of resistant cultivars with different genetic background: *M. floribunda* (*Vf*), *Malus pumila* Russian Seedling 12740-7A (*Vr*), *Malus micromalus* (*Vm*) and the cultivar Antonovka (*Va*). The resistant cultivars were compared with a few non-resistant commercial cultivars. Simultaneously, different *Malus* species and resistant parents of the resistant cultivars were included in these tests.

Shoots of the grafted test plants in a greenhouse were inoculated with scab suspension, at a concentration of 1×10^9 cfu. The scab-infected leaf material was taken from different *M. floribunda* accessions of the Fruit Genebank (named AWS). The control suspension derived from a mixture of scab-infected leaves of non-resistant cultivars in the orchard at different locations without fungicide spraying. Two lines were received from Ahrensburg (KRÜGER), from COOP 8 and 5002 (*Vf*).

Table 2. Multiple resistance in the Pillnitz Re-cultivars®

Re-cultivar®	Resistance [†] to:						
	scab	mildew	fire blight	bact. cancer	red spider mite	spring frost	winter frost
REALKA	x(Vf)	#	x	o	o	#	o
REANDA	x(Vf)	x	x	o	#	x	o
REGLINDIS	x(Va)	(x)	(x)	o	x	–	x
REKA	x(Vf)	(x)	o	x	#	#	(x)
RELEIKA	x(Vf)	o	(x)	x	x	–	–
RELETA	x(Vf)	#	o	x	o	o	o
RELINDA	x(Vf)	(x)	o	x	#	–	–
REMO	x(Vf)	x	x	o	o	x	x
REMURA	x(Vf)	o	o	o	#	o	x
RENE	x(Vf)	o	x	(x)	#	x	o
RENORA	x(Vf)	(x)	o	o	o	x	(x)
RESI	x(Vf)	x	o	x	#	–	–
RETINA	x(Vf)	(x)	o	o	(x)	x	#
REWENA	x(Vf)	x	x	x	o	x	o
Pi-AS-5,157	x(Va+ Vf)	(x)	o	x	x	–	–
Pi-AS-5,169	x(Va+ Vf)	x	(x)	x	x	–	–

[†] x = resistant; (x) = moderately resistant; o = moderately susceptible; # = susceptible; – = not investigated.

These four different scab inocula were able to infest various resistant cultivars to a distinctive extent (Table 3). The non-resistant cultivars were heavily infested.

The Re-cultivars from Pillnitz and the cv. Ahra from Ahrensburg showed resistance characters without symptoms and hypersensitivity. Liberty, Baujade and Delorina were strongly infested by *M. floribunda*-AWS-inoculum, and Priam was infested with slight sporulation. With the exception of Karmina the resistant Czech cultivars showed heavy scab infestations by the inoculum from *M. floribunda*-AWS. Rosana and Vanda were slowly infested also by the control inoculum. The three AWS types of *M. floribunda* including *M. floribunda* 821 showed heavy symptoms after inoculation by *M. floribunda*-AWS (Table 3).

The Vr-resistant cultivars based on the resistance of *M. pumila* R 12740-7A were found with resistance characters in different levels. The resistant cultivars derived from Antonovka (Va) showed various symptoms of scab infection, Reglindis a slight sporulation with the 5002 inoculum, and Angold a strong sporulation with the *M. floribunda*-AWS-inoculum.

The results of natural infection in the field showed heavy infestations on cv. Golden Delicious and on host for race 3 and also on *M. floribunda* 821, but the differential host for Va showed only slight sporulation. The genotype Evereste was completely resistant without symptoms. After the test of the differential hosts for the scab races which were involved in the experiment, we conclude that the scab races 1 and 3 predominate in the natural scab population in the region of Dresden-Pillnitz and we consider race 3 as responsible for the infestations of the Vf genotypes.

Table 3. Characteristics of resistant cultivars, clones and parents inoculated with various scab inocula

Cultivar/ wild species	Resistance		Parents'	Control	Evaluation to inoculum				Origins
	source	without			<i>M. floribunda</i>	AWS	COOP 8	5002	
Golden Delicious	without		unknown	4	4	4	4	4	D-Genbank (GB) Pillnitz
Gloster	without		Glocken x Richared Del.	4	4	1	1	1	D-OVR Jork
James Grieve	without		Potts Seedling x o.p.	4	1	1	1	4	D-GB Pillnitz
Elista	without		Elistar mutant	1	4	2	2	4	D-GB Pillnitz
D - Remo	Vf		J. Grieve x MFK	1	2	2	2	1	D-Ifo Pillnitz
Rewena	Vf		(Cox Or. x Oldenb.) x MFK	1	2	1	1	1	D-Ifo Pillnitz
Retina	Vf		Apollo x MFK	1	2	1	1	1	D-Ifo Pillnitz
Reanda	Vf		Clivia x MFK	1	2	2	2	2	D-Ifo Pillnitz
Relinda	Vf		Undine x MFK	1	2	2	2	2	D-Ifo Pillnitz
Rene	Vf		J. Grieve x MFK	1	2	2	2	1	D-Ifo Pillnitz
Releika	Vf		Clivia x MFK	1	2	1	1	1	D-Ifo Pillnitz
Renora	Vf		Clivia x MFK	1	2	2	2	2	D-Ifo Pillnitz
Resi	Vf		Clivia x MFK	1	2	2	2	1	D-Ifo Pillnitz
Ahra	Vf		Prima x Klon 40	1	1	1	1	1	D-IZZ Ahrensburg
Ahrista	Vf		Elistar x TSR15T3	1	3b	3b	3b	3b	D-IZZ Ahrensburg
US - Liberty	Vf		MFK (Macoun <i>et al.</i>)	1	4	4	4	4	D-Zfs Wurzen
Prima	Vf		MFK (Golden Del. <i>et al.</i>)	1	1	1	1	1	D-Zfs Wurzen
Jonafree	Vf		MFK (Jonathan <i>et al.</i>)	1	1	1	1	1	D-Zfs Wurzen
Ca - Macfree	Vf		MFK (McIntosh <i>et al.</i>)	1	1	1	1	1	D-Zfs Wurzen
F - Priam	Vf		MFK (Golden Del. <i>et al.</i>)	1	3b	3b	3b	3b	F-INRA -Angers
Florina	Vf		MFK (Golden Del. <i>et al.</i>)	1	2	2	2	2	F-INRA -Angers
Baujade	Vf		MFK (Granny Smith <i>et al.</i>)	1	4	4	4	4	F-INRA -Angers
Delorina	Vf		MFK (Golden Del. <i>et al.</i>)	3b	4	4	4	4	D-Latz Saarwellingen
CZ - Jolana	Vf		Spartan x ORT16	4	4	4	4	4	CZ-FSUO Holovousy
Melodie	Vf		Shampion x ORT16	1	3b	3b	3b	3b	CZ-FSUO Holovousy
Resista	Vf		Prima x NJ 56	1	4	4	4	4	CZ-FSUO Holovousy
Selena	Vf		Briemac x Prima	1	3b	3b	3b	3b	CZ-FSUO Holovousy
Otava	Vf		Shampion x Jolana	1	4	4	4	4	NL-BS Heines Baarlo
Rajka	Vf		Shampion x Katka	1	3b	3b	3b	3b	NL-BS Heines Baarlo
Rosana	Vf		Jolana x L. Lambourne	3b	4	4	4	4	NL-BS Heines Baarlo
Rubinola	Vf		Rubin x Prima	1	4	4	4	4	NL-BS Heines Baarlo
Vanda	Vf		Jolana x L. Lambourne	3b	4	4	4	4	NL-BS Heines Baarlo
Karmina	Vf		Karmen x MFK	1	2	2	2	2	D-BS Knein Nideggen
Stela	Vf		Jolana x Rubin	1	4	4	4	4	D-BS Knein Nideggen

