Press release – 25 June 2021

Domestication history of apricots retraced through genomics

INRAE, the universities of Bordeaux and Paris-Saclay, and the CNRS have analysed the entire genome sequence of more than 900 cultivated and related wild apricot trees from different geographic locations. The findings have contributed to our knowledge of adaptation processes and allowed scientists to identify the important genomic sections for breeding and growing fruit trees. Published in the 25 June 2021 issue of *Nature Communications*, this study retraces the domestication events, which go back two to three thousand years, of apricots that are cultivated today in Europe and China. Despite their phenotypic similarities, these apricots have originated from distinct wild populations in central Asia following independent routes to domestication. Life cycle, fruit quality and disease resistance are all traits associated with the genes found to have been under human selection in these fruit trees.

Over the course of the domestication of fruit trees, human selection has affected reproductive and vegetative traits (such as the flowering period), fruit features (for example size, acidity, firmness and flavour), as well as crop response to biotic stress (e.g. bacteria and pests) and abiotic stress (e.g. drought and cold weather). Human selection, being recent and strong, has left footprints in genomes that are easier to detect than those typically left by natural selection.

Apricots are good models for identifying the genes that have been under selection during domestication and for studying the adaptation processes of fruit trees. Indeed, apricots have a small genome (~220 Mb[1], i.e. less than twice that of thale cress, *Arabidopsis thaliana,* and 70 times smaller than that of wheat), and wild populations that share a common ancestor with cultivated apricots are available. To reconstruct the history of their domestication, INRAE, the universities of Bordeaux and Paris-Saclay, and the CNRS assembled four high-quality genomes[2] from the domesticated species and its relatives and analysed the sequences of more than 900 accessions[3] originating from different geographic locations throughout the world.

[1] Millions of base pairs

[2] High-quality genome assemblies consist in assembling sequence reads (long and short fragments) with optical maps into longer sequences (contigs or pseudomolecules) in order to obtain one single sequence for each individual chromosome.

[3] Accessions: Individuals from samples of vegetatively propagated material, taken at the same time from the same place. There is only one way to identify accessions and each accession represents a sample from a parent tree collected *in situ*, a cultivar, a lineage or a population.

Different domestication events

Prunus armeniaca L. refers to both the wild ancestor of apricots and the common cultivated species. Its natural populations still only occur in central Asia[4]. In addition to cultivated and wild apricots, the researchers also studied four other related Armeniaca species: three endemic to East Asia[5], principally China, and one present in the French and Italian Alps[6].

The study shows that European and Chinese cultivated apricots form two distinct genetic groups that resulted from independent domestication events. Long considered native to China, apricots cultivated in Europe actually come from a wild population from northern central Asia, while apricots cultivated in China were domesticated from a population in southern central Asia. Apricots grown in Europe and China have similar traits (shape and fruit size, tree phenology, etc.), which suggests a converging adaptation over the course of parallel domestication events. This raises the question: does such convergent adaptation occur through similar changes in the same genomic regions?

Different regions of the genome impacted

Despite their similarities, human selection targeted different regions of the genome in European versus Chinese cultivated apricots. This means that different genomic modifications can lead to the same adaptive phenotypes. In both groups, the genes affected by human domestication had predicted functions involved in the perennial life cycle, fruit quality and disease resistance. The large size of apricot populations, the long life cycle[7] of perennial cultures, and the subsequent gene flow observed between wild and cultivated populations have allowed domesticated apricots to maintain high genetic diversity and led to relatively low proportions of the genome being affected by selection (0.42% and 0.22% in European and Chinese apricots, respectively).

Compared with annual crops such as maize and rice, the footprints of adaptive events in fruit tree genomes, in response to domestication, are the subject of few studies and poorly understood. The results of this study will help advance knowledge of adaptation processes. Identifying the genomic regions impacted by human selection further provides clues to the biology of selected traits during domestication and targets for fruit tree research and breeding.

