

Report of a Working Group on Barley

Seventh Meeting, 10-12 May 2011, Nicosia, Cyprus

H. Knüpffer, L. Maggioni, M. Jalli, A. Kolodinska Brantestam, D. Fasoula
and E. Lipman



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Regeneration plots of cereal accessions (alternately barley and wheat) at the genebank of IPK Gatersleben, Germany, in June 2008. Courtesy of © H. Knüpffer, IPK Gatersleben, Germany.

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Related presentations can be downloaded from
http://www.ecpgr.cgiar.org/networks/cereals/barley/7th_barley_working_group_meeting/presentations.html

SUMMARY REPORT OF THE MEETING

The seventh meeting of the Working Group on Barley of the European Cooperative Programme for Plant Genetic Resources (ECPGR) was held from 10 to 12 May 2011 in Nicosia, Cyprus. On the evening before the sessions, old members and newcomers of the Working Group met in an informal setting and were introduced to the venue of the meeting.

Session 1. Opening session

Chair: Marja Jalli

Welcome addresses, opening remarks

Maria Jalli, Vice-Chair of the Working Group (WG) welcomed all the participants, members and observers to Cyprus. The Group had a long history, she observed; its first meeting was held in 1983 in Gatersleben, Germany. All participants were encouraged to work together to make this, the seventh meeting, a fruitful one.

Marinos Markou, Vice-Director of the Agricultural Research Institute (ARI), Nicosia, Cyprus, said that it was with great pleasure that the Permanent Secretary of the Ministry of Agriculture, Natural Resources and Environment and the Director of the ARI welcomed the participants to Nicosia and to the meeting organized by ARI. He explained that ARI undertakes research within the wider domain of plant and animal production. Its mission is to conduct high-quality scientific research with the objectives of achieving a secure supply of safe, good-quality food using financially, environmentally and socially sustainable methods. The Institute develops or adapts, and evaluates under local conditions the scientific findings and technology available from international and regional research institutions. M. Markou re-affirmed the support of the Cyprus government to the ECPGR Programme and its various activities. Traditionally, barley is a very important crop for Cyprus. It is a hardy species that grows well even during difficult years, like the years of drought that Cyprus experiences frequently. He wished all participants a pleasant stay in Cyprus and a successful meeting.

Lorenzo Maggioni, ECPGR Coordinator, welcomed the Group on behalf of the ECPGR Secretariat. Twenty-five participants from European countries were present at the meeting, as well as several observers from the host country. He thanked ARI for organizing the meeting, especially Dionysia Fasoula, who had invited the Group to meet in Cyprus. He also thanked the Chair of the WG for preparing the programme of the meeting and its agenda. The Group, remarked L. Maggioni, would be able to directly experience the diversity of situations in Europe, since barley fields were ready for harvest in Cyprus, while they had just been sown in northern Europe.

The participants then introduced themselves.

Preview of the present meeting: aims and agenda, organizational issues, parallel discussions

Helmut Knüpffer, Chair of the WG, informed the participants about the main aims and expected outcomes of the next ECPGR Phase, based on information from the Twelfth Steering Committee Meeting (December 2010, Bratislava, Slovakia).¹ Crop Working Groups have two major objectives: (1) The initiative for "A European Genebank Integrated System" (AEGIS) is operational, and accessions in AEGIS are characterized and evaluated; (2) The functionality of the European Plant Genetic Resources Catalogue (or European Internet

¹ Report: http://www.ecpgr.cgiar.org/fileadmin/www.ecpgr.cgiar.org/SC_reports/SC12%20report_final%20210211.pdf

Search Catalogue, EURISCO) meets user expectations, and the quantity and quality of data in EURISCO, including *in situ* and on-farm data, are enhanced.

The main results expected from this meeting in Nicosia were the definition of the approach to be adopted to reach these goals for barley, and the development of a workplan.

The agenda was then presented. Initially, a session of two or three parallel discussion groups had been scheduled in the morning of Day 2, the topics to be chosen by the participants. It was, however, decided that all topics would be discussed in the plenary session to allow broader participation. The agenda for Day 2 was subsequently modified so that the topics could be taken up sequentially (see Agenda, Appendix IV, pp. 38-40). A few presentations introducing various topics were added. The topics "Pre-breeding" and "Joint research proposals" were to be discussed together. "Precise genetic stocks" was discussed on Day 1, since Morten Rasmussen could not participate on Day 2. Sufficient time was allotted to the discussion on "AEGIS: approaches and aims for the European barley collection, criteria for Most Appropriate Accessions (MAAs), steps and workplan towards the European collection, and quality standards". Rapporteurs were designated for some topics and requested to provide written summaries as contributions to the meeting report. At the end of the meeting, the Group would elect the Chair and Vice-Chair, for which the participants were requested to nominate candidates.

Update on ECPGR – strategy and priorities of the current and next Phases, their implications for the Barley Working Group

Lorenzo Maggioni presented an update on the ECPGR, informing the Group about the status of membership (currently 43 countries), the structure of the Networks, and the budget and management decisions made by the Steering Committee at the start of Phase VIII, which extends from 2009 to 2013.

He then summarized the results of the Independent External Review of ECPGR that took place in July 2010. Three Panel members of the Review recommended that the ECPGR take more responsibility for the conservation and use of plant genetic resources for food and agriculture (PGRFA), by establishing more accountability among its membership, exploring the option of obtaining a legal persona and establishing an Executive Committee. These proposals were not immediately accepted by the Steering Committee at its (extraordinary) twelfth meeting in Bratislava, Slovakia, in December 2010, as they would require an increased investment in the Programme. Nonetheless, it decided to nominate an Executive Committee (ExCo) with a Chair and four members to examine the proposals. The Steering Committee also decided to revise the objectives of the ECPGR and tasked the ExCo to prepare an "Options paper" that elaborates on the ECPGR objectives and analyses its legal status, operating structure, hosting arrangements and the overall cost implications.

Chair's report: activities and achievements of the Working Group on Barley since its sixth meeting and the second meeting of the Cereals Network

Helmut Knüpffer presented an overview of the activities that had been planned in 2008 for the current ECPGR Phase and presented their results and outcomes.

The sixth meeting (one day) of the WG took place in Salsomaggiore, Italy, in 2000, in conjunction with a meeting of the EU GENRES project CT98-104 on "Evaluation and Conservation of Barley Genetic Resources to Improve Their Accessibility to Breeders in Europe".

Smaller meetings were later organized in conjunction with other activities:

- First meeting of the ECPGR Cereals Network, Yerevan, Armenia, 2003 (one day)
- Barley Genetics Symposium, Brno, Czech Republic, 2005 (half-day)
- Second meeting of the ECPGR Cereals Network, Foça, Izmir, Turkey, 2008 (one day).

The WGs on Barley, Wheat and *Avena* met in parallel during the meetings of the Cereals Network. The disadvantage was that participants representing their country in more than one Crop WG could attend only one of the parallel sessions.

The last full meeting (fifth) of the Barley WG was held in 1997 in Alterode, Germany.

The progress made during 2000-08 was reported in the proceedings of the respective meetings, available on the Web site of the Barley WG (<http://www.ecpgr.cgiar.org/networks/cereals/barley.html>).

Based on discussions in Foça (April 2008), the workplan was finalized in June 2008, comprising the following activities corresponding to the Priority Areas of the ECPGR Phase VIII:

- **Priority Area 1. Task sharing (AEGIS), capacity building**

Activity 1.1. Commencement of implementation of AEGIS for barley, based on the experience of *Avena* (model crop).

A prerequisite for implementation AEGIS is the updating of the European Barley Database (EBDB). The work was started in February 2011, but is still ongoing. At the meeting in 2008, it had been suggested that recommendations for AEGIS implementation should draw on the experience of the four model crops, including *Avena*. As the Barley WG had no opportunity to meet and discuss how to proceed with AEGIS since 2008, there has still been no progress with AEGIS.

Activity 1.2. Assessment of barley genetic stock collections in Europe – inventory (description, size, conservation status, contacts, needs) aimed at identifying possible problems in their maintenance and proposing solutions (e.g. long-term maintenance in genebanks). This activity, originally proposed by the Wheat WG, was considered to be of great importance also for barley. It has a capacity-building component.

An overview of barley genetic stock collections had been presented by Udda Lundqvist, Agnese Kolodinska Brantestam and Morten Rasmussen at the EUCARPIA Genetic Resources Conference (5-7 April 2011, Wageningen, The Netherlands)². Information about existing genetic stock collections for barley and wheat is also given in a review article.³ There has been no further progress, but given the importance of the topic, it will be addressed during the current meeting (see p. 6).

- **Priority Area 2. Characterization and evaluation**

Activity 2.1. Organization of a meeting on “Pre-breeding for climatic change”; setting up of cooperation between breeders, genebanks and researchers, focus on barley; preparation and submission of a joint project proposal for funding.

² Lundqvist U, Kolodinska-Brantestam A, Rasmussen M. 2011. Access to Barley Genetic Stocks – a key stone for research in plant biology. In: van Hintum TJL, editor. To serve and conserve, Abstracts of oral presentations and posters of the European Plant Genetic Resources Conference 2011, Wageningen, The Netherlands. p. 87.

Lundqvist U, Rasmussen M, Göransson M, Kolodinska-Brantestam A. 2010. Barley Genetic Stocks – global use and potential. Poster presented at the EUCARPIA Cereals Section Meeting, 6-8 April 2010, Cambridge, UK.

³ Knüpffer H. 2009. *Triticeae* genetic resources in *ex situ* genebank collections. In: Feuillet C, Muehlbauer GJ, editors. Genetics and Genomics of the *Triticeae*. Plant Genetics and Genomics: Crops and Models. Vol. 7, Part 1. Springer Science+Business Media, LLC. pp. 31-79.

A pre-breeding meeting (barley, wheat, oats) was organized by the ECPGR Barley WG in collaboration with several other organizations. The meeting, bringing together 49 participants from 12 countries, was held in Alnarp, Sweden, in November 2009. The report on this meeting was presented by Marja Jalli as a separate topic (see p. 22).

- **Priority Area 3. *In situ* and on-farm conservation and management**

Activity 3.1. Compilation of a list of crop wild relatives (CWR) of barley in Europe.

H. Knüpffer had prepared an overview of *Hordeum* species occurring in countries of Europe and the Mediterranean region, based mainly on information of the Euro+Med Checklist Database, supplemented by other information (see separate presentation p. 11 and Appendix II, pp. 32-35). He had also suggested that, during the MSc course in Birmingham, UK, an ecological gap analysis of wild *Hordeum* species be carried out on the basis of genebank accession data; the results were presented by Holly Vincent (see p. 12).

- **Priority Area 4. Documentation and information**

Activity 4.1. Updating of the EBDB (for at least 50% of the contributors); integration of data from EURISCO additional AEGIS descriptors, and characterization and evaluation (C&E) data; coordination with other Barley databases (DBs); implementation of Web service technology.

The updating was started in February 2011, but is still ongoing. Other essential activities could not be carried out due, once again, to the lack of capacity and external funding. H. Knüpffer gave a presentation on the EBDB during the session on Documentation and Information (see p. 13).

The workplan of June 2008 also included the following activities:

- Full meeting of the Barley WG (2009-10): preparation for AEGIS and approval of criteria and methodology for barley. The meeting was postponed until the current meeting.
- Starting with the designation of MAAs (2010): focus on accessions originating from the host country of each genebank and drafting of an MAA list online. The steps towards designating MAAs for barley and the procedures to create the AEGIS collection for barley were discussed in the plenary session on AEGIS (see p. 15).
- Continuation of the “ring tests” for barley: reported briefly by Marja Jalli in the session on “Pre-breeding” (see p. 22).
- Drafting of review paper on the utilization of the International Barley Core Collection (BCC): not yet prepared.

