VI. "The Tubercular Swellings on the Roots of the Leguminoseæ." By H. Marshall Ward, M.A., F.L.S., Fellow of Christ's College, Cambridge, and Professor of Botany in the Forestry School, Royal Indian College, Cooper's Hill. Communicated by Prof. M. Foster, Sec. R.S. Received April 25, 1887.

(Preliminary Note.)

The author finds that the tubercles on the roots of the Leguminoseæ are due to the action of a parasitic fungus. Not only has he produced the tubercles by infection from without, but he has also found the infecting agent, and repeatedly seen and figured the infecting hypha passing down inside a root-hair and across the cortex of the root into the young tubercle. Here the hyphal branches bud off yeast-like cells, which are extremely minute and numerous, and resemble bacteria at first sight; they differ in their mode of multiplying by budding.

The action of these minute germ-like bodies causes the protoplasm of the cells of the root to assume plasmodium-like characters, and induces the flow of nutritive substances to these cells, and hypertrophy results. On the decay of the tubercles, the germ-like bodies pass into the soil (where they can always be found) and infect other roots; it is very probable they may be of extreme importance in agriculture.

VII. "The Proteids of the Seeds of *Abrus precatorius* (Jequirity)." By Sidney Martin, M.D. Lond., Fellow of University College, London, and Pathologist to the Victoria Park Hospital. Communicated by Prof. E. A. Schäfer, F.R.S. (From the Physiological Laboratory, University College, London.) Received April 21, 1887.

The proteids of the seeds of Abrus, the Indian liquorice, are important physiologically, because they have been shown (by Warden and Waddell*) to be possessed of poisonous properties. To the poisonous product extracted by these observers the name "abrin" was given; and though it was decided that abrin was closely allied to "plant-albumin," yet no experiments were recorded to show whether the product was a mixture or a single proteid. They obtained it by

* 'The Non-bacillar Nature of Abrus-poison.' By C. J. H. Warden and L. A. Waddell. Calcutta, 1884.

making a watery extract of the crushed seeds and precipitating with alcohol, the precipitate being afterwards collected and dried.

Before proceeding to an examination of the physiological action of the jequirity, it seemed to me desirable to determine the kind of proteids present in the seeds, and the present communication embodies the results of the inquiries made with a view to such determination.

Method of Extraction of the Proteids.

The method used was based on the supposition that the proteids present in Abrus were similar to those in other seeds, consisting chiefly of proteids of the globulin and albumose classes.

The finely ground seeds were shaken first of all with chloroform to remove the red cuticle which sinks in this liquid, so that the yellow kernel-powder could be readily removed, and obtained in the dry state by allowing the chloroform to evaporate.

The powder obtained was then extracted with 15 per cent. sodium chloride solution for twenty-four hours, and the mixture filtered. The yellowish filtrate was distinctly acid and gave a copious precipitate on boiling. The proteids were separated from this filtrate in two ways:—

(1.) Saturation with neutral ammonium sulphate and shaking for four hours throws down all the proteids in solution; the filtrate, after saturation, giving none of the proteid tests.

(2.) Saturation with sodium chloride and shaking for many hours gives only a scanty precipitate, which becomes copious on adding a large excess of glacial acetic acid. All the proteids are only with difficulty precipitated by this mode of saturation, even after prolonged shaking.

Since ammonium sulphate so readily throws down all the proteids in solution, the precipitate caused by it was used in the following manner in the examination of the proteids:—The precipitate was collected and dissolved by adding distilled water, and the solution dialysed in running water (with thymol) for five to seven days.

Dialysis caused a copious precipitate, which was collected and washed with distilled water (previously boiled to remove carbon dioxide) until no proteid in solution was present in the washings. The precipitate was then dried over sulphuric acid. The residue was in dark-brown scales. It consisted of globulin with some colouring matter.

It is not possible to remove all the globulin by dialysis, so the liquid, after dialysing for seven days, was filtered into rectified spirit, which precipitated the remaining proteids. After standing under the alcohol six to eight weeks the globulin was coagulated, and the precipitate was collected, dried, and treated with distilled water, which

dissolved out a proteid. This proteid is an albumose. The chloride of sodium method may be used instead of the ammonium sulphate; it takes a longer time, but gives products freer from colouring matter.

For chemical examination, the albumose is readily prepared by boiling and filtering an aqueous infusion of the seed. The globulin is coagulated while the albumose remains in solution.

Properties of the Globulin.

