THE HUMAN COSMOS

First published in Great Britain in 2020 by Canongate Books Ltd,
14 High Street, Edinburgh EH1 1TE

canongate.co.uk

This digital edition first published in 2020 by Canongate Books

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available on
request from the British Library

ISBN 978 1 78689 402 1
Export ISBN 978 1 78689 403 8
eISBN: 978 1 78689 405 2

CONTENTS

CONTENTS

PROLOGUE

Almost 14 billion years ago, everything burst out of nothing. Our universe pricked into being as an unimaginably hot, dense, tiny point, then almost instantaneously exploded outwards, the very fabric of space expanding faster than the speed of light, until all of existence was roughly the size of a grapefruit. After that, the universe continued to expand and cool, and the first matter formed. Within the first second, a dense soup of particles – neutrons, protons, electrons, photons, neutrinos – jostled in a smashing, searing heat that scattered light like fog.

By the time it was about 380,000 years old, this cosmic bubble had expanded to tens of millions of light years across and cooled to a few thousand degrees, mild enough for atoms to hold together, and for the first time the universe became transparent to light. There was an initial flash of illumination, then darkness fell. It took several hundred million years for the attractive force of gravity to work on subtle density variations, inexorably collapsing clumps of gas to form the first stars and galaxies, and one by one, the celestial lights switched on.

Most guides to cosmology tell some version of this sequence of events. Mysteries remain: Was this Big Bang really the start of everything, or is our universe just one inflating bubble in a much larger multiverse? What is the epic force that still pushes space apart? Will it keep expanding for ever, or eventually collapse again in a Big Crunch? But the general nature and story of the universe is agreed. Reality has been revealed as a vast and sophisticated machine, composed of physical particles and forces governed by mathematical equations and laws.

This book tells a different story. The scientific account of the universe

is a pinnacle of our modern civilisation, a vision so powerful that its rivals have been all but obliterated. Cosmology – the study of the cosmos – once described the broad philosophical and spiritual endeavour to make sense of existence, to ask who we are, where we are, and why we're here. It is now a branch of mathematical astronomy. So what happened to those bigger questions? Is there nothing else about the universe we need to know?

Instead of detailing the latest astronomical developments, this is a guide to the long history of knowledge that people have gleaned from the stars. It's about what their view of the cosmos told them of the nature of reality and the meaning of life; about the gods and souls, myths and magical beasts, palaces and celestial spheres that we've discarded; about how the scientific view came to dominate, and how in turn that journey still shapes who we are today. It's a tale about people – of priests, goddesses, explorers, revolutionaries and kings – and it starts not with the Big Bang, nor even with the birth of science, but with the very first humans who looked to the stars, and the answers they found in the sky.

•

Why bother about the celestial beliefs of the past? Archaeologists and historians often don't. We know that science was built on attempts to understand the heavens, but this is rarely a focus for scholars tracing human progress more generally. I think this has created a huge blind spot in our understanding of where we came from. In fact, the patterns people see in the sky have always governed how they live on Earth, shaping ideas about time and place; power and truth; life and death.

We see this in the ancient past: with the eclipse-obsessed Babylonians; the Egyptian pharaohs who built pyramids to guide their souls to the stars; the Roman emperors who fought under the banner of the sun. Ideas about the cosmos have shaped the modern world, too. These influences are still deeply ingrained in our society – even if we've forgotten their origins – in our parliaments, churches, galleries, clocks and maps. Beliefs about the sun, moon and stars played a central role in

the birth of Christianity, and in Europe's exploration and domination of the planet. They guided the rebellious lawmakers who founded the principles of democracy and human rights, the economists who developed the frameworks on which capitalism depends, and even the painters who produced the first abstract art.

Today, as light pollution envelops our planet, the stars are almost gone. Instead of thousands being visible on a dark night, in today's cities we see only a few dozen – and astronomers fear these will soon be vastly outnumbered by artificial satellites. Most people in the US and Europe can no longer see the Milky Way at all. It is a catastrophic erosion of natural heritage: the obliteration of our connection with our galaxy and the wider universe. There has been no major outcry. Most people shrug their shoulders, glued to their phones, unconcerned by the loss of a view treated as fundamental by every other human culture in history.

Yet we're still trying to work out our place in the cosmos. Science has been wildly successful: today's five-year-olds know more about the history, composition and nature of the physical universe than early cultures managed to glean in thousands of years. But it has also dissolved much of the meaning that those cultures found in life. Personal experience has been swept from our understanding of reality, replaced by the abstract, mathematical grid of space-time. Earth has been knocked from the centre of existence to the suburbs; life reframed as a random accident; and God dismissed altogether, now everything can be explained by physical laws. Far from having a meaningful role in the cosmic order, we're just 'chemical scum', as physicist Stephen Hawking put it, on the surface of a medium-sized planet orbiting an unremarkable star.

Critics have fought this mechanistic view of humanity for centuries, often rejecting science wholesale in the process. But now even high-profile scientists are voicing concerns that until very recently were taboo. They are suggesting that perhaps physical matter isn't all that the universe is; all that we are. Perhaps science is only seeing half of the picture. We can explain stars and galaxies, but what about minds? What about consciousness itself? It's shaping up to be an epic fight that just might transform the entire western worldview.

With the battle lines drawn, I think we need a shift in perspective; an overview. Here, then, is a book about the cosmos, not a scientific guide but a human one. Rather than give an exhaustive account, I've chosen twelve moments – stepping stones, if you like – that tell us something about how people through history have seen the sky. In particular, these twelve stories follow the rise of the western material universe and how this model of the cosmos came to dominate our lives. The stories trace a path from humanity's earliest expressions in cave paintings and stone circles; through the birth of great traditions such as Christianity, democracy and science; to the hunt for alien life and our recent flights into actual – and virtual – space.

It's a journey that helps to explain who we are today, and can perhaps also guide a future course. It can be hard to see the limits of something when you're embedded in it. I hope that zooming out to survey the deep history of human beliefs about the cosmos might help us to probe the edges of our own worldview and perhaps look beyond. How did we become passive machines in a pointless universe? How have those beliefs shaped how we live? And where might we go from here?

1

MYTH

There's a curious pattern of dots that recurs in art around the planet and throughout history. The number varies, but commonly it's a close-knit group of six circular spots, distinctively arranged in lines of four and two. This motif is seen in far-flung communities, from holes pierced into the gourd rattle of a Navajo tribe to a painting on a Siberian shaman's drum. It even appears in the logo of the Japanese car manufacturer Subaru.

In all of these cases, the dots represent one of the most characteristic features of the night sky: the star cluster Pleiades. This clutch of six or seven stars (the exact number depends on viewing conditions) appears close to the sun's annual path through the sky, and features in multiple myths and legends: in Cherokee myth, these stars are lost children; the Vikings saw them as the goddess Freyja's hens. They are also a distinctive part of the constellation Taurus. The Pleiades sit just above the shoulder of this celestial bull, with its thrusting horns, prominent eye – the red giant Aldebaran – and another star cluster, the Hyades, splashed in a 'V' across its face.