In addition, the Barley WG participated in the following activities:

- Preparation and coordination of a European project proposal on “Regeneration and safety-duplication of threatened cereal and grain legume accessions” submitted to the Global Crop Diversity Trust, in collaboration with the ECPGR Secretariat, the Grain Legumes WG and the Potato WG. The status of this activity was reported by Lorenzo Maggioni (see p. 10).
- Participation in the EU project proposal on barley for the Knowledge-Based Bio-Economy (KBBE) call on crop wild relatives coordinated by Andy Flavell. The proposal was submitted, but was not successful.

- Participation in the EU project proposal “EUROGENEBANK” (submitted in December 2009, not funded) and in its successor “Plant Gene Access” submitted in November 2011).

In 2008, the Cereals Network had expressed concern about the increasing difficulties in involving the N.I. Vavilov Research Institute of Plant Industry (VIR, St. Petersburg, Russian Federation) in ECPGR activities. Since then, the Russian Federation has joined the ECPGR.

The topics raised in 2008 by George Garland – “Barley breeding for organic farming” and “Recovery of viability in historical seed collections” (collaboration with Isaak Rashal, Latvia) – made no progress due to the economic situation in Ireland, but are still of interest. Some funds would be needed for viability recovery in cereals, since the Latvian partners have experience only in grain legumes.

Discussion

In the discussion that followed, Ahmad Jahoor noticed that many required activities called for more staff than are usually available at the member institutions of the Barley WG. Therefore, sources of external funding should be identified at all possible levels to ensure such activities. Funds are available for research activities but organizations have to apply for them.

Michele Stanca commented that in the EU, barley usually competes with wheat, unless the call is specific to barley.

For activities that are considered non-scientific, such as maintaining and updating the EBDB, it is difficult to find external funding.

A few members pointed out that without external funds no progress can be made, given that it is difficult to dedicate substantial staff time as input-in-kind to the ECPGR.

Session 2. ECPGR Phase VIII – Priority Area 1. Task sharing (AEGIS) and capacity building

Chair: Helmut Knüpffer

Update on AEGIS: criteria and approaches for compiling the European Barley Collection

Lorenzo Maggioni indicated that according to the World Information and Early Warning System of the FAO (WIEWS), as of May 2011, there were around 470 000 *Hordeum* spp. accessions in the world, of which around 149 000 in Europe, held in 34 countries.⁴

He then presented the objectives, perceived benefits and key components of AEGIS. Twenty-six countries are now members of AEGIS; several countries have established Associate Memberships between the National Coordinator and collection-holding institutions. The concept of the European Collection was outlined, stressing the need to accelerate the compilation of lists of accessions to be proposed by the WGs to the respective countries for designation as European Accessions according to the AEGIS principles.

The MAAs proposed should be genetically unique within AEGIS and preferably of European origin, or of actual or potential importance to Europe. Crop-specific selection criteria have to be agreed by the respective ECPGR Crop WGs. The “simplified selection procedure” for European accessions starts with accessions documented in EURISCO or the respective Central Crop Database (CCDB), or both. WGs propose parts of their members’

⁴ 175 000 according to Knüpffer (2009) (reference in footnote 3).

collections as AEGIS candidate accessions to be confirmed by the respective National Coordinators. Procedures for eliminating duplicates need to be agreed upon by the WGs.

The AEGIS Quality System (AQUAS) was also presented, specifically:

1. the "Operational genebank manual" that all AEGIS Associate Members should compile, based on a "Template for the preparation of operational genebank manuals" (finalized and available on the AEGIS Web site⁵);
2. the "Generic operational standards" that were drafted by the FAO and submitted to various agencies, including the ECPGR, for comments, which have to be sent in by the end of February 2011; this document is expected to be endorsed in June 2011 by the FAO Commission on Genetic Resources and also adopted subsequently for AEGIS;
3. the agreed minimum crop-specific technical standards that each WG should prepare expeditiously in order to complement the generic standards (including collecting/acquisition, regeneration/propagation, storage/seed quality and viability monitoring, distribution, characterization); these standards have to be approved by the Steering Committee;
4. the quality management system procedures, including record keeping, reporting and monitoring mechanisms (still to be proposed);
5. EURISCO as the agreed information portal for the European Collection.

The European Commission is expected to launch the Seventh Framework Programme (FP7) call for proposals in July 2011. The draft text of the call was presented. This Research Infrastructure call is expected to be open for a "Plant Genetic Resources Centres" project. The ECPGR Secretariat was mandated by the Steering Committee to coordinate the submission of a project proposal. The preliminary proposed structure of the project was presented, together with a draft list of Work Packages and their respective leaders. All those interested in participating in the project were invited to approach the relevant Work Package leaders.

Precise genetic stocks of barley: inventory of collections and databases

Morten Rasmussen presented the status of the inventory of global genetic stocks and briefly described the barley genetic stock collection at NordGen.⁶ The preliminary inventory was carried out by Udda Lundqvist who gathered information from her network, focusing mainly on mutant collections. Genetic stocks comprise about 9% of the global barley collection. M. Rasmussen listed the types of "genetic stocks" as well-described research material possessing the characterized allele of a specific gene, combinations of mutations that give a unique phenotype, series of mutant alleles of genetically linked genes, variants of cytoplasmic traits, various chromosomal aberrations, monosomic or trisomic aneuploids, alternative ploidy (e.g. tetraploid) and other material that can be used as tools to determine the function of a gene discovered by sequence analysis. Genetic stocks have so far been used mainly in research, but occasionally also in breeding, either indirectly as controls or standards, or directly for their crop improvement properties. NordGen holds a substantial share of the barley genetic stocks (BGS) collection, representing around 44% of the global collections (more than 13 000 accessions) based on a preliminary inventory. M. Rasmussen noted that many genetic stock collections are not sufficiently documented. The regeneration status and quality are not known. These collections are under threat, mainly due to lack of funds or expertise, or both, for the maintenance of such material. Creation of genetic stocks requires many decades of extensive work and substantial investments, but it lays a solid foundation and increases knowledge. M. Rasmussen proposed three steps: (1) to carry out a

⁵ http://aegis.cgiar.org/fileadmin/www.aegis.org/Documents/AQUAS/Template_final240910.pdf

⁶ See footnote 2.

full survey on the status of all types of BGS existing globally; (2) to develop and propose a conservation (and utilization) strategy for BGS; (3) to hold a workshop in order to disseminate the strategy and initiate implementation.

M. Rasmussen emphasized that BGS should not be considered a local European occurrence, but viewed globally. Management and expertise are necessary. A network of institutions should be established at global level to support the maintenance of these stocks. He asked the Group whether this could be recognized as a common interest and be supported by its members. The task would be to agree on European needs and the goals, and to allocate time and funding for a full survey. If sufficient funding could be allocated, the questionnaire results could then be presented at the 11th International Barley Genetics Symposium (IBGS) to be held in China in 2012. During the IBGS, a proposal or a preliminary draft strategy could be discussed, as well as future funding opportunities and the setting up of a task force for strategy development. During the 2012 IBGS, one session will be dedicated to genetic resources and genetic stocks, with a workshop on "How to preserve and use barley genetic stocks for the future". To disseminate the results of the strategy paper, a workshop could be organized back to back with another meeting in 2014. The ultimate goal of these activities is the establishment of an operational global secured BGS system.

Discussion

Dionysia Fasoula expressed her support to this activity and offered to participate in the regeneration of BGS; climatic factors should, however, be taken into account.

Morten Rasmussen replied that regeneration requires a very careful procedure, including verification that the genetic property of the accession is maintained and a quality check; climate is not that important since an accession in most cases represents a line.

Michele Stanca (Italy), Algè Leistrumaitè (Lithuania) and Olga Kovaleva (Russian Federation; 50 lines regenerated per year) have collections of genetic stocks in their countries and consider them to be important. Alexandre Zoubkovitch (Belarus) also expressed his interest and informed that his country holds a collection of iso- and alloplasmic substituted lines.

M. Stanca informed that the European developmental mutants of barley are included in near isogenic lines (NILs) and that many genes that regulate the mutations have been cloned.⁷ M. Rasmussen added that genetic stocks had been created at high cost and will not be created again. They are a global good. Ahmed Jahoor noted that even NordGen will not be able to continue with BGS maintenance without end. External financial and expert help will be needed. Genebanks will have to be approached to assist in the long-term maintenance of such material. Helmut Knüpffer informed that there are several barley genetic stock collections at the Leibniz Institute of Plant Genetics and Crop Plant Research, (IPK), Gatersleben, and probably elsewhere in Germany, and agreed to assist in the survey. M. Rasmussen informed that NordGen will continue working with its own material in any case. Whether or not to extend this activity to the global level remains a question. Support from the Group is needed to help raise funds. Agnese Kolodinska Brantestam suggested that planned activities could be split in three phases—survey, strategy document, maintenance of BGS—and that these three phases could be funded by different bodies.

The funds required for the survey are not high. For the compilation of the Strategy Document, a meeting of one or two days with around five participants was suggested. The WG could apply for ECPGR's "reserve funds" (funds not completely spent on planned activities of the Networks that were returned to the central ECPGR budget) for this purpose;

⁷ Druka A, Franckowiak J, Lundqvist U, Bonar N, Alexander J, Houston K, Radovic S, Shahinnia F, Vendramin V, Morgante M, Stein N, Waugh R. 2011. Genetic dissection of barley morphology and development. *Plant Physiology* 155:617-627.

the Chair of the Barley WG was requested to write a letter to the ExCo. Long-term funding needs to be secured for the continuous and safe maintenance of precise genetic stocks (details to be compiled in the Strategy Document).

Preparation of the Strategy Document may become part of the forthcoming EU project proposal on Plant Genetic Resources Centres.

Collection of developmental mutants of barley and their potential use in pre-breeding work

Michele Stanca presented the work done on the collection of developmental mutants. During the past century, thousands of barley mutants had been brought together worldwide to form Barley Genetic Stocks (BGS).

In particular, the collection of morphological barley mutants developed in Fiorenzuola (Italy) in the past decades continues with the addition of new mutants and the development of double mutants by intercrossing simple mutants. Some of them are near isogenic lines (NILs) and have been obtained and evaluated under field conditions to study the effect of mutation on agronomic performance. The mutants, whether spontaneously or artificially induced, are grouped on the basis of plant morphology.

The different mutant groups are described as mutants of spike, leaves, stem and grain. Many stocks that had been studied and characterized in detail, both genetically and physiologically, provide the most efficient entries for analysing individual genes, understanding regulation and interactions with other genes, and sequencing and cloning them. Genes responsible for the characters hooded, awned vs. awnless, naked vs. covered grain, leafy lemma, lodicule size of cleistogamous vs. non cleistogamous cultivars, etc., have been cloned and their function established.

Discussion

Ahmed Jahoor asked whether a dwarf mutation ("uzu") could be used to develop a dwarf cultivar. M. Stanca replied that this would not be possible since also the roots are dwarfed by this mutation, causing the plant to lodge.

A. Jahoor asked whether the mutants need to be physically preserved if the gene sequence is known. M. Stanca replied that the mutants need to be preserved, since the sequence is just information, while the mutant is living material. Moreover, progeny tests can be carried out with the mutants.

Dionysia Fasoula mentioned that some lines carrying the hooded gene have been developed in Cyprus, but it is difficult to maintain them. M. Stanca replied that improved lines will be available soon.

