European Cooperative Programme for Plant Genetic Resources

ECP//GR

Report of a Working Group on Medicinal and Aromatic Plants

Second Meeting, 16–18 December 2004, Strumica, Macedonia FYR
Third Meeting, 26–28 June 2007, Olomouc, Czech Republic
E. Lipman, *editor*

Bioversity International

Bioversity International is the operating name of the International Plant Genetic Resources Institute (IPGRI).

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The European Cooperative Programme for Plant Genetic Resources (ECPGR) is a collaborative programme among most European countries aimed at facilitating the long-term conservation and the increased utilization of plant genetic resources in Europe. The Programme, which is entirely financed by the member countries, is overseen by a Steering Committee composed of National Coordinators nominated by the participating countries and a number of relevant international bodies. Bioversity International provides the Coordinating Secretariat. The Programme operates through nine networks in which activities are carried out through a number of permanent working groups or through ad hoc actions. The ECPGR networks deal with either groups of crops (cereals; forages; fruit; oil and protein crops; sugar, starch and fibre crops; vegetables) or general themes related to plant genetic resources (documentation and information; *in situ* and on-farm conservation; inter-regional 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.

Citation
Lipman E, editor. 2009. Report of a Working Group on Medicinal and Aromatic Plants. Second Meeting, 16-18 December 2004, Strumica, Macedonia FYR / Third Meeting, 26–28 June 2007, Olomouc, Czech Republic. Bioversity International, Rome, Italy.

Cover illustrations
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Acknowledgements to Dr L. Currah for English language editing and to F. Ferraiuolo for graphics and layout.

ISBN 978-92-9043-812-0

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PART I. REPORT OF THE SECOND MEETING, 16-18 DECEMBER 2004, STRUMICA, MACEDONIA FYR

D. Baričevič, J. Bernáth, L. Maggioni and E. Lipman

Introduction

The Second Meeting of the Working Group on Medicinal and Aromatic Plants (MAPs) of the European Cooperative Programme for Crop Genetic Resources Networks (ECP/GR[1]) was held on 16-18 December 2004 in Strumica, Macedonia FYR. It was organized jointly with the meeting of the MAP Working Group of the South East European Development Network on Plant Genetic Resources (SEEDNet) held on 15 December, since several members are involved in both working groups and this provided an opportunity to establish links and look into potential synergies between the groups.

The joint meeting was attended by a total of 36 participants (22 ECP/GR and SEEDNet country representatives; 11 observers including an invited expert from Austria; the SEEDNet Coordinator; and 2 representatives of the ECP/GR Secretariat (see list in Appendix III, pp. 233-236).

Welcome address from local organizers

Gordana Popsimonova, from the Institute of Agriculture in Skopje, and Macedonian member of SEEDNet, welcomed all participants and wished them a pleasant stay in Strumica, a place rich in both historical and botanical resources, including many MAP species that are indigenous to the Strumica region. She hoped that the outcome of the SEEDNet meeting would be integrated into the discussions of the ECP/GR Working Group and that fruitful links would be established.

Introductory welcome from the Chair of the ECP/GR MAP WG

Dea Baričevič, Chair of the ECP/GR MAP Working Group, also welcomed all participants, addressing particularly the newly nominated members, since several changes had occurred in the composition of the WG since the first meeting in 2002. She said this second meeting of the WG was certainly going to be an important one, both for the future of the WG and for activities of MAP conservation in Europe.

She then presented the agenda, which was approved by the participants, and then asked everybody to introduce themselves.

ECP/GR information

Lorenzo Maggioni welcomed the Group and gave an introduction on the status of the ECP/GR programme. He explained that ECP/GR entered its VIIth Phase (2004–2008) with some modifications made to the structure and mode of operation by the Steering Committee in its last meeting in Izmir, Turkey, October 2003.[2] With specific relevance for the MAP WG, it should be noted that two Networks

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1 Following the decision of the Tenth Meeting of the ECPGR Steering Committee in September 2006, the name of the Programme was simplified to "European Cooperative Programme for Plant Genetic Resources" and the acronym was also modified to "ECPGR", removing the traditional slash of "ECP/GR".

2 See Report of the Ninth Steering Committee Meeting, also available on Internet at http://www.ecpgr.cgiar.org/SteeringCommittee/SC9.htm

(Vegetables and Minor Crops) were merged into a single one (Vegetables, Medicinal and Aromatic Plants Network), which now includes seven Working Groups (*Allium, Brassica*, Cucurbits, Leafy Vegetables, Medicinal and Aromatic Plants, Solanaceae and Umbellifer Crops).[3] The Steering Committee also requested a Network Coordinating Group (NCG) to define five priority groups within the Network and to make proposals, in consultation with the WGs, for actions on the basis of a budget of about 200 000 euro allocated to the Network. As a result of this exercise, which went on during 2004, the MAP WG was included among the priority WGs for Phase VII. The following use of funds that is relevant for MAPs was eventually approved:

- December 2004: second meeting of the MAP WG
- 2007: Vegetables and MAP Network meeting (all seven WGs)
- Meeting reports
- Reserve funds for priority groups (EU project preparatory meetings, data or sample acquisition, public awareness actions): 30 000 euro.

The current meeting in Strumica, Macedonia FYR, was organized in collaboration with the new Sida-funded plant genetic resources (PGR) Network SEEDNet. In order to take advantage of synergies as well as economic savings from a joint meeting, the ECP/GR meeting was organized concomitantly with the first meeting of the MAP Working Group of SEEDNet.

For further information on ECP/GR, it was suggested that participants could check the ECP/GR Web site, where several reference documents were available, including the Network's budget and the Terms of Reference for the ECP/GR operational bodies.

A specific Web page is also dedicated to the MAP Working Group (http://www.ecpgr.cgiar.org/Workgroups/Med_aromatic/med_aromatic.htm) and this can be improved with the help, and according to the needs, of the WG.

Chair's report

Dea Baričevič presented the progress made by the Group during the two years of existence of the WG and the plan for the coming period of 2004–2008.

She presented the specific objectives which were planned at the first MAP WG meeting in Slovenia (September 2002) and achievements. The Working Group successfully completed the majority of planned activities:

- selection of priority list of species (see below);
- development of a proposal for a MAP descriptor list (consisting of five categories of descriptors: Passport; Management; Environment and site; Characterization; Evaluation); and
- preparation of crop-specific characterization and evaluation descriptors – this action is still ongoing.

[3] During the Tenth Meeting (mid-term of Phase VII) of the ECPGR Steering Committee held in Latvia, September 2006, it was decided to move the MAP WG to the Sugar, Starch and Fibre Crops Network, hence reverting the Network's name to the original Vegetables Network.

Many new members attended the second meeting of the ECP/GR MAP WG, and therefore Dea Baričevič summarized the outcomes and decisions of the first meeting in 2002.

Short reports from country representatives

Before the meeting, the members had been requested to provide a short report on the surveys concerning the priority species which had been undertaken since the first meeting, under the workplan defined at that time.

The following reports were presented:

- Albania - H. Haska
- Bulgaria - K. Varbanova
- Czech Republic - K. Dušek
- Hungary - J. Bernáth
- Italy - L. Maggioni, on behalf of C. Vender
- Lithuania - J. Radušienė
- Macedonia FYR - G. Stefkov
- Nordic Countries - Å. Asdal, NGB/Nordic-Baltic project SPIMED ("Strategies for conservation of medicinal and aromatic plant species in the Nordic and Baltic countries"), and B. Galambosi, Finland
- Poland - Z. Węglarz
- Portugal - A.M. Barata
- Romania - Dan Sandru
- Russian Federation - N. Konon
- Serbia and Montenegro - T. Nastovski for Serbia, D. Stešević for Montenegro
- Switzerland - M. Quennoz
- Turkey - A.O. Sari
- Ukraine - T. Platonova
- UK - S. Jury

The corresponding full papers, if available, are included in Part III.

A report was provided before the meeting by the representative of Malta, E. Attard. It is also included in Part III.

Discussion and workplan

The opportunity to publish the report of the present meeting in the same way as was done for the first meeting of the Working Group was discussed by the Group and there was general agreement that a printed version would be necessary.

In addition the ECP/GR Secretariat offered to upload the available presentations on the MAP Web pages (PowerPoint and/or Word format) so as to make the information available more quickly and also for the benefit of the non-attending members. This was welcomed by the Group, although some participants expressed concern about copyright on pictures included in the presentations. It was eventually agreed to distribute the presentations on a CD-ROM, since PowerPoint files were very heavy in some cases. Regarding the material to be printed, the Chair requested that some modifications be made in the form of the reports before publication, i.e. that a specific summary be provided of the survey of populations of

the priority species/genera defined as had been requested. All contributions for publication (max. 5 pages) should be sent to Elinor Lipman ***by the end of February 2005****.*

MAP priority list and development of descriptors

Descriptors: introduction and progress made

Dea Baričevič reviewed the proposal for a MAP descriptor list that had been developed following the first meeting and distributed to the Group in August 2004.

Choice of priority list species

Jenő Bernáth reported on the process of selection of the priority species. According to the recommendation of the first meeting of the MAP WG held in Gozd Martuljek, Slovenia, 12-14 September 2002, the priority list of medicinal and aromatic plants, consisting of 10 genera or species has been completed.

It had been agreed that each country representative could propose genera or species. The country representatives were asked to consider in the course of the selection procedure the following criteria:

- The species or genus should be important from the point of view of utilization,
- The active medicinal or aromatic compounds should be well known and detectable,
- The diversity at genus or species level is high, as indicated by literature references,
- The species, genus, or chemotaxa are rare or endangered somewhere,
- Species or genera should be useful as models for both generative and vegetative conservation,
- A majority of experts of the Working Group should be interested in the genus or species.

Altogether proposals were received from 14 countries for 137 species. The species/genera that were included in the priority list have been cited at least 8 times with the exception of *Gentiana*. The selected species are listed in Table 1 below. The priority list of species/genera was approved by the country representatives.

Discussion in two sub-groups

A discussion followed on the use of descriptors for MAPs. The purpose for which characterization descriptors would be developed needed to be clarified.

Several possible reasons were mentioned, such as the description of genetic diversity conserved in the genebanks or the diversity of *in situ* populations, and taxonomic purposes as well as the description of useful traits for industry and trade.

The need was also raised to define traits that are not influenced by the environment and to agree on standard measurements to allow comparable evaluation, based on statistical analysis of several accessions.

Table 1. Final ten species/genera proposed for modelling[4]

Species/ Genus	Number of proposals	Countries interested in the study
Achillea spp.	9	Bulgaria, Estonia, Finland, Hungary, Israel, Italy, Lithuania, Romania, Serbia and Montenegro
Artemisia spp.	8	Bulgaria, Estonia, Hungary, Israel, Italy, Nordic Countries, Romania, Serbia and Montenegro
Carum carvi	8	Estonia, Finland, Hungary, Lithuania, Nordic Countries, Romania, Serbia and Montenegro, Slovenia
Gentiana spp.	6	Italy, Lithuania, Macedonia (FYR), Poland, Serbia and Montenegro, Slovenia
Hypericum spp.	9	Bulgaria, Estonia, Hungary, Italy, Lithuania, Macedonia (FYR), Nordic Countries, Romania, Serbia and Montenegro
Melissa officinalis	8	Bulgaria, Cyprus, Hungary, Israel, Nordic Countries, Romania, Serbia and Montenegro, Turkey
Mentha spp.	9	Bulgaria, Cyprus, Finland, Hungary, Israel, Nordic Countries, Romania, Serbia and Montenegro, Turkey
Origanum spp.	14	Bulgaria, Cyprus, Estonia, Finland, Hungary, Israel, Italy, Lithuania, Macedonia (FYR), Nordic Countries, Romania, Serbia and Montenegro, Slovenia, Turkey
Salvia spp.	11	Bulgaria, Cyprus, Hungary, Israel, Italy, Lithuania, Macedonia (FYR), Romania, Serbia and Montenegro, Slovenia, Turkey
Thymus spp.	12	Bulgaria, Cyprus, Estonia, Hungary, Israel, Italy, Lithuania, Macedonia (FYR), Nordic Countries, Romania, Serbia and Montenegro, Slovenia

N.B.: Further to the second meeting, the following expressions of interest regarding the above selected species were received from non-attending members:

E. Attard, Malta: *Melissa officinalis*, *Mentha* spp., *Origanum* spp., *Salvia* spp. and *Thymus* spp.

I. Žukauska, Latvia: *Origanum* spp. and *Thymus* spp.

The Group agreed that the main purpose of creating a list of characterization descriptors for the priority species was to:

- *characterize* in situ *populations and genebank accessions* ex situ *for their taxonomic and chemotaxonomic status;*
- *define morphological, chemical and genetic characteristics of genebank accessions for selection/breeding work and cultivar development; and*
- *find potential traits for the food industry and trade.*

[4] N.B.: this table is the revised version of the table published in Appendix I of the Report of the First Meeting of the MAP Working Group (no change in list of taxa, only in the number of proposals/countries for *Achillea* spp.).

With these objectives in mind, the Group split in two sub-groups, in order to discuss draft lists of descriptors of the following species, which were prepared in advance by the members of the Group:

- Group 1: *Achillea, Gentiana, Hypericum* (coordinated by Dea Baričevič)
- Group 2: *Carum, Mentha, Thymus, Origanum* (coordinated by Jenő Bernáth).

Conclusions of the sub-groups and Workplan

1. ***Modification of the priority list:*** *the list needs to be refined down to species level, the genus level is too high. The list of species was reviewed in plenary session and, except for* Origanum *which remains at genus level (since several species of* Origanum *are used/ sold under the name of oregano), the following new list was agreed upon by the Group (see Table 2).*
2. ***Finalization of the species-specific descriptor lists:*** *since the time available did not permit completion of the lists for all species the Group agreed that for each species, one member would be in charge of coordinating the finalization of the descriptors (see Table 2). A note was made that it will be necessary to clearly separate* in situ, ex situ *and laboratory measurements.*
3. ***Time-frame: by end of January 2005,*** *circulation of the draft lists to all members by the coordinator;* ***by end of February 2005,*** *compiled lists to be sent to Dea Baričevič. These lists will then have to be sent to IPGRI*[5] *for endorsement.*

Table 2. Distribution of responsibilities for compilation of species-specific descriptor lists[6]

Previous list	New list	Coordinator
Achillea spp.	*Achillea millefolium* agg.	Dea Baričevič
Artemisia spp.	*Artemisia absinthium*	Stephen Jury
Carum carvi	*Carum carvi*	Karel Dušek
Gentiana spp.	*Gentiana lutea*	Dea Baričevič
Hypericum spp.	*Hypericum perforatum*	Jolita Radušienė
Melissa officinalis	*Melissa officinalis*	Jenő Bernáth
Mentha spp.	*Mentha piperita* and *M. spicata*	Ana Maria Barata
Origanum spp.	*Origanum* spp.	Jenő Bernáth
Salvia spp.	*Salvia officinalis*	Hajri Haska/Tatjana Dishnica
Thymus spp.	*Thymus vulgaris* and *T. serpyllum*	Ana Maria Barata

[5] With effect from 1 December 2006, IPGRI operates under the name "Bioversity International".

[6] Some changes were made at the Third Meeting, see p. 20.

SEEDNet report

General information on SEEDNet (South East European Development Network on Plant Genetic Resources)

(Eva Thörn, Coordinator of the Network)

SEEDNet was established on 1 July 2004. The Swedish International Development Cooperation Agency (Sida) is giving financial support to the network and is committed to continue its support for at least 10 years.

Network members
- Current members of the network: Albania, Bosnia and Herzegovina, Croatia, Kosovo, Macedonia FYR, Montenegro, Serbia and Slovenia
- Five additional countries have been invited to join: Greece, Bulgaria, Romania, Moldova and Hungary.

Major goals
- Support establishment and strengthening of national PGR programmes
- Support PGR conservation and promotion of their utilization
- Strengthening of collaboration in the subregion.

A Steering Committee oversees all activities carried out by the Network.

Six crop-specific Working Groups will be established:
1. Cereals and maize
2. Medicinal and aromatic plants (MAP)
3. Vegetables
4. Fruit crops and *Vitis*
5. Fodder crops
6. Industrial crops.

The MAP WG is the first SEEDNet WG to be established and its first meeting was held on 15 December 2004. There is a strong wish to link up to the activities of the ECP/GR MAP Working Group.

Report on the first meeting of the SEEDNet MAP WG, 15 December 2004

(G. Stefkov, Chair of the WG)

- **Issues addressed included:**
  - Common goals
    - Protection and conservation of genetic resources and traditional knowledge of MAPs in South Europe
    - Promotion of cultivation of MAPs
  - Identification of needs
  - Priorities for the first SEEDNet phase (three years)

- **Sixteen target species were identified for the SEEDNet MAP WG:**
  1. *Gentiana lutea*
  2. *Gentiana punctata*
  3. *Hypericum perforatum*
  4. *Origanum vulgare* subsp. *vulgare*
  5. *Origanum vulgare* subsp. *hirtum*
  6. *Tanacetum corymbosum*
  7. *Tanacetum cinerariifolium*
  8. *Tanacetum parthenium*
  9. *Salvia officinalis*
  10. *Sideritis scardica*
  11. *Sideritis raeseri*
  12. *Achillea millefolium* agg.
  13. *Arctostaphylos uva-ursi*
  14. *Helichrysum italicum*
  15. *Helichrysum spicatum*
  16. *Satureja montana*

- **An action plan has been developed for the first and second years:**

Develop the MAP WG strategy	Draft for next meeting in September
Develop methodology and standards for surveys including training course	Draft version following the workshop
Surveys on natural populations of model species	Following the workshop 2004 and 2005
Inventory of existing (ex situ) collections of target species (Croatia, Serbia, Slovenia)	By end July 2005
Search genebank databases for material from SEEDNet area	By next meeting
Inventory of bibliography of MAP literature including laws	By next meeting
Establishment of database system together with other WG and NGB	By July 2005
Develop standards for collecting and conservation	By summer 2006
Prepare for long-term conservation of collected material	Before summer 2006
Collect seed material of model species	Summer 2006
Compile collecting data in documentation system	Before end of phase one
Regeneration of existing accessions	Before end of phase one

Discussion

Questions were asked about new countries joining SEEDNet and modes of funding. Eva Thörn clarified the status of each group of countries: non-EU partners will receive funding for all activities while EU countries will receive support for attendance at meetings only.

E. Thörn emphasized again the fact that collaboration was expected between the SEEDNet and ECP/GR MAP Working Groups.

Update on documentation systems

EURISCO

L. Maggioni presented the status of EURISCO, the European Internet Search Catalogue, which was launched online in September 2003 in its first demo version. The catalogue, which is centrally maintained at IPGRI, currently contains passport data on 900 000 plant genetic resources accessions maintained *ex situ* in European collection holdings. It is the largest online catalogue of this type in the world. The data are provided to the central catalogue by the European national inventories, following a procedure whereby the national focal person can at any moment send updated information for automatic uploading on EURISCO.

Currently each of 39 European countries has identified its national focal point and 27 national inventories have been entirely or partially uploaded so far.

The catalogue is expected to evolve further, with the inclusion of additional accession data and improvement of the quality of existing data. User-friendliness of the catalogue is also expected to improve, on the basis of users' feedback, and new tools are expected to be added in the near future, such as taxonomy checkers and visualization tools.

The usefulness of this catalogue specifically for medicinal and aromatic plants (MAPs) is dependent on decisions taken at national level to provide EURISCO with *ex situ* collection data for MAPs, through the national inventory. Currently, a limited number of accessions related to the ten MAP priority genera/species is available from EURISCO. Geographical data on the collecting sites of these accessions are even more rare. Examples of distribution maps contained in EURISCO show that coverage of latitude and longitude data is very limited at the moment, but improvement of this type of data would immediately be reflected in the online availability of potentially useful distribution maps. The MAP Working Group members have an important role in encouraging the provision to EURISCO of complete and accurate data by their respective National Focal Persons.

Information was also given on the ongoing EU-funded project PGRForum, which is providing a European forum for the assessment of taxonomic and genetic diversity of European crop wild relatives and the development of appropriate conservation methodologies. PGRForum's primary goal is to build an information system providing access to European crop wild relative data. The database will include all socio-economically important species occurring in Europe and their wild relatives, including food, fodder and forage, medicinal plants, condiments, ornamentals, forestry species, as well as plants used for industrial purposes such as oils and fibres.

The information system will include data on: uses; geographical distribution; biology; population and habitat information; threats (including IUCN Red List Assessments) and conservation actions (http://www.pgrforum.org).

Workplan

Each WG member will try to make sure that appropriate MAP data available in their country are provided in a coordinated way to their respective National Focal Persons for uploading on EURISCO. Any obstacle to this data flow will be communicated to the WG Chair and the ECP/GR Secretariat as soon as possible. A report on the status of MAP data flow to EURISCO will be provided to the ECP/GR Secretariat by the WG Chair ***before the end of November 2005.***

MEDPLANT

D. Baričevič presented the development of the MEDPLANT database over the past two years. The MEDPLANT multi-user relational database, which was developed in Slovenia for monitoring, characterization and utilization of MAPs, was updated with data from surveys made in Slovenia on *Origanum vulgare* subsp. *vulgare* (9 locations), *Gentiana lutea* (7 locations) and *Achillea millefolium* (8 locations) in order to monitor the localities and characterize morphologically and chemically the native populations.

MAP databases in Macedonia FYR

G. Stefkov presented two databases under development in Macedonia FYR:

Manual and monographs for collecting of wild medicinal and aromatic plants according to principles of organic production

Two data sets were presented. Each data set consists of: botanical name, local name, plant description, collecting areas, plant parts in use, period of collection, harvesting tools, collection method, conservation and sustainability, post-collection treatment, yield after drying, conservation status. The database records are easy to fill and can be browsed according to several characters. Additional funding is being sought for completion of this database.

Database for ethnobotanical data

This database is also constructed on the basis of data sets, each concerning a different plant. All collected ethnobotanical data can be included. One data set consists of: plant identification (botanical name, local names), locality, environmental aspects (soil type, land form, habitat), collection number, appearance and abundance, description and characteristics given by local people, data on interviewed person (name, gender, age, occupation, place of residence, ethnic group), interviewer identification, date, local uses and preparations of the plant. The database will be modified so that it can contain all the necessary data needed for documenting ethnobotanical data in the descriptors. Additional funding is being sought for completion of this database.

In the framework of the SEEDNet project, it is expected that all SEEDNet partners contribute information to the databases.

Eva Thörn indicated that the fact that a common information platform was to be developed within SEEDNet did not interfere in any way with the information systems already present in each country. The databases would be compatible with EURISCO and other relevant central databases.

Discussion

The question was raised whether the MAP WG should join in the effort with SEEDNet and contribute to the same database. It was considered that it could be convenient to develop the information data standards together and make sure that they were agreed on a wider level than the SEEDNet community. However, the opinion was that it was not urgent or not relevant for the Group to join this specific initiative at this stage.

European Central MAP database(s)

L. Maggioni presented the ECP/GR Central Crop Databases and explained the rationale behind the decision of Working Groups to undertake the development of

central databases. ECP/GR Central Crop Databases are mainly developed with the objective of sharing information on genetic resource material conserved in genebanks and to enable curators to respond to requests for accessions by potential users (breeders, researchers, farmers, etc.). Harmonization of data standards among different countries and institutions is the key element to enable data sharing and data compilation.

ECP/GR Central Crop Databases are managed by different institutions in Europe, who offer this service for the benefit of the Working Groups.

It was suggested that the WG on MAPs should first define whether a central database should serve this same purpose or a different one, that is, to define what type of users the Group would like to serve.

S. Jury drew the attention of the Group to the fact that the current trend is no longer to send data to a central node, since very powerful "data mining" machines can retrieve the information wherever it is, provided it is made available in the appropriate format.

J. Novak proposed that the Group could agree on compiling a central database to include a minimum number of the descriptors that would be the most interesting for users, such as essential oil content of the accessions conserved in genebanks or in natural populations.

It was agreed that such a relational database would be the preferred option.

MAP conservation, scientific and methodological approaches

This session included three scientific presentations:

- Experiments on the introduction of threatened medicinal plants in Finland (B. Galambosi) (full paper in Part III, pp. 83-96)
- Chemical characterization and quality assessment of wild-growing *Thymus* species (S. Kulevanova)
- Evaluation of oregano *(Origanum vulgare* L.*)* (D. Baričevič) (full paper in Part III, pp. 205-212).

Opportunities to submit MAP projects

Seventh Framework Programme (FP7)

S. Jury informed the Group about the procedure for submitting comments in order to propose potential research subjects to be included under FP7.

He presented the "Comments form" to be filled, available on the Internet, and stressed the fact that the deadline for submission was **31 December 2004** and according to his knowledge, very few forms had been received so far in our field. Therefore he urged the members of the Group to submit a form as soon as possible when back home.

Council Regulation (EC) No. 870/2004

Dea Baričevič presented the text of the Council Regulation published in the Official Journal of the European Union no. L162/18 of 30.4.2004 and a model of a proposal for submission to an EU GENRES project.

Discussion and recommendations

The Group agreed that it is essential to submit a project proposal because the topic of the Regulation relates to the WG objectives and strategy (long-term tasks).

With the approval of the WG, Dea Baričevič asked Stephen Jury whether he would agree to coordinate the project and he kindly agreed.

The call will not be open before January 2005, but then the deadline for applications may be very short so it is important to watch the Web site for the opening of the call.

The steps involved in the drafting of the proposal will be defined by the project coordinator, who will inform all the WG members, including those who did not attend the meeting.

Dea Baričevič suggested that the project proposal should broadly follow the ECP/GR MAP Working Group objectives and long-term strategy (tasks) and the Group agreed.

Regarding the need to identify the acreage of cultivated MAPs in member countries, J. Novak suggested considering the possibility of involving the ***European Herb Growers Association*** in the project, and offered to establish contact with them if needed.

Identification of project partners:

- The eligibility of non-EU countries will be clarified when the call is open.
- Å. Asdal mentioned that, if necessary, there could be some flexibility in organizing the project, such as participation in sub-groups (e.g. Nordic Countries could participate as such).
- It would be essential to link, during the project proposal preparation, with other related or complementary projects such as EURISCO, PGRForum, etc., and to identify potential areas for collaboration and cooperation.

Closing remarks

Next meeting of the Working Group

K. Dušek offered to host in Olomouc, Czech Republic, the next meeting of the Vegetables, Medicinal and Aromatic Plants Network, which is planned to take place in 2007. This meeting will convene the members of the seven Working Groups of this Network. The Group welcomed this offer, which will be brought to the attention of the Network Coordinating Group for consideration.

Workplan for the period 2005-2007 (next meeting expected in June 2007)

- *The persons responsible for the development of descriptor lists should prepare draft proposals for descriptors and send (circulate) them to each of the WG members* ***before 31 January 2005****.*
- *Members should review the drafts, make comments and revisions and send corrected drafts back to the responsible persons* ***before 28 February 2005****. If members do not respond by 28 February 2005, this will be taken to mean that they agree with the draft proposals.*
- *Responsible persons should send the final drafts to Dea Baričevič* ***by 15 March 2005****. Dea Baričevič will send the revised descriptors to IPGRI for comments.*
- *After receiving comments from IPGRI (the WG has suggested* ***by 15 April 2005****) each of the participants/members should make (according to his/her practical possibilities) a survey on the chosen natural populations of selected species and characterize those populations* in situ *or appropriate accessions* ex situ*. Partners will decide on the number of species studied and on the number of locations surveyed on their own.*

- *At the next meeting, each of the members of ECP/GR MAP WG will present their results (as country reports) and comments.*
- *Dea Baričevič should contact the person(s) responsible for the descriptors at IPGRI to inform them about the schedule of the Working Group and enquire about possibilities for publication.*

Election of the Chair and Vice-Chair

The Group agreed to confirm Dea Baričevič as Chairperson of the ECP/GR Working Group on Medicinal and Aromatic Plants for the next period, i.e. until the end of the next meeting. Dea Baričevič accepted with thanks and Jenő Bernáth also accepted the invitation to continue fulfilling the functions of Vice-Chair.

Conclusion

Dea Baričevič thanked the participants for their inputs and work during the whole period since the last meeting; she hoped that the composition of the WG would now remain stable till the next meeting.

She said she felt that important contacts had been established with the SEEDNet MAP WG and she would ensure that the links between the two WGs be continued and strengthened in the near future.

Dea Baričevič closed the meeting after having expressed her thanks to the local organizers for their general support and especially for the pleasant excursion offered to the Group on this last day, and also thanked the ECP/GR Secretariat for their continued support since the previous meeting.

PART II. REPORT OF THE THIRD MEETING, 26–28 JUNE 2007, OLOMOUC, CZECH REPUBLIC

A. Del Greco, D. Baričevič, L. Maggioni and E. Lipman

Introduction

The Third Meeting of the Working Group on Medicinal and Aromatic Plants (MAPs) of the European Cooperative Programme for Plant Genetic Resources (ECPGR) was held on 26-28 June 2007 in Olomouc, Czech Republic. The meeting was organized jointly with the Second Meeting of the ECPGR Vegetables Network (VEGNET), since the Working Group on MAPs had been formally included in the VEGNET from January 2004 to September 2006.

Following the decision of the Steering Committee in Riga, Latvia (September 2006), the MAP Working Group was formally allocated to the Sugar, Starch and Fibre Crops Network.

Dea Baričevič, Chair of the MAP WG, welcomed the participants during the opening ceremony held jointly with the Vegetables Network representatives. She provided the participants with background information and the reasons why the MAP WG was assigned to a different Network. The proposal was raised during the meeting of the ECPGR Network Coordinating Groups (NCGs) in Bonn, March 2006, and approved at the Tenth Meeting (mid-term of Phase VII) of the ECPGR Steering Committee. She explained that the main reason why the Chairs of the Vegetables, Medicinal and Aromatic Plants Network considered that the MAP WG does not fit into this Network, was that the MAP WG deals with more than 400 wild taxa as potential sources of medicinal or aromatic products. Therefore, it would not benefit from collaborative support from the entire Network, which deals with no more than 30 to 40 plant species, mainly focused on *ex situ* conservation, and consequently is working conceptually on different approaches, strategies and methodologies than those of the MAP WG.

The MAP WG meeting was attended by 23 participants from ECPGR member countries plus observers from the ECPGR Secretariat (see Appendix V, pp. 239-241).

Chair's report

Dea Baričevič welcomed all members of the Working Group on Medicinal and Aromatic Plants to their Third Meeting. She said that Jenő Bernáth, Vice-Chair of the WG, sent his apologies, explaining that he was not able to continue actively in his role due to the cessation of support for plant genetic resources conservation from the Hungarian government since 2004. He then had to decide to decrease MAP genebank activities to the minimum. He wished the WG success and fruitful collaboration for the future.

D. Baričevič suggested that Eli Putievsky should be the temporary Vice-Chair for the next 2 days of the meeting and he agreed.

She then reminded the WG members, as already announced by the ECPGR Secretariat before the present meeting, that the reports of the Second Meeting (December 2004, Strumica, Macedonia FYR) and of the current Third Meeting would be published jointly in a single volume.

She introduced Aixa Del Greco as the representative of the ECPGR Secretariat, and also as the person responsible for the coordination of the revision of the descriptor lists.

D. Baričevič reviewed the agenda with the members, explaining that more time for discussion was needed than initially planned. Therefore she proposed to shorten the section on country reports.

She referred to the standard report document that she had compiled and submitted to the Steering Committee (SC) meeting in Riga, Latvia (September 2006), which would be discussed on the second day of the meeting. She also suggested that the participants should consider which possible MAP species should be proposed for inclusion in the initiative for "A European Genebank Integrated System" (AEGIS).

The agenda was eventually approved by all Group members.

D. Baričevič described the progress made by the Group since the previous meeting, as a starting point for discussion of the action plan for the remaining part of Phase VII of ECPGR. She reminded the Group that the main goal of the WG was the development of conservation strategies in Europe. She then highlighted the activities that had not yet been fully accomplished by the WG and the problems faced by working with MAPs, considering the limited available knowledge on wild genetic resources and the high level of threats to their survival. Inventories or surveys on MAP distribution and abundance have not been documented at European level, and this is mainly due to the lack of appropriate descriptors and of financial support both at national and international levels. She therefore stressed the importance of the work done by the MAP WG members for the development of descriptor lists (general and crop-specific).

Country reports

The following attending members presented country reports: Alban Ibraliu (Albania), Wolfgang Kainz (Austria), Kana Varbanova (Bulgaria), Zlatko Šatović (Croatia), Stathis Evangelides (Cyprus), Karel Dušek (Czech Republic), Olesja Volkova (Estonia), Bertalan Galambosi (Finland), Frank Marthe (Germany), Theodoros Koutsos (Greece), Eli Putievsky (Israel), Carla Vender (Italy), Ieva Žukauska (Latvia), Åsmund Asdal (Norway), Ana Maria Barata da Silva (Portugal), Dan Sandru (on behalf of Diana Rusu, Romania), Iveta Čičová (Slovakia), Dea Baričevič (Slovenia), Katarina Wedelsbäck-Bladh (Sweden), Mélanie Quennoz (Switzerland) and Ali Osman Sari (Turkey).

The report for Serbia had been sent to D. Baričevič and was distributed in the meeting.

Dea discussed with Sayyara Ibadullayeva, Azerbaijan the use of descriptors in Azerbaijan and the National Programme.

Theodoros Koutsos, Greece reported on a collecting mission and on the state of the art of MAPs in Greece.

Philip John (attending the meeting on behalf of Stephen Jury, United Kingdom) submitted a country report for publication shortly after the meeting.

All available full papers submitted for publication are included in Part III of this final report.

Discussions

Following the Estonian presentation

D. Baričevič took the opportunity to remind the audience that the scope of botanical gardens is to preserve diversity in general, of different species, while genebanks mainly have the mission to maintain different genotypes of the same species.

Following the Finnish presentation

D. Baričevič asked B. Galambosi to share with the Group the guidelines for long-term conservation that were developed in Finland.

Following the Italian presentation

C. Vender suggested discussing the criteria to choose the appropriate site population to be studied. E. Putievsky commented that two approaches can be considered:

1. To choose one or two major population(s) and collect as many seeds as possible;
2. To collect as many seeds as possible per population from marginal areas.

Following the Norwegian presentation

Å. Asdal distributed a publication on *Spice- and medicinal plants in the Nordic and Baltic countries. Conservation of Genetic Resources*.[7] He explained that these countries use descriptors agreed by the WG whenever available; otherwise they develop their own descriptor lists. D. Baričevič recommended the Group to use ECPGR descriptors developed for MAPs, both general and crop-specific. This is essential for a common understanding and data comparison and exchange. Should the members observe any characteristics which they consider important for amendment, she/he is encouraged to propose the amendments to the WG for approval.

Following the Portuguese presentation

A.M. Barata da Silva proposed to discuss the possibility of using software applications for statistical analysis, in order to elaborate and enhance data value.

General discussion

D. Baričevič opened the discussion by congratulating members on the work carried out and saying that the workplan has been followed during recent years, with more success in some countries than in others, but that the work was proceeding in the right direction.

E. Putievsky commented on the database systems used so far, saying that (1) each country uses its own documentation system, and a common system is not available to record data; (2) there is a problem with the languages used in the databases (DBs), since each country uses its own language; and (3) there is a massive amount of data on populations collected both in the past and more recently, and the problem today is how to record these data in the DB.

D. Baričevič replied as follows:

(1) EURISCO descriptors are clearly defined and useful for data exchange, and National Inventory Focal Points of each country need to use them to send data in standardized format for inclusion into EURISCO.

(2) The official language for sharing information is English.

(3) She suggested that all data should be entered in databases using the data exchange format of the EURISCO catalogue, starting with the most recent data. The process of entering older data would have to be put on hold for budgetary reasons.

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[7] Asdal Å, Olsson K, Wedelsbäck K, Galambosi B, Radušienė J, Žukauska I, Kjeldsen Bjørn G, Pihlik U. 2006. Spice- and medicinal plants in the Nordic and Baltic countries. Conservation of genetic resources. Report from a project group at the Nordic Gene Bank, Alnarp.

During his presentation, Karel Dušek commented that some descriptors are much too detailed. D. Baričevič replied that members are not obliged to fill in the complete set of proposed (crop-specific) descriptors. Nevertheless, when scoring any selected characters, it is strongly recommended to follow the commonly agreed descriptor states, in order to be able to compare data from one country to another. The discussion was postponed to the following day, as planned in the agenda.

Workplan

D. Baričevič will provide the WG members with a template for providing information on MAP-related activities. The template will be distributed within ***one month after the end of the meeting.*** *The list will include,* inter alia*: collecting, biodiversity conservation and documentation, and will include the level of activity. A proposal on how the table should be constructed was drafted.*

Each member country will send the list of MAP species on which his/her country is working to the WG Chair, ***within one month*** *after receiving the format template from her.*

D. Baričevič will then compile the information received from all WG members and share the finalized document with them no later than ***one month after receiving the last contribution.***

Recommendations

- *Information on MAP data transferred to the EURISCO catalogue should be shared among the Group.*
- *Data in the databases will have to be standardized. This is a long-term plan that should facilitate everyone's work.*

MAP descriptors

Discussion on general descriptors

Various descriptors to be included in the "Proposal for a MAP descriptor list (updated version)" were discussed within the Group, to show and explain all the amendments made since the original draft version.

D. Baričevič asked the members for their feedback or comments in order to finalize the list and clarify points raised by Bioversity. Theodoros Koutsos asked if snow should be considered as rainfall. The answer was positive.

D. Baričevič asked the members if the proposed list was accepted and everybody agreed. The list was unanimously considered finalized and will be submitted to Bioversity for endorsement.

Recommendation

The Group recommended that "Seed moisture content at harvest" *be set at 5% for long-term conservation and 8% for medium-term conservation.*

Discussion on draft crop-specific descriptors

Ana Maria Barata asked whether it was possible to publish the finalized crop-specific descriptor lists in the meeting report or whether it was necessary to wait for all lists to be ready. It was agreed that all lists which are ready by the time of publication of the report will be included, while others will be published as

working documents on the Web site. The Group agreed on circulating the lists, once finalized and revised by Bioversity, in order to have the agreement of the Group, before publishing them.

Responsibilities for the revision and finalization of some descriptor lists among the ten model species selected by the WG were assigned to new members.

- Ali Osman Sari (Turkey) took over the responsibility for *Melissa officinalis* and *Salvia officinalis*, replacing Jenő Bernáth and Hajri Haska/Tatjana Dishnica, respectively.
- Ieva Žukauska (Latvia) will be responsible for *Origanum*, replacing J. Bernáth.
- Dea Baričevič (Slovenia) will be responsible for *Artemisia absinthium, replacing* Stephen Jury.

Åsmund Asdal asked about the possibility of exchanging characterization data electronically at the moment, among people working on the same species. D. Baričevič replied that currently it is not possible and that this is the goal of the new database to be created.

Workplan

- *The ECPGR Secretariat will send the first revised version of the lists to the respective responsible members during the week following the meeting.*
- *All members, including new ones, responsible for those descriptor lists that have been already revised by Bioversity will reply to Bioversity's comments before the end of July 2007.*

Review of the standard progress report of the Working Group on Medicinal and Aromatic Plants to the mid-term Steering Committee meeting and discussion on the workplan for the next Phase (VIII) of ECPGR

D. Baričevič showed the Group the document presented to the SC at its mid-term meeting held in September 2006. The agreed workplan for the period 2005-2007 was revised and is considered to have been accomplished.

Members were requested to send their contributions for the second and third meetings' reports by the **end of September 2007**.

Amendments to the standard progress report presented to the SC were made, updating information on the ongoing/finalized work and planning for the remaining part of Phase VII. This document will be considered as the workplan of the WG until 2008 and beyond (see below, pp. 23-26).

The discussion also touched on the workplan for the next Phase VIII of ECPGR and Lorenzo Maggioni, ECPGR Coordinator, was invited to join the meeting to clarify some points. He explained the situation of the MAP WG regarding its new allocation as part of the Starch, Sugar and Fibre Crops Network. He also said that the Vegetables Network was discussing the possibility of requesting the Steering Committee to re-consider the rules of prioritizing WGs within Networks, since they prefer to share the budget equally.

D. Baričevič replied that in her opinion the prioritization mechanism is preferable. She pointed out that the MAP WG is a recent and very large one. The Group is

involved with a large number of taxa and the majority of the plant populations live in the wild (*in situ*). Moreover, no seed company is interested in financing activities for *in situ* conservation of MAPs, therefore she thought that this WG should be prioritized in terms of funds by ECPGR. L. Maggioni indicated that this issue would have to be dealt with at the NCG level.

Main discussion points on the standard progress report

Part I. Results. Section a. Point 5

Submission of collaborative projects: Å. Asdal asked about the possibility of creating a Central Crop Database (CCDB) for MAPs. The idea was welcomed and the Group will have to explore possibilities for implementing this DB.

Considering the 25% of the budget to be devoted to project activities during Phase VIII of ECPGR, the Group was thinking of applying for funds for the implementation of a Central Crop Database for MAPs. In case this application fails, a study on the distribution and characterization of a species widely grown in Europe could be proposed as an alternative idea. *Origanum* spp. populations were chosen as the best representative species.

Questions were asked on the practical/technical aspects of the development of a CCDB for MAPs from scratch and L. Maggioni explained how other databases have been built, i.e. thanks to the support of different managing institutes. He also advised the Group to contact any of the members of the Documentation and Information Network Coordinating Group in order to get the best advice.

In view of L. Maggioni's clarifications on the available budget for Phase VIII, the Group decided to keep the option to establish a MAP database on hold until D. Baričevič could contact Frank Begemann as Coordinator of the Documentation and Information Network for advice.

As an alternative use of funds, Å. Asdal proposed to determine the essential oil content by distillation and quality by chemical analysis in *Origanum* accessions from the various European collections. Material would be sent by all member countries to a selected laboratory. This option was welcomed by the Group, although the coordinator for such a project was not identified. It was agreed that members who wished to volunteer to act as coordinator for this project will inform D. Baričevič. The aim will be to prepare a project proposal **by September 2007.**

Part I. Results. Section b. Point 1

D. Baričevič asked Zlatko Šatović to write a protocol on recommended molecular marker procedures to assess genetic variability among MAP populations. The document will have to be written in a very simple and understandable way. A deadline was agreed as the **end of December 2007** for Z. Šatović to send to the ECPGR Secretariat the document for circulation to the Group and publication on the Web site.

Part II. Analysis. Section a. Point 4

It was reiterated that each member responsible for the descriptor lists will make sure that a reference standard variety is identified and referred to.

A proposal to implement the AEGIS concept for *Origanum* was made by the Group. The first step will be to define criteria for the Most Appropriate Accessions (MAAs)

to be included in a European collection. Technical guidelines for conservation should then be agreed by the MAP WG, to be elaborated from the standard format which is under development. For this activity, the Group will need to interact closely with the AEGIS Coordinator.

The discussion of a second set of ten additional model species to be considered by the Group was postponed to the next WG meeting, due to the current work overload of all members. E. Putievsky proposed to revise the list used for the first selection, originally made in 2002, where a long list of species was already proposed, before considering any others.

A proposal was made by D. Baričevič to host the next WG meeting in Slovenia in spring 2009, together with the Fourth ISHS Symposium on Breeding Research on MAPs. The offer was welcomed; however, due to budgetary limitations for the WG and the need to reduce costs, Alban Ibraliu offered his availability to organize the fourth meeting in Albania as an alternative. The Group agreed that the WG Chair will define the exact date and location for the fourth MAP WG meeting in due course.

The progress report submitted to the SC in September 2006 was revised as indicated below (revised/updated parts are highlighted in grey).

Progress report for the period 2004–2006 (revised in June 2007 with inclusion of a workplan until the end of 2008)

I. RESULTS		
a. Comparison of workplan (milestones) versus results obtained		
Workplan (milestones)	**Which results have been obtained New achievements/plans**	**Which aims/goals have not been (fully) reached? New deadlines**
1. MAP WG Meetings 2nd in 2004 3rd in 2007	The 2nd MAP WG meeting was held 16-18 December 2004 in Strumica, Macedonia FYR, and the 3rd MAP WG meeting 26-28 June 2007 in Olomouc, Czech Republic. Review of the work done by each member country (2004-2007).	Workplan has been agreed for 2007-2008. Report (joint) expected for the end of 2007.
2. Development of descriptors for *in situ* and *ex situ* conservation for ten model species (*Achillea millefolium* agg., *Artemisia absinthium, Carum carvi, Gentiana lutea, Hypericum perforatum, Melissa officinalis, Mentha* spp., *Origanum vulgare, Salvia officinalis, Thymus* spp.	Five categories of descriptors (Passport - accession descriptors + collecting descriptors; Management; Environment and Site; Characterization; and Evaluation) have been identified. Four categories were developed, harmonized and used in surveying MAP distribution at national level of member countries as well as in characterization/evaluation of genetic resources.	Management descriptors have also been developed. Finalization of the ten proposed descriptor lists is expected by the end of 2008.
3. Monitoring (surveying) *in situ* and collecting of seed material in each member country.	Made in 2005 and 2006. Specimens provided to the MAP national genebank collections.	Ongoing activity in 2007 and 2008.
4. *Ex situ* conservation and regeneration of indigenous MAP accessions in member countries.	Made in 2005 and 2006.	Ongoing activity in 2007 and 2008.
5. Submission of collaborative project proposal on: *Characterization of* Origanum *spp. populations in member countries.*		Planned for submission by 15 April 2008 to the ECPGR SC.

6. Update and proactive management of the relational database by the WG Chair.	Made at national level (Slovenia) in 2005 and 2006, coordinated by the WG Chair.	Upgrading of information (database) system presently limited to one country, external funds needed for an international database. Ongoing activity in 2007 and 2008, coordinated by the WG Chair.

b. Contribution to the four ECPGR priorities for Phase VII

1. Characterization/evaluation (including modern technologies)

Due to the lack of biological knowledge on characterization and evaluation of MAP species, descriptor lists, based on current professional and scientific findings, have been developed for ten model MAP species (*Achillea millefolium* agg., *Artemisia absinthium, Carum carvi, Gentiana lutea, Hypericum perforatum, Melissa officinalis, Mentha* spp., *Origanum vulgare, Salvia officinalis, Thymus* spp.).

In member countries MAP accessions are successively characterized/evaluated according to their morphological, chemical and cytological characteristics, defined in the crop-specific descriptors. The results were presented during the third WG meeting in June 2007. On that occasion a discussion was opened in order to find the most appropriate molecular tools to assess the genetic variability among populations of the ten model species.

Zlatko Šatović will send relevant protocol(s) to the ECPGR Secretariat by the end of 2007.

2. Task sharing

At the second MAP WG meeting in Strumica (December 2004) responsibilities for compilation of species-specific descriptor lists were shared among the following members: *Achillea millefolium* agg. - Dea Baričevič (Slovenia); *Artemisia absinthium* - Stephen Jury (UK), replaced by Dea Baričevič (Slovenia) at the third meeting; *Carum carvi* - Karel Dušek (Czech Republic); *Gentiana lutea* - Dea Baričevič (Slovenia); *Hypericum perforatum* - Jolita Radušienė (Lithuania); *Melissa officinalis* - Jenő Bernáth (Hungary), replaced by Ali Osman Sari (Turkey) at the third meeting; *Mentha piperita* and *M. spicata* - Ana Maria Barata (Portugal); *Origanum* spp. - Jenő Bernáth (Hungary), replaced by Ieva Žukauska (Latvia) at the third meeting; *Salvia officinalis* - Hajri Haska/Tatjana Dishnica (Albania), replaced by Ali Osman Sari (Turkey) at the third meeting; *Thymus vulgaris* and *T. serpyllum* - Ana Maria Barata (Portugal).

The descriptor lists developed were distributed among all WG members. After revision, the final drafts were distributed to WG members as working protocols.

3. In situ/on-farm conservation and development

Protocols for assessing the natural distribution of natural populations of selected model MAP species have been developed. Each country should (depending on availability of national funds) make an inventory and survey the distribution pattern of the indigenous populations of the ten selected model species. The survey results on the distribution of MAP populations, the degree of potential threats and data on ecogeographical characteristics of natural habitats were recorded. The seed material from indigenous populations was collected and recommendations for the regeneration of seed/vegetative material were distributed in order for member countries to regenerate the collected material, growing the plants' seed from the *ex situ* collections for characterization/evaluation in 2006, 2007 and 2008. All results will be presented at the next (fourth) meeting within the formal country reports.

4. Documentation and information

The background information on EURISCO descriptors to be used to record data on populations/accessions obtained during national surveys, which should be sent to the respective National Focal Points, was provided to the WG members.

c. Relevance (regional/international)
Information on surveys and mapping of MAPs in member countries will enable regional and international reviews of the distribution and estimation of abundance of natural populations of the ten selected model species, together with registration/evaluation of ecogeographical data on their natural habitats and monitoring the factors with negative impact on the status of observed populations. Such a review will enable the assessing of the level of threats to target species in the European region; in case of results indicating a decrease in biodiversity, actions should be undertaken to control or remove the threatening factors and detailed management or recovery plans should be defined and implemented by natural resource managers, local communities and policy makers.
d. Lessons learnt (recommendations)
Collecting, Environment and Site descriptors, as well as approaches developed for survey purposes, could be used by members of other WG or Networks (for example the *In situ* and On-farm Conservation Network and the Sugar, Starch and Fibre Crops Network).

II. ANALYSIS	
a. Bottlenecks	
What were the bottlenecks experienced?	*How do you plan to solve the bottlenecks?*
1. Morphological, chemical and cytological characterization/ evaluation are time-consuming.	Obtaining external funds for additional human resources.
2. Problems with purification of DNA and molecular markers for the identification of genetic variability among populations.	Submitting an international project with special emphasis on developing rapid and cost-efficient molecular tools for the screening of genetic variability among populations of MAP species with high content of phenolic compounds.
3. Lack of experience and literature references for the development of management descriptors.	Setting up experiments on maintenance of genetic material, study of floral biology of the ten model species, study of the impacts of environment and postharvest handling on seed viability.
4. Providing appropriate standard or reference cultivars (standard varieties) for *ex situ* evaluation.	The key for the selection of standard varieties and distribution pattern will be determined by the MAP WG members by the end of 2007.
5. Insufficient national funds.	Submitting international projects.
b. Internal support needed (Secretariat, Steering Committee, other Working Groups, etc.)	
The Group considers it necessary to obtain greater internal support in order to enable participation of WG members in the 4th Symposium on Breeding research on MAPs, which will be held in Slovenia in 2009. The agenda of the Symposium covers all relevant topics which are important for understanding MAP conservation issues, pre- and postharvest activities and processing of genetic material (diversity evaluation; conservation biology; maintenance of genetic material; postharvest handling of wild/ domesticated material; reproduction biology; conventional breeding; molecular markers and genetic engineering; special analytical methods for breeding, etc.). Therefore the Symposium would benefit from being organized under the auspices of Bioversity and/or ECPGR. Due to the high registration fee (450 euro) some participants will not be able to attend the Symposium, unless internally supported. Support is requested for at least the following countries: Albania, Bulgaria, Estonia, Georgia, Latvia, Lithuania, Macedonia FYR, Romania, Montenegro and Serbia.	

c. External resources needed (collaboration, external funding)
Upgrading of information systems (relational database) is presently limited to one country (Slovenia); external funds are needed to develop an international database. The database incorporates all Environment and Site descriptors, Characterization and Evaluation descriptors (up to now for ten model species). The data (survey data, specimen characters, environment and site descriptions) management system will require a standardized input/output format. Continuation and proactive management of the database and its broadening to provide international coverage has been foreseen for ECPGR Phase VIII with the collaboration and support of all MAP WG members, the Documentation and Information Network, and the Sugar, Starch and Fibre Crops Network.

III. PLANS for 2008	
a. Planned activities	*b. Expected results*
Refining the descriptor lists of the ten target model species (2006-2008).	Distribution and abundance of natural populations recorded *in situ*, ecogeographical data of natural populations analyzed, characterization and evaluation data obtained for *in situ* specimens or *ex situ* accessions.
Development of management descriptors, elaboration of technical design and protocols for implementation of techniques needed for regeneration (by seed or vegetative propagation) of indigenous populations (2006-2008).	Regeneration of indigenous plant material and conservation in *ex situ* collections of member countries.
Review and corrections of the criteria for selection of next group of priority/ model species in member countries (2007-2008).	The listing of MAP species that need urgent conservation in the European region is postponed to the next meeting during Phase VIII.
Development of an approach used for estimation/identification of diversity reduction of endangered, vulnerable and rare wild species (2007-2008).	Promotion of the domestication of wild species that indicate a trend in diversity reduction in member countries, independently from the species threat status.

Conclusion

Discussion and approval of report

The draft report was distributed among the participants who amended it, as appropriate, and eventually endorsed it.

Selection of Chair and Vice-Chair

Dea Baričevič was confirmed as the Chair of the WG until the next meeting of the Steering Committee. Meanwhile, the ECPGR Secretariat will facilitate the selection of a new Chair.

Ana Maria Barata da Silva agreed to be the Vice-Chair of the WG until the beginning of the new Phase.[8]

Closing remarks

Dea Baričevič closed the meeting, expressing her appreciation for the constructive attitude of all participants, which contributed to the meeting's success. She also congratulated the members on the work they have carried out during the past years, which contributed not only to achieving the goals set by the WG, but also to enhancing knowledge at national level. She noted that in the remaining period of Phase VII (till 2008) the Group will have the opportunity to complete the minor tasks that have not yet been carried out. Some tasks have already been defined for the next Phase (VIII) of ECPGR and there are good hopes of successfully fulfilling the Group's expectations.

Finally, she thanked her Czech colleagues for the professional organization of the meeting and their warm hospitality.

[8] The selection process of the new interim Chair and Vice-Chair was carried out after the Eleventh Steering Committee Meeting. The Working Group members elected Ana Maria Barata as interim Chair, and Åsmund Asdal was nominated as interim Vice-Chair.

PART III. PRESENTATIONS AND PAPERS

The contribution of ECPGR to global strategies for the conservation, sustainable management and use of medicinal and aromatic plants

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Introduction

Studies on the uses of natural genetic resources in different cultural environments show a strong relationship between dietary habits and the health of the local population. Many wild plants were used by indigenous peoples both as foods and as medicine (Johns 1999; Pieroni and Heinrich 2003; Rivera et al. 2005). Beside the need to characterize the environmental factors that affect the existence and distribution of natural genetic resources, the knowledge of traditional diets and herbal treatment habits, and of the ethnobotanical and general ethnographic characteristics of a particular area can all serve as the professional background for prospecting for those wild genetic resources that can be of use in the diet and/or as medicine for the local inhabitants (Heinrich 2002, 2003; Bremner et al. 2004; Heinrich et al. 2005). The existence of traditional medicines basically depends on plant species diversity and the related knowledge of their use as herbal drugs. Both the plant species present in an area and traditional knowledge are important to the herbal medicine trade and the pharmaceutical industry, for which plants provide raw materials and traditional knowledge forms part of the prerequisite information (Tabuti et al. 2003). Together with the growth in global demand for medicinal plants and in local demand for plant-based traditional medicines, the pressure on the existing populations of medicinal plants has increased tremendously during the last few decades (Rajan 2003). Historically, most of these plants grew in the wild as natural components of the vegetation of a particular region. The necessary plant materials (roots, bark, leaves) were collected and sold by the local people to the traders and the industry, and exporters purchased them from traders. Since there was no scientific system of collecting or regenerating these plants in the past, several wild plant species have either been completely lost or have now become endangered.

In order to stop further biodiversity loss of the natural resources of medicinal and other socio-economically important plants, modern scientific methods must be used to evaluate the remaining stocks of these populations in their natural habitats and secure their sustainable and permanent use (Johns 2002; Johns and Eyzaguirre 2000, 2002; Troppman et al. 2002) in order to conserve an essential part of our natural and cultural heritage.

The main general aims and long-term goals of conservation of target species in their natural habitats are to protect, manage and monitor the selected populations without interfering with the maintenance of the natural evolutionary processes, thus allowing new variation to be generated in the genepool which will allow the species to adapt to changing environmental conditions such as global warming, changed rainfall patterns, acid rain or habitat loss (Heywood 2004).

In many countries the excessive collecting of wild plants has often been combined with a loss of habitat that has resulted in a severe decline in the numbers of wild

plants of certain species. For that reason, domestication of wild medicinal and other socio-economically important plants is necessary to allow intensive production to meet high demand – especially in the current period of global trade, with massive and expanding markets for medicinal and herbal products. In the history of human civilization, the domestication of wild edible plant species and their agricultural production was the key anthropogenic contribution to the production of agricultural surpluses, capable of supporting urban communities. The maintenance and sustainable management of natural habitats – ecosystems and biological resources – is possible only after there has been a basic decision change from wild plant gathering to agricultural production of any raw materials which are subject to growing commercial demand.

Medicinal and aromatic plants' biodiversity conservation in the light of global strategies and of EU legislation

When considering conservation and use of plant genetic resources of potential use in food and agriculture (including those which have been described as neglected or underutilized species, minor crops or medicinal and aromatic plant species), Community legislation which has an immediate legal effect on the member states should take into account relevant international processes, developments and agreements, in particular as regards: the Convention on Biological Diversity (CBD), the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), the FAO's Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture, the European Plant Conservation Strategy (EPSC) and programmes implemented under international frameworks such as the European Cooperative Programme for Plant Genetic Resources (ECPGR) and the Consultative Group on International Agricultural Research (CGIAR).

