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GREENART: INITIAL GOALS ACHIEVED

It's been more than a year since the GREENART project kicked off! In Naples, on the 14 and 15 December, its members convened to share progress on the development of new restoration products.

Officially launched 15 months ago, GREENART is committed to promoting sustainable conservation and restoration of cultural heritage by developing new, environmentally-friendly tools and seeking alternatives to harmful components in currently marketed products. This involves a complete rethinking of restorers' practices. Engrossed in their tasks, the Works packages — various teams associated with the project, from researchers to museum restorers — gathered to discuss their advancements. Cleaning, protective coatings, consolidation, and packaging materials: every step was meticulously examined.

Cleaning

Dedicated to green cleaning, the first Works package team aims to develop cleaning fluids in the form of microemulsions and gels by July 2025, ensuring safe and controlled cleaning of artworks — that is, the removal of aged, unwanted or deteriorating layers.

As of 30 September 2023, the first phase is complete: developing cleaning fluids with components that can replace today's solvents and market-available surfactants, making them green. These have been selected using a rating scale from 1 to 6, categorising surfactants from "recommended" to "very dangerous". Currently, at least three surfactants in use fall into this latter category.

However, GREENART is innovating. Among the newly developed products, water and oil-based fluids have been created without traditional surfactants, adding a hydrotrope… an interesting solution for researchers, as hydrotropes are generally more environmentally sustainable than conventional surfactants. The latter, being synthetic and derived from petrochemistry, cause more allergies and skin reactions. Not very biodegradable, they release chemical compounds that can be even more toxic upon decomposition. Thus, these surfactant-free microemulsions represent a greener alternative, with a broader range of possible applications. So far, experiments seem to prove the interest and effectiveness of this new type of mixture.

Since 1st October, the second phase has commenced and will continue until March 2024, focusing on the study of gels created from biological, natural, or low-toxicity polymers. These gels will confine the cleaning fluids and solvents developed by the research team for controlled cleaning. They must also be synthesised through low-energy consumption processes, including recycling. Several hydrogel solutions have £been tested, and the researchers have achieved a relatively effective

— Pierre Naquin and Diotima Schuck

positive result after several testing phases. The goal now is to further improve their mechanical and cleaning properties and optimise formulations, particularly by replacing animal-derived polymers with those derived from wheat gluten.

Protection

Regarding the work package dedicated to developing coatings to protect artworks, by 30 June 2025, the team aims to have mastered various key elements: developing passive and active coatings with multifunctional, multilayered, and/or composite protective barriers to prevent various forms of degradation — pollution, humidity, corrosive agents, etc. Naturally, the research is bounded by the use of biological monomers and polymers sourced from sustainable or renewable products and natural waste, as well as by the aspiration to develop solutions enabling the self-repair of artworks.

Currently, researchers involved in the GREENART project face the challenge of the ecological durability of traditional protective products. IPCB and Specific Polymers, two project partners, are working to identify green components that can produce multifunctional coatings. A second group is exploring self-healing capabilities of coatings, while a third is tasked with developing products with anti-corrosion, plasticising, and anti-fouling properties. As of December 2022, the researchers have successfully formulated the base components of new coatings and assessed their durability. Some, though derived from non-biological sources, remain durable in application due to their self-healing properties. However, the researchers aim to go further by exploring these same possibilities with biological products.

Next steps include enhancing the uniformity and protective effects of coatings, both passive and active, and refining their structure and layers. This involves ensuring multiple functionalities in a single product, such as acting simultaneously as an anti-corrosion protection, a barrier against degrading agents or UV rays, and possessing hydrophobic and antifungal properties. These new products have been tested on various metals after accelerated ageing and they demonstrated efficacy, particularly on silver and bronze alloys.

There are challenges in the testing phases, depending on the chosen material, type of object, and the conditions and location of its conservation. By 31 January 2024, the first phase of research should conclude with the development of new passive coatings. Institutions like the Peggy Guggenheim Collection in Venice have offered objects with specific conservation needs for testing with GREENART products. While passive coatings are nearing completion, active coatings are expected to be ready by 30 September 2024.

