M. Berthelot does not contradict it, but, instead, he asperses the moral character of Blagden. This method of treating a witness whose evidence cannot be rebutted is apt, when unsuccessful, to recoil on him who attempts it. It is perfectly true that Blagden interpolated the famous passage in Cavendish's memoir :—

"During the last summer, also, a friend of mine gave some account of them [the experiments] to M. Lavoisier, as well as of the conclusion drawn from them. . . . But at that time so far was M. Lavoisier from thinking any such opinion warranted that, till he was prevailed upon to repeat the experiment himself, he found some difficulty in believing that nearly the whole of the two airs could be converted into water."

This passage, however, was inserted with Cavendish's knowledge and consent, and by his assistant and amanuensis, who happened to be the very man who had a personal knowledge of the facts. Assuming the statement to be true, where is the immorality of the proceeding?

Everything that we can learn authoritatively concerning Blagden goes to show that he was an upright and honourable man. Sir Joseph Banks has testified to his abilities and integrity. Dr. Johnson spoke of his copiousness and precision of communication, with the characteristic addition: "Blagden, sir, is a delightful fellow." Laplace, Cuvier, Berthollet, and Benjamin Delessert, were among his friends.¹ He was rich, and was understood to have speculated to profit in the French funds. For thirteen years he was a Secretary of the Royal Society, and in 1792 he was knighted for his services to science. Every year he spent a considerable time on the Continent, and was frequently in Paris. The gossip of the period states that he aspired to the hand of Madame Lavoisier, who preferred Count Rumford. He died in Berthollet's house at Arcueil, on March 26, 1820. In an obituary notice in the *Moniteur* of September 22, 1820, M. Jomard testifies to his benevolence and generosity, and states that "none of his countrymen have done more justice to the labours and discoveries of the French, or have contributed more than he to the happy relations which have subsisted for six years (1814–20) between the *savans* of the two countries." By his will he provided liberally for his scientific friends: Berthollet, the daughter of Madame Cuvier, and the daughter of Count Rumford, each received £1000; and Laplace £100, "to purchase a ring." M. Berthelot asperses the character, not only of Blagden, but also of his countrymen by his insinuations. Would he have us believe that men like Berthollet, Cuvier, and Laplace, would extend their friendship to, and receive pecuniary benefits from, one whom they believed had foully stabbed their compatriot in the back? It is surely incumbent on M. Berthelot, on every ground, either to substantiate his implications or to withdraw them.

M. Berthelot makes the gratuitous assumption that I am ignorant of the work of Monge. Whether I am or not is altogether beside the mark. There is, indeed, no question of Monge. Monge distinctly disclaims priority

¹ Many of the letters of Berthollet to Blagden are still in existence. In one of these, dated "19 Mars, 1785," he writes from Paris:—"L'on s'est beaucoup occupé ici ces derniers tems de la belle découverte de Mr. Cavendish, sur la composition de l'eau: Mr. Lavoisier a tâché de porter sur cet objet toute l'exactitude dont il est susceptible. . . . Mr. Lavoisier veut répéter l'expérience en faisant brûler l'air dephlogistiqué dans le gas inflammable, et il y a apparence qu'alors on n'aura point d'acide nitreux, selon les belles observations de Mr. Cavendish." Is this language consistent with the belief that Berthollet, who must have known the facts, regarded Lavoisier as the real discoverer of the compound nature of water?

to Cavendish, nor did he attempt to establish a right to be considered an independent discoverer of the true nature of water. In his memoir, "Sur le Résultat de l'Inflammation du Gas inflammable et de l'Air dephlogistiqué dans les Vaisseaux Clos," he tells us that the experiments recorded in it were made in June and July 1783, and repeated in October of the same year. "I did not then know," he adds, "that Mr. Cavendish had made them several months before in England, though on a smaller scale; nor that MM. Lavoisier and Laplace had made them about the same time at Paris in an apparatus which did not admit of as much precision as the one which I employed." I fail to see what M. Berthelot gains by his reference to Monge.

M. Berthelot reproaches Priestley and Cavendish for their adherence to phlogistonism. I say it with all respect, but is it seemly for M. Berthelot, of all men, to cast this stone? Is not he himself an exemplification of that conservatism which he deplors? A generation ago the doctrine of Avogadro became the corner-stone of that edifice of which M. Berthelot asserts that Lavoisier laid the foundations. Indeed, the introduction of that doctrine effected a revolution hardly less momentous than that of which Lavoisier was the leader. But what has been M. Berthelot's consistent attitude towards this teaching? We can illustrate it by a single example. He is the sole teacher in Europe of any position who continues to symbolize the constitution of that very substance of which he claims that Lavoisier discovered the composition by a formula which is as obsolete as any conception of phlogistonism. T. E. THORPE.

