VIII. THE STUDY OF SEEDLINGS

"The seedling represents the most critical stage in the life of a tree. Conditions of seeding and germination may be entirely favourable, and natural seedlings may appear in countless quantities at the beginning of the rainy season, only to disappear largely or entirely within a comparatively short period of time owing to various causes, such as drought, bad soil aeration, competition with weed, shade, or other factors."

"If the requirements of the seedling of any species are well understood, the problem of the natural reproduction of that species is to a great extent solved, while the subsequent treatment of the crop is usually a comparatively simple matter. The whole system of management of a forest crop is fundamentally influenced by the steps necessary to establish reproduction, and it will therefore be readily realized that no branch of silviculture is of more importance than the study of the requirements of the seedlings of forest trees. Again, problems of invasion, succession, and gregariousness have to be approached from the point of view of the seedling, for it is the establishment of the young plant that determines to a great extent, if not wholly, the occurrence of existing forest crops of various types, and in like measure regulates the transition from one type to another from place to place or during the course of time."

These passages, taken from TROUP, amply illustrate the significance of the study of seed and seedlings for forest ecology. Many seedlings of common Indian (and Malesian!) trees are described and depicted by TROUP's excellent book, all in various stages of development, and partly in colour. The significance of the knowledge of germination and seedlings to weed biologists has been well expounded in KING's admirable new book on weeds.

Yet, for all its importance, the study* of fruits, seeds, seedlings, and saplings has been sadly neglected by botanists, and this seems to be so even in Europe, for in a fine and recent paper on the hazel nut, one of the best appreciated delicacies all over Europe, HAGERUP states that "surprisingly little is known about this common subject." Many Floras give the time of flowering, but not of fruiting, and almost no collector records the state of maturity of a fruit on his labels, nor the shape if it is fleshy, nor the measurements in the fresh state.

It is well known that often the leaves of a seedling, of a sapling, and of a sucker shoot, differ from the leaves in the

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*) We are here speaking of macroscopical observation, leaving embryological and anatomical work out of consideration because of their different techniques and magnifications.

adult stage, both in shape and in anatomical structure, and sometimes in phyllotaxis. Recently, GUILLAUMIN described a number of striking cases in conifers and other plants from New Caledonia. Juvenile leaves may be lobed instead of entire (or reverse), simple instead of compound, larger or smaller than the adult ones, a terminal leaflet may be present instead of wanting, and they never have domatia. All differences in the various stages should be known and considered, if seedling characters are to be integrated into a taxonomy which aim it is to classify not fragments but life-cycles, and to employ as many characters as can be found.

CORNER wrote in 1955: "In the Philippines there is a remarkable series from the long, narrow and many-veined leaf of Ficus angustissima Merr. through F.cumingii Miq. and F.terminalifolia Elm. to F.multiramea Elm. with very short, few-veined leaves: their figs and flowers are identical, and I suspect that they are a series of sapling-to-adult gradations with the last as a ridge-form, yet all are fertile and F. angustissima seems to have a trilobed sapling leaf itself! Seedling-sapling specimens of F.ampelas Burm. are confused with those of F.montana Burm. (F.quercifolia Roxb.)."

In his splendid book "The life of plants" CORNER also devoted a few words to the leaves of saplings. "A breadfruit ally (Artocarpus elasticus), which grows as big as any species in its genus, has sapling leaves up to 6 ft. high, the four to five times pinnately lobed; when 20-30 ft. high, the main stem and branches switch over brief transition through webbing and shortening the lobes into the smaller lamina. In other cases (Sterculiaceae), large palmate leaves with many leaflets pass into adult foliage of simple leaves representing the single median leaflet, as in Citrus trees, or a completely webbed leaf. There is some evidence, too, that at this critical height root-pressure, as a means of elevating water to the leaves, becomes less effective and even fails." This leads CORNER to the conclusion that the leaves of seedlings and sucker shoots may have significance in representing earlier stages of evolution. DIELS also discussed the phylogenetic and taxonomic significance of juvenile vegetative stages, notably in connection with precocious flowering, whereby a plant produces flowers and fruit together with ... leaves of the kind that in related groups is known as juvenile as it is there followed by a different, more "adult" kind of foliage. See also VAN STEENIS's remarks in the General Considerations in the Flora Malesiana, who commented on a number of species described on mere juvenile stages of others.

Quite some species described by TROUP occur in Malesia, too, but a book like his for any part of Malesia proper is still wanting. However, Dr. D. B u r g e r, then in the Forestry Service, compiled a MS on seedlings for Java, con-

taining ± 185 common species. During 3 years 3000 collections were received from all over Java, consisting of fresh twigs with ripe fruits, which first went to C.A.BACKER for identification before the seeds were sown and the twigs dried. Two stages of the seedlings were described in a very systematical way in both Dutch and English, with keys and drawings. In 1925 the book was ready for the press, but nothing came of publication; the MS still survives in Holland, while the blocks, and voucher specimens perhaps could be retrieved at Bogor. BURGER's work was continued by MEIJER DREES, who published data and drawings of 13 Acacia species. In the 1930s, Dr. A. T h o r e n a a r collected many silvicultural and ecological data on seedlings in the area of Palembang, Sumatra, but these were not published either; they too may still be at the Forestry Station, Bogor.

