

MALUS/PYRUS WG REPORT FOR PHASE X (2019-2023)

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1. CONTRIBUTION TO ECPGR OBJECTIVES

1.1. Achievements and success stories

- To efficiently conserve and provide access to unique germplasm in Europe through AEGIS and the European Collection

Synonymies, homonymies and redundancies are very common in clonally propagated PGRs, eg. fruit trees, and this is a significant issue in the EU collections. Under the ECPGR Grant Scheme and associated with other European and International partnerships, INRAE Angers coordinated a centralized effort to harmonize molecular marker (SSR) data on apple and pear accessions in order to be able to compare them.

For pear genetic resources a new set of 19 SSR was defined, including 11 out of the 12 previously defined ECPGR common SSR set supplemented by 8 SSR described in the literature. SSR data were standardized and/or analyzed for 4,912 accessions collected from 26 European collections: more than 1,000 accessions originating from 20 European collections were newly genotyped with the 19 SSR; ~3,900 accessions originating from 6 European collections holding existing SSR data were standardized through the development of dedicated allelic correspondence tables. Following the removal of missing data, a dataset with at least 9 standardized SSR across 4,861 accessions was produced. This is sufficient for the identification of duplication with limited risk of error. Among these 4,861 accessions, 2,176 distinct genotypes were identified. A PUNQ code (Pyrus UNiQue genotype code) was assigned for each unique genotype.

On apple, the work was much more advanced than for pear by having already defined a common set of 8 to 12 common ECPGR set of SSR's and a harmonized list of reference varieties. Currently, 4,955 MUNQ codes have been defined from a total of 10,076 analyzed accessions.

The alignment of such a tremendous dataset represents a significant step forward in the coordinated management of field collections of apple and pear genetic resources in Europe and in the world. The AEGIS (A European Genebank Integrated System) initiative to develop a better coordinated European collection within ECPGR relies for an important part on the ability to align and compare DNA marker data produced in different countries.

Whilst these unique genotype codes can be used to identify putative synonyms and homonyms, accessions still need to be carefully validated since (genetically) indistinguishable genotypes could also express different important and valuable horticultural mutation traits (e.g. russet types and or fruit skin colourations). Furthermore, these codes could also be included in EURISCO,

and it is one of the objectives of the current FRUITTREEDATA project to prepare data for submission. Whilst the current intention relates to the codes (rather than raw data) this will make it possible to link clonal accessions (which are often held under synonymous cultivar/accession names in different countries). Currently, harmonized MUNQ and PUNQ codes have been shared with partners and a combined MUNQ dataset (containing 4,319 accessions from 16 partners in 11 countries [including partners from outside of ECPGR]) has been made available through the INRAE data repository <https://doi.org/10.15454/HKGMAS>. This dataset will be regularly updated.

- To provide passport and phenotypic information of actively conserved European PGRFA diversity *ex situ* and *in situ* through the EURISCO catalogue

Previous ECPGR Grant projects, such as Eco-HisPy and Pome Fruit C & E provided as a first step, both harmonized and standardized method and descriptors for the characterization and evaluation of apple and pear genetic resources. Both projects also provided new phenotypic data, especially on old historical and local European pear landraces. Such phenotypic data are available to be encoded in EURISCO.

Again, the project FRUITTREEDATA, approved for funding during the 5th Call for Proposals of the ECPGR Grant Scheme, aims to increase the phenotypic data submission to EURISCO and will also aim to increase and update the listing of available material within EURISCO and/or establish the reasons for the lack of inclusion of known material in National Lists.

- To improve *in situ* conservation and use of crop wild relatives

Outside of ECPGR, some members of the WG were involved in drafting the EU project proposal dealing with Fruit Tree CWR (Project "FRUITDIV", see hereunder).

- To promote on-farm conservation and management of European PGRFA diversity

The WG did not yet conduct specific and coordinated activities in this area but it plans to tackle this complementary safe conservation and valorization strategy.

- To promote communication about objectives, realization and perspectives of ECPGR

The WG was represented on the ECPGR 'Communication' Task Force and the chair was fully involved in the production of (and starred in) the film illustrating the 40th jubilee of the ECPGR (8 to 11th of September 2020).

- To promote use of PGRFA

The characterization and evaluation of *Malus & Pyrus* accessions with standardized tools, such as the newly updated descriptors guidelines released in 2022, are a helpful prerequisite and indispensable condition for facilitating access and promoting the use of PGRFA.