The frequent appearance of this six-spot pattern demonstrates the importance of the Pleiades in societies around the world, as well as the shared human desire to capture aspects of the starry sky in art. But there is more to this story – another example of these dots that seems, frankly, impossible. The cave of Lascaux in southwestern France is famous for its wealth of Palaeolithic art: paintings and engravings of animals, thought to be 20,000 years old, from the dawn of humanity. Scholars have argued over their meaning for decades. Meanwhile, barely noticed on the

ceiling of its grand entrance hall, are six plain spots that match the Pleiades perfectly. Neatly painted in red ochre, they float above the shoulder of a majestic aurochs bull.

At 5.2 metres long, 'Bull No. 18' is the largest and perhaps most recognisable painting in the entire cave. Its striking similarity with the modern Taurus – it even has V-shaped spots on its cheek – has been known for years. Yet it goes unmentioned in guidebooks and is rarely discussed by mainstream archaeologists. Taurus is one of the earliest constellations to be described: it can be traced back through written sources nearly 3,000 years, to Babylonian priest-astronomers who saw the Pleiades as a bristle on the back of a heavenly bull. But could its true origin be a star map invented by the supposedly primitive hunter-gatherers of Lascaux? The idea was not so much rejected as not talked about at all.

In the last few years, however, experts in anthropology, mythology and astronomy have begun to argue for a radical reassessment of our Palaeolithic ancestors' skills, and the lasting influence of the stories they told. So in this history of humanity's relationship with the stars, let's start with the mystery of Bull No. 18. We'll explore whether the artists of Lascaux could really have painted constellations, and ask why they may have cared so much about the sky. It's a journey that takes us to the heart of what the universe meant to the very first humans who had the ability to imagine, remember, explain and represent. The cosmos they created still shapes our lives today.

•

On 12 September 1940, seventeen-year-old Marcel Ravidat, an apprentice mechanic, walked with three friends into the hills near his village of Montignac in southwest France. According to village legend, there were caves beneath the hills – during the wave of executions that followed the French Revolution, the Abbé Labrousse, owner of the nearby manor, supposedly hid in one – and Ravidat wondered if they might hold treasure. A few days before, he had started to unblock a promising hole in the ground. Now, armed with a knife and a makeshift

lantern, he planned to finish the job.

The boys' target was a basin-shaped depression in the ground surrounded by pine trees and junipers, and full of brambles. At the bottom was a small opening that led to a narrow, near-vertical shaft. The boys cleared the thorns – and the remains of a donkey – and dug with their hands to widen the hole to about 30 centimetres across. They dropped down stones, and were surprised by how long they rolled and the resonance of the sound. Those brambles had been hiding something big.

Ravidat, the oldest and strongest of the group, dived in head first and wriggled several metres through the earth before landing on a conical pile of clay and stones. He lit his lamp, which he'd made from a grease pump and a coil of string, but almost immediately lost his balance and slipped all the way to the bottom. He found himself in a large hall, about 20 metres long, and called for his friends to follow.

They crossed the limestone cavern in near-darkness, dodging shallow pools of water on the floor, until they reached a narrow corridor with a high, arched ceiling, like a cathedral vault. Only here did Ravidat raise his lamp, and the boys found their treasure. Covering the white walls was an explosion of life; images from the birth of our species, pulled back into view for the first time in 20,000 years.

First, they noticed coloured lines and strange, geometric signs. Then, moving the lamp around, they saw the animals. There were horses everywhere, golden with black manes, as well as black-and-red bulls, ibexes, and a bellowing, antlered stag. Herds climbed the walls and tumbled across the ceiling, some defined and multi-coloured, others ghostly, as if falling through fog. The boys didn't understand the full significance of what they had found, but they knew it was special, and they celebrated with leaps and cries in the trembling light.

Lascaux cave (named for that nearby manor) now ranks as one of the most spectacular archaeological discoveries in history. It is just one of hundreds of caves in southern France and northern Spain decorated between 37,000 and 11,000 years ago by anatomically modern humans who first migrated into Europe from Africa around 45,000 years ago, during the last ice age. It's a period called the Upper Palaeolithic, named

for the stone tools in use at the time, and it seems to have hosted an explosion in human creativity. Rock art from around this time is known elsewhere, too – in Indonesia and Australia, for example – and the practice almost certainly originated even earlier, in Africa. But thanks to the complexity, exquisite preservation and sheer volume of its paintings and engravings – nearly 2,000 of them – Lascaux is one of the finest examples.

The artists here used plant-based brushes or swabs of hair, and a palette of iron and manganese minerals, kaolin clay and charcoal sticks, to cover corridors and chambers reaching 100 metres into the rock. Their creations provide a rare and hauntingly beautiful insight into the prehistoric human mind. Who were these early people? What did they care about, and what triggered them to create art? What was it, in effect, that made them human?

In the decades since the boys' discovery, scholars have come up with a rich parade of answers to these questions. An early idea was that the mysterious figures were simply decoration, 'art for art's sake', without any special meaning. Another suggestion was that the animals represented different clans, and that the paintings showed battles and alliances between them. Some experts thought that the paintings were intended as magical spells, to boost the success of hunting expeditions or ward off evil spirits. In the 1960s, scholars took a statistical approach, recording how different types of figures were distributed in the caves, and building theories around the patterns they saw, for example that the horses and bison symbolise male versus female identity.

Then there was Norbert Aujoulat, who perhaps came to know the paintings more intimately than anyone else. A cave enthusiast, he described himself as 'an underground man'. He would disappear for days at a time on solitary excursions into the French mountains, and helped to discover dozens of subterranean chambers. But he never forgot the first time he saw Lascaux, one winter afternoon in 1970. Since its discovery the site had opened to the public and closed again: the breath exhaled by thousands of visitors per day, and the germs they tramped in, were damaging the precious paintings. Aujoulat, a twenty-four-year-old local student, joined a private tour guided by Jacques Marsal, one of the

four friends who had discovered the cave three decades before.

To reach the paintings, Marsal led them down a slope through a series of stone-lined entrance halls and doors, built for security, which made Aujoulat feel as if they were approaching the sacred, inner space of a temple. The last door was made of heavy bronze and decorated with polished stones. Aujoulat spent only half an hour exploring the treasures beyond that door, but it was enough to set the course of his life. He was bewitched by the overwhelming sense of human presence inside the cave, powerful enough to stretch across so many thousands of years, and he set his sights on understanding how and why the paintings were created.

It was nearly two decades before Aujoulat was able to fulfil his dream. In 1988, as head of the French culture ministry's Department of Parietal Art, he began a monumental, decade-long study of Lascaux cave, from the great bulls circling the ceiling of the entrance cavern to the dense, entangled engravings in a smaller chamber called the Apse. Whereas other scholars had focused on the art, Aujoulat approached Lascaux as a natural scientist, studying every aspect of the cave, from the geology of the limestone to the biology of the animals on the walls. He came to the conclusion that everyone else had missed a crucial dimension: time.

When he studied overlapping paintings where horses, aurochs and stags appeared together, he found that in every case the horses were painted first, then the aurochs, and then the stags. What's more, the animals were always shown with features corresponding to specific times of year: the horses with bulky coats and long tails corresponding to the end of winter; the aurochs during the summer; and the stags with prominent antlers, characteristic of autumn. For each species, that was their mating season.

