

## TIMES EVOKE

### THE TREES OF OUR LIVES

Sometimes, the greatest journeys occur when we stand still. This is an important lesson from one of nature's miracle-workers — the tree. Today, as the world comes to a standstill, trees offer us amazing journeys, of insight, learning and memory. In heeding trees, we enrich ourselves immeasurably. Much of the current situation the world faces now comes from its growing disconnect with — and disregard for — nature, its unbounded beauty and its clear boundaries, between species, ecosystems and human needs versus greed. Indeed, in humanity's arrogance over 'mastering' the natural world, we have somewhere forgotten that we are simply one part of it.

This moment offers us a valuable opportunity to reacquaint ourselves with nature's tapestry, starting with an ideal guide — trees. As Times Evoke's global experts point out, trees are among the world's most astonishing marvels of science. A single tree gives two humans clean air to breathe while forming a home for multiple species. Trees cool the air — studies find one tree can have the cooling effect of 10 air-conditioning units — and endow it with moisture, mitigating heat. A tree removes harmful atmospheric chemicals and replenishes groundwater supplies. Through carbon sequestration, trees absorb carbon dioxide, storing this away for years, while protecting the very ground we stand on, preventing soil erosion in floods and storms. Wondrously, trees do all this as sentient beings, communicating with other trees, forming a secret underground world of networks which 'speak'. A global planting of trees, scientists say, can even powerfully mitigate climate change, removing up to two-thirds of the pollutants induced into Earth's atmosphere by human activity.

Times Evoke thereby invites you on a fascinating journey to meet the tree, to learn its science and mysteries, and to recall your own life's trees — a tree that thrilled you with its blossom or fruit. A tree that sheltered you in a storm. A tree that calmed a storm inside you. A tree that might not live anymore, unless you help protect it. For, with every conserved and rejuvenated tree, we are simply protecting our only home, Earth, healing it, so it nurtures our loved ones.

# 'Trees permit human beings to exist — they are miracles of science, and of art'

**Graeme P Berlyn** is EH Harriman Professor of Forest Management and Physiology of Trees at Yale University's School of Forestry and Environmental Studies. Writing for Times Evoke, the renowned environmental expert discusses the science of trees — and their poetry:

Trees have many benefits for the entire life of our planet. Trees tower majestically into the atmosphere where they absorb carbon and release oxygen, a process that permits the very life of aerobic organisms — like humans — to exist. Their roots penetrate deep into the soil where they recycle nutrients around the rhizosphere. Trees occupy only about a third of the terrestrial surface of the Earth — but they are responsible for approximately two-thirds of the planetary carbon capture through the process of photosynthesis. This is performed by tree leaves that grow along the stems and branches into the atmosphere.



Significantly, trees have a large area of leaves per unit of ground surface area as compared to other land plants — this accounts for their immense carbon capture. A key factor is the long life of trees, so the carbon that is taken up from carbon dioxide in the process of tree photosynthesis is stored for the life of the tree. When trees are removed due to clearing for various needs that result from population increases, this carbon repository is lost. This is why we need to continue planting trees of appropriate species in the appropriate places where they can prosper, which includes cities, parks and wild land areas. As Gifford Pinchot, who, along with Henry Solon Graves, was the founder of the Yale University Forestry School, said, "The forests



**WHEN NATURE TOWERS:** The coniferous evergreen redwood is the world's tallest tree. These can grow over 345 feet in height and can live from 500 to 2,000 years

should be managed for the greatest good of the greatest number in the long run." The survival of a healthy planet is certainly one of these "greatest goods".

And in this cycle of good, tree leaves are key organs for the energy of the Earth. Tree leaves aggregate into tree crowns and the tree crowns aggregate into forest canopies. These may form a single layer or several layers, depending on the number and kinds of trees that make up a forest. The overstory and subcanopies form a complex ecosystem — each layer may have a myriad of dependent creatures, like insects, birds, mammals and other organisms, that add to the biodiversity of trees and forests.