1.2. Gaps or constraints identified

There is a substantial gap between the material known to be held by ECPGR WG members and curators, and the material currently listed in EURISCO. Under the new Grant Scheme project FRUITTREEDATA, approved for funding during the 5th Grant Scheme Call for Proposals, a joint effort to resolve this gap is planned to increase and update the listing of available material within EURISCO and/or establish the reasons for the lack of inclusion of known material in National Lists.

Another constraint is related to the reduced number of accessions flagged as AEGIS, one of the reasons being the unknown/not high-quality phytosanitary status of many traditional varieties that have been long propagated vegetatively.

2. GRANT SCHEME ACTIVITIES, WG MEETINGS AND EVA ACTIVITIES

- **Grant Scheme proposals (submitted:3; approved:3)**
 - a. **Eco-His-Py** - Building and promoting a European *Pyrus* collection – A case study
 - b. **Pome Fruit C & E** - Common ECPGR protocols and tools available for Characterisation & Evaluation of *Malus/Pyrus* genetic resources
 - c. **Improvement of Fruit Tree Data Inclusion in EURISCO (FRUIT Tree Data)** (in collaboration with the *Prunus* WG; 5th call)
- **Total number of partners involved in 'FRUITTREEDATA: 19 from 11 countries**
 - ECPGR-funded: 16 from 15 countries
 - Self-funded: 3 from 3 countries already represented by funded partners
- **Meetings held**
 - VALDIFRUIT, meeting, June 2019, EUCARPIA Symposium, Prague, Czech Republic.
 - *Malus/Pyrus* WG activities skype meeting, 17/09/2020.
 - *Prunus* & *Malus/Pyrus* WG coordination skype meeting I, 07/06/2021.
 - *Prunus* & *Malus/Pyrus* WG coordination skype meeting II, 17/06/2021.
- **Reports and related data**
 - Common ECPGR protocols and tools available for Characterization & Evaluation of *Malus/Pyrus* genetic resources (Pome Fruit C&E) - Final Report (2023)
- **Funds mobilized [shared with *Malus/Pyrus* WG]**
 - ECPGR granted funds: € 38,775
 - Inputs in-kind declared in Grant activities: € 36,000

3. OTHER ACTIVITIES (CROSS-WORKING GROUP ACTIVITIES, LINKS WITH OTHER NETWORKS, INTERNATIONAL PROJECTS AND INITIATIVES)

- **Cross-Working Group activities:**

Due to the evident affinity between the crops of pertinence and, as a result, of challenges, objectives, and strategies, there has always been a particularly close relationship with the

Prunus WG. The presentation of the collaborative 'FRUIT Tree Data' project, which is intended to be initiated soon, is an example of such closeness and interest convergence.

International Projects:

3.1. Submitted EU project proposals

Whilst (strictly) outside of the scope of ECPGR (and subject to selection processes led by the project consortia leads), a number of WG members have been involved in the following proposals that aim to further ECPGR objectives.

- a. **VALDIFRUIT** - Adding VALue to the DIVersity of FRUITree Genetic Resources through improved coordination on the conservation, characterization, evaluation and access to data and plant materials with valuable traits - H2020-SFS-2018-2020. Coordinated by INRAE Montpellier, 29 partners. Submitted in first step in 2019, pre-selected, re-submitted second step in 2020. Good scores **but not selected**.

VALDIFRUIT aimed to add value to the reservoir of genetic resources of Rosaceae fruit trees. Five major species of European importance and their wild relatives, will be targeted: apple, pear, peach, apricot and sweet cherry. VALDIFRUIT wanted to foster new protocols and standards for sharing knowledge to manage, organize, characterize and use the diversity of ex situ conserved and in situ wild genetic resources in Europe. The project aimed also to provide high-throughput, innovative and generic tools for the characterization of plant material at the phenotypic and genotypic levels. Particular focus was set on old varieties and wild material to search for traits associated with resilience, adaptability and quality of crop production.

- b. **InnOBreed** - Innovative Organic Fruit Breeding and uses - HORIZON-CL6-2021-BIODIV-01-14 – Fostering organic crop breeding. Scientific coordination, INRAE, AGROSCOPE, CRA-W & CIHEAM/AMB. Funded for the period 2022-2026.
- Promotion and evaluation of fruit-tree genetic resources (FTGR) on Organic Farming bases. InnOBReed project has the ambition to promote the evaluation of fruit-tree genetic resources with standardized tools and protocols and to move for both landraces and cultivars to new methods, protocols and traits evaluation.
 - Identify, surround and imbed innovative solutions in an impact-based strategy to foster fruit organic breeding.
 - Participative approach to define new traits, to adapt evaluation methods and to breeding and testing activities fitting with future organic fruit growing challenges.
 - Increasing the use of the FTGR diversity for increasing breeding efficiency.

