SCIENCE

VOL. LXIX JUNE 28, 1929 No. 1800

CONTENTS

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal.

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

HIDEYO NOGUCHI

A BIOGRAPHICAL SKETCH[1]

HIDEYO NOGUCHI was born on November 24, 1876, in Inawashiro, Fukushima, a village in the mountains of northern Japan. His name during childhood was Seisaku which, as is the custom in his country, was changed to another when he reached manhood. The adoption of the name "Hideyo" gives us an insight into the way his budding mental powers impressed those about him, for of the two parts composing the word, "Hide" means superior or eminent, and "yo" means world. The prophecy carried by the name came to a remarkable realization as subsequent events showed.

Noguchi graduated from the local academy at Aizu in 1889, receiving during this period a preliminary introduction into medical practice. The circumstances of his early schooling are delightfully set forth in an account prepared by his teacher and foster-father, Mr. Sakae Kobayashi, which was used in connection with the memorial exercises held in Dr. Noguchi's honor in his native village.

According to this account, Noguchi belonged to a family which had become greatly impoverished. After the restoration of the Meiji, Mr. Kobayashi, a samurai of the Aizu clan, being learned in the Chinese classics, entered the teaching profession and became principal of the higher school (academy) at Inawashiro, with which were affiliated a number of more elementary schools of the neighboring villages.

The principal visited these lower schools, and on one occasion while examining the children at Sanjogata, his interest was aroused in an ill-clad pupil whose left hand was badly deformed. On inquiry it developed that at the age of two years the hand had been severely burned, and the primitive medical treatment had left the fingers, while not completely lost, yet grown together and almost useless. The physically backward child Seisaku gave his age as fourteen, and explained that, because of the poverty of his family, he would be obliged to leave school. On learning that, in spite of having entered the school a year or two later than the other pupils, his progress had been so rapid that he had surpassed them all, the principal had him transferred to his own school at Inawashiro.

[1] The substance of this sketch was adopted as a minute for the records of the Board of Scientific Directors of the Rockefeller Institute for Medical Research.

A day was fixed on which Seisaku was brought to Mr. Kobayashi's house by his mother. The child astonished the teacher by going at once to the altar of Buddha, found in many Japanese houses, kneeling before it and repeating a little prayer before saluting the principal. As is customary in the East, the mother brought with her a present which she tendered the teacher. It consisted of a few fresh-water shrimp, caught doubtless by herself in the adjacent lake.

Seisaku responded quickly to the new environment, making rapid progress in his studies and growing strong in body and daring in temperament. It is recorded that he would fight and even defeat other boys of his class with his single, uninjured arm. However, the deformity of his left hand constantly vexed him and he considered many ways of having it corrected.

Just at this time and while Noguchi's course after graduation was being considered, there came to the neighboring city of Wakamatsu, Dr. Kanae Watanabe, whom Noguchi consulted. Separation of the fingers was undertaken and successfully accomplished, and during the two weeks of residence in the doctor's household, while the treatment was being carried out, Noguchi decided to become a doctor. He continued with Dr. Watanabe, serving as errand boy and apprentice, and when the China-Japanese War broke out and the doctor, an ex-military surgeon, returned to the army, the young Noguchi was left in charge of the household affairs and medical practice.

With a strange forecast of the future, Noguchi immediately arranged with a middle-school teacher for lessons in German and with a French missionary for lessons in French, endeavoring at the same time to make a beginning in English by himself. Curiously enough, he progressed fastest in English, although in time he obtained a reading knowledge of all three languages. This gift for languages persisted, and later he added not only enough Italian and Spanish to enable him to read scientific papers, but during a year's residence in Copenhagen he mastered spoken as well as written Danish. On his several expeditions to South America where he studied yellow fever, he came to converse in Spanish with doctors and officials, which served greatly to extend his personal influence.

