To Burn, Forest, Fire, Katie Paterson's IHME Helsinki 2021 commission, was born out of the artist's fundamental drive to create artwork that heightens awareness of the world's 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 and last forests through the creation of bespoke incense sticks. The artist collaborated with scientists to define and characterise these forests, the scents of which have been made into incense and burned across a variety of sites around the city of Helsinki.

The Earth's first forest grew in modern-day Cairo, New York State, 385 million years ago. It was discovered through fossilised root systems containing three types of ancient plant species, including *Archaeopteris*, which had well-developed roots, a large trunk and branches with leaves. 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.

The second incense stick recreates the scent of a living forest biome that is acutely endangered, and has become an emblem of the ongoing ecological crisis: the Amazon Rainforest. Home to about 10% of all biological species on Earth, the Amazon has thus far been deforested by about 20%. 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.

In *To Burn, Forest, Fire*, the Amazon is represented by a single locality: the Tiputini Biodiversity Station in the Yasuní 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.

These past and future environments have been translated into incense, in collaboration with Japanese perfumers and incense makers Shoyeido. 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.

By comparison, the scent of the last forest can be developed from a much wider body of information. Dr Ana María Yáñez Serrano's research on airborne volatile organic compounds (VOC's) describe 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 and local groups at the Tiputini Biodiversity Station in Ecuador. Field observations in the vicinity of the station in early 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.

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 included 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, collaborators include ecologists and biologists specialised in modern-day, threatened rainforest biomes: Dr Ana María Yáñez Serrano (CREAF, Ecological and Forestry Applications Research Centre, Spain) and David Romo Vallejo (Tiputini Biodiversity Station, Ecuador).

To Burn, Forest, Fire, has been commissioned by IHME Helsinki, a contemporary art organisation that situates its activities in a dialogue between art and science. Collaborating with artists and Finnish and international partners, IHME has commissioned annual art projects for ten years. IHME's current aim is to promote eco-social education and a sustainable and democratic society. IHME Helsinki's work is made possible with support from Pro Arte Foundation Finland, Kone Foundation, and Saastamoinen Foundation in 2020–22.

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On the aromas of the first and last forests
David George Haskell

Inhale: Beginnings. The Earth's first forests.

Exhale. A space between breaths.

Inhale again: Endings. The last forest.

Aroma carries us through time. Katie Paterson's *To Burn, Forest, Fire* uses bespoke incense to transport us. Our senses lead. Imagination follows.

Humans have used incense for thousands of years, mostly as a bridge to what dwells beyond the everyday, through prayer, oblation, and ritual. *To Burn, Forest, Fire* places that experience into the context of deep time and the living Earth community. The aromas of these ancient and future forests are portals. The conveyance that the aromas bring about is partly metaphorical, carrying our minds and emotions into the past and future. But incense also *literally* connects the human body – our experience of the world – to other times and places. When volatile molecules, those chemicals that we call "aromas", enter our nasal cavities, they bind to fragile microscopic hairs on receptors cells. These cells then signal to the deepest parts of our brain, neural centres where memory, emotion, and a sense of time reside. Aroma moves us, working below and at the edges of conscious awareness.

The aromatic experience of each incense stick has many layers, a reflection of the ecological and geological diversity of the forests. Katie Paterson and her team conducted extensive research into the nature of forests for each time period, including interviews with experts, and then worked with the Kyoto-based company Shoyeido to weave this knowledge into a complex but coherent sensory experience. For over three hundred years, incense makers at Shoyeido have perfected the craft of sourcing and blending natural raw materials to yield aesthetic experiences for both sacred and secular contexts. Thus, when we smell the burning incense of the last and first forests, we experience art as a confluence of traditional ecological knowledge, scientific insight, and the perfumier's craft, connected in a creative act that gives us an intimate connection to the many meanings and origins of the molecules in incense smoke. The aroma of this incense, then, not only carries us to other times and places, it offers an experience of wholeness, one in which the complexity of forests and human knowledge resolve into a coherent sensory experience.

The exact age of the "first forest" is hard to pin down. The first algae colonized the damp edges of the Earth's primordial waters about 450 million years ago, but these were mats, not forests. The first fossilised evidence of roots is from 407 million years ago, from low growing, creeping club mosses. It is about 393 million years ago that we find the first evidence of tree-like forms, plants that had extensive root systems and tall trunks. These dates are all approximations and are too conservative: the very first forests were likely decomposed and recycled into the ecosystem by bacteria and fungi, just as almost all forests are today, leaving no fossil marks in stone for humans to exhume hundreds of millions of years later.

