the attempt should be made is a conclusion which forces itself on a student of science who lives and works in an industrial community. Most of all, at such a time of crisis as this, does the need of scientific thought impress itself on us. By widening the conception of science to include sociology, whatever form that incipient science may take, it should be possible to increase very greatly the influence of systematic observation and reasoning, which is what we mean by science, on human life.

From the point of view of the general influence of science the recent tendency to lay emphasis on the uncertainty of scientific prediction in atomic physics is unfortunate. The "principle of uncertainty" is really a confession of ignorance, and it is to be expected that as the theoretical treatment of problems in the structure of matter advances, means will be found of reconciling the difficulties now experienced. It would be unfortunate if an impression were to gain ground among the public that science has abandoned its claim to accurate prediction. The cases in which prediction fails, according to the principle just mentioned, are confined to a difficult section of physical science which has only recently come under discussion. It would be entirely premature, on the strength of such new conclusions, to abandon the principle of determinism which has hitherto served its purpose so well in the sciences.

The inspiration of modern science must come from the original investigators, seeking for nothing but a more profound understanding of the workings of nature, and provided with the facilities for observation and experiment. Linked with them in the most intimate contact that the organization of university and industrial laboratories can make possible, come the workers in applied science, connected closely on the other hand with the technologists, charged with carrying into practice the results of scientific research. It is neither necessary nor possible to draw sharp dividing lines between those classes, but they may be broadly distinguished. All may unite in doing honor to great discoverers, such as Faraday, for all alike may trace their activities back to the products of their genius.

SCHAUDINN

A BIOGRAPHICAL APPRECIATION[1]

By Professor JOHN H. STOKES, M.D.

SCHOOL OF MEDICINE, UNIVERSITY OF PENNSYLVANIA

WE are assembled to-night to memorialize a man, and an occasion. Let us begin with the man.

Fritz Schaudinn was born at Roeseningken, a village in East Prussia, on September 19, 1871. Thirty-five years later, on June 22, 1906, he died of septicemia and collapse at Hamburg. Into this short life-span he compressed activity and achievement that placed him in the ranks of genius.

Of his family and antecedents practically nothing appears in the accessible published sketches and eulogies. His gymnasium education was carried through at Insterburg and Gumbinnen. In 1890 he began his preparation for a career in philology, but by the fifth semester at the University of Berlin was definitely embarked on his life-work as a zoologist, and by his thesis for the doctorate in 1894 committed himself to parasitology, then the infant of the zoo-medical sciences. In July, 1894, from Bergen, Norway, and again in a trip to the Arctic in 1898, he gathered material, published subsequently with Roemer as junior, for a massive communication on the fauna of the region. In October, 1894, he had been appointed assistant in the Zoological Institute in Berlin, and in 1898 achieved his docentship. During this period appeared a number of papers on the reproductive processes in Protozoa, which broke new ground repeatedly and foreshadowed distinctive investigative powers. His contributions with Siedlecki on the Coccidia were especially valuable, and Schultz has rated the account of the complete life cycle of *Eumeria Schubergi,* which appeared in 1900, as an example of the ideal in research, in that it has been impossible since to add one single fact to the material discussed by Schaudinn. In 1899 his contacts with medical protozoology began, in the confirmation and amplification of Ross's observations on the malarial parasite. A mission for the German government, which kept him at Rovigno from 1901 to 1904 to study the pathogenic protozoa, led to his appointment as director of the new division of protozoology in the Imperial Public Health Service. At this time the insistent publicity given by Schulze to Siegel's supposed protozoal cause of syphilis, the *Cytorrhyctes luis,* led to a request made by Köhler, president of the Gesundheitsamt, that Lesser, the head of the Clinic of Dermatology and Syphilis at Berlin, cooperate in a joint clinical and parasitologic study of the prob-

[1] Read before the Section on Medical History of the College of Physicians of Philadelphia at a meeting to commemorate the discovery of the cause of syphilis, November 9, 1931.

lem. Schaudinn, who had already been in contact with Lesser and Hoffmann on the matter, was designated as the protozoologist, and Hoffmann was selected by Lesser as the syphilologist to pass upon and make histopathologic studies of the material submitted to Schaudinn for study. Neufeld and Gonder, Schaudinn's assistant, joined the investigation, the former to control the animal experimental phase. Schaudinn's pioneer work on spirilla, especially in the blood of birds, and his studies of the life cycles of *Halteridium* and *Leucocytozoon Ziemanni* made him the obvious leader of the group. Novy rates his acquaintance with extremely minute spiral organisms thus obtained as a principal factor in the extraordinary discovery which followed. In the *Halteridium* study, although directed at a miscue, Schaudinn had named and described the genus Spirochaetae, remarked on their extreme minuteness, expressed the belief that they might be filterable, and even went so far as to suggest that yellow fever might be caused by similar organisms.

