us contains, in addition to the annual address by the retiring president, Prof. A. Liversidge, F.R.S., three contributions by the new president, Mr. H. C. Russell, F.R.S., one of which briefly discusses the relation between the moon's motion in declination and the quantity of rain in New South Wales, in which the author is convinced that "seeing the rain is shown so clearly to come in times of abundance, when the moon is in certain degrees of her motion south, and when the moon begins to go north, then droughty conditions prevail for seven or even eight years, a phenomenon repeated for three periods of nineteen years each, that it is either a marvellous coincidence, or there is a law connecting the two phenomena." Mr. R. H. Mathews contributes an important paper on "The Thurrawal Language," and shorter accounts of some aboriginal tribes of Western Australia and of rock-holes used by aborigines for warming water. Mr. J. H. Maiden, Government Botanist and Director of the Botanic Gardens, Sydney, gives an exhaustive summary of the gums, resins and other vegetable exudations of Australia, as well as interesting historical notes relating to the death of Captain Cook. Mr. G. H. Knibbs also writes two important papers, that on a theory of city design being of wide interest. These papers by no means exhaust the important contributions to science contained in the volume, but since reports of the proceedings of the Society regularly appear in our columns under "Societies and Academies," it is unnecessary to refer at any greater length to the scientific work being done in New South Wales.

THE additions to the Zoological Society's Gardens during the past week include two Vervet Monkeys (*Cercopithecus lalandii*) from South Africa, presented by Miss Barlow; an Equine Antelope (*Hippotragus equinus*) from Bechuanaland, presented by Major Chas. Fredk. Minchin, D.S.O.; three Fat Dormice (*Myoxus glis*) European, presented by Dr. L. H. Gough; a Mongoose Lemur (*Lemur mongoz*) from Madagascar, two Mexican Snakes (*Coluber melanoleucus*) from Mexico, deposited; two Snake Fishes (*Polypterus senegalus*) from Fashoda, received in exchange.

ERRATUM—In parenthesis near the end of letter on "Summer and Winter" (p. 81), "The average mean temperature of summer below 61°·2," for *below* read *being*.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF THE PERSEID SHOWER.—Herr Koss, director of the Pola Observatory, communicates to No. 3830 of the *Astronomische Nachrichten* the results of the observations of Perseids made at that observatory on August 8, 9 and 10.

The times of appearance, the exact path, the magnitude and the time of duration of each meteor are recorded for ten Perseids seen on August 8, sixteen seen on August 9, and thirty-three seen on August 10. In addition to these, thirteen Perseids and sixteen sporadic meteors were seen, but not mapped.

The position of the radiant point for August 9 and for August 10 was estimated to be $\alpha = 2h.\ 32m.$, $\delta = +56°{\cdot}5$ and $\alpha = 3h.\ 2m.$, $\delta = +54°{\cdot}5$, respectively

NEW VARIABLE STAR, 16, 1902, DELPHINI.—From photographs taken at Moscow by M. S. Blakjo, Madame Ceraski has found that the star B.D. + 16°·4290, having the position α = 20h. 25m. 59s.·5, δ = + 16° 57'·2 (1855), is a variable.

In the catalogue, the magnitude of this object is given as 9·3, and this was confirmed on a negative taken on August 18, 1900. On a plate obtained on August 17, 1901, however, the star does not appear, and, according to the magnitudes of the neighbouring stars which do appear, it must therefore have been fainter than the eleventh magnitude. Visual observations confirmed this latter value (*Astronomische Nachrichten*, No. 3830).

EVOLUTION OF AËROGRAPHY.—In No. 170 of the *Proceedings* of the American Philosophical Society, Mr. Percival Lowell reviews the various steps which have taken place in our knowledge and mapping of the surface of Mars.

By a series of twelve maps, arranged in chronological order, he shows the gradual development in the amount of detail seen and recorded, from the map of Beer and Madler, published in 1840, to that published by himself in 1901. From comparisons of these maps, he divides the history of aërography into three periods, viz., 1840-1876, large dark and light markings shown; 1877-1892, "canals" in bright regions detected; 1893-1902, "canals" in the dark regions detected; and also draws the following three deductions therefrom:—(1) The series agree fundamentally. (2) The regularity of the "canals," as recorded by Schiaparelli, was not due to any predisposition on the part of that observer, but was gradually forced upon him as he became more familiar with the surface of the planet. (3) All the maps show a general evolution, from simple to complex, in the detection of the surface markings of the planet.