In *To Burn, Forest, Fire*, a 385-million-year-old site serves as the exemplar of the first forest. The site, in rural New York State, dates from mid-Devonian period. At this site, three different kinds of fossilised roots were discovered on the floor of a quarry, the fossilised remains of one of the earliest known forests on Earth. One root type, belonging to ancient fern-like plants called *Eospermatopteris*, is just a centimeter wide. They radiate horizontally for a meter or two from the bulb-like base of the trees. Another root type, known from a single specimen of what may be a giant clubmoss, also grows from the remains of a swollen trunk base, starting with thicker roots that break into rootlets. Most impressive of all, stout roots of an ancient fern-like plant that may be distant ancestor of seed plants, *Archaeopteris*, reach out laterally from the base of trunks. They extend across the exposed floor of the quarry up to eleven meters. These spreading fossil roots then branch, and then end in fans of rootlets. Just like a modern forest, each tree species in this ancient grove had its own root architecture. Only the bases of trunks were fossilised here, not the higher parts of the trunks. The trees' roots were preserved when a flood buried them in oozy mud. We can infer from roots and trunk bases that this was a place where trees stood tall, creating both a canopy and a shady understory.

Inhale the incense and imagine what it would have been like in this ancient forest: the ground was wet, and so

the aroma of swampy, decomposing vegetation merged with the richness of clay and loam, smells familiar from freshly turned soil today. The ancient plants of that time left modern descendants – mosses, clubmosses, and ferns – and so pressing our noses to these living plants gives us a hint at how the vegetation would have smelled. Mosses combine the aroma of deep green lushness with an acerbic tang. Ferns are sweetly vegetal, edged with woodsy spiciness and the vigour of humus-rich soil. So distinctive is the smell that perfumiers give it a name, fougère, from the French for fern, a prominent part of many perfumes. Clubmoss is a rare plant today, but dominated many ancient forests. When I press my nose to it, I smell rain-wettened hay, like a late-summer meadow after a shower. Tearing a leaf, I release the smell of fresh lettuce leaves.

The first forests were richly aromatic, and some of these aromas persist into our present time. But these were also places that would be alien to human senses. There were no aromas of flowers or fruits. Familiar trees like oak or pine were absent. This world had no smells of tannic leaf litter from deciduous forests. The gorgeous resinous warmth of piney forests was missing, too. Our other senses would also find the place strange. Although insects lived in the forest, none sang. Frogs, birds, and mammals were absent, too. Indeed, the first terrestrial vertebrate animals had yet to emerge from the water, and so not even the footfall of large amphibians stirred the air. The soundscape was of wind and rainfall in ancient plants, enlivened perhaps by the wing whir of the very first flying insects. The absence of flowers and birds meant that colours of these forests were likely the green, grey, and brown of vegetation and soil. The waters teemed with fish, but even these would seem peculiar to us: many were jawless or plated with hefty bony armour.

Inhale: Beginnings. Our imagination reaches for the Earth's first forests.

Exhale: Turn to the future. The last forests.

Earth has perhaps another billion or so years of habitability before the Sun's expansion torches all life. In about seven billion years, the Sun will engulf the scorched remnants and disassemble our former home. We are stardust, Carl Sagan reminded us. And to stardust we all will return. But forests face a much more imminent threat, one brought about by the climate and extinction crises caused by humanity's ravenous appetites. Imagining the last forests on Earth makes us confront the consequences of our actions, both collectively and individually. "What will be the last forests on Earth?" is a deeply uncomfortable question, its specificity bringing to vivid life the losses of our age and the times to come. The question comes with a hope that we will change paths and avert the loss. Yet, if we do not: what will these last forests be?

The last forests may be outposts of trees on a planet otherwise too hot and arid for sustained plant growth and healthy soils. These redoubts may be in high mountain valleys, perhaps near the poles, or close to the world's last freshwater springs. They might also be in lands too rugged for human access, on cliff ledges or remote islands. For *To Burn, Forest, Fire*, Katie Paterson turned to threatened modern-day forests, choosing a location in the Amazon to represent the imagined last forest on Earth.