It was at this early period in his mental training that he disciplined himself to sleep and work at short intervals. This habit of mind and body, which played a large rôle in his scientific career, he never subsequently relinquished. He would lie on a mat beside his writing desk, and after a few hours of sleep, he would rise and resume study. His wife told me recently that his custom was to repose an hour or two after dinner in a large, comfortable chair and then read or write late into the night. The last days before leaving for Africa he was at the Rockefeller Institute almost unintermittently for forty-eight hours or more, and his letters from Africa were written at the end of long, arduous days and with the dawn stealing into the windows.

Noguchi's mental acumen seems not to have been perceptibly blunted by these excesses. I recall vividly an early morning visit to my home after a night's vigil. I was dressing when word was brought up that Noguchi was waiting. Fearing some catastrophe, I hurried down and found him eager and tense, but not disturbed or excited. He had spent the night in going through a lot of about two hundred slides of paretic brain specimens stained for spirochetes. In the early evening he had detected what he thought were spiral organisms. By going over and over all the slides he had put to one side seven in which he believed he had found spirochetae. However, as so many competent histologists had failed in the same quest, he became distrustful of his judgment and sought confirmation. He was induced to take breakfast, after which we went at once to his laboratory where the accuracy of his observations was immediately established. This discovery constitutes a landmark in the pathology of paresis.

In 1894, after the close of the China-Japanese War, Noguchi spent three years at the Tokyo Medical College, graduating in 1897. Probably the lack of means and want of a college degree barred him from the University Medical School. He at once passed the government examinations, became a licensed physician and surgeon, and entered upon an assistantship under Surgeon-General Satow, at the General Hospital, which he held for about eight months. This hospital issued a monthly medical periodical, the editorship of which was entrusted to Noguchi. The linguistic talents recorded above correspond to a literary facility which he retained throughout his life. He came to write his scientific papers in English with an amazing speed, and while they were never faultless, they required far less editorial correction than might have been expected. It was at this time that Noguchi became lecturer in general pathology and oral surgery at the Tokyo Dental College, and his lifelong friendship with Dr. Chiwaki began. This connection continued until he sailed for America, although in September, 1898, Noguchi became assistant to Professor Kitasato, at the Government Institute of Infectious Diseases, an institution based on the institute founded in Berlin for Robert Koch, who was Kitasato's teacher.

Bubonic plague having appeared in China, Noguchi was sent to New Chwang by the International Sanitary Board; he was made physician-in-chief to the Central Medical Bureau, which comprised both a

hospital and bacteriological laboratory. The plague having disappeared from this region, he was transferred to Manchuria under a Russian medical commission, where he remained until the Boxer outbreak, when he returned to the Institute of Infectious Diseases in Tokyo.

From 1899 until 1900 Noguchi published several text-books, including volumes on the methods of pathological and bacteriological study, general pathology and morphology of the teeth, and he translated from German into Japanese the first part of Hueppe's popular manual of hygiene.

I come now to the chance meeting which I had with Noguchi in Tokyo. In the spring of 1899, I was sent by the Johns Hopkins University as a member of a medical commission to the Philippines in order to study tropical diseases among American soldiers, and on this occasion I made a visit also to Japan. We requested permission from Professor Kitasato to visit his institute, and the invitation to do so was brought to the hotel by Noguchi. The latter having extended the courteous invitation, expressed a wish to go to the United States to study pathology and bacteriology.

It is only proper to state that no particular encouragement was given to this request. It is desirable to explain that the writer was not returning to the Johns Hopkins Medical School in the autumn, but was about to transfer to the University of Pennsylvania. To avoid embarrassment, Noguchi was asked to write him there. In due time a letter, composed in English which under the circumstances must be regarded as remarkable, arrived.

