REPORT

ON

M. PASTEUR'S RESEARCHES ON RABIES
AND THE TREATMENT OF HYDRO-
PHOBIA BY PREVENTIVE
INOCULATION.BY M. WILLIAM VIGNAL,
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PART II.

INOCULATION WITH RABID VIRUS A PROPHYLACTIC TREATMENT FOR ANIMALS.—*A Prophylactic for Hydrophobia.*—*Statements of MM. Gallier and Gibier negatived by M. Pasteur.*—*Virulence of Virus Attenuated by Passage through a Series of Monkeys.*—*Virulence of Virus increased by Passage through a Series of Rabbits and Guinea-Pigs.*—*Virulence of Virus brought to a Maximum in Rabbits persists; if used for Inoculating Dogs, it produces Fatal Rabies.*—*Attenuated Virus from Monkeys regains its Maximum Virulence after Passage through a Series of Rabbits.*—*Virus of Different Degrees of Virulence obtained.*—*Inoculation with Rabid Virus described: Virulence of Virus gradually increases.*—*Method of Rendering Dogs Refractory to Madness.*—*Possibility of Prophylactic Inoculation for Hydrophobia suggested.*—*Commission of Inquiry appointed by the Minister of Public Instruction: Report: Twenty-three Dogs successfully Inoculated.*

A Prophylactic against Hydrophobia.—On May 19th, 1884, M. Pasteur¹ stated to the Academy of Sciences that he had advanced a step further in his experiments, for the purpose of rendering animals refractory to the virus of rabies by inoculation with an attenuated virus.

Statements of MM. Gallier and Gibier negatived by M. Pasteur.—Before giving the result of those researches, as they are described in M. Pasteur's note, we believe it to be necessary to refer again to M. Gallier's experiments. This experimenter had injected a rabid virus into the veins of sheep, and observed that these animals did not contract hydrophobia, but were, nevertheless, refractory to the disease, even though a fresh inoculation were made. M. Pasteur, on November 11th, 1882 (*loc. cit.*), said that the result of his own experiments had not furnished him with facts proving the truth of M. Gallier's statements. M. Paul Gibier stated, in a note sent to the Academy of Sciences, June 11th, 1883, that the virus of rabies is attenuated by the influence of a temperature of 40° to 46° Centigrade. This experiment was repeated by M. Pasteur, and demonstrated by him to be erroneous. Excepting MM. Gallier's and Gibier's statements concerning attenuated virus, now recognised to be inexact, we believe that no others besides those of M. Pasteur have been made.

Virulence of Virus attenuated by Passage through a Series of Monkeys.—In the note to which we have referred, M. Pasteur states that, if a monkey be inoculated with virus taken from a mad dog, and a second monkey be inoculated from the first, and a third from the second, and so on through a successive series, the virus becomes attenuated in each successive monkey, until finally it becomes incapable of producing rabies in dogs by hypodermic injection. It may happen that inoculation with this virus, after trephining, also fails; nevertheless, the animals are rendered refractory to the disease.

Virulence of Virus increased by Passage through a Series of Rabbits and Guinea-Pigs.—The virulence of rabid virus is increased after passing through a successive series of rabbits and guinea-pigs by inoculation. Thus, it must be concluded that directly opposite phenomena take place in these animals from those which operate in the animal economy of monkeys. M. Pasteur, as we have previously stated, judges of the virulence of the virus by the inverse proportion of the incubation-period.

Virulence of Virus brought to a Maximum in Rabbits persists; if used for Inoculating Dogs, it produces Fatal Rabies.—When the virus of rabies has, in rabbits, reached its maximum of virulence, and it is then used for inoculating dogs, its virulence persists, and is much more intense than virus taken direct from a mad dog. If this virus

be injected into the veins of a dog, it invariably produces rabies, resulting in death.

Attenuated Virus from Monkeys regains its Maximum Virulence after Passage through a Series of Rabbits.—In order to restore to the virus from monkeys (the attenuated virus) its original virulence, it must be passed, by inoculation, through a successive series of rabbits. The attenuated virus then finally regains its maximum of virulence.

