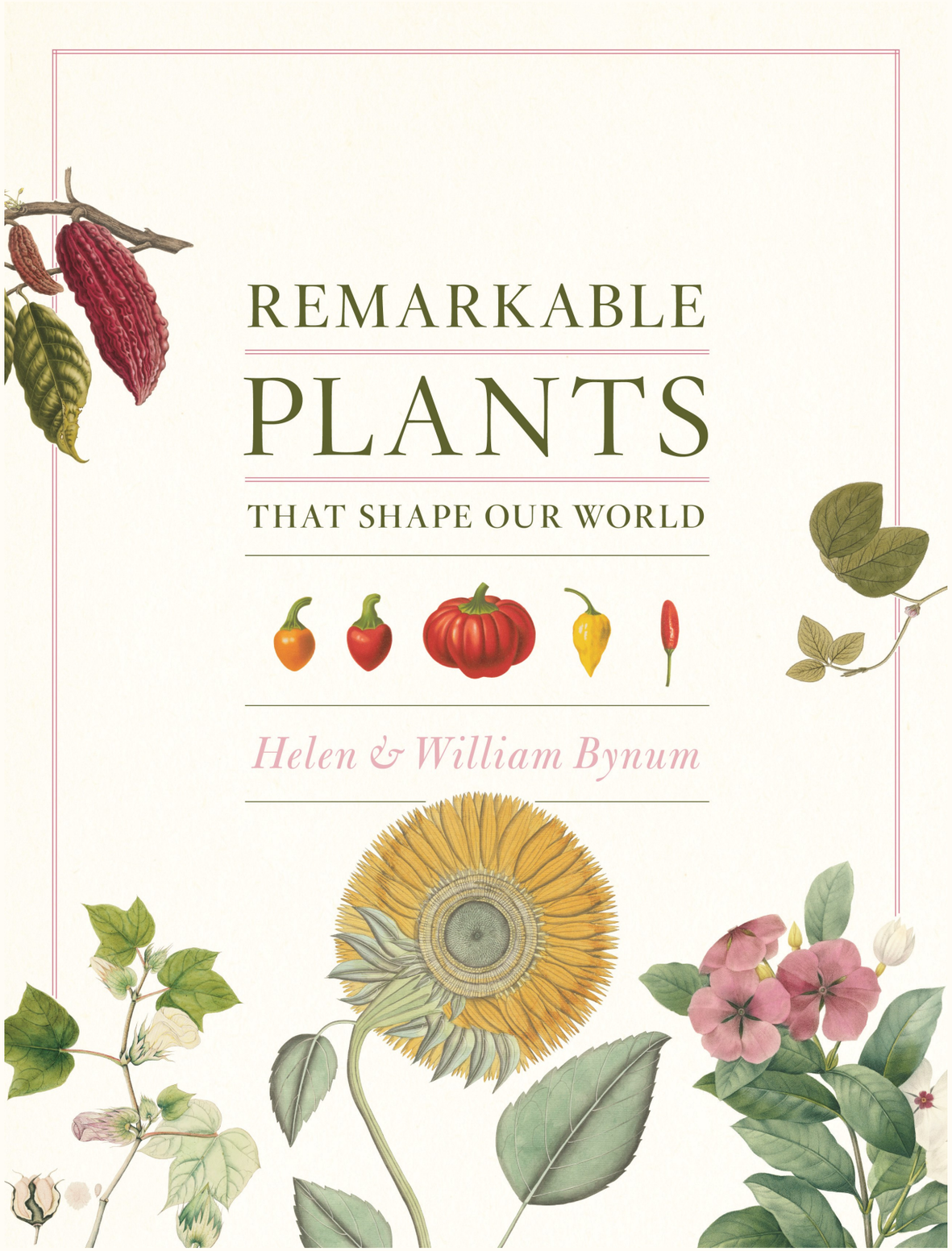


# Remarkable Plants That Shape Our World

*Helen and William Bynum*

*Remarkable Plants* celebrates the wonder and utility of the green kingdom, taking a detailed look at how plants have shaped our world. It focuses on eighty key species and richly explores their history, highlighting their importance and bringing to light surprising stories.

Organized thematically into eight sections, the book starts with "Transformers" (including rice, beans, olives) and moves through sections such as "Heal and Harm" (poppy, aloe, strychnos) and "Revered and Adored" (lotus, frankincense, rose). Each species is introduced with its common and scientific names and followed by an exploration of its cultural, historical, botanical, and symbolic associations. Hundreds of botanical illustrations show full plants as well as highlight distinctive leaves, blooms, and fruits.

Rooted in one of the world's most important and renowned temples of greenery, the Royal Botanic Gardens, Kew, *Remarkable Plants* is a symbiotic balance of science and art that will open readers' eyes to the deep influence of the natural world on our modern one.

**William F. Bynum** is professor emeritus of the UCL Centre for the History of Medicine in London. Helen Bynum is a historian of science and medicine. Together they are coeditors of *Great Discoveries in Medicine* and *Dictionary of Medical Biography*.

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Lauren Salas
Promotions Manager,
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# Contents