On Day 3, a draft list of questions for the survey on genetic stock collections was discussed and completed. The list is presented in Box 1.

Box 1**List of questions for the survey on the status of Barley Genetic Stocks Collections (global)*****Information to be extracted***

Location of the collection and the kind of material it contains
 Quantity and quality of material, regeneration status, age, viability, purity
 Safety backup; if yes, its location
 Data, quantity and quality, publications, digitalized, formats, intellectual property rights (IPRs)

Availability, use
 Legal status, multilateral system (MLS), IPRs, public/private

Maintenance costs, technical and expert requirements for maintenance

Costs of creating the material and information, approximate value

Potential for use

Contact person (holder, creator)

Initial purpose of genetic stock collection, age (when was it created?)

Did the stock pass through the hands of several holders?

Is the gene isolated?

Is DNA available (if yes, where, contact person)? Sequence available (database, where)?

Other remarks, relevant information

Threats to the collection (cancellation of funds, change in priorities of the department, etc.)

Method

- Questionnaire (Web-based), email (Word document, can also be printed)
- Database search
- + information from ECPGR Barley WG

Identification of the target group for the questionnaire

Identify persons, groups, institutes and companies that have or may have this information and/or material

Request support from the country representatives of the Barley WG

Conclusions

- The Group acknowledged that maintaining precise genetic stocks responds to a common interest.
- The Group agreed that a long-term and sustainable solution for maintenance of precise genetic stocks in barley should be found.

Decisions and workplan

- A Task Force was formed to carry out a full survey and draft a global conservation (and utilization) strategy paper for barley genetic stocks. Members of the Task Force are: Agnese Kolodinska Brantestam (coordinator), Dionysia Fasoula, Ahmed Jahoor, Helmut Knüpffer, Olga Kovaleva, Algè Leistrumaitè, Joanne Russell, Michele Stanca and Alexandre Zoubkovitch.
- Funding for the survey should be secured before starting the activity. The possibility of using funds of the Cereals Network already allocated to wheat precise stocks by extending the survey to barley will be investigated.

- *The approach and method for the survey were agreed upon:*
 - *A questionnaire will be developed and sent out to the target group (the Web-based and Word document will be available for distribution)*
 - *A database search will supplement the identification method.*
- *Members of the Barley WG will assist in the identification of target groups (persons, groups, institutes and companies that may have useful information and/or material) to whom the questionnaire will be sent.*
- *The type of information on existing BGS to be obtained through the questionnaire was agreed upon.*

Trust multiplication project for cereals and legumes: present status with respect to barley

Lorenzo Maggioni reminded the Group of a project that had been submitted to the Global Crop Diversity Trust in 2008 by the ECPGR Cereals Network and the Grain Legumes WG, and funded for two years (2009-10) with a total budget of US\$ 130 000. The project involved the regeneration and safety-duplication of priority collections; the plan had targeted 5211 accessions in 10 countries. Specifically, the plan was to regenerate 3956 cereal accessions (including 1299 barley) and duplicate them in recognized international collections. At the conclusion of the project in December 2010, 2675 (68%) cereal accessions had been successfully regenerated, of which 1100 were barley accessions (85% of those originally planned). An additional 76 barley accessions are still in the field in Armenia and Bulgaria, which agreed to complete regeneration through a no-cost extension of the project.

Regeneration of barley was carried out in Armenia, Belarus, Bulgaria, Greece, Hungary and Israel. It was generally successful except for:

- Armenia (40% regenerated): low germination, combined with bad (rainy) weather at harvest;
- Belarus (54% regenerated): low germination and unfavourable weather both in 2009 (excess rainfall in May and June) and in 2010 (winter freeze, spring flooding and extreme summer heat).

In most cases the regenerated material was also morphologically characterized and evaluated for lodging, winter hardiness, and drought and disease resistance. Safety-duplicates will be sent to the International Center for Agricultural Research in the Dry Areas (ICARDA, Syria) (to NordGen in the case of wild barley from Israel), and to Svalbard.

Session 3. ECPGR Phase VIII – Priority Area 2. Characterization and evaluation

Chair: Helmut Knüpffer

Pre-breeding workshop and activities, ring tests update

Marja Jalli briefed participants on these topics for the discussion on "Pre-breeding and joint research proposals" that took place on Day 2 (see p. 20).

Breeding for climate change

Dionysia Fasoula introduced this topic with a short presentation. Breeding for climate change is a new challenge. Breeding is a slow process, but it needs to be accelerated to meet challenges posed by the rapidly changing micro- and macro-environments. Innovative approaches and methodologies are required to achieve this target. D. Fasoula referred to a

relevant recent publication.⁸ The paper addresses the multiple issues stemming from the established negative correlation between yielding and competitive ability and suggests a novel selection equation that can accelerate progress through selection and facilitate breeding for climate change.

Session 4. ECPGR Phase VIII – Priority Area 3. *In situ* and on-farm conservation and management

Chair: Isaak Rashal

Hordeum wild species in Europe, crop wild relatives of cultivated barley

Helmut Knüpffer gave an overview of the occurrence of wild *Hordeum* species in Europe and the Mediterranean region, based mainly on information extracted from the Euro+Med PlantBase.⁹ In addition, the following sources were consulted: Agroatlas¹⁰, Bothmer et al. 1995¹¹, GRIN-Taxonomy for Plants¹², Lukyanova et al. 1990¹³. The Euro+Med PlantBase contains some scientific names that are considered synonyms by Bothmer et al. 1995, and some obscure names. Individual records of Euro+Med PlantBase have their own references not cited here; however, they can be used for verifying individual items of doubtful information.

A compilation of the names accepted here according to Bothmer et al. (1995) and alternative names under which certain taxa occur in the other sources is provided in Appendix I, Table 1 (p. 32).

The wild species occurring in this region are listed in Appendix I, Table 2 (pp. 33-35.) based on the taxonomic treatment described by Bothmer et al. (1995).

Some of the information may need to be confirmed or refined. Additional information, comments and corrections are welcome.

⁸ Fasoula DA. 2011. An overlooked cause of seed degradation and its implications in the efficient exploitation of plant genetic resources. *Plant Genetic Resources* 9:321-323. DOI: 10.1017/S1479262111000219.

⁹ Valdés B, Scholz H; with contributions from von Raab-Straube E von and Parolly G. 2009. Poaceae (pro parte majore). Euro+Med Plantbase – the information resource for Euro-Mediterranean plant diversity. (<http://ww2.bgbm.org/EuroPlusMed/>)

¹⁰ Afonin AN, Greene SL, Dzyubenko NI, Frolov AN, editors. 2008. Interactive Agricultural Ecological Atlas of Russia and Neighboring Countries. Economic Plants and their Diseases, Pests and Weeds. (<http://www.agroatlas.ru>)

¹¹ Bothmer R. von, Jacobsen N, Baden C, Jørgensen RB, Linde-Laursen I. 1995. An ecogeographical study of the genus *Hordeum*. 2nd edition. Systematic and Ecogeographic Studies on Crop Genepools 7. International Plant Genetic Resources Institute, Rome. (http://www2.bioversityinternational.org/publications/Web_version/271/)

¹² USDA, ARS, National Genetic Resources Program. Germplasm Resources Information Network – (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. (http://www.ars-grin.gov/cgi-bin/npgs/html/tax_search.pl).

¹³ Lukyanova MV, Trofimovskaya AY, Gudkova GN, Terentyeva IA, Yarosh NP. 1990. Flora of Cultivated Plants. Vol. 2, part 2, Barley [in Russian]. Leningrad, Agropromizdat. 421 pp.

Towards a conservation strategy for wild *Hordeum* species using niche modelling

Holly Vincent, a student from the University of Birmingham, UK, was invited under the Chair's quota to present results of her studies on the distribution of wild *Hordeum* accessions.

In her presentation, she highlighted the important role of crop wild relatives (CWRs) in crop improvement and why they should be conserved. *H. vulgare* subsp. *spontaneum* (K. Koch) Thell. and *H. bulbosum* L. (primary and secondary genepool of barley, respectively), both CWRs of cultivated barley, were highlighted as extremely important donors of pest and disease resistance; *H. chilense* Roem. et Schult. (tertiary genepool) was also identified as an important CWR. Accession passport data of wild *Hordeum* spp. were collected and processed from seven data sets: IPK, ICARDA, NordGen, EURISCO, Plant Gene Resources of Canada (PGRC), the United States Department of Agriculture-Agricultural Research Service (USDA-ARS), and the collection of Roland von Bothmer in Alnarp, Sweden.

The database now comprises 17 169 accessions, after excluding *H. vulgare* subsp. *vulgare* and eliminating duplicate accessions and accessions without georeferences. Of these unique accessions, 13 258 belong to *H. vulgare* subsp. *spontaneum*. South America was found to be the region with highest species richness with 21 species. The richest areas in number of species in the Middle East and Asia were Iran, Turkey, Tajikistan, Uzbekistan and Armenia. The area with the highest number of accessions was around the Fertile Crescent, which is the centre of diversity for *H. vulgare* subsp. *spontaneum*. Due to its importance in breeding, this taxon has been collected more intensively compared with other wild species.

Distribution maps were created from the database using DIVA-GIS (<http://www.diva-gis.org/>); additional maps were produced to find the predicted distribution of each species using an inbuilt algorithm in DIVA-GIS. These distribution and predicted distribution maps were compared (*ex situ* gap analysis) to find areas where collection has not yet been carried out but may potentially contain the species in question.

Ex situ priorities were identified as: *H. tetraploidum*, *H. pusillum*, *H. intercedens*, *H. guatemalense*, *H. euclaston*, *H. depressum*, *H. capense*, *H. roshevitzii*, *H. procerum*, *H. halophilum*, *H. flexuosum*, *H. erectifolium*, *H. cordobense* and *H. arizonicum*.

For *H. vulgare* subsp. *spontaneum*, *H. bulbosum*, three subspecies of *H. murinum*, *H. marinum*, *H. gussoneanum*, *H. secalinum* and *H. brevisubulatum* subsp. *violaceum*, regions in the Euro-Mediterranean area were identified for undertaking collection because they are not represented in *ex situ* genebank collections.

For the *in situ* gap analysis, known National Protected Areas were compared with actual distribution points to see which accessions currently had passive protection. Twenty-five wild species had passive protection; *H. erectifolium*, *H. euclaston*, *H. flexuosum*, *H. guatemalense*, *H. procerum*, *H. cordobense* and *H. stenostachys* were not represented. DIVA-GIS was used to designate the optimum location of *in situ* reserves globally based upon the accessions in the *Hordeum* database. It is suggested that genetic reserves should be set up near Mendoza and Bahía Blanca in Argentina to conserve the wealth of species, including many under-represented wild species, found in the region. For the priority taxa *H. vulgare* subsp. *spontaneum* and *H. bulbosum*, reserves should be established in central Israel (near Jerusalem) and Western Turkey (Izmir), respectively. Reserves should also be established for the small endemic populations of *H. guatemalense* and *H. erectifolium* instead of further *ex situ* collection.

H. Vincent will conduct further gap analysis, investigating *Hordeum*, *Avena* and *Aegilops* species to propose a combined conservation strategy for these important species.

In the discussion, Michele Stanca asked why *spontaneum* and *vulgare* from South America were not represented in genebank collections. H. Vincent agreed there were very few of these accessions in collections. H. Knüpffer added that collectors looking for indigenous wild species probably tend to ignore alien species (invaders or those escaped from cultivation).

