France, carried out daily analyses on the supply of the city in which he was stationed. These analyses were continued for a period of a little over three months. At the same time similar work on the same supply was being done by a French military laboratory and a French civil laboratory. There was close agreement in the interpretation of the results of the analyses.

Unfortunately the writer's work in England was such that a similar check of results could not be carried out there, for his work was largely confined to single inspections and single sets of samples. In most cases there was no special discrepancy between his interpretations and those of the British analysts entrusted with the examination of the supplies investigated, judging from conversation with the analysts themselves, or from their reports, when these were shown to him. It would be interesting to see the results of an examination carried out by English and American analysts, each using the methods to which he was accustomed and both working upon a supply of variable character. Perhaps the work of Race, at Ottawa, or of Howard, at Toronto, might provide a near approach to this comparative work. The writer feels certain that there would not be any such wide variation of practice as has been indicated in the review. He is sure that "if the raw water contained, say, *B. coli* in 0.001 c.c. and in the final effluent this was reduced to a positive result with 1 c.c." American water-supply workers would not by any means be satisfied with the safety of the water.

¹ D. B. Hyles, Review of "Water Purification Plants and Their Operation," by Milton F. Stein, J.S.C.I., Vol. XL., No. 8, p. 159 (April 30, 1921).

² Final Report of the International Joint Commission on the Pollution of Boundary Waters, Washington, 1918, p. 14.

³ United States Public Health Reports, Vol. 20, No. 45, p. 2959 (November 6, 1914).

⁴ Amendment No. 8 to U.S. Interstate Quarantine Regulations, July 14, 1919.

⁵ J. F. Norton, "A Comparison of the Methods for the Examination of Water at Filtration Plants," Journal of Infectious Diseases, Vol. 23, p. 344 (1918).

⁶ L. B. Morse and A. Wolman, "Practicability of Adopting Standards of Quality for Water Supplies," Journal of the American Water Works Association, Vol. 5, p. 195 (1918).

⁷ Jack J. Hinman, Jr., American Water Works Laboratories, Journal of the American Water Works Association, Vol. 5, p. 133 (1918).

⁸ Jack J. Hinman, Jr., Standards of Quality of Water, Journal of the American Water Works Association, Vol. 7, p. 821 (1920).

⁹ Standard Methods for the Examination of Water and Sewage, American Public Health Association, 4th Edition, Boston, 1920.

¹⁰ Bartow and Legendre, La Chloration, Masson et Cie., Paris, 1918.

THE DESTRUCTION OF RATS BY CHEMICAL MEANS.*

C. L. CLAREMONT.

Only recently has the problem of rat destruction been seriously considered in Great Britain. Its importance cannot be gainsaid. The material damage caused by rats in this country was estimated to be £2,000,000 in 1909, and in India the total losses, including those due to plague, were evaluated at £828,000,000 over a period of twenty years. A rat population of 10 million pairs would number over 41 million pairs at the end of twelve months, allowing for death and other wastage, and the cost of maintenance, at 1d. per day per rat, would be over £9,000,000 per annum. Further, the rat is a notorious carrier

of disease; through the parasites which it harbours it gives rise to plague, trichinosis, rat-bite fever, and spirochaetal jaundice, and the dissemination of other diseases has also been attributed to it.

For some years the Vermin Repression Society carried on vigorous propaganda, but it was not until war conditions rendered the problem even more pressing that the Government took action, which resulted in the formation of a Rats Branch of the Board of Agriculture and Fisheries and the passing of the Rat and Mouse Destruction Act of 1919. In the following year a research laboratory was established together with a small factory for supplying raticides for use on Government premises. The work of the laboratory, which has only recently been started, has been the chemical examination of proprietary and other rat poisons, and the investigation of materials believed to contain such poisons, experiments on live rats being undertaken when necessary.