Aujoulat described his findings in a 2005 book called *Lascaux: Movement, Space, and Time*. By showing the fertility cycles of important animals, he argued, the cave should be understood as a spiritual sanctuary, intended to symbolise creation and the eternal rhythm of life. The cycle of creation represented by the paintings wasn't just an earthly one, however, relating to animals and the weather. It extended to the entire cosmos.

The annual re-creation of life taking place in the Palaeolithic world

was mirrored, of course, by the cycles of the stars: each season is marked by the passage of the sun as well as the appearance of characteristic constellations in the night sky. Aujoulat believed this was central to the artists' vision; they were showing, he concluded, how biological and cosmic time were entwined. He compared the cave, with its overhanging walls and paintings that crossed the ceiling, to 'the celestial vault', and suggested that the animals weren't being shown on the ground, but in the sky.

That could explain why the animals often appear to be floating – painted at all angles, without any ground-line, sometimes even with hanging hooves. If Aujoulat is right, Lascaux cave is as much about cosmology as it is about biology: rather than copying their immediate surroundings, the artists were synthesising all of the changes – on the Earth and in the sky – that defined their existence. It was an ode, if you like, to their universe, representing humanity's first ideas about the nature of the cosmos and the origins of life.

Aujoulat was at the heart of the French academic establishment, and his work has been hugely influential. Even so, his ideas about the sky are rarely discussed; without direct evidence, archaeologists find it easier to accept the paintings as a celebration of nature than as a vision of the sky. There are some scholars, though, who think he didn't go far enough, that rather than simply imagining animals in the sky, the artists of Lascaux were painting maps of the stars.

•

In 1921, a French prehistorian called Marcel Baudouin came across a fossilised sponge that was shaped like a penis. The fossil, found in Beynes in north-central France, had a vibrant red patina which some ancient artist had chipped off in places to create a series of yellow, hoof-shaped dots. 'It is the first time I have seen work like this!' Baudouin wrote in excitement. In a paper called 'The Great Bear and the Phallus of Heaven', he argued that the pattern matches the northern constellation of Ursa Major (the Great Bear), even down to brighter stars being represented by larger dots.

It wasn't possible to date the dots, but he concluded that they were carved in Palaeolithic or Neolithic times. Because of the Earth's rotation, the stars of the northern hemisphere appear to circle around a stationary point in the sky directly above the North Pole (known today as the north celestial pole). Baudouin suggested that the fossil was intended to show this pole as a celestial penis, and that the carved dots represent nearby Ursa Major rotating around its shaft.

He was one of the first to see stars in prehistoric art; throughout the 1920s and '30s, several scholars, including Baudouin, reported constellations in the concave depressions, called cup marks, dug out of stone monuments and cave walls in locations from southern France to Scandinavia. Their claims were impossible to prove and are now largely forgotten, but decades later, the US archaeologist Alexander Marshack popularised the idea of Palaeolithic astronomy in his influential 1972 book, *The Roots of Civilization*.

Marshack used a microscope to examine markings on bone fragments made by people in the Upper Palaeolithic. One of the first he studied was a 30,000-year-old piece of bone from the Blanchard rock shelter in the Dordogne region of France. It is engraved on one side with 69 disc- or crescent-shaped pits, arranged in a snaky line. Marshack showed that the pits were created using 24 different types of stroke, suggesting they were carved in groups on 24 different occasions. Rather than simply doodling, someone was keeping track of something; Marshack thought it was the changing phases of the moon. He surveyed similar patterns on a range of bones, stones and antlers, and argued that the people of the Palaeolithic were routinely tracking the sky, using lunar calendars to mark the passing of time.

With Marshack's ideas about Ice Age astronomy widely taken seriously, if not proven, it wasn't long before researchers started to look again for prehistoric star constellations, in particular in the chambers of Lascaux. German astronomer Michael Rappenglück first heard about the idea as a student at the University of Munich in 1984, when he attended a lecture suggesting that Lascaux's paintings might contain star maps. 'I was fascinated,' he says. Now director of the Adult Education Centre and Observatory in Gilching, Germany, and a former president of the

European Society for Astronomy in Culture, Rappenglück has been investigating the theory ever since.

One of the scenes he studied was Bull No. 18. Over long periods of time, constellations shift in the sky because of a wobble in the axis of Earth's rotation; individual stars also follow their own trajectories. So to test how well it matches Taurus and the Pleiades, Rappenglück calculated how these stars would have looked around 20,000 years ago and compared this with measurements taken from photographs of the cave wall. He found that when the bull was created, the Pleiades were slightly higher above the bull's back and that Aldebaran (the bull's eye) was more clearly framed by the Hyades – an even closer match to the painting than they are today.

He's convinced that isn't a coincidence, arguing that our constellation Taurus (which once represented an entire bull but lost its hindquarters over the centuries to make room for a new constellation, Aries the ram) has its origins in a far older star grouping – let's call it 'Aurochs' – inspired by the giant bulls that the people of the Ice Age hunted for food.

Rappenglück supports his ideas with evidence from anthropology. Societies throughout history have used the Pleiades as a calendar, he points out. Stars circle around the north and south celestial poles each night, but our orbit around the sun means they follow an annual cycle too; different stars and constellations 'rise' or 'set' (first become visible above the horizon at dawn or disappear from view at dusk) at particular times of year. As a distinctive star cluster close to the ecliptic – the sun's path through the sky – the Pleiades mark the seasons particularly well.

Today, farming communities from Lithuania to Mali to the Andes still mark their agricultural year according to the visibility of the Pleiades. Native American peoples such as the Blackfoot traditionally synchronise their lives with these stars and the life cycle of the bison: when the Pleiades set, it is time to hunt. The Teton Sioux and Cheyenne even name some months after the bison life cycle: November is 'the moon of the fertilisation of the buffalo cows', while January is 'the moon when the coat of the young buffaloes takes on colour'.

Rappenglück suggests that the artists of Lascaux could have developed

a star calendar, with the Pleiades similarly marking key moments in the life cycle of the aurochs bull. He calculates that at the time Bull No. 18 was painted, the Pleiades would have appeared just before sunrise in mid-October, reached their highest point in the sky at the start of spring, and disappeared at the end of August. That means the disappearance and then reappearance of the Pleiades would have defined the mating season of the aurochs, which lasted between August and October. From there it was perhaps a natural step to associate the stars around the Pleiades with the image of a bull. It would have dominated the spring sky to the west of the hilltops that surround Lascaux cave; a giant, celestial creature with a twinkling red eye and glittering hairs on its back, ready to toss the Milky Way with its horns.

Rappenglück sees possible astronomical associations in other caves too. Another aurochs, nearly 4,000 years older than Bull No. 18, in the Tête-du-Lion cave in the Ardèche, has a group of seven dots on its body that he thinks might represent the Pleiades. And in El Castillo cave in Santander, Spain, there's a mysterious group of seven ochre discs dating from 12,000–11,000 BC, arranged in a downwards-pointing curve and close to a striking 5-metre-long frieze of red hand stencils.

