THURSDAY, JUNE 27, 1889.

SCIENTIFIC WORTHIES.

XXVI.—DMITRI IVANOWITSH MENDELEEFF.

DMITRI IVANOWITSH MENDELEEFF was born on February 7 (N.S.), 1834, at Tobolsk, in Siberia. He was the seventeenth and youngest child of Ivan Paolowitsh Mendeleeff, Director of the Gymnasium at that place. Soon after the birth of Dmitri his father became blind, and was obliged to resign his position, and the family became practically dependent upon the mother, Maria Dmitrievna Mendeleeva—a woman of great energy and remarkable force of character. She established a glass-works at Tobolsk, the management of which for many years devolved entirely upon her, and on the profits of which she brought up and educated her large family. The story of Mendeleeff's youth is given in the preface to his great work "On Solutions," which he dedicated to the memory of his mother in a passage of singular beauty and power. Having passed through the Gymnasium at Tobolsk, Mendeleeff, at the age of sixteen, was sent to St. Petersburg, with the intention that he should study chemistry at the University, under Zinin. He was, however, transferred to the Pedagogical Institute, the aim of which was to train teachers for the District or Governmental Gymnasiums throughout the Empire. The Institute (which was abolished in 1858) was established in the same building as the University, and was divided into two Faculties—Historico-philological and Physico-mathematical. Mendeleeff attached himself to the natural sciences, and thus came under the influence of Woskresenky in chemistry, of Emil Lenz in physics, of Ostrogradsky in mathematics, of Ruprecht in botany, of F. Brandt in zoology, of Kutorga in mineralogy, and of Sawitsh in astronomy, most of whom were Professors of the same sciences in the University. Whilst at the Institute he wrote his first paper on "Isomorphism," and on the termination of his course of instruction he was appointed to the Gymnasium at Simferopol, in the Crimea. During the Crimean war he was transferred to one of the Gymnasiums at Odessa, and in 1856 he was admitted to the degree of *Magister Chemiæ* of the Physico-mathematical Faculty of the University of St. Petersburg, and was made *Privat-Docent* in the University. Even at this early period of his career we find Mendeleeff speculating on the great problems with which his name is inseparably connected. The relations between the specific gravities of substances and their molecular weights had begun to attract increased attention. Kopp had just published the first instalment of that long and laborious series of experimental observations which constitutes the real foundation of all our knowledge concerning the specific volumes of liquids, when the young Siberian philosopher laid a number of theses on problems relating to specific volumes before the Physico-mathematical Faculty of the University. He pointed out that magnetic elements have smaller specific volumes than diamagnetic elements. He also showed that Avogadro's supposition, that electro-positive elements have larger specific volumes than electro-negative elements, was in accordance with the greater number of well-established facts. When we remember how slowly, in spite of the powerful advocacy of Williamson, the ideas of Laurent and Gerhardt and what came to be known as the modern French school, found favour in this country, it is remarkable, as indicating the radical and progressive character of his mind, and the keenness of his mental vision, to find Mendeleeff, as far back as 1856, insisting that to Gerhardt was due the best mode of determining the chemical molecule; that the molecule of oxygen was expressed by the symbol O_2; those of arsenic and phosphorus by As_4 and P_4 respectively; that of alcohol by $\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}O$; and that of ether by $\left.\begin{matrix}C_2H_5\\C_2H_5\end{matrix}\right\}O$.

Mendeleeff's researches on specific volumes were begun in 1855, and were continued, with intermissions, down to 1870; but part only of the work has been published. In 1859, Mendeleeff obtained permission from the Minister of Public Instruction to travel, and repaired to Heidelberg, where he established a small private laboratory, and occupied himself with the determination of the physical constants of chemical compounds. He returned home in 1861, and in 1863 was named Professor of Chemistry at the Technological Institute of St. Petersburg. In 1866 he became Professor of Chemistry at the University, and was made Doctor of Chemistry after a public defence of his dissertation "On the Combinations of Water with Alcohol." He is now Emeritus Professor, and delivers annually a course of lectures on general chemistry.