In the late winter and early spring of 1905 the investigation got under way, with an admirable selection of material, limited to the most infective lesions. On March 3, Schaudinn, in the room devoted to the investigation in the women's clinic of the old Charité in Berlin, saw the *Spirochaeta pallida* in numbers in a fresh preparation made by Hoffmann from an eroded syphilitic vulvar papule, using a Zeiss apochromatic objective with ordinary illumination. He then demonstrated the specimen to E. Hoffmann and to Neufeld. Secretions from a pointed condyloma were found apparently in the same session or in one immediately following, to contain spirochetes likewise, but the morphologic differences between *Sp. refringens,* later so named by Schaudinn, and *Sp. pallida* seem never for a moment to have been in doubt in his mind, although the final demonstration of their disparateness required further study. The work carried through between this date and the preliminary note published by Schaudinn and Hoffmann, presented as a communication from the Kaiserliche Gesundheitsamt (April 10, 1905), included the demonstration of the organism both in the fresh and azureosin (Giemsa) stained specimens of fluid from both open and closed lesions and also from the pulp juices of the satellite lymph-nodes. In the film preparations Schaudinn had recognized but did not stress what he regarded as possible resting stages of the organism. This first communication closes with control studies of non-syphilitic conditions and lesions, and with citation of the observations of Berdal and Battialle on spirillar organisms in balanoposthitis circinata, of Csillag in the same condition, and of Rona on the occurrence of spirilla in genital lesions and in hospital gangrene and normal smegma. Metchnikoff, who with Roux had accomplished the first successful transfer of syphilis to the apes, was drawn into Schaudinn's studies by a letter dated May 2, 1905, and after a careful search succeeded in finding the organisms in the primary lesion of a *Macacus cynomolgus,* and subsequently in other apes, their identity being confirmed by Schaudinn. This was followed by Metchnikoff and Roux's announcement to the Paris Academy of Medicine on May 16. On May 17 Schaudinn and Hoffmann formally demonstrated their discovery to the Berlin Medical Society and the announcement to the medical public, with a fuller discussion of the differential morphology of the organisms concerned, together with Levaditi's confirmation from congenital syphilitic material, appeared in the *Berliner Klinische Wochenschrift.* The rapidity with which the discovery was taken up by the scientific world is illustrated by the collection recorded by Hoffmann, of 750 titles by the end of December, 1906.

In October, 1905, appeared Schaudinn's last publication, a masterly presentation of the spirochete problem in which he foreshadowed his interest in the life cycle and developmental studies which he was not to take up. The relation of the spirochetal organisms to trypanosomes and the possible life cycle transformations appear to have raised a controversy among protozoologists which the loss of Schaudinn's genius has left to a large extent unresolved.

On January 11, 1905, Schaudinn was called to the directorship of the Institute for Ship and Tropical Hygiene in Hamburg. This appointment was a welcome one, for it released him from the bureaucratic atmosphere and executive hack-work of the Gesundheitsamt, which threatened to subordinate his investigative capacity to minor ends, and assured him of unrestricted research opportunity. It carried with it a salary which would at once have lifted the burden of meager living which had rested on him and his family during his short working years. But the opportunity came too late. The perirectal infection which finally overcame him was already in progress. The journey to the International Medical Congress at Lisbon, undertaken in part in the hope of regaining health, had the opposite effect, and an emergency operation, followed by a period in the Eppendorf Hospital in Hamburg, terminated in a second operation, collapse and death. Three weeks after his death his third child, a younger son, was born.