A SIMPLIFIED FORM OF FOUCAULT'S PENDULUM.—The reinstallation of Foucault's famous experiment at the Pantheon by MM. Berget and Flammarion has, according to M. D'Arsonval, called forth many ingenious devices for proving the same result by means of a simpler apparatus.

Of these devices, M. D'Arsonval describes, in the *Comptes rendus* for November 17, the one which, in his opinion, is the simplest and best.

The main point of this device is the simplicity of the method of suspension. A steel wire, 0·035mm. in diameter, carries a leaden ball, which is covered with copper and weighs about 2¾ lbs., and is fixed to the ceiling by an ordinary nail. Its upper end is then clamped in a metal block, so that it is immovable above the lower face of the block, but free to swing about the point where it enters this face from below, and the block is then screwed to the ceiling or other suitable support. A pendulum suspended in this manner is capable of swinging for about three hours.

The whole apparatus is contained in a small wooden box, which also carries the sand in which the pendulum pointer marks the trace of its plane of swing, and is accompanied by a small model pendulum, which may be used to illustrate the principle of the invariability of the plane of oscillation.

The simplicity, the compact form and the low price (20 francs) of this device should render possible its use in schools and colleges, where hitherto the students have had to depend upon descriptions and illustrations for their knowledge of this important experiment, or else pay a visit to the western galleries of the Victoria and Albert Museum, where a large model may always be seen and, if formal representations be made to the authorities, demonstrations may be given.

PHYSICAL CHEMISTRY APPLIED TO TOXINS AND ANTITOXINS.

A VERY important contribution to our knowledge of the toxins and antitoxins is contained in the "Festskrift" recently published to celebrate the inauguration of the State Serum Institute at Copenhagen, in the form of a paper with the above title by Arrhenius and Madsen. In passing, we note with pleasure that English has been chosen as the international linguistic medium for the entire contents of the volume. The necessity for collaboration between the representatives of different branches of science for the satisfactory study of many of the complex problems of physiology, bacteriology and pathology is gradually becoming generally recognised, and in the present instance we have a striking example of the joint work of two celebrated investigators on a subject lying on the common boundary of their special provinces of knowledge and experience.

It is well known that tetanus toxin, prepared by filtering off the bacteria from a broth culture and saturating with ammonium sulphate, contains two distinct toxic substances, a *spasmin*, which produces the characteristic convulsions, and a *lysin*, which hæmolyses the red blood corpuscles of many animals. In the same way, the antitoxin produced in the serum of animals immunised against tetanus contains two distinct antitoxic substances, an *antispasmin* and an *antilysin*.

It has, moreover, been shown by Madsen that experiments on the properties and mutual relationships of the tetanus lysin and antilysin can be performed with great facility and comparatively great accuracy on blood *in vitro*, the uncertainty attendant upon animal experiments and the great expenditure of time required by them being thus avoided.

The aim of the present investigation was to study the hæmolytic action of tetanus lysin and its reaction with antilysin in the light of ordinary chemical reactions, and to compare both these phenomena with similar actions brought about by substances of known molecular weight, constitution and purity.

The method of estimating the hæmolytic power, which was employed in all the experiments, consisted in allowing the substance under examination to act for a given time upon an emulsion in normal saline, or other liquid, of a known quantity of well-washed blood corpuscles, and then estimating the amount of hæmolysis produced colorimetrically by comparison with standard tubes prepared from varying quantities of the same blood by complete hæmolysis with distilled water.

The investigation falls naturally into two parts, the first of which deals with the hæmolytic action of tetanus lysin compared with that of caustic soda and ammonia.

The hæmolysis of a blood corpuscle by a base such as caustic soda or by tetanus lysin is a phenomenon of considerable complexity and appears to take place in two stages—the combination of the hæmolytic agent with the material of the corpuscle, and the hæmolysis of this compound by the "lysin" which remains free. The three substances under investigation differ from each other in the rate at which they unite with the corpuscles and also in the stability of the compounds which are produced.