After calculating how the sky would have looked at the time, Rappenglück concluded that the dots are a close match for a constellation called the Northern Crown, and suggests that the nearby strip of hands might represent the Milky Way. In 12,000 BC the Northern Crown never set, but – as the Palaeolithic equivalent of Polaris, our pole star – rotated around the northern celestial pole, so would have been important for marking the direction north. Like the Pleiades, the Northern Crown also features prominently in mythology. A Celtic myth describes it as the star goddess Arianrhod's home, an icy castle set on a magical, rotating island in the northern sky. Might elements of the myth date from the Palaeolithic, when these stars really did trace a circle in the heavens?

Sceptics insist that these ideas can't ever be proved. There are just too many possible combinations – too many sets of dots in European caves and too many stars in the sky. But others argue that the various features of Bull No 18 in particular would be an extraordinary coincidence if not

intentional. And Rappenglück isn't the only one linking the caves of the Palaeolithic with the stories we tell about the stars.

•

It's a long-standing mystery why similar myths often exist in apparently unrelated cultures in different places. Take the story of the Cosmic Hunt, in which an animal is chased into the sky and transformed into a star constellation. Variants of this tale – featuring different stars, hunters and prey – are found all over the world.

In one Greek version of the myth, Zeus tricks the princess Callisto, companion of goddess Artemis, into giving up her virginity and she gives birth to a son, Arcas. An incensed Artemis turns Callisto into a bear. Arcas grows up to be a hunter and almost kills his mother with a spear, but Zeus intervenes, turning Callisto into the constellation Ursa Major and putting Arcas next to her as Ursa Minor, the Little Bear.

Meanwhile the Iroquois of the northeastern US tell of three hunters who wound a bear in a forest; its blood stains the autumn leaves. The hunters then follow the bear into the sky and together they become Ursa Major. Among the Siberian Chukchi, the constellation Orion is a hunter who chases a reindeer, Cassiopeia, whereas for the neighbouring Finno-Ugric people, the pursued animal is an elk.

French archaeologist and statistician Julien d'Huy probes the origins of such stories using the principles behind phylogenetics, a technique developed to glean evolutionary relationships between species by comparing their DNA sequences. Biologists use computer software to analyse similarities and differences in the DNA and construct family trees showing the most likely relationships between species. D'Huy does a similar thing for myths.

Instead of studying DNA, d'Huy analysed 47 versions of the Cosmic Hunt from around the world, splitting them into 93 individual components, or 'mythemes', such as 'the animal is a herbivore' or 'a god transforms the animal into a constellation'. For each myth, he coded the presence (1) or absence (0) of each mytheme to give a string of 0s and 1s, then used phylogenetic software to compare them and construct the

most likely family tree. His results, published in 2016, suggest that the myth originated in northern Eurasia. One branch then spread to western Europe and another reached North America when humans migrated across the Bering Strait, which once connected the eastern tip of Russia with Alaska. That means, he says, that the story must date from before about 15,000 years ago, after which that land bridge became submerged.

The original Palaeolithic version of the Cosmic Hunt, concludes d'Huy, most likely involves a lone hunter pursuing an elk. The hunt moves into the sky, but before the animal can be killed, it transforms into what we know as the Big Dipper, or Plough (the tail and flank of Ursa Major). Elk were the dominant mammals in the forests of northern Eurasia during Palaeolithic times, crucial for hunting, and there's evidence that they were important culturally too. A 2017 study of hundreds of animal-tooth pendants discovered in Estonia, for example, found that elk was the most common mammal represented in the Mesolithic and Neolithic periods (8900–1800 BC), before gradually switching to bears. As the story of the Cosmic Hunt moved around the planet and through history, different peoples would have adapted the tale to fit the animals and constellations most important to them.

Other tales analysed by d'Huy seem to date back even earlier, spreading out of Africa with the first waves of human migration more than 40,000 years ago. He has compiled a core of 'protomyths' that he thinks early humans brought with them as they migrated north and east. Not all of these involve stars. There are dragons: giant, horned serpents that guard water sources and can fly, form rainbows, and produce rain and thunderstorms. But they also include the Pleiades, often as a woman or group of women set against Orion as man, and the idea of the Milky Way as a river, or a road travelled by the dead.

In other words, the star myths we tell today are not just stories. They're cultural memories passed through generations for thousands of years, that sometimes do reach back to the Palaeolithic. D'Huy calls them a 'glimpse into the mental universe of our ancestors'. That glimpse doesn't directly link the Pleiades to an aurochs bull. But just like the paintings of Lascaux, it overwhelmingly tells of living beings imprinted on the sky.

•

For the native Chumash people of southern California, the universe consisted of three disc-like worlds, floating in a great abyss. At the bottom was the Lower World, inhabited by deformed, malevolent beings. The Middle World, where humans lived, was supported by two giant serpents that triggered earthquakes when they moved. Above that, the Upper World was held up by a great eagle, whose wing movements caused the phases of the moon.

This cosmos was ruled by the sun, an old widower who lived in a quartz-crystal house in the Upper World and dined on human flesh. Each day he travelled across the sky, carrying a torch and wearing only a feather band around his head. At night, he gambled against Sky Coyote (probably Polaris, the North Star) to determine the fate of the people below. Not surprisingly, the Chumash watched the sun very carefully. But their knowledge of the Upper World didn't just come from tracking the sky. They knew about it, as we'll see, because they had travelled there themselves.

A few centuries ago, the Chumash thrived along the south-central Californian coast, and their journeys give us one more insight into what prehistoric people like the artists of Lascaux may have thought about the heavens. That's because the Chumash lifestyle appears to have been very similar in complexity to that of Upper Palaeolithic Europe. They had round grass houses, beautifully carved wooden bowls, fine baskets and plank-built sea canoes which they used to catch swordfish weighing up to 270 kilograms. The men wore body paint and feather headdresses, the women had skirts of deer or otter skins, and they used shell beads for money.

There were perhaps 15,000 of them before the Spanish arrived in the eighteenth century. The soldiers who made first contact in 1769 described large towns with roofs piled high with barbecued fish. In the following decades, however, the population crashed, as the Chumash succumbed to the colonisers and their infections: typhoid, pneumonia and diphtheria.

By the beginning of the twentieth century, the Chumash culture and

language had almost disappeared. But some traces survive, thanks to a linguist called John Peabody Harrington, who worked for the Smithsonian Institution. He dedicated his career to tracking down elderly speakers of dying languages across North America, persuading them to share everything they could remember about their heritage.

Eccentric and obsessive, Harrington worked alone. After his death in 1961, Smithsonian curators discovered hundreds of boxes that he had stored in warehouses, garages and even chicken coops throughout the western United States. Mixed with Native American-made flutes and dolls, dead birds and tarantulas, dirty laundry and half-eaten sandwiches, was what came to be known as 'the Harrington gold mine': photographs, sketches, notes and recordings detailing the words and beliefs of cultures that had been thought lost – including the Chumash.

A few years later, Travis Hudson, a curator at the Santa Barbara Museum of Natural History, used thousands of pages of Harrington's notes to reconstruct the most detailed account of astronomical beliefs for any hunter-gatherer community in the world. In his 1978 book, *Crystals in the Sky*, Hudson concluded that the Chumash knowledge of the sky was far richer and more sophisticated than western scholars had ever thought possible.

