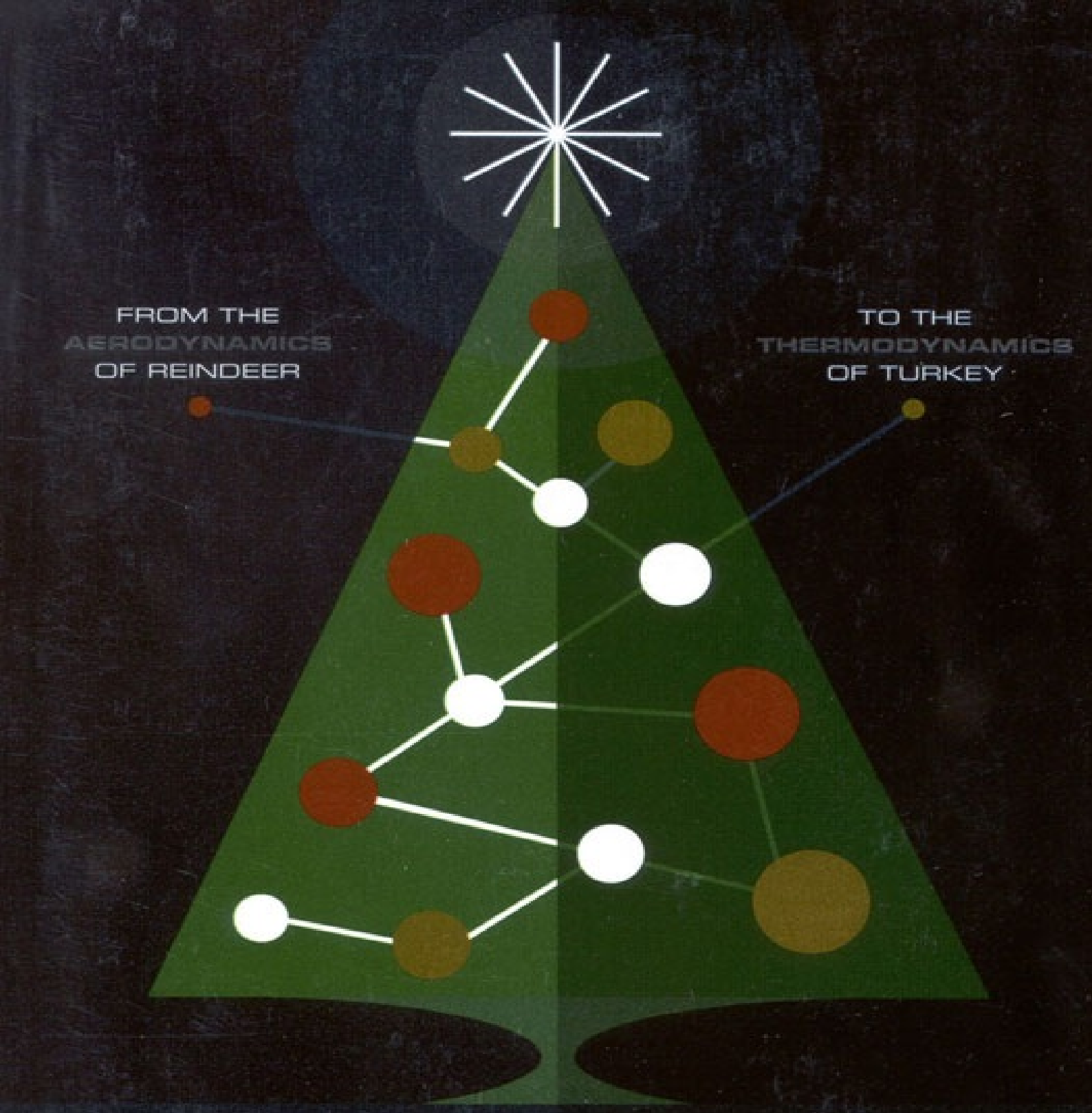

ROGER HIGHFIELD

THE PHYSICS OF CHRISTMAS

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Contents

Delight in the physics of…

Snow… A single snowflake might contain on the order of 100,000,000,000,000,000,000 water molecules…. The snowflakes that adorn Christmas cards are somewhat idealized. Most snowflakes are ugly sisters: only 1 percent are symmetrical.

Christmas spirits… The body treats the alcohol from your Christmas tipple like a poison and attempts to break it down in the liver. This organ can deal with large amounts of the substance, but it requires time to do so. Drink a liter of spirits in one go, and you may well die. Pace yourself, and you liver efficiency will contribute to your tolerance for seasonal celebrations.

Shopping… Although the lines of people in a supermarket are all subject to random delays, on average they tend to move at about the same rate. This feature of the Christmas shopping experience captured in a mathematical form by the so-called Poisson process, which assumes that people are as likely to arrive at one time as at any other, but that precisely when they arrive is entirely random.

Holiday decorations … What is so beautiful about the act of lighting a candle on a Christmas tree is that it honors the cycles that turn within and without living things. The chemical energy generated by photosynthesis in plants is passed up the food chain, for instance, to grazing cattle and then on to a tallow candle. When the candle is lit at the gloomiest time of year, it releases this “cryptic sunlight” and returns the complex fat, or wax, molecules to the form in which the plants found them — water and a hot breath of carbon dioxide that can again be incorporated into living things.

“Is *The Physics of Christmas* the perfect Christmas present? Pretty nearly. There is a risk that it won' reach the intended recipient if you open it yourself”.

— New Scienti

FRONTIERS OF COMPLEXITY, with Peter Coveney

THE PRIVATE LIVES OF ALBERT EINSTEIN, with Paul Carter

THE ARROW OF TIME, with Peter Coveney

ACKNOWLEDGMENTS

I have endeavoured in this Ghostly little book, to raise the Ghost of an Idea, which shall not put my readers out of humour with themselves, with each other, with the season, or with me. May it haunt their house pleasantly, and no one wish to lay it.

Their faithful friend and servant,
C.D.
December 1843

LIKE CHARLES DICKENS IN HIS PREFACE TO*A Christmas Carol*, I propose “to raise the Ghost of an Idea”

In Dickens's classic book, the Ghosts of Christmas Past, Present, and Future reveal the true meaning and spirit of the season to Ebenezer Scrooge, transforming him from a miser into a potent symbol of charity. I, too, hope to enlighten the reader by acting as a guiding spirit, one who will illuminate Christmas by viewing the holiday and its rituals from a new perspective, that of science. Christmas and associated celebrations offer a wonderful excuse to explore a broad range of fields, from biotechnology and fractals to neuropharmacology and nanotechnology. If appetites are whetted for science, or at the very least curiosity about the subject is stimulated, I will be pleased. Any chang in the charitable behavior of the reader would, of course, be a welcome bonus.

