

Atelier Luma Algae Review

ATELIER LUMA ALGAE REVIEW

*Everything you always
wanted to know about algae*

The Algae Review is a curated newsletter and research project dedicated to knowledge around algae and Atelier Luma's Algae Platform activities. By mapping existing algae knowledge — from literature to scientific research — Atelier Luma aims at consolidating a community of international algae practitioners, creatives, and experts to actively participate in the research, the understanding, and the valorization of algae resources.

Created ahead of the Algae Summit, the Algae Review was a way of communicating with our existing network and helping bring together different fields of expertise. Issue #8 of the Algae Review concludes a first series of publications. Its new format will be developed to keep up with the commitments and goals of Atelier Luma and of the algae community.

If you would like to contribute to the new format and content of the next publication of the Algae Platform, please let us know. [✉](#)

“We begin by eschewing the role of specialists who deal only in parts. Becoming deliberately expansive instead of contractive, we ask, “How do we think in terms of wholes?” If it is true that the bigger the thinking becomes the more lastingly effective it is, we must ask, “How big can we think?”

— Richard Buckminster Fuller's,
Operating manual for spaceship earth

GLOBAL CYCLES

In the current issue, we are taking a step back to examine algae on a more global scale, amid the Earth's natural cycles. Algae are involved in keeping things running smoothly on our planet. At the heart of the Gaia Hypothesis, they play a key role in generating, supporting and sustaining life. From the lifecycle of cyanobacteria to the circulation of a postcard, from Earth to Mars, here is an overview.



ALGAE SUMMIT ALGAE: A PRECIOUS ALLY

On December 9th, Atelier Luma hosted its first international Algae Summit from Arles, South of France. The Algae Summit, organised by the Algae Platform, marks the achievement of 4 years of research in the field of algae and opens up new fields of research for the future.

In line with Atelier Luma's philosophy, the Algae Summit was created with the ambition to connect the research around algae with the environmental and social urgencies of our time. Both international and local actors were invited to take part in round table discussions on the event's central topic, which was the role of algae in the necessary ecological and cultural transition within territories.

The Algae Summit has shown that algae are actors of our contemporary world and not a futuristic resource. The algae sector is already well implemented in the local bioregion of Arles and other regions. It is hiring skilled people, developing technical innovations in biotechnology, and is crossing over to various other sectors, from traditional fishermen communities to high-tech companies. Cutting-edge research on algae requires finding more facilities and means, to join forces and exchange knowledge, and lead to bring about positive change in the standards and regulation levels... Transversal platforms such as Atelier Luma can help make those challenges more apparent to public authorities and help create links between the more local scale to the bigger, global scale.

At the same time, we notice how a more nuanced approach is necessary. We advocate for a better understanding of algae as living things within human and non-human ecosystems.

This re-evaluation is crucial to develop collaborative strategies with algae in terms of biomass production, agricultural practices, new architectural developments or bioremediation systems. Where technology is often already available, we have noticed that the cultural shift to carry out its implementation is missing. During the Algae Summit, it became clear that this shift could only take place if communities were involved in the preservation, use and valorisation of algae. Arts, crafts, and technology are mediums to create and share new narratives and formulate new relationships amongst living things.

On the European level, the Algae Summit highlighted the urgency to support the emerging Blue Economy, while remaining aware of its limits. The social and environmental disasters resulting from decades of intensive land farming, extractivist systems and destructive modes of production should alert us to the dangerous acceleration of sea waters domestication. The immense potential of algae must not be a pretext for over-exploiting the oceans. Atelier Luma invites researchers, practitioners and artists to take part in a group discussion with the aim to develop a more holistic approach, to research the value chain in its entirety and to promote best practices in the algae sector.

The Algae Summit was an important moment to put forward a number of proposals and fuel ongoing reflections. At Atelier Luma design is thought of as a tool for transition. We advocate for approaches and methodologies rather than ready-made solutions, and we rely on the power of the community. We are looking forward to exploring further, inviting new voices into the discussion, and carrying out concrete proposals on the ground.



The full replay is available on Luma's website



Look back at the highlights of 2020 with the Luma YearBook 2020



Thank you to all participants and contributors:

Isabelle Viallon (European Commission), Susanne Kadner (Acatech), Sébastien Dutreuil (CNRS), Florine Colbalchini (ADECAL Technopole), Thierry Jauffrais (AMICAL), Susana Fernandes (Pau University), Mariachiara Chiantore (Genoa University), Filip van Dingenen (artist), Ellen Schoenmakers (Wild Wier), Julien Le Tellier and Lilian Ducci (Solis Culturae), Vincent Usache (Microphyt), Philippe Lavoisier (Eranova), Eric Klarenbeek and Maartje Dros (Studio Klarenbeek & Dros), Violaine Buet (designer), Jean-François Sassi (CEA Cadarache), Fredrik Gröndahl (KTH Stockholm), Jakob Kudsk Steensen (artist), Jan Wurm (ARUP), Lucie Novoveska (SAMS), Alexandra Dubini (Cordoba University), Shneel Malik (UCL), Brenda Parker (UCL), Marc-André Selosse and Claude Yepremian (Museum National d'Histoire Naturelle de Paris), Hilde Methi (LIAF 2019), Astrida Neimanis (University of Sydney), Samuel Iliffe, Reeve Schumacher, Studio AATB, Lilly Sophie Gratzfeld.

