do not penetrate deeply, and that he never found the roots attached to those of other plants. Should the young plants in cultivation here, and elsewhere, continue to thrive, it may be possible to make experiments and to satisfactorily elucidate the question.

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ON THE STRUCTURE OF THE STEM IN TWO SPECIES OF LYCOPODIUM.—Among the few species of *Lycopodium* possessing dimorphic leaves, *L. volubile*, Forst., and *L. scariosum*, Forst., approach very closely to the habit of most species of *Selaginella*. That this is only a general resemblance is seen when one examines the arrangement of the leaves in *L. volubile* in detail. In the stouter branches of this species the leaves are not dimorphic; they are all small and similar, and cannot be referred to a definite phyllotaxy. There may be as many as twenty-two leaves from one to the next in the same vertical line, and they are arranged in an irregular manner, some at considerable intervals, a few of them in pairs, and others crowded into a short spiral, which may be succeeded by a few leaves forming a spiral running in the opposite direction. In the crowding of the leaves there is a tendency towards the formation of pseudo-whorls.

In the smaller branches (roughly those of the three highest orders) the *Selaginella*-type of habit is found; this may be called the distichous region. There are here two series of large leaves extended in one plane, but, judging by the insertion of these leaves, they probably represent four orthostichies, which approximate to two in the upper region. Besides these, there are also about three ventral and three dorsal orthostichies of small leaves with their points directed forwards. This species is thus much more complex than *Selaginella*, which has only two rows of large leaves, and two dorsal rows of small ones. Towards the tips of the branches of *L. volubile*, the smaller leaves become reduced in number. Thus in the lower distichous region there are often three small leaves (two dorsal and one ventral) to each pair of large leaves, while, near the tip of a branch, there may be only two dorsal and one ventral leaf to a length of stem bearing two pairs of large leaves. The phyllotaxy of the cone is $\frac{2}{7}$. The other dimorphic species of *Lycopodium*¹ have various numbers of

¹ Baker, Handbook of Fern-Allies.

orthostichies, *L. complanatum*, Linn., having four, but all those examined (viz. *L. carolinianum*, Linn., *L. Wightianum*, Wall., *L. complanatum*, Linn., *L. scariosum*, Forst.) appeared to differ from the *Selaginella*-type either in leaf-arrangement or in the number of orthostichies.

The structure of the stem of *L. volubile* was examined to see whether the distichous habit was connected with any modification in the structure of the stele, but this was not found to be the case. The larger stems have a perfectly normal *Lycopodium*-structure, with several xylem-bands, separated from one another by phloem, and bearing peripheral protoxylem-groups. The stele shows reduction in its size and complexity at each successive branching, just as may be seen in a species of *Lycopodium* with radially placed leaves. In branches of four successive orders the protoxylem-groups numbered seventeen, fourteen, eight and seven respectively. Some of the xylem-bands are free; others fused. They are generally straight, and lie in the plane of branching of the stem, which is also the plane of the large leaves in the distichous region. In the latter region there are mostly only two xylem-bands fused at one end, and bearing seven or eight very prominent protoxylem-groups. It may be mentioned here that the mature sporangium in *L. volubile* is axillary in position, and has a well-marked stalk, as in *L. Selago*, Linn.¹

L. salakense, Treub, is not one of the dimorphic species, but has small, sparse, adpressed leaves on its stem, and crowded leaves on its branchlets in eight orthostichies or sometimes in whorls of five at the apices². It is mentioned here because it differs from other species of *Lycopodium* in the structure of its stem. The xylem of the stele does not form well-marked bands, but the tracheides are arranged in small groups and curved uniseriate rows, mostly rounded off, and separated from one another by a network or labyrinth of phloem. The structure has consequently a deceptive resemblance to that of a *Gleichenia*. In the larger branches the protoxylem-groups also are unusual, in that they are very broad tangentially, so that they have the appearance of a nearly continuous peripheral band, which is interrupted at intervals by peripheral groups of phloem. The phloem is thus sometimes completely shut in by xylem for considerable distances. The above structure appears to belong to the type of

¹ Bower, Morphol. of Spore-producing Members, Phil. Trans. 1894, p. 511.

² Treub, Ann. Jard. Bot. de Buitenzorg. vii. p. 141.

L. squarrosum, Forst., as described by C. E. Jones¹. The material of *L. volubile* and *L. salakense* examined consisted of herbarium specimens collected by Raciborski in Java.

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THE VASCULAR STRUCTURE OF THE OVULE OF CEPHALOTAXUS.—The seed of *Cephalotaxus* possesses a thick coat, consisting of an outer fleshy and an inner woody layer, thus perfectly resembling that of *Ginkgo* and the Cycads. This outer fleshy layer I regard, with Čelakovský, as homologous with the fleshy aril of *Taxus*. Strasburger has found that the vascular bundles traversing this fleshy portion, one on either side of the seed, are characterized by their *inverted orientation*, i.e., by having their xylem directed outwards, and their phloem inwards towards the woody layer of the seed-coat. This peculiar orientation of the bundles tends to indicate that the outer fleshy layer of the seed-coat is equivalent to a *ligular* structure. When ligules are sufficiently well-developed to possess a vascular strand, the orientation of the latter must necessarily be inverted in relation to the foliar organ on which they are inserted. The ligules of *Isoëtes* and Lycopodiaceae have been regarded by Čelakovský and others as homologous with the *outer integument* of ovules; the velum of *Isoëtes* and Ferns being homologous with the inner integument. This view, which is most probably correct, would lead us to regard the outer fleshy layer of the seed-coat of *Cephalotaxus* as an outer integument, for its bundles are shown to exhibit the orientation required by those of a ligule.

Unfortunately, the aril of *Taxus*, which Čelakovský also regards as an outer integument, possesses no vascular bundles with which to compare those in the ovule of *Cephalotaxus*. But yet another character, which Strasburger does not appear to have remarked, in the outer integument (as I prefer to term it) of *Cephalotaxus* calls for special attention. As above stated, there is a single bundle on each side of the seed. It is greatly extended in the tangential direction, and situated on the innermost side of the outer and in close proximity to the woody inner integument. The secondary centrifugal xylem of the bundle is two or three layers thick. Besides this, however,

¹ C. E. Jones, British Association, Section K, 1898. Ann. of Bot. Vol. xii, p. 558.

Boodle, Leonard Alfred. 1900. "On the structure of the stem in two species of Lycopodium." *Annals of botany* 14, 315–317.

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