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Botany. — "*Dichotomy and lateral branching in the Pteropsida*".
By Mr. J. C. Schoute. (Preliminary communication). [1])

(Communicated in the meeting of Oct. 26, 1912).

In 1900 and more recently [2]) Jeffrey argued that the correspondence in structure of Filicales, Gymnosperms and Angiosperms justified the union of these three groups into a higher group, that of the Pteropsida.

Palaeontological research has later rendered this conclusion more probable [3]).

When on this account we assume a closer relationship between these groups, there naturally still remain many great differences between them; one of these is in the method of branching. For whilst the Gymnosperms and Angiosperms without exception branch by means of axillary buds (apart from adventitious buds), we find the ferns are typically dichotomous [4]). Mettenius [5]) described long ago in ferns lateral buds in every kind of position (axillary, next to the insertion of the leaf, under the insertion, half on the stem and half on the petiole) but all this has been explained by Velenovský as due to the formation of "stable adventitious buds [6]). The distinction between dichotomy and lateral branching has always been considered by all writers to be of great phylogenetic importance.

An investigation on branched tree-ferns has led me to the idea that there may perhaps be no difference in principle between these various modes of branching; in other words, that dichotomous branching would be, in its essence, the same as the lateral branching of ferns or Angiosperms. The fine material, mostly collected by Mr. Koorders, on which this investigation has been made, will be described exactly in the detailed publication. Here I only remark that in these trees ordinary dichotomy can sometimes take place, as a reaction to certain pathological processes, with a normal

1) A detailed paper, illustrated by plates, will appear on this subject in the Recueil des Travaux botaniques néerlandais.

2) E. C. Jeffrey. The Morphology of the Central Cylinder in the Angiosperms; Canadian Inst. Trans., Vol. 6, 1900. – The Structure and Development of the Stem in the Pteridophyta and Gymnosperms; Philos. Trans. R. Soc. London, Vol. 195, 1902.

3) See e. g. D. H. Scott, Studies in fossil. Botany, 2nd Ed. London 1908/09, p. 638.

4) J. Velenovský. Vergleichende Morphologie der Pflanzen. Prag 1905, p. 245.

5) G. Mettenius. Ueber Seitenknospen bei Farnen, Abhandl. math-phys. Classe k. Sächs. Ges d. Wiss. Bd. 5, 1861, p. 611.

6) l.c. p. 247.

angular leaf, such as, according VELENOVSKÝ, characterizes dichotomy in ferns [1]).

In this process however, one of the two branches may also be smaller than the other, in which case the larger branch places itself entirely in the prolongation of the base. These cases gradually pass into such in which one branch forms in every respect a prolongation of the base, and the other is placed next to an ordinary leaf of the stem as a thin branch or small lateral bud; this leaf we may then still regard as the angular leaf of the dichotomy.

From these observations we may deduce that probably all branchings in ferns, including those by means of VELENOVSKÝ's "stable adventitious buds", are to be referred to one and the same process and also that it is not permissible to consider the lateral buds of ferns as adventitious buds. It then further becomes highly probable that the axillary branching of Gymnosperms and Angiosperms is due to the same process. The only points of difference between the lateral branching of ferns and that of these groups, are that in ferns the bud is not always placed above the insertion of the leaf and that by no means all leaves produce buds.

In the Conifers we find already an intermediate stage to the extent that by no means all leaves have axillary buds, whilst in the cycads another intermediate stage seems to the found, for in this group the rare non-adventitious buds appear to be placed, not above, but next to the corresponding leaf [2]).

If this is so then, the normal dichotomy, which occurs in rare cases among Angiosperms [3]) is a different, new process, a dichotomy of the second order, as it were.

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1) l. c. p. 246.

2) E. WARMING, Undersøgelser og Betragtninger over Cycadeerne. Oversigt K. Danske Vidensk. Selsk. Forh. 1877 p. 91. — H. Graf von SOLMS LAUBACH, Die Spoorsfolge der Stangeria und der übrigen Cycadeen. Bot Zeitung 48, 1890, p. 197.

3) See my article "Ueber die Verästelung bei monokotylen Bäumen II. Die Verästelung von Hyphaene", in Recueil des Trav. botan. Néerl. Vol. 6 1909 p. 211. The opinion expressed there on p. 232 that the dichotomy of *Hyphaene* is the first case described in the literature of dichotomy in a phanerogam is incorrect since CHURCH in his "Relation of phyllotaxis to mechanical laws" (London 1904) in the "notes and errata" at the end of the book (p. 352) already described the dichotomy of fasciated heads of *Helianthus*.

Mathematics. — "*On loci, congruences and focal systems deduced from a twisted cubic and a twisted biquadratic curve*". II. Communicated by Prof. HK. DE VRIES.

(Communicated in the meeting of Oct. 26, 1912).

11. We found in § 1 [1]) a surface Ω^6 as locus of the points P for which the chord a of k^3 and the two chords b of k^4 are complanar; in the plane of those three chords then lies a ray s of the tetrahedral complex discussed in the preceding § [2]), so that the rays s corresponding to the points P of Ω^6 form a congruence contained in the complex; we wish to know this congruence better.

Through an arbitrary point P of space pass six rays of the congruence, thus $\mu = 6$; for all rays s through that point form a quadratic cone, the complex cone (§ 10), and the foci corresponding to the edges of this cone lie on the ray s of P; this intersects Ω^6 in 6 points and the rays s conjugated to these pass through P. The number μ is called the order of the congruence.

Exceptions we find only for the points of k^4 and in the 4 cone vertices. If P lies on k^4 then the conjugated line s is the tangent in P, which now belongs itself to the complexcone of P, for it is generated as line of intersection of the two polar planes of P itself with respect to Φ_1, Φ_2, which planes coincide with the tangential planes to the two quadratic surfaces. The tangent s to k^4 is now however at the same time tangent to Ω^6 and it contains therefore besides the point of contact only 4 points of Ω^6; thus besides the tangent only 4 rays of the congruence pass through P, from which ensues that the tangent itself counts double.

The four cone vertices bear themselves quite differently. To T_1 e.g. are conjugated as rays s all the lines of the plane $T_2T_3T_4 = \tau_1$, which plane intersects Ω^6 in a curve k^6 of order 6 containing T_2, T_3, T_4 as single points, the points of intersection with k^3 on the other hand as nodal points; to each point of the curve a ray s through T is conjugated, so that through T_1 pass an infinite number of rays of the congruence forming a cone. This cone can be determined more closely as follows. As of an arbitrary line s_1 in τ_1 the two conjugated lines pass through T_1, the ray s_1 corresponding to the points of that ray s_1 form a quadratic cone; now s_1 intersects the curve k^6 in 6 points, thus the quadratic cone must intersect the cone to be found in 6 edges.

Let us consider the point of intersection of s_1 with the edge T_3T_4

[1]) See *Proceedings* of Oct. 26th, 1912, p. 495.

[2]) l. c. p. 509.