NOTICES OF BOOKS.

‘DIE MORPHOLOGISCHE UND CHEMISCHE ZUSAMMENSETZUNG DES PROTOPLASMAS,’ VON DR. FRANZ SCHWARZ (Separatabdruck aus Cohn’s ‘Beiträge zur Biologie der Pflanzen,’ Bd. v. Heft 1, 1887).

IN this important paper the author publishes the results of extensive and laborious investigation into the chemistry of protoplasm, and into the structure of protoplasmic bodies, such as the chloroplastid, the nucleus, and the cytoplasm.

He begins with the study of the reaction of the cell-contents. As regards the cell-sap, he points out that it is sometimes acid and sometimes alkaline,—a fact which is clearly established by the action of acids and alkalies on cells containing either blue or red cell-sap: in the former case, treatment with acid caused the blue to change to red; in the latter, treatment with alkali caused the red to change to blue; hence, the original reaction must have been respectively alkaline and acid.

The protoplasm, using the term in its widest sense, he found to be in all cases alkaline. This was ascertained by the observation both of cells containing red or blue cell-sap, and of cells with colourless cell-sap, but treated with an extract of red cabbage. In either case, when the protoplasm was killed by an electric shock, or by treatment with alcohol, or by heating, the colouring matter diffused into the protoplasm and generally gave a distinctly alkaline reaction: that is, the protoplasm stained blue, bluish-green, or green, according to the degree of alkalinity. In some cases the staining of the protoplasm was preceded by a change of colour, indicating neutralisation or alkalinity in the cell-sap. In no case did the protoplasm stain yellow, indicating a high degree of alkalinity: nor did it ever stain red, indicating acidity. These conclusions are confirmed by Pfeffer’s observation¹ that the protoplasm of living cells gives an alkaline reaction with cyanin.

¹ Bot. Zeitg. 1886.

The reaction of the cell-contents, as a whole, depends upon the relative quantities of alkaline protoplasm and of acid cell-sap which are present. The alkaline reaction is most marked in young cells in which the protoplasm preponderates, the acid reaction in old cells in which the cell-sap is present in excess.

The author then proceeds to ascertain the cause of the alkalinity of protoplasm. He has recourse to analyses of the ash, and, taking leaves as giving the most reliable data, he cites a number of analyses which prove that there is a close relation between the amount of proteid in the leaves and the amount of potash in their ash. This, he believes, to be the cause of the alkalinity of protoplasm; and, after discussing the various possible forms in which potash may be present, he comes to the conclusion that it exists in combination with proteid.

The next point considered is the structure and the chemical composition of chloroplastids. After giving an account of the views of Schmitz, Frommann, Meyer, Schimper, Pringsheim, and others, as to the structure of these bodies, the author states his own conclusion, which is this: that a chloroplastid consists of a ground-substance in which are imbedded a number of fibrillae lying closely side by side; there is no definite membrane, but there is a peripheral plasma-membrane.

The colouring-matter of the plastid is confined to the fibrillæ, which are coloured green throughout; but it is especially collected into small spherical vacuoles (*grana* of Meyer).

The fibrillar structure of the chloroplastid is not apparent under normal conditions, but it becomes evident when they are caused to swell up by treatment with water. The fibrillae then swell up somewhat and separate, the ground-substance being dissolved. Hence it appears that the fibrillae and the ground-substance consist of two distinct proteid substances; the former is termed by the author *chloroplastin*, the latter, *metaxin*.

A long series of observations is given describing the effect of solutions of various salts, of potash, and of acids, upon chloroplastids. Although these are all of interest, yet it is only possible to refer to some of them. The action of potash on the colouring matter is worthy of special note. When treated with solution of potash, the green vacuoles disappear, and the whole chloroplastid becomes uniformly coloured of a yellowish green. The author considers, in

agreement with Hansen¹, that this is due to the saponification of the oily solution of chlorophyll, which constitutes the oily green drops, the 'vacuoles' or 'grana,' described above as occurring in the fibrillae. With regard to the action of strong hydrochloric acid, it is interesting to compare the author's conclusions with those of Pringsheim. The colouring matter is gradually exuded as masses of chlorophyllan (Pringsheim's hypochlorin), and the body of the plastid presents darker and lighter areas which Pringsheim interpreted as due to a trabecular or spongy structure. Schwarz, however, shows that the darker areas are granular or fibrillar masses formed by precipitation of some of the proteid by the strong acid; hence the structure of the chloroplastid is not spongy or trabecular.