A HAND-BOOK OF PHOTOGRAPHY.

Handbuch der Photographie. Part I. Fourth Edition. By Prof. Dr. H. W. Vogel. (Berlin: Robert Oppenheim, 1890.)

THIS is the latest edition of a work which has been known in Germany for ten years, and of which the author is the Director of the Photochemical Laboratory of the Imperial Technical High School in Berlin. The existence of such a post as that occupied by Dr. Vogel in one of the foremost technical schools of Germany is as much an indication of the advanced state of technical education in that country as the non-existence of such specialists in the technical schools of this country is a sign of our comparatively backward condition in the field of chemical technology. The subjects comprised under this heading are so wide in their range and so difficult to grasp, excepting by actual personal contact with the chemical industries, that no instruction likely to be of any great value to those preparing for, or engaged in, the latter can be given, unless the instructor has this qualification. Nor can the student properly avail himself of the instruction thus offered, unless he on his part is well grounded in the general principles of the science which underlies his subject. When such a ground-work has been laid, and the student thus equipped is passed on to the specialist, the result is a chemical technologist who is likely to be of real use to his country. The Germans have realized this long ago—the machinery exists both for laying the foundation and for raising the superstructure of specialized knowledge. In this country, so far as

chemical technology is concerned, we have not yet advanced very much beyond the stage of furnishing the appliances for the general training—the real technical or special training has been allowed to take care of itself, and the student is supposed to have finished his education at the time when he ought really to be beginning it.

These ideas naturally suggest themselves in having brought under one's notice the various special works on applied science which reach us from time to time from the German press, and of which Dr. Vogel's book is a not unfavourable specimen. The present volume, which is the first part of the work only, contains some 350 pages, and the advancement of the subject since the last edition is indicated by the fact, which the author states in the preface, that the subject of photochemistry alone has been increased from $8\frac{1}{2}$ to 22 pages. The whole volume consists of an introductory portion, three chapters, and an appendix. We propose to give, in the first place, a brief analysis of its contents.

The introduction consists of a history of photography, followed by some remarks on the study of the subject. The scientific aspect of photography forms the subject of the three chapters which constitute the main portion of the work. The first chapter deals with the physical action of light, and comprises such subjects as phosphorescence, phosphorography, the photophone, telephotography, the action of light on polished surfaces, Crookes's radiometer, and the action of light on ebonite, including an account of Edison's tasimeter, which, the author thinks, may become serviceable as a chemical photometer.

The second chapter occupies over 200 pages, and is divided into two sections, dealing with the action of light on non-metals and metals respectively. The subdivisions of this portion of the subject are well planned, but are not carried out with logical consistency. The action of light on inorganic compounds brings in allotropy and the photochemical combination of hydrogen and chlorine, &c. The action of light on organic compounds begins with the remarkable subject of the photopolymerisation of such compounds as vinyl bromide, anthracene, quinine, chloral, and asphalte, the latter, of course, leading to the original heliographic process of the elder Niepce. The author gives good reasons for the belief that the change in this last case is due to polymerisation, and not to oxidation. Instances of combination between organic compounds under the influence of light are then discussed, the formation of a compound from phenanthrene-quinone and acetaldehyde being compared with the synthetical processes which go on in plants by the action of this same agency.

The photochemical decomposition of organic substances is dealt with at considerable length. The remarks concerning the action of light on cellulose in the form of wood and paper should be carefully studied by those interested in the technology of paper-making. The action of light on colouring-matters, both organic and mineral, is also treated of very completely, and the tables given will be found valuable to dyers, colourists, and painters. This portion of the subject is covered to some extent by Russell and Abney's Report on the fading of water-colours, of which the author has evidently availed himself. With respect to the fading of organic colouring-matters, it is of

interest to note that all the artificial yellows are faster than the natural vegetable yellows. The section treating of the action of light on the vital processes of plants and animals brings the author into contact with such physiological subjects as germination, the formation of chlorophyll and other plant colouring-matters, the respiration of plants, and Aimé Girard's observations on the formation of sugar in the beetroot. Under the action of light on animals, the author gives an account of Engelmann's experiments on *Bacterium photometricum*, but Lubbock's analogous experiments with the Daphnidæ are not alluded to.