Each Christmas for the past decade, I have written about seasonal science for *The Daily Telegraph.* Many thanks to my editor, Charles Moore, and his predecessor, Max Hastings, for indulging my obsession. Gulshan Chunara, as ever, provided me with invaluable assistance. It has als been stimulating discussing aspects of the book with my colleagues Adrian Berry, Aisling Irwin, David Johnson, Laura Spinney, Tom Standage, and Robert Uhlig. Sarah Foot provided me with a wonderful retreat on Islay where I could work on the U. S. edition.

John Brockman and Katinka Matson gave me the encouragement to develop a book proposal. Ver many thanks are also due to Little, Brown and Rowohlt for backing the project and in particular to Rick Kot for his warm encouragement and support.

I would like to thank the following people and organizations for helping me to seek out the science behind the festivities: Leonard Adleman, Denis Alexander, Anthony Astbury, Peter Barham, Linda Bartoshuk, Sam Berry, Gerard Bond, Roy Bradshaw, British Antarctic Survey, Donald Brownlee, L. P. Bucklin, Stephen Burley, David Cheal, David Clary, Chris Clayton, Cary Cooper, Malcolm Cooper, Winnifred Cutler, Daniel Dietrich, Piero Dolara, Jonathan Dorfman, Robert East, Matthew Freeman, Jeffrey Friedman, Adrian Furnham, Takanari Gotoda, Richard Gross, Steven Gues Sunil Gupta, Odd Halvorsen, Patrick Harding, Alan Hirsch, James Home, David Hughes, Ilpo Huhtaniemi, Colin Humphreys, Nina James, Charles Jenkins of IBM, Steve Jones, Dan Keathley, David Kelly, Barry Kemp, Harold Koenig, Sir Harry Kroto, Michel Laroche, Dale Lewison, Robin Lovell-Badge, Laurie Lucchina, George Masterton, Dale Matthews, John Maynard Smith, Patrick McGovern, Wendy Mechaber, Dave Mela, John Metz, Michael Molnar, John Moore, Les Noble, Adrian North, José Pardo, Kenneth Pargament, David Peel, Raj Persaud, David Phillips, Krishna Podila, Bill Proebsting, Sir Martin Rees, Wolf Reik, Allen Riordan, Norman Rosenthal, Delwen

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I am also indebted to a number of researchers who gave me feedback on specific sections of the book. I have covered such a wide range of fields that I am confident of one thing: a number of howler remain, all of which are my responsibility. Many thanks to the following for helping me weed out some of the worst: Miguel Alcubierre, Peter Atkins, Peter Barham, Charles Bennett, Sam Berry, Davi Bonthron, Roy Bradshaw, Samuel Braunstein, Roger Buckland, Carole Burgoyne, Linda Capper, Isaac Chuang, David Clary, Roger Cone, Cary Cooper, Peter Coveney, Glenn Cox, Peter Davies, Leslie Dawes, Daniel Dietrich, Robert East, Sabine Eber, Ron Evans, Matthew Freeman, Adrian Furnham, David Gems, Alexei Glebov, Richard Gross, Rose Gubitosi-Klug, Sunil Gupta, Laurance Hall, Odd Halvorsen, Patrick Harding, Mike Hayden, James Home, David Hughes, Ilpo Huhtaniemi, Colin Humphreys, Dan Keathley, David Kelly, Gerd Kempermann, Harold Koenig, Tom Lachlan-Cope, Michel Laroche, Dale Lewison, Robin Lovell-Badge, Neil Martin, Patrick McElduff, Stanley McKnight, Dave Mela, Randolf Menzel, Daniel Miller, Les Noble, Adrian North, José Pardo, Daniele Piomelli, Caroline Pond, David Price-Williams, Wolf Reik, Allen Riordan, Margaret Robins, Delwen Samuel, Larry Silverberg, Gene Stanley, Ian Stewart, Scott Swartzwelder, Luca Turin, Mark Uncles, Dietmar Voelkle, Bernard Wentworth, Diederik Wiersma, Andy Yeatman, Anton Zeilinger, and Timothy Zwier.

God bless us, every one!

ROGER HIGHFIELD

CHRISTMAS AND THE SCIENTIST:

AN INTRODUCTION

There seems a magic in the very name of Christmas.

CHARLES DICKENS, SKETCHES BY BOZ

CHRISTMAS IS A TIME FOR THE CRUNCH OF SNOW, spiced wine, and tinseled trees. Christmas is a time for giving, meeting friends, and feasting. Christmas is a time for carols, family gatherings, gaudy greeting cards, and all the jollity of the seasonal spirit. Christmas is also a time for science.

Chemists are hard at work in the Christmas kitchen. Experts on thermodynamics have drafted equations to help us cook turkeys to perfection, scanners have scrutinized steaming plum puddings, and pharmacologists have traced the baroque metabolic pathways of the brain to explain why chocolates can be so addictive.

Meteorologists study every aspect of the snow cycle that provides a seasonal sprinkling, from the seeding of an ice crystal high in the sky to the traces of past Christmases buried deep in the snowpack.

Climatologists are plundering this record to help predict white Christmases far into the future. A handful are even concocting outlandish schemes to guarantee that each and every Christmas is white.

Psychologists tease out the hidden agenda of the Christmas card and what it reveals about our social status. The same goes for presents. The price, the nature of the gift, and even the way it is wrapped say a great deal about the giver and his or her relationship with the recipient. All the while, anthropologists hunt for the foundation of the celebration in pagan rituals that took place before the birth of Christ, during long winter nights when our ancestors feared that the sun would never return.

The origins of the holiday in the darkness of prehistory emphasize perhaps the most fundamental aspect of Christmas: everyone's invited. The seasonal message of hope and charity is a message for all — Christians, Jews, Hindus, Moslems, Buddhists, and, yes, even scientists and engineers.

I have been investigating the science of Christmas for more than a decade. When I first began to take an interest in the subject, I was unprepared for the breadth and depth of the insights that would eventually emerge. Take those flying reindeer, Santa's red and white color scheme, and his jolly disposition, for example. They are all probably linked to the use of a hallucinogenic toadstool in ancient rituals.

I can add that Santa was born with a genetic propensity to become obese and now suffers from diabetes. He does not live at the North Pole, preferring the warmth of an island off the coast of Turkey. There, panting at his side, you will find Rosie — not Rudolph — the reindeer.

I was at first puzzled by how Santa could fly in any weather, circle the globe on Christmas Eve, carry millions and millions of presents, and make all those rooftop landings with pinpoint accuracy.

The answer lies in his unprecedented research resources and expertise across a range of fields, spanning genetic engineering, computing, nanotechnology, and quantum gravity.

My experience of writing this book undermines the idea that the materialist insights of science destroy our capacity to wonder, leaving the world a more boring and predictable place. For me, the very reverse is true. I can still remember the day when, as a child, I first became convinced that Santa did not exist. Now, by refracting the Santa myth through the prism of science, he seems more real than ever.

I believe that science and technology can even shed a little light on a deeper question: where did Christmas come from in the first place? Peel back the wallpaper of centuries, and you will find that the festival is an amalgam of influences — German, Dutch, English, American, and other traditions, both religious and pagan — that emerged over the millennia.