Cultivar/ wild species	Resistance source	Parents†	Evaluation to inoculum				
			Control	<i>M. floribunda</i> AWS	COOP 8	5002	Origins
<i>M. floribunda</i> AWS 054	Vf	(<i>M. baccata</i> × <i>M. sieboldii</i> ?)	1	4	4	2	D-GB Pillnitz
<i>M. floribunda</i> AWS 012	Vf	(<i>M. baccata</i> × <i>M. sieboldii</i> ?)	1	4	2	2	D-GB Pillnitz
<i>M. floribunda</i> 821	Vf	?	3b	4	3b	2	F-INRA Angers
D - Reka	Vr	J. Grieve × MFK	1	2	2	1	D-Ifo Pillnitz
Remura	Vr	(Cox Or. × Oldenb.) × MFK	1	2	2	2	D-Ifo Pillnitz
Realka	Vr	Carola × MFK	1	3a	2	1	D-Ifo Pillnitz
Regia	Vr	Clivia × MFK	1	2	2	1	D-Ifo Pillnitz
Ca - Nova Easygro	Vr (?)	MFK (Spartan <i>et al.</i>)	1	1	-	-	D-ZIS Wurzen
<i>M. pumila</i> R12740-7A	Vr		1	2	1	1	D-GB Pillnitz
D - Reglindis	Va	J. Grieve × MFK	2	3a	2	3b	D-Ifo Pillnitz
CZ - Angold	Va	Antonovka × Golden Del.	1	4	-	-	CZ-FSUO Holovously
D - Pi-AS 34,10	Va	Antonovka × o.p.	1	2	4	1	D-GB Pillnitz
Pi-AS 34,15	Va	Antonovka × o.p.	1	2	3b	2	D-GB Pillnitz
US - R2T107	Va	MFK (Antonovka <i>et al.</i>)	1	2	2	1	D-GB Pillnitz
R2T110	Va	MFK (Antonovka <i>et al.</i>)	1	2	2	2	D-GB Pillnitz

† MFK = multiple crossings; o.p. = open-pollinated.

These results can be summarized as follows:

1. Strategies to increase resistance stability must be applied in apple breeding programmes. A number of distinct genes for scab resistance should be combined in one cultivar ($V_f \times V_r$, $V_f \times V_a$, etc.). The different resistance genes must be identified by molecular markers.
2. Resistant cultivars bred under different ecological conditions are to be tested at the breeding site for their degree of resistance.
3. Evaluation of the resistance has to be carried out with highly virulent scab inocula.
4. Resistant cultivars and clones must be tested against all five or six races of scab, and at different locations. This is a good project for fruit genebanks cooperation and using the evaluation results.

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Research activities at INRA Angers relevant to *Malus* and *Pyrus* genetic resources

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The Fruit Breeding Station of INRA Angers carries out the French apple and pear breeding programmes, with three main objectives for both species (Laurens 1995):

1. High fruit quality: attractiveness, taste, long storage life and shelf life are taken into account.
2. Disease and pest resistance: all the material released from the apple breeding programme is resistant to the common races of *Venturia inaequalis* (Cke.) Wint. The main research activities of the apple laboratory are performed to study and include in the breeding programmes durable scab resistance. We also intend to include, in the selections resistance or low susceptibility to mildew (*Podosphaera leucotricha* (Ell. & Ev.) E. Salmon), rosy apple aphid (*Dysaphis plantaginea* Passerini) and fire blight (*Erwinia amylovora* (Burril) Winslow *et al.*). In the pear selection cycle, the first screenings are performed to eliminate seedlings highly susceptible to fire blight (*Erwinia amylovora*) and scab (*Venturia pirina* Aderh.). Resistance to *Psylla* is also sought.
3. Tree habit: the aim of apple and pear breeding programmes is to create good and regular cropping cultivars, easy to prune and to harvest.

Whilst genetic diversity of the genus *Malus* is wide, commercial apple cultivars have a narrow genetic base (Noiton and Alspach 1996). Of the 10 000 cultivars which are documented (Way *et al.* 1990), only a few are grown on a large scale. Furthermore, the tendency of breeders has been to derive new cultivars from these few: Golden Delicious, Jonathan, Red Delicious, Cox's Orange Pippin, McIntosh. But the apple breeder needs genetic diversity because the larger the diversity within his breeding population, the more efficient will be the selection.

The situation for pear is very different. Most of the commercialized cultivars are quite old and a lot of old cultivars are currently included in the hybridization strategies.

Various studies have been developed at INRA Angers on old cultivars of apple and pear. We will not put emphasis on the characterization of all the cultivars planted in INRA's orchards; unfortunately these data have not yet been computerized. We will just highlight three recent studies which illustrate different research activities performed on genetic resources:

Characterization of allozyme diversity on apple

Analysis with 16 enzymatic systems (25 polymorphic loci, 109 alleles) was applied on 36 wild species, and 179 cultivars (18 cider and juice cultivars, 18 rootstocks; 68 old French cultivars, 43 old foreign cultivars, 25 recent commercial cultivars; 7 scab-resistant hybrids) (Coutant 1996).

Multidimensional analyses show a large polymorphism in the wild species group. Local cultivars show a tendency to pool according to their geographic origin. This fact could confirm the climatic adaptation of the cultivars or highlight

the fact that the geneflow is bigger between two different countries than within the same country.

Quantitative analyses of variability show that allelic diversity has been affected by selection. However, in the cultivated apple, enzymatic polymorphism is still high: all cultivars can be distinguished (Table 1).

This study should be continued by using molecular markers.

Table 1. Different criteria to assess genetic diversity

Group studied	Sample size	Marshall & Jain polymorphism index	% poly-morph loci	Total no. alleles identified	Average no. alleles per locus	Heterozygosity rate (): standard deviation
Wild species	35	0.124	100	103	4.2	0.33 (0.10)
Rootstocks	18	0.097	92	73	2.8	0.32 (0.08)
Foreign traditional varieties	43	0.094	92	73	2.8	0.34 (0.09)
French traditional varieties	68	0.091	88	74	2.8	0.35 (0.08)
Cider apples	18	0.081	76	59	2.1	0.31 (0.10)
New cultivars	32	0.083	72	61	2.4	0.35 (0.09)
Total population	215	0.1040	100	109	2.8	0.33 (0.09)

Source: Coutant 1996.

Testing resistance

As mentioned before, disease and pest resistance is a major objective of the apple and pear breeding programmes. Various sources of resistance are checked in order to enlarge the variability of the potential genitors. Old and local cultivars are often tested to find durable resistance. Two examples of such screening will be given.

Fire blight/Pear

Thibault and Lelezec (1990) tested the resistance to fire blight of 76 apple cultivars and 83 pear cultivars. The experimentation took place between 1981 and 1986 in an orchard at Dax (south of France). Resistance/susceptibility behaviour was assessed after artificial inoculation on shoots and leaves. This study shows a great variability in the resistance of the tested cultivars. The same results could be pointed out for apple and pear: among the old cultivars, very few are resistant: Beurrée Alexandrine Lucas, Beurrée Giffard for pear; most of them are very susceptible: Passe Crassane, Doyennée du Comice, Alexandrine Douillard for pear; James Grieve, Reine des Reinettes for apple. A recent screening (1993-96) performed in glasshouse conditions after artificial inoculation on old cultivars of pear showed a high amount of susceptible and highly susceptible plants among the old cultivars tested.

Scab/Apple

Large scab resistance screening tests were performed in 1996 and 1997 on 120 old apple cultivars from various French regions. Head curators of conservatoires (=repositories) selected the cultivars which were the most resistant to scab in their

orchards and sent budwoods to INRA. Grafted trees were inoculated in glasshouse with different scab strains: race 1, race 6 and other strains collected in Europe.

First results showed a wide variability of behaviour among accessions. Some of them, which seemed very resistant in the field, were very susceptible in the glasshouse. Others showed specific resistance with some strains and were highly susceptible to others. A few accessions showed resistance symptoms whatever the tested strains. These latter accessions could be very useful as durable sources of resistance to be incorporated in breeding programmes. This study will be completed next year.

Hybridization

At INRA Angers, some of the cultivars released from the dessert apple breeding programme derived from old or local cultivars. They have been used for various characteristics: good fruit taste, resistance, etc .

Chantecler was released in 1977 (Lelezec 1990). It was obtained by crossing Golden Delicious and Reinette Clochard, a local French cultivar which transmitted a very good taste.

Baujade, released in 1991, is scab resistant. It has in its pedigree Reinette du Mans, an old French variety which gives flavour to Baujade (Lespinasse *et al.* 1992).