Of the methods in use for destroying rats, hunting and trapping are obviously of limited application. The virus method, i.e., infecting with disease, is uncertain; the susceptibility of rats varies, sub-lethal doses tend to immunise them, and the virus, by its passage through the rat, may become more virulent and therefore more dangerous to human beings. Poisoning is undoubtedly the best method, and "gassing" is one of the most effective, for it kills the females and their young in the nests. Hydrocyanic acid and carbon bisulphide are very deadly, but as the former is colourless, its use is dangerous even to skilled operators, and the latter is very inflammable. Chlorine and phosgene are somewhat dangerous for general use, and have to be stored compressed in cylinders, which are difficult to transport. Sulphur dioxide is best; it is easily handled as liquid, can be prepared on the spot by burning sulphur, and is not too dangerous, as its odour will warn the operator when the concentration is becoming too high. A mixture of sulphur dioxide and sulphur trioxide is stated to be more toxic and to kill not only the rat, but also its parasites.

Of the solid poisons, phosphorus, arsenic, and strychnine must be ruled out as too dangerous. The *desiderata* of a good rat poison are:—Relative harmlessness to domesticated animals; cheapness and availability; effectiveness; absence of a repellent taste; it must be easy and clean to handle and readily incorporated in the bait; and it should be stable. There are not many poisons which satisfy all these conditions, but those which most nearly do so are barium carbonate and Red Squill (*Scilla maritima*). Barium carbonate is rather more toxic to other animals than is desirable, and the disadvantages of Squill are that the bulbs irritate the hands (thick leather gloves should be used), the preparations do not keep well (a defect which will probably soon be overcome), and the supply in this country has been irregular. Although the lethal doses of barium carbonate for many domesticated animals are known, the information concerning Squill is very scanty, but, assuming the figures given by Abderhalden to be correct, it is probable that 10.66 grains would kill a rat weighing 0.5 lb., and 77 grains of the bulb would kill a dog of 10 lb.

Successful poisoning naturally depends upon the nature and size of the bait employed. Experiments have shown that baits should weigh from 30 to 60 grains and contain the following percentages of toxic agent:—Barium carbonate, 25 per cent., or 7½ grains in 30 gr. of bait; Squill bulb, 20 per cent., or 10 gr. in 50 gr. of bait; Squill powder, 20 per cent., or 5 gr. in 25 gr. of bait; arsenic, 5 per cent., or 1 gr. in 20 gr. of bait.

The bait should be ready for use and easy to handle, operations such as spreading on bread, etc. being undesirable. It should be capable of being

* Based on a paper entitled "National Research on Rat Destruction," read before the Royal Sanitary Institute, at Folkestone, on June 24, 1921.

applied without excessive handling and in such a form that the amount required can easily be ascertained. Also, the bait should be attractive and freshly prepared; and each toxic agent should be used in a variety of baits, so that if one kind is not eaten another can be employed. The best general vehicle is a mixture of oatmeal and fat in the form of a hard paste, variety being obtained by the use of fish or cheese; or the poison can be mixed with flour and made into small biscuits with various additions. For mice, coarse powders similar to the paste for rats but with much less fat are recommended; three kinds are made, viz., plain, cheese, and fish. Squill preparations are prepared in a similar way, either chopped bulb or powder being used; biscuits and cake with cheese are the most useful forms. Only one Squill paste is made, but being uncooked it is only suitable for immediate use. Squill is also prepared in the form of liquid extract. Baits containing no fish or cheese, and therefore without odour, should be slightly flavoured with aniseed.

SOCIETY OF CHEMICAL INDUSTRY.

Messrs. E. F. Armstrong, J. Allan, J. W. Hinchley, and W. J. U. Woolcock have been elected members of the Council at the annual meeting held in Montreal.

PERSONALIA.

The McGill University, Montreal, has conferred the degree of Doctor of Laws on Sir William Pope.

Prof. C. S. Sherrington, president of the Royal Society, has been elected president of the British Association for the year 1922-23 (Hull Meeting).

Dr. H. Leo Ward, formerly of the National Chemical Co., has been appointed assistant professor of chemistry at Washington University, St. Louis.

Mr. B. A. Keen, head of the Soil Physics Department at Rothamsted, has been awarded a travelling fellowship by the Ministry of Agriculture and has left for the United States.

