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Minor forest products - their total value is of a major order

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The authors give a survey of minor forest products which are significant in the economies of tropical lands in particular. These include turpentine from pines, perfumery oils from roots, stumps and fruits of various tree species, and gums and exudates which go into products as different as confectioneries and golf balls. There are also spices, medicines, dyes and tannins. Most minor forest products are export currency earners and many are well suited for local processing industries.

Even on a comparatively restricted definition of the term "minor forest products" it is evident that the total annual value of all such products entering all forms of economic activity is of a major order, and for many countries the foreign exchange earning potential of minor forest products is comparable with that of their timber. For many minor forest products, however, statistics of production, local usage and international trade are not available and it is not possible to provide a quantitative estimate of the total impact made by all such products on the world economy. For the purposes of the present article the subject is best covered in breadth rather than in depth within a narrow field, and qualitatively rather than quantitatively, although it is clear that there is room for more systematic research on the subject than has been accorded it in the past. It is perhaps not surprising that much of what has been written previously on such a broad subject has been of a very ad hoc nature geared to a particular product or products in a given forest environment. However, a broader, long-term examination of the economic opportunities and potential presented by the world's forests, whether managed or unmanaged, in terms of the secondary products potentially obtainable from them, would indeed be desirable.

GUM ARABIC IN PORT SUDAN - A high price

A definition

The problem of defining minor forest products has already been hinted at above. The narrowest definition restricts the use of the term solely to those products obtainable directly from the wood, bark, leaves or roots of the principal forest trees. A slightly wider definition would allow inclusion of-products obtained from any species of tree in a managed or unmanaged forest stand, regardless of the significance of the species

with respect to the major end uses or economic objectives of the forest. A further category which might reasonably qualify for inclusion would be products obtained from plants and shrubs which either naturally favour a forest environment or are ideally cultivated in the shade. Utilization of the forest floor for the successful production of secondary products may be no easy matter given conditions of deep shade and undergrowth and a thick carpet of leaves or pine needles. The writers firmly believe that the two last-mentioned categories of products should be included in spite of the fact that many such products are more often obtained outside the forest environment than within it. Their inclusion is justified by the fact that their presence affects the total commercial and social return per area of forest, even though the increase in revenue attributable to them may accrue not to the forest authorities but to local villagers, farmers and tradesmen. At the same time it seemed reasonable to exclude commodities which are traditionally classified as plantation crops-rubber is an obvious example-since these are of major economic importance in their own right.

Hundreds of products

Within these fairly generous terms of reference fall many hundreds of products, of which a large proportion are to be found within one or other of the following categories: arboreal exudates in the form of gums, resins, balsams, latex; drugs; dyes; edible nuts; essential oils; oil-bearing nuts; spices; tannins; and products emanating from insect activity. A further category of great importance is naval stores, that is, turpentine and rosin and derived products, and it can plausibly be argued that the economic significance of these materials effectively excludes them from the field of minor forest products; certainly the naval stores industry is a large one in many temperate countries but this is by no means the case everywhere.

In temperate regions where softwood forests predominate there is a tendency for the secondary products to be exploited in a fairly organized manner, and in any case the range of products readily available is comparatively limited, although those that are obtainable are mostly of high value. In tropical areas, by contrast, there is a much greater proportion of unmanaged forest and the minor products, which are likely to be very large in number, will more often be the staple and cash crops of local communities and entrepreneurs. In the latter case the presence of a wide variety of products, often of very high value in spite of a limited volume, encourages the development and continued existence of rural communities in the neighbourhood of and within forest stands, and the income potential is often sufficient to act as a significant brake on the all-too-familiar tendency for agricultural communities to migrate to urban areas. There is of course considerable potential for organized exploitation of the minor products of tropical rain forests, and the primary economic returns from forestry could probably be very significantly enhanced through a more systematic harnessing of these minor natural resources and through a reduction in needless waste. If, however, such development was effected at the expense of the livelihoods of local communities, the overall benefits would probably be negative. Urban migration and its concomitant problems of unemployment and deficiencies in housing and services constitute a major social cost to a developing nation. Ill-considered programmes of commercialization of forest resources which effectively deprived local villagers of a large proportion of their staple or cash income and forced them to move away from traditional settlements would in many cases result in a net social loss to the nation, notwithstanding the gains accruing to the organizations harvesting the products. Furthermore, just as a comparatively small decrease in the effective local availability of a traditional product may result in a disproportionately costly population shift, a fall in the price of a minor cash crop might have the same

effect.

