The Importance of NPs in Human Affairs

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Abstract and Keywords
This chapter shows how human obsession for certain NPs (e.g. coffee, tea, spices, morphine, cocaine, hops, quinine, etc.) has influenced world history. If one looks at NPs as a group rather than each individually, the importance of NPs in human history is even more striking. Indeed, it is apparent that over the centuries, those rulers who have gained a near monopoly on the supply of certain NP-rich materials have shaped the current geopolitical map of the world. The wealth created by trading in NPs was used to build great cities with magnificent houses and public buildings, cities where arts and science flourished. Even today the legal, and illegal, trading in a few NPs still dominates economic activity in the world. Remarkably, this very obvious fact is rarely appreciated.

Keywords: Natural Products, NPs, drugs, cigarettes, human economic activity, world history
A historian who would convey the truth must lie. Often he must enlarge the truth by diameters, otherwise his reader would not be able to see it.

—Mark Twain

Summary
Humans often value a rare object more than a common object, even if the rare object has little practical value. History suggests that this generality applies to some NPs. The rarity of a particular NP at any one time is a consequence of the fact that each NP is usually made by a few closely related species (for reasons that are explored in Chapter 5). If individuals of such an NP-rich species are quite rare, then the unique mix of NPs characteristic of that species will be in limited supply. If humans find that mix of NPs attractive, then opportunities will arise for those who control the supply of the plant, or one of its NP-rich products, to make very large amounts of money. With money comes power and power dictates world history. Hence, it is hardly surprising that the human obsession for certain NPs (e.g., coffee, tea, spices, morphine, cocaine, hops, quinine, etc.) has influenced world history. However, if one looks at NPs as a group rather than each individually, the importance of NPs in human history is even more striking. Indeed, it is apparent that over the centuries, those rulers who have gained a near monopoly on the supply of certain NP-rich materials have shaped the current geopolitical map of the world. The wealth created by trading in NPs was used to build great cities with magnificent houses and public buildings, cities where arts and science flourished. Even today the legal, and illegal, trading in a few NPs still dominates the economic activity in the world (Figure 2.1). Remarkably, this very obvious fact is rarely appreciated.

Making money from NPs
Simple market economics
Humans in all the ancient cultures selected appropriate plants to produce the carbohydrates, fats or oils and proteins needed for their sustenance. Most of the chosen crops produced structures (e.g., seeds, tubers, etc.) that the plant had evolved for propagation (p.14)
purposes. Evolution has ensured that these structures contained the appropriate mix of elements needed to sustain the crucial early life of the next generation of the plant and that these substances were stable and hence stored well. Many organisms, including humans, have evolved to exploit the storage reserves of plants. One of the criteria for the selection of domesticated crops was that the plant storage substances were contained in high amounts in an easily harvested and stored structure and that semipurified palatable substances could be produced with relatively little effort using simple techniques. For example, most grains contain large amounts of starch and the grinding of the seeds can produce ‘flour’ enriched in starch. However, such processed grains have a low odour and flavour because they contain few NPs (could it be that basing ones diet on high odour, high taste staples could burden the body’s NP processing systems? See Chapter 7). Given the dependence of humans on their food crops, it is understandable why the main

![Figure 2.1](image-url) The world sales or trade values of some major plant products. It is doubtful whether the figure for each is strictly comparable because the monetary value of a product depends on several factors—the amount of processing, the ease of maintaining a monopoly, whether taxes are included, and so on. For example, the monetary value of narcotic drugs increases many fold from grower to consumer, much more than the increase in the value of wheat for example. Because many countries grow wheat, most of which is consumed domestically, the total value of the world wheat sales ($120 billion in 2008) greatly exceeds the amount traded. In contrast, many NP-rich plant products are grown mainly for export, hence have greater significance in world trade. The figures are mainly derived from FAO data covering the years 2005–8.
plant products traded in the world, in terms of tonnage, are grains, sugar, oil and protein containing seeds. These are commodity products containing chemicals of relatively low value (except in times of famine).

(p.15) Because all plants possess the capacity to produce storage carbohydrates, storage lipids (fats and oils) and storage proteins, it is relatively easy for any group of humans to find some local plants that can supply these substances. The domesticated grasses (rice, wheat, oats, barley, rye, maize) were not only attractive to grow, harvest, store, transport and process, but also capable of yielding reliable harvests when grown over a range of soils and climates. The major grain crops such as wheat and maize are now grown on every continent. Because wheat starch is similar to barley or maize starch, it is possible to substitute one form of starch for another in several uses—brewing, the production of animal food, biofuel production or the production of sweeteners. Finally, the ability to store dried grain for many years means that surplus production in one year, in one part of the world, can benefit consumers in subsequent years in parts of the world where local grain production has failed to meet demand. The fact that farmers all over the world can produce starchy grains, and the fact that it is easy to substitute one starch for another for some uses, means that highly competitive markets have kept grain prices low for decades. The same arguments apply to other commodity food products such as plant proteins, plant oils and plant fats where competition and substitutability keep prices low. So a general lesson emerges. Throughout history, except in times of famine or very limited supply of staple foods, wealthy societies place rather little value on their staple foods. In particular, the wealthy members of society never spend much of their income on staple foods.

In contrast to the commodity products, the NP-rich plant materials added to the staple ingredients to give flavour, odour or colour to a food have often had very high value. It is the NPs that humans desire or even crave in their foods, not the nutritional substances. Not only have humans appreciated NPs in their foods, they have also used NPs much more widely. Drinks are more enjoyable if they have a flavour. Life becomes more pleasant if the nose is stimulated by the NPs in scents or perfumes. Pills and potions containing NPs, NPs that might have a pharmacological effect, are also more likely to benefit
from a placebo effect if they have a distinctive taste. The most extreme case of this interest and attraction to certain NPs is found in narcotics.

But why are NP-rich plants more expensive than commodity or crops? Simply because, in contrast to the easily substitutable staple foods, the plants that produce highly attractive NPs usually have a much more limited geographical distribution. Consequently, there is less competition in the market place and substitution remains very difficult in most cases (e.g., there is no satisfactory synthetic coffee, tea or chocolate). Some of the NPs used in scents and flavours have been substituted with synthetic chemicals but even then many consumers were prepared to pay a premium for plant-derived flavouring (e.g., natural vs. synthetic vanilla).

The difference between commodity products and NP-rich plant products are summarised in Table 2.1. The properties of sought after NP plants show the factors that helped growers and traders establish a monopoly of supply. When each of those factors is examined it becomes clear why for every desirable NP, the monopoly is finally broken.

Table 2.1. The key differences in the characteristics of crops producing commodity products and crops producing NPs.

<table>
<thead>
<tr>
<th></th>
<th>Commodity crops</th>
<th>NP crops or products</th>
</tr>
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<tbody>
<tr>
<td>Geographical range</td>
<td>Very wide</td>
<td>Very limited</td>
</tr>
<tr>
<td>Stability in storage</td>
<td>Very good</td>
<td>Mostly poor</td>
</tr>
<tr>
<td>Substitutability</td>
<td>Very high</td>
<td>Very low</td>
</tr>
<tr>
<td>Ease of transport</td>
<td>Increasingly economic</td>
<td>Always economic</td>
</tr>
<tr>
<td>Price per kg</td>
<td>Very low</td>
<td>Very high</td>
</tr>
</tbody>
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**Geographical range**

By increasing the geographical range of any valued NP producing species, the monopoly enjoyed by the original
producers, more particularly the traders who controlled the routes between growers and the consumers, was eroded.

- Improved husbandry skills allow NP-rich plants to be propagated and grown in more geographical regions, hence increasing supply (see sections on coffee, tea, vines, hops, rubber, etc.).

- Variants can usually be found within a population of plants that can survive in environments that were once considered unsuitable and further selections eventually produces plants that can produce a profitable harvest.

- Navigational techniques and ship technologies, which enabled transglobal voyages to begin in the fifteenth century, led to an accumulation of knowledge of the existence of equivalent climates, soils and weather and this knowledge encouraged people to identify certain valuable NP-rich plant species that might grow well (see section on spices).

**Stability in storage and distribution**

Because products rich in desirable NPs command a high price, it becomes economic to build storage facilities that reduce NP loss and to invest in improved packaging—look at foil wrapped tea or vacuum wrapped coffee. Freeze drying, controlled atmosphere packaging and optimum harvesting also help deliver the best NP-rich products to the consumer.

**Substitutability**

There are examples of three kinds of substitutability:

- Species substitution, where one species that produces the sought after NPs is replaced by another similar species that produces a similar product—for example, coffee and tea.

- Chemical substitution, where chemists devise synthetic routes to make commercial production of the chemical economical—vanillin is one example.

(p.17)

- Combined species substitution and chemical synthesis—the best example of this is the production of analogues of the anticancer drug taxol which is now made by using a species related to that which makes taxol (see Chapter 7). This related species make no NPs with useful anticancer
properties, but one of its NPs can be converted to the useful analogue of taxol by chemists.

Ease of transport
Once again the high value of NPs relative to their weight enabled the investment in special ships (e.g., the beautiful nineteenth-century tea clippers) and facilitates such craziness as the airfreighting of roses (rich in NPs that smell nice and have pretty colours) from South America or Africa to Europe.

Adding value—miracle cures, patents and branding
Although many plants valued for their NP content were of limited geographical distribution, some others, especially annuals, were less demanding in their cultural requirements hence were more widely grown. This was especially true in the case of medicinal herbs. For medicinal use, many herbs (mint, thyme, feverfew, camomile, etc.) are needed only in small amounts and, given considerable care, can be grown over wide geographical areas (herb gardens were a common feature of monasteries throughout Europe). Many herbs can be propagated easily, either by seed or vegetatively, and hence are available to even the poor in many societies. However, extra value could be added to these materials by the herbalist in a way that was impossible for the miller and the baker processing a grain. Humans will pay handsomely for the promise of health but meagrely for the promise of food, unless they are starving. Most individuals know from experience that many different foods will satisfy their hunger but they are also likely to believe that only one herbal potion will treat their ailment. Consequently, even when herbs were actually widely available to many people, a few people found a way of ‘adding value’ using the NP content as the selling point. A mixture of substances, including NPs to give colour, odour and flavour, could be sold to people suffering a wide range of different ailments. The herbalist could make money by taking cheap substances and combining them in a supposedly unique way. The skill of the herbalist was valued in most human societies for thousands of years and even remains appreciated today.

In the nineteenth and early twentieth century, the developed world gradually replaced locally made herbal remedies with more purified, processed NPs which commanded even higher prices because patent laws could restrict the competition in the sales of such products. However, even NPs which were not protected by patent were to benefit from a remarkable form of
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monopoly that began to infect the developed world in the nineteenth century and spread worldwide in the twentieth century—the monopoly of the brand. Indeed, some of the world's first major brands were NP-rich products (see section on tobacco). A nice example of this is found in cola drinks where (p.18) simple, cheap ingredients, including several NPs, are sold to gullible consumers who seem prepared to pay extra money simply to drink brand 'A' rather than drinking the equally refreshing unbranded competitor. Another example, the mixture of NPs that we call coffee, is sold in branded cafes at a vastly inflated price, the consumer effectively awarding the retailer a form of monopoly. The most extreme version of the exploitation of the human obsessions with NPs and brands is the perfume market—as I write this I find one perfume on sale for £230,000 per bottle! One hopes that there were no buyers but the 2006 world sales of less expensive fragrances were still a remarkable $16 billion.

The history of the human obsession with NPs
The account that follows comes from an English-speaking north European with no training in history or economic history. The narrative will attempt to illustrate the way in which a few NPs have influenced human economic activity.

Ancient history
The characteristic taste or smell of a food is used to signal an acceptable or non-acceptable food source. The evolution of the senses capable of detecting NP has long predated humans. For example, it is clear that many insect species select their food source, or the food source for their offspring (i.e., which plant is chosen to lay eggs on), partly on the basis of the NP composition (see Chapter 9).

The discovery of fennel, cumin and coriander seeds at some ancient burial sites suggests that taste and/or smell was incorporated into human cultural practices very long ago. A few cloves in a charred vessel found in a settlement on the banks of the Euphrates in Syria have been dated to about 1700 BC and because cloves grew thousands of miles to the east in the Spice Islands, this suggests that NP-rich products were being trade over very long distances at an early stage in human history.¹

The Indo-Iranian cultures
The Indo-Iranian culture, which archaeological evidence suggests stretches back beyond 2500 BC, was centred initially near the Ural River and then it spread to cover large areas of the Eurasian steppes, stretching down into what is now Pakistan and northern India. During a later period lasting from 1800 BC to 1000 BC there developed a ‘soma culture’. Soma was a drink supposedly favoured by the gods and those who consumed it supposedly experienced increased power and euphoria. A debate continues as to which plant species (or indeed fungal species) provided the NP, which was the active ingredient of the drink. One candidate is a species of the genus *Ephedra*, which contains Ephedrine. The concept of the power of soma is also evident in Hinduism and in some western literature (most notably Aldous Huxley's *Brave New World*).

