of the nucleic acid greatly enhances the power of the protein to stimulate antibody production.

Although the two proteins are found in our preparations, we have been unable to convert the nucleoprotein into native protein plus nucleic acid. In every case where nucleic acid is liberated, the protein is denatured. It is of interest to note here that the protein is denatured in the cold at *p*H 7 in solutions containing more than 30 per cent alcohol by volume, and the nucleic acid is left in solution. When prepared in this way, the nucleic acid solutions evidently contain large thread-like molecules, and if the concentration is as much as a few milligrams per millilitre they set into jellies. In this way the nucleic acid resembles that of tobacco mosaic virus[8]; but the method of isolation is even less drastic and is, in fact, the mildest method for the isolation of a pentose nucleic acid which we know.

Insect Relationships of the Virus

The method of transmission of this virus in the field differs from that of all other known plant viruses, the insect vector being a flea beetle (*Phyllotreta* spp.) with biting mouth parts instead of the usual sap-sucking type of insect, such as aphides or leaf-hoppers. This is also the first time a crystallizable plant virus has been shown to have an insect vector. The relationship between the virus and the insect which transmits it has not yet been completely worked out, but certain interesting facts have been elucidated. Whereas in Nature the transmitting insects are one or more species of flea beetle which feed on the turnip plant, under experimental conditions several entirely different types of insect will transmit the virus. These include three or four species of beetles, including *Phædon cochleariæ*, the mustard beetle and its larva, the common earwig and two species of grasshoppers. These insects have, however, one characteristic in common, namely, they all have biting mouth parts. A large number of transmission experiments, mostly with the larva of the mustard beetle, including some using artificial feeding methods, have been carried out. For the artificial feeding the larvæ were desiccated slightly by starving them for twenty-four hours. They were then allowed to feed upon drops of purified virus solution to which had been added a little sucrose.

These experiments have shown that, as a rule, an insect does not become infective after feeding on a source of virus until after the lapse of a period of 24–48 hours. On the other hand, there are exceptions to this, in which the processes of feeding on the source of virus and infecting the healthy plant can be carried out in a total period of ten to fifteen minutes.

For these two types of virus transmission, we suggest the following explanation. The rapid type of infection can be explained on the assumption that the mouth parts are contaminated with virus which is thus passively transferred to the healthy plant. Some other explanation, however, is necessary for the delay of 24–48 hours before infection and the subsequent retention of infective power by the insect for one or two days more. It seems to be a fact that most beetles and their larvæ do not possess salivary glands, and digestion of plant tissue is aided during mastication by regurgitation of some of the contents of the foregut. During this process some of the virus previously ingested would be brought into contact with the healthy tissue and thus cause infection of the plant. This would explain both the delay in the development of infective power and the retention of the ability to infect. Some support for this hypothesis is given by the fact that in most of the transmitting insects, besides the beetles, the salivary glands appear to be missing or rudimentary.

Detailed accounts of this and other work on this virus will be published elsewhere.

Our thanks are due to Mr. R. Cecil and Dr. A. G. Ogston for their co-operation in this work.

Summary

(1) Some of the unusual properties of turnip yellow mosaic virus are described.

(2) This virus is transmitted by biting insects only, and there appears to be a correlation between the ability of an insect to transmit the virus and the absence of salivary glands which necessitates regurgitation of the contents of the foregut. Artificial feeding methods have been successful.

(3) Two proteins have been isolated from plants infected with this disease and both have been crystallized. One is a nucleoprotein containing 28 per cent of pentose nucleic acid, and the other appears to be the same protein without the nucleic acid.

(4) The nucleic acid may be obtained from the virus by a method milder than any so far employed for the isolation of a pentose nucleic acid. The nucleic acid is a very large molecule, probably rod-shaped.

(5) It is not possible to differentiate between the two proteins by means of serological precipitation, but, when injected into rabbits, the nucleoprotein is many times as antigenic as the protein.

(6) Only the nucleoprotein is infectious to plants, and the presence of combined nucleic acid would appear to be necessary for virus multiplication.