The Convention on International Trade in Endangered Species (CITES), which laid down provisions for the protection of endangered species of flora and fauna, controls international trade in specimens of these species and is the basis of a worldwide policy on the protection of endangered species (Council Regulation (EC) No 338/97, Commission Regulation (EC) No 939/97, Commission Regulation (EC) No 1808/2001, Commission Regulation (EC) No 1497/2003**,** Commission Regulation (EC) No 834/2004).

Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products (Annex I, point 4) lays down provisions on sustainable collection of edible plants and parts thereof, growing naturally in the wild and in forests and agricultural areas, postulating that the collecting should not affect the stability of the natural habitat or the maintenance of the species in the collection area.

In addition, the German Federal Agency for Nature Conservation (Bundesamt für Naturschutz, BfN), the World Wild Fund for Nature (WWF), the wildlife trade monitoring network (TRAFFIC), and the Medicinal Plant Specialist Group (MPSG) of the Species Survival Commission (SCC) of the International Union for Conservation of Nature (IUCN) have developed a strong base of expertise and knowledge and prepared practical standards and performance criteria in the field of sustainable wild collecting of medicinal and aromatic plants (MAPs) (Klingestein et al. 2004). Their efforts have resulted in an International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP) (Medicinal Plant Specialist Group

2007). However, when wild collecting is the source for supplying the demands of the expanding markets for raw materials, and especially while there continues to be a lack of attention to illegal and unsustainable trade, one of the major concerns still remains the risk of the loss of the plant species' ability to regenerate, when quantities of harvested material exceed the safe limits for the population.

On 26 June 2003, EU farm ministers adopted a fundamental reform of the Common Agricultural Policy (CAP, Official journal L270 – 10/21/2003). On 29 September 2003, the Agriculture Council formally adopted the legal texts of the June 2003 CAP Reform agreement. The CAP's objectives include helping agriculture to fulfil its multifunctional role in society: producing safe and healthy food, contributing to sustainable development of rural areas, and protecting and enhancing the status of the farmed environment and its biodiversity. The reform will completely change the way the EU supports its farm sector (Council Regulation (EC) No 1698/2005).

The International Treaty on Plant Genetic Resources for Food and Agriculture came into force on 29 June 2004. Each country that ratifies the Treaty will develop the legislation and regulations needed to implement the Treaty. The Treaty's objectives are the conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of benefits derived from their use for sustainable agriculture and food security, in harmony with the CBD and the Global Strategy for Plant Conservation (GSPC). The Treaty summarizes the GSPC's definition of sustainable management and use of plant diversity which should integrate social and environmental considerations, such as fair and equitable sharing of benefits and the participation of indigenous and local communities. All the actors involved benefit, in many ways:

- farmers and their communities, through Farmers' Rights;
- consumers, because of a greater variety of foods, and of agriculture products, as well as increased food security;
- the scientific community, through access to the plant genetic resources crucial for research and plant breeding;
- International Agricultural Research Centres, whose collections the Treaty puts on a safe and long-term legal footing;
- both the public and private sectors, which are assured access to a wide range of genetic diversity for agricultural development;
- the environment, and future generations, because the Treaty will help to conserve the genetic diversity necessary to face unpredictable environmental changes and future human needs.

Long-term goals in this field are managed according to the provisions of numerous global strategic documents, which were used in the preparation of international conventions or national programmes, i.e. *World Conservation Strategy* (IUCN/UNEP/WWF/FAO/Unesco 1980), *Caring for the Earth* (IUCN/UNEP/WWF 1991), *Global Biodiversity Strategy* (WRI/IUCN/UNEP 1992). Special directives for the conservation of medicinal plants were included in the *Guidelines on the Conservation of Medicinal Plants* (WHO/IUCN/WWF 1993), where the significance of ecology, identification and traditional uses of plants, as well as cultivation and conservation of plants both *in situ* and *ex situ* are strongly emphasized (Baričevič and Kušar 2006). Together with the World Health Organization's *Guidelines on Good Agricultural and Collection Practices*

(GACP) for medicinal plants (WHO 2003), these guidelines offer the background supporting documents for many national and international initiatives, programmes and frameworks, aimed at improving knowledge on the distribution, abundance, sustainable management and use of medicinal plants worldwide.

In April 2002 the European Plant Conservation Strategy (EPCS) was recognized as a contribution to the GSPC, adopted by the CBD (Decision VI/9). The EPCS is a joint initiative of the Council of Europe and the Planta Europa Network, and will significantly help to raise the profile of the Planta Europa Network's efforts to protect plants in Europe. It contributes also to the CBD and the Pan European Biological and Landscape Diversity Strategy (PEBLDS). The Planta Europa Network, at its 4th Planta Europa Conference (Valencia, September 2004), set itself a challenging agenda to be achieved by 2007. Among seven "Critical Targets", which were used to provide the framework for Planta Europa activities in the next three years, target 7 refers to the identification of best practice for conservation and sustainable use of medicinal and other socio-economically important plants and the promotion of this information to relevant policy-makers. This critical target corresponds to Target 3.1 of the EPCS.

The role of ECPGR in conservation, sustainable management and use of MAPs

Conservation programmes, aimed at conserving the natural heritage, at the improvement of knowledge of the MAPs genetic variability and improving biological knowledge, including MAPs-related user safety, as well as sustainable management and use of MAPs should be promoted in the EU countries.

The Steering Committee of the European Cooperative Programme for Plant Genetic Resources Networks (ECPGR), which operates through nine broadly focused networks (http://www.ecpgr.cgiar.org/Index.htm), agreed on the establishment of the Medicinal and Aromatic Plants Working Group (MAP WG) in October 2001 in order to facilitate European collaboration within the field of conservation of natural resources of MAPs and their sustainable use. Up to now the ECPGR MAP WG has met three times – for the first time at the Gozd Martuljek meeting in Slovenia (September 2002), for the second time in Strumica, Macedonia FYR (December 2004). Our third meeting here in Olomouc aims to review the work done within the past 3-year-period. After the first meeting, ten target species/genera to be used as model species were selected, enabling development of specific MAP descriptors: *Achillea millefolium* agg., *Artemisia absinthium*, *Carum carvi*, *Gentiana lutea*, *Hypericum perforatum*, *Melissa officinalis*, *Mentha* spp., *Origanum vulgare*, *Salvia officinalis* and *Thymus* spp. MAP descriptor lists, harmonized with those of the European Internet Search Catalogue (EURISCO), have been prepared and were proposed to the members as a working scheme during the second meeting. Members who were interested in the same species/genus worked on characterization of specimens *in situ* and on the evaluation of accessions within their genebanks. The reports, obtained after evaluation of morphological, cytological and genetic characterization *in situ* and evaluation of accessions *ex situ* in each of the member countries are expected to be presented during the present (third) meeting of the WG in Olomouc.

The Group is expected to contribute to the development of the conservation strategy for MAPs at the European level. Legislative limitations, implemented by EU trade regulations on endangered MAPs and our current poor knowledge of biological conditions and biodiversity status, emphasize the need for coordinated action and

the involvement of European experts and scientists. Efforts are to be carried out in partnership with a variety of actors (at local, national and international level) and deploying a variety of tools that contribute more effectively towards the common overall aim – conservation of MAPs and their habitats in the European region.

The inventory and monitoring of endangered MAP species and their *ex situ* maintenance, the study of intraspecific diversity, the assessment of threats, preparation of relevant descriptors and successive evaluation of ecotypes are just some of the research programmes that will contribute to the knowledge on current genepools of MAPs and their degree of vulnerability in individual countries. The field work should be restricted to the areas which have been selected at the national level to take into account the relative importance of each natural habitat type in the member countries.

Best practice for the conservation and sustainable use of medicinal plants (and other sociologically important plants) which in the majority of cases occur outside protected areas (a protected area *per se* already represents a protection measure) would be the study and identification of risks of biodiversity loss, and the promotion of appropriate conservation measures to relevant policy-makers and policy-based conservation actions.

Monitoring the impacts of bad influences on the status of the endangered species could be considered as an important factor in the notification of biodiversity decrease. Plant species can be endangered due to the loss of habitats because of natural succession (e.g. reforestation) or due to direct extermination (collecting, land amelioration, agricultural activities, infrastructure developments, etc.). For the conservation of the natural species populations some extra measures are needed. The *in situ* and *ex situ* measures should be coordinated, especially the propagation of the plants for their reintroduction and the establishing of suitable environmental conditions for their further domestication. Studies of the level of endangeredness of species populations are the basis for their effective conservation. For threatened species (whether of known economic importance or not) ecogeographical surveying should be undertaken, the extent of the genetic representation in the natural habitat assessed, actions undertaken to control or remove the factors that cause the threats and the detailed management or recovery should be planned and implemented through natural resource managers, local communities and policy-makers.

Seed material from rare and vulnerable species should be collected and transferred to appropriate *ex situ* collections, where the plants should be propagated. Thereafter, morphological, cytological, usage and chemical characteristics of plants in different developmental stages should be recorded. In case of "not threatened" species, ecogeographical surveying should be undertaken to establish the amount and distribution of genetic variation, potential changes in population size in the natural habitat (*in situ*) as well as to assess conservation needs.

Due to the fact that farmers involved in the domestication of MAPs mostly have rather limited resources, while knowledge on the cultivation of species new to agriculture is rather scarce, MAPs are grown in Europe only on a relatively small area (approximately 150 000 ha). Domestication of wild species where demand indicates an increasing trend in economic importance should be promoted, independently of the species' endangeredness status. In this context one of the most important tasks for the ECPGR MAP WG will be to develop professional standards/criteria, which could be of immediate use in member countries in order to follow up the current

status of MAP populations in their natural habitats and which will point out which of the measures should be addressed to the management of target species in order to control/prevent their biodiversity loss.

ECPGR MAP WG results (2002–2007)

The MAP WG workplan covers activities related to documentation, *in situ* and *ex situ* characterization/evaluation and on-farm conservation of MAPs. Harmonization of methodologies for the evaluation of natural plant populations and their habitats is based on the principles of a descriptor system. Descriptors needed to be set up on the basis of observations and measurements of floristic and phytocoenological data, morphological, chemotaxonomic, cytological and genetic variables. These should meet the criteria of the population characteristics "significance" and "distinctiveness".

A descriptor-based approach consists of five categories of descriptors, with the following descriptor categories:

1. Passport and Collecting descriptors describe all parameters which have been obtained during inventory and/or survey (mapping) of genetic resources and provide basic information for managing accessions, including registration, identification, ethnobotanical and ethnographic data. Collecting descriptors comprise all data registered during field work, and which describe natural habitats together with natural genetic resources.
2. Management descriptors consist of prescriptions and technical instructions for preparation of genetic material and conditions for long-term maintenance of accessions. Protocols for management of genetic material, its maintenance and multiplication (regeneration), based on international standards and regulations, are to be established (e.g. prescription of seed moisture content before medium- or long-term conservation; pre-treatment of seeds by low temperature or chemical treatment in order to break the dormancy prior to germination).
3. *Environment and Site descriptors* explain environmental (geographic, pedological, topographic, phytocoenological, microclimatic) and habitat-specific parameters, which are important for recording the distribution and assessment of abundance of populations, characterization and evaluation, as well as for the assessment of useful properties of a particular genetic source which can be attributed to the interaction between ecotype and environment.
4. *Characterization descriptors* express morphological, taxonomic, cytological, chemical, production (biomass/m^2) characteristics of representative samples (composed of 20-25 specimens per population) of a defined genetic source and are crop-specific. Characterization descriptors are being prepared for ten model species selected by the MAP WG during the first phase.
5. *Evaluation descriptors* will be used in *ex situ* evaluation of genetic resources of a sample under study (20–25 specimens per population) and consist of (i) observations/measurements of plant biomass (fresh and dry weight in g/plant); regeneration potential (weight of 1000 seeds, possibility of vegetative propagation); earliness (measured by developmental stage); (ii) determinations of the contents of the secondary metabolites; and (iii) evaluation of sensitivity of a genetic source to abiotic and biotic stress factors, with a characterization of the relevant stress factors.

The WG members agree that establishment of a relational database, which was forecast as a long-term task of the ECPGR MAP WG, would advance the background knowledge on the ecosystem interactions (plant–environment–organisms) in which natural populations have evolved and have adapted to the microclimatic conditions of their habitats. Also, through compiling information data from inventories, surveys and evaluation of natural MAP genetic resources and of MAP genetic resources *ex situ*, the relational database would facilitate monitoring of abundance changes, trigger conservation measures on endangered MAP species and provide supervision on available seed material for cultivation purposes.

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An overview of the flora and genetic resources of medicinal and aromatic plants in Albania

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The Albanian flora

Albania is one of the European countries which has a very rich flora because of several factors: a highly varied landscape; favourable climatic conditions, with a range from coastal subtropical to inland continental climates; its geographical position in the Mediterranean region and in the Balkan Peninsula; and the many different types of landscape (Paparisto et al. 1988).

The flora of Albania includes 3250 plant species, e.g. about 30% of the European Flora (Paparisto et al. 1988). There are 30 endemic species and about 180 subendemic species (Vangjeli et al. 1995).

It is important to emphasize the rare species, endangered species and relict species, which together form 10% of the Albanian Flora (Vangjeli et al. 1995).

The origin of the Albanian flora is shown in Fig. 1.

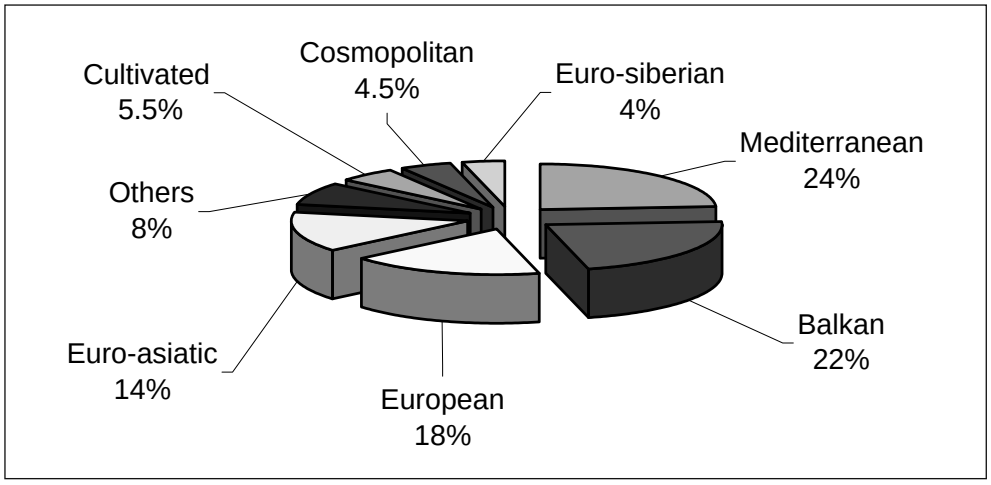

Fig. 1. The floristic spectrum of the Albanian flora.

Rare and endangered species in Albania

According to the categories defined by the International Union for Conservation of Nature (IUCN), the Red Book of Albania (Vangjeli et al. 1995) classifies these species as shown in Fig. 2.

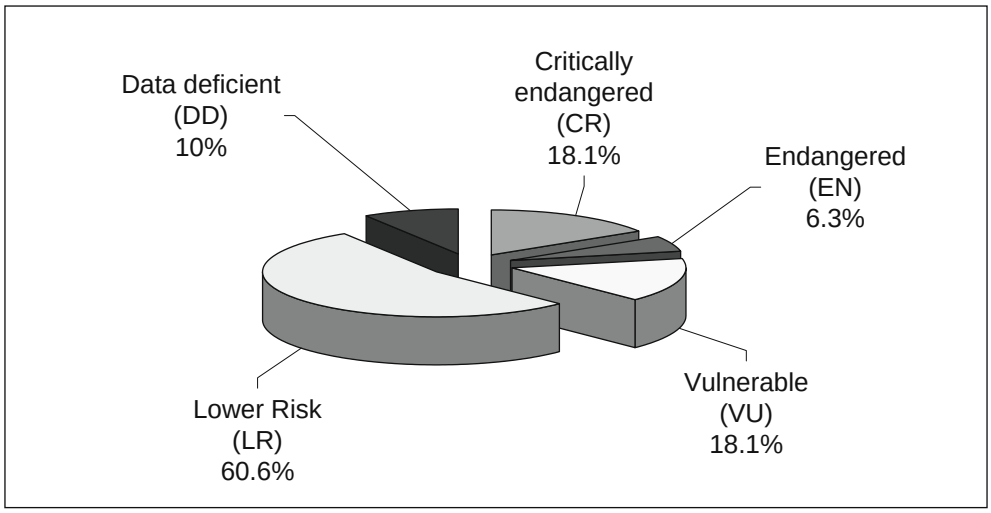

Fig. 2. Spectrum of endangered plant species of Albania according to the IUCN classification.

Medicinal and aromatic plants (MAPs)

Albania has very good geographical and climatic conditions for the growth and development of MAPs.

The MAPs have an important potential for social development, especially in the rural regions.

More than 300 species are identified as aromatic/medicinal plants in the Albanian flora, and they are considered as an important source of economic revenue; 182 of them are regarded as common.

Medicinal and aromatic plants play an important role in everyday life in this region; many people consume phytomedicines, herbal teas, etc.

Twenty-two wild species of medicinal and aromatic plants are included in the Red Book of Albania (Table 1).

Harvesting techniques may often exacerbate the threat to medicinal and aromatic plants by causing unnecessary damage, as in the cases of *Salvia officinalis*, *Sideritis raeseri*, *Origanum vulgare*, *Gentiana lutea* and others, where uprooting of the whole plant to use only the aerial parts or roots of the plant causes unnecessary depletion of population levels of the species, as well as damage to the top-soil.

Habitat changes across most parts of Albania have also eroded species' population levels. This implies an urgent need for designating more protected areas in Albania, in particular in those areas with a high biodiversity of medicinal and aromatic plants and in those where threatened species occur. Some MAP species are being affected by genetic erosion.

Collection and trade in medicinal plant species

Prior to 1992, the trade structure was hierarchically organized. Now, harvesting and export of medicinal and aromatic plants are completely uncontrolled. In Albania these species are highly exploited by uncontrolled harvests which people carry out for their own consumption or to sell most of the products (seeds, leaves, flowers, etc.) in markets.

These harvests are being made without any efficient controls or biological planning, and are therefore causing serious damage to natural populations of the relevant species.

Because of this situation, Albania is a country where there is an urgent need to intervene to achieve MAP germplasm safeguard, inventory and collecting of natural populations for conservation purposes.

During the past 15 years no collecting missions have been carried out in Albania.

Table 1. The threatened medicinal plant species of Albania, according to the national Red Book (Vangjeli et al. 1995)

Taxon	Degree of threat as defined by IUCN*
Agrimonia eupatoria	EN
Capparis spinosa	EN
Convallaria majalis	EN
Colchicum autumnale	EN
Digitalis lanata	EN
Dryopteris filix-mas	EN
Ephedra distachya	EN
Gentiana lutea	CR
Hyoscyamus niger	EN
Hypericum perforatum	EN
Laurus nobilis	EN
Orchis sp.	EN
Origanum vulgare	EN
Salvia officinalis	EN
Sambucus nigra	EN
Satureja montana	EN
Sideritis raeseri	EN
Valeriana officinalis	EN
Viscum album	EN
Adiantum capillus-veneris	VU
Juniperus communis	EN
Vaccinium myrtillus	EN

* CR: critically endangered; EN = endangered; VU: vulnerable

Conclusions

- Medicinal and aromatic plants play an important role in everyday life in Albania.
- It is necessary to make an inventory of the MAPs.
- It is necessary to identify those MAPs that are considered to be most threatened by collecting because of the demand for them by the trade.
- Habitat changes across most parts of Albania have also eroded species' population levels.
- This implies an urgent need for designating more protected areas in Albania, in particular in areas with a high biodiversity of medicinal and aromatic plants and in those where threatened species occur.

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Medicinal and aromatic plants in Austria – status 2007

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Introduction

I would like to give you an overview of the situation on the conservation of medicinal and aromatic plants (MAPs) genetic resources in Austria, the various existing collections, the targets for collecting new accessions, starting with an overview about the uses and the production of MAPs in Austrian agriculture.

The main production is done by two large farmer cooperatives ("Waldland" in Lower Austria and "Saatbau Linz" in Upper Austria). There are also a few small cooperatives of farmers who deliver to local bakeries or sell their own products directly from the farm.

Table 1 shows the production of MAPs in Austria in 2005, by decreasing order of importance.

Most of these crops are used in the diet in the form of blended herbal teas or as kitchen spices. Only certain plants are used for pharmaceutical purposes.

The Styrian oil pumpkin *(Cucurbita pepo)* is of high importance in Austria for pressing oil, a very tasty oil which is green in colour and rich in a high proportion of polyunsaturated fatty acids. About 200 ha worth of the product is exported for pharmaceutical uses as a prostate medicine.

Flaxseed (*Linum usitatissimum*) is used in a small part (250 ha) for fibre production, the rest for oil and mostly as a foodstuff as crushed seeds.

The production of more than 1900 ha of holy (or milk) thistle *Silybum marianum* is very interesting. Austrian production covers a high proportion of the demand from the pharmaceutical industry in Europe. Two thirds of the products are exported for further extracting as the dried and pressed oil-free drug; one third is used as animal medicine, as a foodstuff for solving liver problems.

Poppy is used for nutritional purposes only, as poppy seeds for baking, along with caraway and coriander.

It is worth mentioning that more than 200 ha of hops are produced in Austria, mainly used for beer brewing.

Most of the *Hypericum* harvest (99%) is exported for pharmaceutical extraction: this also applies to *Echinacea*. The main species grown in Austria is *Echinacea angustifolia*, from which the roots are used.

Fagopyrum is not used as a medicinal plant. The product is used mainly as seed which is used to grow a green manure sown on fields in autumn.

Sinapis is mainly used for the production of mustard and as green manure sown on fields.

Gentiana is totally used for Schnaps production within Austria and Germany. The price is very high as it takes 4 years until the first harvest of roots.

Worth to be mentioned is the importance of small areas of production, e.g. that 10 farmers produce 3 ha of *Gentiana* or 20 farmers produce 4 ha of *Calendula*.

Table 1. Agricultural MAP production in Austria for 2005

Botanical name	English name	No. of farmers	Cultivated area (ha)		
			Conventional	Organic	Total
Cucurbita pepo	Styrian oil pumpkin	5000	15100	300	15400
Linum usitatissimum	Flaxseed	1500	4200	450	4650
Silybum marianum	St Mary's thistle, Milk thistle	300	1950	5	1955
Papaver somniferum	Poppy	700	1700	50	1750
Carum carvi	Caraway	300	1040	36	1076
Cannabis sativa	Hemp	100	320	41	361
Humulus lupulus	Hop (10% medicinal, 90% aromatic)	85	215	4	219
Amoracia rusticana	Horseradish	120	200	0	200
Hypericum perforatum	St John's Wort	40	60	1	61
Mentha piperita	Peppermint	50	50	10	60
Foeniculum vulgare	Fennel	30	5	50	55
Petroselinum crispum	Parsley	30	50	5	55
Fagopyrum esculentum	Buckwheat	40	20	20	40
Melissa officinalis	Lemon balm	20	10	25	35
Coriandrum sativum	Coriander	10	5	25	30
Plantago lanceolata	Ribwort plantain	20	25	3	28
Chamomilla recutita	Common chamomile	9	0	25	25
Allium sativum	Garlic	20	10	3	13
Anethum graveolens	Dill	10	5	5	10
Ocimum basilicum	Basil	10	3	5	8
Levisticum officinale	Lovage	8	5	3	8
Origanum majorana	Marjoram	5	3	5	8
Origanum vulgare	Oregano	5	5	3	8
Sinapis alba	White mustard	5	5	2	7
Thymus vulgaris	Common thyme	10	2	5	7
Echinacea spp.	Echinacea	6	6	0	6
Plantago arenaria	Branched plantain	3	5	0	5
Carthamus tinctorius	Safflower	3	5	0	5
Allium schoenoprasum	Chive (fine)	10	5	0	5
Melilotus officinalis	Yellow melilot	5	5	0	5
Anisum vulgare	Aniseed	2	0	4	4
Urtica dioica	Stinging nettle	4	2	2	4
Calendula officinalis	Marigold	20	3	1	4
Salvia officinalis	Sage	4	2	2	4
Gentiana lutea	Great yellow gentian	10	3	0	3
Satureja montana	Winter savory	3	1	1	2
Satureja hortensis	Summer savory	3	1	1	2

MAP genetic resources collections in Austria

- ***Provincial Centre for Special Crops in Wies (Styria)***

It is not only a genebank but also provides a service to farmers in the provincial government area in processing and selling seeds and also young plants for the production of both medicinal and aromatic plants for herbal tea production. As already mentioned, the farm sales of MAPs are of high value in Austria.

- ***Arche Noah***

A very active cooperative between home-gardeners and also some farmers, Arche Noah is interested in traditional plants from nearly all parts of the world. Their main collection consists of different kinds of vegetables. They collect seeds from their members and sell traditional and exotic seeds and plants to other members in small amounts.

- ***Universities***

The main Universities active in this area are both situated in Vienna: the **University for Applied Life Sciences (Boku)** and also the Botanic Department of the **University of Veterinary Medicine**. Prof. Novak who attended the second MAP Working Group meeting in Strumica, December 2004, told me that unfortunately the collections used for different projects are not conserved after the conclusion of the projects. Since then, cooperation has begun, initiated by this WG, for these collections to be maintained further in Linz to conserve both the information and the genetic resources.

- ***Austrian Agency for Health and Food Safety (AGES), Linz***

One part of the collection is a poppy collection of 150 Upper-Austrian landraces, collected in 1968. The other part of the collection, containing different species of MAPs, is much older: it was set up in 1905 by Prof. Himmelbaur of the former University of Agriculture (Boku) in Vienna. The greatest importance of this collection was during and after the First World War as very few synthetic pharmaceutical products were available at that time. Due to the reorganization within the AGES, its genebank activities were concentrated in Linz in 2003.

A brief overview of the AGES database to manage the MAP collection

Initial passport data are documented according to the descriptors of the European Internet Search Catalogue (EURISCO), as discussed during the first meeting of the MAP Working Group. Additionally some information is recorded about the amount of seeds stored and the year of harvest. As new information, we also cite the status according to the International Treaty (IT). Exchange status is multilateral for exchange with a Standard Material Transfer Agreement (SMTA), or bilateral. For example, *Epilobium* is not listed in the Appendix of the IT and so its exchange is based on bilateral agreements.

Data are documented in a local MS Access database managed by the author.

Fig. 1 gives an example of passport data for an accession of oregano. In addition to the photographs of the plants in flower, we also started to give information about the seeds of single accessions. I think that seed photos are important for genebanks checking the uniformity and purity of an accession during and after regeneration.

In a separate window can be found further information about the drug, for example, whether it is found in the leaf, the flower or the root and how it is used and what for. Information on toxicity and against poison contamination is very important for the poisonous plants. Flowering time, methods of running germination tests etc. are documented.

We also intend to present this database on the Internet (http://www.genbank.at). As a service to users it is planned to set up this database in German and English as well in the near future.

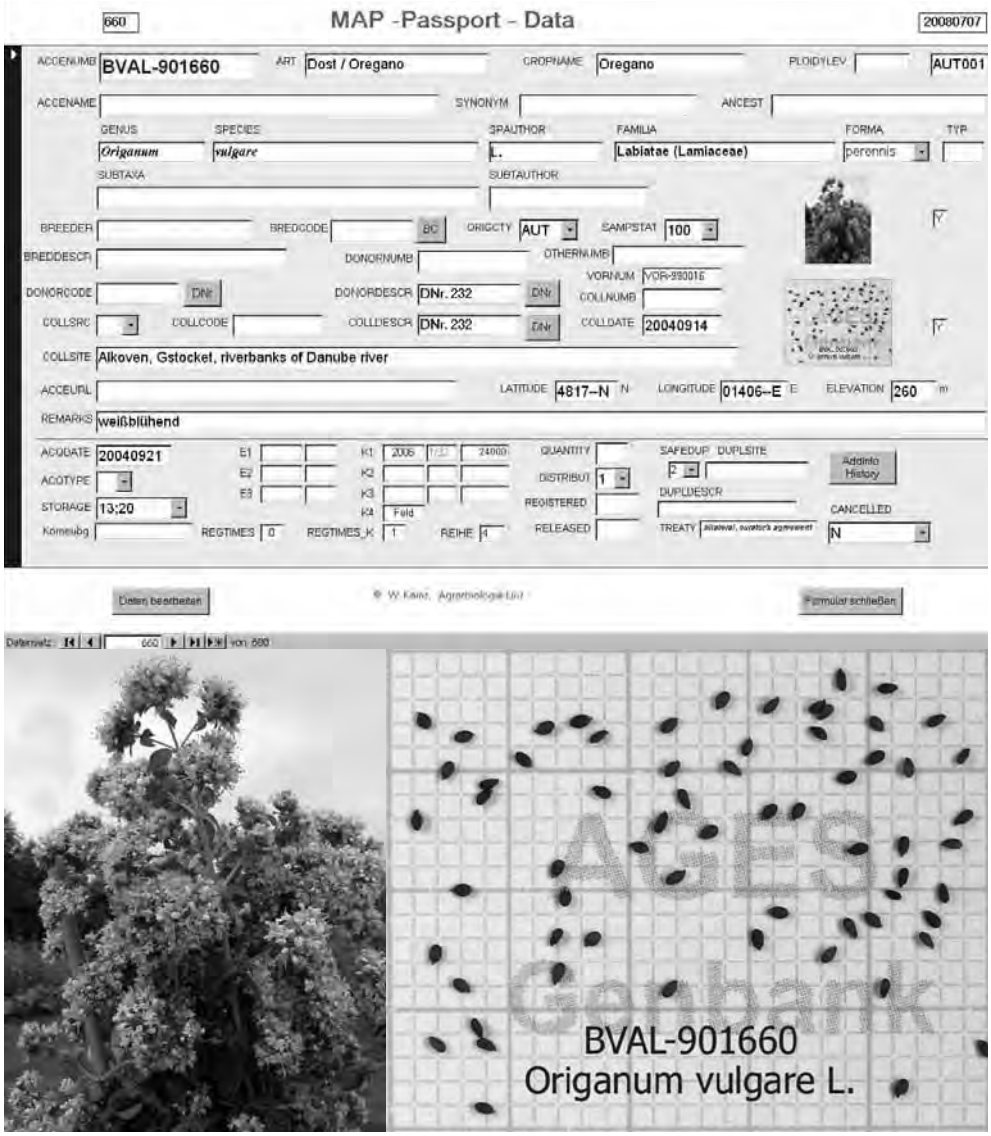

Fig. 1. (top) Passport data of the oregano accession BVAL-901660, with thumbnails of the photos of the plant and of the seeds; (below) enlarged photos obtained by clicking on the thumbnails.

Inventory of natural resources of medicinal and aromatic plants in Bulgaria[9]

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For the sustainable utilization of natural resources from medicinal and aromatic plants (MAPs), it is very important to make periodical inventories of their natural populations as well as to determine the extent of their utilization.

The objective of this study is to record the distribution in Bulgaria of the ten "model species/genera" selected by the Working Group on Medicinal and Aromatic Plants at its first meeting in 2002.[10]

Bulgaria is divided into 20 floristic regions. According to the regional distribution of MAPs, the species are divided into three groups: widespread – found in 7 to 20 floristic regions; species with limited distribution – found in 4 to 6 regions, and locally distributed species – found in 1 to 3 regions.

On the basis of the collected information, published data, and our observations, we prepared the following general accounts of some species found in our flora.

Genus *Achillea*

This genus includes 18 wild species, but 8 species are widespread in the whole country (20 floristic regions): *Achillea clypeolata* Sm., *A. coarcata* Poiret, *A. collina* J. Becker ex Rechend, *A. crithmifolia* Waldst. et Kit., *A. millefolium* L., *A. nobilis* L., *A. pannonica* Scheele and *A. setacea* Waldst. et Kit. Some of these species are of great interest for their medicinal uses: *Achillea clypeolata* Sm., *A. coarcata* Poiret and *A. millefolium* L.

Four species have a local distribution: *Achillea chrysocoma* Friv., *A. leptophylla* Bieb., *A. serbia* Nyman and *A. thracica* Velen.

Achillea clypeolata Sm. is a Balkan endemic, included in the "Red Data Book of Bulgaria" (Dakov 1984). It is found on rocky and stony sites and in grasslands from 0 to 1600 m above sea level (asl). Its populations are found mainly in the Struma Valley, Black Sea coast and in northeastern Bulgaria. The species has an enormous potential for wide utilization.

Achillea coarcata Poiret is a widespread species found on dry and rocky sites and grasslands from 0 to 100 m asl. It is localized and dispersed north to Stara Planina Mountain. It is found mainly on the Black Sea coast and in southern Bulgaria (Struma Valley, Eastern Rhodope Mountains, Mesta Valley, Tracian plain and the Tundža hills region).

Among the group of species belonging to the *Achillea millefolium* complex, some have economic importance for our country: *A. setacea, A. pannonica, A. collina* and *A. millefolium*. They are widespread from 800 to 2000 m asl in the whole country, excluding the highest parts of the mountains above 2300 m.

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[9] Paper presented at the Second Meeting of the MAP Working Group, December 2004, Strumica, Macedonia FYR.

[10] Appendix I in Baričevič et al. 2004.

Genus *Artemisia*

Artemisia absinthium L. is a widespread species in the whole country from 0 to 2000 m asl. Compact populations and habitats for this species are found in the Central and Western Stara Planina Mountain, Black Sea coast, northeastern Bulgaria, Sofia region, Tracian Plain, Central and Eastern Rhodope Mountains.

Artemisia alba L. is a widespread species, found on dry, limy and eroded areas in the xerophytic oak belt up to 500 m asl. Its main habitats are found in the Balkan foothill region, northeastern Bulgaria, Central Rhodope Mountains and in the following mountains: Ljulin, Slavjanka and Pirin.

Artemisia vulgaris L. is a widespread species in the whole country, found near roads, settlements and sparse woodlands up to 1500 m.

Artemisia pontica L. is a rare species with limited distribution, mainly in northeastern Bulgaria, along the Black Sea coast and very occasionally in the Sofia region.

The following species have only local distribution: *Artemisia chamaemelifolia* Vil., *A. eriantha* Ten., *A. lerchiana* Veber and *A. pedemontana* Balb. The last two species are included in the "Red Data Book of Bulgaria" as rare and endangered respectively. They are elements of the steppe and limestone flora in the Black Sea area.

Carum carvi L.

This is a widespread species, but its habitats are quite limited. It is found from 700 to 1600 m asl, mainly on the slopes of the following mountains: Central and Western Stara Planina, Vitosha, Rila, Pirin, Western and Central Rhodope.

Gentiana spp.

Gentiana asclepiadea L. is distributed mainly in the uplands of the country from 1000 to 2900 m asl. The natural resources of this species are very limited because of the low density of its populations. Main habitats are found in several mountainous floristic regions – Stara Planina, Vitosha, Slavjanka, Pirin, Rila, and the Central and Western Rhodope Mountains.

Gentiana cruciata L. is a widely distributed species in the whole country from 200 to 2900 m asl, excluding the northwestern and southeastern parts of Bulgaria. There are significant resources of this species, but its populations are very dispersed and with low density.

The species *Gentiana lutea* L., *G. punctata* L. and *G. acaulis* L. are very restricted, with local distribution. They are included in the "Red Data Book of Bulgaria" as endangered species. The populations found are very restricted, with low density and according to the *Law for Nature Protection* (1967) they are banned from utilization. The species *Gentiana frigida* Haenke, *G. nivalis* L., *G. pyrenaica* L., *G. urticulosa* L. and G. *verna* L. all have limited distribution in the country.

Hypericum perforatum L.

This is a widespread species in the whole country. Compact populations are found in the foothills and mountains up to 2000 m asl. This species occupies the first place among the commercially harvested ones; during 1996-1998 it had the highest percentage of the total herb exports.

Melissa officinalis L.

This species is widely spread in the whole country up to 1000 m asl. Its populations are found mainly in limited spots, with small size and low density. The species is used and marketed. Because its natural resources are not concentrated in large areas, the raw materials are provided mainly from industrial plantations.

Origanum vulgare L.

Origanum vulgare L. subsp. *vulgare* is widely spread in the whole country up to 2000 m asl. The largest reserves are found in the mountains – Stara Planina, Rhodopes, Rila and Pirin.

Origanum vulgare L. subsp. *hirtum* (Link) Ietswaart has a limited distribution. It is found only in the Eastern Rhodope Mountains and Struma Valley. The populations observed are found in very small areas or only as single plants. According to the *Law for Nature Protection* the utilization of this species is limited. The species is of commercial importance, but natural resources are very insufficient so industrial plantations have been established.

Mentha spp.

The species *Mentha aquatica* L., *M. pulegium* L. and *M. spicata* L. are widespread in the whole country from 100 to 1700 m asl. They are found on moist grasslands near rivers and swamps.

Mentha arvensis L. and *M. longifolia* (L.) Hudson are found on stony and shrubby lands all over the country up to 1200-2000 m asl.

Mentha suaveolens Ehrh. has very limited distribution. It is found in small populations or as single plants in the most southwestern and southeastern parts of Bulgaria.

Mentha piperita L. is a cultivated species with established plantations. The drug is used for the home market and for export.

Salvia spp.

There is a rich diversity of *Salvia* species in Bulgaria. The following species are widespread in the whole country: *Salvia aethiopis* L., *S. glutinosa* L., *S. nemorosa* L., *S. pratensis* L., *S. sclarea* L., *S. verticillata* L. and *S. virgata* Jacq.

The species *Salvia argentea* L., *S. nutans* L., *S. ringens* Sibth. et Sm., *S. tomentosa* Miller, *S. verbenaca* L. and *S. viridis* L. have only limited distribution.

The species *Salvia scabiosiflora* Lam. and *S. pinnata* L. have local distribution (only one floristic region) and the species *Salvia foskahlei* L. and *S. austriaca* Jacq. are found in three regions.

Thymus spp.

Genus *Thymus* is polymorphic with a large number of species which are taxonomically difficult to identify. The drug is gathered mainly from the wild-growing plants of *Thymus serpyllum* L. and other species.

According to published data the species *Thymus pannonicus* Velen, *T. pulegioides* L. and *T. sibthorpii* Bentham are widespread in the whole country.

The species *Thymus bracteosus* Vis. ex Bentham, *T. comptus* Friv., *T. perinicus* (Velen) Jalas and *T. stojanovi* Degen are distributed only in one or two floristic regions.

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Collection and evaluation of medicinal and aromatic plants "model species" in Bulgaria[11]

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Introduction

The Institute for Plant Genetic Resources (IPGR), Sadovo is the National Coordination Centre for plant genetic resources in Bulgaria. The main scientific research projects are aimed at collection, study and preservation of plant resources including medicinal and aromatic plants (MAPs) (Angelova et al. 1994; Dimitrova et al. 2001; Varbanova 2004; Varbanova and Dimitrova 2000; Varbanova et al. 1997, 2005).

The IPGR started collecting the MAP "model species/genera" selected by the Working Group on Medicinal and Aromatic Plants at its first meeting (September 2002) in 2004. Expeditions took place to the North Black Sea region, Strandja, Rhodope and Rila Mountains. Seed and vegetative material was collected from *Achillea* spp., *Artemisia* spp., *Hypericum perforatum, Melissa officinalis, Origanum* spp., *Salvia* spp. and *Thymus* spp.

The collected material was grown and maintained in field collections at the Sadovo site in Central Bulgaria at 42°57'N, 24°27'E, altitude 159 m, with a temperate-continental climate. The species were evaluated using the accepted descriptors.

Results

- **Achillea *spp.***

***Achillea clypeolata* Sm.** was collected from Kaliakra reserve, North Black Sea. *Achillea clypeolata* is a Balkan endemic, included in the "Red Data Book of Bulgaria" (Dakov 1984). It is found on rocky and stony sites, on Ridi Rendzinic Leptosol soils and at 0-20 m above sea level (asl).

***Achillea millefolium* L.** was collected from the East Rhodope Mountains in the area of Dabovetz village.

In *ex situ* collections the species show good adaptability to the new growing conditions

- **Artemisia *spp.***

Plants from ***Artemisia austriaca* Jacq.** and ***A. pedemontana* Balb.** were collected from the North Black Sea region and they were included in the field collections of IPGR, Sadovo.

Artemisia pedemontana is a short (18-22 cm) tuft-like plant with delicate pubescence. The plant's width reaches 50 cm. The inflorescence is a cluster 13 cm in length, made up of 17 florets attached with short shanks. Other characteristics are listed in Table 1.

The plants of *Artemisia austriaca* are 28 cm high and 35 cm wide. The stem is round, 2 mm in diameter; the first leaf grows at 4 cm height. It is a greatly branched plant with separate branches 13 cm long. The leaves are greyish green, 2.5 cm long. Other characteristics are listed in Table 1.

[11] Paper presented at the Third Meeting of the MAP Working Group, June 2007, Olomouc, Czech Republic.

Table 1. Morphological evaluation of *Artemisia* spp. in the Sadovo *ex situ* collection

Descriptor	Species	
	Artemisia pedemontana	***Artemisia austriaca***
Plant – developmental stage	after blooming	vegetative stage
Plant – growth habit	erect	erect
Plant – growth form	tuft	-
Plant height (cm)	22	28
Plant width (cm)	50	35
Branching of the stem	dense	dense
Colour of the stem	reddish green	grey-green
Length of the stem (cm)	10	13
Density of foliage	dense	dense
Leaf shape	dissected	dissected
Colour of the leaf	greyish green	greyish green
Leaf peduncle	present	present
Shape of leaf segments	sharp-ended	sharp-ended
Segments width (mm)	1	1
Lower leaves	present	present
Length of the flowering stem (cm)	11	-
Length of inflorescence (cm)	13	-
Number of flowers	17	-

- **Hypericum *spp.***

The seeds of ***Hypericum perforatum* L.** were collected from the plain of the East Rhodope Mountains and planted in field collections. Observations in field conditions were made at the period of full flowering. The plants formed 9 branches 47 cm in length on average. The plants have good foliage and the leaves are covered with little glands. Other characteristics are listed in Table 2**.**

Table 2. Morphological evaluation of *Hypericum perforatum* in the Sadovo *ex situ* collection

Descriptor	
Plant – phenological phase	full bloom
Age of plant	third year
Plant habit	compact
Plant branching	medium
Plant height (cm)	62
Plant width (cm)	48
Stem – number of stems per plant	9
Length of the stem (cm)	47
Branching of stem	medium
Leaf – length (mm)	15
Leaf – width (mm)	5
Colour of leaf blade	green
Flower colour	yellow

- **Melissa officinalis *L.***

Seeds of ***Melissa officinalis* L.** were collected and stored in field collections from habitats in Strandja Mountain and northeast Bulgaria (Kaliakra). Populations of the species could only be found in very small and scattered areas in both habitats, because of the increased collecting and use.

The evaluation of the species from Strandja in *ex situ* collections was made before the flowering season. The leaves are green and heart-shaped. Other details are in Table 3.

Table 3. Morphological evaluation of *Melissa officinalis* in the Sadovo *ex situ* collection

Descriptor	
Plant habit	erect
Plant branching	dense
Plant height (cm)	73
Plant width (cm)	167
Stem – number of stems per plant	86
Length of the longest stem (cm)	30
Leaf – density of foliage	dense
Length (blade + petiole) (mm)	90
Length of leaf blade (mm)	70
Maximum width of leaf blade (mm)	50

- **Origanum *spp.***

Vegetative material of ***Origanum vulgare* subsp. *hirtum* (Link) Ietswaart** was collected from populations which are found rather rarely in East Rhodope and Rila. Plants from both sites were stored in *ex situ* collections and observations were made at the beginning of flowering.

From both sites the stems are light green and the leaves are oblong. The length of the inflorescence is 23 cm and there are 20 flowers. In the plants from Rila, the leaves are light green and the inflorescence light lilac. The plants from the East Rhodope have green leaves and white inflorescences. All the plants flowered early.

Vegetative material of ***Origanum vulgare* L.** was collected from Rhodope at 760 m asl. The populations covered an area of 130-160 m^2 where the species was dominant. In the *ex situ* field collection the observations were made at full flowering.

The plants reached 68 cm in height and 125 cm in width and they formed a great number of branches which were 56 cm long and 2 mm wide. The stems are pubescent and are green with a dark red flush at the top. The leaves are 2 cm long, 11 mm wide, they are green and rounded-oblong in shape. The plants have dense foliage as each branch has approximately 26 leaves. The width of the inflorescence is 6 cm and it includes 32 lilac-pink flowers.

- ***Mentha spp.***

During the expeditions a natural habitat of ***Mentha longifolia* L.** was examined and some material was transferred into the field of IPGR, Sadovo. The plants were evaluated at the habitat and at the place of cultivation.

The habitat of *Mentha longifolia* was at 700 m in the region of Jrebichko village, Central Rhodope Mountains on an area of 0.3 ha. The density of the population was 36 plants/m^2. The accompanying species were *Clinopodium vulgare, Thymus* sp., *Rubus fruticosus, Hypericum perforatum* and *Mentha spicata*. The height of the plants in natural conditions, the main stems and the number of the inflorescences gave higher values compared to the cultivated plants, which had longer inflorescences (Table 4).

Table 4. Morphological evaluation of *Mentha longifolia in situ* (wild population, Jrebichko) and *ex situ* (cultivated, Sadovo)

Descriptor	Site	x ± Sx	S	CV (%)
Plant height (cm)	Jrebichko	71.10 ± 2.71	3.8	5.3
	Sadovo	52.50 ± 3.41	4.8	9.1
Number of flowering stems	Jrebichko	9.46 ± 1.55	2.2	23.2
	Sadovo	5.43 ± 1.01	1.4	23.4
Number of inflorescences	Jrebichko	67.26 ± 6.62	9.3	13.9
	Sadovo	46.66 ± 7.22	10.2	21.8
Length of inflorescence (cm)	Jrebichko	10.43 ± 0.50	0.7	6.7
	Sadovo	14.30 ± 0.31	0.4	3.0

x = average value. Sx = sample standard deviation. S = average quadratic deviation. CV = coefficient of variation

- **Salvia *spp.***

***Salvia verticillata* L.** was found on stony and shrubby lands, along roads up to 1800 m in altitude. Seed material was collected from three habitats: Kuklen (Tracian Plain), Batak and Ravnogor (Central Rhodope). It is included in the *ex situ* collection in Sadovo.

The evaluation shows that the plants could be grown successfully at Sadovo whatever their origins. Differences were observed in the width of the plants and the numbers of inflorescences per plant (Table 5).

Table 5. Morphological evaluation of *Salvia verticillata* from three different sites in the Sadovo *ex situ* collection

Descriptor	Origin of species (region)		
	Ravnogor	Kuklen	Batak
Plant height (cm)	79	83	83
Plant diameter (cm)	85	120	123
Number of stems	26	38	46
Number of inflorescences	15	16	17
Inflorescence length (cm)	27	30	34
Flowering stem length (cm)	9	11	14
Number of flowers in inflorescence	76	89	92
Leaf length (cm)	8	9	10
Leaf width (cm)	3.1	3.2	3.8

- **Salvia officinalis *L.***

***Salvia officinalis* L.** could not be found in the wild in Bulgaria. Seeds from Germany were received and stored at IPGR, then grown in the field. The observations in Table 6 were made at the period of running to seed. The stems are round in section, 4 mm in thickness, with pubescence and with light blue coloration. There were 14 leaves per branch, and the leaves were 7 cm long and 2.5 cm wide with light green coloration. The sepals were 10 mm long and 5 mm wide and the corolla's diameter was 9 mm. Other details are in Table 6.

The seed material of ***Salvia sclarea* L.** was collected from the region of Kuklen (Tracian Plain). The evaluation was made at the *ex situ* collection at full flowering. The stem is four-ribbed, with pubescence, and is 12 mm thick. The plants form 6-7 branches which are light green. There are 10-11 leaves on the branches, which are 15 cm long and 16 cm wide. The leaves are opposite on the stems. They are wide ovate in shape, green and with many glands. The inflorescence reaches 60 cm in length. It forms branches with 17 light lilac flowers. Other details are in Table 6.

Table 6. Morphological evaluation of two *Salvia* species in the Sadovo *ex situ* collection

Descriptor	Species	
	S. sclarea	***S. officinalis***
Plant habit	erect	erect
Plant height (cm)	119	56
Plant diameter (cm)	87	102
Number of primary branches	7	9
Length of the branch (cm)	96	29
Density of foliage	medium	dense
Leaf – colour of the upper surface	green	greyish green
Petiole length (mm)	75	55
Inflorescence length (cm)	60	13
Number of flowers per inflorescence	17	24
Colour of petals	pale violet	violet

- **Thymus *spp.***

An evaluation of ***Thymus* spp.** was made at the period of full flowering on one accession collected in the Stara Mountain and grown in IPGR.

The plants are perennial, sub-erect, 22 cm high and 2 mm thick, without pubescence. The leaves are spread over the whole stem and they are linear-elliptical in shape with an acute apex. The inflorescence is dense, the shape is capituliform with the flowering part 12 mm long. Flowers are only carried at the tip of the stem.

Conclusion

The species described here are showing good adaptation towards the new growing and breeding conditions in Sadovo where the climate is continental with cold winters and hot summers.

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Conservation of medicinal and aromatic plants in Croatia

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Introduction

The collection of medicinal and aromatic plants of Croatia was established in 1998 at the Department of Seed Science and Technology of the Faculty of Agriculture, University of Zagreb. Activities on collecting, maintenance, characterization, evaluation and regeneration of medicinal and aromatic plants (MAPs) were carried out in the framework of two national scientific projects financed by the Ministry of Science, Education and Sports of the Republic of Croatia: "Croatian Bank of Plant Genes (1991-2006)" and "Genetic Variability of Medicinal and Aromatic Plants (2002-2006)". Currently, these activities are supported by the scientific project entitled "Biodiversity of Medicinal and Aromatic Plants" (2007-2009; Ministry of Science, Education and Sports) as well as by the South East European Development Network on Plant Genetic Resources (SEEDNet) programme (http://seednet.geminova.net). The Commission on Plant Genetic Resources was established in 2006 by the Ministry of Agriculture, Forestry and Water Management, and through the implementation of the National Programme on Conservation and Sustainable Use of Plant Genetic Resources the relevant financial resources will be secured.

A report on the legal protection, conservation and cultivation of MAPs in Croatia was published as part of the Report of a Working Group on Medicinal Plants following the First Meeting of the ECPGR MAP WG held in 2002 in Gozd Martuljek, Slovenia (Šatović 2004). Therefore, this report describes what has been achieved as regards the conservation of MAPs in Croatia since 2003.

Current status and future prospects

MAP accessions are held at *ex situ* maintenance facilities at the Faculty of Agriculture, University of Zagreb (cold chamber 75 m^3; medium-term seed storage at +4°C; seed samples in paper bags or glass jars). Currently, the collection consists of 1464 accessions of 258 MAP species. More than 80% of the accessions were collected from natural populations throughout Croatia, while the rest of the accessions represent mainly foreign cultivated material obtained from genebanks and research institutes. The most frequently represented species are basils (*Ocimum* spp. – mainly *O. basilicum* L.), St. John's wort (*Hypericum perforatum* L.), Dalmatian sage (*Salvia officinalis* L.), marshmallow (*Althea officinalis* L.) and oregano (*Origanum vulgare* L.).

Since 2003, nine multi-species and two species-specific collecting missions have been carried out. During the multi-species collecting missions, which covered the municipalities of Donja Stubica, Duga Resa, Koprivnica, Krapina (river Sutla valley), Kutina, Samobor (Žumberak hills), Senj (Velebit mountain), Split (Kozjak mountain) and Zadar, an ecogeographical survey was conducted based on the MAP multicrop collecting form including data such as: accession identification, collecting

site information (physical description, vegetation description, and assessment of overall risk of genetic erosion (abundance, spatial pattern, diversity status, causes of biodiversity loss, overexploitation status, etc.)). Species-specific collecting missions focused on Dalmatian sage and Dalmatian pyrethrum (*Tanacetum cinerariifolium* (Trev.) Schultz Bip.) with the aim of carrying out more extensive sampling of natural populations throughout the geographical distribution of both species (Adriatic coastal region) (Grdiša et al. 2007).

Since 2003 several field trials have been set up in order to characterize and evaluate accessions of basils, Dalmatian sage (Židovec et al. 2006), Dalmatian pyrethrum, lemon balm (*Melissa officinalis* L.; Brezovec et al. 2006), St. John's wort (Sever et al. 2006) and oregano (Horvat et al. 2006).

In order to establish a national documentation system, a first phase of The Croatian Plant Genetic Resources Database (CPGRD) project was successfully carried out in 2006. It has been decided that the database structure will include: passport data, collecting data, characterization data and management data. As the database will cover the data on plant genetic resources collected in the framework of six working groups, the members of each working group will have an opportunity to modify the database structure and data format to that best suited to their needs. The database system is currently in the experimental phase and only the data of MAP collections are available, namely the passport data based on of the European Internet Search Catalogue (EURISCO) descriptors and collecting data based on the MAP collecting form. The database is available online (http://cpgrd.agr.hr/gb/map/).

A training programme on "Production and processing of medicinal and aromatic plants" has been organized by the Open University Samobor with the aim of promoting the production of MAPs as well as to raise awareness of the threats from the overexploitation of natural resources. Since 2001 the programme has been held eight times and it has become an influential forum bringing together family farm owners (current and future producers), wholesalers and processors of MAPs in Croatia (Kolak et al. 2007).

Current research activities include the analyses of genetic variability using molecular markers on target species such as basils (Carović et al. 2007), Dalmatian sage, Dalmatian pyrethrum and wild hops (*Humulus lupulus* L.) as well as biochemical characterization of basil, oregano (Carović et al. 2007) and wild hops accessions.

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Genetic resources of medicinal, aromatic and culinary plants in the Department of Vegetables and Special Crops in Olomouc, Czech Republic – Working period 2004-2007

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Introduction

On 1 January 2007 the Research Institute for Crop Production (RICP) Prague, Department of Gene Bank – Workplace Olomouc went through a change of legal entity which resulted in the changing of its official name to the Crop Research Institute (CRI) Prague, Department of Vegetables and Special Crops Olomouc.

The main goal of the institution remains unchanged. Our department concentrates on the maintaining of resources of medicinal, aromatic and culinary plants (MAPs). Collections of MAPs are incorporated in the "National Programme for Plant Genetic Resources Conservation and Utilization" which is based on international treaties in the field of nature conservation and on Law No. 134/1999Sb. ("Convention on Biological Diversity") which was accepted in 2002. The main national programme's activities are focused on the protection and conservation of plant resources, and part of this general programme is related to MAP resources.

Structure of MAP collections

Collections of MAPs in the Olomouc Department are maintained *ex situ* (field collections and genebank seed collections). Main activities are collecting plants for their diversity, creation and enrichment of collections, conservation, plant characterization and evaluation. The overall MAP collection in Olomouc is currently represented by 662 accessions distributed among 72 species. The highest species diversity is found in the families Lamiaceae, Apiaceae and Asteraceae. In the period 2004-2007, since the second meeting of the ECPGR Working Group (WG) on Medicinal and Aromatic Plants in Macedonia, the MAP collection in Olomouc has increased by 90 accessions. The current structure of the collection is shown in Table 1.

Among the ten priority species/genera selected at the first meeting of the ECPGR MAP WG (Baričevič et al. 2004), nine are found in the Czech Republic. These are marked in bold type in Table 1. There was a marked increase in the number of accessions for these species within the period 2004–2007.

Expanding the MAP Collection in the period 2004-2007

The expanding of the MAP collection was mainly due to the introduction of new accessions from the wild during the expeditions carried out both in the Czech Republic and abroad in cooperation with partners from Slovakia, Slovenia and Croatia. The most significant role in the expanding of the collection was played by expeditions to flower meadows in five selected landscape protected areas in the Czech Republic (České středohoří, Jizerské hory, Šumava, Bílé Karpaty and Moravský Kras). The expeditions were focused on endangered and difficult to propagate species and also on species which are suitable for further practical utilization (developing the flower meadows with the objective of recultivation in the landscape protected areas and/or production for the pharmaceutical industry). The collection also expanded through

exchanges with other partner organizations such as genebanks, botanical gardens (Index Seminum), and commercial companies. In this way we managed to collect important Czech traditional cultivars (e.g. *Galega officinalis* 'Běla', *Valeriana officinalis* 'Trazalyt', *Marrubium vulgare* 'Moravský', *Cnicus benedictus* 'Krajový', etc.) and include them into our MAP collection. The passport data of the new items were included in the online information system "Plant Genetic Resources Documentation in the Czech Republic" (EVIGEZ) available from http://genbank.vurv.cz/genetic/resources.