Mendeleeff is so prolific a writer that it is impossible within the limits of an article of this kind to do justice to his work. There is, in fact, no section of chemical science which he has not enriched by his contributions. Some of his earliest work related to questions of mineralogy and chemical geology; and at times, as in his papers on Œnanthol-Sulphurous Acid, on Fermentation Propyl Alcohol, and on the Nitriles, he cultivated the rapidly extending domain of organic chemistry. But his reputation mainly rests upon his contributions to physical chemistry and to chemical philosophy. In his papers on Specific Volumes he extends Kopp's generalizations, and traces the specific volumes of substances through various phases of chemical change. He shows that in the thermal expansion of homologous liquids the expansion-coefficient diminishes in a regular manner as the series is ascended, and he indicates the intimate connection which exists in the case of liquids between expansion and cohesion, and the *rôle* played by molecular cohesion in the determination of chemical activity. His paper on the thermal expansion of liquids above their boiling-points is noteworthy as demonstrating that the empirical expressions given by Kopp, Pierre, and others, for the expansion of liquids up to their boiling-points, are equally applicable to far higher temperatures, and that the expansion-coefficient gradually increases with the diminution in molecular cohesion of the liquid, until, in the case of certain liquids, *e.g.* ether at 133°, it becomes even greater than that of the gas. The expansion-coefficient of ether increases to 0·0054 at the temperature of its *absolute boiling-point*—that is, at about 190°. The absolute boiling-point is defined by Mendeleeff as that temperature at which the cohesion and latent heat of vaporization are *nil*, and at which the liquid becomes gaseous independently of pressure and volume. It is, in fact, that temperature which the researches of Andrews have made us familiar with as the "critical-point." In this paper Mendeleeff presents us for the first time with a number of determinations of the critical-temperatures of various substances, founded partly on his own determinations, and partly on those of Cagniard de la Tour, Wolff, and Drion.

Other papers on physical chemistry relate to Contact Action, to Fractional Distillation, and to the Heat of Combustion of Organic Substances. In 1883 Mendeleeff was made an honorary member of our Chemical Society, and in the following year he contributed a remarkable paper to the Journal of the Society (Transactions of the Chemical Society, xlv. 126), in which he developed an extremely simple general expression for the expansion of liquids under constant pressure between 0° and their boiling-points. This expression may be written $1/V_t = 1 - kt$, in which V_t is the volume at $t°$ (that at 0° being unity), and k is a quantity which varies with different substances, but which may for any one substance be considered invariable between 0° C. and the neighbourhood of the boiling-point. This formula is analogous to that which expresses Gay Lussac's law of the uniformity of expansion of gases. But just as Gay Lussac's formula, $V = 1 + kt$, applies only to a so-called ideal gas, Mendeleeff's expression is in like manner to be regarded only as a first approximation—that is, as applicable only to ideal liquids. The deviations are not large in either case; they are, as might be expected, especially remarkable near temperatures at which the states of the bodies change. In the case of actual liquids the deviations from the ideal form of expansion increase not only as the liquid approaches the point at which its state of aggregation is changed, but also with diminishing density, increasing cohesion, and diminishing molecular weight. This last cause is especially noteworthy since Mendeleeff showed, more than a dozen years ago (*vide supra*), that the deviations from Gay Lussac's law were related to the molecular weights of the gases. The well-known irregularities in the expansion of water are, according to Mendeleeff, connected with its small molecular weight, its high capillary constant (which expresses its cohesion), and the comparatively small temperature-interval within which its state of aggregation is unchanged. Subsequent observers, by applying Van der Waal's theory of the general relation between the pressure, volume, and temperature of bodies to Mendeleeff's expression for the thermal expansion of an ideal liquid, have shown that the reciprocal of the constant k is the number obtained by subtracting 273 from the product of the critical temperature into a quantity which should be the same for all substances. The value of this quantity is approximately 2, and since the range of its variation is apparently very small, the development of Mendeleeff's formula affords a simple and ready method of calculating the critical temperature of bodies from observations of their expansions as liquids.

Mendeleeff's skill in physical measurement is well illustrated by his determinations of the Specific Gravities of Aqueous Solutions of Alcohol. Such determinations have been frequently made the subject of the most rigorous experiment in this and other countries, inasmuch as they constitute the basis of the methods of assessing the duty on spirits, which is so important a factor in the national income of many States. Mendeleeff's work has served to confirm and extend that of Drinkwater, Fownes, and Squibb, and has been utilized by certain Continental Governments (*e.g.* that of Holland) for the purposes of revenue. But it was not the utilitarian aspect of this subject which alone attracted Mendeleeff. In a paper communicated a couple of years ago to our Chemical Society (Trans. Chem. Soc., li. 778), these determinations are applied towards the elucidation of a theory of solution in which it is sought to reconcile Dalton's doctrine of the atomic constitution of matter with modern views respecting dissociation and the dynamical equilibrium of molecules. According to Mendeleeff, solutions are to be regarded as strictly definite atomic chemical combinations at temperatures higher than their dissociation temperature, and just as definite chemical substances may be either formed or decomposed at temperatures which are higher than those at which dissociation commences, so we may have the same phenomenon in solutions; at ordinary temperatures they can be either formed or decomposed. In addition, the equilibrium between the quantity of the definite compound and of its products of dissociation is defined by the laws of chemical equilibrium, which require a relation between equal volumes, and their dependence on the mass of the active component parts (*loc. cit.* p. 779). It follows from this hypothesis that the specific gravities of solutions depend on the extent to which active substances are produced, or that the expression for the specific gravity, s, as a function of the percentage composition, p, may be represented by the general equation—

