XI. THE STUDY OF LIANAS

Take almost any profile diagram of rain forest and it reveals you the neglect: nothing but trees. Even in Flora Malesiana* the manner of their climbing is not always indicated. Foresters regard them as weeds and persecute them systematically (see FOX 1968), which subjects them to extra dangers beyond the 'normal' forest devastation. This makes them perhaps the most threatened life form amongst plants. Yet it is good to remember that two of the main climber families, Menispermaceae and Piperaceae, contain an extraordinary variety of interesting chemical substances (see HEGNAUER in the reference list). For this same reason it is risky to drink water from Menispermaceae trunks, as can be done by holding up a fresh-cut piece of 1-1½ m (Piperaceae are slenderer). Rattans, which are largely bound to primary forest, are of course well known, also economically. Horticulturists have taken hundreds of ornamental climbers in cultivation, on which MENNINGER produced a large popular book, with quite a body of practical knowledge.

Lianas (i.e. the larger woody vines) occur in a great number of families, although concentrated in about a dozen; taxonomically as well as morphologically they are heterogeneous. They are a main feature of the tropical forests, where according to an old estimate, they make up 8% of the flora, far less so in the temperate forest (about 2% of a much poorer flora). MEIJER (quoted by FOX, 1968) estimated their number for Sabah alone at 150 genera: 13 in the Asclepiadaceae, 12 in the Menispermaceae, 10 in the Rubiaceae, 9 in the Apocynaceae, 9 in the Leguminosae, 8 in the Annonaceae. As for numbers of individuals, in Sabah, FOX (1969) found on ten plots of 0.4 hectares in typical lowland dipterocarp forest an average of 839 climbers (range 472-1146); out of these 690 (range 380-1003) were thinner than 2½ cm, while 56 (range 28-91) were thicker than 5 cm.

In the ecology of the forest, their role is big, and two-

* Genera containing lianas written up in Flora Malesiana are: Actinidia, Adenia, Agatea, Agelaea, Ancistrocladus, Argyreia, Aspidopterys, Bonamia, Bougainvillea, Cardiopteris, Celastrus, Cnestis, Combretum, Connarus, Dapania, Dichapetalum, Dioscorea, Enkleia, Erycibe, Fagraea, Gardneria, Gelsemium, Gnetum, Hiptage, Hollrungia, Iodes, Ipomoea, Jacquemontia, Linostoma, Loeseneriella, Lonicera, Lophopyxis, Miquelia, Neuropeltis, Operculiana, Passiflora, Phytocrene, Polyporandra, Porana, Pyrenacantha, Quisqualis, Reissantia, Rhyssopterys, Rourea, Roureopsis, Salacia, Sarcostigma, Scaevola, Stenomeris, Stictocardia, Strychnos, Tetracera, Tristellateia.

fold, perhaps threefold. First, they help close the canopy, thereby stabilizing the microclimate underneath, and the density of a 'vegetable blanket' of Convolvulaceae, Cucurbitaceae, Dioscoreaceae and others over secondary forest suggests that this effect must be considerable. Second, they tie the tree crowns together, giving the canopy more coherence, much to the chagrin of foresters, who find that big climbers contribute considerably to damage during logging. FOX (1968) made a (somewhat improvised and preliminary) experiment to cut liana stems 7 months before logging; this led to a crown damage of 43.7% vs. 61.7% in the untreated plots. They also annoy the foresters as they "may smother seedlings, damage poles and sometimes form tangles through which the regeneration, if it is to succeed, must emerge" (FOX 1968). In case of moderate wind and soil creep, they will help the trees to stand up, but under very severe conditions will be counterproductive as they may cause whole clumps of trees to come down. Third, they may facilitate the movement of animals through the canopy. In view of the enormous effects of man's mobility on his environment and society, we may presume that the effects of lianas as traffic arteries on the forest ecosystem and on populations of plants and animals are considerable.

No one less than Charles DARWIN studied climbing behaviour, in a series of clever, elegant experiments on plants available to him; most of these are indigenous in Britain, a number of them (sub)tropical. Since he was interested in plant movements, he concentrated on twiners and tendrilbearers. He gave a thorough review of the previous literature. His book is a delight to read, and offers ideas for similar work in Malesia, for which the flora has limitless potential. The physiology of the movements of twig tops and tendrils has been investigated by BREMEKAMP who studied the rotation of Ipomoea purpurea stem tips by means of a clinostat, by KONINGSBERGER who studied the effects of light of different wave length, and by KONING, who further analysed the rotation of Ipomoea, distinguishing four components in the motion. Further physiological work I know of, deals with the rise of sap: SCHOLANDER.