Session 5. ECPGR Phase VIII – Priority Area 4. Documentation and information

Chair: Isaak Rashal

European Barley Database and EURISCO, International Barley Core Collection

The European Barley Database (EBDB) Manager, Helmut Knüpffer reported on the status of the EBDB and the International Barley Core Collection. The EBDB was previously updated in 1999-2002 (EU GENRES project on barley genetic resources) and prior to that in 1997 (with additional IPK-funded staff, three months). Three non-European collections (ICARDA, Syria; Okayama University, Japan; and Australian Winter Cereals Collection (AWCC)) were included since they did not have their own Web sites. A more detailed report of activities since then is included in the report of the second meeting of the Cereals Network in Foça, Turkey, in 2008.¹⁴

As background information, an overview of *Hordeum* accessions in European collections according to the EBDB, EURISCO, and FAO WIEWS was distributed among participants. It included responses from Barley WG members to the request to provide updates of their barley data. As of November 2010, EURISCO had 99 995 barley accessions, the EBDB 155 558 (of these, 38 335 belong to the three non-European collections), and WIEWS documented 149 140 accessions (of these, 40 015 for the three non-European collections).

On the IPK Web site, there are two versions of the EBDB, both presently containing the same accessions. The “old” EBDB, in addition, gives access to the characterization and evaluation (C&E) data generated during the barley GENRES project (1999-2003), mostly on reaction to biotic and abiotic stresses. The “new” EBDB was created from the “old” version by transforming the data structure, transferring the database to the Oracle platform and designing a new Web interface. The C&E data were, however, not transferred, owing to lack of staff. Therefore, the “old” version is still kept alongside the “new”.

Updating of the EBDB contents was initiated in early 2011 with a request for new data from the members of the Barley WG. Some feedback was received before the current meeting; more contributions are required to start the actual updating of the DB. Some respondents sent information on the size of their collections and persons in charge, but wrote that they would send their data later. The next steps will be to:

- repeat the request for data;
- approach collections in countries not covered by the Barley WG membership and collections not represented by Barley WG members; and
- add new data to the “new” EBDB.

¹⁴ Maggioni L, Katsiotis A, Knüpffer H, Kleijer G, Lipman E. 2011. Report of a Cereals Network. Second Meeting, 21-24 April 2008, Foça, Turkey. Bioversity International, Rome, Italy. ([http://www.ecpgr.cgiar.org/index.php?id=644&user_bioversitypublications_pi1\[showUid\]=5091](http://www.ecpgr.cgiar.org/index.php?id=644&user_bioversitypublications_pi1[showUid]=5091))

The “old” EBDB will not be updated. H. Knüpffer informed the participants that further development of the EBDB beyond a simple update of contents was not possible due to lack of staff. Tasks such as identifying duplicates, designating unique AEGIS accessions, extending the data structure for AEGIS and other descriptors will depend on the availability of external funding, which is rather difficult to obtain for such non-research activities.

H. Knüpffer informed the Group that no substantial progress had been made in the development of the International Barley Registry to be established at ICARDA (information from Jan Konopka, ICARDA, who had been invited as observer but could not attend the meeting).

A discussion on the future of the EBDB followed. The participants agreed that an update of the EBDB is desirable. Members of the Group confirmed that they regularly use the EBDB. Regarding the inclusion of C&E data, H. Knüpffer informed the Group that attempts to establish handling of C&E data in EURISCO are ongoing within the frame of the ECPGR Documentation and Information Network. He suggested focusing on EURISCO to avoid duplication of work. Audrey Didier informed that France currently lacks a Focal Point for EURISCO, and thus the EBDB is the only place to publish the French barley collection.

For the designation of AEGIS accessions, H. Knüpffer proposed that EURISCO should be used rather than the EBDB. All AEGIS accessions should anyway be in EURISCO and in the public domain. EURISCO has already incorporated additional AEGIS descriptors, and it is expected that software will be developed in addition to EURISCO that will support the AEGIS process, as it had been indicated in the EUROGENEBANK project proposal and will possibly be in the forthcoming revised proposal. Such a solution would benefit all Crop Working Groups in assisting them with the AEGIS process.

The decision whether to continue developing the EBDB or to use EURISCO alone can be taken at a later stage when the AEGIS and C&E functionalities will be available in EURISCO. If considered useful by the Group and the users, the EBDB should be retained to provide additional crop-specific value. Development of a “crop portal” for barley would require commitment and work, as confirmed by Morten Rasmussen who recounted attempts to develop Nordic crop portals.

The International Barley Core Collection (BCC) is available from IPK (almost all subsets) via its Genebank Information System (GBIS/I)¹⁵ and can be requested online. Details of the BCC are included in the report of the Working Group on Barley of the Foça meeting¹⁶ and the publication by Knüpffer and Hintum.¹⁷ The respective subset coordinators can also be approached for material. The subset on “genetic stocks” is available only from the USDA (Aberdeen, Idaho). No subset on Ethiopian and Eritrean material exists.¹⁸

The review paper on the utilization of the BCC, as included in the plan of the WG, has still to be drafted. A documentation system for the BCC was not developed due to lack of staff and funding.

¹⁵ <http://gbis.ipk-gatersleben.de>, search for accession number starting with “BCC”

¹⁶ pp. 16-24 in Maggioni et al. 2011 (reference in footnote 14).

¹⁷ Knüpffer H, van Hintum Th. 2003. Chapter 13: Summarised diversity – the Barley Core Collection. In: von Bothmer R, van Hintum Th, Knüpffer H, Sato K, editors. Diversity in Barley (*Hordeum vulgare*). Elsevier Science BV, Amsterdam. pp. 259-267.

¹⁸ Å. Bjørnstad, Norway, supervised a PhD study on Ethiopian barley, in which 95 candidate BCC accessions were selected. However, due to the present impossibility to obtain permission from Ethiopia to include Ethiopian material in the BCC, with the implication that it would be available in the same way as other subsets of the BCC, it appears impossible to designate an Ethiopian subset of the BCC at present.

Joanne Russell wanted to know whether the entire BCC had been genotyped. H. Knüpffer responded that no complete overview was available about the utilization of the BCC in research projects. Researchers who requested the BCC or large parts of it could be identified and contacted to obtain their relevant publications. The individual subsets of the BCC (from Europe¹⁹, East Asia, Central and West Asia and North Africa (CWANA) and the Americas) were studied using molecular markers in the 1990s. An overview of utilization of the BCC would be part of the planned review paper.

Ahmed Jahoor informed that he had a collection of Eritrean landraces that is being studied by a project.²⁰ The question of compiling an Ethiopian core subset from the pre-Convention on Biological Diversity material existing in genebank collections outside Ethiopia was discussed. H. Knüpffer replied that the initial intention had been to involve partners from Ethiopia and Eritrea in the selection process and to obtain their official agreement for use of this material for research and breeding. Since the International BCC Committee does not exist any longer (discontinued in 2005), no action could be taken.

Recommendations

1. *The Group agreed that EURISCO should be used rather than the EBDB for designating accessions for AEGIS, since all AEGIS accessions must be present in EURISCO.*
2. *The decision whether to continue developing the EBDB or to use EURISCO alone will be taken at a later stage, when all the AEGIS and C&E functionalities will be available in EURISCO.*

Session 6. Plenary discussions

Chair: Külli Annamaa

1. AEGIS – approaches and aims for the European Barley Collection, criteria for Most Appropriate Accessions, steps towards the European Collection, quality standards

(Chair: Helmut Knüpffer, Rapporteur: Lorenzo Maggioni)

Helmut Knüpffer explained to the Group that the definition of the European Barley Collection was not a minor exercise, if the first step of the approach involved an analysis of the EBDB to search for duplicates. He quoted the example of the *Brassica* WG which analysed the *B. rapa* dataset and estimated that eight person-months were required for the additional workload of developing the *B. rapa* AEGIS collection.²¹ Even though the *Brassica rapa* accessions were fewer than 4000 (compared with the nearly 100 000 barley accessions), the effort was time-consuming and yielded partial results due to incomplete data. Several person-months would be necessary to analyse the EBDB, and substantial external funding

¹⁹ Russell JR, Fuller JD, Macaulay M, Hatz BG, Jahoor J, Powell W, Waugh R. 1997. Direct comparison of levels of genetic variation among barley accessions detected by RFLPs, AFLPs, SSRs and RAPDs. *Theoretical and Applied Genetics* 95:714-722.

Backes G, Hatz B, Jahoor A, Fischbeck G. 2003. RFLP diversity within and between major groups. *Plant Breeding* 122:291-299.

²⁰ Orabi J, Backes G, Wolday A, Yahyaoui A, Jahoor A. 2007. The Horn of Africa as a centre of barley diversification and a potential domestication site. *Theoretical and Applied Genetics* 114:1117-1127. Backes G, Orabi J, Wolday A, Yahyaoui A, Jahoor A. 2009. High genetic diversity revealed in barley (*Hordeum vulgare*) collected from small-scale farmer's fields in Eritrea. *Genetic Resources Crop and Evolution* 56:85-97.

²¹ Meeting of the AEGIS model crops curators and database managers, 1-3 July 2008, Radzików, Poland. Progress report of the AEGIS model crop: *Brassica* (available online from: <http://aegis.cgiar.org/index.php?id=1917>).

would be required. Moreover, in the case of barley, the cost of identifying and confirming the duplicates would be much higher than the benefit from discontinuing the maintenance of duplicates. Lorenzo Maggioni explained that according to the simplified approach, AEGIS accessions could be designated without the quality system being in place.

H. Knüpffer also remarked that the entire barley collection of IPK could be designated as part of AEGIS (a formal offer from IPK is expected to be made soon), since IPK is prepared to guarantee its quality and availability. He proposed a different approach by which entire collections or part of them could be offered as part of AEGIS, without entering into detailed analysis of the presence of unnecessary duplicates.

Ahmed Jahoor suggested that each country or genebank propose accessions that they are willing to include in AEGIS, starting with accessions that originate from the country or those that are unique (e.g. pre-World War II Hindu Kush collections at IPK). In a discussion round the table, country delegates expressed their position regarding designation of accessions for AEGIS:

Armenia	Gayane Melyan said that Armenia could offer some original accessions.
Belarus	Alexandre Zoubkovitch said that he did not represent the Belarus genebank and would need to check. Besides cultivars, there were also genetic stock collections. The Belarusian Genebank included 262 cultivars, of which 56 were of Belarus origin.
Cyprus	Dionysia Fasoula said that Cyprus held 30 accessions of barley landraces and <i>H. spontaneum</i> . These were already included in the Multilateral System. They could be included into AEGIS in the future, but no commitment could be made at the moment.
Czech Republic	Marta Balounová said that she did not represent the Czech genebank and would need to check.
Denmark	Ahmed Jahoor said that Denmark relied on the Nordic System for conservation. Some interesting <i>H. spontaneum</i> material would be handed over to NordGen for inclusion in AEGIS.
Estonia	Külli Annamaa said that Estonia could offer Estonian accessions, but it would not be useful if they were already present at IPK. Discussion: Such duplicates could later be removed through bilateral agreement between the genebanks concerned.
Finland	Finland: Marja Jalli said that Finland relied on the Nordic System for conservation. Only few Finnish landraces had not yet been included in the NordGen bank. A large number of Finnish landraces are held at VIR.
France	Audrey Didier said that France had some unique material in that could be offered for AEGIS, but the appropriate authority to take this decision had not yet been designated.
Georgia	Tamar Jinjikhadze said that a number of unique, recently collected Georgian accessions could be offered. Internal discussion regarding other accessions would be necessary. The historical collections in Georgia (VIR, IPK) had been encouraged to offer their Georgian material for AEGIS.