(p.19) Mediterranean cultures—the demand for NPs grows

The pre-Roman spice era

The history of the cultures that participated in trade around the Mediterranean suggests that the consumption of NP-rich spices spread west and north, so the ports at the eastern end of the Mediterranean grew rich on the profits from the trade in NP-rich products.\(^2\) For hundred of years, the Egyptians used their position on the Red Sea to trade by sea with India via Arabian merchants in Yemen. The ancient Egyptians had been using NP-rich products like balsam and myrrh, imported from the Yemen kingdom in south Arabia, in embalming since the third millennium BC.\(^2\) The numerous conflicts in the region during these times can be interpreted as being caused by a desire to gain control over the trade in NP-rich products. However, as the demand for these products increased, more northerly trade routes were developed so the wealth from NP trading spread to several rulers controlling the Mediterranean ports, and the trade routes leading to them, in the Middle East (Figure 2.2). From 500 BC, the Greeks were importing cinnamon and pepper from India and nutmeg, ginger and mace from the Spice Islands in the Far East (islands which are now part of Indonesia). The use of these spices and others in medicine, religious practices and cooking spread throughout the Greco-Roman Empire.
after Rome conquered the Greeks around 150 BC; subsequently, the use of spices spread into other parts of Europe as the Roman Empire extended west and north. The Roman spice era

Given the growing importance of spices in Roman culture it is hardly surprising that the Romans sought to take control of the supply routes of these products from the East. The Romans annexed Egypt in 30 BC. Roman merchants invested in new ports on the Red Sea and they improved camel train routes across the desert to the Nile where they could load their precious cargo into barges for transport to Alexandria. From Alexandria the spices could be shipped to Rome and other ports in the Roman Empire. According to the geographer Strabo (63 BC–AD 24), 120 ships per year were engaged in the Roman trade to India and some of the freighters displaced 1000 tonnes (dwarfing by a very large margin the Portuguese, British or Dutch vessels that were to rediscover the Indian spice ports nearly 1500 years later). An understanding of the annual cycle of monsoons in the Indian Ocean gave these traders the ability to cross rapidly to their destinations. These

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**Figure 2.2.** The major trade routes leading to Europe from the regions of spice production before the end of the fifteenth century, after which some western European nations (Portugal, Spain, The Netherlands and England) opened up ocean routes via Africa or South America. The control of the major sea ports at the eastern end of the Mediterranean and land routes across the deserts of the Middle East leading to them were key to capitalising on the spice trade. By the sixteenth century, when it was possible to bypass the Middle East traders, controlling the trade in India became important to maximising profits from spice trading. A little later the few major European nations seeking to control the spice trade fought for control of the areas of spice production in the Far East.
huge vessels carried many different goods each way, with
spices being one of the exotics that the Romans desired. This
new spice trade flourished as the appetite for spices in the
imperial city and the empire grew. The Romans found new
uses for spices, especially pepper, in their increasingly rich
and diverse cuisine. As the trade grew, the price of pepper fell
to the extent that even soldiers serving at an outpost in
northern England could expect some pepper to spice their
rations. However, while the price of individual spices fell for a
time, the overall cost of importing spices from India grew and
this began to put a strain on the Roman economy. The problem
for the Romans was that Indian merchants found rather few
Roman goods attractive; hence, the Indians insisted on bullion
in exchange for their spices. A Roman balance of trade
problem, so familiar to modern economists, became evident
quite quickly. Tiberius in AD 22 condemned the new obsession
with imported luxuries before the Senate but many of his
audience, no doubt, went home to feast themselves on their
delicious spicy foods that evening. Not for the first or last time
in history, would a rational argument against the unnecessary
consumption of NPs fail to change the minds of those whose
senses were enjoying them so much.

By AD 200 the price of spices had increased again to the
extent that trade declined. As the power of Rome declined, the
empire began to fray at the edges. The Red Sea ports fell to
the Blemmyes, an African Nubian tribe who cut the direct
Roman links with India. The spice trade between east and west
was now to be dominated for nearly 1000 years by Arab and
North African traders. However, even as the Roman Empire
declined in Europe, the taste for spices continued. Indeed,
some of Rome’s enemies even sought spices as a tribute from
Rome. Rome retreated from the west Mediterranean and
mainland Europe and retrenched in the third century AD to
the Eastern Roman Empire (or Byzantium) with its capital in
Greek-speaking Constantinople (modern Istanbul). It is surely
significant that Byzantium was at the end of one of the
northern spice route and gave this last bastion of Roman
power access to some spices that had not passed through the
Red Sea.

(p.21) The Arabian control of spices
The Byzantium and Jewish spice traders were to be increasingly marginalised by the remarkable growth and power of the Arab, and subsequently Muslim, traders. The Arabs had been very successful in gaining influence further to the east of the spice route—in the Indian subcontinent and beyond. There were Arab-speaking merchants in Sri Lanka by the fourth century AD and by the eighth century the Arabs even had their own commercial enclave on the Chinese mainland at Guangzhou (known formerly as Canton). However, the founding of Islam brought his religious insights to many Arab tribes and united them under Islam. Mohammed married Khadija, the rich widow of a spice trader. Mohammed had worked briefly for Khadija, taking charge of one of her caravans taking goods to the Syrian ports. The favourable reports of his character and ability encouraged the older Khadija to subsequently marry Mohammed. Given Khadija's business as a trader in spices, it is not surprising that the new religion spread along the existing spice routes as well as locally. There was an Arab community established on the Malabar Coast of India 500 years before the Moghuls came from the north to bring Islam to other parts of that subcontinent. (The Indian coast was also the home to the oldest Jewish community outside the Middle East because of the involvement of Jews in the spice trade.) Because the spice route stretched to the country now known as Indonesia, Arab traders and their Islam religion became established in Indonesia. So the human quest for NPs explains why Indonesia was eventually to become the world's most populous Islamic country.

By AD 700, the Arabs had pushed the Byzantium Empire back to an area around current Turkey and the Byzantium influence in Europe was confined to a few enclaves (including Rome, Naples and some ports on the northern Adriatic coast). However, this limited access to the European trade routes enabled Byzantium to continue its profitable spice trading to mainland Europe until it lost control of its European ports in the eighth century. Byzantium lost trade into Europe to a community of fishermen living on some easily defended marshy islands in the gulf at the north of Adriatic. The new city that soon grew from this new source of wealth, Venice, was soon to be enriched by its increasingly dominant role in the European spice trade, a dominance maintained for many
centuries (Figure 2.3). By AD 813, Venice claimed a monopoly on all Byzantium trade into Europe, forming an alliance with Constantinople. It was about this time that records of the purchase of spices and documents telling of spices being used as part of the payment of salary become more common. Spices, in their unground form store well, have a high value per unit weight and easily traded throughout the world, hence were an acceptable form of ‘currency’ (the term peppercorn rent which now means a nominal sum had a different meaning during that period). This currency might also have had an attraction in the ninth century when the price of spices rose very rapidly.

The competition between the northern spices routes leading into Europe via Byzantium and southern spice routes from the Red Sea continued. Venice and Genoa (p.22)

Figure 2.3. The City of Venice, like some other cities in Northern Italy, was greatly enriched by its participation in the spice trade.
were to compete for their share of the spice trade into Europe for many decades. Some European traders were happy to trade with the Muslim traders offering spices that were being imported via the Red Sea ports. A visitor to Cairo in AD 996 recorded that the city was host to 160 merchants from Amalfi alone. The cosmopolitan nature of some Middle Eastern cities was remarkable. In these modern times, it is sometimes forgotten that Muslims, Christians and Jews coexisted peacefully in many cities for long periods. At this time, the Karimis, a group of Jewish merchants based in Cairo, had a network of trading agents that stretched from China in the east to Mali in West Africa. However, this coexistence and mutual benefit was to be upset at the end of the next century.

trade with the resulting blossoming of the arts, science and architecture.
The Crusaders, the spice trade and the rise of the Ottoman Empire

In 1095, the first Christian crusade against Islam was launched. There were many motives for participation in the crusades, not all religious. Although Pope Urban preached the radical doctrine of fighting a holy war, some were motivated more by mammon. As the first Crusaders gathered in Byzantium to launch their assault south, some Venetian merchants were well aware of the fact that their traditional spice trade routes were already under threat from Islamic military and commercial competition, so aiding an army that might counter those threats might be a good investment. Some other wealthy Italian trading cities also gave assistance to the Crusaders because the merchants in those cities were given guarantees of important trade concessions in the eastern Mediterranean ports should the Crusaders be successful. These merchants saw an opportunity to compete more successfully with the Venetians by taking control of alternative spice supply chains, currently controlled by Islamic rulers. The first assault failed when the shambolic, undisciplined Christians were routed by a Turkish army. In 1097, more organised, reinforced and professional Christian armies moved again and began to push the Turks south and eventually the Europeans occupied parts of Syria and Palestine. So began a struggle that lasted for hundreds of years as the invaders and local rulers fought over this area, an area so important in the spice trade. The new Christian states in the Levant gave the Europeans improved access to the southerly spice routes and the eastern end of the Mediterranean was safe for the growing Italian fleets which enriched Genoa, Pisa and Venice. The trade in spices increased, prices fell, and the spice market in Europe expanded again. By the twelfth century, the spice trade in Europe had grown to the extent that guilds of spicers and pepperers were formed. By the thirteenth century, specialist spice shops were doing business in some European cities. Although the short-lived conquests in the Levant reduced the power of the Arab traders for a period, inevitably the traders to the east increased their supply via the more southerly Egypt routes, where Cairo and Alexandria blossomed with new wealth.
An important change in the trading relationship between spice producers and spice consumers was about to occur with the growth of the Ottoman Empire (1299–1922). Gradually, the European powers lost control of the Levant and power was also slipping away from Byzantium in Turkey. Osman I started a dynasty which grew over the centuries to cover all the major spice trade routes leading to Europe. By 1453, when the Ottomans took Byzantium, this great Islamic Empire had complete control of the trade between India and the Mediterranean and they profited greatly by this monopoly. The resulting wealth that accrued to the Ottoman Empire from its monopoly of trade (not only spices but silks) between the East and Europe led to a blossoming of Islamic art, architecture, science and theology, such that its culture seemed very sophisticated compared to contemporary European culture (Figure 2.4). The Muslim rulers tolerated non-Islamic, especially Jewish, traders in their midst because these traders had access to the heart of Europe, which assisted their trade. As noted earlier, Italian traders were well represented in Egypt; hence, even when there were tensions between Christians and Muslims, some Christian traders, and in particular Jewish traders, continued to do business with Arab traders. The Venetians in particular were ready to put trade before religious zeal and it took the threat of excommunication of many Venetian merchants by the Pope in 1322 to temper this trade and then only for a short time.² Surprisingly, there was less tolerance to Christian traders because of the memory of the terrible acts of violence conducted by the Crusaders in the previous centuries. One wonders whether this Muslim preference for Jewish NP traders might have been one of the causes of Christian resentment of Jewish businessmen so evident in European literature (e.g., The Merchant of Venice) and society in general. (p.24)
The rise of western European power

The increasing Ottoman control of the spice trade into Europe was to have profound consequences there. Each link of the chain of traders and merchants, stretching from Indonesia to Europe, took their profit as spices passed through their hands and the rulers extracted their taxes. It was not surprising that a 1000% rise in value between the source and the final market place was common.

Predictably, this huge economic activity caught the imagination of some merchants furthest from the source of supply of the spices. These merchants wondered if, and how, they could get their goods without paying so much to middlemen. The merchants in northern Europe and those at the west end of the Mediterranean had most to gain by finding a route to the sources of the spices (and silks), a route which would bypass the Muslims in Middle East and traders in the Italian states. The Spanish and Portuguese were the first to turn speculative discussions about the possibility of sailing west to the Spice Islands into reality. The Portuguese had already explored extensively down the east coast of Africa and some navigators were confident that they could find a passage to the east around that land mass. In 1492, Columbus set off to find the western route, with the source of spices being his main goal. He was quite sure he had found his goal when he reached the Caribbean; indeed he collected aromatic plant specimens to prove that he had reached the land of spices. On his return to Spain, he blamed poor storage and a necessity to harvest at the wrong time as the reasons why his ‘spice’ samples were nothing like the genuine articles. Columbus never fully accepted that he had not found the Indies, indeed

Figure 2.4. During the period when the Ottoman Empire controlled the spice routes leading to Europe, it was noted for its flourishing arts, science, medicine and sophisticated culture.
parts of the region he brought to the attention of Europeans became known as the West Indies. (p.25) Some of its inhabitants were even given the generic name of Indians! Although this Spanish quest for spice led to the discovery of a very valuable source of gold and silver, and subsequently led to European colonisation of the newly discovered continent, it failed in its primary objective. But, as outlined below, centuries later some other important exploitable NPs (found in coca, quinine, capsicum, vanilla, tobacco and chocolate) were to come from this continent.

