THE ELECTRICAL INDUSTRY

The Rise of the Electrical Industry during the Nineteenth Century. By MALCOLM MACLAREN. Princeton University Press. 1943.

PROFESSOR MACLAREN throughout his long career as an electrical engineer in industry and as professor of electrical engineering at Princeton University has had many opportunities to associate with men who have contributed during the late nineteenth century to the development of the electrical industry. His opportunities for analyzing this development have been enhanced by his close association with the excellent collection of old instruments, including experimental models used by Joseph Henry, in the Princeton Electrical Museum.

Professor MacLaren states in his preface that he has described the development of the electrical industry in non-technical terms "in the hope that it may appeal to the general reader"; he has, however, inserted an extensive bibliography so that readers may inquire further into technical details. It is the opinion of the reviewer that the book will be most interesting to those readers who have a knowledge of the technical basis of electrical engineering. The author's brief reviews of the developments of various kinds of apparatus do not appear to be easy reading for a layman, although such brevity is to be commended from the point of view of the technically trained reader.

The early history of electricity is very briefly reviewed in the first chapter. Professor MacLaren then goes on to chapters devoted to the description of the development during the nineteenth century of communications, illumination, direct-current motors and generators, measuring instruments, direct-current distribution systems and early developments of alternating currents. These chapters present clearly and concisely the facts related to each subject. The value of the text is further extended by more than 150 reproductions of photographs of specific pieces of apparatus. Many of these illustrations are photographs of experimental apparatus and of early commercial models of batteries, motors, generators, meters, control devices and switchboards. The value of these illustrations would be greatly increased if some means had been used in each case to indicate the linear dimensions of the apparatus.

Professor MacLaren has chosen to limit his discussion to the nineteenth century. This is perhaps necessary, because an adequate history of the development during the twentieth century could not have been compressed into a single volume. His plan, however, has brought about an interesting result; the reader is conducted through a fascinating story of the development of a particular electrical device up to the beginning of this century. This is the end of the chapter, so that the reader finds himself in the same state of mind as one who reads a serial novel and is forced to wait for another month to continue a particularly exciting episode.

It is quite probable that this book will be examined with great interest by historians of science. They will find not only a series of interesting facts treated briefly and objectively in the text, but they will also be stimulated to study the bibliography which Professor MacLaren has supplied, and find there the extensive literature to which such a bibliography naturally leads.

S. REID WARREN, JR.
MOORE SCHOOL OF ELECTRICAL ENGINEERING,
UNIVERSITY OF PENNSYLVANIA

SPECIAL ARTICLES

PURIFICATION AND CHARACTER OF THE SWINE INFLUENZA VIRUS[1]

RECENTLY, there were described the purification and characterization of the influenza viruses A (PR8 strain)[2] and B (Lee strain).[3,4] The influenza virus A was found to be a lipoprotein complex of rounded or ovoid particle shape and of variable size. The average diameter of the particles, as measured from electron micrographs, was 77.6 mμ. The sedimentation diagram revealed a slightly diffuse boundary moving at a rate corresponding to the constant $S_{20^\circ} = 724 \times 10^{-13}$, from which the particle diameter was calculated to be 80 mμ. The influenza virus B was somewhat similar in constitution and in appearance in electron micrographs, but the diameter of the particles, measured from electron micrographs, was 97.3 mμ and calculated from the sedimentation constant, $S_{20^\circ} = 832 \times$

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[2] A. R. Taylor, D. G. Sharp, D. Beard, J. W. Beard, J. H. Dingle and A. E. Feller, *Jour. Immunol.*, 47: 261, 1943.

[3] D. G. Sharp, A. R. Taylor, I. W. McLean, Jr., D. Beard, J. W. Beard, A. E. Feller and J. H. Dingle, SCIENCE, 98: 307, 1943.

[4] D. G. Sharp, A. R. Taylor, I. W. McLean, Jr., D. Beard, J. W. Beard, A. E. Feller and J. H. Dingle, *Jour. Immunol.*, in press.

10^{-13}, was 100 mμ. Similar studies on the purification and character of the swine influenza virus are reported here.

The virus employed was an egg-adapted strain of swine influenza virus obtained from Dr. John F. Enders. A 10^{-3} dilution in hormone broth of virus-infected chorio-allantoic fluid was inoculated into the chorio-allantoic cavity of chick embryos of 11 days' incubation at 37.5 C. After 42 hours' further incubation at 37 C, the chorio-allantoic fluid was drawn off and spun in the angle centrifuge at 2,000 g for 10 minutes. Purification of the virus was then effected either by adsorption on and elution from chicken red blood cells followed by ultracentrifugation or by ultracentrifugation alone.

