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On the Characters of the Akazga Plant, and the difference between the Structure of its Stem and that of Strychnos Nux-vomica. By THOMAS R. FRASER, M.D., F.R.S.E., M.R.C P.E., Assistant to the Professor of Materia Medica in the University of Edinburgh.

We have been indebted, within recent years, to several travellers in West Africa for interesting accounts of the properties of a poisonous plant called akazga, which is extensively used as a judicial ordeal. The chemical characters of this poison were examined, in 1862, by Messrs Attfield and Simmonds. The results obtained by these gentlemen were, however, unsatisfactory, as they had only a small quantity of akazga at their disposal; but they supposed that they obtained indications in it of the presence of strychnia. Its physiological action was investigated, in 1866, by MM. Pcholier and Saintpierre, and found to be very similar to that of nux-vomica.*

Some specimens of akazga were lately sent to Scotland by the Rev. A. Bushnell, of Baraka, and these were given to me for examination by Mr Thomson, of Glasgow. I am also indebted to these gentlemen, and to Dr Nassau, of Bonita, for the very interesting and trustworthy information they have supplied regarding the employment of the ordeal; by which, principally, I am enabled to communicate the following particulars to this Society.

The poison is known among the various tribes who employ it as *akazga*, *boundou* (or *m'boundou*), *ikaja*, and *quai*. Akazga is probably derived from *nkazga*, which signifies pain or hurt. It is employed as an ordeal on the West Coast of Africa, in a district which extends for a considerable distance north and south of the equator and many miles inland, and also in the adjacent island of Corisco. Witchcraft is believed in almost universally over Africa as the cause of all deaths, of unexplainable misfortunes, and of many crimes; and to detect the sorcerer this poison is employed. The supposed sorcerer is obliged to drink a certain quantity of the infusion prepared from

* Comptes Rendus, 1866, p. 809.

the bark, and to step over a number of akazga sticks placed parallel to one another at the distance of two feet. If this be done, the person tried is pronounced innocent; if guilty, difficulty is experienced in stepping over the sticks, they appear like large logs, to surmount which suitable efforts are made, and these are rendered more and more difficult by spasmodic muscular twitches, until the victim staggers and ultimately falls in tetanic convulsions. If the poison do not now immediately prove fatal, the knives and clubs of the onlookers quickly free the tribe of the supposed sorcerer. In those cases in which the trial is successfully undergone, a copious flow of urine is described as occurring, and by this means the poison is supposed to be removed.

The akazga was sent to me in bundles which consisted of long, slender, and crooked stems, having their roots generally attached to them, but sometimes their leaf-bearing branches only, and containing also a few complete plants, with roots, stem, and branches. I have also recently obtained a few seeds, the greater number of which, however, have germinated and possess radicles six or eight inches in length.

The plant is ususally about six feet in length; but some specimens were only four, and others as long as eight feet. They have generally a diameter of half-an-inch, and this varies from a quarter to one inch. The bark is of a yellowish orange colour, and in some parts light red; and over it a grey efflorescence is frequently found. A few of the stems are of a dark-brown colour, with numerous yellow tubercles. The bark adheres firmly to the stem, but it can be readily detached after exposure to a gentle heat for some days. Its internal surface is light brown.

The wood is dense and hard throughout, the plant being apparently of very slow growth.

The leaves are opposite, and oval-acuminate in form; the apex frequently consisting of a linear prolongation more than an inch in length. They have five parallel ribs, three of which are prominent. The leaves vary greatly in size. The majority are from three to six inches in length, and from one and a-half to two and a-half in greatest breadth. A few, selected at hazard, had the

following dimensions in inches: — $5 \times 2\frac{1}{8}$, $6\frac{1}{2} \times 2\frac{1}{4}$, $5 \times 1\frac{3}{4}$, 5×2 , $5\frac{1}{2} \times 1\frac{3}{4}$, $7 \times 2\frac{1}{8}$, $6\frac{3}{4} \times 2\frac{3}{4}$, $2\frac{3}{4} \times 1\frac{1}{2}$, $5\frac{5}{8} \times 3\frac{1}{2}$, $7 \times 2\frac{1}{2}$, $8\frac{1}{2} \times 4$, $6\frac{1}{4} \times 1\frac{7}{8}$, $3 \times 1\frac{3}{4}$, $4 \times 2\frac{1}{2}$, $3\frac{1}{2} \times 2$, $11 \times 4\frac{1}{2}$, $6 \times 1\frac{3}{4}$, 4×2 , $12\frac{1}{2} \times 5\frac{1}{8}$, 5×2 .