The Chumash elders interviewed by Harrington spoke of an Upper World filled with powerful, supernatural beings. The pole star, Polaris, was Sky Coyote, father of mankind and the being around which the rest of the sky revolved. The stars Castor and Pollux (the Gemini twins) were the sun's female cousins, while Aldebaran was another coyote, who followed the Pleiades maidens across the sky. Orion's Belt was 'Bear', and the Milky Way was a ghosts' road.

The movements of these deities were intertwined with life on Earth. The Chumash knew that when the sun rose or set at a certain location on the horizon, or when particular stars appeared in a dawn or twilight sky, certain seasonal changes were about to take place on Earth: seeds would ripen, deer would migrate, the rain would come. The winter solstice, the point in the dead of winter when the sun reaches its furthest point south and days are shortest, was seen as a critical time for the cosmos. If the sun couldn't be persuaded to return, darkness would fall

and life on Earth would be snuffed out. The Chumash made careful observations to predict the solstice, and on the crucial morning conducted rituals, often in caves, planting quartz-tipped sun sticks into the ground to 'pull' the sun back onto a northern course.

This knowledge, however, was not for everyone. These celestial secrets were held by an elite group of astronomer-priests called the *'antap* who formed what was essentially a secret society led by the sun-priest. They never shared their knowledge with commoners, and wielded great political influence, claiming that they were the only ones who could understand and influence the cosmic system around which Chumash life revolved.

The priests acquired their detailed astronomical knowledge from countless nightly observations, but also with the aid of hallucinogenic plants from the genus *Datura* (part of the nightshade family) that they used to go on 'vision quests'. This allowed them to visit the Upper World, where they could contact supernatural guardians such as Coyote, predict and influence the future, and communicate with spirits of the dead.

It's a practice called shamanism. The term comes from Siberia, where western travellers in the seventeenth century encountered religious leaders called *saman* among Tungusic peoples, but similar practices and beliefs exist in traditional hunter-gatherer societies all around the world. Shamans enter trance states to visit an alternate reality or spirit world. During such journeys they meet and gain power from spirit guides, and this allows them to fulfil a range of roles such as foreseeing the future, harming enemies, controlling the weather and animals, and healing the sick. Trances are induced in different ways – sometimes by hallucinogenic plants such as *Datura* or ayahuasca; by meditation, fasting or sensory deprivation; or by rituals such as drumming or dancing.

Western anthropologists initially rejected shamanism as not even worth studying, dismissing its practitioners as either conmen or mentally ill. But the Romanian historian of religion Mircea Eliade changed that with his seminal study *Shamanism: Archaic Techniques of Ecstasy*, first published in English in 1964. Eliade surveyed the practice of shamanism

throughout history, arguing that it is ubiquitous among hunter-gatherer societies from Siberia to North America to Tibet. Because these traditions are all so similar, he argued that they must descend from a common source in the Palaeolithic, which spread as people migrated around the planet, just like the myths studied by d'Huy. Shamanism, in other words, was humanity's first religion.

Scholars have since questioned some of Eliade's assumptions. But his work triggered a wave of popular and scientific interest in shamanism. There are now several lines of evidence suggesting that shamanic trances aren't a purely cultural (or imagined) phenomenon, but represent a universal capacity of the human brain. Neuroscientists have measured characteristic patterns of brain activity in shamans undergoing spirit journeys which share some features with hypnosis and meditation, suggesting that they aren't acting but really do enter a distinct, altered state of consciousness.

Meanwhile anthropologists have documented the experiences of thousands of westerners in such trance states, mostly triggered by drumming, and found that even when people have no idea what to expect, they report very similar experiences to traditional shamans. Western shamans argue that this is because the spirit worlds they visit are real, but scientists tend to see it as evidence that the human nervous system has the ability to generate specific kinds of visions and hallucinations. Both traditional shamans and westerners undergoing spirit journeys often meet and communicate with animals, or transform into an animal themselves. Another key feature is the experience of tunnelling down into the ground, or flying up into space, often passing through membranes or barriers to move from one layer to another. These types of visions are commonly reflected in the cosmological beliefs of hunter-gatherer societies: a tiered cosmos, with lower, middle and upper worlds, as seen by the Chumash, is an almost universal theme. Shamans in many different communities believe that they can contact the spirits of the Upper World, for example, by flying up to a specific constellation or star. So it may have been altered states of consciousness, rather than simple stargazing, that helped to create humanity's first models of the universe.

In their 1998 book *The Shamans of Prehistory*, the South African rock-art specialist David Lewis-Williams and the French cave expert Jean Clottes applied ideas about shamanism to Palaeolithic sites such as Lascaux. Lewis-Williams had previously studied nineteenth- and twentieth-century rock art of the nomadic San people in South Africa. The San explicitly relate their art to shamanic vision quests, describing the figures as shamans in animal form, for example, or spirit guides.

Lewis-Williams followed up with a bestselling 2002 book, *The Mind in the Cave*. All human beings have the same nervous system, he argues, and the people of the Upper Palaeolithic were anatomically the same as us, so it's probable that they would have experienced the same kinds of hallucinations. In modern western society, he points out, we tend to dismiss trance states and visions as abnormal or suspect. We value logical, rational thought. But studies of shamanism show that shifting states of consciousness exist, and are highly prized, in pretty much every traditional society on the planet. By seeing cave art only through our own literal lens, perhaps we are missing the point. Entering the deep, narrow caves of France and Spain would have been just like penetrating the nether spirit realm, so perhaps the shamans of prehistory went into the caves on vision quests – just as Chumash shamans did 20,000 years later – and painted what they saw onto the rock walls.

The theory would help to solve several mysteries about the paintings in Lascaux and other Upper Palaeolithic caves. First, it might explain the abstract, geometric patterns that are common, such as dots, grids, zigzags and wavy lines. Such optical effects are commonly seen during the first stages of trance, points out Lewis-Williams (people suffering from migraines often see them too). The Tukano people of South America, who induce trances using *yajé*, a brew made from a psychotropic vine, often paint the geometric symbols they see during visions onto houses or bark.

It would also help to explain the bizarre hybrid figures seen in Palaeolithic art, such as a bison man at Chauvet cave in southeast France; or the Sorcerer at Trois-Frères cave in the southwest, which has the ears and antlers of a stag, athletic human legs and haunches, a horse's tail, and wizard's beard. In deep trances, people often report seeing

thrust forwards, with a black spot on its shoulder and a series of loops hanging beneath its belly, as if its guts are falling out. Directly beneath the man is a bird perched on a vertical staff.

This bizarre tableau has mystified generations of scholars. But d'Huy and Rappenglück both suggest that the secret to understanding it may lie in the sky. With a slight shift in perspective, it is the man who stands vertical, looking to the heavens as the bird stick and bison follow him upwards. D'Huy suggests that the scene might show the Cosmic Hunt, as hunter and beast rise into the sky to become constellations. That would explain why the bison, despite its aggressive position, doesn't appear to be charging forwards. The black spot on its withers might be a star, and black marks on the ground beneath could be the bloodstained leaves of the hunted animal, signalling the onset of autumn.