A recent hybridization programme has been developed in collaboration with the Conservatoire Nord Pas de Calais in the north of France. Cultivars selected by this conservatoire have been crossed together and with seven hybrids coming from INRA's breeding programmes and carrying the *Vf* gene. We faced problems for the scab screening in glasshouse compared with tests carried out usually in our breeding programmes on the progenies involving only the *Vf* gene. Therefore new scab-screening processes adapted to this type of material (lower inoculum concentration, adapted assessment scale, etc.) were developed.

At INRA Angers, pear breeding programmes involved a lot of old local varieties. A new pear hybrid will be released in 1997. It is originated from a cross between Doyennée d'hiver and Doyennée du Comice. It is a late-maturing variety which could replace Passe Crassanne because of better fruit quality and longer storage ability. Furthermore it is less susceptible to fireblight and has no secondary blossom.

Conclusion

These three examples – characterization of the diversity, screening for resistance and hybridization – illustrate part of the research activities involving germplasm which are carried out at INRA Angers.

To achieve an efficient selection, the breeder needs the largest variability. A broad germplasm range is very useful to breed all the characters. But the breeder encounters several difficulties in including old cultivars or landraces as parents in the breeding programmes:

- usually, this material brings on one hand some very interesting characters but, on the other hand, it could also transmit undesirable traits which are very difficult to eliminate through the selection; i.e. unattractive fruits, biennial bearing, low productivity, short storage ability
- generally, no genetic data are available on them; only phenotypical data or subjective observations.

It is therefore necessary to collect and conserve a large number of accessions in germplasm orchards but their characterization and evaluation are crucial for an efficient use in breeding programmes. This is what we are trying to achieve with the *Malus/Pyrus* germplasm network in France, in collaboration with all partners involved in the conservation of these two species.

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Development of the European Apple Crop, by integrating demand for high-quality, disease-resistant varieties suited to regional circumstances with advanced breeding methods

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This was a shared-cost research project under the EC Framework III programme in research and technical development for Agriculture and Agro-Industries (AIR). The project was funded from 1993 to 1996.

Participating institution			Research
HRI	Horticulture Research International, Wellesbourne & East Malling	UK	coordination, reference populations, database, markers, genetic map
CPRO	Centre for Plant Breeding Research, Wageningen	NL	genetic map, markers, reference populations
IZZ	Bundesanstalt für Züchtungsforschung, Institute for Ornamental Plant Breeding, Ahrensburg	GE	marker for mildew resistance, reference populations
INRA	Fruit Breeding Research Station Angers	FR	isozyme markers, reference populations
PIN	Pomology Institute Naoussa	GR	isozyme markers, reference populations
DCA	Fruit-Growing Department, University of Bologna	I	marker for scab resistance, reference populations
ETH/ FAW	Swiss Federal Institute of Technology Zürich / Federal Research Station Wädenswil	CH	marker scab resistance variability of scab fungus
KUL	Catholic University of Leuven	B	fruit quality
IFR	Institute of Food Research, Reading	UK	sensory perception
SAC	Scottish Agricultural College, Edinburgh	UK	socioeconomic aspects

The research was conducted with five specifically designed families:

Family	Female parent	Male parent
J	Prima	Fiesta
R	Fiesta	3762
Y	Fiesta	SA 572/2
G	Crimson Spy	3762
P	Double Red Northern Spy	SA 572/2

These populations consist of 812 trees in total and were replicated onto M27 rootstock and subsequently distributed to project partners in order to correlate the phenotypic data with the molecular data. It was decided to use the J family as the primary mapping population.

The activities and disciplines involved in this project ranged from basic molecular biology through genetics and breeding to all sciences related to characters selected in apple breeding such as plant pathology, entomology, analysis of fruit quality and tree habit. In addition the project was focusing on the economic and social aspects of apple production. A major effort was devoted to the development of the Apple Store database. The aim of this database was to store genetic data, phenotypic data and analytical results and make them available in a user-friendly way to all researchers.

There are three main groups worldwide working towards detailed genetic linkage maps for apple: the European Group; Cornell University, USA, and the New Zealand Apple Gene Mapping Programme. All three groups are aiming to accumulate molecular markers to the major genetic components of interest to apple breeders.

The European Apple Project has produced interesting results which are reviewed in a large number of scientific and popular publications. Markers for scab and mildew resistance genes, aphid resistance and further characters have been developed and will partly be applied in marker-assisted breeding. A European Apple Genetic Linkage Map was constructed, based on the J population. The project has fostered collaboration among research teams in different European countries and we hope that a new collaborative project coordinated by INRA-Angers and recently submitted at Brussels will be approved.

Investigation of *Pyrus* germplasm with reference to susceptibility to *Psylla pyri* L.

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During the last couple of years, *Psylla pyri* has caused serious problems to the pear orchards in our country. All the main European cultivars are susceptible to these dangerous pests (Bell 1991). Gautier (1988) reports that in fact *Psylla* attacks all cultivars. General Leclerc, Beurré Hardy, Passe Crassane, Doyennée du Comice are among the most susceptible cultivars.

In 1995 and 1996 the old pear collection, which was more than 20 years old, was violently attacked by *P. pyri*. In this collection each accession was represented by five trees. Susceptibility was determined using a five-grade scale: 0=resistant, 1=very low susceptibility, 2=low susceptibility, 3=moderate, and 4=high susceptibility. Most of the accessions (more than 200) were graded 3 or 4, and only a very small part from 0 to 2.

Table 1 shows that in the two successive years only the cultivar Liatifa from Azerbaijan was absolutely resistant, and the local Bulgarian cultivar Karamanets and *Pyrus betulifolia* Bunge had very low susceptibility (practically resistant), followed by Zelenak and the hybrids No. 8851 and No. 3445.

Our results for the resistance of *Pyrus betulifolia* are identical to those reported by Bell (1991), as well as for the average susceptibility of *P. elaeagnifolia* Pall. As a result of this study, the cultivars resistant to *P. pyri*, i.e Liatifa and Karamanets, were included in the breeding programme for 1997.

Table 1. Susceptibility to *Psylla pyri*

Pear accession	Rate of attack [†]	
	1995	1996
Liatifa	0	0
Karamanets	0	1
<i>Pyrus betulifolia</i>	0	1
Zelenak	1	1
Hybrid - 3445	1	2
Hybrid - 8851	1	2
Josephine von Meckeln	2	1
Xe Hua Li	2	2
Doyenne M. Levavasseur	2	2
Al. Douillard	3	2

[†] 0=resistant; 1=very low susceptibility; 2=low susceptibility; 3=moderate susceptibility; 4=high susceptibility.

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Microsatellite markers for accession identification, pedigree analysis and assessment of allelic diversity in *Malus* genetic resources

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Genetic Resource collections may be regarded as 'allele collections' where each distinct accession represents a unique combination of alleles. *Ex situ* collections of cultivated perennial species tend to contain only a limited subset of the alleles available in the 'allele pool' at the centre of diversity for the genus/species.

For *Malus*, documentary and anecdotal evidence suggest that many accessions held in collections represent varieties selected from a small subset of parents within the last few centuries. In effect these collections are likely to contain much allelic redundancy.



Siblings or half-siblings with many common alleles

A range of molecular marker technologies is currently available. Until recently there have been limitations in the ability of existing markers (both isozyme and DNA) to be used for practical management and assessment of genetic resources. This has been due to high cost, low reproducibility or low polymorphism. The development of DNA Simple Sequence Repeats (SSRs or Microsatellites) offers many advantages for genetic, breeding, pedigree, fingerprinting and genetic diversity studies of plants. They are amenable to accurate and absolute size determination, and possess the requisite level of polymorphism for the information content, provided they are relatively easy and inexpensive to use. In the longer term, the assays are amenable to automation and locus multiplexing, where the SSR primers are fluorescently tagged and analyzed on standard DNA sequencing instruments. However, the costs of development are often prohibitive.

At HRI, we have developed and used a range of SSR markers for *Malus* which are capable of distinguishing between closely related apple varieties. We are continuing to locate these marker loci on the European Apple Linkage Map. There are several advantages to using mapped SSR markers. Choice of marker loci from different linkage groups will maximize genome coverage. Where markers are linked to known agronomic traits or introgressed regions, then these may be targeted to identify conserved chromosomal segments among groups of accessions.

