VII. THE STUDY OF MINOR FOREST PRODUCTS

Rattans as an example — Interest sporadic — An economic note — Distinctions to be observed — Focus on the rain forest; some figures — The paradox of logging — Chronology of standard works on Malesia — Mixed state of knowledge — An overview of the relevant fields — A threefold approach in order — Can the tradition be resumed? — Summary: a new outlook.

Rattans as an example. — 'Minor' are called all forest products other than timber. Rattan is one of the best-known. In Malaya, according to Dransfield in his book of 1979, there are 104 species; 54 of them are utilized for cane. In addition, 4 are sought for their edible fruits, 5 for their leaves (as thatch and for cigarette paper), 4 for their 'dragon blood' (jernang, used for varnish, red dye, and medicine), 4 have still other uses. This means that over 2/3 of the Malayan rattans are useful to some extent. At present, we can say that 'great' use is made of 12 species, that is more than 1 in 8. Of all species, the stock is in the primary rain forest. For Indonesia, M. H. S i m a t u p a n g presented a paper The processing of rotan, a minor forest product from the tropical rain forest, to the 8th World Forestry Congress (1978) summarized on *page 3222*. The total yield was 59,600 tons a year, of which 7000 tons from plantations.

The value of rattan in the world trade is enormous: Dransfield (in The biological aspects of rare plant conservation, edited by H. Synge, 1981) adopts an estimate of US$ 1.2 billion, end value, and adds: "Rattan is in fact the most important forest product after timber in southeast Asia. From a social point of view it is the most attractive forest product, tending to benefit local villagers much more directly than timber operations. Traditionally the exhausting and unpleasant task of rattan pulling is carried out during slack agricultural periods (such as after harvest and before sowing the rice crop) and is also greatly influenced by the current price of rubber; when rubber prices have slumped, rattan pulling has become a more attractive source of income" (p. 180).

Dransfield (ibidem, p. 181) credits Borneo with c. 151 species, Malaya with 104, Sumatra with 77, Thailand plus Indo-China with 62, the Philippines with 60, New Guinea with 52, Celebes with 28, Java with 26; his Short Guide to Rattans of 1974 gives 9 for the Moluccas and 2 for the Lesser Sunda Islands. If similar percentages as in Malaya are useful, one can form an impression.

Interest sporadic. — The mangrove is known for a long time as a source of minor products. This is reflected in the First Report on the Global Status of Mangrove Ecosystems, edited by P. Saenger e.a. for IUCN (1981). Under Fuel, Construction, Fishing, Textiles and leather, Food, drugs and beverages, Household items, Agriculture, Paper products, they list 48 products, of which more than half are non-timber; besides, there is medicine, and other natural products like fish, crustaceans, shellfish, honey, wax, birds, mammals, reptiles and their skins, and other fauna. As the

Malesian mangrove is richest, we presume that virtually all of these uses hold good for it. As the number of vascular plant species involved is about 200, the incidence of usefulness is here very high indeed, and cannot be at all expressed in terms of wood only. However, the mangrove is merely one kind of habitat.

The significance of non-timber crops for the population in tropical countries has induced the U.S. Academy of Sciences to publish several quick compilations, e.g. The winged bean / A high-protein crop for the tropics, i.e. Psophocarpus tetragonolobus, a Malesian papilionacea (1975); Underexploited tropical plants with promising economic value (1975); Making aquatic plants useful: some perspectives for developing countries (1976); Leucaena / Promising forage and tree crop for the tropics (1977); Tropical legumes: Resources for the future (1979); Firewood crops / Shrub and tree species for energy production (1980). They were compiled by a panel of authors, and can be requested from the Commission on International Relations (JH 215), National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C. 20418, U.S.A. Most of these plants are, however, light-loving and, except a few 'Underexploited' fruit trees, do not belong to the rain forest. Nor do bamboos, on which in 1980 a workshop was held; the Proceedings were reviewed on *pages 3610-3611*. Two books were mentioned but not seen, both by A. B. & J. W. C r i b b, Useful wild plants in Australia, 269 p. (1981, Collins; Sydney), and Wild medicine in Australia, 228 p. (ditto).

The general paper to the 8th World Forestry Congress by T. C. W h i t m o r e, Potentially economic species of South East Asian forests has been published now in Intern. Tree Crops J. 1 (1980) 171-181, with 33 references. Most of its space is in fact devoted to non-timber plants. Animals, too, can be counted as suppliers of minor forest products, mostly in the form of birds. Lord M e d w a y 's paper to the above congress, The tropical forests as a source of animal genetic resources (summarized on *page 3220*), also calls attention to monkeys for medical research, and to invertebrates which are natural enemies of herbivorous pests, and the health of plantation crops may depend on them. The soil fauna, virtually untapped, may serve a variety of agricultural purposes. The International Consultation on Wildlife Resources for Rural Development, held in July 1980 at Hyderabad, India, touched on this theme in a broader context; see the report in Tiger Paper 7(3), 27 p. (July 1980).