(7) Both proteins are the same size and shape and have identical electrophoretic mobilities.

(8) This is the first time that a virus protein has been obtained in a native condition, free from nucleic acid.

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CHEMICAL RESEARCH LABORATORY, TEDDINGTON

THE Chemical Research Laboratory of the Department of Scientific and Industrial Research has again held a very successful series of 'open days'. On June 29 the Laboratory was visited by the Lord President of the Council, Mr. Herbert Morrison, who was received by Sir Edward Appleton, secretary of the Department, Dr. R. P. Linstead, director of the Laboratory, and Sir Norman Haworth, chairman of the Chemistry Research Board. During the remainder of the week there were nearly a thousand visitors, including chemists from industry, university laboratories, technical colleges, research and trade associations and Government establishments. These visits serve to keep the chemical community aware of the work of the Laboratory, and enable problems of

common interest to be discussed. They supplement the published reports of the Laboratory and its Advisory Board. It may be noted that the reports for the years 1938–46 have recently appeared*.

The exhibits on view in the Laboratory covered the whole range of its activities, which include organic chemistry; inorganic chemistry, including radiochemistry; corrosion of metals, including microbiological corrosion, and high polymers and plastics. The semi-scale laboratories and engineering workshops were also open to inspection.

The research work of the Corrosion Section attracted a large number of visitors. The main equipment of the Section, namely, the high- and low-speed rotor assemblies and the moving-belt apparatus for achieving accelerated corrosion, were on show. In the field of atmospheric corrosion, attention was particularly directed to a new 'condensation' type of test whereby comparisons can be made of protective methods; also to studies of special alloy steels. Electrochemical studies of immersed corrosion were on view, and recent advances in the technique of stripping natural protective films were demonstrated. Interesting discoveries have recently been made at the Laboratory on organic corrosion inhibitors. The inclusion of these in cooling liquids for internal combustion engines and wrapping materials was demonstrated. A particularly interesting exhibit showed the incorporation of an organic inhibitor into rubber latex.

The Microbiology Section illustrated the problem set by the external corrosion of iron pipes in clay soils. This is especially serious to-day because of the extensive post-war programme for laying rural water mains and gas and water systems for new housing estates. The virulent type of corrosion which occurs in clay is due primarily to the activity of anaerobic sulphate-reducing bacteria. Recent work at Teddington suggests that these bacteria may also be responsible for much of the internal corrosion experienced with soft moorland waters. The exhibits illustrated the fundamental properties of the bacteria, which are facultative autotrophs. Their remarkable morphological changes were shown by electron micrographs. Laboratory and field work on protective measures were also demonstrated.

Research in organic chemistry at the Laboratory covers a wide field, and investigations in coal tar have been in progress for more than twenty years. This work is now being concentrated in three directions. One group is concerned with the isolation and identification of the individual constituents of various coal tar fractions. For this purpose extensive use is made of high-efficiency fractional distillation. A notable exhibit comprised a battery of packed distillation columns all operating at pre-selected constant pressures and capable of a very high standard of performance. A second team is concerned with the collection of fundamental reference data for pure compounds.

Chemical processes and the design of chemical plant depend to-day to an ever-increasing extent on the availability of reliable physico-chemical data. These are very scanty in the field of coal tar constituents, and this part of the Laboratory's programme aims at filling the gap. Research in this field was illustrated for pyridine of 99·9 per cent purity. The composite all-glass apparatus used for the manipulation and transference of pure compounds under vacuum and for the measurement of boiling point, freezing point, vapour pressure, etc., was on view. This equipment incorporates an automatic barostat which will maintain pressures constant to at least 0·025 mm. mercury. Other apparatus displayed included an automatic recorder for freezing point determination and an ebulliometer, both of which employ a thermistor for the detection of small temperature changes. In this way differences of temperature of 0·001° C. can readily be recorded, and the equipment can be applied to the measurement of chemical purity. One exhibit which excited special interest was a miniature platinum resistance thermometer capable of reading temperatures to 0·001° C. This has been constructed in collaboration with the Physics Division, National Physical Laboratory.