Uses of *Malus* SSR markers in genetic resource management:

- testing hypotheses relating to SYNONYMS and HOMONYMS
- observing the PREVALENCE of ALLELES in cultivated gene pools
- estimated relative genetic DIVERSITY
- confirming PEDIGREE relationships
- suggesting or excluding likely PROGENITOR accessions

- identification (exclusion) or FINGERPRINTING likelihoods.

Here we present the results of preliminary allele surveys based on reproducible SSR markers. The results as presented demonstrate that SSRs are amenable to comparison and collation of data from different laboratories.

Example A. 46 diverse *Malus* accessions scored with two SSR markers reveal differences in level of polymorphism

Two SSR loci were scored on 46 accessions. These accessions represent cultivar and breeding selections used as parents of genetic mapping populations; cider and dessert varieties; scab-resistant varieties and *Malus* species (some different sources of scab resistance). See Table 1 (SSRs A and B).

- SSR locus A was highly polymorphic and revealed 19 alleles. Locus B had only 9 alleles.
- There is an unequal distribution of alleles in the *Malus* genepool, e.g. allele 3 is relatively common, whereas allele 11 was only detected in Granny Smith.
- Allele 12 in SSR A was only detected among cider varieties
- It is clear that Antonovka Grammovaya and Antonovka Kamenichka are distinct genotypes.

Example B. Survey of 7 markers reveals 69 alleles

- Testing seven loci over 10 varieties and selections used in mapping studies revealed between 5 and 11 alleles per locus.
- Restricting the range of genotypes tested has reduced the number of alleles observed.
- Some markers represent more than one locus, and this is reflected in larger mean number of alleles per (diploid) accession

Most SSR markers selected to date for mapping studies represent one locus - two alleles are typically resolved per *Malus* genotype (homozygotes are relatively rare). Triploids are commonly detected through the presence of three alleles (Table 1).

Example C. Survey of a locus from the linkage group containing *Sd1* aphid resistance scored over 160 cultivar accessions reveals unequal distribution of 6 alleles

See Table 2.

- The presence of common alleles in progenitor and half-sibling progeny demonstrates that SSRs may be used to corroborate or exclude pedigree relationships.
- All documented pedigree relationships appear to be consistent with the distribution of alleles.
- One may infer the presence of alleles in lines which have not been tested.

- The presence of common alleles (e.g. allele 2) in modern varieties suggests narrowing of the genepool and allelic redundancy.
- Possession of a combination of relatively rare alleles is likely to reflect greater genetic diversity, and may guide resource managers.

Baskatong
Niedzwetkzyana
Derivative

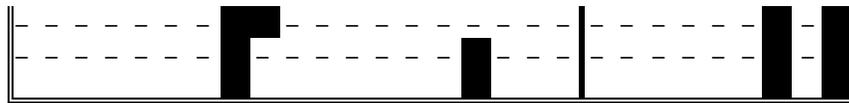


Table 2. Distribution of SSR alleles among different accessions of *Malus*, with cultivar names as assigned at HRI or the UK National Fruit Collections, Brogdale. Each allele per marker locus is assigned a column. Solid shading represents presence of an allele, "-" represents absence, grey shading represents a missing value.

Variety Id	Parent – Female	Parent – Male	1	2	3	4	5	6
Sunburn	Cox's Orange Pippin		■	-	-	■	-	-
Ingrid Marie	Cox's Orange Pippin		-	■	-	■	-	-
Ellison's Orange	Cox's Orange Pippin	Calville Blanc	-	-	■	-	■	-
Suntan	Cox's Orange Pippin	Court Pendu Plat	-	-	■	-	-	-
Anna Boelens	Cox's Orange Pippin	Freiherr von Berlepsch	-	-	-	■	-	-
Advance	Cox's Orange Pippin	Gladstone	-	-	-	■	-	■
Kent	Cox's Orange Pippin	Jonathon	-	-	-	-	-	■
Cox's Early Export	Cox's Orange Pippin	King of the Pippins	-	-	-	■	-	-
Cox's Orange Pippin			-	-	-	■	-	-
Queen Cox			-	-	-	■	■	-
Dukat	Golden Delicious	Cox's Orange Pippin	-	-	-	-	■	-
Golden Nugget	Golden Russet	Cox's Orange Pippin	-	-	-	-	-	-
Prinses Marijke	Jonathan	Cox's Orange Pippin	-	-	-	-	-	■
Tydemans Late Orange	Laxton's Superb	Cox's Orange Pippin	-	-	-	-	-	■
Merton Charm	McIntosh	Cox's Orange Pippin	-	-	-	-	-	-
Schweizer Orange	Ontario	Cox's Orange Pippin	-	-	-	-	■	-
Charles Ross	Peasgood Nonsuch	Cox's Orange Pippin	-	-	-	-	■	-
Merton Russet	Sturmer Pippin	Cox's Orange Pippin	-	-	-	■	-	-
Acme	Worcester Pearmain x Rival	Cox's Orange Pippin(?)	■	■	-	■	-	-
Ribston Pippin			■	-	-	-	-	■
Blenheim Orange			-	-	-	■	-	■
Margil			-	-	-	■	-	-
Freiherr von Berlepsch	Ananas Reinette	Ribston Pippin	■	-	-	-	-	-
Moore's Seedling	Newton Wonder	Blenheim Orange	-	-	■	-	-	-
Cox's Pomona	Ribston Pippin	Blenheim Orange (sister seedling of CoP)	■	■	-	-	-	-
Sturmer Pippin	Ribston Pippin	Nonpareil (?)	■	-	-	-	■	-
Starkspur Golden Delicious			-	■	■	-	■	■
Elstar	Golden Delicious	Ingrid Marie	-	■	■	-	-	■
Red Elstar	Elstar mutation		-	■	■	-	-	-
Goldjon	Golden Delicious	Jonathan	■	■	-	-	-	-
Telstar	Golden Delicious	Kidd's Orange Red	■	■	-	■	-	-
Trajan	Golden Delicious	McIntosh Wijcik	-	■	-	■	■	-
Golden Delicious	Golden Delicious mutation		-	■	-	-	■	-
Maigold	Franc Roseau	Golden Delicious	-	-	-	-	-	■
Falstaff	James Grieve	Golden Delicious	-	-	-	-	-	■
Greensleeves	James Grieve	Golden Delicious	-	-	-	-	■	-
Rubin	Lord Lambourne	Golden Delicious	-	-	-	-	-	-
Karmen	Lord Lambourne	Linda	■	■	-	-	-	-
Horei	Ralls Janet	Golden Delicious	-	■	-	-	-	-
Worcester Pearmain			■	-	-	■	-	-
Discovery	Worcester Pearmain	Beauty of Bath	-	■	-	■	-	■
Discovery	Worcester Pearmain	Beauty of Bath	-	■	-	■	-	■
Flame	Worcester Pearmain	Rival	-	■	-	-	-	-
Opal	Rival	Worcester Pearmain	-	■	■	-	-	-
Lord Lambourne	James Grieve	Worcester Pearmain	-	■	■	-	-	-
McIntosh			-	■	-	■	-	-
Wijick			-	■	-	■	-	■