Passing now to the nucleus, the author distinguishes in it the following components: a peripheral membrane, a ground-substance (*Kernsaft* of R. Hertwig), nucleoli, and a fibrillar framework. These, he finds, consist of different substances, as indicated by their reactions, which he distinguishes by various names. The substance composing the nuclear membrane is termed *amphipyrenin*; that of the nucleoli *pyrenin*; those of the framework and of the ground-substance, respectively *linin* and *paralinin*. Besides these substances there is *chromatin*, which usually occurs in the form of granules in the fibrillar framework of the resting nucleus. In the young nucleus, the chromatin is uniformly distributed throughout the fibrillar framework, though in some cases granules of chromatin are also present. This account of the chemical composition of the nucleus differs widely from that given by Zacharias², according to which the nucleus consists of nuclein, plastin, and albumin, the first being present especially in the chromatin-granules, the second in the framework and the ground-substance, the third in the nucleoli.

With regard to the structure and composition of the nucleus at different stages, the author points out that the framework consists at first of a single filament which, by the formation of anastomoses, forms a reticulum. This change is accompanied by an increase in size of the nucleus as a whole, due to an increase in the bulk of the framework and of the ground-substance, and, at first, to a growth of the nucleoli. But the nucleoli begin to diminish before the nucleus has completed its growth, so it appears as if the substance

¹ Arb. d. Bot. Inst. in Würzburg, III. 1884.

² Bot. Zeitg., 1882.

of the nucleoli were used in the formation of the other portions of the nucleus. The chromatin is very abundant at first, but it does not seem to increase in proportion to the growth of the nucleus.

After it has attained its full size, the nucleus begins to diminish. The framework has either more delicate fibrillae, or some of them disappear altogether, so that the reticulum becomes much looser, and the granules of chromatin are few. In fact, all the constituents of the nucleus diminish in quantity, but no one of them disappears.

It is convenient to defer an account of the reactions of these various substances for the present, but it may be mentioned here that in some cases the author observed *complete solution* of the nucleus on treatment with water, but only in very young cells. In older nuclei the effect of water was to cause swelling-up and vacuolation, accompanied by the solution of certain of the constituents, especially the paralinin. In some cases treatment with water caused no perceptible change; this appeared to be due to the action of the tannin or acid dissolved in the cell-sap.

The author does not give any satisfactory explanation of the difference in treatment with water between young and older nuclei. The inference to be drawn from his remarks is, that the same substances are present in both, but in somewhat different forms. For instance, in controverting the conclusion of Zacharias that the nucleoli consist of albumin and plastin, the author suggests that they consist of two forms of pyrenin, one more soluble, the other less so, and that the former predominates in young, the latter in old nuclei. But this suggestion appears to beg the question. The general conclusions at which the author arrives are based mainly on the differences in solubility of the various substances which he distinguishes, and if this criterion is not admitted in this case, why should it be admitted in the others?

Coming now to the cytoplasm, the author concludes that the fibrillar structure which has been described by Schmitz and others is not normal, but is the result of precipitation or of vacuolation. In support of this view, he gives figures of precipitates obtained by the action of alcohol and other reagents on solutions of albumin, peptone, gelatin, etc., as well as of precipitates produced in both the protoplasm and the cell-sap of living cells by various chemical reagents as well as by electric shocks.

The observations on the formation of precipitates in living cells recall those made by Darwin¹ on roots and chlorophyll-corpuscles on treating them with carbonate of ammonia and other alkaline salts. Further, the fact that Schwarz obtained precipitates by means of electric shocks, suggests that the 'aggregation' induced by stimulation in the tentacle-cells of *Drosera*, etc. is to some extent a phenomenon of precipitation.

With regard to the ectoplasm and the 'vacuole-membrane,' Schwarz concludes that these are membranes of precipitation, and that consequently it is impossible to isolate them as distinct structures. The thick vacuole-membrane described by De Vries² is regarded by Schwarz as an artificial product formed on the death of the cell. The microsomata appear to consist of various different substances, and not to be structural constituents of the protoplasm.

The cytoplasm consists chemically, according to the author, except in the case of very young cells, of one proteid substance, which he terms *cytoplastin*.