The existence of canopies also explains how forests accumulate ni-

trogen from the atmosphere and survive without much fertilisation, while agricultural fields lose nitrogen from the atmosphere using symbiotic microorganisms (rhizobia, Frankia), another striking fact of the natural world.

Also, forests ameliorate climate itself. During the 1930s, President Franklin D Roosevelt of the United States initiated a system of planting windbreaks to ameliorate the blowing away of top soil in the 'dust bowl' areas, from North Dakota to Texas. Tree crowns are the basis for this effect. In the winter, going into a forest seems warmer because of the reduction of wind. In the summer,

forests are cooler because the tree crowns shield the forest floor from direct solar radiation. This effect is also seen in snowmelt — the snow melts first in open fields or meadows. This influences animals as well in these environments.

Trees have been around for about 400 million years — in contrast, humans have only existed for about 100 million years. Once conifers and other gymnosperms dominated Earth, but in the Cretaceous era, flowering plants arose and these are now the dominant flora of the planet. Many of the gymnosperm groups became extinct. Some tree species have become extinct quite recently. The American chestnut, for instance, once dominated the forests of northeastern United States, but an invasive fungus, called the chestnut blight, almost totally eliminated this stately and useful species.

My own favourite trees are the redwoods (*Sequoia*, *Sequoiadendron*, *Metasequoia*). Many of the redwoods have had their distributions greatly diminished because of climate change and pathogens like insects and diseases. I like these trees because they grow fast and live long. There are other long-lived species, like the bristlecone pine (*Pinus longaeva*), but they grow slowly and remain small in stature. In contrast, redwoods have great growth plasticity and change their leaf morphology and physiology with their height along the tree bole. They can also reiterate their architecture after mechanical damage.

Walking through the giant redwood forests of the Sierra Nevada mountains is always an awe-inspiring experience for me. There is magnificent science at work here. Yet, as I walk amidst these forests, I also remember the words of Joyce Kilmer, "I think that I shall never see a poem lovely as a tree..."

### WHEN TREES TALK THROUGH THE 'WOOD-WIDE WEB'

- Forest trees have evolved **cooperative relationships**, maintained by **communication** through **underground networks**
- Trees' deep roots house mycorrhizal networks — a **'mycorrhiza'** is a symbiotic relationship between a plant and a fungus. The plant makes organic molecules, like sugars, by photosynthesis, giving these to the fungus, which supplies water and nutrients from the soil to the plant
- About **90% of land plants are interconnected with such fungi** — each tree combines a dozen species of fungi which communicate with fungi in another tree's roots
- Scientists find older **'mother trees'**, with deeper roots, use these networks to nurture younger saplings — the older trees send these nutrients, increasing supplies when detecting distress signals
- A tree's fungi also **exchange signals about droughts, insect attacks, etc.**, enabling defences by increasing enzyme production
- This **'underground internet'** also boosts trees' immunity. When a fungus reaches a tree's roots, it triggers defensive chemicals, causing 'priming' — greater efficiency of later immune system responses, making 'connected' trees **stronger against disease**
- Scientists find injured trees even use these networks to **transfer their carbon deposits** to younger trees — which is important knowledge in countering climate change

Research: National Geographic, Smithsonian Magazine, TED, BBC, Yale Environment 360 Journal

## 'I've seen ancient, immortal trees — these face dangers now'



**Beth Moon** is a celebrated photographer, famed for her collections capturing the world's oldest trees. Speaking to Srijana Mitra Das at Times Evoke, Moon discussed the sheer majesty and endurance of these antiquities — and what threatens them today:

### What drew you to photograph the world's most ancient trees?

I find great solace in the beauty of the natural world. I believe there is a value in sharing the appreciation of nature. I chose monumental, iconic trees, hoping to draw attention to the environment.

### What did you learn from the trees you photographed?

At the beginning of the project, I was impressed with the size and resilience the trees demonstrated over time. I saw them as strong and formidable. Fast-forward to 20 years later into the project.