Caustic soda combines very rapidly and forms a very stable compound; the consequence of this is that when a certain definite number of blood corpuscles are present, practically the whole of the alkali is taken up and very little hæmolysis occurs. With small amounts of blood, hæmolysis is complete, but as the amount of blood is increased beyond the amount which can be completely hæmolysed, the alkali is thereby withdrawn in increasing amounts from the solution, so that the extent of hæmolysis rapidly diminishes. Tetanolysin, on the other hand, combines much more slowly with the corpuscles and forms a much less stable compound, which is partially decomposed into its constituents, or hydrolysed, by the water of the solution. Hence, in the case of the lysin solutions, there is always some free lysin to effect the hæmolysis of the lysin-corpuscle combination, and, as a consequence, the falling off after the maximum is not nearly so marked. Ammonia takes up a position intermediate between caustic soda and lysin.

All these hæmolytic actions are affected by the presence of certain foreign bodies, among which salts, albumin and serum have hitherto been examined. It seems probable that salts have two distinct effects. In the first place, they probably render the corpuscles more susceptible to the attack of the hæmolytic agent, and hence tend to increase hæmolysis. This tendency is not counteracted in any way in the case of the tetanus lysin, and hence an increase in the action is in this case observed. The compounds of the alkalis with the corpuscles, on the other hand, are affected by salts containing the same ion, much in the same way as a weakly dissociated salt, in which case the dissociation is decreased and the salt then enters less readily into reaction. Hence the caustic-soda combination is affected in this way by sodium salts and, since the diminution of hæmolysis thus produced outweighs the increase due to the effect of the salt on the corpuscles, a nett decrease of action is observed. The ammonia combination is less strongly dissociated than the soda combination, and is therefore still more strongly affected by the presence of ammonium salts.

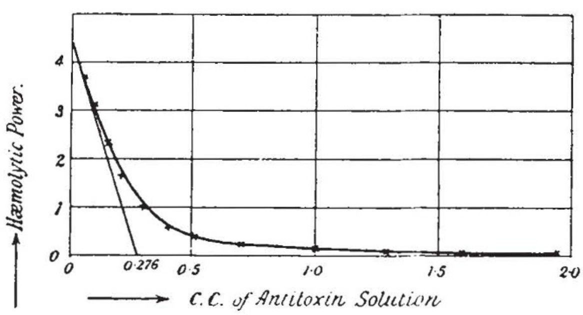
The dissociation spoken of in this case is the electrolytic dissociation of a salt or salt-like compound into its ions, and must not be confused with the hydrolysis mentioned above. Thus a salt-like sodium carbonate is at the same time partly dissociated into its ions, and partly hydrolysed by the water of the solution into caustic soda and carbonic acid; sodium chloride, on the other hand, is much more completely dissociated into its ions, but is practically not hydrolysed at all.

The effect of egg albumin and normal serum is also to diminish the hæmolytic power, both of the bases and of tetanus lysin, but whilst the effect on the bases is very slight, that on the lysin is considerable. It would seem that in each case the albumin combines with the hæmolytic agent, forming a compound in which the hæmolytic power is modified to a certain extent. The properties of caustic soda and ammonia are only slightly affected; those of the tetanus lysin, on the other hand, are more profoundly modified. This explanation is confirmed by the fact that the further addition of albumin exerts no appreciable effect after a certain limit has been reached. Normal serum, on the other hand, has a progressively increasing effect on the lysin, and in fact behaves like a mixture of a large amount of albumin with a small amount of an antitoxin.

Further information is gained as to the nature of the hæmolytic action by the determination of the velocity of the change, and this reveals a still greater complexity. The reaction exhibits a very decided *period of induction*; when the substances are first mixed, the change begins to take place at a very low rate, which gradually increases as the change proceeds. Such a period of induction occurs in certain well-known chemical reactions, although its exact significance is not perfectly understood. In the case under consideration, the authors suggest that it "depends on the circumstance that the red blood corpuscles' cellular membrane must be destroyed before hæmolysis can occur." The actual velocity is found to be proportional to the concentration of the hæmolytic agent, so that if the dose be doubled, the time required to produce a given amount of hæmolysis is halved. This result is of great importance because it shows that the hæmolytic action of bases is not due to the hydroxyl ions, in which case the velocity would be proportional to the square root of the concentration. The same thing is shown by the fact that ammonia acts more rapidly than caustic soda, although it is much less strongly dissociated.

The second part of the investigation deals with the important subject of the action of the antilysin on tetanus lysin.