In Malaya, some well-defined activities are going on. The Forest Research Institute, Kepong, has been the base of Dransfield's rattan project which resulted in his book, and which has now been moved to Sabah and Sarawak. Also, bamboo has been taken up as a research subject, by Mr. K.M. Wong. At the University of Malaya, Mr. S.C. Chin has engaged himself on ethnobotanical studies for several years, both in Malaya and Sarawak. In March 1982, Ms. Wanda Avé, a student of biology at Leiden, is to start work for some 8-10 months on small-scale utilization of rattans and foodplants among Orang Asli in Malaya, with support of WWF Netherlands Appeal and Treub Society, under supervision of Mr. Chin and Dr. M. Jacobs.

In the IUCN Ecological guidelines for development in tropical rain forests (1976), minor products are only mentioned in passing, on page 11.

BIOTROP and LBN kindled interest through their symposium on South East Asian Plant Genetic Resources (edited by J. T. W i l l i a m s e.a., Bogor 1975), with several good contributions on fruits, ornamentals, and tengkawang nuts. The Flora Malesiana has always carried more or less extensive notes on the uses of genera and species. Under 'Phytochemistry' (after Vol. i 5) important information is also given. The serials Lloydia and Economic Botany sometimes give an article on a Malesian subject, like in the latter 25 (1971) 312-316 a report by J. E. V i d a l on French ethnobotanical work in Indo-Malesia after 1959. The chapter Ethnobotany by J. M. P o w e l l (in K. Paijmans, ed., The Guinea Vegetation, p. 106-183. 1976) gives many tables of species names with terse indication of utilization all over New Guinea, under 19 headings. Each category is discussed in a running text; thus 1035 species are recorded (c. 11% of the total) in 470 genera (c. 32%) as having some or other kind of use to the native population. Altogether, it seems a masterful digest, and quite original in concept.

While e.g. the Buletin Kebun Raya of Bogor and the Philippine forestry journals Canopy International and FORPRIDE Digest regularly carry brief papers on minor products, the subject has been painfully absent in the UNESCO book Natural Resources of Humid Tropical Asia (1974), and in the UNESCO-UNEP-FAO book Tropical Forest Ecosystems (1978). Yet in the internal report by UNEP of the Second Experts Meeting on Tropical Forests held in Rome in January 1982, the need was mentioned "to develop authoritative economic data on the intangible benefits and on the very numerous products other than wood accruing from tropical forests", and a suggestion was made "to extend the scope of these assessment studies so as to include genetic resources and non-timber products (e.g. wildlife, protein resources, etc.) and their rational utilization, and further refine the classifications used" (both on p. 3).

Altogether, the impression persists of an imbalance. While lots of attention go to timber, the 'major' forest product which is, however, fast giving out, interest in all other products is sporadic and marginal. In India, the situation is much better. There is the excellent 11-volume book The Wealth of India (1948-1976), and the Central Institute of Medicinal and Aromatic Plants (P.O. Faridinagar, Lucknow, 22 60 10 India) issues the quarterly CIMAP Newsletter, which is now reaching volume 9. But our concern here is with the rain forests of Malesia.

An economic note. — The variety of non-timber products from a rain forest area is nevertheless astonishing. A rough-and-ready classification effort of the products in Burkill's Dictionary resulted in 102 categories, viz. under Animals 15, Chemical substances other than medicines 26, Cultural objects and utensils 14, Fibrous elements 9, Food from plants 7, Medicine 14, Wood and bark 8, Whole plant 9; so 87 are vegetable. Ways of utilization are so many and so ingenuous, that no brief anthology would suffice; reading Burkill is time and again a source of delight.

The role of useful plants in general and of minor forest products in the economy is not only exceedingly hard to estimate*, but its importance

* Footnote, see next page.

relative to timber has gone through big changes. H. C o h e n in an extensive study on the economic significance of minor forest products in the Netherlands Indies, Tectona 32 (1939) 883-919, gave many data over the decade 1928-1938. He arrived at an approximate worth of trade from the 'outer islands' to Java and Madura and to foreign countries during 1938 of Dfl. 16 million in timber and 13 million in minor forest products. This would equal the ten-fold amount of present time Dutch Guilders; Dfl. 1 equals US$ 0.40.

The main minor products thus shipped were: rattan, benzoin, other resins like damar and kopal, wild rubber, jelutong, sago products, tengkawang nuts, kayu putih oil, and bark for tanning. Included in these figures were products from Pinus of the secondary mountain forests, and of Melaleuca of the secondary swamp forests.

Indonesia in 1975 exported forest products for US$ 560 million; 4-5% of this amount was in the form of 'minor products'. Sarawak exported in 1974 for M$ 217 million in 'major' products, 1.3 million in minor ones; in 1975 for 159 and 1.0 million respectively (Malays. Forester 40: 2-13. 1977).