Twenty-five years is not too short a time in which to begin to accumulate legend centering about a personality whose career has such unmistakable elements of the dramatic as this. It is perhaps a tribute to scientific detachment that the eulogies of Schaudinn

deal so largely with discussions of his scientific accomplishments, so little and in such general terms with the life history and make-up of the man, himself a biological phenomenon of no mean order. There appears to have been no family background of scholarly and intellectual achievement such as lies behind the Galtonian concepts of inherited ability. The single portrait that survives in the memorial literature, and a few scattered descriptive words, portray him as a physically massive but finely tooled personality, to which are applied the resonant and almost majestic German words, "gewaltigen, imposanten und kräftigen Gestalt." He evidently lived life in outflowing fashion, with robust humor, frankness at times almost too outspoken for his advantage among bureaucrats (witness a brush with Altdorf), and with an enthusiasm, a joyous and sparkling abandon mingled with his love of truth and work that earned the adjectives "schaumenden Lebenslust." His death shocked his friends into a silence in which they could scarcely grope for words to describe the qualities that endeared him to them. Yet he had the grace to make a few enemies. His extraordinary fairness and generosity, in the face of what might well have been and indeed was to others an incentive to small practice, appears in his full, meticulous recognition of his associates in the spirochete discovery. He was beloved of his pupils no doubt for this among other reasons. His closest friends were given a glimpse of the tenderness, the sensitiveness that lay behind this truly magnificent front. His family was the joy of his life, music his release, the piano his instrument to an unusual degree. Those phrases which so untranslatably express the best the German spirit sees in the personal life are freely applied to him—"Gemütigkeit, voll Anmut und Stimmung." He moved with directness upon the worthwhile objectives; bore no jealousies, was indifferent to the side-issues of form and manner that to so many obscure the substance of creative thought. It is easy to imagine, if this is the man, what genuine anguish must have seized those from whom he was taken on the eve of fulfilment.

But we are concerned, too, with the structure of his mind and body as an implement of research. Passing at thirty-five, he misses, perhaps, the reappraisals inevitable for those who live to later years, entering the shadow of the reflective, and vanishing in the mists of senility. He gathered no rust, was spared the weatherbeating of life. Hartman, and his other zoological associates, appreciate his extraordinary preparation for the culminating discovery of his life. He was not a product of lucky coincidences. His training conformed to the classic scientific pattern. Up to the final illness, his career shows that extraordinary kinetic drive which is a priceless gift in science. Though he died too soon to display to the full the orderliness and grasp of his mind, his indefatigable industry was reinforced by the ability to distinguish almost on the instant between the essential and the non-essential in a problem. He therefore moved with directness upon his objective, wasting neither time nor force on minor issues. The result was a succession of genuine bursts of discovery—a few hours, a few days sufficed to change the whole face of modern medicine, as in the *pallida* work. As one who has had some experience of the difficulties that have confronted post-Schaudinn syphilology, to me the astonishing thing is not alone the prepared mind but the astounding eyesight. Recall that in 1905 no satisfactory darkfield equipment existed. E. Hoffmann had used the Zeiss dark chamber in a search for the organism of syphilis in 1904, without success, and nothing of the sort we know to-day was available until Landsteiner and Mucha demonstrated the organism with the Reichert substage condenser in 1906 (Novy). Schaudinn, a trained microscopist, with a vision superacute through the study of minute organisms in his work on the parasitology of birds, at once saw, in the fresh preparation, what literally dozens of the ablest investigators of the day must have had pass uncomprehended before their eyes. It is a curious commentary on the claims of the great to super-greatness that Bordet and Gengou had, according to Metchnikoff, undoubtedly seen the spirillum of syphilis in a single drop preparation in 1903. They saw nothing in the second preparation, and, as so often happens, the glory passed from them and was gone. It is impossible to escape a thrill of predestination, a sense of the almost intolerably dramatic, in the moment when Schaudinn's mind crossed swords with the problem within the field of the microscopic objective. Something in the universe clicked. What might have been, had he been permitted to go forward to the problems of the life cycle and biologic defense, of symbiosis and pathogenetic mechanism—had he been spared to work with Ehrlich on the chemotherapy—only leaves us with a more tragic sense of loss.