Consolidants: strengthening artworks

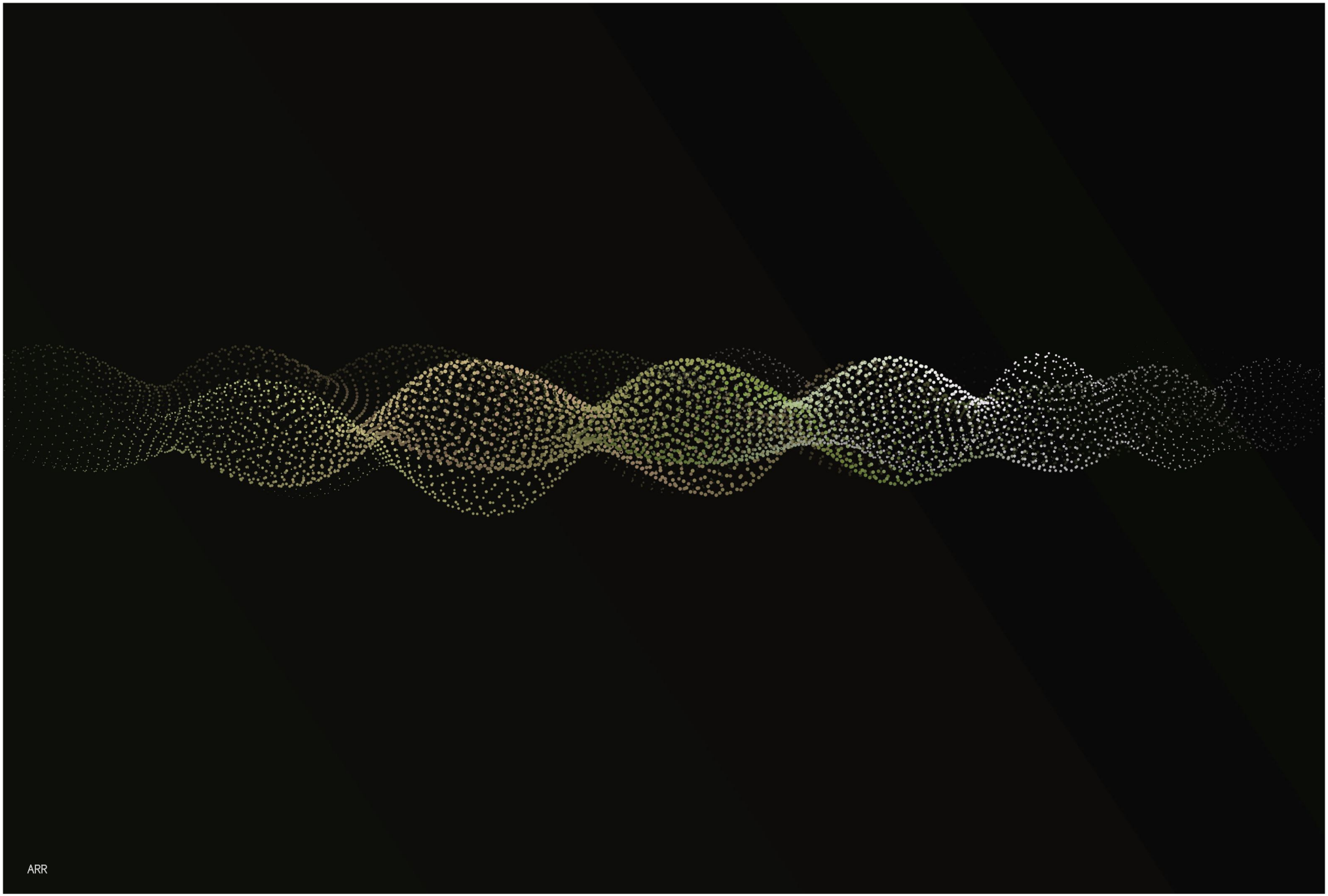
Consolidants, though less visible, are crucial in art conservation. The team dedicated to consolidants aims to develop tools to support and reinforce fragile artworks, as well as packaging materials and foams for their storage and transport. This Works package directly influences preventive conservation methods, seeking sustainable solutions aligned with long-term conservation goals. It involves both material consolidation and structural support (frames and panels).