For Malaya in 1964 and 1965, revenues from minor forest products amounted to M$ 349,036 and M$ 324,108. Export values in the same years were M$ 1.3 million and 0.8 million, vs. for sawn timber 54 and 56 million. But if according to expectations, Malaya will become an importer of timber in the course of the 1980's, owing to excessive logging, the proportions again may alter .... if the resource of minor products has not been destroyed as well.

There is another difference with timber: the latter can be harvested on a large scale, with many de-stabilizing effects on society and environment. A reservoir of other useful plants acts as a buffer in many ways, as Dransfield above did indicate. Since such a variety of products can be harvested, a factor of flexibility is present, and large-scale operations are unlikely to occur in view of their relative rarity.

Banana and citrus are the most-traded tropical fruits. Both crops are good for tens of millions of dollars a year; both Musa and Citrus have their centre of diversity in the Malesian lowland rain forests. Genetic material from the wild could perhaps be used for improvement of cultivars. Once such improvements have been made — to breed a more tasty variety, or a more resistant one against some pest or disease — the profits in cash may be enormous. While at present, genetic material from the wild is more or less free for the taking, it seems conceivable that governments owning forests rich in genetic resources, will charge money for such wild materials. When those funds are applied for absolute protection

* One recent study is J. R. H u n t e r, Tendu (Diospyros melanoxylon) leaves, bidi cigarettes, and resource management. Econ. Bot. 35 (1981) 450-459, 2 fig. In India, where in Madhya Pradesh these leaves are collected from the forests as wrappers for a peculiar brand of cigarettes, this was in 1979 a US$ 381 million industry, which sustains some 10 million of tribal people, whose labours earned the state of Madhya Pradesh some US$ 40 million in revenue.

of large tracts of forest, annex field station and nursery, an interesting cost/benefit account may result. Not only geneticists of tropical fruit and tropical timber species are among the prospective customers, but also pharmaceutical firms. Many more medicinal plant species await cultivation than the handful now grown. As from logged-over forests not much is to be expected because of their ecologically disrupted, i.e. unstable, state, protection of intact forests will only be a wise step.

Distinctions to be observed. — Minor forest products are part of all natural products coming from the three kingdoms of plants, animals, and minerals. Burkill is the only author to cover them all, although plants make up 92% of the contents of his book.

The plants, for practical reasons, can be divided into: aliens and native ones, cryptogams and phanerogams, thallophytes and vascular plants, ornamentals and wild species, timber and non-timber plants; various combinations thus have been selected by authors to limit their subject matter.

Plants may come from: dryland forest primary or secondary, freshwater swamp forest or its secondary stages with Melaleuca, peat swamp forest, kerangas with the secondary 'padang', mountain forest or its secondary scrub or the more seasonal savanna with pine or cemara, mangrove of the muddy beach, coastal forest of the sandy beach, river beds, marshes, estuaries, deciduous forest or secondary savanna, or more peculiar vegetation types. The distinctions are important with regard to the question of renewability of a resource. Secondary forest is renewable, primary is not. Products from a non-renewable resource can be obtained on a permanent basis only by harvesting very small quantities, or by cultivating the species elsewhere.

Not all useful plants give 'forest products', of course, although naturally the distinction vanishes in the trade. For that, other distinctions seem valid: some products are used directly in the homes of the collectors, or in their village. Others are locally traded or exchanged, in more or less crude state, often to traders who travel a whole region for periodic visits. Thus a channel operates which may eventually feed the international trade. In the course, the products often are refined: rattan is first processed by hand when the stems are peeled and made durable by cooking in motor oil. Refinements follow in a more industrial and/or artistic manner, until a highly sophisticated object is sold in luxury shops at a stiff price: a nice rattan chair in a Leiden shop fetches US$ 100-140.

It makes a difference whether a 'forest product' has been taken directly from a forest, like rattan, or is taken from cultivated plants belonging to species which have their wild stock in a forest, like rambutan in Malesia itself, or kina in Amazonia. While these are from primary forests, a threatened habitat, others (e.g. Leucaena, a green manure, fodder, and firewood plant) belong to the secondary formations, and are not threatened at all. Bamboo is a product chiefly taken from deciduous forests which have been under the influence of man, but also has been cultivated widely. Some deciduous forests too, face heavy threats; without

protection, the genetic base of cultivated bamboo, too, will be narrowed as a result of habitat destruction.

Timber and non-timber species deserve different considerations, because exploitation of forests for timber practically precludes exploitation of minor products. Timber extraction damages the canopy and the soil, whereby the ecosystem is disrupted with bad consequences for all species in it; silvicultural measures aim at killing as many of the non-timber species as possible. It is either timber extraction and silviculture, or minor products collecting, that seems possible in a rain forest.