Even today, the traditional Christmas hoopla is far from a homogeneous phenomenon, taking place alongside Kwanzaa, an African-American harvest holiday, and the eight-day Jewish celebration of Hanukkah. Together they constitute *the* annual celebration.

Part of the reason winter festivities went global can be found 150 years ago, at the tail end of the Industrial Revolution. It was then that “Christ's Mass” (*Cristes maesse* in Old English), the church service that celebrates the birth of Jesus Christ, along with a wealth of other traditions, entered the scientific age of mass communications, transport, and other technologies.

This collision between ancient tradition and the age of science and technology was particularly significant in Victorian Britain, where, during a single decade, there was a striking coincidence of events of significance for science, the annual celebrations, and this book.

The 1840s saw a dizzying rate of change in society due to efforts across a proliferating range of disciplines. In the world of science, there were Darwin's ideas on natural selection, Joule's work on thermodynamics, and Faraday's studies of magnetism, light, and electricity.

In the sister disciplines of engineering and technology, there were developments in factories, machine tools, and information technology. Babbage was hard at work on his difference engine, and a web of telegraph lines spread across the nation. All the while the old certainties seemed to have been squashed flat by the steam hammer, steamboat, and steam train. The resulting turmoil in society made the traditional Christmas message of charity more relevant than ever.

Emerging communications technologies, from speedy railways to the telegraph, paved the way for that message to be disseminated and homogenized for mass consumption, forging much of what we think of today as the traditional festivities.

The tumultuous 1840s also saw an important token of the rising influence of science: the birth of a specific label for the burgeoning army of individuals at work in this field. William Whewell, a polymath who was a Fellow of the Royal Society, coined the word *scientist* in earnest in his two-volume book *The Philosophy of the Inductive Sciences.* The word was of dubious legitimacy in philological terms, a hybrid of Latin and Greek, and was attacked (wrongly) as “an American barbarous trisyllable.” But the pressure to put a name to this increasingly influential group was overwhelming.

That same decade saw the introduction to Britain of one component of the German Christmas that remains very much a part of the celebrations today. Queen Victoria and Prince Albert set up a Christmas tree for the first time in Windsor Castle in 1840. She recorded that this German custom quite affected dear Albert, who turned pale and had tears in his eyes! Eight years later they appeared beside the tree in the *Illustrated London News,* one of the magazines established that decade to exploit advances in illustration technology. This would become one of the most famous nineteenth-century

Christmas scenes of all.

At the same time that *scientist* was born and Albert gazed upon his tree, an eminent and extraordinary individual, Henry Cole, decided to reduce the burden of writing Christmas greetings letters by taking advantage of another development he had had a hand in: the introduction of the penn post in 1840.

His invention, the first Christmas card, was published in 1843 and cost a shilling, the equivalent a day's wages for a laborer. After two decades the price fell dramatically thanks to one of the technological innovations of the day, cheap color lithography, and Christmas cards entered the mass market.

Cole regarded the card as the folk art of the Industrial Revolution, and it ultimately became the greatest popularizer of now-standard Christmas iconography, with designs ranging from bizarre characters with pudding heads to mannequins in period costume, as well as the more conventional mistletoe, robins, holly, and fireside scenes. Not only were the cards printed on paper, but they were also gilded, frosted, and dressed with satin or fringed silk. Some were even made to squeak.

Through the evolution of one of the card's most familiar characters, it is possible, in the wake of the pioneering contributions of Cole, Prince Albert, and Whewell, to trace the influence of scientists, engineers, and technologists on our way of life. I am, of course, referring to the many depictions of that fat man with the white beard.

A silk-fringed card published in 1888 reveals how, by then, Santa had resorted to the latest communications technology to improve links with his market. The figure shown on the card seems to be engaged in what can only be described as a conference call, listening to the simultaneous demands for presents from an assortment of children. Only the previous decade, Alexander Graham Bell had patented the telephone that made it all possible.

By the 1890s Santa had decided to give up his sleigh and reindeer, preferring to haul his gifts around by “the new monstrosity from France,” the automobile. As a result of the development of the internal combustion engine, the silent night, holy night now throbs to the sound of traffic. The stillness of the snowy landscape shown on so many Christmas cards is marred by the groan of the snowplow and the susurrus of chains on wheels. The search for the Bethlehem star is now obscured b a haze of photochemical smog.

Another newfangled device, the wireless, appears on one 1929 Christmas card, which features a Santa apparently mesmerized by the crackling message it is receiving over the ether: “You're in my Christmas circuit / And on the waves of thought / A Happy Christmas and New Year / To you is gladl brought.” Radio would become the first mass medium to reinforce the tendency for Christmas to be a festival held behind closed doors.

When Santa reached for a cool soda pop in a Coca-Cola advertisement that appeared during the Christmas season of 1937, he was again a technological pioneer. The source of his refreshment was a refrigerator, even though iceboxes were still being used by most American households that year.

Santa can now be found in cyberspace. The last time I checked, there were hundreds of Santa home pages for children's e-mail. Digitized images of Santa now scud about the web of international computer networks every Christmas.

One day these images may even supplant the traditional Christmas card. However, I believe that an e-mailed Santa, spouting digital “ho, hos” and seasonal greetings, would still honor the spirit in which Henry Cole first dreamed up the card — as a practical way to marry mass communications and art.

Cole would be amazed and gratified by the extent to which his little invention has caught on

today. The significance of the 1840s does not end there, however. As Cole sent out his first cards, the greatest and most influential of all Christmas books made its first appearance in a crimson and gold binding.

A Christmas Carol was published by Chapman and Hall on December 19, 1843. By Christmas Ev it had sold six thousand copies, the most successful publication that season. Within two months eight pirated theatrical productions had been staged.

The genesis of this work of popular genius dates back to around 1840 and Dickens's correspondence with the philanthropist Lord Ashley. Dickens was horrified by the impact on society of the age of machines, notably the appalling conditions endured by children working in coal mines and factories. He started work on the book to make a sledgehammer blow against these evils of the industrial age.

One newspaper described the book as “sublime.” Thackeray said that it was a “national benefit.” Lord Jeffrey told Dickens that it had “prompted more positive acts of beneficence than can be traced to all the pulpits and confessionals in Christendom since Christmas 1842.”

Thus the 1840s saw a striking convergence: the first scientist, the tree, the card, and the Christma book to top all Christmas books. A century and a half later, science is still altering the very nature an fabric of the celebrations through the introduction of new technology, whether cloned Christmas tree the Internet, or those infuriating cards that play carols over and over again.

And so on to the science of Christmas.

SANTA AND THOSE REINDEER

His eyes how they twinkled! His dimples how merry!
His cheeks were like roses, his nose like a cherry.
His droll little mouth was drawn up like a bow
And the beard on his chin was as white as the snow.
The stump of a pipe be held tight in his teeth,
And the smoke, it encircled his head like a wreath.
He had a broad face and a little round belly
That shook, when he laughed, like a bowl full of jelly.

