circuit in an operating condition. When the tone is withdrawn from the circuit, relays click in the same succession over the round trip to Philadelphia, and one by one the transmitters are automatically turned off. Philadelphia has the same control over the circuit as New York.

The new circuit is described by officials of the Radio Corporation of America as an example of the value of coordinated research and engineering in many special phases of radio. There being no precedent for building apparatus for commercial operation on three meters, the equipment developed is new. Antennas, because of their curious form, are characterized as "Christmas trees" and "turnstiles." Certain parts of the receivers look like small steam engines and the transmitters might be taken for hot-water boilers. These odd shapes result from the application of the principle of "resonant lines" to both transmitters and receivers. That principle, developed by the Radio Corporation of America for this use, eliminates crystal control and provides economical and efficient means of maintaining radio equipment in steady tune at extremely short wave-lengths.

The heart of the receiver is the "shoe button" or "acorn" tube, so-called because of its minute dimensions, and in the transmitters there are new power tubes specially designed for microwave service. These special tubes, along with the antenna, transmitter, receiver, facsimile and terminal control apparatus, were all developed in a group of Radio Corporation of America laboratories, each specializing in a separate phase of the work.

SPECIAL ARTICLES

THE SIZE OF ANTIBODIES

RECENT work has demonstrated that at least some of the antibodies in the blood of immunized animals are proteins or are intimately associated with proteins. Thus arises the question of the relation between these bodies and proteins found in the blood sera of normal animals. The ultracentrifugal analysis initiated by Svedberg[1] offers a way of investigating this problem. To make such an analysis a small quantity of solution is centrifuged at very high rotational speeds. In the intense gravitational fields thus produced big solute molecules will be thrown down just as are precipitates in an ordinary centrifuge. The rate at which the different molecular species are sedimenting can be recorded by photographing through the solution. This rate of sedimentation is commonly expressed as a sedimentation constant s. Though not directly a measure of weight, since it also depends on such factors as the molecular shape, s increases with the molecular weight.

Mutzenbecher[2] and later McFarlane,[3] both working in Svedberg's laboratory, have subjected many sera to this analysis. The normal sera of several kinds of animals show an albumen with a sedimentation constant $s = ca\ 4 \times 10^{-13}$ cm sec^{-1} $dynes^{-1}$, a principal globulin with $s = ca\ 7 \times 10^{-13}$ and small amounts of heavier globulins. Equilibrium studies have proved that this albumen has a molecular weight of ca 69,000 and that the globulin with $s = 7 \times 10^{-13}$ has a probable weight of ca 138,000.

We have applied the same method of analysis to several concentrated antibody preparations to see how the sedimentation constants of their proteins compare with those of normal sera. The apparatus used, which is a development of the air-driven turbine,[4] is described in a forthcoming number of the *Journal of Experimental Medicine*.

Among the most thoroughly studied antibodies are those in antipneumococcic horse serum. The work of Felton[5] and others has made possible commercial preparations containing these antibodies in concentrated form. We have made ultracentrifugal analyses of the ultra-violet absorbing material in such concentrates[6] of Types, I, II and VIII antibodies. Recent ultrafiltration experiments[7] on old but untreated Type I antipneumococcic horse serum have shown that its antibodies have a particle size between 54mμ and 140mμ. This means either that these antibodies have exceptionally large molecular weights or that as the serum aged they became or attached themselves to larger colloidal particles. All antibody concentrates have accordingly been examined to find out whether they contained appreciable quantities of such large molecules.

The chief component capable of absorbing light of wave-lengths λ2400–λ2700 in each Felton antibody preparation has a sedimentation constant of ca 15×10^{-13}. Besides the principal globulin with $s = 7 \times 10^{-13}$, normal horse serum[8] contains a small amount of another globulin with $s = ca\ 19 \times 10^{-13}$ and

[1] T. Svedberg, *Naturwiss.*, 22: 225, 1934, for bibliography.

[2] P. Mutzenbecher, *Biochem. Zeits.*, 235: 425, 1931; 266: 226, 250, 259, 1933.

[3] A. P. McFarlane, *Biochem. Jour.*, 29: 407, 660, 1175, 1209, 1935.

[4] J. W. Beams and E. G. Pickels, *Rev. Sci. Instruments*, 6: 299, 1935.

[5] L. D. Felton, SCIENCE, 79: 277, 1934; *Jour. Immunol.*, 27: 379, 1934; etc.

[6] All ultracentrifuged preparations have been manufactured by the Lederle Laboratories, Inc.

[7] W. J. Elford, P. Grabar and W. Fischer, *Biochem. Jour.*, 30: 92, 1936.