In the meantime, encouraged by a loan of 500 yen (about two hundred and fifty dollars) from Mr. Yashuhei Yako, Noguchi consulted Mr. Kobayashi about his desire to go to America. His teacher is reported to have said to him that "money borrowed is not like money earned. Once it is spent, another loan is asked for; hence he would do well to think twice before going abroad on borrowed money." The advice determined Noguchi to earn the necessary money. This accomplished, he went again to his teacher to ask him to look after his parents, brothers and sisters in his absence. Mr. Kobayashi's account of this incident represents Noguchi as saying, "If I wish to be filial and faithful to the Noguchi family, I feel in duty bound to remain in my country, and so must sacrifice my cherished hope. If I go to America, I must forsake my dear mother. What then am I to do?" Mr. Kobayashi, feeling that no ordinary obstacle should be permitted to prevent the fulfilment of so deep an aspiration, promised to look after the family, whereupon the two friends clasped hands and wept, and Noguchi said, "Allow me in the future to call you father," to which consent was given. Thereafter in his letters Noguchi always addressed Mr. Kobayashi as "father," and in 1915 on his only return to Japan he entered into a pledge of brotherhood with Mr. Kobayashi's sons and daughters. I have received a letter written a short time before Noguchi sailed for Africa, and its tone and contents show a deep affection for his foster-father and reveal that he was in the habit of keeping him informed of his scientific work. The progress of the studies on trachoma is related in this letter. [Mr. Kobayashi is said to have told Noguchi that his three main assets in life arose from his physical deformity, his poverty and his stubborn will.] Mr. Kobayashi wrote after Noguchi's death that he had made a great mark in the world by virtue of these valuable circumstances.

His life has been a long series of struggles, and when he died a dramatic death in West Africa in pursuit of knowledge, a great storm was raging. Providence did not give him peace even on the verge of death, for Seisaku, the child, had dreaded above everything—thunder.

Noguchi arrived in Philadelphia at the end of 1899 under circumstances not too auspicious. He presented himself at the dormitories of the University of Pennsylvania unexpectedly, and in accordance with Eastern custom bearing several gifts, which the writer still possesses and cherishes. It developed that the most immediately pressing question would be that of financial support. The small capital with which Noguchi started on his enterprising voyage had been all but exhausted by the expenses of the long journey. University funds for his support there were none; inquiry among Japanese officials brought only disappointment. Hence there was one thing only to do, namely, to start work and to wait for something to turn up. A theme in bacteriology was chosen and work begun in the cramped quarters allotted to pathology in the old medical building. Providence was, however, not unkind, and before long a patron was found.

A short time before Noguchi's arrival, Dr. Weir Mitchell, whose contributions to the nature and action of the venoms are famous, had conceived the notion of a further study along the lines of immunology which was then a fresh and advancing subject. He and the writer had discussed this undertaking and were awaiting a suitable opportunity to make a start.

The matter was now presented to Noguchi, who fell in with the idea, confessing of course that he knew nothing whatever of venoms and next to nothing of the methods of immunology. Dr. Mitchell provided funds, which at the outset just sufficed for the experiments and a modest sum for Noguchi's living.

It was a period of strenuous endeavor and simple living for him, but Noguchi's long struggle with adverse conditions in Japan made it one of no great hardship. The first lot of rattlesnakes, magnificent specimens, shipped from Florida, was killed by cold, but Dr. Mitchell soon secured others, and the study was not only begun but quickly began to yield illuminating results. It was not long before Dr. Mitchell interested the National Academy of Sciences, which made contributions from the Bache Fund to extend the scope of the investigation, and somewhat later he interested the Carnegie Institution of Washington, which made liberal grants. As each special topic of research was completed it was published in the University of Pennsylvania *Medical Bulletin* or elsewhere, and finally the results of the studies as a whole were brought together in a handsome volume, freely illustrated, brought out by the Carnegie Institution. Noguchi undertook the preparation of this volume in English, and it is a tribute to his talents as a linguist that in spite of the almost herculean task the editorial revision required was not great. This writing facility persisted and was perfected as the years went on. Noguchi came to produce English manuscripts not only as readily as a trained English writer but even more quickly than most writers, and he would write clearly under considerable pressure of work and time. His powers in this direction were distinctly unusual, since he wrote well and accurately at periods when his days were given to arduous laboratory work and his nights to little sleep. His last finished large work, namely, the remarkable monograph on trachoma, was produced under this kind of stress, while he was preparing for the African expedition.