In 1497, the Portuguese launched their first maritime expedition to the Spice Islands. Three small ships, commanded by Vasco da Gama, set sail and headed south in what was to be a two year ocean voyage covering 24,000 miles. This was to be an epic voyage, surpassing Columbus's feats in both navigation and endurance. Unlike the earlier Spanish expedition, it was to succeed in re-establishing direct European contact with India spice ports for the first time since the Romans. Having made landfall, Vasco da Gama, en route for the city of Calicut, was impressed by the cosmopolitan nature of the area but sadly took little time to consider why this peaceful, civilised society had been so successful and why its ruler, the Zamorin, was so tolerant to so many races of foreign traders. The arrogance and religious intolerance of Vasco da Gama upset the Zamorin, who was also unimpressed by the gifts Vasco da Gama could offer—Europe had nothing very novel or useful to offer the East at that time. Gifts from the Portuguese that had impressed the rulers along the African coast in previous explorations seemed paltry to the Zamorin who regularly hosted richer, more generous traders than the new Europeans. However, Vasco da Gama was given the right to trade and returned home with a load of spices. This voyage was the beginning of the rise to world status of the western European powers. In 1500, the Portuguese dispatched 13 ships commanded by Pedro Cabral, crewed by one thousands sailors, back to India (coincidentally discovering Brazil en route (hence laying the foundation of the Portuguese empire in South America). The intention of this venture was not only to import spices but also to export Portuguese power and influence. On arrival in Calicut, Cabral demanded that the Zamorin expel all Muslim merchants, contrary to his host's long tradition of free trade. The tension, first provoked by Vasco da Gama, now exploded into violence.
The Portuguese knew that there was no competition for their naval artillery and they were determined to eliminate all local Muslim competition. They did so in a bloody and terrible way and took control of Calicut. This was the first of many such uses of Portuguese power in the Indian Ocean, an Ocean that the Portuguese came to dominate for a century. The Portuguese were building an Asian trading empire that was to last for 500 years. Unlike the Asian colonies of other European nations, the Portuguese trading empire was based on small, strategic, well-fortified trading posts and not on large territory possessions. By 1501, the Portuguese merchants could easily undercut the Italian spice merchants in European markets. Not only had the Portuguese their own cheaper source of supply but their disruption of the trade on the Malabar Coast had caused a rise in the price of spices imported via other traditional routes. Not content with their wealth, the Portuguese now pushed their way further east along the supply chain. By 1505, the Portuguese were trading cinnamon directly with suppliers in Sri Lanka; in 1511 they had seized control of Malacca, the key port in controlling trade between India and the Spice Islands. In that year, the Portuguese launched an expedition from newly conquered Malacca to find the Spice Islands which they finally located the following year after some epic adventures.5

The early western European success in dominating so much of the global spice trade so rapidly fed a hubris that was wonderfully illustrated by the fact that the Pope decided that the world trade would be shared by only two Christian nations! The Spanish were granted exclusive rights to trade in products from one half of the globe, while the other half of the globe was assigned to Portugal by the pontiff. Spain decided that they had right to the Spice Islands, not the Portuguese. This was remarkable given that there were no accurate maps of the world, the earth's circumference was unknown and the Pacific was unexplored by Europeans. However, this dispute was sufficient for the Spanish to seek their own route to ‘their’ islands. The Spanish decided to finance an exploration by (ironically) another Portuguese explorer Magellan, who proposed to the Spanish that a route around the southern tip of South America would be quicker and more convenient than the route around the Horn of Africa. Little did he know that of the five ships that set sail in 1519 with 270 men, only one ship was to return to Spain and only 18 men survived. This voyage
was the first circumnavigation of the globe but Magellan had died in the Philippines long before the fleet reached the Spice Islands. With this visit to the Spice Islands to bolster their claim, Spanish diplomats restated their ‘rights’ but after further arguments with the Portuguese, the Spanish king, in need of money for his wedding, traded the trading rights to the islands to the Portuguese. This might have been a rational settlement because the Portuguese were much more able to defend their established posts in the east than the Spanish were able to attack them. So, Portuguese hegemony continued.

However, the hopes that the Portuguese might have of establishing a monopoly were doomed to failure because market forces simply stimulated competitors to adjust to the new realities. Muslim traders soon developed such skills at smuggling spices from the many small ports on the Malabar Coast that trade via Alexandria and Venice recovered within decades. The smuggling of NPs is a theme that will reoccur repeatedly and it continues to the present day with narcotic smuggling.

Meanwhile, the Protestant Dutch and English were no more happy with the Catholic dominance of the spice trade than they were with the previous Muslim dominance. English and Dutch ‘Privateers’ (an English euphemism for what they would call a piracy in others) were gaining wealth, and seafaring experience, by raiding Spanish and Portuguese trading ships returning from their voyages. The Dutch and the English were nations with growing maritime confidence. Both nations had penetrated the Indian Ocean and the Pacific Ocean and eventually their ships turned up in the Spice Islands. Sir Francis Drake had visited the Spice Islands in 1578 and left with an agreement from one sultan that the British could have exclusive rights to the cloves that he could supply. On Drake's return to London it was hardly surprising that some merchants decided that an investment in an expedition to the Spice Islands might enrich them. But with no single merchant confident enough or rich enough to bankroll the expedition, the East India Company was formed in 1600 to spread the risk and the investment. (This model of investment was copied elsewhere: the Dutch East India Company was formed in 1602, the Danish East India Company in 1616, the Portuguese in 1628, the French East India Company in 1664, and the Swedish East India Company in 1731). The British
East India Company was to lead British colonial expansion and to develop a remarkable skill at trading many different NPs. The Dutch arrived in the Spice Islands in 1599 and the English in 1601. Neither the Dutch nor the British, being Protestants, took any notice of the ‘ownership’ of the world as decreed by the Pope and both nations laid claim to any territory they could gain control over by use of force. The Dutch went east, ready to fight for possession, and quickly took over power from the Portuguese, sometimes aided by alliances with disgruntled locals. Sri Lanka, with its source of cinnamon, fell under Dutch control in the 1630s, Malacca in 1641 and the Malabar ports in the early 1660s. Just as the Catholic neighbours from southern Europe had found themselves in conflict over their claims to the Spice Islands and strategic territories en route, the Protestant English and Dutch neighbours now found themselves competing for the same distant parts of the world. The English never seriously challenged the Dutch in the spice trade despite considerable effort. By 1662, King Charles II issued a decree forbidding English merchants to buy cinnamon, cloves, nutmeg or mace from any other than the growers. But this was not an early enlightened example of Fair Trade, rather it was because the English king hated to see his tax collectors in competition with Dutch spice merchants. The conflicts between the Dutch and the English led to war in 1665–7, but a peace treaty gave the Dutch sovereignty over the Spice Islands (which the English could not practically challenge in any case) in exchange for the Dutch giving up their claim to New Amsterdam which the English actually already occupied and called New York. The Dutch economy and culture blossomed in the way that the Ottoman and Venetian economies and cultures had done previously when the spice trading had enriched them. The period from 1620 to 1670 was the golden age of Dutch painting, the city of Amsterdam became one of the richest cities in the world at that time and science and learning flourished (Figure 2.5).

The Dutch East India Company (VCO) ruthlessly and efficiently operated a monopoly. For example, in 1735, the VCO burned half a million kg of nutmeg in Amsterdam in an attempt to raise prices. In Indonesia, the Dutch would torch plantations if new growers tried to enter the market or if established growers tried to smuggle their products to non-Dutch traders.
The remarkable legacy of the spice trade

The fact that the Dutch had to manipulate the market by destroying their once valuable spices tells us that the market that had expanded so dramatically for hundreds of years was becoming saturated—a modern economist would say that the spice market was mature. Consumers only needed a certain amount of spice. Furthermore, (p.28)

Figure 2.5. When the Dutch gained a near monopoly on the spice trade into northern Europe, the resulting wealth made Amsterdam one of the richest cities in the world, with a consequential blossoming of the arts, education, medicine and science.
other NPs were beginning to interest the palate of the wealthy, with coffee and tea also possessing interesting scents and flavours to tickle the taste buds of discerning consumers. Other economic factors were also at play. As other European nations increased their territorial possessions around the globe, some inevitably gained land with climates that were not unlike the places where spices had been grown exclusively until the seventeenth century. Both the Portuguese and the Spanish had tried to establish spice plantations in their new colonies in South America but without significant economic success. The Dutch were well aware of this potential competition. For example, the Dutch treated nutmeg with lime before export to ensure the nutmeg would not germinate. However, as in the case of all plants with economic importance, some plants will inevitably be smuggled out if the price is right. Peter Poivre eventually succeeded, after many remarkable adventures, in taking nutmeg plants to the French colony of Mauritius. Even though these plants failed to thrive, Poivre's writing about his exploits inspired others. He raised French money and returning to the Spice Islands he managed to smuggle 2000 nutmeg seedlings and 300 clove seeds from the islands. In Mauritius, a few plants grew and they cropped in the late 1770s. However, the new Mauritius producers could not compete with the Dutch, who were still supplying several thousands of kg of cloves every year to France some decades later. But the principle of moving NP-rich plants to new parts of the globe to break a monopoly was proven.

(p.29) The Dutch lost the control of Sri Lanka to the British and its cinnamon groves in 1795 as the British East India Company expanded and consolidated its power base around India. During the Napoleonic Wars, the British gained control of the Moluccas for some years and they transplanted many of the spice crops to their possessions in Penang (Malaysia) and Singapore. In 1818, the French found that cloves that merely grew in Mauritius thrived in Madagascar and Zanzibar to the extent that two centuries later these islands supplied cloves to Indonesia. In 1843, the English established successful nutmeg plantations in Grenada. Thus by the nineteenth century, the Dutch spice hegemony was broken and for the first time in thousands of years it was no longer possible for states, cities or individuals to make fortunes from the spice trade.

The legacy of all the groups who gained wealth and power from spice trading is still very evident. The current geopolitical map of the world was shaped in part by the Greek, Roman, western European, Muslim and Indian involvement in satisfying the human craving for spices. Languages, cultures and religions were spread as traders sought profitable sources of spices. For example, it was not the British state that
imposed the English language around the globe, it was the British commercial interests in NP trading, starting with spices. British power around the globe was initially simply a means of protecting these British traders and much of that power was privately financed and managed. For example, in India it was the East India Company that provided the military power. That power was subsequently (in the second half of the nineteenth century) brought under crown control, and the concept of the British Empire was a late Victorian construction. However, as history shows, the power that accrues to those who have a monopoly on spice trading is easily lost once spices became more like commodity products. The British and Dutch were, however, about to pull off a coup by finding new NPs to excite European consumers.

Beyond spices—NPs shape society, fashion, business and politics in Europe

As the European spice traders encountered novel cultures, they learned about new plants rich in NPs, and these novel NPs soon fascinated them. By encouraging consumers in Europe to share this fascination, there was money to be made. Many of the features of what is now termed ‘the global economy’ can be traced to this period. In nearly all cases, the initial rarity of the NP-rich product ensured that only a few rich people enjoyed the exclusivity of the product. Given that the rich often liked to show that they had time and money, they usually developed little rituals around their conspicuous consumption of these expensive NPs. The aspiring middle classes, a growing group with most developing European countries, were usually keen to adopt some social behaviour of the upper classes and NP consumption was one activity that was within their reach as the prices of NPs fell due to a rising supply in a competitive market. The middle class might not be able to afford the capital to buy a big house, beautiful horses, land or fine furniture but they could stretch to a cup of tea or coffee and some (p.30) chocolate cake, as served in the finest houses. The NP traders found that selling their products more cheaply to a bigger market was a natural way of developing their business. Likewise, by encouraging a passing fashion for a new taste, the market for NPs could be kept fresh by introducing new NP-based products at intervals.

The seventeenth century—the fashion of tea drinking
The drinking of herbal infusions had long been known in Europe, mainly in a medicinal context. However, in parts of China and Japan the social drinking of infusions of the leaves of tea plants had a very long tradition, stretching back thousands of years. The Europeans, who first encountered tea drinking, sampled the drink, and being businessmen they wondered if there was a market for the product back home. The only significant producer of tea at that time was China, and the first tea was brought to Lisbon by the Portuguese in the last few decades of the sixteenth century. It was nearly a century, in 1652, before tea was recorded in London and in that same year coffee and cocoa also arrived in England. By the last half of the seventeenth century, there was a major trade in tea between China and Europe and that supplemented the spice trade. This is an example of the trade in one commodity, valued for its NP content, causing the development of another market for a different NP. Not only tea but also ‘china’ was introduced to European society. This fine, strong but delicate porcelain has taken its name, China, from its country of origin but its introduction to Europe was partly coincidental. The sailing ships that went to China to carry the tea to Europe, like all sailing ships, needed to carry ballast in their lowest holds to establish the correct weight distribution for safe and efficient sailing. Tea itself is light because it is simply dried leaves and the tea had to be kept dry, hence was stored in the more airy upper holds. The ideal material for ballast is something that can itself be traded and porcelain pottery was so cheap in China that there was little to loose if there was little market for it in Europe. In Europe, the pottery being manufactured was usually a heavy earthenware; hence, the wonderful decorative fine china was seen as very attractive, especially by the rich serving the newly fashionable tea. During the period of intensive porcelain imports from China (1684–1791), 24,000 tonnes of porcelain were imported to the United Kingdom with over 200 millions individual pieces being sold. The quality of the cheaply imported fine china was such that European potteries were forced to innovate in order to compete. Eventually, in 1709 the art of making porcelain was developed in Europe with the introduction of Meissen china and later in 1742, similar processes were devised in the United Kingdom using ‘china clay’ from Cornwall.
The limited competition in tea trading, due to monopolies being granted, usually to the East India companies in each country, allowed governments to tax these imports efficiently. However, this heavy tax inevitably encouraged tea smuggling. By 1770, the 12,000 tonnes of legally traded tea entering England might have been joined by 6000 tonnes of smuggled tea. Scotland and the south east of England were the most active regions for tea smuggling with well organised and violent gangs providing an early example of the way in which crime thrives when governments attempt to control NP supply (see sections on tobacco, opium, cocaine and cannabis). It has been argued that tea smuggling had a significant impact on the profits of the East India Company; indeed, the company was in serious financial difficulties in the 1770s. The company successfully petitioned the UK government for a monopoly on tea supply to North America and the company paid more attention to the emerging North American market where smuggling was less damaging to its interests. However, the English colonists in America resented this monopoly of tea supply, and the tea tax, so they added this grievance to others (tobacco taxes were possibly even more irksome) and eventually fought for their independence from Britain. When the tea tax in the United Kingdom was reduced by a factor of 10 in 1784, tea smuggling became unprofitable and tea consumption increased greatly. The percentage of the UK population that could afford tea increased and tea drinking became part of the British culture at all social levels. The removal of the East India Company UK monopoly in 1834 further reduced the price of tea but by then the company had found another NP-rich monopoly to exploit—opium. One problem that the European traders faced when trading with the Chinese for tea (and to a lesser extent silk) was that the Chinese merchants wanted rather few goods or products that the Europeans could offer. The Chinese (like their neighbours, the Japanese) were remarkably self-sufficient. The English East India Company could offer the Chinese copper but the company still had to part with large amounts of silver to purchase the tea they needed. Where was that money to come from? The answer was another NP, the morphine contained in opium, which considered in detail later. However, the East India Company had another strategy—to break the Chinese monopoly on tea production. It first planted tea in Assam in 1835, and sold its first Indian tea in London in 1838. In the 1840s and 1850s, tea cultivation spread to Ceylon. Darjeeling
joined the tea growing areas in 1856. In the last half of the
nineteenth century, China tea lost its popularity in Europe.
China tea held over 90% of the market in 1866 but less than
10% by the end of the century. Tea had become a commodity
product and in the twentieth century several nations were
competing in the market (India, China, Sri Lanka, Indonesia
and nine nations in East Africa, led by Kenya). The breaking of
the monopoly on the supply of tea had been accompanied by a
breaking of the monopoly on the supply of caffeine in tea. The
total world production of tea is around 3 million tonnes per
annum, worth $9 billion to the producers.