Virus of Different Degrees of Virulence obtained.—M. Pasteur then stated that he believed, by logically reducing these facts to practical application, he had succeeded in rendering dogs refractory to hydrophobia. He had thus obtained virus of rabies of different degrees of virulence, some not fatal, yet rendering the economy insusceptible to the effects of more active virus. These more active virus, in their turn, preserve the economy from the effects of deadly virus. ("Les uns non mortels preservent l'économie des effets des virus plus actifs, et ceux-ci des virus mortels." (*Loc. cit.*, p. 1230.)

Inoculation with Rabid Virus described: Virulence of Virus gradually increases.—M. Pasteur gave the following description of inoculating with rabid virus. A rabbit is inoculated with rabid virus taken from a rabbit dead from hydrophobia, and having passed through an incubation-period several days longer than that of the shortest period observed in rabbits—perhaps from seven or eight days. When this second rabbit dies, the virus taken from it is used to inoculate a third rabbit, and so on through a successive series, until it occurs that each rabbit contracts hydrophobia after seven or eight days' incubation. After every successive passage through a rabbit by inoculation, the virus becomes more virulent; that is to say that the incubation-period becomes shorter and shorter. Thus a series of virus of increasing virulence is obtained.

Method of rendering Dogs Refractory to Madness.—Each time the virus is passed from one rabbit to another, a certain dog is also inoculated with it. This animal finally becomes capable of resisting the influence of a deadly virus, and is rendered refractory to hydrophobia, even though rabid virus taken from a mad dog be injected into its veins, or inoculated on the cerebral surface.

Possibility of Prophylactic Inoculation for Hydrophobia suggested.—These experiments may be called the scientific experiments of anti-rabid inoculation. Evidently they are not generally practical, but they indicate the possibility of arriving at a practical method of inoculation for animals, constituting a prophylactic for hydrophobia. This is also M. Pasteur's view. He said: "My first attempt encouraged my hopes for success, inasmuch as the incubation-period is long. I, therefore, have reason for believing that a condition, refractory to the influence of hydrophobia, can be determined before the disease consequent on the bite of a mad dog be manifested." (*Loc. cit.*, p. 1231.) He then stated that he had written to the Minister of Public Instruction, to be furnished with the means to enable him to repeat his experiments before a Commission, composed of members of the Academy of Sciences, and of the Academy of Medicine, in order to satisfy the Commission that the experiments just described tend to obtain a prophylactic for hydrophobia.

Commission of Inquiry appointed by the Minister of Public Instruction: Report: Twenty-three Dogs successfully Inoculated.—M. Pasteur's request was granted. The Minister named a Commission, composed of MM. Béclard, Paul Bert, Bouley, Tisserand, Villemin, and Vulpian. On August 6th, 1884, the Commission sent to the Minister of Instruction its report on M. Pasteur's experiments. This was published on August 8th,² and contained the following statements. "The results observed by the Commission may be thus summarised. Nineteen control dogs were experimented on. Among six dogs bitten by mad dogs, three were seized with hydrophobia.³ There were six cases of hydrophobia among eight dogs after venous inoculations; and five cases of hydrophobia among five dogs consequent on inoculation after trephining. The twenty-three dogs inoculated, and then tested, all escaped hydrophobia. In the course of the experiments, a dog rendered refractory to rabies by inoculation, died on July 13th from diarrhoea, with black motions, which set in at the beginning of July, when the dog was in the infirmary of M. Bourrel, a veterinary surgeon, who had in his keeping some mad dogs. Some of M. Pasteur's experiments, made before the Commission, were done at M. Bourrel's establishments. In order to ascertain if the dog, which died after suffering from diarrhoea, had died from hydrophobia, inoculations were made with portions of its medulla oblongata. On July 13th, three rabbits and a guinea-pig were inoculated. On August 4th, they were

² *Journal Officiel de la République Française.* Lettre et rapport présentée au Ministre de l'Instruction Publique par le Commission chargée de contrôler les Expériences de M. Pasteur, sur le Prophylaxie de la Rage, p. 4228, et suiv.

³ Every bite from a mad dog does not produce hydrophobia, especially when the dog bitten has a long hairy skin. The virus on the teeth of the mad dog is wiped off, and is not lodged in the wound.

