Hence :

$$(\mu_1)_{v_0,\beta_0} = (\mu_1)_{V,\beta_0} + RT \log \frac{V}{v_0},$$

and therefore, if we may again put

$$(\mu_1)_{V,\beta_0} = C_1 - RT \log V + RT + RT \log (1 - \beta_0)$$

for $(\mu_1)_{V,\beta_0}$, also when there is no equilibrium at the degree of association β_0, finally :

$$\zeta_{v_0,\beta_0} = (\mu_1)_{v_0,\beta_0} = C_1 - RT \log v_0 + RT + RT \log (1 - \beta_0), \ldots (2^d)$$

quite identical with (1^d). [For $(\mu_1)_{v_0,\beta_0}$ may namely be written ζ_{v_0,β_0}, because v_0,β_0 represents a state of equilibrium, and hence $\zeta = \mu_1$ (see above)].

This way, which is much shorter than the preceding, and therefore the prevalent one, leads therefore — in spite of $(\mu_1)_{V,\beta_0}$ being changed into its value, if the mixture β_0 is considered as an *arbitrary* one, i. e. apart from the presence or absence of internal equilibrium between the reacting components — to the perfectly accurate expression, which we have found in (1^d) by the much more lengthy but perfectly unobjectionable way.

Baarn, Oct. 21, 1912.

Botany. — *The Linnean method of describing anatomical structures. Some remarks concerning the paper of* Mrs. Dr. MARIE C. STOPES, *entitled : "Petrifactions of the earliest European Angiosperms."* By J. W. MOLL and H. H. JANSSONIUS.

In our "Mikrographie des Holzes der auf Java vorkommenden Baumarten" we are trying to show that important results in systematic Botany can be obtained by anatomical investigations concerning the wood, if these are conducted with sufficient care. For this purpose descriptions of the anatomical structure are necessary, made with careful observance of the rules given by LINNÉ for describing the external appearance of plants. Of course some additions to these rules and some alterations have been necessary, because anatomical and morphological facts belong to somewhat different orders of things and because the microscopic method presents peculiar difficulties. But in the main it is the Linnean method we apply.

The results obtained in the two first volumes of our work are from a systematic point of view most satisfactory, which we hope will become still more apparent, when after some years the work will be finished. Families, genera and in many cases even species

are easily recognisable from the anatomical structure of their wood alone.

The method used by us, though extremely simple and well known in its principles, by aiming at a complete survey of the anatomical structures, an analysis leaving no rest, becomes a very laborious task, taxing rather heavily the psychical energy of the student. But a somewhat wide experience in these matters has taught us that only by the help of this method, results really worth while are to be attained in anatomical investigations of every kind.

Thus it is our conviction that the eyes of students in anatomy must be gradually opened to this truth. But we feel very well that this is not a result easily to be obtained. It is a notion widely spread among botanists, that every one having some general anatomical knowledge can, without making use of any special method or form, construct with great facility a good and useful description of anatomical structure. Literature more and less recent abounds with proofs of the truth of what has been said here. Descriptions are to be found everywhere, unripe, incomplete, abounding in repetitions and omissions, referring to many things with which the reader is not in the least concerned, unsteady and supported by lots of necessary and unnecessary drawings. [1])

We cannot see however that up to this date the example we try to give has procured us many followers. Nevertheless we want some because there are most important problems, only to be solved by the cooperation of many botanists using this same Linnean method of micrography.

Therefore we try to avail ourselves of every opportunity offered, to show the value of our method in obtaining results, vainly aimed at otherwise.

Thus some time ago we studied the wood of *Cytisus Adami* and its two components *C. Laburnum* and *C. purpureus* [2]) and were able to show that the wood of *C. Adami* is that of *Laburnum*, very slightly altered, it is true, but by no means in a direction tending to the structure of the wood of *C. purpureus*. This result could in the main have been anticipated from the splendid work of WINKLER and BAUR on this subject and in so far may not be accounted very interesting. But it was valuable as a testimony for the usefulness of our method, because several other botanists had tried in vain to identify this wood.

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[1]) Alph. De Candolle. La Phytographie végétale.

[2]) Recueil d. trav. bot. Néerl. Vol. VIII- 1911. 333.

Now again a similar opportunity is offered by the publication, some months ago, of an elaborate paper by Mrs. MARIE C. STOPES, entitled: Petrifactions of the earliest European Angiosperms [1]).

In this paper detailed anatomical descriptions are given of 3 specimens of fossil wood belonging to the collections of the British Museum of Natural History. These specimens are from the Lower Greensand, a formation of the Cretaceous Period and are considered by the author as representing the oldest European Angiosperms, known up to this date. For this reason a careful study of the interesting specimens was commenced, and descriptions were made, so far as the condition of the specimens permitted.