Focus on the rain forest; some figures. — The primary forests hold our attention here, because they contain the largest numbers of species, and are therefore likely to contain the largest numbers of (potentially) useful plants as well. It is difficult but not impossible to make an educated guess about these numbers, not anyway in Malaya, thanks to a far advanced state of inventory of the flora and to Burkill's famous Dictionary. A count made in this book, native plants only, revealed a total of c. 2432 species in 1061 genera that are useful in some or other way. To get a closer idea of the significance of the rain forests as 'shopping centres' for useful plants — part of which are (potentially) useful enough to be regarded as 'minor product species' — a further count was made, with taxa listed.

From this count were excluded a) taxa confined to non-rain forest habitats, b) taxa confined to mountains, c) cryptogams, d) taxa known to furnish only timber, e) aliens. Thus the selection was narrowed down as well as possible to the native useful non-timber seed plants of the lowland primary dryland forests in Malaya: there turned out to be c. 1283 species in 503 genera. This is just about half the total of useful plant species and genera, or 16% of all native species in Malaya (which, according to Hsuan Keng, Mal. Nat. J. 28: 28. 1974, contains c. 8000 species, seed plants only) in terms of species, and 32% of all genera. If these figures hold good for the rain forests in general, our educated guess points to 1 species in about 6 that somehow has been known as useful for non-timber purposes, and that 1 in 3 genera contains at least one useful species. Burkill incorporated few ornamentals, and probably not enough food plants from the forest; the rates are higher in that case.

For a count of medicinal plants, we have the booklet by M. J. v a n S t e e n i s - K r u s e m a n, Select Indonesian medicinal plants (1953). Virtually all the 306 species in it occur in Java, 303 of them are vascular plants. These represent 4.6% of the total given in the Flora of Java (vol. 2 table 1) as 6534 species. For species native in Java, the respective figures are 99, 4.4%, and 4598 species. The percentages carry weight in view of the expert selection of the species. The 858 species of the Philippines dealt with by Quisumbing would represent about 10% of the species there, the total of which may be something like 8500, aliens included. So an estimate of 4½% of all species as medicinal seems a responsible minimum. If we presume, as a very rough estimate, that of all the species about half occur in the lowland primary rain forests, which would be c. 4000 in Malaya, 5000 in Borneo, 4000 in New Guinea (where many oc-

cur at higher altitudes), then the rain forests in Malaya and New Guinea might well contain 180 important medicinal species each, and those in Borneo 200. There may be more, and as many rain forest species are endemics, there would be little overlap.

The paradox of logging. — When a decision is to be made about the destiny of a tract of primary forest which for some unfortunate reason cannot be kept intact, the prospects of exploitation for minor products should weigh heavily, to the exclusion of logging. Logging does three things to the forest ecosystem which minor products collecting does not, a) damage the canopy, b) damage the soil, c) carry off minerals in large quantity.

In fact, the study of minor forest products places the exploitation of rain forests in an entirely different light. The present-day picture of this exploitation reveals a strong fixation on timber. This is strange, because the rain forests are so evidently unsuited to timber exploitation. Logging is feasible in species-poor, renewable forests, such as abound in temperate regions. In the species-rich, non-renewable forests, where trees of a species are widely spaced, the situation is very different. A finely tuned, slow-moving ecosystem, a factory capable of turning out hundreds of exquisite and often irreplaceable products with utmost economy of inorganic matter, is ripped open by bulldozers and chainsaws to pull out the very pillars supporting its roof. In a notoriously wasteful process, quantities of scarce minerals that the ecosystem might be able to convert into fruits, latex, medicine, spices, stimulants and other precious articles, get lost. A mere fraction of the economic species is used for timber; to obtain them, all others are left to their fate. It seems almost too clumsy an approach to spend any more words on .... not to mention the complete removal of such a multi-purpose ecosystem for replacement by (often ephemeral) agricultural crops. Future critics may stand in amazement about such destruction of diversity for such a low percentage of it.

Indeed, this pre-occupation with timber — which may be a short-lived one anyway because of resource destruction — is a recent phenomenon in history. Till well into the 19th century, not extraction of timber was the prevalent way of rain forest utilization, but collection of minor products. An interesting reconstruction of the activities of Rain forest collectors and traders in Malaya, from c. 20,000 years ago, was made by F.L. Dunn in a 151-page book under this title (1975; Monographs of the Malaysian Branch of the Royal Asiatic Society, number 5, Kuala Lumpur). Almost throughout history, utilization other than shifting cultivation touched the forests but lightly and over a broad spectrum, by taking a little of many species. Large-scale logging and conscious efforts in tropical forestry to alter the forest composition by killing many unwanted species through 'silvicultural measures' are scarcely older than a century.

Chronology of standard works on Malesia. — Efforts to improve the sporadic interest will all require a familiarity with the standard books. They are the following:

c. 1917, Indonesia. K. HEYNE, De nuttige planten van Nederlandsch-Indië. Volume 1 (1913) was re-published in a new edition in 1922. This and vol. 2 (1916), 3 (1917), and 4 (1917) are all separately paged.* A supplement with catalogue and indexes, announced, was not seen.