There can be no doubt that Noguchi was highly gifted as an investigator nor that his true medium of research was the biological field. He was fortunate in entering it at a rewarding period of bacteriological and immunological advance. But it is probable that his peculiar talent in meeting obstacles and overcoming them by insight and technical skill would have brought him to the front at another period, and in another branch of biological investigation. Noguchi's exceptional powers arose from a threefold union of natural abilities: he was gifted with a clear, apprehensive mind; his technical skill was phenomenal; his industry was extraordinary. His perspicacious intellect enabled him to state a problem sharply; his resourcefulness in devising means to ends prevented him from being blocked by methodical obstacles; his inexhaustible industry and physical prowess, which often made virtually two days of one, immensely extended the range of his activities. If we add to this formidable list of qualities the fact that his mind was many tracked, in the sense that he would keep several major problems moving at the same time, we may begin to get an insight into the secrets which determined Noguchi's remarkable productivity, which tended to become speedier as the years advanced and experience became richer. To a visitor who happened into his laboratory late at night and inquired whether he ever went home he is said to have replied, "Home? Why this is my home."

The department of pathology of the University of Pennsylvania between 1900 and 1903 was carrying a heavy burden of routine, while the staff was young and small in size. Noguchi was excepted from these duties, not only because of the bar of language, but because his talents as an investigator were apparent to his colleagues, who admired him for his gifts and loved him for his ingratiating personal qualities. Very soon Noguchi was a marked man throughout the university, and even throughout the world. These captivating individual traits never diminished. Every one who came within their influence felt them and was impressed with a kind of noble simplicity and dignity of personality which scientific success, no matter how great, never impaired. Part of his outstanding position as a world figure arose from a kind of living charm of manner and conduct, raised of course to high power by his eminence as a scientific investigator.

The Rockefeller Institute for Medical Research in New York was opened in 1904. The year intervening beween the transition of Noguchi from the University of Pennsylvania to New York was spent by him in Copenhagen. The choice of place to study was determined by the recent publications of Madsen and Arrhenius on immunochemistry, in which it was sought to range immunological processes with physicochemical reactions. Noguchi already possessed an understanding of the opposing chemical view, as embraced in the side chain theory of Ehrlich. The incident led, however, to a misunderstanding not without diverting features. Ehrlich had praised the venom work, which fitted in well with his theory; hence he interpreted Noguchi's choice of Copenhagen as a criticism and defection. All this came out one day in Emil Fischer's laboratory in Berlin, where the writer was spending a semester. Ehrlich walked him up and down in the aisle between the long rows of work tables expostulating ever more excitedly. At the height of the exhortation, which had stopped all work going on in the room, Fischer entered from his private laboratory, having been attracted by the uproar. The two friends greeted each other warmly, and Ehrlich, realizing the commotion he had caused, laughed and said to Fischer, "Why do you not have me thrown out?" To which the latter replied, "Oh,

we are very tolerant here." Ehrlich accepted the explanation offered and nothing more came of the episode. Noguchi remained rather in the Ehrlich camp of immunologists, although he concerned himself little with the merely theoretical basis of immunity. With the opening of the Rockefeller Institute, Noguchi continued for a time his studies on the Wassermann reaction begun with Madsen, and devised a new method for its application in which an antihuman system is employed. Valuable as this contribution proved to be, its significance is small compared to the by-product it yielded, namely, the pure cultivation of the class of spirochetal micro-organisms.

This class of spiral organism had become clinically enhanced in importance through the discovery of the syphilis and yaws spirals. They, together with known spirals of other sorts inhabiting various organs, were recognized wholly through their microscopic characters. All efforts to secure them in pure, artificial cultivation had failed. Noguchi set himself to this task, which he accomplished in a brilliant manner. The entry into this field of bacteriological research was to prove his most important, as well as daring venture, because so many of his subsequent discoveries were reared on the mastery of the technical means of cultivation which he secured in working with the spirochetae.