Variety Id	Parent – Female	Parent – Male	1	2	3	4	5	6
SA572/2			-	█	-	█	-	█
Ashdown Seedling	McIntosh		-	█	-	█	-	-
Gloucester Royal	McIntosh		-	█	-	█	-	-
Sharon	McIntosh	Longfield	█	█	-	-	-	-
Charlotte	McIntosh Wjick	"Malling" Greensleeves	█	-	-	-	-	-
Telamon	McIntosh Wjick	Golden Delicious	█	█	-	-	█	-
Tuscan	McIntosh Wjick	Greensleeves	-	█	-	-	█	-
Alton	Early McIntosh	New York 845 (Red Canada x Yellow Transparent)	-	█	█	-	-	█
Maypole	McIntosh Wjick	Malus basketong	-	█	-	-	-	█
Stonehenge	Stone	McIntosh	█	-	-	-	█	-
Early McIntosh	White Transparent	McIntosh	█	-	-	-	-	-
Milton	White Transparent	McIntosh	-	█	-	-	-	-
Granny Smith			-	█	-	█	-	-
Red Granny Smith	Granny Smith	Jonathan	-	█	-	-	-	█
Lady Williams	Granny Smith (?)	Jonathan (?)	█	█	-	-	-	-
Jonagold	Jonagold mutation		-	█	-	-	-	█
Jonathan			█	-	-	-	-	-
Fukutami	Jonathan	Ralls Janet	-	█	█	-	-	-
Holiday	Macoun	Jonathan	-	█	█	-	-	-
Beverly Hills	Melba	Early McIntosh	█	█	-	-	-	-
Lodi	Montgomery	White Transparent	█	█	-	-	-	-
Red Devil	Discovery	Kent	-	█	█	-	-	█
Plymouth Cross	Allington Pippin	Star of Devon	█	█	-	-	-	█
Cheddar Cross	Allington Pippin	Star of Devon	-	█	-	-	-	-
Slavyanka	Antonovka	Ananas Reinette	█	-	-	-	-	-
Pobeda Chernenko	Antonovka	Pepin Londonskii	-	█	-	█	-	-
Julyred	(Petrell x Early McIntosh)	(Williams Favourite x Starr)	-	-	-	█	-	█
Von Zuccalmaglios Renette	Ananas Reinette	Purpurroter Agatapfel	█	-	-	-	█	-
Duchess of Bedford Criterion	Cellini	Beauty of Bath	-	-	-	█	-	█
	Chance seedling (poss. Golden Delicious)	(poss. Red Delicious)	█	-	-	-	█	█
Florence Bennett	chance seedling/Bramley (?)		-	█	-	-	-	█
Wealthy	Cherry Crab		█	-	-	-	-	-
Sweet Delicious	Deacon Jones	Delicious	-	█	-	-	-	-
Hazen	Duchess of Oldenburg	Starking Delicious	█	-	-	-	-	█
Redsleeves	Exeter Cross	TSR15T3	-	█	-	-	-	-
Gooseberry Apple	False		-	-	-	-	█	█
Gooseberry Pippin	False		-	█	-	-	-	█
Cola Gelata	Gelata	Cola (?)	-	-	-	-	█	-
Neue Goldparmane	Golden Winter Pearmain	Parker's Grey Pippin	-	█	-	-	-	-
Aroma	Ingrid Marie	Filippa	-	█	█	-	█	-
Erich Neumann's Roter King of the Pippins	James Grieve mutation		-	█	-	-	-	█
	King of the Pippins mutation		█	-	-	-	█	-
Braeburn	Lady Hamilton (Red)	Open pollinated	█	█	-	-	-	█
Beauty of Bedford	Lady Sudeley	Beauty of Bath	-	█	-	-	-	█
Linda	Langford Beauty		█	█	-	-	-	-
Early Strawberry	Margaret seedling		█	█	-	-	-	-

Variety Id	Parent – Female	Parent – Male	1	2	3	4	5	6
Carlton	Montgomery	Red Astrachan	■	■	-	-	-	-
Pitmaston Russet	Nonpareil		■	■	-	-	-	-
Nonpareil			■	■	-	-	-	-
Macy	Northwestern Greening	Wealthy	■	-	-	■	-	-
Krasnyi shtandart	Pepin Shafrannyi	Rubynovoye	■	-	-	-	-	■
James Grieve	Pott's Seedling or Cox's		-	■	-	-	-	■
	Orange Pippin		-	■	-	-	-	■
Fuji	Ralls Janet	Delicious	-	■	-	-	-	-
Astillisch	Red Astrachan	Signe Tillisch	■	-	-	-	-	-
Spijon	Red Spy	Monroe	-	-	■	-	-	-
Belle de Boskoop	Reinette du Montford		■	■	-	-	-	-
	mutation		■	■	-	-	-	-
Lane's Prince Albert	Russet Nonpareil	Dumelow's Seedling	■	■	-	-	-	-
Summerred	S-4-8 (McIntosh x	Open pollinated	-	-	-	-	■	■
	Golden Delicious)		-	-	-	-	■	■
Fairy	Scarlet Siberian Crab		■	-	-	-	-	■
Stayman's Winesap	Stayman's Winesap		-	-	■	■	-	-
	mutation		-	-	■	■	-	-
Folkestone	Tydemans Early		-	-	-	■	-	-
	Worcester		-	-	-	■	-	-
Ontario	Wagener	Northern Spy (direction	-	■	-	-	-	-
		unknown)	-	■	-	-	-	-
Norfolk Beauty	Warner's King	Walton Abbey	-	-	-	■	-	-
Gloster 69	Weisser Winter	Richard Delicious	■	■	-	-	-	-
	Glockenapfel		■	■	-	-	-	-
Mareda	Winesap		-	■	-	-	-	■
Glebe Gold	Yellow Ingestrie	Cellini	■	-	-	-	-	■
Abbondanza			■	-	-	■	-	-
Adamsapfel			-	-	-	■	■	-
Ostpreussischer			-	-	-	■	■	-
Ananas Reinette			-	■	-	-	-	-
Arkansas			■	■	-	-	-	-
Aromatic Russet			-	■	-	-	-	-
Aromatic Russet			-	■	-	■	-	■
Ashmead's Kernel			■	■	-	-	-	■
Beauty of Kent			■	■	-	-	■	-
Bramley's Seedling			■	■	-	-	-	-
Bukhovitsa			-	■	-	■	-	-
Burr Knot			-	-	-	■	-	-
Calville Rouge			■	-	-	-	-	■
Crispin			-	■	-	-	■	■
De l'Estre			■	-	-	-	-	■
Delicious			■	■	-	-	-	-
Dubbele Belle Fleur			■	■	-	-	■	-
Duchess's Favourite			-	■	-	■	-	-
Esopus Spitzenburg			-	■	-	-	■	-
Fall Harvey			■	■	-	-	-	-
Fromme Scab Resistant			-	-	-	■	■	■
Gilliflower of Gloucester			-	-	-	■	■	■
Glass Apple			-	■	-	■	-	-
Greasy Pippin			■	■	-	-	■	-
Harvey (Wakeley)			■	■	-	■	-	-
Hog's Snout			■	■	-	-	-	-
Improved Ashmead's			■	■	-	■	-	-

Variety Id	Parent – Female	Parent – Male	1	2	3	4	5	6
Kernel			■			■		
King Coffee			-	-	-	-	-	-
Kingston Black			-	-	■		■	
Knobby Russet			-	-		■		-
Konigin Sophiensapfel			■	■				
Kosmonaut			■	■				
Luntersche Pippeling			-	■			■	-
Maid of Kent			■	■				-
No Pip			■	-	-	■	-	■
Northern Greening			-	■				■
Obelisk			■	-	-	■		-
Old Golden Russet			■	-	-			-
Opalescent			-	■	■			-
Pig's Nose Pippin			■	■				-
Pomme d'Amour			-	■			■	
Robinson 1			■	-	-			■
Rome Beauty			■	■				■
Rough Pippin			-	-		■	■	-
Shoreditch White			-	-		■	■	-
Thurgauer Weinapfel			-	■				■
Udarria Zagarra			■	■		■		■
Wellington Bloomless			■	■			■	
Winter Banana			■	■				■

- The relationship between 'old' and 'modern' varieties may be tested through prevalence of alleles.
- The clustering of particular alleles in varieties with common characteristics (e.g. cider varieties, red-flowered varieties) may suggest common ancestry or linkage to that characteristic.
- We have demonstrated the utility of SSR markers for confirming pedigree analysis. In addition, we are able to detect some alleles which appear common among dessert apple varieties.

Conclusions

A subset of high-quality SSR markers is appropriate for genetic resource management.

Long insert SSRs with robust, well-designed stable primer sequences are ideal for long-term reference use.

Standardization and calibration of marker assays, combined with compatible database management, will be required by the user community to maximize impact on genetic resource harmonization.

Postscript

Somatic mutations are commonly observed among vegetatively propagated plants, especially where these affect pigmentation or tree habit. Such sports may represent only single base pair mutations in functional genes, and so are unlikely to be detected through the use of randomly selected markers. HRI is currently

targeting the gene families in the Rosaceae most likely to be involved in such mutations in order to develop highly specific allele-specific markers.

This work will be presented in more detail in a future refereed publication. This work was funded by the UK Biotechnology & Biological Sciences Research Council (BBSRC), Ministry of Agriculture Fisheries and Food (MAFF) and the CEC (AIR-3 programme). HRI has also developed similar SSR marker systems which are effective for *Pyrus*, *Prunus* spp., etc.