Heyne (see Fl. Males. i 1: 230. 1950, i 4: cliv-clv. 1948) prepared this work in his capacity as director of the Museum for Economic Botany in Bogor (1906-1927). The materials in this museum, to which frequent reference is made in his book, are no longer there. Herbarium material is in the Forest Research Institute, Bogor. He received much botanical help from C.A. Backer.

The number of species dealt with is c. 3000, including cryptogams; no ornamentals are incorporated, nor are animals. The system follows Engler-Prantl and De Dalla Torre-Harms; the genera are numbered accordingly.

c. 1920, Philippines. W.H. BROWN, Minor products of the Philippine forests, 3 vol. (Bureau of Forestry Bulletin 22, consisting of Bulletins 15-21, 1918-1920, with additions incorporated).

Only plants are dealt with. Volume 1 (1920) describes mangrove species with their products; palms with their products; bamboos; fiber plants. Volume 2 (1921) deals with resins, gum, seed oils, essential oils; wild food plants; natural dyes. Volume 3 (1921) deals with ornamental plants; soap substitutes; medicinal plants in pharmacopoeas; poisonous plants; other useful plants; edible fungi; indigenous medicinal uses. This volume contains one comprehensive index, which under each species denotes the sort of use, and gives many vernacular names.

A practically-minded book. The 'forests' is taken in a very wide sense. Many aliens are also discussed. The text is easy to read, the lay-out clear. A fair amount of illustrations are given, and a limited number of sources.

1927, Indonesia. K. HEYNE, De nuttige planten van Nederlandsch Indië, 2nd ed., 1662 + ccxli pages, in 3 parts. The last part contains the indexes, namely of products in 40 (sub)categories, of botanical names and of scientific names.

This edition was revised and updated in several places, but is essentially similar to the former. Plates were made for this edition, but were never published.

1935, Malaya. I.H. BURKILL, A dictionary of the economic products of the Malay Peninsula, xi + 2402 pages, in two parts.

Plants (including timber) and in smaller numbers animals and minerals are dealt with under generic or common name, in alphabetical order. Brief characteristics of habit, affinity, occurrence or origin (many aliens are incorporated), and usefulness are summed up first in general terms, then often more extensively under the species. A mine of information, rich in

* Dr. F.S.P. Ng, Forest Research Institute, Kepong, Malaya, located a type-written copy of an English translation of the 1st edition (1913—1917), which starts with the Cycadaceae. It is now being re-typed and can be made available to a limited number of subscribers.

historical detail, with many interesting particulars. The index covers only the vernacular names. An Index to Genera under Family, recently prepared by W. Rodenburg, is available at the Rijksherbarium, Box 9514, Leiden, The Netherlands. An index to products is still needed.

After having assisted George Watt for 11 years in the study of economic plants in India, Burkill was Director of the Singapore Herbarium from 1912 to 1925, and worked on this book throughout; he finalized it at Kew, which took him another 9 years. He wrote many papers on economic botany; see his bibliography in Gard. Bull. 22 (1967) 71-105.

1939, Indonesia. E. MEIJER DREES 'On sources, uses and destination of the more important minor forest products of the Netherlands Indies', Tectona 32: 920-1017. Text in Dutch, summary in English.

Overview of the main non-wood products of the indigenous forests, in 27 (sub)categories, namely: 1) Rattan, 2) Resins, a. benzoin from Styrax, b. kopal from Agathis, c. dragon's blood from Daemonorops, d. damar from Dipterocarpaceae, e. resin and turpentine from Pinus, f. camphor from Dryobalanops, 3) Gutta-percha from Sapotaceae, 4) Caoutchouc, a. from jelutong, Dyera, b. from Willughbeia, 5) Sago, 6) Fat-containing seeds, a. illipe from Palaquium, b. tengkawang from Shorea, 7) Drugs and spices, a. fruits of Cassia fistula, b. nutmeg and mace, c. cardamon, d. cinnamon, 8) volatile oils, a. kayu putih from Melaleuca, b. lawang bark from Cinnamomum, c. massoia from Cryptocarya, 9) Tannins, from mangrove, 10) Others, a. sandalwood, b. incense woods, c. basketry, d. pulai bark, from Alstonia, e. deluang paper, from Broussonetia. Under each category is given: main literature, characteristics, products, utilization, and commercial statistics (a total of 103 tables).

This paper is preceded by an article by H. COHEN on the economic value of the minor forest products of Indonesia outside Java: Tectona 32 (1939) 883-910, with many more statistics, covering the period 1928-1938.

1950, Indonesia. K. HEYNE, De nuttige planten van Indonesië, 3rd ed., 1662 + ccxli pages, in 2 parts. Except the modernized spelling, and omission of the numbers of families and genera, this edition is similar to the former, but re-typeset, with the same pagination.