Caribbean pines (Pinus caribaea) are tapped in Honduras for the production of turpentine. Spraying the shallow cuts with sulfuric acid increases the yield. A variety of pines may be tapped, and the value of the wood for timber is unimpaired.

Although it would be a major and difficult undertaking, a survey of the worldwide effect of fluctuations in prices of minor forest products on the existence and stability of local communities would be a worthwhile exercise. Inevitably the degree of local dependence on minor forest products varies immensely from region to region. The precise trade structure for a given product in terms of traditional arrangements for collection and marketing will be unique to that product and to that region. There is little room for generalization in this field and it is necessary to consider each product separately in any development scheme.

Price rise effects

From the point of view of commercial and industrial end-users of minor forest products, the outlook for sustained growth in their use has not been particularly favourable in recent times, primarily on account of the phenomenal rise in world commodity prices which has affected most or all cash crops, including those obtained from forests. This price rise stems from several factors but increasing pressure of world demand and shortage caused by adverse climatic conditions are the two dominant ones. In the absence of other major developments one would have expected to see an intensification in the trend toward substitution for natural products by synthetics. How ever, the commodity boom is not expected to last indefinitely and although it is unlikely that prices will ever revert to their former levels some downturn is widely anticipated. More crucial, though, are the immense recent and current increases in the price of fuel oil which point to the imminence of major increases in the price of plastics and of other petroleum-based chemicals. Although it is believed that a number of these chemicals could be derived from organic materials such as, for instance, carbohydrates if the use of petroleum were no longer economically feasible, there is certain to be a widespread revival of interest in naturally occurring raw materials, including many minor forest products. The magnitude of such a revival can be no more than a matter for speculation at the present time, but there is evidence that it may already be occurring in some areas of manufacturing.

Naval stores

It has already been suggested above that in temperate zones, where pine forests are present in abundance, the naval stores industry is likely to be highly developed and can reasonably be regarded as a comparatively major industry. In the less developed tropical or semitropical areas, however, this is less likely to be the case in spite of the widespread presence of tropical pines, and the production of the two main products in this category, namely turpentine and rosin, will normally only constitute a minor activity if it takes place at all. Nowadays turpentine is obtained from one of the following sources: gum rosin, obtained by the direct tapping of pine trees and which consists of 20 percent turpentine and 80 percent rosin; wood rosin and crude turpentine derived from the extraction of pine stumps; or crude sulfate turpentine, a by-product of the production of paper pulp by the sulfate (kraft) process in which pinewood is digested with a mixture of sodium hydroxide and sodium sulfide. The last-mentioned process is the dominant method employed in more advanced areas

but in tropical and semitropical regions gum rosin is widely tapped, this process being technically simple.

Among the varied uses of rosin are two important ones, namely as an ingredient in paints and in the sizing of paper. The uses of turpentine, of course, are many and well known. As a starting material for the derivation of a range of chemicals, including many used in the perfumery industry, it has to some extent been responsible for a decline in the use of certain natural products (including forest products, mostly essential oils, of which more will be said in the next section). The main constituents of some turpentines are the pinenes which form the basis of a synthetic chemical industry; in particular, B-pinene can be converted to vitamin A through the intermediary of the ionones, which are materials of considerable importance in perfumery. Among the most important perfumery products obtainable from the several processes involved are linalol, geraniol, citral and hydroxycitronellal which are also obtained from naturally occurring essential oils such as those of bois de rose (a source of linalol), palmarosa (geraniol), lemongrass (citral and the ionones) and citronella (citronellal, hydroxycitronellal and geraniol). The chemist is therefore particularly concerned with the B-pinene content of the turpentine and whereas, for example, New Zealand turpentine obtained from *Pinus radiata* has been found to contain as much as 65 percent B-pinene, turpentine obtained from the most common species of pine grown in, for instance, China, India, Sweden and Finland contain 5 percent or less.