CLEMENT CLARKE MOORE,
"A VISIT FROM ST. NICHOLAS"

WHERE DO YOU THINK SANTA CLAUS IS RIGHT now? Sitting with a glass of sherry in front of the glowing embers in a cozy wooden house while Arctic snow falls softly on his sleigh outside? Or maybe feeding the reindeer? Perhaps he has his maps out and is making adjustments to his route across the North Pole for Christmas Eve?

Not the *real* Santa. For the sake of accuracy, Christmas cards should show Santa in sunglasses, clad in red and white swimming trunks, and sipping a cool Coke next to a swimming pool. For the sake of completeness, a reindeer with a sunburned nose, called Rosie, should be panting nearby.

There is now evidence to suggest that Santa's abode lies not on the polar ice cap, but among Mediterranean olive groves on Gemiler, a tiny island off Turkey. It is there, historians believe, that S Nicholas, a direct ancestor of Santa Claus, may have died.

Gemiler is well-known to tourists and has recently been the subject of a number of archaeologica studies, most recently by the University of Osaka, and by a group of scholars including David Price-Williams, an archaeologist who lectures at London University. Though it is only half a mile long, it has at least five churches decorated with frescoes and mosaics and all the hallmarks of a major religious site — a holy city dedicated to St. Nicholas.

Medieval Venetian sailing instructions refer to Gemiler as the Island of San Nicolo. On a church door near the anchorage is a painting of "Osios Nikolaus" — St. Nicholas himself. The island also ha a huge Byzantine ecclesiastical complex, with a magnificent 300-meter barrel-vaulted processional way. At other Byzantine sites processional roadways are often associated with monastic complexes dedicated to the veneration of major saints, but few ever reached the grandeur of the one at Gemiler.

Who Was Santa?

Legend suggests that St. Nicholas was born around A.D. 245 in the town of Patara, an important Byzantine port in Turkey, only a couple of hours' sail from Gemiler. When Nicholas was a young man, his father died, leaving a great fortune. Nicholas began anonymously giving away the money to the needy, especially to children. Eventually he became Bishop of Myra (the modern-day coastal tow of Demre), at the southernmost tip of the Bey Daglari Mountains. (The name "Myra" is derived from that of the resin myrrh.) There he supposedly performed several miracles, including saving sailors from drowning and resurrecting three boys who had been killed by an evil butcher. It is the best-known of his miracles, however, that helps to wrap St. Nicholas into the legend of Santa Claus.

This miracle concerned a noble and his three daughters, who had fallen on hard times. The daughters had little chance of marriage, as their father could not pay their dowries, so they faced a lif of prostitution. One night St. Nicholas, hearing of the girls' plight, threw a sack of gold through a window of the nobleman's shabby castle. The sack contained enough gold to provide for one daughter's marriage. The next night he tossed another sack of gold through the window for the second daughter. But on the third night the window was closed. Ever resourceful, St. Nicholas dropped the third sack of gold down the chimney. Townsfolk heard the story and began hanging stockings by the fireplace at night to collect any gold that might come their way, presumably — hence the tradition of the Christmas stocking and Santa's affinity for fireplaces.

St. Nicholas probably died sometime in the mid-fourth century. (One oft-quoted date is Decembe 6,343.) The earliest Byzantine portraits show him with a long white beard, and when the reformed church spread throughout Europe, he became linked with Christmas because his feast day is 6 December. His fame was widespread by the sixth century — a possible explanation for the huge settlement on Gemiler.

But just after 650, this place of veneration was disbanded. The Islamic governor of Syria launche a fleet to challenge Byzantine sea power in the Mediterranean. He quickly destroyed the settlements on Cyprus, followed by those on Rhodes and Cos. Gemiler was abandoned. The site lay forgotten and forlorn — the lost sacred city of St. Nicolas. Today St. Nicholas remains one of the most popular Christian saints and is known as the patron of children, sailors, teachers, students, and merchants.

There are many and varied explanations of how St. Nicholas evolved into the character we know. All that can be said with certainty is that Santa's roots lie in folk customs and beliefs from a sackful o sources. These include the British Father Christmas, the French Père Noël, the Dutch Sinterklaas, the Danish Jules-Missen, and even the Romanian Mos Craicun.

The Protestant church also influenced the evolution of this icon. When Martin Luther objected to the practice of gifts being given to children in the name of a Catholic saint, Nicholas was joined during the Reformation by a child, the Christkindlein. This would mutate back into the Father Christmas figure Kriss Kringle in English-speaking society.

Then the Christkindlein was joined by a dwarfish, dark-faced companion, often a frightening figure, known variously as Krampus, Pelzebock, Pelznickel (Nicholas in furs), Hans Muff, Bartel, or Gumphinkel. There were also female equivalents — Berchtel, Buzebergt, and Budelfrau. Most commonly the companion was called Knecht Ruprecht and carried a bundle of switches to mete out punishment to naughty children.

The Dutch are often credited with transforming the saint into the character we know today. Their custom of giving presents to children on the Day of St. Nicholas was brought to America by early Dutch settlers of New Amsterdam (renamed New York when the British took over the colony). There Sinterklaas, the colloquial Dutch for St. Nicholas, evolved into Santa Claus.

Sinterklaas was traditionally depicted with a broad-brimmed hat and a pipe, and his long churchl

robe was replaced with short breeches. By the beginning of the nineteenth century, the various traditions started to mingle, so that in 1809, for instance, the American writer Washington Irving wrote of a jolly, chubby fellow riding in a wagon over treetops.

There is another, quite different way to trace the evolution of the modern Santa. His development could be viewed in terms of how brains have been parasitized through the ages by entities that evolve to thrive in just such a niche. These are *memes* (loosely speaking, units of cultural transmission), a term coined by the biologist Richard Dawkins to show that ideas replicate rather like genes do. Examples include tunes, catchphrases, innovative concepts, clothes, fashions, and, of course, Santa Claus, Father Christmas, and the rest.

Genes are carried by organisms in which they produce effects (skin color, blood type, and so on) that make each of us individual. Memes are carried by meme vehicles — poems, books, sayings, and so on — bearing an idea that will distract us, burden our memories, and coerce children to be well behaved in the frantic run up to Christmas Day. Otherwise, as the memes warn, Santa will not deliver any presents. As one sociologist puts it, “Parents use the belief in Santa Claus to control children, to induce children to defer demands for gratification to Christmas, and to make it appear that Santa, not the parents, causes the deprivation of children.”

Modern Santa and Meaning

It would be a mistake to describe today's Santa as a simple amalgam and evolutionary endpoint of his rich mixture of ancestors. For one thing, many versions still exist. In different regions of Germany St Nick is known by various names, including Klaasbuur, Burklaas, Rauklas, Bullerklaas, and Sunnercla In eastern Germany, where the Santa figure remains more connected with his pagan past, he is called Ash Man, Shaggy Goat, or Rider. There is also the Weihnachtsmann, a Father Christmas–like figure who is depicted as tired and stooped from toiling through the dark winter night with his heavy burden of toys.

