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deduced¹⁾, the figures of the crystal-sections for the section-planes (P), (Q), and (R), then one finds the sections that are represented in fig. 3.

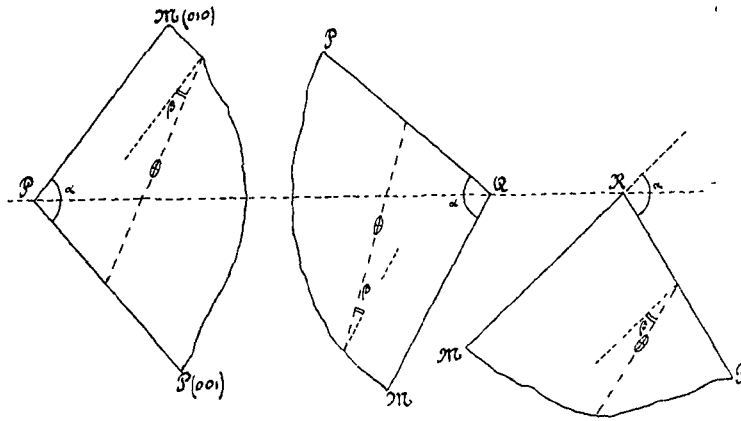


Fig. 3.

At the sections (P) and (Q) the traces of P (001) and M (010) include an obtuse angle, at (R) its supplement $\pi - 101^{\circ}45' = 78^{\circ}15'$. Whilst between the sections (P) and (Q) on the one side, (R) on the other side a choice can easily be made, now the sections (P) and (Q), at first sight looking identical, can be distinguished again on account of their different double refraction.

Botany. — “*A few observations on some new and little known cases of Leguminosae with mechanically irritable leaves.*” By S. H. KOORDERS, at Buitenzorg.

(Communicated in the meeting of May 27, 1911).

Introduction. The observations here described were made from 30 January to 13 February 1911 at Buitenzorg in the Botanical garden, partly at older specimens, partly at young pot-plants. Although other occupations took too much of my time to study these cases in detail still I think them worth publishing, how incomplete they may be, for from the literature at my disposition I must conclude that the occurrence of mechanically irritable leaves in the species examined by me is either quite unknown or as yet not observed at Buitenzorg.

§ 1. *Albizia stipulata* BENTH. — The first observation on movements of the leaflets (foliola) after vigorous tapping was made

¹⁾ Proc. Royal Acad. Amst. 1911, p. 1033.

by my wife and myself on 30 January at half past five p. m. at a pot-plant of about 1 M. high. Within 5 minutes after tapping on the stem all the leaflets of the youngest leaf folded upwards close together; the narrow leaflets of the older leaves (in this species bipinnate) folding distinctly upwards in oblique direction. At the beginning of the experiment all the leaflets were nearly quite expanded, whereas 5 minutes after the irritation the younger leaves had assumed the nocturnal position.

When we repeated the experiment next morning at 7 o'clock with pot-plants of the same species, all the younger leaflets showed, it is true, a distinct movement indicating irritation, but the older leaflets folded upwards only hardly perceptibly, the younger ones on vigorous tapping and shaking assuming almost nocturnal position.

Be it noticed that the irritated leaflets not only perform a movement upwards, but also take an inclined position with regard to the secondary leafstalks, in such a way that the faces of the leaflets remain fairly parallel.

The determination of the species of the experiment plant has been verified by me and found correct.

§ 2. *Poinciana regia* BOJER. — The hitherto unnoticed extreme irritability of this species, not seldom cultivated on Java as an ornamental tree, was first observed by me with regard to mechanical stimulants (as shaking and tapping), which hitherto had remained unknown, on 1 February last at some very young pot-plants grown in the Buitenzorg Hortus. When on that date between 8 and 9 a.m. I slightly tapped the stem of some of these plants all the leaflets made within few minutes very obvious movements indicating irritation, whereas in the non-irritated plants all the leaves (in this species bipinnate, with narrow leaflets) remained in the normal expanded day position.

After the plants had been left some hours, the leaflets had, at least outwardly, quite recovered from the irritation. At the hand of some simple irritation experiments with a young pot-plant of *Poinciana* I will try to describe the quick and very peculiar complex movements performed by the leaflets.