The classic on lianas is a monumental volume by SCHENCK, who studied them in the field in Brazil. As general characteristics he names the long internodes with very small leaves on the climbing shoots; the shorter fertile branches come later. Leaf shape is often cordate to peltate, venation palmate. A list of families is given with their climbing tribes or genera, compiled from B & H and E & P, with indication of mode of climbing and rough distribution, followed by a summary of occurrence of climbers, in the plant kingdom and over the globe, with remarks: Apocynaceae have tendrils in the Old World only, lianas and epiphytes mostly occur together, outside the tropics especially in humid climates. On climbing device, groups are distinguished which are discussed: scramblers, root-climbers, twiners, tendril-bearers (including those with sensitive twigs, which are confined to the tropics and had been described only in 1867, by MÜLLER). Schenck then deals with the anatomy, characterized by 'anomalous' secondary thickening and often the arrangement of vascular bundles in strands. He distinguishes 5 main groups and 17 subgroups of cambium distribution and secondary thickening (one group confined to the Sapindaceae which in S. America belong to the main liana families together with Bignoniaceae, Leguminosae, and Malpighiaceae). He discusses the purpose of the peculiar stem structures, to stand pulling, kinking and twisting. He also points to the storage capacity of the copious parenchyma in the stems, which enables the tissue to live long, like in one piece of ½ m by 5 cm which was well after four months, and even relates a case of two years' survival. In about 60 families, samples are described and literature reviewed. One remarkable finding was that liana roots often reflect the anatomy of the stems.

Much later work leans heavily on Schenck. SCHIMPER with whom he cooperated summarized his results in the Pflanzengeographie, which is also available in English. Two extensive studies in German were subsequently made: PFEIFFER perfected the <u>anatomy</u> of abnormal secondary thickening, and so did TROLL to the <u>morphology</u> of the climbing apparatus. I don't think, however, that they made spectacular additions. Worth mentioning is TIREL-ROUDET, who studied the tendrils of Strychnos, on which Troll was still in doubt, and showed them to be of inflorescential nature. On the tendrils of Smilax I know of no agreements. For several reasons — a shoot may first attach by twining (Hoya) or by tendrils (Bignonia) before roots crop out; morphological interpretations of organs differ — classifications of lianas according to climbing apparatus vary. Certainly much about relationships and evolutionary trends is yet to be defined.

The most remarkable feature is the least discussed, namely the <u>absence of any obvious contraptions</u> in some successful climbers. True, it is known that climbers, once established high up in a tree, don't bother any more to produce climbing apparatus; one then is lucky to find some on an occasional branch that found reason to grow on. But it is possible that a climber fixes itself only with strong patent branches, especially when these sprout from opposite leaf axils. However, this feature of patent branches I met in very many climbers, including those which did have contraptions.

Collecting climbers is a sport of its own, in which JACOBS indulged in Papua New Guinea in 1973, and soon understood why good material in herbaria is so scarce. So much care is required that only the responsible botanist of an expedition can do it, and for this purpose the supporting tree(s) must be felled. In the ensuing crash, the fast-growing tender young parts, which may bear a characteristic indumentum, are easily broken or crushed, and it takes time to make 6-8 equal duplicates. It may be very hard to find the typical climbing contraptions, for reasons just indicated. Variation in foliage, of course, must be looked for. This done, the taking of wood samples can begin; the more liana species are in the tree, the trickier this is. One begins at the top, tracking the stems downwards along the fallen tree, which is done by pulling and counter-pulling. At all major junctions, a chunk half a metre long is cut from the stem, so as to preserve a representative series of sections from top to bottom, preferably with the axil of a branch. The harvest of wood samples is bound together with string, under addition of a twig of the liana, to certify the identity; bark characters cannot be relied on, and cross section patterns differ widely at the various heights. In collecting stolons — which in e.g. Faradaya may creep 5-8 m over the ground before going up in another tree — one cannot be meticulous enough in establishing the identity, and all doubtful material must be discarded. In the camp, each piece is to be provided with a tag, and the wood samples are cut to the required size, with a saw, as a parang would damage the delicate anatomical structure. Marking the wood samples gives problems since a number cannot be stamped or inscribed upon these soft tissues, and a tag may come off. For drying, you can roll some adhesive Scotch tape around the sample, on which the number can be inscribed with a felt pen, several times. A double folded tag with the number in pencil on the facing surfaces can be fixed under the tape as an extra precaution. But in the drying the samples shrivel to as much as half their diameter; what a wood anatomist will particularly appreciate is samples in alcohol 70%. If up to an inch thick, these can be placed in bottles; thicker ones can be put in plastic net of the sort in which oranges and potatoes are sold in the supermarket. For 25 dollars a roll can be bought holding several hundreds of metres; a piece is cut off, and the ends are closed with a knot. Tag-labels in liquid soften and get illegible when bruised, so always 2 or 3 must be attached. Still better is a piece of bamboo as H.O. Forbes applied in which a neck has been cut for string, and is inscribed with hard pencil. A number of such nets go in a plastic container of 10-15 litres as zoologists use. Large fruits can conveniently be packed in the same manner, and since fruits, too, have been so badly neglected in the collecting, many novelties are sure to be the reward.