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[4] Liu *et al.*, 2019 (DOI: 10.1111/mec.15296); Decroocq *et al.*, 2016 (DOI: 10.1111/mec.13772)
[5] *P. mume*, *P. sibirica L.*, *P. mandshurica*
[6] *P. brigantina*
[7] 40 - 45 years for apricot trees

Reference

Groppi, A., Liu, S., Cornille, A. *et al.* Population genomics of apricots unravels domestication history and adaptive events. *Nat Commun* 12, 3956 (2021). DOI: 10.1038/s41467-021-24283-6

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About INRAE

INRAE, the French National Institute for Agriculture, Food and the Environment, is a major player in research and innovation. Dedicated to targeted research, it came about from a merger between INRA and Irstea on 1 January 2020, and brings together a community of some 12,000 people, with 268 research, service and experimental units located in 18 centres throughout France. The Institute is one of the world's very first bodies of research dedicated to agricultural science, food and plant and animal science, and eco-environmental issues. It is the world's leading research body specialising in all aspects of the "agriculture-food-environment" trilogy. INRAE strives to be a key player in the necessary transitions to rise to major global challenges. Faced with a rising population, climate change, dwindling resources and threatened biodiversity, the Institute is finding solutions for multi-performance agriculture, quality food, and the sustainable management of resources and ecosystems.

About the CNRS

The French National Center for Scientific Research is one of the most recognized and renowned public research institutions in the world. For more than 80 years, it has continued to attract talent at the highest level and to nurture multi-disciplinary and interdisciplinary research projects at the national, European and international levels. Geared towards the public interest, it

contributes to the scientific, economic, social and cultural progress of France. The CNRS is above all 32,000 women and men, more than 1,000 laboratories in partnership with universities and other higher education institutions bringing together more than 120,000 employees and 200 professions that advance knowledge by exploring the living world, matter, the Universe, and the functioning of human societies. The CNRS ensures that this mission is carried out in compliance with ethical rules and with a commitment to professional equality. The close relationship it establishes between its research missions and the transfer of acquired knowledge to the public makes it today a key player in innovation in France and around the world. Partnerships with companies are at the heart of its technology transfer policy, and the start-ups that have emerged from CNRS laboratories bear witness to the economic potential of its research. The CNRS provides also access to research findings and data, and this sharing of knowledge targets many audiences: scientific communities, the media, decision-makers, economic players and the general public.
For more information: www.cnrs.fr

About University of Bordeaux
With more 56,000 students, 3,100 researchers and teachers, and 2,600 staff members, the University of Bordeaux is one of the leading French public research and higher education institutions, located in a dynamic and culturally rich, fast-developing region. Ranked among the top universities in France, the University of Bordeaux is renowned for the quality of its academic courses and research. It is a multi-disciplinary, research-focused institution with a strong ambition to develop as a leading, international campus. The University of Bordeaux is leading an ambitious, competitive development program in partnership with local higher education institutes and national research organizations, in order to promote Bordeaux as a "Campus of Excellence".

About Université Paris-Saclay
Université Paris-Saclay brings together ten constituent faculties and institutes, four Grandes Écoles, the Institut des Hautes Etudes Scientifiques, two associate institutions and shared laboratories with six national research organisations.
With 48,000 students, 8,100 lecturers and 8,500 administrative and technical staff members, Université Paris-Saclay offers a comprehensive and varied range of undergraduate to doctorate level programmes and engineering degrees, renowned for their quality thanks to the reputation and commitment of the University's academic staff.
Located in the south of Paris on vast sites that stretch across Paris, Orsay, Évry and Versailles, Université Paris-Saclay benefits from a strategic geographical and socio-economic position that is strengthened by its international visibility. A leading University, Université Paris-Saclay is recognised for its excellent Mathematics and Physics programmes but also for Biological and Medical Sciences, Agriculture, Engineering, and its extensive Humanities and Social Sciences courses. Close to Paris, Université Paris-Saclay is nested in a protected natural area, at the heart of a dynamic economic hub.