For the former, 200 ml of fluid were adsorbed with 6 ml of washed chicken red blood cells. Agglutination was strong and rapid, as was the case with influenza virus A. The massed red cells were sedimented, separated from the supernate and washed rapidly with chilled Ringer solution. Elution was carried out at 25 C in a volume of Ringer solution one fourth that of the starting chorio-allantoic fluid, and in contrast with the conditions favorable for elution of influenza viruses A[2] and B,[3,4] 6 hours were allowed for separation of the virus from the red cells. The eluate, freed of red cells, was spun in the ultracentrifuge at 20,000 g for 1 hour. The supernate was poured from the clear gel-like pellets, which were redispersed in Ringer-calcium chloride solution,[2] adjusted to pH 7.3 (with 0.01 N NaOH) at 150 times concentration with respect to the starting fluid. The concentrate was cleared of aggregates by spinning at 5,000 g for 5 minutes.

For purification of the virus by ultracentrifugation alone, the virus-infected chorio-allantoic fluid, after angle centrifugation, was put through two cycles of alternate high (20,000 g) and low (5,000 g) speed centrifugation similar to the single cycle employed for the eluate described above.

The infectious titer of the chorio-allantoic fluid varied from $10^{-7.3}$ to $10^{-7.8}$ and the hemagglutinative titer from 1–128 to 1–256. In the adsorption-elution process from 70 to 100 per cent. of the activity were carried into the eluate. In ultracentrifugation of the eluates, 50 to 80 per cent. of the hemagglutinative activity and 20 to 50 per cent. of the infectivity were recovered in the concentrates. The yield of activity in the concentrates of ultracentrifugation alone was about the same as that obtained when adsorption, elution and ultracentrifugation were carried out. In all instances, virus activity was associated with the concentrates obtained at 20,000 g.

The final pellets obtained by either procedure were clear, gel-like and could be quickly dispersed in Ringer-calcium chloride solution to give a bluish opalescent preparation. Preparations containing 0.28 mg nitrogen per ml sedimented in the analytical ultracentrifuge with a slightly diffuse boundary and at a rate corresponding to $S_{20^\circ} = 662 \times 10^{-13}$. From this constant and the density, 1.18, as determined by pycnometer measurement, the particle diameter was 81.5 mμ. Analyses made both by the adsorption procedure of Svedberg and by the scale method gave comparable results.

Examinations of the purified material in the electron microscope revealed images which were for the most part nearly round but in many instances were ovoid or bean-shaped, similar in appearance to those of influenza virus B. The particles in solutions of the concentrates showed a strong tendency to aggregate, especially in material sedimented at 27,000 g, the ultracentrifugal field employed in preliminary work with this virus. In individuals clearly shown, there was an internal structure of relatively high density. Wide variations were seen in diameter. From measurements on 1,051 images, the average diameter was 78.3 mμ.

Studies with the electron microscope were made also of the various fractions obtained in the purification process. In the crude chorio-allantoic fluid there was a profusion of small particles of about 20 mμ and less diameter, which were somewhat like those seen in the instance of influenza virus A[2] and wholly unlike the relatively large particles of variable size in the chorio-allantoic fluid infected with influenza virus B.[3,4] Interspersed with the small particles there were many larger particles of a size and appearance corresponding to the virus in the purified concentrates. Small particles, comparable in numbers to those seen in chorio-allantoic fluid, were present in the fluid after adsorption, but very few particles of about 78 mμ were visible. In the eluate, four times concentrated, many more of the large virus particles were seen amidst many of the small ones carried over in the adsorption-elution process. The appearance of the supernate after ultracentrifugation resembled that of the adsorbed fluid in the presence of many small particles and very few of the large ones. The final concentrates contained but few of the small particles.

The concentrates gave positive biuret, Millon and ninhydrin reactions, negative glyoxylic acid reactions and delayed, weakly positive Molisch tests. The reaction for pentose with Bial's reagent was negative after hydrolysis of the material with 10 per cent. sulfuric acid. This result, together with a weakly positive diphenylamine reaction, indicated the presence of nucleic acid of the desoxypentose type. The specific volume by pycnometer measurement was 0.850.

Analysis of the concentrates, dialysed against distilled water, frozen and dehydrated *in vacuo* and then

over P_2O_5 gave carbon 51.4, nitrogen 9.0 and phosphorous 0.87 per cent. By extraction with alcohol-ether (3–1) and reextraction of the lipids with petroleum ether,[5,6] the lipid fraction was 24 and the non-lipid fraction 77.76 per cent. of the material. The total lipid fraction was made up of 10.64 per cent. phospholipid, 5.67 per cent. cholesterol and 7.64 per cent. neutral fat. Of the total phosphorous, 52 per cent. were found in the lipid fraction. If the remainder of the phosphorous was present in nucleic acid, the virus would contain about 4.0 per cent. nucleic acid of the desoxypentose type.