1951, Philippines. E. QUISUMBING, Medicinal plants of the Philippines, 1234 pages.

Arrangement according to Engler-Prantl. Information is given on 858 species, cryptogams included, and plants from all vegetations. Synonyms and vernacular names are given, brief notes on distribution and habit. Data on use have been brought together from 630 listed sources, nearly all from before 1941. Indexes are given to therapeutic properties (116 categories), disease to be cured (126), vernacular names, scientific names. Illustrations were made but got lost, only the manuscript was saved by the author's son.

1953, Philippines. W.H. BROWN, Minor products ...., verbatim reprint (Manila), 2 volumes seen; I am in doubt about volume 3.

1966, Malaya. I.H. BURKILL, A dictionary ...., 2nd ed., xiv + 2444 pages, in two parts. Similar to the one of 1935, but containing corrections and additions, up to 1962; this caused a shift in pagination.

1980, Malesia. L.M. PERRY, Medicinal plants of East and Southeast Asia: Attributed properties and uses, ix + 620 pages.

Impressive compilation on flowering plants and ferns, from 910 references. Covers China, Burma, Thailand, Indo-China, and the whole of Malesia. Arrangement alphabetical by family. Country of use is indicated, use epitomized in running text. Therapeutic properties are indexed in 94 categories, disorders to be cured in 93 categories. The closing date was 1961.

A mixed bag of knowledge. — We see that the main bodies of knowledge are old: over 45 years for Malaya, c. 65 years for Indonesia and the Philippines.

Even these highly reputed works, which absorbed immense amounts of critical investigation are, however, shot through with compilation of sometimes much older data. Copywork exists side by side with authentical fresh information. Most authors took great pains indeed to segregate the two. Sources may be excellent and venerated, like Rumphius. He began work in Ambon in 1657, where he died in 1702. His books were mostly concluded in 1690, and published between 1741 and 1755. Of the about 1700 plant taxa in them have been useful at the time, and since Heyne meticulously digested Rumphius's works, and incorporated what he found necessary to supplement his other data, an estimate that information on something like 300 and 600 Rumphian species found its way into Heyne's book may not be far off the mark. If correct, this would mean that 10-20% of the species as treated by Heyne owe something to Rumphius, two and a half centuries previously. Although many uses well may have persisted for even longer, there has never been any verification in the Moluccas and surrounding islands whence Rumphius received materials. Burkill compiled impressive amounts of information from 19th century sources, which he verified as well as he could, but many questions, often concerning minor uses, had to be left open. The uses themselves probably vary with the circumstances: in times of hardship, people will reach down to levels of preference far lower than in times of prosperity. Recent increase of wealth has no doubt caused people to leave many plants alone; future famine no doubt will change that .... if the plants have not been destroyed through 'development' projects.

An overview of the relevant fields. — Research on traditional use of plants involved long assignments. The scarcity of handy data on useful plants finds its cause in the difficulty to gather data in a critical manner from several very different fields, namely:

1) the technical field. What is the nature of products used, what is their origin, and how are they manufactured? This has to be done over a whole country or even block of countries,

2) the ethnological field. What are the cultural and spiritual relationships between people and plants? Often relationships are occasional

(in time of famine), or periodical (at harvest time, or at rare ceremonies), and little known outside a small community. While several tribes and some individuals no doubt possess and could transfer a vast store of knowledge on traditional use of plants that are of great potential for wider utilization — it is in this way, after all, that most of our familiar tropical products became known — this knowledge needs conversion into international scientific terms to be wider applicable,

3) the botanical field. Products must be traced to the living individual plants that supply them. These must be identified on account of voucher specimens, which are to be deposited in a number of Herbaria for reference. These vouchers must carry flower or fruit to serve their purpose; collecting them may require a long time of watchful presence of a trusted person in a district. Estimates of local occurrence will also be welcome,

4) ecological aspects are in the standard literature unevenly covered. Some specialized papers tell in detail the type of forest in which e.g. incense wood is to be found, or ebony for carving. In general, however, it is not possible to compile from literature a list of useful species for the various vegetation types primary and secondary, that can be called reliable or complete. As for altitudinal distribution, the situation is no better. Often an experienced botanist can relate a genus to those vegetation types where it is best-represented, but quantitative estimates can, at present, be responsible approaches only. Consultation of labels in Herbaria, however, will be productive in a number of cases,

5) the aspects of trade. Since a variety of minor forest products change hands in the context of small-scale rural economies, there is a general absence of statistics. The figures that are available, like those on inter-island trade, reflect in no way the importance of products for local utilization,

6) the field of literature is there to reckon with. Burkill, in the preface to his Dictionary, complained that the literature "has grown so large that it is difficult to use to the full even where libraries are well stocked, and it is altogether out of the reach of those who live in remote places." Apparently, Singapore was one of these: Burkill laboured for 3 years in the Kew library just to complete his slip-index and to sort out questions for his four correspondents in Malaya; it took another 6 years before all answers were in. This was in 1935, and things have not grown easier since that time, due to developments in

7) the phytochemical field. Sophistication in methods of analysis and synthesis, and advances in biochemistry and molecular biology have opened up new horizons, and made possible an understanding of all sorts of connections with medicine. Many an ancient way of application thus might provide a clue to a modern appreciation in phytochemical terms.