# Introduction

## Utility and Beauty

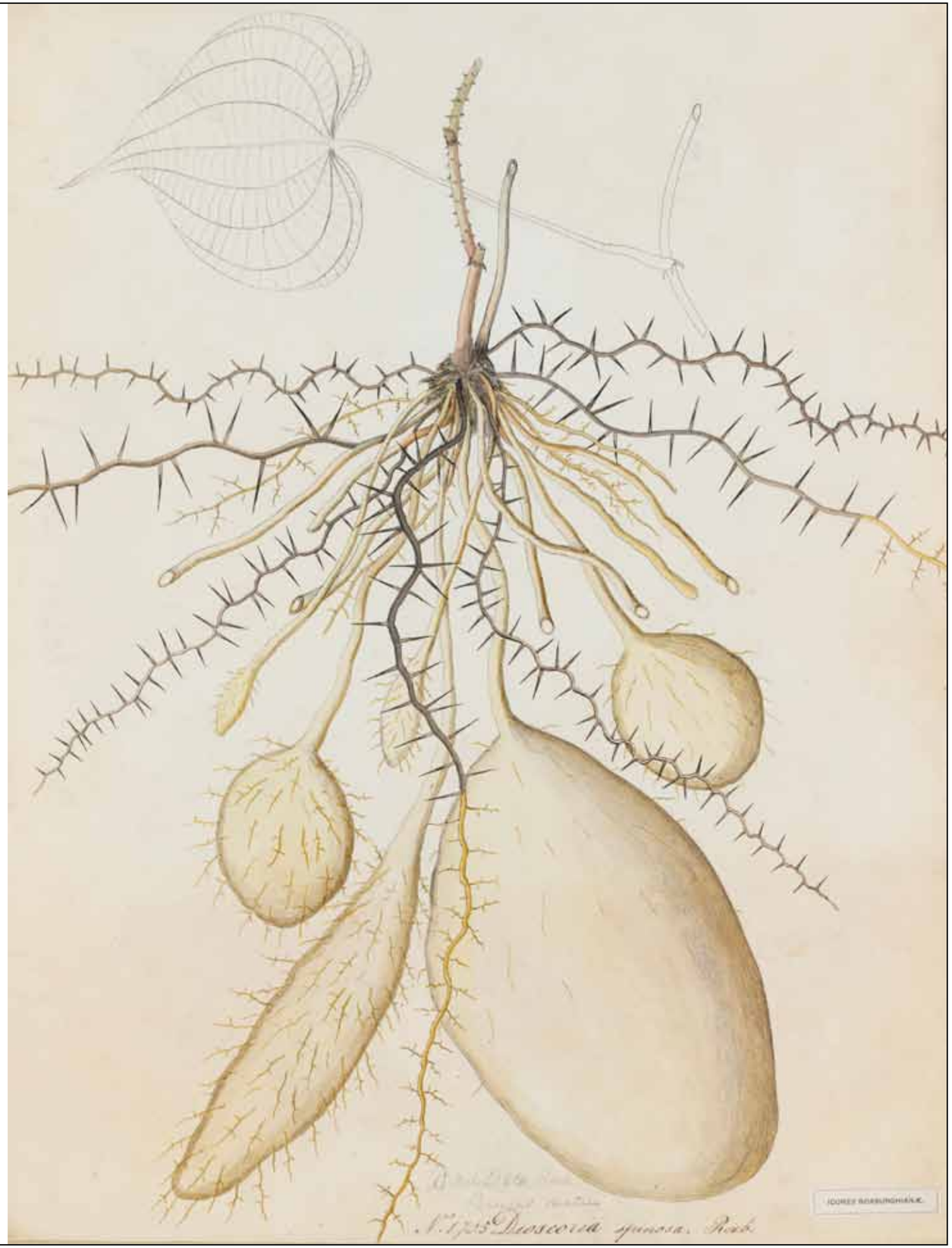
*Opposite* *Dioscorea esculenta* or lesser yam has edible potato-sized tubers; it remains an important source of food in Asia, from where it spread to other yam-eating parts of the world. The watercolour was commissioned by Sir William Roxburgh (1751–1815), a surgeon turned botanist who worked for the British East India Company in India and sought to develop the economic potential of the subcontinent's flora.

*Remarkable Plants That Shape Our World* is a celebration of the utility, beauty, diversity and sheer wonder of the plant world gracing our planet. For millennia we relied on plants for much of our food, shelter, clothing, transport and medicine. Our roaming ancestors took what was on offer from the wild, like other foraging animals, but when we entered into synergy with certain plants after the last ice age, their domestication at our hands and our novel settled habits began a new era. Although today we enjoy the convenience of the products of the modern petrochemical industry, our need for plants remains keen. They are the basis of all food chains and our great ingenuity hasn't changed this. And in an increasingly urbanized world the capacity of plants to act as green lungs for cities and solace for the soul of the city-dweller is paramount. The areas of untouched wildness are few and far between and therefore more precious than ever.

Such a latter-day fusion of utility and beauty has deep roots. It reflects the ways humans have long engaged with plants, from appreciating their purely practical benefits to responding to their stimulation of the senses and swaying of the emotions. Plants have been instrumental in the development of cultures and even empires. They have been worshipped and deified; their forms, colours and scents have inspired a desire to own and grow certain ones amounting to an obsession – think of tulips, roses and orchids. Other plants have elevated food beyond mere sustenance to the heady delights of rarefied taste. Essential oils and resins have perfumed our bodies and some chemical constituents have proved remarkably efficacious medicinally or have taken our internal neural chemistry in exotic, perhaps frightening directions.

The green kingdom itself is marvellous. Plants have an essentially unique ability to capture the energy of the sun and use it to power a chemical reaction in their cells which combines water and carbon dioxide to produce sugars and proteins – food – while releasing oxygen. This is the process we call photosynthesis. Plants can perform this alchemy because at some time in their ancestral history one type of unicellular organism co-opted another, a photosynthesizing cyano-bacteria, and within the new host this became a chloroplast possessing the chemical molecule chlorophyll, which conducts the photosynthetic reaction. Since chlorophyll is a green pigment, plant life is overwhelmingly this hue.





*Above left* After picking, tea leaves were once processed, dried and packed into bricks for transport from the tea estates. The tea bricks were often wrapped in bamboo for the journey, and were used as a form of currency and as gifts.

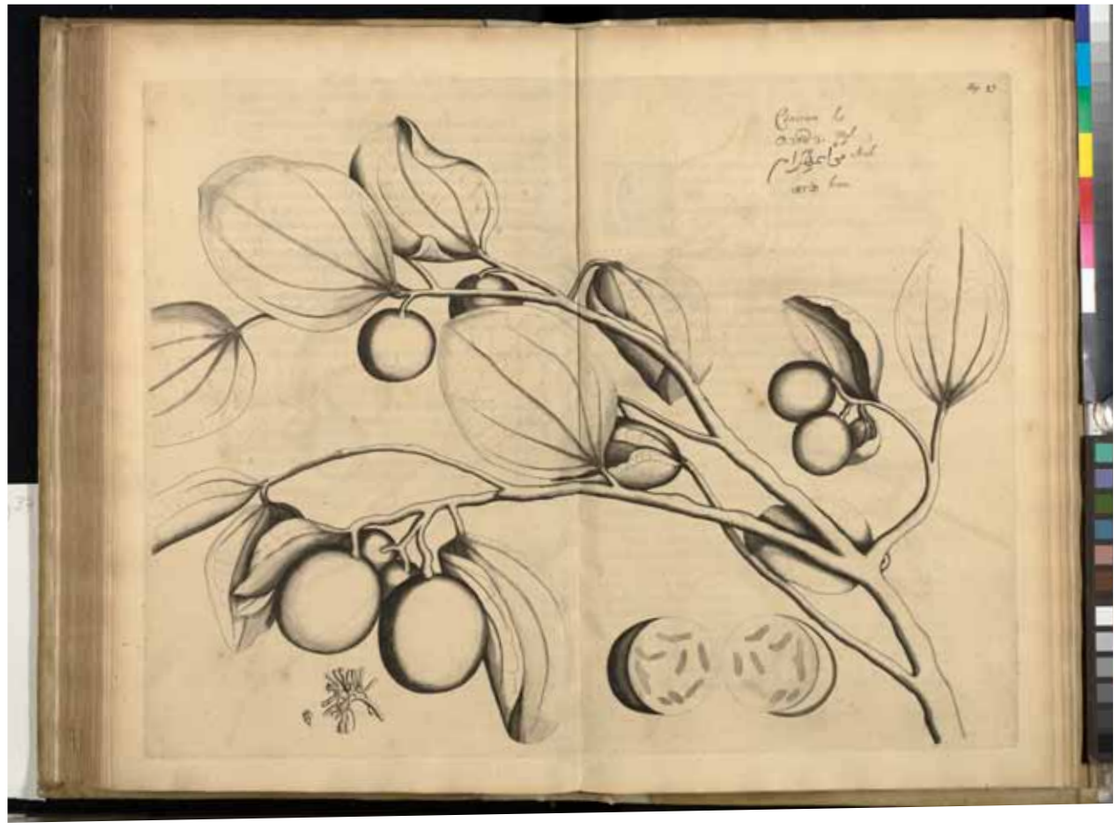
*Above right* Creating a new landscape, a plantation of Australian white gum trees (*Eucalyptus alba*) in the Bogor botanical garden, Java, Indonesia, 1894.