What I didn't realise was that I would be recording their deaths within my lifetime. I have witnessed first-hand the disease that is wiping out ancient olive trees in southern Italy. I saw a dwindling number of quiver trees in Namibia, and likewise, a declining growth of dragon's blood trees in Yemen. Most recently, I was horrified by the deaths of so many of the oldest baobab trees in the southern countries of Africa.

I have learnt that we must find a solution to the dangers of the climate crisis we are in. We must inspire action and work for change now.



**MILLENNIA OF MYSTERY:** Enduring the harshest conditions, baobab trees have survived on Earth for thousands of years



Courtesy: Beth Moon

**NATURE'S INFINITE ANTIQUITY:** An ancient baobab tree in Senegal is also the heart of its village community

yew trees that compete for the 'oldest tree' title with bristlecone pines can exist for 4,000 years. They could be considered immortal.

With time and age, large yew trunks also often become hollow. The tree sends down an aerial root to support the crown and the root will eventually develop into a firm new trunk. Astonishingly, this regenerative tactic allows the tree to rebuild itself from the inside out!

### Which is the most stunning tree you have seen?

I love each tree in its own way for different reasons. However, I will highlight this gigantic baobab from a recent trip to Senegal. The first day I visited, I understood how central the tree was to village life and the community. Many people gathered to talk and share news under its massive outstretched branches. The innermost cavity of the trunk was hollow, and I was able to crawl inside, following a maze of open passages, right into the centre of the tree. The inside walls were smooth to the touch, like polished marble, and as I looked up, I saw bats hanging from a central ceiling high above me.

I returned the next day before dawn, hoping to have some time alone with the tree. I set up my tripod and waited for the first rays of morning light. I was lucky to visit in the middle of October when the tree was laden with fruit — I think there were millions of seed pods hanging from its branches. I enjoyed this tree as the dawn broke and the villagers approached their peanut fields in carts, that giant baobab standing there amidst it all.

### How does the force of survival reflect in your photographs?

Well, bristlecone pines are an excellent example of endurance and the ability to grow in an extreme environment. High in the White Mountains of the Inyo National Forest live many windswept, gnarled bristlecone pines — they are over 4,000 years old. The overwhelming sight of these strange, contorted trees

is astounding, a ghost forest seemingly at the top of the world! Their growth is stunted by a lack of water. These trees live in extreme conditions — and yet, they have an astonishing capacity for endurance. Their longevity comes, in part, from the nature of the wood, which is extremely durable. A bristlecone pine can last for centuries, their very forms, a testament to their strength.

### Is there a sense of time in your art?

Well, the life span of a tree is unique to the species. What does the term 'ancient' even mean? Some oaks can reach 1,000 years — as the saying goes, 300 years growing, 300 years living and 300 years dying.

Giant sequoias can live for 3,000 years, fast-growing kapoks can reach gigantic proportions at 60 years, while

## 'We can restore one trillion trees — this will powerfully slow down climate change'



**Tom Crowther** is an acclaimed ecosystem ecologist, head of the Crowther Lab at ETH Zurich and chief scientific adviser to the United Nations' Trillion Tree Campaign. Speaking to Times Evoke, Crowther discussed how reforestation can achieve much better planetary health:

### Why does your research focus intensively on trees?

Well, it's almost impossible to list all the thousands of benefits that trees provide to support life on Earth — they provide clean air and water and food and medicines for humans, they stabilise the soil to avoid erosion, they support thousands of species, they produce oxygen that we need to breathe and they capture carbon from the atmosphere to help slow climate change.