Germany	Helmut Knüpffer - see previous page, remark about IPK's collection.
Hungary	Lajos Horváth said that the Hungarian genebank held around 4000 barley accessions, of which around 300 were Hungarian.
Ireland	George Garland said that he did not think there would be any problem in offering unique Irish accessions.
Italy	Michele Stanca said that he could speak only on behalf of the Genomics Research Centre in Fiorenzuola, where more than 1000 cultivars, a collection of <i>H. spontaneum</i> and a diverse population of <i>H. bulbosum</i> were maintained in short-term conservation conditions (multiplication every five years). He had no information about the situation of the national genebank in Bari. He remarked that <i>H. bulbosum</i> was one of the best candidates for developing barley as a perennial crop.
Latvia	Isaak Rashal said that the genebank held a number of Latvian accessions that could be offered. Latvia will become a member of AEGIS.
Lithuania	Algè Leistrumaitė said that the genebank held a number of Lithuanian accessions that could be offered.
Macedonia (FYR)	Borche Jonovski said that he had no information about the collection.
Norway	Lars Reitan said that Norway relied on the Nordic System for conservation. A few Norwegian cultivars were not yet included in NordGen but would be handed over after regeneration.
Romania	Domnica Placinta said that a number of Romanian accessions were held in the genebank (about 20% of the collection). She would discuss with the Head of the genebank about AEGIS designation.
Russian Federation	Olga Kovaleva said that the VIR collection included unique barley accessions of Russian and other origins (e.g. historical collections in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan); recently collected samples from Kazakhstan and Tajikistan could be offered.
Slovakia	Michaela Benková would provide Slovakian accessions, but the decision would have to be taken by the National Coordinator of Slovakia.
Spain	José Luis Molina Cano said that the Spanish landraces collection included 2500 accessions. There was also a completely evaluated core collection (the "Spanish Core Collection"), and the data were available online. He could not state the position of the National genebank on contribution to AEGIS and would welcome a request from the Group.
Sweden	Agnese Kolodinska Brantestam said that Sweden had not yet joined AEGIS, but this was expected to happen soon. NordGen would offer primarily material of Nordic origin, or of importance for Nordic barley breeding and research.
United Kingdom	Joanne Russell said that it would not be a problem to offer Scottish and other UK accessions (via John Innes).

Helmut Knüpffer suggested to start compiling the offers from different places without regarding their duplicate status and then eventually decide to remove duplicates from the collection following bilateral agreements. This activity would not be urgent. He informed the Group that a small one-year AEGIS project had been approved recently, which would allow the Centre for Genetic Resources, The Netherlands (CGN) to develop a software tool for identifying duplicates in passport data, and that this tool may be explored for removing duplicates from the AEGIS barley collection later.

Agnese Kolodinska Brantestam enquired whether genetic stocks should be included into the European Collection and also informed that duplicates in this case were often outside Europe. H. Knüpffer thought that these could be included, depending on the WG decision, but it would be better to wait for the results of the specific task force on genetic stocks before including them.

Recommendation and workplan

1. *The Group agreed to recommend the establishment of the European Barley Collection as part of AEGIS, starting with a substantial part of the barley collection of IPK, with the addition of accessions that are held in their respective countries of origin and of other evidently unique accessions.*
2. *By the end of August 2011, the WG members will prepare lists of accessions suggested for inclusion in AEGIS and send them to the Database Manager, H. Knüpffer. These lists should include accessions that originated in their respective countries and other evidently unique and important accessions. At the discretion of the WG member, the lists could be prepared already at this stage in consultation with the respective National Coordinators, in order to ensure that there is agreement at the national level to designate these accessions as part of AEGIS.*
3. *By the end of November 2011, H. Knüpffer will compile the lists received from the WG members into a European list and validate it, checking for obvious inconsistencies or mistakes. A thorough analysis to identify duplicates is not expected.*
4. *By 15 December 2011, the Chair of the WG, in consultation with the ECPGR Secretariat, will prepare a message informing the respective National Coordinators of the lists of accessions recommended by the WG for inclusion into AEGIS (for countries where the list of AEGIS accessions was not agreed in advance, cf. step 2. The designated accessions should also be flagged in EURISCO).*

2. Species-specific maintenance protocols for wild Hordeum species (as part of AQUAS)

(Chair and Rapporteur: Agnese Kolodinska Brantestam)

The topic was introduced by Helmut Knüpffer. The AEGIS Quality System (AQUAS) prescribes regeneration protocols to ensure that AEGIS accessions are maintained properly in their respective genebanks. It is a prerequisite for establishing AEGIS that AEGIS partners can trust each other in that all are following agreed-upon standards in their genebank operations. The other element of AQUAS is an operational genebank manual that all participating genebanks (Associated Members of AEGIS member countries) will have to develop based on the template mentioned earlier.²²

²² http://aegis.cgiar.org/fileadmin/www.aegis.org/Documents/AQUAS/Template_final240910.pdf

The “Draft FAO Genebank standards” should be used as a starting point for developing species-specific regeneration protocols.²³ These standards provide general guidelines for genebank operations. The species-specific regeneration protocols should, therefore, include only the specific requirements for a particular species.

In his email of 1 February 2011, Jan Engels, AEGIS Coordinator, informed the WG Chairs that the ECPGR Steering Committee was expecting progress and results from the Crop WGs in defining and agreeing upon these protocols and finalizing them so that they could be adopted as part of AQUAS.

The *Avena* WG had discussed this issue during its sixth meeting in Bucharest, Romania (October 2010), and formed a task force made up of curators of collections having wild species (information from Andreas Katsiotis, Chair of the *Avena* WG).

H. Knüpffer then explained the regeneration protocols for *Hordeum* species as applied in the German Genebank (IPK Gatersleben); they are included in the Quality Management System for ISO 9000 certification. A handout with the information was distributed to the participants. IPK also completed its “Operational Genebank Manual”, which is posted on the AEGIS Web site.²⁴

Crop-specific information related to maintenance in genebanks is also available for *Hordeum* species in the Crop Genebank Knowledge Base.²⁵ It includes current practices for management of barley genebanks (conservation, characterization, regeneration and safety-duplication) drawn from various genebanks, the accumulated experience of the ICARDA and CIMMYT genebanks, and literature and Web sites of major small-grain collection genebanks (e.g. USDA-Fort Collins and VIR).

The establishment of a task force was proposed; its members would include those of the Barley WG who deal with the maintenance of wild species. Its aim would be to:

- collect information about the regeneration procedures from curators of genebanks and research collections having wild species;
- compare the different approaches, compile an overview of species-specific regeneration methods, and recommend “minimum” and “optimum” standards for regeneration.

The protocols for regenerating cultivated barley (*Hordeum vulgare* sensu stricto) should also be taken into consideration.

In the discussion, Agnese Kolodinska Brantestam informed that multiplication of wild *Hordeum* material taken over from the Swedish Agricultural University (Roland von Bothmer) had started recently. She recommended that specific tests with wild species, especially with small-grained wild species, should be developed. For this purpose, it would be useful to know also the specific requirements in other steps of plant genetic resources (PGR) maintenance, such as procedures for viability testing. In the discussion that followed, it was suggested that the protocols should cover all aspects of PGR maintenance that are species-specific. The Group agreed that the protocols be named “species-specific maintenance protocols” instead of “regeneration protocols”. Information from the Knowledge Base and other relevant sources should also be considered.

²³ <http://www.fao.org/agriculture/crops/core-themes/theme/seeds-pgr/itwg/5th/en/> (document “CGRFA/WG-PGR-5/11/Inf.3”, especially p. 17 ff. “Standards for regeneration”)

²⁴ <http://aegis.cgiar.org/index.php?id=4493>

²⁵ http://crogenebanksgrp.cgiar.org/index.php?option=com_content&view=article&id=145&Itemid=250&lang=english

Workplan

The task group has the following members: Agnese Kolodinska Brantestam (coordinator), Dionysia Fasoula, Helmut Knüppfer, Olga Kovaleva and Gayane Melyan.

The agreed-upon protocols for wild (and cultivated) barley species should be available by end May 2012, but the initial collection of information via email should start before mid-June 2011.

3. In situ and on-farm activities in barley

(Chair and Rapporteur: Dionysia Fasoula)

Dionysia Fasoula explained that very few farmers still use barley landraces. Not all landraces compare well with modern elite cultivars, but the few that have desirable traits are still sought after by farmers. They demand permission from the government to use them, which shows that improvement or development of new cultivars from landraces meets a need. In Cyprus, barley landraces no longer in cultivation are evaluated using modern methods, as part of a programme which also involves participatory breeding.

George Garland remarked that on-farm projects are important, because they concern production of the object of the Group's work, which would otherwise remain theoretical. In Ireland, trials are sown and harvested, and data are collected all by government staff, but the farmers follow their own husbandry protocols. Two years of evaluation are required for National Listing and a minimum of three years for Recommended Listing. The result is a "National List of Recommended Varieties"²⁶, which is compiled with the help of farmers, who therefore trust it. This is seen from the high uptake by farmers of cultivars that are on the Recommended List.

Olga Kovaleva said that tests are undertaken each year at four barley stations around Russia. After three years of tests, the best material is sent to breeding stations in various parts of Russia. Farmers can then buy seed at breeders' stations.

The new EU directive on "conservation varieties" was adopted in some countries, including Cyprus.

Recommendation

A short summary of the Group's work, aims and directions should be made available to breeders and National Coordinators. It should be distributed during on-farm trial visits and inspections by other farmers. The summary should include maps showing member countries to illustrate the European context and indicate Web addresses and similar information.

4. Pre-breeding and joint research proposals

(Chair: Michele Stanca, Rapporteur: Marja Jalli)

These topics were combined into one session.

To introduce the topic, Michele Stanca summarized the events occurring during the process of domestication of barley, which gradually accumulated traits that facilitated agricultural production. Through a combination of natural and human selection, genetically variable landraces were developed, leading to a broad adaptation. Barley is one of the crops best adapted to very different conditions; crop duration of its cultivars ranges from 70 days to as long as 220 days (these must be very strong to survive all kind of stress such as pests, cold, etc.). The genetic basis of new cultivars was narrowed by the use of closely related parents in cross-breeding. However, the concept of "cross the best to get the best" is scientifically supported by the dynamism of the genome, due to the presence of transposons and *de novo*

²⁶ The term "variety" in the meaning of "cultivar" should be avoided, except in the case where it forms part of an official designation, as in the present case. HK.

recombination. In other cases, the genetic basis of crops was widened through the introgression of increasing diversity from “exotic” sources and even wild materials. Mutation is one of the key factors for creating diversity. Genetic diversity originates from the differentiation of DNA sequences. Changes of DNA sequences may lead to diversity only at the molecular level and not always result in visible phenotypic differences. Collections of developmental mutants of barley are available in several laboratories. The introgression of useful agronomic mutations into elite germplasm is important for designing the “Barley for the Future”. An important question is how and when the good alleles that are dispersed in the population can be used. The strategy for the near future is to understand the genotype versus the corresponding phenotype, and vice versa. Ongoing projects funded by the EC are rapidly advancing the knowledge of the barley genome: “Genomics-Assisted Analysis and Exploitation of Barley Diversity” (EXBARDIV), coordinated by Andrew Flavell, University of Dundee, UK, concluded in October 2010; “Genomics-assisted Dissection of Barley Morphology and Development” (BARCODE), coordinated by Robbie Waugh, Scottish Crop Research Institute, UK, concluded in November 2010; work of the International Barley Genome Sequencing Consortium (IBSC) is progressing.