It is no more than 'a plausible hypothesis', d'Huy admits. But the shaft scene does look strikingly similar to a Neolithic rock painting from the Maia river in Siberia that is thought to represent an early version of the Cosmic Hunt, in which a hunter takes aim at an elk with the sun hanging under its belly. Perhaps the loops beneath the Lascaux bison, too, represent not its intestines but the sun.

Rappenglück, meanwhile, thinks the birdman is a shaman with a staff, and that the bison is his spirit-helper, guiding his journey to the sky. Similar scenes appear in the art of modern-day shamanic cultures, such as the ecstatic shaman in flight to the sky, penis erect and bound to a celestial bull, that appears on a tipi of the Oglala people in North America. Rappenglück further suggests that the eyes of the Lascaux bison, birdman and bird correspond to Vega, Deneb and Altair – the 'Summer Triangle' – among the brightest stars overhead in summer. Twenty thousand years ago, this trio never set but rotated around the northern celestial pole, indicating the time of night like a giant sky clock. Perhaps the people of Lascaux imagined this constellation as a celestial shaman (the Palaeolithic equivalent of the Chumash's Sky Coyote), turning each night around the axis of the cosmos. Surrounded by spirit-helpers, he ruled and fertilised the sky. Rappenglück interprets the scene as an image of the sky, but also a map for an earthly shaman's own voyage to the celestial pole.

It won't ever be possible to prove what the artist really intended. But the different strands of evidence do seem to converge on one explanation: that this prehistoric scene, far underground in the deepest part of Lascaux cave, represents a journey to the stars. Similarly, the various lines of enquiry described in this chapter – Bull No. 18, the Dead Man, the Cosmic Hunt – seem to me, despite the uncertainties, to add up to an overwhelming broader conclusion: that if we want to understand where we come from as a species, to reach the source of humanity's earliest beliefs and identity, then we have to include a consideration of the wheeling night sky.

Seeing those repeated celestial cycles – night to night, season to season – surely helped to stimulate the very first ideas about who we are and about the nature of reality; ideas that survive in hunter-gatherer communities today. 'They had the same questions,' Rappenglück says. 'What is birth? What is death? Where does the sun go? What is behind the world?'

The universe that our ancestors came up with in answer to those questions was a quintessentially human one, inspired not just by the sky but by the shifting states of consciousness that our brains can produce. In it, there were no boundaries between living and non-living, humans and nature, Earth and stars. It was a cosmos that created us as we created it; in which internal experience and external reality were inextricably entwined. We've been trying to separate ourselves from it ever since.

a square chunk of crystallised quartz, which seemed to have worked as a shutter; a second chunk had fallen to the floor. Scratches on the stone of the roof box suggested that these shutters had been repeatedly slid open and closed. The opening was too small and high for people to climb through, so O'Kelly was mystified by its purpose. Perhaps it was a place for offerings, or formed a doorway for the souls of the dead.

Then he considered a third possibility. Another story told by locals was that at midsummer, the light of the rising sun shone into the tomb, illuminating a distinctive triple-spiral carving at the back of the burial chamber. O'Kelly couldn't find any witnesses. And he knew that the story was impossible, because the tomb faces southeast, over the valley of the Boyne river, whereas the midsummer sun rises much further north.

But the stories were persistent, and O'Kelly realised that the tomb's entrance does point in roughly the right direction to be lit at midwinter, when the sun rises at its furthest point south. So in the early hours of the morning on the winter solstice in December 1967, he drove over a hundred miles through the darkness from his home in Cork to test the idea. When he arrived, the surrounding fields and even the road below were deserted. He entered the tomb feeling utterly alone.

It was a clear morning, so as he waited in the burial chamber he was hopeful that the sunrise might indeed creep inside. But what actually happened was sudden and dramatic. As the sun's first rays appeared above the ridge on the river's far bank, a thin, bright shaft of light burst through the roof box and struck not the entrance passage but the floor at his feet: a direct hit right in the tomb's heart. The light soon widened to a rich golden beam about 15 centimetres across, until the chamber was so bright he could walk around without a lamp, and see the roof 6 metres above.

'I was literally astounded,' O'Kelly said later. 'I expected to hear a voice or perhaps feel a cold hand resting on my shoulder, but there was silence.' After 17 minutes, the sun passed across the slit and darkness returned. He was deeply moved by the experience, and returned to the tomb every winter for the rest of his life, lying on the soft sandy floor of the burial chamber as the light shaft danced across his face.

Thanks to O'Kelly's work, the tomb is now a World Heritage Site,

with tens of thousands of people applying each year for the privilege of standing inside when it lights up. And although his discovery was rare and unexpected at the time, we now know that Newgrange is just one of many stone monuments constructed in western Europe during the Neolithic period[1] that were aligned to events in the sky.

Some are exceptional and dramatic, such as Stonehenge in England, aligned to the midsummer and midwinter solstices; or the stone circle at Callanish in the Outer Hebrides in Scotland, which captures the nineteen-year cycle of the moon. But there are many smaller examples, such as the hundreds of simple dolmen tombs in southern Europe, whose entrances face the rising sun.[2]

What did these stones mean to their Neolithic builders? Why did people go to such effort to build these monuments, and to relate so many of them to the sky? The answers, as far as we can glean, reveal aspects of human identity and cosmology at a transformative time in our history, perhaps the ultimate transformation, when our species first adopted agriculture.

The hunter-gatherers of the Palaeolithic had existed as an integral part of the natural world, sharing their environment on equal terms with other species. During the Neolithic revolution, people cut those ties and became farmers, controlling and exploiting the land. This shift in lifestyle and mindset changed humanity for ever, setting a trajectory of technological progress that has ultimately made us capable of reshaping not just landscapes but the entire planet.

The revolution was about more than forging a new relationship with wheat or fields or sheep. It transformed our wider cosmos; how people viewed the spirit world and the sky. In fact, there's a case to be made that these new cosmological ideas didn't simply reflect the shift to farming. They caused it.

It's a story that starts not in Ireland but with humanity's oldest known megalithic monument, built a staggering six millennia earlier than Newgrange, and thousands of miles to the east.

•

around the edge of each space were connected by a stone bench. Two more giant pillars – up to 5.5 metres high and each weighing several tonnes – stood parallel in the centre, with traces of carved arms, belts and loincloths made of animal skins. Other stones are covered in carvings of animals: spiders, scorpions, vultures, foxes, boar, gazelles. The archaeologist and prehistorian Steven Mithen has said that Göbekli Tepe is 'an amalgamation of Lascaux cave and Stonehenge', and in time, too, it is a stepping stone, falling roughly midway between the two.

The discovery of huge stone monuments at such an early date – 12,000 years old – was astounding. It takes colossal effort and organisation to erect constructions like this, with hundreds of people working together; other sites on such an enormous scale aren't known until thousands of years later. Archaeologists had assumed that hunter-gatherers simply weren't capable of doing it. They figured that the conversion to agriculture, perhaps triggered by climate change or growing populations, eventually made such monuments possible by providing the resources for large, permanent settlements. This led to a more complex society, as well as changes in religious belief, which together produced both the ability and the motivation to create giant symphonies in stone.