1. It is insoluble in distilled water, but readily soluble in 10 to 15 per cent. sodium chloride or magnesium sulphate solution; soluble to a less extent in 5 per cent. sodium chloride solution, and scarcely at all in 0·75 per cent.

2. It is completely precipitated from solution by saturation with sodium chloride after slightly acidifying, and with ammonium sulphate, whether the solution be neutral, acid, or alkaline.

3. It is coagulated by heat in 10 per cent. magnesium sulphate solution, between 75° and 80° C., the liquid being made distinctly acid; in 10 per cent. sodium chloride, between 66° and 73° C.

4. When the solution in 10 per cent. sodium chloride is placed in the incubator at 35° to 40° C., and allowed to remain twenty-four or even forty-eight hours, no precipitation occurs; a reaction in marked contrast to that given by some vegetable globulins. In its high coagulation temperature, and in its non-precipitation from solution by prolonged exposure to a moderate heat, abrus-globulin agrees with the proteid I have described in the juice of the fruit of *Carica papaya*, which, from its resemblance to serum-globulin, I have called vegetable paraglobulin.* The vegetable myosins occurring in the cereals, wheat, rye, and barley, have a lower coagulation temperature than the paraglobulins, viz., 50°—55° C., and are precipitated from solution and rendered insoluble by a prolonged exposure to a temperature of 35°—40° C.†

Properties of the Albumose.

1. Soluble in cold or boiling distilled water. Its chemical and physical properties are not apparently altered by boiling its solution.

2. It is not precipitated from solution by saturation with sodium chloride unless a large excess of glacial acetic or phosphoric acid be added. It is readily precipitated by saturation with neutral ammonium sulphate.

3. It does not form an albuminate.

4. Nitric acid does not precipitate it in a watery solution; but a precipitate falls if solid sodium chloride be added nearly to saturation.

* "Nature of Papaïn, &c.," 'Journ. of Physiol.,' vol. 6, p. 353.

† 'Physiol. Soc. Proc.,' Feb. 12, 1887.

5. Acetic acid causes a cloudiness, which is increased by potassium ferrocyanide.

6. Copper sulphate and basic acetate of lead cause precipitates, soluble in excess; mercuric chloride, a precipitate insoluble in excess.

7. Copper sulphate and potash give a pink coloration (biuret reaction).

For the albumoses occurring in the vegetable kingdom I have proposed the name *phytalbumoses*, as they differ in many respects from the animal varieties.

The phytalbumose in Abrus is closely allied to Kühne and Chittenden's deutero-albumose,* and identical with the α-phytalbumose occurring in the papaw juice.†

There are, therefore, two proteids in the seeds of *Abrus precatorius*, a vegetable paraglobulin and α-phytalbumose. In conjunction with Dr. Wolfenden, I am now engaged in investigating the physiological action of each of these proteids, and hope soon to publish the results. For the present it will be sufficient to call to notice the close resemblance between the proteids of the papaw juice and those of jequirity, since their physiological action appears to be in many respects similar.

VIII. "On the Diameters of Plane Cubics. Preliminary Notice." By J. J. Walker, F.R.S. Received April 21, 1887.

I showed some time back ('London Math. Soc. Proc.,' vol. 10, pp. 184–5) that the Newtonian diameters of a plane cubic (u) envelope a conic, called hereinafter its "centroid," the equation of which, if in the system of co-ordinates chosen the line at infinity be

$$\xi x+\eta y+\zeta z=0,$$

is generally

$$\xi^2\left\{\frac{d^2u}{dy^2}\,\frac{d^2u}{dz^2}-\left(\frac{d^2u}{dy\,dz}\right)^2\right\}+\cdots\quad+2\eta\zeta\left(\frac{d^2u}{dz\,dx}\,\frac{d^2u}{dx\,dy}-\frac{d^2u}{dx^2}\,\frac{d^2u}{dy\,dz}\right)+\cdots=0.$$

The "centroid" has the same "criterion-function," but with changed sign, as the cubic; viz., it is equal to minus one-fourth of the reciprocal of u, with the substitution of $\xi\eta\zeta$ for $\alpha\beta\gamma$; *i.e.*, if u be written

$$u\equiv ax^3+by^3+cz^3+\;\ldots\;+6exyz,$$

the criterion-function is equal to

$$-(b^2c^2\xi^6+\;\ldots\;)/4;$$

* Kühne and Chittenden, "Ueber Albumosen," 'Zeitschr. für Biologie,' vol. 20.

† "Nature of Papaïn, &c.," 'Journ. of Physiol.,' vol. 6, p. 344.