By far the best preserved specimen was that called *Aptiana radiata*, gen, et spec. nov. We will only treat of this one.

Reading on p. 90 of the paper the discussion of the affinities of *Aptiana radiata*, the prospect does not indeed seem very hopeful. Mrs. STOPES points out that no branch of modern botany is in a more chaotic condition than that dealing with the anatomy of Angiosperms, which from a taxonomic point of view must certainly be admitted.

She considers that it is entirely premature to attempt any discussion of the possible affinities of this fossil. "In evidence of this "I may mention, that for more than a year I have been showing "this fossil wood to many of the leading botanists of this country, "Europe, and America, and that among the numerous opinions kindly "offered, I have been told it resembled closely nearly every family "ranging from the *Gnetales* on one hand to the *Malvales* on the "other. This is not to be interpreted to mean that the woods of all "these families are alike, and that consequently classification of them "is impossible, but it is due to the comparatively few samples that "any one individual studies and to the great range of variations "between the woods of so-called species of so-called genera."

Mrs. STOPES concludes: "The genera which I was able to examine, "which showed most points of likeness to the fossil, were some "species of *Lonicera*, of *Viburnum*, of *Magnolia* and of *Liriodendron*. "On this however I lay no stress and consider that for the present "more definite statements regarding possible affinities would be purely "theoretical and unprofitable."

We have quite another opinion. After the reading of Mrs. STOPES' paper, it occurred at once to us, that *Aptiana* could very well belong to the family of the *Ternstroemiaceae*. And knowing, that

[1]) Phil. Trans. o. t. Roy. Soc. B. Vol. 203. 1912. Pp. 75—100 and Plates 6—8.

with the help of our method we could hope to obtain certainty in this matter, we proceeded at once to testing our hypothesis.

For this purpose the first thing we needed was a Linnean description of the wood of *Aptiana* in order to compare it with the several summarizing descriptions of the wood of whole families, already published in our "Mikrographie des Holzes". Having done this we found, that our first impression had been correct and that *Aptiana* was no doubt a plant belonging to the family of the *Ternstroemiaceae*, very nearly allied to the genus *Eurya*, if not belonging to it indeed.

In order to give the reader the means of judging for himself, we will now go somewhat more in detail, first giving the Linnean description of *Aptiana*, mentioned above, then a translation of our description of a species of *Eurya*, given in the "Mikrographie des Holzes", and ending with a discussion of the results obtained.

The Linnean description of the wood of *Aptiana* now following was of course abstracted from the paper of Mrs. STOPES. The data thus gathered were arranged in the Linnean fashion, according to a form for the description of secondary xylem, which we always use as a basis of our description [1]). As far as possible Mrs. STOPES' own words were used and the pages where they are to be found were mentioned. But in some cases, where our interpretation disagreed with that of the writer or where characters were described only to be seen in the drawings or photos, this was of course impossible. These passages were printed in italics and if necessary a footnote explains why it was desirable to alter the writer's statement.

Micrography of the wood of Aptiana radiata,

M. C. STOPES, Phil. Trans. Ser. B vol. 203, p. 75.

A stem or branch thick about 3,5 c.m.

Topography.

Annual rings structurally recognisable [2]), the limit of some of the rings a little difficult to determine; thick about 0.6 mm. (p. 85). *The number of vessels and their transverse dimensions, also the cavities of the fibre-tracheids in the inner part of the annual ring*

[1]) This form has been published with many others in: "J. W. MOLL. Handboek der Botanische Micrographie". Groningen. 1907. p. 49.

[2]) On p. 85 is added: "but not clearly marked by any noticeable change in the character of the wood or size of the vessels." By studying Pl. 6 Photo 4 and Pl. 7 Photo 6 we have come to an opposite opinion, to that mentioned in the text.