Another blow against the Santa-as-amalgam model has been struck by anthropologists. They have set to work on the most ubiquitous form of the modern Santa and declared him to be more than the sum of his European influences — indeed they see him as distinctly American. They highlight five key differences between the Santa of today and his ancestors: (1) Santa lacks the religious baggage of his predecessors; (2) he is, by the standards of Knecht Ruprecht, a bit boring; (3) he has turned into a softhearted liberal with no stomach for the punishment meted out by the likes of Sinterklaas and Knecht Ruprecht; (4) this mythical figure is more tangible than his predecessors, thanks to appearances in films, TV shows, and department stores (even in Japan); and (5) he spends much more than his central European forebears, preferring to give Nintendo video games rather than nuts, for example.

The distinguished anthropologist Claude Lévi-Strauss has provided a wonderful pen portrait of this Christmas icon: “Father Christmas is dressed in scarlet: he is a king. His white beard, his furs and his boots, the sleigh in which he travels evoke winter. He is called ‘Father’ and he is an old man, thus he incarnates the benevolent form of the authority of the ancients.”

Importantly, says Lévi-Strauss, children believe in him, paying homage to him with letters and prayers, while adults do not: “Father Christmas thus first of all expresses the difference in status

between little children on the one hand, and adolescents and adults on the other. In this sense he is linked to a vast array of beliefs and practices which anthropologists have studied in many societies to try to understand rites of passage and initiation."

Sociologists have also been toiling away to reveal what we mean by Santa. Warren Hagstrom of the University of Wisconsin, Madison, couches his analysis in terms of either positivism or Clauseology. For the positivist (nineteenth-century version), "belief in Santa Claus is defined as erroneous; and the problem of the positivist is to discover how such erroneous beliefs arise. The positivist, arguing that all beliefs arise by inference from experiences, finds the meaning of Santa in false inferences from actual experiences."

The naturism of the German-born British philologist Max Müller is a variety of positivism that finds the origins of figures like Santa in natural phenomena, says Hagstrom. Children, like primitive people, often personalize the forces of nature. "While small children may find it difficult to conceptualize the winter solstice, they find it easy to conceptualize Santa Claus. (Ask any child questions about the two phenomena.)"

The Clauseologist position, Hagstrom explains, is that Santa Claus exists but that his essential nature ("meaning") cannot be empirically ascertained. "The empirical phenomena associated with Santa are likely to be illusory and deceptive. It is instead necessary to rely on nonempirical methods of investigation, of which there are two types: inner experience and revealed sources. I cannot report here my inner experiences of Santa Claus, since it has been so long since I've had any genuine experiences of this type." This piece of whimsy, published in *American Sociologist*, goes on to say that one of the major problems facing Clauseologists is collecting authentic revealed sources.

Fortunately, Hagstrom accepts works like "A Visit from St. Nicholas" as part of the canon. This Christmas poem marks perhaps the most important single blueprint for modern Santa. It was written by Clement Clarke Moore, a professor at the General Theological Seminary in New York. A classical scholar and poet, Moore had translated Juvenal and other Roman poets into English verse and turned his hand to poetry in the romantic style. He was familiar with the folklore of the Dutch, German, and Scandinavian immigrants who had settled in the northern United States, including the Dutch tradition of Sinterklaas (which by then was widely observed on December 24 and 25) and the Teutonic and Norse notions of a jovial but somewhat impish figure who presided over the pagan midwinter festivities. In 1822 he synthesized the lot into a figure who stars in his poem "A Visit from St. Nicholas."

That December Moore read the verses aloud to his children. A visitor to his home was so impressed that he had the poem published the following year in the *Troy Sentinel* in upstate New York. The poem gave us these oft-quoted lines: "'Twas the night before Christmas, when all through the house / Not a creature was stirring — not even a mouse." In dozens of rhyming couplets, often derided today as doggerel, he described a plump, pipe-smoking Santa who traveled from the north in sleigh drawn by tiny flying reindeer with "dainty hooves." This St. Nicholas also had a belly "that shook … like a bowl full of jelly" and a beard that was "white as the snow." That much sounds very familiar. However, he was "dressed all in fur, from his head to his foot," which is more reminiscent of Pelznickel than of a latter-day Santa.

Alas, St. Nicholas probably did not celebrate Christmas and probably never saw, or even knew about, reindeer. In Dutch legends Sinterklaas travels on a gray horse and wears bishop's robes. It is not clear when, if ever, Moore saw a sleigh drawn by reindeer, let alone the beasts in the wild, though he may have been acquainted with a Finnish legend concerning "Old Man Winter," who drives his reindeer down from the mountains, bringing snow with him.

Further evolution in the image of Santa occurred when he was depicted as a pear-shaped, jolly character with a flowing white beard in drawings by Thomas Nast in *Harper's Weekly* between 1863 and 1886. The break with his religious past was by then clear: Nast's Santa was reminiscent of his drawings of a drunken Bacchus and the corpulent plutocrat William “Boss” Tweed. Nast himself admitted that he was also inspired by the furs of the Astors when he designed Santa's fur-trimmed garb.

When it comes to the kind of Santa that we see stalking shopping malls and TV today — the jolly fat figure clad in red and white — a leading manufacturer of carbonated beverages claims the credit for that archetype. A year or two ago, Coca-Cola even had the cheek to celebrate Santa's sixty-fifth birthday.

Before 1931, the company says, Santa Claus appeared in many different guises, from a green elf a somber St. Nicholas and even a gaunt figure dressed in animal skins. That year, so the publicity goes, Coca-Cola commissioned a young Swedish artist, Haddon Sundblom, to give the icon a makeover.

From 1931 on, Sundblom created at least one Santa picture annually. His St. Nicholas wore an ample red coat trimmed in white and held in place with a thick leather belt, and he was depicted in various seasonal scenes. A hat, also trimmed in white, appeared in 1934. Sundblom removed Santa's pipe, which can be seen in Nast's creation, and gave him a bottle of Coke.

Through a succession of poses — with children, reindeer, sacks of toys, or letters — he was neve without his fizzy drink. With the billowing beard, expansive girth, and rosy cheeks, he would gaze intently at his bottle or grasp it heartily, ready for that “pause that refreshes.”

Santa: The Hallucinogenic Connection

A rival suggestion for the origins of much of Santa's paraphernalia — his red and white color scheme those flying reindeer, and so on — is much more fun, less commercial, more scientific, and somehov more appealing than Coca-Cola's version, because it is so politically incorrect.

Patrick Harding of Sheffield University in England argues that the trappings of the traditional Christmas experience owe a great deal to what is probably the most important mushroom in history: fly agaric *(Amanita muscaria)*, the recreational and ritualistic drug of choice in parts of northern Europe before vodka was imported from the East. Each December this mycologist dresses up as Sant and drags a sleigh behind him to deliver seasonal lectures on the toadstool. The garb helps Harding drive home his point, for Santa's robes without doubt honor the red-and-white-dot color scheme of th potent mind-altering mushroom.