ALGAE SUMMIT INTERVIEW WITH JOHN THACKARA

John Thackara is a writer, advisor and event producer whose work is focused on exploring how communities think and take action to realize a sustainable future.

Why did you watch the Algae Summit?

John Thackara: I wanted to know about the ways in which research has progressed into commercial and non-commercial activities, as I observed a kind of growing wave of interest in the use of algae from the industrial corporations. My second interest is more or less the opposite: I am curious about the critical reaction to the idea of commercializing algae. Which new voices are there and what are the arguments to say: “Just a minute, this is not just a new industrial resource”.

These were the main reasons for watching the Algae Summit and I must say I got a great deal of new insights from those two perspectives.

We repositioned algae in the local context of the bioregion but also within the more global context of Gaia, according to the theory that considers the Earth as a living organism. What did you learn from that? Does it change your view on algae as being a valuable resource?

JT: Referring back to the presentation made by Sébastien Dutreuil about the Gaia Hypothesis: it was great to hear a new voice telling a story with fresh language. It’s a story I’ve heard before but in different versions, in the film by Lynn Margulis and the book by James Lovelock. There is also a book by Stephan Harding called *Animate Earth*. This was a real epiphany for me, and it really helped me have a deeper understanding as to why algae, micro-plankton and other small things in our world interact with each other and ‘inanimate’ things, in order to create our planet. So, the more voices telling a story the better!

One of the big questions which we have to ask is: how do we humans go beyond solely seeing the world as a resource for our personal consumption? The economy is an integral part of our reality of course, but it is only one aspect! As soon as you consider something as being a resource, then your attitude, your behaviour, and your relationship with it changes. It’s not about ignoring how important the economy is, but I do think we need to have a critical discussion with people who show up and say: “Hey this is a nice resource”.



It is important that a scientist like Dutreuil tells a story that connects a scientific big picture with a more philosophical approach. The whole Summit has welcomed those different voices, which is one of the reasons why what Atelier Luma is doing is pretty unique.

How can we rely on the Gaia Hypothesis to redefine the human position within the Earth’s life-supporting system? And is granting a legal status to nature part of the solution?

JT: We thought we had made the amazing discovery that Earth was a living thing, but then we realised that several lawyers in South Africa, Germany and Australia were having the exact same conversation! There is also a lot more information available around the idea of the ‘Earth Law’. I am a writer, but I believe creating law is far more effective in shaping human behaviour than words are, as we are forced to obey. It is very slow, passing a bill can take years and decades, but if we can get government laws to shape certain things, then it is very powerful. It is not simply a binary choice between law or culture though, we do need both.

We had a panel discussion about the Blue Economy that highlighted the European Commission’s ambition to work on a European roadmap. We asked the question of how to allow bottom-up initiatives to be heard by European policymakers, and what metrics were needed to measure their impact. What is your position on those issues?

JT: I have slightly lost my enthusiasm towards the European Commission at the moment. We are in a crisis of course, but everything is set up to restore and revive the economy. What we call “roadmaps” or “resource maps” are old ways of thinking about the world we live in. I don’t want to keep having discussions about whether it is relevant to consider nature in terms of resources only.

I think it is boring and part of an old paradigm. We have to replace the word 'resources' with 'living things'. But for various reasons, those institutions are in a system where they have to prove they are going to save the economy, not to transform it.

I would add a comment about the Summit: there are quite a lot of top-down points of view, and I don't think that's where change is happening. The biggest companies or the European Commission can't trigger transformative change. They just can't, whether they want it or not. However they can make it possible, which is why having those types of conversations with them is necessary. Take the example of the artist on the seashore (Filip van Dingenen), and people who learn how to communicate with living things: that's to me where transformation is happening. And that filters up into the political system.

Concerning metrics: I think you should resist being obsessed with metrics. There are a lot of people for whom metrics is a form of practice, and others who have to measure things because they are forced to. However there is a middle ground between the two, which is to believe in the power of cultural transformation. What I appreciate about Atelier Luma is that philosophers and artists are considered as important as scientists and systemic experts. This is the most crucial point in my opinion. You don't need to measure impact if you can tell a persuasive story about your activity in the world.

There is an issue which was also raised during the panel talk around bioremediation strategies: the speakers insisted on the fact that even though they are currently working on ways to clean the air and water, as well as make soils more fertile - all invaluable things - they still feel they are under a lot of economic pressure.

JT: This is a gigantic debate. In the UK this week, they published a paper on the important value of nature. The whole of Europe is going to embrace a model of valuing nature which will provide figures about the amount of clean water, clean air, clean forests and soils. However this is a dilemma, because even though this can lead to positive things, this model can also be used to entrap and monetize natural resources. Once you can determine a price for each natural resource, and agree on a specific number for each one 'this forest is worth X', it becomes easy to raise the money to buy and privatise the forest. Therefore the lack of metrics and agreement on how to financializing things is, in a funny way, a defense against private property. If you can measure the value of algae, someone for sure, before we even think about it, will swoop in and capitalize on that resource.