While we yield first place, then, to the undoubted genius, we may draw a little practical guidance from his career. How shall we break the front of an embattled, a seemingly impregnable problem? First, there must be a *man* to whom work is divine, to whom it is meat and drink, rest and play—perhaps even sometimes, as in Schaudinn's fellow Spirochaetenforscher, Noguchi, almost home and love. Such men are few. There must be a fitness of the mind and body to the task. After the man there must come method. He must develop an instrument, a technique

with which he attacks his problems. This method will perhaps always contain some elements of the intuitive, the esoteric. But as rapidly as possible these should be reduced to the objective factual basis which alone makes possible scientific control. Into biologic research, dealing with mutable and changing material, plastic to influences often unconsciously exerted, there creeps an unusual element of personal equation, too often overlooked. It was said of Noguchi that for a long time an unconscious trick, probably due to his one-handedness, of carrying cultures between incubator and microscope in his vest pocket, of which he was never aware, prevented the confirmation by others of his results in cultivating the *Spirochaeta pallida*. I have seen abundant evidence that Warthin has left behind him many unsolved problems in the personal equation of spirochetal staining methods, which even his coworker Starry may have trouble in solving. Schaudinn was no desk-man, as his biographers say. His published notes and papers reach, however, a total of fifty. When he died a rich field lay buried in uncompleted publications and observations referred to only by a word here and there. Perhaps it is always so. But it illustrates what to me in these complex and crowded days is a desirable, perhaps an essential quality in an investigator. He keeps his table, and thereby his mind, mopped up. It is all very well to minimize publication, and to rate it for what it too often is, a cheap substitute for work. But the devices of honest publication are sufficiently varied now to permit, and in fact require, that the trained man *communicate* as he goes along, rather than to leave a mass of unintelligible and useless notes, or the second-hand impressions of a single assistant to carry on.

And lastly, the third essential to the investigator nowadays is persistent singleness of purpose. Occasionally genius may still perhaps scatter over the whole field of a science a series of germinal or epochal discoveries. Most of us would fare much better, however, and serve more effectively if, like Emil Fischer, we selected our field and perfected one or two tools with which in a lifetime to lay it clean and open, like the well-plowed furrow, to all mankind. Thus indeed, it needed in 1905 a zoologist, a parasitologist and a Spirochaetenforscher, rather than a bacteriologist and a medical man, to uncover what many had seen, unknowing.

In a reflective moment after this review of Schaudinn's life, a syphilologist may pause to look back over the directional influence of such a discovery and its fruits. A ready comparison or contrast is at hand in the discovery by Neisser of the gonococcus. The two discoveries opened similar roads. It is impossible to escape the belief that the concentration of intellectual forces upon syphilis, as contrasted with gonorrhea, arose to some extent from the intriguing Mephistophelian quality of the one, the sordidly venereal quality of the other. Neisser himself lived to advanced years, was throughout his life one of the foremost clinicians of Europe and an organizer of facilities that might well have embraced at least the machinery for the chemotherapeutic conquest of gonorrhea. Yet nothing has come of it. The discovery of the organism has at least achieved full use in diagnosis. Schaudinn was cut off, but by the identification of the organism among the Spirochaetes, he passed the torch, so to speak, to Ehrlich, who had been a student of the chemotherapy of trypanosomiases, near relatives of the spirochaetoses. Then flowered forth the whole modern structure of treatment, only for it to be discovered, after a decade or so, that it was, in a sense, a premature blooming. The original discovery of Schaudinn has never yet been carried to its logical outcome for practical medicine—the development of easily available, universally applied methods for the recognition of the organism by the everyday doctor or his laboratory deputy. Yet how essential such a simplified detection must be to the present-day problem of syphilis is daily reemphasized. And curiously enough, yet another epochal development in the syphilologic field has crossed the path of Schaudinn's discovery, to its deferred and even partially defeated usefulness. The Wassermann test, developed with the acclaim and support of the medical profession, overshadowed from the start the early recognition of the organism. To-day, to thousands of physicians, syphilis is summed up and described in terms of a positive Wassermann test on the blood. How few know it in that far more significant phase for the public health and the ultimate extinction of the infection—the seronegative, dark-field-positive syphilis of the first few days of the primary sore? Yet this is the truly significant syphilis of the future, the one moment that brings the modern chemotherapy to its full possibilities. The serologic tests, negative at this most significant moment, by their emphasis on diagnosis in the later stages, important rather for the individual at the moment than for the race in the ultimate, have delayed the perfection of Schaudinn's discovery to its fullest usefulness.