Table 1. Current structure of selected collection of MAPs (priority genera in bold type)

Species	No. of accessions in		Species	No. of accessions in	
	Base collection	Working collection		Base collection	Working collection
Achillea	43	80	*Leuzea*	2	
Agastache	2		*Levisticum*	1	
Agrimonia	5	21	*Majorana*	6	1
Althaea	18	2	*Malva*	13	2
Amsonia	1	1	*Marrubium*	3	
Anethum	23	1	***Melissa***	7	
Anchusa	1		***Mentha***	10	9
Anthriscus	2		*Monarda*	1	
Arctium	3		*Nigella*	2	
Archangelica	1		*Ocimum*	47	15
Artemisia	8	16	*Oenothera*	15	2
Atropa	1		*Ononis*	2	1
Bellamcanda	2		*Onula*	5	
Betonica	4	22	***Origanum***	31	42
Borago	10		*Pimpinella*	5	1
Calendula	16	1	*Plantago*	12	53
Carum	103	4	*Polemonium*	2	1
Centaurea	1	2	*Potentilla*	4	14
Cnicus	6		*Rhodiola*	2	15
Coriandrum	9	28	*Ricinus*	1	
Datura	8		*Ruta*	8	1
Digitalis	6	10	***Salvia***	31	55
Dracocephalum	1	2	*Sanguisorba*	2	3
Echinacea	2	15	*Saponaria*	2	1
Epilobium	2		*Satureja*	18	5
Eryngium	1		*Scutellaria*	2	
Filipendula	1	5	*Silybum*	7	1
Foeniculum	14	2	*Solanum*	1	
Galega	5	1	*Solidago*	1	1
Genista	1		*Tagetes*	3	
Hyoscyamus	1		*Tanacetum*	2	
Hypericum	9	68	***Thymus***	8	25
Hyssopus	12	1	*Trigonella*	6	
Chamomilla	1		*Valeriana*	4	
Imperatoria	1		*Verbascum*	7	12
Lavandula	8	37	Others	55	248
Leonurus	2				
Total base collection = 662 / Total working collection = 827					

MAP evaluation and research

The work with the collection of genetic resources in the period 2004-2007 was focused on regeneration and subsequent characterization of the existing and newly acquired accessions. Regeneration is carried out in the Department's plots. The system used, the type of isolation cages as well as the efficient insect pollination conditions are the outcome of longstanding work to optimize this process.

To characterize MAPs in the collections the existing Czech minimum descriptors were used, due to their optimal compatibility with the documentation system EVIGEZ. The descriptors list of *Calendula, Lavandula* and *Ocimum* are available on the EVIGEZ Web site (http://genbank.vurv.cz/genetic/resources/asp2/default_a.htm).

Characterization included complex evaluation of biological, morphological and economic characteristics. The descriptors were designed for the evaluation of the most numerous species in the collection in genera such as *Ocimum, Anethum, Lavandula, Betonica, Plantago, Agrimonia, Foeniculum,* etc. The species in the less numerous collections (1-10 accessions) are not evaluated by the set of descriptors. In these cases a written description of the plant characteristics and photo documentation is used (e.g. *Malva, Silybum, Potentilla, Borago,* etc.).

For species/genera which belong to the priority list defined at the first meeting of the ECPGR MAP WG we have tried to implement the descriptors proposed at the second meeting of the WG in Macedonia (2004): for *Carum carvi* we used the proposed set of descriptors in its entirety; for *Hypericum perforatum* and *Thymus* spp. we used only some selected descriptors chosen with a view to the further possible practical utilization of the data.

The numbers of evaluated accessions and numbers of descriptors used are shown in Table 2.

All the data acquired will be recorded in the online information system EVIGEZ.

Table 2. Outline of the evaluated selected MAP collections in the period 2004-2007

Species	No. of evaluated accessions	No. of descriptors used
Ocimum spp.	20	33
Anethum spp	22	20
Lavandula spp.	40	22
Calendula spp.	40	13
Agrimonia eupatoria L.	15	6
Salvia pratensis L.	15	10
Salvia verticillata L.	17	10
Plantago spp.	15	7
Betonica officinalis L.	12	6
Hypericum perforatum L.	20	8*
Carum carvi L.	22	18
Thymus spp.	20	20**

* Plant height; Leaf: length, width, shape; Length of inflorescence; Diameter of flower; Content of hypericin; Content of hyperforin

** Plant: life form, growth form, height, diameter; Foliage: density; Stem: length, pubescence; Inflorescence: shape; Leaf: shape of blade, width, pubescence, margins, colour; Flower: diameter, colour of petals, calyx pubescence, corolla colour; Date of beginning of flowering, date of the end of flowering; Weight of 1000 seeds

Conclusion

We recommend the further development of the common set of descriptors for evaluation of MAP genetic resources as a very useful tool which can provide data on the comparable and concrete characteristics of the chosen MAPs for all potential users.

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Genetic resources of medicinal and aromatic plants in Estonia with research on native populations of wild thyme (*Thymus serpyllum* L.)

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Introduction

The collection of medicinal and aromatic plants (MAPs) in Estonia is maintained *ex situ* in the experimental garden of the Botanical Garden of the University of Tartu. It contains 190 species. The highest diversity of species is found in the families Asteraceae, Rosaceae, Apiaceae, Fabaceae, Lamiaceae, Ranunculaceae, Solanaceae and Scrophulariaceae. Wild species collected from Estonia and other countries are included in the collection, which is essential for the research and studies of pharmacy students. Many farmers have also started growing indigenous MAP species. As a result it is now possible to find considerably more herbal drugs and tea blends in Estonian chemists' shops. Some of the drugs, mainly the most common, widely spread species, are gathered from the wild. Estonian native species grow in many localities all around the country. The aim of this research was to determine the pharmaceutically effective substance content of different populations of wild thyme (*Thymus serpyllum* L.) growing in Estonia.

Botany and distribution

Wild thyme belongs to the family Lamiaceae. It is a perennial small shrub growing to a height of 0.2 m with a spread of 0.25 m. The stem is woody, creeping, quadrangular and branching. The leaves are bright green, opposite, oval to lanceolate, with hairy margins and prominent veins on the undersurface. The flowers are bluish purple, small and tubular, with two expanding lips; they occur in dense, terminal whorls and appear in spring and summer. The fruit is a nutlet.

Wild thyme is a native of the areas from Europe into Western Asia and then South into northern parts of Africa, and is also naturalized in the United States. The plant has been in cultivation for centuries, because it is important in pharmacology and decorative horticulture. Wild thyme is an important nectar source plant for honeybees (Eilart et al. 1973).

Medicinal uses of wild thyme

Nicholas Culpeper, the 17th-century herbalist advised taking wild thyme to treat internal bleeding, coughing, and vomiting. Carolus Linnaeus (also known as Carl Von Linné), the very famous Swedish botanist, used the plant to treat headaches and hangovers (Chevallier 2000).

Nowadays the flowering aerial parts of wild thyme are used medicinally (Bunney 1993; Wichtl and Bisset 1994). Since 2003, wild thyme has been included in the European Pharmacopoeia (EP) (Council of Europe 2005). The constituents of the drug include an essential oil with thymol and carvacrol as the main components,

bitter compounds, tannins and mineral substances. Thymol is a strong antiseptic, better than phenol because it does not burn the skin and it also acts as a deodorant. The essential oil contained in some preparations is used as an expectorant and antispasmodic in the treatment of whooping cough, bronchitis and gastrointestinal disorders (Bunney 1993). Common thyme (*Thymus vulgaris* L.) is known as a decongestant and it helps clear a stuffy nose, and is used to treat sinusitis, ear congestion and related complaints (Chevallier 2000). Externally the oil is sometimes used as a nerve tonic and in bath preparations and in compresses or ointments for wounds (Bunney 1993); it may be applied as a poultice to treat mastitis, and an infusion may be used as a wash to help to heal wounds and ulcers. Wild thyme is also antifungal (Chevallier 2000).

Wild thyme contains constituents similar to those of common thyme, but it has lower essential oil content. Wild thyme is, according to Weiss and Fintelmann (2000) one of the less significant cough and whooping cough remedies, and is far inferior to officinal thyme. Its value lies in other areas: it is an excellent drug for preparing herbal baths and herbal pillows.

The essential oil of wild thyme is used in the manufacture of toothpastes, mouthwashes, gargles and other toilet preparations (Bunney 1993).

Content and composition of the essential oil of wild thyme growing in Estonia

Wild thyme is regarded as a source of essential oil containing aromatic terpenes. The EP standard for the essential oil content is not less than 3 ml/kg (~0.3%) (Council of Europe 2005). The content of the essential oil in the wild thyme drug varies to a great extent depending on the origin of the plants; it is between 0.1 and 0.6% (Wichtl and Bisset 1994).

Samples of wild thyme were gathered from 46 different Estonian habitats in July and August of 2001-2004 by pharmacy students. The whole dried aerial part was used as the research material. The plants were identified on the basis of macroscopic characteristics, and the drug was dried at a temperature of 30-40°C.

The essential oil was isolated from dried plant material by the distillation method recommended by the EP. The essential oils were analyzed by gas chromatography with a flame ionization detector on two fused silica capillary columns (50 m × 0.20 mm i.d.) with stationary phases NB-30 and SPB-5 (film thickness 0.25 μm). The identification of the oil components was accomplished by comparing their retention indices (RI) on two columns with the RI values of standard compounds, with our RI data bank and with data in the literature. The results obtained were confirmed by gas chromatography/mass-spectrometry (GC/MS).

The content of essential oil in 46 drug samples collected in summer 2002-2004 varied between 0.06 and 0.44%, with an average value of 0.01-0.02%. The upper limit of 0.3% stated by the EP was exceeded only in two samples, one from Võrumaa (Southern Estonia, 0.44%) and one from Pärnumaa (West Estonia, 0.40%). The average values of the contents of essential oil in samples collected in different years were respectively 0.13, 0.12 and 0.19% and the differences are not statistically significant (r=0.276). The content of essential oil was not statistically differentiable in drug samples from various regions of the country.

We have identified and quantified 94 components (Raal et al. 2004; Paaver et al. 2008) of the essential oils of wild thyme samples growing in Estonia. The major

components were (E)-nerolidol, geranyl acetate, caryophyllene oxide, linalyl acetate, linalool and myrcene, followed by camphene, camphor, borneol, (E)-β-caryophyllene, germacrene D and α-terpineol. The quantities are shown in Table 1.

The essential oil of wild thyme from Estonia contains thymol and carvacrol only at 0-4.0%. These two compounds are named as the main components of essential oil of wild thyme (Wichtl and Bisset 1994). For example the essential oil of wild thyme from India contains 60-64.6% of thymol (Mathela et al. 1980; Puri et al. 1985), from Pakistan 42.6% (Sattar et al. 1991), from Japan 35% (Shimano and Nomura 1952) and from Iran 18.7% (Sefidkon et al. 2004). The content of carvacrol is usually lower than that of thymol (Mathela et al. 1980; Puri et al. 1985; Sefidkon et al. 2004). In the essential oils of wild thyme from Lithuania, thymol and carvacrol were not detected, which is a characteristic feature of the *serpyllum* species growing in the northern European countries (Ložienė et al. 1998). Neither of these two phenols were the main components of the essential oils of *T. serpyllum* var. *serpyllum* and *T. serpyllum* var. *tanaenis* from Finland (Stahl-Biskup and Laakso 1990).

Table 1. Main components of the essential oil of wild thyme collected from Estonia (%)

Compound	Retention index (RI)		Min-Max	Mean (n=33)	Standard deviation
	NB-30	SPB-5			
Camphene	944	944	nd-10.8	2.17	2.76
Myrcene	984	990	nd-20.2	6.15	6.68
Linalool	1089	1100	0.4-22.8	3.00	4.08
Camphor	1123	1138	0.2-14.2	3.55	2.92
Borneol	1156	1160	nd-19.0	4.67	5.85
α-terpineol	1177	1188	0.2-9.7	2.49	2.33
Linalyl acetate	1244	1254	nd-31.0	1.17	5.46
Geranyl acetate	1362	1382	nd-46.4	3.30	8.72
(E)-β-caryophyllene	1415	1413	tr-13.3	6.22	3.64
Germacrene D	1478	1474	tr-12.4	5.50	3.79
(E)-nerolidol	1554	1565	1.7-70.1	24.53	18.54
Caryophyllene oxide	1770	1574	1.4-45.0	10.29	9.65

nd = not determined
tr = trace (<0.05%)

Conclusions

- (E)-nerolidol, caryophyllene oxide, myrcene and borneol chemotypes of wild thyme drug are distinguishable in Estonia.
- Unlike the data from foreign countries with hotter climates, we found that thymol and carvacrol are not the main components of essential oil of wild thyme growing in Estonia.
- The oil content of Estonian wild thyme drugs is not usually compliant with the European Pharmacopoeia requirements.

Composition of the essential oils of wild thyme, common thyme and oregano
The chemical composition of the essential oils of wild thyme, common thyme and oregano are rather similar, for example all of their essential oils contain thymol and carvacrol (Wichtl and Bisset 1994). We compared the chemical composition of these plants growing in Estonia (Table 2).

Table 2. Composition of the essential oils of different samples of wild thyme (*Thymus serpyllum*), common thyme (*T. vulgaris*) and oregano (*Origanum vulgare*) (%)

Compound	*Thymus serpyllum* (n=46)	*Thymus vulgaris* (n=20)	*Origanum vulgare* (n=7)
Camphene	nd-10.8	nd-1.9	nd-0.1
Myrcene	nd-20.2	0.4-5.1	tr-1.5
Linalool	0.4-22.8	0.7-2.9	nd
Camphor	0.2-14.2	nd-3.8	nd
Borneol	nd-19.0	nd-4.3	nd
α-terpineol	0.2-9.7	nd-1.5	1.0-2.7
Linalyl acetate	nd-31.0	nd	nd
Geranyl acetate	nd-46.4	nd	nd
(E)-β-caryophyllene	tr-13.2	0.5-9.3	1.3-45.0
Germacrene D	tr-12.5	0-4.3	0.7-21.0
(E)-nerolidol	1.7-70.1	nd	nd
Caryophyllene oxide	1.4-45.0	0.1-2.5	nd
Thymol	nd-4.0	22.5-67.5	0.1-2.7
Carvacrol	nd-4.0	1.5-34.6	nd-0.7

nd = not determined
tr = trace (<0.05%)

The commercial "Thymi herba" samples were obtained from retail pharmacies of different European countries (France, Hungary, The Netherlands, Russian Federation, Greece, Scotland, Moldavia, Armenia and Estonia (12 samples); "Origani herba" samples were obtained from the Russian Federation, Lithuania and Estonia (5 samples).

Fifty-nine components were identified in the samples of common thyme. The total concentration of four major constituents (thymol, carvacrol, p-cymene and γ-terpinene) in thyme oils studied amounted from 67.7% to 92.2%. The concentrations of thymol and carvacrol in the oils of common thyme were much higher than in the oils of wild thyme.

In this study a total of 49 compounds were identified in the oils of oregano. Three chemotypes of essential oils from oregano lines cultivated in Estonia were identified:

- Mono- and sesquiterpene-rich oil: (E)–β-caryophyllene, germacrene D, (Z)-β-ocimene, sabinene
- Sesquiterpenoic compound-rich oil: (E)–β-caryophyllene, germacrene D, caryophyllene oxide, α-cadinol
- Oxygenated terpenoid-rich oil: caryophyllene oxide, linalool, spathylenol, (Z)-linalyl oxide.

Conclusions

The chemical compositions of essential oils of wild thyme, common thyme and oregano were not very similar and wild thyme cannot be used as a source of drugs to substitute for the other two species. Chemical composition of the wild thyme drug varies to a great extent depending on the growing site of the population. Wild thyme growing naturally in Estonia has a low quality of the drugs of interest.

Acknowledgements

Financial support for the work reported here was provided by the Estonian Science Foundation (grant No. 4332).

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Inventory of herb genetic resources in Finland: preliminary results

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Introduction

The Finnish National Plant Genetic Resources Programme for Agriculture and Forestry, developed during 1998-2000, was published in 2001 (Anonymous 2001). A national board was established in 2003.

The responsible institute for the coordination and implementation of the programme for agriculture and horticulture is MTT Agrifood Research Finland (www.mtt.fi). The seeds of agricultural plant genetic resources (PGR) will primarily be stored in the Nordic Gene Bank (NGB) and the conservation of vegetatively propagated agricultural and horticultural crops will be arranged nationally, particularly at MTT. During 2004 four working groups were established at MTT: 1. Landscape gardening, 2. Fruits and berries, 3. Vegetables, herbs and spices and 4. Field crops.

Currently, the main target of the national groups is to organize collections within MTT. Working groups are also preparing national guidelines for the long-term conservation of different species. The working groups will carry out systematic inventories on national PGR collections, evaluate their genetic diversity, set up necessary activities for urgent maintenance and plan several research projects. Case studies have been started, such as the cultivation trials of local plum races in Finland and the Finnish clonal collection of hops which is part of the NGB Hop project 2000-2003 (Suojala and Pennanen 2003).

The inventory work on medicinal and aromatic plants (MAPs) was initiated following the first meeting of the ECPGR Working Group on Medicinal and Aromatic Plants held 12-14 September 2002, in Gozd Martuljek, Slovenia. This work has been supported by the national board of the Finnish PGR Programme. In this report we present preliminary results of the inventory work, which is separated into two parts:

- Inventory of model MAP species in Finland
- Inventory of MAP genetic resources in existing herb collections in Finland.

Our working group also takes an active part in the inventory and methodological work of the SPIMED project ("Spice and medicinal plants in the Nordic and Baltic countries. Strategies for conservation of genetic resources"), coordinated by the Nordic Gene Bank (Asdal 2004).

Inventory of model MAP species proposed by the ECPGR MAP Working Group

According to the recommendations of the first meeting of the ECPGR MAP Working Group, "each member of the WG should make all possible efforts to ensure that an exhaustive survey of natural populations of the selected MAP species is carried out in his country". In the priority species/genera (Appendix I, in Baričevič et al. 2004) the representative of Finland was interested in the following: *Achillea* spp., *Carum carvi*, *Mentha* spp. and *Origanum* spp. These endemic plants have been chosen on the basis of their economic importance. The interest among growers and several previous existing studies were also important criteria for selecting the species for detailed study.

- **Carum carvi *L. (caraway)***

Caraway is an archaeophyte, and a common species in Finland, where it grows in meadows, pastures and roadsides in nearly all parts of the country. Natural caraway has no threats in the wild; it is a widespread and abundant species, classified by the International Union for Conservation of Nature (IUCN) among the taxa of "Least Concern" (LC).

It has been used as a spice for different aromatic purposes for a long time: the first commercial cultivation guide on caraway was published in 1916. Historically it is interesting that during 1850-1900 ca. 200-450 t/year were exported mainly to Germany and Holland (Grotenfelt 1916).

Currently, caraway is only occasionally collected and only for local purposes. The commercial product comes from cultivation.

Caraway is at present the most important cultivated spice seed in Finland. Between 1984 and 2004 its cultivation area has increased from 20-30 ha to 7100 ha. About 350-450 growers are involved in its cultivation on a contract basis. The annual domestic consumption is ca. 100-120 t of seeds. Nearly all the crop is exported and it is estimated that 5-7% of world consumption originates in Finland.

No special research has been carried out on caraway genetic resources in Finland. Research activity has been concentrated mainly on the production of caraway. One study was carried out in South Finland, in which 24 natural populations were compared to 19 cultivated caraway populations/cultivars (Galambosi and Peura 1996). The seeds were obtained from botanical gardens and cultivated during 1991-1992, at Mikkeli, Finland (61°44'N, 27°18'E). Thirteen populations were from Finland, and two each from Sweden, Norway and Iceland.

Clear agrobotanical differences were observed between the wild and cultivated populations. The wild populations were characterized by a 10-14 day shorter growing period and by the prostrate growth habit of the leaf rosettes, while the cultivated varieties had definite erect, upward growing leaf rosettes. Wild caraway populations had shorter and lighter seeds (average of 1000-seed weight: 2.39 ± 0.30 g) compared to those of the cultivated populations (average: 3.15 ± 0.36 g). The seeds of the cultivated population showed higher and more consistent germination capacity (59-64%) than the seeds of wild populations (13-18%).

It has been suggested that caraway in the northern parts of Europe contains more oil than that grown in southern Europe, and furthermore that wild caraway contains more oil than cultivated caraway. In this experiment the oil content of caraway seeds in both groups showed great variability (2.3–7.6%). The average oil contents of the wild and the cultivated forms were 5.0% and 5.1% respectively. The highest oil contents were found in a cultivated Swiss and a wild Finnish population, with 7.6% and 7.5%, respectively. The oil content of the wild Finnish populations was significantly higher (5.3%, n=13) compared to cultivated Finnish forms (4.8%, n=6) ($p<0.001$). The carvone/limonene ratio of the wild populations from the northern parts of Finland was higher compared to southern populations. Particularly high carvone contents (60%) were found in two populations, one from Norway, one from Iceland. Also, populations from the higher elevations in the Alps had high carvone/limonene ratios. However, these results do not strongly support the hypothesis that caraway in the north possesses a higher oil content than caraway in the south.

More detailed studies should be carried out to investigate the quality of the Nordic caraway populations.

- **Mentha *spp. (mints)***

There are two native mint species in Finland: *M. arvensis* L. and *M. aquatica* L. (Suominen 1966). The origin and the distribution patterns of the different mint species are presented in Table 1.

Table 1. Distribution of natural *Mentha* and *Achillea* species in Finland (Hämet-Ahti et al. 1998)

Species	Finnish name	Origin	Distribution
Mentha arvensis L.	Rantaminttu	native	common in all the country
Mentha x *gentilis* L. (*M. arvensis* x *spicata* L.)	Jalominttu		
M. x *gentilis* var. *arrhenii* (H. Lindb.)	Suomenminttu	established alien	rare, South Finland
M. x *gentilis* var. *hirtella* Markl.	Uudenmaanminttu	established alien	rare, South-West Finland
M. x *gentilis* var. *parviflora* Hartm.	Jalominttu	established alien	rare, South-West Finland
Mentha x *dalmatica* Tausch. (*M. arvensis* x *longifolia* (L.) Huds.)	Karjalanminttu	established alien	rare, South-East Finland
Mentha aquatica L.	Vesiminttu		
M. aquatica var. *aquatica*	Vesiminttu	rare, casual alien	rare, South-West Finland, Åland
M. aquatica var. *littoralis*	Meriminttu	native, rare in Åland	rare, South-West Finland, Åland
Achillea ptarmica L. (*Ptarmica vulgaris* Blakw. ex DC.)	Ojakärsämö	established alien	common in all country
Achillea silicifolia Besser.	Isokärsämö	casual alien, after 1950	rare in Central Finland
Achillea millefolium L.	Siankärsämö	archaeophyte	common in all country
A. millefolium subsp. *millefolium*	Etelänsiankärsämö		South and Central Finland
A. millefolium subsp. *sudetica* (Opiz) E.Weiss	Pohjansiankärsämö		North Finland
A. nobilis L.	Jalokärsämö	casual alien, after 1950	rare, South and Central Finland

Mentha aquatica var. *littoralis* is presently classified as a Near Threatened (NT) taxon in Finland. It is native on the Åland islands and on the western coast of Finland, but very rare. It grows in the coastal meadows and the threat factors include hay cutting or grazing, chemical disturbances by oil pollution, and hybridization with other species.

Mint species have long been important aromatic plants in Finland. Both native and introduced foreign mint species have been used as edible plants. There are more than ten "false mint" species, which have been named after mint due to their essential oil content and aromatic properties (Table 2).

Table 2. Aromatic plants with "false mint" name in Finland (Galambosi et al. 1999a)

Finnish name	Scientific name	Essential oil (%)	Main compounds
Helttanminttu	*Elsholtzia ciliata* (Thunb.) Hylander	1.00	Dehydro-Elsholtzia ketone 69.5%
Hurtanminttu	*Marrubium vulgare* L.		Marrubin 0.22% Premarrubin 0.40%
Aitokissanminttu	*Nepeta cataria* L.	0.44	Dehydronepetalactone 44.8% Nepetalactone 15.4%
Sitruunakissanminttu	*Nepeta cataria* subsp. *citriodora*	1.90	Geraniol 36% Nerol 28.5% Nepetalactone 7.9%
Katinminttu	*Nepeta racemosa* Lam. (*N. mussinii*)		
Kollinminttu	*Nepeta grandiflora* Bieb.		
Mirrinminttu	*Nepeta* x *faassenii* Bergmans ex Stearn		
Pystykissanminttu	*Nepeta nuda* L.		
Sitruunaväriminttu	*Monarda citriodora* Cerv. ex Lagasca	1.20	Thymol 63.11% Carvacrol 10.97%
Vuoriminttu	*Pycnanthemum pilosum* Nutt.	2.50-3.20	Pulegone 59-74% Menthone 13-22%
Väriminttu	*Monarda didyma* L.	3.00	Thymol 51.53% p-Cymene 12.9% Carvacrol 10.19%

Currently, mint species are very popular with Finnish gardeners and growers. Several commercial clones, varieties and hybrids are in cultivation. Imports of mint essential oil and pure menthol are about 2 to 3 t/year and several development projects for cultivation and distillation of mints have been in progress in order to promote domestic production. *M.* x *piperita* and *M. japanensis* are cultivated commercially and some aromatizated mint liqueurs have been produced with domestically distilled mint oils.

Mint collection at Mikkeli

Due to the economic importance of mint species, several research groups have been involved in mint studies in Finland. Summaries of the mint research results were presented at a Mint Research Seminar in 1999 (Salo 1999). During the last 15 years, numerous endemic and introduced mint species/varieties/clones have been collected and studied. All the studied mint accessions have been assembled into one collection, which is presently maintained by MTT Ecological Production at Mikkeli. The preliminary evaluation of the collection, concerning their overwintering, rust tolerance, herb and oil yield and essential oil composition, have been published (Galambosi et al. 1999b) and the best accessions/varieties have been made available to the mint growers.

- **Achillea *spp. (yarrow)***

Two native yarrow species grow commonly all over the country: *Achillea ptarmica* L. and *A. millefolium* L. The latter has two subspecies: *A. millefolium* subsp. *millefolium* grows in South and Central Finland, while *A. millefolium* subsp. *sudetica* grows in the northern part of the country.

Achillea silicifolia and *A. nobilis* are new species found in Finland only after 1950 and they are quite rare (Table 1) (Hämet-Ahti et al. 1998).

Yarrow is a widespread and abundant taxon, classified as a "Least Concern" (LC) species. *Achillea ptarmica* has endangered status in several Central European countries (Lange 1998), but has no threat problems in Finland.

As a common native herb, yarrow has had an important role in the herbal traditions of Finland. Yarrow raw materials for industry and for local herb farms are collected from the wild and from field cropping. Due to their better chemical quality, several named, specially bred varieties have been tested in Finland and seeds of 'Alba' and 'Proa' cultivars have been offered to the growers (Galambosi et al. 2001). In an introduction experiment, cultivation methods used for yarrow have been successfully adopted for *A. ptarmica* (Jokela and Galambosi 2004).

- **Origanum vulgare *L. (oregano)***

The reddish flowered oregano is a native species in the southwestern parts of the country and on Åland Island and it can also be found rarely as a casual alien in the inland parts of South Finland. There is no threat to the natural populations, and it is classified as an LC taxon. Oregano has traditionally been used as a spice. However, the native species is less aromatic than the Mediterranean species. In a comparative study carried out in Mikkeli the oil content of wild oregano was very low, 0.3-0.4%. The samples were collected from the archipelago of South Finland or they originated from Finnish botanical gardens. The main components of the oils were gamma-terpinene (5-34.9%) and sabinene (11-17%) and the carvacrol content was very low, 0-6.3%. At the same time, the oil content of oregano species obtained from Greece was 4.5-4.8% and the carvacrol content of the oil was 80-81% (Galambosi and Svoboda 1994). Although the native North European oregano plants have better winter tolerance, their chemical composition does not meet market requirements.

Currently oregano is a very popular spice for ethnic fast foods (pizza, kebab) and nearly all of the quantities used are imported from the Mediterranean countries. Greek oregano can be cultivated in the southern part of Finland only for 2-3 years, due to its rather poor overwintering (Galambosi et al. 2001).

Inventory of MAP genetic resources in Finnish herb collections

Since the low industrial and domestic consumption have no negative impacts on the genetic resources of the wild medicinal plants in Finland, the main purpose of this one-year inventory project was to collect data on the cultivated herbs and medicinal plants maintained in herb collections in Finland during 2004.

In the first phase we collected data on the existing collections by questionnaires, local visits and expert discussions. After the quantitative inventory, we will focus on the evaluation of the species spectrum, the origin of the species, their suitability

to Nordic latitudes, their historical and present economic importance, and the present status of some rare or threatened species, and we will make proposals to the national PGR board concerning conservation and sustainable use.

Preliminary results

In the period up to 1 October 2004 we found altogether 35 existing herb collections in Finland. The maintainers of the collections are: universities (5 collections), research institutes (3), agricultural schools (9), public collections (11) and private or production herb farms (7) (see Table 3).

The number of herb species in the university and research collections ranged between 60 and 250, whereas in the educational and public gardens the species number was lower, between 18 and 120.

Despite the harsh Nordic climatic conditions, a great number of medicinal and culinary herbs have been used since early in Finland's history. The first-used plants originated from the Finnish flora, but later the plant spectrum was enlarged by non-domestic species. The introduction of new herb species was influenced by several historical factors, such as medieval monastery culture or the Swedish governmental policy favouring the domestic cultivation of herbs during the 18th century (Peldan 1967). In military fortresses, herb gardens supplied the necessary healing plant materials for the surgeons, and in towns a herb garden of about 100 m² was the precondition for the permission for a new pharmacy.

The available historical sources report different number of species used as medicinal and spice plants in Finland. In the earliest plant list, from the Naantali Monastery near Turku (South West Finland), medicinal use of 21 plant species was reported in 1440 (Peldan 1967). Elias Tillandz in 1673 listed about 60 species used and cultivated around Turku for medicinal and flavouring purposes (Ruoff 2001). In the first Finnish language herb book, Pietari Gadd described the cultivation of 17 spice and medicinal plants (Gadd 1768). A literature survey by Saarnijoki (1976) listed the medicinal plants which were cultivated in the vegetable and herb gardens in Finland during the 17th to 19th centuries. The number of the most popular herb species was 24. Kalliomäki (1999) mentioned 50 herb species from the wild and from garden cultivation which were used for medicinal purposes in Finland.

We compared the historically reported plant lists with our inventory results, and concluded that MAP species belonging to the Finnish herb heritage are still strongly represented in present-day Finnish herb gardens (Table 4). A survey of 12 public herb gardens showed that *Origanum* and *Levisticum* were found in all collections, *Hyssopus* and *Myrrhis* in 11 collections, *Artemisia absinthium*, *Calendula* and *Carum* in 10 collections, *Anethum, Angelica, Humulus, Melissa, Ocimum* and *Salvia* species in 9 collections. More than 35 species were cultivated in at least 5-8 collections (Table 4). The origin and the real genetic resources of these old medicinal plants maintained in the herb collections need further study.

Table 3. Herb collections in Finland, 2004

Stakeholders of collection	Name of the organization	Location	Area (m^2)	No. of species
Botanical gardens	University of Helsinki	Helsinki		115
	University of Turku	Turku		80
	University of Kuopio	Kuopio		71
	University of Joensuu	Joensuu	250	75
	University of Oulu	Oulu		131
Research institutes	MTT/Ecological production	Mikkeli	600	190
	MTT/Institute of Horticulture	Piikkiö	100	10
	MTT/North Ostrobothnia research station	Ruukki	15	22
Collections in agricultural schools	Hämeen Ammattikorkeakoulu	Lepaa	ca. 500	
	Yrkesinstitutet Sydväst	Espoo	300	
	Perheniemen evankelinen opisto	Iitti	100	67
	Varsinais-Suomen Luonnonvaraopisto	Piikkiö, Tuorla	100	35
	Uudenmaan maaseutuopisto	Hyvinkää		
	Pohjois-Savon Ammattiopisto	Muuruvesi		
	Savonlinnan Opettajakoulutuslaitos	Savonlinna	400	66
	Mäntsälän Ammattiopisto	Mäntsälä	30	
Historical collections of public organizations	Pukkilan Kartanomuseo	Piikkiö	250	41
	Lohjan museo	Lohja	150	30
	Työtehoseuran Lönnrot Opisto	Saamatti	200	50
	Hyötykasviyhdistysry. Annalan puutarha	Helsinki	500	96
	Lönroot puisto	Kajaani	28	18
Herb gardens in public parks	Hatanpäänpuistokuja	Tampere	30	
	Redutti, yrttitarha	Kotka	400	83
	Etelä-Savon Marttaliitto, Kenkävero	Mikkeli	400	113
	Elonkierto, MTT	Jokioinen	40	31
	Perinnepuisto, yrttitarha	Kangasniemi	40	22
Private collections	Kehäkukka näytetarha	Hämeenkyrö	300	119
	Arja Aminoff yrttitarha	Bilnnäs	100	32
	Kärsälän Ruusutila	Somero	100	92
	Westersin puutarhan yrttitarha	Kiila	800	ca. 300
	Tertin kartanon yrttitarha	Mikkeli	320	32
	Kukkolan tilan näytepuutarha			
	Majakarin tilan yrttikokolema	Haapajoki		

Table 4. Plant species reported by bibliographic sources and their frequency in herb gardens in Finland in 2004

Species	Naantali 1440 (in Peldan 1967)	Tillandz 1673	Gadd 1768	Saarnijoki 1974	Kalliomäki 1999	Galambosi 2004*
Achillea millefolium					x	8
Alchemilla spp.					x	6
Allium sativum		x	x			4
Allium schoenoprasum				x		8
Althaea officinalis		x				6
Angelica archangelica		x			x	9
Anethum graveolens		x	x	x		9
Anthriscus cerefolium		x	x	x		6
Armoracia rusticana	x	x		x		8
Artemisia abrotanum		x		x	x	8
Artemisia dracunculus		x				7
Artemisia absinthium	x	x		x		10
Betonica officinalis		x				
Borago officinalis		x				4
Calendula officinalis		x			x	10
Carum carvi		x		x	x	10
Chelidonium majus	x				x	1
Cnicus benedictus		x				
Cochlearia officinalis		x	x			2
Coriandrum sativum		x	x			6
Foeniculum vulgare			x			6
Humulus lupulus		x	x	x	x	9
Hypericum perforatum					x	7
Hyssopus officinalis			x	x		11
Inula helenium		x				7
Lamium album						5
Levisticum officinale		x		x		12
Lavandula angustifolia				x		8
Matricaria recutita	x				x	7
Melissa officinalis		x		x		9
Mentha spp.		x		x	x	6
Myrrhis odorata	x		x	x		11
Ocimum basilicum		x	x	x		9
Origanum majorana	x	x	x	x		8
Origanum vulgare					x	12
Petroselinum crispum	x	x	x	x	x	6
Petasites hybridus		x				1
Peucedanum ostruthium		x				
Plantago lanceolata					x	3
Pimpinella anisum	x	x	x	x		2
Primula veris		x			x	4
Rheum officinalis		x				5
Rosmarinus officinalis				x		7
Ruta graveolens	x	x	x			3
Salvia officinalis		x		x		9

* Number of collections in which the species were found

Table 4 (cont). Plant species reported by bibliographic sources and their frequency in herb gardens in Finland in 2004

Species	Naantali 1440 (in Peldan 1967)	Tillandz 1673	Gadd 1768	Saarnijoki 1974	Kalliomäki 1999	Galambosi 2004*
Satureja hortensis		x	x	x		5
Sinapis alba	x	x	x	x		2
Solidago virgaurea					x	4
Symphytum officinalis					x	4
Thymus serpyllum			x		x	6
Thymus vulgaris				x		8
Trapeolum majus				x		4
Urtica dioica	x				x	2
Valeriana officinalis					x	5
Verbascum thapsus					x	6
Viola tricolor	x				x	8

* Number of collections in which the species were found

During the last two decades of the so-called "herb-boom", the fashion for the use and cultivation of spices, herbs and medicinal plants has increased significantly in Finland, as in other countries. As a consequence, several unfavourable phenomena were noted during the inventory process.

- The seed companies offer seeds of old species only from imports. Tens of thousands of hobby growers and small growers cultivate new and foreign MAP species and varieties without any real information on their suitability to the cooler climate. The herb collections were full of newly introduced MAP species, like *Echinacea, Leuzea, Rhodiola, Agastache, Cryptotenia, Pycnanthemum pilosum, Tagetes lucida*, etc.
- The university botanical gardens, due to their educational and research tasks, maintain large collections of aromatic and medicinal plants, mainly from foreign Index Seminum seed exchanges.
- With the aim of improving the quality of the raw material of the cultivated herb species, about 40 selected and possibly bred varieties of herbs and spice plants from Central European countries were tested in Finland during 1997-2000 and their seeds were offered to seed companies and small growers (Galambosi et al. 2001).

Due to these trends, at present it is quite difficult to evaluate the real genetic diversity of the endemic MAP species or to evaluate their impact on the Finnish herb heritage.

- At the same time we observed that the interest in using and cultivating more herbs and medicinal plants has been aroused in numerous individuals, institutes and public organizations and as a result, intensive research and development activities have focused on the diversification of the medicinal plant spectrum in Finland (Galambosi 2000).
- Several local organizations have focused on the collection of the old local plant races. Collections of historically used MAP species have been created in connection with old historical sites, buildings, local museums and public parks, etc.
- In contrast to the imported plant species, efforts have also been made to collect and maintain natural or old landraces of the MAP species. Maatiainen ry – a

voluntary organization of plant growers – collects and sells seeds from the wild or from cultivation providing seeds of known origin. Their seed catalogue of perennials, annuals, decorative and vegetable plants reports the reputed age of the varieties or races, including some more than 20- or 50-year-old races (Karppinen and Kahila 2003) (Table 5).

Table 5. Seeds of old local races of MAP species in Maatiainen seed list 2004, Finland

Category	Time of cultivation in collector's garden	Species	Cultivar
1	Less than 10 years (very young race)	*Achillea millefolium*	Proa, Alba
		Alchemilla mollis	
		Adonis vernalis	
		Coriandrum sativum	
		Dracocephalum moldavicum	Blue and Snow Dragon
		Leonorus cardiaca	
		Malva subsp. mauritiana	
		Matricaria recutita	Budakalasz-2
		Meum athamanticum	
		Satureja hortensis	Aromata, Compacta, Saturn
		Agastache foeniculum	
		Origanum vulgare	
		Sanguisorba minor	
2	10-20 years (young race)	*Allium ursinum*	
		Borago officinalis	
		Gentiana lutea	
		Levisticum officinalis	
3	More than 20 years (old race)	*Allium schoenoprasum*	
		Calendula officinalis	
		Hyssopus officinalis	Blue
		Leuzea carthamoides	Lujza
		Papaver somniferum	
4	More than 50 years (very old race)	*Saponaria officinalis*	
		Rheum rhabarbarum	
5	Natural race, collected from the wild	*Agrimonia eupatoria*	
		Alliaria petiolata	
		Anthoxanthum odoratum	
		Carum carvi	
		Bidens tripartita	
		Centaurea cyanus	
		Satureja acinos	
		Verbascum thapsus	
		Viola tricolor	

Summary

The present inventory is the first attempt to overview the existing MAP collections and their species spectrum in Finland. The preliminary results show that there is an increasing interest in growing and using medicinal plants. At present, 35 herb collections exist in different parts of the country, and they offer good possibilities for studying the genetic diversity of the old and current herb species. Because of the strong influence of the imports of herb seed, it is rather difficult to determine the real origins of the herbs and medicinal plants in the collections. Using a multidisciplinary approach on herb research, additional historical, botanical, genetic, pharmaceutical and agronomic expertise should be dedicated to carry out deeper evaluation of the genetic diversity of the Finnish MAP species.

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Experiments on the introduction of threatened medicinal plants in Finland

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Introduction

During the last 20 years efforts have been focused on the development of herb and medicinal plant cultivation and production in Finland (Galambosi 2000a). The motivations of these research and development processes were quite similar, as pointed out in the overview by Németh (2001). The long-term aim of these efforts was to give alternative production possibilities for the farmers who live in underdeveloped areas in the countryside. This aim was realized partly with the introduction of new alternative crops into Finland, planning to supply new plant raw materials for the medicinal and food industries and for export.

The final initiative for the introductory studies on threatened medicinal plants was given in the first congress on this subject (TRAFFIC Europe 1998) where international organizations asked for more efforts to be made to replace the endangered medicinal plants from the wild by cultivation. During the congress an important market report was published (Lange 1998) which provided a strong basis and good arguments for these efforts. Inspired by these reports, new research projects were initiated in Finland (Anonymous 2001). This report is a short summary of the results of Finnish research on plant introduction.

Material and methods

- ***Plant choice***

The plants for introduction experiments were chosen taking into consideration several preconditions:

- Climatic suitability, cold tolerance
- Earlier cultivation experience as decorative plants in Finland
- Economic importance, market and the industrial need
- Threatened status.

Further reports concerning the threatened status of several medicinal plant species in European countries were used to strengthen the choices of the species. In Table 1 we present the list of medicinal plants chosen for research.

Table **1.** List of MAP species chosen for introduction research

Species	Climatic suitability (A) Cultivation as perennial (B)	Threatened status*	Industrial interest (I)
Achillea ptarmica	A	D, H	
Acorus calamus	A	D, L, H	I
Alchemilla alpina	A, B	C,	
Alchemilla spp.		D,	
Allium ursinum	A	C, D, E	
Antennaria dioica	A,B	D,	
Arnica montana	A	D, L, P, H	I
Arctium lappa	A	C, L	
Asarum europaeum	A, B	C, D, P	
Convallaria majalis	A, B	D, L, P	
Drosera rotundifolia	A, B	D, L, P	I
Gentiana lutea	A, B	D, P	I
Gratiola officinalis	A	D,	
Herniaria glabra	A	C, L	
Hierochloe odorata	A	P	I
Leontopodium alpinum	A, B	D,	
Marrubium vulgare		D, H	
Menyanthes trifoliata	A	D, H	
Primula veris	A, B	C, D, L,P	
Rhodiola rosea	A, B	D,	I
Viola tricolor	A	L	I

* C = Finland (Rassi et al. 2001)
D = Lange 1998
E = Estonia (Pihlik 2004)
H = Hungary (Bernáth and Németh 2004)
L = Lithuania (Radušienė 2004)
P = Poland (Węglarz and Geszprych 2004)

- ***Experimental methods***

The cultivation experiments were mainly carried out in the fields of the Ecological Research Station, MTT Agrifood Research Finland, Karila, Mikkeli (61°44'N, 27°18'E). Several experiments were carried out in the harvested energy peat field of Vapo Ltd. The methods used were observational experiments, small plot and fairly large scale field experiments. For disseminating the research results, demonstrations and educational activities were an integral part of this process (Galambosi 2003).

- ***Research funds***

The experimental activities were funded from several financial sources. Since the aims of this research were in harmony with the line of the general agricultural development policy, some projects were financed by the Ministry of Agriculture in Finland, and from the research funds of the institute Agrifood Research Finland. Several developmental projects – focused mainly on the dissemination of the results - were financed by national funds and by the European Agricultural Guidance and Guarantee Fund (EAGGF). For promoting the availability of domestic raw materials, resources were obtained from several industrial companies, like Bioforce AG, Switzerland for *Drosera rotundifolia*, Weleda AG, Switzerland for *Arnica montana,* Vapo Ltd., Finland, for *Acorus calamus*, *Menyanthes trifoliata* and Hankintatukku Ltd., Finland for *Gentiana lutea* and *Rhodiola rosea.*

Results

According to the research results and the cultivation experiments, we may group the species studied into three groups.

- ***Group I. Species in the commercialization phase***

These species have had important research impacts, due to their economic importance and to industrial interest. The experimental research has ended, and, on the basis of the results, the first cultivation techniques have been published and several growers have started their larger scale cultivation on a contract basis. The plant list and the relevant publications are presented in Table 2.

- ***Group II. Problematic species***

This group includes those so-called problematic species, for which cultivation in our experiments seemed to be difficult, due to several biological factors, to their slow-growing character and to low biomass accumulation and low yields. These species are: *Allium ursinum, Antennaria dioica, Asarum europeum, Convallaria majalis* and *Menyanthes trifoliata*; their cultivation will need further specific research efforts.

- ***Group III. Promising species***

This group includes those species for which the cultivation experiments were successful, and we found that the plants can be cultivated under Nordic climatic conditions with satisfactory yields. These species were the first to be newly cultivated for medicinal raw material purposes in Finland.

Table 2. Publication of experimental results for medicinal plants (Group I)

Species	References to experimental results published	
	in English and in French	in Finnish and in Norwegian
Arnica montana L.	Galambosi et al.1998a	Galambosi 1993a
	Galambosi 2000b	Galambosi 1995
	Galambosi 2003	Dragland and Galambosi 1996
	Galambosi 2005	Galambosi et al. 2000c
Gentiana lutea L.	Galambosi 1996a, 1996b	Galambosi 1993b
	Galambosi 2000b	Galambosi 1995
	Galambosi 2003	Dragland and Galambosi 1996
Rhodiola rosea L.	Galambosi et al.1999c	Dragland and Galambosi 1996
	Galambosi 2000b	Tuominen et al. 1999
	Galambosi 2002	Galambosi 2002
	Galambosi 2003	
Drosera rotundifolia L.	Galambosi et al. 1998b	Galambosi and Takkunnen 1998
	Galambosi et al. 1999a, 1999b	Tuominen et al. 1999
	Galambosi et al. 2000a, 2000b	
	Repčak et al. 2000	
Viola tricolor L.		Galambosi et al. 2000c
		Tuominen et al.1999

In the following paragraphs we present summaries of the results on Group III, which have already been published in Finnish (Galambosi et al. 1999a; Galambosi and Jokela 2002; Jokela and Galambosi 2004).

- **Achillea ptarmica *L. (sneezewort)***

Achillea ptarmica L. is a well established native perennial taxon, which grows commonly in meadows, pastures, roadsides and ditches in all parts of Finland. Several "bred" varieties are cultivated as decorative perennial plants. The cultivation techniques for yarrow have been successfully adapted for *A. ptarmica*. It can be propagated by transplantation of seedlings, and as a perennial it can be cultivated for several years. In organic cultivation the weeds can be managed by mechanical weeding or by using organic or plastic mulches. The flowers can be harvested by hand berry harvester, and the harvest of the leafy herb can be mechanized. In experiments, the dry flower and herb yields of accessions from the wild were higher than those of the decorative varieties. The essential oil content of the flowers ranged between 0.083 and 0.166% and that of the herb was between 0.041 and 0.076% (Table 3).

Table 3. Yield and essential oil content of *Achillea ptarmica* L. grown in Mikkeli, Finland

Type	Origin	Dry yield (g/m²)				Essential oil (%)	
		Herba			Flower	Herba	Flower
		Hand harvest		Mechanical harvest	Hand harvest		
		2000	2001	2002	2001		
Natural	Porvoo, Finland	783	901	767	138	0.041	0.133
	Mikkeli, Finland	-	782	286	126	0.076	0.166
	Mean		**841**	**526**	**132**	**0.058**	**0.149**
Decorative	Richters, Canada	693	588	356	79	0.058	0.150
	'Pearl', Finland	569	448	403	79	0.041	0.133
	'Ballerina', Germany	430	797	258	102	0.044	0.083
	Mean	**564**	**611**	**339**	**87**	**0.048**	**0.132**

- **Acorus calamus *L. (sweet flag)***

Sweet flag grows only in the southwestern parts of the country, where it occurs on the banks of rivers and streams. It is an established alien taxon.

Cultivation experiments started during 1999, aiming for the after-utilization of industrial peat fields from which the peat had been harvested. The experimental plots were established by planting rhizomes collected from the wild around Turku, Finland, or obtained from the botanical garden of Zalec, Slovenia or by transplanting seedlings grown from seeds obtained from Canada, Ontaria (*A. calamus americanus*). The plots situated in a peat field sited 40 km from Mikkeli were fertilized by NPK at 75-90-300 t/ha after liming with 15 t/ha $CaCO_3$.

The growing conditions in the peat field were quite harsh. Water covered the area for nearly 6 months, but in summer the area became dry, with temperatures of

40-50°C at the peat surface. Sweet flags withstood these conditions well and grew strongly. Towards the end of the third growing year, the diameter of one plant was ca. 60-80 cm.

The dry root yields harvested by hand were 1.25-1.95 kg/m² (Table 4). The essential oil contents of the roots were 1.0-1.5% (Héthelyi et al. 2002). According to chemical analyses of the roots, there were distinct differences between the accessions of European and Canadian origin (Table 5). The contents of β-asarone in the essential oils of the Finnish and Slovenian accessions were 11-12%, while in the North American accession they were only 1.2%, and in the dried leaves the β-asarone was highest at 34.8% of the essential oil in the accession from Turku.

Table 4. Fresh and dry root yield of *Acorus calamus* L. grown in peatland in 2002 in Juva, Finland

Accession	Fresh weight (g/plant)		Dry root weight (g/plant)	Root yield (kg/m²)	
	leaves	roots		fresh	dry
1) Turku, Finland	1150	1826	533	5.47	1.60
2) Zalec, Slovenia	1317	2167	650	6.50	1.95
3) Richters, Canada	1054	1534	417	4.60	1.25
Mean	**1174**	**1842**	**533**	**5.52**	**1.60**

Table 5. Content and composition (%) of the essential oils of *Acorus calamus* L. strains in Mikkeli, Finland

Compound	Origin and plant part			
	Turku, Finland		Zalec, Slovenia	Richters, Canada
	Leaf	Root	Root	Root
ß-pinene	2.7	1.9	1.9	
p-cimole	3.3			
limonene		1.1	1.1	
linalool		1.2	1.3	
camphor		3.2	3.7	
caryophyllene		2.7	2.6	
ß-selinene	1.8	5.2	4.9	
ß-malinene		3.8	3.9	2.3
aristolene	2.6	5.1	5.1	4.6
calorene		5.7	6.3	4.3
eremophyllene		1.1	1.4	11.8
delta-cadinene		2.1	1.9	1.7
a-asarone	1.7	1.1	1.2	-
ß-asarone	34.8	12.1	11.2	1.8
acorone	1.6	6.9	7.4	13.1
aristalone	4.0	7.3	7.6	6.1
cyclohexamone		7.2	7.8	8.8
naphtalone		4.9	5.9	1.4
solaretinone		7.5	7.1	24.6
oil content (%)	0.44	1.52	1.16	1.08

From these experimental results, it seems that biologically there is a possibility of using the exhausted peat fields for cultivation of such sweet flag strains which do not contain undesirable carcinogenic compounds. However, we met some serious practical difficulties when checking the possibilities. The roots can be harvested only by machinery, but due to the wetness of the peat field, the machine could not move over the ground surface. When eventually we dug out the roots by excavator, the leaves were still attached. To wash the plant mass was very difficult, since the peat was stuck closely to the hairy roots and after drying the root/leaves mixture, ca. 15% of soil and peat was still adhering to the roots.

In our view, this kind of raw material is suitable only for distillation in fresh form. Since the essential oil compositions of the leaves and the roots were different (Table 5), the oil obtained from a root/leaves mixture needs to be evaluated. Finally, after a fairly large scale pilot distillation, the whole process should be checked to see if it is economically viable.

- **Alchemilla *sp. (Lady's Mantle)***

The *Alchemilla* genus is a native one in Finland, where it includes about 25 small apomictic species and *A. mollis* which is widely cultivated as a garden perennial. During 1997-2002 cultivation techniques, flower and herb yield and quality were studied in three species: *A. alpina*, *A. mollis* and a Swiss bred variety 'Aper' of *A. xanthochlora.*

The experimental plots were established by transplantation of seedlings into plastic mulch 0.8 m wide. The spring growth and the regrowth after harvest was intense and plastic mulch seems to be very effective against weeds. The leaves were harvested 2-3 times/summer by hand and mechanically. The highest leaf yields were measured in the second year, being 780-840 g/m² (Table 6). The herb yield was 1270-1700 g/m², and the tannin content was above 7.0% of the dry yield. Judging by these results, cultivation of these species seems to be possible in practice.

Cultivation of *A. alpina* seems to be problematic due to its slow growing habits. Losses from mechanical harvest were high and the tannin content of the leaves was low, 4.4%.

Table 6. Yield and tannin contents of *Alchemilla* species grown in Mikkeli, Finland

Species	Harvest method	Dry leaf yield (g/m²)			Contents of tannin (%)
		2000	2001	2002	2001
Alchemilla alpina	Hand		600[c]		
		120[a]	780[b]	577[c]	4.40
	Machine*	-	-	53[a]	-
Alchemilla mollis	Hand	475[b]	780[c]	592[b]	7.09
	Machine*	-	-	1270[c]	-
Alchemilla xanthochlora	Hand	225[a]			
		373[b]	838[b]	746[b]	7.28
	Machine*	-	-	1700[c]	-

plant density: 8/m²
[a] = one harvest/summer; [b] = two harvests/summer; [c] = three harvests/summer
* = dry herb yield in full flower

- **Arctium spp. (burdock)**

Arctium tomentosum and *A. minus* are common archaeophyte species in the South and Central parts of Finland, but two other species which grow in the southernmost parts and in Åland Island are rare. *Arctium lappa* has a "regionally threatened" (RT) status and the native *A. nemorosum* an "endangered" status (EN). As medicinal plants, roots of all species can be used, but at present there is no commercial collection in Finland.

In the cultivation experiments we studied the effects of propagation methods on the growth and root yields of three *Arctium* species. For easy root harvest the plants were cultivated in potato ridges, at 80 cm apart. The seeds were collected from the wild and from botanical gardens. The plants can be grown from transplanting or from direct sowing. The seeds need 35 days stratification before spring sowing. Direct sowing has to be carried out in autumn, since autumn sowing gives 92% germination, while spring sowing without stratification only gives 5% and the seeds germinate in the following spring. The plant spacing in direct sowings should be 6-10 cm apart; in more dense populations the individual root weight remains under 30 g. The roots must be collected in autumn, since the biennial plants start to flower during the second year. The roots of transplanted plants were much heavier (152-373 g/pot), than the roots from direct sowing (40-50 g), since 2-4 seeds were sown into each pot. The dry matter content of the directly sown roots was 30.8% and that of the transplanted roots 33.3%. In this experiment, transplanted *Arctium minus* gave the highest fresh and dry root yield, due to its high root weight (Fig. 1).

Although the root yields from transplanting were higher, in practice direct sowing is proposed as a cheaper propagation method for burdock. From sowing the anticipated fresh and dry root yields are 60-70 kg and 18-23 kg per 100 m of row, respectively.

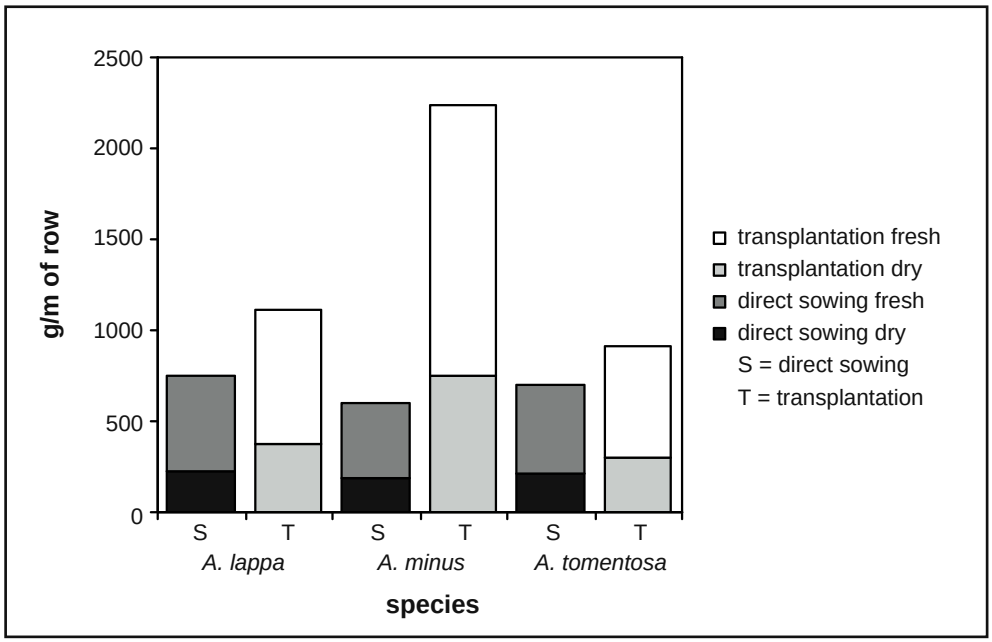

Fig. 1. Fresh and dry root yields of *Arctium* species in Mikkeli, 1992.

- **Gentiana lutea *L. (yellow gentian)***

Yellow gentian is a non-native perennial plant in Finland, but it grows in botanical gardens without problems. The first series of plot experiments was carried out between 1989 and 1994 (Galambosi 1996a, 1996b) and a fairly large scale experimental field of 400 m² was planted up in 1997.

This species can be established by transplanting seedlings. One-year-old seedlings were transplanted into black plastic mulch, fertilized by 20 t/ha compost, with a plant density of 9/m. Five to eight seeds were sown into one pot, after a 70-80 day period of stratification. Hand weeding is necessary during the first 2 years for the slow growing seedlings; later, the plants suppress the weeds in the holes. No particular insects or diseases were observed during the past 10 years, except for *Botrytis cinerea* in very moist autumns which was without harmful consequences.

To produce an adequate size of root, the plants needs 4-6 growing seasons. The roots are 25-40 cm deep and strong root lifters seem to be necessary for root harvest. The plant density used here (30 x 30 cm) seems to be too dense. A too dense transplant spacing led to decreased growth in the middle of the beds and resulted in united root masses which were difficult to harvest. In 2000 the individual root weights of 5-year-old plants in the middle of the beds was 0.52 kg, while in the rows near the edge it was 1.15 kg.

The amarogentine and the gentiopicroside content of the root was 0.07% and 2.44%, respectively (Galambosi 1996b). The bitter value of the 6-year-old roots was high (35 000). The essential oil content was low, 0.01-0.026%; the oil contains 85-95% of sesquiterpenoids, from which β-caryophyllene, β-selinene, β-cubebene and germacrene-D have been identified (Héthelyi et al. 2004).

