property, it killed those animals into which it was injected, and by no amount of artificial training could their serum become endowed with any immunising effect. Exactly similar results were obtained with frogs, and whilst the normal blood of these animals was repeatedly proved to be quite devoid of all toxic action on mice, yet after the frogs had been inoculated with abrine, and trained to acquire an immunity beyond their brother frogs towards this substance, their blood invariably killed the mice into which it was injected. Dr. Calmette concludes from these observations that natural immunity to a particular toxin does not imply the existence of a specific anti-toxic substance in the blood of such refractory animals, and that whilst apparently warm-blooded abrine-refractory animals can be trained to elaborate anti-toxins, cold-blooded abrine-refractory animals cannot produce such anti-toxins in the normal conditions of their existence. The latter portion of this generalisation receives some support from Metchnikoff's observations of the same phenomenon in the case of tortoises and tetanic-toxin.

Prof. Calmette next proceeds to discuss the properties of serum derived from those animals in which the immunity to a particular toxin is not natural, but has been artificially induced. We are again for this purpose taken back to anti-venomous serum, and some additional information is given incidentally of the wonderful efficacy which characterises this remarkable remedy for snake bites. Perhaps one of the most astonishing properties of this serum is the rapidity with which it operates. Thus if two cubic centimetres of anti-venomous serum be inoculated into the marginal vein of a rabbit's ear, it at once confers upon the latter immunity towards snake poison. Immediately after the injection of the serum, venom sufficient to destroy an ordinary rabbit in a quarter of an hour may be injected with impunity into the vein of the other ear. Its degree of therapeutic efficiency is also extraordinarily intense, as is well illustrated by the following experiment: four rabbits are inoculated with a quantity of venom sufficient to destroy them in two hours; one of these is left, whilst the other three receive, one hour and three-quarters later, an intravenous injection of serum equal in quantity to one four-hundredth part of their weight. Whilst the unprotected rabbit dies in two hours, the other three remain in perfect health. "Voilà donc un sérum qui," writes Calmette, "d'emblée, sans reaction préalable de l'organisme, produit l'insensibilisation absolue des cellules à l'égard du venin."

Of great importance in their practical bearing are the experiments which are recorded on the *local* action of anti-abrine and anti-venomous serum respectively. As is well known, abrine was at one time used for the treatment of trachoma, but unfortunately the subsequent suppuration which attended its use was in many cases so intense and so dangerous that it had to be abandoned for therapeutic purposes.

Now Calmette has found that by applying anti-abrine serum to the local parts affected, the inflammatory action of abrine is modified in a very remarkable manner, and the hope is held out that by using this serum, and so controlling the inflammation induced by the application of abrine, this valuable substance may once more be reinstated in the therapeutics of ophthalmology. Anti-venomous serum has apparently the same local immunising action as the anti-abrine serum.

Another practical point of great importance concerning these serums is also dealt with in detail; this is the diagnostic value attaching to their use. Already Pfeiffer and other investigators have shown how, by means of serum, it is possible to differentiate between cholera and other non-pathogenic vibrios, and to distinguish the typhoid from the closely-allied *B. coli communis*. A most interesting opportunity occurred for testing the diagnostic power of anti-venomous and anti-abrine serums respectively. In India the natives frequently wreak their vengeance on their enemies by poisoning their domestic animals, and the substances selected for this purpose are those which they know will be with difficulty detected by expert analysis. Two materials are specially favoured by them for this purpose, *i.e.* abrine and serpent venom. One method of administering the poison consists in taking short pieces of wood shaped in the form of a club, in the thick end of which small-pointed rods are carefully fitted. These rods are composed of a hard greyish-looking substance. Armed with these tiny clubs, which they can easily conceal in their hands, they inflict small scratches, scarcely visible, upon the cattle, but in the production of which the pointed end of the little rod is broken off, and in this manner the cattle become inoculated with the poison. Some of these small broken-off points were sent by Mr Hankin, of Agra, to Dr. Calmette for examination. On dissolving these fragments in water and inoculating the liquid into rabbits, the latter died, exhibiting the symptoms typical of abrine poisoning. The same quantity of this liquid mixed with some anti-abrine serum produced no toxic result whatever. Thus Dr. Calmette considers his diagnosis of the poison employed as being abrine fully justified. In a somewhat similar manner the use of serpent venom was also detected.

These results open up a new avenue to the physiological detection of toxins, whether of animal, vegetable, or bacterial origin by means of serums.