When increasing quantities of antilysin are added to a fixed amount of lysin, the hæmolytic power of the mixture is not diminished in direct proportion to the amount of antilysin added, but the effect of each successive portion of antilysin is less than that of the preceding one, the diminution of hæmolytic power being rapid at first and then becoming more and more gradual. If the results be plotted with the amounts of



antilysin added as abscissæ and the hæmolytic powers of the resulting mixtures as ordinates (the amount of lysin being constant throughout), a curve of the form shown above results. This curve represents what is usually know as the *toxin spectrum* of Ehrlich.

When we compare this phenomenon with the action of an acid on an alkali, we find that it does not resemble what occurs when an equivalent of hydrochloric acid is added to caustic soda, for in this case the alkalinity diminishes in direct proportion to the acid added, the last portion of acid having exactly the same neutralising effect as the first.

On the other hand, it corresponds precisely with the phenomena observed when a base such as ammonia is treated with a weak acid, like boric acid. In fact, if ammonia be treated as a lysin and boric acid as an antilysin, and hæmolytic experiments be made in precisely the same way as with tetanus lysin and antilysin, the curves of hæmolytic power produced in the two cases are of precisely the same kind. Now the phenomena which occur when boric acid is added to ammonia and in similar cases have been carefully examined by physical chemists, and they are known to be due to the fact that, in a solution of this kind, the ammonium borate which we should expect to be formed is partially hydrolysed by the water into its components, so that the liquid contains ammonium borate, water, free ammonia (ammonium hydrate) and free boric acid. The case is susceptible of mathematical treatment according to Guldberg and Waage's law, and the equivalents of the substances and the coefficient of dissociation can be calculated from the observations.

Precisely the same can be done for the tetanus lysin and antilysin, and the natural conclusion is that these two changes are of the same kind, a reaction taking place in each case between two molecules and resulting in the formation of two molecules of the products. It does not in any way follow that the *substances* concerned are of the same chemical type, and in fact other considerations render this very improbable.

In the particular experiment quoted, the amount of antilysin solution which was chemically equivalent to the lysin employed was 0·276 c.c. When this quantity of antilysin was added, however, the hæmolytic power remained equal to 36 per cent. of the original, whilst even after the addition of seven times the equivalent, the power was still 1·8 per cent. of the original. These facts, nevertheless, do not indicate the presence of a series of lysins of different hæmolytic powers and affinities for antilysin, any more than the precisely similar phenomena observed with ammonia and boric acid indicate the presence of a series of bases possessed of different hæmolytic powers and affinities for boric acid. It is therefore unnecessary to suppose, as Ehrlich has done for diphtheria toxin, that proto-, deutero- and trito-toxins as well as toxones are present.

All the phenomena are explained by the presence of a single lysin, the compound of which with its antilysin is partially decomposed into its constituents by water. Recent experiments of Dreyer and Madsen show that these conclusions may fairly be extended to the constitution of diphtheria toxin.

The deterioration of tetanus lysin is a subject of great interest in connection with the theory of toxins, and its study has also yielded interesting results, although it has not yet been pushed very far. The examination of an altered lysin by the method described above serves to indicate which of its constants—the equivalent or the coefficient of dissociation—has been altered. To take a single example, the hæmolytic power of a solution of lysin was found to have diminished to one-sixth in about five days. Examination showed that its equivalent had not altered, but that its coefficient of dissociation had increased by 50 per cent. As a result of this increase, the hæmolytic power of this lysin would be diminished to a less extent than that of the original lysin by a given dose of antilysin. The effect of deterioration in this case can therefore be explained by supposing a slight change to have occurred in all the molecules of the lysin, "perhaps a transformation into a metameric compound, less toxic," possessing an increased coefficient of dissociation and an undiminished combining power for antilysin. Ehrlich's explanation, on the other hand, would be that five-sixths of the lysin had been converted into a non-hæmolytic substance (toxoid) which had a greater affinity for the antilysin than lysin itself and was therefore "neutralised" first.

This explanation may be applicable in some cases, but, as will be seen, it is not necessarily required by the facts.

A further point of interest is that lysin and antilysin unite slowly and at a rate which can be measured. The investigation of this reaction has been carried out to a certain degree, and its further examination will probably throw more light on the nature of the change which occurs.