New technologies that dissect the genome of single genotypes are now available at low cost for genotyping, but molecular investigations without a platform for phenotyping are akin to an intellectual exercise. Curators of genebanks and their expertise play an important role in the discovery of useful alleles and the development of new pre-breeding and breeding strategies. For example, the “Multi-parent Advanced Generation Inter-Cross” (MAGIC) strategy aims to obtain recombinant inbred lines that accumulate all the useful genes for improved quality, sustainability and productivity. This is achieved by combining genetic, genomic and eco-physiological analyses with high-throughput phenotyping and genotyping to identify markers and candidate genes for yield and quality traits under new biotic and abiotic stresses resulting from climate change.

The “Barley for the Future” will consist of new cultivars with high yield potential and yield stability. Genetic resources should be used efficiently, including wild relatives and local landraces that likely contain novel and unique alleles. Also useful are modern cultivars bred outside Europe in more severe or more fertile environmental conditions; these are differentiated from the European gene pool and contain complementary alleles. Collaborative project proposals should ideally encompass Europe and the Mediterranean Basin.

The project should incorporate the use of genetic resources (new alleles); production of genome-based resources to support molecular breeding; crop physiology and advanced agronomy; quality traits for phenotyping; bioinformatics tools; integration of the actors of the barley production chain; and dissemination of the new materials and technologies. The final aim should be to collaborate (not compete) with other international projects and strengthen European leadership in barley research, breeding and production in order to deliver safe, high-quality and functional food and feed, and raw materials for energy in a sustainable production model.

Michele Stanca informed the participants about a new book on barley, edited by S. Ullrich²⁷, and the online posting of the proceedings of the 10th IBGS in Alexandria (2008).²⁸ He strongly recommended proposing and organizing a PGR workshop at the next IBGS.

²⁷ Ullrich SE. 2011. Barley: Production, Improvement, and Uses. Blackwell Publishing Ltd.

²⁸ Ceccarelli S, Grando S, editors. 2010. Proceedings of the 10th International Barley Genetics Symposium, 5-10 April 2008, Alexandria, Egypt. ICARDA, Aleppo, Syria. (**Error! Hyperlink reference not valid.**)

Pre-breeding workshop and activities; ring tests

Marja Jalli reported that at the sixth meeting of the Barley Working Group in Turkey in 2008, a project plan on pre-breeding for climatic change was approved. Pre-breeding was defined as "All activities designed to identify desirable characteristics/genes from unadapted PGR and to transfer them to an intermediate product that breeders can manipulate". The objective of the project was to convene a meeting for establishing pre-breeding cooperation between breeders, genebanks and researchers in the framework of the ECPGR Cereals Network, with focus on barley, but also covering the other major mandate crops of the Network (oats and wheat).

A questionnaire was sent in 2008 to all Barley WG members concerning their activities and interests in the pre-breeding field. Eleven countries responded showing their interest: Azerbaijan, Czech Republic, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Spain, Russian Federation and UK. NordGen also expressed its interest. Some partners also showed their interest in crops other than barley. The ongoing work on pre-breeding among partners covers a wide field: drought resistance; resistance to *Ramularia collo-cygni*, *Rhynchosporium secalis*, *Ustilago* spp., *Pyrenophora graminea*, *Pyrenophora teres*, *Puccinia hordei* and *Blumeria graminis*; amino-acid composition; β-glucan content; quality parameters; short day; transpiration index; genetic diversity; hulless; mineral use efficiency; phytate content; starch characters and threshing ability.

The pre-breeding workshop on cereals was held in Alnarp, Sweden, on 24 and 25 November 2009. It was organized by the ECPGR, NordGen, the Swedish Agricultural University (SLU), Graminor, MTT Agrifood Research Finland and Oatly. Altogether 49 participants from 12 countries attended the first meeting on the increasingly important subject of pre-breeding.

The programme included 20 presentations, covering four themes: (1) Pre-breeding in cereals: status and examples of existing collaborations, (2) Breeding goals and needs, (3) Challenges of funding and (4) Future needs and application.

The programme, presentations and the conclusions for further activities are available from <http://www.nordgen.org/index.php/en/Innehaall/Activities/Cereal-Pre-Breeding-Workshop>.

The first steps in cooperation on pre-breeding were defined: (1) Develop a joint disease resistance database where data can be deposited and searched on PGR reactions to different diseases and related molecular markers, (2) Develop and describe phenotype tests relevant to abiotic stress resistance, (3) Lobby and market for pre-breeding at EU and national levels, and support the establishment of public-private collaboration.

For marketing pre-breeding at national and international levels, a concept note was prepared on "Pre-breeding for small grain cereals – How to meet future challenges of food supply under a changing climate" (<http://www.ecpgr.cgiar.org/networks/cereals.html>).

The Alnarp pre-breeding meeting strengthened national and international cooperation. In particular, this workshop supported the Nordic initiative for Nordic Public-Private Partnership on Pre-breeding (PPP). A pilot project on PPP in barley has been approved by the Nordic Council of Ministers.

Plans and recommendations for 2011–2013

To place the pre-breeding discussion in context, Dionysia Fasoula briefed the Barley WG members on experiences in breeding for climate change and on the importance of networking for focused breeding activities. Michele Stanca gave a presentation on "Perspectives for genetic resources work in the framework of EU programme," motivating the Group towards active cooperation.

The Group discussed and agreed on the following items related to barley pre-breeding and breeding cooperation among the WG partners:

- It was decided that *a joint disease resistance database* among participants would first be tested on a smaller scale. It would include, for example, data on PGR reactions to different biotic and abiotic stresses and information on availability of molecular markers and on differential sets and nurseries for the various diseases of importance. The database would combine the Focused Identification of Germplasm Strategy (FIGS) concept²⁹ and evaluation data to develop precise models. Marja Jalli will contact Rikke Bagger, the Nordforsk's Climate Change project leader, and suggest integrating the database into the Nordic project, which involves genebanks, private breeders and research institutes and could serve as a good pilot initiative.
- It was decided to start *the development of phenotype tests relevant to abiotic stress resistance* by collecting information on test methods and distributing it to the WG partners. M. Stanca accepted the responsibility of managing this task together with his colleagues.
- *Evaluation of germplasm* is an essential part of pre-breeding and breeding. Ring tests are one way of cooperation. However, the work is meaningless if the methodology and results are not collected and summarized. The Barley GENRES project also provided information on common and agreed methods for conducting biotic stress tests,³⁰ which could be a useful starting point. A questionnaire on the evaluation of germplasm for different traits will be sent to the WG members. The aim is to collect information on the willingness and capacity of institutes to (1) phenotype/genotype genebank material for the missing data and (2) participate in ring tests of different traits. The outcome and conclusions of the evaluation will be prepared and distributed to partners **before August 2011**. M. Jalli took the responsibility for this task.
- *Lobbying and marketing for pre-breeding at EU and national levels and supporting the establishment of public-private partnerships* were deemed important tasks that should be carried out by all. Planning and lobbying should start **in summer 2011** to reach the next possible call.

The project plan for funding was widely discussed. It was underlined that the project should focus on and lead to concrete results and should not overlap with other barley projects. As expressed above by M. Stanca, it is important to collaborate (not compete) with other international projects and to strengthen European leadership in barley research, breeding and production in order to deliver safe, high-quality and functional food and feed, and raw materials for energy in a sustainable production model.

The keyword candidates suggested for the project were: climate change, use of genetic resources, new alleles, genome-based resources, molecular breeding, quality traits, traceability and safety, biotic/abiotic stresses, phenotyping, crop physiology, advanced agronomy, bioinformatics. The Work Package (WP) on "Genotyping/Phenotyping" appeared less interesting for barley, since this was done extensively in the EXBARDIV project.

It was decided that the project plan for funding would have two parts. The first one would cover the possibility of being involved in the EC proposal on Plant Genetic Resources Centres (in preparation, under the coordination of the ECPGR Secretariat). Barley will be offered as a model crop in the WPs on "Genetic stocks" and "Landraces identification". Agnese Kolodinska Brantestam will contact the designated leader of

²⁹ <http://www.figstraitmine.com/index.php?dpage=14>

³⁰ http://barley.ipk-gatersleben.de/EU_methods.htm

the Genetic Stocks WP (Morten Rasmussen), and Dionysia Fasoula the leader of the Landrace WP (Valeria Negri). The second part would cover the preparation of a barley project for EU calls or others (e.g. World Bank, European Bank). Alongside careful project planning, lobbying has an important role to play. A suitable project leader should be identified **before July 2011**.³¹

- A decision to carry *an expertise survey among WG members* was taken. A questionnaire will be sent to partners, requesting information on projects related to WG matters and on contact persons, funding bodies and possible Web page links. M. Jalli will distribute the questionnaire and forward the collected information to be posted on the WG's Web page.
- *Dissemination of information* among partners is an important part of cooperation. Partners are encouraged to use email and Web pages on issues relevant to the Group. Other meetings (Fourth International Workshop on Barley Leaf Blights, Dundee, June 2011; 11th IBGS in China in 2012) will also be opportunities for ECPGR members to meet and discuss. The next International Triticeae Conference planned for 2013 in China was also mentioned.

Session 7. Other matters and remaining issues

Chair: Helmut Knüpffer

Ahmed Jahoor enquired whether cultivars removed from the "Official list of varieties" were automatically transferred to genebanks. Helmut Knüpffer responded that the matter has to be settled individually in each country. In the case of Germany, an agreement between the Federal Plant Variety Office (Bundessortenamt) and the IPK Genebank had been reached to transfer remaining seeds together with documentation to the genebank.

Michele Stanca suggested organizing a workshop on plant genetic resources during the next IBGS to be held in Hangzhou, China, 15-20 April 2012³²; the request should be sent to the local organizing committee. The workshop would add value to the session on PGR, since topics specific to barley genetic resources could be better discussed in a workshop than after presentations in the plenary session. R. von Bothmer should be involved in the organization of the workshop. H. Knüpffer reminded that the IBGS included a Committee on Barley Genetic Resources but it had apparently been discontinued and should be revived. The Barley WG should approach the organizers of the Symposium to carry out such a workshop and to discuss the question of re-establishing the Committee on Barley Genetic Resources.

³¹ Although the Group agreed that the development of a project proposal would be desirable, no coordinator or coordinating group could be designated during 2011. This will be followed-up in 2012.

³² <http://www.ibgs.zju.edu.cn/>

Session 8. Final session

Chair: Helmut Knüpffer

The draft report was presented to the Group and approved after few amendments.

Election of Chair and Vice-Chair

The Group unanimously re-elected Helmut Knüpffer as Chair and Maria Jalli as Vice-Chair of the Working Group on Barley.

Concluding remarks

Michele Stanca wished to send Roland von Bothmer the Group's regards after his retirement. The Group remembered with appreciation the time when he served as Chair of the Barley Working Group (1997-2000); he is still considered honorary member of the Group and his participation will always be welcome.

Helmut Knüpffer thanked Dionysia Fasoula for the excellent organization of the meeting and other colleagues from the host country who attended the meeting as observers. He complimented her on the choice of the meeting place; Cyprus with its hospitable and friendly people, its excellent food and culture, deserved to be visited again. D. Fasoula thanked the Group for choosing Cyprus for the meeting, and the ECPGR Secretariat and the Chair of the WG for their supportive collaboration in the preparation of the meeting. H. Knüpffer closed the meeting.

