these compounds when in solution lose their colour almost as rapidly as chlorophyll itself, those containing copper are remarkably stable, since their solutions may be exposed for many weeks to light and air without undergoing any apparent change.

The products derived from phyllocyanin by reduction are next described. The action of tin and hydrochloric acid on phyllocyanin passes through two distinct stages. During the first stage a colouring matter is formed which is remarkable from its solutions showing no less than eight absorption bands. The product formed during the next stage of the process is interesting from its yielding solutions of a bright red colour without any tinge of green, and from its resembling in some respects the colouring matters of red flowers.

VI. "On the Changes in the Proteids in the Seed which accompany Germination." By J. R. GREEN, B.Sc., B.A., Demonstrator of Physiology in the University of Cambridge. Communicated by Professor M. FOSTER, Sec. R.S. Received November 25.

(Abstract.)

The processes of the germination of the seed have been in recent years investigated by v. Gorup-Besanez, who in a series of papers written in 1874 and 1875,* has stated that the changes in the reserve proteid materials are probably due to the action of a proteolytic ferment, as from the seeds of the vetch, hemp, flax, and barley plants he was able to extract a body which converted fibrin into peptone. Later, in 1878, Krauch† disputed v. Gorup-Besanez's conclusions, and claimed that his results were erroneous on account of imperfect methods of working. As v. Gorup-Besanez based his statement partly on the detection of peptone by the biuret test after the digestion had gone on for some time, and partly on a diminution of the fibrin, Krauch explained his results by saying that the digestive extract itself gave a biuret reaction, and that the diminution of the fibrin was only due to a shrinkage of its flocks.

During the past year I have been carrying out a series of experiments bearing upon this disputed point, and have succeeded in demonstrating in the seeds of the lupin (*Lupinus hirsutus*) the existence of such a ferment as v. Gorup-Besanez stated to be present, and in ascertaining some particulars as to its condition in the resting seed, the nature and conditions of its action, and the changes which

* 'Deutsch. Chem. Gesell. Ber.,' 1874, p. 1478. *Ibid.*, 1875.

† "Beiträge zur Kenntniss der ungeformten Fermente in den Pflanzen," 'Landwirthsch. Versuchs-Stat.,' vol. 27, 1878, p. 383.

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it brings about not only in the course of its action on fibrin, but also on the aleurone or proteid reserve material in the seed itself.

The method which I used in the investigation was somewhat different from that of v. Gorup-Besanez. As Krauch claimed that the biuret reaction obtained was due to some proteid in the digestive extract used, and as the vegetable peptones found in the seed of the lupin do not dialyse, while true peptone does so readily, I carried on my digestions always in carefully tested tubes of dialysing paper, so that the fluid outside the latter might enable me to see if peptone were really formed or no.

Seeds of *Lupinus* were germinated for about a week, till they had protruded a radicle of about $1\frac{1}{2}$ inch in length; they then gave an acid reaction to litmus-paper. They were divested of their coats, the radicles removed, and the cotyledons ground. The resulting powder was extracted with glycerine, and the extract dialysed till no trace of any crystalline bodies that had been formed during the germination could be detected in the dialysate. No trace of peptone or other body giving a biuret reaction passed the dialyser, even after a week's exposure. The extract was then acidified with HCl to the extent of 0·2 per cent., put into a fresh dialyser, some swollen-up boiled fibrin added, and the dialyser put into a beaker and surrounded with 0·2 per cent. HCl. It was then left at a temperature of 40° C. Control experiments, some with boiled digestive extract, some with 0·2 per cent. HCl only, were carried out side by side with the others.

The process of digestion was very slow, the time taken up being very much more prolonged than is the case with the gastric or pancreatic ferments. After some time, however, the dialysate in the beaker containing the tube in which the unboiled extract of the cotyledons had been placed gave a very marked biuret reaction, and after concentration it deposited crystals of leucin. The other dialysates contained no peptone or crystalline body.

I repeated the experiments many times with varying quantities of the extract of the cotyledons and with varying amounts of fibrin, and in all cases I was able to see that a proteolytic ferment was present in the germinating seed, and that it formed not only peptone but leucin, behaving like pancreatic rather than gastric juice. In this latter particular I am somewhat at variance with v. Gorup-Besanez, who says he was not able to see that the decomposition of the fibrin proceeded beyond the stage of peptone.