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Appendix I. *Malus* passport descriptors

Based on the FAO/IPGRI Multicrop Passport Descriptors (14 Feb 97) and the main descriptors in the different forage databases:

<i>Malus</i> PASSPORT DESCRIPTORS	
<p>1. Institute code (INSTCODE) Code of the institute where the accession is maintained. The codes consist of the 3-letter ISO 3166 country code of the country where the institute is located plus number or an acronym as specified in the Institute database that will be made available by FAO. Preliminary codes (i.e. codes not yet incorporated in the FAO Institute database) start with an asterisk followed by a 3-letter ISO 3166 country code and an acronym.</p>	
<p>2. Accession number (ACCENUMB) This number serves as a unique identifier for accessions and is assigned when an accession is entered into the collection. Once assigned this number should never be reassigned to another accession in the collection. Even if an accession is lost, its assigned number should never be reused. Letters should be used before the number to identify the genebank or national system (e.g. IDG indicates an accession that comes from the genebank at Bari, Italy; CGN indicates an accession from the genebank at Wageningen, The Netherlands; PI indicates an accession within the USA system).</p>	
<p>3. Collecting number (COLLNUMB) Original number assigned by the collector(s) of the sample, normally composed of the name or initials of the collector(s) followed by a number. This item is essential for identifying duplicates held in different collections. It should be unique and always accompany subsamples wherever they are sent.</p>	
<p>4. Genus (GENUS) Genus name for taxon. Initial uppercase letter required.</p>	
<p>5. Species (SPECIES) Specific epithet portion of the scientific name in lowercase letters plus authority*. Following abbreviation is allowed: "sp."</p>	
<p>6. Subtaxa (SUBTAXA) Subtaxa can be used to store any additional taxonomic identifier plus authority*. Following abbreviations are allowed: "ssp." (for subspecies); "var." (for variety); "convar." (for convariety); "f." (for form).</p>	
<p>7. Accession name (ACCNAME) Either a registered or other formal designation given to the accession. First letter uppercase. Multiple names separated with semicolon.</p>	
<p>8. Country of origin (ORIGCTY) Name of the country in which the sample was originally collected or derived. Use the ISO 3166 extended codes, (i.e. current and old 3 letter ISO 3166 country codes)</p>	
<p>9. Location of collecting site (COLLSITE) Location information below the country level that describes where the accession was collected starting with the most detailed information. Might include the distance in kilometers and direction from the nearest town, village or map grid reference point, (e.g. CURITIBA 7S, PARANA means 7 km south of Curitiba in the state of Parana)</p>	
<p>10. Latitude of collecting site (LATITUDE) Degrees and minutes followed by N (North) or S (South) (e.g. 1030S). Missing data (minutes) should be indicated with hyphen (e.g. 10—S).</p>	
<p>11. Longitude of collecting site (LONGITUDE) Degrees and minutes followed by E (East) or W (West) (e.g. 07625W). Missing data (minutes) should be indicated with hyphen (e.g. 076—W).</p>	

* Authority is only provided at the most detailed taxonomic level.

12. Elevation of collecting site (ELEVATION) [in meters above sea level]			
13. Collecting date of original sample [YYYYMMDD] (COLLDATE) Collecting date of the original sample where YYYY is the year, MM is the month and DD is the day.			
14. Status of sample (SAMPSTAT)			
1 Wild habitat	0 Unknown		
1A Natural ecotype			
1B Semi-natural ecotype	99 Other (Elaborate in REMARKS field)		
2 Weedy			
3 Traditional cultivar/Landrace			
4 Breeder's line			
5 Advanced cultivar			
15. Collecting source (COLLSRC) The coding scheme proposed can be used at 2 different levels of detail: Either by using the global codes such as 1, 2, 3, 4 or by using the more detailed coding such as 1.1, 1.2, 1.3 etc.			
1 Wild habitat	2 Farm	3 Market	4 Institute/ Research organization
1.1 Forest/ woodland	2.1 Field	3.1 Town	
1.2 Shrubland	2.2 Orchard	3.2 Village	
1.3 Grassland	2.3 Garden	3.3 Urban	0 Unknown
1.4 Desert/tundra	2.4 Fallow	3.4 Other exchange	99 Other (Elaborate in REMARKS field)
	2.6 Store	system	
16. Donor institute code (DONORCODE) Code for the donor institute. The codes consist of the 3-letter ISO 3166 country code of the country where the institute is located plus number or an acronym as specified in the Institute database that will be made available by FAO. Preliminary codes (i.e. codes not yet incorporated in the FAO Institute database) start with an asterisk followed by a 3-letter ISO 3166 country code and an acronym.			
17. Donor number (DONORNUMB) Number assigned to an accession by the donor. Letters should be used before the number to identify the genebank or national system (e.g. IDG indicates an accession that comes from the genebank at Bari, Italy; CGN indicates an accession from the genebank at Wageningen, The Netherlands; PI indicates an accession within the USA system)			
18. Other number(s) associated with the accession (OTHERNUMB) Any other identification number known to exist in other collections for this accession. Letters should be used before the number to identify the genebank or national system (e.g. IDG indicates an accession that comes from the genebank at Bari, Italy; CGN indicates an accession from the genebank at Wageningen, The Netherlands; PI indicates an accession within the USA system). Multiple numbers can be added and should be separated with a semicolon			
19. Remarks (REMARKS) The remarks field is used to add notes or to elaborate on descriptors with value "99" (=Other). Prefix remarks with the field name they refer to and a colon (e.g. COLLSRC: roadside). Separate remarks referring to different fields are separated by semicolons.			
A. Plant use (PLANTUSE) The coding scheme proposed can be used at two levels of detail: either by using the global codes (1 or 2) or by using the more detailed coding (e.g. 1.1).			
1 Fruit	2 Tree		
1.1 Dessert	2.1 Pollinator		
1.2 Cooking/Processing	2.2 Ornamental		
1.3 Juice/Cider	2.3 Root/Interstock		
1.4 Multipurpose	2.4 Multipurpose		
	99 Other (Elaborate in REMARKS Field)		

B. Parentage	(PARENTAGE)
1 Mutant – (a vegetative mutant of a known cultivar)	
2 Open-pollinated – (only the mother is known)	
3 Controlled cross – (both parents are known)	
4 Seedling/unknown origin – (no information regarding parentage is known)	

FAO WIEWS DESCRIPTORS	
1. Location of safety duplicates	(DUPLSITE)
Code of the institute where a safety duplicate of the accession is maintained. The codes consist of 3-letter ISO 3166 country code of the country where the institute is located plus number or an acronym as specified in the Institute database that will be made available by FAO. Preliminary codes (i.e. codes not yet incorporated in the FAO Institute database) start with an asterisk followed by a 3-letter ISO 3166 country code and an acronym. Multiple numbers can be added and should be separated with a semicolon.	
2. Availability of passport data	(PASSAVAIL)
(i.e. in addition to what has been provided)	
0 Not available	
1 Available	
3. Availability of characterization data	(CHARAVAIL)
0 Not available	
1 Available	
4. Availability of evaluation data	(EVALAVAIL)
0 Not available	
1 Available	
5. Acquisition type of the accession	(ACQTYPE)
1 Collected/bred originally by the institute	
2 Collected/bred originally by joint mission/institution	
3 Received as a secondary repository	
6. Type of storage	(STORTYPE)
Maintenance type of germplasm. If germplasm is maintained under different types of storage, multiple choices are allowed, separated by a semicolon (e.g. 2;3). (Refer to FAO/IPGRI Genebank Standards 1994 for details on storage type)	
1 Short-term	99 Other (elaborate in REMARKS field)
2 Medium-term	
3 Long-term	
4 <i>In vitro</i> collection	
5 Field genebank collection	
6 Cryopreserved	

Appendix II. Selection of minimum descriptors for characterization of *Malus* and *Pyrus*

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Introduction

A request was made before this First *Malus/Pyrus* Working Group Meeting in Dublin for workers to provide suggestions of characters to be included in minimum descriptor lists for characterization of *Malus* and *Pyrus*. I have compiled these suggestions in List A for *Malus* and List B for *Pyrus*. I am particularly grateful to Jan Blažek, Vassiliy Djouvinov, Marc Lateur, Bronislovas Gelvonauskis and Alison Lean for their contributions.

The rest of this paper concerns itself purely with *Malus*, although it is hoped that the following discussion will also include *Pyrus*.