Excursion

A half-day bus excursion followed. The Group visited a traditional house-restaurant-chateau in Kornos village (45 min from Nicosia to the South), where they watched the making of traditional pottery and were guided through the wine cellar and an exhibition of traditional handicraft and lifestyle. A lunch with typical dishes and local wines was served in a traditional setting. On the way to Paphos (southwestern part of Cyprus), the Group stopped at the legendary birthplace of Aphrodite. Near the city of Paphos, it visited a botanical garden with endemic plants of Cyprus and an exhibition showing traditional agriculture and processing of agricultural products. The visit was followed by a dinner accompanied by a performance of local dancers and traditional village musicians playing *lauto* (the traditional lute) and violin.

APPENDICES

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Appendix I. Workplan

(Agreed at the seventh meeting of the Barley Working Group, May 2011)

Action	Carried out by	By when
Survey on barley genetic stock collections		
Assist in carrying out a full survey and drafting a global conservation (and utilization) strategy paper for barley genetic stocks	Task Force members: Agnese Kolodinska Brantestam (coordinator) Ahmed Jahoor Joanne Russell Michele Stanca Algè Leistrumaité Olga Kovaleva Dionysia Fasoula Alexandre Zoubkovitch Helmut Knüpffer	
Secure funding for the survey, also investigate the possibility of using funds of the Cereals Network already allocated to wheat precise stocks, by extending them to barley	Task Force	Before starting the activity
Develop a questionnaire to be sent out to the target group (a Web-based survey and a Word document will be available for distribution)	Task Force	
Use database search as a complementary method	Task Force	
Assist in the identification of target groups that should receive the questionnaire (persons, groups, institutes, companies that may have useful information and/or material)	Members of the Barley WG	
AEGIS – approaches and aims for the European Barley Collection, criteria for MAAs, steps towards the European collection, quality standards		
Establish the European Barley Collection as part of AEGIS, starting from a substantial part of the IPK barley collection, with the addition of accessions that are held in their respective countries of origin and of other evidently unique accessions.	All WG members	
Compile lists of accessions suggested for inclusion in AEGIS and send them to the Database Manager, Helmut Knüpffer. These lists should include accessions that originated in the respective countries and other evidently unique and important accessions. At the discretion of the WG member, compilation could start already at this stage in consultation with the respective National Coordinator, so that there is agreement at the national level on designation of these accessions as part of AEGIS.	WG members and National Coordinators	By the end of August 2011

Action	Carried out by	By when
Compile the lists received from the WG members into a European list and validate this list, checking for evident inconsistencies or mistakes. A thorough analysis to identify duplicates is not expected	Helmut Knüpffer	By the end of November 2011
Inform the National Coordinators about the lists of accessions that the WG recommends for inclusion in AEGIS. The designated accessions should be flagged in EURISCO.	Chair of the WG, in consultation with the ECPGR Secretariat	By 15 December 2011
Update EBDB	Helmut Knüpffer	31 December 2011
Species-specific maintenance protocols for wild <i>Hordeum</i> species (as part of the AEGIS quality system)		
Start initial collection of information via email	Task group members: - Agnese Kolodinska Brantestam (coordinator) - Dionysia Fasoula - Helmut Knüpffer - Olga Kovaleva - Gayane Melyan	Before mid-June 2011
Make available (via ECPGR Web site) agreed-upon protocols for wild barley species and <i>H. vulgare</i>	Task group	By end May 2012
Pre-breeding and joint research proposals		
Test a joint disease resistance database among participants (including, for example, data on PGR reactions to different biotic and abiotic stresses, information on availability of molecular markers and on differential sets and nurseries for various important diseases; combining the FIGS concept and evaluation data to develop precise models) Suggest to the Nordforsk's Climate Change project leader (Rikke Bagger) integration of the database matter into the Nordic project, which includes genebanks, private breeders and research institutes and could serve as a good pilot initiative.	Marja Jalli	
Start the development of phenotype tests relevant to abiotic stress resistance by collecting information available on test methods and then distributing it to the WG partners.	Michele Stanca, together with his colleagues	
Send a questionnaire on the evaluation of germplasm for different traits to the WG members. The aim is to collect information on the willingness and possibilities of institutes to 1) phenotype/genotype genebank material for the missing data and 2) participate in ring tests of different traits. Report the outcome and conclusions of the evaluation to partners	Marja Jalli	Before August 2011
Lobby and market for pre-breeding at EU and national levels, and support establishment of public-private partnerships.	All WG members	Start in summer 2011 to reach the next possible call

Action	Carried out by	By when
<p>Project plan for funding - Part I: check the possibility of being integrated in the EC proposal on Plant Genetic Resources Centres (in preparation under the coordination of the ECPGR Secretariat). Barley will be offered as a model crop in the Work Packages on "Genetic stocks" and "Landraces identification".</p> <ul style="list-style-type: none"> - Contact the designated leader of the Genetics Stocks WP (Morten Rasmussen) - Contact the leader of the Landrace WP (Valeria Negri) 	A. Kolodinska Brantestam Dionysia Fasoula	
<p>Project plan for funding - Part II: plan a barley project for EU calls or others (e.g. World Bank, European Bank). Alongside careful project planning, lobbying has an important role</p> <p>Identify suitable project leader</p>		2012
<p>Conduct an expertise survey among WG members</p> <ul style="list-style-type: none"> - Send questionnaire to partners, requesting information on projects related to WG matters and on contact persons, funding bodies and possible Web page links; forward the collected information for posting on the WG's Web page - Upload information forwarded by Marja Jalli 	Marja Jalli ECPGR Secretariat	
<p>Dissemination of information among partners</p> <ul style="list-style-type: none"> - e.g. propose and organize workshop on Barley Genetic Resources during 11th IBGS - re-establish Commission on Barley Genetic Resources within IBGS 	All WG members	Ongoing: use of email, Web pages, and specific opportunities such as meetings (Dundee June 2011, 11th IBGS China 2012, International Triticeae Conference 2013, etc.)

Appendix II. *Hordeum* wild species distribution in the European and Mediterranean Region

(See also Session 4, p. 11 of this report)

Table 1. Taxonomic correspondence between scientific names provided by the sources consulted (right column), and the names accepted by Bothmer et al. (1995) (left column), used in Table 2 (for references of sources, see p. 35).

Taxon (Bothmer et al. 1995)	Names as indicated in the sources
<i>H. bogdanii</i> Wilensky	
<i>H. brevisubulatum</i> (Trin.) Link subsp. <i>brevisubulatum</i>	
<i>H. brevisubulatum</i> subsp. <i>iranicum</i> Bothmer	
<i>H. brevisubulatum</i> subsp. <i>nevskianum</i> (Bowden) Tzvelev	
<i>H. brevisubulatum</i> subsp. <i>turkestanicum</i> (Nevski) Tzvelev	
<i>H. brevisubulatum</i> subsp. <i>violaceum</i> (Boiss. & Hohen.) Tzvelev	
<i>H. bulbosum</i> L.	
<i>H. jubatum</i> L.	<i>H. caespitosum</i> Scribn. (Euro+Med)
<i>H. marinum</i> Huds.	
<i>H. marinum</i> subsp. <i>gussoneanum</i> (Parl.) Thell.	<i>H. geniculatum</i> All. (Lukyanova et al. 1990)
<i>H. murinum</i> L. subsp. <i>murinum</i>	
<i>H. murinum</i> subsp. <i>glaucum</i> (Steud.) Tzvelev	
<i>H. murinum</i> subsp. <i>leporinum</i> (Link) Arcang.	<i>H. hrasdanicum</i> Gandilyan (Euro+Med); <i>H. murinum</i> subsp. <i>hrasdanicum</i> (Gandilyan) A. Trof. (Lukyanova et al. 1990)
<i>H. murinum</i> subsp. <i>montanum</i> (Hack.) H. Scholz & Raus	
<i>H. murinum</i> subsp. <i>setariurum</i> H. Scholz & Raus	
<i>H. pusillum</i> Nutt.	
<i>H. secalinum</i> Schreb.	
<i>H. stenostachys</i> Godr.	<i>H. compressum</i> Griseb. (Euro+Med)
<i>H. vulgare</i> subsp. <i>agriocritthon</i> (Åberg) Å. Löve & D. Löve	<i>H. spontaneum</i> subsp. <i>agriocritthon</i> (Åberg) A. Trof. (Lukyanova et al. 1990)
<i>H. vulgare</i> subsp. <i>spontaneum</i> (K. Koch) Thell.	
<i>H. vulgare</i> L. subsp. <i>vulgare</i> [cultivated barley – not included in Table 2]	<i>H. vulgare</i> subsp. <i>aegiceras</i> (Nees ex Royle) Å. Löve; <i>H. vulgare</i> subsp. <i>distichon</i> (L.) Körn. (Euro+Med)

Table 2. Distribution of *Hordeum* wild species in Europe and the Mediterranean Region

Names according to Bothmer et al. (1995). The column “Additional references” contains only those references that provide information in addition to Euro+Med Plant Base (references listed p. 35). Information followed by a question mark [?] seems doubtful but could not be verified by the Group.

Taxon	Native / Naturalized	Adventive / Introduced	Additional references
<i>H. bogdanii</i>	European Russia (S)	European Russia (C), Ukraine	
<i>H. brevisubulatum</i> subsp. <i>brevisubulatum</i>	Azerbaijan <u>Naturalized:</u> European Russia (C, E)	Baltic States	Lukyanova et al. 1990
<i>H. brevisubulatum</i> subsp. <i>iranicum</i>	Armenia		
<i>H. brevisubulatum</i> subsp. <i>nevskianum</i>	European Russia (C, E)	European Russia (N)	
<i>H. brevisubulatum</i> subsp. <i>turkestanicum</i>		Latvia, Asiatic Turkey	Lukyanova et al. 1990: “Baltic States”
<i>H. brevisubulatum</i> subsp. <i>violaceum</i>	Armenia, Azerbaijan, Georgia, European Russia (N Caucasus), Asiatic Turkey	European Russia (N)	
<i>H. bulbosum</i>	Albania, Armenia, Azerbaijan, Bulgaria, Croatia, Cyprus, France (Corsica), Georgia, Greece (Crete, Aegean Islands), Italy (incl. Sardinia, Sicily), Portugal, Romania, European Russia (N Caucasus), Serbia, Spain, Ukraine (Crimea); Israel, Jordan, Syria, Turkey; Algeria, Libya, Morocco, Tunisia		GRIN-Tax
<i>H. jubatum</i>	European Russia (N Caucasus) <u>Naturalized:</u> Austria, Belarus, Belgium, Czech Republic, Denmark, Finland, Germany, Hungary, Moldova, Netherlands, Poland, European Russia, Slovakia, Norway, Sweden, Switzerland	Belarus, Belgium, Czech Republic, Denmark, Finland, Germany, Great Britain, Hungary, Moldova, Netherlands, Norway, Poland, Romania, European Russia (C, E, S), Slovakia, Sweden, Switzerland, Ukraine <u>Cultivated [?]:</u> Baltic States, European Russia (N)	GRIN-Tax
<i>H. marinum</i>	Austria, Albania, Armenia, Azerbaijan, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, France (incl. Corsica), Georgia, Germany, Great Britain, Greece (incl. Crete), Hungary, Italy (incl. Sardinia, Sicily), Moldova, Netherlands, Slovakia, Slovenia, Portugal (incl. Azores, Madeira), Romania, European Russia (S, N Caucasus), Serbia, Spain (incl. Baleares, Canary Islands), Switzerland, Ukraine (incl. Crimea); Israel, Jordan, Lebanon, Syria, Turkey; Algeria, Egypt, Libya, Morocco, Tunisia <u>Naturalized:</u> Czech Republic, Hungary, Slovakia Norway	Hungary, Norway, Slovakia	GRIN-Tax