$$s = C + Ap + Bp^2.$$

Between two definite compounds which exist in solution, the differential coefficient $\frac{ds}{dp}$ is a linear function of p—

$$\frac{ds}{dp} = A + 2Bp.$$

By the application of this method to the case of aqueous solutions of ethyl alcohol, Mendeleeff infers the existence of three definite hydrates, viz. $EtHO.12H_2O$, $EtHO.3H_2O$, and $3EtHO.H_2O$, the first two of which he has isolated by subjecting the mixture to low temperatures. The hypothesis respecting the linear character of the differential coefficient $\frac{ds}{dp}$ has been proved to be correct for solutions of many salts, of acids, and of ammonia.

We have the consummation of this work on solution in the monograph published by Mendeleeff last year. This volume, the fruit of many years of labour, is unquestionably the most important contribution to the theory of solution yet given to science.

Much of Mendeleeff's scientific activity since 1871 has been absorbed in an extended work on the elasticity of the gases, which he has executed in conjunction with his pupils, Kirpitshoff, Hemilian, Bogusky, and Kajander. Part only of the results have as yet appeared. The first volume, published in Russian in 1875, contains details of the modes of measurement, which involved many forms of apparatus new to physical science. A summary of the principal results obtained was published in the form of a pamphlet in 1881. Regnault found that the product

$p . v = \text{const.}$—*i.e.* Boyle's law—was true for ideal gases only. Between one atmosphere and thirty atmospheres the deviations were positive in the case of hydrogen, and negative in those of all other gases. Mendeleeff pointed out that the deviations must become positive for all gases at sufficiently high pressures, and the fact has since been confirmed by the observations of Amagat and Cailletet. Mendeleeff, more particularly, made observations at low pressures, *i.e.* below one atmosphere; and here the deviations were again found to be positive and relatively very large. It was found, in fact, that, at the limit of condensation, the gases seemed to behave like solid bodies—*i.e.* the molecules were incapable of being stretched or brought nearer together to any appreciable extent by varying pressure. Mendeleeff has further determined the *real* coefficients of thermal expansion of gases. This, for air between 0° and 100° under a standard atmosphere, was found to be 0·0036829. Determinations made in the case of other gases have shown that the coefficients of expansion increase with increasing molecular weight, gases of the same molecular weight giving the same coefficient.

	Molecular weight.	Coefficient of expansion.
Hydrogen	2	0·00367
Nitrogen	28	0·00373
Carbon monoxide ...		
Nitrous oxide	44	0·00373
Carbon dioxide ...		
Sulphur dioxide ...	64	0·00385
Hydrogen bromide...	81	0·00386

The coefficient of expansion is found to decrease with increasing pressure in the case of hydrogen. Thus at

200 mm.	0·00369
760 ,,	0·00367
8 atmos.	0·00366

But with the so-called coercible gases the reverse is found to take place. Thus, in the case of carbon dioxide,

120 mm. pressure	0·00372
220 ,, ,,	0·00370
760 ,, ,,	0·00373
3 atmos. ,,	0·00389
8 ,, ,,	0·00413

The decrease of the coefficient of expansion with increasing pressure is a normal phenomenon of gases, the positive deviation observed in the case of hydrogen being found to hold equally good for all gases at very high and very low pressures. Hence the laws of Boyle and Charles are only valid at points of the curve when the deviation changes from positive to negative or *vice versâ*.

These experiments have also borne fruit in various meteorological papers on the physical nature of the highly rarefied air existing in the upper strata of the atmosphere. In this connection it may be stated that Mendeleeff has attempted to organize meteorological observations in the upper regions of the atmosphere by means of balloons, and hence he has been led to study aëronautics. His practical acquaintance with the subject induced him to make an ascent from Klin during the total solar eclipse of August 19, 1887, for the purpose of observing the extension and structure of the corona when seen through highly rarefied air.