There were dissenters. The French archaeologist Jacques Cauvin argued in the 1990s that cultural or religious changes must have come first. From a technical point of view, early humans could have started farming long before, 'but neither the idea nor the desire ever came to them'. Something must have happened, he suggested, to change how they viewed the natural world. But there was little hard evidence for what that shift might have been, or how it happened.

What Schmidt found, however, suggested that Cauvin was right. Here was clear evidence of a complex, organised society, with some form of religion, or at the very least sophisticated mythology, all *before* the invention of farming. What's more, the pillars of Göbekli Tepe were erected at precisely the place where farming was about to originate.

Biologists have pinpointed this small region, between the upper reaches of the Euphrates and Tigris rivers, as the only place where all seven Neolithic founder crops (chickpea, einkorn wheat, emmer wheat,

barley, lentil, pea and bitter vetch) grew together, while genetic studies of hundreds of einkorn and emmer wheat strains have concluded that domesticated versions of both likely originated from wild strains that grew in the Karacadag Mountains, just 30 kilometres from Göbekli Tepe.

Large numbers of people, maybe hundreds, would have had to congregate on the hilltop to build Göbekli Tepe. Simply having to feed them all may have created pressure to develop new and more predictable food sources. Mithen has suggested that gathering and processing wild grain at or near the site could have led to fallen grain springing up and being gathered again, leading over time to domesticated strains. Rather than being a response to climate change, he concluded, the domestication of wheat 'may have been a by-product of the ideology that drove hunter-gatherers to carve and erect massive pillars of stone on a hilltop in southern Turkey'.

But the connection might run deeper than that. German archaeologist Jens Notroff and his colleagues, who have continued excavating Göbekli Tepe since Schmidt's death in 2014, see clear evidence of a shifting relationship to the natural world, as suggested by Cauvin. In the cave art of the Palaeolithic, people are rarely represented; it's the animals that take centre stage. By contrast, the foxes, snakes and scorpions of Göbekli Tepe are reduced to smaller attributes or decorations on those huge anthropomorphic pillars. As the team put it in 2015, 'humans are no longer depicted as a coequal part of nature, but are clearly more prominent and "raised" above the animal world'. The art shows, they argue, that people had already begun exerting power over nature: a 'mental control' that led to the subsequent physical control of domestication.

Another striking aspect of Göbekli Tepe is an apparent obsession with death. The art here features multiple images of headless people, as well as statues of heads apparently broken from larger statues. Among animal remains found in the sediment – thought to be the debris from lavish feasts – are hundreds of pieces of human bones. Anthropologists reported in 2017 that most of these are from skulls, and that some are carved with grooves and holes in a way that suggests intact skulls were

once hung up for display.

Schmidt interpreted the abstract T-shaped statues as beings from a 'transcendent sphere' (naturalistic statues found at this site and elsewhere show that the builders could depict realistic humans when they wanted to). And, intriguingly, the circular enclosures appear to have been accessed not via doors or gateways but through small openings in 'porthole stones'. One of these stones is decorated with a boar lying on its back. The circles, Schmidt suggested, represented the realm of the dead, which could only be entered by crawling through the hole.

In fact, a preoccupation with death and particularly skulls emerges across the region at this time and in the centuries following, with human remains commonly buried inside people's houses. At sites such as Jericho and 'Ain Ghazal in Jordan, dating to the tenth and ninth millennia BC, selected skulls were removed after death and given faces made of plaster, with shells for eyes, before being placed under the floor. At Çayönü, southern Turkey, archaeologists found a building that they called the 'House of the Dead', dating to around 8000 BC, with 66 skulls beneath the floor and the remains of a further 400 people. It also held a large, flat stone like an altar, with traces of human and animal blood.

A particularly bizarre example is Çatalhöyük, a 20-metre-high mound on Turkey's Konya Plain, a few hundred kilometres from Göbekli Tepe. The mound contains mud-brick houses from a settlement that housed thousands of people at its height in around 7000 BC. The closely packed houses were dug down into the ground, and entered by climbing down a ladder through a hatch in the roof. Inside, the houses were richly decorated with paintings, as well as sculptures of animals that burst out of the walls. There were no doors; to move between rooms, inhabitants had to crawl through portholes. The small chambers were further subdivided into sections, just a metre square, which occupied different vertical levels, with their edges marked or guarded by bulls' heads. Human bones were found buried beneath these platforms and in the walls, including a stillborn foetus enclosed in a brick.

The residents seem to have found the walls of their houses highly significant. As well as embedding objects in them, some had small, undecorated alcoves just big enough for a single person to crouch within.

more formulaic designs: circles, pillars, squares. As Lewis-Williams has pointed out, this shift towards purpose-built structures would have allowed for greater social control too, with the emergence of powerful elites and formal rituals – including decorating and displaying selected skulls after death and possibly human sacrifice – that prescribed who could access these other realms and how.

Göbekli Tepe, then, epitomises two important changes that seem to have happened in parallel just before the adoption of farming, both of which involve societies beginning to separate themselves from, or elevate themselves above, nature. The spirit realms became populated primarily not with animal guides but human ancestors. And instead of using existing caves or natural features as entrances to these other worlds, people started to build their own.

•

It was many millennia before these changes reached the Boyne valley. Genetic studies suggest that farming gradually spread throughout Europe from the Near East, carried by migrants who largely replaced the local populations. The new way of life arrived in Greece around 7000 BC, in northwestern Europe around 4500 BC. And when these farmers reached the Atlantic coast, they made monuments from giant stones, in an explosion of pillars, circles, tombs and graves, from Portugal to Brittany to Sweden.

Different societies expressed this common theme in a variety of ways: in Ireland, a tradition of passage tombs led to Newgrange, one of the most spectacular Neolithic monuments of all. Farmers arrived here around 3750 BC, bringing with them pottery and robust rectangular houses as well as cereals such as wheat and barley. Studies of plant remains suggest that the transition was relatively swift. Within a century or two, cereals were grown across the island, while large areas of forests had been axed or burned.

At the same time, people started building simple stone tombs, with a burial chamber defined by five or six large stones plus a flat capstone on top, all covered with a mound of earth. Over the following centuries, the

Williams suggests that people may have imagined the sunlight, with the released spirits of the dead who had been placed in the chamber, then continuing up through the high corbelled roof and back to the sky, where they would join the sun 'in the eternal round of cosmological life, death and rebirth'.

There was a problem, though. No matter how impressive a tomb like Newgrange or Dowth might have looked to the gathered crowds, the main event – the lighting of the burial chamber – could only be witnessed by the handful of individuals inside. Maybe that's one reason the tradition reached a dead end; passage tombs were no longer built after about 2900 BC. The focus shifted instead to a new kind of monument which took those same illuminations and made them visible to hundreds of people at once.

•

Few ancient monuments have inspired as many different interpretations as the worn, tumbling ruin of Stonehenge, set in the open grasslands of England's Salisbury Plain. Over the centuries, this mysterious giant circle has been described as a druid temple, astronomical observatory, healing centre, war memorial and even a landing point for alien spacecraft. But thanks to a series of recent excavations at Stonehenge and beyond, archaeologists are now in a better position than ever before to tell the stones' real story.