Commonly found in northern Europe, North America, and New Zealand, fly agaric is fairly poisonous, being a relative of the more lethal death cap *(Amanita phalloides)* and destroying angel *(Amanita virosa)*. The hallucinogenic principles of fly agaric are due to the presence of the chemicals ibotenic acid and muscimol, according to the International Mycological Institute at Egham, Surrey, England. Ibotenic acid is present only in fresh mushrooms. On drying, it turns into muscimol, which ten times more potent. In Lapp societies, the village holy man, or shaman, took his mushrooms dried — with good reason.

The shaman knew how to prepare the mushroom, removing the more potent toxins so that it was

safe enough to eat. During a mushroom-induced trance, he would start to twitch and sweat. His soul was thought to leave the body as an animal and fly to the otherworld to communicate with the spirits. The spirits would, the shaman hoped, help him to deal with pressing problems, such as an outbreak of sickness in the village. With luck, after his hallucinatory flight across the skies, he would return bearing the gifts of medical knowledge from the gods.

Santa's jolly “Ho, ho, ho” is the euphoric laugh of someone who has indulged in the mushroom. Harding adds that the big man's fondness for popping down chimneys is an echo of how the shaman would drop into a yurt, an ancient tentlike dwelling made of birch and reindeer hide. “The ‘door’ and the chimney of the yurt were the same, and the most significant person coming down the chimney would have been a shaman coming to heal a sick person.”

Harding uses the shaman's urine to link reindeer to the myth. For one thing, reindeer were uncommonly fond of drinking human urine that contained muscimol. The hoi polloi from the village also were partial to mind-expanding yellow snow, because the potency of the muscimol was not greatly weakened — although it was probably safer — once it had passed through the shaman. “There is evidence of the drug passing through five or six people and still being effective,” Harding says. “This is almost certainly the derivation of the phrase ‘to get pissed,’ which has nothing to do with alcohol. It predates inebriation by alcohol by several thousand years.”

Such was the intensity of the drug-induced experience that it is hardly surprising that the Christmas legend includes flying reindeer. Witches soar for related reasons: a witch who wanted to “fly” to a sabbat, or orgiastic ceremony, would anoint a staff with specially prepared oils containing psychoactive matter, probably from toad skins, and then apply it to vaginal membranes.

References to flying can be found in more recent applications of the mushroom. St. Catherine of Genoa (1447–1510) used fly agaric to soar to the heights of religious ecstasy, according to Daniele Piomelli of the Unité de Neurobiologie et Pharmacologie de I'Inserm in Paris. An account of the life of St. Catherine describes the use of ground agaric, so that God “infused such suavity and divine sweetness in her heart that both soul and body were so full as to make her unable to stand.”

In Victorian times travelers returned with intriguing tales of the use of fly agaric by people in Siberia, Lapland, and other areas in the northern latitudes. One of the first was reported by the mycologist Mordecai Cooke, who mentioned the recycling of urine rich in muscimol in his *A Plain and Easy Account of British Fungi* (1862). Harding points out that Cooke was a friend of Charles Dodgson (Lewis Carroll), the author of the fantastic children's story *Alice's Adventures in Wonderland* (1865). “Almost certainly, this is the source of the episode in Alice where she eats the mushroom, where one side makes her grow very tall and the other very small,” Harding says. “This inability to judge size — macropsia — is one of the effects of fly agaric.”

Rudolph the Red-Nosed Reindeer

Long before 1949, when that perennially popular Christmas hit “Rudolph the Red-Nosed Reindeer” was launched, the myth of the reindeer was already well established. English texts from the Renaissance mention the display of antlers during Christmas dances centuries before any belief in Father Christmas, much less the development of his legend.

Rudolph himself first appeared in an illustrated booklet written by Robert May in 1939 for the

Montgomery Ward department stores to hand out to children at Christmas, and was used as the them for the popular song written by Johnny Marks a decade later. It was first performed by Gene Autry, t "Singing Cowboy."

One commonly held view is that Rudolph's nose was red due to a cold. Others claim that the song has saddled Rudolph with the red-nose slur — the implication being that while Santa consumes the milk and cookies left out for him, Rudolph helps himself to the strong stuff. The unexpected triumph of the drunken, inefficient Rudolph over his sober companions chimes with the relaxation of social conventions that has long taken place during winter festivals.

Recent research conducted in Norway, however, offers a more convincing explanation. Unfortunately for Rudolph, reindeer noses provide a welcoming environment for bugs. They have elaborately folded turbinal bones covered with blood-rich membranes, which warm the air as they breathe in and cool it as they breathe out, thereby reducing the loss of both heat and water. (Even wh there are icicles and frost on Santa's beard, his faithful reindeer have dry muzzles.) Odd Halvorsen of the University of Oslo suggested some years ago in the journal *Parasitology Today* that the "celebrated discoloration" of Rudolph's nose is probably due to a parasitic infection of his respirator system. Even today, he is awed by the response that followed this revelation. "This paper brought me more fame than anything else I have published," he admits.

Despite living in such chilly conditions, reindeer not only share many of the same parasites that plague other ruminants, such as the warble fly, but also are preyed upon by around twenty different parasites that are specific to them. The pentastomid *Linguatula arctica*, one of a group of creatures called tongue worms, can be found in reindeer sinuses; larvae of the fly *Cephenemyia trompe* wriggle in the nasal cavity; and nematodes of the genus *Dictoycaulus* squirm in the lungs, as do vast numbers of *Elaphostrongylus rangiferi* larvae. "We have not been able to quantify the combined effects of these parasites, but it is no wonder that poor Rudolph, burdened as he is by parasites, gets a red nose when he is forced to pull along an extra burden like Santa Claus," Halvorsen notes.

Rudolph notwithstanding, it remains something of a puzzle why reindeer are so embedded in modern Christmas culture. They were only one among many kinds of grazing and browsing mammal that once roamed the forests and plains of Europe, northern Asia, and North America, according to Caroline Pond of the Open University in England. Pond is a biologist who has studied reindeer with other biologists from the University of Tromsö, Norway. Indeed, ancient reindeer remains suggest th they ranged as far south as Spain and Italy.

They had been established for around a million years by the time humans came on the scene. Nov the animals are the most important land-based species for indigenous people in the Arctic. Reindeer meat is delicious, the fur a good insulator, and the antlers and bones are handy for making tools and ornaments. No wonder the beasts are featured in cave art and rock carvings, such as one found in Sagelva, Norway, that dates back to 2000 B.C.

But reindeer are badly misrepresented during Christmas festivities, says Pond. Take the depictio of the beasts typically found on cards, for example. True, reindeer are the only deer species for which both sexes have antlers — bone, often branched, that is covered with a thin layer of skin, or "velvet," rich in blood vessels. But the males actually lose their crowning glory around the time that the holida is celebrated. The reason has to do with sex.

Antlers of mature male reindeer are usually larger than those of females, with the most impressiv found in caribou and Norwegian reindeer. They probably evolved as a secondary characteristic of males under sexual selection: they depend on the sex hormone testosterone; are larger, more elaborat and heavier in older males; and are at their biggest during the breeding season, when they are essenti

for ritual combat and fighting. Afterward, the males are “rutted out” (even Rudolph), exhausted by th loss of body weight and fat reserves. It comes as no surprise that studies have found that male reinde suffer greater mortality than females.