Russia is indebted to Mendeleeff for the training of two generations of her chemists. His writings have largely modified the mode of teaching chemical science in that country. His treatise on Organic Chemistry was the standard work of its time, and exercised great influence in spreading abroad the conceptions which are associated with the development of modern chemistry. His "Principles of Chemistry," published in 1869, and repeatedly reprinted, is a veritable treasure-house of ideas, from which investigators have constantly borrowed suggestions of new lines of research. This book is one of the classics of chemistry; its place in the history of science is as well assured as the ever-memorable work of Dalton. Mendeleeff, indeed, might with equal fitness have styled his book a "New System of Chemical Philosophy." In it he has developed the great generalization which is known under the name of the "Periodic Law"—a generalization which is exerting a profound influence on the development of chemical science in all countries in which its study is actively prosecuted. Mendeleeff first drew attention to the principles upon which the Periodic Law is based in a paper read to the Russian Chemical Society in 1869, in the following series of propositions:—

(1) The elements, if arranged according to their atomic weights, exhibit an evident *periodicity* of properties.

(2) Elements which are similar as regards their chemical properties have atomic weights which are either of nearly the same value (*e.g.* platinum, iridium, osmium), or which increase regularly (*e.g.* potassium, rubidium, cæsium).

(3) The arrangement of the elements, or of groups of elements in the order of their atomic weights, corresponds to their so-called *valencies*, as well as, to some extent, to their distinctive chemical properties; as is apparent among other series in that of lithium, beryllium, barium, carbon, nitrogen, oxygen, and iron.

(4) The elements which are the most widely diffused have *small* atomic weights.

(5) The *magnitude* of the atomic weight determines the character of the element, just as the magnitude of the molecule determines the character of a compound body.

(6) We must expect the discovery of many yet *unknown* elements—for example, elements analogous to aluminium and silicon—whose atomic weight would be between 65 and 75.

(7) The atomic weight of an element may sometimes be amended by a knowledge of those of its contiguous elements. Thus the atomic weight of tellurium must lie between 123 and 126, and cannot be 128.

(8) Certain characteristic properties of elements can be foretold from their atomic weights.

In the Faraday Lecture recently delivered to the Chemical Society, and from which these words are taken, Mendeleeff has indicated for us the lines upon which the evolution of his theory proceeded. In the first place, it is to be noted that it is based wholly on experiment: it is as much the embodiment of fact as are the laws of chemical combination formulated by Dalton. Without the knowledge of certain data it could not possibly have been discovered; with this knowledge its appearance, says Mendeleeff, is natural and intelligible. Three series of data were necessary to pave the way for its enunciation:—

(1) The adoption of the definite numerical values of the atomic weights founded on the conceptions of Avogadro and Gerhardt, as insisted upon by Cannizzaro.

(2) The recognition that the relations between the atomic weights of analogous elements were governed by some general law. Many chemists, and more especially Dumas, Gladstone, and Strecker, had drawn attention to the numerical relationship existing between correlated groups of elements, but no one before Newlands in England, and De Chancourtois in France, had sought to generalize this conception, and to extend it to all the elements by considering their properties as functions of their atomic weights. (3) A more accurate knowledge of the relations and analogies of the rarer elements, such, for example, as that given to us by Roscoe in the case of vanadium, and by Marignac in that of niobium. The law of periodicity was the systematized expression of these data; it was, to use Mendeleeff's language, "the direct outcome of the stock of generalizations of established facts which had accumulated by the end of the decade 1860–70."

We can only very rapidly allude to some of the more striking services which Mendeleeff's generalization has rendered to science during the twenty years of its existence. By a more systematic arrangement and co-ordination of the known chemical elements, it has not only indicated the existence of new forms of elementary matter, but it has pointed out the probable sources of the undiscovered substances, and has enabled us to know their properties even before we have knowledge of their existence. It was this power of divination inherent in the law which, perhaps more than any other feature, first attracted attention to it, and quickened the interest with which its development was regarded by men of science. There are now three instances of elements of which the existence and properties were foretold by the periodic law: (1) that of *gallium*, discovered by Boisbaudran, which was found to correspond with the *eka-aluminium* of Mendeleeff; (2) that of *scandium*, corresponding to *eka-boron*, discovered by Nilson; and (3) that of *germanium*, which turns out to be *eka-silicium*, by Winckler. No one who was present on the occasion of the delivery of the Faraday Lecture will forget the enthusiasm which followed the reading of these words of Mendeleeff's: "When, in 1871, I described to the Russian Chemical Society the properties, clearly defined by the periodic law, which such elements ought to possess, I never hoped that I should live to mention their discovery to the Chemical Society of Great Britain as a confirmation of the exactitude and the generality of the periodic law."