A good day of work in lowland primary forest may yield 4-5 species of lianas, complete material. Most of these are canopy climbers. After heavy logging, when only broken stumps of non-commercial trees are left, these are quickly overgrown with lianas, and full of expectation I spent several days to search some of such sites. I was disappointed: the liana harvest was poor in comparison with undisturbed forest. This is also suggested by FOX (1968): "Mesoneuron and Uncaria are very abundant in logged over forest, being capable of growing on bare ground, as also is Merremia borneensis as very common climber after logging all of which are much less common in virgin forest." So it seems safe to say that logging seems harmful to the liana flora.

As is well known, many species, especially under drier conditions, begin their life as shrubs, to develop into tall climbers when they find support. BRETELER gives photographs showing the main stem of one species of Dichapetalum, which as a shrub on section has an entire xylem cylinder like any tree, whereas in the climbing stem it is deeply lobed as lianas often have; in another species the stouter lianescent stem has deeper lobed xylem than the thinner one has. More typical xeromorphic structures, like the swollen stem base of Neoalsomitra podagrica, may hold anatomical surprises as well.

Recent comparative anatomical work has been done by Miss MENNEGA (on New World material), who was kind enough to bring under my attention the large study made by Madeleine OBATON (on Ivory Coast material). The useful distinction between canopy and understorey lianas was not made by Obaton, and she studied only thin branches. She gives an interesting historical account of climber anatomy, then proceeds to describe 7 'abnormal' types of wood arrangement in liana stems: 1 flat and lobed (Landolphia), 2 grooved (Salacia bipindensis), 3 punctuated (Strychnos), 4 with concentric rings (Salacia cornifolia), 5 wood torn up (Iodes), 6 wood scattered (Afromendoncia), 7 peripheral (Paullinia). This is followed by a systematic treatment of families, with occurrence of these types, in young and adult twigs compared, viz Acanthaceae, Apocynaceae, Aristolochiaceae, Celastraceae, Combretaceae, Connaraceae, Convolvulaceae, Icacinaceae, Loganiaceae, Malpighiaceae, Menispermaceae, Mimosaceae, Papilionaceae, Passifloraceae, Rubiaceae, Sapindaceae. General conclusions are given and compared to those of other authors; as is evident from the above, there is no relation between type and taxonomy. There is a considerable bibliography; much of the older literature can also be found through REHDER.

A new line of enquiry, most valuable for a good understanding and precise description, was opened up by CREMERS, who studied blastogeny and architecture. Cremers, too, worked on Ivory Coast, stimulated by Hallé in connection with the latter's studies on tree architecture. Cremers sowed liana seeds in cultivation and studied the sequence of development stages called blastogeny, which he tried to correlate with the tree types distinguished by Hallé & Oldeman (see page 2371); he reported on 20 species, in Ancistrocladaceae, Annonaceae, Apocynaceae, Celastraceae, Dioncophyllaceae, Icacinaceae (5 types!), Loganiaceae, Menispermaceae, Myristicaceae, Passifloraceae, Polygalaceae, Polygonaceae, Rhamnaceae (2 types!), Sapindaceae. The points of diversity in architecture are: leaf position, position of buds, degree of development of parts, direction of parts, modification of parts, position of inflorescences. In general can be distinguished between a juvenile stage and a lianescent stage (compared character by character at the end), often connected by transitions, all are carefully analysed, described, summarized, and figured. The fertile stages come later and are mostly not considered.