The objective of the third group is to develop new industrial outlets for neglected constituents of coal tar. This was illustrated by work on the dehydrogenation of acenaphthene and the conversion of the product, acenaphthylene, into polymers of interest to the plastics industry. Among the exhibits by this group was a reference collection of more than a hundred pure coal tar compounds.

The Laboratory is now preparing to synthesize organic intermediates on a small scale in order to assist in the application of isotopic tracers to chemical, medical and biological problems. Work is in hand on both heavy and radioactive carbon; this involves the synthesis of useful compounds from simple carbon sources such as barium carbonate or potassium cyanide in which a proportion of the carbon consists of C^{13} or C^{14}. Syntheses with the radioactive isotope C^{14} have been undertaken in collaboration with the Radiochemical Centre, Amersham, members of the staff of which are at present working at Teddington. The elaborate apparatus required for these studies was on view; it demonstrated the value of the Laboratory's skilled glass-blowing service.

Other exhibits in the organic chemical field illustrated the part played by the Laboratory in the early development of the new synthetic fibre 'Terylene' (polyethylene terephthalate). The work of the Laboratory in the preparation and purification of methyl-silicon intermediates was illustrated and samples of a heat-resistant material were on show. The ability of methyl chlorosilanes to render glass and cellulose water-repellent were strikingly demonstrated.

Inorganic chemistry has of late been a comparatively neglected branch of the science; but many recent technological developments, including the discovery of atomic energy, have helped to revive interest greatly. This revival was illustrated at the Laboratory by a number of exhibits, prominent among which was one on recent work on the analytical chemistry of uranium and thorium. Examples of the increased interest in very pure and less common metals were provided by exhibits of recent work on pure vanadium, gallium and germanium.

Great interest was shown by visitors in the Laboratory's work on high polymers and plastics. Recent research on ion-exchange resins, originally discovered at Teddington in 1935, was illustrated. An attractive exhibit showed the preparation of sulphonated cross-linked polystyrene in bead form. Work on the problem of swelling of polymers, and on the mechanical properties of reinforced plastics, was also on view; and the very successful recent development of synthetic adhesives at the Laboratory was illustrated.

* Chemistry Research, 1938 to 1946. (London: H.M. Stationery Office.)

Special attention is given at the Laboratory to the development of physical and other special techniques of general usefulness. This was illustrated by demonstrations of spectrographic equipment, including a double-beam infra-red spectrograph, radiometric methods, microanalysis, chromatography, polarography and other modern techniques.

IMMUNITY TO VIRUS DISEASES

ON July 1 at Cambridge, during the course of the scientific meeting of the British Medical Association, the Section of Pathology discussed "The Prophylaxis of Virus Infections with Special Reference to the Use of Vaccines".

For some human virus infections, such as rubella and infectious jaundice, there is not yet available a susceptible laboratory animal—or even a susceptible egg!—and vaccines are thus at present unattainable. For others, such as (within limitations) influenza, inactivated vaccines are available; these are safe, but do not give enduring immunity. For others, such as smallpox and yellow-fever, living attenuated viruses are available, and these give rise to immunity of longer duration. Dr. C. H. Andrewes, who opened the discussion, held up the 17*D* strain of yellow-fever as an example of an ideal vaccinating agent, a standard to which we should like all vaccines to attain. It gives but trifling reactions, and immunity is long-lasting after a single dose. Later in the discussion, however, Dr. G. W. M. Findlay pointed out one flaw in its perfections—a difficulty in preserving its potency without rigorous attention to technique.