[8] P. Mutzenbecher, *op. cit.*

occasionally an intermediate globulin with $s = 9 \times 10^{-13}$. Whether the Felton globulin with $s = ca\ 15 \times 10^{-13}$ represents an alteration or an association product involving one of these normal globulins or is a totally new protein can not of course be told from the present experiments. No molecular species sedimenting faster, and thus having a larger weight than the Felton globulin, could be found in any preparation. These experiments demonstrate that the globulins present in Types I, II and VIII concentrates have approximately the same sedimentation constants. Some samples, however, contained antibodies against more than one type so that additional experiments with monovalent preparations are being carried out to ascertain whether small differences characteristic of type can be detected.

All the Felton antibody concentrates also contained a considerable quantity of ultra-violet absorbing material sedimenting more slowly than the lightest protein molecules in normal horse serum. This "uncentrifugable" material, which very possibly consists of split products introduced by the concentrating procedures accounts for about 30 per cent. of the total ultra-violet light absorption.

Normal horse serum treated by the Felton procedure gives only a very small globulin yield. This yield is, however, materially increased if the final precipitation is made after a slightly more alkaline pH adjustment. When ultracentrifuged, such normal globulin concentrate is found to contain two components, one with $s = 17 \times 10^{-13}$, the other with $s = 9 \times 10^{-13}$. It is quite possible that these are to be identified with the two heavier globulins found by Mutzenbecher.

We have also examined a purified antibody[9] obtained from a rabbit immunized against one of the azoproteins of Landsteiner and van der Scheer.[10] The sedimentation pattern of this material, which was supplied by Dr. K. Landsteiner, shows but one molecular species. Its sedimentation constant, 7×10^{-13}, does not differ from that of the lightest and principal globulin in normal sera.

CONCLUSION

The sedimentation constants from the ultracentrifugal analysis of several concentrated antibody preparations are of the same order of magnitude as those of the globulins of normal sera. If these antibodies are proteins or are associated with proteins and if concentration has proceeded till such proteins are a major constituent of these preparations, then it follows that antibody properties are not necessarily associated with exceptionally large molecular size. A more detailed account of these and related experiments will be published later.

J. BISCOE
FERD. HERČÍK
RALPH W. G. WYCKOFF

ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH
NEW YORK, N. Y.

[9] This antibody was made by a modification of the method described in K. Landsteiner and J. van der Scheer, *Jour. Exp. Med.*, 63: 325, 1936.

[10] See K. Landsteiner, "The Specificity of Serological Reactions" (Thomas, Springfield, 1936).

THE ORGANISMS OF CHROMOMYCOSIS OF NORTH AND SOUTH AMERICA[1]

THE organisms responsible for the disease known as chromomycosis (chromoblastomycosis) or dermatitis verrucosa are perhaps as confusing to the clinician and mycologist as the fungi producing the infectious condition known as blastomycosis. Heretofore, the exponents of the microbes of this malady have classed only two organisms as causative agents. One, *Phialophora verrucosa,* was described for the first time in the United States by Thaxter from a case of Medlar, and the other, the much disputed *Acrotheca Pedrosoi,* was described in South America (Brazil) perhaps for the first time by Pedroso in 1911.

The organism of North American chromomycosis has withstood any change in nomenclature, and since its first description in 1915 has been isolated from a second case in the United States in 1933 and reported by Wilson, Hulsey and Weidman from Texas. In the same year (1933), the same fungus was isolated from the disease in Montevideo, Uruguay, by MacKinnon. *Acrotheca Pedrosoi,* on the other hand, was first named *Hormodendrum Pedrosoi* by Brumpt in 1921. In the following year, Terra Torres, Fonseca and Leão found conidiophores suggestive of *Acrotheca* and changed the name. In 1929, Langeron in France studying the culture obtained by Brumpt from Brazil found on liquid media indications that suggested characteristics of *Trichosporium,* and the name was again changed to *T. Pedrosoi.* Since then, the three names have been used interchangeably for the same microbe, with *Acrotheca* perhaps dominating. Weidman in his publication suggested that perhaps these two organisms were different form genera of one and the same species, which in the light of present observations is quite possible.

Unfortunately, from a mycological, nomenclatorial point of view, a good comparative, cultural study of the fungi of North and South America had never been made. While in São Paulo, Brazil, the opportunity presented itself to make such a study, with Floriano de Almeida, of the organism of Thaxter and several from South America, including Brazil, Uruguay and Argentina. Several interesting facts arose as a result.

[1] A study made by the author while in Sao Paulo, Brazil, as a John Simon Guggenheim Memorial Foundation fellow.