During root harvest additional hand labour is necessary for cleaning, washing and cutting the roots. General root washing machines and shrub cutters were used successfully in processing the roots. The roots have to be sliced to accelerate the drying process. The mechanically harvested fresh and dry root yield was 4.7 and 1.3 kg/m² calculated on the net area of plastic mulch. In cultivation, yellow gentian plants developed flowering stems after the third growing year, and the germination of the seeds ranged between 60 and 80%.

- **Herniaria glabra *L. (glabrous rupturewort)***

Rupturewort is an established alien taxon in Finland, and can be found rather rarely in the southern parts of the country. It grows as an annual or biennial and easily spreads from seed. It has a prostrate growth habit, which makes its cultivation difficult, since the herb is easily contaminated with soil. In our experiments we used black plastic mulch to avoid soil contamination. Rupturewort can be propagated by transplanting of seedlings or by sowing seeds directly into the holes in the plastic mulch. The low-lying plants cover the whole mulched area and the plant forms a dense carpet, which can be harvested easily and gives a clean quality crop. In a 2-year experiment the plant overwintered well and gave the highest yield in the second year in the most densely planted crop (Fig. 2). The dry yields during the first and second year ranged between 168-486 and 186-798 g/m², respectively. The plastic mulch growing technique was successfully used with other medicinal plants with prostrate growth habits, such as *Thymus serpyllum*, *Polygonum aviculare* or *Prunella vulgaris.*

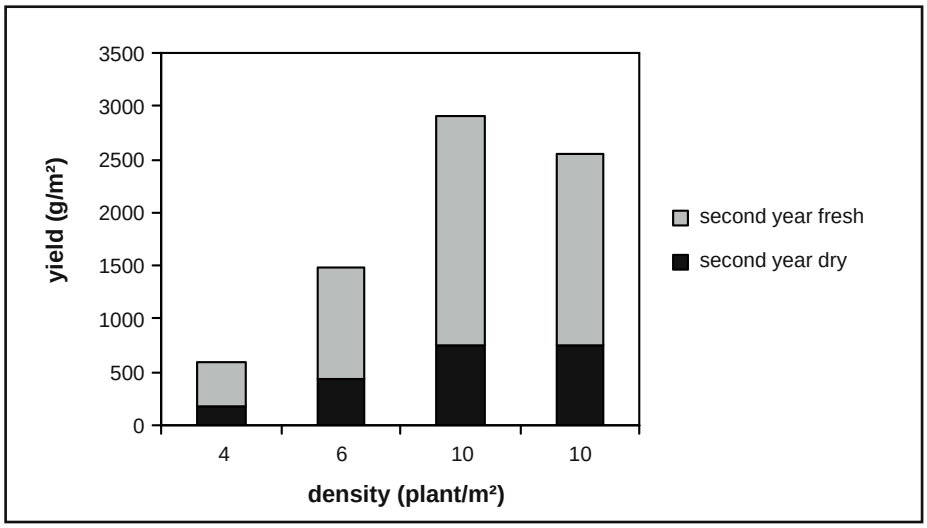

Fig. 2. The effect of plant density on fresh and dry herb yields of *Herniaria glabra* L. in plastic mulch. Mikkeli, Finland 2001-2002.

- **Leontopodium alpinum *L. (edelweiss)***

Edelweiss is not a native plant in Finland, but it is cultivated as a garden perennial in the southern part of the country. Growth, overwintering, flower yield and quality of two accessions obtained from Germany were studied during 1997-2002 at Mikkeli.

Edelweiss can be cultivated successfully for flower and herb production in South Finland. The plants overwintered well during 4-5 successive years, started to flower in the first year and gave satisfactory yields from the second year. For flower harvesting, the Finnish berry hand harvester seems to be suitable. During the second and third growing years from the fourth harvest onwards the fresh and dry and flower yields have ranged between 360-778 g/m² and 98-196 g/m², respectively (Fig. 3). The growth of the accession from Quedlinburg seemed be more vigorous and its fresh and dry herb yield in the third year was significantly higher (1360 and 372 g/m²) than that of the accession 'Chrestensen' (860 and 243 g/m² respectively). The chemical contents of the two accessions were nearly similar (Table 7), but the tannin contents were lower than was reported earlier (5-6%) by Rey and Slacanin (1999).

Table 7. Chemical components of the flower yield of *Leontopodium alpinum* L. in Mikkeli, Finland

Compound	Accession	
	Chrestensen	Quedlinburg
Tannin	2.75	2.71
Chlorogenic acid	0.19	0.18
Flavonoids		
Luteolin-3',7-glucose	0.08	0.05
Luteolin-7-glucose	0.16	0.38
Luteolin-4'-glucose	1.34	1.46

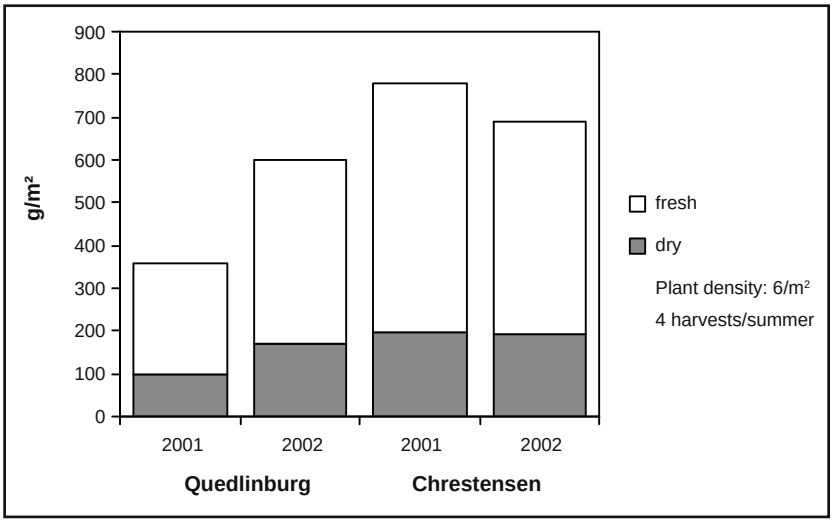

Fig. 3. Fresh and dry flower yield of two *Leontopodium alpinum* accessions in Mikkeli, Finland.

- **Marrubium vulgare *L. (white horehound)***

White horehound is a non-native perennial plant, originating from Southern Europe. It can be found rarely in South Finland as a casual alien, but sometimes it is cultivated in private gardens. From 1993 onwards several experiments were carried out in Mikkeli to study its overwintering and the quantity and quality of the herb yield.

As a result of these adaptation experiments, we concluded that horehound can be cultivated safely in Finland only as an annual, since it did not survive the harsh winter conditions.

It has to be cultivated from transplanting of seedlings and the herb is harvested in September by hand or mechanically. The average yield level could be expected to be 0.30-0.60 kg/m² (Table 8). The yield level is affected mainly by the heat sum of the summer. The highest fresh and dry yields were measured in the warm summer 1994. The black plastic mulch decreased the weeding works significantly. In another study the yields and marrubin contents of 20 different accessions were compared. There were no big differences in the biomass production of the accessions of European origin, which ranged from 507 to 840 g/plant. The average marrubin content was 0.62%, with larger variations between 0.35 and 1.01% (Galambosi et al. 1996).

Table 8. Dry herb yields of *Marrubium vulgare* L. during 1993-1996 in Mikkeli, Finland

Growing place	Plant/m²	Dry herb yield (kg/m²)			
		1993	1994	1995	1996
Soil , no mulch	4	0.30	0.78	-	-
Black plastic mulch	4	-	0.58	0.63	0.24
	6	-	0.63	0.49	0.31
	9	-	0.85	0.59	0.49
Mean		**-**	**0.68**	**0.57**	**0.35**

- **Primula veris *L. (cowslip)***

Cowslip is a common native plant in the South-West part of Finland and it is a symbol of the Åland County. In other parts of the country it is occasionally found and it is commonly grown as a frost tolerant garden perennial. Its collection for marketing purposes is not allowed, except in Åland.

During 1997-2002, cultivation experiments were carried out to determine its yield potential as a possible special crop for use as an industrial raw material. Cowslip can be propagated by transplanting of seedlings. The seeds need stratification and germinate quite unevenly. One-year-old seedlings should be transplanted into the field with a density of 6-10/m². The plants did not tolerate the warm black plastic mulch, therefore organic mulch or regular mechanical weed control is important to keep the plantation clean.

The root and flower yield in our experiments seemed to be very low. The root biomass accumulates quite slowly and the root yield can be harvested after 2-3 field years. Cleaning and washing of the fresh fibrous roots is a labour-intensive process. The dry root yield in the second and third growing years ranged between 0.3-1.0 and 0.42–1.6 kg/m², respectively, the highest value being obtained with a density of 10 plants/m². During the third growing year the average fresh flower weight was 11.6 g/plant (n=90), its dry matter content was 17%. Calculated with 10 plants/m², the dry flower yield could be 20 g/m². In our experiments it ranged between 8 and 40 g/m², which is very low.

Conclusion

The introduction of new medicinal plants into cultivation is a long-term task. Due to the general public concern on environmental questions, research funds have been quite easily obtainable. At the same time, in a country where cultivation of MAPs has no long traditions, intensive development and educational activities are necessary to turn the research results into the practical cultivation of a new crop. The most important prerequisite is the interest of the medicinal plant industry. Intensive and practically oriented research has been carried out, initially in the case of concrete raw material demands by companies. As a result, several new species are currently in practical cultivation on a contract basis. Concerning several other promising species, the results of which are presented here, only theoretical possibilities for marketing exist at present. It takes a long time from the dissemination of the results to their implementation, and this process is heavily influenced by socio-economic factors (income level, prices, market channels).

Acknowledgements

The author is thankful to Hankintatukku Oy, to Vapo Oy and to South Savo Development Funds and EMOTR in Finland, to Bioforce AG and Weleda AG in Switzerland for the inspiration and financial support for different parts of this research and to the staff of the herb team of our institute.

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Characterization of the Mentha *collection of Agrifood Research Finland - Mikkeli*

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The importance of mints in Finland

The taste and aroma of mints have always been very popular in Finland. There are several references to its use by the local people hundreds of years ago (Suominen 1966). An indication of its popularity and economic importance is that during the 1990s Finland imported about 8 t of dry mint leaves, 10-20 t of peppermint oil and ca. 10 t of pure menthol a year (Galambosi and Aflatuni 1999).

Due to its popularity and importance, during the last decades mints have been the subject of several research and development projects. During the 1960s and 1970s botanical and chemotaxonomic studies were carried out, during the 1980s mainly agronomic and production technology questions were studied, and during the 1990s, the focus was on quality on the different mint species and varieties. After planting sufficient field crop areas, the distillation of mint essential oil was developed. At present, commercial distillation and product development is taking place, as well as the preservation of mint genetic resources.

Cultivation techniques for mints under Nordic climatic conditions have been the subject of several university diploma studies and one PhD thesis (Aflatuni 2005). In 1999 a research seminar summarized the results obtained so far with mints. The main publications dealing with the different aspects of mint cultivation are presented in Table 1.

Table 1. Mint research activity in Finland during 1966-2006

Subjects studied	References
Endemic mint species and chemotaxonomy	Suominen 1966; von Schantz et al. 1973, 1975
Growing techniques of peppermint	Galambosi 1991; Galambosi et al. 1991; Simojoki 1995
Suitability of peppermint in different latitudes in Finland	Järvi et al. 1994; Heikkinen 1997; Aflatuni et al.1998; Aflatuni and Galambosi 1999; Galambosi et al. 1999; Aflatuni et al.1999; Galambosi 1999
Propagation methods of peppermint	Holm et al. 1989; Sorvari 1997; Aflatuni 1999; Hupila and Galambosi 1999
Mulching and organic fertilization of mint species	Aflatuni 1993; Galambosi 1994; Galambosi and Valo 1999; Kemppainen et al. 1999
Drying and distillation of peppermint	Aflatuni 1999; Korhonen 1999; Pääkkönen et al. 1999
Quality of mint species and mint oils	Galambosi and Holm 1999; Holm 1999; Héthelyi et al. 2002
Yield and quality of mint accessions in Finland	Aflatuni et al. 1999; Galambosi et al. 1999a
Economical questions of mint production	Galambosi and Aflatuni 1999; Karjalainen 1999
Guidelines for long-term conservation of mint genetic resources	Ahokas et al. 2006
False-mint species	Galambosi et al. 1999b

In connection with these research activities, more and more mint species and varieties were collected, studied and cultivated in Finland. A need emerged from the mint growers for a collection of well studied domestic propagation materials of known origins.

History of the mint collection at Agrifood Research Finland – Mikkeli

The basis of the collection was the ca. 15 accessions which were collected during 1984-1988 in the Puumala project of the University of Helsinki (Galambosi et al. 1991). The mints were the subjects of several biological and agrotechnical investigations and new accessions have continually been sought.

From 1988 the authors started to collect and preserve mint accessions available from different institutes, university botanical gardens, projects and growers, collected from within the country and abroad.

The collection was enlarged during 1989-1995 in two research stations of the Agrifood Research Finland, South-Savo Research Station and North Ostrobothnia Research Station (Aflatuni 2005).

Due to the mint rust infection, in Mikkeli the collection was replaced every four years. During the first phase (1998-2001) altogether 49 accessions were collected, transplanted and studied in 2 m^2 plots. In the second phase (2002-2005), the mint collection was replanted into the gene collection of MTT (1 m^2/accession). Several accessions were discarded, due to their bad wintering, mint rust infection, low yield or unsuitable chemical characteristics.

In the third phase (2006-2009), 24 accessions altogether are preserved: 12 of *Mentha* x *piperita* L., 5 of *M. spicata* L., 2 of *M. arvensis* L. and 5 of other mint species (Table 2).

During 1998-2000 the main agronomic characteristics of the accessions were evaluated (growth, overwintering, yield, rust sensitivity, leaf/stem ratio). The essential oil content and composition of leaf yield were analyzed during 1999-2000 in the Department of Pharmacognosy, University of Helsinki (Rautiainen 2000).

- ***Agronomic evaluation of mint accessions***

- **Wintering**

Generally, the wintering of mints at this Nordic latitude (61°) depends on the cultivation sites and on winter conditions. In a soil with good drainage the mints generally winter well. Wet and water-retaining soils are not suitable for mints, as the roots and stolons are sensitive to frost. In spring, early snow melting and night frosts are the most dangerous for the wintering of stolons. This kind of winter caused serious frost damage during 1998-1999. Serious damage was inflicted on *Mentha suaveolens* Ehrh. 'Variegata' (98%), *M. pulegium* L. (85%), *M. spicata* var. *crispa* (Helsinki) (75%), *Mentha arvensis* L. (China) (60%) and *M. arvensis* subsp. *sachalinensis* Briq. (65%) (Galambosi 1999). Mint accessions kept in the present collection in a suitable soil have good overwintering characteristics.

- **Growth and yield**

According to the results presented in Table 3 the height of mints was from 50 to 105 cm. Short accessions were No. 35b *M. aquatica* L. (40 cm) and No. 35 *M. spicata* L. (56 cm). Among spearmints, accessions No. 33 and No. 19/3 are tall (90-110 cm), as well as No. 11 *M. arvensis* L. 'Prilukskaja' (94 cm).

The average fresh yields of the accessions presented in Table 3 ranged between 0.8 and 3.3 kg/m². The dry matter contents of the fresh herbs was from 20 to 25% and the leaf ratio of the total dry herb yield was 50-56%.

Table 2. Species in the mint collection at MTT - Mikkeli in 2007

Species	Accession no.	Accession name		Origin	Year of obtaining
		Scientific name and variety	Finnish		
Mentha* x *piperita	1	*Mentha* x *piperita* L.	piparminttu	Bulgaria	1987
	2	*Mentha* x *piperita* L. 'Mitcham'	piparminttu	Hungary	1984
	3	*Mentha* x *piperita* L.	piparminttu	Czech Rep.	1990
	4	*Mentha* x *piperita* L.	piparminttu	Poland	1992
	5	*Mentha* x *piperita* L.	piparminttu	Finland	1989
	6	*Mentha* x *piperita* L.	piparminttu	USA	1993
	7	*Mentha* x *piperita* L.	piparminttu	China	1993
	8	*Mentha* x *piperita* L. 'Black Mitcham'	piparminttu	Egypt	1996
	14	*Mentha* x *piperita* L. 'Tsornolistnaja'	piparminttu	Russian Fed.	1999
	48	*Mentha* x *piperita* L. 'Native Wilmet'	piparminttu	USA	2000
	49	*Mentha* x *piperita* L. 'Frantsila'	piparminttu	Finland	2000
Mentha spicata	19	*Mentha spicata* L.		Finland	1999
	35	*Mentha spicata* L. 'Bulgaria'	viherminttu	UK (Kew)	1998
	36	*Mentha viridis* L.*	viherminttu	Egypt	1998
	33	*Mentha spicata* L. 'Zgadka'	viherminttu	Russian Fed.	1997
	51	*Mentha spicata* 'Morocco'	marokon minttu	Morocco	1999
Mentha arvensis	11	*Mentha* sp. 'Prilukskaja'	minttu	Russian Fed.	1996
	31	*Mentha arvensis* var. *piperascens* (Holmes) Hara	japaninminttu	China	1993
Other species	10	*Mentha citrata* 'Eau de Cologne'	sitruunaminttu	UK (Scotland)	1996
	21	*Mentha* x *gentilis* var. *parviflora*	jalominttu	Finland	1988
	28	*Mentha suaveolens* Ehrh.	pyöröminttu	Finland	1988
	29	*Mentha* x *dalmatica* Tausch	karjalanminttu	Finland	1997
	35b	*Mentha aquatica* L.	vesiminttu	Austria	2000

* syn. *M. spicata*

Table 3. Some morphological and agronomic features of mint accessions in Mikkeli during 1998-2000 (figures are means of 3 years)

Species	Accession no.	Accession name	Height (cm)	Leaf length x leaf width (cm)	Fresh yield (kg/m²)	Dry matter content (%)	Leaf/ stem ratio (%)
Mentha* x *piperita	1	*Mentha* x *piperita*	68.9	6.4 x 3.3	2.44	22	54/46
	2	*Mentha* x *piperita* 'Mitcham'	67.9	7.1 x 3.2	2.02	25	48/52
	3	*Mentha* x *piperita*	65.5	7.5 x 3.8	1.48	21	55/45
	4	*Mentha* x *piperita*	91.4	7.6 x 4.0	3.33	25	52/48
	5	*Mentha* x *piperita*	80.0	7.1 x 3.8	2.05	24	52/48
	6	*Mentha* x *piperita*	70.4	6.3 x 2.9	2.25	24	53/47
	7	*Mentha* x *piperita*	91.4	9.4 x 4.0	2.43	20	59/41
	8	*Mentha* x *piperita* 'Black Mitcham'	71.0	7.6 x 4.0	2.26	19	62/38
	14	*Mentha* x *piperita* 'Tsornolistnaja'	93.0	5.3 x 2.7	2.14	22	48/52
	48	*Mentha* x *piperita* 'Native Wilmet'	74.0	8.2 x 4.0	1.28	25	55/45
	49	*Mentha* x *piperita* 'Frantsila'	79.3	8.1 x 4.0	1.0	22	54/46
mean			**77.5**	**7.3 x 3.6**	**2.06**	**23**	**54/46**
Mentha spicata	19	*Mentha spicata*	63.4	6.6 x 3.0	1.84	22	56/44
	35	*Mentha spicata* 'Bulgaria'	56.1	5.3 x 2.0	0.78	26	59/41
	36	*Mentha viridis*	80.9	5.3 x 2.3	2.14	23	53/47
	33	*Mentha spicata* 'Zgadka'	103.9	7.7 x 3.4	2.32	27	47/53
	51	*Mentha spicata* 'Morocco'	91.0	6.0 x 3.2	2.91	22	55/45
mean			**79.1**	**6.2 x 2.8**	**1.99**	**24**	**54/45**
Mentha arvensis	11	*Mentha* sp. 'Prilukskaja'	94.4	9.3 x 4.9	3.22	22	48/52
	31	*Mentha arvensis* var. *piperascens*	60.3	7.4 x 4.0	1.21	27	53/47
mean			**77.4**	**8.4 x 4.5**	**2.22**	**25**	**51/49**
Other species	10	*Mentha citrata* 'Eau de Cologne'	62.2	6.0 x 4.8	1.9	19	54/46
	21	*Mentha* x *gentilis* var. *parviflora*	65.8	4.4 x 2.9	2.42	21	52/48
	28	*Mentha suaveolens*	85.2	6.9 x 5.6	1.48	22	56/44
	29	*Mentha* x *dalmatica*	97.3	10.7 x 5.7	2.8	28	50/50
	35b	*Mentha aquatica*	40.3	4.4 x 3.4	1.72	18	75/25
mean			**70.2**	**6.5 x 4.5**	**1.96**	**22**	**57/43**

- **Mint rust infection of peppermint accessions**

Mint rust (*Puccinia menthae* Pers.) is one of the most dangerous diseases for peppermint. We have recorded its occurrence regularly, obtaining data on susceptibility or resistance to mint rust (Table 4): most of the accessions were highly susceptible. Accessions Nos. 2, 3, 6, 7, 8 and 9 had severe infections every year. Among the newest accessions, Nos. 48 and 49 seem to be sensitive to mint rust as well. At the same time some of the accessions had no infections whatsoever. Accessions Nos. 1, 4, 5 and 14 were totally free of mint aecidiospores each year.

Table 4. Occurence of mint rust *(Puccinia menthae* Pers.) on the peppermint accessions *Mentha* x *piperita* in Mikkeli 1999-2002

Accession no.	Date of observation												
	1998					1999						2000	
	16.08	26.08	01.09	30.09*	20.10*	30.07	11.08	18.08	25.08	06.09	21.09	17.08	13.09
1		-	-	-	-	-	-	-	-	-	-	-	-
2	##	##	###	#	-	-	-	##	##	###	###	#	###
3	-	##	###	###	-	#	#	###	###	###	###	#	###
4	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-
6	##	##	###	#	-	-	#	###	###	###	###	#	###
7	-	-	-	#	-	-	-	##	##	###	###	-	-
8	-	#	#	###	###	###	###	###	###	###	###	##	##
9	-	##	###	###	###	-	##	###	###	###	###	-	###
14						-	-	-	-	-	-	-	-
48												-	##
49												#	###

Level of occurrence of aecidiospores:
- = absent # = sporadic only ## = medium ### = abundant (Cells with no value = no observation made)
*= new shoots after first harvest

- ***Characterization of the mint collection***

In the second phase of the collection, we carried out the characterization of the accessions, using the descriptors for *Mentha* spp. developed by A.M. Barata da Silva, Banco Português de Germoplasma Vegetal (BPGV), Braga, Portugal, except for the details of the inflorescence. The descriptors used were the following:

- plant aspects: plant height (cm), plant diameter (cm), growth habit
- stem: main stem diameter (cm), branching type, branching density, stem shape, stem colour and stem pubescence
- cauline leaves: shape of blade, length of fully grown leaf (mm), width of fully grown leaf (mm), colour of fully grown leaf, pubescence, margins
- inflorescence: corolla colour
- chemical composition.

The growth and morphological features of mints were generally normal.

The chemical analyses of the samples collected during 1999 and 2000 were carried out in the Department of Pharmacognosy, University of Helsinki. The results of the analyses are presented in Tables 5, 6 and 7.

Table 5. Characterization of the chemical composition of *Mentha piperita* accessions, Mikkeli, Finland 2005-2006

Accession no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**14**	**48**	**49**
Species	***M.* x *piperita***	***M.* x *piperita* 'Mitcham'**	***M.* x *piperita***	***M.* x *piperita***	***M.* x *piperita***	***M.* x *piperita***	***M.* x *piperita***	***M.* x *piperita***	***M.* x *piperita* 'Tsornolistnaja'**	***M.* x *piperita* 'Native Wilmet'**	***M.* x *piperita* 'Frantsila'**
Origin	Bulgaria	Hungary	Czech Republic	Poland	Finland, (Helsinki)	USA	China	Egypt	Russian Federation	USA	Finland
Chemical composition											
Essential oil rate in dry leaf (v/w)	2.70	2.50	2.00	2.10	1.70	2.55	2.60	2.80	1.60	2.10	2.09
Menthol %	21.09	44.09	44.67	33.50	9.43	39.83	34.68	30.83	32.39	31.30	46.60
Menthon %	3.98	3.18	3.16	28.40	23.41	14.28	3.33	4.75	4.60	38.70	19.80
Limonene %	1.01	1.16	0.97	0.30	0.50	1.29	4.33	1.18	0.71	0.80	0.80
1-8 cineol %	3.80	5.40	4.53	2.20	4.21	5.95	4.60	6.05	4.25	5.10	5.30
Pulegone %	2.17		1.26	2.20	2.28				4.59		
Menthyl acetate %	6.48	4.31	5.22	4.70	5.18	2.28	8.32	1.52	3.78	0.80	1.70
Isomenthon %	26.25	15.50	12.97	6.60	37.08	2.82	23.00	28.86	23.46	4.50	2.90
Carvone %				0.20							

Table 6. Characterization of the chemical composition of *Mentha spicata* and *M. arvensis* accessions, Mikkeli, Finland 2005-2006

Accession number	**19**	**51**	**33**	**35**	**36**	**11**	**31**
Species	***M. spicata***	***M. spicata* 'Morocco'**	***M. spicata* 'Zgadka'**	***M. spicata***	***M. viridis***	***Mentha* sp. 'Prilukskaja'**	***M. arvensis* var. *piperascens***
Origin	Finland	Morocco	Russian Federation	Bulgaria	Egypt	Russian Federation	China
Chemical composition							
Essential oil rate in dry leaf (v/w)	1.10	1.89	1.76	1.32	2.15	4.58	
Menthol %	6.27	0.40	0.58	0.48	0.32	57.58	71.30
Menthon %	8.86		0.17			17.13	14.19
Limonene %	4.78	4.80	10.00		2.71	2.73	1.47
1-8 cineol %	11.98	2.60	0.14	1.28	5.24	0.18	0.14
Pulegone %			1.27				
Menthyl acetate %	3.41					3.92	
Isomenthon %	1.52					3.17	
Carvone %	25.00	69.60	66.29	1.40	59.52	3.04	
Linalool %				88.05			

Table 7. Characterization of the chemical composition of other mint species, Mikkeli-Finland, 2005-2006

Accession number	**10**	**21**	**28**	**29**	**35b**
Species	***M. citrata*** **'Eau de Cologne'**	***Mentha* x *gentilis*** **var. *parviflora***	***Mentha suaveolens***	***Mentha* x *dalmatica***	***Mentha aquatica***
Origin	UK (Scotland)	Finland	Finland (Helsinki)	Finland	Austria
Chemical composition					
Essential oil rate in dry leaf (v/w)	2.37	2.09	2.73	1.89	0.92
Menthol %			0.50		6.40
Menthon %		0.16			
Limonene %	0.38	4.72	12.45	9.40	3.70
1-8 cineol %	2.58	3.24	5.19	0.90	9.40
Pulegone %					
Menthyl acetate %					0.70
Isomenthon %					
Carvone %		30.18	64.62	62.70	2.10
Linalool %	31.55				
Linalyl acetate %	27.65				
Geraniol %	4.50				
Geraniolacetate %	5.64				
ß-caryophyllene %		5.92	7.90		7.20
3-octanol %		20.35			
Mentofurane %					36.20
Viridiflorol %					17.10

- **Peppermint accessions**

According to the European Pharmacopoeia requirements (Council of Europe 1997), the essential oil of peppermint should be 1.2% of the dry weight (Holm 1999). The oil contents of accessions ranged between 1.7 and 2.8% (Table 5). No significant differences occurred in the contents of limonene, 1-8 cineol, pulegone and carvone.

The menthol contents of the essential oil ranged between 30 and 46%, except for two accessions: No. 5 (from Helsinki) had very low menthol content (9.43%) and No. 1 (from Bulgaria) had a lower content (21.0%) than the Pharmacopoeia requirement (30.0–55.0%).

The menthon content should be 14-32%. In the collection only four oils fulfilled this requirement (accessions No. 4, 5, 6 and 49). Four accessions (Nos. 1, 2, 3 and 7) had very low contents, 3.1-3.98%. One accession, No. 48, had a higher content than required (38.7%).

The isomenthon content of peppermint oil should be 1.5–10%. Only four accessions fulfilled this requirement (Nos. 4, 6, 48 and 49), the oil of other accessions had higher isomenthon contents. Those accessions which had low menthon content (1, 2, 3 and 7) had high isomenthon contents: 13-26%.

The menthyl acetate content in the oil has to be 2.8–10.0%. From 11 accessions studied, its content in 3 accessions was lower, between 0.8 and 1.7% (accessions Nos. 8, 48 and 49).

The high variation of the main compounds and their departure from the Pharmacopoeia requirements needs to be studied further. Several research results demonstrate that the quality of essential oil depends on harvesting at the right phenological phases (Héthelyi et al. 2002; Aflatuni 2005). The short growing season in Finland and the lack of time for completion of the growth phases of the shoots and leaves could be the reason for the phenomena observed.

- **Spearmint accessions**

According to the French Pharmacopoeia (Holm 1999), spearmint oil has to contain 55-67% carvone and 2-55% limonene. In our collection, the oil of three of the *M. spicata* accessions (Nos. 33, 36 and 51) fulfilled these requirements, having high carvone content (59-69%) and 2.7-10% of limonene. The Finnish accession (No. 19) had very low carvone content and a non-characteristic aromatic scent. In accession No. 35, originally from Kew Botanical Garden, London, while its external morphological features were similar to those of other spearmints, the chemical composition was irregular. Its main compound was 88% linalool, and the characteristic of the smell was sweet, resembling that of lavender.

- **Japanese mint accessions**

Accession No. 31, *M. arvensis* var. *piperascens,* originating from China, had a high content of menthol (71%). The Russian origin variety 'Prilukskaja' had a high (57.5%) menthol content, but it had several other small components as well. 'Prikulskaja' had very high biomass potential, on average 3.2 kg/m².

- **Other mint species**

From the group of the other mint species three accessions are endemic species in Finland. Accessions No. 2, *M. suaveolens* Ehrh. and No. 29, *M.* x *dalmatica* Tausch have

good wintering, strong upright growth and good yield potential. The main component of their essential oil is carvone (62-64%). No. 21, *M.* x *gentilis* var. *parviflora* is a smaller species, with quite pleasantly scented essential oil. Its main components are carvone (30.18%) and 3-octanol (20.35%). All three species were used by the Finnish and Karelian populations in former times (Suominen 1966). Due to the high content of mentofurane (36.20%) *Mentha aquatica* L. has no pleasant scent for utilization.

The most pleasant oil composition in this group is from accession No. 10, *M.* x *citrata* – originating from the Medicinal and Aromatic Garden of the Scottish Agricultural College, Ayr. This species has high essential oil content (2.37%) with linalool and linalyl acetate, and the smell is similar to that of lavender. Unfortunately its wintering is poor at this latitude (30-50%).

- ***Utilization of the mint collection***

During its existence, the mint collection of MTT has been used for different purposes. Several accessions have been provided for cultivation in North Finland and at 64° latitude (Aflatuni 2005).

The antioxidant activity of ten accessions was tested in the University of Helsinki (Dorman et al. 2003.) Cultivation techniques and quality of several mints were the subjects of four university diploma studies (Niskanen 1996; Heikkinen 1997; Sorvari 1997; Rautiainen 2000).

Propagation materials of the best varieties were provided to several growers in Finland. At present mints are generally cultivated in special herb farms which make their own products. Professional growers cultivate Japanese mint for oil distillation and two alcoholic products are marketed in Finland using domestically produced essential oils. Several accessions were also provided to Estonian growers.

Mints have a significant role among the medicinal and aromatic plants in Finland. Due to the high hand labour requirements, their cultivation at present is limited to only a few hectares. The interest in studies and demand for high quality varieties is increasing among the growers. One of the most important roles of the MTT mint collection is to keep the studied accessions as a gene collection and provide propagation materials for the specialist growers and researchers.

On the basis of the last 15 years, abundant experience has been obtained on maintaining and caring for mints and other medicinal and aromatic plant species collections. According to the Finnish National Programme for Plant Genetic Resources, guidelines for long-term conservation of herbs and medicinal plants have been created, including for *Armoracia, Humulus lupulus*, *Mentha, Arnica, Acorus* and *Rhodiola* species (Ahokas et al. 2006.)

Acknowledgement

The authors are thankful to Dr Yvonne Holm, Department of Pharmacognosy, University of Helsinki, for chemical analyses of the samples.

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Biodiversity protection of medicinal and aromatic plants in Georgia

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In 1994 Georgia ratified the Convention on Biological Diversity (CBD) and assumed an obligation to protect the diversity of flora, fauna and ecosystems within its own territory and to support the conservation of global biodiversity.

Regarding medicinal and aromatic plants (MAPs), we have developed recommendations for Georgia based on historically traditional priorities, dealing with the growth and production technology of ecologically sound standard raw materials and products derived from medicinal plants: *Valeriana officinalis* L., *V. colchica* Utkin (endemic), *Calendula officinalis* L., *Melissa officinalis* L., *Carum carvi* L., *Chelidonium majus* L. and other endemic species.

The study of the interactions between soil, environment, plant, fertilization and harvest led to the development of a predictive diagnostic model and the impact of ecosystems on productivity, quality of raw materials and production has been described (Korakhashvili 2001; Kacharava 2003).

Successful current activities include:

1. Survey of unique biodiversity and natural resources, natural habitats and populations;
2. Study of the impact of ecosystems on genetic resources and their protection;
3. Study of the influence of the ecosystem and of the varieties on the productivity and quality of MAPs;
4. Determination of MAP chemical composition;
5. Searching for new MAPs as well as pharmacologically active substances.

Plantations of MAPs have been established, thus promoting the preservation of the unique genepool of the country.

Valerian (*Valeriana officinalis* L.) deserves special interest: indeed, this species is not only an extremely valuable species and an indispensable raw material for the domestic pharmacological industry, but also has a serious prospect of being exported. Therefore valerian has been the subject of detailed studies in Georgia, including both its cultivated and wild forms (Korakhashvili and Kacharava 2002; Kacharava 2004; Korakhashvili and Kacharava 2007).

Valerian is also used as a spice, basically in Europe (e.g. fresh leaves are added to salads in England) while in the USA they are used for essences, cordials, liqueurs and infusions.

The most widely used MAPs in Georgia are *Valeriana officinalis* L., *Calendula officinalis* L., *Melissa officinalis* L., *Carum carvi* L. and *Chelidonium majus* L., all used as components of herbal teas for everyday use, in both preventive and curative medicine.

Intensification of the selection of varieties and cultivation of ecologically sound industrial plantations of MAPs on the basis of ecological, biological and medical research will promote the conservation of the unique genepool of our country, the biodiversity of which is decreasing as the use of raw plant materials in both medicine and in domestic life is increasing.

The areas and numbers of populations of MAPs have decreased in recent years in Georgia, owing to the following factors: loss of areas of distribution, excessive use of pastures causing variations in the vegetation cover, erosion and uncontrolled collecting of MAPs. It must be noted that areas and populations of wild medicinal plants have not been inventoried in recent years.

One of the major priorities regarding MAP production is the creation of a standard, high- capacity Seed Bank. This modern bank of germplasm is now in the process of development in Georgia.

Selection of MAPs is desirable to supply the domestic market with highly productive, standardized and comparatively cheap seeds, and to maintain the seeds of the unique endemic varieties in seed banks.

Local varieties of MAPs are distinguished not only by their adaptability to local ecosystems but also by their resistance to various diseases and pests as well as by their high productivity and quality.

An "artificial diversity" has been obtained through the use of genetic methods such as hybridization, mutation, genetic and cellular engineering, leading to the creation of new varieties.

The preservation of biodiversity includes conservation of crop plants with their allied wild forms along with the whole ecosystem. Preservation and management of plant genetic resources in Georgia is possible through their conservation and sustainable use.

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Sideritis *species in Greece: the current situation*

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Introduction

Greece has a flora which is very rich in medicinal and aromatic plant (MAP) species; many of them are endemic. The natural resources of several MAP species are now limited. Over-exploitation, destructive harvesting techniques and the depletion or conversion of natural habitats, pollution and climate changes that influence ecosystems have led to some of these plants being threatened. Protection and preservation of medicinal plants is of great importance all over the world and the countries where these plant species are indigenous and growing wild must ensure that they survive by using appropriate strategies.

The most important and commercially valuable species of the Greek flora are conserved *ex situ* in the **Department of Medicinal and Aromatic Plants** of the National Agricultural Research Foundation (NAGREF).

The main activities of the MAP Department are:

- Maintaining collections of MAPs
- Identification, *ex situ* conservation, adaptation and introduction into cultivation and contribution to genetic improvement of MAPs
- Organic techniques for MAPs cultivation
- Production and analysis of essential oils from wild-growing and cultivated MAPs
- Characterization of the MAP species/varieties by their essential oil analysis and through our databank.

The *Sideritis* species

Among the threatened wild-growing species in Greece are those of the genus *Sideritis* (Lamiaceae). The *Sideritis* species, known here as Greek "mountain tea", are used traditionally as a popular decoction, widely consumed and well established in folk medicine for its many therapeutic properties.

Greek mountain tea is a group of different species, indigenous to Greece, of the genus *Sideritis,* which includes about 140 species. Ten species are annual and the rest of them are perennial (Baden 1991). The annual species are indigenous to the area that extends from the Eastern Mediterranean coast as far as Armenia and the Middle East. The perennial species are indigenous to mountainous areas of Greece, Turkey, Lebanon, Syria, North Africa, the Iberian Peninsula, the Canary Islands and Madeira.

The genus *Sideritis* is a taxonomically complex group. According to Hayek (1929) in "Prodromus Florae Peninsulae Balcanicae", ten taxa were accepted for Greece. Heywood et al. (1972) in "Flora Europaea" reduced the number of taxa occurring in Greece to four. Taxonomic revision (Papanikolaou and Kokkini 1982) of *Sideritis* L.

section Empedoclia, reported the following species of the genus *Sideritis* as part of the Greek flora:

- *Sideritis raeseri* Boiss. et Heldr.
- *Sideritis clandestina* Chaub. et Borry
- *Sideritis scardica* Griseb.
- *Sideritis euboea* Heldr.
- *Sideritis athoa* Papanikolaou et Kokkini
- *Sideritis perfoliata,* reported as syn. *S. athoa*
- *Sideritis syriaca* L., syn. S. *cretica* Sibth. et Sm.

Sideritis species grow mainly in stony or rocky places at high altitudes, and they are collected from natural populations which grow only in mountain areas.

The first step for the protection and preservation of threatened *Sideritis* species is *ex situ* conservation by preserving their seeds and germplasm. The second step is to introduce them into cultivation, to cover the increasing demands from consumers.

From the various species of *Sideritis* only *S. raeseri*, which is the most widespread, is systematically cultivated in Greece. Its cultivation started in the late 1960s, on soils of low productivity in mountainous and semi-mountainous areas at an altitude higher than 700 m. Genetic material taken from the indigenous populations of the region is used to provide the cultivated material.

The other species, *S. clandestina*, *S. syriaca* and *S. scardica*, which have fewer populations compared to *S. raeseri*, are threatened as well, due to over-collecting to cover the increasing demand. In particular, *S. scardica* which grows in the wild mainly on Mt. Olympus, has colonies which are easily approached, because Mt. Olympus is a tourist trap. All Greek species are cross-pollinated, thus every colony at a particular site is a different open-pollinated population (Goliaris et al. 1999). As a result, the evolution of the species is speeding up through natural hybridization.

- ***Chromosomal study***

All the species of the genus *Sideritis* have the same number (2n=32) of isodiametric and metacentric A chromosomes (Goliaris 1995). The different phenotypes of the species denote variance among the genes. Some variance potentially exists in the genes that control the phenotype of the bract leaves.

- ***Biological activities***

Plant extracts and essential oils of many *Sideritis* species are biologically active, mainly due to their flavonoid and terpenoid content (Papanicolaou and Kokkini 1984; Villar et al. 1984; Samaras et al. 2002). Modern studies have shown that some *Sideritis* species have anti-inflammatory, anti-ulcer, analgesic, antimicrobial, antirheumatic and antioxidant activities (Menghini et al. 2005; Gabrieli et al. 2005).

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Main fields of research activity on medicinal and aromatic plant species in Hungary in relation to the ECPGR "priority list"

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Considerable amounts of the medicinal and aromatic plant (MAP) drugs which are produced and commercialized in Hungary come from indigenous sources even now (Bernáth 1992, 1993, 1994). The ratio of raw plant material providing the drugs utilized in traditional medicine is about 40% indigenous and 60% cultivated origin. If the amount of MAP drugs which are produced for industrial processing is included, the ratio of plant material coming from the indigenous flora decreases to 30-40%. These figures mean that an enormous amount of plant material, about 10 000-15 000 t of dry biomass, is removed from the Hungarian indigenous flora, year after year. This exploitation of natural plant populations - without scientific analysis and control – is likely to harm the biodiversity of the Hungarian flora.

To avoid the extinction of the plant populations utilized as MAPs, systematic ecological, chemical and biological investigations leading to their production in cultivation have to be initiated. At the same time the genebank conservation of the species and their chemotaxa has to be accelerated.

In this report our first aim is to give an overview on the Hungarian MAPs of greatest importance, whether produced by collecting in the wild or by cultivation. We have also compiled detailed descriptions and characterizations of the ecological requirements of the species, which may have a great influence on further utilization.

The second intention of this work is to demonstrate Hungarian efforts on species/genera which are on the priority list of the ECPGR MAP Working Group[12], indicating which of them are being studied and what detailed investigations are in progress.

Finally we wish to demonstrate the importance of chemical diversity of secondary compounds, which has great importance from the point of view of gene conservation. We present our up-to-date results on wild-growing *Achillea collina* Becker populations, found in the Carpathian Valley.

Description and characterization of ecological requirements of the Hungarian MAP species of great importance

From the Hungarian plant spectrum, 97 wild-growing and 55 cultivated species are listed in Tables 1 and 2. The species are characterized from different points of view, describing their geographical distribution and the original habitat of occurrence, as well as their known ecological requirements.

[12] Appendix I in Baričevič et al. (2004).

Keys to abbreviations used in the Tables

- Tables 1 and 2
  - The definition of "**life forms**" was applied according to the Raunkier system as published by Simon (1992). The abbreviations of life forms are as follows:

MM	tree	Ch	Chamaephyte	TH	Hemitherophyte
M	shrub	H	Hemicryptophyte	Th	Therophyte
N	semi-shrub	G	Cryptophyte	E	Epiphyte

  - The **geographical distribution** of the species was completed using data from various authors (Simon et al. 1984; Simon 1992; Bernáth 2000). The terms of abbreviations were used in conformity with Simon (1992):

ad	adventive	Cont	Continental	N	North
Afr	African	E	East	Pont	Pontius
Am	American	Eu	European	S	South
amph-Atl	Amphyatlantic	Eua	Eurasian	sib	Siberian
As	Asian	Eusib	Eurosiberian	Subatl	Subatlantic
Atl	Atlantic	Ind	Indian	SubMed	Submediterranean
Circ	Circumpolar	Med	Mediterranean	Trop	Tropical
cosm	cosmopolitan	midl	middle	W	West

  - The **ecological requirements** of the species are characterized by giving "T" (temperature regime), "W" (water regime) and "R" (soil reaction) data of the actual plant habitats. The categories used in evaluation and some of the data were taken from the works of Ellenberg (1950) and Walter (1979) and completed by the results of up-to-date botanical research (Simon 1992) and our own observations (Bernáth 2000).

- Table 2
  - The **ecological amplitudes** of the species were identified by using data of Duke and Hurst (1975), which were completed from many other literature sources published since then. The abbreviations are identical to the terms which were used in the original publication of Duke and Hurst, fixing the name of the actual life zone of geographical occurrence (after Holdridge 1966), which were characterized by the mean annual temperature values of the zone and the amount of precipitation:

Tx	Tropical Desert Scrub	(>24°C, 125-250 mm)
Tt	Tropical Thorn Woodland	(>24°C, 250-500 mm)
Tv	Tropical Very Dry Forest	(>24°C, 500-1000 mm)
Td	Tropical Dry Forest	(>24°C, 1000-2000 mm)
Tm	Tropical Moist Forest	(>24°C, 2000-4000 mm)
Tw	Tropical Wet Forest	(>24°C, 4000-8000 mm)
St	Subtropical Thorn Woodland	(18-24°C, 250-500 mm)
Sd	Subtropical Dry Forest	(18-24°C, 500-1000 mm)
Sm	Subtropical Moist Forest	(18-24°C, 1000-2000 mm)
Sw	Subtropical Wet Forest	(18-24°C, 2000-4000 mm)
Wt	Warm Temperate Thorn Steppe	(12-18°C, 250-500 mm)
Wd	Warm Temperate Dry Forest	(12-18°C, 500-1000 mm)
Wm	Warm Temperate Moist Forest	(12-18°C, 1000-2000 mm)
Cs	Cool Temperate Steppe	(6-12°C, 250-500 mm)
Cm	Cool Temperate Moist Forest	(6-12°C, 500-1000 mm)
Cw	Cool Temperate Wet Forest	(6-12°C, 1000-2000 mm)

Table 1. Characterization of medicinal and aromatic plants growing wild in Hungary (for abbreviations see text p.116)

Species	Life form	Geographical distribution	Characterization of original habitat by TWR values		
			"T" (temperature regime)	"W" (water regime)	"R" (soil reaction)
Achillea collina	H	E-midl-Eu	deciduous forest	dry	not specific
Acorus calamus	HH	S-SE-As	Med. Atlantic-evergreen forest	rather watery	slightly limy
Adonis vernalis	H	Eua-Cont	Sub-Mediterranean	moderately dry	limy, basic
Aesculus hippocastanum	MM	S-Eu-S-As	deciduous forest	moderately moist	not specific
Agrimonia eupatoria	H	Eu-(Med)	deciduous forest	moderately dry	close to neutral
Agropyron repens	G	Circ	deciduous forest	moderately dry	not specific
Alkanna tinctoria	H	SubMed	Med. Atlantic-evergreen forest	extremely dry	limy, basic
Althaea officinalis	H	Eua-(Med)	deciduous forest	moderately wet	limy, basic
Arctium lappa	TH	Eua-(Med)	deciduous forest	moderately wet	slightly limy
Artemisia absinthium	H	Eua-(Med)	Sub-Mediterranean	moderately dry	slightly limy
Artemisia vulgaris	H	circ-(Med)	deciduous forest	moderately moist	not specific
Atropa belladonna	H	Atl-Med-(midl-Eu)	deciduous forest	moist	close to neutral
Betula pendula	MM	Eusib	taiga	moderately moist	close to neutral
Calluna vulgaris	Ch	Eu	deciduous forest	moderately moist	acidic
Capsella bursa-pastoris	Th	Cosm	Sub-Mediterranean	moist	not specific
Castanea sativa	MM	SubMed	Sub-Mediterranean	moderately moist	slighty acidic
Centaurium erythraea	Th, TH	Eua-(Med)	deciduous forest	moist	close to neutral
Chelidonium majus	H	Eua-(Med)	deciduous forest	moderately moist	limy, basic
Cichorium intybus	H	Eua-(Med)	Med. Atlantic-evergreen forest	moist	slightly limy
Colchicum autumnale	G	midl-Eu-(SubMed)	deciduous forest	moderately wet	slightly limy
Consolida orientalis	Th	Se-Eu-S-Med	Med. Atlantic-evergreen forest	moderately dry	slightly limy
Consolida regalis	Th	Eua	Med. Atlantic-evergreen forest	moderately dry	slightly limy
Convallaria majalis	H	Eu	deciduous forest	moderately moist	close to neutral
Corylus avellana	M	Eu	deciduous forest	moist	close to neutral

Table 1 (cont.). Characterization of medicinal and aromatic plants growing wild in Hungary (for abbreviations see text p.116)

Species	Life form	Geographical distribution	Characterization of original habitat by TWR values		
			"T" (temperature regime)	"W" (water regime)	"R" (soil reaction)
Cotinus coggygria	M	S-Eua	Sub-Mediterranean	dry	limy, basic
Crataegus monogyna	M	Eua-(Med)	deciduous forest	moderately moist	close to neutral
Crataegus laevigata	M	midl-Eu	deciduous forest	moist	close to neutral
Cynodon dactylon	G	Cosm	Sub-Mediterranean	moderately dry	not specific
Datura stramonium	Th	Cosm	deciduous forest	moderately moist	not specific
Dryopteris filix-mas	H	Cosm	mixed coniferous-deciduous	moist	not specific
Echium vulgare	TH	Eua	Sub-Mediterranean	moderately dry	not specific
Epilobium parviflorum	H	S-Eua	deciduous forest	watery	not specific
Equisetum arvense	G	Circ	not specific	moderately watery	not specific
Euphrasia rostkoviana	Th	Subatl-midl-Eu	deciduous forest	moist	close to neutral
Filipendula ulmaria	H	Eusib	taiga	moderately watery	not specific
Frangula alnus	M	Eua-(Med)	deciduous forest	wet	close to neutral
Fumaria officinalis	Th	Eua-(Med)	Sub-Mediterranean	moderately dry	slightly limy
Galega officinalis	H	SE-Eua-Pont-Med	deciduous forest	moderately watery	slightly limy
Galium odoratum	H	Eua	deciduous forest	moist	close to neutral
Galium verum	H	Eua-(Med)	deciduous forest	moderately dry	slightly limy
Geum urbanum	H	Eua-(Med)	deciduous forest	moderately moist	slightly limy
Glechoma hederacea	H-Ch	Eua	deciduous forest	wet	not specific
Glycyrrhiza glabra	H	Pont-Med	Med. Atlantic-evergreen forest	moist	slightly limy
Gypsophila paniculata	H	Eua	Sub-Mediterranean	dry	limy, basic
Hedera helix	E-M	Atl-Med	deciduous forest	moist	close to neutral
Helichrysum arenarium	H	midl-Eua	deciduous forest	rather dry	not specific
Hepatica nobilis	H	Eu	deciduous forest	moist	slightly limy
Herniaria glabra	Th-TH	Eua-(Med)	Sub-Mediterranean	dry	slightly acidic

Table 1 (cont.). Characterization of medicinal and aromatic plants growing wild in Hungary (for abbreviations see text p.116)

Species	Life form	Geographical distribution	Characterization of original habitat by TWR values		
			"T" (temperature regime)	"W" (water regime)	"R" (soil reaction)
Hyoscyamus niger	TH-Th	Eua-(Med)	Sub-Mediterranean	moderately dry	not specific
Hypericum perforatum	H	Eua-(Med)	deciduous forest	moderately dry	not specific
Inula helenium	H	Adv	Med. Atlantic-evergreen forest	moist	slightly limy
Juniperus communis	M	Circ	mixed coniferous-deciduous	moderately dry	slightly limy
Lamium album	H	Eua-(Med)	deciduous forest	moderately moist	not specific
Leonurus cardiaca	H	Eua-(Med)	deciduous forest	moderately dry	slightly limy
Malva sylvestris	Th-TH	Eu-SubMed	deciduous forest	moderately wet	slightly limy
Marrubium vulgare	H-Ch	Eua	Med. Atlantic-evergreen forest	moderately moist	close to neutral
Matricaria chamomilla	TH-Th	Eua	Sub-Mediterranean	moderately moist	limy, basic
Melilotus officinalis	Th-TH	Eua-(Med)	Sub-Mediterranean	moderately moist	not specific
Nepeta cataria	H	Eua-(Med)	deciduous forest	moderately dry	slightly limy
Ononis spinosa	Ch-H	Eua-(Med)	deciduous forest	moderately dry	not specific
Origanum vulgare	H	Eua-(Med)	deciduous forest	moderately dry	slightly limy
Papaver rhoeas	Th	Eua	Med. Atlantic-evergreen forest	moderately dry	slightly limy
Pinus sylvestris	MM	Eua	taiga	moderately dry	limy, basic
Plantago spp.	H	Eua	deciduous forest	moderately moist	not specific
Polygonatum odoratum	G	Eua-(Med)	deciduous forest	moderately dry	slightly limy
Polygonum aviculare	Th	Cosm	not specific	moderately moist	close to neutral
Populus nigra	MM	Eua-(S-Eu)	deciduous forest	wet	slightly limy
Potentilla anserina	H	Cosm	deciduous forest	wet	close to neutral
Potentilla erecta	H	Eua-(Med)	deciduous forest	wet	not specific
Primula veris	H	Eua	deciduous forest	moderately dry	limy, basic
Pulmonaria officinalis	H	midl-(Eu)	deciduous forest	moderately wet	close to neutral
Rosa spp.	M	Eua-(Med)	deciduous forest	moderately dry	close to neutral

Table 1 (cont.). Characterization of medicinal and aromatic plants growing wild in Hungary (for abbreviations see text p.116)

Species	Life form	Geographical distribution	Characterization of original habitat by TWR values		
			"T" (temperature regime)	"W" (water regime)	"R" (soil reaction)
Rubia tinctorium	H	Adv	Sub-Mediterranean	dry	not specific
Rumex spp.	Th, H	Eua-(Med)	deciduous forest	dry	slighty acidic
Sambucus nigra	M-MM	Eua-(Med)	deciduous forest	moist	close to neutral
Saponaria officinalis	H	Eua-(Med)	deciduous forest	moderately moist	not specific
Solidago canadensis	H	Adv	not specific	moderately watery	slightly limy
Solidago virgaaurea	H	Eua-(Med)	mixed coniferous-deciduous	moderately moist	close to neutral
Stellaria media	Th-TH	Cosm	not specific	moist	not specific
Symphytum officinale	H	Eu	deciduous forest	moderately watery	not specific
Tanacetum vulgare	H	Eua-(Med)	deciduous forest	wet	not specific
Taraxacum officinale	H	Eua-(Med)	not specific	moist	not specific
Thymus serpyllum	Ch	midl-S-Eu	deciduous forest	rather dry	close to neutral
Tilia spp.	MM	midl-SE-Eu	deciduous forest	moist	close to neutral
Tussilago farfara	G (H)	Eua-(Med)	deciduous forest	moist	slightly limy
Urtica dioica	H	Cosm	deciduous forest	moist	slightly limy
Vaccinium myrtillus	Ch-N	Circ	taiga	moderately moist	acidic
Valeriana officinalis	H	Eua-(Med)	deciduous forest	moderately moist	slightly limy
Veratrum album	G	Eua	deciduous forest	wet	slightly limy
Verbascum phlomoides	TH	Eua-(Med)	deciduous forest	moderately dry	slightly limy
Verbena officinalis	TH-H	Cosm	Sub-Mediterranean	moderately moist	slightly limy
Veronica officinalis	Ch	amph-Atl	deciduous forest	moderately moist	slighty acidic
Vinca minor	Ch	SubMed-(midl-Eu)	deciduous forest	moderately moist	close to neutral
Viola odorata	H	Eu	Sub-Mediterranean	moderately moist	slightly limy
Viola tricolor	Th-H	Eua	deciduous forest	moderately dry	not specific
Viscum album	E	S-Eua-(Med)	deciduous forest	moderately moist	not specific

Table 2. Ecological characteristics of medicinal and aromatic plants of greatest importance cultivated in Hungary (for abbreviations see text p.116)

Species	Life form	Geographical distribution	Holdrige-Duke life zone	Categorization of original habitat by TWR values		
				"T" (temperature regime)	"W" (water regime)	"R" (soil reaction)
Achillea collina	H	E-midl-Eu	Cm-Sd	deciduous forest	dry	not specific
Althaea officinalis	H	Eua-(Med)	CM-Sd	deciduous forest	moderately wet	limy, basic
Althaea rosea var. *nigra*	H-TH	S-Eu-(Med)	Cm-Sd	Sub-Mediterranean	moist	not specific
Anethum graveolens	H	Med-E-India	Bw-Txt	Mediterranean, Atlantic evergreen forest	moist	not specific
Angelica archangelica	TH	Eua-N-Eu	Cmw-Wd	mixed coniferous decidous forest	moist	not specific
Anthemis nobilis	H	Med	Wdm-Sdm	Mediterranean, Atlantic evergreen forest	moist	not specific
Artemisia absinthium	Cg-H	Eua-(Med)	Cmw-Sd	Sub-Mediterranean	moderately dry	slightly limy
Artemisia annua	Th	Eua	Cmw-Wmd	deciduous forest	moderately fresh	slightly limy
Artemisia dracunculus	H	N-E-As-(N-Am)	Bm-Wtm	mixed coniferous decidous forest	moderately wet	close to neutral
Borago officinalis	Th	As-S-Eu-Afr	Cmw-Sd	Sub-Mediterranean	moist	not specific
Brassica spp.	Th	Eua-Med	Cmw-Txt	Sub-Mediterranean	dry	not specific
Calendula officinalis	Th	Med	Cmw-Tv	Mediterranean, Atlantic evergreen forest	dry	not specific
Carthamus tinctorius	Th	As-Ind-Med	Cmw-Tv	Mediterranean, Atlantic evergreen forest	moderately dry	not specific
Carum carvi var. *annua*	Th	Eua-(Med)	Bm-Wdm	Sub-Mediterranean	moderately wet	close to neutral
Carum carvi var. *biennis*	TH	Eua	Bm-Txt	deciduous forest		close to neutral
Chrysanthemum cinerariaefolium	H	S-Eu-Med	Cm-Txt	Mediterranean, Atlantic evergreen forest	rather dry	limy, basic
Cnicus benedictus	Th	Med-As	Cmw-Txt	Sub-Mediterranean	moderately moist	not specific
Coriandrum sativum	Th	Med	Cmw-Tv	Sub-Mediterranean	moist	close to neutral
Cucurbita pepo var. *styriaca*	Th	Am-Trop	Cmw-Tv	Sub-Tropical	moist	close to neutral

Table 2 (cont.). Ecological characteristics of medicinal and aromatic plants of greatest importance cultivated in Hungary (for abbreviations see text p.116)

Species	Life form	Geographical distribution	Holdrige-Duke life zone	Categorization of original habitat by TWR values		
				"T" (temperature regime)	"W" (water regime)	"R" (soil reaction)
Digitalis lanata	TH	Balk-Pann	Csm-Sd	Sub-Mediterranean	moderately dry	slightly limy
Dracocephalum moldavica	Th	E-midl-As	Cm-Wd	mixed coniferous decidous forest	moist	close to neutral
Echinacea spp.	H	N-Am	Cm-Wd	mixed coniferous decidous forest	moist	close to neutral
Fagopyrum esculentum	Th	Didl-As	Cm-Sd	mixed coniferous decidous forest	moist	close to neutral
Foeniculum vulgare	H	S-Eu-(Med)	Cmw-Tv	Sub-Mediterranean	moderately dry	close to neutral
Hippophaë rhamnoides	M	Eua-(Med)	Bm-Cm	Sub-Mediterranean	moderately dry	limy, basic
Humulus lupulus	H	Circ	Cmw	deciduous forest	wet	not specific
Hyoscyamus niger	H-Th	Eua-(Med)	Cmw-Tw	Sub-Mediterranean	moderately dry	not specific
Hypericum perforatum	H	Eua-(Med)	Cmw	deciduous forest	moderately dry	not specific
Hyssopus officinalis	Ch	Med-(As)	Cmw-Sd	Mediterranean, Atlantic evergreen forest	dry	limy, basic
Lavandula angustifolia	N	Med-(S-Eu)	Cmw-Wmd	Mediterranean, Atlantic evergreen forest	dry	limy, basic
Lavandula x intermedia	N	Med-(S-Eu)	Cmw-Wmd	Mediterranean, Atlantic evergreen forest	dry	limy, basic
Leuzea carthamoides	H	E-Sib-(midl-As)	Bm-Cm	taiga	moderately dry	not specific
Levisticum officinale	H	S-W-As	Cw-Wt	deciduous forest	moist	not specific
Linum usitatissimum	Th	E-Med	Cmw-Tvd	Sub-Mediterranean	moderately dry	slightly limy
Majorana hortensis	Th	N-Afr-S-W-As	Cmw-Sdm	Mediterranean, Atlantic evergreen forest	moderately dry	close to neutral
Malva sylvestris subsp. *mauritiana*	H	Med-N-Afr	Cm-Sdm	Mediterranean, Atlantic evergreen forest	moderately dry	close to neutral
Marrubium vulgare	H-Ch	Eua	Cmw-Wtm	Mediterranean, Atlantic evergreen forest	moderately moist	close to neutral
Matricaria chamomilla	Th	Eua	Cw-Sd	Sub-Mediterranean	moderately moist	limy, basic
Melissa officinalis	H	S-(midl)-Eua	Cmw-Sd	deciduous forest	moderately dry	limy, basic

Table 2 (cont.). Ecological characteristics of medicinal and aromatic plants of greatest importance cultivated in Hungary (for abbreviations see text p.116)

Species	Life form	Geographical distribution	Holdrige-Duke life zone	Categorization of original habitat by TWR values		
				"T" (temperature regime)	"W" (water regime)	"R" (soil reaction)
Mentha piperita	H	E-As-(Eu)	Cmw-Sdw	deciduous forest	moderately wet	not specific
Ocimum basilicum	Th	Ind-(S-As)	Cmw-Tmw	Mediterranean, Atlantic evergreen forest	moist	slightly limy
Oenothera erythrosepala	Th	Eu-(N-Am)	Csm-Wdm	deciduous forest	moderately dry	not specific
Papaver somniferum	Th	As-(W-Med)	Csw-Tvd	Sub-Mediterranean	moderately moist	close to neutral
Pimpinella anisum	Th	Med-(N-Afr)	Cw-Sm	Sub-Mediterranean	moderately moist	close to neutral
Plantago spp.	H	Eua	Cm-Sd	deciduous forest	moderately moist	not specific
Ruta graveolens	N	Med	Cmw-Tm	Mediterranean, Atlantic evergreen forest	moderately dry	limy, basic
Salvia officinalis	H-N	Med	Cmw-Td	Mediterranean, Atlantic evergreen forest	dry	limy, basic
Salvia sclarea	Th-H	Med-As-N-Afr	Csm-Wdm	Mediterranean, Atlantic evergreen forest	moderately dry	slightly limy
Satureja hortensis	Th	Med-W-As	Cw-Sd	Mediterranean, Atlantic evergreen forest	dry	slightly limy
Silybum marianum	Th	Med	Cm-Std	Mediterranean, Atlantic evergreen forest	dry	close to neutral
Sinapis spp.	Th	Med-W-As	Bw-Sd	Mediterranean, Atlantic evergreen forest	moderately dry	not specific
Thymus vulgaris	Ch	Med	Cmw-Tdm	Mediterranean, Atlantic evergreen forest	dry	limy, basic
Trigonella foenum-graecum	Th	Med-N-Afr	Cw-Tv	Mediterranean, Atlantic evergreen forest	dry	limy, basic
Valeriana officinalis	H	Eua-(Med)	Cw-Tv	deciduous forest	moderately moist	slightly limy
Verbascum phlomoides	Th	Midl-Eu-(Med)	Cw-Sd	deciduous forest	dry	not specific

It is obvious from the data that the ecological requirements of the two plant groups, i.e. the collected and the cultivated ones, are fairly different. Based on the data, the species used for cultivation mainly require Submediterranean and Mediterranean types of climate. About 63% of the cultivated species belong to these two ecological groups. The original habitat of one cultivated species (*Cucurbita pepo*) is assumed to be a Subtropical one. However the majority of collected plants (61.8%) are grouped into the category characterized as "deciduous forest" habitat.