The site is unique for the sheer epic size of its stones and the staggering distances they were carried. Giant sandstone slabs called 'sarsens', weighing 22–27 tonnes each, were probably brought from hills near Avebury, more than 30 kilometres to the north. Smaller bluestones standing among them, weighing several tonnes each, were brought hundreds of kilometres from Wales: one of the most impressive achievements of the entire Neolithic. Adding to the mystery is the monument's famous orientation to the sun.

Modern excavations and radiocarbon dating show that Stonehenge was constructed in several phases. Just after 3000 BC, a circular earthen ditch and bank (loosely described as a 'henge'[4]) was dug from the chalk

what his friend thought of the prehistoric site, Parker Pearson explained to Ramilisonina that archaeologists didn't know why the stones had been erected. 'He asked if I had learned nothing from working in Madagascar,' Parker Pearson recalled in 2013. 'It was obvious to him that such stone circles must be monuments to the ancestors, constructed in stone to represent the eternity of life after death.' Perishable materials such as wood, by contrast, belonged to the temporary world of the living.

At first, Parker Pearson dismissed the idea that Madagascan beliefs could reveal anything new about the purpose of these Neolithic monuments; the idea of Stonehenge as a memorial to the dead had been suggested before. But the next day, during filming at the site itself, he wondered if Ramilisonina's words might help to explain not just these ancient stones, but the entire surrounding landscape.

A few miles up the River Avon from Stonehenge is another Neolithic site, built from earth and wood. Durrington Walls is the largest known henge in the British Isles, an earthen circle that encloses over 17 hectares and includes several large rings of timber posts. Archaeologists had long thought that Durrington Walls was centuries older than Stonehenge, but redating of the Stonehenge stones had just revealed that the two sites could have been in use at the same time. After speaking to Ramilisonina, Parker Pearson wondered if Stonehenge and Durrington Walls might not be two separate monuments after all. Perhaps they were two halves of the same complex: one for the living and one for the dead.

To test the idea, Parker Pearson and his colleagues excavated across both sites from 2003 to 2009. As predicted, the team found evidence of a previously unsuspected settlement at Durrington Walls. It dates to around 2500 BC, when the giant sarsens were erected at Stonehenge. The site overflowed with debris from domestic life, whereas Stonehenge has yielded almost exclusively cremated human remains (archaeologists estimate hundreds of people may have been buried there in the third millennium BC). What's more, the team uncovered an avenue leading from one of the timber circles to the Avon, suggesting the site was linked to Stonehenge by river. They also confirmed several solstice alignments at Durrington Walls – including that this circle and its river avenue both

face southeast towards either midsummer sunset or midwinter sunrise – and the remains of lavish midwinter feasts.

Parker Pearson concluded that this was where the builders of Stonehenge's epic second phase lived. They appear to have travelled from miles around at certain times of year, to celebrate their ancestors and perhaps usher the dead from the living world into the eternal afterlife. The midwinter solstice, when the sun had waned to its lowest point and plant life was dormant, might have been seen, he suggested, as the point at which 'the dark world of the dead was closest to the world of the living'. Perhaps people gathered then at Durrington Walls to commemorate the recently deceased by feasting and erecting timber posts.

A procession might have started in the midwinter-oriented timber circle at dawn, with people walking down to the river towards the rising sun. They could have floated downriver by raft or canoe into the realm of the ancestors, perhaps carrying the cremated remains of selected dead, before walking up towards Stonehenge in the afternoon. From this angle, the lintelled circle would have presented a solid silhouette against the sky. The sun would have set directly behind, shining straight through a tight window between the top of that circle and the upper portion of the towering central trilithon. For anyone walking up the slope towards Stonehenge, the last glimmer of sunset would have been held there for a few moments, transformed as at Newgrange into a beam of light framed by stone.

The idea of Stonehenge as a realm of the dead, visited by the midwinter sun, makes sense in the light of theories about passage tombs such as Newgrange. In both cases, the Neolithic builders used the stones to convert their knowledge about repeating patterns of Earth and sky into dramatic moments of sensory perception. Knowing that the solstice falls on a certain day is one thing, collectively witnessing it in the depths of winter would have been quite another: during the time of greatest darkness comes the light. From their knowledge of cosmic cycles, they constructed a dramatic message about eternity – perhaps eternal afterlife – that would last for millennia.

The big innovations of the Neolithic are often said to be stone

monuments and farming. Yet both of these can be traced back to a deeper shift, as humans mentally separated themselves from nature, and it became conceivable to manipulate and dominate the natural world. Instead of simply adapting to their environment people took control, shaping not just individual monuments but eventually entire landscapes to give their beliefs and desires physical form.

It's a revolution begun at and around Göbekli Tepe, but completed 6,000 years later by the builders of Stonehenge. Here the animal spirits are gone; human ancestors rule supreme. And the dependence on caves and the underworld has been broken. The farmers of Neolithic Britain constructed a new cosmology, suitable for a larger, more complex society. People now explored their universe not through individual trance states, deep inside caves as at Lascaux or in tombs like Newgrange, but in public arenas dramatically aligned with the sky. Instead of hiding in the dark, they had stepped into the light.

1 The Neolithic begins with the introduction of farming and ends with the appearance of bronze tools.
2 Dolmen tombs are single-chamber tombs in which a large, flat capstone rests on two or more vertical stones.
3 Many of the excavation's finds went to the archaeological museum in Sanlıurfa, where they are on display today – including the complete cult building, which has been carefully rebuilt inside the museum.
4 True henges, however, have the ditch outside the bank. Stonehenge is unusual in having its ditch on the inside.
5 Claims made in the 1960s that the stones incorporate dozens of astronomical alignments, and that the 'Aubrey Holes' were used to predict eclipses, are not generally accepted by scholars today.

3

FATE

In December 1853, a twenty-seven-year-old archaeologist named Hormuzd Rassam was leading excavations near Mosul, now in Iraq, on behalf of the British Museum in London. It was the opportunity of a lifetime, particularly for someone born and raised in the Middle East. But after more than a year of work, he had yet to make a big discovery, and the spot he was desperate to investigate had been promised to a rival team. He had one last-ditch idea, but the timing had to be perfect. So he watched the desert sky, waiting anxiously for the full moon.

Mosul was Rassam's home city. Today, it's known largely as a casualty of the war against terror, left as a pile of rubble and bones after Iraqi forces won it back from ISIS in July 2017. But in Rassam's time, Mosul was part of the Turkish Ottoman Empire, with centuries-old brick walls that enclosed dusty streets, crowded bazaars and mosques with bulging domes and soaring minarets. Rickety, flat-bottomed boats ferried passengers across the River Tigris to the fertile land beyond: cornfields; melon and cucumber beds; and a series of shallow grassy hills.

Over the past few years, European adventurers digging in these mounds (and at Nimrud, 30 kilometres south) had revealed a spectacular ancient world. The largest mound, called Kuyunjik, was a mile long. In 1847, the British explorer Austen Henry Layard, with Rassam as his assistant, tunnelled into its southwest corner and unearthed the ruins of a great palace, built in the seventh century BC. The luxurious riverside residence had at least eighty rooms and passages, with stone doorways guarded by huge winged bulls and lions, and walls decorated with around 3 kilometres of carved alabaster friezes, showing victorious