Hence there is a need to consider the question from a global perspective, which is why the concept of Gaia is so important. You can't divide the world and decide "we put the shit here" and "we can do the good stuff here". And that's sort of where we are at the moment.

That leads us to the concept of "bioeconomy" which is at the core of our activities but is still a rather large concept. We interviewed Marc-André Selosse who is very critical of the bioeconomy.

JT: This whole vegan movement that Marc-André Selosse is talking about is a very good example. Many vegan food ingredients come from the sea, from kelp, and we see the emergence of marine plantations. Some big companies now try to monopolize the growing of these ingredients — which means ocean plantations of a very damaging nature — to get all of these ingredients for all of this vegan food. And that's because one separates the interests of human beings and their diet from the health of the land and from the health of the seas as if it were two distinct things. That's why Selosse and people like me say that you can't just look at bits of the world in isolation. We have to think holistically about our planet and more locally about the bioregions.



Should we keep talking about bioeconomy?

JT: That's a good question: no! You and I can stop talking about it, but the commissioners are obsessed with it, and lots of people are into it.

I have said this a few times: you can argue about it and point fingers at the economists and businessmen — you know, people wanting metrics — or you can focus on getting more and more people to love nature for itself, love life for itself.

And in that way, they begin to become critics. So, I always focus on finding ways to amplify the sort of natural biophilia of human beings that has been distorted by modernity and the capitalist economy. For thousands of years in many cultures, we have valued the richness of societies by the amount of different lifeforms they had in them. Measuring things by GDP or money is a rather recent phenomenon that we have to get out of. Most commissions and most people think of the bioeconomy just in terms of products and services that generate incomes.

If you want to know what the opposite of metrics is, it is poetics. Poetics is what will save us from metrics. We need both, but for me, we need more poetics at the moment.

Do you think the Algae Summit confirmed the role and position of Atelier Luma as a mediator and translator between different voices? Did you think that certain voices were missing?

JT: The position of having scientists and designers and artists and philosophers is perfect because there is no correct answer to the question of where does this algae world take us. We have to explore, and the more voices the better.

Actually, in the Algae Summit, I missed voices from the Global South. The idea that we are part of nature is something that 70% of the world population doesn't have to think about because they already believe that!

During the Summit, the idea of collaborating together on a common roadmap emerged. What would you like to see on this roadmap? And how does that fit your concept of "knowledge ecology"?

JT: I think that roadmaps are not a perfect metaphor. The roadmap implies that you know where your destination is, and I don't think we do know where our destination is. And therefore, having a roadmap is not going to be so helpful.

The notion of "knowledge ecosystem" comes from what we call the agricultural extension that began in the 19th century which allowed the dissemination of agricultural information to farmers all over the world. It rather successfully enabled farmers to adopt new techniques in many places, by basically taking the knowledge to them, rather than having them come to our universities and institutions. So, I actually think that what we have to do now is some version of that but with an opposite agenda: find ways of relating to people with various solutions, and supporting them with tools such as an Algae Summit, advice, or more importantly, connecting them to each other. The most powerful to me is helping people to tell each other about stuff.

And this is a big challenge for most institutions. The business model of universities is to sell valuable expertise. If Atelier Luma wants to become an academy, you should do what you are doing, but do more of it, in a very open way, in a very distributed way. The big fundamental problem is connecting people and connecting them to information. And that is never paid for by metrics by the way, which is another reason to be cautious about metrics.

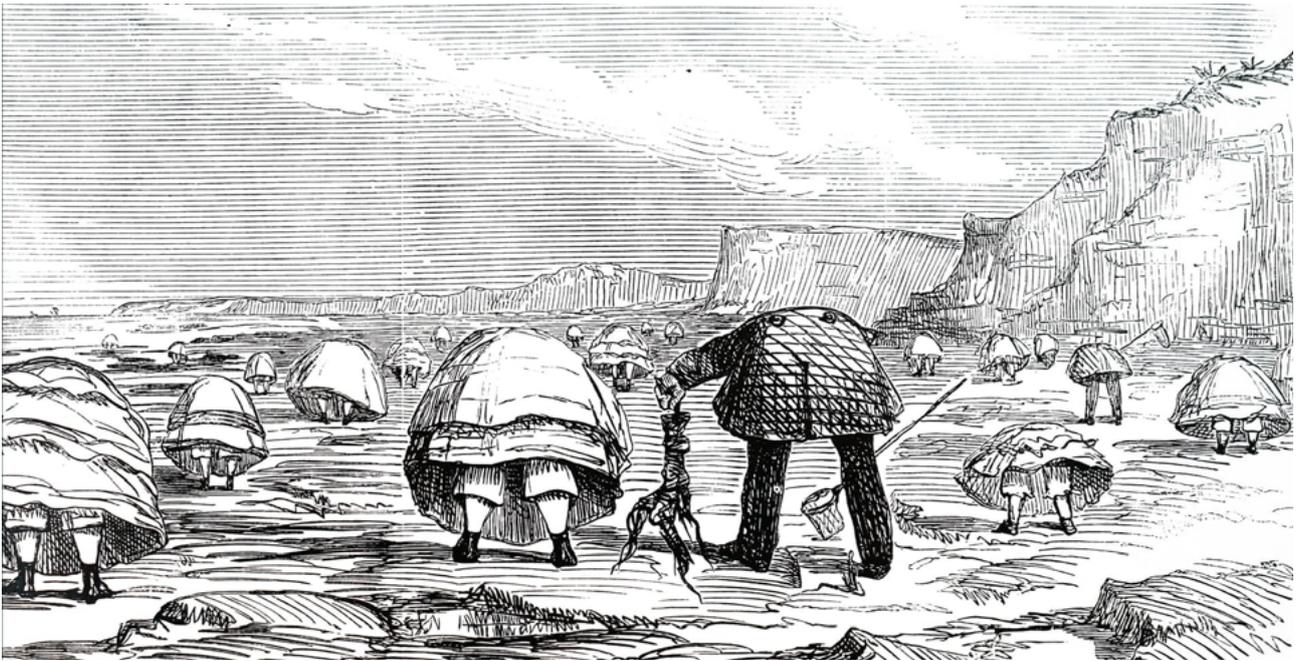
Lastly, a final word: I have become obsessed with the value of librarians. Librarians are people who connect people to information in a way that is grotesquely undervalued by all systems. Nobody values librarians.