Passing to the second section, we find 167 pages devoted to the action of light on metallic compounds. The logical sequence is here broken by the introduction of a large amount of ordinary chemistry, *i.e.* the formulæ and properties of the most important compounds of the metals used in photography. This is very well in its way, and it is essential that the scientific photographer should be familiar with this portion of his subject, but it may be suggested that in future editions these paragraphs should be relegated to the third chapter, which deals with the chemistry of photographic materials. The author's use of formulæ, we may here point out, is somewhat antiquated, capricious, and inconsistent. Thus in some places chloracetic acid is written $C_2\overset{H_3}{Cl}\}O_2$, ferrous tartrate, $C_4\overset{H_4}{Fe}\}O_6$, ferric tartrate, $C_{12}(\overset{H_{12}}{Fe_2})O_{18}$, ferrous acetate, $C_4\overset{H_6}{Fe}\}O_4$; while on the same page, or in other parts of the book, we find ferric citrate written, $(C_6H_5O_7)_3Fe_2$, silver tartrate, $C_4H_4O_6Ag_2$, and silver citrate, $C_6H_6O_7Ag_2$. In the same equation, on p. 152, sodium thiosulphate is written $Na_2S_2O_3$, and the double silver salt, $\overset{Na_4}{Ag_2}\}3S_2O_3$. Then, again, some compounds of very definite composition, such as sodium nitroprusside, Prussian blue, &c., are not favoured with formulæ at all; while in other cases, such as under the salts of ammonia, the alkalis, and the alkaline earths (third chapter), the formulæ suddenly rise to the dignity of thick type.

Under the action of light on iron salts, we have a description of the various printing processes depending on the use of these compounds, such as Willis's platinotype, the negative and positive blue processes and other less widely-known methods. Under chromium compounds we have an account of the chromatized gelatine processes, including that of Pretzsch (relief process), Fox Talbot (steel etching), pigment printing, Woodburytype, photogalvanography, lithography, and zincography, and a multitude of other processes, which form quite a special feature among the recent developments of applied photography. The salts of uranium and copper are dealt with in due order, but the chief interest, of course, centres in the compounds of silver. After a brief description of the pulverulent metal, the use of silver as a developing agent in acid and alkaline developers is discussed. Speaking of the black compound which is precipitated when ammonia is added to a solution containing silver nitrate and a ferrous salt, the author uncompromisingly gives the formula, $Ag_4O + Fe_3O_4$, which at least may be said to require confirmation. The chemical principles of intensification and toning, and the transformations of

silver pictures by substitution, are well dealt with, and a long account of Carey Lea's researches on the allotropic modifications of silver is given. When treating of silver nitrate, Dr. Vogel gives way to patriotic bias in the form of a footnote:—

“Als Thatsache erwähnen wir, dass das in Deutschland fabricirte Silbernitrat das reinste ist, welches geliefert wird. Ueberhaupt übertreffen ALLE deutschen Chemikalien die ausländischen weit und werden daher von allen Pharmazeuten des Auslandes hoch geschätzt. Selbst in China, Japan, Indien, Nordamerika werden deutsche Chemikalien allen übrigen vorgezogen. Wenn zuweilen in ausländischen Zeitungen Verdächtigungen derselben versucht werden, so laufen diese auf Concurrenzneid hinaus” (p. 147).

Our chemical manufacturers had better see to this!

Of fundamental importance in photography are the silver haloids, and to these we naturally turn with the greatest interest. The author admits the existence of a subchloride, but justly expresses reserve as to its formula. The “photosalts” of Carey Lea are described, and the oxychloride theory referred to, but the author omits to mention that these coloured compounds, produced by chemical methods, were discovered by the British Association Committee of 1859. Photochromy is treated of briefly, and in an earlier portion of the work (p. 9) the author distinctly asserts that permanent photography in natural colours has never been accomplished. Of course we knew this before, but it is well that the public should have the statement from such a recognized expert as Dr. Vogel. Under silver bromide will be found an account of Stas's modifications of this haloid, and after discussing the ripening of the salt in emulsions, and the action of ammonia thereon, the author arrives at the conclusion that these modifications represent different states of physical aggregation—a conclusion which most scientific photographers will endorse. The discussion of this part of the subject is, we may add, very thorough. Silver iodide is similarly treated of, and then comes a section on the influence of different substances on the sensitiveness of the silver haloids.

This last subject leads to the action of sensitizers, and some very useful tables, giving the results of experiments with all kinds of sensitizers, are here given. The subject of development, which the author divides into chemical and physical, is dealt with under this same section, and the different compounds which have been used for this purpose are enumerated. Sensitizers are again discussed after development has been disposed of, and we are sorry to see that Dr. Vogel still classifies these as chemical and optical sensitizers. The latter comprise those colouring-matters which confer on the silver haloid film a special sensitiveness for certain rays of low refrangibility, and the author gives a long account of this discovery, with which his name will always be associated. We confess to being somewhat disappointed with this section. The theory of orthochromatic photography is in a very unsatisfactory state, and we should have liked to know the author's views on this subject. By his still retaining the term “optical sensitizer,” he leads us to infer that he has not abandoned the physical theory. In this case a discussion of Abney's results and a repetition of his experiments are most urgently needed. We shall, however,

perhaps, be more enlightened in the practical portion of the work which is to follow the present part.