The differences between collected and cultivated species are appreciable too, if the distribution of their characteristic water regime ("W" values) are compared. The water requirements of cultivated species are less extreme than those of the collected ones. The majority of cultivated species require dry (moderate dry) or moist (moderately moist) habitats, and none of them are cultivated under extremely dry or watery habitats. In the case of collected species the amplitude of their water requirements is much more wide-ranging. Species occur either in rather dry (*Thymus serpyllum, Helichrysum arenarium*), extremely dry (*Alkanna tinctoria*), or in moderately watery (*Equisetum arvense, Filipendula ulmaria, Galega officinalis, Solidago gigantea, S. canadensis, Symphytum officinale*), watery (*Epilobium parviflorum*) and rather watery (*Acorus calamus*) habitats.

Recent Hungarian projects on MAP species/genera on the "priority list"

The main results of Hungarian scientific activities carried out on the species/genera on the priority list are shown in Table 3.

Table 3. Recent Hungarian projects on medicinal and aromatic plants on the MAP WG priority list

Species/genera	Exploring Hungarian diversity	Exploring European accessions	Selection	Genebank conservation	Main institutions involved (*)
Origanum spp.	-	+	+	+	1, 2, 3, 5
Thymus spp.	+	+	+	+	1, 2, 5
Salvia spp.	-	+	+	+	1, 2, 3, 5
Achillea spp.	+	+	+	+	1, 5
Mentha spp.	-	-	+	+	1
Hypericum spp.	+	-	+	+	1, 2, 3, 4, 5
Carum spp.	-	+	+	+	1, 3
Artemisia spp.	-	-	-	+	1, 3
Melissa officinalis	-	-	-	+	1
Gentiana spp.	-	-	-	-	-

(*) Codes of institutions:
1 - Corvinus University, Budapest, Dept. Medicinal and Aromatic Plants
2 - University of Szeged, Department of Pharmacognosy
3 - Research Institute of Medicinal and Aromatic Plants, Vácrátot
4 - Semmelweis University, Budapest, Department of Pharmacognosy
5 - Herbanova Bt.

According to the data, all the designated species/genera, excluding *Gentiana*, are the objects of one or more of the Hungarian genetic conservation projects. However, the research background of the species differs a great deal.

Some of the species (*Achillea*, *Thymus* and *Origanum)* are being studied rather extensively in Hungary, while work on some other species (*Artemisia*, *Melissa*) is restricted to genetic conservation.

Characterization of chemical diversity of wild-growing *Achillea collina* populations

In the case of MAPs the presence or absence of active agents, even their percentages in the essential oils, seem to be among the most important descriptive characteristics. For this reason, to identify the chemical diversity of species should be one of the most important tasks of gene conservation. To determine the chemical diversity of *Achillea collina* populations – belonging to a genus which is included in the MAP priority list – collection of seeds from 23 indigenous populations was started in 2001 (Fig. 1). Using these seeds, a plantation was created in Soroksár in both 2002 and 2003. The populations were characterized and compared under the original growing conditions and under similar conditions at the Research Station.

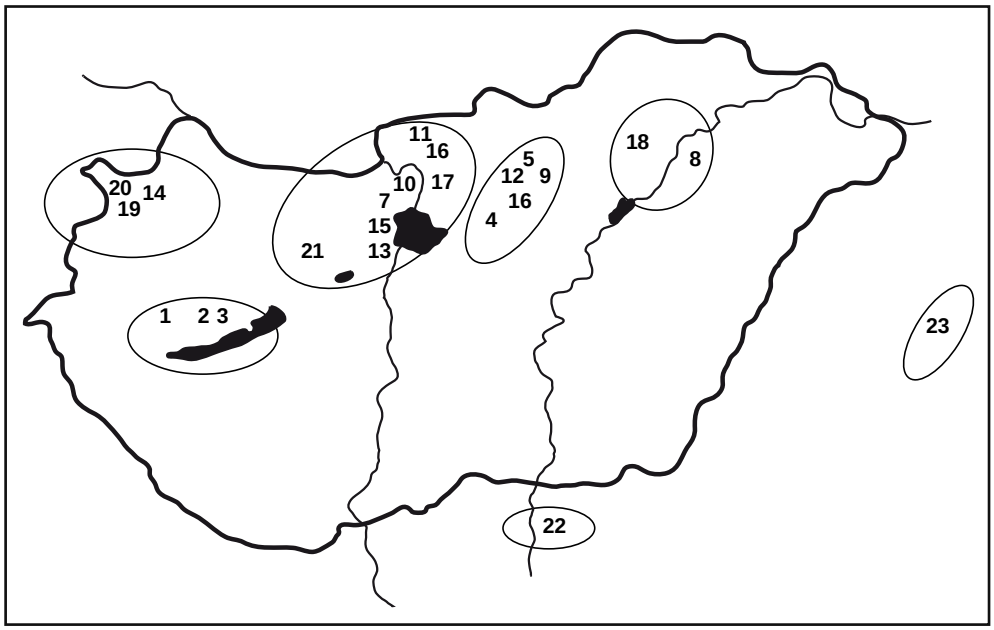

Fig. 1. Original growing sites of populations of *Achillea collina* used for chemotaxonomic analysis.

According to references in the literature, the essential oil content in *A. collina* plants ranges between 0.10-1.35% dry weight. This large diversity was confirmed by our investigations (Fig. 2). In the leaf mixtures of individuals collected from different populations, a minimum of 0.10% and maximum of 0.35% of essential oil was found in dry material. In the flowers the oil content was twice as high and a 0.70% maximum value was obtained. However, the percentages of the oil in the flower and leaf show high correlation and they both can be used for comparisons between different populations.

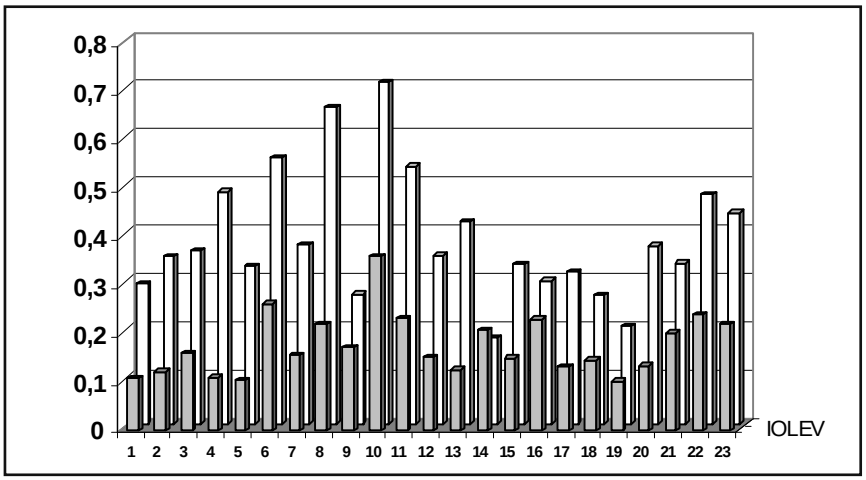

Fig 2. Geographical diversity in accumulation level of essential oil of *Achillea collina*. Essential oil content of the flowers (□) and leaves (■) (% dry weight).

The chamazulene content of the oil is rather variable, too, as was reported in many earlier investigations. The differences found were as much as: 1-34% (Hachley et al. 1990), 0-42% (Michler et al. 1992), 1-51% (Bélanger and Dextraze 1993), 8-29% (Maffei et al. 1993), 1-28% (Hofmann and Fritz 1993), 46-73% (Orth et al. 1999) and 4-32% (Orav et al. 2001). Similar results were obtained by Hungarian researchers: 25-43% (Tyihák et al. 1963), 0-40% (Tétényi 1970), 10-54% (Héthelyi et al. 1989) and 0-50% (Máthé et al. 1963).

In our recent investigations the chamazulene content of different populations ranged between 30-70% of the essential oil. There was no significant difference between values whether either the leaf or the flower was used for analysis (Fig. 3).

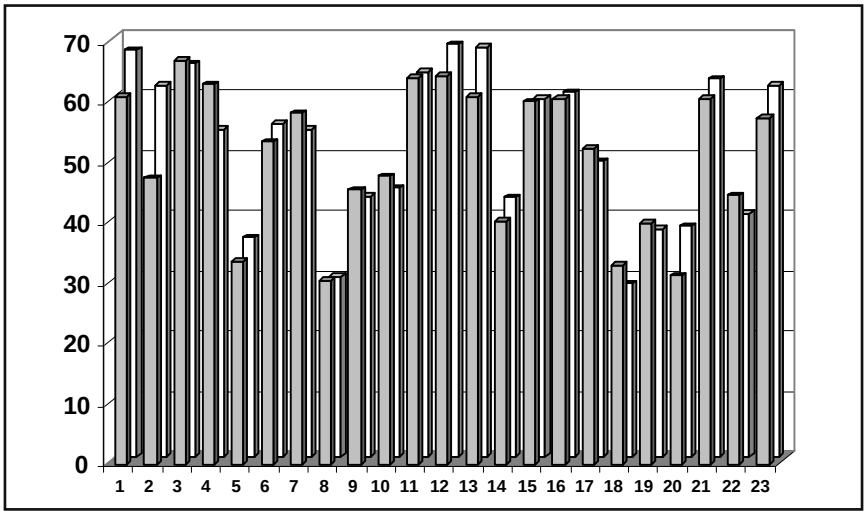

Fig 3. Geographical diversity in chamazulene content in 23 accessions of *Achillea collina.* Chamazulene content of the flowers (□) and leaves (■) (% of the essential oil).

When the chemical evaluation was completed by determining the caryophyllene and cubebene values, the chemical differences between populations became obvious. Using cluster analysis (Fig. 4.) we were able to separate three distinct chemical groups (chemotaxa), which are as follows:

1. High chamazulene - medium caryophyllene - medium cubebene - no other significant compounds
2. Medium chamazulene - high caryophyllene - high cubebene, plus some others
3. Low chamazulene - medium caryophyllene - medium cubebene, plus several others

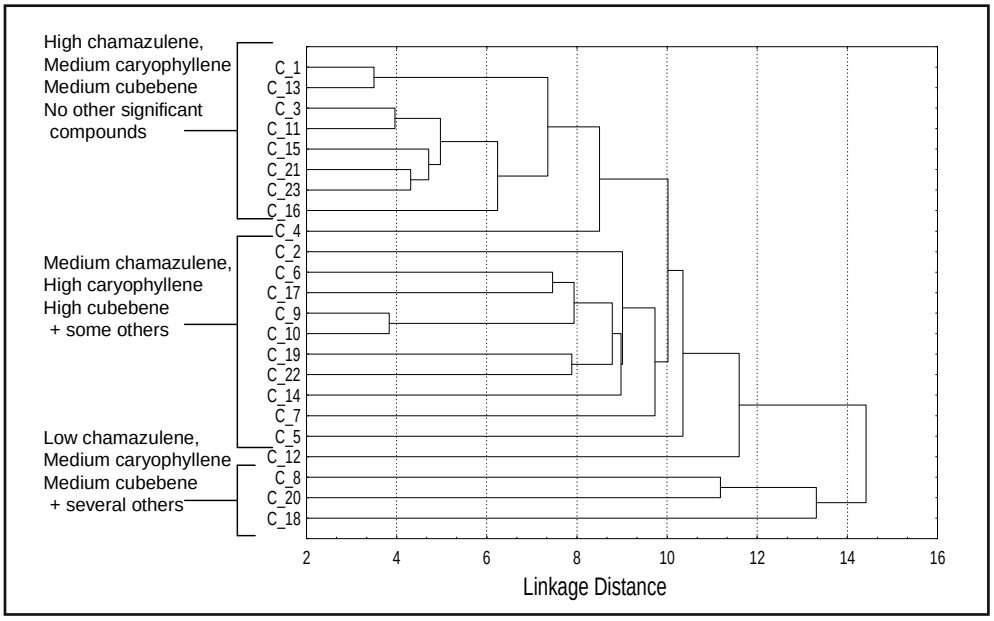

Fig. 4. Clustering of the populations of *Achillea collina* according to the main essential oil components.

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Surveys and research activities on medicinal and aromatic plant species in Italy – report for the period 2002-2007

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Foreword

It is difficult to report on the adoption of many specific actions aimed at monitoring and characterizing MAPs present in the Italian peninsula, because as already stated (Vender and Fusani 2004) these plants have a marginal importance in our country. Indeed, excluding a few species typical of the South (*Origanum* spp. and *Myrtus communis)* which are still largely collected in the wild, and some alpine plants in the North (*Gentiana lutea* and *Artemisia* spp.), almost all home-grown herbs come from cropping, not from collecting in the wild.

However, while the risk of unsustainable harvests is limited to a very few species, there is a growing danger linked to changed uses for soils, to urbanization and so on. These problems are very difficult to tackle.

This paper reports on the activities carried out on some of the ten "model species/genera" selected by the ECPGR Working Group (WG) on Medicinal and Aromatic Plants (MAPs) at its first meeting in 2002: *Achillea millefolium, Artemisia absinthium, Carum carvi, Gentiana lutea, Hypericum perforatum, Melissa officinalis, Mentha* spp., *Origanum* spp., *Salvia officinalis* and *Thymus* spp. (Appendix I, in Baričevič et al. 2004).

Distribution of the ten "model species/genera"

Information on the distribution in the Italian regions of the ten "model species/genera" and their preferred habitat is summarized in Table 1, according to the main guide on the topic, "Flora Italiana" (Pignatti 1982). In addition to the model species, other species of the same genera cited in this Flora and known to have medicinal or aromatic properties are also included in the Table.

- **Achillea millefolium – *Volg. group***

Yarrow is an herbaceous perennial plant indigenous to Eurasia and is widespread in various other temperate zones of the world. Due to its polymorphism "*Achillea millefolium"* is not a true species, but rather a group of species with different ploidy levels. According to Pignatti, the following species are found in Italy:

1. *A. setacea* W. et K.: diploid; densely woolly, it grows in arid valleys of the Central Alps from Pusteria to Val d'Aosta (0-1200 m). Rare.
2. *A. roseo-alba* Ehrend: diploid; common in the Padania plain and in Alpine valleys from Trieste to Piedmont (0-1500 m).
3. *A. collina* Becker: tetraploid; present in arid meadows of all regions. Very common (0-1500 m).

4. *A. millefolium* L. *sensu stricto* or *A. millefolium* subsp. *millefolium*: hexaploid; common in mountain and subalpine dry meadows of the Alps (0-2200 m).
5. *A. stricta* Schleicher: hexaploid; common in subalpine scrubs and rich meadows of the Alps (1000-2200 m).
6. *A. distans* W. et K.: hexaploid; it grows in arid meadows and stony slopes of the Alps (500-1500 m). Rare.

Thanks to their bitter-tonic and antispasmodic properties, two other species of *Achillea* are also used in Italian folk medicine and in liquor preparation: *A. moschata* Wulfen and *A. erba rotta* All. (for which the vernacular name is "Iva herb"). These last species are both endemics of the Alps and grow on rocks and siliceous stony ground (1800-2800 m).

- **Artemisia *spp.***

Wormwood is common in arid waste environments of most Italian regions. Due to the high content of thujone in the essential oil, this plant is utilized to a very limited extent; however the species *A. pontica* L. is grown in Piedmont for the liquor industry (Vender 2004). There are also some alpine species: *A. genipi* Weber (genepi or black genepi), *A. umbelliformis* Lam. (white genepi), *A. glacialis* L. (glacier genepi) and *A. vallesiaca* All., which thanks to their content of aromatic and bitter substances are used in the manufacture of local liquors. All these plants are collected in the wild, while *A. umbelliformis* Lam. (= *mutellina* Vill.) is also cropped in small fields in Piedmont and Val d'Aosta.

- **Carum carvi *L.***

Caraway is common in mountain and subalpine meadows of all northern regions and is also present in some central ones, but in Italy it does not have any commercial importance and all seed/spices traded come from abroad.

- **Gentiana *spp.***

Numerous gentians rich in bitter substances (*G. lutea* L., *G. pannonica* Scop., *G. punctata* L., *G. purpurea* L., *G. symphyandra* Murb., etc.) grow in different mountainous environments, but the yellow gentian (*G. lutea* L.) is, without doubt, of the greatest commercial interest. However, since it is protected in 11 regions, its harvest is strictly regulated and most roots traded come from abroad, mainly from the Balkan area and France. Thanks to protection measures, this species is pretty common in alpine pastures both calcareous and siliceous, while according to some authors (Conti and Manzi 1996) serious conservation problems for the species mainly occur in Emilia Romagna and in Sardinia. In Lombardy, Alto Adige, Liguria and Emilia Romagna, all species of this genus are protected.

- **Hypericum *spp.***

In "Flora Italiana", 25 species of *Hypericum* are listed, but the only one of medicinal interest is *H. perforatum* L. (St. John's wort) of which the following three subspecies grow in Italy: subsp. *perforatum* L., the most common, has leaves of 8-13 x 15-25 mm;

subsp. *veronense* (Schrank) Frohlinch, is typical of arid zones and has smaller leaves, and subsp. *angustifolium* (DC.) Gaudin, with lanceolate-linear leaves, is rare or rarely recorded.

For some years, commercial varieties have been grown (e.g. 'Topaz') for commercial purposes, wild plants being collected for domestic use only.

- **Melissa officinalis *L.***

According to Pignatti (1982) lemon balm is present in all regions, but it is difficult to know whether we are dealing with native plants or with plants which have become wild after escaping from cultivation. All lemon balm processed in Italy comes from cropping.

- **Mentha *spp.***

As regards the genus *Mentha* a large number of hybrid species are listed in the "Flora Italiana", but currently none is collected. The only one exploited is *M.* x *piperita*, cultivated in many regions and on large scale in Piedmont (>200 ha) for the essential oil and utilized in many commercial products (Vender 2004).

- **Origanum *spp.***

This is a genus of complex and somewhat contradictory classification. In "Flora Italiana" only four species are cited: *O. heracleoticum* L., *O. vulgare* L., *O. majorana* L. and *O. onites* L.

O. vulgare (pink flowers) is spread in almost all regions from North to South, but has no aroma, however in Central and even more in Southern Italy the subsp. *hirtum* (Link) Ietswaart (syn. *O. heracleoticum*) and subsp. *viridulum* (Martrin-Donos) Nyman are present and abundantly collected from the wild for local markets, but also cultivated. *O. onites* is typical of Sicily where marjoram (*O. majorana* L.) is also present, but almost all marjoram traded in Italy comes from cropping.

- **Salvia *spp.***

Among the three sages of medicinal and aromatic interest present in our country, the garden sage (*S. officinalis* L.) and the clary sage (*S. sclarea* L.) are rare (R), while the third (*S. triloba* L.) is very rare (RR).Garden sage is one of the most popular herbs and everybody grows it in pots on their balconies or window-ledges. Furthermore, for fresh consumption, small crops are frequent, mainly in the surroundings of northern cities.

- **Thymus *spp.***

This is a genus of complicated classification comprising a huge number of species. In "Flora Italiana" 18 species are listed and according to Pignatti (1982), *T. serpyllum* is not just one species but a group of similar species, the most widespread being *T. pulegioides* L.

In Sardinia the endemic species *T. herba-barona* Loisel is very popular and locally traded. Its aroma recalls that of caraway.

Table 1. Presence in the regions, distribution and habitats of the ten "model species/genera" according to "Flora Italiana" (Pignatti 1982)

Genus	Species / subspecies	Distribution [1]	Regional presence [2]	Environment / altitude (m asl)	Sites / notes
Achillea	*erba-rotta* All.	R	1, 2, 3	Rocks and stony siliceous grounds (2000-2800 m)	Endemic
	millefolium group		All regions, Sicily excluded	Mainly in mountain and subalpine, arid meadows (0-2200 m)	*A. millefolium* group = *A. setacea*, *A. roseo-alba*, *A. collina*, *A. millefolium s.s.*, *A. stricta*, *A. distans*
	moschata Wulf.		1,2, 4, 5, 6	Arid meadows and also moraines (1800-2800 m)	Alps, from Cadore to Val d'Aosta
Artemisia	*abrotanum* L.				One time cultivated, at present disappeared pretty well everywhere
	absinthium L.	C	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16	Arid waste lands, hedges, stone walls (0-1100 m)	
	annua L.	R	4, 5, 6, 7, 11, 12	Waste, disturbed lands with sand, gravel (0-500 m)	Alps and Po Valley, Rome, Naples
	dracunculus L.		1		The subsp. odorata is grown
	genipi Weber	R	1, 2, 3, 4, 5, 6	Rocks and gravels in the alpine and snowline belt (2400-2800 m)	Alps: from Cadore to Maritime Alps
	glacialis L.	C	1, 2, 3	Rocks and stony grounds, mainly moraines (2100-3300 m)	From Valsesia to Maritime Alps
	pontica L.		1		Only cultivated
	umbelliformis Lam.	R	1, 2, 3, 4, 5,6 and only in isolated sites in 9	Rocks and gravelly, glacial river beds (2400-3000 m)	Alps: from Cadore to Maritime Alps; Apuan Alps
	vallesiaca All.	R	1	Rocks and arid slopes (calc.) (600-1000 m)	
Carum	*carvi* L.	C	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	Mountain and subalpine meadows and pastures, pathways (800-2250 m)	

[1] R= rare; RR= very rare; C = common; CC = very common

[2] Regions: 1: Piemonte, 2: Val d'Aosta, 3: Liguria, 4: Lombardia, 5: Trentino-Alto Adige, 6: Veneto, 7: Friuli Venezia Giulia, 8: Emilia-Romagna, 9: Toscana, 10: Umbria, 11: Marche, 12: Lazio, 13: Campania, 14: Abruzzo, 15: Molise, 16: Basilicata, 17: Puglie, 18: Calabria, 19: Sicilia, 20: Sardinia.

Table 1 (cont.). Presence in the regions, distribution and habitats of the ten "model species/genera" according to "Flora Italiana" (Pignatti 1982)

Genus	Species / subspecies	Distribution [1]	Regional presence [2]	Environment / altitude (m asl)	Sites / notes
Gentiana	*lutea* L.	R	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 18, 20	Meadows and pastures (1000-2000 m)	Alps: from Giulie to Maritime; Central/ South Appennines to Pollino; Sardinia
	pannonica Scop.	RR	4 and 5	Subalpine siliceous pastures (1500-2200 m)	Brennero, Vaja Alps, Val Camonica
	purpurea L.	R	1, 2, 3, 8	Clearings, scrub and pastures (1400-2000 m)	Alps, from Lombardy to Val d'Aosta; Northern Appenines
	punctata L.	R	1, 2, 3, 4, 5, 6	Alpine pastures, scrub (siliceous) (1500-2600 m)	Alps, from Carnia to Maritime Alps
	symphyandra Murb.		5, 6, 7	Meadows and pastures (1000-2000 m)	Giulie Alps, pre-Alps of Friuli, to Belluno Alps
Hypericum	*perforatum* L.	C	All regions	Arid meadows, scrubs, forest margins, along roads, waste lands (0-1600 m)	The most common type
	veronense	C			Mostly in arid sites
	angustifolium	R			Rare or rarely observed
Melissa	*officinalis* L.	R	All regions	Mainly cultivated and "escaped" wild plants (0-1000 m)	Disappeared in many sites
Mentha	*requieni* Bentham	R	9 and 20	Moist zones, near springs (500-1600 m)	Archipelago of Tuscany: R
	pulegium L.	C/R	All regions	Riversides (0-1200)	Peninsula and Isles: C; North Italy: R
	arvensis L.		1, 2, 3, 4, 5, 6, 7, 8, 9, 14, 18	Waste lands, humid meadows, fields (0-1600 m)	Northern Italy: C; Tuscan Appenines; Abruzzo; Pollino
	aquatica L.		All regions	Banks, riversides and marshes (0-200 m)	*M. x piperita* (hybrid)
	spicata L.	CC	All regions	Waste lands, along roads, meadows etc.	group of *M. spicata*

[1] R= rare; RR= very rare; C = common; CC = very common

[2] Regions: 1: Piemonte, 2: Val d'Aosta, 3: Liguria, 4: Lombardia, 5: Trentino-Alto Adige, 6: Veneto, 7: Friuli Venezia Giulia, 8: Emilia-Romagna, 9: Toscana, 10: Umbria, 11: Marche, 12: Lazio, 13: Campania, 14: Abruzzo, 15: Molise, 16: Basilicata, 17: Puglie, 18: Calabria, 19: Sicilia, 20: Sardinia.

Table 1 (cont.). Presence in the regions, distribution and habitats of the ten "model species/genera" according to "Flora Italiana" (Pignatti 1982)

Genus	Species / subspecies	Distribution [1]	Regional presence [2]	Environment / altitude (m asl)	Sites / notes
Origanum	*heracleoticum* L.	C	13, 16,17, 18, 19, 20	Scrub and bushy lands (200-1400 m)	Southern Italy and isles
	vulgare L.	C	All regions	Scrub and bushy lands (0-1400 m)	Rare in Sicily and Sardinia
	majorana L.		All regions (?!)	Waste lands, along roads	Data to be verified
	onites L.	R	19	Rocks, walls, dry waste lands (calcareous) (0-300 m)	Eastern Sicily between Catania and Siracusa
Salvia	*officinalis* L.	R	7, 13,14,16,17, 18, 20	Arid rocks and stony calcareous grounds (0-300 m)	Friuli: Carso; Abruzzo: Fucino
	triloba L.	RR	12,16,17, 18	Gravels, moors and calcareous rocks (0-1000 m)	Lazio, South Puglia, Calabria
	sclarea L.	R	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14,15,16, 19, 20	Dry slopes, scrubs (0-900 m)	Often returned to wild
Thymus	*capitatus* (L.) Hofmgg. et Lk.	C	12, 13, 14, 15, 16, 19, 20	Garigues, arid slopes, Mediterranean pine forests (0-600 m)	Typical of South and isles
	pulegioides L.		Almost all regions, Sardinia excluded	Arid pastures preferably siliceous (0-2200 m) of Alps and Appennines	The most widespread species within the group "*T. serpyllum*"
	striatus Vahl	C	From Emilia Romagna till Calabria	Arid slopes and rocks (0-2000 m)	Centre and South
	vulgaris L.	R	1, 2, 3, 9, 10	Garigues and arid slopes (0-800 m)	Western regions; coast zones
	herba-barona Loisel	R	20	Arid and windy slopes (0-800 m)	Creeping undershrub

[1] R= rare; RR= very rare; C = common; CC = very common

[2] Regions: 1: Piemonte, 2: Val d'Aosta, 3: Liguria, 4: Lombardia, 5: Trentino-Alto Adige, 6: Veneto, 7: Friuli Venezia Giulia, 8: Emilia-Romagna, 9: Toscana, 10: Umbria, 11: Marche, 12: Lazio, 13: Campania, 14: Abruzzo, 15: Molise, 16: Basilicata, 17: Puglie, 18: Calabria, 19: Sicilia, 20: Sardinia.

Progress on surveys (2002-2004)

Table 2 shows the data of the two regions, Trentino and Puglie, for which it was possible to record some data concerning the distribution of the ten model species/genera. Trentino is an Alpine region located in the North-East of Italy. By contrast, Puglie is a typical Mediterranean region, situated in the South-East.

The data collected in the province of Trento was supplied by two botanists working locally (D. Orlandi and F. Prosser, personal communications, 2004) while the data concerning Puglie was drawn up from a project (De Mastro 2004) started in 2001 with the aim of surveying and exploiting MAPs present in the Gargano National Park. This park, with an area of about 121 000 ha, dominates a large part of the promontory of the same name, well-known "as the Italian spur", which stretches out into the Adriatic Sea opposite Albania. This particular position makes this territory unique and in fact previous studies carried out in this area (Fenaroli 1974) had recorded more than 2000 taxa, equal to 33% of the Italian flora, spread over an area barely corresponding to 0.7% of the total national territory. Among these 2000 taxa, 92 MAP species, belonging to 13 families, were recorded.

In order to confirm and supplement the bibliographic reports on the presence of MAP species, this project necessitated visits to the locations (182 in number) indicated by Fenaroli. Furthermore, as in the meantime numerous sites previously recorded had become urban areas, 26 additional sites were also visited.

The preliminary results so far published have been quite worrying, because MAP species have been found only in 40% of the visited sites; the number of species identified (62), belonging to 19 families, were less than 70% of those found in the previous study and as many as 50% of the species were present only in five sites.

Within this project, as regards the genus *Origanum,* eight biotypes of *O. vulgare* L. subsp. *hirtum* (Link) Ietswaart were collected and one of them is now in agronomic trials.

Model species/genera among endangered MAP species

The task of updating the cartography of the flora, checking endangered species and storing their seeds has been undertaken by some regional authorities of Northern Italy, for example in the Autonomous Province of Trento (Bonomi et al. 2003) and Lombardy Region. In particular the Centre for Autochthonous Flora (Centro Flora Autoctona, CFA) (http://www-1.unipv.it/labecove/) of Lombardy listed 600 species considered as threatened, which include species belonging to the ECPGR "model" list. For instance, there are as many as 17 species of the genus *Gentiana* (among which *G. lutea* L., *G. pannonica* Scop., *G. punctata* L. and *G. purpurea* L.); within the genus *Achillea: A. clavenae* L. and *A. moschata* Wulf.; within the genus *Artemisia*: *A. genipi* Weber and *A. umbelliformis* Lam.

Seed of these species is already stored in the Germplasm Bank of the Department of Land Ecology of the University of Pavia (Rossi, personal communication, 2004).

The main actions foreseen by both these administrations are:

1. updating their regional lists of plant species considered as endangered
2. first survey of endangered populations
3. seed collection
4. germplasm conservation.

Table 2. Progress on surveys carried out from October 2002 to September 2004 in Italy

Genus	Species / subspecies	Research institutions (*)	Survey dates	Locations and altitude (m asl)	Region, Province
Achillea	*millefolium*	1	June-September 2004	Malga Salnzada – Cavalese 1050 m; Passo Rolle 1900 m.; Monte Bondone 1500 m	Trentino
	millefolium	3	May-June 2002	Bosco Quarto, Monte Giovannicchio, Stignano, Torre del Telegrafo, Valle Carbonara	Puglie
	moschata	2	2003	Forcella di Lusia (2363-2390 m)	Trentino
	clavenae	1	August 2004	Southern Brenta 2200 m	Trentino
Artemisia	*genepì*	2	2003	Pian della Nana – Cima del Sasso Rosso (2370-2400 m)	Trentino
	umbelliformis	2	2003	Lakes of Cornisello (2120 m)	Trentino
	nitida	1	July 2004	Sasso Rosso (Northern Brenta) 2200 m	Trentino
	absinthium	1	August 2004	Villazzano-Trento	Trentino
Carum	*carvi*	1	June-September 2004	Malga Salnzada – Cavalese 1050 m; Passo Rolle (TN) 1900 m; Monte Bondone (TN) 1500 m ; Southern Brenta 2200 m	Trentino
Gentiana	*lutea*	1	June-August 2004	Monte Bondone 1500 m; Southern Brenta 1800 m; Monte Peller 2000 m	Trentino
Hypericum	*perforatum*	3	May-June 2002	Coppe di Ceccasole, Dolina Pozzatina, Isola di Lesina, Mandrione, Monte Giovannichio, Poggio Imperiale, San Giuseppe, San Nicandro, Santa Maria Torre di Pucci, Torre del Telegrafo, Torre Fortore	Puglie
Melissa	*officinalis*	3	May-June 2002	Centopozzi, Fontana Sfilzi, Monte Lo Sfrizzo, Sorgentola, Torre Palermo, Valle della Sorgentola	Puglie
Mentha	*longiifolia*	1	June-July 2004	Malga Salnzada – Cavalese (TN)	Trentino
			September 2004	Prabi, Arco (TN) – 95 m	Trentino
	pulegium	3	May-June 2002	Centopozzi	Puglie
	suaveolens			Isola di Lesina, Monte lo Sfrizzo	Puglie

* Data supplied by:
1. Diego Orlandi, CRA-ISAFA, Trento
2. Filippo Prosser, Museo Civico of Rovereto, Trento
3. Giuseppe De Mastro, Dipartimento di Scienze delle Produzioni Vegetali, Università di Bari.

Table 2 (cont.). Progress on surveys carried out from October 2002 to September 2004 in Italy

Genus	Species / subspecies	Research institutions (*)	Survey dates	Locations and altitude (m asl)	Region, Province
Origanum	*vulgare subsp. hirtum*	3	May-June 2002	Bosco Ischitella, Cassana, Coppa dei 3 confini, Cutino d'Umbra, Monte Castellana, Monte Giovannichio, Monte lo Sfrizzo, Monte Nero, Monte Sacro, Orefice, San Giuseppe, Stignano,Testa del Gargano, Valle Carbonara, Valle S. Martino, Grava di Zazzano	Puglie
Salvia	*verbenaca*	3	May-June 2002	Bosco di Manfredonia, Coppe di Ceccasole, Dolina Pozzatina, Mandrione, Murgia Bianca, Peschici, San Nicandro, Valle Carbonara	Puglie
Thymus	*serpyllum*	1	July-August 2004	Malga Salnzada – Cavalese (TN) 1050 m; Passo Rolle (TN) 1900 m; Monte Bondone (TN) 1500 m; Monte Peller (TN) 1800 m; Brenta 2200 m	Trentino
	striatus	3	May-June 2002	Caserma Murgia, Florio, Monte Castellana, Monte Nero, Monte Sacro, Necropolis La Salata; Peschici, Ruggiano, Stignano, Valle della Vecchia, Valle Grande	Puglie
	pulegioides	3	May-June 2002	Bacino idrico, Bosco della Ginestra, Monte Castellana, Monte Giovannichio, Monte Nero, Poggio Imperiale, San Giuseppe, San Nicandro, Santa Maria Torre di Pucci, Torre del Telegrafo, Torre Fortore	Puglie
	capitatus	3	May-June 2002	Peschici	Puglie

* Data supplied by:
1. Diego Orlandi, CRA-ISAFA, Trento
2. Filippo Prosser, Museo Civico of Rovereto, Trento
3. Giuseppe De Mastro, Dipartimento di Scienze delle Produzioni Vegetali, Università di Bari.

A privileged partner of both projects is the Kew Gardens Millenium Seed Bank, which stores a portion of the collected seed. Furthermore the coordinators of both projects actively collaborate with each other and with the Germplasm Bank of the Botanic Garden of the University of Pisa which has been storing seed samples of threatened populations collected in the Toscana area, in particular in the Apuan Alps and along the Tyrrhenian Sea coast. These three institutions are all members of the European Native Seed Conservation Network (ENSCONET).

Research projects involving MAPs (2004-2007)

Within various research studies and projects concerning MAPs, some of them have involved the collection and characterization of different accessions of the ten model MAPs, and even if the prevalent approach was agronomic, some useful information about populations was also obtained.

- **Hypericum perforatum**

A research study (Aiello et al. 2004) aimed at assessing the yield capacity and the qualitative characteristics of 11 wild populations collected in different Italian regions in comparison with 4 commercial varieties was carried out in 2001-2002. This study, among other things, confirmed the presence of the two subspecies *perforatum* and *angustifolium*, with a hypericin content from 0.06 to 0.20%.

- **Origanum *spp.***

Research (Tuttolomondo et al. 2007a) was carried out on various native Sicilian landraces of *O. vulgare* L. subsp. *hirtum* (Link) Ietswaart, with the aim of characterizing them for yield capacity and essential oil composition. The essential oil of these landraces was characterized by a high percentage of thymol (>58% on average).

Other authors (Montano et al. 2007) assessed the agronomic performance of five ecotypes of *O. vulgare* L. subsp. *viride* Ietswaart (1980), collected in Liguria and Tuscany, compared with two commercial varieties. In this case the essential oil composition showed wide variations and on the basis of the main component (±20%) the following four chemotypes could be identified: β-caryophyllene, carvacrol, linalool and thymol. In the oil content at the flowering phase a wide variation (0.20-0.65%) among ecotypes also emerged.

On 17 Sicilian accessions of *Thymus* spp. belonging to *T. vulgaris* L., *T. serpyllum* L. and *T. spinulosus* Ten. the main productive parameters were recorded (Tuttolomondo et al. 2007b).

- **Achillea millefolium**

According to our colleagues (Orlandi and Clementel, personal communications, 2006) who carried out from 1978 to 2005 more than 100 observations on meadows and pastures of the Trento province situated at 1000 to 2000 m asl, yarrow is a very common species (vegetation cover range: 2.5-34%).

But even if yarrow is a very common plant, due to its polymorphism it is considered a difficult species by botanists and according to "Flora Alpina" (Aeschimann et al. 2004) different species of yarrows (*A. collina* Rchb., *A. roseo-alba* Ehrend and *A. pratensis* Saukel et Langer) have morphological characteristics very similar to those of *A. millefolium* subsp. *millefolium*; therefore it is almost impossible to distinguish

them without using karyological methods. As regards their essential oil components, *A. roseo-alba* and *A. collina* both contain azulenes, while *A. millefolium sensu stricto* is azulene-free (Németh 2005). The azulenes and in particular the chamazulene is the most desirable substance produced at the stage of essential oil extraction and therefore, varieties endowed with a high content of azulene are preferred.

To verify the characteristics of a local accession in respect of commercial varieties, an experimental trial was carried out during 2004-2005 at the farm of the Forest and Range Management Research Institute (Istituto Sperimentale per l'Assestamento Forestale e per l'Alpicoltura, CRA-ISAFA)[13] in Villazzano. In this trial the main morphological characteristics, the fresh and dry herb production and the essential oil yield and quality of three types of yarrows were tested (Aiello et al. 2009). The three types of yarrows were a landrace bred by a local grower and two commercial varieties ('Alba' and 'Proa'), one of which ('Alba') was adopted as the standard variety in the yarrow descriptor list developed by some members of the ECPGR MAP WG.

Table 3 shows the morphological and productive yield data recorded in 2004 on the cultivar 'Alba' and on the landrace. Compared with the landrace, cv. 'Alba' needed more days to reach full flowering, was taller and gave a superior fresh and dry biomass yield per plant. The content of essential oil obtained by steam distillation of fresh plants was in average 0.06% v/w, corresponding to ≈0.2% from dry material. However, as regards the oil quality, wide variations emerged between the landrace and cv. 'Alba' and also between the 2004 and 2005 data for the same yarrow type (Table 4). Seasonal changes may have played an important role. The analysis of the oil clearly showed that the landrace was closer to the subspecies *millefolium* (with only traces of or no chamazulene), but was richer in camphor, borneol and cineol, while the cultivar 'Alba' belongs to the species *collina* and is rich in chamazulene (Maffei et al. 1993). Other Italian authors (Giorgi et al. 2005) working as well on a yarrow grown from wild seeds collected at 400 m asl in Valle Camonica (Central Italian Alps) during the summer of 1998, had determined that chamazulene "was present at a very low concentration or absent in all the oil analysed".

Table 3. *Achillea millefolium*: main phenotypic and productive characteristics of a landrace compared with cv. 'Alba' (2004)

Accession	Beginning of full flowering (no. of days)	Inflorescence colour	Plant			Essential oil content	
			Height (cm)	Biomass (g)		Fresh plant % (v/w)	Dry plant* % (v/w)
				fresh	dry		
Landrace	21	White and pink	70	87	24	0.04	0.16
cv. 'Alba'	27	White	83	160	49	0.06	0.21
Average	24		76	124	37	0.05	0.19

* calculated data

[13] Now Unità di ricerca per il Monitoraggio e la Pianificazione forestale (CRA-MPF).

Table 4. *Achillea millefolium:* main oil components (% v/v) of a landrace compared with cv. 'Alba' over 2 years

Components[1]		Landrace		Cv. 'Alba'	
		2004	2005	2004	2005
Monoterpenes	α-pinene	0	4.2	0.9	2.8
	β-pinene	1.3	15.8	8.9	22.8
	sabinene	0	12.2	10.8	18.4
	terpinene	4.3	3.4	2.0	1.5
Monoterpenoids	α-terpineol	8.3	4.4	0.5	0.6
	borneol	3.1	1.4	2.2	1.3
Esters	bornylacetate	3.9	2.5	0.0	0.1
Ketones	camphor	9.2	10.4	0.2	0.6
Terpenoid oxide	1,8-cineol	5.3	13.7	4.4	8.2
Sesquiterpenes	β-caryophyllene	3.6	2.2	13.8	8.4
	germacrene-D	6.5	8.5	22.8	14.4
	chamazulene	0.3	0.0	19.0	7.0

[1] average of four samples

- **Gentiana lutea**

Yellow gentian is found growing from the plain to the high mountains, right up to the subalpine level at about 2100 m. As this species grows in different types of communities (*Nardion, Calamagrostidion* and *Seslerietalia),* it has no particular indicative value from the phytosociological point of view (Oberdorfer 1979, p. 755.).

Research projects aimed at exploring the possible cultivation of this species and to characterize different populations were carried out by our Institute in the past (Bezzi et al. 1986). Within these studies, in 1980 wild seeds of six populations growing in the Western and Eastern Alps were collected and their seedlings transplanted in an experimental field located on the Bondone mountain, near Trento, at 1550 m asl. Four accessions were collected in the Trentino province (Monte Peller, 2000-2050 m asl, M. Roen, 1850-1980 m asl, M. Bondone, 1540 m asl and M. Tremalzo, 1780 m asl), one in the Friuli Venezia Giulia region (Iouf di Chiusaforte, 1600 m asl, Udine), and another one in the Val d'Aosta region (Valgrisenche, 1800 m asl).

According to our experience, yellow gentian thrives in soils which are not too heavy, moist, deep and basic, but also grows well in soil of siliceous origin and prefers sunny places. As regards the development of the plants obtained by seed and transplanted in the experimental field of the Bondone mountain, the main parameters recorded after 4 years of cropping are shown in Table 5.

Table 5. *Gentiana lutea*: main morphological and productive characteristics of 5 accessions cropped for 4 years near Trento, at 1550 m asl (data derived from Bezzi *et al*. 1986)

Features	Origin of the accessions				
	Aosta	Udine	Trento		
	Valgrisenche	Iouf	M. Peller	M. Roen	M. Tremalzo
Flowering plants (%)	52	15.4	20.1	16.2	5.7
Leaf width (cm)	14.3	7.3	6.6-11.3	6.6-8.6	6.6
Leaf veins (no.)	7	6.2	6-6.8	6.2-6.6	5.2
Flowering stem length (cm)	114	118	113	93	92
Flowered nodes (no.)	5.3	6.1	6.5	6.4	6.5
Amarogentin (%) (on dry roots)	0.03	0.06	0.05	0.11	0.06
Dry root/plant (g)	89	-	97	64	33

Thanks to the previous experience and also because *Gentiana lutea* is an alpine plant still widely used in the liquor industry and threatened at European level (Lange 1998), we have planned to carry out the characterization of this plant in Trentino and in the other neighbouring Italian regions during the summers of 2007-2008, basing our research on previous studies carried out from our Institute (Bezzi et al. 1986).

According to more recent studies (Aeschimann et al. 2004) in the Alpine range three subspecies of *Gentiana lutea* are present: subsp. *lutea* grows in the western half of the Alps (from Maritime Alps to Central Alps), subsp. *vardjanii* in the area between Trentino-Alto Adige to Slovenia, and subsp. *symphyandra*, rarer than the other two, and easy to identify thanks to its linked anthers, prefers the southeastern belt of the Alpine range.

Conclusions

As already stated, most medicinal plants traded in Italy come from abroad, while aromatic plants come from cropping (Vender and Fusani 2004). These two facts together with the huge variability of habitat and consequent number of species present in our country (about 6000), make it arduous at present to find sufficient resources to carry out surveys on MAP wild populations in Italy, as the human and financial effort needed would be out of proportion in comparison with the rewards. And unfortunately this problem persists even when we limit the number of MAP species to be monitored to the ten model species/genera selected by the ECPGR MAP Working Group in 2002. In fact, some of these species (*Achillea millefolium, Artemisia absinthium, Hypericum perforatum, Mentha* spp. and *Thymus* spp.) are very common all over Italy so that characterizing only some of the populations from our region would have been meaningless. Furthermore the characterization of some of these (i.e. *Achillea millefolium* and *Thymus* spp.) needs to be based on specific botanic competence and laboratory equipment which we do not have. On the other hand, other species (*Origanum* spp. and *Salvia officinalis*) which are much more interesting from a commercial point of view, grow only in the Centre and South of the country, which are out of range.

For these reasons and on the grounds of the limited funds and time available, it is worth limiting our own survey to *Gentiana lutea*, an alpine plant famous from antiquity, which is still widely used in the liquor industry and is threatened at European level.

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The medicinal and aromatic plant collection and related research in the Department of Horticulture, Faculty of Agronomy, Latvia University of Agriculture, 2002-2007

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Introduction

Ex situ conservation of medicinal and aromatic plant (MAP) species is carried out at the Department of Horticulture, Faculty of Agronomy, Latvia University of Agriculture. This collection, established in 1968, includes about 50 introduced and wild species, which are intended for use for ecological studies, and for scientific, practical and educational purposes. Collecting of MAP wild species started in 1975, but significant activities related to genetic resources began in 1994. The *ex situ* MAP collection in Jelgava is represented by MAP species distributed in 8 families, the highest number belonging to the family Lamiaceae. According to the origin of the plant material, species are divided into two groups: introduced and wild. These groups include local and foreign cultivars and wild populations.

Main research activities on MAP species

- ***Introduced species***

This group includes introduced species obtained by exchange with European countries, including mainly species with culinary, medicinal and ornamental qualities: *Ocimum basilicum* L., *Coriandrum sativum* L., *Majorana hortensis* L., *Satureja hortensis* L., *Satureja montana* L., *Foeniculum vulgare* L., *Thymus vulgaris* L., *Hyssopus officinalis* L., *Lavandula angustifolia* L., *Artemisia dracunculus* L., *Salvia officinalis* L., *Ruta graveolens* L., *Melissa officinalis* L., *Nepeta cataria* L., *Mentha spicata* L. and *Mentha piperita* L.

Research aims at helping to develop domestic production of herbs. It is focused on the cultivation possibilities for herb species under Latvian climatic conditions, the effects of different ecological conditions on the quality and quantity of the biologically active substances of herbs, and acclimatization experiments on introduced herbs.

- ***Wild species***

The wild species group is represented by accessions from four regions of the country: Zemgale, Kurzeme, Vidzeme and Latgale. This group includes *Achillea millefolium* L., *Angelica archangelica* L., *Artemisia vulgaris* L., *Artemisia absinthium* L., *Alchemilla vulgaris* L., *Allium ursinum* L., *Anchusa officinalis* L., *Helichrysum arenarium* L., *Tanacetum vulgare* L., *Valeriana officinalis* L., *Primula veris* L., *Carum carvi* L., *Cichorium intybus* L., *Convallaria majalis* L., *Euphorbia lathyris* L., *Filipendula ulmaria* L., *Humulus lupulus* L., *Leonurus cardiaca* L., *Matricaria chamomilla* L., *Thymus serpyllum* L., *Thymus pulegioides* L., *Tussilago farfara* L., *Origanum vulgare* L., *Plantago major* L., *Sanguisorba officinalis* L., *Symphytum officinale* L., *Urtica dioica* L., *Verbascum thapsus* L., *Viola tricolor* L., *Viola arvensis* L. *and Veronica officinalis* L.

The highest diversity is found in *Origanum vulgare* L. and *Thymus* spp. *Ex situ* conservation of MAPs includes the additional activities of preparing herbarium specimens and collecting seeds.

The investigation of species includes projects such as finding out and testing suitable genotypes of wild-growing plants in order to study whether their agrobotanical properties are suitable for cultivation, further selection and conservation. Beside these investigations, other activities should be pursued to improve the current situation on MAP protection and conservation. At present the collection acts as a source of bioversity and is essential to the studies and researches of the students.

Progress on the survey carried out on MAPs since 2002

Since the end of 2001 Latvia has been participating in the project supported by the Nordic Gene Bank "Spice and medicinal plants in the Nordic and Baltic countries. Strategies for conservation of genetic resources" (SPIMED). The project coordinator is Åsmund Asdal. Its aim is to develop strategies for conserving spice and medicinal plants *in situ* and *ex situ* in the Nordic and Baltic countries (Asdal 2001).

Accordingly, planned activities for Latvia have been to:

- Produce a country report on what species should be given priority for Latvia;
- Make a list of existing *in situ* MAP populations;
- Collect information about threatened populations for *ex situ* conservation;
- Establish collection of *Origanum vulgare* L. and *Thymus* spp. for characterization;
- Develop descriptors for characterization of *Origanum vulgare* L.;
- Characterize the collected material *Origanum vulgare* L. and *Thymus* spp. according to the developed descriptors.

In Latvia oregano, *Origanum vulgare* L., is a common plant in certain areas. It is found in dry and fairly damp meadows, field borders and dry hills. The wide use of *Origanum vulgare* L. is one of the reasons why the population of these plants is severely depleted. Sustainable use of *Origanum vulgare* L. in Latvia can be achieved by promoting its cultivation. At present oregano is cultivated on about 30 ha for commercial purposes.

Before the SPIMED project, collections of *Origanum vulgare* L. were established by accessions collected from 9 natural growing sites located in 7 different districts and *Thymus* spp. was collected from 5 natural growing sites located in 4 districts.

The collecting activities in the SPIMED project started in 2002 and proceeded during the summer of 2003.

During the SPIMED project existing collections were expanded with new accessions of *Origanum vulgare* L. and *Thymus* spp., reaching a total 140 specimens of *Origanum vulgare* L. (10 accessions collected from each of 14 different sites) and 35 specimens for *Thymus* spp. (5 accessions collected from each of 7 different sites).

Descriptors for *Origanum vulgare* L. comprise vegetative and flowering parts, evaluation of flowering and biotic stress, chemical composition and cytological characters. Descriptors were developed in the course of time in collaboration with colleagues from Lithuania and Estonia (Žukauska 2007).

Out of the total number of accessions in the Latvian field collection, 100 accessions of *Origanum vulgare* L., 20 accessions of *Thymus serpyllum* L. and 15 accessions of *Thymus pulegioides* L. have been characterized in the SPIMED project (Asdal et al. 2006).

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Research on medicinal and aromatic plant genetic resources in Latvia during 2004-2007

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The issue of conservation and use of medicinal and aromatic plant (MAP) genetic resources has become urgent on Latvia joining the European Union. Collections of both wild and cultivated aromatic, culinary and medicinal species are maintained in the Institute of Agrobiotechnology of the Latvia University of Agriculture (LUA). Location of the collection is: 23°45′13″E / 56°39′47″N.

The implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture, which Latvia ratified on 7 April 2004, is the responsibility of the Ministry of Agriculture. In order to fulfil the commitments mandated by the Treaty at national level the programme on conservation and sustainable use of plant for food and agriculture, animal, forest and fish genetic resources (2007-2009) was accepted by the Latvian government in 2007. To implement this programme, the Genetic Resource Centre at the Latvian State Forest Research Institute "Silava" has been established. The Genetic Resource Centre incorporates the Latvian Gene Bank of Cultivated Plants, the Database and the Genetic Analysis Laboratory. The implementation of the programme is coordinated by the Council of Genetic Resources in the Ministry of Agriculture (http://www.genres.lv/en_index.php).

With the support of the Ministry of Agriculture the state programme "Preservation and sustainable use of plant genetic resources for food and agriculture" has been developed. When the programme started, projects on maintenance, preservation and research on aromatic plants, medicinal plants and culinary herb collections received financial support.

It was therefore necessary to discuss which species should be defined as "culinary herb genetic resources" – these have not been defined and inventoried officially in Latvia, and it is rather difficult to acquire information about the culinary herbs that have been used in Latvia since bygone days, since this subject has scarcely been researched (Žukauska 2008).