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→ BOTTOM-UP BIODIVERSITY

TEXT BY JOHN THACKARA COMMISSIONED BY THE SWISS MINISTRY OF THE ENVIRONMENT, SWISS FEDERAL OFFICE FOR THE ENVIRONMENT

→ THE HISTORY, DEVELOPMENT, AND FUTURE OF AGRICULTURAL EXTENSION, BY GWYN E. JONES CHRIS GARFORTH, UNIVERSITY OF READING, UNITED KINGDOM



OCEAN MEMORY

Still largely unknown compared to land, the oceans are getting more attention as we become more aware of their essential role in balancing global cycles on Earth. However modern record-keeping for ocean conditions only began about 80 years ago. How to retrieve historical data from the ocean?

The Ocean Memory Lab at the Monterey Bay Aquarium, which specialized in collecting historical data from the sea, investigated the historical collections of pressed seaweed. The art of pressing seaweed exploded during the natural history boom of Victorian Britain. While science was a male-exclusive field, it was then socially acceptable for women to go “seaweeding”. At the end of the century, inspired by their British counterparts, American settlers – again, mostly women – started collecting seaweed on the California coastline. That’s how some seaweed specimens from those collections are 142 years old!

As seaweed uses nitrogen to grow, the researchers were able to retrace nitrogen samples by analyzing the tissues of the pressed seaweeds. They revealed historical nitrogen cycles that matched the cycles of ocean currents on the California coastline. This study extended the record of Californian currents by seven decades. It enabled a new understanding of past phenomena, such as a sudden sardine crash in the 1940s.

Technological sensors and drones are developed to explore the ocean. But actually, marine animals and plants might be our best sampling equipment!



SOURCE

→ **WHAT VICTORIAN-ERA SEAWEED PRESSINGS REVEAL ABOUT OUR CHANGING SEAS •**

BY LAURA TRETHEWEY, 27TH OCTOBER 2020

ALGAE, SUPER PHOTOSYNTHESIZERS

Research teams from the Universities of Birmingham and Utrecht are exploring the amazing photosynthetic abilities of certain microalgae that are pertaining to the oldest life forms on the planet. These microalgae have developed extremely efficient light-harvesting systems, reaching a 95% rate of light conversion, that enables them to survive in the most extreme environments.

Using mass spectrometry to analyze the chemical and structural properties of the organisms, scientists try to reveal the architecture of this extremely fine-tuned light-harvesting machinery. These antennas, termed phycobilisomes, facilitate the conversion of light into chemical energy. Understanding how these systems work could be the key to designing new super-efficient organic solar panels. Most solar panels currently work with an average of 20% efficiency.

Professor Albert Heck from Utrecht University pleads for reconsidering the complexity of microalgae: "Our presumption is that when you see algae, they look sluggish and certainly not very interesting. But when you look into the molecular details of the machinery that make them convert sunlight into energy so efficiently, you think these are more sophisticated than the most sophisticated Swiss watch. This needs to be the product of 3 billion years of fine-tuning, called evolution."

SOURCE

→ **SECRETS OF FLUORESCENT MICROALGAE COULD LEAD TO SUPER-EFFICIENT SOLAR CELLS** • BY UNIVERSITY OF BIRMINGHAM , 9TH MAY 2019_

FROM VENICE WITH ALGAE

Every stamp tells a story. Designer Pablo Dorigo Sempere has designed a collection of stamps directly reflecting the situation in Venice. Dorigo collaborated with the Italian paper company Favini, that created a paper made with invasive algae from the Venetian lagoon. Invasive algae blooms are getting more frequent as a reaction to overflows of manmade nutrients and warmer waters. Dorigo also designed the barcodes in a way that is visually interesting, alluding to the digitization of the postal industry that has made the sophisticated watermarks on stamps disappear in favour of those barcodes.