larger than in the outer; the breadth of medullary rays sometimes smaller in the inner part of the ring. Vessels for the rest uniformly distributed; with a few exceptions isolated and standing separated from each other in the radial rows of fibre-tracheids (Plate 6 Photo 4, Plate 7 Photo 6, Plate 8 Photo 10 and text-fig. 1); in one or two cases 2 vessels standing adjacent in the tangential direction, but such pairs are rare (p. 85) and disturb remarkably little the radial rows of the fibre-tracheids (p. 86). *Fibre-tracheids*: the wood appearing be entirely composed of fibre-tracheids; arranged with considerable regularity in radial rows (p. 86). *Wood parenchyma* scarce and possibly wanting; several times lying just behind vessels, spanning the distance between the rays (text-fig. 1 and p. 86). *Medullary rays* [1]) in 2 kinds. The most numerous principally 1-seriate, 4 to 10 cells in height *and simple* (*Einfache Markstrahlen*, Mikrographie I. 59). The other kind 4 cells wide — a few 3 or 2 — a dozen cells in height [2]), *often composite* (*Zusammengesetzte Markstrahlen*, Mikrographie I. 59) [3]), *consisting of* 3 *stories*. Between the multiseriate rays innumerable 1-serate rays (p. 86). The medullary rays running between almost every 2 radial rows of tracheids and vessels (p. 84) and in such a way that nearly every fibre or vessel is in direct contact with them (p. 86, see also p. 90). *The cells of* 1*-seriate rays*

[1]) A character, described by Mrs. Stopes (p. 87) as a noticeable feature, is the way of dying out or dwindling down to 1 cell thick in transverse section of the broader rays (Pl. 6 Photo 3 and 4 *dm* and text-fig. 4). The authoress says herself: "while it is very possible that, as both Prof. Oliver and Dr. Scott have suggested "to me, this is due to the rays therein lying somewhat oblique, in a radial sense, "so that any transverse section passes through them, yet it remains an unusual "feature in the truly transverse section of the wood, and gives it the character "shown in text-fig. 4, which separates it from any wood with which I am acquainted." Without doubt the explanation given by Prof. Oliver and Dr. Scott is the right one. In our investigations we have very often met with the same phenomenon, which is represented in a considerable number of our figures, e. g. 16, 24, 34, 38, 40, 41 etc., also in that of *Eurya acuminata*, given below.

[2]) Plate 6 Photo 5 shows that these rays can be at least 3 times this number of cells in height.

[3]) The term *zusammengesetzte Markstrahlen* was first used by us in our Mikrographie as cited above. The definition of the term is given there as follows: "aus in senkrechter Richtung übereinander gestellten, regelmässig abwechselnden 1- und mehrschichtigen Teilen zusammengesetzt. Die einschichtigen Teile fast immer aus aufrechten Zellen aufgebaut; stets das oberste und unterste Stockwerk bildend. Die mehrschichtigen Teile fast immer aus liegenden Zellen aufgebaut."

The study of p. 87 of Mrs. Stopes' paper, text-fig. 3 and 5, Plate 6 Photo 5 and Plate 8 Photo 11 will convince the reader, that our description, as given in the text, is correct.

having the same shape as those of the 1-seriate stories of the composite rays (Pl. 6 Photo 5).

Description of the elements.

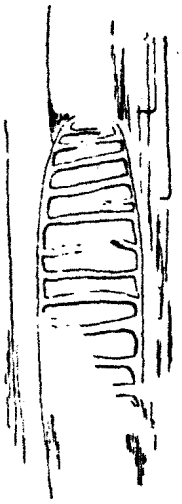

Fig. 1.
Aptiana radiata Stopes. Transverse wall of vessel; showing scalariform perforation. Reproduction of text-fig. 2 of Mrs. Stopes' paper.

I. *Vessels.* R. and T. 28 to 40 μ, about 33 μ being the commonest size. Roughly circular cylinders. *Transverse walls placed very obliquely; with scalariform perforations and horizontal* rungs, see fig. 1 [1]). *Walls* thickened, but not remarkably so and the lignified wall much thinner than that of the adjacent cells (fibre-tracheids); — with irregularly placed simple round or slightly oval pits (p. 86).

II. *Fibre-tracheids* R. and T. 15 to 50 (?) μ, the radial dimension often somewhat smaller than the tangential; 4- to 6-, generally 6-angular. *Walls* in most cases thickened, the lumen of the cells $^1/_3$ or less that of its whole diameter (see Pl. 8 Photo 10 and text-fig. 1); — with bordered pits, *on the tangential walls at least as numerous as on the radial* (p. 86, Pl. 8 Photo 10, and text-fig. 1); arranged in 1 and in a few cases in 2 slightly irregular rows, not very closely arranged in vertical position, each being spaced at a distance from its neighbour roughly equal to its own diameter; borders of pit-chambers circular (p. 86).

III. *Wood parenchyma. Cells on a transverse section somewhat elongated in the direction of the circumference of the vessels.* (Pl. 8 Photo 10 and text-fig. 1). *Walls* thickened; — with only simple pits. *Contents* more blackened than that of other cells (p. 86).