In reviewing the history of orthochromatic photography, the results of Eder are given almost *in extenso*, but the experiments of Abney and Bothamley in connection with this subject are not referred to. Perhaps these, again, are being reserved for the succeeding parts of the book. Dr. Vogel can certainly score against those who discredited his discovery in 1874, but he is hardly correct in stating that the Berlin Academy of Sciences alone recognized its importance. In *NATURE*, vol. x. p. 281, the value of the discovery was pointed out, and an account, of the early experiments was given. The treatment of the subject of solarisation, which follows that of “optical sensitizers,” is somewhat meagre, and from the scientific point of view we should have been glad to have a more complete discussion of a topic of such fundamental importance to the theory of the photographic image. The author accepts the explanation of reversed chemical action, but he does not, we venture to think, lay sufficient stress on the important part played by the vehicle or sensitizer in this phenomenon.

After dealing with the salts of silver, we are led in due order to the compounds of mercury, lead, gold, platinum, and allied metals. The only comment we have to make is that the ordinary chemical properties of these different salts would be more in place if described in the third chapter, so that this portion of the work might be restricted to what its title indicates, viz. the chemical action of light. Nor do we understand why the author should retain the old name “platina,” as his own countrymen have now generally dropped the terminal letter, while here and in America the names of all the metals of the group are made to end in “um.” It certainly seems strange to a chemist of the present time to read: “hierher gehören Platina, Iridium, Palladium, Osmium, &c.”

The third chapter is devoted to a description of photographic chemicals, and is more or less of the nature of an ordinary descriptive manual of chemistry, having special reference to the elements and compounds used in photography. Among the metalloids, oxygen, hydrogen, and the halogens are alone treated of. Under solvents, we have the compounds water, ethyl and methyl alcohols and some of their homologues, glycerin, ether, chloroform, benzene, &c. Then follow the acids, inorganic and organic, and bases and salts, beginning with the compounds of potassium, sodium, and ammonium, and ending with those of the earthy metals. The salts of the heavy metals, having been taken (out of order) in the preceding chapter, are not dealt with here. The author, in explaining the theory of salts, clings to the old water type, *e.g.* $\text{SO}_2 \left\{ \begin{array}{l} \text{O}_2 \\ \text{H}_2 \end{array} \right\} \text{NO}_2 \left\{ \begin{array}{l} \text{O}_2 \\ \text{H} \end{array} \right\} \text{O}$, &c. Under ammonia (p. 269) we are told that in the salts of this base ammonium (NH_4) is present, “das mit Sauerstoff das Ammoniumoxyd (NH_4O) bildet.” On p. 261 potash alum is written $\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 + 24\text{H}_2\text{O}$, and on p. 269 ammonia alum is formulated $(\text{NH}_4)\text{Al}(\text{SO}_4)_2 + 12\text{H}_2\text{O}$. The section on reducing agents and developers treats of hydroxylamine, tannin, gallic acid, pyrogallol, hydroquinone, pyrocatechol and resorcinol, paraphenylene-diamine, phenylhydrazine, and eikonogen.

Following this section we again have some ten pages

devoted to optical sensitizers, the compounds described being eosin and allied colouring-matters, cyanin, quinoline red, and chlorophyll. There are some amusing foot-notes attached to this section, one of which we cannot refrain from quoting, as illustrating the author's method of dealing with the sceptics at home and abroad. After attempting once more to make clear his definition of an optical sensitizer, he admits that this definition can only be made intelligible to those

"welche von farbigen Strahlen, d. h. Spectralfarben, und von optischer Absorption derselben, also Absorptions-spectralanalyse, eine klare Vorstellung besitzen, die leider bei sehr vielen Empirikern (und auch Wissenschaftern) die in dieser Sphäre arbeiten, vermisst wird."

Then comes the note :—

"Wie übel es in dieser Hinsicht bestellt ist, geht daraus hervor, dass sogar ein Professor der Chemie und Physik in Berlin das Spectrum von Eosin und Eosinsilber, welche total von einander verschieden sind, als gleich erklärte, dass der gerichtliche Sachverständige Prof. Spiller in England die Behauptung aufstellte, Eosin und Chinolinroth seien identisch, und dass sogar Carey Lea meinte, ein Sonnenspectrum lasse sich durch eine Anzahl farbiger Glasstreifen ersetzen."