The specialist group collected basic information about the most important culinary herbs used in our country for centuries**.** On the basis of historical information, species' biological features and conservation capacity, the definition of culinary herb genetic resources was approved as "local wild and cultivated species, which historically were used as culinary herbs, were multiplied vegetatively and are well adapted to ecological conditions in Latvia".

At present the *ex situ* genetic resources collection of culinary herbs is represented by 120 accessions representing the following 14 species: caraway (*Carum carvi*), lemon balm (*Melissa officinalis),* southernwood (*Artemisia abrotanum)*, tarragon (*Artemisia dracunculus)*, hyssop (*Hyssopus officinalis),* catmint (*Nepeta cataria),* spearmint (*Mentha spicata),* lavender (*Lavandula angustifolia),* bear's garlic (*Allium ursinum*), lovage (*Levisticum officinale),* thyme (*Thymus serpyllum* and *T. pulegioides),* peppermint (*Mentha* x *piperita)* and oregano (*Origanum vulgare).*

Spice plants, a new mandate area for Latvia, hold the promise of very interesting new directions for the science and management of genetic resources.

The main priorities in the conservation of genetic resources of culinary herbs (2006-2009) are to:

- make an inventory of existing collections and select plants for *ex situ* conservation;
- establish characterization and evaluation systems at propagation and maintenance sites;
- adapt existing or develop new descriptor lists;
- investigate the material obtained; and
- develop a database and participate in research on biodiversity conservation.

Beside the culinary herb research, other activities should be pursued to improve the financial and scientific situation for other MAP species.

The project "The developpment of descriptors for cultivated plants and forest genetic resources for agriculture and food" has been developed and carried out in 2006. Within its framework, descriptors have been developed for some culinary herb species: spearmint, catmint, lemon balm and caraway (Žukauska 2008).

In 2007 description of plants was started using these descriptors.

On the basis of the results obtained, initial sampling of oregano (*Origanum vulgare* L.*)* and thymus (*Thymus* spp. L.*)* clones has been started for further research.

In 2007 a project was confirmed on molecular research on these two species.

Four different genetic clones of oregano harvested in 2007 at three different development stages (budding, flowering, end of flowering) were studied. They differ both in quantitative and qualitative content of aroma compounds, showing differences among samples collected at various development stages. A total of 35 volatile compounds were identified in Latvian oregano samples. Sabinene, caryophyllene, germacrene-D and Z-β-ocimene are the major aroma-forming compounds. The biggest amounts of volatile aroma compounds were found in the leaves of two clones collected at budding stage and in the flowers of one clone collected at flowering stage (Galoburda et al. 2008).

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Progress report on medicinal and aromatic plant surveys carried out in Lithuania since October 2002

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Inventory of medicinal and aromatic plant (MAP) species in Lithuania

Information on MAP use in Lithuania was assembled from all known published and unpublished sourcebooks on medicinal plants. In order to determine the importance of the medicinal plant families in use, a regression analysis method previously used and developed by Daniel Moerman (1991) (Moerman et al. 1999) was applied for the vascular species growing in Lithuania (Fig. 1). Out of the known 1500 spontaneous species of vascular flora in Lithuania, 462 species are considered as MAPs used in folk and traditional medicines. The medicinal flora belonged to 87 families. The top five families in medicinal usage are the following: Lamiaceae, Apiaceae, Ranunculaceae, Asteraceae and Solanaceae. The lowest level of usage in the regression analysis was shown by Poaceae, Cyperaceae, Polygalaceae, Caryophyllaceae and Chenopodiaceae. The Asteraceae involved the highest number of species (47 out of a total of 250) with ethnobotanical usage, while maximum importance of medicinal plant usage within the families was found in the Lamiaceae. Out of a total of 94 species of Lamiaceae, 36 are used as medicinal plants in the treatment of gastrointestinal, respiratory and inflammatory ailments. The Poaceae is the largest family of vascular plants in Lithuania. Out of a total of 176 species, four are used medicinally: *Avena sativa* L., *Hierochloe odorata* (L.) P. Beauv., *Elytrigia repens* (L.) Nevski and *Zea mays* L. The Cyperaceae includes only one medicinal species (*Carex arenaria* L.) out of a total of 90.

The indigenous species comprised 62% of all species used as medicinal plants, introduced species 28%, and alien 10%. Rare and/or endangered species make up 43% of the MAP species in Lithuania.

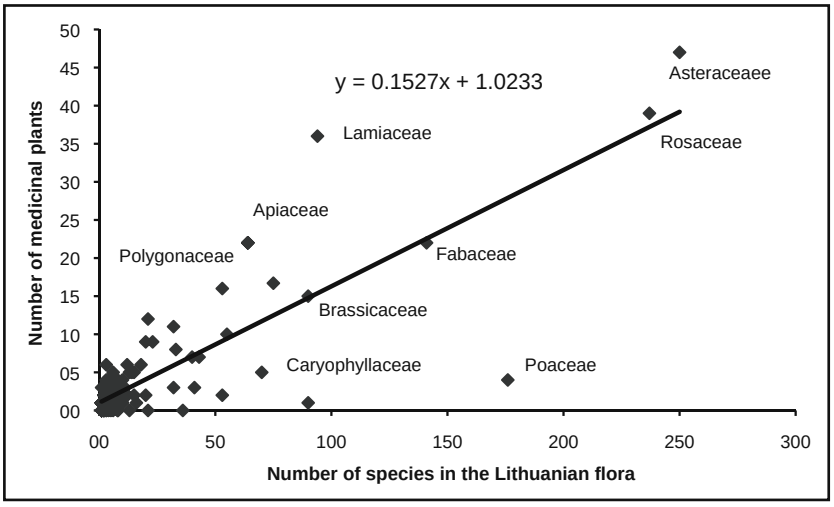

Fig. 1. Regression analysis of medicinal flora in Lithuania.

Details on the surveys of MAPs

- **Achillea millefolium *L. s.l.***

The raw material of yarrows or milfoils (*Millefolii herba*) is one of the oldest and most important drugs used both in folk and official medicine, and is usually gathered from natural populations. The inventory of *A. millefolium* was made in 2001-2003, at 140 growing sites. Voucher specimens of plants from all sites have been deposited in the Herbarium at the Institute of Botany (BILAS), Vilnius, Lithuania. The vegetation was assigned to 29 types of communities, representing a wide range of ecological conditions. *A. millefolium* was confined mainly to grassland, ruderal and segetal communities. The species occurred at low frequency in coniferous and deciduous woodland communities. The plants were tested for the presence of proazulenes. After testing, all plants were grouped into three groups: proazulene-free, low and high amount of proazulene-containing plants. On average 38% of all tested plants contained proazulenes. The vast majority of plants gathered in woodland and scrubland habitats contained proazulenes. In segetal and wasteland communities, only proazulene-free plants were found. Results of the surveys are shown in Fig. 2 and Table 1.

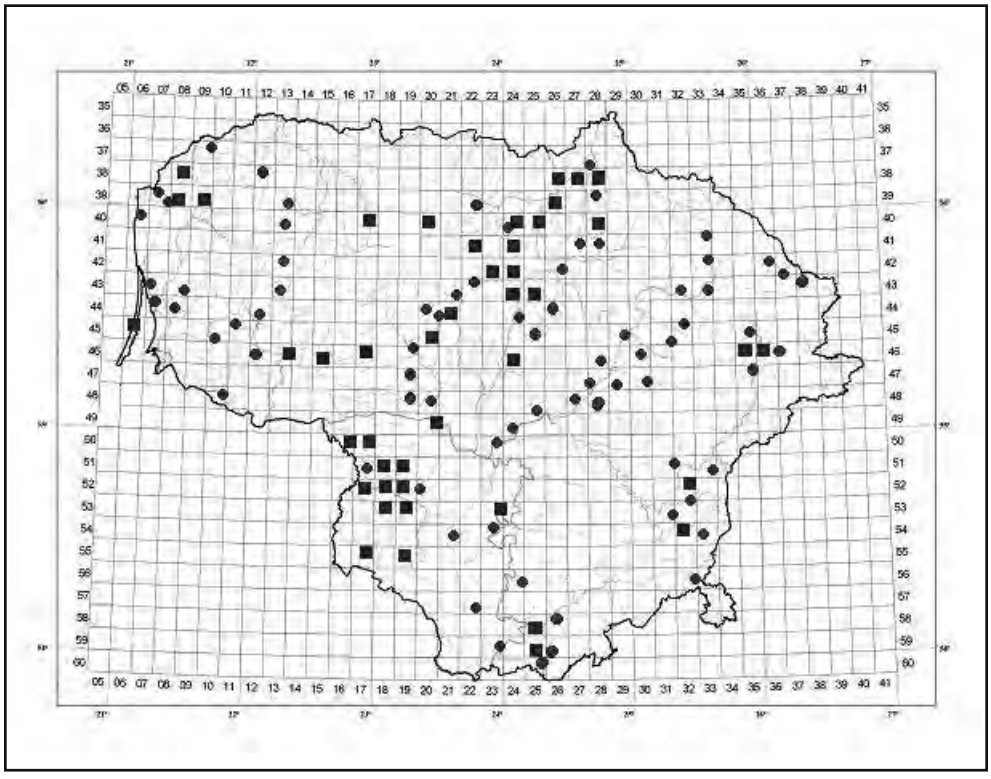

Fig. 2. The distribution of proazulene-containing (■) and proazulene-free (●) populations of *Achillea millefolium* in Lithuania. The map of the territory of Lithuania is divided into 579 squares. All tested populations in one square were marked as one dot.

Table 1. Distribution of *Achillea millefolium* s.l. plants in different habitats according to their proazulene contents

Habitat	Proazulene-free plants (%)	Proazulene-containing plants (%)		
		Total	Low amount	High amount
Grassland communities	67.2	32.8	6.4	26.4
Sand communities	74.4	25.6	5.1	20.5
Ruderal communities	78.6	21.4	2.2	19.2
Segetal communities	100.0	0	0	0
Wasteland	100.0	0	0	0
Woodland and scrubland	49.3	50.7	12.3	38.4

- **Origanum vulgare *L.***

The field collection of oregano was supplemented by 10 new accessions, which were gathered from indigenous populations in 2003-2004. The mother plants were multiplied by separating the roots and transplanted into the field collection. The characterization of accessions was carried out according to morphometric analysis of the phenotype and content of essential oil. The botanical identification of the plants was based on the description of subspecies given by Ietswaart (1980). On the basis of discriminative morphological characters (bracts, calyces, corollas) oregano growing in Lithuania was attributed to *O. vulgare* L. subsp. *vulgare*. Bracts ovate with acuminate tops, hirtellous, and membranous, purple or greenish violet, highly heterogeneous in size – 2.5-5.5 mm long and 1-3 mm wide. Calyces were more or less homogenous in length (2.5-3.0 mm), with glandular trichomes, and violet teeth. Corollas were 2.5-6.0 mm long. A wide variation in the colour of corollas was observed, ranging from red-purple to pale purple. Spikes ovoid, gathered in the paniculate type of inflorescence. Leaves were ovate with acute ends, 10-50 mm long, and 5-25 mm wide. The essential oil content of the investigated accessions ranged from 0.25 to 1.51% of absolute dry weight in inflorescences and from 0.09 to 0.98% in leaves.

- **Carum carvi L.**

Populations of caraway were found mostly in meadows of *Molinio-Arrhenatheretea* and *Trifolio-Geranietea sanguinei* communities. Plants growing in hayfields (35% of all investigated cases) and pastures (65% of all cases) were different morphologically. The content of essential oil in the fruits varied from 3.2 to 5.6%. Fruits of 54 accessions were gathered from the wild and sown in the field collection in 2003-2004 (Fig. 3). At present the field collection of caraway at the Lithuanian University of Agriculture holds 112 accessions.

It was found on evaluation that field accessions of caraway varied in: time of flowering and ripening of fruits, colour of inflorescence, shape and colour of leaves, plant height, fruit weight, essential oil and carvone content, fruit crop per plant, resistance to cold. Three morphological types of caraway were distinguished according to the form and amount of dissection of leaves. The most stable characters were height of plant, diameter of inflorescence, content of essential oil, and the most variable, diameter of rosette and number of inflorescences per plant. Investigations of genetic polymorphism were started in 2003.

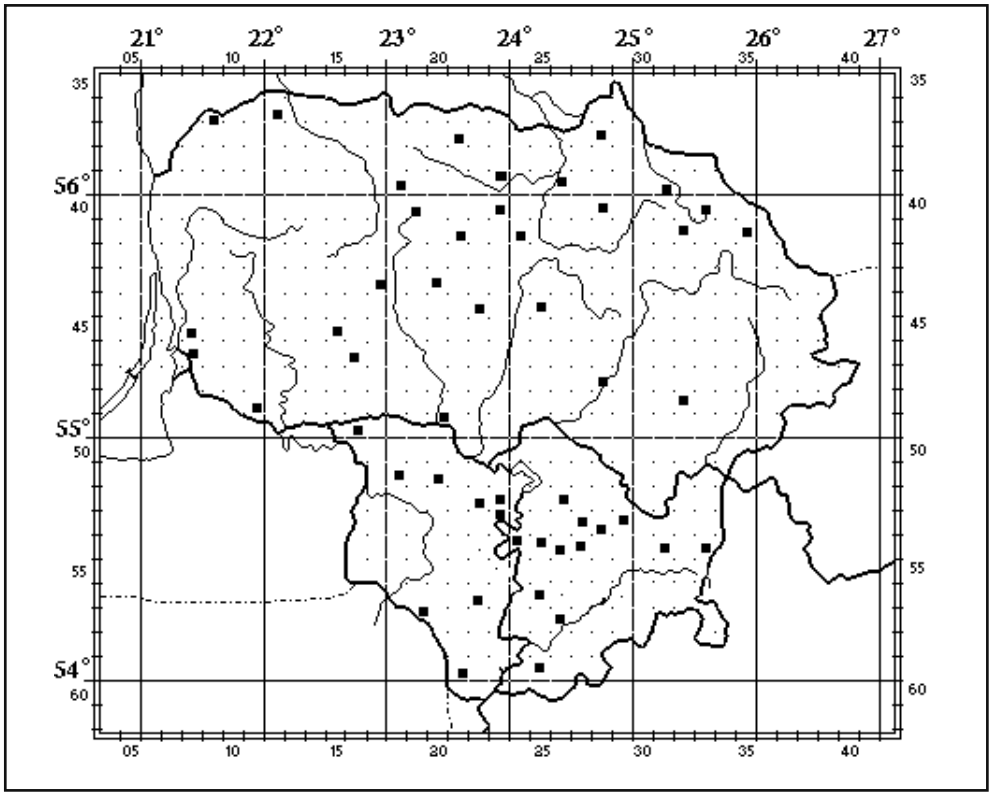

Fig. 3. Locations of *Carum carvi* L. indigenous populations investigated in 2003-2004.

- **Hypericum perforatum *L.***

This is a common species in Lithuania. The demand for raw material is supplied from natural sources. The field collection at the Institute of Botany holds 25 accessions of *H. perforatum* gathered from the wild, whose seeds are conserved in the Gene Bank at Dotnuva, Lithuania. Characterization of accessions was carried out according to descriptors of morphological parameters. The highest significant differences among accessions were observed for height of plants, length of sepals, width and length of petals, width of leaves and length of inflorescences. The most important characters for distinguishing the morphological variants appeared to be the dimensions of leaves. The leaf length/width ratio in different accessions of *H. perforatum* varied from 2.05 to 3.89. The results indicated three morphological variants of *H. perforatum*: narrow (3.5:1), intermediate (3:1), and broad (2:1) leaved (Radušienė et al. 2004).

- **Gentiana cruciata *L.***

This species is included in the National Red Book (Balevicius and Ladyga 1992) as a vulnerable species. Only one accession was introduced into the field collection of the Institute of Botany.

Summary table of surveys of MAPs

Species / Genus	Institution(s) responsible for the survey(s)	Date(s) and number of accessions collected during the survey(s)	Location(s)
Achillea millefolium	Institute of Botany	2003-2004 – 42 accessions	Whole country
A. cartilaginea	Institute of Botany	2003-2004 – 3 accessions	Birstonas, Silute, Kaunas districts
Carum carvi	University of Agriculture	2003 – 33 accessions	Southern and southwestern parts of the country
		2004 – 21 accessions	Northeastern and northwestern parts of the country
Gentiana cruciata	Institute of Botany	2003 – 1 accession	Vilnius district
Origanum vulgare	Institute of Botany	2003-2004 – 10 accessions	Ukmerge, Marijampole, Kaunas, Kaisiadorys, Vilnius, Kupiskis, Jurbarkas, Kedainiai, Silute districts

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Progress report on medicinal and aromatic plants in Malta, 2002-2004

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Introduction

The Maltese Archipelago is a group of small islands with relatively high plant biodiversity (1264 vascular plants). About 36% of these plant species have been used in the past to treat medical conditions (Lanfranco 1975, 1993). The aim of this study was to determine the abundance and favourable propagation conditions of some selected medicinal plants. Species of the Labiatae family account for 7% of the total local medicinal flora (Attard 2004). This family ranks second after the Compositae family (15%), with regard to phytobiodiversity. Locally, there are 30 species of the Labiatae family, the *Mentha* genus predominating in number. Most of these species flower between April and September. Due to their culinary and medicinal uses, they have been frequently cultivated as pot herbs in the past. In fact, some of the local medicinal and aromatic plants have become extinct in the wild. Most of these species are perennials, with a few exceptions (Haslam et al. 1977). Traditionally, they have been most commonly used in the treatment of coughs and colds, gastrointestinal disorders, rheumatic pains, and as insect repellents (Penza 1969; Lanfranco 1993). The medicinal properties are mainly attributed to the accumulation of essential oils that contain a wide array of secondary metabolites, mainly mono- and sesquiterpenes, phenolics and simple organic molecules that give these plants their characteristic smell.

Materials and methods

Six local medicinal plants, from five genera, have been selected for this study. These include *Melissa officinalis*, *Mentha pulegium*, *Mentha spicata*, *Origanum vulgare*, *Salvia officinalis* and *Thymus capitatus*. This study was divided into two sections. These included a survey of the selected plants and preliminary cultivation studies.

A survey was carried out throughout the islands of Malta and Gozo, to determine the habitat characteristics and relative abundance of the selected species. To ensure effective survey coverage, the study area was divided into seven zones (Fig. 1). The initial phase was carried out by on-site visits to the three major river valley systems of the Maltese Islands (Wied il-Għasel, Wied il-Kbir and Wied is-Sewda), Buskett Gardens, North-West minor valleys, South-East minor valleys and Gozo. The plant morphology was determined using a descriptor list.

A preliminary cultivation study was carried out to determine the regeneration potential of these medicinal plants, especially those under threat. The parameters studied were seed/cutting origin, planting distance and fertilizer application. The influence of these cultivation factors on biomass and essential oil yield were considered with special reference to high yield constituents from essential oils.

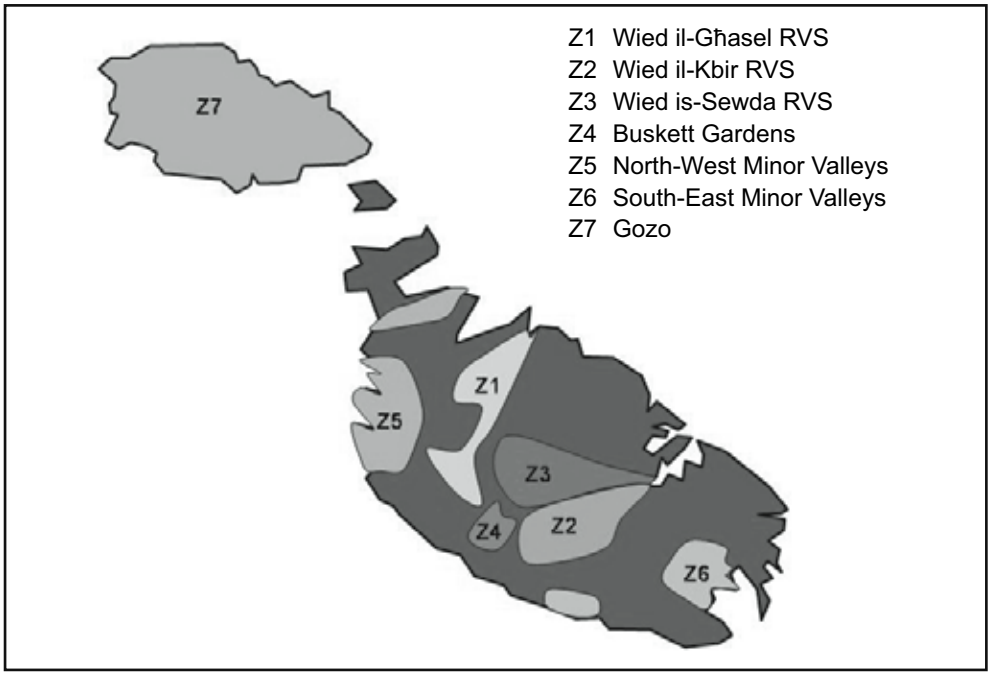

Fig. 1. The seven zones of the study area. (RVS: River valley system)

Results

Table 1 and Fig. 2 illustrate the distribution and relative abundance of these medicinal plants in the wild and under cultivation. Table 2 shows the cultivation parameters in relation to essential oil yield.

Table 1. The distribution of some Maltese medicinal plants in the wild or through cultivation

Plant species	English name	Matese name	Flowering period	Wild stocks	Cultivation
Melissa officinalis subsp. *altissima*	Melissa, Balm	Burieħa	May till July	Z4	Yes
Mentha pulegium	Pennyroyal	Plejju	May till August	Everywhere in wasteplaces and valley beds (esp. Z1 and Z2)	No
Mentha spicata	Spearmint	Nagħniegħ	June till September	Extinct	Yes (naturalized in gardens)
Origanum vulgare	Common marjoram	Riegnu	May till September	Rare (naturalized at Z2)	Yes
Salvia officinalis	Common sage	Salvja	April till June	Z2	Yes
Thymus capitatus	Mediterranean wild thyme	Sagħtar	May till August	Z1 – Z7	No

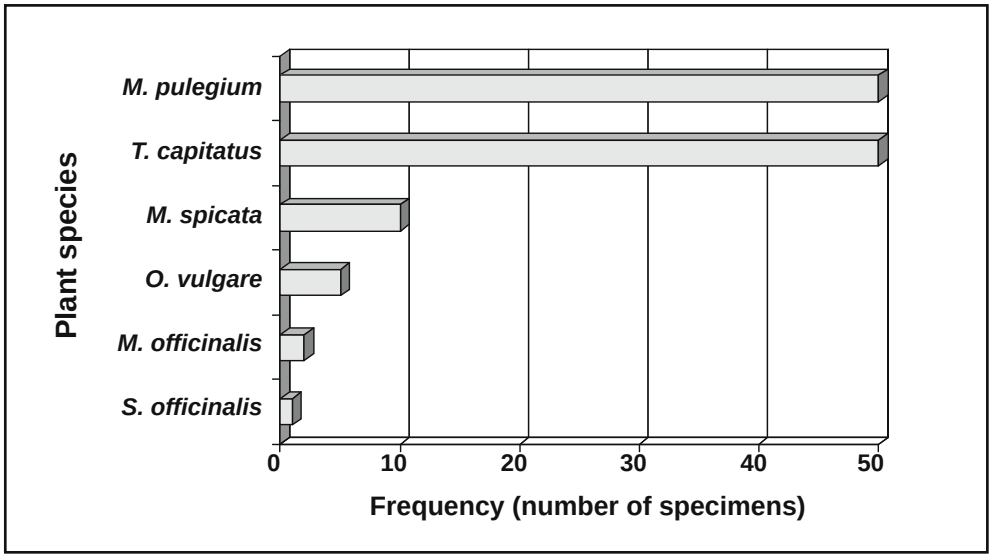

Fig. 2. The frequency of the selected medicinal plants in the wild and under cultivation.

Table 2. The cultivation parameters in relation to essential oil yield

Plant species	Cultivation parameters	Essential oil yield (% v/w)	Major constituent(s)
Melissa officinalis subsp. *altissima*	Fertilizer application^{NS}; seed type*	0.1	cis-Citral (47.39%); trans-Citral (37.11%)
Mentha pulegium	-	0.73	Pulegone (85.82%)
Mentha spicata	Fertilizer application^{NS}; shaded environment	0.42	Carvone (68.67%)
Salvia officinalis	Cuttings; shaded environment	1.16	α-Thujone (29.28%); Camphor (26.69%)

*$p<0.05$, n=3

Discussion

From survey results, some of the rare and wild species qualified for the preliminary cultivation study. These were *Melissa officinalis*, *Mentha spicata* and *Salvia officinalis*. *Mentha pulegium* and *Thymus capitatus* are very abundant in the wild, so they were not included in the preliminary cultivation programme (Fig. 2). Since *Origanum vulgare* is already in cultivation no initial studies were considered (Table 1).

The plants listed above have both medicinal and aromatic value. In fact, *Melissa officinalis*, *Mentha pulegium*, *Mentha spicata* and *Salvia officinalis* and were studied for the quality and quantity of their essential oils (Table 2).

Cultivation was selected as the primary source of conserving the medicinal plants for several reasons, mainly:

- The local resources of these species are limited. In fact, they are found in relatively small pockets throughout the island (Haslam et al. 1977). Propagation of plant material is necessary to obtain a significant amount of seeds for conservation;
- No genebank is yet available locally, and so cultivation and possibly micropropagation can be utilized for conservation purposes.

Strategy for conservation

From the local perspective, due to limited resources, the Ministry of Rural Affairs and the Environment (MRAE, Malta) and the Institute of Agriculture, University of Malta (IOA/UOM) are working on joint projects to conserve the endangered species through *ex situ* and *in vitro* propagation. The project, at the Government Research and Development Centre, is aimed at stimulating the interest of the local producers in cultivating these medicinal plants, apart from conservation purposes. This will eventually lead to the cultivation of these species on a large scale. Although there is no local genebank, MRAE and IOA/UOM are planning to develop a pilot seed collection as an initial trial.

Further studies are aimed at formulating propagation and micropropagation protocols to sustain the genepool of these medicinal plants. This can be mainly utilized as an emergency replacement source if one or more of these plants should become completely extinct on the islands. Apart from this, this project can be used to further study the quality and quantity of medicinal constituents, particularly the essential oils, under different cultivation and tissue culture conditions.

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The status of medicinal and aromatic plants in Montenegro[14]

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Introduction

The particular biological and geological history through which the Balkan Peninsula has passed since Tertiary times has determined the richness and diversity of the flora of Montenegro (Stevanović et al. 1995). On the relatively small territory of 13 812 km², approximately 3150 species and subspecies of vascular plants have been recorded. Data summarized from different studies show that from ca. 700 species of medicinal plants, about 300 are commonly used in the pharmaceutical industry and in traditional medicine (Pulević 1965). This number will be significant higher if we include the species classified only as aromatic.

In the last couple of years interest in MAPs has started to grow rapidly. But the low level of knowledge of the topic, combined with inadequate gathering and overexploitation, are endangering natural populations of some species. An additional problem is the present inconsistency between the laws that should regulate the protection of, and trade in, MAPs.

National legislation concerning MAPs

In Montenegro protection of MAPs and their natural habitats is partly regulated by the following laws and regulations:

- The Law of Nature Protection ("Official Gazette SRCG", No. 36/77, 2/89) and its subordinate regulation "Resolution about protection of rare, infrequent, endemic and threatened plant and animal species" ("Official Gazette SRCG", No. 36/82).

  This Law establishes five protection categories: 1. Natural parks and landscapes; 2. Nature reserves; 3. Monuments of nature; 4. Memorial monuments of nature; and 5. Protected plant and animal species.

  The list of the rare, infrequent and threatened plants contains 49 species of vascular plants and 1 genus – *Ophrys* (Box 1).

  Under this regulation it is forbidden to collect or export species from the list without special permission from the Republic's Institution for Nature Protection and the Ministry of the Environment.
- The Law of National Parks ("Official Gazette SRCG", No. 47/91) and its subordinate regulations:
  - Regulation on Physical Development Plan for Areas of Special Purpose for National Park "Biogradska Gora" ("Official Gazette SRCG", No. 44/98)
  - Regulation on Physical Development Plan for Areas of Special Purpose for National Park "Durmitor" ("Official Gazette SRCG", No. 20/97),

[14] Presented at the Second Meeting of the ECPGR MAP Working Group, December 2004, Strumica, Macedonia FYR.

- Regulation on Physical Development Plan for Areas of Special Purpose for National Park "Lovćen" ("Official Gazette SRCG", No. 19/97) and
- Regulation on Physical Development Plan for Areas of Special Purpose for National Park "Skadarsko jezero" ("Official Gazette SRCG", No. 46/01).

The Law of National Parks **does not forbid** species collecting in the area of National Parks, apart from the species on the list of rare, infrequent and threatened ones, for which protection is regulated by the Law of Nature Protection. The Law of National Parks foresees the establishment of areas with a special purpose, which in theory will benefit from a stricter regime of nature protection.

Adopting the programme of protection and development of National Parks (excluding NP "Skadarsko Jezero") is still in progress.

- The Law of the Environment ("Official Gazette RCG", No. 12/96).
- The Law on the Confirmation of the Convention of International Trade in Endangered Species of Wild Fauna and Flora ("Official Gazette RCG", No. 11/01).
- The Law of Forests ("Official Gazette RCG", No. 27/02) which regulates the protection of commercial plant and animal species.
- The Book of Regulations which specifies the methods and conditions of collecting and using non-protected plant species ("Official Gazette RCG", No. 64/03).
- The Resolution about the control list for the import and export of goods ("Official Gazette RCG", No. 44/04), which however is not compatible with the Law of Nature Protection. For example, the Resolution allows liberally (LB) collecting and exporting *Gentiana lutea* subsp. s*ymphyandra*, which is a protected species according to the Law of Nature Protection.

National legislation is the most crucial part of the system of legal instruments. The success of implementation of international treaties and strategies depends on the quality of national legislation and on the level of liability (Skoberne 2002).

Adoption of the new national legislation which will deal with the natural goods of national importance in general, has already been delayed for 7 years.

The list of protected plants in Montenegro ("Official Gazette SRCG", No. 36/82) is given in Box 1 and the list of non-protected species free for gathering and trade ("Official Gazette SRCG", No. 27/02) in Box 2.

Ex situ conservation

Conservation of certain MAPs, but only representatives of the high mountain flora, is carried out at two botanical gardens: the Botanical Garden of Mountain Flora "Dulovine" in Kolašin and the Botanical Garden "Brezojevice", near Plav.

Because of the lack of a national seed collection, collected seed material is deposited in the Gene Bank of the FYR in Belgrade.

There are no inventories (databases or collection of herbarium specimens) of MAPs in Montenegro. Therefore future activities should be focused on the foundation of a national collection of medicinal and aromatic plants, then on the monitoring and characterization of natural (wild) populations.

Box 1. List of protected plants in Montenegro ("Official Gazette SRCG", No. 36/82) (bold and underlined species belong to the category of medicinal or aromatic plants)

Adenophora lilifolia (L.) Ledeb.

Allium phthioticum Boiss. & Heldr.

Arnica montana L.

Asperula baldacci (Hal.) Ehrend.

Aster alpinus L. subsp. *dolomiticus* Beck(Hay)

Bruckenthalia spiculifolia (Salisb.) Rechb.

Buxus sempervirens L.

Centaurea alpina L.

Colchicum hungaricum Jnka.

Daphne blagayana Frey.

Daphne cneorum L.

Daphne laureola L.

Daphne malyana Blecic

Dianthus knappii (Pant.) Asch. & Kan.

Dioscorea balcanica Kosanin

Edraianthus glisicii Cernj & Soska

Edraianthus wettsteinii Hal. & Bald.

Ephedra major Host.

Erica carnea L.

Eryngium alpinum L.

Euphorbia dendroides L.

Gentiana lutea subsp. ***symphyandra*** Murb.

Gentiana punctata L.

Hermodactylus tuberosus (L.) Salisb.

Hyacinthella dalmatica (Baker) Chouard

Ilex aquifolium L.

Leontopodium alpinum L.

Loroglossum hircinum (L.) Rich.

Lycopodium alpinum L.

Myriacaria ernesti mayeri Lakusic

Narthecium scardicum Kosanin

Omphalodes verna Mch.

Ophrys spp.

Orchis simia Lam.

Orchis cordigera Fr.

Pancratium maritimum L.

Phagnalon rupestre (L.) DC.

Pinguicula balcanica Casper.

Prunus cocomilla Ten.

Quercus robur L. subsp. *scutariensis* Cernj.

Ramondia serbica Panc.

Salvia brachyodon Vand.

Saxifraga grisebachii Deg. & Doerfl. subsp. *montenegrina* (Hal. & Bald.) Micevski & Mayer

Stellaria saxifraga L.

Silene macrantha (Pancic) Neumayer

Taxus baccata L.

Trollius europaeus L.

Tulipa grisebachiana Pant.

Valeriana pancicii Hal. & Bald.

Wulfenia blecicii Lakusic

Box 2. Non-protected species free for gathering and trade ("Official Gazette SRCG", No.27/02) (the majority of species belong to the category of medicinal or aromatic plants)

Acacia dealbata Link.
Achillea abrotanoides (Vis.)Vis.
Achillea millefolium L.
Aconitum spp.
Agrimonia eupatoria L.
Alchemilla vulgaris L.
Allium ursinum L.
Althea officinalis L.
Anemone hepatica L.
*Antennaria dioica (*L.) Gaert.
Anthyllis vulneraria L.
Arctium spp.
*Arctostaphylos uva-ursi (*L.) Spreng.
Artemisia absinthium L.
Asparagus spp.
Asperula odorata L.
*Anthirium filix-femina (*L.*)* Roth.
Atropa belladonna L.
Bellis perennis L.
Betula spp.
Borago officinalis L.
Calamintha spp.
*Capsella bursa pastoris (*L.) Med.
Carlina acaulis L.
Castanea sativa L.
Centaurea cyanus L.
Centaurium erythrea Rafn.
Ceratonia siliqua L.
Chelidonium maius L.
Cichorium intybus L.
Colchicum autumnale L.
Consolida regalis S.F.Gray.
Convallaria majalis
Cornus mas L.
Coryllus avellana L.
Crataegus monogyna Jacq.
Datura stramonium L.
Digitalis spp.
*Dryopteris filix-femina (*L.) Schott.
Equisetum spp.
Foeniculum vulgare Mill.
Fragaria vesca L.
Frangula alnus Mill.
Fumaria officinalis L.
Galium verum L.
Geranium macrorhizum L.
Geranium robertianum L.
Geum urbanum L.
Glechoma hederacea L.
Helichrysum italicum (Roth.) Guss.
Humulus lupulus L.
Hypericum perforatum L.
Hyoscyamus niger L.
Hyssopus officinalis L.
Inula helenium L.
Iris germanica L.
Iris pseudoacorus L.
Laurus nobilis L.
Leonurus cardiaca L.
Linaria vulgaris Mill.
Malva sylvestris L.
Marrubium vulgare L.
Matricaria chamomilla L.
Melissa officinalis L.
Mentha spp.
Myrtus communis L.
Narcissus radiflorus L.
Olea europaea L.
Ononis spinosa L.
Origanum vulgare L.
Plantago lanceolata L.
Plantago major L.
Polygonum aviculare L.
Potentilla anserina L.
*Primula elatior (*L.*)* Hill.
Primula veris Huds.
Primula vulgaris Huds.
Prunus spinosa L.
Pulmonaria officinalis L.
Punica granatum var. *spontanea* L. Maly
Rosa canina L.
Rosmarinus officinalis L.
Rubus ulmifolius L.
Rubus idaeus L.
Ruscus aculeatus L.
Salvia officinalis L.
Sambucus nigra L.
Sanicula europaea L.
Saponaria officinalis L.
Satureia montana L.
Sedum acre L.
Solanum dulcamara L.
Solidago virgaurea L.
Spartium junceum L.
Symphytum officinale L.
Tanacetum cinerariifolium (Vis.) Schultz-Bip.
Taraxacum officinale L.
Teucrium chamaedrys L.
Teucrium montanum L.
Thymus spp.
Tilia spp.
Trifolium pratense L.
Trifolium repens L.
Tussilago farfara L.
Urtica dioica L.
Vaccinium myrtillus L.
Vaccinium uliginosum L.
Vaccinium vitis-ideae L.
Valeriana officinalis L.
Veronica chamaedrys L.
Viola arvensis Murr.
Viola odorata L.
Viola tricolor L.
Viscum album L.

Cultivation of MAP species

Apart from a few family farms, in which cultivation of MAPs is only a marginal activity, in Montenegro there are no specialized farms for MAP production. The reasons are the unstable markets and the lack of processing facilities, of big exporters (the biggest exporter of medicinal plants in the country, "Exportbilje" Risan has ceased to exist), and of a certification mechanism – certified products being essential for the world market.

The most widespread method of exploitation of the MAP potential in Montenegro is the collecting of plants from the wild.

For the period up to 2003 there are no statistical data about the amount of raw plant material gathered or about revenues. For the year 2003, 50 000 € were collected as the revenues on the use of medicinal plants and mushrooms, by the Directorate for Forests. For the first nine months of 2004, from the territory of Montenegro, 500 000 kg of medicinal plants, forest fruits and mushrooms were gathered. The most exploited plant species are: *Salvia officinalis, Juniperus communis, Helichrysum italicum, Laurus nobilis, Arctostaphylos uva-ursi, Veratrum album, Hypericum perforatum, Achillea millefolium, Colchicum autumnale, Tilia* spp., *Rosa canina* and *Crataegus monogyna* (data from the Ministry of Agriculture and Forests).

Gathering the plants from the wild is the easiest and the most rapid way of obtaining the raw plant material. But in spite of the extraordinary natural potentential of MAPs, inadequate gathering methods and overexploitation have started to present a serious threat for natural populations.

Besides improving the national legislation, other measures such as multidisciplinary MAP research and the development of MAP collections, and activities such as education programmes for collectors together with the limitation and control of collecting should be undertaken.

Previous and current investigations on MAPs and planned activities

It is worth mentioning that the first investigations into the medicinal plants in Montenegro were undertaken by the Institute for Medicinal Plant Research (IMPR) "Dr Josif Pančić" from Belgrade. These investigations covered the areas of Podgorica, Cetinje and Bokakotorska district, then Komovi and Prokletije; they resulted with four reports published in 1955 and 1966. In the period since then, many other scientific articles and papers have been published. Information about these publications is available in the Bibliography of Flora and Vegetation of Montenegro (Pulević 1980a, 1980b, 1985; Pulević and Bulić 2004).

Recent investigations of selected taxa (conducted by IMPR "Dr Josif Pančić" and its collaborators) included the genera *Gentiana, Gentianella, Hypericum, Amphoricarpus, Anthemis,* and species *Cephalaria pastricense, Tanacetum larvatum, Salvia brachydon, Oxytropis dinarica, O. halleri, Onobrychis scardica, Astragalus glycyphyllos, Centranthus, Narthecium scardicum* and other endemic species.

Apart from the initial activities of field investigation and multidisciplinary MAP research, the founding of a register herbarium and later a seed collection, further planned activities required for MAP protection and conservation are:

1. Improving the new national legislation that deals with the protection and exploitation of natural products of potential interest

2. Limitation and control of collecting
3. Education programme for collectors and future breeders
4. Farming
5. Investigations on the possible reintroduction and breeding of endangered wild MAPs.

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Medicinal and aromatic plants – report from the Nordic countries[15]

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Medicinal and aromatic plant (MAP) species have not up till now been included in the Nordic Gene Bank (NGB) mandate taxa. Except for one single NGB ad hoc report from 1994 about MAP species in the Nordic countries (Wahlin and Blixt 1994), no effort has been made to assess the distribution of genetic resources of MAP species, their genetic variation, potential use or the need for conservation measures.

Finland is one exception and activities in Finland are reported separately in three articles by Dr Bertalan Galambosi (this volume, pp. 71-109).

In 2001 the NGB recognized the need for studies and recommendations on the conservation and use of MAP species in the Nordic countries, and the SPIMED project ("Strategies for conservation of medicinal and aromatic plant species in the Nordic and Baltic countries") was launched as a joint project between the Nordic and Baltic countries. The project is run in collaboration with national plant genetic resources (PGR) programmes and is thematically based on previous work on exploring utilization options for MAP species in Finland, Latvia and Lithuania.

The SPIMED project (2001-2005) has the following objectives and activities:

a) to make a priority list of MAP species for Nordic and Baltic action plans, for genebanks and for national PGR programmes;
b) to investigate distribution of priority species, including assessing Red List status;
c) to develop strategies and recommendations for conservation of genetic resources in medicinal and aromatic plants;
d) to collect plants for *ex situ* conservation of eight target species;
e) to develop descriptors for the target species; and
f) to characterize collections with the aim of documenting genetic variation among populations in our countries.

The target species in the SPIMED project are listed in Table 1.

Regarding the target species as selected by the ECPGR MAP Working Group in 2002[16], there have been collecting missions and the development of descriptors for *Hypericum* spp., *Origanum vulgare* and *Thymus* spp. To roughly express distribution and Red List status of MAP species in the eight countries, the codes in Table 2 have been used.

The ECPGR MAP Working Group has ten species/genera on the priority list. Within these 23 species are present in the flora of the Nordic and Baltic countries (Table 3).

[15] Summary of presentation, Second Meeting of the ECPGR MAP Working Group, 17 December 2004, Strumica, Macedonia FYR.
[16] Appendix I in Baričevič et al. (2004).

Table 1. Target species in the SPIMED project showing which species have been collected in which countries

Species	Countries*							
	N	**S**	**DK**	**Fi**	**Ic**	**Es**	**La**	**Li**
Acorus calamus				x				
Arnica montana		x		x				
Helichrysum arenarium		x				x		x
Hypericum spp.			x					x
Origanum vulgare	x					x	x	x
Rhodiola rosea	x	x		x	x			
Thymus spp.			x		x		x	x
Valeriana officinalis		x	x					

* N = Norway; S = Sweden; DK = Denmark; Fi = Finland; Ic = Iceland; Es = Estonia; La = Latvia; Li = Lithuania

Table 2. Red List categories and codes used for the distribution of MAP species in the Nordic countries

IUCN Red List categories	**Letter codes**
Extinct	Ex
Extinct in the wild	Ew
Critically endangered	CR
Endangered	En
Vulnerable	Vu
Near threatened	NT
Least concern	LC
Categories used in current national red lists	
Rare	R
Declining, care demanding	DC
Lower risk	LR
Categories for national distribution	
Not present in the wild	N
Common, widely distributed	A
Common in certain areas of the country	B
Sparsely distributed, but not red-listed	C

Table 3. Species on the ECPGR priority list present in the Nordic and Baltic countries and their distribution expressed with letter codes (defined in Table 2) for each country

Species	Countries							
	N	S	DK	Fi	Is	Es	La	Li
Achillea millefolium L.	A	A	A	A	B	A	A	A
Achillea ptarmica L.	A	A	A	A	B	B	C	C
Artemisia absinthium L.	C	B	B	C	N	B	B	B
Artemisia maritima L.	R	C	C	N	N	EN	C	N
Artemisia vulgaris L.	A	A	A	A	N	A	A	A
Carum carvi L.	A	A	A	A	A	A	A	A
Gentiana cruciata L.	N	N	N	N	N	C	C	V
Gentiana purpurea L.	B	Vu	N	N	N	N	N	N
Hypericum hirsutum L.	B	C	C	C	N	B	C	R
Hypericum maculatum Cranz	A	A	C	A	N	A	B	A
Hypericum montanum L.	B	C	C	CR	N	EN	N	R
Hypericum perforatum L.	A	A	A	B	N	A	A	A
Mentha longifolia (L.) Hudson	N	C	N	N	N	N	C	LR
Mentha spicata L.	N	C	C	N	N	N	N	N
Mentha x *verticillata* L.	N	C	C	C	N	B	C	A
Mentha - hybrids	C	C	C		N	N	N	B
Origanum vulgare L.	A	B	B	B	N	B	B	C
Salvia pratensis L.	N	EN	C	C	N	C	C	R
Thymus praecox Opiz subsp. *arcticus* (E.Durand) Jalas	DC	N	N	N	A	N	N	N
Thymus pulegioides L.	C	NT	B	C	N	C	B	A
Thymus serpyllum L. subsp. *tanaënsis (Hyl.)* Jalas	R	B	N	C	N	N	N	N
Thymus serpyllum L. subsp. *serpyllum*	C	B	C	B	N	A	B	A
Thymus vulgaris L.	N	B	N	N	N	N	N	N

The project will conclude by recommending strategies for the use and conservation of MAP species in the Nordic and Baltic countries.

Evaluation of threats to natural populations will comprise:

- Changes in agricultural practice
- Changes of land use, urbanization etc.
- Environmental pollution
- Harvesting / overexploitation of natural populations
- Change caused by invasive species
- Climate change.

Furthermore the project will prioritize species for further inventories, collecting missions and characterization in the Nordic and Baltic countries. Relevant conservation methods *in situ* and *ex situ* will be explored.

The final reports from the project will be published during 2006 (see p. 169).
Members of the project group:

- Bertalan Galambosi, MTT Agrifood Research, Finland
- Gitte Kjeldsen Bjørn, Danish Institute of Agricultural Sciences, Denmark
- Ieva Žukauska, Latvia University of Agriculture, Latvia
- Jolita Radušienė, Institute of Botany, Lithuania
- Ulve Pihlik, University of Tartu, Estonia
- Haakan Tunon, Centre for Biological Diversity, Sweden
- Katarina Wedelsbäck, NGB, Sweden
- Kerstin Olsson, Svaløv-Weibull, Sweden
- Eva G. Thorvaldsdottir, Reykjavik Botanical Garden, Iceland
- Åsmund Asdal, Norwegian Crop Research Institute, Norway.

Reference

Baričevič D, Bernáth J, Maggioni L, Lipman E, compilers. 2004. Report of a Working Group on Medicinal and Aromatic Plants. First Meeting, 12-14 September 2002, Gozd Martuljek, Slovenia. International Plant Genetic Resources Institute, Rome, Italy.

Wahlin B, Blixt S, editors. 1994. Nordiska Medicinalväxter [Nordic Medicinal Plants]. Skrifter Nordiska Genbanken nr 24 [Publications of the Nordic Gene Bank no. 24]. NGB, Alnarp, Sweden. 100pp.

Activities on medicinal and aromatic plants in Norway[17]

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Out of the ten medicinal and aromatic plant species/genera that have been prioritized by the ECPGR Working Group on medicinal and aromatic plants (MAP), eight species/subspecies are present in the Norwegian flora. They are listed below together with some short comments regarding their distribution.

- *Achillea millefolium* L. (abundant and widely distributed throughout the country)
- *Artemisia absinthium* L. (sparsely distributed in some regions)
- *Carum carvi* L. (abundant, but the populations are decreasing due to changes in agriculture)
- *Hypericum perforatum* L. (abundant and widely distributed in most parts of country)
- *Mentha spicata* L. (sparsely distributed in some regions)
- *Origanum vulgare* L. (abundant and widely distributed in most parts of the country)
- *Thymus serpyllum* L. subsp. *tanaensis* Hyl. (sparsely distributed in one limited part of northern Norway)
- *Thymus serpyllum* L. subsp. *serpyllum* (rare, but not red-listed)

Two species are being emphasized in ongoing projects, namely *Origanum vulgare* and *Carum carvi*.

Origanum vulgare
- 36 accessions were collected in 2006. Samples were collected from all regions and these are considered to cover all parts of the distribution area in Norway.
- The accessions represent significant diversity as regards adaptation to climate, day-length and soil.
- Accessions were described using the descriptors developed in the SPIMED project ("Strategies for conservation of medicinal and aromatic plant species in the Nordic and Baltic countries") in 2004.
- Renewed characterization will be carried out in 2007, adapted to ECPGR descriptors, and will also include some chemical content analysis.

Carum carvi
- Caraway is probably the most widely used MAP species from the domestic flora in Norway. Seeds are used in various foods (cheese, cabbage etc.) and liquors.
- The agricultural production of caraway in Norway has increased the recent years. Caraway for domestic use was previously imported, but we are now able to export material. The exports amounted to 35 tonnes in 2004.

[17] Summary of presentation, Third Meeting of the ECPGR MAP Working Group, 27 June 2007, Olomouc, Czech Republic.

- Nordic accessions have high carvone contents.
- 66 accessions were collected from all parts of Norway during 2006, and this collection is considered to cover the distribution area of the species in Norway.
- The collection covers significant diversity regarding adaptation to climate, day-length and soil.
- Habitats for *C. carvi* in Norway are dependent on some agricultural practices, and populations of *C. carvi* is decreasing, mainly due to the cessation of hay cutting in many previously cultivated or grazed areas. The collected accessions will be multiplied in 2007 and further investigated in 2008.

The SPIMED project

The project "Strategies for conservation of medicinal and aromatic plant species in the Nordic and Baltic countries" (2001-2005) was finalized in 2005 and the report was issued in 2006 (Asdal et al. 2006). Copies of the report were distributed to the MAP WG.

The main general points of the report are:

- A total of 134 species/subspecies was suggested as the mandate taxa for the Nordic Genebank and for the Nordic National PGR programmes.
- Current and potential threats to wild populations of MAP species have been estimated.
- The report gives recommendations for conservation strategies and methods for conserving MAP diversity in the Baltic and Nordic countries.
- The report suggests priorities for further work regarding species and projects.

The target species in the SPIMED project are: *Acorus calamus, Arnica montana, Helichrysum arenarium, Hypericum* spp., *Origanum vulgare, Rhodiola rosea, Thymus* spp. *and Valeriana officinalis* (see also Table 1, p. 165).

Information about these target species in the report includes the following topics:

- Botany and distribution
- Medicinal use and biological effects
- Potential future use and threats to natural populations
- Information about the collected material
- Descriptors and a summary of results from characterization.

Reference

Asdal Å, Galambosi B, Kjeldsen Bjørn G, Olsson K, Pihlik U, Radušienė J, Þorvadsdóttir E, Wedelsbäck Bladh K, Žukauska I. 2006. Spice- and Medicinal Plants in the Nordic and Baltic Countries. Conservation of genetic resources. Report from a Project Group at the Nordic Gene Bank. Nordic Gene Bank, Alnarp, Sweden.

The diversity of wild-growing medicinal plants in Poland

Zenon Węglarz[1], Ewa Osińska[1], Waldemar Buchwald[2], Anna Geszprych[1], Jarosław Przybył[1], Ewelina Pióro-Jabrucka[1] and Małgorzata Pelc[1]

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The studies carried out in 2004 concerned 17 species of medicinal and aromatic plants (MAPs) on 212 natural sites and 272 accessions in *ex situ* collections. The seeds of 111 accessions were transferred to the Polish Gene Bank (Table 1).

Table 1. MAP species investigated *in situ* and *ex situ* in 2004

Species	No. of verified *in situ* sites	No. of accessions in *ex situ* collections	No. of accessions transferred to the Polish Gene Bank
Adonis vernalis L.	3	7	5
Arctostaphylos uva-ursi (L.) Spreng.	14	15	6
Arnica montana L.	8	6	-
Asarum europaeum L.	15	29	12
Asperula odorata L.	12	17	11
Colchicum autumnale L.	14	24	13
Convallaria majalis L.	14	26	15
Epilobium angustifolium L.	20	4	-
Epilobium hirsutum L.	20	4	-
Helichrysum arenarium (L.) Moench	16	10	14
Hierochloe odorata (L.) P. Beauv.	4	36	-
Hypericum perforatum L.	59	21	11
Hypericum sp.	-	7	6
Hyssopus officinalis L.	-	16	10
Origanum vulgare L.	5	27	5
Satureja sp.	-	13	3
Thymus serpyllum L. emend. Fr.	8	10	-
Total	**212**	**272**	**111**

This report presents detailed results of the investigations on four species which are on the list of "model species/genera" defined by the ECPGR MAP Working Group at its first meeting in 2002 (*Hypericum perforatum*, *H. maculatum*, *Thymus serpyllum* and *T. pulegioides)* and in addition, two species of *Epilobium* (*E. hirsutum* and *E. angustifolium*).

Eighty accessions of *Hypericum* growing wild in the central-eastern and southeastern parts of Poland were investigated. This region is the richest one in respect of both the area and number of their natural sites. The accessions differed in both morphological and chemical traits. In Table 2 the differences in the content of selected compounds in the essential oil of the chosen accessions of *Hypericum* are presented.

The main constituents of the essential oil of *H. perforatum* were 2-methyloctane and β-pinene, whereas in the essential oil of *H. maculatum* the dominant compound appeared to be α-terpineol. Distinct differences between accessions in the share of particular compounds in the essential oil were also observed.

Table 2. Content of major constituents of essential oil from *Hypericum perforatum* and *H. maculatum* herb

Species	Accession Number	Constituent (% in essential oil)					
		2-methyloctane	α-pinene	β-pinene	sabinene	β-caryophyllene	α-terpineol
H. perforatum	1	8.91	4.81	3.94	0.32	6.76	13.17
	5	24.88	12.16	15.31	0.12	5.72	3.70
	11	16.52	2.07	6.93	0.51	4.39	12.31
	12	28.09	30.32	10.00	-	1.89	0.27
	19	26.76	17.37	5.91	-	5.11	8.63
	23	10.24	10.88	5.12	0.36	10.61	2.53
	41	39.43	7.09	4.50	0.39	7.52	3.67
	45	20.80	15.14	8.27	1.01	7.91	6.17
	47	10.16	8.14	3.04	1.07	4.03	27.69
	51	10.33	16.66	4.81	1.81	5.12	19.13
H. maculatum	52	1.10	0.81	1.53	0.83	3.81	16.11
	53	5.47	7.83	2.34	0.52	3.34	27.84
	55	1.01	0.61	1.46	0.34	3.60	29.63
	56	8.06	6.90	3.35	1.80	0.89	29.10

Regarding the similarities in the content of hypericin, flavonoids and essential oil in the herb, 15 groups of accessions were distinguished (Fig. 1). The chemical similarity of accessions did not depend on the geographical location of their natural sites.

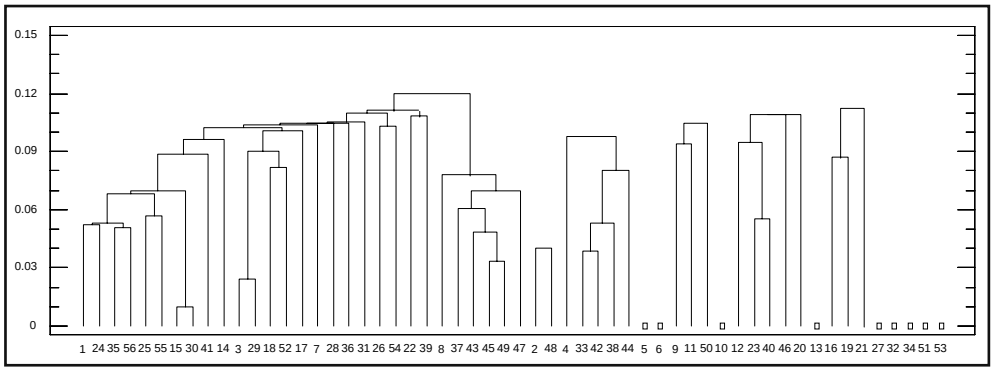

Fig. 1. Chemical similarity between investigated accessions of *Hypericum perforatum* and *H. maculatum* regarding the content of hypericin and pseudohypericin, flavonoids and essential oil in the herb.

The results of the studies on 13 chosen accessions of *Thymus* are also presented. The natural sites of these accessions were located mainly in central-eastern Poland. The morphological differences between the two species investigated concerned mainly plant height, type of growth (*Eurepens* and *Suberectus*), leaf area and type of inflorescence (capitulum and spiky). The intraspecific morphological differences were relatively small (Table 3). However, the molecular analysis showed distinct genetic distance between some accessions which did not reveal morphological differences, e.g. accessions nos. 3 and 4 or 9 and 10. Interesting but difficult to explain is the very close genetic similarity between accessions nos. 6 and 8, belonging to two different species (Fig. 2).