IV. *Cells of medullary rays. Walls* thickened; pitted (see Pl. 8 Photo 10 *m*, and p. 89).

Having completed this description we compared it with the general descriptions of the wood-anatomy of the several families, published in the two first volumes of our "Mikrographie des Holzes". It was soon found that the only family with which the characters of *Aptiana* coincided and did so in a very satisfactory manner, was indeed that of the *Ternstroemiaceae.*

[1]) On p. 86 Mrs. Stopes says: "In longitudinal section not many of the vessels show the character of their walls, but those that do, have broad, simple scalariform pitting (see text-fig. 2)". If a regular Linnean description had been made, this mistake would no doubt have been avoided.

We now sought in this family among the species of which a full description was given, for that which corresponded in the largest number of most essential characters with *Aptiana*. We found that this was the case with *Eurya acuminata* and we reproduce here a literal translation of this description, as given in our Mikrographie, but somewhat shortened for the reader's convenience, by omitting all those characters of which no mention is made in the description of *Aptiana*.

If the reader will compare the two descriptions with each other, he can judge for himself of the validity of *Aptiana*'s claim to be considered as a member of the family of the *Ternstroemiaceae*.

Micrography of the wood of Eurya acuminata, DC. Mém. Ternstr. 26.

A stem or branch of about 7 cm.

Topography. (See fig. 2).

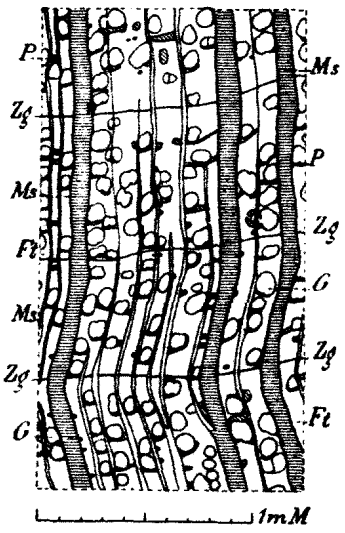

Fig. 2.
Eurya acuminata. Transverse section. Zg Annual rings; G Vessels; Ft Fibre-tracheids; P Wood parenchyma; Ms Medullary rays.

Annual rings, especially in the sample most minutely examined, fairly distinct; 0.35 mm to 2.5 mm thick. In several rings a period in the number of vessels and the transverse diameters of vessels, fibre-tracheids and wood parenchyma cells, in the 2 last named elements especially of the radial diameter; the maximum of this period about in the middle of the ring, the minimum in the outer lower than in the inner part, especially for the radial diameter of the fibre-tracheids. The limits of the rings sometimes more distinct, by the number of vessels in the different rings being unequal. On the limits of the rings the medullary rays mostly somewhat broader. *Vessels* for the rest regularly distributed; almost always isolated, only very seldom in pairs. *Fibre-tracheids* constituting the groundmass of the wood; only now and then in radial rows. *Wood parenchyma* scarce, scattered between the fibre-tracheids; when bordering on vessels, on the inner side of these only. *Medullary rays* in 2 kinds. The most numerous generally 1-, in the middle sometimes 2-seriate, 6 to 30, mostly 10 to 15 cells in height and

simple. The second kind 3- to 6-seriate, up to 150 cells in height, often composite and consisting of 3 stories. The absolute height of the first kind of medullary rays smaller than that of the latter. Between 2 multiseriate medullary rays mostly some 1-seriate. The medullary rays laterally separated by 1 to 4 rows of fibre-tracheids often adjoining vessels. The cells of the 1-seriate rays resembling those of the 1-seriate stories.

Description of the elements.

I. Vessels. R. 25 to 80 μ, T. 20 to 70 μ. Elliptical and circular cylinders or multilateral prisms with rounded edges. Transverse walls placed very obliquely, showing scalariform perforations with 50 to 125 horizontal rungs. The scalariformly perforated part of the transverse walls sometimes 500 μ in length. *Walls* 1.5 μ thick; — with numerous transversely elongated bordered pits, when adjoining each other; — with very numerous elongated bordered pits, when adjoining fibre-tracheids; — with a few simple and numerous elongated one-sided bordered pits, when adjoining wood parenchyma cells and upright ray-cells; — with unilateral bordered pits, when adjoining procumbent ray-cells.

II. *Fibre-tracheids.* R. 20 to 30 μ, T. 25 to 35 μ; 4- to 8-angular. *Walls* thick 6 to 8 μ; — with numerous elongated bordered pits, when adjoining vessels or each other; these pits more numerous on the tangential than on the radial walls; borders of pit-chambers circular or somewhat elongated in a vertical direction, e.g. 5 by 6 μ.