The characters of the seed cannot be accurately determined from the specimens in my possession, as the non-germinated ones appear to have been injured by exposure. It seems to have a globular form, with two somewhat flattened sides, and to vary in size from $\frac{5}{8}$ to $\frac{6}{8}$ of an inch in greatest diameter. Its external surface is covered with a downy layer of long hairs, but it does not present the velvety appearance that characterises the seed of *nux-vomica*. The albumen is easily split into two halves, between which the embryo is found furnished with two five-ribbed, oval-acuminate cotyledons.

The bark has a strongly bitter, faintly aromatic taste, and a distinct bitterness may also be perceived in the wood, leaves, and seed.

These general characters at once suggested that this plant is one of the Loganiaceæ; but with the materials in my possession, it was impossible to identify it. Professor Balfour kindly placed at my disposal a large collection of West African plants, and with his assistance and that of Professor Dickson these were compared with the akazga, but we found nothing that exactly corresponded with it. Professor Oliver, of Kew, who is intimately acquainted with the flora of West Africa, also examined some of my specimens, and considers that there is great reason to suppose that the plant is undescribed.

The results I have obtained by a chemical examination of this poison appears to support Professor Oliver's opinion; and, if it be proper to be guided by the nature of the physiological action of substances derived from a plant, I believe there can be little doubt that akazga will be found to be a new species of *Strychnos*. I have separated from it, by a process that has been elsewhere published,* a crystalline alkaloid which closely resembles strychnia, but which is readily distinguishable from it. For this alkaloid I have proposed the name *akazgia*, derived from akazga, apparently

* Proceedings of the Royal Society of Edinburgh, 1866-67, No. 73, p. 159; and "British and Foreign Medico-Chirurgical Review," July 1867.

the most usual as it certainly is the most euphonious of the synonyms of this ordeal. Akazga is principally distinguished from strychnia by a difference in its equivalent, by being precipitated from solutions of its salts by the *bicarbonates* of sodium and potassium, and by the comparative difficulty of obtaining it in a crystalline form. It agrees with strychnia in possessing those colour reactions that have been hitherto regarded as characteristic of that alkaloid, and in producing the same physiological effects.

I have endeavoured still further to ascertain the differences between akazga and nux-vomica by examining the microscopic anatomy of their stems. The following descriptions indicate the principal characters of these:—

Akazga. (Plate VII. figs. 1 and 2.)

The *pith* consists of complete parenchyma. Its cells have, in transverse section, a more or less regularly hexagonal form, and, in longitudinal section, they present the appearance of four-sided parallelograms. Their transverse diameter varies from $\frac{1}{800}$ th to $\frac{1}{1000}$ th of an inch, being usually, however, about $\frac{1}{800}$ th; while their longitudinal diameter is from $\frac{1}{400}$ th to $\frac{1}{600}$ th of an inch. The majority of the cells are indurated and marked by radiating canals. A few non-indurated cells occur irregularly throughout the pith, and these contain starch granules.

The *wood-cells* have pretty constantly a diameter of $\frac{1}{800}$ th of an inch, and are greatly indurated, the cavity being so much reduced in size as to appear, in cross-section, like a point. Such a section also shows that the wood-cells are divided into irregular four-sided groups; *firstly*, by numerous medullary rays, which vary greatly in thickness—some consisting of only one layer of cells, and others of three or four; and, *secondly*, by portions of concentric rings, which consist of plates of parenchyma placed at right angles to the medullary rays. The *dotted ducts* are almost invariably placed within these parenchymatous plates. They are nearly circular in form, though sometimes compressed radially, and, at others, concentrically; and they vary in diameter from $\frac{1}{300}$ th to $\frac{1}{1000}$ th of an inch, usually, however, being about $\frac{1}{800}$ th. Longitudinal cylindrical tracts of delicate parenchyma surround the pith, and occur

also in various portions of the wood. In the latter situations, these tracts vary from $\frac{1}{160}$ th to $\frac{1}{80}$ th, and, in the former, from $\frac{1}{80}$ th to $\frac{1}{60}$ th of an inch in diameter.*

The cells of the medullary rays and of the concentric plates of parenchyma are filled with starch granules of moderate size (about $\frac{1}{400}$ th of an inch in greatest diameter) and of irregular oval forms, which seem identical in appearance with the starch granules in the non-indurated pith cells.