Up to the time of the formulation of the law, the determination of the atomic value or valency of an element was a purely empirical matter, with no apparent necessary relation to the atomic value of other elements. But to-day this value is as much a matter of *a priori* knowledge as is the very existence of the element or any one of its properties. Striking examples of the aid which the law affords in determining the substituting value of an element are presented by the cases of *indium*, *cerium*, *yttrium*, *beryllium*, *scandium*, and *thorium*. In certain of these cases, the particular value demanded by the law, and the change in representation of the molecular composition of the compounds of these elements, have been confirmed by all those experimental criteria on which chemists are accustomed to depend. One of the most interesting instances of the kind is seen in the example of *uranium*, the atomic weight of which was formerly regarded as 120, then as 180, but which, on the authority of the periodic law, is now established as 240, a value completely confirmed by the independent experiments of Zimmermann and Rammelsberg. Uranium has a special interest in being the last term in the series: no element of higher atomic weight is at present known.

As examples of the value of the law in enabling us to correct the atomic weights of elements whose valencies and true position were well known, we may cite the cases of *gold*, *tellurium*, and *titanium*, the values of which were apparently higher than those demanded by it. In each of these cases a redetermination of the atomic weight has resulted in a value which is in conformity with the previsions of the periodic law.

The law has, moreover, enabled many of the physical properties of the elements to be referred to the same principle of periodicity. At the Moscow Congress of Russian physicists in August 1869, Mendeleeff pointed out the relations which existed between the density and the atomic weights of the elements; these were subsequently more fully examined by Lothar Meyer, and are embodied in the well-known curve in his "Modern Theories of Chemistry." Similar relations have been discovered in certain other properties, such as ductility, fusibility, hardness, volatility, crystalline form and thermal expansion; in the refraction equivalents of the elements, and in their conductivities for heat and electricity; in their magnetic properties and electro-chemical behaviour; in the heats of formation of their haloid compounds; and even in such properties as their elasticity, breaking stress, &c.

In the Faraday Lecture, Mendeleeff indicated the bearing of the law of periodicity upon the doctrine of constant valency, and especially on the conception of a primordial matter. The mind almost instinctively clings to the notion that the law can only find its rational interpretation in the idea of unity in the formative material, and it is not surprising that the promulgation of the law has been heralded by some as the most convincing proof of the validity of the Pythagorean conception that experiment has yet been able to adduce. But the author of the periodic law will not admit that his generalization has either sprung from this conception or has any relations towards it. "The periodic law, based as it is on the solid and wholesome ground of experimental research, has been evolved independently of any conception as to the nature of the elements; it does not in the least originate in the idea of an unique matter; and it has no historical connection with that relic of the torments of classical thought; and therefore it affords no more indication of the unity of matter or of the compound nature of the elements than do the laws of Avogadro and Gerhardt, or the law of specific heats, or even the conclusions of spectrum analysis. None of the advocates of an unique matter has ever tried to explain the law from the standpoint of ideas taken from a remote antiquity, when it was found convenient to admit the existence of many gods—and of an unique matter."

No record of Mendeleeff's intellectual activity would be complete without some reference to his influence on the development of the industrial resources of Russia. In 1863 he brought out the first encyclopædia of chemical technology of any magnitude which the literature of that country possessed, and he has been frequently commissioned to report on the progress of chemical industry as manifested at the various International Exhibitions. But it was on the petroleum industry of Baku, on the Caspian, that this influence has been most widely felt. Fifteen years ago the production of petroleum in Russia was a monopoly, and was accompanied by all the evils which usually spring from monopolies: the trade was exceedingly limited, and apparently incapable of development. Thanks largely to his action, both on the platform and in the press, the opening up of the boundless supplies of the peninsula of Apsheron was thrown open to the world, with the result that petroleum threatens to effect an industrial revolution in Eastern Europe and in Asia. Indeed, it is not too much to say that the oil industry of Baku is rapidly becoming, directly and indirectly, one of the most powerful factors in the Central Asian problem. Mendeleeff's interest in the development of the Baku industry has led to his being sent to the Caucasus and to Pennsylvania, to report upon the best modes of working the wells, and of separating and utilizing the products. Last year, during the coal crisis in Southern Russia, he was commissioned to study the economic condition of the industry in the rich coal-basin of Donetz.