What tools are involved? Consolidants address issues like fragile paint layers, flaking or crumbling pigments and textiles. These issues arise from industrial paint formulations rich in additives and artistic material experimentation. Improper storage and handling also contribute. Research is also focused on fibre reinforcement in artworks, using biological processes like silk fibroin, a natural protein from silkworms and spiders known for its high mechanical strength. The aim is also to control the gelation and aggregation of products on the artworks.

Regarding the development of consolidating adhesives, researchers are striving to create products that are compatible, sufficiently strong, and avoid potential new deteriorations while making the application as simple and feasible as possible. Currently, they have managed to create dispersions — used in adhesives and as binders in paints — that can consolidate encaustic paint. These will soon be evaluated on test objects.

Consolidants: strengthening structures

When artworks deteriorate, so do their structures. Physical, biological, and environmental factors cause deformations or flaking of paints. Typically, wooden supports or various systems are used to hold the object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in place, but GREENART is looking to propose walls or panels made of custom mechanical properties natural fibres, more resistant to ageing, while optimising their stability. By 30 September, the packaging materials and foams should address issues related to surrounding humidity and pollution, with an appropriate lifespan and usage — or reuse. For instance, paper fibre boxes have been studied for alternatives: by deacidifying them or replacing their components with different materials. Further research on the composition of these solutions will complete the data collected so far.

The current market products for artwork packaging are not at all durable or recyclable. If researchers are addressing these issues, improving these tools will also involve modifying their components to reduce their thermomechanical properties, eliminating risks of shocks or vibrations during transport. GREENART also envisages custom packaging, produced using digitisation of the artwork, followed by 3D printing. For surrounding temperature and humidity, researchers recommend designing a new sensor made of bioplastics and sustainable materials.

Currently developed foams offer significant advantages: they are non-toxic, green, easy to handle, light yet strong, and can be easily produced in desired shapes and sizes. Notably, they change colour when exposed to organic acids or aldehydes, can absorb acids and gases, and resist the growth of fungi, mould, and bacteria. However, their production is costly and still consumes too much energy for GREENART standards…

Studies have already been conducted on various test objects: papers, paintings, textiles — from aged faux leather handbags to mineralised or non-mineralised archaeological fabrics. The different problems presented by each fabric, wool, cotton, linen are being identified to propose the most adequate treatments possible.

Monitoring technologies

The team dedicated to new green technologies must devise devices made from recycled materials or waste, which will be evaluated by museums and art galleries later. Naturally, these new devices must be as or more efficient than those currently available.

After selecting materials for sensor manufacturing, the challenge was to create compounds that function effectively for real environment testing. The researchers' results are positive but need optimisation, especially in sensor fabrication. Soon, other alternative materials will be studied for their humidity and temperature change detection properties.

Seeking to improve existing tool capabilities, GREENART also proposes reducing the size of some tools, like the transponders used by sensors. While some tests have been positive, others require more research, particularly regarding new natural materials proposed, which still poorly respond to temperature changes and humidity, leading to premature degradation of the object.

In summary, further studies will provide more insights into the limitations of these new green technologies: response time, detection limits, accuracy, etc.

The task of finding the best combinations and the most suitable application for each artwork, object, and material is complex. It requires numerous experiments and research, as well as the development of suitable chemical solutions. So far, the researchers of the GREENART project have met the objectives set for the first year, and some of the Works packages are already able to propose products more effective than those available on the market for art restoration. While some still require optimisation, they will soon enter the testing phase on artworks, in collaboration with conservators and institutions.