The Secretary of State for the Colonies has appointed Sir C. H. Bedford to be his honorary adviser on questions relating to power and industrial alcohol in the Colonies and Protectorates.

Prof. R. A. Millikan, of the University of Chicago, has been appointed director of the new Norman Bridge Laboratory of Physics at the California Institute of Technology and chairman of the executive council of the Institute.

Mr. W. G. Campbell, assistant chief of the United States Bureau of Chemistry, has been appointed acting chief in place of Dr. Alsberg, now director of the Food Research Institute at Stanford University, California, and Dr. W. W. Skinner has become assistant chief.

On the occasion of the Edinburgh meeting of the British Association for the Advancement of Science the Senate of Edinburgh University has conferred the honorary degree of Doctor of Laws upon Sir E. Thorpe, Sir O. Lodge, Dr. Irving Langmuir, of New York, and Prof. Arrhenius, of Stockholm.

Prof. F. Dupré, professor of chemistry at the Royal Technical Institute at Pesaro, died on July 20.

Mr. L. A. Fischer, physicist and chief chemist of the Division of Weights and Measures of the United States Bureau of Standards, died on July 25 at the age of 57.

NEWS AND NOTES.

UNITED STATES.

Research on Lignite.—An arrangement has been made between the Bureau of Mines of the United States and the corresponding institution of Canada for the exchange of information relating to research on lignite, and it is hoped that in the future such research will be carried out conjointly. In this way much duplication of effort and expense could be avoided.

Research Chemicals.—A course in the manufacture of organic chemicals is being given during the summer by the chemistry department of the University of Wisconsin in order to reduce the cost of research chemicals needed in the scientific departments of the University. Eight advanced students have been admitted to the course and will be paid 40 cents an hour for their work which, whilst providing for the needs of the University, will give them an intensive training in practical organic chemistry and experience in larger-scale operations.

Manufacture of Anthraquinone.—One of the drawbacks to the production of vat dyes, of which 1786 long tons is consumed annually in the United States, has been the high cost of making anthraquinone by the oxidation of anthracene with dichromate in acetic acid solution; to which may be added the lack of demand for the hard pitch which remains after the anthracene has been extracted from the tar. These difficulties, it is believed, will be overcome by the Thatcher process, which is electrochemical and involves the use of a special type of cell, and by means of which the daily production of 1000 lb. of anthraquinone has now been started.

Fuller's Earth in 1919.—The activity recorded in the fuller's-earth industry in the United States during 1918 (*cf.* J., 1919, 456 n) continued throughout 1919, following the upward trend of petroleum production. Alabama, Florida and Texas were the chief producing States, and the total output was 106,145 short tons valued at \$1,998,829, an increase of 26 per cent. in quantity and nearly 75 per cent. in value. Prospects for increased output seem good, and many new developments may take place shortly, particularly on the Pacific Coast, where large deposits of excellent material have been found. The average selling price—\$18.83 per short ton—was the highest on record. Imports of fuller's earth, mainly prepared material, amounted to 13,873 tons, valued at \$189,711 (increase over 1918, 1266 t.), and exports to about 1400 tons.—(*U.S. Geol. Surv.*, Mar. 9, 1921.)

SOUTH AFRICA.

Rhodesia in 1920.—In his report for 1920, the Director of Agriculture of Rhodesia states that the oil factory at Salisbury is re-starting, and that it is proposed to extract oil from maize and to prepare cattle cake and meal from the by-products of the maize-milling industry. The whole of last year's cotton crop was dealt with by the new ginnery, bales of raw cotton were prepared for export and seed for oil extraction. Fibre, particularly Doecan hemp (*Hibiscus cannabinus*), is being sold to the Northern Rhodesia Fibre Co. and the Barberton Jute Co., and the manufacture of sacks, etc., has been started at Umtali. A new industry has been started by the Rhodesia Leather Co., Ltd., which has established a tannery and is preparing hides and skins both for local use and for export. Fertiliser production has been increased by the exploitation of the bat-guano deposits found in several localities in the Hartley, Lomagundi, and Victoria districts. The dairying industry is making great progress.