The corky layer and cellular envelope of the *bark* are moderately developed. In the endophlœum the development of bast cells is very slight, only a few isolated bast cells being seen in cross-section. Immediately internal to these, however, there is a distinct layer, about $\frac{1}{40}$ th of an inch thick, and three or four cells deep, of indurated parenchyma, the cells of which are small and of various shapes, and exhibit radiating canals.

Strychnos Nux-Vomica. (Plate VII. fig. 3).

The *pith* is only slightly indurated; and, in the sections examined, its cells almost invariably contain starch granules—a very few nearly perfectly indurated cells are, however, present. These cells vary considerably in diameter, some being met with of $\frac{1}{200}$ th of an inch, and others of $\frac{1}{60}$ th. The majority of the smaller cells occur at the circumference of the pith.

The *wood-cells* are of the same character as those of akazga. The cylindrical tracts of delicate parenchyma are, however, larger, and much more numerous than those in akazga.

The *dotted ducts* are also more numerous, and, in place of being arranged singly or in groups of two or three, they frequently occur in groups formed of radial lines of five or six. In consequence, apparently, of this great development in the number of the dotted ducts, the wood of *nux-vomica* is divided into much smaller masses than that of akazga.†

* Similar tracts of parenchyma have been observed by Professor Oliver in *Strychnos toxifera* (Oliver, "On the Stem of Dicotyledons;" *Nat. Hist. Review*, vol. ii. 1862, p. 317.)

† This structural character of *nux-vomica* is apparent on simple inspection of a cross-section.

The general botanical characters of the akazga plant, the minute anatomy of its stem, the nature of its poisonous action, and the chemical and physiological properties of the alkaloid that it contains, are, therefore, sufficient to show that it is nearly allied to *Strychnos Nux-vomica*; but they are also sufficient to distinguish it from that plant. It will be interesting to see how far this opinion is confirmed when an opportunity is obtained for examining its floral structure, and thus ascertaining its affinities with certainty.

In the parcels of akazga I received there were a few leafless stems, which were found to contain an immense number of sparkling crystals beneath the bark. These stems also differ from the others in the exterior of the bark having a more smooth appearance. A microscopic examination of the stem revealed the following characters:—

The *wood* has the same general structure as that already described as belonging to akazga, the wood-cells being greatly indurated, and the medullary rays being arranged in the same manner. The cross-plates of parenchyma in connection with the dotted ducts are, however, shorter in cross-section, hardly extending beyond the immediate neighbourhood of the dotted ducts.

The *pith* contains very few indurated cells.

In the inner portion of the *bark*, and also in the longitudinal cylindrical tracts of delicate parenchyma traversing the wood, a number of prismatic crystals, terminated in domes, occur. These are arranged longitudinally to the stem. *There is no layer of indurated parenchyma in the bark.*

Guided by these characters, Professor Dickson—who had kindly interested himself in the subject—pronounced that these were not stems of akazga. I was at first unwilling to adopt this opinion, but a physiological and chemical examination has now convinced me of its correctness; for the bark of these stems is perfectly inert, and the alcoholic extract that is obtained from it does not possess the well-marked chemical reactions of that obtained from akazga.

Fig. 4 represents a cross-section of one of these stems, and, in the absence of any means of identifying the plant, I have, meanwhile, designated it *False Akazga*.

Explanation of Plate VII.

- Fig. 1. Transverse section of large stem of Akazga, showing a portion of the wood and the bark.
Fig. 2. Transverse section of small stem of Akazga, extending from pith to bark.
Fig. 3. Transverse section of stem of *Strychnos Nux-vomica*, extending from pith to bark.
Fig. 4. Transverse section of stem of "False Akazga," showing a portion of the wood and the bark.