In essence, the method was invented by Theobald Smith, and it consisted in employing a culture medium in which a fragment of a sterile, normal organ (rabbit kidney) had been placed. Noguchi had to modify the original medium in many ways to adapt it to the cultivation of the many spiral and other micro-organisms which he obtained in pure form for the first time. Even for the class of spirals the culture requirements are various, while when the method was applied to the growth of still other organisms, *e.g.*, globoid bodies in poliomyelitis, *Bacterium granulosis* in trachoma, profound modifications became necessary. Still it remains true that he found in the principle of employing fresh, sterile tissues in addition to the more common culture media, as introduced by Dr. Smith, the key which was to unlock many bacteriological doors previously unopened.

The cultivation of the parasitic spirals, including the syphilis spiral, proved, of course, clinically most significant; but in addition to more than half a dozen pathogenic species, he cultivated pure for the first time as many merely saprophytic species living in or on the bodies of animals. The culture of the syphilis spiral was made to yield luetin, a soluble extract based on tuberculin, of use in detecting latent and congenital syphilis.

There is no better incident than this to bring out Noguchi's almost faultless and infinitely varied technical skill. The culture medium we are considering is not only very variable in itself, because of the chemical complexity of the materials entering into its composition, and therefore exceedingly difficult to keep approximately constant, but it demands constant modification in order to adapt it to the many organisms the cultivation of which he accomplished through its use. It is no wonder, therefore, that so many of Noguchi's would-be followers have failed in their efforts. Several years had, indeed, to elapse before his work was repeated by others and began to become widely fruitful. The belief became current that the methods had not been fully disclosed. There is no doubt that Noguchi did always describe them as fully as language permitted. With factors so variable in their nature, what he perhaps did not do, and what such consummate masters of technique almost never find it possible to do, is to put into words those subtle, imponderable yet essential twists and turns of method used by them, often unconsciously, in adapting a medium to a recalcitrant micro-organism. The patient and resourceful among bacteriologists have learned in time to repeat what Noguchi has done, but the mass of the conventional among them undoubtedly soon tired and gave up the unequal contest.

In 1912, Noguchi married Mary Dardis, whom he surrounded with devotion and who, on his perilous journeys, as we learn from letters and cable messages, he had constantly in his mind, lest she suffer from undue anxiety. He required few diversions in order to refresh his spirit. An occasional game of chess at the Nippon Club or at his home, or an evening with friends sufficed. In the summer at his bungalow in the Catskills he fished in the stream which ran beside his little place, or he painted in oils in a self-taught manner in which there were both talent and charm. In earlier days he was skilful with the brush and produced water-color illustrations for his published papers, which were faithful, finished and original. As his mind was too restless to renew itself by idleness, he found in these simple devices means to restore his strength. These avocations were followed purely for refreshment, and he always took himself humorously as painter or sportsman.

The last ten years of Noguchi's life were spent in the investigation of certain obscure diseases, including yellow fever, trachoma, Rocky Mountain spotted fever, poliomyelitis, rabies, kala-azar and Oroya fever and verruga peruana. It is true, of course, that he did not find solutions of all these riddles of pathology, but the remarkable thing is rather that he should have solved as many of them as he did.

There was a logic in Noguchi's work which is not always perceived immediately by readers of his mono-

graphs and many papers. As a matter of fact he was always capitalizing and refining his experience. He learned that the gonads of the rabbit not only serve to grow the syphilis spirochete in great numbers, but also to free them of associated, contaminating bacteria. His studies on Rocky Mountain spotted fever emphasized further the suitability of these organs to the abundant multiplication of even undetermined micro-organisms. He therefore employed the method to enrich and purify vaccine virus, and thus for the first time secured this important material in an uncontaminated state. The neurovaccine, so widely employed in Europe for vaccination, is, of course, a direct outgrowth of Noguchi's discovery, as are many of the studies now in progress in which particular organs of living animals are used to procure evidences of the presence of parasitic organisms in diseases of unestablished origin.