Qualities of minimum descriptors

In selecting descriptors to be used in minimum lists, we aim to choose the least number of characters which will successfully describe, and discriminate between, the majority of *Malus* accessions. Ideally, characters used in minimum lists must meet the following criteria:

- they must be highly heritable
- they must exhibit low variability
- they must show differentiation between apple cultivars
- they must be easy to identify and to measure/score.

Table 1 gives a list of *Malus* characters which may be unsuitable for use in minimum descriptor lists, with reasoning given.

Table 1. Descriptors that may be unsuitable for inclusion in minimum lists for *Malus*

Descriptor types	Reason for unsuitability
Tree: Vigour/Growth habit	Very dependent on rootstock, local environmental conditions and management practices
Leaf: Stipule	Very variable
Leaf: Margin	Very variable
Fruit: Russet	Dependent on local climatic conditions
Fruit: Eye aperture	Changes with fruit maturity
Fruit: Skin surface	Changes with storage
Fruit: Stalk	Very variable
Fruit: Lenticel	Very time consuming
Fruit: Taste of flesh	Very subjective measurement
Fruit: Sepal pose	Changes with fruit maturity
Flower/Fruit/Seed: Set	Unpredictable

Selection of a Minimum Descriptor List for *Malus*

The proposed list of minimum descriptors for *Malus* presented below was compiled using:

- List A (see p. 98)
- the results of a study carried out on selected common cultivars in UK, France, Belgium and Italy (see p. 24)
- International Board for Plant Genetic Resources - Descriptor List for Apple (*Malus*), 1982
- UPOV Guidelines for the conduct of tests for distinctness, uniformity and stability - Apple TG/14/8, 1995

Proposed Minimum Descriptor Lists for *Malus*

The following accession characters were accepted as common descriptors for *Prunus* at the extraordinary meeting of the ECP/GR *Prunus* Working Group and the first coordination meeting of the project GEN RES 61 in Rome, October 1996. It may be useful to consider them here in the context of *Malus* and/or *Pyrus*. The next few pages contain more detailed tables regarding these suggested flower and fruit characters.

Accession characters

- Fruit use
- Plant use
- Country of origin
- European collection (belonging to)
- Status of sample
- Virus disease status

Flower

- Season of flowering
- Flower shape
- Petal shape
- Position of petal margin
- Bud colour
- Upper flower colour

Fruit

- Harvest maturity
- Fruit size
- Fruit shape
- Crowning at apex
- Ground colour
- Over colour
- Over colour coverage
- Flesh colour

***Malus* - Draft Flower Descriptors**

State	Season of flowering	Reference cultivars
1	extremely early	Anna, Ein-Shemer
2	very early	Gravenstein
3	early	Idared, Belle de Boskoop, Jersey mac
4	early/intermediate	Mutsu
5	intermediate	Cox's Orange Pippin
6	intermediate/late	Delicious
7	late	Court Pendu Plat, Gloster 69, Northern Spy
8	very late	Crawley Beauty, de Jaune
9	extremely late	Feuillermorte, Spatbluhender, Taffetapfel

State	Flower shape	Reference cultivars
1	flat	
2	intermediate	
3	cupped	

State	Petal shape	Reference cultivars
1	narrow elliptic	
2	elliptic	
3	broad elliptic	
4	circular	
5	narrow ovate	
6	ovate	
7	oblong	

State	Position of petal margin	Reference cultivars
1	free	Worcester Pearmain
2	part-overlapping/touching	Bramley's Seedling
3	overlapping	Golden Noble

State	Bud colour (Balloon stage)	Reference cultivars
1	white	Cox's Pomona
2	yellowish and pink	Herenhut
3	light pink	Gravensteiner
4	medium pink	Kidd's Orange Red
5	dark pink	Sylvia
6	red	Rafzubin, Melrose

State	Upper flower colour	Reference cultivars
1	white	
2	pink and white	
3	light pink	
4	medium pink	
5	dark pink	
6	crimson	

Malus - Draft Fruit Descriptors

State	Harvest maturity	Reference Cultivars	
		UPOV	IBPGR
1	extremely early	Close	White Transparent, Jersey mac, Close
2	very early		Discovery
3	early	Jersey mac	Paulared, Tydeman's Early Worcester
4	early/intermediate		James Grieve
5	intermediate	Golden Delicious	Cox's Orange Pippin
6	intermediate/late		Delicious, Golden Delicious
7	late	Fuji	N. Spy, Blaxtayman, Jonagold
8	very late		Glockenapfel
9	extremely late	Granny Smith	Rome Beauty, Granny Smith

State	Fruit size	Reference Cultivars	
		UPOV	IBPGR
1	very small	Golden Harvey	<i>Malus</i> spp.
2	very small to small	Api Noir	Api
3	small	Miller's Seedling	Pigeon, Beauty of Bath
4	small to medium	Alkmene	Discovery, Cox's Orange Pippin
5	medium	Cox's Orange Pippin	Golden Delicious
6	medium to large	Gravensteiner	Holsteiner Cox, Lobo
7	large	Mutsu	Belle de Boskoop
8	large to very large	Bramley's Seedling	Bramley's Seedling, Mutsu
9	very large	Howgate Wonder	Howgate Wonder

State	Fruit shape	IBPGR	UPOV	Reference cultivars
1	globose	yes	yes	
2	globose-conical	yes	yes	
3	broad-globose-conical		yes	
4	short-globose-conical	yes		
5	flat	yes	yes	
6	flat-globose	yes	yes	
7	conical	yes	yes	
8	narrow conical		yes	
9	truncate conical		yes	
10	long conical	yes		
11	intermediate conical	yes		
12	ellipsoid	yes	yes	
13	ellipsoid conical	yes	yes	
14	oblong	yes	yes	
15	oblong-conical	yes	yes	
16	oblong-waisted	yes		

State	Crowning at apex	Reference cultivars
1	Absent (smooth)	Charles Ross
3	Weak	Beauty of Bath, Cox's Orange Pippin
5	Intermediate	Mutsu
7	Strong	Red Delicious
9	Very strong	Cox's Pomona

State	Flesh colour	Reference cultivars
1	White	Spartan
2	Cream	Jonagold
3	Yellowish	Cox's Orange Pippin
4	Pink	Red Sauce
5	Greenish	Gloster 69

State	Ground colour	Reference cultivars
1	red	Baskatong
2	orange	Highview Pippin
3	cream-white	Melba, Keswick Codlin
4	whitish-yellow	Transparent de Croncels
5	yellow	Golden Delicious, Alderman, Wyken Pippin
6	green-yellow	Cox's Orange Pippin
7	whitish-green	White transparent
8	green	Granny Smith

State	Over colour	Reference cultivars
1	orange	Egremont Russet, Alice
2	pink	Khoroshavka Alaya
3	red	Jonathon
4	dark red	Court Pendu Plat, Starking
5	purple	Spartan
6	brownish	Lord Burghley

State	Over colour coverage	Reference cultivars
1	absent/very low	Granny Smith
2	low	Cox's Orange Pippin
3	medium	Gala
4	high	Spartan
5	very high	New Europe

**List A. Characters suggested by European colleagues for possible inclusion
in Minimum Descriptor Lists for *Malus***

Flower characters

Season of flowering
Duration of flowering
Bloom time
Flower shape
Petal shape
Position of petal margin
Petal hairiness
Lower flower colour
Upper flower colour
Flower colour at full bloom
Prebloom flower colour
Bud colour
Flower pedicel colour
Flower set
Inflorescence colour
Inflorescence type
Style colour at full bloom
Style position in relation to anthers
Fusion of style
Style-hair-location
Quantity of styles per pistil
Pistil/stamen length ratio
Anther colour before dehiscence

Tree characters

Tree vigour
Bearing habit
Growth habit
Precocity of bearing
Cropping efficiency

Leaf characters

Apex shape
Hairiness of leaf surfaces
Margin
Leaf shape in middle of shoot
Leaf width in mm
Leaf length in mm
Stipule length
Stipule shape

Fruit characters

Harvest maturity
Shape
Size
Over colour type
Over colour coverage
Over colour pattern type
Ground colour
Crowning at apex
Tube size
Russet type
Russet location
Fruit lenticel colour
Fruit set
Seed colour
Number of seed per carpel after optimum pollination
Taste of flesh
Flesh colour
Texture
Eating quality
Maximum storage life
Low spring temperature tolerance
Susceptibility to bitter pit
Susceptibility to bruising
Susceptibility to mildew
Susceptibility to scab
Susceptibility to fireblight