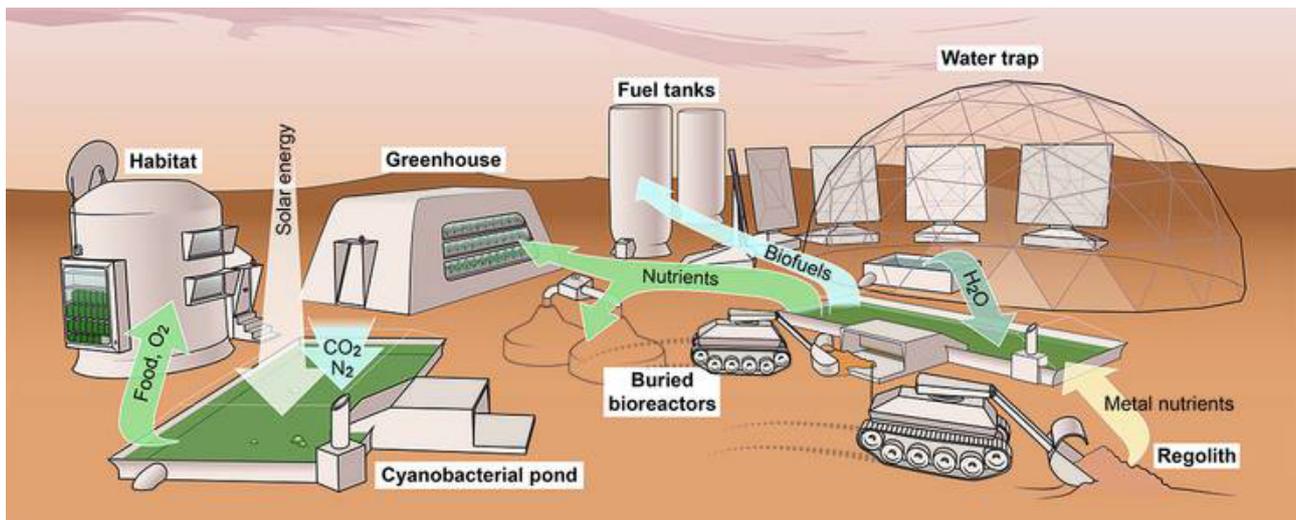
By traveling, stamps tell a story of a specific place and bring it to the other side of the world. Dorigo bridges the gap between technological innovation, the environmental context of Venice, and people. As Dorigo says: "Conveying a story in a capillary way can be very important to change the collective consciousness".

Various global intertwined phenomena are here pointed at through the prism of algae: mass tourism, climate change, and postal communications are reflected in the story of this Venice stamp.

SOURCE

→ **FROM VENICE WITH ALGAE** • BY PABLO DORIGO, 2018





CYANOBACTERIA TO EXPLORE MARS

Sending humans on long-duration missions to Mars is no longer a fictional scenario but the challenge that all major public and private space agencies are seeking to meet in the coming decades. It will be necessary to install crews on Mars, in the medium and long term, in order to be able to conduct research. Such a deployment would make possible to streamline launch costs, travel time, and associated risks. However this would only be feasible if it is supported by a local production system for consumables to ensure the survival of the teams and the proper functioning of the equipment. A system based exclusively on raw materials imported from the Earth would not be sustainable enough to ensure a long-lasting production in the Martian environment.

At the University of Bremen in Germany, in the Laboratory of Applied Space Microbiology (LASM), a team of researchers is considering such a production by exploiting the resources available on Mars and reproducing pre-existing and known biological systems on Earth. In their research, microorganisms offer a solution for producing what humans would need on Mars, including oxygen, food, medicines, chemicals, and waste management.

The LASM team, led by Dr. Cyprien Verseux, is working on the use of cyanobacteria as the basis for a Bioregenerative Life-Support System (BLSS). A BLSS is an extremely advanced survival technology, an artificial ecosystem consisting of multiple symbiotic relationships between plants, animals, and microorganisms. On Mars, cyanobacteria would have to be grown locally from the regolith, gases, and resources available on the planet. The LASM team is evaluating the optimal atmospheric conditions for their growth and productivity.

In a not-so-far future, Mars could host a replica of Earth's natural cycles, at the heart of which the preservation of the minuscule cyanobacteria is the only condition for life sustainability.