Some extremely interesting experiments were also made to ascertain whether toxins and antitoxins were capable of modifying one another outside the body *in vitro*. The following examples give some idea of the results obtained. 5 cubic centimetres of anti-venomous serum were mixed *in vitro* with 4 milligrammes of cobra venom, and this mixture was injected intravenously into a rabbit. The animal remained unaffected; at the end of an hour, this same rabbit was again intravenously inoculated with 1 milligramme of venom. It died thirty-five minutes afterwards. Thus although its death was slightly deferred beyond that which was noted for the control animal, yet it succumbed almost as readily as if it had received no protective serum whatever. Again, 5 cubic centimetres of anti-venomous serum were mixed with 4 milligrammes of venom and 1 cubic centimetre of a 10 per cent. solution of hypochlorite of lime, and the whole was inoculated into a rabbit. This same animal, on subsequently receiving a dose of venom usually fatal, suffered no ill-effects at all. In this case, Dr. Calmette points out, that whilst the serum had remained unaffected by the addition of a chemical substance, the toxic nature of the venom had, on the contrary, been entirely destroyed. Hence it is claimed that when toxins and their anti-toxins are mixed *in vitro*, the former do not appear to undergo any change or modification through the presence of the latter. Therefore, either these substances can remain side by side outside the body intact, or, if any combination between them does occur under these circumstances, it is a combination which is so unstable that the application of heat or various chemical substances is able to easily bring about their disunion, restoring to either the properties they possessed before being brought into contact. Dr. Calmette, in concluding his most valuable memoir, records a large number of experiments made to ascertain what is the degree of protective power exercised by anti-toxic serums of different origin and certain liquids on animals inoculated with abrine. It has been found that broth freshly prepared, normal ox-serum, anti-tetanic serum, anti-diphtheritic serum, anti-anthrax serum, and, above all, anti-cholera serum, exert individually a decided immunising action with regard to abrine. Although the protective action of these so-called foreign serums is not so pronounced as in the case with anti-abrine serum, yet they do most undoubtedly confer a certain degree of protection. Dr. Calmette considers that this artificially induced immunity must be regarded as a condition in which the cells of the body are specially stimulated, and are thus enabled to either temporarily or permanently resist the action of particular poisons.

The mechanism of immunity will not permit itself to be lightly mastered, and it is only by the conduct of painstaking and patient inquiries, of which those just described are such a splendid example, that a comprehension of this most important as well as fascinating phenomenon can ever be hoped for.

ON THE VARIATION OF LATITUDE.[1]

AT the autumn meeting of the National Academy in 1894, which was the last occasion upon which the author asked for its attention to this subject, he presented the numerical theory of the motion of the pole, synthetically derived from the observations from the beginning of the history of the astronomy of precision up to that time, in its complete development, exactly as it stands to-day. Since then he has been interested to compare it with the various series of observations, as they have been published from time to time, not only for the purpose of verification or improvement of the numerical values of the various constants, but also to detect any additional characteristics which these later data might make apparent. These additional investigations have individually been neither extensive nor important enough to call for separate publication; since their general result has been merely a satisfactory confirmation of the

[1] Abstract of a paper read before the National Academy of Sciences at Washington, April 21, by Prof. S. C. Chandler.

previous deductions as to the nature of the laws of these motions, without furnishing material improvement of the numerical elements. But sufficient material has thus been gradually accumulating to make the present communication of some interest.

The new material to be here utilised consists of the various series of observations by Tallcott's method up to the middle of 1896, as far as published, at the following European stations, named in the order of longitude: Kasan, Vienna, Prague, Berlin, Potsdam, Karlsruhe, and Strasburg. America has Doolittle's series at Bethlehem, which was brought to an end in the summer of 1895. He is now carrying forward a new series at Philadelphia, of which the results may soon be expected. Of the series at Columbia University, by Rees, Jacoby and Davis, begun in the spring of 1893 and still current, the results for the first fourteen months came into the author's hands a few days ago, so that he was able to incorporate them in his investigations.

The curves of latitude-variation from these various series were then exhibited, and comparisons made with the known numerical theory. This shows a concordance and fidelity of representation which is in every way satisfactory, the difference between computation and observation being practically within the range of the uncertainty of errors of observation.

A determination of the elements of the ellipse of the annual component of the polar motion was then presented, made from the new observations independently of the older ones previously used. The resulting elements are practically identical as to form, size, and position. This seems to show that the axis of this elongated vibratory motion is stationary on the earth's surface along a meridian forty-five degrees east of Greenwich. This negative evidence as to any apsidal motion seems to be of extreme importance in its bearing on the theory of the earth's rotation.

A demonstration was then presented of the fact that since 1890 the circular 428-day motion has been diminishing its radius, in conformity to the requirements of the numerical theory derived from the observations from 1825 to 1890.