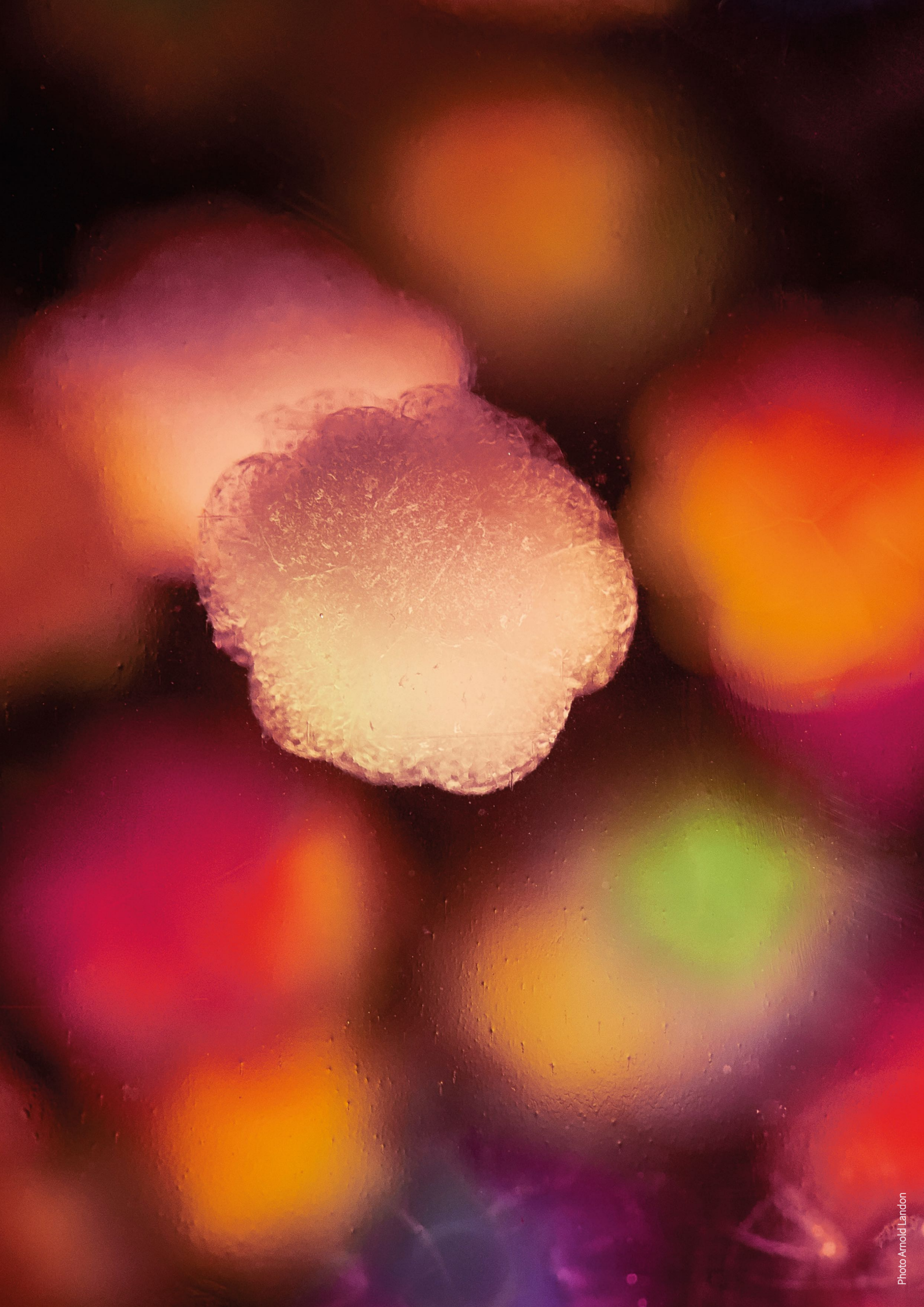

Photo Arnold Landon

GREENART meeting, Naples, December 2023

Courtesy GREENART

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