Coffee—the Ottoman's favourite stimulant becomes the world's
most important NP-rich drink

The drinking of tea had provided the main stimulant (caffeine)
in the Far East for over 4000 years. Another source of caffeine,
coffee, has a much shorter, but equally interesting and
important history.

*Coffea arabica* is a native of Ethiopia. It was grown in some
regions bordering the Red Sea and was traded throughout the
Arab world. The chewing of the beans was a practice adopted
by those seeking an aid for keeping alert on long journeys or, it
is said, attending long prayer meetings. Coffee consumption
has been known in the Middle East and (p.32) further east
from about 800 BC. Later Ottoman scholars traced the history
of coffee drinking in their empire using Islamic edicts which
reveal discussions of the properties of the drink and whether
its consumption was consistent with Islamic law. The
consumption of alcoholic drinks was banned by Islamic law, so
the fact that coffee had some physiological effects concerned
some clerics. The debate was won by those who liked its mild
stimulant effect, a majority that included many influential
rulers. It was the Turks who developed ways of roasting and
processing the beans and using them to make a drink. Coffee
reached the capital city of the Ottoman Empire,
Constantinople, in 1453 and coffee shops became increasingly
important places for social discourse (Figure 2.6). Coffee was
being drunk by Sufis in Cairo by the early sixteenth century
and in Aleppo (an important spice trading port in northern
Syria). The first documented European record of coffee was in
1573 when Leonard Rauwolf provided the first botanical
description of *C. arabica* seeds. Through Rauwolf's writing and
his collected specimens, knowledge of the plant, and the drink
derived from its roasted berries entered European scientific discourse.\(^7\)

It was through links with spice traders that coffee was introduced to the United Kingdom (and some other nations). The Company of Merchants of England Trading into the Levant Sea (incorporated in 1605) was a very rich group of UK merchants who were given a monopoly of trading between England and the Ottoman Empire. Spice trading was a significant part of their business. Some of these merchants lived in large, very affluent European enclaves in Syria, along with Greek, Italian, Dutch and French traders. In 1651, one of the traders in Smyrna was Danial Edwards who came back to London bringing with him his Greek assistant Pasqua Rosee, some coffee beans and the apparatus for roasting the beans. London at that moment was under Puritan influence with alcoholic drinks being frowned upon; hence the drinking of a new stimulant appealed to Edwards and his friends. The popularity of the social coffee drinking at the Edwards house gave Edwards and his father-in-law Thomas Hodges the idea of opening a coffee shop. In 1654, they opened a stall, managed by Pasqua Rosee, on a site near the Royal Exchange, an area frequented by merchants in London. With a thriving business, Rosee was joined by Christopher Bowman and moved the business in 1658 to new premises, but Rosee encountered increased prejudice as a foreigner so he left England to start a coffee shop in the Dutch capital, The Hague. The success of this first English coffee house encouraged others to start similar coffee houses and Europe’s first coffee culture was flourishing by 1660. Not only did merchants favour these new coffee houses, but

\(\text{(p.33)}\)

\begin{figure}[h!]
\centering
\includegraphics[width=\textwidth]{image.png}
\caption{The coffee shop, as a place to enjoy social interactions and to benefit from business deals (at least for males), began in the Ottoman Empire and was adopted throughout the rest of the world. It is a rare high street in any city that does not now have at least one coffee shop.}
\end{figure}
writers, philosophers and scientists also found the company and atmosphere stimulating. Coffee houses became the places where news was exchanged, politics discussed (this was a period of intense political debate in England as the roles of the parliament and the crown were under scrutiny) and business transacted. As the number of London's coffee houses increased (in 1739, a survey counted 551 in a city of 500,000), some were favoured by particular groups and one can trace the founding of some important commercial institutions to individual coffee houses. In Garraway's, the first lists of share prices was maintained and other coffee houses kept list of commodity prices, currency exchange rates and the price of government bonds. Mr Bridges Coffee House maintained a list of goods recorded by the Custom's Office. As early as 1692, Edward Lloyd published his shipping list at his coffee house and those seeking shipping news increasingly congregated at Lloyds. This collection of coffee drinking merchants, brokers and underwriters involved in shipping organised themselves into a group, left the old coffee house, founded their own more exclusive coffee house, which became Lloyds of London. Not until 1773 did Lloyds of London leave behind the making of coffee to concentrate on the making of money.

In 1761, at Jonathan's Coffee House, a group of stock jobbers (share traders) who met there regularly to conduct their business (aided by paper, quills and ink provided by the coffee shop owner) concluded that their affairs could be conducted more pleasantly if they had sole use of the coffee house. They negotiated a 3 hour exclusive daily use, but when challenged in the courts by someone excluded from the group they decided to leave Jonathan's and start their own club in Threadneedle Street. The New Jonathan's included a large coffee room but its name was soon changed and it became the London Stock Exchange (The New York and Boston Stock Exchanges also grew out of their coffee house cultures).

In many other European cities by 1700 coffee houses began to appear, attracting the wealthy and fashionable. As in London, gentlemen, scholars and merchants deemed the new coffee houses to be the place to meet like-minded people. Meeting for coffee with the real intention of meeting to socialise, gossip, do business and to plot was now part of the European culture. As the demand for coffee grew, coffee merchants began to worry about the near monopoly of supply by the Ottoman Empire—the experience of the spice trade monopolies were still fresh in the minds of many merchants. Inevitably, thoughts turned to finding an alternative source of supply. For centuries, the Ottoman traders had very effectively ensured
that coffee plants and viable seeds were kept away from those who were buying one of their most valuable products. The Europeans had broken the Arabian spice monopoly, so the coffee monopoly was worth guarding. However, a few coffee plants had already been grown in India and in 1696 the Dutch East India Company obtained some of these plants and shipped them to their colony in Indonesia. By 1720, these new plantations were producing significant amounts of coffee for export to Europe. Coffee plants were also sent to Amsterdam, where they were grown in the Botanical garden, and these plants provided a source material for the French to take to their Caribbean colony of Martinique. By 1712, the Dutch had coffee growing in their South American colony Surinam, and coffee reached the Portuguese Brazilian colony in 1729 and later Columbia. The British established plantations in Jamaica in 1730 and later introduced the crop to East Africa. So by the eighteenth century, the ‘colonial’ traders (the same merchants who had been trading spices and tea—predominantly the Portuguese, Dutch and the British) had successfully taken coffee to other continents. The Ottoman monopoly was broken and several nations competed to supply coffee to the growing markets in Europe and North America.

Coffee shops remained an important part of European culture in the nineteenth century, but coffee consumption at work and in home increased throughout the industrial world. So embedded is the consumption of coffee in business, academia and social affairs that a day without access to coffee is unusual. Business meetings often require the supply of coffee. Scientific meetings always have coffee breaks (which many think are the most productive parts of the meeting) and many scientific institutions have ‘coffee clubs’ where research is discussed in a less formal way. In social life, ‘drop by for coffee sometime’ or ‘would you like to come up for a coffee’ had all sorts of interesting hidden meanings. Although the monopoly of coffee supply was broken in the eighteenth century, a new form of monopoly was developed in nineteenth and twentieth centuries that enabled huge amounts of money to be made from coffee again—the coffee brand. Anyone can buy coffee beans quite cheaply but only Starbucks can sell Starbucks. By clever marketing, a few companies buy coffee beans very cheaply and using the monopoly of a brand they now control the mass market for coffee. The way in which consumers award a near monopoly to a brand, despite perfectly good
alternative sources of supply, changes the rules of the NP economic model and we shall find more examples of this remarkable consumer behaviour later.

The annual world coffee production is about 8 million tonnes, worth about $16 billion to producers. Coffee is the second most valuable legally traded commodity after oil and 25 million people worldwide gain their living from coffee. Starbucks purchase about 140,000 tonnes of coffee each year and customers spend about $4 billion in their cafes; coffee is the largest imported food in the United States. A remarkable 2.25 billion cups of coffee are consumed every day—20% in the United States.

(p.35) The South and Central American chemical gems—coca, quinine, tobacco and cocoa

The Portuguese were displaced from the East Indies trade before the tea and coffee trades expanded and the Spanish never managed to gain exclusive access to any Far East products so they have featured rather little in the NP products story so far. However, these southern European nations were to find several useful NPs in their South and Central American colonies.

Cocoa—Central America’s great contribution to human happiness

The NPs found in cocoa were to bring great pleasure to many throughout the world in the form of chocolate. The key NP in chocolate is the bromine which is a pleasant stimulant related to caffeine. Although valued as a drink in Central America for centuries, the first shipment of cocoa beans only reached Spain in 1585. The drinking of chocolate was taken up by the Spanish monarchy and spread to the French court when there was a marriage between the two families of ruling monarchs. The French King Louis XIV was especially fond of chocolate. By the mid-seventeenth century, chocolate had become fashionable among the rich in Paris, helped by its reputation as an aphrodisiac. In 1657, the drinking of chocolate was introduced to London and quickly became fashionable. The fashion spread to many European capitals during the last half of the seventeenth century and cooking with chocolate became increasingly common in rich households. By the start of the eighteenth century, there were signs of a wider use, as evidenced by a tax imposed on it by Germany. By the start of the nineteenth century, chocolate was being processed on an industrial scale and during that century the market grew as
prices fell and the number of consumers grew. The development of the chocolate press in 1828 allowed the cocoa butter to be separated from the remainder of the bean so producing a better, cheaper drink and also allowing the development of what we would now call chocolates. Some of the major multinational industrial chocolate manufacturers can trace their roots to this period. In 1857, the cocoa plant was being cultivated in West Africa with Ghana being especially successful at producing the crop.

The fact that drinking chocolate was regarded as a healthy and acceptable drink, even by those who denounced other stimulants, encouraged the Quakers to become involved in its manufacture. The great Quaker chocolate industrialist in England, the Cadburys, the Fry's, the Rowntrees and the Terry's not only made their products widely available but also they used some of their NP-linked wealth to encourage serious social reform. Indeed the United Kingdom's most important and influential source of social research is still the Rowntree Trust, so society can once again thank the human obsession with NPs for a social good.
Coca

Fifteen of the over 200 species of Erythroxylon produce coca but E. coca and E novogranatense now dominate coca production. These two small bushy shrubs grow well in the Andean rain forests (Columbia, Bolivia, Peru and Ecuador). Coca thrives well in partial shade, hence can be grown among other forest trees or it can be grown in plantations. The leaves of the tree were widely used by Andean residents for two millennia before Europeans first encountered the practice. Chewing the coca leaves gives the consumer, whether human or animal, a sense of well-being, competence and energy. Tasks are easier to perform and to sustain. Needless to say, such attractive attributes came to the attention of the military and in the 1880s the Bavarian army obtained cocaine from Merck to try on soldiers. The troops showed greater endurance, were more cheerful in the face of adversity and most importantly required less food and drink. The most attractive of these effects to the military was the loss of appetite because it was estimated that a valuable 15–20% reduction in the transport of provisions could be gained. Some members of the medical profession were as impressed as the military. Cocaine was found to be a good palliative for toothache and it was an effective local anaesthetic. Sigmund Freud experimented with the drug himself for 3 years and also prescribed it for some of his patients (and supplied it to fellow doctors and even some students in the Medical Faculty of Vienna University). Freud found that the drug helped his depression, fatigue and insomnia. He argued that cocaine was not addictive but other scientists were starting to report negative effects that included addiction and severe psychological effects in some who partook of the drug. However, there were no restrictions on the use of cocaine (or indeed most drugs) in the nineteenth century and the use of cocaine, or less pure coca extracts, increased. Because cocaine has an ability to reduce mucus secretion and swellings, it was a common ingredient of medicine sold to alleviate the symptoms of catarrh and malaria. Some medicines contained mixtures of cocaine or coca extracts, phenacetin (an early synthetic medicine discovered in 1887) and another NP quinine. However, the most widespread use of the chemicals in the coca leaf in western society between 1850 and 1914 was in ‘patent medicines’ that were available from doctors, pharmacists and even the corner shops. All manner of imaginative mixtures,
differing in colour, consistency, taste and smell were sold as ‘pick-me-ups’. Coca extracts were eventually to find occasional uses in a chewing gum for those with toothache, cocktails and even ice cream and fruit cordials.