No man in Russia has exercised a greater or more lasting influence on the development of physical science than Mendeleeff. His mode of work and of thought is so absolutely his own, the manner of his teaching and lecturing is so entirely original, and the success of the great generalization with which his name and fame are bound up is so strikingly complete, that to the outer world of Europe and America he has become to Russia what Berzelius was to Sweden, or Liebig to Germany, or Dumas to France. Nowhere has Mendeleeff's pre-eminence been more quickly or more fully recognized than in this country. English men of science and of learning have delighted to do him honour. In 1882 the Royal Society gave him the Davy Medal; and now, the Chemical Society, which is proud to number him among its Honorary Fellows, has conferred upon him the highest distinction in its power, by the award of the Faraday Medal. To the great regret of the large gathering of British chemists which had assembled to welcome him and to listen to the memorable address on the subject which he of all others is best fitted to expound, Mendeleeff was unable to receive the gift in person; but the circumstances of his absence awakened a deep feeling of commiseration and sympathy, and served to intensify the sentiment of respect and admiration with which he is regarded by all English men of science.[1]

T. E. THORPE.

THE PREVENTION OF HYDROPHOBIA.

AS was foretold three years ago, by those experienced in its behaviour, rabies is again making itself felt in this country by becoming epidemic. No disease probably has been more misunderstood in the past, none is more clearly known to-day. We are not therefore, as in 1885, caught napping. Since M. Pasteur showed us the whole story of rabies, we have acknowledged the brilliancy of his researches and the most gratifying discovery he made of the way in which the disease may be prevented from developing in any individual unfortunately bitten by a rabid dog. The manner too in which he gradually unfolded one secret of Nature after another, by his extraordinary insight into the phenomena of infectious disease, has been demonstrated with beautiful clearness in the recent Croonian Lecture delivered by Dr. Roux before the Royal Society.

The gradual evolution of the science of preventive inoculations by M. Pasteur has taught us how to obviate the appearance of rabies or hydrophobia when the virus has been introduced into the system; how, in fact, the virus may be hindered from exerting its frightful effects on the nervous centres of those unfortunately exposed to the danger. Consequently he enjoys the supreme pleasure of having saved hundreds, not only from a most painful and miserable death, but from what is actually far more painfully important—the most dreadful of apprehensions.

But this last point, the apprehension or dread of the disease, which is so appalling a feature of this malady, owing to the extraordinary length of its incubation period, has forced upon everyone save the anti-vivisectionists, the fact that it is far more necessary, in this of all troubles, to prevent the chances of the mischief occurring, than to try and shut the door after the evil has found admission. We have persistently urged that in islands like Great Britain the mere existence of rabies is a matter of the greatest reproach; that preventive legislation is to a very unusual degree able to cope with it and destroy it utterly. A brief repetition of the grounds of this belief will not be out of place. Of all acute specific diseases, rabies is evidently the one in which the virus survives removal from living tissues with the greatest difficulty. As retention of virulence and viability by the viruses of different acute specific diseases is a subject of the highest interest, as well to the practical hygienist as to the pathologist, we fortunately know enough from the work of recent years to speak with confidence on the point. Bacteriological experience has shown that the difficulty of artificially cultivating a zymotic virus in dead material, *e.g.* gelatine, increases, roughly speaking, in proportion to the length of the incubation period. In proof of our contention we may quote the extreme cases of tuberculosis and anthrax. In the former disease the virus is a slow-growing bacillus, growing in artificial cultures with the utmost difficulty, and destroying life only at the end of many weeks. In anthrax, on the contrary, we have a bacillus which develops with the utmost activity on artificial nutrient soils, and which kills in a few hours.

Duration of incubation period, however, is not necessarily an index to the viability of a bacillus. But while it was clear from what has just been said that we were *a priori* fully justified in prophesying that the rabic virus would probably not develop in the absence of a living pabulum, *i.e.* living tissue, we have actual evidence to show that fortunately this most terrible virus in all probability is not possessed of powers of active resistance to those injurious influences which act upon it

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[1] I have to express my grateful acknowledgments to Prof. Menshutkin and M. Gorboff, of St. Petersburg, and to Dr. B. Brauner, of the University of Prague, for much of the information on which this article is based.—T. E. T.