Turpentine sources

Apart from New Zealand, pines from Australia and Mauritius have also been found to be sources of turpentine comparatively rich in B-pinene. At present, however, the major commercial source of B-pinene is American sulfate turpentine derived from the slash pine (*P. elliottii* and *P. caribaea*) grown along the Atlantic seaboard, since supplies of the New Zealand raw material are limited. The other pinenes are also of importance, and in particular the dextropinene obtainable from the species Pinus halepensis grown in Greece can be used as a source of laevo-citronellae, a highly desirable form of active citronellal which occurs in natural geranium oils and has important outlets in the perfumery industry.

These synthetic chemicals are not invariably regarded as being perfect substitutes for the natural products in respect of odour characteristic but at the time when the pace of their development was at its peak there was an immense worldwide increase in demand for perfumery materials, and the rapid development of synthetics was welcomed as a means of stabilizing prices. While total usage of some natural products has declined in absolute terms, this has been very far from the case with many of them and in these instances the development of turpentine-based synthetics has merely slowed down the rate of growth of total consumption of the natural equivalents. There is, besides, a steadily growing demand for many highly specialized essential oils, some of which originate in afforested areas, which so far have proved to be prohibitively expensive to synthesize.

The foregoing covers only a small area of the total usage of turpentine, but insofar as it impinges on the market outlook for some other forest products it is worth covering in a little detail. Turpentine is probably the only byproduct of any consequence from pine forests, in the shade of which very little can grow unless the trees are more than usually widely spaced. The method of tapping the trees for gum rosin has one marked advantage vis-à-vis the wood sulfite pulping process, in that a cash return is realized at an early stage in the tree's life which is highly attractive in the context of discounted

cash flow accounting.

Sandalwood oil

Sandalwood oil is one of the longest established and best-known of all perfumery oils, and the wood itself is also a highly valued article of commerce, finding widespread application in furniture, carvings and incense. Production is located principally in India, where the oil is distilled from the heartwood and roots of *Santalum* album, a parasitic tree whose roots attach to such hosts as *Cassia simea* and *Lantana acuminata*. Production in India is directed mainly, although not exclusively, by the Mysore and Madras State Governments and is nowadays a well-organized operation. Although propagation of the trees used to be wild, controlled seeding now takes place following experimental work carried out by the Indian Forestry Department. The trees take at least 50 years, and often 6080 years, to reach maturity and they are never cut before the age of 30 years unless they are threatened by or actually suffering from the "spike" disease to which they are so vulnerable. The oil is steam-distilled in private and state-owned distilleries and annual exports are currently valued at Rs.25-30 million, having slipped back slightly from the 1968-69 peak. Attempts have been made to synthesize the oil, especially at times of high prices, but usually without apparent success since the main constituent, santalol, is difficult to derive from other starting materials. A greater threat to the oil's reputation and future is the practice of adulteration which occasionally reaches serious proportions. This is a problem with many essential oils.

Substitutes

Somewhat similar oils are produced in southeast Asia (Singapore) and Australia. The Australian oil is important commercially and is distilled from the tree *Eucaria spicata*, which is to be found in Western Australia. Cultivation, collection and distillation are a well-organized activity. The oil is regarded as a typical sandalwood oil and its characteristics are very similar to the Indian oil. Singapore has recently been making serious attempts to obtain a larger share of the market, and the oil is of good quality.

The main economic importance of sandalwood oil lies in the fact that it is a valuable export earner. Its value as a local cash crop is rather limited in view of the comparatively high degree of centralized organization of the industry, but in parts of Indonesia where the industry is less developed local communities can participate rather more in its exploitation.