Nothing more clearly presents to my mind the enormous difficulties that beset biologic research and the devastating nature of a loss such as that of Schaudinn than the present status of the *Spirochaeta pallida* as a scientific asset. The efforts to develop a virulent organism in culture, the first step to biochemical advance by other than hit-or-miss methods in chemotherapeutic control, has apparently made

little headway, in spite of the genius of Noguchi. Twenty-five years after Schaudinn's announcement—a period longer than that which has sufficed to change the whole face of modern physics, for example—and his predictions as to the life cycle, so much needed both for clinical comprehension and treatment research lie almost where they were when he left them. In the recent announcements of Warthin, and of Levaditi, there is little more than Schaudinn foreshadowed in his first communications.

But is there nothing left us but a sense of loss? Before it is too late, perhaps a biographer may provide us with the material for a genuine personality study of the discoverer of the *Spirochaeta pallida*. Then we may know, perhaps, his inward motivations, his possible sense of destiny, if such existed, his foibles, his forebears, his inspired moments, the molders of his personality. I regret that I have not been able to lay such a study before you. But I can console myself, and perhaps, to some degree, you, too, by asking you to consider in the light of what I have told you, what are the critical essentials of a life. Was his death at thirty-five all tragedy? He escaped all need for debunking, not having lived into the middle period when accumulated responsibility and flagging energies might have demanded first a front and then a mask to conceal a slowly creeping inadequacy. There is something Grecian, Jovian, majestic, in the end. Just as there is much in his work and his discoveries that seems to spring, as Athene, full-blown from the forehead of Zeus, so he vanishes, as she did, in a thunder-clap from the summit of Olympus. But what are the critical essentials of a life, to be measured by deeds rather than by length of days? Surely they lie not in the time or manner of the ending but in the *living*. As I name them, you will know that Schaudinn lived them. They are, to use the utmost talent, to the utmost, for good.

SCIENTIFIC EVENTS

THE UNIVERSITY OF WISCONSIN RESEARCH PATENTS

PATENTS on eleven processes discovered by twelve members of the faculty of the University of Wisconsin are controlled in the public interest and at the same time protected from possible unrestrained exploitation by the Wisconsin Alumni Foundation at the university. The peoples of twelve nations in various parts of the world are protected by these patents, which are held at the University of Wisconsin. The nations in which they have either been taken out or applied for include the United States, Canada, Great Britain, France, Belgium, Germany, Argentina, Italy, Norway, Sweden, Denmark and Brazil.

The foundation is the only one of its kind in existence at any university or college, is an organization through which the results of research at the university are used for the public benefit through corporate channels. Established in 1925, its purposes according to its charter are:

> To promote, encourage and aid scientific investigations and research at the university and to assist in providing the means and machinery by which the scientific discoveries and inventions of the staff may be developed and patented and the public and commercial uses thereof determined; and by which such utilization may be made of such discoveries and inventions and patent rights as may tend to stimulate and promote and provide funds for further scientific investigation and research within said university.

The most recent scientific discovery, for which a patent has been applied for, is the new welding process invented recently by Professor Edward Bennett.

Other processes on which the foundation has patent rights and the names of those responsible for their discovery are: Antirachitic activation of medicinal and food products by ultra-violet irradiation, by Professor Harry Steenbock; improvements in process of producing lactic and acetic acids, by Professors E. B. Fred and W. H. Peterson; liquid air freezing of hard-shell seeds, by Mr. W. Busse; use of copper and iron salts in anemia, by Professor E. B. Hart; acetic acid and glucose fermentations of cellulose, by Mr. P. A. Tetrault; apparatus for measuring venous pressure, by Professor J. A. E. Eyster; leavening agent, by Mr. E. O. Wiig; mechanic's cleanser, by Professor Farrington Daniels; pituitary hormones, by Professor F. L. Hisaw, and marine paint, by Dr. L. C. Hurd.

THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION

THE great value of microscopic motion pictures to research workers in medicine and biology has been expressed by Dr. Heinz Rosenberger, of the Rockefeller Institute for Medical Research, and others, meeting at Yale University to organize the Biological Photographic Association, the first of its kind. The *New York Herald-Tribune* reports that the organization was started with thirty-five members, from the United States and Canada, with Dr. Ralph P. Creer, director of photography in the School of Medicine of Yale University, as its first president.

Speaking on "Micro-cinematography in the Research Laboratory," Dr. Rosenberger declared that to-day "all institutions of learning know the value of the motion picture, particularly the microscopic