The experiment plant is about 25 cm. high and has 5 quite expanded leaves. They are bipinnate and (in this young specimen) have from 5—7 pinnae. The pinnae bear from 7—12 pairs of oval, un-haired leaflets, of irregular width, very short-stalked, oblique at the base, rounded or crenate at the top, the topmost dark green, those at the base pale green, and about 1 cm. long. The common petiole has a

length of from 3—6 cm. The petiolules are $\frac{1}{2}$ millimeter long, rather thin, nearly without hairs, with small articulations. The leafstalk and the common rachis are nearly bare or very short-haired. Both are, also after irritation, almost horizontal. By day in non-irritated state all the leaflets are always in such a position that the midrib of each leaflet is standing almost vertically on the secondary rachis, the blade being normally and horizontally expanded. Hence, in unirritated diurnal condition all the leaflets are lying nearly in the horizontal plane.

As to the movements provoked on 4 and 5 February in the above experiment plant of *Poinciana regia* by mechanical agency (shaking and tapping) I refer to Plates 1 and 2 and further to the following observations.

Explanation of the plates of *Poinciana regia*.

Plate 1. The foresaid plant in non-irritated state photographed at 9.40 a. m. on 5 February 1911.

Plate 2. The plant figured on Plate 1, 5 minutes later (9.45 a. m.) after irritation by vigorous shaking. The exterior of the plant has quite changed within 5 minutes in consequence of the mechanical irritation, and this is most obvious when the plant is considered from above. By the stimulation the leaflets have in the first place performed a rotation around their longitudinal axis with the result that the left half of each leaflet is turned obliquely downwards, the right one obliquely upwards. Secondly the leaflets make simultaneously another irritation movement. Of all the leaflets, namely, the tops move almost at the same time, or at least in very quick succession, sideways in horizontal direction so that, owing to this second movement the midrib of the leaflets, which primitively was at right angles with the secondary petiole, now is at acute angles with it. After this complex movement, performed within 5 minutes, all the leaflets are standing obliquely upright, clog-wheellike, whilst in consequence of the inclined position of their midrib the two leaflets of each pair have taken the shape of the letter V and have their faces almost parallel.

Further observations on the above plant of
Poinciana regia photographed on
5 February.

5 February, 4.30 p. m. — The plant has outwardly quite recovered from the stimulation (of 9.40 a. m.) and all the leaflets are

again horizontally expanded, the midrib of each leaflet being at right angles with the secondary rachis.

5 *February*, 8.45 *p. m.* — The plant is standing out of doors at a sheltered place. No rain. No wind. Since about 2 hours there has been a thunderstorm. All the leaflets have taken the so characteristic nocturnal position. They all have, namely, by night their tops directed vertically downwards, the upper surfaces of each pair pressed together, the leaflets on the same side of the secondary rachis being imbricated. Hereby the midrib of the leaflets stands vertically or more or less inclined on the secondary petiole, the latter being placed with all its leaflets in a nearly vertical plane. A comparison of the nocturnal position of *Poinciana regia* with that assumed within 3 minutes by the strongly irritated leaflets, proves that in the latter case the movement amounts about to the half of that performed in from 1—1½ hour at the passage from day to night position.

7 *February*, 1 *p. m.* — Cloudy. No wind. — All the leaflets are in non-irritated day position, quite expanded. About 3 minutes after our slightly tapping with a lead-pencil on the leafstalk and the common rachis of the topmost leaf, all the leaflets of the irritated leaf had taken the before described "irritation position", apparently, however, the irritation had not been transmitted to the other leaves. At least after a quarter of an hour the latter did not yet show irritation movements and all the leaflets were quite outspread whereas, still then, all the leaflets of the irritated leaf were in the described highly interesting "irritation position".

7 *February*, ½ *p. m.* — It has become dark since ½ hour. The leaves are nearly in the nocturnal position. Only in the topmost leaves each pair of leaflets has its upper surfaces closely pressed against each other. In the other somewhat older leaves the leaflets are almost, but not closely, pressed together. It further appears that the closing of the leaflets takes place acropetally at the secondary rachis.

11 *February*, 2 *p. m.* The experiment plant in non-irritated condition (now with its leaves quite outspread) is cautiously, without shaking, placed in a shut cupboard.

Idem, 4 *p. m.* — All the leaves have the peculiar appearance of the "irritation position", but not one shows the "nocturnal position". This was neither the case at another date by day after the plant had been left 5 hours in the dark room. In the latter case also all the leaves had the peculiar clog-wheel appearance, characteristic of the "irritation position", with obliquely rising *V* shape-placed leaflets, whilst yet in not one leaf the downward turned

leaflets were pressed together, as takes place in from 1—1½ hour at the periodical passage from day to night position.