Production of cedarwood oil is far more widespread than that of sandalwood oil. There are many varieties of cedar tree and the oils obtained from them vary, but all are widely used in perfumery. The cedar fragrance is currently fashionable in "men's-line" talcums and after-shave lotions. Cedar-wood oils commanding commercial interest include: oil of *Cedrus deodara*, obtained at high altitudes in the Himalayas in the north of India, Pakistan and Afghanistan, and used mainly in local industries; oil of *Cedrus atlantica*, or "Atlas" cedarwood oil from Morocco and Algeria, is highly regarded although supplies tend to be restricted; oil of *Juniperus procera*, or east African cedarwood oil, of which much is exported; oil of *Mexicali juniperas*, from Texas, United States; and a well-known high-quality oil from China which is exported in large quantities, mostly to industrialized countries. It must be stressed that cedar trees are exploited principally for their wood, which has always been well regarded in the building industry and particularly in the manufacture of high-quality furniture; the oil has usually been distilled from the stumps of felled cedar trees and from the waste

shavings from furniture factories. In the United States, however, it is reported that the cedarwood furniture industry is declining somewhat and, as it is uneconomic to fell cedar trees solely for their oil, there is a growing risk of oil shortages. Whether this decline in the use of the wood is going to be worldwide remains to be seen, but it does not seem likely that there will be a major fall in cedarwood consumption even in the event of a substantial price rise, so high is the esteem in which the wood is held.

The cedarwood industry is well organized, and even in developing countries the wood is not exploited by local communities save on a very small scale. The extent of demand is such that some centralized control is inevitable, especially in areas where the tree has been threatened with extinction.

Guaiac wood oil

Guaiac wood oil, which originates mostly in Paraguay, has been known for centuries but it was not until the Mennonites settled in Paraguay in the first half of this century that production became more systematic. The wild guaiac wood tree (*Bulnesia sarmienti*) grows abundantly in the somewhat inhospitable Gran Chaco area, and as the Mennonite settlers built up the industry they attracted many local Indians and thereby helped to spread the industry into hitherto largely inaccessible corners of the country. Distillation is sometimes hampered by lack of water in the rather dry Chaco region but nonetheless between 75 and 100 tons of guaiac wood oil are produced each year. The opinion has been expressed that a shortage of cedarwood oil and its derivatives would lead to increased interest in guaiac wood oil and derivatives such as guaiac wood acetate. In 1968 there was a major surge in demand for the oil following an increase in popularity of a leather-type aroma in "men's line" products, but the market has since stabilized although, as with almost all essential oils, the price of guaiac wood oil has risen in line with the movement in world commodity prices. The price is nevertheless still attractive to consumers and the oil remains popular as a blender in woody-floral perfumes and in some soaps. It is possible that periodic supply bottlenecks may occur since collection of the wood is becoming somewhat more difficult and expensive, the wood having to be collected from a greater distance each year as supplies close to the main distillery are progressively exhausted. There is no evidence, though, that this constitutes an immediate threat to the industry and it remains an interesting example of the contribution which a minor forest product can make to community development in a developing country.

Natural growth cork oaks (Quercus suber) in the Forest of Mamora, Morocco, two years after being stripped of their bark. Trunks turn brown and it takes about ten years for new bark to grow to commercially useful thickness.

Rosewood oil

Rosewood oil is distilled principally from the chipped twigs and small branches of *Aniba rosaeodora*, a tropical medium-sized wild-growing evergreen from the Amazon basin. Most of the oil is produced in Brazil but some production also takes place in Peru. Annual production is nowadays only a fraction of what it used to be, having tumbled from over 1 500 tons in the late 1930s to less than 150 tons in 1972. The principal reason for this is that the oil's main component, linalol, can be synthesized satisfactorily, as was indicated in the section on naval stores. Prices fell to a point at which it became virtually uneconomic to distil the oil; moreover, the cost of collection increased annually as the collectors had to travel ever further into the jungle for their supplies. Recently rosewood oil producers have benefited by the sharp rise in world

commodity prices, but owing to the pressure of competing economic factors production has not risen to any significant degree. At the same time world demand for the oil, which is exported mainly to the United States, has increased owing to its popularity as a perfume material in its own right.

The most recent price movements suggest that users are prepared to pay a substantially higher price than the US$4.2 per kg at which it stood recently, and it is thought that the equilibrium price might be in excess of $10 per kg.

The rosewood is, of course, well known for its reddish wood, which is widely used in high-quality furniture and woodwork, and the decline of the oil market has scarcely affected the level of exploitation of the tree. The process of collection and distribution is a well-organized operation in the hands of a few firms, and local communities play little part in it, the main importance of this tree lying in its potential as a foreign exchange earner.