Throughout the work there are numerous observations as to the physics of vacuolation which may be conveniently brought together. The author's theory of vacuolation, which is remarkably simple, is based on the fact that vacuolation only takes place in a mass consisting of at least two substances, one of which is insoluble but capable of limited swelling by imbibition, the other being soluble. He proves this by showing that no vacuolation takes place in a mass of a pure substance, such as gelatin, which is capable of limited imbibition, and this overthrows the possible view that vacuolation may be simply due to the imbibition of a larger quantity of water than the substance can retain in its molecular interstices. On the other hand, it does not necessarily follow that, in a mixture of a swelling substance, and of a soluble substance, vacuolation will be induced on the addition of liquid, as the author shows by examples. A further condition is, that the insoluble substance should be impermeable to the solution of the soluble substance. This last condition probably sets up surface-tensions which lead to the aggregation into drops of the solution of the soluble substance.

The various phenomena of vacuolation presented by chloroplastids,

¹ Journal Linn. Soc., Botany, vol. xix. 1882.

² Pringsheim's Jahrb. f. wiss. Bot. xvi. 1885.

nuclei, and cytoplasm, are explained on this theory by the author as follows. Treatment with water causes in many cases well-marked vacuolation of the chloroplastids; this is due to the swelling-up of the fibrillae, the chloroplastin, and to the solution of the metaxin. In some cases vacuolation does not take place because, apparently, the chloroplastin does not swell sufficiently to cause the separation of the fibrillae. That a proteid substance is actually present in solution in the vacuoles at the chloroplastids can be shown by reagents inducing precipitation, etc.

Treatment with water also frequently induces vacuolation of the nucleus: this appears to be due to the swelling of the nucleus as a whole, and to the solution of the paralinin.

The vacuolation of the cytoplasm is peculiar in that it does not appear to be due to the presence of a soluble proteid, as is the case in the chloroplastid and the nucleus—at least Schwarz failed to detect any such substance;—but no suggestion is made as to what the soluble substance may be. Vacuolation does not, however, take place in very young cells, in which the cytoplasm simply swells by imbibition; neither does it take place in old cells in which the cytoplasm is scanty, nor in cells which contain tannin; in these latter cases there is also no swelling by imbibition.

In conclusion, the chemical properties of these various substances are considered.

Chloroplastin and cytoplastin appear to be closely allied. The author rejects the suggestion of Zacharias that the plastins are identical with the insoluble nucleins, though they resemble them in some respects, on the ground that whereas these nucleins are soluble in strong potash and in concentrated hydrochloric acid, neither chloroplastin nor cytoplastin dissolve in these reagents, nor do they stain readily, as do the nucleins.

The differences between chloroplastin and cytoplastin are slight. Cytoplastin dissolves slowly in 5% disodium phosphate, and swells or even dissolves in 20% solution of the salt, whereas chloroplastin swells but little and does not dissolve in these solutions.

Metaxin appears to be an altogether peculiar proteid. Although the metaxin of the chloroplastid dissolves on treating a chloroplastid with water, yet the author doubts if it is actually soluble in water, for the observed solution may be due to the alkalies which, as has been shown, are present in the protoplasm. However, since it is stated, in

the table of reactions given, that metaxin is only doubtfully soluble in dilute potash, it appears probable that it is really soluble in water. It differs from globulin and albumin in not being soluble in 10% solution of common salt, and from albuminates in not being readily soluble in dilute acids and alkalies.

Of the substances which are described as constituting the nucleus, linin and paralinin form one group, pyrenin and amphipyrenin form another, and chromatin stands by itself. They all agree in being digestible by trypsin, and differ in this respect from the plastins, cytoplakin and chloroplastin.

So closely do linin and paralinin resemble each other, that the author is doubtful if he is justified in regarding them as distinct substances. The main difference between them is that linin is not digested by pepsin, whereas paralinin is. They resemble the globulins, especially myosin, in being soluble in 10% solution of common salt, but not in stronger solutions, as also in being soluble in dilute potash;—but, unlike the globulins, they are insoluble in hydrochloric acid, whether dilute or concentrated.

With regard to pyrenin and amphipyrenin, they differ mainly in their solubility in 10% common salt solution, the former being more readily soluble than the latter, and in that the former stains whereas the latter does not. They dissolve in potash solutions, whether dilute or concentrated, and they are not digested by pepsin; they are also soluble, but not readily, in 1% solution of hydrochloric acid.

Chromatin is apparently soluble in water, but its apparent solubility when a nucleus is treated with water may be due to the alkalinity of the protoplasm. It is soluble in saturated solution of magnesium sulphate, in solutions of disodium phosphate and of common salt, and in potash, but it is not soluble in acetic or hydrochloric acid, nor is it digested by pepsin.

