

The paper concludes with a brief deduction of the observed laws of Conjugate and Secondary Joints from known mechanical principles.

II. "On the supposed Identity of Biliverdin with Chlorophyll, with remarks on the Constitution of Chlorophyll." By G. G. STOKES, M.A., Sec.R.S. Received February 25, 1864.

I have lately been enabled to examine a specimen, prepared by Professor Harley, of the green substance obtained from the bile, which has been named biliverdin, and which was supposed by Berzelius to be identical with chlorophyll. The latter substance yields with alcohol, ether, chloroform, &c., solutions which are characterized by a peculiar and highly distinctive system of bands of absorption, and by a strong fluorescence of a blood-red colour. In solutions of biliverdin these characters are *wholly wanting*. There is, indeed, a vague minimum of transparency in the red; but it is totally unlike the intensely sharp absorption-band of chlorophyll, nor are the other bands of chlorophyll seen in biliverdin. In fact, no one who is in the habit of using a prism could suppose for a moment that the two were identical; for an observation which can be made in a few seconds, which requires no apparatus beyond a small prism, to be used with the naked eye, and which as a matter of course *would* be made by any chemist working at the subject, had the use of the prism made its way into the chemical world, is sufficient to show that chlorophyll and biliverdin are quite distinct.

I may take this opportunity of mentioning that I have been for a good while engaged at intervals with an optico-chemical examination of chlorophyll. I find the chlorophyll of land-plants to be a mixture of four substances, two green and two yellow, all possessing highly distinctive optical properties. The green substances yield solutions exhibiting a strong red fluorescence; the yellow substances do not. The four substances are soluble in the same solvents, and three of them are extremely easily decomposed by acids or even acid salts, such as binoxalate of potash; but by proper treatment each may be obtained in a state of very approximate isolation, so far at least as coloured substances are concerned. The *phyllocyanine* of Fremy* is mainly the product of decomposition by acids of one of the green bodies, and is naturally a substance of a nearly neutral tint, showing however extremely sharp bands of absorption in its neutral solutions, but dissolves in certain acids and acid solutions with a green or blue colour. Fremy's *phylloxanthine* differs according to the mode of preparation. When prepared by removing the green bodies by hydrate of alumina and a little water, it is mainly one of the yellow bodies; but when prepared by hydrochloric acid and ether, it is mainly a mixture of the same yellow body (partly, it may be, decomposed) with the product of decomposition by acids of the second green body. As the mode of preparation of *phylloxanthine*

* Comptes Rendus, tom. I. p. 405.

is rather hinted at than described, I can only conjecture what the substance is ; but I suppose it to be a mixture of the second yellow substance with the products of decomposition of the other three bodies. Green sea-weeds (*Chlorospermeæ*) agree with land-plants, except as to the relative proportion of the substances present ; but in olive-coloured sea-weeds (*Melanospermeæ*) the second green substance is replaced by a third green substance, and the first yellow substance by a third yellow substance, to the presence of which the dull colour of those plants is due. The red colouring-matter of the red sea-weeds (*Rhodosperrmeæ*), which the plants contain in addition to chlorophyll, is altogether different in its nature from chlorophyll, as is already known, and would appear to be an albuminous substance. I hope, before long, to present to the Royal Society the details of these researches.

“Continuation of an Examination of *Rubia munjista*, the East-Indian Madder, or Munjeet of Commerce.” By JOHN STENHOUSE, LL.D., F.R.S. Received December 21, 1863*.

In the former, preliminary notice of the examination of the *Rubia munjista* †, the mode of extracting munjistine from munjeet, and a number of its properties, have been already described. I now proceed to detail some results which have been subsequently obtained.

When munjistine is extracted from munjeet by boiling solutions of sulphate of alumina, as the whole of the colouring matter is not extracted by a single treatment with the sulphate of alumina, the operation must be repeated five or six times instead of two or three as was formerly stated. During the boiling of the munjeet with sulphate of alumina, a large quantity of furfural is given off. I may mention, in passing, that the most abundant and economical source of furfural is found in the preparation of garancine by boiling madder with sulphuric acid. If the wooden boilers in which garancine is usually manufactured were fitted with condensers, furfural might be obtained in any quantity without expense.

In addition to the properties of munjistine already described, I may mention that acetate of copper produces in solutions of munjistine a brown precipitate but very slightly soluble in acetic acid.

When bromine-water is added to a strong aqueous solution of munjistine, a pale-coloured flocculent precipitate is immediately produced ; this when collected on a filter, washed and dissolved in hot alcohol, furnishes minute tufts of crystals, evidently a substitution-product. Unfortunately these crystals are contaminated by a resinous matter, from which I have been unable to free them, and therefore to determine their composition.

When munjistine is strongly heated on platinum-foil, it readily inflames and leaves no residue ; when it is carefully heated in a tube, it fuses, and crystallizes again on cooling. If heated very slowly in a Mohr's apparatus,

* Read January 14. See Abstract, page 86.

† Proceedings, vol. xii. p. 633.