Dr. Andrewes devoted chief attention to the complications introduced by the existence of serological races of some viruses, particularly influenza and poliomyelitis. Within the two distinct groups of influenza viruses, *A* and *B*, there exist serological races, sufficiently divergent to be of importance from the points of view of epidemiology and vaccine-prophylaxis. Very potent vaccines can be made from embryonic fluids of infected fertile eggs, inactivated with formalin. In 1943 such vaccines effected four-fold reduction in the incidence of influenza *A* in trials in a number of centres in America; in 1945–46 they had done even better in a *B* outbreak, apparently decreasing incidence ten- to twenty-fold. In 1947 they were quite, or almost, useless against the prevailing influenza *A* both in America and in Britain. This failure was almost certainly due to an antigenic divergence of the current *A* strain from those incorporated in the vaccine. More work on the potentialities of the influenza viruses for antigenic variation is necessary, before one can advocate general use of vaccines. In particular, there is ignorance as to whether there are limited numbers of defined types or whether the viruses are antigenically labile; also as to whether 'new' races spread about from country to country. To study this latter aspect, the World Health Organisation has lately set up a World Influenza Centre in London with the function of collecting, distributing and studying strains from all over the world.

Dr. Andrewes briefly discussed the possible application of the 'interference phenomenon' in control of virus infections and mentioned experiments in ferrets by Dr. Gledhill and himself; in these an innocuous influenza *B* strain had suppressed the symptoms of infection by an active *A* strain given within the next two or three days.

Prof. R. Hare, who followed, took a very pessimistic view of the prospects of successful vaccination, particularly against influenza. He emphasized past failures, particularly of vaccine trials in 1947, even going so far as to wonder whether killed viruses would ever be of value in immunizing man. Various methods of improving their activity have been reported—the use of the intradermal route, adsorption on to calcium phosphate and other substances, and mixture with oil. The amount of virus in vaccines has been increased by various concentrating procedures. Yet no consistent success can be reported. Antigenic variation among the viruses further confuses the issue. Prof. Hare felt that, if this is all vaccines made in eggs can do, he would rather have the eggs to eat. Despite his gloom, he did not dispel the thought that if the vagaries of antigenic variation of influenza virus could be understood, the prospects might be a good deal brighter.

Prof. W. I. B. Beveridge, the recently appointed professor of animal pathology at Cambridge, thought that much depends on how effective is the contact between an attacking virus and antibody. Against general infections such as the exanthemata and most insect-borne virus diseases, such contact is good and prompt; immunity is enduring and the possibility of vaccination good. Viruses like the common cold and influenza, which probably never reach the blood-stream, make poorer contacts and the prospects are, therefore, less favourable. He believes that allergy plays an important part in mobilizing the body's defences quickly, and he discussed methods of procuring such a favourable allergic state. Attenuation of viruses to make an effective, safe vaccine is a noble ideal, but is a process difficult to control. There may, as in rinderpest, be a rapid transit from a state of insufficient attenuation to one in which immunizing power also is lost. A degree of attenuation just right for some breeds of cattle may be too drastic or not drastic enough where other breeds are concerned. He thinks that, as regards living viruses, recall or 'booster' doses of vaccine may achieve no immunity-boost unless and until the recipient's immunity has fallen to quite a low level.

Dr. Stoker discussed reasons for failures of immunization against smallpox, such as neglect of many people to be revaccinated after infancy. He particularly stressed that the so-called immune response was an index of sensitivity, not immunity, and should be regarded as equivalent to failure to 'take'. Only with vesiculation accompanying a take of primary or accelerated type does immunity rise satisfactorily. Vaccinia preparations contain an agglutinin for certain red blood cells, and antibodies to this hæm-agglutinin develop in immune people. Increase in such anti-hæmagglutinin titres of serum may be a useful guide to what is happening after revaccination. Vaccinia grown in fertile eggs should be given more trials. It is perhaps less stable than calf lymph, but on the other hand could be produced much more rapidly in an emergency. Dr. Stoker also referred briefly to Kaposi's varicelliform eruption, some cases of which he thinks are due to generalized vaccinia in eczematous contacts of vaccinated people. Some of Dr. Stoker's remarks might have afforded useful propaganda for an anti-vaccinationist, had he not begun with the warning that they applied only to failures of vaccination in individuals: its value in inducing herd-immunity was not in doubt.