III. *Wood parenchyma cells.* Those adjoining vessels mostly elongated in the direction of the circumference of the vessels. *Walls* thick 1.5 μ; — with a few simple, and numerous elongated 1-lateral bordered pits, when adjoining vessels; with elongated 1-lateral bordered pits, when adjoining fibre tracheids; — with simple pits when adjoining each other or ray cells. *Contents*: sometimes a few starch grains and some red brown mass on the transverse walls.

IV. *Cells of medullary rays.* Walls thick 1.5 μ or more; pits the same as in the wood parenchyma cells.

A simple comparison shows, that there is a coincidence in almost every particular, such as cannot be the outcome of accidental circumstances and as in classifying systematic botany must needs lead to identification. As leading features in this comparison we consider the very oblique transverse walls of the vessels, with their scalariform perforations; the groundmass of the wood consisting of fibre tracheids; the excessive scarcity of woodparenchyma and the oc-

currence of composite medullary rays — all of which are characters not found in many families and coinciding only in that of the *Ternstroemiaceae, Staphyleaceae* and in some of the *Olacineae.* But the two last could be excluded by differences in several other characters. The objection might perhaps be made, that in our "Mikrographie des Holzes" we have studied only a comparatively small number of families, viz. 33, up to this date, and that it would by no means be impossible, that afterwards another family might be found coinciding as well or even better than that of the *Ternstroemiaceae* with the characters found in *Aptiana.* But we are going right through the system, following the Genera Plantarum of BENTHAM and HOOKER. Thus this objection implies the probability, that in a region of the system far distant from the *Ternstroemiaceae* a family will be found showing an anatomical structure of the wood coinciding in almost every particular with that of the *Ternstroemiaceae.* Our experience in wood matters leads us to tax this probability as infinitely small. But we do not know what lengths some botanists might go in such a matter. The argumentation stated above thus led us to the scientific conviction that *Aptiana* belongs to the *Ternstroemiacea.*

Having reached this point, we tried, making use of the analytical key for the identification of the species in our Mikrographie and comparing the descriptions of the species whether some nearer ally of *Aptiana* than *Eurya acuminata* could be found. If the reader does the same, he will be led to *Eurya japonica* and *E. glabra.* Therefore we think that the genus *Eurya* may safely be considered as a most near ally of *Aptiana,* leaving it undecided whether both could be united with each other in the genus *Eurya,* which however to us does not seem improbable.

In conclusion we want to say some words on the work of Mrs. STOPES and on the character of the observations made by us. In the foreground must be placed the fact that for the whole of our knowledge of *Aptiana* we are indebted to the careful work of Mrs. STOPES. But we can go farther and trust, that the reader will not have mistaken our work for a criticism of Mrs. STOPES' paper. If we had not indeed considered this paper as a very fair specimen of what at this time may be called good anatomical work, we could not have written as we have done. That bad work does not produce good results is a truth, which we by no means want to prove. We do not criticize a special paper, but the method or rather the want of method still prevailing in almost all anatomical work published at this day. And we think that we have shown how a research on a

very interesting subject, bringing to light a most interesting palaeontological result and ably conducted, might have brought us still nearer to the truth if the Linnean method had been used in making the descriptions.

This method indeed asks much of the investigator's time and energy and the use of it can only be learnt by patient study. But we mean to say, that at some future time a botanist of Mrs. STOPES' power will not be satisfied with descriptions of anatomical structures made without the use of the Linnean principles of micrography.

Groningen, Oct. 21th 1912.

Bacteriology. -- "*On the reaction velocity of Micro-organisms*". By Prof. C. EIJKMAN.

(Communicated in the meeting of September 28, 1912).

I. *Velocity of disinfection.*

Micro-organisms have been the object of various researches as regards the velocity of their reaction, when exposed to external agents. From the experimental evidence brought forward it appeared, that considerable differences exist between individuals of the same species, of the same stock, nay of the same culture: they do not react all about at the same time, but the reaction proceeds in an orderly manner.

It is especially the orderly progress of disinfection of bacteria, under the influence of germicidal agents, either chemical or thermal, which, in virtue of its vital importance for theory as well as for practice, has recently been studied by several investigators.

Attempts have even been made to find a mathematical formula for this gradual process. As I stated before[1]) MADSEN and NYMAN arrived at the conclusion[2]) that in the disinfection of anthrax spores the reaction proceeds according to the equation for the so-called "unimolecular reactions". This view found favour with most experimenters.

When the reaction is illustrated graphically by plotting the results (abscissae representing the times and ordinates the numbers of survivors), a "curve of survivors" is obtained, having the shape of  . This

[1]) Proceedings of the Meeting of 27 Feb. 1909.

[2]) Z. f. Hyg. u. Inf. Kr. Bnd. 57, 1907.