Changes in the concentration of sex hormones promote bone reabsorption at the base of the antle in adult males. Eventually the antlers fall off, and there is a delay of up to four months before new ones grow in the spring. Perhaps the inaccurate depictions of Rudolph sporting his antlers wish to deny this seamy side of reindeer life.

The reindeer Lapps, or Sami, an ethnic group living in northern parts of Sweden, Norway, Finlan and Russia, acknowledge this link between virility and antlers by selling powdered reindeer “horn” to the Japanese with the claim that it increases potency. The Sami are unusually virile, but the reason, according to a study by Ilpo Huhtaniemi of Finland's Turku University, is not due to this horny folk medicine but to a genetic mutation.

The mutation is found in 40 percent of Sami men (compared with 25 percent of other men in Finland and 20 percent of Swedes) and apparently maintains a high level of testosterone in older men It seems that the farther south you go, the lower the incidence of the mutation. “The frequency of the mutation is 15 percent in men from southern Europe, 10 percent in Asian men, and 5 percent in American Indian men,” Huhtaniemi says.

The very fact that Christmas card artists show Rudolph with his antlers in place may underscore another unfortunate fact, one drawn to my attention by Odd Halvorsen: the Sami mostly use castrated male reindeer to pull or carry loads. Without their equipment, males have an abnormal antler cycle, s they keep their headgear longer than functional males. To keep his antlers for the sake of the Christmas card, Rudolph would have had to be castrated. “This introduces another sad aspect to the story,” Halvorsen says.

The more we know about reindeer, the worse the problems faced by card illustrators become. While the males are squandering their energy on sex and violence, the females are piling on fat, Caroline Pond notes. By the time Christmas arrives, the only adult reindeer with antlers and enough energy to drag around a sleigh full of presents are females. That is why Marks's song should have bee about Rosie the Red-Nosed Reindeer.

Reindeer are well adapted to living in a snowy landscape, though one that is more barren than the kind found on Christmas cards. In winter they dig through snow to feed on the plants underneath. Fin powdery snow is easy enough for them to handle, but if the snow is too deep or too hard, feeding becomes difficult. Snow that melts and refreezes to form a crust of ice can be so firm that the reindee cannot dig through it to reach the food underneath.

Other reindeer behavior is also misleadingly depicted on Christmas cards. The animals’ fur is an efficient insulator; outer hairs are long and hollow, supporting a fine, dense undercoat. Together they trap a layer of warm air. Insulation is so effective that snow does not melt on the backs or heads of reindeer. Rudolph, Dasher, Prancer, and the rest of the crew are so well adapted to the cold that they would probably find loafing around chimneys and firesides with Santa too warm to be comfortable.

THE FLAME AND TREE

I have been looking on, this evening, at a merry company of children assembled round that pretty German toy, a Christmas Tree. The tree was planted in the middle of a great round table, and towered high above their heads. It was brilliantly lighted by a multitude of little tapers; and everywhere sparkled and glittered with bright objects.

CHARLES DICKENS, A CHRISTMAS TREE

A TREE FESTOONED WITH FLICKERING CANDLES can be found on many Christmas cards, and for good reason. The evergreen and the candle celebrate the same thing: life-giving sunlight, an ancient symbo that dates back long before Prince Albert introduced the tree to Britain or Martin Luther supposedly first bedecked a tree with candles in the sixteenth century to remind children of the heavens from which Christ descended.

Our ancestors held winter festivities to usher in the annual return of sunlight, warmth, and fertili with rituals involving evergreens, which seemed to defy the cold winter months, and the yellow light of a living flame. Today Christmas and other seasonal celebrations, such as Kwanzaa and Hanukkah, are united by this latter symbol of the rebirth of the suns life-giving energy.

We can gaze deeply into the workings of the living world by studying what happens when we ligh a candle. The resulting flame marks the last step in an extraordinary series of physical and chemical processes that first capture sunlight to forge chemical bonds in wick and wax, then snap them to release the long-pent-up light.

The most important of the processes is photosynthesis, a word derived from *photo*, meaning "light," and *synthesis*, meaning "the production of something." Photosynthesis drives the living economy that thrives on the surface of our planet. Each year green plants, including Christmas trees, harness the energy of sunlight to pluck 100 trillion kilograms of carbon dioxide from the sky, then combine it with hydrogen from water to build carbohydrates — their food — and to release oxygen.

One acre of Christmas trees can produce the daily oxygen requirement for eighteen people. In the United States there are approximately one million acres of growing Christmas trees; that means around eighteen million people each day are supplied with the oxygen generated as the trees harvest sunlight.

What is so beautiful about the act of lighting a candle on a Christmas tree is that it honors the cycles that turn within and without living things. The chemical energy generated by photosynthesis in plants is passed up the food chain, for instance, to grazing cattle and then on to a tallow candle. When the candle is lit at the gloomiest time of year, it releases this "cryptic sunlight". and returns the complex fat, or wax, molecules to the form in which the plants found them — water and a hot breath of carbon dioxide that can again be incorporated into living things.

The Christmas Tree

Like so many aspects of holiday celebrations, the roots of this symbol stretch back to prehistoric times, when ancient people became fascinated by how some trees and plants continued to thrive among the dead branches of a forest in winter. To a primitive mind in a deciduous world, an evergree suggested permanence and a magical ability to endure with little help from the sun.

The ancient Egyptians brought green palm branches into their homes on the shortest day of the year, in December, as a symbol of life's triumph over death. This symbolism is also apparent in the Roman festival of Saturnalia, when buildings were decorated with evergreen branches of holly, pine, and ivy in honor of Saturnus, the god of agriculture.

Holly, ivy, and mistletoe are not only green but also bear recognizable fruit during the winter, again paying little heed to the elusive sun and keeping alive the hope that a fruitful year is to come. This triumph of fertility over the elements is echoed in the English legend of the Glastonbury thorn, planted by Joseph of Arimathea. The legend goes that soon after the death of Christ, Joseph went to Britain to spread the message of Christianity. Being tired from his journey, he lay down to rest and pushed his staff into the ground beside him. When he awoke, he found that the staff had taken root. The resultant bush was the Glastonbury thorn, which flowered each year on Christmas Day.

When discussing the prehistory of the Christmas tree, one also should take account of the Yule log, which was made from timber big enough to burn throughout the longest winter night, again to help usher in the return of the sun. The resulting ashes supposedly had the power to protect a house against lightning, to cure maladies, and to fertilize fields.

The use of the fir as a Christmas tree started in ancient times in the Black Forest in southwestern Germany, where evergreens and small trees were part of the winter solstice festival of pagan tribes. But it is not known when the fir, or *Tannenbaum,* was adopted in other parts of the country. Legend has it that Martin Luther (1483–1546) was so moved by the brightness of the millions of stars on a winter's night that he set candles on his tree to simulate the effect. However, the idea of a decorated tree dates from much earlier, being reminiscent of tree-dressing rituals, which can be found from Russia to India in forms such as Yggdrasil, the Nordic tree of life; the Indian *bodhi* tree; and Eden's tree of knowledge. In various pagan rituals, a tree was decorated to encourage the tree spirits to retur to the forest so that it would sprout again, which of course it did every spring.