If the results of the authors are accepted, a great simplification of the present ideas as to the constitution of toxins will be necessary. A point which is of fundamental importance and appears to call for further examination is the mode of action of the lysin molecule in hæmolysis. In other words, does hæmolysis take place between the lysin-corpuscle and free lysin, as is the case with caustic soda, or does the lysin molecule which forms the combination bring about the hæmolysis by means of another group contained in its molecule?

A. HARDEN.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—An important change has recently been made in the regulations for Responsions. The change affects the examination in the Elements of Geometry. Instead of Euclid's Elements Books i. and ii., with Euclid's axioms and Euclid's sequence of propositions, the subject will in future be defined as the subject-matter of certain specified portions of Euclid's Elements Books i., ii., iii., and the papers will contain elementary questions on this subject-matter and easy deductions from the specified propositions. The regulations state that any method of proof will be accepted which shows clearness and accuracy in geometrical reasoning, and that algebraical proofs of certain propositions in Book ii. will be allowed. The change is to come into force in the Michaelmas term of 1904. The announcement made by the Board of Studies for Responsions, in the *University Gazette* for November 25, reads as follows:—"In the regulations as to the Elements of Geometry (*Examination Statutes*, 1902, p. 18), the words 'Euclid's Elements, Books i., ii. Euclid's axioms will be required, and no proof of any proposition will be admitted which assumes the proof of anything not proved in preceding propositions of Euclid,' have been struck out and the following words substituted:—'Elementary questions, including propositions enunciated by Euclid and easy deductions therefrom, will be set on the subject-matter contained in the following portions of Euclid's Elements, viz., Book i., the whole, excluding propositions 7, 16, 17, 21; Book ii., the whole, excluding proposition 8; Book iii., the whole, excluding propositions 2, 4-10, 13, 23, 24, 26-29. Any method of proof will be accepted which shows clearness and accuracy in geometrical reasoning. So far as possible, candidates should aim at making the proof of any proposition complete in itself. In the case of propositions 1-7, 9, 10, of Book ii., algebraical proofs will be allowed.' This change will come into force at the examination of Michaelmas term, 1904."

Sir Oliver Lodge has been appointed the Romanes lecturer for next year.

ON Wednesday evening, December 10, a paper on "French Rural Education, and its Lessons for England," will be read by Mr. Cloudesley Brereton at the Society of Arts.

THE clerk of the Privy Council has sent an official notice to the authorities at University College, Liverpool, fixing the hearing of the petition in regard to the proposed Liverpool University for Wednesday, December 17.

THE annual meeting of the Association of Technical Institutions will be held at the Goldsmiths' Hall, London, on Tuesday, January 6, 1903. The president, Lord Avebury, will occupy the chair, and an address will be given by the president-elect, Sir John Wolfe Barry, K.C.B., F.R.S.

MR. J. S. MACDONALD has been appointed to succeed Prof. Myers-Ward in the chair of physiology at Sheffield University College. Mr. Macdonald, who is at present assistant lecturer in physiology at Liverpool University College, takes up his new appointment in January next. Prof. Myers-Ward goes to Charing Cross Hospital as lecturer in physiology.

THE *British Medical Journal* announces that the Board of Trustees of Cornell University, New York, has arranged to purchase sixteen additional acres of land, and to erect new buildings, including the Hall of Physics, for which Mr. John D. Rockefeller gave a quarter of a million dollars, and a Hall of Arts and Humanities, upon which a like amount is to be expended. In connection with this University, it is of interest to notice that professors of the University who reach the age of seventy years will hereafter be retired with a pension. Their salary will be continued for one year, and they will thereafter receive 1500 dollars a year for four years, which time will doubtless be extended. They will act as special lecturers with such duties as may be assigned to them.

WE regret to see that Sir Michael Foster has written to the chairman of his Parliamentary Committee to say he feels compelled to resign his seat as member of Parliament for the University of London. He hoped to be relieved of his duties in the House of Commons at the beginning of the present term, but now, at the request of his committee, has deferred his actual resignation until the close of the present session. Among the names mentioned in connection with the vacancy thus caused are those of Sir Henry Roscoe, for some time vice-chancellor of the University, and Sir John Williams.

WRITING to the *Times*, Mr. A. C. Holzapfel points to the striking difference between English and German fees for scientific instruction. One of his sons studied chemistry at Aachen, and the fees for lectures, laboratory work, breakages, &c., were between 6*l*. and 7*l*. yearly. Another son attended King's College, London, for a course of work similar to that