Sassafras oil is another minor forest product from South America, an essential oil distilled from the wood of the tree *Ocotea pretiosa* which grows abundantly in parts of Brazil. This is not an oil which has been known for very long, and in fact it was not seriously produced until 1938. The oil is used principally for the isolation of its main component safrole, and for the conversion of the latter into heliotropin. These products are used in the preparation of soaps, certain cosmetics, disinfectants and insecticides. The last-mentioned application is of some importance, as safrole is being used increasingly in the important range of preparations based on pyrethrum, its main function being that of a synergist which increases the overall effectiveness of the preparation.

It does not appear that the indigenous inhabitants of the areas in which *Ocotea pretiosa* flourishes have ever been instrumental in exploiting the tree, and since the oil began to be produced in earnest the industry has been self-contained, the distillers controlling the felling and collection of the wood. Like rosewood oil, it is a valuable foreign exchange earner.

Eucalyptus oils

So widespread is the use of eucalyptus oil that it almost falls outside the category of "minor" forest products. However, it is the wood which is of principal importance, and although in many locations eucalyptus is cultivated virtually as a plantation crop, brief consideration of the oil will not be out of place here.

Two eucalyptus oils are of major commercial importance, namely, oil of *E. citriodora*, a perfumery oil produced mainly in Brazil, Zaire and China, and oil of *E. globulus* and similar varieties which are rich in cineole and mainly of medicinal interest, originating in Tasmania but growing nowadays in Spain and Portugal. The so-called Chinese eucalyptus oil is not a true eucalyptus oil but is in fact derived from the cineole action of white camphor oil. Although Australia is famous for its eucalyptus trees, the species from which commercial eucalyptus oils are derived are all of comparatively minor importance, and include *E. radiata, E. dives, E. leucoxylon* and several others. These oils are important earners of foreign exchange, although the significance of the eucalyptus in the livelihoods of local communities is extremely limited, exploitation usually being centrally organized.

Grasses and plants

Most of the more important oil-yielding grasses and plants are cultivated under controlled conditions, but collection and distillation of the wild equivalents still take place to a small degree and the grasses are from time to time grown in forest clearings, so they deserve a brief mention. Certain grasses of the *Cymbopogon* species, known as lemongrass, are widespread, and the oil is distilled principally in India, Sri Lanka, Indonesia, Honduras and Guatemala. A highly regarded perfumery oil in its own right, it is holding its own on world markets in spite of the fact that its main constituent, citral, can be synthesized successfully. Citronella grass is a source of another very well-known essential oil, which, although it has faced strong challenges from synthetics as a source of geraniol and citronellal, continues to command a share of the market. Citronella oil is produced in large quantities in Sri Lanka and Indonesia, there being a distinct difference between the oils from each region. Palmarosa oil, produced from the grass of the wild plant *Cymbopogon martini*, is of lesser importance on world markets than either lemongrass oil or citronella oil, but the grass grows abundantly in India, Pakistan, Indonesia, Brazil and Madagascar and is an excellent natural source of geraniol. As with citronella oil, synthetics have presented a formidable challenge, but the oil is holding its own and is a valuable asset to the afforested areas in which it grows.

Future of spices

Many spice-bearing trees and plants are to be found in and around forests, but for the purpose of commercial production the vast majority of them are cultivated in plantations. Clove, nutmeg, cinnamon and vanilla, to name but four, fall into the plantation crop category, and although it is possible to find all of them growing wild, they are not exploited in this form to any significant degree. Discussions of these products here is therefore unwarranted. Spice production is likely to become more highly organized in the future since demand is booming, primarily as a result of greatly increased direct consumption by the housewife, and also because quality standards are more stringent nowadays. The only spice of any importance in the present context is cardamom.

Cardamom is the dried ripe fruit of *Elettaria cardamomum*, a perennial plant grown in southern India, Sri Lanka, Central America and parts of Africa. Although this is the cardamom of commerce, a similar plant, the *Amomum cardamomum* L., is grown in Thailand, Indonesia and other parts of southeast Asia for local consumption. As well as being used as a flavouring agent in both sweet and savoury preparations, an essential oil can be distilled from the seeds which is also used in flavouring.