Decorated trees are recorded in 1605 in homes in Strasbourg, then part of Germany. By 1796 we have the first illustration featuring a candlelit Christmas tree, showing Christmas Eve at Wandsbek Castle, near Hamburg.

In time the tree was brought to America by German settlers and by Hessian mercenaries paid by the British to fight in the Revolutionary War. In 1804, two hundred years after the first sighting of decorated trees in Germany, soldiers stationed at Fort Dearborn (now Chicago) were seen *to* haul tree from the surrounding woods to their barracks at Christmas.

Charles Minnegrode introduced the custom of decorating trees to Williamsburg, Virginia, in 184 Almost a decade later, Mark Carr hauled two ox sleds loaded with trees from the Catskills to the streets of New York City and opened the first retail lot in the United States. By the end of the nineteenth century, the tree was so much a part of seasonal festivities that a description of Christmas at the White House refers to “an old-fashioned Christmas tree.” Today around forty million America families celebrate the holidays with the fragrance and beauty of trees.

In Britain the custom of decorating Christmas trees was known to the socially aware from the middle of the eighteenth century because of the German background of the Hanoverian monarchs. It was not, however, until Queen Victoria and Prince Albert set up their tree for the first time in Windsor Castle in 1840 that this symbol was firmly fixed at the heart of the Victorian Christmas. Eight years later Victoria and her family appeared beside the tree in the *Illustrated London News*, marking one of the most famous nineteenth-century Christmas scenes of all.

Today the symbolism of the flame and tree burns as brightly as ever. In Oberammergau, German trees planted on graves are decorated with glowing tapers to allow the dead to take part in Christmas celebrations.

WHY CHRISTMAS TREES ARE EVERGREEN

Leaves and needles are highly efficient solar cells, and to understand why a Christmas tree hangs on to this power supply during the dark winter months while others shed it, we need to understand a little more about the biochemical machinery that turns within their leaves.

The needles, fronds, and palms of green tissue provide plants with energy by harnessing sunlight through the process of photosynthesis. This occurs inside structures called chloroplasts, contained within leaf cells. There pigment molecules capture light energy. Chlorophyll is the most important pigment, absorbing red and blue light and allowing green wavelengths to reach the eye.

Winter sees less daylight combined with a sun that hangs much lower in the sky. That means less sunlight, a decline in the amount of photosynthesis, and thus less energy to sustain an individual tree. Moreover, temperatures become cold enough to threaten cell damage. Trees have adapted by resting through this period and living off excess food stored during the summer months. This process is not triggered solely by cold weather, even though chemical reactions within the leaf do slow in response to lower temperatures. The signal for dormancy is the decline in the hours of sunlight and the longer periods of darkness.

Trees have evolved different strategies to deal with the annual decline in sunlight. In general, they can be categorized as either deciduous (Latin for “to fall”) or evergreen, a group that includes holly and conifers such as pines, junipers, and firs. Both types of trees cease growth in winter, but whereas deciduous trees shed all their leaves for this event, evergreens do not. Various factors govern when and why evergreens shed their needles. For example, some needles are lost if conifers are shadowed for any appreciable time or if deprived of water.

One might think that there is a simple reason why deciduous trees are stripped during winter: the broad leaves are less able to cope with winds and other vagaries of winter weather when compared with the aerodynamic needles of firs. To some extent this is true. Nonetheless, the loss of leaves is a deliberate affair that may be hastened by windy weather but is not dependent on it.

According to Bill Proebsting of Oregon State University, an elaborate cellular mechanism governs the process by which leaves and trees part company. At the base of each leaf is a special layer of cells called the abscission zone. When the time comes to shed the leaf, the cells in this layer begin to swell, slowing the transport of materials between the leaf and the tree. Once the abscission zone has been blocked, enzymes begin to break down the matrix holding the zone's cells together. A tear line is formed at the top of the zone and progresses downward, and eventually the leaf is blown away or falls

off. Once the leaf falls, the stem side of the abscission zone forms a protective layer to seal the woun preventing water from evaporating and bugs from getting in.

Peter Davies, a professor of plant physiology at Cornell University, says that several factors influence why Christmas trees and other conifers evolved to hang on to their needles in the winter rather than shed them all in one go. Dressed in their leaves, evergreens can carry out photosynthesis t take advantage of the light during the occasional days of winter sunshine. As a result, the leaves mus be coated with a resin or wax to prevent moisture loss, and they must possess modified biochemical machinery to prevent cell damage caused by winter cold. This means that it takes evergreens more energy to make and maintain leaves as compared to trees that have thin leaves that are too delicate to withstand low temperatures. In effect, deciduous trees have decided not to invest any more resources in their doomed solar panels.

Within each leaf of a deciduous tree the green chlorophyll that captures sunlight and the biochemical machinery that converts sunlight into food gradually degrade. As the green pigment fades, it reveals other pigments, notably the yellow and orange carotenoids that provide vivid autumn colors, and reduces the ability of the leaf to harness sunlight. By shedding leaves, deciduous trees can maintain their energy efficiency at a slightly higher level.

Once the plant has withdrawn any useful nutrients and stored them in the cells of the trunk for us the next spring, leaf loss also can help rid the plant of the by-products that build up in leaves. One suggestion is that leaves are “excretophores” and that the shedding of a yellowed leaf is the equivalen of going to the toilet. This explanation adds an entirely new dimension to the ancient obsession with evergreens.

SUPERTREE

The Christmas tree is under threat from a vulgar impostor: plastic trees that shed no needles, show no flaws, and can be used year after year. This is taking the deep-rooted obsession with the evergreen a step too far.

All is not lost, however. Thanks to the science of cloning, the real thing is staging a comeback. Various teams are developing methods of mass-producing thousands of copies of an individual high-quality Christmas tree.

The problem with the old-fashioned varieties of Christmas trees is that their seeds contain genetic variability, not only spelling imperfection for the consumer but also creating a headache for the grower when it comes to harvesting trees of many shapes, girths, and heights. To produce genetically homogeneous tree seeds, the traditional way would take about seven generations of breeding. Each generation takes fifteen to twenty years to mature, so it is just not feasible to obtain genetically uniform seeds this way. The alternative is to use cloning to create inbred lines of trees.

Dan Keathley's group at Michigan State University is focusing its cloning efforts on Douglas fir and Scotch pine. The first step in cloning, says Keathley, is to find “individuals that are really select. What we are talking about is the one tree in ten thousand.” This flawless tree should have the following properties: a straight trunk that easily slips into a stand, the strength to hold lots of ornaments and tinsel, thick needles, good color, limbs angling upward at forty-five degrees, a uniform conical shape that tapers upward at thirty-five to forty-five degrees, and good needle retention.