Through periods of time measured in immense geological epochs, all the different evolving forms of plant life proved to be much more than passive passengers on the revolving planet. They are now considered to be one of the active forces that have customized the atmosphere and surface of the Earth by their shaping and reprocessing of its fresh water and minerals, helping to make it more habitable for us. Some 290 million years ago some plants began to produce seeds, bringing the benefits of sexual reproduction. By 140 million years ago the first flowering plants (angiosperms) were evolving. In a relatively short period of geological time after this (some 60–70 million years) their forms and habitats had diversified to the extent that flowering plants were now dominant.

With flowers came colour. Green was now embellished with a dazzling array of tints. This was not for our delectation. Long before our love affair with them, flowering plants co-evolved with other organisms to assist with the transfer of pollen, usually from one plant to another, for fertilization. While plants seem to have escaped the kinds of mass extinctions that saw the fall of the dinosaurs and the rise of the mammals, there have been important shifts in the world's plant populations. As the continental plates crunched more or less into their current positions about 65 million years ago and temperatures subsequently rose and fell to produce the successive ice ages of more recent geological







A nut-bearing branch of the Asian strychnos tree (*Strychnos nux-vomica*), from *Hortus Malabaricus* (1678–93). The plant has a long history of use in Ayurvedic medicine.

time, the grasses appeared to be winners and the forests losers, while arid land plants increased.

This was our inheritance some 12,000 years ago, at the end of the last ice age, and this book is concerned with the diverse plant worlds of the planet as we made the transition from hunting and gathering to agriculture. How have we exploited some of these plants and what relationships have been forged between humanity and aspects of the plant world since then? In what ways do they impinge on our lives and we on theirs? Although each plant is allocated to one of a series of categories, it is one of the wonders of the plant world that they can be highly efficient multi-taskers and could appear in several of our sections.

Our first, *Transformers*, looks at those plants that brought humankind to the settled way of life in many different parts of the world, including staples such as wheat, maize and rice. In *Taste* we explore plants that then enlivened and enriched our diet, from basic ones such as the useful alliums to the luxurious flavours of spices and saffron. *Heal and Harm* reminds us that there is often a fine balance

# Transformers

## *Settling Down, Tending the Fields*

The shift from foraging to farming as the Earth warmed after the last ice age is one of the great transitions of human history. It was a protracted and by no means inevitable trajectory. The early farmers were often less well nourished than their foraging predecessors and subject to a disease burden that resulted from close, sustained contact with other humans and animals – intentional or otherwise. It is, though, from the permanence enshrined in farming that most of our present-day cultures have evolved.

Only in the continent of Australia did farming not take hold among the original inhabitants. In Asia, Europe, the Americas and Oceania it occurred independently, and each time it involved different groups of plants – the 'founder crops' – grains, legumes, tubers; exactly 'what' depended on 'where'. Lentils, potatoes, yams, breadfruit, along with many others, formed the basis of diets around the world. Technology and seeds were then also carried from one place to another. Additional plants – fruits, vegetables, herbs – were brought into the garden. To the potent images made by humans as hunter-gatherers were added the art and artifacts representing a settled way of life. Storage, processing and cooking provided a new impetus to practical material culture. Deities believed to watch over the annual planting of seed and the subsequent harvest were feted and feared; life moved to new rhythms.





Farmers gradually altered the landscape, clearing and preparing land for growing crops and herding animals. Crucially, they also transformed the plants they came to rely upon. Under cultivation these plants were 'domesticated' so that they came to vary in fundamental ways from their wild ancestors.

Take the cereals. Archaeology has revealed that we gathered the seeds of many of these wild grasses such as wheat, rice and maize before we deliberately planted them. From purposeful cultivation of wild plants the early farmers went on to select those that had randomly mutated and better suited their needs. It was much more efficient to cut the stems of wheat or rice with intact ears and thresh them to release the grains than pick up what had been shed on the ground. A different genetic shift that resulted in seeds all germinating on the same environmental cue – spring rain or warm sunshine – was a great advantage over the wild state which staggered this vital process. Cereal growers also chose to plant seed of more flavoursome and plumper-grained parents that stood on thicker stalks, the better to hold up newly enlarged heads.

Seemingly ordinary, the founder crops of grains and pulses, roots and tubers were the transformers of our race around the globe. To their starch and protein are added here the fruit and oil of the olive and the flesh and juice of the grape, the elements, along with wheat, of the Mediterranean triad. They remind us that

# Wheat, Barley, Lentil, Pea

*Triticum* spp., *Hordeum vulgare*, *Lens culinaris*, *Pisum sativum*

Founder Foods of the Fertile Crescent

*Ceres, most bounteous lady, thy rich leas*
*Of wheat, rye, barley, fetches, oats and pease.*

William Shakespeare, *The Tempest,* act 4, scene 1

Wheat and barley, lentils and peas; these are the quintessential grains and pulses of the Neolithic revolution in southwest Asia. They are some of most important foods that allowed us to adapt our way of life in the face of the changing climate and plant landscape that began around 11,500 years ago at the opening of the Holocene. Rather than being the brilliant inventors of a settled agricultural economy, we need to see our ancestors as coping as best they could by relying upon a small number of key crops when circumstances dictated and survival demanded.