SOURCES

→ **A LOW-PRESSURE, N₂/CO₂ ATMOSPHERE IS SUITABLE FOR CYANOBACTERIUM-BASED LIFE-SUPPORT SYSTEMS ON MARS** • BY CYPRIEN VERSEUX*, CHRISTIANE HEINICKE, TIAGO P. RAMALHO, JONATHAN DETERMANN, MALTE DUCKHORN, MICHAEL SMAGIN AND MARC AVILA, 16TH FEBRUARY 2021

→ **UNIVERSITY OF BREMEN LABORATORY OF APPLIED SPACE MICROBIOLOGY** • BY DR. CYPRIEN VERSEUX

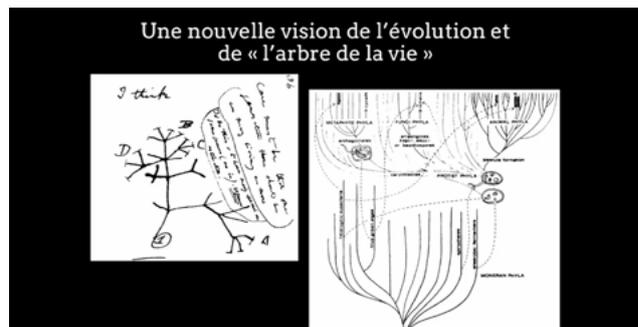
ALGAE AND THE GAIA HYPOTHESIS

Developed at the heart of the 1960s and 1970s, at the age of space exploration and the Voyager missions, the Gaia Hypothesis bears witness to the new point of view that humanity is discovering: the Earth seen in its entirety, from a distance, and among an infinite number of other planets. James Lovelock, then working for NASA to detect life on Mars, began studying the Earth from the context of space. By reversing the reference point of observation, he examined what differentiated it from other planets. Bruno Latour underlines the importance of this original gesture by drawing a parallel with Galileo Galilei, who observed the other planets from Earth to find similarities.

As we understand more about the composition of the other planets in the solar system, we notice that the Earth stands out as an exception, in that it is the only one which offers the necessary conditions for the appearance of life and its maintenance. Following these observations, James Lovelock and biologist Lynn Margulis formulate the Gaia Hypothesis: it is Life which, by regulating the global environment, ensures its stability and its capacity to host living things. And the profound changes that occurred on Earth since the initial Big Bang, such as large-scale climate change, geological transformations, and the appearance of metal ores, are the result of an interrelationship between living things and the physical elements of the Earth itself.

Sébastien Dutreuil, historian of science at the CNRS, revisited the Gaia Hypothesis showing the central role of algae. Lynn Margulis, co-author of the Gaia Hypothesis, observed that the chloroplasts present within plant cells, that perform photosynthesis, directly come from ingested (and not digested!) cyanobacteria: a phenomenon called endosymbiosis. These observations imply that there might be connections between the different branches of the tree of life and challenge our conceptions of biological individuality. Secondly, Lovelock showed that algae play a major role in the continuity of global cycles thus massively impacting their geological environment on a global scale. From that perspective, the environment is necessarily a global concept, which leads us to fundamentally rethink the borders between organic and non-organic matter. The atmosphere and the oceans, directly shaped by life, could be considered as a “vital extension”.

Sometimes caricatured and controversial, the Gaia Hypothesis gained importance in the 1980s with the awareness of the climatic emergency. It changes the philosophical approach to nature, humans, life, and the environment. In the words of Sébastien Dutreuil: “It is indeed the acknowledgement of a new entity, Gaia, which has both played a founding role for the sciences of Earth’s systems and was the basis of a new understanding of nature for political ecology”.



Watch again the presentation by Sébastien Dutreuil “Algae at the centre of a transformation of our concepts of the Earth, life and nature : Margulis, Lovelock and Gaia” broadcasted during the Algae Summit at 1:13:00



LONDON PILOT USING ALGAE TO FILTER URINE

by Samuel Iliffe

In October 2019 I started working on an offshoot of the Algae Platform, based in London and developed in collaboration with the Royal Academy of Arts. I was eager to explore what was both complementary to the current research interests of the Atelier and inspired by the urban landscape I was in.

Over the course of a year, I researched the potential of algae as a biomaterial and how one could use its incredible properties to benefit both humans and urban ecosystems. The eventual idea of using biomaterials as filters came from observations of the algae in London's rivers at the time.

On one of my research trips around London, I found an algae bloom in the River Lea. It was an example of a stage in the eutrophic process, a chain reaction initiated by an excess amount of what is usually a limiting factor for growth (the main factors being light, nitrogen, heat, and phosphorus). The blooms affect other organisms in the river ecosystem: they can disrupt other organisms' senses, they can be toxic when eaten, and they can create oxygen-deprived "dead zones" when they decay. They can also be harmful to humans, and a 2009 study found that the estimated costs of eutrophication are \$2.2 Billion annually in the United States alone.¹

Although there is evidence that eutrophic events happened before the Industrial Revolution, anthropogenic activities have made them more common. Fertiliser overspill in rivers, wastewater overspill in heavy rain, insufficient wastewater treatment (to be clear, the main goal of wastewater treatment is not to remove nitrogen or phosphorus, it is to remove parasites and pathogens), and increased warming due to climate crises all produce an excess of the limiting factors, thereby increasing the number of events. Limiting these anthropic factors is key to reducing eutrophication.