The Amazon, its people and biodiversity are threatened both by land clearing and by climate change. Forest loss there has been relentless for decades and, after a short-lived lessening of the pace of cutting, has recently increased. Climate change also imperils the forest by altering temperature and rainfall so severely that fires become more common and the regeneration of trees slows or halts, even without fire. As a consequence, by the end of this century, the Amazon forest as we know it may be gone, replaced by cleared land and savannah. This decline is a major driver of the extinction crisis. The Amazon is the largest remaining tropical rainforest and, along with other tropical forests such as those in Africa and Asia, is home to the greatest densities of species known anywhere on Earth. Deforestation in these regions has brought us to the Earth's sixth mass extinction. The loss of the Amazon is also a human rights crisis, as the indigenous peoples are deprived of their rights to land and livelihoods. Currently, a wave of violence directed at indigenous defenders of the forest is sweeping the region.

As with the first forest, the Amazon is represented in *To Burn, Forest, Fire* by a single locality, the Tiputini Biodiversity Station, located in the Yasuní Biosphere Reserve in Ecuador. This site provides a singular exemplar of the Amazon forest which, at least for now,

remains a vast and varied rainforest biome. Scientists estimate that this part of the Amazon is home to the highest density of species anywhere, a conclusion derived from studies of the numbers of plants and animals found within Yasuní. The six hundred species of birds and over one hundred and fifty species of amphibians in Yasuní represent the most diverse communities of these species in the world, supported by four thousand known plant species. A single hectare of forest here can contain more species than thousands of hectares in the temperate world.

Such diversity produces a rich sensory world. Colourful birds and flowers abound. Hundreds of different insects, frogs, and birds sing day and night. The odours are overwhelmingly varied and intense. Every tree, patch of leaf litter, and animal has its own aromatic signature. To walk in the forest is to move through thousands of different smells, an immersion in the world's most diverse collection of fragrances. To discern some of the most noticeable scents, scientists and local guides shared their insights and experience: armadillos smell of rotted leaves, whereas peccaries smell of salty, concentrated chicken broth. The garlic vine has a sweet, medicinal smell, contrasting with the alcoholic fizz of fermenting fruits from guava and other trees. The soil and leaf litter are variegated, smelling of fresh peanuts in some places, cloves, pepper, or mould in others. Algae coat every twig and leaf, raising a briny, chlorophyllic haze.

Through the incense of the last forest, our senses bring us into direct relationship with the living Earth's richness, a wordless experience of the diversity of life. This embodied connection and understanding is a stimulus to imagination and a ground for ethical discernment. After all, we live in relationship to the Amazon and other threatened forests every day – in the air we breathe, the palm oil in our diets, the fuel in our homes and vehicles, and the wood in our furniture, musical instruments, and other forest products. Yet, these connections are almost all hidden from our senses and thus our human ability to understand. Here, the connection is made manifest directly to our most primal sense, smell. This manifestation calls us to foundational questions: what are the relationships that sustain us? How should we honour and sustain these? What is our role in the last forest – will we hasten this end or forestall it?

Inhale. Connect, both to the forest and to inner reflections and understandings.

In *To Burn, Forest, Fire*, incense is not isolated inside a worship space or meditation hall, the doors closed against other beings while we cultivate our relationship with the divine, sending smoke heavenward. Instead, the swirling incense smoke draws our attention outward into the world around us – the world as it was in the first forest and as it might be in the last forest. Our imagination is drawn into biological and geological deep time, and into the community of life. These are mostly times and places that are strange to us, but they should not be so. We are a species born in relationship to forests. Forests sustained our ancestors and they are essential to human life today. In the aromas of the first and last forests of the world, we sense the forests' stories, but also a part of our own histories and futures.

Aroma is a powerful messenger. When we smell a forest, we sense that a tiny part of the forest is inside us, literally bound to the cell membranes in our noses. Sight and sound are not so intimate. They act through the intermediaries of energy waves. But aroma offers a direct connection from the substance of the forest, via our senses, to human memory and emotion. This is an experience of interbeing, to use the term coined by Buddhist teacher Thích Nhất Hạnh. Aroma is a call to remember that we live in a relationship with the forest. This relationship has a narrative arc – from the first to the last forests. We now have a choice. Will we bring about the premature end or diminishment of this long arc? We can choose some of the direction of the story.

Inhale: Beginnings.

Exhale.

Inhale: Endings.

What will we do with the space between the breaths, between first and last?