One of these cocoa-containing mixtures was to gain a particularly fine reputation and was to have a profound effect in influencing western culture. Angelo Mariani, a Corsican, devised a tonic by steeping coca leaves in red wine for 6 months. This tonic wine gained the endorsement of three popes, six heads of state (including Queen Victoria and US Presidents Grant and McKinley), Bleriot, Ibsen, Rodin and HG Wells. The recipe for this product was so successful that there were many imitators. One of these was John Pemberton, a pharmacist from Atlanta, who like many such pharmacists made up mixtures containing many attractive NPs—in his case it seems he used caffeine, coca leaf extract, cinnamon, nutmeg and vanilla in a base of sugar, phosphoric acid and alcohol. However, Atlanta banned sales of alcohol; hence, Pemberton devised a non-alcoholic syrup that could be diluted with water and could also be carbonated. Extract of kola nut was added to the new tonic cordial and Coca-Cola was introduced to the world. It was a failure. Pemberton sold less than 800 litres in 5 years, so he sold his business to (p.37)

Figure 2.7. The importance of NPs in the manufacture and marketing of soft drinks has grown since western consumers have demanded ‘natural’ ingredients. A recent advertisement for the drink ‘Red Bull Cola’ nicely illustrates this fact.
Asa Griggs Chandler, another, more astute pharmacist who saw the potential in Coca-Cola as a soft drink rather than a tonic. In the next 15 years, he made a fortune from the Coca-Cola company and founded what was to become the world’s best known multinational. The formula of Coca-Cola has changed over the years and the coca extract was removed in the early twentieth century and many decades later caffeine-free versions became available. Competitors produced their own versions of what became known as cola drinks, nearly always containing caffeine and a variety of natural and synthetic flavouring (Figure 2.7).

**Coca and cocaine**

It seems that the chewing of coca leaves and the ingestion or injection of the pure alkaloid cocaine produced rather different symptoms. This is not surprising because even if the main physiologically active ingredient is cocaine in both cases, the dose and purity of the ingested chemicals will differ. A chewed leaf is likely to release its chemicals much more slowly into the bloodstream than ingestion or injection of the pure chemical—the dose profile with time will be very different. It is also quite possible that coca leaves release other physiologically active substances that may themselves have physiological effects or may modify the effects of the cocaine. It seems that the Andean cultures, over the two millennia use of coca, had found a way of exploiting the beneficial aspects of coca ingestion without encountering the undoubted negative effects. In contrast, western cultures found little attraction in the use of cocoa leaves when it could ‘benefit’ from the technology it possessed to obtain the purified active ingredient. The fact that the growing pharmaceutical industry initially saw only the benefits to be gained by prescribing their purified alkaloids (and preferably patented) was to set a pattern which has repeated itself.

(p.38) **The illegal cocaine market**

Unfortunately, addiction is such a complicated psychophysiological process that it is difficult to judge whether modern, western society could benefit from some of the reported positive effects of the coca leaf without encouraging the addiction of many of its citizens. Although cocaine in pure form is more addictive than many other drugs we ingest, western societies have largely learned to live with the milder addictive substances such as alcohol, tobacco and caffeine. However, in all cases, some individuals suffer the negative effects of their addiction while many get the benefit. Because coca is easy to cultivate in several South or Central American...
countries (and was successfully grown by the Japanese in Taiwan and by the British in India) and because it has been part of the Andean culture for many generations, it is still widely grown despite the attempts of national and international agencies to abolish its cultivation. If history tells us anything, it is that humans crave the effects of certain NPs so much that they will expend great effort and money to obtain them. Hence there will always be a market for plant material containing stimulants. Consequently, as predicted by free market economics, growers will be found to produce the plant, processors will make a living by practising their skills and a sales and distribution chain will develop to connect the component parts of the business. A poor farmer in South America can expect to harvest two tonnes of coca leaves per hectare (with three leaf harvests per year being possible over the 20+ years of the perennial plant). The leaves contain about 1% of impure, mixed alkaloids and simple processing will give 15 kg of pure cocaine. This material fed to the illegal street market in North America could sell for over a $1 million; hence, the monetary yield per hectare is vastly in excess of any other plant material that could be grown by the farmer. Consequently, it is hard to offer sufficient financial incentives to make coca cultivation unprofitable. It has been estimated that the real production costs of pure cocaine could be less than $1000 per kg yet street price in London in 2007 was approximately 100 times more.

Although cocaine became an illegal substance in the United States in 1914, its use continued, especially in ‘creative’ industries such as the cinema and theatre (some opera singers also found it beneficial) before the Second World War and again in the latter part of the twentieth century in the music, media and financial industries. Such is the potency of pure cocaine that less than 500 tonnes would supply the current US market of an estimated 10 million users. The funds flowing from the United States to the economies of the four main countries that supply the drug (Bolivia, Ecuador, Chile and Columbia) may account for up to 33% of the GNP of these countries. These vast sums suggest that even larger sums would be needed to eliminate the supply from these sources and the fact that the coca plant will grow on other continents would suggest that the cultivation of coca will be very hard to control.
Quinine—vital drug and a pleasant drinks mixer

Quinine is an alkaloid that can be extracted from the bark of the *Cinchona officinalis* (which also contains the related compounds such as cinchonine, quinidine and (p.39) cinchonidine). The tree, and 70 related species that contain lower concentrations of these substances, is found in the Andean mountains in regions of Peru, Bolivia and Ecuador. These trees grow naturally at elevations between 700 and 300 m on the slopes of valleys about 10–15 degrees either side of the equator. The bark of the tree was used by the indigenous people to treat fevers and the early Europeans learned of its value. In 1638, the wife of the Viceroy (the Countess of Cinchona) was dangerously ill with malaria in present day Lima, Peru. The court physician suggested that the local remedy quinquina be used. The patient recovered and the Europeans named the genus of the tree named after her. On her return to Spain some years later the Countess took with her more of this useful bark and used it to treat fevers of those who worked on the estates of her husband. The value of the bark was soon known to many in South America and Europe and a trade of the bark soon developed. The Jesuits used their organisation to collect large amounts of the bark from Peru, Bolivia and Ecuador and used the money so gained to fund their missionary work. By the end of the seventeenth century, extracts of the Cinchona, made by steeping the bark in white wine, were used by some of the richer members of the society to treat fevers (especially malaria). The need for an effective treatment for malarial fevers stimulated the use of this treatment throughout the eighteenth century and very large numbers of Cinchona trees were destroyed for their barks. The German naturalist, Humboldt, in 1795 estimated that 25,000 trees were being felled annually in the Loxa region alone and was concerned about the sustainability of the trade. The Jesuits were also conscious of the need to harvest the tree sensibly and they tried to ensure that one tree was planted for each one felled. By the time the former Spanish colonies became independent (1810–1830), demand was outstripping supply and the problem of continuity of supply was made worse by the political instability that characterised that period in South America. However, the destructive harvesting in the Andes continued for some decades until other sources undercut the South American producers.
The value of the quinine containing bark was now very evident in the growing British colonies in India and elsewhere. Not only were British troops and administrators often weakened by fevers but the local labourers were less productive if suffering from malaria. The economic incentive to find alternative sources of supply eventually encouraged the British and the Dutch (with colonies in the East Indies) to take Cinchona trees to their new colonies where they sought conditions similar to those found in the Andean valleys. These attempts were successful and by the middle of the nineteenth century, plantations of Cinchona trees in the Nilgiri Hills in southern India were well established. By experimenting with harvesting regimes (coppicing and selective bark peeling rather than the destructive harvesting of the tree) and cultural conditions, great improvements in both the yield and the quality of the product were made. The harvesting methods also increased the percentage of alkaloid from about 4% to nearly 7%. By 1880, these new plantations were mature and dominating the market, so the production in South America declined rapidly. The British and the Dutch production served different markets. The former used nearly all their production for their own colonies, while the Dutch took over the rest of the world market and operated a cartel for many years. The Dutch plantations in Java supplied 80% of the world market until the Second World War, when they lost their colonies to the Japanese, and western allies lost ready access to the drug that allowed its soldiers and administrators to operate in areas of high rates of malarial infection. Fortunately, the importance of quinine had been a very significant factor in the rapid development of the science of chemistry in the nineteenth century and just in time synthetic quinine substitutes were ready to fill the sudden and very important new demands.

The size of the market for quinine, the growth of that market and the insecurity of supply in the middle decades of the nineteenth century corresponded with the great advances in synthetic and analytical chemistry at that time. By 1834, the German chemist Runge had attempted to synthesise quinine from coal tar but made quinoline instead. However, encouragingly in 1842, the important alkaloids found in Cinchona bark had been shown to degrade when treated with the strong alkali caustic soda to give the compound that Runge had made, quinoline. The next advance was made by an 18-year-old English student, William Perkins, who was trying
to make quinine from coal tar when working during the holidays in a home made laboratory. Like Runge, he failed and like Runge his product was to be more important industrially as a dye than a drug. The messy tar-like product in Perkin's reaction flask, when washed out with water, formed a deep purple coloured solution. Perkins immediately realised that the highly pigmented material might be useful as a dye and he tested this by dipping some fabrics in the pigmented solution. The dye was found to permanently dye wool and the purple colour, mauve, quickly became the fashionable colour of society. Perkins established dye works, made his fortune within 20 years then sold his company to a German competitor and retired to the life of an amateur chemist and patron of other scientists.\textsuperscript{10, 11}

Quinine—a popular tipple
Low concentrations of quinine in water (about 80 mg/L) have a sharp, bitter taste that some people find attractive. The first known such drink was lemonade, sold in New Orleans in 1843. The best known commercial product, Schweppes Indian Tonic Water, a carbonated, sweetened quinine solution is often used to dilute the juniper flavoured (due to NPs) gin to produce the very popular drink Gin and Tonic.

There are some\textsuperscript{8} who have argued that without the use of Cinchona extracts, and later synthetic quinine analogues, world history over the past two centuries would have taken a very different course. It is argued that the use of quinine to treat malaria (and to a lesser extent yellow fever) facilitated colonialisation by western European countries of territories that would have been too hostile for foreigners with little natural resistance to parasitic-induced fevers. For example, the Panama Canal might not have been built without access to quinine. The outcome of the American Civil War has even been speculated upon because the successful blockade of the Confederate ports caused severe shortages of quinine so the Confederate Armies were debilitated by fevers.

\textit{(p.41) Tobacco—the first industrial exploitation of a harmful NP}

\textit{A lone man's companion, a bachelor's friend, a hungry man's food, a sad man's cordial, a wakeful man's sleep, and a chilly man's fire.}
There are 66 species of the genus that includes the tobacco plants (*Nicotiana tabacum*). These species are found worldwide and some of these have provided hundreds of millions of people with their daily dose of nicotine for a very long time.\textsuperscript{12–14} There is evidence that the stimulant effects of the alkaloids found in several members of this genus were discovered independently by humans in different parts of the world. Although most of the early European explorers to the New World noted the curious local habit of smoking, *N. tabacum* only became of interest in Europe in 1559 when the French ambassador to the Portuguese court, Jean Nicot, sent seeds to the French Queen to be grown as a pretty garden plant. The source of the seeds was the Portuguese colony of Brazil but it seems that the species originated in the Andes and had been taken to the length and breadth of the New World thousands of years ago. In all parts of the New World, tobacco was regarded as a source of medicines but also had specific cultural and ceremonial uses. However, *N. tabacum* did not have a monopoly of human interest. When at the start of the seventeenth century, Europeans first encountered the Amerindians in the English colony of Virginia and they found a culture of smoking *Nicotiana rusticum*. Likewise, over 100 years later, the first English settlers in Australia found some Aborigines using *Nicotiana bethamania*. When the early European explorers penetrated the interior of Africa in the nineteenth century, they found smoking of tobacco to be an important part of social interaction. However, it was *N. tabacum* that was to be distributed throughout the world and processed on an industrial scale. The species was subjected first to selection, then intensive breeding and more recently genetic manipulation. Slowly, *N. tabacum* became the basis of a very major world industry. In some ways, *N. tabacum* was an unlikely plant to be used to gain great wealth because

- it is a remarkably adaptable species—it can be successfully grown on all populated continents, hence it is hard to create a monopoly of supply;

- the processing of the plant is relatively simple—a gardener can produce enough, acceptable tobacco for their
own use with little more skill than they need to grow vegetables; and

- it is easy to store, distribute and transport.