Although cardamom is widely grown as a plantation crop, the wild-growing plant is also harvested, and a special characteristic is that the plant thrives in the shade and can thus be cultivated in locations which would be unsuitable for many other valuable plants. Its potential for increasing the per hectare return from tropical forest is therefore considerable. Prospects for increased use of the essential oil depend on how the prices of competitive synthetics move in future. These are unlikely to be very great and, unless the price of the natural product rises unduly, the spice is likely to be used in increasing quantities.

True chicle or chicle gum is one of the most important exudates. It is the coagulate latex of the sapodilla tree, *Achras zapota* L., which is often grown in tropical countries for its fruit. Commercial supplies of chicle are, however, obtained from trees growing wild in forest areas. The tree is indigenous to Central America. The main commercial producing countries are Mexico, Guatemala, Venezuela and Honduras. It is of economic importance as the primary ingredient of chewing gum, of which the highest

grades are made solely with natural gums, although synthetics are used for lower grades. The most important of the other natural gums is jelutong or pontianale, the coagulated latex of trees belonging to the genus Dyera occurring in Malaysia and Indonesia. The rubbery characteristics of this latex render it particularly suitable as a basis for bubble gum. Other natural gums which are or have been used in the manufacture of chewing gum include: crown gum (from *Achras chicle*, Pittier) and chicle faison (froze *Dipholis stevensonii* Standl.) from Honduras, red Kano gum (from *Ficus platyphylla*, Delile) from Nigeria, gutta hangkang (from *Palaquium leiocaroum* Boerl) and gutta ketiau (from *Ganna motyleyiana* Pierre), both from Indonesia. These are minor forest products which contribute both to export revenue and to local employment at the village level.

Latex

Gutta-percha is the product obtained by coagulating the latex of several species of trees of the genus *Palaquium* (the Sapotaceae family) which, although principally found in Malaysia and Indonesia, is fairly widely scattered from India to the central South Pacific area. Palaquium gutta is the most important species. Trees yielding an almost identical material occur in the Amazon region of South America, and are of the genus *Lucuma* although belonging to the Sapotaceae family. The South American latex is normally known as balata. Although tapping of the latex has in places been quite extensively commercialized, local villagers still exploit and use it for the manufacture of sundry items, such as lightweight bowls and jars, as they have done for centuries. Commercialization is a comparatively recent development, and the world market for gutta-percha reached its peak in the early 1900s when it was considered the best available material for electric cable insulation, particularly for submarine cables. Nowadays its use is restricted to the outer covering of golf balls, and a very little is still believed to be used in industrial transmission belting, but in these fields it faces competition from synthetics. Even if the international market continues to decline, however, it is unlikely that local communities will cease using it and it will remain a valuable product.

There exists a group of soluble gums exuded from fissures in the bark of certain species of *Acacia*, and the most important of these, gum arable, has been well known for many centuries. Probably 50 percent of total world production of this gum is destined for the confectionery industry, other outlets including pharmacy, postage stamp gum and the paper industry. A major producer is the Sudan, but the gum is produced over a wide area from Senegal in west Africa to Tanzania in the east. It is usual to collect the gum from wild trees (*Acacia verek*) and it has been said that they yield less gum if attempts are made to cultivate them or otherwise interfere with their natural growth. The gum is tapped both by local inhabitants and by itinerant traders and provides a valuable local occupation as well as foreign exchange.

Grading gum arabic in the Sudan. By late 1974 the price had risen to US$3 172 per ton on the London market, nearly ninefold its normal price of $367, due to an acute shortage. The Sudan produces 80 percent of world supplies, mainly from the wild acacia trees (Acacia Senegal) of Kordofan province in the west. Other producers are Mauritania. Senegal and Nigeria.