The wild progenitors of these most important foundation crops in the Fertile Crescent (others included the still important chickpea and flax, and now forgotten bitter vetch) helped nourish those dwelling there long before formal domestication. Nomadic and semi-nomadic people were collecting wild wheat and barley, and grinding and baking the seeds from at least 23,000 years ago. After collecting, a long phase of pre-domestication cultivation followed, accompanied by hunting increasingly small prey. Fully domesticated crop lineages emerge from around 10,600–8,800 years ago onwards.

There was no single glorious moment in time when thrifty farmers somewhere picked out the best seeds from the previous harvest and effected a rapid change in either lifestyle or plant. Instead, there were a host of independent domestications, much reintroduction of wild species, and an exchange of domesticated varieties and know-how between people before farming could be said to have arrived for good. And if a different way of life suited, people would abandon farming and take up mobile pastoralism, using animals to process the plant cellulose that we cannot into milk and meat, or move on to new areas.

It was the storage potential and the surpluses generated from planned cultivation that fuelled the emerging agro-urban civilizations of Mesopotamia, Egypt and the Levant. Civilization in this case also required the abandonment of the egalitarian values of the limited size hunter-gather bands and the acceptance of a clear social hierarchy of haves and have-nots living in large cities. Cities measured their inhabitants in the tens of thousands. Large groups required administration and bureaucracy, and enabling technologies such as a written language developed.

*Opposite* Edible-podded sugar peas from the *Album Benary* (1879). Until the 16th century peas were dried staples of the poor and the fresh garden vegetables were luxury items, made fashionable at the court of Louis XIV.



*Opposite* Something of the rich variety of shapes, sizes and colours of cultivated capsicums can be seen here. Their heat is measured in Scoville Heat Units (SHU) on a scale devised by the American pharmacist Wilbur Scoville in 1912. Bell peppers score 0 SHU as they have no capsaicin; while long red cayenne scores 30,000–50,000 SHU. The range reflects the interaction of varietal genetics and the circumstances under which it is grown.

*Above* *Capsicum baccatum* was probably domesticated in Bolivia, although its natural range stretches from Peru to Brazil. It is known as aji in South America where the subtle bouquet and the distinct flavours of the cultivated varieties are valued.

# Chilli Peppers

## *Capsicum* spp.

### Some Like it Hot

*[The Aztecs] have one [plant], like a pepper, as a condiment which they call chilli, and they never eat anything without it.*

'The Anonymous Conqueror', *Narrative of Some Things of New Spain*, 16th century

Few plants pack such a potent punch as the fruit of the medium-sized bushes *Capsicum annuum* or the even hotter *C. frutescens*, the chilli (also 'chili' or 'chile') used in Tabasco sauce. They owe their heat to an alkaloid called capsaicin, which probably evolved, as did many other plant alkaloids, as a protection against predators. It is most concentrated around the seeds; this is why removing the core and seeds of the chilli takes away much of the heat. Since capsaicin in not soluble in water, drinking it doesn't help relieve the hot sensation.

*C. annuum* was found in the wild in Mesoamerica and was prized by the Aztecs. The stews of the milpa fields (maize, beans, squash) would have been much tastier with it, and it was also added to chocolate. Chillis (the word is from the Aztec language Nahuatl) were picked from the wild as early as about 7000 BC and were cultivated by about 4000 BC. By the time of the Spanish conquest, they came in varying sizes, shapes, colours and degrees of hotness. Chillis had also spread to North America and the Caribbean islands. Columbus encountered them on his first visit to the New World; the Taíno people of Santo Domingo confirmed him in his mistaken belief that chillis were the pepper (*Piper nigrum*) of the East Indies and that he had found the western route there. Although unrelated, the word 'pepper' has stuck as part of the common name of *Capsicum*, especially for the larger, sweeter varieties.

Columbus took chillis back with him to Spain, where they were immediately popular with a few. They proved easy to cultivate there, much to the alarm of merchants of the lucrative trade in black pepper. European sailors soon spread the new taste sensation to Asia, Africa and Brazil. They quickly became so important in Indian cooking that it is hard to realize that they are a relatively recent addition. The Renaissance naturalist Leonhart Fuchs even assumed they were native to India.

As with most new additions to the diet, chillis were also evaluated as a medicine. They were regarded, like black pepper, as hot and dry, and so useful against cold, wet diseases. The chilli never really established itself as a mainstay of medical therapeutics, however, and it is as a condiment that the plant is cultivated today, with Mexico and India the major producers. More than a dozen major varieties are




available, with dramatic differences in flavour and hotness. Most modern ones are derived from *C. annuum*, but the seeds of *C. frutescens* are used to make cayenne pepper. Paprika (the word is derived from *Piper*) is a mainstay of Hungarian cooking, and also comes in a variety of degrees of heat and shades of sweetness.

In addition to *C. annuum* and *C. frutescens*, other species of capsicum have local importance, including *C. chinense*, which is popular in the West Indies. Despite its name, *chinense* did not come from China, nor is the dominant species, *annuum*, an annual. When Carl Linnaeus named it in the 18th century, he was responding to its European behaviour; in tropical countries, capsicums are perennials.

# Coca

*Erythroxylum coca*

Stimulant and Nerve Blocker

*For me, there still remains the cocaine bottle.*

Sherlock Holmes, in *The Sign of Four*, Arthur Conan Doyle, 1890

For the Incas coca was sacred; it was so important that the state monopolized its production and distribution, and coca leaves were offered to the gods. A small tree or shrub, coca grows best on the lower slopes of the tropical Andes and its use in the area has a long history. The leaves, which can be harvested several times a year, contain a potent cocktail of alkaloids, of which the most significant one is cocaine; they also contain a small amount of caffeine.

When gathered, dried and mixed with some lime, the leaves can be placed between the cheeks and gums, where their alkaloids are slowly absorbed. The result is an increase in muscle strength, a reduction of hunger and a general sense of alertness. Spanish conquistadors described the plant and its effects, and when they forced native peoples to labour in their mines, they ensured that they were supplied with the leaves to increase production. In the mid-19th century two German chemists independently isolated its most potent alkaloid. One of them, Albert Niemann, gave it the name that has stuck: cocaine.

Cocaine was one of many plant alkaloids attracting medical and chemical attention at the time, but the young Sigmund Freud, then a budding neurologist, started self-experimenting with it in 1884. His collection of papers on the subject, 'Uber Coca' (On Coca), more advocacy than sober scientific analysis, came back to haunt him. He downplayed any addictive qualities of the drug, emphasizing the psychological euphoria and increase of energy and muscular strength. One of Freud's colleagues, the ophthalmologist Carl Koller, noticed at the same time that cocaine was a powerful local anaesthetic.