Cremers found 9 species out of his 20 of which the architecture could be correlated to Hallé-Oldeman tree models; by adding 4 he arrived at 13, leaving 11 tree models unmatched. The remaining 11 unmatched liana models appeared to have an architecture of their own. This also holds good for the many root climbers, which are still to be studied. His paper concludes with a brief but valuable review of relevant literature, a synopsis of the types (showing that here, too, taxonomic correlations are not impressive), and a few phylogenetic considerations, related to those of L. Diels, Jugendformen und Blütenreife im Pflanzenreich (1906), not cited. When well-collected material is present, it should be possible to assign Malesian lianas, too, to these models, and perhaps find a couple more.

As for phytochemistry, another promising field, HEGNAUER has eloquently explained the value of secondary metabolites (plant substances not needed for the essential primary metabolism) in the plant's own ecological relations, as well as to agriculture and industry. He kindly informed me that in Menispermaceae two genera are of current interest: Cocculus for alkaloids with hypotensive and anti-tumour effects, and also with a repellent effect on phytophagous insects; and Dioscoreophyllum, for a substance 1500 times more sweet than sugar, in the fruits of D. cumminsii of tropical Africa. The substance, which may be a polypeptide, occurs in the fruits. Connaraceae, another well-known family of climbers, were in SW. Africa found to contain substances toxic to bacteria. It would be foolish not to preserve a phytochemical reservoir of perhaps 8% of the tropical plants and to eradicate it instead.

Rattans, of course, make a subject of their own. CORNER wrote a fine general chapter on them, concluding with the words that "Burkill's account of them (in the Dictionary) should be enjoyed as well as the botanical preface to Beccari's monograph on Calamus." They are typically primary forest creatures, centered in Malesia, where their products widely support the economy; it is also the only group of lianas that currently receives attention, by Dr. J. Dransfield at Kew.

The ecology of lianas is virtually a blank. The paper by LEBRUN carries ecology only in the title; otherwise it names a number of Congo lianas with some details according to the manner of climbing. Some good remarks were made by SCHENCK. In his book on the rain forest, RICHARDS gave a fine general summing up, with sensible remarks, but this is only a beginning. (In a letter full of welcome information, Professor Richards asserted that "... lianas are very important in the dynamics of the forest community and of course are also very interesting in many other ways ... if I were younger and had the opportunity I would certainly like to work on them.") Some significant observations are found in papers by JANZEN, who noted that ants bite off tips of lianas which otherwise might smother the tree on which the ants live (1969), and that lianas which must grow fast and therefore need nutrients are conspicuously absent on the poorest soils (1974). The only ecological paper listed in the Kew Catalogue is by VAN STEENIS, who described cases where the supporting plants, mostly in secondary vegetation, break down under the weight of the fast-growing climbers they must carry. Such climbers can also be very noxious in agriculture.

We have ample reason to suppose that ecological work on lianas will have a bearing on forest management. FOX (1969), too, says that "a lot of work is necessary on the silvicultural characteristics of the species of climbers present." On theoretical grounds, I suspect that a primary forest full of lianas differs greatly from one cleared of lianas, in microclimate and in fauna, hence in plant regeneration and in the recycling of minerals, to begin with. Long-term differences are yet another matter. Questions abound. What is the significance, if any, of the frequency of the cordate leaf shape in lianas? Is the succession of young secondary forest to old secondary forest to primary forest reflected in the climber flora? Do the climber floras reflect soil conditions; In short: it is high time for research on lianas to catch up with research on trees. To this end, recognition in the field needs to be pursued, fundamental as this is to all other work. Slash characters of lianas should be easier to memorize than those of trees, because of the smaller number of taxa, and the often highly characteristic macro-anatomy. On characters of this sort, an early key to Indonesian families and some genera was prepared by ZEIJLSTRA, in Dutch. Far more detailed is an effort by HALL & LOCK to distinguish the 13 taxa of Salacia in Ghana, in a key on macro-anatomical, twig and leaf characters.

It will take ingenuity, effort, a knowledge of languages (but good botanists always help each other), and facilities for field work in lowland rain forest, to study lianas. But scientifically, there is gold in them.

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