The total carbohydrate[7] (as glucose) content of the whole virus was 10 per cent. The carbohydrate, apparently firmly bound in complex form, was greatly in excess of that expected for the amount of nucleic acid present. Subtracting this value from that of the non-lipid fraction, 77.76 per cent., the probable protein content of the virus was about 67.76 per cent.

A similar finding has been encountered with influenza virus B (Lee strain), in which the total carbohydrate was 9.3 per cent.

The infectious unit of the virus when inoculated in 0.05 ml volumes in chick embryos was $10^{-12.16}$ to $10^{-13.1}$ grams with an average of $10^{-12.74}$. One concentrate, purified by adsorption, elution and centrifugation and titrated in fivefold dilutions employing 40 embryos per dilution, gave the value $10^{-13.11}$ grams; another concentrate purified by ultracentrifugation alone and titrated similarly in 40 embryos per dilution gave $10^{-12.75}$ grams. The hemagglutinative activity of the concentrates was such that $10^{-6.16}$ to $10^{-6.46}$ grams with an average of $10^{-6.29}$ grams gave the 2 plus end point.

A. R. TAYLOR
D. G. SHARP
I. W. MCLEAN, JR.[8]
DOROTHY BEARD
J. W. BEARD[9]
J. H. DINGLE[9]
A. E. FELLER[9]

DEPARTMENT OF SURGERY,
DUKE UNIVERSITY SCHOOL OF MEDICINE
AND
RESPIRATORY DISEASES COMMISSION LABORATORY
STATION HOSPITAL, SECTION 2, FORT BRAGG, N. C.

[5] E. Kirk, *Jour. Biol. Chem.*, 106: 191, 1943.
[6] E. Kirk, I. H. Page and D. D. Van Slyke, *Jour. Biol. Chem.*, 106: 203, 1943.
[7] J. Tillmans and K. Philippi, *Biochemische Zeitschrift*, 256: 36, 1929.
[8] Fellow in virus research, Division of Medical Sciences of the National Research Council.
[9] Representing the Commission on Acute Respiratory Diseases, whose other members are Drs. T. J. Abernethy, G. F. Badger, N. L. Cressy, Captain, M. C., A. D. Langmuir, C. H. Rammelkamp and E. Strauss.

DECREASE IN LACTIC ACID CONTENT OF THE BRAIN IN POLIOMYELITIS[1]

RACKER and Kabat[2] demonstrated that anaerobic breakdown of glucose is significantly decreased in mouse brain infected with poliomyelitis virus, while oxidation of glucose by the infected tissue is apparently unimpaired. Brodie and Wortis[3] reported some determinations of the lactic acid content of brain and spinal cord in poliomyelitic monkeys. Their data indicate a decrease in lactic acid content of the brains infected with poliomyelitis as compared to normal monkey brains, although there were too few determinations to be conclusive. It therefore appeared of interest to determine the lactic acid content of the brain in mice infected with poliomyelitis.

Swiss albino mice four to six weeks of age were inoculated intracerebrally with a 10 per cent. suspension of tissue of the central nervous system from mice infected with the Lansing strain of poliomyelitis virus. When the animals showed definite paralysis, they were sacrificed by sudden immersion in a mixture of solid CO_2 and ether and left in the mixture for at least ten minutes. The brains were removed carefully using chilled instruments; the tissue was crushed and finely ground in a chilled mortar or tissue crusher and added to cold trichloroacetic acid in a tared glass-stoppered flask. The flask was reweighed and placed in an ice bath. After fifteen minutes, the solution was filtered. Lactic acid of the filtrate was determined by the Miller-Muntz method using the photoelectric colorimeter.[4] Lactic acid content of the normal mouse brain was determined by the same procedure. Three brains were pooled for each determination, giving a total wet weight of brain tissue of approximately one gram.

Data on lactic acid content of the brain in normal mice and in mice infected with the viruses of poliomyelitis and encephalitis are presented in Table I. The lactic acid content of the normal mouse brain is similar to the results reported by Stone,[5] who obtained a mean value of 18.9 mg per cent. and a range of 12–25 mg per cent. after freezing in liquid air. It is apparent that brain lactic acid is decreased in poliomyelitis, since the mean value is only 16.0 mg per cent. as compared to 20.7 mg per cent. for the normal controls, a decrease of 22.7 per cent. By use of the "t distribution,"[6] this difference has been found to be

[1] Aided by a grant from the National Foundation for Infantile Paralysis. Dr. Kabat is at present with the Division of Chemotherapy, National Institute of Health, Bethesda, Md.
[2] E. Racker and H. Kabat, *Jour. Exp. Med.*, 76: 579, 1942.
[3] M. Brodie and S. B. Wortis, *Arch. Neurol. and Psychiat.*, 32: 1159, 1934.
[4] R. H. Koenemann, *Jour. Biol. Chem.*, 135: 105, 1940.
[5] W. E. Stone, *Biochem. Jour.*, 32: 1908, 1938.