So why was it possible for certain countries, some companies and a few people to accumulate great wealth from producing and distributing a NP-rich product that was in theory easily accessible to most consumers? At first it was state power that was used to create and maintain a monopoly of supply with the aim of raising taxes. Several major states are still involved in the nicotine trade, even though they recognise that tobacco consumption can be harmful. It seems that states, as well as individuals, can become addicted to tobacco. However, after state monopolies began to fail, tobacco manufacturers developed a new convenient tobacco variant (the cigarette) that could not be duplicated by amateur growers. A few manufacturers soon recognised that by careful marketing they could make tobacco consumption more widely acceptable in society by advertising the virtues of cigarettes. One part of the tobacco story illustrates, yet again, the role of NPs in human ceremonies and ritual. The ceremonial use might be at the state level (Amerindian), the tribe level (North American Indians), the home level (the after dinner cigar taken while the women withdraw) or the person level (the individual sitting down to take a cigarette, smoke a pipe or flourishing their snuff box with their own little quirks).

**1550–1850—tobacco used in small amounts as a mild stimulant**

Throughout this period, the way in which tobacco was used in Europe and North America was confined largely to 50% of the population—men. The way in which tobacco was taken depended on class and nationality.
• Smoking was largely confined to pipe smokers or cigars. In some social situations, a pipe of tobacco was shared by being passed around. Pipes were usually made of clay in this period in Europe but very elaborate wood pipes were used in Amerindian cultures and in Africa, where the communal smoking had a profound social significance; consequently, pipes were works of art. Pipe smoking in Europe was limited by the fact that the cheap clay pipes were weak, easily broken and were hard to light until friction matches were invented in 1827 and slowly improved in later decades. It was also hard to carry out manual work while smoking a fragile clay pipe, so smoking at work was uncommon. Cigar smoking became more common in the middle of the nineteenth century, with Cuban cigars becoming the smoke of choice by the affluent in the United States and Europe. Although there were a few exceptions, it was usually, socially unacceptable for women to smoke pipes or cigars.

• Chewing tobacco was very common in the United States, until the mid-twentieth century and was common elsewhere among manual labourers (e.g., miners could not use naked flames to smoke during their long shifts and seamen found it hard to smoke while at sea). The preparation of the chewing tobacco could sometimes involve the addition of other NPs, such as liquorice to add to the flavour. In the nineteenth century, most tobacco consumed in the United States was chewed. However, the stained teeth, strong mouth odour and need to expectorate at frequent intervals made tobacco chewing increasingly socially unacceptable. By maintaining a ‘chaw’ of tobacco in the mouth for up to an hour, salivation was stimulated such that up to 250 ml of extra saliva was generated and had to be expelled into spittoons or on the ground. As a visitor to the United States, Charles Dickens was appalled by ‘the filthy custom’ and was horrified that the ‘odious practice’ was even accepted by judges, medical students and US senators at their places of work.

• the taking of snuff, the sniffing of powdered tobacco (sometimes scented with other NPs) via the nose, was the most socially acceptable form of tobacco used in Europe (p. 43) until the development of the cigarette. The flourishing of an ornate snuff box was a sign of wealth and offering the precious contents to a guest was a token of generosity and
friendship. A few rich women felt comfortable using a little mild snuff but heavy use caused soiled handkerchiefs which would have been considered unladylike.

*Nicotiana tabacum* was grown in many parts of the world on a small scale by the seventeenth century but one part of the world was soon to dominate commercial tobacco production—Virginia (and then Maryland and North Carolina). The first settlers in Virginia found the Amerindians growing their tobacco and the settlers realised that they could adapt and develop those proven methods to produce *N. tabacum*. Although the English king James I hated tobacco use (he published his ‘Counterblast’ to make his opposition clear), he also realised that it would be hard to abolish its use (at that time, about 25% of the UK men smoked tobacco more than three times a week). Instead, James decided to tax tobacco and to give the new Virginian colony a monopoly in supply. This was a clever scheme at that time (although, maybe, not a good long-term move for reasons we shall soon learn) as it gave the new colony a source of income to pay for the import of the manufactured English goods and it was easier to collect the tax on tobacco when it was imported at English ports than it was to collect the tax on any UK tobacco production. Once again a tax on an NP was seen as an excellent way of raising revenue—by 1660 tobacco tax accounted for 25% of all UK tax revenue. The tobacco growers of Virginia expanded production and trade between the English colonies and the home land flourished. However, tobacco is an extremely greedy plant to grow and a good crop could only be produced for one or two years before the soil was exhausted (the removal of most of the plant biomass from the field at harvest inevitably depletes the field of minerals). Although fields could be left fallow to rebuild some fertility, enough ‘new’ land was available within the state (and later within neighbouring states) to enable tobacco production to be continued and even expanded. This availability of low cost and fresh land gave the North American producers a very real advantage in competition to European production. At that time, the shipping of commodity products from North America to Europe would not have been economic, so a high value NP-containing product was extremely valuable to the new colonies. The tobacco trade expanded throughout the seventeenth century and into the eighteenth century, enriching many tobacco growers who enlarged their estates, built grand houses and developed into a class of well-educated, rich men of influence. This group began to resent the fact that their English rulers demanded not only that tobacco was shipped in English ships but also that tobacco had to be landed, and taxed, in England before re-export to mainland Europe. Inevitably the smuggling of tobacco became increasingly appealing, even to some in the United Kingdom. After the union of Scotland and England, there were no trade barriers between the two former countries, but the new UK government
found it hard to enforce collection of taxes in Scotland. Scottish merchants exploited this weakness ruthlessly and flourished. Between 1707 and 1722, the Scots paid only half the duties owed. By 1750, 10 million kg were being landed annually in Glasgow. Scottish merchants became very active in Virginia, buying stock and warehousing the tobacco for export to their home port. By 1760, nearly 50% of tobacco from the Chesapeake area was smuggled and imports to Glasgow exceeded the total of all other UK ports combined.

1860–1960—the rise of the cigarette brands dramatically increases the use of tobacco worldwide

Not all European governments encouraged tobacco consumption to raise taxes; for example, smoking was banned in Berlin streets until 1831. However, those governments enjoying the tobacco taxes would have been thrilled to know that tobacco consumption was about to grow massively with the development of the cigarette making machine.

Cigarettes, as their name suggests, were developed from cigars which came in various sizes. In Seville, small papelotes were devised where paper was used instead of a tobacco leaf to form the outer casing of the little cigar and it was realised that leaf fragments could be placed inside these wrappers rather than rolled leaves as used in cigars. They soon became popular with consumers because it was easier to disguise smuggled tobacco inside these papelotes and predictably in 1801 the state tried, unsuccessfully, to ban them. The manufacture of papelotes, or cigarettes as they are now known, spread slowly throughout Europe but they remained expensive because each had to be handmade. In France, the state tobacco monopoly began making cigarettes in 1845, and the first British cigarette factory was set up in 1856 by Robert Peacock but was followed soon by the now famous name of Philip Morris. But in Britain and the United States, cigar ettes were seen as effeminate so were insignificant in the trade at that time but this attitude was changing. Between 1875 and 1880, annual cigarette consumption in the United States suddenly grew from 42 million to 500 million. No one reason can be given for the change in attitude, but the introduction of the cardboard cigarette packet, brand advertising and the safety match made cigarettes the most convenient and socially acceptable way of accessing nicotine. The brilliant idea of inserting colourful, interesting cigarette cards into cigarette packets appealed to consumers, especially children. So great was the demand for these nicely packaged, well-advertised
goods that the manual production became a problem—a skilled woman could make 5 cigarettes per minute and her labour accounted for 90% of the cost of production. In 1880, 21-year-old James Bonsack designed a machine to make over 200 cigarettes per minute, a machine that could work continuously and could produce a superior uniform product. In the United States, the first tobacco manufacturer to realise the potential of the Bonsack machine was Buck Duke, who came to a very favourable agreement with Bonsack and gained an advantage over his competitors that Duke was to exploit ruthlessly. Within 5 years, Duke was selling 2 million cigarettes per day (more than the French sold in a year). Duke spent lavishly on advertising, took over competitors or drove them out of business by undercutting them. By the start of the twentieth century, Duke had gained such a monopoly in the United States that the government forced him to split his American Tobacco Company into three separate companies. Duke left the industry and gave much of his wealth to found Duke University.

(p.45) In Britain, the Bristol Company of Wills introduced some Bonsack machines in 1883 and was selling 11 million cigarettes per year by 1888. By 1891, they were selling over 85 million cigarettes per year and the business boomed. Wills led the consolidation of the industry in the United Kingdom by negotiating the formation of Imperial Tobacco, which was formed from the 13 leading UK companies including Wills. Duke's attempt to enter the UK market in 1901 was thwarted but only when Imperial Tobacco and Duke's American Tobacco agreed to carve up the world markets between them by forming a joint company British American Tobacco (BAT). The tobacco industry in the United Kingdom had a strong negotiating position because of their dominant presence in the British colonies. For example, there were more consumers in India than in the United States, and India was second only to the United States as a tobacco producer at the end of the nineteenth century. The UK and US tobacco industries were to dominate the worldwide tobacco business throughout the twentieth century.

As cigarette consumption grew in the first few years of the twentieth century, several individuals and groups spoke out strongly about the dangers of smoking but they made little progress until decades later. The First World War saw soldiers being given tobacco as a way of maintaining morale, because a
cigarette gave a soldier a few moments of calm before battle or when wounded. A captor might give a captive a cigarette as an act of kindness. By the 1920s, cigarette smoking began to spread to women, helped by film makers showing worldly, beautiful, successful women using cigarettes. By 1940, the per capita cigarette consumption in the United States was 2500 and in war torn Europe packets of cigarettes became an informal currency. But the critics of tobacco use were finally getting a hearing because medical evidence was accumulating that tobacco consumption was harmful. By the time the US Surgeon General declared tobacco use harmful in 1964, over half the US males were smokers but only some gave up their tobaccos. By 1973, the average American (15+) annually smoked over 3800 cigarettes, compared to 3200 in Japan, 3200 in the United Kingdom and Italy and 2700 in West Germany. As smoking was banned in public spaces in the developed world, as health warnings on cigarette packets became more graphic, the big tobacco companies simply turned their attention to the less developed world. The companies see plenty of potential in the 80% of the planet’s population who do not smoke currently, especially as in the less developed countries there are thousands of millions of young people who are especially susceptible to advertising. The big tobacco companies boast that they help governments collect tax efficiently (the company BAT claims that in 2006, it collected $32 billion in tax for governments), yet there is evidence that they also collude with smuggling where it suits them—about 10% of world cigarette trade is smuggled but in some countries it reaches 50%.

The total annual world production of tobacco is about 6 million tonnes and the Food and Agriculture Organisation (FAO) predicts an increase in annual production and in the number of smokers. The high taxation on tobacco means that it is widely smuggled as evidenced by official figures. In 2003, the number of cigarettes officially recorded as being exported (851 billion) exceeds the number officially recorded as being imported (p.46) (664 billion)! The total world cigarette sales in 2003 were $340 billion and the lost tax revenue was estimated to be $40 billion.

Opium—the good, the bad and the ugly in one plant
It banishes melancholy, begets confidence, converts fear into boldness, makes the silent eloquent, and dastards brave.

—John Brown (influential Edinburgh physician, published *Elements of Medicine*, 1795)

Opium is the term given to the alkaloid-rich material derived from the opium poppy, *Papaver somniferum* which grew in parts of south-east Europe and western Asia. The opium poppy is quite tolerant of the growing conditions and the plant is now cultivated worldwide. The major narcotic is morphine, a chemical that has wonderful beneficial properties for some humans and terrible long-term effects on others. Strangely, the very long history of morphine use suggests that some societies can gain the benefits of morphine use without the negative effects of the drug yet other societies seem to find morphine abuse a serious problem.

**Thousands of years of use begins**

There are several European Neolithic sites where seeds of the opium poppy have been found, with one site in Spain having been dated to 4200 BC. There is evidence that by 3400 BC the Sumerians in Mesopotamia (Iraq) were cultivating the plant, which they called ‘Hul Gil’ (joy plant). The Assyrians, Babylonians and Egyptians continued to exploit the plant and a trade was developed in opium to ports in the Mediterranean. Opium was used in religious ritual, medicine and what currently would be called recreational use.

The Greek writers make numerous references to opium with some evidence that they used species other than *P. somniferum*. Hippocrates, considered by some to be the father of medicine, rejected the supernatural attributes of opium but acknowledges opium's usefulness as a narcotic, especially in the treatment of certain diseases. It has been claimed that Alexander the Great took opium to Persia and India in 330 BC. The Romans continued the use of opium in medical applications and there is little evidence that addiction was a problem in these ancient cultures. After the rise of Islam, the use of opium in medicine was further developed and documented. At some stage, the Arab spice traders took opium to the Far East and some credited them with introducing it to
China. By the middle ages, the drinking of opium mixtures for recreational use is recorded in Persia and India.
The opium trade—hundreds of years of abuse

Given that the opium poppy can be grown in many countries and opium resin for smoking can be produced with very little technical knowledge or expensive processing, one would expect opium to be priced very much as a commodity product, with limited (p.47) opportunities for the generation of wealth for those who make or trade in the substance. This was indeed the case up until the seventeenth century and it might have remained so, except that a new group of consumers were found and government prohibition in some countries forced the price of opium up. Those countries which had few controls of opium use saw little increase in price to consumers until each country, one by one, made opium use illegal in the late nineteenth century or early twentieth century. This is yet another example of the way in which governments play a large part in creating the conditions for wealth generation associated with the NP use.