Rootstock characters

Suckering tendency
Dwarfing
Yield efficiency
Best method of propagation
Anchorage
Induction of precocious bearing

**List B. Characters suggested by European colleagues for possible inclusion
in Minimum Descriptor Lists for *Pyrus***

Flower characters

Season of flowering
Duration of flowering
Secondary flowering
Inflorescence (flower frequency)
Petal length
Petal length/breadth ratio
Flower (overlapping of petals)
Petiole length
Stipule presence
Stipule distance from the base of the
petiole
Pedicel pubescence
Pedicel length
Stigma position in relation to anthers
Anther

Fruit characters

Harvest maturity
Size
Shape
Length relative to diameter
Ground colour
Over colour
Russet amount
Fruit length of stalk
Fruit thickness of stalk
Fruit cavity of stalk
Fruit size of eye
Fruit opening of eye
Fruit depth of eye basin
Fruit shape of seeds
Eating quality
Texture
Ploidy level
Low spring temperature tolerance
Susceptibility to bruising
Susceptibility to *Psylla*
Susceptibility to fireblight

Tree characters

Tree vigour
Growth habit
Affinity to quince
Precocity of bearing
Cropping efficiency

Leaf characters

Attitude
Length
Length/breadth ratio
Shape of base
Shape of upper part
Shape of the tip
Indentation entire of margin
Depth of indentation of margin
Number of glands on midrib

Rootstock characters

Suckering tendency
Dwarfing
Yield efficiency
Best method of propagation
Anchorage

Appendix III. Non-Governmental Organizations (NGOs) involved in *Malus/Pyrus* conservation in Europe⁸

Belgium

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 Boschelstraat 21
 B-3724 Kortesseem
 Tel. and Fax (32)12237001

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 Rue de l'église 14
 B-1350 Orp-Jauche
 Tel. (32)10634298

M. Bosschaerts
 Weerstands Plein 7
 B-2640 Mortsel

France

Association du Verger Expérimental d'Alsace
 VEREXAL
 Neuerbrunnen
 67210 Obernai

Groupe des ressources phylogénétiques d'Aquitaine
 Evelyne Leterme
 Résidence Le Coteau
 48 rue du Commandant Céré
 40000 Mont de Marsan

Association Croqueurs de pommes Jarez
 Denise Matigneux
 14 rue Berthelot
 42800 St Martin la Plaine

Association des Mordus de la Pomme
 Mr Martin
 Le Grand Clos - Quevert
 22100 Dinan

Société Pomologique du Berry
 Jacques Aubourg
 Mairie
 36230 Neuvy-Saint-Sépulcre

Association des Croqueurs de Pommes (Fédération Nationale)
 Claude Scribe
 Sente des Brosses
 77580 Voulangis

Jardin du Luxembourg
 Jean Noël Burte
 15 rue de Vaugirard
 75006 Paris

Association Fruits Oubliés
 Christian Sunt
 4 av. de la Résistance
 30270 St Jean du Gard

Conservatoire Régional du Tarn
 Ferme du Roc
 81140 Puycelsi

Centre Régional Ressources Génétiques Nord-Pas-de-Calais
 René Stievenard / J. Lebrun
 Ferme du Héron
 59650 Villeneuve d'Ascq

CEDENA
 Parc Régional de Brotonne
 Thierry Leconte
 Place de l'Eglise
 Ste Opportune La Mare
 27680 Quillebœuf-sur-Seine

Association Z'ont creuqué eun pomm
 Daniel Valiergue
 23 rue du Général Leclerc
 60250 Mouy

Conservatoire Botanique Alpin de Gap-Charance
 Domaine de Charance
 05000 Gap
 Marie-France Tarbouriech
 Tel: (+33-4) 92535682
 Fax: (+33-4) 92519458
 Email: cbn_gap@alpes_net.fr

⁸ Non-exhaustive list.

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04100 Manosque

**Association Fruits et Nature en
Revermont**

J.P. Cotton
Mairie de Treffort-Cuisiat
01370 Treffort-Cuisiat

**Association ŒIL DORMANT - Fruits
retrouvés d'Ardèche**

Le Monteil
07380 Jaujac

Germany

**Mecklenburger Landschafts- und
Territorientwicklung**

Warnow-Ost e.V.

Dr Moll
Griebnitzer Weg 6
18196 Dummerdorf
Tel. (49-38208)60729

Fruchtquell GmbH & Co. KG

W. Schüler
Kogeler Weg 35
19243 Dodow
Tel (49-38852)990

**Verein KULTUR-Landschaft
Haldensleben-Hundisburg e.V.**

Gartenverwaltung
(Obstsortenmustersammlung im
Barockgarten Hundisburg)
R. Heller
Oberhof
39343 Hundisburg
Tel. (49-3904)44265

OVA-Jork Betrieb Esteburg

R. Stehr
Moorende 53
21635 Jork
Tel. (49-4162)8024

Naturpark Saale-Unstrut-Triasland e.V.

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06642 Nebra
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Irish Seed Saver Association

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Nuova Ricerca Cooperativa

Via Ripolimosani 37/7
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Il frutto permesso

Dario Martina
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 Tel. (39-121)55383/55620

There are many other societies and individuals interested in *Malus* in Italy. They can be contacted through I. Dalla Raggione, Assoc. Archeologia Arborea (address above). See also her paper on 'The informal sector in Italy', p. 31, this report.

The Netherlands

Noordelijke Pomologische Vereniging
 C. Couvert
 Sluisstraat 165
 9406 AX Assen
 Tel. (31-5923)55221

**Stichting Behoud en Bevordering
Fruitcultuur**

B. Giesen
 Postbus 83
 6980 AB Doesburg
 Tel. (31-313) 473672

Gemeente Ijsselstein

Dienst Openbaar Groen
 Planetenbaan 2
 3402 HP Ijsselstein
 Tel. (31-3068) 61691

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Pro Specie Rara
 Martin Bossard
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 Postfach 95
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Peter Enz
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 44 Earlham Street
 London WC2H 9LA

There are many other societies and individuals interested in *Malus* in the UK. They can be contacted through:

National Fruit Collections

Wye College, University of London
 National Fruit Collections
 Brogdale Road, Faversham, Kent. ME13 8XZ
 Tel. and Fax (44-1795)590272
 Email: nfc@wye.ac.uk

Appendix IV. Abbreviations and acronyms

AFCEV	Association française pour la conservation des espèces végétales, France
AGPS	Seed and Plant Genetic Resources Service, FAO
AIR	Agriculture and Agro-Industries (EC-funded Programme in research and technical development)
ASSINSEL	Association Internationale des Sélectionneurs
BAZ	Bundesanstalt für Züchtungsforschung an Kulturpflanzen, Germany
BBSRC	Biotechnology and Biological Sciences Research Council, UK
BRG	Bureau des Ressources Génétiques, France
CIATA	Centro de Investigacion Aplicada y Tecnologia Agroalimentaria, Spain
CNR	Consiglio Nazionale delle Ricerche, Italy
COO	Centro Operativo Ortofrutticolo, Italy
EC	European Commission
ECP/GR	European Cooperative Programme for Crop Genetic Resources Networks
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
HRI	Horticulture Research International, UK
IBPGR	International Board for Plant Genetic Resources
INRA	Institut National de la Recherche Agronomique, France
IPK	Institut für Pflanzengenetik und Kulturpflanzenforschung, Germany
ISF	Istituto Sperimentale per la Frutticoltura, Italy
ISTAT	Istituto Nazionale delle Statistiche, Italy
MAFF	Ministry of Agriculture, Fisheries and Food, UK
NFC	National Fruit Collection, UK
NGB	Nordic Gene Bank, Sweden
NGO	Non-Governmental Organization
PCR	Polymerase chain reaction
RAPD	Random amplified polymorphic DNA
SACs	Special Areas of Conservation, Ireland
SSR	Simple sequence repeats
UCD	University College Dublin, Ireland
UPOV	Union pour la protection des obtentions végétales
VIR	N.I. Vavilov Research Institute of Plant Industry, Russia

Appendix V. List of participants

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