In addition to the above, a discussion of 718 observations of the Pole-star, made with the Pulkova vertical circle between 1882 and 1891, was given. This series is especially interesting and important in that it covers an interval during which we have very little other information, of an extended character, as to the variations of latitude. A comparison of the curves of observation and theory, thus provided for this decade, exhibited the most startling accordance, and seems to leave no possible doubt that Nyren's inference, that his observations do not betray evidence of the existence of the annual component of the polar motion, is erroneous and attributable to illogical methods in drawing his conclusions.

TECHNICAL EDUCATION IN LONDON.

THE work of the Technical Education Board of the London County Council has been favourably commented upon in these columns on many occasions. The Board includes among its members several well-known educationists; and in its Secretary, Dr. W. Garnett, it possesses an official whose knowledge of science makes him capable of taking a wide view of things, and of seeing the best and most practicable lines of development of technical education. The fourth annual report of the Board, presented to the Council on Tuesday, is a substantial testimony of work accomplished during the year ending with March. To do the report justice would take many columns of NATURE, but brief references to a few of the operations of the Board will, perhaps, suffice to give an idea of the valuable and extensive character of the work carried on.

The Board has continued its policy of attempting primarily to coordinate and develop the provision for technical education made by the various public institutions of the metropolis. By its grants of money, no less than by the expert assistance which it has placed at the disposal of the various governing bodies, the technical work of these institutions has been greatly extended during the past year. There are now no fewer than ninety-eight separate institutions in London to a greater or less extent supported by the Board, and inspected by its officers.

Special attention has been paid to developing and improving the instruction provided for apprentices, improvers and journeymen in the principal London industries. There are now more than two hundred well-equipped and efficient centres of definitely practical instruction in various trades. The character of the instruction given differs slightly, but, on the whole, it is of a kind that will assist industrial progress. As to instruction in electrical engineering, it is a noteworthy fact that from sixteen to eighteen students from the Royal College of Science have been attending the evening classes for electrical engineers at the South-West London Polytechnic Institute. This may be taken as good evidence of the Polytechnic's efficiency.

London now has eleven polytechnic institutions, which have on their rolls probably not fewer than 40,000 separate members or students. Nearly all the polytechnics provide instruction in science, art, technology, commercial subjects, literary subjects and domestic economy, and during the session 1895–96, before the Northampton Institute and the Northern Polytechnic were opened, the students registered at the London polytechnics, including the People's Palace and the Goldsmiths' Institute, in the several departments, were—

Science	8371
Art	2910
Technology	4692
Domestic economy	2678
Commercial subjects	8244
Total	26,895

The eleven polytechnic institutes referred to may be estimated for the current session 1896–97 to be spending in all their departments a total of about 128,000*l.* per annum, of which, roughly speaking, 29,000*l.* will probably be provided by the City Parochial Trustees, 25,000*l.* by the Technical Education Board, 22,000*l.* from City Companies, 12,000*l.* from private subscriptions and other endowments, 9000*l.* from Government grants, and 30,000*l.* from students' fees, &c. The total capital expenditure can only be roughly guessed at, but it will certainly have exceeded 500,000*l.* They may be expected to have in 1897–98, a total of about 45,000 separate students in all subjects, as compared with a corresponding total for 1892–93 of probably not more than 20,000.

The development of the higher departments at several of the polytechnics has during the last two or three years greatly increased the provision of higher instruction, especially in engineering, chemistry and physics. In the new and well-equipped laboratories now provided at these institutions by means of the Board's equipment grants, facilities are given for the student to pursue his work, without a break, from the elements of the subject up to the highest branches, and to undertake, in conjunction with his teacher, original investigation and research. A considerable addition has thus been made to the instruction of distinctly university rank now accessible to the London student, and it is estimated that, in addition to a large number preparing for matriculation, there are now over one hundred matriculated students in the polytechnics who are definitely studying for London university degrees in science. This number constitutes no small proportion of the total of matriculated students for science degrees, other than those in the medical schools, who are studying in organised educational institutes in London.

This great development of instruction of university rank in new institutions has increased the importance of bringing about a more systematic coordination of university education in London. The Board has accordingly continued to press for the early establishment of the promised new Teaching University for London, towards the technical departments of which it was proposed in Mr. Llewellyn Smith's report that the Board should contribute. The establishment of a well-endowed Teaching University for London, which should effectively coordinate and direct all the teaching of university rank that is now scattered about the metropolis, would probably do more than anything else to promote technical education. When this university will be established, it would be unwise to guess. Meanwhile the Board has attempted to bring about more coordination between the different institutions providing university instruction in technical subjects, and arrangements are in progress for courses of inter-collegiate lectures, mainly in post-graduate and specialist subjects, which will be open to all students of the various institutions concerned.

An interesting map, showing the places of residence of the thousand junior county scholars elected by the first four competitions of the Board, in the years 1893–95, accompanies the report. The map shows that the scholars were distributed with fair uniformity about the whole area of the county of London.