Further investigations into the condition of the action of the ferment showed that it worked best in a medium acidified to the extent of 0·2 per cent. HCl: that the temperature most favourable for its working was 37—40° C., that its activity was somewhat impeded by the presence of excess of neutral salts, and that it was speedily destroyed by contact with alkalis, even to the extent of 1 per cent.

In the resting seed the ferment exists in the form of a zymogen, as is the case with those of the stomach and other digestive organs. This is, however, very readily converted into the active ferment by contact with dilute acids. The point was somewhat difficult of proof, but was ascertained by a modification of the method adopted by Langley and Edkins* in their work on the condition of the ferment in the gastric glands. From this paper it appears that while both alkalis and CO_2 destroy both the ferment and the zymogen, the latter is much more easily affected by CO_2 than the former. I found this to be the case with the extracts of the seeds. After a stream of CO_2 had been passed through them, treatment with acid failed to make them active, though the acid soon developed ferment-power in extracts not treated with the gas. The reaction of the resting seeds was neutral.

The proteids existing in the seeds of *Lupinus* have been ascertained by Vines† to consist of hemialbumose and globulin. I prepared from a quantity of the resting seeds a considerable bulk of these by the methods Vines describes, and submitted them in a state of fair purity to the action of the ferment. The outcome of a long series of experiments so carried out was that the proteids of the seeds were changed by the ferment in much the same way as fibrin. There was soon a quantity of parapeptone formed, which was soluble readily in weak acids or alkalis. This was followed or accompanied by the appearance of peptone, and later, leucin and asparagin were formed. The latter bodies were obtained in some quantity by the method described by v. Gorup-Besanez‡ for the separation of leucin from other bodies in the fluids in which it is found.

This course of digestion of the seed proteids was confirmed by examination of the seeds at different stages in their natural germination. In those which were just starting, parapeptone in quantity was present in the germinating cotyledons; a little later abundance of peptone was found. In no case was peptone found in the radicles, but from these plenty of asparagin was easily obtainable.

Besides the biuret test for the peptone a more delicate one was generally used, which has been described by many writers. It consists in freeing the solution from all other proteids by boiling with freshly prepared ferric acetate and then adding to it acetic acid and phosphotungstate of soda. Peptone is then precipitated.

The conclusions which seem to follow from the whole course of the experiments are:—

1. There exists in the seed of the lupin when germinating a proteo-

* 'Journal of Physiology,' vol. 7, p. 371 (1886).

† 'Journal of Physiology,' vol. 3, p. 93 (1881).

‡ 'Anleitung zur qualitativen und quantitativen Zoochemischen Analyse.'

lytic ferment which will convert fibrin into peptone and then into leucin and tyrosin.

2. This exists in the resting seed in the form a zymogen, which is easily convertible into the ferment.

3. The ferment acts best in a slightly acid medium; its activity is hindered by neutral salts and destroyed by alkalis, and it is most active at a temperature of 40° C.

4. The process of germination is started or accompanied by a transformation of the zymogen into ferment on the absorption of water and the development of vegetable acids in the cells of the seed.

5. The ferment so developed converts the proteids of the resting seed into acid albumin or parapeptone, peptone, and crystalline amides.

6. The nitrogen travels from the cells of the seed to the growing points in the form of the latter bodies and not in that of peptone or other proteid.

VII. "Preliminary Account of the Observations of the Eclipse of the Sun at Grenada in August, 1886." By Captain DARWIN, R.E. Communicated by LORD RAYLEIGH, Sec. R.S. Received November 25, 1886.

The instruments allotted to me consisted of the coronagraph and the prismatic camera; the two instruments being mounted on the same equatorial stand.

The prismatic camera is the same instrument which was used at the eclipses of 1882 and 1884. It consists of an ordinary photographic camera with a 60° prism placed in front of the lens.

The coronagraph consists of a reflecting telescope arranged for obtaining photographic records, and in which special precautions are taken to avoid internally reflected light.

This instrument was designed by Dr. Huggins, with the idea that it might be possible to obtain photographs of the corona in sunlight, that is at other times than at eclipses, and I was especially directed to test the practicability of this method. The test could be applied in two ways:—

1st. By obtaining photographs shortly before or after the eclipse, and comparing any irregularity that might appear in the halo round the sun with any photographs of the corona taken during totality; a similarity of form indicating that the corona had been photographed.

2nd. To take photographs during partial eclipse. Then if the light of the corona produces any effect on the plate, the limb of the moon should be visible against it.