Some members/Institutions of the two top fruit WGs are currently collaborating on this project funded by the EU. Among the aims of this project, is the identification of ideotypes of perennial fruit GRs (apple, pear, peach, cherry, plum, apricot) that are more resilient/robust/tolerant to diseases/adaptable to the organic production and better fitting with organic farming requirements. Moreover, the evaluation and valorization of underutilized local old genetic resources (cultivars and landraces) are also emphasized, as well as their use in pre-breeding and breeding for more robust cultivars. New, more comprehensive guidelines including traits specific for identifying

more robust germplasm are being developed, and the results will be of benefit to ECPGR too.

c. GenRes Bridge – Genetic Resources for a food-secure and forested Europe.

Participation as stakeholder in meetings and contribution to the ECPGR Task Force for developing during several meetings, the *Plant Genetic Resources Strategy for Europe* document, which was launched in Brussels on 30 November 2021.

d. FRUITDIV - Exploiting the Untapped potential of Fruit tree Wild DIversity for Sustainable Agriculture - HORIZON-CL6-2023-BIODIV-01. Coordinated by INRAE, Bordeaux, 29 partners.

FRUITDIV project will monitor, characterize, use and conserve the diversity of emblematic fruit tree CWR, with a particular emphasis on Malus, Pyrus and Prunus. To better characterize the genetic and phenotypic diversity of CWR fruit trees and identify favourable traits for future introgression into cultivars, FRUITDIV will use a combination of floristic, ethnogeography and population genomics on genebanks and historical European hotspots of diversity.

- Submitted in March 2023 – Decision pending.

3.2. Global Crop Diversity Trust

Contribution to the final document: Bramel, P.J. and G. Volk. 2019. A global strategy for the conservation and use of apple genetic resources. Global Crop Diversity Trust. Bonn, Germany. DOI: 10.13140/RG.2.2.34072.34562

Working Group Documents & publications related to WG activities:

- **Denance, C., Ordidge, M., Lateur, M., & Durel, C. E.** (2019). Molecular characterization of a very large set of European pear accessions with SSR markers. Poster presented at the XV EUCARPIA Fruit Breeding & Genetics symposium, Praha.
- **Lateur, M., Rondia, A., Ordidge, M. (2019).** 'Fruit tree genetic resources: from diversity safeguarding to diversity of uses - a complementary goal'. Invited speaker to the XV EUCARPIA Fruit Breeding & Genetics symposium, Praha.
- **Lateur, M., Ordidge, M.** (2019). Integrating vegetatively propagated crops into AEGIS, using Malus as an example. In: Assessing current practices and procedures to strengthen AEGIS, the initiative for A European Genebank Integrated System, Report of a Workshop. Eds. J.M.M. Engels, L. Maggioni and E. Lipman, pp. 12-14. Bioversity International, Rome.
- **Denancé, C., H. Muranty, and C. E. Durel.** "MUNQ—Malus UNiQue genotype code for grouping apple accessions corresponding to a unique genotypic profile." Portail Data INRAE 1 (2020).