It took some time before cocaine's potent addictive qualities were appreciated, and in the meantime enterprising pharmaceutical companies sold the drug with a syringe for ease of administration, and it became an ingredient of popular beverages. Cocaine was also touted as a safe way to break morphine addiction. Sherlock Holmes was habituated to cocaine, although his creator Arthur Conan Doyle eventually broke his character's habit, as




the dangers of cocaine use became more obvious. Among prominent individuals trapped by cocaine in those early days was the pioneer of aseptic surgery, William Stewart Halsted, professor of surgery at Johns Hopkins University. Although he managed to keep his career going, he never completely lost his addiction to morphine, which he substituted for cocaine.

Despite medical uses, cocaine has become a controlled drug in most places. Criminalizing its use has not met with marked success, and cocaine, both in its pure form, and in the adulterated form of 'crack', is used by millions of people. Supplying it is highly profitable, especially for Colombia, despite encouragement for its growers to plant coffee trees instead, or for Peruvians to grow asparagus. Selling illegal drugs is the third largest international business, after oil and arms, a sober indictment on modern life.

# Rubber

*Hevea brasiliensis*

Amazonia's Precious Latex

*…the pith of a wood that was very light.*

Pietro Martire d'Anghiera, 1525

A number of plants produce rubber, but only the Brazilian 'rubber plant' is employed commercially today. It is one of many gifts of the New World to the Old, and it was exploited and revered long before the Europeans came. The Amazonian Indians knew of the remarkable waterproofing properties of the latex sap that can be tapped from the tree, and rubber use was widespread in pre-Columbian Mesoamerica and South America. Containers, shoes and musical instruments were made from the hardened substance, which could be moulded as it dried, and it also had medicinal, ritual and ceremonial applications.

In the early 16th century Aztec teams demonstrated a game using a rubber ball (made from another rubber-producing plant) to the court in Spain. Indeed, Europeans seemed most fascinated by the ball game, the object of which was to put the rubber ball through a hoop, without using the hands or allowing it ever to touch the ground. Only in the 18th century did naturalists take a serious interest in the tree and its product. A French engineer and amateur botanist, François Fresneau, described both the tree and the tapping for the sap in 1747, and others in South America brought home accounts of the unusual properties of rubber.

Early European attempts to exploit the substance were not successful. Various entrepreneurs in the early 19th century imported rubber to make rubber boots and raincoats and waterproof cloth. (It was also, more successfully, noted that the material could remove pencil marks: the 'rubber', or eraser, had arrived.) All these enterprises failed, because in very hot weather the rubber melted, and in very cold it hardened and cracked.

The breakthrough came in 1839, when an eccentric American, Charles Goodyear, discovered after a good deal of empirical experimentation that adding sulphur to the melting rubber stabilized it; extreme temperatures no longer had their undesirable consequences. Goodyear spent much of his life moving his family from place to place, seeking backers and spending some time in debtors' prisons. Although his name was posthumously perpetuated in a major international tyre company, he didn't reap the rewards of his successful discovery. At about the same time, an English chemist, Thomas Hancock studied the process in more detail,



# Technology and Power

*The Material World*

Whoever controlled the lands where the Cedar of Lebanon grew, controlled access to this most valuable of trees and the bounty that its wood afforded. Cedar wood empowered the Phoenicians, setting their trading empire afloat. Much in demand as a durable and fragrant building material, it provided a valuable commodity for exchange. Its resin too was held in high regard. This viscous exudate helped preserve the dead of Egypt for the after life. Mummification was available only to the elite, those who ruled the lands of the Nile and determined the structure of its society. Cedar wood thus sets the tone for *Technology and Power*, sampling the material applications of plants and what that might bring.

What cedar had done in the eastern Mediterranean oak (*Quercus* spp) would do for seafarers of a different time and place. Exploiting its strength, dynamic oak-keeled ships took the Vikings overseas. Naturally endowed with dense oak forests the English merchant and naval fleets used its own supplies so long as these could be cut and transported to the shipyards. The demand for oak stimulated trade with the Baltic ports but competition with other expansive countries – the Dutch in particular – was intense. Power at sea was matched by majesty at home. Oak provided the durability and strength to create many of great churches and other buildings. And there were barrels: sturdy, cheap, rollable, stackable and able to impart the taste of the oak tannins to wine.

Yew brought power differently. It made stout hunting spears that have lasted long enough to date their use back some 150,000 years. The subtle difference in flexibility between sapwood and heartwood created the bows that helped the English triumph at Agincourt, France in the fifteenth century and inspire one of greatest of battle speeches in English theatre. The long bow may have joined the spear as an historical relic, but yew's biochemistry has yielded weapons of another sort – drugs to kill the rapidly dividing cells of certain cancers.

All of these woods can be used for furniture, but there is always the shock of the new. When Europeans encountered the tropics they found huge trees, their growth stimulated by the moist, hot conditions and untouched by loggers. Big trees provided usable wood in dimensions hitherto unknown. Tropical hard-woods, mahogany in particular, became the wood of choice for furniture in the eighteenth century. Its deep reds formed a different colour palette. Easy to work and inherently stable, its products were highly desirable. Demand outstripped supply, but by the time the fashion for mahogany had run its course the future of the tropical woodlands was already threatened.

From tree to grass and the amazingly versatile bamboo. Spread through the temperate and tropical world these perennial, woody, hollow-stemmed plants have proved to be extraordinary adaptable in human hands. The stringy strength

with better chemical knowledge, and obtained an English patent for vulcanized rubber (he called it 'ebonite', but Goodyear's 'vulcanization' has lasted).

Goodyear never stopped preaching the multiple uses of rubber. At the Great Exhibition in London (1851) and the Exposition Universelle in Paris (1855), Goodyear was there with displays of furniture, inkstands, vases, combs, brushes and many other ordinary items, all made of rubber. Although his efforts failed to direct the flow of funds into instead of out of his coffers, the public displays did alert the world to the possibilities of this adaptable plant material.

Increasing popularity was good for Brazilian growers and traders of rubber, if not for the collectors of the raw material – the task entailed long hours and tedious, backbreaking labour. Demand for rubber produced an accelerating clearing of the Amazonian rainforests to be replaced by rubber plantations. It also stimulated the search for other areas of the world where *H. brasiliensis* could thrive. And it had to be that particular rubber tree: the Brazilian Joao Martins da Silva Coutinho demonstrated its undoubted superiority.