Authors like Heyne and Burkill operated effectively in several of those fields, by mastering enough of them to made critical assessments, and to bring the results together in a balanced way. They did so single-handed for a good deal, and this may have accounted for the fact that they were able to keep the subject matter within the limits of one hand-

book of encyclopaedic qualities. If this could be done again to day at all, it would require a team led by a superb organizer of people and of information.

A threefold approach in order. — The study of minor forest products should be continued vigorously, to make a balanced and durable utilization of vegetable resources possible, if care is taken to prevent their extinction. We saw that the standard works which still contain most of the information are pretty old, and that part of their information is even much older.

On the one hand a use, once established, tends to persist for a very long period; on the other, there are significant ups and downs. One factor is changes in the economy, where prosperity leads to a rather different spectrum of consumption than do scarcity or famine. Another factor is changes in long-distance trade, when new markets are opened up or closed. A third factor is new developments in pharmaceutical and chemical industries, which have led, for instance, to an obsolescence of many dyes, but an increase of demand for certain alkaloids. Sometime a product vanishes from the market because the supply has come to an end; Burkill cites quite a number of such cases due to overexploitation.

Thus a threefold approach emerges: i) updating and extending the available knowledge, ii) conserving the resource, iii) developing the resource.

i) Updating and extending the available knowledge. Beginning with an inventory of literature subsequent to the main standard works, information is to be collected. This will eventually result in a picture which gives us at least an idea of the present state of affairs in the 7 rather different fields.

This updating would already be a huge effort in itself. New estimates must be made in the technical field. The ethnological field needs exploration almost from scratch. Some ethnologists, who have an embryonic interest in botany, could be stimulated and educated so that they can communicate between their peoples and Herbaria. The latter are to extend their manpower to supply identifications, and also some special exploration efforts will be needed, to locate useful species beyond doubt. Much verification of older sources, too will have to be done. In certain groups rich in useful plants, taxonomic work would have to be sped up, as is now being done in rattans. But Apocynaceae, Leguminosae, and Myrtaceae, deserve priority as well. Watching the trade in products and gathering statistics for a good span of years would also keep quite a few persons busy.

All told, the effort will be a complex one, as activity in many fields is needed for an even progress. The result should be a number of manuals of clever design, each of them dealing with a clearly defined portion of the subject.

ii) Conservation of the resource. It is a strange thing that protection of rain forest from logging in favour of collection of minor products seems hardly to have entered conservation philosophy. Now that a hardwood famine is imminent in countries like Malaya and the Philippines,

responsible people may come to take a second look at patterns of rain forest exploitation. They are likely to discover, that in the long run the harvest in limited quantity of the many non-timber products like rattan, resin, alkaloids &c. may be much more economical than logging. But the onslaught on the forests for timber and conversion is such, that time is running out or big sectors of the resource will be damaged beyond repair. Where a choice still is possible between giving out a tract of forest for logging or for minor products exploitation, it seems wise to opt for the latter; the reasons have been explained.

Such forests will be degraded in the process, to be sure, and they are to be regarded as 'production forest', only is production better tuned to the ecological reality of the forest, and much more diverse in kind. The timber inside is to be kept to make possible the 'minor production' which, when properly regulated, can last for quite a number of generations.

Strictly protected forests are needed besides, to ensure a continuous supply of genetic materials to make cultivation possible ad infinitum. The whole spectrum of species is to be kept intact; this requires absolute protection of habitat. Seeds can be gathered in limited quantity for nursery outside these 'protection' forests.

iii) Development of the resource. We may expect that, in addition to customary uses which support a rural economy in so many unobtrusive ways, demand will focus on all sorts of chemical substances, located in both plants and animals. Considerable primary scanning for anti-cancer drugs is in progress; see e.g. the account by Perdue & Hartwell (Cancer Treatment Reports 66: 973-1215. 1976) mentioned on *page 3079*. The spectrum of medicinal uses in general is broadening constantly at that. Other ways of utilization in the sector of pheromones (i.e. substances secreted by insects in minute quantities which can be used to lure other individuals for destruction) seem within reach.

It seems evident that demand on any commercial scale can only be met through cultivation of the species. While a certain amount of experience has been built up since Junghuhn and Teijsmann pioneered in Cinchona cultivation from the 1850's; see 'Chapters in the History of Cinchona' in P. Honig & F. Verdoorn, Science and Scientists in the Netherlands Indies (1945) p. 181-207.