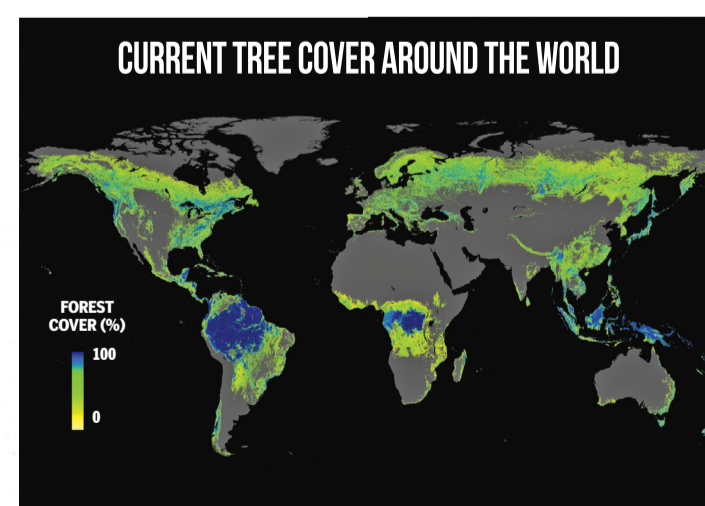
### Why is the relationship between trees, soil and fungi crucial?

Trees live in association with thousands of microorganisms in the soil. This includes fungi that the trees need to survive. When trees capture carbon from the atmosphere, much of that carbon enters the soil to feed those microorganisms, which are responsible



### PORTRAIT OF JOY

Many a heart leaps upon sighting the *Mangifera indica* plant, also known as the mango tree



Data adapted from Hansen et al 2013. Science. Courtesy: Crowther Lab

for building healthy soil that supports life and stores carbon for a long time.

### Your research maps forest data globally. What are some of your most important findings?

There are currently about three trillion trees on Earth — we think this number has fallen by almost half since the start of human civilisation. We were also very worried to find that we are

currently losing about 10 billion trees every year — this is speeding climate change and biodiversity loss. But we've found that there is room for about one trillion new trees in the degraded regions of the world that we are not currently using for agricultural or urban land — if we restored those trees, we could capture 100-200 gigatons of carbon from the atmosphere over the rest of the century, which would have a huge impact on

biodiversity and climate change.

Based on our research, the United Nations' Trillion Tree Campaign has been launched to encourage people all around the world to restore trees. Many of the largest companies and governments are pledging funding to support people in restoring healthy, diverse forests. We need to support a huge global movement to protect and restore the world's forests. This is an opportunity for all of us to get involved.

### How do you envision balancing economic demands with ecological rejuvenation?

Restoration must be socially responsible. It must not come at the expense of local communities. However, when it's done right, the restoration of ecosystems can bring countless economic benefits because trees enhance soil fertility and water storage that promotes the growth of other crops — that's why agroforestry represents a very exciting opportunity to restore trees while increasing agricultural yields.

With funding from the Trillion Tree Campaign as well, we hope more people will be able to receive the support they need to restore diverse forests around the world. This benefits us all.

### THE GIFTS OF TREES

• A tree produces up to **250 pounds of oxygen per year** — between 1990-2007, forests also absorbed about one-third of global fossil fuel emissions

• Computational modelling studies find that trees can reduce particulate matter (PM) from 7% to over 20%

• Trees reduce temperatures between 2-8 degrees Celsius

• Trees store away carbon dioxide (CO<sub>2</sub>) through carbon sequestration — a tree can hold up to 800 pounds of CO<sub>2</sub> per year

• Scientific studies find over time, human beings have cut down at least 46% of the trees on Earth — between 1990 and 2016 alone, over 1.3 million square kilometres of forests have been felled

Research: National Geographic, Environment Protection Agency, American Forests, BBC, Royal Society of Chemistry, Stanford University, United Nations

• Trees are filters for dust, smoke and harmful gases — their leaves absorb nitrogen oxide, sulphur, etc, through the same stomata that absorbs CO<sub>2</sub>

• Tree leaves cool the atmosphere via **evapotranspiration** — this process releases moisture into the air. A large oak tree, for instance, can transpire up to 40,000 gallons of water into the atmosphere in one year

• Providing a home to hundreds of species, a Stanford University study found that adding one single tree to a pasture **increased a region's diverse bird species from near 0 to 80**

Graphic: Sajeew Kumarapuram