Joseph Hooker, Director of the Royal Botanical Gardens at Kew, was instrumental in spreading the cultivation of the rubber plant. His agents in Brazil produced seeds that arrived at Kew in 1876. Although only a tiny fraction germinated, seedlings were later dispatched to Singapore. They all subsequently died.



Plants in Ceylon (Sri Lanka) also struggled in the early years, although successful plantations were established eventually. The appointment of Henry N. Ridley in 1888 as superintendent of the Singapore Botanical Gardens proved to be the turning point. Ridley was a tireless enthusiast for the product: he experimented on the optimum growing conditions, on how, where and how often the plants could be tapped, and how seeds and seedlings were best transported. More efficient methods of collecting were also devised, especially the use of acid to coagulate the latex. By the end of the century, Southeast Asia, including Malaysia, was a major source of rubber.

Everywhere, the creation of plantations required land clearance and a large workforce. The Chinese are a notable presence in the area mainly because of the indenture system created in the period to meet this demand. Use of rubber products grew continuously during the latter part of the 19th century, but the pneumatic tyre, for bicycles and then automobiles, created a vast new market. The Michelin brothers, Édouard and André, in France, pioneered the use of rubber for vehicles. In 1891 they patented a tyre for bicycles that could easily be removed and repaired. With the coming of automobiles, the limitations of solid tyres were shown up: they tended to break the wheels at speeds of more than 15 mph (25 km). Pneumatic tyres were the answer, and in 1895, they demonstrated one. Although the tyres had to be changed every 150 km (90 miles or so), the world was convinced that this was the way forward.

Tyres, though important, are just one of a host of uses for rubber. Automobiles and most other modern machines contain rubber in hoses, fittings, washers, cable insulation and numerous other parts. It is also still used for boots and shoes, gloves, condoms and much else. All this encouraged chemists to examine the molecular basis of rubber's distinctive properties. The German chemist Hermann Staudinger showed that the substance consisted of polymers (long chains) of hydrogen and carbon, and that vulcanization, by adding sulphur, resulted in stabilizing chemical bonds. He won a Nobel Prize for his work in 1953. Although synthetic rubber is now widely used, it cannot replace the natural material for some purposes; and natural rubber is of course renewable. Brazil now produces little rubber, but the Malay Peninsula is still a major player, with China also in the game.

# Taste

## *Beyond the Bare Necessities*


The staple crops were closely bound up with the founding of civilizations, but while they may feed and sustain us and satisfy our hunger, alone they do not always fulfil our cravings for flavour, something to make the ordinary special. It is this additive quality of plants and their products that is explored in *Taste*.

Pre-eminent is the gorgeous yellow spice saffron, redolent of the expensive and the exclusive. This of course has much to do with availability. One man's ordinary is another's exotica, but the nature of hand-picking the threads of the saffron crocus has always elevated its rarity value. From India and the Spice Islands came pepper, nutmeg and cloves; the desire for these condiments drove trade and some of the great voyages of exploration.

In contrast the alliums may seem a rather ordinary part of the kitchen garden. Garlic, onion and leeks each have their own cocktail of pungent sulphur compounds, leeks being the most delicately flavoured. Garlic is one of today's superfoods and was planted in ancient gardens across Asia and the eastern Mediterranean and left as an offering in Egyptian tombs. The smell of garlic and onions made it unattractive and there was a distinct class bias. Its consumption was encouraged for Roman slaves and soldiers, who were thought to benefit from its strengthening powers.

The Romans also held asparagus in high esteem. They did much to bring this plant into cultivation and valued its medicinal qualities. When our diet was more about the qualities of ingredients and less about food groups such as starch and protein it was prized in the Renaissance for its subtlety and easy digestibility. The diarist Samuel Pepys looked forward eagerly to the arrival of 'sparrow grass' each spring.

Brassicas are often considered humble greens, but what astounding versatility in these highly nutritious species and cultivars. The ancestors of today's cabbages (and from them the cauliflowers, sprouts, broccolis and kohlrabi) were headless, the heads appearing first in plants raised in northern Europe. At last, a key plant from the cold north. In China a plethora of oriental leaves belong to the same family.

Beer, of various kinds, often seen as an indulgence or a danger today, was an important part of the daily diet of labourers in early civilizations. It provided a source of clean water, calories and pleasurable intoxication, but it didn't keep. Enter the hop. However, it was only in the 8th or 9th century that this aphrodisiac herb was added as one of several flavourings in Europe, and its preservative qualities subsequently determined.

The final two tastes originated in the New World but became so essential in their adoptive homes that they now help define their cuisines. Chilli peppers were

# Chocolate

*Theobroma cacao*

Food of The Gods

*Up, and Mr. Creede brought a pot of chololatt ready made for our morning draught.*

Samuel Pepys, *Diary,* 6 January 1663

For many of the ancient cultures of Mesoamerica and South America, the chocolate tree held a special place. It featured in the creation myths of the Maya, and the Aztecs used the beans (seeds) as a currency. It was so prized that the latter imported it over long distances. The even older Olmec civilization also valued the beans of the tree, and 'cacao' probably derives ultimately from their language, now unfortunately lost. The Maya referred to the plant, its seeds and the product as *cacao*, and cognates exist in other Mesoamerican languages. Linnaeus, who was fond of chocolate, bestowed its current botanical name: *Theobroma*, meaning 'food of the gods', and the native word *cacao*.

*T. cacao* is a fastidious tree that doesn't naturally grow beyond a range of about 20 degrees north or south of the equator. It needs shade, high temperature and humidity. On modern plantations, the over storey is generally provided by either rubber or banana plants. The pods grow directly from the tree's trunk and stems (a phenomenon called 'cauliflory'), and the flowers are fertilized exclusively by midges (they do have some use). Only a tiny fraction of the flowers go on to produce a pod, and a good tree will produce about 30 pods each year. Within the pod, the pulp surrounding the seeds is sweet but the raw kernels are quite bitter. They must be fermented, dried, roasted and winnowed (the removal of the thin shell) before the cacao 'liquor' is produced. Debate continues about where the tree originated – probably Amazonia – but it was domesticated in Mesoamerica. Another species of *Theobroma* (*bicolor*) is also grown from southern Mexico to Brazil, where its product, called *pataxte*, is drunk or mixed with the seeds of the more expensive *cacao*.