The final paragraph is worth quoting. "Cinchona culture in Java has come a long way from the indiscriminate slashing of quina trees in the forests of the Amazonian Andes. For more than two hundred years ruthless and quite reckless cutting threatened the only source of quinine known in the world. To guard against that disaster the first tentative efforts at cultivation seem now a pitiful and ineffectual gesture. But persistence, skill, and scientific coordination of plant scientists, chemists, geneticists, manufacturers and soil scientists has transformed experimental procedures into a highly organized and productive industry. Not the least satisfaction in such an enterprise is that this welding of modern science and native skills, produces a world remedy perhaps procurable in no other way" (p. 207). Resistance against quina in still least of all drugs.

Can the tradition be resumed? — For several decades now, plans have circulated for a revised edition of Heyne, and nothing tangible has appeared. We may as well wonder if such an effort would be feasible. Brown, Heyne, and Burkill have not found successors. As conditions are at present, there is no way of producing a comprehensive work on useful plants.

Yet it seems wise to keep up the scientific study of this broad base of common interest to all who consume products derived in whatever way from the tropical rain forest. How could the threefold approach be made workable?

As for conservation, much is in progress. Things could be better, of course, and the link between rattan utilization and conservation is still to be established in practice; so is the link between extraction of medicinal plants and of fruit tree genetic material.

As for updating knowledge and development of the resource, a firm beginning has been made with rattan, with bamboo in its wake, and this could well serve as a model for other sectors. For instance, Leguminosae would make an excellent choice for studies in the field of non-timber utilization, in concurrence with the taxonomic work being done. It fulfills all the requirements of being a large group, well-known in agriculture and forestry, well-recognizeable, yielding a great variety of products many of which are already known in the market, domestically and abroad.

Carving out a project which is both feasible and useful will require much thought and ability to plan. Broader investigation of economic plants in a whole region, too, has its challenges, and great potential to benefit a local population who is not rich and rather directly dependent on the biotic environment. One region to consider might be the Moluccas; little has changed there (comparatively) since the time of Rumphius. The plant and animal world is not so rich as to pose great identification problems; much good forest is still there; updating knowledge and development of the resource in this part of Malesia — where land use planning is still in its infancy — seems possible there better than elsewhere. The Lesser Sunda Islands might make another suitable area, although it is much more strongly seasonal. Knowledge of the plant world has greatly increased of late, and also the local plant names have been well-researched. One fine example of an ethno-ecological study is the book by J. J. F o x, Harvest of the palm (Harvard 1977), about Borassus and Corypha utilization in three islets between Sumba and Timor.

Summary: a new outlook. — We conclude that the study of minor forest products has much to contribute to tropical forestry. Species from secondary formations are receiving attention for reforestation, firewood, agroforestry, or soil improvement. Also the mangrove is object of concern, increasingly so as a multipurpose ecosystem. There is a clear interest in rattan (belonging to the primary everwet forests) and also in bamboo (of the seasonal formations). But other non-timber species and their products seem at present in rather bad neglect, from scientists as well as from foresters and planners for development.

The primary forests of Malesia, which harbour most of the world's

stock of rattan and fruit trees, and an enormous spectrum of medicinal and other useful species of which the products have a place in many markets, are now being subjected to logging, shifting cultivation, and conversion into plantations, that this non-timber resources are heavily endangered. One factor in the degradation is the (historically recent) preoccupation with timber on the part of foresters and economists. However, because of their species-richness and generally poor soil, tropical rain forests seem far better adapted to minor products collection (whereby a little is taken from many species) than to logging (whereby much is taken from a few species, with heavy damage to canopy and soil). A new look at rain forest exploitation seems therefore in order.

A large body about useful plants in Malesia has been brought together in an encyclopaedic tradition which gave rise to the standard works by Brown, Heyne, and Burkill. This tradition seems to have come to an end. Based on these works, new attempts to study useful plants of rain forests might be feasible, if wise limitations are imposed, by concentrating on a region, an ethnological group, a plant family, a category of products, or a habitat. Serious application of the results could provide an alternative to logging as a way of utilization, which would make the forests last longer, and might generate a far greater variety of economic benefits in different social strata.

Cultivation of species for minor products deserves continuous attention, for which cocoa, kina, rubber, vanilla and others furnish examples. Renewed study of minor forest products will require effective institutional strengthening, in close association with Herbaria to supply the taxonomic knowledge needed. For such many-species utilization — which must not touch on virgin forest reserves — large tracts of primary forest will have to be saved from logging. If genetic material from reserves or otherwise is to be made available in a commercial context, it should be priced adequately.

Rijksherbarium, Leiden M. Jacobs

P.S. A Dutch forester, J. A. L a s s c h u i t (1909-1980), collected many data on minor forest products from literature and in the field, particularly for Malesia but also for Latin America. His notes have been ordered, and are being summarized in a synthesizing report in English. It is prepared under supervision of Professor M.M.G.R. Bol, Hinkeloord, Foulkesweg 64, Wageningen, The Netherlands.