Taxon	Native / Naturalized	Adventive / Introduced	Additional references
<i>H. marinum</i> subsp. <i>gussoneanum</i>	Albania, Armenia, Austria, Azerbaijan, Bulgaria, Belarus, Croatia, Cyprus, Czech Republic, France (incl. Corsica), Georgia, Greece (incl. Crete), Hungary, Italy (incl. Sardinia, Sicily), Macedonia FYR, Moldova, Montenegro, Portugal, Romania, European Russia (C, S; N Caucasus), Serbia, Slovakia, Slovenia, Spain (incl. Baleares), Ukraine (incl. Crimea), former Yugoslavia; Israel, Jordan, Lebanon, Syria, Turkey; Algeria, Egypt (incl. Sinai), Libya, Morocco, Tunisia	Denmark, Estonia, Germany, Great Britain, Portugal (Azores)	GRIN-Tax
<i>H. murinum</i> subsp. <i>murinum</i>	Albania, Austria, Belgium, Bulgaria, Bosnia-Herzegovina, Belarus, Croatia, Cyprus, Czech Republic, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy, Moldova, Netherlands, Poland, Romania, European Russia (C, NW), Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine (incl. Crimea), former Yugoslavia <u>Naturalized:</u> Denmark, Finland, Ireland, Norway	Denmark, Finland, Ireland, Norway, European Russia (N Caucasus)	GRIN-Tax
<i>H. murinum</i> subsp. <i>glaucum</i>	Armenia, Azerbaijan, Cyprus, France (Corsica), Georgia, Greece (Crete), Portugal, European Russia (C; E; N Caucasus), Spain (incl. Canary Islands), Ukraine (incl. Crimea); Israel, Jordan, Lebanon, Syria, Turkey; Algeria, Egypt (incl. Sinai), Libya, Morocco, Tunisia <u>Naturalized:</u> Great Britain	Great Britain, European Russia (N)	GRIN-Tax, Lukyanova et al. 1990
<i>H. murinum</i> subsp. <i>leporinum</i>	Albania, Armenia, Azerbaijan, Bulgaria, Belarus, Croatia, Cyprus, France (incl. Corsica), Georgia, Greece (incl. Crete), Hungary, Italy (incl. Sardinia, Sicily), Moldova, Portugal (incl. Azores, Madeira, Selvagens), Romania, European Russia (C, E, S; N Caucasus), Serbia, Slovenia, Slovakia, Spain (incl. Baleares, Canary Islands), Switzerland, Ukraine (incl. Crimea), former Yugoslavia; Israel, Jordan, Lebanon, Syria, Turkey; Algeria, Egypt (incl. Sinai), Libya, Morocco, Tunisia	Austria, Germany, Great Britain, European Russia (E), Slovakia, Switzerland	GRIN-Tax
<i>H. murinum</i> subsp. <i>montanum</i>	Spain		
<i>H. murinum</i> subsp. <i>setariurum</i>	Greece		
<i>H. pusillum</i>		European Russia (E)	

Taxon	Native / Naturalized	Adventive / Introduced	Additional references
<i>H. secalinum</i>	Austria, Azerbaijan, Belgium, Bulgaria, Denmark, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy (incl. Sicily), Macedonia FYR, Netherlands, Poland, Portugal (incl. Madeira), Slovenia, Spain, Sweden, Switzerland, Ukraine (Crimea); Algeria, Tunisia <u>Naturalized:</u> Czech Republic, Luxemburg, Norway	Czech Republic, Luxemburg, Norway	GRIN-Tax
<i>H. stenostachys</i>		S France, Germany, Norway, Switzerland	Lukyanova et al. 1990
<i>H. vulgare</i> subsp. <i>agriocriton</i>	Armenia, Cyprus, Greece (Crete, Aegean Islands); Israel, Lebanon, Syria, Turkey; Libya, Morocco		
<i>H. vulgare</i> subsp. <i>spontaneum</i>	Armenia, Azerbaijan, Belarus [?], Cyprus, Greece (Crete, Aegean Islands); Israel, Jordan, Lebanon, Syria, Turkey; Egypt (incl. Sinai), Libya		

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Appendix III. List of acronyms and abbreviations

AEGIS	A European Genebank Integrated System
AQUAS	AEGIS Quality System
ARI	Agricultural Research Institute, Nicosia, Cyprus
ARS	Agricultural Research Service (<i>of the USDA</i>)
AWCC	Australian Winter Cereals Collection, Tamworth, Australia
BARCODE	Genomics-assisted dissection of barley morphology and development (<i>EU project</i>)
BCC	International Barley Core Collection
BGS	Barley Genetic Stocks
C&E	Characterization and evaluation
CCDB	Central Crop Database (<i>of ECPGR</i>)
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Center), Mexico (CGIAR)
CRA	Consiglio per la Ricerca e la sperimentazione in Agricoltura (Italian Agricultural Research Council), Italy
CRA-GPG	Centro di ricerca per la genomica e la postgenomica animale e vegetale - Centro interdipartimentale (Genomics Research Centre), Fiorenzuola d'Arda, Italy
CWANA	Central and West Asia and North Africa (<i>mandate region of ICARDA</i>)
CWR	Crop wild relative
DNA	Deoxyribonucleic acid
EBDB	European Barley Database
ECPGR	European Cooperative Programme for Plant Genetic Resources
EU	European Union
EUCARPIA	European Association for Research on Plant Breeding
EURISCO	European Internet Search Catalogue
EXBARDIV	Genomics-assisted analysis and exploitation of barley diversity (<i>EU project</i>)
ExCo	Executive Committee (<i>of the Steering Committee of ECPGR</i>)
FAO	Food and Agriculture Organization of the United Nations
GBIS/I	Genebank Information System (Internet portal) of IPK
GENRES	Genetic resources in agriculture – preserving the diversity (<i>EU programme</i>)
GRIN	Germplasm Resources Information Network (<i>USDA</i>)
IBGS	International Barley Genetics Symposium
IBSC	International Barley Genome Sequencing Consortium
ICARDA	International Center for Agricultural Research in the Dry Areas, Aleppo, Syria (CGIAR)
IPK	Leibniz Institute of Plant Genetics and Crop Plant Research, Gatersleben, Germany
IPR	Intellectual property right
KBBE	Knowledge-Based Bio-Economy (<i>EU programme</i>)
MAA	Most Appropriate Accession (<i>for AEGIS</i>)
MAGIC	Multi-parent Advanced Generation Inter-Cross
MTT	MTT Agrifood Research Finland

NIL	Near isogenic line
NordGen	Nordic Genetic Resource Center, Alnarp, Sweden
PGR	Plant genetic resources
PGRFA	Plant genetic resources for food and agriculture
PPP	Nordic Public-Private-Partnership on Pre-breeding
SLU	Swedish Agricultural University
USDA	United States Department of Agriculture
VIR	N.I. Vavilov Research Institute of Plant Industry, St. Petersburg, Russian Federation
WG	Working Group
WIEWS	World Information and Early Warning System (<i>of the FAO</i>)

Appendix IV. Agenda

Seventh meeting of the ECPGR Working Group on Barley 10-12 May 2011, Nicosia, Cyprus

Monday, 9 May

Arrival of participants

Tuesday, 10 May

- 8:30 **Session 1. Opening Session**
Chair: Marja Jalli
Opening of the meeting, welcome addresses, opening remarks
Local host: Dr Marinos Markou, Vice-Director of the Agricultural Research Institute
ECPGR Secretariat (Lorenzo Maggioni)
Introduction of participants (max. 1 minute each)
Overview of present meeting: aims and agenda, organizational issues of the meeting, parallel discussions and selection of topics (*Helmut Knüpffer*)
Discussion
Update on ECPGR – strategy and priorities of the current and next phase, and implications for the Barley Working Group (*Lorenzo Maggioni*)
- 10:00-10:30 *Coffee break*
- (Session 1 continued)**
Chair's report: activities and achievements of the Working Group on Barley since its sixth meeting (Salsomaggiore, Italy, 2000) and the second meeting of the Cereals Network (Foça, Turkey, 2008) (*Helmut Knüpffer*)
- Session 2. ECPGR Phase VIII Priority Area 1. Task sharing (AEGIS) and capacity building**
Chair: Helmut Knüpffer
Update on AEGIS – criteria and approaches for compiling the European Barley Collection (*Lorenzo Maggioni*)
Trust Multiplication project for cereals and legumes – present state with respect to barley (*Lorenzo Maggioni*)
Precise genetic stocks in barley – inventory of collections and databases (*Introduction: Morten Rasmussen*)
- 12:30-13:45 *Lunch*

(Session 2 continued)

The collection of developmental mutants of barley and their potential use in pre-breeding work (*Michele Stanca*)

Discussion on genetic stocks (*Chair: Morten Rasmussen, Rapporteur: Agnese Kolodinska Brantestam*)

Session 3. ECPGR Phase VIII Priority Area 2. Characterization and evaluation

Chair: Helmut Knüpffer

Pre-breeding workshop and activities, ring tests (*Marja Jalli*)

Breeding for climate change (*Dionysia Fasoula*)

Discussions in Session 6

Session 4. ECPGR Phase VIII Priority Area 3. In situ and on-farm conservation and management

Chair: Isaak Rashal

Hordeum wild species in Europe – crop wild relatives of cultivated barley (*Helmut Knüpffer*)

Towards a conservation strategy for wild *Hordeum* species based on niche modelling (*Holly Vincent and Nigel Maxted*)

15:00-15:30 Coffee break

Session 5. ECPGR Phase VIII Priority Area 4. Documentation and information

Chair: Isaak Rashal

European Barley Database and EURISCO, International Barley Core Collection (*Helmut Knüpffer*)

Wednesday, 11 May

8:30 **Session 6. Plenary discussions**

AEGIS

Chair: Külli Annamaa

1. AEGIS – approaches and aims for the European Barley Collection, criteria for MAAs, steps towards the European collection, Quality standards (*Introduction, Chair: Helmut Knüpffer, Rapporteur: Lorenzo Maggioni*)

2. Species-specific regeneration and multiplication protocols for wild *Hordeum* species, as part of the AEGIS quality system (*Introduction: Helmut Knüpffer, Chair and Rapporteur: Agnese Kolodinska Brantestam*)

10:30-11:00 Coffee break

Session 6. Plenary discussions (continued)

In situ/on farm activities

Chair and Rapporteur: Dionysia Fasoula

3. In situ / on farm activities in barley (Dionysia Fasoula)

Pre-breeding and joint research proposals

Chair: A. Michele Stanca, Rapporteur: Marja Jalli

4. Perspectives for genetic resources work in the framework of EU programmes (A. Michele Stanca)

12:30-13:45 *Lunch*

Session 6. Plenary discussions (continued)

Discussion on Pre-breeding and Joint research proposals (including presentations from Session 3)

Session 7. Other matters and remaining issues

Chair: Helmut Knüpffer

15:15-15.45 *Coffee break*

Report drafting (designated participants)

Thursday, 12 May

9:00 **Session 8. Final session**

Chair: Helmut Knüpffer

Presentation and discussion of essential parts of the draft report

10:30-11:00 *Coffee break*

Election of Chair and Vice-Chair

Conclusions, arrangements on report finalization, etc.

Concluding remarks, closing of the meeting

11:50 *Departure to the Castelli hotel, individual preparation for excursion*

12:15 *Excursion (start from Castelli hotel), including light lunch in Kornos, and social dinner in Paphos*

22:30 *Arrival at Castelli Hotel*

Friday, 13 May

Departure of participants

Appendix V. List of participants

Seventh meeting of the ECPGR Working Group on Barley
10-12 May 2011, Nicosia, Cyprus

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