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Art meets geology

The IHME Helsinki 2021 commission brings the distant past and future to Helsinki in the autumn

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The IHME Helsinki 2021 commission

IHME Helsinki is a contemporary art organization that situates its activities in a dialogue between art and science. Collaborating with artists and Finnish and international partners, IHME Helsinki has for ten years commissioned annual art projects aiming to promote eco-social education and a sustainable and democratic society.

To Burn, *Forest*, *Fire*, the title of Katie Paterson's IHME Helsinki 2021 commission was born out of the artist's fundamental drive to create artwork that heightens awareness of the sixth extinction. Using scent to explore the first-ever forest on earth, and the last forest in the age of the climate crisis, the artwork employs the senses to cultivate an intimate, intuitive experience that aims to transport participants through time as a reminder of the increasing levels of extinction caused by humanity.

To Burn, *Forest*, *Fire* explores the scent of the first-ever forest on earth, and the scent of the last forest of the age of the climate crisis through the creation of bespoke incense sticks. The project collaborates with scientists to define and characterize the first and last forests, the scents of which will be made into incense and then burned across a variety of sites around the city of Helsinki in autumn 2021.

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Scientific collaborators

To pinpoint the first and last forests, the project turned to geology, and the scientific knowledge about the long-term evolution of life on Earth. A team of advising geologists was assembled, including **Prof. Jan Zalasiewicz** (University of Leicester, UK) and **Dr. J. Sakari Salonen** (University of Helsinki), with further comments and advice from **Prof. David George Haskell** (University of Sewanee, USA), **Dr. Chris Berry** (University of Cardiff, UK), and **Prof. Sarah Gabbott** (University of Leicester, UK). In addition, the collaborators include ecologists and biologists specialized in modern-day, threatened rainforest biomes (**Dr. Ana María Yáñez Serrano**, Center for Ecological Research and Forestry Applications (CREAF), Spain; **David Romo Vallejo**, Tiputini Biodiversity Station, Ecuador).

First forest detailed

How does one locate the first forest on ancient Earth? There is no straightforward answer to this question. Indeed there cannot be, as life took a long while to evolve onto land, to be able to cope with the ever-present threat of drying out and huge day-night temperature swings, perils which are absent or much reduced in life's birthplace, the sea. It took many millions of years for life on land to gradually evolve from patches of algae in a few wet, low-lying places, to small simple land plants such as mosses and liverworts, to thickets of simple stems just a few centimetres high, to larger plants with stems, leaves, bark, deep roots – indeed, to the kind of things that we would recognise as forests: assemblages of plants big enough to tower over a human, and extensive enough to get lost in.

Reaching this state was slow and gradual – but our task in choosing a "first" forest is helped because it is not easy to fossilize a forest. Growing on land, they are subject to decay and erosion, and most forests on Earth have simply been recycled into the biosphere: it is rare for them to be buried and petrified in place, to be preserved well enough to yield their secrets, very much later, to questing palaeontologists.

Looking among the rare examples of fossil candidates for the "first forest", the consensus example chosen was a North American example from the town of Cairo, in New York State. This is from broadly the same set of strata that had yielded, in the 19th century, a classic fossil forest in Gilboa in New York State, long regarded as the "earliest forest". But the forest here, discovered in 2009, is 2–3 million years older at some 385 million years old, dating back to the middle of the Devonian Period (Stein et al. 2020). There are no fossilized stands of upright trees here, though (such things do happen in geology, but exceedingly rarely). Rather, what is now left of the forest is part of the root system within a fossilized soil, about the size of a football field. It preserves the remains of at least three types of ancient plant species, including the earliest known examples of *Archaeopteris*, which has a claim to being *the* pioneering tree species, with well-developed roots, a large trunk and branches with leaves. Pack those together, and a shade-giving primeval forest takes shape, something that, according to Chris Berry of Cardiff University, one of the team of scientists that discovered and analysed the site, had not been present on Earth before.

What would it have been like, this forest? A shady place of greens and browns, certainly, but probably with little other colour – the evolution of flowers was still a long way into the future. A quiet place, probably – not quite bereft of animal life, for small millipedes, mites, springtails, crustaceans and other invertebrates had already moved onto land with the plants. No vertebrates walked through that forest, though – this was still ten million years before the first evidence we have of amphibious "fishopods" like *Tiktaalik*. If one was to go fishing in a river that ran through that forest, though, one might pull out an early freshwater fish (it might make for difficult eating, though, because of its heavy armour). For a time-travelling human, it would be a somewhat alien and unsettling place.