The following lettering applies to all the figures:—*m*, pith; *m r*, medullary ray; *w*, woody tissue; *d*, dotted duct; *c pl*, cross-plate of parenchyma in wood; *l t*, longitudinal tract of delicate parenchyma; *b*, bark; *l*, liber-cell; *ind*, indurated layer of endophlœum.

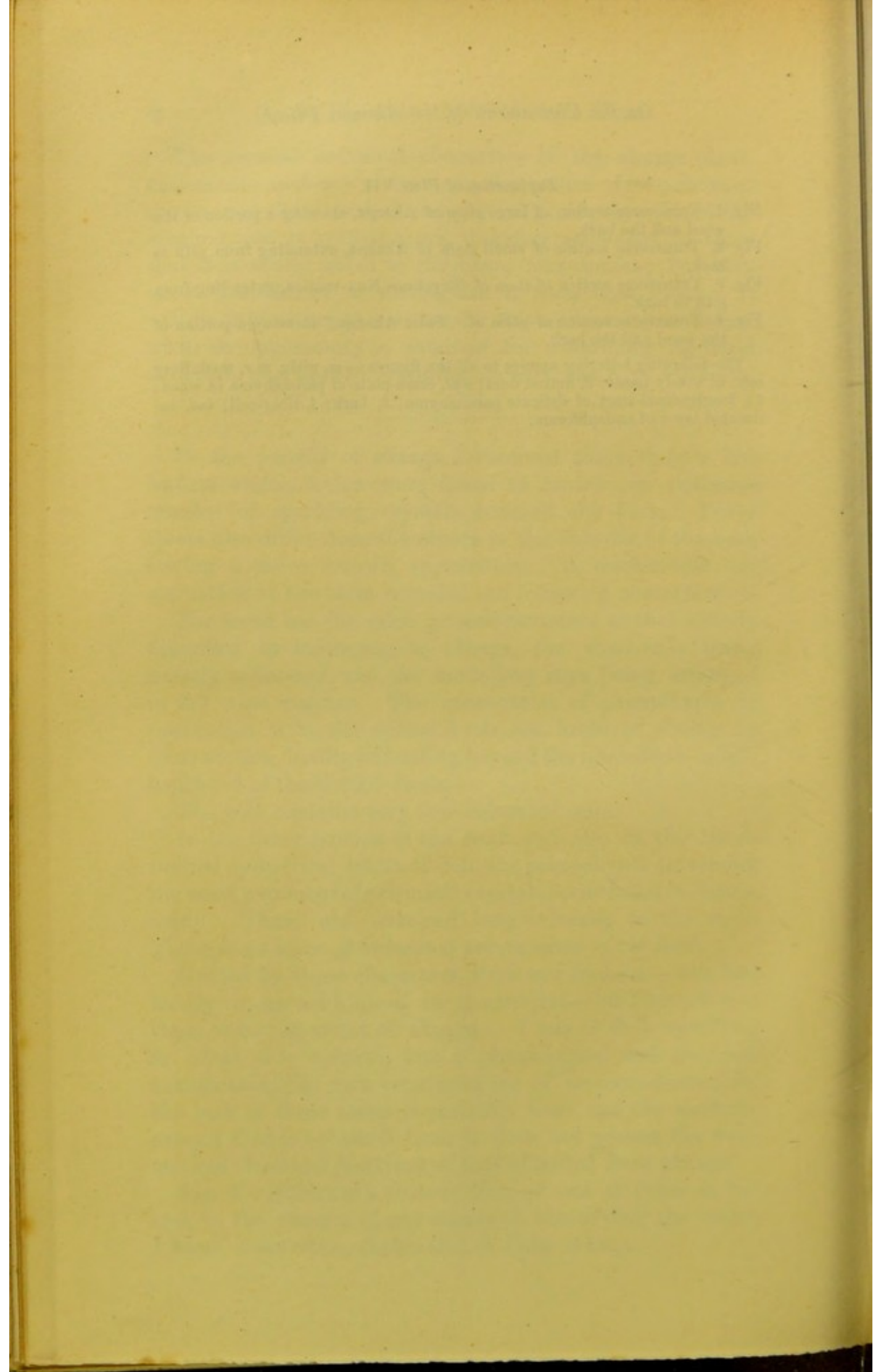


Fig. 1.