From a practical perspective, it would be impossible to control the amount of heat and light on a body of water like the River Lea, and many algae are diazotrophic - meaning they can source nitrogen from the air - so have a plentiful source, which is again difficult to control. But like a row of windows in a line, only one window needs to be dirty for the entire row to be obscured; only one of these factors needs to be limited to stop an eutrophic event. So it turns out that eutrophic events can effectively be stopped by reducing the excess of a single nutrient - phosphorus.²

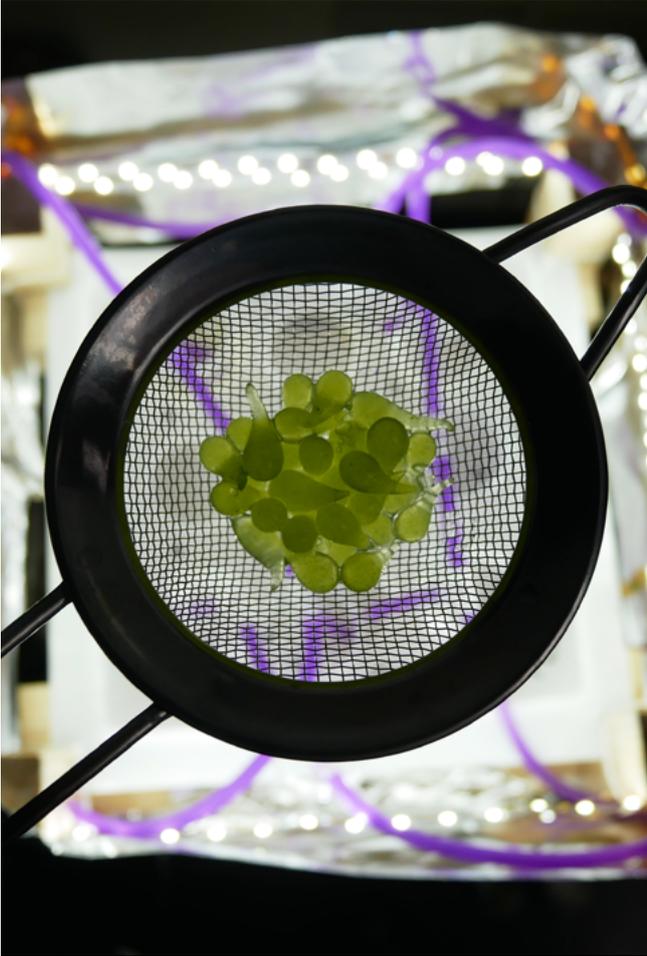
Excess levels of phosphorus tend to be a problem in countries with larger urban areas³. This can be explained by the fact that 53% of anthropogenic phosphorus pollution comes from domestic wastewater. Further inspection of the composition of domestic wastewater⁴ shows that while urine makes up around 1% of domestic wastewater by volume, it contains around 56% of the phosphorus, meaning that 30.4% of all phosphorus pollution (the single largest source) comes from human urine. Therefore removing phosphorus from urine is an effective method of tackling the problem of eutrophication in freshwater bodies.

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3 Mekonnen, M. M., & Hoekstra, A. Y. (2018). Global anthropogenic phosphorus loads to freshwater and associated grey water footprints and water pollution levels: A high-resolution global study. *Water Resources Research*, 54, 345- 358.

4 Yukesh Kannah R. et al. (2019) Valorization of Nutrient-Rich Urinal Wastewater by Microalgae for Biofuel Production. In: Gupta S., Bux F. (eds) *Application of Microalgae in Wastewater Treatment*. Springer, Cham

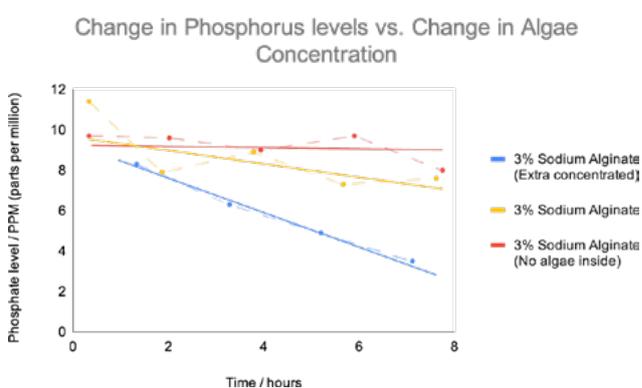


I spent time looking at several methods of removing phosphorus from urine. Our current way of dealing with urine, especially in urban areas is quite different from even 200 years ago: before the understanding of fertiliser, urine was inadvertently used as an unofficial fertiliser for plants. It has been described as a “virtuous cycle”⁵, which has been broken in urban areas.

The phosphorus used in agriculture is currently supplied from mining phosphate rocks. Use of mineral fertilizers boomed in the second half of the 20th century along with the development of intensive agriculture but reserves are now declining. On top of that, most of the phosphate used on the field is actually wasted as it runs off the field. In short: the phosphorus in our urine comes from the food we eat, which needs fertilizer to grow, which is extracted from the earth. Looking at urine as a source of fertilizer is a way to circle again the cycle.

During this time I conducted interviews with farmers around the UK. Some of the farmers were using biofertilizers, in other words fertilisers that contained living microorganisms like cyanobacteria, a form of algae. Biofertilizers promote growth in the plants, are able to give them nutrients more efficiently and do not run off in the same way that mineral fertilisers do.