Although opium had been introduced to China as a medicine by Arab traders in the eleventh century, its use was very restricted when the first European traders (the Portuguese) began to supply it in 1557. From 1637 onwards, opium became the main commodity of British trade with China and it was in 1700s that the Dutch introduced to the Chinese the famous practice of smoking opium in a tobacco pipe. It seems that such opium use began in the Dutch colonies and then spread to mainland China via Taiwan. The Chinese authorities, realising the harm being done to many of their citizens on the East Coast, tried to control this trade. In 1729, the Chinese Emperor, Yung Cheng, issued a decree prohibiting opium, except for medicinal purposes, but the extraordinary euphoric effects of the narcotic were well known and imports continued. Indeed, by 1753, the authorities were taxing this illegal import. By the end of seventeenth century, Chinese Emperor Kia King banned opium completely, including the cultivation of the plant. However, this abolition of opium production in China opened up an opportunity for others to step in and supply the drug. Large profits were to be made by trading opium with the Chinese and traders from Europe, North America (who bought their opium from the Ottoman Empire) and Japan, all took advantage of this growing business. The British exported 60 tonnes to China in 1776, 300 tonnes in 1790 and 1500 tonnes in 1830. The East India Company, knowing the harmful effects of sustained opium use,
banned its ships from carrying opium but they continued selling the opium they were making on an industrial scale in Calcutta, India to others and allowing them to trade with the Chinese. The British government had begun taking a direct interest in the affairs of the East India Company because of the economic importance of the company to the British economy. Indeed, the British Prime Minister, William Pitt, knew of this terrible trade but was so worried about the loss of silver bullion to pay for tea imports from China should the opium trade between India and China decline that he lobbied for it to continue. Despite the banning of the use of opium by the Chinese government, many Chinese gangs and individuals were making money from opium dealing and the illegal trade increased. In 1838, the Chinese Emperor, Tao-kwang, appointed Commissioner Lin Tze-su to stop the opium trade. Lin took the drastic action of setting fire to warehouses and the British hulks in port which contained the opium. He also arrested some British citizens. Outraged, the British shelled Canton in a punitive response. By 1840, China and the United Kingdom were at war but the superior military technology available to the Britain made the struggle an unequal one. The Chinese signed a humiliating peace treaty in 1842, paying the British a large sum of money and giving the British the control of Hong Kong and also access to other new open ports (Shanghai being the most notable, where a sizeable European population was to be found 100 year later before they fled the Japanese). A second opium war (1856–60), in which the French and the United Kingdom defeated China again, allowed even greater access for European countries to many parts of China. Further conflict at intervals throughout the nineteenth century gave the Chinese an understandable, negative view of the advantages of trading with the Europeans and Americans. Opium imports to China represented about 16% of the total imports to that country in the nineteenth century. Even at the start of the twentieth century, addiction in China remained a major problem. In 1906, of the 41,000 tonnes of opium produced, 39,000 tonnes were consumed in China.

It is hard to overemphasise the impact of the consumption of opium on China in the nineteenth century. Before this trade began, China was a proud, self-sufficient, technologically and scientifically advanced nation (some have claimed China was often 4–7 centuries in advance of the European nations in these respects). By the end of the nineteenth century China
was weakened to the extent that it was hard to govern, impoverished and technologically surpassed by its neighbour Japan, North America and the European nations. The roots of its troubled history in the twentieth century could be said to lie in the soil of Bengal where the East India Company grew its opium.

The Opium War, also called the Anglo-Chinese War, was the most humiliating defeat China ever suffered. In European history, it is perhaps the most sordid, base, and vicious event in European history, possibly, just possibly, overshadowed by the excesses of the Third Reich in the twentieth century. (Richard Hooker, 1999)
The medical use of opium and morphine

Opium was used medically in all cultures where it was known. In the fifteenth century, the great physician Paracelsus was so impressed by the medical potential of opium that he devised a special mixture, Laudanum (after the Latin word for praise), which included opium. There were many others making mixtures containing opium, one of the best known came from the English physician Thomas Sydenham, who in the 1660s devised a cordial rich in many NPs but with morphine as its major active ingredient (0.5 litre of sherry or other fortified wine, to which were added saffron, cloves, cinnamon and 50 g opium). The use of Laudanum as a sedative helped the depressed, the restless of all ages (it was given commonly to children in the nineteenth century) and it dampened pain. However, there was also a growing recreational use among all classes. In the newly industrialised towns in England, many workers saw opium as a cheaper, more effective way of escaping reality than alcohol. Among the literati, opium was also a popular form of escapism and considered to aid creativity. Many of the great nineteenth century English writers were opium users, including Lord Byron, Samuel Taylor Coleridge, Percy Bysshe Shelley, Elizabeth Barrett Browning, Charles Dickens, Lewis Carroll, Edgar Allan Poe and John Keats.

(p.49) The medical use of opium was changed dramatically after the introduction of some of the purified ingredients extracted from the poppies. In 1803, the German pharmacist FW Sertturner isolated the principal alkaloid in opium, which he named morphium after Morpheus, the Greek god of dreams. A little later, two more alkaloids were isolated from opium, codeine (1832) and papaverine (1848). By the 1850s, the medicinal use of pure alkaloids, rather than crude opium preparations, was common in Europe. Some extolled the safety, reliability and a long-lasting effect of morphine and considered it as ‘God’s own medicine’. However, it was possibly modern warfare, with mass produced, rapid firing and accurate weapons, that really stimulated the use of morphine. For example, in the United States the drug was widely used during and after the Civil War because it so successfully controlled the pain of wounded soldiers. But this early mass use made the addictive nature of morphine use even clearer and in the United States, morphine addiction became known as ‘the army disease’ or ‘soldier’s disease’. The Crimean War
in Europe also stimulated use, as did the First World War and all subsequent wars. However, the evident morphine addiction in a group of men which society held as worthy (i.e., soldiers) prompted a scientific search for a potent, but non-addictive, painkiller. The Bayer Pharmaceutical Company of Germany was the first to produce, by the acetylation of morphine, a new drug under the brand name *Heroin* (Figure 2.8). Sadly, although initially thought to be non-addictive, subsequent studies showed heroin to have narcotic and addictive properties far exceeding those of morphine.

Currently, the world spends billions of dollars per year trying to stop the illegal production and use of opium, yet all societies greatly value morphine as one of the most effective painkillers available for those needing pain relief. Annual world production of opium is currently estimated at 5000 tonnes (about 10% of the production 100

*Figure 2.8.* In the nineteenth century, morphine was widely used by the medical profession but also sold directly to consumers in various remedies. Even the purified Heroin was available for purchase from pharmacists.
The Importance of NPs in Human Affairs

(p.50) years ago) with only 200 tonnes per annum used for legal medical purposes. Like all attempts to control the use of any NP, prohibition has simply enriched many criminals and made criminals of some people, who have chosen to enrich their lives by limited opium use. The reasons why it is so hard to control the use of any NP is perfectly illustrated by opium. In 2002, an Afghan farmer growing opium would receive $300 per kg, hence make about 10 times more profit per hectare than growing wheat. Local dealers in Afghanistan would expect to receive $800 per kg yet the street price in Europe is equivalent to $16,000 per kg. After the Taliban government fell, Afghanistan's share of the world market increased many fold. Opium poppy production now occupies nearly 10% of the country's total cropland, supplying over 90% of the world's need and yielding over 60% of Afghanistan's GNP. Even if opium production is abolished in Afghanistan, production will simply increase elsewhere to meet the demands of the market—the area of land needed to supply the world is trivial (<100,000 ha). As has been noted many, many times, unless the demand from the consumers decreases, opium production will be sustained. One interesting question is why opium abuse was so uncommon until recently and why only some people succumb to excess opium use?

Cannabis—a valuable plant or terrible narcotic?

Cannabis is an annual herb that is native to central Asia. The species is known for its use to make the fibre hemp and its use as a psychoactive material. Cannabis sativa can be selected to contain minimal amounts of the main psychoactive chemical THC (Δ9- tetrahydrocannabinol), to make hemp, or large amount of THC to consume in various forms as 'hash' (hashish). There is evidence of the use of cannabis (the dried leaves and flowers or resins obtained from them) in medicine, ritual, religion and recreation for at least 3000 years. Its use was tolerated in many regions of the world until the twentieth century when narcotic control laws spread throughout the developed world. Despite these laws the UN reports that 4% of the human population have used cannabis in the past 12 months and campaigns to legalise its use began in the 1960s and it continues. Many sufferers of serious medical conditions report that limited cannabis consumption alleviates their symptoms and research is being undertaken to verify the beneficial effects of limited THC intake for certain patients. There is credible evidence that cannabis consumption is less harmful, and causes less dependence, than the legal substances alcohol and tobacco (Figure 2.9) and this evidence gives politicians a great dilemma. Because the cannabis plant tolerates a wide range of growing conditions (including an ability to thrive indoors when grown
hydroponically under artificial lights), its ‘domestic’ production is global but some countries illegally export significant amounts. The annual global sale of cannabis has been estimated by the UN at $140 billion (with the market in the United States worth $35 billion). In several countries, cannabis consumption was higher in 1980 than in 2000 but recent UN surveys suggest a steady rise in cannabis consumption worldwide. (p.51)

Plant and microbial pigments—pretty flowers and colourful mushrooms

Why consider plant pigments as NPs?

Plant pigments are included at this point despite the fact that some are not universally accepted as being NPs. However, as is explained in Chapter 9, the categorisation of substances into neat groups cannot be justified in any meaningful way. In Chapter 9, it is argued that the evolutionary constraints that gave rise to substances which humans have

![Figure 2.9. An estimate of the detrimental effects of some NP-rich drugs and some synthetic drugs suggests that cannabis (with its important NP THC) is less harmful than some widely used legal substances. (See Nutt D, King LA, Saulsbury W, Blakemore C. (2007). Development of a rational scale to assess the harm of drugs of potential misuse. The Lancet, 369, 1047–53.)](image-url)
grouped artificially into NPs have also shaped the evolution of plant pigments.

There are hundreds, possibly thousands, of chemicals made by organisms which have molecular structures that result in them absorbing light—hence they are ‘coloured’ to our eyes. The precise molecular structure of any molecule determines which \( \text{wavelengths of the visible}^{18} \text{ light are absorbed.} \) Microbes, and subsequently plants, evolved pigments to absorb harmful wavelengths of light, to capture light energy, to act as visual signals to animals after animal behaviour evolved and to use for light sensing. However, it is clear that for some uses, once a particularly effective light absorbing chemical had evolved, the use of that form of pigment was conserved. For example, chlorophyll diversity is quite limited after billions of years. So one has to question why plants as a group make several hundreds of different red/orange/yellow pigments (members of the \textit{carotenoid} family, produced by the \textit{isoprenoid} pathway introduced in Chapter 3, a pathway which makes some important NPs). It seems hard to believe that every carotenoid serves a specific role, so not only do some carotenoids seem to be, like some NPs, optional extras, they are also made by a pathway used to make NPs. Consequently, until we reach Chapter 9 where this relationship is explored further and an explanation given, carotenoids will be treated as NPs.

Similar arguments to those outlined for the carotenoids apply to the phenylpropanoid pigments (see Chapter 3 to remind yourself which NPs are made by this pathway) which account for most of the blue, pink, purple and some yellow and red plant pigments.
The importance of plant pigments to humans

One of the evolutionary selection pressures for the evolution of plant pigments was the evolution of vision in animals. Plants that were coevolving with animals could gain fitness by becoming more obvious to those animals. For example, a plant benefiting from insect or bird pollination gains fitness by having its flowers very visible to those beneficial visitors by being ‘colourful’. Likewise, the typical red/orange/yellow pigments in many fruits not only make the fruit more visible (hence attractive) to animals which will disperse the seeds in the fruits but can also signal the ‘ripeness’ of the fruit (i.e., if the seeds are mature enough) so that the animals learn to take the fruit when it benefits the plant most. Colourful signals can also be used by animals to identify plants, or plant parts, that they best avoid. Interestingly, many colours that we find attractive in animals are actually derived by those animals from their food originally made by plants. For example, goldfish and flamingos need carotenoids in their diets to remain colourful, and egg yolks and butter are coloured by plant pigments.

Given the co-evolution of plants and animals, it is not surprising that humans inherited from their ancestors an acute ability to sense plant pigments—there were rather few non-plant pigments in the human environment until recent centuries.

As in the case of all NP-rich plant products, plant pigments have long been adopted in rituals. The use of flowers in ceremonies is common to many societies—weddings, funerals and many official functions would be dull affairs without some colourful flowers. Likewise, what better way to please someone than to give a bunch or posy of flowers. Once the flowers were locally grown and seasonal but now the well-developed international trade in cut flowers spans the globe. An email or phone call can result in flowers being delivered to a recipient at the other side of the world within hours. The cut flower market has blossomed in recent decades. In the United Kingdom, the fresh cut flower and indoor (p.53) plant market is worth over £1.5 billion at retail level (to put this in perspective, the UK music industry is worth around £2 billion). Some other European citizens spend 2–4 times the amount the UK citizen spends each year on flowers. However, flowers are
not only bought as gifts but also as a way of enhancing one's own home. In the United Kingdom, around 60% of spending represents people buying flowers and plants for themselves.