Searching for the last forest

While our search for the first forest had its own challenges, it was constrained by geological history and past analogues found therein. By comparison, the last forest presented far more of a conundrum.

In the long term, climate change could precipitate a wide-ranging transformation of Earth's ecosystems. We might be headed, at a minimum, towards a world similar to the Pliocene (about 3 million years ago), with several metres higher sea level and about 2 degrees warmer temperatures (Fischer et al. 2018). If climate change proceeds unchecked, a closer analogue could be provided by the 'Greenhouse Earth' of the Eocene (about 50 million years ago), when tropical forests with palm trees and mangroves extended up the latitude of Helsinki (Wolfe 1985).

On even longer timescales, the fate of life on Earth is bound to the evolution of the Sun. The Sun is getting brighter as it ages, from 70 % of its current energy output in Earth's early history, and with a continuing increasing trend. In about a billion years, Earth's oceans will start to evaporate, and the planet will enter a transformation into a global desert. The Earth is expected to become hostile to complex multicellular life in about 1–1.5 billion and completely sterilized in about 3–4 billion years (Adams 2008).

What might the very last forest be like? One could envision a final microclimatic pocket, just cool and moist enough, perhaps on a shady flank of a high-elevation mountain range somewhere in the polar latitudes. In a world that has largely dried out under the relentless heat of the Sun, such an environment could sustain a sparse, drought-adapted woodland – perhaps similar to the Tibesti and Hoggar mountains of Sahara, where relics of an ancient Mediterranean forest biome survive today (Prentice et al. 2000), sustained by slightly elevated rainfall compared to the surrounding desert.

Due to the highly speculative nature of these future environments, we ultimately turned to modern-day forests projected to be under variably immediate threat. We briefly considered the boreal forest (taiga) so familiar to the Finnish people. Ultimately, however, our decision fell on a biome that is acutely endangered, and has become an emblem of the ongoing ecological crisis: the Amazon.

Home to about 10 % of all biological species on Earth, the Amazon has thus far been deforested by about 20 %, projected to reach 27 % by 2030. The rate of deforestation was successfully reduced by

the early 2000s, however starting from 2016 the rate has again rapidly increased, due to the reversal of conservation policies in Brazil during the presidencies of Michel Temer and Jair Bolsonaro. A second, insidious threat to the Amazon arises from climate change. Reduced rainfall due to climate change is driving a feedback loop in the Amazon involving wildfires and the local hydrological cycle, which could convert much of the rainforest to savanna by the end of this century (Staal et al. 2020).

In our work, the Amazon is represented by a single locality: the Tiputini Biodiversity Station in the Yasuni Biosphere Reserve in Ecuador. The Tiputini station provides the IHME commission a discrete look into the Amazon which, at least for the time being, remains a vast and varied rainforest biome.

From forests to scents

In an ongoing, final stage of the work these past and future environments are being translated to incense, in collaboration with Shoyeido, a Japanese company which has developed incense products for over three centuries. The scent of the first forest is guided by basic, identifiable elements of the Devonian environment: the soil, the plants and their closest modern analogues such as lycopsids and liverworts, and the swampy aroma of anaerobic decay. But perhaps as defining are the smells which were *not* present in the primordial forest lacking most modern vegetation components.

By comparison, the scent of the last forest can be developed from a much wider body of hard data. The research on airborne volatile organic compounds (VOC's) by Dr. Ana María Yáñez Serrano describes the chemical constituents of the modern rainforest scents: the isoprene emitted by almost all plants, but also an assemblage of dozens of monoterpenes and sesquiterpenes unique to the Amazon. This chemical foundation is complemented by careful descriptions made by the staff of the Tiputini station in Ecuador, including guides who have lived in the Amazon for their entire lives. Field observations in the vicinity of the station in February 2021 recorded a stunning array of scents, from the alcoholic fizz of guava trees to the fresh peanut-like aroma of the earth, all combining to a unique sweet and bitter fragrance of the modern Amazon.

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Websites

IHME Helsinki: https://www.ihmehelsinki.fi/
Tiputini Biodiversity Station: https://www.usfq.edu.ec/es/estacion-de-biodiversidad-tiputini-tbs

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