- Muranty, H., **Denancé, C., Feugey, L.**, ..., **Lateur, M., Ordidge, M.**, ... et al. (2020). Using whole-genome SNP data to reconstruct a large multi-generation pedigree in apple germplasm. *BMC Plant Biol* **20**, 2 (2020). <https://doi.org/10.1186/s12870-019-2171-6>
- Winfield, M., Burridge, A., **Ordidge, M.** et al. (2020). Development of a minimal KASP marker panel for distinguishing genotypes in apple collections. *PLOS ONE*. <https://doi.org/10.1371/journal.pone.0242940>
- Jung, M., Roth, M., Aranzana, M. J., Auwerkerken, A., Bink, M., **Denancé, C., Durel, C. E.**, et al. (2020). The apple REFPOP—a reference population for genomics-assisted breeding in apple, *Horticulture Research*, Volume 7, 2020, 189, <https://doi.org/10.1038/s41438-020-00408-8>
- **Lateur, M., Giovannini, D., Ordidge, M.** (2021). ‘Fruit Tree Genetic Resources: from maintaining to sharing material through Europe – issues with quarantine and ‘regulated non quarantine pests’’. Webinar jointly elaborated by members of the ECPGR Working Groups of Malus/Pyrus and Prunus presented during the GENRes Bridge Seminar ‘Workshop on phytosanitary barriers for genetic resources’, 24 February 2021, online MS Teams
- Cazenave, X., Petit, B., **Lateur, M.**, Nybom, H., Sedlak, J., Tartarini, S., Laurens, F., **Durel, C. E.**, Muranty, H. (2022). Combining genetic resources and elite material populations to improve the accuracy of genomic prediction in apple, *G3 Genes|Genomes|Genetics*, Volume 12, Issue 3, March 2022, jkab420, <https://doi.org/10.1093/g3journal/jkab420>
- Venison, E.P., Litthauer, S., Laws, P., **Denance, C.**, Fernandes-Fernandez, F., **Durel, C. E., Ordidge, M.** (2022). Microsatellite markers as a tool for active germplasm management and bridging the gap between national and local collections of apple. *Genet Resour Crop Evol* **69**, 1817–1832 (2022). <https://doi.org/10.1007/s10722-022-01342-5>
- **Durel, C. E., Denancé, C.**, Muranty, H., **Lateur, M., & Ordidge, M.** (2022). MUNQ and PUNQ - A European and international apple and pear germplasm coding system. *In IHC 2022*, 31st International Horticultural Congress.
- **Lateur, M.**, Ristel, M., Bolliger, N., **Dapena, E.**, Spornberger, A., Audergon, J M., **Toldam Andersen, T.**, Korsgaard, M., Vavra, R., Buscaroli, C., Warlop, F., Koutis, K. (2022). Integration of local fruit landraces and genetic resources in the concept of EUROrganic Fruits – a European charter under development on Organic Participatory Breeding Network in Fruit Species. Lecture for the 6th Scientific Meeting for Landraces and Indigenous Varieties - Exploring the world of Crop Landraces. Aristotle University of Thessaloniki (Greece), 01/06/2022.
- **Lateur M, Szalatnay D, Höfer M, Bergamaschi M, Guyader A, Hjalmarsson I, Militaru M, Miranda Jiménez C, Osterc G, Rondia A, Sotiropoulos T, Zeljković M K, Ordidge M.** (2022). ECPGR Characterization and Evaluation Descriptors for Pear Genetic Resources (*Pyrus communis*). European Cooperative Programme for Plant Genetic Resources, Rome, Italy, pp. 48.

- **Lateur M, Dapena E, Szalatnay D, Gantar M E, Guyader A, Hjalmarsson I, Höfer M, Ikase L, Kellerhals M, Laciš G, Militaru M, Miranda Jiménez C, Osterc G, Rondia A, Volens K, Zeljković M K, Ordidge M.** (2022). ECPGR Characterization and Evaluation Descriptors for Apple Genetic Resources (*Malus x domestica*). European Cooperative Programme for Plant Genetic Resources, Rome, Italy, pp. 57.
- Nicholas P. Howard, N. P., Micheletti, D., Luby, J. J., **Durel, C. E., Denancé, C., Muranty, E., Ordidge, M.,** Albach, D. C., (2023). Pedigree reconstruction for triploid apple cultivars using single nucleotide polymorphism array data. *Plant People Planet* 5 (2), 98-111. <https://doi.org/10.1002/ppp3.10313>

4. EXPECTED ADDITIONAL ACHIEVEMENTS AND FUTURE ACTIVITIES THAT COULD CONTRIBUTE TO THE IMPLEMENTATION OF THE PGR STRATEGY FOR EUROPE

- Increased phenotyping characterization and evaluation of European *Malus* & *Pyrus* PGRs, including traits useful to identify more robust germplasm, better adaptability to climate changes, better tolerance to pests and diseases and improved fruit quality – gustative and nutrients – both for direct use or for future pre-breeding and breeding actions
- Increased collaboration/coordination with the Documentation and Information WG to increase and update the listing of available material within EURISCO, providing easier access to information about *Malus/Pyrus* GRs conserved in EU
- Increase awareness on developing ad hoc quality standards manuals and more regional partnership – mentorship, national collection concept strategies and long-term safe duplication strategies including on-farm conservation
- Developing capacity-building tools and activities
- Reorganizing formal WG meetings for at least National contact persons from each country.