Beyond Seed Banking: Can Ecosystem Networks Preserve Threatened Plant Species?

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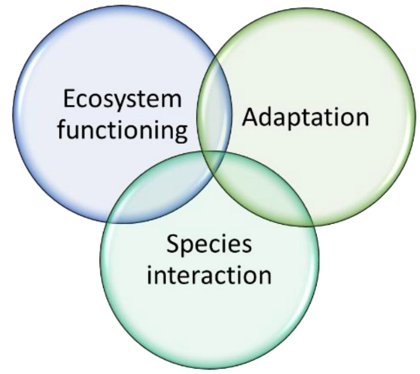
Big hope is put in preservation of plants and their different varieties in a frozen seed bank far from human influence and natural disasters, and many exist around the world[1]. The largest ones, mainly focusing on the crops for human consumption, are the Kew's Millennium Seed Bank Project in Wakehurst, England, the Svalbard Global Seed Vault in Northern Norway[2], the Navdanya in Uttrakhand, India, the National Center for Genetic Resources in Fort Collins, Colorado and the Vavilov Research Institute in Russia**.** Their importance for the present and the future in not in discussion here, especially regarding catastrophes, because of the seeds are meant to be protected from extreme weather events, local political events, economic instability and local climatic changes.

Display of the herbarium from the Vavilov Institute, Expo Milan, 2015

However, a recent article [3] suggests that it might miss its purpose for many threatened plants. The reason is that an important portion of fragile plants have seeds that either do not resist frost and/or drying - so called recalcitrant- or do not germinate anymore after some years, which both makes conservation very difficult. The comment, published in Nature plants in November 2018, explains the shortcomings of cryopreservation especially for threatened plants. Those are indeed more prone to be recalcitrant or short lived after desiccation.

How can we re-shape conservation, how can we maintain a sufficiently diverse genetic pool to ensure adaptability and resilience with regards to the huge modifications climate change is provoking and will cause in the future? What is or are the best complements to ex-situ seed banks?

Preservation is indeed not only a matter of the conservation of seeds or other reproductible elements, it is also ensuring the organism can survive and reproduce further after re-implantation. The point is, a plant might germinate if placed under correct conditions - this allows to jubilate when a seed can even germinate in a capsule on the moon. However, it does not necessarily mean the plant will grow enough to reproduce and ensure the survival of the species. In the worst case, germination of the seed without successful fulfillment of the lifecycle means the loss of the genetic material contained in it.



Hereafter conservation shall include the life-cycle of the plant, especially for fragile plants, or those that are quite dependent on symbiosis partners or other partnerships to thrive or even survive. **An up-to-date and broadly available knowledge about ecosystems, species interactions and their thriving conditions is an unavoidable step for such enterprise**.

Therefore, living in-situ - as national parks - and living ex-situ conservation - as done in botanical gardens for instance, are more important than previously thought.

While gardens might be criticized because they might come short in some cases because the species variety rather than conservation of genetic variety is the main aim, they represent a valuable tool and an essential part of the puzzle for conservation. National parks are also of crucial interest but changing climatic conditions are challenging the survival of endemic species or those limited to very specific conditions. More importantly, only the cooperation between those single parks and gardens can ensure a real survival of species and genetic variety under changing or unsecure conditions. The concept of a global network for conservation is followed by the Botanic Gardens Conservation International (BGCI)[4], and is present in most parts of the world.

To meet the goals of the Global Strategy for Plant Conservation[5] and its 16 goals set for 2020, it's indeed time to build up a real, **targeted ecosystem preservation network** to ensure not only the preservation of known, threatened recalcitrant species and their genetic variants, but also the yet undefined, uncultivable or undiscovered species of plants and microorganisms that are associated. Furthermore, to keep a dynamic system in which the living genetic variety allows a gradual response to changes is also in the interest of a world of climatic shift[6]. Finally, as **agriculture is one main obstacle to conservation, it is important to find the way to integrate and transform one into the other**, and support projects that push **towards sustainable agriculture and beyond**.

There is still much work to be done to estimate the minimum size and number needed, to know enough about plant partnerships and genetic variability and how living conservation should look like in each place. Indeed, **for an efficient conservation to take place, it needs to be assimilated by locals in every place, and therefore needs to be adapted to each place and people,** rather than just follow a pattern imposed from outside. As an example of integration, and a note of hope, it is worth mentioning the story[7] from forest ecologist Alemayehu Wassie. His conservation efforts, together with ecologist Meg Lowman, led them to collaborate with local Tewahedo churches in Ethiopia, preserving and treasuring in a common movement the lush, wild, green pockets surrounding the church buildings, resisting green sanctuaries after decades of deforestation.

How can we, similarly, encourage and strengthen, educate and extend local movements, local population to unite the efforts and outcomes of preservation? Can we collect information about species partnerships in order to preserve their dynamics? Can a network of preserved or reconstructed ecosystems, i.e. dynamic seed banks, be the partner to dormant seed banks?

1. Russo V. Five Global Seed Banks That Are Protecting Biodiversity. 2019;2019.
2. TheCropTrust.
3. Wyse SV, Dickie JB and Willis KJ. Seed banking not an option for many threatened plants. *Nature Plants*. 2018;4:848-850.
4. (BGCI) BGCI. Business Case and Plan for Botanic Gardens Conservation International 2015-2020 2015.
5. GLOBAL STRATEGY FOR PLANT CONSERVATION: TECHNICAL RATIONALE, JUSTIFICATION FOR UPDATING AND SUGGESTED MILESTONES AND INDICATORS. *Convention on Biological Diversity CONFERENCE OF THE PARTIES TO THE CONVENTION ON BIOLOGICAL DIVERSITY*. 2010.
6. Boisselet T. Missing the potential of evolutionary ecology. 2018.
7. Abbott A. Biodiversity thrives in Ethiopia's church forests *Nature briefing*. 2019.