Native Americans ate the juicy pulp or drank the ground beans in a beverage, mixed with a variety of flavourings including chillies and vanilla. As befitted a substance so venerated, it was used on ceremonial occasions. The Maya had a cacao god, with a regular festival. Elaborate utensils for drinking chocolate survive, and the vessels, and probably the beans themselves, were left in the tombs of important individuals. One cache, thought to be actual beans that had miraculously survived the heat and humidity of Mesoamerica, turned out to be models beautifully made


from clay in the shape of the bean. Always expensive, the beans were reserved for elites and the rich. Chocolate was thought to be intoxicating and too dangerous for women and children. The beans do contain a complex set of alkaloids, including caffeine and theobromine that today would be described as stimulants rather than intoxicants.

Columbus encountered the beans in a captured canoe during his third voyage to the New World, but it was not until the Spanish landed in Mexico that Europeans sampled the exotic drink. They didn't take to it immediately, but soon learned to flavour it with vanilla and other spices. Sugar was eventually added to make it the sweet drink it now is. The beans reached Spain by 1544, and were a commodity rather than simply a novelty by 1585, although as in their homeland they remained so expensive that only royals and elites could indulge in them. Chocolate gradually spread to other parts of Europe, including Italy. The French discovered it in the early 17th century, and by 1657 there was a chocolate seller in London, with the drink soon available at the tea and coffee houses. Europeans generally preferred to take it sweetened and hot, although the Spanish continued to add chillies.



Once the commodity was more widely available, cooks began to incorporate it too, although it was mostly used either medicinally or socially. Increasing European demand led to further planting of the tree in several Caribbean islands, including Trinidad and Jamaica. When the British captured Jamaica from the Spanish in 1655, it became a major supplier for the British market. The plantations had grown the original Mesoamerican variety, Criollo, which produces fine chocolate but is very disease prone. After a blight virtually wiped out the Trinidad plantations, a more robust variety, Forastero, replaced it. It had been discovered growing wild in Brazil. Forastero now accounts for almost 80 per cent of world production, although hybrids are being developed that combine the robustness of Forastero with the finer flavour of Criollo. The international market has resulted in the spread of *Theobroma* cultivation to many areas, within the climatic constraints of the plant, although West Africa is now the world's leading producer.

The processing of the pods yields a number of different products, each of which has uses. The sun fermentation of seed and pulp is essential to develop the flavours and results in a full-fat liquor, which was what was consumed until the early 19th century. Then, in 1828, a Dutchman, Coenraad van Houten, with his father, patented a process that reduced the paste by about two-thirds, yielding a product called cocoa. A portion of the cocoa butter that had been extracted could then be added back to the residue, producing the solid (which melts in the mouth) that we call chocolate. Within a couple of decades, chocolate bars were on the market.

Many of the familiar names in chocolate confectionary date from the 19th century: Cadbury in Britain, Lindt in Switzerland, Hershey in the USA. As with any mass-produced product, the finished product varies and is generally determined by the percentage of cocoa solids. 'Milk chocolate' was invented when a Swiss confectioner, working with Henri Nestlé, added dried milk in 1876. There is now a chocolate for every taste.

# Baobab

## *Adansonia* spp.

### The Upside Down Tree

*They carried me to a particular spot where I saw a herd of antelopes, but I laid aside all thought of sport, as soon as I perceived a tree of prodigious thickness, which drew my whole attention.*

Michel Adanson

According to one African creation myth, God gave each animal its own tree. The hyena was the last to receive his and got the baobab. He was so disgusted that he threw the tree away and it landed upside down: the baobab's distinctive shape does make its branches look like a root system. It has always been a botanical curiosity to outside observers, but it was the complete tree for those who lived in the areas of its unusual geographical distribution.

The genus *Adansonia* is named after the French naturalist Michel Adanson, whose initial encounter in around 1750 is described above. But the tree had been known in Egypt and the Middle East for centuries, prized especially for its fruit – mixed with water it produces a refreshing drink. This fruit, sold in Cairo markets, was understood by a Venetian naturalist in the late 16th century to be called *bu hobab*, although this may have been *bu hibab*, ' the fruit with many seeds'. Locally, the whole tree could be turned to use: the leaves and flowers were eaten as salad, the seeds roasted like coffee beans, the pliable bark pounded into rope or its fibres woven into cloth. The hard outer shell of the fruit made excellent dishes or containers. And the enormous, hollow truck of older trees could store great quantities of water, which was then available during the dry season. The trees were occasionally fitted with a tap for ease of drawing. The huge size and hollow centres means that the trunks have been turned to a variety of uses, including a pub, a prison and a restaurant.

The trees' vast size – as big as 30 m (100 ft) in circumference – gives the genus greater girth (if not total volume) than the giant redwoods of California (p. 00), and early naturalists assumed that baobabs were amazingly long-lived. Adanson used the fact that two trees inscribed by 15th- and 16th-century travellers had grown so little between then and his visit that the trees much be upwards of 5,000 years old. The explorer-missionary David Livingstone admired the trees but didn't think they had survived Noah's Flood. Modern estimates give the tree a maximum lifespan of about 2,000 years, although precise determination is difficult.

Baobab's natural distribution is also unusual. The genus consists of eight species: the African one (*Adansonia digitata*) is the most common. It prefers relatively dry



savannah conditions, about 450–600 m (1,475–1,970 ft) above sea level. There is also a single Australian species (*A. gibbosa*), indigenous to the Kimberly region of Western Australia. The other six species are all found in Madagascar, where baobabs almost certainly originated. It is thought that perhaps a million years ago hard-coated fruit floated the relatively short distance from Madagascar to the African coast, and the much longer journey to Australia. Time and different environmental conditions led to the two new species.

Its unusual size and shape, combined with the many uses to which the tree could be put, endowed the baobab with special meanings to native peoples. Trees could have a spiritual significance, and doubled as places of worship. Many have individual names and when they die have been accorded full funeral rites. An ability to grow new trunks from fallen branches means that a single tree can extend over a large area. Although specimen trees have been grown in many tropical countries, at least two of Madagascar's six species are now threatened, through land clearing and neglect.

# Wonders of Nature

## *The Extraordinary Plant World*

Is it invidious to privilege some plants more than others, because they fascinate, or astound, perhaps even repel? Good parents know they must love their children equally. Yet without creating dangerous value-ridden hierarchies that might allow us to cast some aside, there are plants that have inspired great wonderment. Even the hardened (and hardy) souls familiar with the world's most biodiverse regions have been brought to a standstill by certain plants. Nature's plant wonders are not merely sensory splendours. Scratch the surface, and their adaptations help reveal the history of life on earth, in all its abundance and tenacity.