Table 3. Morphological characteristics of investigated accessions of *Thymus serpyllum* and *T. pulegioides*

Species	Accession Number	Height (cm)	Type of growth	Length of leaf (cm)	Width of leaf (cm)	Hairs on leaf blade	Type of inflorescence	Colour of perianth
T. serpyllum	1	4.0	*Eurepens*	0.4-0.8	0.2-0.4	None, only on the petiole and partly on the margin of the leaf blade – short plant hair	capitulum	violet
	2	2.5	*Eurepens*	0.3-0.5	0.2	None, only on the petiole	capitulum	dark pink
	6	3.0	*Eurepens*	0.4-0.7	0.2-0.3	On the petiole	capitulum	violet
	7	4.0	*Eurepens*	0.4-0.7	0.2-0.3	On the petiole and on the margin of the leaf blade	capitulum	violet
	13	8.0	*Eurepens*			None, only on the petiole and partly on the margin of the leaf blade – short plant hair	capitulum	dark pink
T. pulegioides	3	27.0	*Suberectus*	6-11	5-8	None	spiky	pink
	4	28.0	*Suberectus*	6-11	5-8	None	spiky	pink
	5	22.0	*Suberectus*	3-8	3-5	None	spiky	light pink
	8	20.0	*Suberectus*	13-15	7-10	Only on the petiole	spiky	pink
	9	18.0	*Suberectus*	8-13	4-6	Only on the petiole	spiky	pink
	10	19.0	*Suberectus*	8-13	4-6	Only on the petiole	spiky	pink
	11	23.0	*Suberectus*	5-11	4-6	None	spiky	pink
	12	25.0	*Suberectus*	5-10	4-6	None	spiky	pink

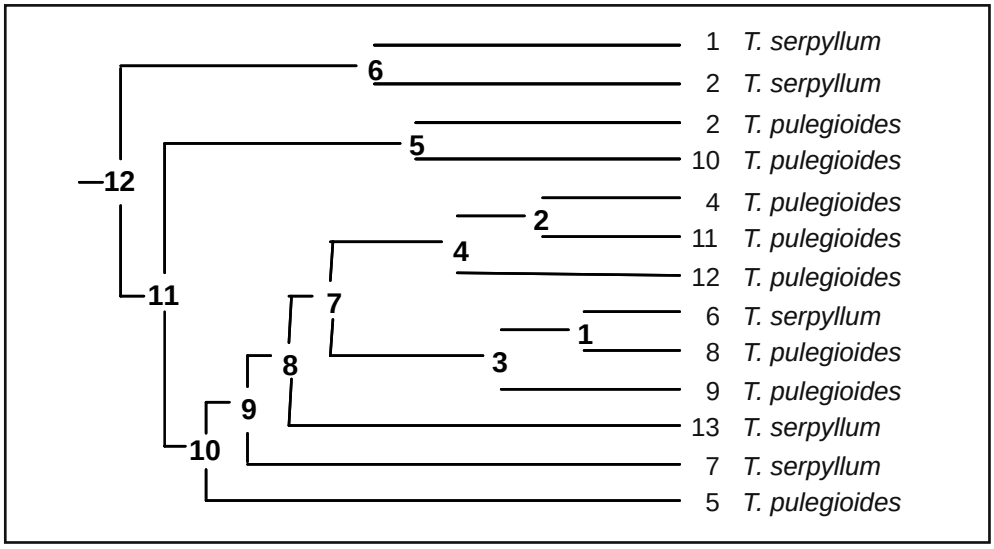

Fig. 2. Dendrogram of genetic distance of investigated accessions of *Thymus serpyllum* and *T. pulegioides.*

The investigated accessions differed in respect of the content of flavonoids (7.4-19.0 mg/100 g), polyphenolic acids (0.43-1.17 g/100 g) and essential oil (0.20-2.80 ml/100 g) in the dried herb. The most distinct differences between species were observed in the content of essential oil (Table 4).

Table 4. Content of biologically active compounds in *Thymus serpyllum* and *T. pulegioides* herb

Species	Accession Number	Active compounds		
		Flavonoids (mg/100 g)	Polyphenolic acids (g/100 g)	Essential oil (ml/100 g)
T. serpyllum	1	12.0	1.17	0.45
	2	7.4	0.46	0.20
	6	14.0	0.81	0.30
	7	14.0	0.54	0.30
	13	16.0	0.70	0.60
T. pulegioides	3	10.0	0.46	1.35
	4	10.4	0.72	1.40
	5	16.0	0.91	2.80
	8	19.0	0.69	1.50
	9	12.0	0.59	1.20
	10	18.0	0.68	1.50
	11	10.6	0.43	1.45
	12	10.0	0.96	1.30

Qualitative analysis of essential oils indicates that taking into consideration the dominant constituent of an essential oil, a few groups of accessions can be distinguished: those with thymol as a main compound (mainly *T. pulegioides* accessions), β-myrcene (in the case of *T. serpyllum*), carvacrol or geraniol (Table 5).

Table 5. Content of major constituents of essential oil from *Thymus serpyllum* and *T. pulegioides* herb

Species	Accession Number	Constituent (% in essential oil)											
		thymol	β-myrcene	carvacrol	geraniol	p-cymene	borneol	α-terpinene	camphene	α-terpineol	cineol	β-caryophyllene	α-terpinene
T. serpyllum	1	-	13.4	-	-	0.6	12.5	0.6	7.3	-	11.0	6.9	-
	2	1.1	0.4	19.9	-	22.8	-	7.1	-	6.5	-	-	7.1
	6	54.5	2.9	-	-	-	0.8	12.5	1.8	6.9	-	1.0	8.0
	7	0.6	14.3	0.1	1.0	0.2	12.1	1.8	6.7	4.4	0.3	9.0	1.0
	13	6.2	21.1	0.8	-	1.3	3.4	1.3	10.4	10.2	10.4	3.1	0.6
T. pulegioides	3	0.5	0.6	26.5	4.0	23.7	-	9.9	-	13.0	-	6.4	1.0
	4	0.1	0.3	33.8	4.2	12.6	4.3	6.3	-	0.1	0.3	7.6	0.5
	5	26.7	0.6	1.1	41.5	4.5	1.5	2.6	0.5	1.2	0.2	3.0	2.6
	8	52.0	1.5	3.7	2.5	6.5	0.6	7.2	1.6	3.5	0.4	5.3	1.2
	9	41.1	1.9	13.7	5.6	8.6	0.8	7.4	2.2	3.2	0.1	3.6	1.6
	10	17.2	9.7	3.8	-	9.5	0.7	9.0	11.7	5.1	1.7	0.9	2.0
	11	0.1	-	-	30.2	0.8	-	-	-	29.8	-	-	-
	12	1.5	-	4.8	24.1	7.1	25.8	-	0.2	15.4	-	4.5	0.2

Essential oil from the herb of investigated accessions revealed different antimicrobial activity. Essential oils obtained from *T. serpyllum* were not effective against gram-negative bacteria, in contrast to those obtained from *T. pulegioides*, which were rich in thymol (Table 6).

The ethnopharmacological studies resulted in the growth of interest by the phytopharmaceutical industry in the production of medicines based on *Epilobium* herb, which reveals anti-inflammatory activity and is used in benign prostatic hyperplasia. There are a few species of *Epilobium* in Poland, but the most important, taking into consideration the traditional usage and phytochemical studies made so far, seem to be *E. hirsutum* and *E. angustifolium*.

The most active compounds of *Epilobium* herb are sterols, especially b-sitosterol. The chemical studies carried out on 20 accessions of *Epilobium* showed distinct differences in the content of particular sterols. However, there were no clear differences between *E. hirsutum* and *E. angustifolium* (Table 7).

Table 6. *In vitro* antimicrobial activity of essential oil from *Thymus serpyllum* and *T. pulegioides* herb

Species	Accession Number	MBC = Minimal Bactericide Concentration (µg/ml)			
		Gram-negative bacteria		Gram-positive bacteria	
		Escherichia coli	***Pseudomonas aeruginosa***	***Staphylococcus aureus***	***Streptococcus pyogenes***
T. serpyllum	1	-	-	1500	-
	13	-	-	1500	2500
T. pulegioides	5	300	3500	500	300
	8	200	2000	300	100
	9	300	1500	300	50
	10	300	2000	300	100

Table 7. Content of identified sterols in *Epilobium hirsutum* and *E. angustifolium* herb (mg/100g)

Species	Accession Number	Identified sterols					
		β-sitosterol	**β-sitosterol-D-glucoside**	**Cholesterol**	**Brassicasterol**	**Campesterol**	**Stigmasterol**
E. hirsutum	1	125.5	109.0	2.3	24.5	211.1	6.8
	2	97.3	95.4	15.4	39.7	171.6	11.8
	3	203.6	112.3	2.4	42.4	59.5	15.9
	4	3.7	13.4	1.1	4.6	11.2	1.0
	5	311.4	-	56.0	-	-	-
	6	231.5	121.5	5.2	52.3	75.6	21.4
	7	133.8	85.0	6.8	26.9	42.8	0.4
	8	113.5	54.3	5.8	25.3	69.5	6.8
	9	118.5	39.4	4.6	14.7	29.8	4.8
	10	131.7	77.1	4.1	17.3	50.1	4.9
E. angustifolium	11	159.0	72.7	1.3	26.1	234.5	36.7
	12	152.7	46.4	1.6	25.8	102.1	14.2
	13	115.6	58.4	3.1	25.5	334.5	24.2
	14	164.3	49.3	2.3	24.0	60.2	33.9
	15	171.2	66.1	2.4	24.0	137.8	20.4
	16	137.8	41.6	20.9	74.9	19.7	1.9
	17	251.5	97.1	4.7	46.9	61.1	24.2
	18	108.5	86.0	10.6	21.7	157.1	23.6
	19	112.3	41.1	8.7	32.9	119.7	27.8
	20	117.9	26.2	4.2	18.2	73.2	21.3

The dry herb samples of investigated *Epilobium* accessions also differed in respect of the content of identified flavonoid compounds. Rutin was the only flavonoid that markedly differentiated the two species studied (Table 8).

Table 8. Content of identified flavonoids in *Epilobium hirsutum* and *E. angustifolium* herb (mg/100g)

Species	Accession Number	Identified flavonoids						
		Rutin	Luteolin	Quercetin	Isorhamnetin	Apigenin	Myricetin	Quercitrin
E. hirsutum	1	8.63	139.08	105.76	3.88	-	212.67	5.23
	2	346.32	281.35	40.42	-	-	10.02	0.48
	3	439.69	149.28	41.19	-	-	10.63	0.59
	4	308.75	273.91	49.84	23.93	-	12.25	1.23
	5	202.73	252.65	35.11	17.94	1.28	10.87	2.98
E. angustifolium	11	13.44	108.56	32.12	-	-	27.48	0.40
	12	62.05	149.28	41.19	-	0.58	11.61	0.74
	13	35.78	123.93	24.95	-	3.84	11.92	1.17
	14	17.37	131.05	106.77	-	-	210.50	0.30
	15	43.29	304.80	166.92	-	-	206.47	0.20

Genetic variability in field collections of Origanum, Thymus *and* Mentha *spp. from North-West Portugal*

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Introduction

The Iberian Peninsula is one of the greatest centres of diversity for medicinal and aromatic plants (MAPs) in the world. However, these resources are threatened and must be actively preserved, due to the fact that the genetic diversity that characterizes this region is in the process of dilapidation and loss as a result of the occupation and progressive transformation of the natural habitats by the expansion of agriculture, intensive grazing and the disordered expansion of urban and industrial activities and also by the pressure of tourism.

The medicinal and aromatic species are both an important heritage and economic resource for rural populations and part of the biological and cultural patrimony that characterizes each region.

For the last three decades the Portuguese Genebank (Banco Português de Germoplasma Vegetal, BPGV), Braga has been actively collecting germplasm and, through surveying and making inventories, has become aware of the need and urgency for a timely and integrated approach for MAP diversity conservation. Therefore, BPGV proposed and led a project to promote, at national level, integrated activities to collate and document traditional knowledge and to collect, conserve, document and characterize MAP germplasm. The initiative, a 3-year project designated *"Ethnobotany, the use and management of aromatic and medicinal plants and their sustainable utilization as a contribution to the improvement of rural areas"*, involved several institutions in the areas of agricultural research, education, and environmental protection. These efforts are being continued in another on-going project called *"National network for the conservation and utilization of aromatic and medicinal species"* which aims to carry out surveys and systematic collecting missions, to conserve, evaluate and to collate and document anthropological information on the aromatic and medicinal species in different regions of the country.

The activities of the first project resulted in the collection of 219 samples of MAPs representing 13 species, and the material was included and conserved in germplasm collections, assisting the understanding of variability which is related to ecogeographic distribution.

With the aim of assessing the genetic variability present in the material maintained in the BPGV field collections, a total of 52 accessions belonging to the genera *Origanum, Mentha* and *Thymus* were characterized according to their morphological traits, permitting us to identify the most representative populations which were then evaluated for the content of phenolic compounds.

Whenever available, BPGV uses the international proposed standards for morphological characterization. Since for these species, *Mentha aquatica* L. (water mint), *M. pulegium* L. (pennyroyal), *Origanum vulgare* L. (oregano) and *Thymus caespititius* Brot. (Cretan thyme), no such standard descriptors existed, a set of morphological descriptors was developed as an activity within the project's workpackages.

Capitalizing on our previous experience in this field, during the second meeting of the ECPGR Medicinal and Aromatic Plants Working Group, 16-18 December, Strumica, Macedonia, BPGV accepted the responsibility, on behalf of the WG, of leading the process of preparing draft proposals to be adopted as standards for the morphological characterization of the genera *Mentha* and *Thymus*.

Since comprehensive documentation and good quality data are prerequisites for optimal conservation, promoting access and encouraging sustainable utilization of PGR, it is clear that advantages derive from the utilization of widely agreed standards, namely: 1. Facilitated acquisition and registration of characterization and evaluation (C&E) data; 2. Facilitated storage and analysis of data and retrieval of information and 3. Facilitated exchange of information associated with the germplasm.

However, in our opinion, in their present format, the existing international proposed descriptor lists do not entirely fulfil the role of information exchange standards. For that, the development of future standards needs to evolve from the actual descriptor list format so as to include a computer application that will allow for the registering, storage, analysis and retrieval of data in a truly standardized manner. This electronic version of the standards (the computer application) would include preliminary statistical analysis tools which would greatly enhance the value of C&E data and the associated germplasm. This would be an asset, not only to better inform conservation strategies and promote utilization but also to add value to the associated plant genetic resources.

Materials and methods

In 2002 and 2003 BPGV carried out surveys and systematic collecting missions for seed and vegetative propagating material of *Mentha aquatica*, *M. pulegium*, *Orignaum vulgare* and *Thymus caespititius* in Entre Douro e Minho region, North-West Portugal, resulting in 52 wild populations collected (Table 1 and Fig. 1).

Table 1. Number of samples collected by species

Species	No. of samples
Mentha aquatica L.	6
Mentha pulegium L.	18
Origanum vulgare L. subsp. *virens*	12
Thymus caespititius Brot.	16
Total	**52**

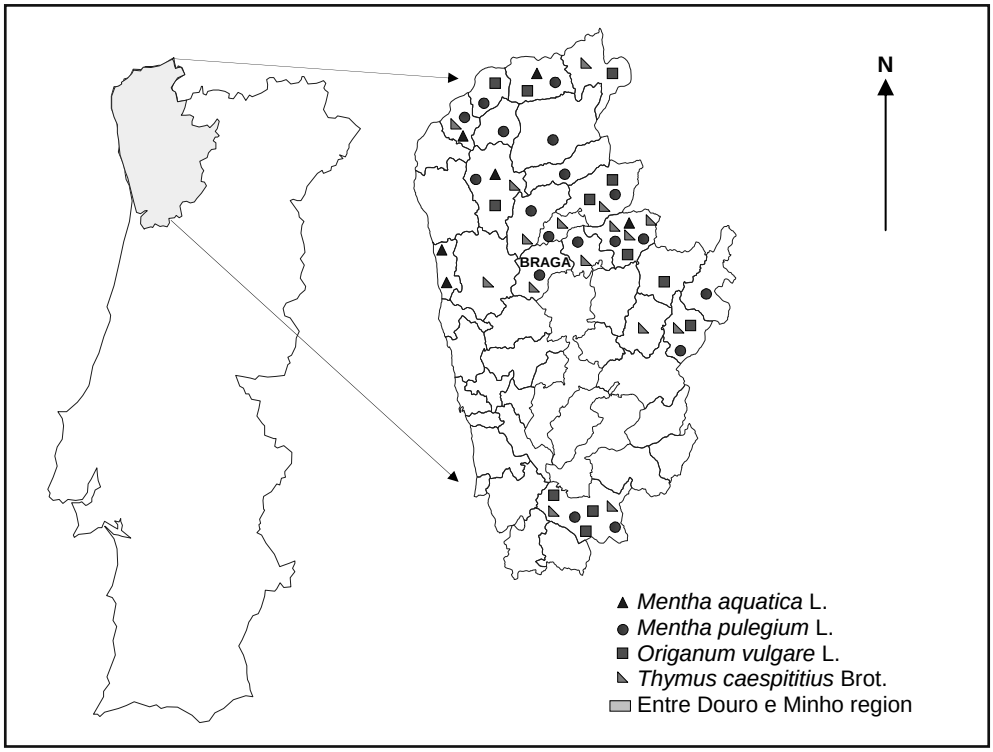

Fig. 1. Geographic distribution and number of samples collected in Entre Douro e Minho region, North-West Portugal.

The material collected was vegetatively propagated by dividing the plants which were then planted in 10 clay pots per population, and the passport data documented in the genebank documentation system. The morphological characterization was carried out on the field collection, using 10 plants per accession (population).

The morphological characterization and preliminary evaluation data were analyzed using analysis of variance (ANOVA) and multivariate analysis by SAS, JMP v. 3.0, MSTAT-C and NTSYS v. 2.0 programs.

Based on the clusters obtained by the multivariate analysis of the morphological traits, the three most representative populations were further evaluated for their content of phenolic compounds.

Results and discussion

Based on the surveying and collecting data, it was clear that the NW region of Portugal has adequate ecological conditions for the occurrence of species of *Mentha pulegium, Origanum vulgare* and *Thymus caespititius*.

M. pulegium populations are most commonly found in wet habitats or near river banks and it is generally associated with riparian vegetation, sharing the same habitat preferences with *M. aquatica*.

O. vulgare populations occur in ruderal habitats, fallow land or abandoned cultivated fields and by the roadsides.

T. caespititius is well adapted to dry and stony soils occurring in xerophilous bushland.

Characterization

- **Mentha aquatica *and* M. pulegium**

Generally, the bigger plants have bigger leaves. Likewise, plants with the most heavily pilous stems have the more hairy leaves and calyces. In *M. aquatica,* some variability was observed regarding flowering date and degree of pilosity of the different organs. For *M. pulegium*, there were also variations in flowering date, plant habit and in the number of axillary flowers.

- **Origanum vulgare**

The 12 accessions which were initially classified as *O. vulgare* were re-classified as *O. vulgare* L. subsp. *virens* (Hoffmannsegg & Link) Ietswaart according to the morphological characterization data.

Based on the utilization of the descriptors and the analysis of the agro-morphological data, we can say that, out of the total 63 descriptors observed and registered, 32 are highly discriminative of the population's diversity, and therefore, in our view, constitute the minimum descriptor list for the morphological characterization of *O. vulgare* L. subsp. *virens* (Hoffmannsegg & Link) Ietswaart.

The most variable traits observed were: plant height; leaf, bract and corolla size; growth habit; and plant cycle.

Based upon the analysis of the characterization data we found that the accessions present a broad genetic base which is an asset for the utilization in the genetic improvement of the species. According to Franz and Novak (1997), this is what several countries have done, using indigenous wild material in their breeding programmes. In the field collection there are populations (accessions) with erect growth habit which is an important character for mechanical harvesting (Leto and Salamone 1997), mainly when that characteristic is combined with great plant height (De Mastro 1997). In this respect, there is a great genetic variability between populations for plant height (43.3 cm to 64 cm). There are also populations with different plant life cycles, which is also an important and interesting characteristic for genetic enhancement purposes. Another important feature is the presence of gynodioecy which is well known to occur in the genus *Origanum*. This characteristic is particularly sought for breeding purposes as it greatly simplifies and facilitates cross-pollination which is normally difficult due to the minute size of the flowers and the type of inflorescence (Franz and Novak 1997).

- **Thymus caespititius**

From the total of 27 descriptors, 21 proved to be useful to assessing and studying the genetic variability among populations.

Populations' variability is most markedly evident in relation to the flower traits and plant vigour. These populations are characterized by plants which are generally prostrate and with spatulate leaves. Style length is a characteristic that differentiates

among populations, since short styles are more frequent on smaller flowers which are male sterile.

From the utilization point of view, this germplasm shows good potential both for use as a culinary condiment and as an ornamental (populations with many flowers and erect plants), while some also have potential value for soil protection (populations with vigorous and prostate plants). Other populations, showing a combination of plant vigour and high flowering intensity, have great utilization potential for essential oils production and for culinary uses. As far as ecogeographical variability is concerned, the populations studied show that altitude and physical barriers are important factors influencing the biodiversity distribution. In this study, altitudes over 400 m and the Cavado River are related to the population clusters.

Evaluation of phenolic compounds

- **Mentha aquatica *and* M. pulegium**

The chromatograms show homogeneity between populations with predominance of rosmarinic acid. This indicates that the phenolic compounds are not directly correlated with morphological differentiation but they are, nevertheless, a good marker for the species. Besides rosmarinic acid the following were also quantified: chlorogenic, caffeic and hesperidin acids.

- **Origanum vulgare**

For this species the chromatograms quantified rosmarinic and caffeic acids. Caffeic acid was identified in variable and small quantities, while rosmarinic acid content was similar in two populations and half of that value in the other one. This may indicate that the rosmarinic acid content could be used as a taxonomic marker and confirm, at the chemical level, differences among populations. This acid is an excellent anti-oxidant.

- **Thymus caespititius**

In the accessions of this species, chlorogenic and rosmarinic acids, apigenin 7-0-glucoside and genkwanin were identified. However they appeared to be of little value in differentiating between populations.

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Medicinal and aromatic plants in Romania – cultivation, conservation and distribution of selected species

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A previous report on the "Status of the Romanian medicinal and aromatic plant collection" was provided by Murariu et al. (2004).

The present paper provides additional information on the cultivated medicinal and aromatic plants (MAPs) in Romania, the status of *ex situ* MAP collections, and the natural distribution of the "priority species/genera" selected by the ECPGR Working Group on Medicinal and Aromatic Plants (Baričevič et al. 2004).

Further information on Romanian MAP species (protection, conservation, collecting, cultivation, trade, relevant legislation) can be found in Kathe et al. (2003).

Cultivated MAPs in Romania

From all the wild native plants, a total of 3700 taxa, only 57 species are cultivated by agricultural companies and family farms. Sixteen of the most important species are listed in Table 1.

Table 1. Estimated area of cultivation and annual harvest yield for 16 important MAP species cultivated in Romania (adapted from Kathe et al. 2003)

Species cultivated	Area under cultivation (ha)	Current annual harvest (t)	Parts harvested
Coriandrum sativum L.	8675	1735.0	fruits
Lavandula angustifolia, *Achillea milefollium*, *Matricaria chamomilla*	750	431.0	flower
Hippophae rhamnoides	650	230.0	fruits
Papaver somniferum	50	30.0	fruits
Carum carvi, *Foeniculum vulgare*	43	27.0	fruits
Ribes nigrum	15	18.0	leaves and fruits
Atropa belladonna	12	22.0	roots
Echinacea purpurea	10	20.0	roots
Mentha x *piperita*	10	24.0	leaves
Salvia officinalis	9	6.5	leaves
Cynara scolymus	8	20.0	leaves
Calendula officinalis	7	4.0	flowers
Digitalis purpurea	5	7.5	leaves

Researchers and breeders of the Fundulea Research Station succeeded in creating 65 Romanian varieties of MAPs and established cultivation technologies adapted to the pedoclimatic conditions from Romania for about 57 species, including those listed in Table 1. Some of these varieties are included in the Official Catalogue of varieties in Romania (Table 2).

Local agricultural cooperatives dominate MAP cultivation in Romania; however, individual farmers and national companies also occasionally cultivate MAPs. Private MAP tillage accounts for well over 50% of the total area used for MAP cultivation but its share appears to be decreasing (Kathe et al. 2003).

Information about the share of organic farming is very contradictory; while some state that about 65% of the medicinal and aromatic plants harvested from cultivation were grown according to the principles of organic farming, others deduce from the data obtained, that only few if any organically grown MAPs are produced in Romania (Kathe et al. 2003).

Table 2. Named varieties of MAPs cultivated in Romania (source: Official Catalogue of varieties of cultivated plants of Romania, The Parliament of Romania (Anonymous 2004))

Species	Family	Variety	Owner institution	Comments
Thymus vulgaris L.	Lamiaceae	De Dolj Smarald	Fundulea	Local population Protected variety
Mentha piperita L.	Lamiaceae	Columna Cordial Cristal	Fundulea	- Protected variety -
Mentha spicata L. var. *crispa* (Benth.) Mansf.	Lamiaceae	Mencris Record	Fundulea	- Protected variety
Artemisia dracunculus L.	Asteraceae	Armonia Artemis De Ilfov	Fundulea	- - Local population
Salvia officinalis L.	Lamiaceae	De Rasmiresti	Fundulea	Local population
Salvia sclarea L.	Lamiaceae	Vosnesenki 24	Fundulea	Local population
Melissa officinalis L.	Lamiaceae	De Dobresti	Fundulea	Local population
Carum carvi L.	Umbelliferae	De Ghimbav Mare de Roman	Fundulea	Local population Local population

Ex situ MAP collections in Romania

- ***Botanical gardens***

The botanical gardens were conceived and set up as institutions of national standing fulfilling multiple functions: as teaching places, as scientific and cultural/recreational institutions, as well as for the preservation of the genetic resources of indigenous plants.

- Botanical Garden "Anastasie Fatu" of the Alexandru Ioan Cuza University in Iaşi
- Botanical Garden of "Babes Bolyai" of the University of Cluj-Napoca
- Botanical Garden "Dimitrie Brandza" of the University of Bucharest

- ***Agricultural schools***
  - Agricultural University Iaşi (80 samples – 67 species)
  - Agricultural University Timisoara (74 samples – 66 species)

- ***Research institutes***
  - Central Research Station for MAP Fundulea (931 samples – 297 species)

- ***Suceava Genebank***

The main activities of the Suceava Genebank are focused on prospecting, collecting, evaluation and conservation of plants for the long term.

Conservation of MAPs in a field collection for the medium and long term is carried out at the Suceava Genebank.

The conservation methods of MAP genetic resources follow the FAO/IPGRI Genebank standards (1994).

The Suceava Genebank contains 820 seed accessions of 110 MAP species from 31 families, kept in two types of collections: base and active.

The base collection provides long-term conservation of 525 accessions at a temperature of -20°C and at a moisture content of seeds 5±1%.

The active collection contains a total of 295 accessions under mid-term storage conditions, at a temperature between 0 and +4°C and at a moisture content of seeds between 3 and 7%.

Table 3 shows the taxonomic composition of the MAP collections maintained at the Suceava Genebank.

Table 3. Numbers of MAP species and accessions of which seeds are preserved in long- and medium-term storage in the Suceava Genebank, by botanical families

Family	No. of species	No. of accessions	Family	No. of species	No. of accessions
Amaranthaceae	6	106	Malvaceae	3	9
Asteraceae	22	150	Onagraceae	1	1
Betulaceae	1	7	Papaveraceae	4	45
Brassicaceae	4	54	Phytolaccaceae	1	1
Campanulaceae	1	7	Piperaceae	1	2
Cannabinaceae	1	77	Plantaginaceae	2	5
Caryophyllaceae	3	5	Polygonaceae	1	2
Cesalpiniaceae	1	2	Ranunculaceae	2	5
Chenopodiaceae	3	6	Rubiaceae	2	2
Cucurbitaceae	2	7	Rutaceae	1	2
Echinaceae	1	5	Scrophulariaceae	1	3
Eleagnaceae	1	2	Solanaceae	7	88
Fabaceae	10	75	Tropaeolaceae	1	2
Geraniaceae	1	5	Umbelliferae	12	98
Hypericaceae	2	5	Verbenaceae	1	2
Lamiaceae	11	40			
Total no. of species = 110 / Total no. of accessions = 820					

The "priority MAP species/genera" in Romania

Pedoclimatic conditions have determined the development of a flora in Romania which impresses by its richness and variability.

The "priority species/genera" as defined in 2002 by the ECPGR MAP WG (Baričevič et al. 2004) are some of the most important in terms of numbers and pharmaceutical interest, offering a large field for study and research. Table 4 shows the holdings of the Suceava Genebank for these species.

Table 4. "Priority MAP species" in the Suceva Genebank collection

Species	No. of samples
Achillea millefolium L.	2
Artemisia absinthium L.	1
Carum carvi L.	15
Gentiana lutea L.	-
Hypericum perforatum L.	3
Melissa officinalis L.	3
Mentha piperita L.	58
Mentha spicata L.	40
Origanum vulgare L.	12
Salvia officinalis L.	8
Thymus vulgaris L.	9
Thymus serpyllum L.	6
Total	**139**

Romania is considered an important meeting point between different biogeographical regions and ecosystems, linking Europe and Central Asia. Prior to anthropogenic influences, the territory of today's Romania consisted mainly of forests (27%) and steppe grasslands (16%); aquatic ecosystems and wetlands accounted for about 5.8%, and alpine and subalpine ecosystems for about 1.2% of the territory (National Strategy and Action Plan for the Biological Diversity, Conservation and Sustainable Use of its Components in Romania (NSAP), cited by Kathe et al. 2003).

The major types of ecosystems in Romania from which MAPs are harvested are: boreal coniferous forest, mesophilous broadleaved forests, hygrophilous broadleaved forest, xerothermic broadleaved forests, cryophilous alpine grasslands, mesophilous grasslands, hygrophilous grasslands, xerophilous and xerothermic grasslands, psamophilous grasslands, halophilous grasslands, saxicole and petrophilous formations, mountain and subalpine herbs, cryophilous small alpine bushes, subalpine bushes, mesophilous and submesophilous bushes, xerophilous bushes (steppe), hygrophilous bushes.

The distribution of the priority species/genera in relation to main vegetation types in Romania is shown in Table 5.

Table 5. Distribution of the priority MAP species in relation to main vegetation types in Romania

Species	Vegetation type				
	Plain	Hill	Mountain	Subalpine	Alpine
Achillea millefolium	x	x	x	x	
Artemisia absinthium	x	x	x		
Carum carvi		x	x	x	
Gentiana lutea			x	x	x
Hypericum perforatum	x	x	x	x	x
Melissa officinalis	x	x			
Mentha piperita		x	x	x	
Mentha spicata	x	x			
Origanum vulgare	x				
Salvia officinalis		x	x		
Thymus vulgaris	x	x			
Thymus serpyllum		x	x		

Use of MAPs in Romania

The therapeutic value of the medicinal plants is based on the relationship between the chemical structure of the active elements and their pharmaceutical action on the human body. The complexity of the chemical composition of plants from 2-3 active compounds to 30-40 identified in some plants, explains the therapeutic efficacy of the same plant in different diseases or conditions.

The products obtained from MAPs include drugs, phytotherapeutic products, phytotherapeutic additives, preserving products, dyestuffs, flavouring products and nutrient supplements.

Due to their specific demands, some MAP species can be grown on land which is unsuitable for other crops, for instance:

- *Lavandula angustifolia* Miller (common lavender) which grows on hillside slopes,
- *Matricaria chamomilla* L. (chamomile) which grows on semi-salty soils,
- *Acorus calamus* L. (sweet flag or calamus) which grows on swampy lands,
- *Artemisia petrosa* Baumg., *Cerastium alpinum lanatus* L., *Dianthus spiculiformis* L., *Silene acaulis* (L.) Jacq., all of which grow in alpine areas like little cushions attached to the rock,
- *Linaria alpina* (L.) Mill., *Papaver pyrenaicum* L., *Geum reptans* L. grow on boulders, gravels and screes.

The use of MAPs in Romania for cosmetic, medicinal, colouring and aromatic purposes has a long tradition. MAPs are also used in herbal teas, food supplements, liquors, bitters, insecticides, fungicides, essential oil products, perfumes, flavouring liquids, varnishes and cleaning products.

Future stategies

Due to the social and economic importance of MAPs, increases in the quality of the products from these plants will be needed for the future. To achieve this, several steps are required:

- Greater efforts in scientific research into agrobiology issues, breeding, phytochemistry and pharmacology;
- Bringing some MAP species of the native flora into cultivation in order to increase the content of active substances (for which research will also be needed);
- Improvement of modern extraction technologies and diversification of the production of medicines of plant origin and semi-synthetic medicines;
- Increase of the content of active substances, taking into account precise procedures (zoning of MAPs brought into cultivation, choice of the cultivation technology and harvesting methods best adapted to each species, selection and breeding of the biological material, transport and preparation for drying, drying and storage).

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Recent activities on the genetic resources of medicinal and aromatic plants in Serbia (2003-2004)

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Uncontrolled and unsustainable harvesting of medicinal and aromatic plants (MAPs), as a consequence of increased demand for MAP raw materials, both at domestic and international market level, has resulted in the diminution of a number of native MAP populations, serious disturbance of their habitats, and the endangering of many species.

A complex coordinated approach for biodiversity maintenance based upon various *ex situ* and *in situ* germplasm conservation programmes (Heywood 1989) in Serbia is conducted in compliance with the recommendations of international institutions such as the International Union for Conservation of Nature (IUCN), the World Wide Fund for Nature (WWF), the World Health Organization (WHO), the International Plant Genetic Resources Institute (IPGRI, now Bioversity International) and others.

MAP genetic resources are extremely rich, heterogeneous and specific in comparison to other crops, knowing that chemical characterization of active substances and related descriptor lists refer mainly to this group of plants. One of the first problems is that no precise definition of a "medicinal" plant has so far been adopted. Another difficulty is that different therapeutic powers are attributed to many species in ethnomedicine of various countries, and even in regions of the same country.

A consciousness of the lack of coordinated activities in the monitoring of natural resources, protection of endangered, rare and vulnerable MAP species, and the increasing role of IPGRI in creating the policy of preservation and utilization of MAP genetic resources (Guarino et al. 1999), led to the formation of the European ECPGR MAP Working Group. Taking part in the activities of this WG has significantly contributed to increasing the number of MAP accessions in the National Gene Bank and has improved the systematic survey and inventory of natural MAP populations in Serbia.

General activities in preservation of MAP genetic resources

Activities conducted following the first meeting of the ECPGR MAP Working Group in 2002 on the preservation of MAP genetic resources in Serbia can be summarized as the collecting of MAP accessions for the National Gene Bank, evaluation of MAP resources and mapping of native MAP populations. In this period (September 2002-December 2004) the collection of the National Gene Bank was enriched with a total of 218 accessions of MAP species, an increase of approximately 280%. At the moment, there are 337 accessions of 212 medicinal and aromatic species in the National Gene Bank.

For a majority of MAP accessions the complete passport and most of collecting/monitoring descriptors exist (see example in Table 1). However, these descriptors still need to be harmonized with the list of descriptors (within this category) proposed by the ECPGR MAP Working Group. Management and characterization/evaluation descriptors are generally missing. Here is worthwhile mentioning the recent PhD study (Jelačić 2003), at the Faculty of Agriculture in Belgrade where ten basil accessions were evaluated in detail and almost completely harmonized with the proposed list of descriptors which is to be adopted by the ECPGR MAP Working Group.

Table 1. Example of data recorded for an accession *of Hypericum androsaemum*

ACCESSION NUMBER					
1.1.	Accession number	316			
1.2.	Name and address of donor (institution)	Institute for Medicinal Plant Research "Dr J.Pančić", Tadeuša Košćuška 1, 11000 Belgrade			
1.3.	Full name of donor(s)	Tasić Slavoljub, Katarina Šavikin Fodulović, Nebojša Menković			
1.4.	Other names and ID numbers associated with the accession	Gordana Zdunić			
1.5.	Collecting date of sample	21.06.2003.			
ACCESSION NAME					
	Series	Theales			
2.1.	Family	Hypericaceae Lindl.			
	Genus	*Hypericum* L.			
2.2.	Species	*Hypericum androsaemum* L.			
2.3.	Subspecies	/			
2.4.	Common crop names	Krvavac			
DATA ON ACCESSION					
3.1.	Type of collected sample	Seed			
3.2.	Observed pests / diseases	No			
3.3.	Other	/			
BIOLOGICAL STATUS OF ACCESSION					
4.1.	Wild growing	Yes			
4.2.	Cultivated	/			
DATA ON COLLECTING SITE					
5.1.	Country of origin / Republic	Serbia and Montenegro / Serbia			
5.2.	Location of collection site / description	Mountain Maljen, road to Brežđe			
5.3.	Longitude of coll. site	200 04' 10" (± 10")			
5.4.	Latitude of coll. site	440 10' 25" (± 10")			
5.5.	Type of soil at coll. site	Not determined			
5.6	Elevation of coll. site	650m			
5.7.	Collecting source and environment	Wild habitat	Yes	Forest	Deciduous forest, by the road, moisture stands, in shadow
				Shrubland	/
				Meadows / pastures	/
				Desert / tundra	/
				Rocky habitat	/
				Other	/
		Cultivated habitat	/	/	
DATA ON POPULATION					
6.1.	Evaluation of incidence at collection site (5 =Very abundant stand) (4 = Abundant stand) (3 = Moderately present) (2 = Rare) (1 = Very rare)	2			
6.2.	General appearance of population (1 = Poor) (2 = Moderate) (3 = Rich)	3			
6.3.	Associated flora	*Atropa belladona, Hypericum hirsutum, Rubus idaeus, Rubus fruticosus, Solanum dulcamara, Equisetum* sp., *Staphylea pinnata*			

Collecting of MAP accessions, supervised by the Department for Plant and Animal Genetic Resources of the Republic of Serbia, has been followed by monitoring of natural MAP populations in the West, South-East and North-East of Serbia.

Additional activities of *ex situ* MAP conservation were associated with the recently re-established field collection of medicinal and aromatic plants of the Institute for Medicinal Plant Research "Dr Josif Pančić" (IMPR) in Belgrade. The collection contains 73 species, out of which 13 belong to the group of ten priority or "model" species/genera proposed by the ECPGR MAP Working Group at its first meeting (Baričević et al. 2004).

There are also several other seed collections of MAPs in Serbia, such as the seed collection of the IMPR in Belgrade, which contains more than 300 accessions belonging to 94 MAP species, and the collection of the Institute for Field and Vegetable Crops, Novi Sad, Department for Hops, Sorghum and Medicinal Plants in Bački Petrovac, which contains 480 cultivars, populations and genotypes of 202 plant species of 38 families (Dajić and Dražić 2003). Most of the accessions of these two collections lack any descriptors, including the passport data.

Activities on the ten "model species/genera" proposed by the ECPGR MAP Working Group

The ECPGR MAP Working Group at its first meeting agreed to select a list of ten species/genera to serve as models for further studies on MAP genetic resources (Baričević et al. 2004). Accordingly, an inventory of their natural populations and the related status of these species based upon IUCN categories and the Convention on International Trade in Endangered Species (CITES) was conducted in Serbia, accompanied by a survey of the available literature data (Benić 1996; Jančić 1998; Dajić and Kojić 1998, 1999; Ranđelović et al. 1999; Aćić et al. 2004; Dajić 2004; etc.). We found that many species ought to be protected and treated with special attention, as they are endangered, vulnerable, locally rare, or at risk (Table 2). Among them are several species of the genera *Achillea, Gentiana* and *Hypericum*. In the "Flora of Serbia" (Josifović and Diklić 1970-1986), it is stated that the genus *Achillea* L. in Serbia has 20 species, *Thymus* L. 31 species and approximately 50 subvarieties, *Salvia* L. 14, *Mentha* L. 11, and *Gentiana* L. 10 species. Nevertheless, the presence of several taxa seems to be uncertain and has to be confirmed, as these species were designated as rare or were listed according to the names in older literature (e.g. *Hypericum olympicum* L., *H. humifusum* L., *H. transsilvanicum* Cel., *H. elegans* Willd., *Thymus decipiens* H. Braun, *T. ocheus* Heldr. et Sart., *Salvia argentea* L., *S. virgata* (Jacq.) Sibth. et Sm., etc.).

A review of the genus *Mentha* in Serbia (Jančić 1998) indicated the presence of the following species: *M. arvensis* L., *M. aquatica* L., *M. longifolia* (L.) Huds., *M. spicata* L. and *M. pulegium* L. There are also three hybrids (beside *M.* x *piperita* L.) in the flora of Serbia: *M.* x *verticillata* (*M. arvensis* x *M. aquatica), M.* x *hirta (M. aquatica* x *M. longifolia*) and *M.* x *dalmatica* Tausch. *(M. arvensis* x *M. longifolia).*

Regarding attempts to assess the size and condition of natural populations of the *Thymus* species, there are serious problems with the determination of particular species. Thus, the presence of many species, subspecies, varieties and subvarieties is very arguable.

Despite the fact that there are citations referring to the presence of *Thymus adamovicii* Vel., both in "Flora of Serbia" (Diklić 1975) and "Flora Europaea" (Tutin et al. 1968) this species has not been recorded at the quoted localities during several recent collecting missions (Šoštarić and Dajić, unpublished data).

Therefore, the list of *Thymus* species (Table 2) was prepared according to a recent survey on their distribution in parts of the North, South and East Serbia (Šoštarić et al., unpublished data).

Table 2. Status of the "priority species/genera" of the ECPGR MAP Working Group in Serbia

Species	IUCN status*				Legal status	
	CR	EN	VU	LR	Legally protected	Quota in force
Achillea abrotanoides				x	x	
Achillea ageratifolia		x			x	
Achillea alexandri-regis	x				x	
Achillea atrata				x		x
Achillea clavenae				x	x	
Achillea clypeolata						x
Achillea crithmifolia						x
Achillea lingulata				x	x	
Achillea millefolium						x
Achillea ochroleuca	x				x	
Artemisia absinthium						x
Artemisia austriaca	x				x	
Artemisia dracunculus						
Artemisia lobelia		x			x	
Artemisia pancicii	x				x	
Carum carvi						
Gentiana acaulis		x			x	
Gentiana asclepiadea						x
Gentiana ciliata						
Gentiana cruciata						x
Gentiana cruciata						x
Gentiana lutea			x		x	
Gentiana pneumonanthe subsp. *nopcsae*	x				x	
Gentiana pneumonanthe subsp. *pneumonanthe*			x			x
Gentiana punctata			x			x
Gentiana utriculosa						
Gentiana verna subsp. *tergestina*				x		
Hypericum acutum				x		
Hypericum androsaemum				x		
Hypericum barbatum						x
Hypericum boissieri				x		
Hypericum hirsutum						

* IUCN categories: CR = critically endangered; EN = endangered; VU = vulnerable; LR = locally rare

Table 2 (cont.). Status of the "priority species/genera" of the ECPGR MAP Working Group in Serbia

Species	IUCN status*				Legal status	
	CR	EN	VU	LR	Legally protected	Quota in force
Hypericum maculatum						
Hypericum montanum						
Hypericum perforatum						x
Hypericum repens				x		
Hypericum richeri				x		
Hypericum rumelicum						
Hypericum umbellatum				x		
Melissa officinalis						x
Mentha aquatica						
Mentha piperita						
Mentha pulegium						x
Mentha spicata						x
Origanum vulgare						x
Salvia aethiopis			x			
Salvia amplexicaulis				x		
Salvia austriaca				x		
Salvia glutinosa						
Salvia nemorosa						
Salvia officinalis				x	x	
Salvia pratensis						
Salvia ringens		x				
Salvia sclarea				x	x	
Salvia verticillata						
Thymus dacicus			x			
Thymus glabrescens						
Thymus jankae						
Thymus lykae						
Thymus malyi			x			
Thymus marschallianus						
Thymus moesiacus						
Thymus pannonicus						
Thymus pulegioides						
Thymus rohlenae			x			
Thymus serpyllum						x
Thymus striatus				x		
Thymus vulgaris						x
Thymus wandasii						

* IUCN categories: CR = critically endangered; EN = endangered; VU = vulnerable; LR = locally rare

The National Gene Bank at the Department for Plant and Animal Genetic Resources contains a total of 75 accessions belonging to the ten MAP model species/genera (Table 3).

Table 3. Number of accessions of the ECPGR "priority species" deposited in the National Gene Bank of Serbia and Montenegro

Species	No. of accessions
Achillea abrotanoides Vis.	3
Achillea ageratifolia Boiss.	3
Achillea clavenae L.	1
Achillea clypeolata Sibth. et Sm.	1
Achillea lingulata W. et K.	2
Achillea millefolium L.	1
Gentiana asclepiadea L.	4
Gentiana crispata (Vis.) Holub.	1
Gentiana cruciata L.	3
Gentiana dinarica Beck.	3
Gentiana kochiana Perr. et Song.	2
Gentiana lutea L.	4
Gentiana pneumonanthe L.	3
Gentiana praecox (A. et J. Kern.) Dost.	1
Gentiana punctata L.	3
Gentiana utriculosa L.	7
Hypericum acutum Moench	1
Hypericum androsaemum L.	3
Hypericum atomarium Boiss.	2
Hypericum barbatum Jacq.	3
Hypericum boissieri Petrov.	1
Hypericum hirsutum L.	4
Hypericum perforatum L.	6
Hypericum richeri Vill.	5
Melissa officinalis L.	2
Origanum heracleoticum L.	1
Origanum vulgare L.	1
Salvia officinalis L.	1
Salvia sclarea L.	1
Thymus vulgaris L.	2
Total	**75**

The highest numbers of accessions were collected within the species *Gentiana utriculosa, Hypericum perforatum* and *Hypericum richeri*.

Another activity – introduction, as a possible model of *ex situ* protection of certain MAP species of special interest – has been carried out in previous years by the agronomist of the Institute for Medicinal Plant Research in Belgrade. In the framework of various scientific projects approved by the Ministry of Science of the Republic of Serbia as well as the internal projects of the Institute itself, considerable research has been done on the introduction of three "model" MAP species: *Hypericum perforatum, H. barbatum* and *Gentiana lutea*. Experiments were conducted at the Forest Nursery of the National Park "Tara" and at Suvobor Mountain. The results were very promising for the yield, quality and quantity of biologically active substances. Furthermore, obtaining practical information on the cultivation of pharmaceutically interesting MAP species which are much in demand in the markets, especially when such good results were achieved with cultivation, should be also considered as very valuable from the standpoint of conservation of their natural resources.

Certain efforts on *ex situ* MAP conservation have also been put into the micropropagation of many MAP species. The following species are on the priority list: *Gentiana lutea, G. pneumonanthe, G. asclepiadea, G. punctata, Salvia brachyodon* and *Hypericum perforatum* (Prof. dr Radoslav Konjević, personal communication).

Attempts at *in situ* protection of some model species so far have been limited to the reintroduction of *Gentiana lutea* and *Hypericum perforatum* into their natural habitats in West Serbia, at Suvobor Mountain.

Main problems and further tasks in surveying and protecting MAP genetic resources in Serbia

Despite the long tradition, the experience and in-depth research already done on medicinal and aromatic plants in Serbia regarding morpho-anatomical, ecological and chemical characterization of model species/genera, such as *Salvia* spp. (Marin 1999; Dajić and Kojić 1999; Ristić et al. 1999), *Mentha* spp. (Jančić 1998; Marin 1998a, 1998b; Dajić and Kojić 1998; Lakušić and Živanović 1998; Tasić and Krivokuća-Đjokić 1998), *Thymus* spp. (Lalević et al. 2003; Dajić-Stevanović et al. 2004), *Gentiana* (Benić 1996; Radanović et al. 2004), *Hypericum* (Šavikin Fodulović 2002; Šavikin Fodulović et al. 2003), management and characterization descriptors for related accessions in the Gene Banks do not exist. Unfortunately, there is a lack of herbarium specimens as well.

Among several current studies on the characterization of some of the model species, perhaps we can highlight research on the range of accessions of different *Hypericum* species, conducted by the IMPR in Belgrade, which studied their resistance to plant diseases and their content of biologically active substances (D. Pljevljakušić, Master's Thesis in progress), as well as research on the chemical characterization of the natural populations of different *Hypericum* species collected at some localities in West Serbia (the mountains Maljen, Povlen, Jablanik, Bobija, Tara) (Šavikin Fodulović 2002). As well as this work, an attempt to estimate the diversity of some natural populations of the genus *Thymus* in Serbia, made using the tool of internal transcribed spacer (ITS) molecular markers (carried out in Kew, UK, under the supervision of Dr M.W. Chase) revealed the necessity for using the amplified fragment length polymorphism (AFLP) technique for this purpose (Šoštarić et al., unpublished data).

We therefore recommend that morphological and especially, chemical evaluation of MAPs collected for the genebanks should be an integral part of programmes within the national strategy for the preservation of MAP genetic resources.

Concerning the overall situation of genetic resources of MAPs in Serbia, including the group of high-priority model species, it is necessary to continue mapping their natural populations, and to expand the inventory work to less exploited regions of the country. It would be very useful to take herbarium samples of collected MAP accessions at the same time, and to record many of the habitat characteristics for the purpose of submitting collecting/monitoring descriptors. It seems that much effort should be spent on characterization/evaluation descriptors, especially chemical descriptors, cytological characters, abiotic and biotic stress susceptibility. The development of molecular marker characterization will be particularly useful.

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Genetic resources of medicinal and aromatic plants in Serbia – status 2007

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Regarding the follow-up processes on *ex situ* and *in situ* conservation of medicinal and aromatic plant (MAP) genetic resources in Serbia, the following topics will be outlined:

In situ conservation

The conservation and use of MAP resources in Serbia is under strong legislation, after ratification of international conventions such as Agenda 21, the Rio Declaration on Environment and Development of the United Nations (1992), the Bern Convention (1982), Council Regulation (EC) No. 338/97 on the protection of species of wild fauna and flora (1996), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1975), all ratified by Serbia in 2001.

Since 1993, general Serbian legislation on environmental protection defined methods and opportunities for the sustainable use of medicinal plants, through the following legal instruments:

- Resolution on Environment Protection
- Resolution on Policy of Biodiversity Maintenance
- Law on National Parks, Law on Environment Protection
- Directive on Protection of Natural Rarities
- Directive on Control of Use and Trade of Wild Plant and Animal Species.

The exploitation of MAP species of some CITES categories is strictly forbidden. The list of such species, proposed by the Institute for Nature Protection of Serbia, includes critically endangered, endangered, vulnerable and locally rare species. Among these the following can be noted: *Achillea ageratifolia, A. clavenae, Aconitum napellus, Acorus calamus, Adonis vernalis, Allium victorialis, Arcostaphylos uva-ursi, Artemisia lobelii, Corylus colurna, Daphne alpina, D. blagayana, Drosera rotundifolia, Gentiana lutea, Gypsophila paniculata, Salvia offcinalis, S. sclarea, Helichrysum arenarium, Hyssopus officinalis, Lycopodium clavatum, Menyanthes trifoliata, Micromeria albanica, M. thymifolia, Orchis* spp., *Pinus mugo, Vaccinium vitis-idaea*, and others.

Most traded MAP species (a total of 153, according to the *Directive on Control of Use and Trade of Wild Plant and Animal Species* of 2005, accepted by the Ministry for Nature Protection of Serbia) are under the quota system. Nevertheless, the list of MAP species under the quota system has been recently modified in order to remove a group of widely spread plants, including weeds and ruderal species. It is expected that the final proposal on the species and quantities that can be collected will be officially accepted very soon.

Specific protection measures are undertaken for the 590 recognized natural protected areas, covering a total area of 516 000 ha. These include 5 national parks, 24 nature parks and protected landscapes, 54 general nature reserves and 17 special nature reserves, and 398 nature monuments.

Some important activities have been carried out recently by the Institute for Medicinal Plant Research "Dr Josif Pančić" (Belgrade) related to the establishment of the field collections, re-introduction and nursery plant production of the most endangered and/or widely used MAPs in their typical habitats of the hilly and mountainous regions of the country.

Ex situ conservation

The whole set of plant genetic resources accessions, including MAPs, is maintained in the form of an active collection, and is temporarily stored in the Institute of Maize Research (Belgrade), because of the still unsolved problems related to the management and facilities of the National Gene Bank.

The total number of MAP accessions is 264, belonging to 214 species. All accessions have passport data (according to the European Internet Search Catalogue (EURISCO) descriptors); some have additional descriptors, such as collecting/monitoring descriptors, management descriptors, or characterization/evaluation descriptors.

Most species are represented by one or two accessions, with the exception of basil (17 accessions).

The National Collection of MAP genetic resources should be completed with accessions of domestic cultivated MAP cultivars and genotypes which are kept by some institutes, such as accessions of *Mentha piperita, Carum carvi, Salvia officinalis, Levisticum officinale, Coriandrum sativum, Borago officinalis, Angelica archangelica, Artemisia* spp., *Majorana officinalis,* etc., followed by the native species which are also missing in the National Collection (*Taraxacum officinale, Plantago* spp., *Centaurium umbellatum, Vaccinium* spp., *Juniperus* spp., *Satureja* spp., *Genista* spp., *Geranium* spp., *Digitalis* spp., *Symphytum officinale, Teucrium* spp. and many others).

Special attention should be paid to collecting of endangered, vulnerable and locally rare species, such as *Arctostaphylos uva-ursi, Menyanthes trifoliata, Orchis* spp., *Acorus calamus, Adonis vernalis, Cnicus benedictus, Helichrysum arenarium, Lycopodium clavatum, Ruta graveolens, Veratrum album* and others.

It is expected that as soon as the National Gene Bank management is established, the status of accessions will be checked and all necessary activities relating to genebank practices (germination, regeneration, characterization and evaluation) will be performed.

In addition to the National Gene Bank collection of MAPs, there are other field or seed collections located at institutes and faculties, such as the Institute for Medicinal Plant Research "Dr Josif Pančić" (collection located in Pancevo, near Belgrade), the Institute for Hops, Sorghum and Medicinal Plants in Backi Petrovac, the Faculty of Pharmacy and the Faculty of Agriculture (both of the University of Belgrade). These collections comprise nearly 500 cultivars, genotypes and populations of more than 200 MAP species.

Status of the national collection of medicinal and aromatic plants in Slovakia

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The growing of medicinal and aromatic plants (MAPs) has a long tradition in Slovakia. Medicinal and aromatic plants which were used in folk medicine included wild-growing species and also varieties obtained by selective breeding. In official medicine, 150 domestic and 70 imported species of plants with curative effects are used. On the basis of several years' results on research and its practical application, we have worked out techniques for growing 30 MAP species.

Slovakia has been devoting itself to collecting, evaluation, multiplication and conservation of the genetic resources of crop plants with great attention. There is a long tradition of work on crop genetic resources in our country. The Slovak Gene Bank, established in Piešťany in 1997, conserves and documents a seed collection. The Gene Bank implements the tasks resulting from the National Programme (NP), the Law No. 215/2001 on Conservation of Plant Genetic Resources for Food and Agriculture and Regulation No. 238/2006, with the cooperation of 18 other institutes around the country. In total, there were 28 758 plant genetic resources (PGR) accessions by 31 December 2006. The tasks of the National Programme can be summarized as:

- gathering and evaluation of biodiversity of the original domestic genepool of Slovakia;
- conservation of seed accessions in individual *ex situ* collections, *in vitro* and field collections;
- acquisition of rare foreign genotypes into the NP collection;
- creation of passport and descriptive databases;
- participation in international cooperation;
- education; and
- offering of biological material for breeding, research and study purposes and for exchange with other genebanks.

The collection of medicinal and aromatic plants (MAPs) was begun in 2003. The Slovak Gene Bank holds 191 accessions of MAPs in the active collection and 30 in the base collection.

The most represented families are the Asteraceae (31 accessions), Lamiaceae (31), Rhamnaceae (19), Ranunculaceae (16), Hypericaceae (14), Droseraceae (11) and Liliaceae (10). Other families are represented by less than 10 accessions (Table 1). The distribution per genus is given in Table 2.

Table 1. Number of MAP genetic resources held in the active collection of the Slovak Gene Bank, by family

Family	No. of samples	Family	No. of samples
Apiaceae	5	Malvaceae	2
Asteraceae	31	Plantaginaceae	8
Brassicaceae	1	Pyrolaceae	1
Caryophyllaceae	6	Ranunculaceae	16
Droseraceae	11	Rhamnaceae	19
Ephedraceae	1	Rosaceae	1
Ericaceae	1	Rutaceae	8
Fabaceae	1	Scrophulariaceae	9
Geraniaceae	3	Thymelaeaceae	8
Hypericaceae	14	Utriculariaceae	1
Lamiaceae	31	Vacciniaceae	1
Liliaceae	10	Valerianaceae	2

Table 2. Number of MAP genetic resources by genus

Genus	No. of samples	Genus	No. of samples
Aconitum	6	*Hypericum*	14
Adonanthe	10	*Hyssopus*	3
Agrimonia	1	*Ledum*	1
Agrostemma	5	*Leonurus*	1
Achillea	11	*Leuzea*	2
Alcea (syn. Althaea)	1	*Levisticum*	1
Anethum	1	*Majorana*	3
Anthemis	3	*Malva*	1
Artemisia	4	*Marrubium*	1
Asparagus	10	*Matricaria*	2
Calendula	1	*Melissa*	2
Coriandrum	1	*Mentha*	2
Cota (syn. Anthemis)	6	*Ocimum*	6
Daphne	8	*Oxycoccus*	1
Dictamnus	7	*Pimpinella*	1
Dracocephalum	1	*Plantago*	8
Drosera	11	*Pyrola*	1
Echinacea	1	*Ruta*	1
Ephedra	1	*Salvia*	6
Eruca	1	*Saponaria*	1
Euphrasia	1	*Satureja*	1
Foeniculum	1	*Silybum*	1
Frangula	19	*Thymus*	5
Galega	1	*Tribulus*	1
Geranium	3	*Valeriana*	2
Gratiola	7	*Verbascum*	1

The most represented genera are *Frangula* (19 accessions), *Hypericum* (14), *Achillea* (11), *Drosera (*11), *Asparagus* (10), *Adonanthe (*10), *Daphne (*8), *Gratiola* (7), *Dictamnus* (7) and *Salvia* (6). Other genera with fewer accessions are *Anthemis, Artemisia, Calendula, Echinacea, Geranium, Hyssopus, Majorana, Marrubium, Melissa, Ocimum, Plantago* and *Satureja*.

All the genotypes were previously evaluated according to descriptors for morphological, biological and yield data. All measured data are entered into passport and description databases. At the Research Institute of Plant Production (RIPP) in Piešťany we are going to collect and evaluate the genetic resources of the medicinal plants of the genera *Cnicus, Calendula, Mentha, Verbascum, Althaea, Thymus, Lavandula* and *Achillea*.