We do not regard it as "good form" in this country to make horrid examples of our co-workers in a book intended for the use of students. If any remarks of a polemical character had to be brought forward, there were other arenas, both here and in Germany, where Dr. Vogel might have broken a lance with his adversaries.

Under the heading "Bildträger" (image-carriers or film-producing materials), we have an account of cellulose, starch, pyroxylin, albumin, gelatine, and paper. The description of the various cellulose nitrates and their preparation is fairly complete. Under gelatine we do not find, either in this chapter or in the historical portion, any reference to the name of Maddox, who first made the use of this vehicle practicable, and laid the foundation of our modern gelatino-bromide emulsion processes. Some miscellaneous subjects which are not included in the text are added in an appendix. It must be mentioned that there are numerous prints and thirteen plates inserted in the work, some of them very beautifully executed, and introduced with the object of illustrating the various photo-etching, engraving, and printing processes, the difference between orthochromatic and ordinary plates, spectrum photography on dyed films, &c.

With respect to the work as a whole, it will be seen that it covers to a large extent the same ground as the "Ausführliches Handbuch der Photographie" of Eder, which is also a recognized standard work. In some respects Dr. Vogel's book offers advantages over the latter, but in other respects it is inferior. We miss the splendidly complete lists of references with which Eder's work abounds, and in neglecting to supply this information the author often unconsciously does himself injustice, for there is much original work included in the volume which many readers would desire to refer to in the original papers. Dr. Vogel has contributed so largely to the advancement of photography that any observation or experiment of his is entitled to the fullest consideration.

The criticisms which have been offered in the course of this notice are on minor points, but taken in their *ensemble* they indicate certain weaknesses which are to be regretted.

It is obvious from the examples given that pure chemistry is not the author's strong point, and it would have been better, seeing how largely the subject is connected with this science, if he had consulted some of his chemical colleagues. The inconsistencies of formulation and classification which have been pointed out might thus have been avoided, and the work made more logically coherent. Another defect is the retention here and there of passages which look like survivals from an earlier edition. For example, we read on p. 7: "Der Collodium process verbreitete sich allgemein, wurde im Laufe der Zeit immer mehr und mehr vervollkommen und ist jetzt der ausschliesslich angewendete." Again, on the same page: "Collodium für den Negativprocess, Albuminpapier für den Positivprocess bildeten die wichtigsten Grundlagen unserer photographischen Bilder." This may have been true at the time of the last edition (1878), but is certainly not the case now.

In concluding this notice we can only express regret that the author should have fallen into the habit, now, unfortunately, becoming only too common on the Continent and across the Atlantic, of allowing insufficient credit for, or, worse still, of ignoring altogether, work done outside his own country. The historical portion of the book hardly does justice to the labours of Fox Talbot when it is stated that "nach dem Bekanntwerden der Daguerre'schen Entdeckung suchte Talbot auch Camera-bilder auf Papier aufzunehmen." If the introduction of the collodion process by Archer and Fry is considered worthy of historical record, surely the gelatino-bromide emulsion process of Maddox is at least of equal importance. When dealing with the action of light on selenium (p. 23), the author gives a description of Shelford Bidwell's experiments on telephotography, but the experiment of Ayrton and Perry having for its object the electrical transmission of moving images (*telopy*) is not referred to. When treating of optical sensitizers, he tells us that von Baeyer discovered fluorescein, that Caro discovered eosin, and that Jacobsen discovered quinoline red, but the reader is not informed that cyanin, one of the best special sensitizers, was given to science by Greville Williams as long ago as 1860. These and the other blemishes which we have felt bound to indicate have only to be remedied in future editions to make Dr. Vogel's book take that high position to which it is justly entitled, both on account of the vast body of useful and often original information which it contains, and the deserved reputation of the author as one of the foremost of German scientific photographers.

R. MELDOLA.

CONTRIBUTIONS TO INDIAN BOTANY.

Annals of the Royal Botanic Garden, Calcutta. Vol. II. Pp. 110; with 104 Lithographed Plates. (Calcutta: Bengal Secretariat Press, 1889.)

THE whole of this volume, like the first, with the exception of a part of the Appendix, is the work of Dr. G. King, the Director of the Calcutta Botanic Garden. It contains a monograph of the species of *Artocarpus* indigenous to British India, and a monograph of the Indo-Malayan species of *Quercus* and *Castanopsis*, both fully and excellently illustrated. The genus *Artocarpus* was founded by the Forsters (father and son, who