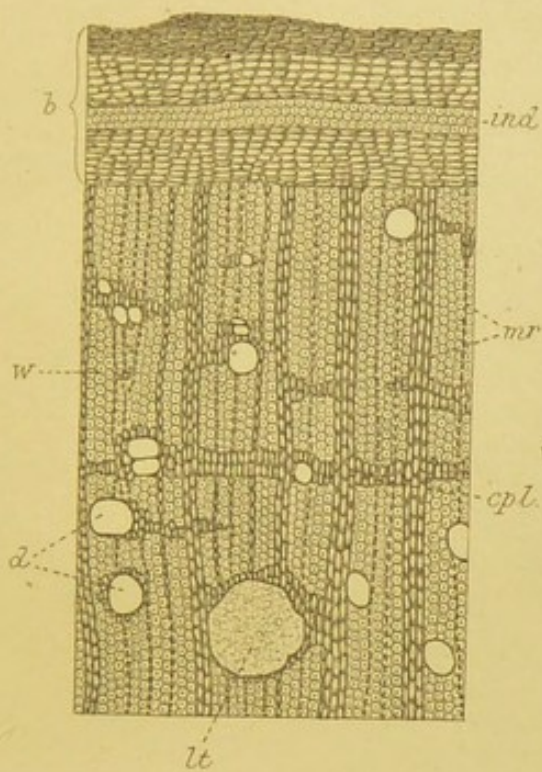


Fig. 4.

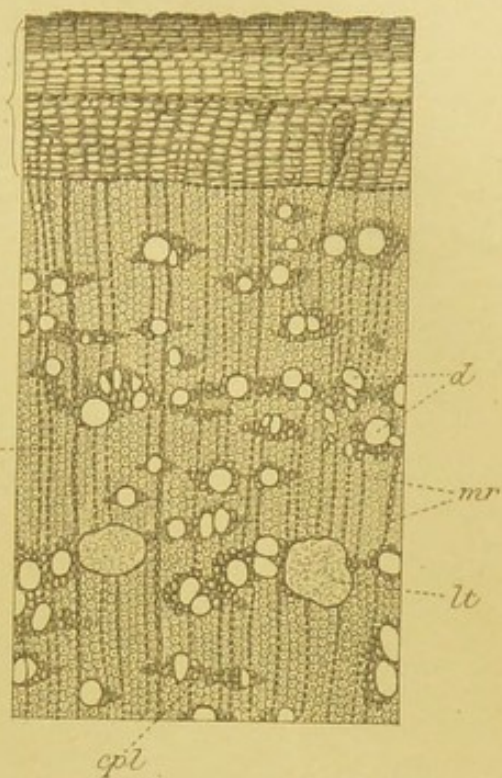


Fig. 2.

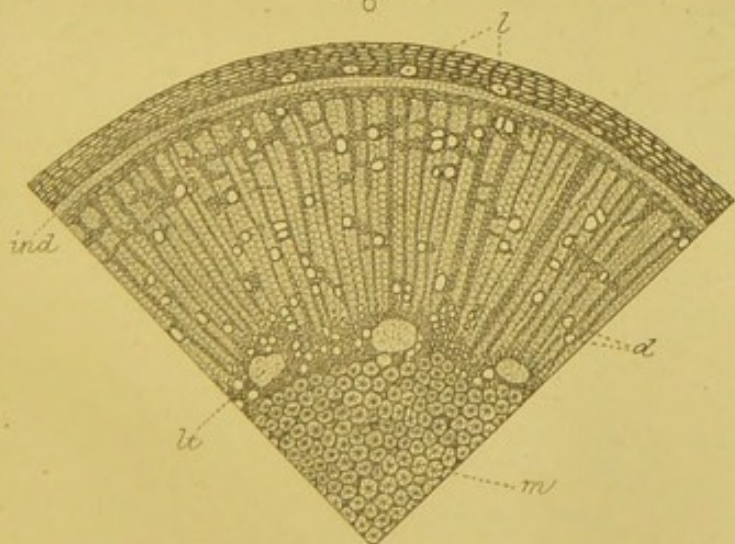


Fig. 3.