It remains to point out the relation between these substances and those which had previously been described as entering into the composition of the protoplasm. According to Zacharias¹, the nucleus consists of three proteids—nuclein, plastin, and albumin; the chloroplastids and the cytoplasm of two proteids—plastin and albumin.

Since Zacharias has shown that his 'nuclein' is localised in the

¹ In Bot. Zeitg. 1882 and 1883.

chromatin-granules, it appears probable that it is identical with the substance which the author terms chromatin.

The author points out that the substance which Zacharias found to constitute the nuclear framework, and termed plastin, differs widely in its reactions from both cytoplastin and chloroplastin; Zacharias' nucleo-plastin is the author's linin.

The substance in the nucleus which Zacharias terms 'albumin' is apparently the same as the author's paralinin, assuming, as the author contends, that there is no albumin in the nucleoli.

The substances pyrenin and amphipyrenin, described by the author, seem to have no parallel in previous investigations.

With regard to the chloroplastids, the 'plastin' and 'albumin' of Zacharias appear to be the equivalents of the author's chloroplastin and metaxin. Similarly, in the case of the cytoplasm, Zacharias' 'plastin' is the cytoplastin of the author; the 'albumin' is recognised by both writers.

Of the substances described by the author, the majority, namely cytoplastin, chloroplastin, pyrenin, amphipyrenin, chromatin, linin, are not digested by pepsin; metaxin and paralinin being the only digestible proteids. On this ground the author refers the proteids of the former group to the class of nucleins. No one of them seems to agree in all its reactions with any form of nuclein as yet described. Hence it appears that there is no one substance which is to be regarded as nuclein proper, but that the term must be used for a class of proteids agreeing in their indigestibility by pepsin, and differing from each other in minor points.

As to the digestible proteids, metaxin and paralinin, their reactions do not identify them with any known group of proteids. Metaxin, in fact, does not appear to be allied to any of the groups of proteids, but paralinin is clearly allied to the globulins.

One general conclusion to be drawn from these researches is this, that the globulins, albumins, albumoses, etc. which have been obtained from plants are not constituent elements of the protoplasm; they are simply reserve-materials.

Since the investigation was carried out entirely by micro-chemical methods, and in view of the great difficulty of such observations, it is possible that some of the author's conclusions, especially those regarding the nucleus, may eventually have to be somewhat altered. But be this as it may, the author offers us valuable information as to

the chemistry of protoplasm, and has indicated methods by which our knowledge may be extended and confirmed. To those who are especially interested in this subject the paper cannot be too highly recommended.

S. H. V.

**MONOGRAPHIAE PHANEROGAMARUM, PRODROMI
NUNC CONTINUATIO, NUNC REVISIO**, editoribus
et pro parte auctoribus Alphonso et Casimir De
Candolle. Vol. quintum, pars secunda: AMPELIDEAE,
auctore J. E. PLANCHON. Parisiis sumptibus G. MASSON. Julio,
MDCCCLXXXVII.

THIS is another of those valuable monographs supplemental to the Prodrômus which are being issued from Geneva through the munificence and under the supervision of the De Candolles, father and son. The fifteenth family which has been thus presented, it forms a goodly part of 350 pages, completing the fifth volume of the series. The Ampelideae appeared in the first volume of the Prodrômus issued by Auguste Pyrame de Candolle in 1824, and their description occupies exactly ten pages of the volume; in 1887 their treatment, even when one group is excluded, requires 313 pages. Difference in method of exposition of course accounts for some of the additional space required, and a better comparison to bring out the enormous increase in our knowledge of the group during the century is to be found in the number of species recorded in the two monographs; in the Prodrômus there are 108, in the new volume 390 are pronounced certain; and there are a number of species 'non satis notae' as well.

The monograph does not include the forms belonging to *Leea* which are usually incorporated in the Ampelideae, and M. Planchon explains: 'C'est à dessein que je laisse à part les *Leea* qui forment une section très spéciale, si non une famille à part, et qui viennent d'être étudiées monographiquement par M. J.-B. Clarke, dans le Journal of Botany, new series, vol. x. (1881).' In dealing with the other forms the author differs considerably from preceding writers in his method of generic grouping. Bentham and Hooker (*Genera Plantarum*, i. 387) have been content to place the 230 odd species known to them in two genera, *Vitis* and *Pterisanthes*, the former including the other well-known genera *Cissus* and *Ampelopsis*, and being almost co-extensive

1887. "Die Morphologische Und Chemische Zusammensetzung Des Protoplasmas by Frannz Schwarz [Review]." *Annals of botany* 1, 187–195.
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