World sales of flowers were $44 billion in 2002, so it is a large and growing commercial activity globally. Brazil exports over 500 million rose stems annually and other developing countries are entering the market as suppliers. In Ecuador, the industry employs 45,000 people directly and contributed over US $100 million to overall export earnings in 1997. In Colombia, the industry is estimated to employ 80,000 people directly and another 50,000 indirectly. It is Colombia's fourth largest export earner. The biggest wholesale market is in the Netherlands, where there are 100,000 jobs in the flower industry and remarkably 10% of all flowers sold in the United States come via The Netherlands. No doubt the world's flower growers are looking with relish towards China where the average person spends less than a $1 per year on flowers in contrast to the Swiss who lead the world with an annual spend of $112 per person.
Wine and spirits—mainly water with a few wonderful NPs

At the start of the twenty-first century, 250,000 million litres of wine were being consumed annually, valued at about $100 billion. The market is growing by about 5% annually. Wine is a chemically complex mixture but it is not the major constituents (water, alcohol, sugar and organic acids) that give a wine its value but the minor ones—the plant-derived NPs or compounds derived from them. It is the NPs that give a wine a unique flavour or odour; hence wine experts are simply well-trained, capable NP detectors.

Wine making can be traced far back (4000 BC) into recorded human history and might have begun near the Caspian Sea then spread towards the Mediterranean. By 2700 BC, wine was being made in Egypt, where as might be expected of an NP-rich luxury, it was consumed by royalty and priests. The Greeks and Romans improved the husbandry of vines and introduced vines to newly colonised areas. The Greeks improved the ways of making, storing and transporting wine so that a vigorous wine trade was established around the Mediterranean. After the Romans, Christian monasteries were especially influential in maintaining and developing the skills of growing grapes and making wine. As the European explorers spread around the world they took vines and wines with them to new lands. These new vineyards initially satisfied local consumers but in the last half of the twentieth century, the vineyards of South Africa, the United States, Australia, Chile and New Zealand produced high-quality wines which flooded into the European and North American markets. Wine is another example of an NP-rich product where a monopoly was impossible because the vine is so tolerant to growing conditions. However, the growing conditions, combined with the soil properties, both restricted to relatively small areas of the world to produce distinctive wines and a form of branding has developed to increase the value of certain wines. In Europe, the law can give protection to a product (p.54) made in one geographical area so that only a product made in its traditional location can use a particular regional name for marketing purposes. So a wine labelled as Bordeaux or Burgundy must have been made in the respective region and is effectively branded to achieve a higher value than its NP composition might justify.
Predictably with an NP-rich product like wine, consumption is accompanied by ritual. Wines are served at official dinners, at weddings, to celebrate births and to show displays of triumph after car racing. Special drinking vessels (wine glasses), special storage containers (wine bottles), special storage racks and wine cellars, all point to wine having a special value in European culture.

Some spirits and many liquors are also NP-rich products, some markedly so. Thus, gin gains its special flavour from the NPs found in juniper berries. Some companies developed more distinctive flavours in their brands of gin by adding other NP-rich ‘botanicals’ (lemon, orange, anise, angelica root, licorice, cinnamon, coriander and cassia).

**Beer—the wonderful taste of the NPs found in hops**

The fermentation of sugar to produce alcohol was discovered by many societies. The oldest physical evidence for the production of beer is in the remains of 5000-year-old pots from Iran. The source of the sugars for making beer depended on the plants available and in Europe the main sources were starch found in grains grown for food—wheat, barley, oats and rye. By allowing grains to germinate for a few days, the starch in the grain is broken down by enzyme action to produce soluble sugars. The simple techniques needed to produce an acceptable brew made beer a very widely available drink and it had the advantage of being alcoholic and usually free of pathogenic microbes because the brewing process often involves a boiling of the ‘mash’. In many parts of the world it is safer to drink beer than tap water.

The NP-rich hop plant (*Humulus lupulus*) was first cultivated in Germany in the eighth century and its use in brewing was first recorded in 1067. In the following centuries, the use of hops to flavour, and help preserve beer, spread throughout Europe (reaching Britain in the early sixteenth century) and then was taken globally by the explorers. Extracts of the hop inflorescence provides a bitter taste that complements the sweetness of the remaining soluble sugars in the brew (which have a malty taste). It is also thought that some of the NPs in hops inhibit microbial growth, hence reduce spoilage which could be a problem in the small local brewhouses before industrial brewing emerged.
More than 250 chemicals have been identified in hop oils and no doubt more minor products remain to be characterised. Annual world beer sales are currently about $300 billion (130 billion litres).

Soft drinks—a very profitable way of selling water by adding a few cheap NPs

Until recently drinking water was a product that commanded a low price in most societies. How can one make lots of money by selling water? Simply by exploiting the human desire to experience the exotic tastes and smells associated with NPs. The first (p.55) recorded NP-flavoured drink was lemon-flavoured water marketed by Compagnie de Limonadiers, a company given a monopoly to sell that product in Paris. NP-flavoured drinks were often regarded as inherently healthy for two reasons. First, because fruits were regarded as good, nutritious foods (we now know that fruits are a good source of vitamins). Second, the common, simple way of extracting the flavoursome NPs from the plant material was to boil the plant material in water and that killed the pathogens that were common in drinking water supplies in towns at that time. So such drinks, if freshly made, were a good choice for the consumer.

The next major development in soft drinks was the concept of carbonation—making the water fizzy by pressurising the water with carbon dioxide gas. This was first achieved by the radical preacher and scientist Joseph Priestley in 1767. Within a few years, others had developed various types of apparatus to generate the carbon dioxide and to carbonate drinks for sale in shops. The mass market awaited the development of ways of economically making glass bottles, bottle caps and bottling machines which were achieved in the nineteenth century. The introduction of ginger beer (1851), root beer (1876), Dr Pepper (1885), Coca-Cola (1886) and Pepsi Cola (1898) were examples of particular NP-based mixtures finding large markets. The development of metal cans in the twentieth century made the soft drink businesses some of the most successful global brands. The range of NPs used in drinks is now very large but many synthetic versions are used, although the preference of the more wealthy consumers for ‘natural’ flavours sustains the market for some major NPs. Some soft drinks also appeal to consumers because they contain NPs that have a physiological effect such as caffeine and
Theobromine. Such chemicals are mildly addictive which helps sales.

The world market for soft drinks is about 500 billion litres. In 2002, the world sales of soft drinks reached $200 billion, with the US market accounting for nearly one-third.

**Khat**

*Catha edulis* produces cathenone, an alkaloid with a mild stimulatory effect, thought to be similar to amphetamine. There has been a debate as to whether the plant originated in Ethiopia and was then taken to Yemen or vice versa. The leaves of the plant are chewed. The ancient Egyptians considered the plant a divine food and it has been used for thousands of years in the regions of the Horn of Africa and East Africa. Its use has spread slowly but the need to chew large amounts of the leaf and the habit of users to expectorate frequently means that in western societies it has never gained popularity. However, Somali immigrants to some countries have spread the habit globally and a small international trade has begun. In many countries Khat is regarded as a narcotic but in Britain, surprisingly (and somewhat inconsistently) it is still legal to use it.

**Betel nut**

The nut of the palm *Areca catechu* contains a mildly stimulatory alkaloid and in some Asian countries the chewing of pieces of the nut is enjoyed because of the mild euphoric state it induces. Restrictions in the use of betel nut remain rather few despite some (*p.56*) evidence that its use could be harmful. As with other plant products that are chewed, the expectoration that heavy users experience is an annoyance to non-users and that is likely to limit its use in many societies.

**Perfumes and scents—NPs oldest human obsession?**

Flowers produce a range of volatile chemicals, some of which are attractive to some organisms, some repellent and some which are unlikely to be detected by any organism (for reasons which are discussed in Chapter 9). Most humans find the scent of some flowers attractive and they enjoy the sensation that detection of these smells gives them. The selective breeding of plants bearing attractive flowers has resulted in some cultivated species which have extremely strong and very characteristic odours. Many people can identify roses, lavender, hyacinth, *Louisiana* iris or lily of the valley by their
smell alone and extracts of these flowers have been important to the perfume industry for centuries. Until the twentieth century, extracts containing NPs were the basis of the perfume industry but once chemists had developed methods to isolate, chemically characterise and synthesise the individual characteristic chemical components of the scents, synthetic chemicals were increasingly used in perfume production and also in food flavourings. However, the last quarter of the twentieth century saw many wealthy consumers express a preference for ‘natural’ NPs (see Chapter 4 for a discussion of this aspect of human behaviour); hence the market for naturally occurring flavouring and odour chemicals remains healthy. The annual fragrances sale worldwide is about $15 billion.

What does this chapter tell us about how science works? The wealth that can be accumulated by trading in NPs (and it is noteworthy that actually growing the NP-rich plants seems never to have enriched farmers to a similar extent) not only allowed the arts to flourish but also seems to have encouraged scientific endeavour. The periods of great scientific achievement associated with various regions of the world seem correlated to a degree with the periods of NP-associated wealth generation. However, some very influential scientists have suggested a more direct association between NP consumption and scientific creativity. Charles Darwin felt ‘most lethargic, stupid and melancholy’ after giving up tobacco for a month. Albert Einstein noted ‘that pipe smoking contributes to a somewhat calm and objective judgement in all human affairs’.

Given that this chapter shows how important NPs have been throughout history, the chapter has tried to bridge the sad gulf between the study of science and other disciplines. How many students of science appreciate the importance of NPs? How many students of history appreciate the role that a human obsession with NPs has played throughout history? Science is about understanding the natural world and surely the role of NPs in evolution and in human affairs must be part of science.

**Conclusion**

Ask a scientist to produce a list of the important biological topics that need to be understood to appreciate human affairs, historically and currently, and it is doubtful if many would mention NPs. Yet surely this chapter shows that the human
desire to access a few NPs has been extremely important in human affairs. The language some nations speak, the cultural traditions they follow, the religions they practise and even the sports they play can often be traced to that nation's historical links to the NP trade. This massive impact of NPs on human affairs makes it all the more remarkable that very few biologists are aware of the way humans seem in thrall to NPs. The impact of NPs on the lives of every person, every day is seemingly invisible to most members of society, including scientists. This tells us that scientists do not always have powerful abilities to observe, question and analyse. (p.58)

Notes:


(4.) The Venetians did a remarkable job of exploiting crusaders. The Fourth Crusade, launched in 1199, commissioned the Venetians to transport the armies to Alexandria but the Venetians managed to get the crusaders first to attack the Christians ruling the growing Adriatic port of Zara, a commercial competitor of Venice. Then, the Venetians decided that the crusaders might usefully invade Byzantium, rather than Egypt, to increase the Venetian control of that important trading region. So, instead of fighting Muslims, the crusaders fought the Christians and sacked the city of Constantinople. The Venetians even got paid for their devious work as well as gaining control of more strategic ports. However, the weakening of the power on Byzantium was to have terrible consequences within a short period.


(6.) Allen SL. (2001). *The devil's cup—coffee, the driving force in history*. Canongate, Edinburgh


10. Perkin befriended and employed the young Jewish chemist Chaim Weizmann who used his knowledge of coal tar chemistry to devise a method of making acetone, which was necessary to make explosives during the First World War. Weizmann became director of chemical research at the British Admiralty when Arthur Balfour was the First Lord (1915–1916). Balfour was much impressed by Weizmann’s contribution to the war effort and when Balfour moved on to be British Foreign Secretary he made the famous Balfour Declaration which promised the Jews a national home in Palestine. Weizmann became the first President of Israel when it was finally established after the Second World War. Thus, the strange links between the NP quinine, a failed synthesis, an accidental discovery of great importance and the eventual founding of a state which had been central to world tension throughout the past half century.
(11.) The search for a synthetic source of quinine led to the growth of the synthetic dye industry and ultimately to the development of the pharmaceutical industry (see also Chapter 2). The growth, and economic importance of the German dye industry in particular, was a major stimulus to the blossoming subject of synthetic chemistry in the late nineteenth century, and a very large number of synthetic dyes of all shades and hues were developed. The chemical stability of such compounds was essential for their use and some were much more stable than natural vegetable dyes. Thus, when Paul Ehrlich was given the task by the German chemist Hoffman (who had also taught Perkins while employed for a period in London) of seeking to establish the path of infection of malaria, Ehrlich found that methylene blue allowed him to trace the protozoan in an infected sailor who seemed to recover. The concept of selective toxicity began to grow. Clearly, a parasitic cell that took up a dye to such an extent that it became visibly stained against a background of cells that were not stained suggested that the concentration achieved in cells by dyes that penetrated them varied depending on the cell type. Given that for centuries it had been appreciated that poisons only acted when they were administered above a certain dose, it was reasonable to think that it might be possible to give high (= poisonous) doses of a chemical to some cells while leaving other cells unharmed. Ehrlich pioneered this approach and in doing so laid the foundation for modern methods of drug discovery. However, a drug to treat malaria eluded him. In 1905, the first drug to treat sleeping sickness, trypan red, was reported. In 1910, he discovered Salvarsan as a treatment for syphilis. However, it took his successors in Germany to finally discover the effective antimalarial drug. Pamaquin was discovered in 1926, and the drug mepacrine was developed in the United States and in the United Kingdom a few years later. These drugs were widely used in the Second World War.


(15.) State tobacco monopolies are still common—China has the largest but the state is still involved in the industry in Japan, Korea, Egypt, Turkey, Austria and so forth.
(16.) One lover of snuffboxes was Napoleon, who it is reputed consumed 1 kg of snuff a week! Napoleon also improved France's finances by enforcing tobacco taxation and his armies found tobacco a useful appetite suppressant when food supplies were limited.