In Slovakia MAPs are grown on an area of 1316 ha. This corresponds to the areas officially declared to the Central and Testing Institute in Agriculture in Bratislava. There is further undeclared cultivation on areas which are relatively small, so the total area is somewhat larger than that stated.

Some companies have been investigating growing medicinal plants from seed, for example Istropol a.s. Solary, Seva-Slovensko Bratislava, Semex and Vilora Stará Ľubovňa.

Research on MAPs has been done at:

1. The **Botanical garden of the Slovak University of Agriculture in Nitra,** which was dealing with the growing, study of biology and sowing of MAPs in *ex situ* and *in situ* conditions for the species *Acorus calamus, Echinacea angustifolia, Echinacea purpurea, Ephedra distachya* and the genus *Hibiscus.* Genetic resources of MAPs from the families Asteraceae and Lamiaceae were also studied.
2. The **Department of Experimental Botany and Genetics of the Science Faculty P.J. Šafárika Prešov,** dealing with breeding and seed improvement of crop plants. The medicinal plants under study are:

- *Chamomila recutita* – var. 'Bona', 'Novbona', 'Lutea'
- *Achillea millefolium* – var. 'Alba'
- *Hypericum perforatum* – breeding, var. 'Gold', 'Uperikon'
- *Agrimonia eupatoria* – var. 'Peter'
- *Tilia cordata* – var. 'Aurea'.

3. The **Department of Pharmacognosy and Botany of Comenius University in Bratislava** carries on research on the effects of exogenous factors on medicinal plants. Research is aimed at solving practical and theoretical issues related to the creation of therapeutically active ingredients and the production of biomass, the issue of pathophysiology of selected species that represent the raw material base for the pharmaceutical industry, or appear to be promising.
4. The **Institute of Agroecology in Michalovce**, dealing with medicinal plants, especially lemon balm *(Melissa officinalis)* and common sage *(Salvia officinalis).* Research topics include production parameters; qualitative indexes, growing techniques for medicinal plants; secondary metabolites; quality of plant drugs; nutrition systems for medicinal plants; genetic resources of medicinal plants.
5. The **Faculty of Agrobiology and Food Resources of Slovak University of Agriculture in Nitra.**
6. **Other work places, stations and associations:** Zentiva a.s. Hlohovec, Vilora Stará ľubovňa, Afra, NATURES s.r.o., VULM a.s. Modra.

Processing and marketing of medicinal and aromatic plants is carried out by several Slovak companies (Agrokarpaty, s.r.o. Plavnica; Ekotrend Myjava spol. s.r.o.; Zelex Slovakia, s.r.o.; Herbex Hrašné; Hanus; Baliarne obchodu a.s. Poprad; CALENDULA a.s. Nová Ľubovňa; ZENTIVA). Their products include a wide range of fruit and herbal teas, instant powder soft drinks, essential oils, medicinal preparations, food supplements, etc.

Distribution and characterization of indigenous populations of Achillea millefolium *agg.*, Gentiana lutea *L. and* Origanum vulgare *L.* subsp*. vulgare in Slovenia*

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Introduction

In 2003 and 2004, surveys were made in different areas of Slovenia in order to obtain data on either *in situ* or *ex situ* characteristics of selected species of medicinal and aromatic plants (*Achillea millefolium* agg., *Gentiana lutea* L. and *Origanum vulgare* L. subsp. *vulgare*). Based on measurements of morphological, chemical and cytological characteristics, a proposal for crop-specific characterization and evaluation descriptors was developed.

Surveys and characterization of yarrow (*Achillea millefolium* agg.)

Yarrow aggregate (*Achillea millefolium* agg.) in Slovenia is a highly polymorphic taxon, consisting of nine species (*Achillea setacea, A. pannonica, A. collina, A. tanacetifolia, A. distans, A. pratensis, A. millefolium, A. roseo-alba* and *A. asplenifolia*). This widespread group is common all over Slovenia. More than 30 known localities with *Achillea millefolium* agg. are registered in our MEDPLANT database. In 2003 and 2004, surveys were made in the southwestern part of Slovenia (Podnanos, Podnanos–Kortine, Klanec pri Kozini), central Slovenia (Ig-Brest, Želimlje) and the eastern part of Slovenia (Ljutomer).

In order to characterize indigenous populations morphologically and/or chemically, *in situ* and/or laboratory measurements were made. Selection of morphological characteristics was based on the study of Saukel and Länger (1992a, 1992b). Chemical characterization was based on the prescriptions of the European Pharmacopoeia, 4th edition (Council of Europe 2002).

Surveys and characterization of yellow gentian (*Gentiana lutea* L.)

Out of ten areas where *Gentiana lutea* L. grows, registered in our MEDPLANT database, in 2003 and 2004 surveys were made in the southwestern part of Slovenia (two localities of the Vremščica area and two localities of the Nanos area) and in the Alpine area (Komarča, Sedmera jezera, Komna).

The abundance of the populations and some of the morphological characteristics were measured *in situ;* other characteristics, which needed laboratory measurements, were determined from the herbal samples.

Surveys and characterization of oregano (*Origanum vulgare* L.)

The genus *Origanum* is characterized by a wide morphological and chemical diversity. The genus is divided into 10 sections or into 42 species and 49 taxa (species, subspecies or varieties) belonging to this genus (Ietswaart 1980). The most common species is *Origanum vulgare* L. In Slovenia only *O. vulgare* L. subsp. *vulgare* can be found in the wild (Martinčič et al. 1999). *Origanum vulgare* L. subsp. *hirtum* is, because of its high essential oil content, cultivated in the garden and used as a culinary herb. *Origanum vulgare* L. is also used as a medicinal plant, even though its activity is not officially confirmed. In plant protection it is used against parasites, insects, nematodes and snails (Baričevič and Bartol 2002).

Surveys on *Origanum vulgare* L. subsp. *vulgare* were made in nine localities of Slovenia in 2001, 2002 and 2003 (Blato, Drežnica, Jesenice, Mežakla, Nanos, Slovenske Konjice, Stari vrh, Završnica and Žirovniška planina). Nine indigenous populations of *O. vulgare* subsp. *vulgare* were compared to *O. vulgare* subsp. *hirtum* (Slovene Genebank for MAPs, Accession No. 9/1) with regard to their morphological and chemical characteristics. The seed material of *O. vulgare* subsp. *vulgare* was collected in the natural habitats, sown in pots and the seedlings were planted on Eco-Tex foil at the laboratory field *ex situ.* Weeds were mechanically removed; otherwise the plants were not disturbed. The plants were harvested just before full bloom.

The following characteristics were measured:

- length of stems
- thickness of stems
- useful part ratio (ratio weight of stems and inflorescence/total weight of above-ground parts)
- number of stems per plant
- number of nodes
- leaf area
- shape of leaves
- roundness of leaves
- upper angle of leaves
- lower angle of leaves
- length of thyrsus
- length of bracts of the 1st order
- length of bracts of the 2nd order
- length of calyx leaves and length of petals.

Morphological descriptions also involved:

- branching of stems
- pubescence of stems
- colour of stems
- colour of bracts of the 1st order
- nonglandular trichomes on bracts of the 1st order
- glandular trichomes on bracts of the 1st order
- colour of bracts of the 2nd order
- nonglandular trichomes on bracts of the 2nd order
- glandular trichomes on bracts of the 2nd order
- pubescence of calyces with nonglandular trichomes inside
- pubescence with nonglandular trichomes of calyces outside
- colour of calyces
- colour of petals
- glandular trichomes on petals
- pubescence of the upper and of the lower part of the leaves
- pubescence of leaf margins and leaf stalks with nonglandular trichomes
- colour of leaves
- glandular trichomes on the leaves.

The significance of the differences in morphological characters between *O. vulgare* subsp. *vulgare* and *O. vulgare* subsp. *hirtum* as well as between indigenous populations of *O. vulgare* subsp. *vulgare* was defined by statistical analysis. Results are shown in Tables 1 and 2.

Table 1. Statistically significant differences between *Origanum vulgare* L. subsp. *hirtum* and *O. vulgare* L. subsp. *vulgare*

Characteristic	Indigenous populations of *O. vulgare* L. subsp. *vulgare* that significantly differ from *O. vulgare* L. subsp. *vulgare* Hirtum
Length of stem	Slovenske Konjice, Blato, Završnica, Nanos, Žirovniška planina, Jesenice, Mežakla
Thickness of stem	No difference
Useful part ratio	Završnica, Slovenske Konjice
Number of stems	No difference
Number of nodes	Nanos, Mežakla, Žirovniška planina
Leaf area	Završnica, Mežakla
Leaf length	Završnica, Mežakla
Shape of leaves	Stari vrh, Jesenice, Završnica , Mežakla
Roundness of leaves	Žirovniška planina, Drežnica
Upper angle of leaves	Mežakla, Stari vrh
Lower angle of leaves	Drežnica, Slovenske Konjice, Žirovniška planina, Stari vrh
Length of thyrsus	Nanos, Mežakla, Žirovniška planina
Length of bracts of 1st order	Jesenice, Slovenske Konjice, Stari vrh, Mežakla, Drežnica, Žirovniška planina, Nanos
Length of bracts of 2nd order	Drežnica, Jesenice, Slovenske Konjice, Mežakla, Žirovniška planina, Nanos
Length of calyx leaves	Žirovniška planina
Length of petals	Blato, Završnica, Drežnica, Žirovniška planina

One of the techniques used for distinguishing the plants in the Lamiaceae family is to measure the type and number of glandular and of nonglandular trichomes. Peltate and capitate trichomes were found in *Origanum vulgare* L. (Werker 1993; Gang et al. 2001). *Origanum vulgare* subsp. *vulgare* had fewer glandular trichomes than *O. vulgare* subsp. *hirtum*. These observations were confirmed in our study by scanning electron microscope.

The average contents of the essential oils in the dried herb measured by Clevenger apparatus were 2.1% in *O. vulgare* subsp. *hirtum* and 0.35% in *O. vulgare* subsp. *vulgare*.

The concentrations of rosmarinic acid (the main phenolic compound) in 80% methanolic extracts were measured by high performance liquid chromatography (HPLC). The data in the literature on concentrations of rosmarinic acid in the dry plant material varied from 0.57% (Labuda et al. 2002) to 1.32% (Koşar et al. 2003). Our results varied from 0.4 to 0.6% in the dry material. Secondary metabolites were also

Table 2. Descriptive characteristics of *Origanum vulgare* L. subsp. *hirtum* compared with indigenous populations of *O. vulgare* L. subsp. *vulgare*

Characteristic	*O. vulgare* L. subsp. *hirtum*	*O. vulgare* L. subsp. *vulgare*
Branching of stem	High	Different, Drežnica high
Pubescence of stem	Yes	Yes
Colour of stem	Brown and green predominate	Brown, red and red-green, Blato in Jesenice mostly green, Drežnica in Stari vrh mostly red-green, Konjice, Mežakla in Nanos mostly brown
Colour of bracts of 1st order	Green	Mostly green, some colouring, specially Jesenice, Slovenske Konjice in Žirovniška planina
Nonglandular trichomes on bracts of 1st order	Rare or not present	Rare or not present
Glandular trichomes on bracts of 1st order	Numerous in the upper third	Not present or rare
Colour of bracts of 2nd order	Green	Coloured up to two thirds, in most of the population from Mežakle
Nonglandular trichomes on bracts of 2nd order	Not present or rare	Not present or rare
Glandular trichomes on bracts of 2nd order	Present	Not present
Pubescence of calyx leaf with nonglandular trichomes on outside part	Medium pubescent	In most cases no pubescence
Pubescence of calyx leaf with nonglandular trichomes on inside part	Exceedingly pubescent	Exceedingly pubescent
Pubescence of calyx leaf with glandular trichomes on outside part	Present	Not present
Colour of calyces	Green	Green with red top
Colour of petals	White	White with pink cast
Presence of glandular trichomes on petals	Present	Not present
Pubescence of upper part of the leaves	Dense	No or rare pubescence, population from Drežnica is exceedingly pubescent
Pubescence of lower part of the leaves	Dense	No pubescence, population from Drežnica is exceedingly pubescent
Pubescence of leaf margin, and leaf stalk with nonglandular trichomes	Dense	Dense
Colour of leaves	Green	Green, only population from Drežnica grey-green
Glandular trichomes on leaves	Many	Present
Essential oil content (%)	2.1%	0.35%

detected by thin layer chromatography (TLC) and natural substance-polyethylene glycol (NST/PEG) reagent (2 phenolic acids and 3-4 flavonoids). The presence of phenolic compounds was shown with Folin-Chiocalteu reagent. The blue coloured spot with Rf value around 0.43 on the TLC plate and retention time around 6 minutes on HPLC was determined to be a good chemotaxonomic marker for distinguishing the investigated subspecies. The subspecies *hirtum* does not contain this compound or its concentration is very low.

A high radical scavenging activity of the 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical of *Origanum vulgare* L. extracts and of a pure rosmarinic acid (measured with TLC, spectrophotometer and electron paramagnetic resonance **(**EPR) of the superoxide radical (X/XO) (measured with EPR) and the hydroxide radical (Fenton reaction and UV-radiation) (measured with EPR) were established. In our research the highest number of antioxidative compounds was detected in 80% methanol extracts. Both *Origanum vulgare* L. extracts and rosmarinic acid showed a high radical scavenging activity of the DPPH radical in all systems. *Origanum vulgare* L. extract at a concentration of 5 mg/ml eliminated 60% of the superoxide radical, while rosmarinic acid at the same concentration eliminated the entire superoxide radical. A high hydroxide radical scavenging activity was also detected in the lipid system. There was no antioxidative activity, or there was even a prooxidative activity (detected as increased concentration of hydroxide radicals) of plant extracts, when we measured antioxidative potential, using the Fenton reaction for hydroxide radical generation.

Our study showed that in Slovenia only *Origanum vulgare* L. subsp. *vulgare* could be found, and that this subspecies differed from *O. vulgare* L. subsp. *hirtum* in essential oil content, in the number and distribution of glandular trichomes, in the colour of inflorescences, and in the colour of stems and leaves. There were some differences between the various indigenous populations in defined taxonomic measurements, but there were no differences in the secondary metabolite concentrations and in antioxidative activities between individual populations.

Because of high variability in the morphological characters, we could not define the key groups of *Origanum vulgare* L. in Slovenia and classify them into more exact subgroups. The study showed a possible new use of *O. vulgare* subsp. *vulgare* in the food industry, because plants of this subspecies have a high radical scavenging activity and they are almost odourless. The results from morphological analysis indicated the direction for developing descriptors for characterization and evaluation of accessions and for conservation of *O. vulgare* subsp. *vulgare* natural resources.

Results

The distribution of natural populations of selected species, together with field characterization data (environmental descriptors) obtained during surveys were documented in the relational database MEDPLANT (Figs. 1, 2 and 3).

The measurements made were used in the preparation of a set of morphological and/or chemical characteristics, which enabled us to distinguish and determine different taxa. Based on this set of characters, draft descriptor lists for *Achillea millefolium* agg. and for *Gentiana lutea* L. were developed.

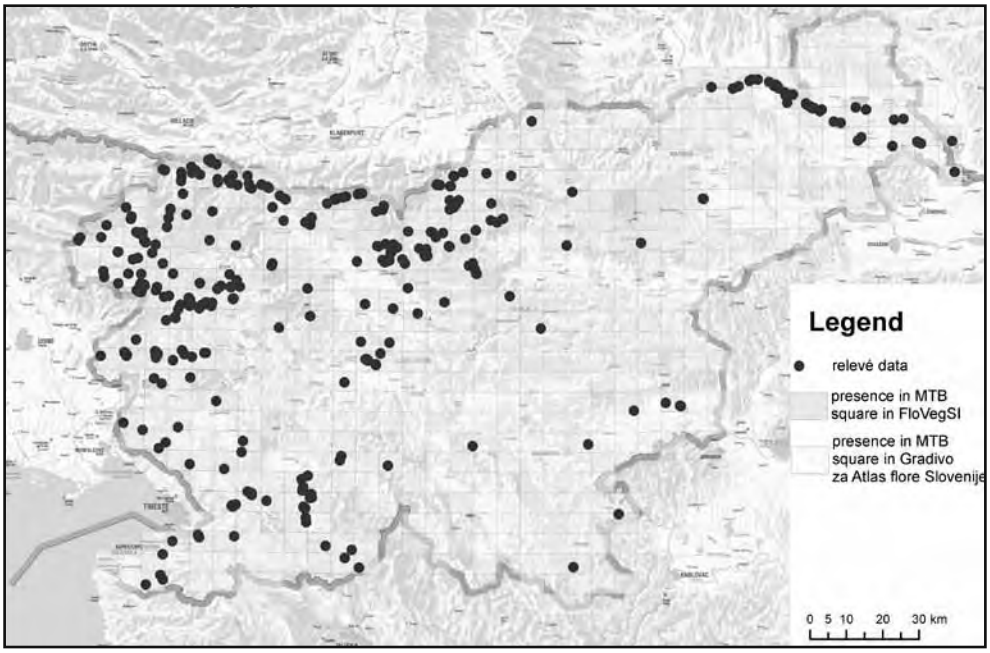

Fig. 1. Distribution of *Achillea millefolium* agg. in Slovenia, as registered in the MEDPLANT database.

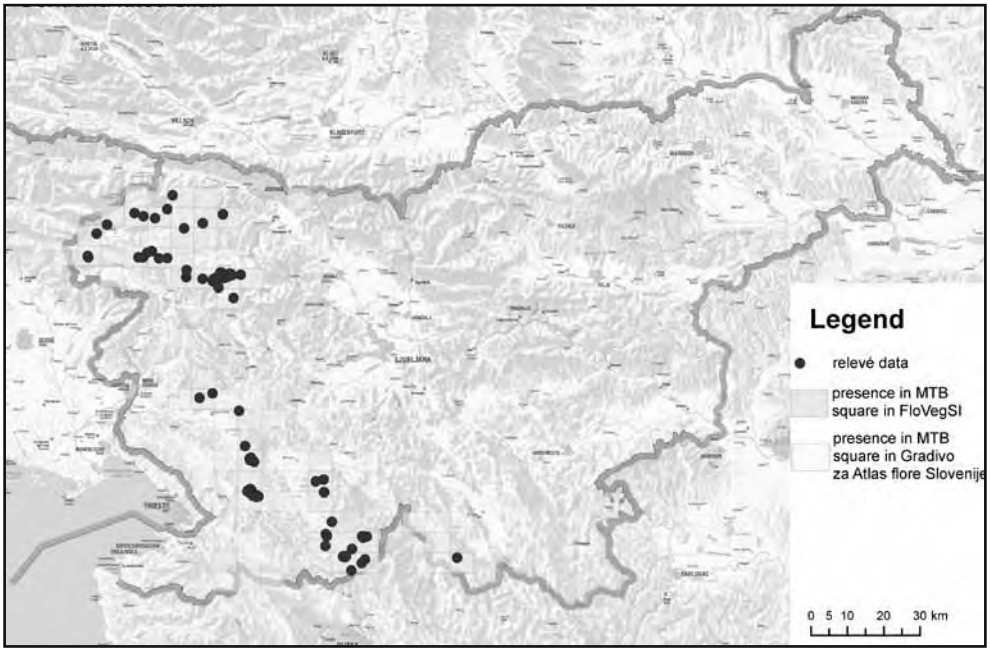

Fig. 2. Distribution of *Gentiana lutea* L. in Slovenia, as registered in the MEDPLANT database.

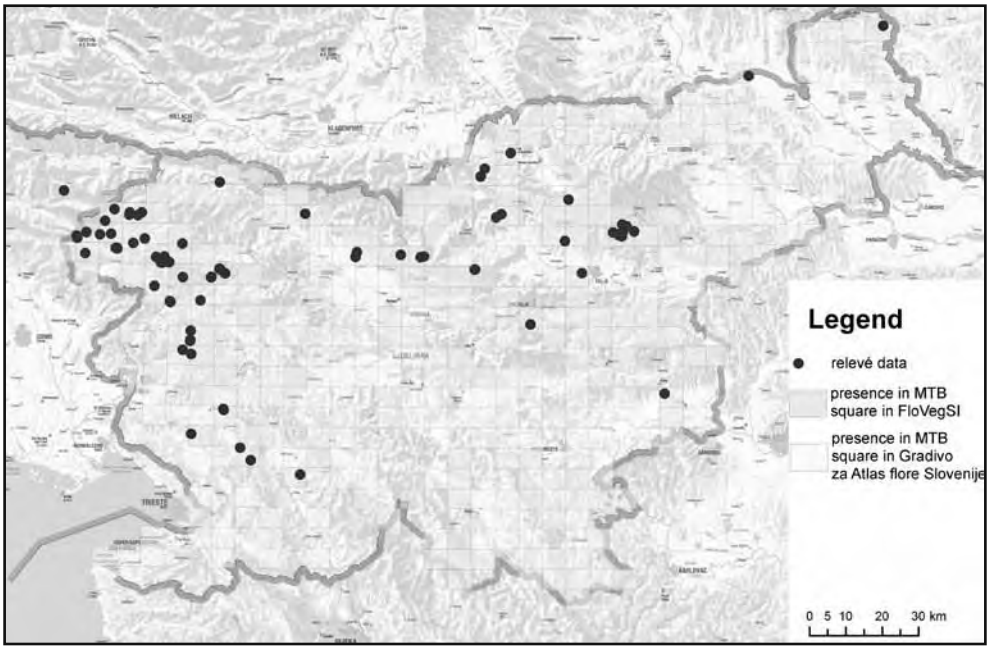

Fig. 3. Distribution of *Origanum vulgare* L. subsp. *vulgare* in Slovenia, as registered in the MEDPLANT database.

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Medicinal and aromatic plants in Switzerland

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Introduction

Switzerland is a relatively small country which is less than 45 000 km^2 (41 295 km^2) in total area. The country contains:

- 30% forests,
- 38% agricultural zones (mountain and lowland regions),
- 26% lakes, rivers and areas above the forest's limit, and
- 6% cities, industrial zones and roads.

Since the end of the 19th century, there has been an increase in the forested area and a decrease in the area of cultivated land.

The altitude of Switzerland ranges from 193 m above sea level (asl) to 4634 m:

- 15% of the territory is below 500 m,
- 32% between 500 and 1000 m,
- 29% between 1000 and 2000 m, and
- 24% above 2000 m.

Five phytogeographical regions can be distinguished: the Jura, the plateau, the north of the Alps, the central part of the Alps and the south of the Alps (Vust and Galland 2001).

Although Switzerland is small (0.4% of the European territory), its central position within the European continent has given it very considerable biodiversity (20% of the European species). which originates from the different parts of Europe.

Legal protection of flora

We found 3144 different species (indigenous and introduced), all of them indexed in "Flora Helvetica" (Lauber and Wagner 2000) and in the Red List (Moser et al. 2002).

Of these 3144 taxa, 1534 taxa are considered as not threatened, while for another 191, no data for a precise classification is available; 990 taxa are on the Red List (all categories included). An additional 429 species are listed as nearly threatened.

Fifty species out of the 990 on the Red List are now extinct in the wild in Switzerland, 180 are critically endangered, 321 are endangered and 438 are vulnerable.

The Red List (Moser et al. 2002) allows us to evaluate threats to the flora; this list is revised every ten years. Since 1991 (the preceding list), there has been an increase in the numbers of threatened species.

With reference to this list, different levels of protection status were created: 900 species are legally protected at least in one canton (semi-autonomous region) of Switzerland. All cantons choose to protect more species than the overall country list. Cantons and the state have not really protected all the threatened species, but have concentrated mainly on species which are frequently harvested for medicinal or ornamental purposes.

Harvesting authorizations are given for protected plants, but this authorization is for named collectors, for a limited duration, a precise place and a precise quantity.

The laws and regulations applied differ between each canton; consequently harvesting possibilities vary among geographical regions of the country.

Medicinal plants

In Switzerland, about 150 species are considered as medicinal and/or aromatic, and 31 are protected (Table 1). Species considered as medicinal should be indigenous, used in popular medicine or be listed in the "Pharmacopoea Helvetica" (Anonymous 2006). Foreign species cultivated in Switzerland and well adapted to its climatic conditions are also listed as medicinal and/or aromatic.

Table 1. List of Swiss protected medicinal and aromatic plants (MAPs) (Vust et al. 2001)

Genus	Species	Protection
Achillea	*clavenae*	Regional
Adiantum	*capillus veneris*	Swiss
Adonis	*vernalis*	Swiss
Agrimonia	*eupatoria*	Regional
Antennaria	*dioica*	Regional
Aquilegia	*vulgaris*	Regional
Arctostaphylos	*uva-ursi*	Regional
Aristolochia	*clematitis*	Regional
Arnica	*montana*	Regional
Artemisia	*genipi*	Swiss
Artemisia	*glacialis*	Swiss
Artemisia	*umbelliformis*	Swiss
Calla	*palustris*	Swiss
Daphne	*mezereum*	Regional
Drosera	sp.	Swiss
Ephedra	*helvetica*	Swiss
Gentiana	*lutea*	Swiss
Globularia	*punctata*	Regional
Gratiola	*officinalis*	Regional
Helleborus	*niger*	Regional
Leontopodium	*alpinum*	Regional
Leonurus	*cardiaca*	Regional
Lycopodium	*clavatum*	Regional
Paeonia	*officinalis*	Swiss
Pinguicula	sp.	Regional
Primula	*veris*	Regional
Rhododendron	*ferrugineum*	Regional
Ruscus	*aculeatus*	Regional
Salix	spp.	Regional
Sempervivum	*montanum*	Regional
Valeriana	*celtica*	Regional

There is little harvesting of plants from the wild in Switzerland, so most of the medicinal plants are not endangered. The most important threats are from environmental changes.

In situ conservation

Three percent of the national territory is protected by various laws which have created national parks, reserves, etc. The federal state hopes to create new protected areas in the future in order to cover 10% of the territory.

Many organizations are involved in the protection of Swiss wild species. The more important of them are the Swiss Commission for Wild Plant Conservation (CPS/SKEW, http://www.cps-skew.ch) and the Swiss Floristic Network (CRSF, Centre du Réseau Suisse de Floristique, www.crsf.ch). These different organizations watch over the evolution of the threatened plants' populations. The CPS/SKEW has put forward short recommendations, based on the "Guidelines to be followed in the design of plant conservation or recovery plans" of the Council of Europe. These two organizations coordinate activities between cantons, federal state and private organizations. The CRSF collects information about new species, new locations, observation on re-established species, etc.

MAP cultivation

MAP cultivation is a new activity in Switzerland. It started in the 1980s with the purpose of limiting the exodus of rural farmers and to maintain the mountain landscape by developing new crops.

In 1982, a research unit on MAPs was created in the Swiss Agricultural Research Centre. Its role is to help producers with special cultural techniques, to create new varieties, to optimize the harvesting time and so on.

The most important outlets for Swiss production are sweets (Ricola), teas, condiments (spice or herb mixtures), essential oils for perfumery, cosmetics and phytopharmaceutical products (Weleda, Bioforce, Zeller, etc.).

MAPs are cultivated on 150 ha in Switzerland. Forty species are cultivated with organic methods in mountain regions. Swiss production of dried herb reaches 500 t while 3000 t of plants are used every year in the country.

Most of imported plant materials come from Germany, Hungary, Eastern European and Asian countries.

Breeding research is currently carried out in Agroscope Changins Wädenswill (ACW), the Federal Research Centre, in order to develop adapted and resistant species. Seventeen homogenous high-yielding varieties were selected during the past 20 years of activities, e.g. *Salvia officinalis* var. 'Regula' (Carron et al. 2005), *Origanum vulgare* var. 'Carva' (Rey et al. 2002) (see also ACW activity reports, http://www.acw.admin.ch/themen/00569/index.html?lang=en).

Ex situ conservation

Coordination between CPS, CRSF and the Swiss Agency for Environment, Forests and Landscape is important. For especially threatened species, *ex situ* conservation is needed; indeed, plant multiplication for the future reinforcement of existing populations is desirable.

Conservation *ex situ* is done in the 14 botanical gardens in Switzerland, but usually, they have rather few different ecotypes or accessions from only one origin.

Within the world action plan, Switzerland undertook to conserve the genetic diversity of cultivated plants.

There is at federal level a genebank for seed conservation, but this is only used for cultivated and selected Swiss varieties. At the moment no MAPs are conserved in this genebank.

Two projects concerning MAPs are in progress. The first will publish guidelines for long- lasting conservation and use of MAPs. The second will make an inventory of all the varieties of cultivated MAPs in Switzerland. This project will provide a list of old varieties which need to be conserved.

Priority list of species

Even if some species from the ECPGR MAP "priority list" defined at the First Meeting of the Working Group in 2002 (Appendix I, in Baricevic et al. 2004) are protected in Switzerland, none of them is threatened (Table 2).

Table 2. IUCN status of some MAPs in Switzerland (Moser et al. 2002)

Species	IUCN Status
Achillea millefolium	Least Concerned
Artemisia absinthium	Least Concerned
Carum carvi	Least Concerned
Gentiana lutea	Least Concerned
Hypericum perforatum	Least Concerned
Melissa officinalis	Only cultivated
Mentha x *piperita*	Only cultivated
Mentha spicata	Cultivated and subspontaneous
Origanum vulgare	Least Concerned
Salvia officinalis	Cultivated and subspontaneous
Thymus vulgaris	Only cultivated
Thymus pulegioides	Least Concerned

Exhaustive surveys of all Swiss species were made.

All distribution maps for these species are available online (Swiss Web Flora, http://www.wsl.ch/land/products/webflora/welcome-en.ehtml). Because these species are not endangered, no *ex situ* conservation is envisaged.

The Red List is also available online (http://www.crsf.ch//?page=listerouge).

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Medicinal and aromatic plants in Turkey – status of the ECPGR "priority species/genera"

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Introduction

Turkey is a large peninsula situated between Europe and Asia with 780 600 km^2 of land mass, lying between 42°N and 36°N latitudes. The altitude of the country ranges from sea level to over 5000 m with the highest point on the peak of the Mountain Ararat, 5137 m (Başer 2002). Three main types of climate are found in Turkey. The Mediterranean climate influences the south and west coastal areas. Most of the inland area enjoys a continental climate, and a small area in the north-east part of Turkey has an oceanic climate. Turkey hosts the following three important phytogeographical regions: Euro-Siberian Flora Area, Mediterranean Flora Area and Irano-Turanian Flora Area. The Black Sea coastal region is in the Euro-Siberian Flora area; the coastal areas of the Mediterranean, Aegean and Marmara Seas are in the Mediterranean Flora Area, and a large part of Turkey lying from central Anatolia to the Iran and Iraq borders is in the Irano-Turanian Flora Area. The richness of Turkey's climates, topography and geomorphology has resulted in a great richness of plant diversity. There are around 9000 vascular plant species in Turkey and around 3000 of them are endemic (Güner et al. 2000). More than 500 species are used for medicinal and aromatic purposes (Baytop 1984).

There are very many species from the priority list of species/genera selected by the ECPGR Medicinal and Aromatic Plants (MAP) Working Group[18] in Turkey. These are listed below. The number of endemic species is also quite high especially for the genera *Achillea, Hypericum, Origanum, Salvia* and *Thymus*.

List of the species belonging to the MAP WG priority species/genera in Turkey

(E = endemic); (sources: Davis 1965-1985; Güner et al. 2000)

***Achillea* spp.**

A. aleppica (E)	*A. cucullata (E)*	*A. millefolium*	*A. sintenisii (E)*
A. armenorum (E)	*A. falcata*	*A. monocephala (E)*	*A. sipikorensis (E)*
A. biebersteinii	*A. filipendulina*	*A. multifida (E)*	*A. spinulifolia (E)*
A. boissieri (E)	*A. goniocephala (E)*	*A. nobilis (E)*	*A. tenuifolia*
A. brachyphylla (E)	*A. grandifolia*	*A. oligocephala (E)*	*A. teretifolia (E)*
A. cappadocica	*A. gypsicola (E)*	*A. phrygia (E)*	*A. vermicularis*
A. clypeolata	*A. kotschyi (E)*	*A. pseudoaleppica (E)*	*A. wilhelmsii*
A. coarctata	*A. latiloba*	*A. schischkinii (E)*	*A. setacea*
A. cretica	*A. magnifica (E)*	*A. lycaonica (E)*	*A. biserrata*
A. crithmifolia	*A. membranacea*	*A. sieheana (E)*	

[18] Appendix I in Baričevič et al. (2004).

***Artemisia* spp.**

A. abrotanum
A. absinthium
A. annua
A. araratica
A. arborescens
A. armeniaca
A. austriaca
A. campestris
A. caucasica
A. chamaemelifolia
A. haussknechtii
A. herba-alba
A. incana
A. marschalliana
A. santonicum
A. scoparia
A. spicigera
A. splendens
A. taurica
A. tournefortiana
A. alba
A. vulgaris

***Carum* spp.**

C. caucasicum
C. leucocoleon
C. meifolium
C. multiflorum
C. carvi

***Gentiana* spp.**

G. asclepiadea
G. boissieri
G. brachyphylla
G. cruciata
G. gelida
G. nivalis
G. olivieri
G. pyrenaica
G. septemfida
G. aquatica
G. verna
G. lutea

***Hypericum* spp.**

H. retusum
H. adenotrichum (E)
H. amblysepalum
H. androsaemum
H. armenum
H. atomarium
H. aucheri
H. aviculariifolium (E)
H. bithynicum
H. bupleuroides
H. capitatum
H. cardiophyllum
H. cerastoides
H. confertum
H. crenulalum (E)
H. cuisini
H. elegans
H. empetrifolium
H. fissurale (E)
H. formosissimum
H. helianthemoides
H. heterophyllum (E)
H. hircinum
H. hirsutum
H. huber-morathii (E)
H. hyssopifolium
H. imbricatum (E)
H. lydium
H. kotschyanum (E)
H. linearioides
H. lanuginosum (E)
H. lysimachioides
H. marginatum (E)
H. minutum (E)
H. monadenum (E)
H. montanum
H. montbretii
H. neurocalycinum (E)
H. nummularioides
H. olympicum (E)
H. orientale
H. origanifolium
H. pallens
H. perfoliatum
H. perforatum
H. polyphyllum (E)
H. pruinatum
H. pseudolaeve (E)
H. pumilio (E)
H. rupestre (E)
H. salsolifolium (E)
H. salsugineum (E)
H. saxifragum (E)
H. scabroides (E)
H. scabrum
H. spectabile (E)
H. ternatum
H. tetrapterum
H. thasium
H. thymbraefolium (E)
H. thymifolium
H. thymopsis (E)
H. triquetrifolium
H. uniglandulosum (E)
H. vacciniifolium (E)
H. venustum
H. xylosteifolium
H. calycinum

***Melissa* spp.**

M. officinalis

***Mentha* spp.**

M. aquatica
M. arvensis
M. longifolia
M. spicata
M. suaveolens
M. x piperita
M. pulegium

***Origanum* spp.**

O. acutidens
O. amanum (E)
O. bargyli
O. bilgeri (E)
O. boissieri (E)
O. brevidens (E)
O. calcaratum
O. haussknechtii (E)
O. husnucan-baseri (E)
O. hypericifolium (E)
O. laevigatum (E)
O. leptocladum (E)
O. majorana
O. micranthum (E)
O. minutiflorum (E)
O. munzurense (E)
O. onites
O. rotundifolium
O. saccatum (E)
O. sipyleum (E)
O. solymicum (E)
O. syriacum
O. vulgare

***Salvia* spp.**

S. adenocaulon (E)
S. adenophylla (E)
S. aethiopis
S. albimaculata (E)
S. amplexicaulis
S. aramiensis
S. argentea
S. atropatana
S. aucheri (E)
S. ballsiana (E)
S. blepharochlaena (E)
S. brachyantha
S. bracteata
S. cadmica (E)
S. caespitosa (E)
S. candidissima
S. cassia
S. cedronella (E)
S. ceratophylla
S. chionantha (E)
S. chrysophylla (E)
S. cilicica (E)
S. cryptantha (E)
S. cyanescens (E)
S. dichroantha (E)
S. divaricata (E)
S. eriophora (E)
S. euphratica (E)
S. forskahlei
S. freyniana (E)
S. frigida
S. fruticosa
S. glutinosa
S. halophila (E)
S. haussknechtii (E)
S. heldreichiana (E)
S. huberi (E)
S. hydrangea
S. hypargeia (E)
S. indica
S. kronenburgii (E)
S. kurdica
S. limbata
S. longipedicellata (E)
S. macrochlamys
S. microstegia
S. montbretii
S. multicaulis
S. napifolia
S. nemorosa
S. nutans
S. odontochlamys (E)
S. pachystachya
S. palaestina
S. pilifera (E)
S. pinnata
S. pisidica (E)
S. poculata
S. pomifera
S. potentillifolia (E)
S. quezelii (E)
S. recognita (E)
S. reeseana (E)
S. rosifolia (E)
S. russellii
S. sclarea
S. sericeo-tomentosa (E)
S. smyrnaea (E)
S. spinosa
S. staminea
S. suffruticosa
S. syriaca
S. tchihatcheffii (E)
S. tigrina (E)
S. tobeyi (E)
S. tomentosa
S. trichoclada
S. verbenaca
S. vermifolia (E)
S. verticillata
S. virgata
S. viridis
S. xanthocheila
S. yosgadensis (E)
S. modesta (E)

***Sideritis* spp.**

S. wiedemannii

***Thymus* spp.**

T. argaeus (E)
T. atticus
T. aznavouri (E)
T. bornmuelleri (E)
T. brachychilus (E)
T. canoviridis (E)
T. cappadocicus (E)
T. cariensis (E)
T. comptus
T. convolutus (E)
T. eigii
T. fallax
T. fedtschenkoi (E)
T. haussknechti (E)
T. kotschyanus
T. leucostomus (E)
T. migricus
T. pectinatus (E)
T. praecox (E)
T. pseudopulegioides
T. pubescens (E)
T. pulvinatus (E)
T. roegneri
T. samius (E)
T. spathulifolius (E)
T. striatus
T. thracicus
T. transcaucasicus
T. zygioides (E)

Status of collections at the Turkish Gene Bank

The Turkish Gene Bank was established in 1963. Since then many excursions, surveying and collecting activities have been carried out. Several plant species including MAPs were collected and seeds were taken into conservation in the Gene Bank (Sari et al. 2004). Although there are many genebank accessions from *Achillea, Hypericum, Mentha, Origanum, Salvia* and *Thymus* species (Table 1), more MAP species need to be collected, characterized and evaluated in Turkey. International cooperation and specific projects are needed to make the process faster and more efficient.

Table 1. Accessions of the priority species/genera of the ECPGR MAP Woking Group held in the Turkish Gene Bank

Genus	No. of species[1]	No. of endemic species[1]	Status[2]	No. of collected species[3]	No. of genebank accessions[3]	No. of genebank herbarium speciments[3]
Achillea	40	23	2 CR 2 EN 2 VU	20	60	40
Artemisia	22	-	2 VU 1 DD	2	6	4
Carum	5	-	1 VU	1	22	-
Gentiana	12	-	1 EN 1 VU	-	-	-
Hypericum	69	27	2 CR 10 EN 15 VU	17	73	25
Melissa	1	-		1	24	9
Mentha	7	-	1 VU	-	267	2
Origanum[4]	23	15	1 CR 3 EN 3 VU	10	174	26
Salvia	86	43	3 CR 7 EN 20 VU	47	285	154
Thymus	37	22	7 CR 4 EN 14 VU	7	64	33

[1] source: Davis 1965-1985
[2] CR: Critically endangered; EN: Endangered; VU: Vulnerable; DD: Data deficient (source: Ekim et al. 2000)
[3] source: Tan et al. 2004a, 2004b
[4] source: Sari and Oğuz 2002

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Medicinal and aromatic plant conservation, legislation and production in the United Kingdom

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Introduction

For the first meeting of the Working Group on Medicinal and Aromatic Plants (MAPs) held in Slovenia in 2002, Rosemary Cole of the National Herb Centre at Banbury, UK reported that UK herb production was small (on around 4000 ha) and mainly concerned with culinary herbs, and she described three then current research projects which were examining the potential of UK-produced plant products for pharmaceutical applications (Cole 2004).

In the present report I shall briefly describe UK legislation that controls the collection of *in situ* MAPs, *ex situ* conservation and genebanks in the UK, and potential drivers for UK production of MAPs.

Legal protection for the collection of plant material from their natural habitats

The UK has no specific legislation to protect MAPs *in situ*. In England and Wales, The Wildlife and Countryside Act of 1981 (www.jncc.gov.uk/page-1377) provides the national legislation to implement the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). This Act makes it an offence (subject to exceptions) to "pick, uproot, trade in, or possess for the purposes of trade any wild plants listed in Schedule 8, and prohibits the unauthorized intentional uprooting of such plants". Schedule 8 is subject to a statutory review every 5 years, and currently lists nearly 200 plants which have been identified as being endangered. Few of these species are, or have been in the past, exploited for their medicinal or aromatic qualities. Although in the UK as elsewhere, wild plants are vulnerable to collection for any number of reasons, collection of plants from their natural habitats for commercial exploitation of their medicinal or aromatic properties is not on a large enough scale to be a serious problem. In Scotland the protection of endangered plants is covered by the Nature Conservation (Scotland) Act 2004, and in Northern Ireland there is the equivalent legislation.

Ex situ conservation and genebanks

In general, conservation of MAP species, like the conservation of plant species in general, has been the responsibility of botanic gardens such as the well established Royal Botanic Gardens at Kew (www.kew.org/msbp/index.html) and the Royal Botanic Garden Edinburgh (www.rbge.org.uk/). Their collections have always been on an international rather than national scale, and their primary role has not been to build up *ex situ* genebanks of plants such as MAPs. In terms of seed banks, Kew is making an important contribution with its development of the Millennium Seed Bank at Wakehurst Place, which now contains seeds from virtually the whole of the British higher plant flora, and with some 20 000 species in total, it is well on its way to the 24 000 species target which it has set for the year 2010. Collections of MAPs are also kept at the Chelsea Physic

Garden (www.chelseaphysicgarden.co.uk/), which now has principally an educational role, and at the Eden Project (www.edenproject.com/), which attracts large numbers of visitors to its unique site in Cornwall in the south-west of England. At the University of Reading we are developing a collection of medicinal plants in our Harris garden to serve the teaching and research of a newly established Department of Pharmacy and a School of Biology with active research in the biomedical sciences.

UK Production of MAPs

It has been estimated that the UK provides the fourth largest market in Europe for medicinal plants (Dennis 1998) with an estimated quarter of the UK population taking herbal medicines regularly. The country satisfies this demand by importing virtually all of the plant material, and it grows only insignificant quantities. This may well change in the future however.

The first factor in encouraging such a move is traceability of the material. Particularly when they are imported from South Asia and the Far East, imported MAPs have given rise to concerns of safety. Accidental mistaken identity of the botanical species has led to fatalities, and the deliberate substitution of cheaper for expensive herbs has also given rise to concerns. It has been proposed that these problems could be overcome by cultivation in the UK. In addition to the potential of the UK for supplying herbal plants, a recent report on Plant-based Pharmaceuticals (Fowler and Law 2006) encouraged the UK to invest in the research and development of single molecule drugs derived from plants. In 2005, plant-based prescription medicines worldwide were responsible for worldwide sales of € 30 billion. There is a great difference between the two categories of medicine. On the one hand herbal medicines consist of the dried herbs themselves, tinctures or unpurified extracts; they may be harvested from the wild; and their efficacy can depend on the active constituents working together. On the other hand, single molecule phyto-pharmaceuticals require defined production to standards of Good Agricultural Practice (GAP) and expensive purification to standards of Good Manufacturing Practice (GMP). Single molecule prescription drugs have to go through the regulatory processes of development, preclinical and clinical trials and licensing, including a demonstration of efficacy, while herbal medicines have, in the past, been subject to a lighter regulatory regime. However specific guidelines are now available outlining how the UK is implementing EC Directive 2004/24/EC, which amends Directive 2001/83/EC, regarding traditional herbal medicinal products. The Directive requires that traditional, over-the-counter herbal remedies are made to assured standards of safety and quality and for regulations to be standardized across Europe. Implementation in the UK is being accomplished via a statutory registration scheme that will allow all products on the market at April 2004 to remain on the market until April 2011 before they are required to be registered. Four products have been registered via this scheme in the UK at the date of writing (June 2007). The UK Medicines and Healthcare Products Regulatory Agency (MHRA) is responsible for registration. Evidence of traditional usage would substitute for the conventional requirement to demonstrate efficacy. Potential benefits of implementing the Directive are seen as: fewer people taking herbs that are dangerous through having the wrong ingredients or being contaminated with heavy metals; a safer interaction with conventional medicines and better informed customers; and remedies being better labelled for specific health conditions, with user instructions and increased traceability.

This proposed legislation does not include any requirement that herbal products are produced through sustainable harvesting, which leads us to the second factor in encouraging cultivation of MAPs in the UK: sustainability.

As a first step towards the sustainable sourcing of medicinal plants, the UK-based charity PlantLife International in collaboration with WWF-UK (World Wide Fund for Nature), Herbal Apothecary and members of the UK Medicinal Plant Sustainability Forum commissioned a survey (Vines 2004). They consulted people working in the UK herbal medicine industry, as well as members of herbal associations and conservationists. Of the 17 companies interviewed only 6 were growing even a small proportion of the medicinal plants used. Generally, companies saw no incentive to invest in the development of cultivated sources, fearing that "growing their own" might not be economically viable in an uncertain market. From the consultations, PlantLife International drew up a set of recommendations, including a code of practice that could be considered for adoption throughout the herbal medical industry to encourage sustainable sourcing of medicinal plants by herbal companies. These are embodied in their report, "Herbal Harvests with a Future – Towards Sustainable Sources for Medicinal Plants" (Vines 2004). Specifically, the report proposes the introduction of certification schemes with an appropriate chain of custody mechanisms, the development of a code of practice for the industry, the incorporation of sustainability principles in law, more support for cultivation and a new programme of research and education.

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Web sites

Royal Botanic Garden Edinburgh	www.rbge.org.uk/
The Wildlife and Countryside Act of 1981	www.jncc.gov.uk/page-1377
Royal Botanic Gardens at Kew	www.kew.org/msbp/index.html
PlantLife International	www.plantlife.co.uk
The Chelsea Physic Garden	www.chelseaphysicgarden.co.uk/
The Eden Project	www.edenproject.com/

APPENDICES

Appendix I. Acronyms and abbreviations

AARI	Aegean Agricultural Research Institute, Menemen, İzmir, Turkey
AEGIS	A European Genebank Integrated System
AFLP	Amplified fragment length polymorphism
AGES	Österreichische Agentur für Gesundheit und Ernährungssicherheit GmbH (Austrian Agency for Health and Food Safety), Austria
ANOVA	Analysis of variance
ARCNG	Agricultural Research Center of Northern Greece, Thermi, Thessaloniki, Greece
BAZ	Bundesanstalt für Züchtungsforschung an Kulturpflanzen (Federal Centre for Breeding Research on Cultivated Plants), Germany
BPGV	Banco Português de Germoplasma Vegetal (Portuguese Plant Germplasm Bank), Braga, Portugal
BSBCP	Bulgarian/Swiss Biodiversity Conservation Programme
CBD	Convention on Biological Diversity
CCDB	Central Crop Database
CGIAR	Consultative Group on International Agricultural Research
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington Convention)
CPS/SKEW	Swiss Commission for Wild Plant Conservation
CRA	Consiglio per la Ricerca e la Sperimentazione in Agricoltura (National Council for Agricultural Research), Italy
CRI	Crop Research Institute, Prague-Ruzyne, Czech Republic
CRSF	Centre du Réseau Suisse de Floristique (Swiss Floristic Network)
ECP/GR	European Cooperative Programme for Crop Genetic Resources Networks (*now ECPGR*)
ECPGR	European Cooperative Programme for Plant Genetic Resources
EP	European Pharmacopoeia
EPSC	European Plant Conservation Strategy
EU	European Union
EURISCO	European Internet Search Catalogue
FAO	Food and Agriculture Organization of the United Nations
GC/MS	Gas Chromatography/Mass Spectroscopy
GSPC	Global Strategy for Plant Conservation
HPLC	High Performance Liquid Chromatography
IMPR	Institute for Medicinal Plant Research "Dr Josif Pančić", Belgrade, Serbia
IOA/UOM	Institute of Agriculture, University of Malta
IPGR	Institute for Plant Genetic Resources "K. Malkov", Sadovo, Plovdiv, Bulgaria
IPGRI	International Plant Genetic Resources Institute (*now Bioversity International)*, Rome, Italy
ISAFA	Istituto Sperimentale per l'Assestamento Forestale e per l'Alpicoltura (Forest and Range Management Research Institute), Villazzano, Italy
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture

IUCN	International Union for the Conservation of Nature, Gland, Switzerland
LUA	Latvia University of Agriculture, Jelgava, Latvia
MAA	Most Appropriate Accession
MAP	Medicinal and Aromatic Plant
MHRA	Medicines and Healthcare Products Regulatory Agency, United Kingdom
MRAE	Ministry of Rural Affairs and the Environment, Malta
MTA	Material Transfer Agreement
NAGREF	National Agricultural Research Foundation, Greece
NCG	Network Coordinating Group
NGB	Nordic Gene Bank, Alnarp, Sweden (*now the Nordic Genetic Resource Centre, NordGe*n)
NGO	Non-governmental organization
PEBLDS	Pan European Biological and Landscape Diversity Strategy
PGR	Plant Genetic Resources
RAPD	Random Amplified Polymorphic DNA
RICP	Research Institute of Crop Production, Prague-Ruzyne, Czech Republic
RIPP	Research Institute of Plant Production, Piešťany, Slovakia
SARC	Slovak Agricultural Research Centre
SEEDNet	South East European Development Network on Plant Genetic Resources
TRAFFIC	The wildlife trade monitoring network
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization, Paris, France
VEGNET	Vegetables Network (ECPGR)
WG	Working Group
WHO	World Health Organization, Geneva, Switzerland
WRI	World Resources Institute, Washington DC, USA
WWF	World Wide Fund for Nature

Appendix II. Agenda of the Second Meeting

16-18 December 2004, Strumica, Macedonia FYR

Wednesday 15 December 2004
Arrival of participants

Thursday 16 December 2004

8:30 – 9:30 **Introduction**
- Introductory welcome from local organizers (*G. Popsimonova*) and from the Working Group's Chair (*D. Baričevič*)
- Self-introduction of participants
- ECP/GR information (*L. Maggioni*)
- Chair's report (*D. Baričevič*)

9:30 - 10:30 **Reports from country representatives**
Progress on surveys made in the countries (*10 min. presentations by representatives from Bulgaria, Czech Republic, Hungary, Italy, Macedonia FYR*)

10:30 – 11:00 *Coffee break*

11:00 – 12:30 **MAP priority list and development of descriptors**
- Descriptors: introduction and progress made (*D. Baričevič, 20 min.*)
- Choice of priority list (*J. Bernath, 10 min.*)

12:30 – 14:00 *Lunch*

14:00 – 15:30 **Reports from country representatives (continued)**
Progress on surveys made in the countries (*10 min. presentations by representatives from Lithuania, Nordic Countries, Poland, Turkey*)

15:30 – 16:00 *Coffee break*

16:00 – 17:30 **MAP priority list and development of descriptors:** discussion in two sub groups
1) *Achillea, Gentiana, Hypericum - D. Baričevič*
2) *Carum, Mentha, Thymus, Origanum - J. Bernath*

Friday 17 December 2004

8:30 – 8:45 **SEEDNet information**
- General presentation (*E. Thorn*)
- Report of the SEEDNet MAP WG meeting (*G. Stefkov*)

8:45 – 10:30 **Reports from country representatives (continued)**
Progress on surveys made in the countries (*10 min. presentations by representatives from Portugal, Romania, Russian Federation, Serbia and Montenegro, Switzerland, Ukraine, United Kingdom*)

10:30 – 11:00 *Coffee break*

11:00-12:30 **Update on Documentation systems**
- EURISCO (*L. Maggioni*)
- MEDPLANT (*D. Baričevič*)
- MAP Databases in Macedonia FYR (*G. Stefkov*)
  - Database for ethnobotanical data
  - Database for organic and sustainable production of wild-growing MAPs
- European Central MAP database(s) – *Discussion introduced by L. Maggioni*

12:30 – 14:00 *Lunch*

14:00 – 15:30 **MAP conservation, scientific and methodological approaches**
- Experiences and results with introduction of threatened medicinal plants into cultivation in Finland (*B. Galambosi*)
- Chemical characterization and quality assessment of wild-growing *Thymus* species (*S. Kulevanova*)
- Evaluation of *Origanum* in Slovenia (*D. Baričevič*)

15:30 – 16:00 *Coffee break*

16:00 – 17:00 **Opportunities to submit a MAP project** *(discussion introduced by D. Baričevič)*
- EC Regulation 870/2004
- Seventh Framework Programme

Descriptors for characterization of selected MAPs (continued)
- Reports from sub-groups
- Discussion

Saturday 18 December 2004

Morning **Drafting of the "Discussion and Recommendations" of the meeting** (only rapporteurs)

Excursion – Social programme

Afternoon **Presentation of the draft report and adoption of recommendations**
Election of Chair and Vice-Chair
Closing remarks

Evening *Social dinner*

Sunday 19 December

Departure of participants

Appendix III. List of participants in the Second Meeting

16-18 December 2004, Strumica, Macedonia FYR

N.B.
Contact details updated at the time of publication.
The list below includes only members who attended the meeting.
The composition of the Working Groups is subject to changes; the latest update for the WG on Medicinal and Aromatic Plants can be found on the Web page (http://www.bioversityinternational.org/networks/ecpgr/Contacts/ecpgr_wgMAP.asp).

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Appendix IV. Agenda of the Third Meeting

26-28 June 2007, Olomouc, Czech Republic

Tuesday 26 June 2007

8:30 – 10:30 **Plenary session – Introduction (Vegetables Network and MAP WG)**
- Welcome address and opening remarks (*Local organizers, Dave Astley, Dea Baričevič*)
- Information on ECPGR and AEGIS (*Lorenzo Maggioni*)
- Discussion

10:30 – 11:00 *Coffee break*

11:00 – 13:00 **MAP meeting – Introduction**

11:00 – 11:20 • **Chair plenary lecture – scope of the meeting, achieved and expected results**

11:20 – 11:45 • **Amending of the Agenda, short discussion**

11:45 – 13:00 • **Country reports** *(each representative 10 min + 5 min discussion)*
- Alban Ibraliu – Albania
- Wolfgang Kainz – Austria
- Kana Varbanova – Bulgaria

13:00 – 14:30 *Lunch*

14:30 – 16:30 • **Country reports – continuation**
- Zlatko Šatović – Croatia
- Stathis Evangelides – Cyprus
- Karel Dušek – Czech Republic
- Olesja Volkova – Estonia
- Bertalan Galambosi – Finland
- Frank Marthe – Germany
- Eli Putievsky – Israel
- Carla Vender – Italy

16:30 – 17:00 *Coffee break*

17:00 – 19:00 *Excursion to Department of Vegetables and Special Crops Olomouc (experimental field, isolation cages, drying house, etc.)*

19:00 – 22:00 *Barbecue*

Wednesday 27 June 2007

8:30 – 10:30 • **Country reports – continuation**
- Ieva Žukauska – Latvia
- Åsmund Asdal – Norway
- Ana Maria Barata da Silva – Portugal
- Dan Sandru (on behalf of Diana Rusu) – Romania

- Iveta Čičová – Slovakia
- Dea Baričevič – Slovenia
- Katarina Wedelsbäck-Bladh – Sweden
- Mélanie Quennoz – Switzerland

10:30 – 11:00 *Coffee break*

11:00 – 13:00 • **Country reports – continuation**
- Ali Osman Sari – Turkey
- Theodoros Koutsos – Greece

12:45 – 13:00 • **Discussion**

13:00 – 14:30 *Lunch*

14:30 – 16:00 • **Discussion on draft descriptors**

• **Review of the standard progress report of the Working Group on Medicinal and Aromatic Plants to the Mid-term Steering Committee Meeting and discussion on the workplan for the next Phase (VIII) of ECPGR**

16:00 – 16:30 *Coffee break*

16:30 – 18:00 • **Review of the standard progress report of the Working Group on Medicinal and Aromatic Plants to the Mid-term Steering Committee Meeting and discussion on the workplan for the next Phase (VIII) of ECPGR (continued)**

18:30 – 19:30 *Dinner*

19:30 – 21:30 *City tour – historical centre of Olomouc*

Thursday 28 June 2007

8:30 – 12:00 *Excursion to Open Air Museum in Rožnov pod Radhoštěm (on-farm conservation)*

8:30 – 15:00 **Drafting of the report** (*only Chair, Vice-Chair and ECPGR Secretariat are involved in the drafting*)

12:00 – 15:00 *Lunch*

15:00 – 18:00 • **Discussion and approval of report**
• **Selection of Chair and Vice-Chair**
• **Closing remarks**

19:00 – 22:00 *Social dinner in restaurant Podkova (Horse-shoe) in the centre of Olomouc*

Friday 29 June 2007

Departure of participants

Appendix V. List of participants in the Third Meeting

26-28 June 2007, Olomouc, Czech Republic

N.B.
Contact details updated at the time of publication.
The list below includes only members who attended the meeting.
The composition of the Working Groups is subject to changes; the latest update for the WG on Medicinal and Aromatic Plants can be found on the Web page (http://www.bioversityinternational.org/networks/ecpgr/Contacts/ecpgr_wgMAP.asp).

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ISBN: 978-92-9043-812-0