Tanning materials

In the more advanced industrialized countries tanning technology has progressed very considerably over the past 20 years, and far more use is made of mineral

tanning materials than formerly. At the same time, the primitive village tanneries which have existed in developing countries for millenia continue to flourish, and the vegetable tannins obtained locally for use in these rudimentary industries are among the more important minor forest products. Even in industrialized countries vegetable tannins are still used extensively, particularly for the heavier leathers. Of total world consumption of tanning materials, 10 percent is attributed to chromium-based and other mineral tanning materials, with vegetable tanning materials accounting for almost all the remaining 30 percent. Of this group two thirds are from wattle, and a large proportion of the remainder from quebracho and myrabolan. Although all other tanning materials account for less than 1 percent of recorded world consumption, there is certain to be a large unrecorded use by local communities, and some, such as those from mangrove and chestnut, are still employed widely.

Wattle or mimosa bark is the most important of all vegetable tanning materials. It is derived from the black wattle *Acacia mollissima*, an Australian tree now cultivated on a plantation basis in South Africa, and also in east Africa. It is still used quite widely by local inhabitants.

The two South American trees exploited for tannin under the name of quebracho are *Schinopsis balansae* and *S. lorentzii*; they occur mainly in Argentina. Their slow rate of growth has discouraged the development of plantations, and as the wild trees were somewhat overexploited during the period of rapid growth of this industry quebracho has never been used on the same scale as wattle. Unlike many other tanning materials, quebracho does not appear to have been used through the ages by local inhabitants in preparing leather; the value of the wood as a tanning material was discovered only during the nineteenth century, and exploitation has always been the work of organized commercial interests. A large proportion of total production is exported.

The dried flesh of the myrabolan fruit, obtained from the *Terminalia* tree species found in India and Burma, contains 30-32 percent tannin. A valuable export product, these fruits have been used for tanning by the natives of India from time immemorial, and the extract imparts many desirable qualities to leather, particularly when used in conjunction with other tanning materials.

Insects and shellac

Shellac is obtained as a result of the action of the lac insect varieties, found from India to Indochina, on various "host" trees such as *palas* (*Butea monosperma*), *ber* (*Zizyphus jujuba*), *ghont* (*Zizyphus xylopyva*) and *kusum* (*Schleichera oleosa*); raw lac when thoroughly cleaned is known as seedlac, and further processing involving the application of heat yields the shellac which is so well known as an ingredient in paints, varnishes, and printing inks. Synthetics have to some extent eroded the market for this product, but the recent upward trend in the price of petroleum-based products has induced, at the time of writing, at least one manufacturer of printing ink to revert to the use of shellac, and it is probable that other manufacturers will follow. Lac collection provides much local employment and shellac is in all respects a valuable product.

The cashew nut is unique in that it grows outside of the fruit, which is also edible. It is native to Brazil and was introduced to Africa and India where it has become a significant export earner.

Many nuts are rich in protein and constitute a valuable addition to staple diets. Almost

all forests contain a proportion of nut-bearing trees and the species are endless. The ubiquitous walnut, the betel nut and the cohune nut of Belize are but three examples. World trade in edible nuts, excluding such major plantation crops as groundnuts and cashew nuts, is far from insignificant, but edible nuts are also important as a local diet supplement.

Although beekeeping is for the most part a highly organized activity nowadays, honey can be obtained in considerable quantities from wild nests in less developed areas and in many regions it is much sought after as a sweetener in local diets. It might seem strange to include this commodity in the minor forest product category, but it is nonetheless fair to do so since a large proportion of wild nests occur in thickly treed areas.

Very many plants or trees yield compounds from wood, bark, leaves, flowers or roots which are used in dyes and drugs. Examples are the purple dye obtained from the Asian logwood, the red dye from the north African henna plant and the orange-brown dye from the Indian tree *Acacia catechu*, commonly known as cutch. Of the many drugs yielded by plant products, papain from the tropical papaw tree, quinine from the *Cinchona* species and senna from the Indian plant are well known, but there are many others. Papain and quinine are exploited on a commercial scale, but many dyes and drugs are used predominantly at the village level or constitute a useful local cash crop.

Research needed

The few commodities specifically mentioned here are only the more important under the broad and somewhat arbitrary headings, and there are innumerable others. A much lengthier treatise on the subject would evaluate the contribution of minor forest products to forestry economics and to the wider economy on a regional or even national basis. There is room for much additional research along these lines. The foregoing short account, however, may give an indication of the contribution which these products could make to the world economy if they were fully and efficiently exploited.