Idem, 4½ p. m. — The plant is cautiously transported from the dark room into the full light without.

Idem, 5 p. m. — The three topmost youngest leaves have quite recovered from the stimulation and are again fully expanded. Only the two at the base are partly restored.

Finally be it mentioned that a simple "burning experiment", to which another *Poinciana regia* was submitted, proved that the irritation caused by burning one or two leaflets with a match was not transmitted to the neighbouring leaflets, notwithstanding this species was very sensitive to mechanical stimulation (shaking).

Further it may be noticed that the non-artificially irritated control plant which was continually kept at a sheltered place, showed all the day quite expanded leaves. The determination of the species of this biologically highly interesting plant I have verified and found right.

§ 3. *Calliandra spec.* — A very young pot-plant grown in the Buitenzorg Hortus under the garden-name of *Calliandra hamata* (evidently erroneous for *haematocephala* Hassk.) was subjected to an irritation experiment on 5 February 7.30 a. m. by vigorously tapping on the stem with a lead-pencil.

Within about 3 minutes the leaflets of the topmost (youngest) leaf had closed, the other leaves only indistinctly reacting on the stimulation, whereas in all the non-irritated plants all the leaves (also the youngest) were then almost fully expanded.

§ 4. *Calliandra portoricensis* BENTH. — A shrub about 3 M. high with bipinnate leaves and narrow leaflets, grown in the Hortus Bogor. in garden-bed XV. J. (A. XIV) Number 6, under the said name found correct by me.

When on 2 February at 5¾ p. m. I made an experiment with it by vigorous shaking, all the leaves were still in fully expanded day position. Directly after the shaking the leaflets of the irritated branches folded upwards and assumed closely pressed together the nocturnal position typical for that species. Meanwhile the leaves of the non-shaken branches remained expanded. When repeating this experiment some days consecutively about ½—1 hour before sunset I obtained the same results. However, the experiment plant showed in the forenoon at 7 o'clock, also when vigorously shaken, only relatively feeble irritation movements, whilst in that case the nocturnal

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Plate I.



Poinciana regia Bojer. — The young plant not irritated in day position, at 9—10 a. m. 5 Februar 1911.

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Plate II.



Poinciana regia Bojer. — The same plant after 5 minutes, in irritation-position by shaking.

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position was not taken by a single leaf. Of this species there are two specimens more in the Hortus Bog. under Number 1 and Number 1A in garden-bed I H.

§ 5. *Adenanthera microsperma* TEYSM. & BINN. — Tree grown under this name in Hortus Bogor. in garden-bed IB, Number 49. On 5 February at 9 a.m. I found that the leaves (in this species bipinnate), at least the younger ones, performed rather distinct but only feeble irritation movements after vigorous shaking of the branches. These movements reminded of those typical for *Poinciania*, but in *Adenanthera* the movement is much slighter. The determination of the species has been verified by me and, in as much as the material at hand allowed, found correct.

§ 6. *Tetrapleura Thonningii* BENTH. — A young tree about 1 M. high, grown under the said name in the Hortus under Number 14 in garden-bed I.G. The leaves are bipinnate and remind of *Adenanthera*. At 7 a.m. on 5 February, the plant was vigorously shaken. Within few minutes the younger leaves which before, like the older ones, were quite expanded, plainly showed irritation movements similar to the *Poinciania* type, but much less vivid.

§ 7. *Schrankia hamata* HB. & BFL. — Undershrub kept in the Buitenzorg Hortus under that name, which was verified and found right, in garden-bed A XXV of the Leguminosae herbs division, under Number 2, with bipinnate leaves and very narrow leaflets. Not only in the forenoon but also in the afternoon, all the branches when mechanically irritated (by shaking) reacted almost as quickly as *Mimosa pudica*.

Buitenzorg, February 12, 1911.

Mathematics. — “*On the structure of perfect sets of points*” (second communication ¹⁾). By Dr. L. E. J. BROUWER. (Communicated by Prof. KORTEWEG).

(Communicated in the meeting of April 28, 1911).

§ 1.

A further extension of Cantor's fundamental theorem.

The proof of CANTOR's fundamental theorem and of its Schoenflies extension, given in § 2 of the first communication, holds also for the following property :

¹⁾ For the first communication see these Proceedings, Vol. XII, p. 785.