And we learnt with great pleasure that at the Arboretum at Kepong a survey of tree seedling morphology is being made by Mr. F. S. P. N g. In recent years Dr. LEENHOUTS, wishing to supplement his herbarium work on Canarium, obtained seeds of several species, and observed their germination and growth in the greenhouse at Leyden. He studied their morphology and blastogeny as part of an investigation of the stipular-like structures in the Burseraceae; besides, Canarium seedlings turned out to differ with the section of the genus. It also appeared, that the pinnate Canarium leaf develops by gradual augmentation of the first, simple, leaves, which casts doubt on LAM's idea that the burseraceous leaf represents a reduced twig. LEENHOUTS, who is now working in the Sapindaceae, found similar ways of development in Aphania.

Outside the tropics, seedlings are hard to come by, and the arrival of an airmail package with viable tropical seeds is at Leyden a rare and happy occasion. In several of the large groups now under revision: Anacardiaceae, Caesalpiniaceae, Sapindaceae, seeds and seedlings are very much wanted now and in the years to come. They are also valuable for chromosome counting: to that purpose they are grown in a small pot with earth, and permitted to root through. The pot is then placed within another pot which is kept moist, and in the space between clean roots develop, part of which can be taken for counting and the plant be kept alive.

But even the first collecting and description has, in Malesia, barely started. If they can be identified with certainty, and voucher specimens are added or referred to, the taxonomist is glad already with collections of dried seedlings. JACOBS found, from dried collections, that in Capparis sect. Busbeckea (mainly Australian), most species produce a particular kind of juvenile foliage typical for the section.

For a keen observer who has a garden in a tropical country with some forest, seedlings would make a fine subject for several years of study, description and drawing. LUBBOCK's

classical work made, as far as the tropics are concerned, a mere beginning, as only the tropical plants common in European hothouses are included in it among the temperate species.

As early as 1910, GUILLAUMIN gave an interesting and still valid general introduction. He discussed seedling characters, stated that in the Guttiferae tribes can be distinguished on account of their embryos, and devised a key on fruits and embryos to all genera in the Burseraceae.

A number of special studies have been made, e.g. by WAGNER and by LÉONARD. The latter found, in an extensive study, that in two African Legume tribes seedling characters concur with generic delimitation, but goes too far by immediately claiming that seedling characters invariably have generic value, which is at variance with the well-known rule that characters may have different values in different groups. RUMBALL found in two New Zealand species that anatomical differences concur with heteroblastic stages.

From DUKE's nice paper it can be seen that it is quite possible to make clear, concise keys to seedlings. DUKE employs a few terms, partly new. Cryptocotylar means that the cotyledons remain in the testa after germination; phanerocotylar is the opposite. Cataphylls are brown or hyaline scale leaves succeeding the cotyledons. Eophylls are the first few leaves with free expanded lamina. Metaphylls are the mature leaves as opposed to juvenile forms.

Finally, we will copy from TROUP a model for description of seedlings, namely that of Heritiera fomes.

"Roots: primary root moderately long, thick, terete, tapering; lateral roots numerous, long, fibrous, distributed down the main root but most numerous on the upper part. Hypocotyl distinct from the root, 0.4-0.5 in. long by 0.2 in. or more in diameter, pink to light brown, subterranean. Cotyledons subterranean; petiole 0.4-0.5 in. long by 0.1-0.15 in. in diameter, terete or slightly compressed, woolly tomentose, curved to one side of the stem; lamina 1.1-1.3 in. in length and breadth, thick, fleshy, orbicular, apex rounded, base sagittate, pinkish white, glabrous, outer surface convex, smooth inner surface concave or irregularly undulating. Stem erect, terete, light greenish brown, covered with silvery scales and lenticels, leafless for several nodes and for a length of 7-18 in. or more; internodes chiefly 0.5-1.5 in. long, the earlier ones often longer, up to 6 in. or more. Leaves simple, alternate, the first few abortive. Stipules 0.1-0.15 in. long, acuminate, caducous. Petiole 0.1-0.2 in. long, stellate pubescent. Lamina 2.5-6 in. by 0.4-1 in., oblong lanceolate, acute or acuminate, entire, coriaceous, upper side green, glabrous or with scattered silvery scales, lower side covered with silvery scales.

The early development of the seedling is very rapid. With-

in a month the stem may reach a height of 18 in. or more, and the stout taproot a length of 7 or 8 in., with a number of fairly long lateral roots. This early development enables the seedling to obtain a footing in spite of floods, and it is interesting to note that there may be a considerable length of bare stem with only scaly abortive leaves, the normal ones being borne in the upper part of the stem where they are likely to be above the level of the water. During the rapid development of the leafless stem the plant receives its food from the starchy cotyledons. A similarly early development is noticeable in the case of Carapa moluccensis, and it is possible that a further study of the development of seedlings of littoral species may reveal other instances of the same kind."

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