With all this in mind, my approach was to grow algae on urine, and then valorise the algae as a biofertilizer for farmers. I analysed the ability of algae to remove phosphorus from urine and found that polycultures are more suited to this than monocultures, since a pathogen which can decimate a whole monoculture might not affect all the organisms in a polyculture. I redesigned a urinal mat, traditionally used to stop men’s urine splashing back on themselves, to encase the algae. The urinal is useful as it is a separated source of urine. The materials used to encase the algae were hydrogels, which allowed nutrients to pass through but prevented the need for expensive methods of separating the algae from the urine, such as centrifugation. Further redesigns of the mat used many algal beads secured in a net, as this drastically simplified the production process and improved the rate of phosphorus removal.



And yet, after almost a year, this is just the beginning of what could be a new area of research, the validation of an idea. To progress further, more experiments are needed, stricter protocols and controlled conditions. What about differences in urine from person to person, say, with someone who was diabetic? Or had a virus, as pathogens are passed out through our urine and faeces? Would intermediate steps, such as converting the phosphorus in the urine to struvite⁶, be enough to remove the problematic legal aspects of using human waste products as a fertiliser? Or could this be used for non-edible crops like bio-oils? What are the best ways of collecting this source of phosphorus? As with all exciting areas, any new answers bring many more new questions.

5 J. Driver , D. Lijmbach & I. Steen (1999) Why Recover Phosphorus for Recycling, and How?, Environmental Technology, 20:7, 651-662.

6 Struvite are phosphate minerals that can easily be produced from urine



NEWS

→ The exhibition *Critical Zones - Observatories for Earthly Politics* at **ZKM Karlsruhe** (Germany) is extended to August 8th. Atelier Luma presents its project *Algae Platform* within the **BiodesignLab**, an incubator and platform for production launched by the Karlsruhe University of the Arts and Design. **The BiodesignLab** was presented for the first time in the context of *Critical Zones*.

→ Atelier Luma takes part in the exhibition *Plant Fever* at the CID Grand Hornu (Belgium) open until March 7th, with a few pieces produced during a pilot project developed in Sardinia in collaboration with IS FAINAS cooperative (with the support of the MEDSEA Foundation and LUMA Arles). *Plant Fever* will travel to Switzerland as the Museum Für Gestaltung in Zürich announced it will host the exhibition from December 3rd 2021 to April 3rd 2022.

RESTITUTION ALGAE SUMMIT AND INTERVIEW JOHN THACKARA

Image 1, 5, 6, 7

Studio installed in Atelier Luma for the Algae Summit
©Adrian Deweerdt

Image 2

Presentation of the INDUS system by Brenda Parker and Shneel Malik during the panel talk *Bioremediation Scenarios* as part of the Algae Summit program.

Image 3

Presentation of the project ROCPOLife for the restoration of *Cystoseira*, by Mariachiara Chiantore (University of Genoa) during the panel talk *Algae: Resources & Territories* as part of the Algae Summit program.

Image 4

Extract from the video "Algae Diplomacy" with Filip van Dingenen and Ellen Schoenmakers, broadcasted during the Algae Summit.

Image 8

Portrait of John Thackara
©Uroš Abram

Image 9

Extract from the video *(Re)Valorising the living*, with Marc-André Selosse from the Muséum National d'Histoire Naturelle, broadcasted during the Algae Summit.

OCEAN MEMORY

Image 1

A 19th century cartoon by John Leech depicting British enthusiasm for natural history
©Universal History Archive/Universal Images Group/ Getty Images

Image 2

Sample of Victorian-era seaweed at the University Herbarium, University of California, Berkeley.,
©University Herbarium, University of California, Berkeley

FROM VENICE WITH ALGAE*Image 1*

Stamp designed by Pablo Dorigo Sempere using an algae-based paper by Favini
©Pablo Dorigo Sempere

Image 2

Postcard from Venice and stamp designed by Pablo Dorigo Sempere
©Pablo Dorigo Sempere

CYANOBACTERIA TO EXPLORE MARS

Rendering of a cyanobacterium-based life-support system (CyBLiSS) on Mars.
©Artwork by Sean McMahon, originally published in Verseux et al. (2016).

ALGAE AND THE GAIA HYPOTHESIS

Screenshots of Sébastien Dutreuil's presentation at the Algae Summit
©Sébastien Dutreuil

ALGAE PLATFORM COLUMN*Image 1*

Samuel working in the architecture studio at the Royal Academy of art
©Agnes Sanvito

Image 2

Algal beads prototype for removing phosphorus from urine
©Samuel Iliffe

Image 3

A test rig designed so that several small photobioreactors could test in unison the effect of different variables on the amount of phosphorus removed from water
©Samuel Iliffe

Image 4

Prototype of urinal mat containing algae
©Samuel Iliffe

Image 5

The Tennessee Valley Authority, formed after the great depression in 1933, paid for test farms to show the benefit of using phosphate among other mineral fertilisers in crops.
©Franklin D. Roosevelt Presidential Library

NEWS

Exhibition of the Algae Platform project at the BioDesignLab of the Karlsruhe University of the Arts and Design, as part of the Critical Zones exhibition at ZKM.