The peculiar upside down or baobab trees bestride the thirsty regions of Africa, Madagascar and Australia. They serve as giant water towers and indigenous people literally tap the swollen trunk for its stored water. Welwitschias cope with their limited water supply in a range of ways from their ever-growing leaves to a special kind of metabolism. They also endure. Squat and low, welwitschias sit out the seasonal drought and sandstorms of their relic home in the Namib Desert. So far, they have managed to survive as a species from the age of the dinosaurs, when life was warmer and wetter.

If the Welwitschia is renowned for it ugliness, few would dispute the loveliness of the giant waterlily native to the waterways of South America. While the pineapple-scented flowers attract the attention of pollinating beetles, the structure of the leaves – a masterclass in vegetable engineering – inspired the ironwork for the London's Crystal Palace, home to the Great Exhibition of 1851. Evolution has led to some near optimum configurations in the natural world. The special arrangement of the seeds of a sunflower head and the plant's initial ability to track the sun both inspire solar-engineering projects.

Pitcher plants and the giant rafflesia find the nutrients they need in singular ways. Pitchers grow in nitrogen poor areas and compensate for this environmental deficiency by catching insects (and sometimes larger prey) in their highly modified leaves. The pitcher holds a solution of acidic digestive fluid enzymes. Must-have plants of the nineteenth century hothouse, the exploitation in the wild reached dangerous levels. Rafflesias are the world's largest single flowers. They are also obligate parasites, living on the roots of tropical vines and attracting their pollinators, carrion flies, by emitting the smell of rotting meat. Loss of the host vine through habitat destruction in the forests will also take away these exceptional plants from our midst.

Man-made habitat destruction doesn't come much harsher than the atomic bomb dropped on Hiroshima at the close of World War II. Less than a mile from the epicentre of the bomb a ginkgo tree rose like a phoenix from its burnt remains. Plants do seemingly limitless things for us. Our relationship with the plant world

# Tulip

## *Tulipa* spp.

### A Mania for a Bulb

*All these fools want is tulip bulbs/Heads and hearts have but one wish*
*Let's try and eat them; it will make us laugh/To Taste how bitter is that dish.*

Petrus Hondius (1621)

Tulip bulbs are humble looking things, easily held in the hand, a thin dry papery layer protecting the softer tissues within. But great potential lies deep inside. For here, in the centre of the scales that will provide its nourishment, is a new stem. At its tip is the embryonic flower bud. Once planted, and after the roots have formed and an essential period of coolness has passed, the stem will propel the growing flower bud upwards before its petals colour and open for a glorious two weeks or so of unbridled beauty.

In its quiescent state the tulip can easily be transported, ensuring instant gratification somewhere else the following spring. It was this that helped the Ottoman Turks of Istanbul move and transform various species of tulips from wild flowers to essential jewels of the garden. After his conquest of Constantinople in 1453, Mehmed II built the Topkapi palace and laid out its Persian-inspired gardens, replete with carnations, roses, hyacinths, irises, jonquils and tulips. Under his successors the tulip became intimately involved with Ottoman culture from the 16th century, evident in textiles, pottery and most famously its ornate glazed tiles.

Turkey may have been the place where the wild tulip entered the garden in grand style, but only four species of tulips are thought to be native here, although more now grow wild in mountainous areas of the country. The likely natural home of the tulip is further east, between the mountains of Tian Shan and Pamir-Alai in Central Asia. From here it spread where mountain and steppe provided the right combination of free drainage, winter chill, spring rain and a good baking in summer sun. The Ottoman sultans and their equally rapacious viziers were able to demand huge quantities of bulbs to be dug up from the wild in the empire's provinces and vassal states, while their florists began to manipulate nature. They selected and crossed the seeds of those tulips that grew ever closer to their ideals of perfection: long, slender flowers consisting of six same-length dagger-shaped petals, held upright on an elegant but strong stem.

For Europeans it wasn't quite love at first sight. The first tulip bulbs to arrive in Antwerp in 1562 suffered an inauspicious fate. Very much an adjunct to the bales of cloth he received, a merchant tried them roasted with oil and vinegar like

onions and tossed the rest into his garden. Most languished, but a few were treated with respect by George Rye, another merchant and keen gardener. Similar cargoes brought bulbs to Amsterdam. Some of Leiden's came when the new head of the physic garden, Carolus Clusius, arrived in 1593. He hoarded his blooms, refusing to share or sell, and fell victim to theft. The attraction was growing and spreading. Dutch tulipomania is the most famous, but France and England experienced periods of intense frenzy, and countries such as Germany were influential markets.

Tulip-fancying was part of the wider interest in exotic plants brought back through journeys of trade and exploration, itself part of the passion for owning and displaying natural curiosities. Plants, and especially tulips as tulipomania took hold, were to be grown in precisely arranged beds of exact dimensions, which visitors were invited to witness and admire as the flowers reached their peak.

And what a peak it was. European taste in tulips favoured a plumper look to the flower. The flower heads were often large, on long stems, but what drove tulip madness was the colour. Not the pure solid colours familiar in today's mass plantings and flower-shop blooms, but the delicate feathering and flaming of tulips that by some occult process had become multicoloured. This was termed 'breaking' – one colour apparently breaking into another on the petals as if painted with the finest brush. There were three desired types. Bizarres were red streaked on yellow, Roses red on white and Bybloemens purple on white.

Such astonishing beauty is now known to be caused by viruses, which interfere with the genes that code for proteins producing particular pigments in the petals. The virus also weakens the plant and slows the formation of bulblets. These baby bulbs were grown on, bulking up the stock (seeds do not come true). Over time what is essentially a diseased individual plant dies out, but its progeny continue. There is also the potential for new favourites as parasitic virus and tulip host co-existed in the florists' beds. So, ironically, it was damaged goods that were traded with such passion initially by aficionados and then in the 1620s by the emergent professional nurserymen. Such businesses profited as the price of bulbs (sold by weight after lifting) rose and they continued to prosper as entrepreneurial burgomasters entered the market as middlemen trading in tulip futures. This was the bubble that burst in late 1636 and early 1637.

The Dutch were already organizing successful packaging for long-distance transport and using travelling salesmen to create markets for their wares. Such enterprise would see them become the world's leading growers of bulbs and flowers, moving into the massive American market with new breeds of pure coloured flowers in the 20th century. Today the Dutch grow 4.32 billion tulips, 2.3 billion of which fill the flower stalls and bouquets as cut flowers. They are now as virus-free as possible and those flamboyant blooms of the past live on only among a few cognoscenti growers and in the still-coveted still life paintings of the old masters.