¹ Sur la Rage; par M. Pasteur, avec la collaboration de MM. Chamberland et Roux (*Comptes Rendus de l'Académie des Sciences*, tome xxviii, p. 1, 220).

in perfect health, but had, nevertheless, passed the period when hydrophobia appears, in animals of their species, after cerebral inoculation."⁴

[To be continued.]

ABSTRACTS OF THE LUMLEIAN LECTURES ON THE ELECTRICAL CONDITION OF THE HUMAN BODY: MAN AS A CON- DUCTOR AND ELECTROLYTE.

Delivered at the Royal College of Physicians, London, April, 1886.

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LECTURE I.

AFTER thanking the President of the College for allowing him the use of the noble library for his lectures, and for the permission to ask the attendance of his scientific friends, Dr. Stone commenced his lecture by emphatically disclaiming the idea that his lectures were intended to be devoted to "Medical Electricity." The term itself was incorrect, and was of ill-omen, as recalling the meretricious devices by which it had been sought to recommend electricity, empirically, as a therapeutic agent. It was too true that, up to the present time, it had not fulfilled expectations, which were only reasonable in the case of so powerful a force. It was a convenient physiological stimulant, and a good test of muscular irritability, but it had been accepted with too little examination as a mere agent in physiological research.

The Importance of Absolute Measurements.—The importance of placing the physiological and medical application of electricity on a physical basis of absolute measurement being admitted, the imperfections of the methods until recently available were pointed out. Methods which depended upon the use of the galvanoscopic frog or the induction coil were not suited to solve the problems presented. Professor Hughes had recently pointed out that the telephone might be used as a galvanoscope, thus replacing the galvanoscopic frog by an instrument constructed upon principles which were thoroughly understood.

To show the applicability of the telephone to such uses, a double wire was carried along the gallery, and connected in multiple arc with six independent derived circuits, each containing a telephone. On joining up the line with the secondary coil of a Dubois-Reymond induction sledge, and starting the chronometric interruptor, it was quite easy to hear all over the room the feeble click of making, and the powerful click of breaking circuit. As the secondary coil was run along the sledge, these were diminished in intensity, the former soon fading out, but the latter persisting till the secondary was 500 mm. or more from the primary coil. A physiological experiment was thus reproduced, physically, without the interposition of animal tissue, whether nerve or muscle.

Early Estimations of Resistance.—In investigating the electrical reaction of the human body, as in all other cases, the first point to determine was its resistance, the reciprocal of conduction. This problem had engaged the attention of many experimenters since the time of Volta. The first serious systematic attempt was made by Edward and William Weber, but Dubois-Reymond had published, in 1860, an elaborate memoir on the resistance of the uninjured human body; that distinguished observer, however, had been compelled to admit that the variations in the results obtained were so great and inexplicable, as to reduce their value to a minimum. The Webers, and all those who followed them, had taken it for granted that a current of high tension and of alternating character might be substituted indifferently for the constant current of a battery in the measurement of this unit, or even combined with it in an arbitrary way. This error the lecturer believed he had been one of the first, if

not the very first, to detect; it was of a serious character, as would be noted in the subsequent lectures. The earlier observers had also neglected the effects of what is termed "polarization," or the establishment by electrolysis of a counter electromotive force, which acted as increased resistance.

Fig. 1.—Kohlrausch's Meterbridge.

Du Moncel's Approximate Estimation.—Comte Du Moncel had obtained a nearer approximation to the real resistance of the human body than had been previously reached. In an experiment made on his wife, he found it from wrist to wrist, at first equal to 330 kilometres of telegraph wire, equivalent to 3,500 ohms, but gradually sinking to 2,200 ohms. He used small platinum electrodes ($1\frac{1}{2} \times 1\frac{1}{2}$ in.) with the result that the skin beneath them was electrolysed, and deep

Fig. 2.—Hastmann's Demonstrating Aperiodic Galvanometer.

ulcers were produced, of which the Countess Du Moucel, now an old lady, bears the marks to this day. Herein lay the first difficulty; the human body, considered from an electrical point of view, was a mass of fairly good conducting material, enclosed in a remarkably badly

⁴ The experiments which M. Pasteur made in the presence of the Commission were not precisely those he had proposed to the Academy of Sciences. The Commission had slightly modified the proposed programme contained in the note of May 10th, 1884.