In 1918 Noguchi became a member of the commission sent by the Rockefeller Foundation to Guayaquil, Ecuador, to investigate yellow fever. This was the first of four expeditions made by him to South America between 1918 and 1924. On each expedition he isolated in culture a spiral organism from cases diagnosed as yellow fever which he subsequently named *Leptospira icteroides*. He came to regard this spiral, which he recognized as biologically related to the spiral organism of infectious or hemorrhagic jaundice, as the parasitic incitant of yellow fever. In all his studies he secured the spiral only in a part of the cases examined—six of twenty-seven in Guayaquil—but he detected evidences in the blood of other cases of the presence of the spiral at some time. This spiral was found afterwards by other bacteriologists by the employment of Noguchi's technique. However, there were many failures also to confirm his findings. At the present moment, Noguchi's work on yellow fever in South America has come into question, so that it is desirable to perceive clearly just what the question is. There is no doubt that Noguchi and others cultivated *Leptospira icteroides* from the cases diagnosed by clinical experts as yellow fever, and with the cultures reproduced in animals symptoms and pathological changes resembling those of yellow fever in man. Now that the extensive investigations of African yellow fever by Adrian Stokes and others have failed to reveal the leptospira and have yielded a filter-passing virus, believed to be the incitant of the disease, and the reinvestigation of South American yellow fever is offering results tending to confirm the African findings, there is inclination to discredit Noguchi's earlier studies. There is really no conflict between the two classes of findings: the only conflict possible arises from the interpretation to be placed upon each. Recent experience, gained with full knowledge of the existence of the filterable virus, has reestablished the occurrence of leptospira in the blood of yellow-fever patients. The future alone can determine whether cases of another infectious disease, due to leptospira, have been and still are confused clinically with yellow fever, or whether in yellow fever a second pathogenic leptospiral micro-organism sometimes invades the blood. Such instances of secondary or concomitant infection are, of course, known to arise in other defined or specific diseases.

In 1925, Dr. T. Battistini, of Lima, came to study with Noguchi under a Rockefeller Foundation fellowship. He brought with him a sample of blood taken from a case of Oroya fever. This circumstance enabled Noguchi to turn his attention to the rod-shaped bodies found by Dr. Barton in 1905 in the red corpuscles of persons suffering from the disease. These bodies had not been secured in artificial culture and were looked upon not as bacteria, but as protozoa. Noguchi threw himself into this problem with characteristic energy, and the solution which he found was undoubtedly aided by the fact, already determined in 1910, that the warty or verrugous lesions appearing on the skin bear a relationship, if a disputed one, to Oroya fever, and they had actually been already communicated by inoculation to monkeys. It was, indeed, this disputed relationship which led the Peruvian medical student Carrion in 1885 to inoculate himself with material taken from the warty formations, from which a fatal attack of Oroya fever developed. Since this time the composite malady is often called Carrion's disease.

The rods yielded to artificial cultivation, and with the cultures Noguchi was enabled to reproduce both verruga peruana and the equivalent of Oroya fever in monkeys. Moreover, the rods have been cultivated repeatedly from verrugous nodules sent to New York from Peru. The bacterial incitant of Carrion's disease having been established, Noguchi turned his attention to the manner in which infection arises.

A good many acute observations made by Peruvian physicians and others had already indicated that direct transmission from person to person did not occur. Indirect evidence, indeed, pointed to an insect carrier or vector of the micro-organism. An American entomologist, Charles H. Townsend, who had studied the subject minutely had concluded that this vector belonged to the phlebotomus class of nocturnal blood-sucking insects. He even went so far as to name the supposed vector *Phlebotomus verrucarum*.

Just before sailing for Africa, Noguchi planned a definitive investigation of this question. Through the cooperation of the Rockefeller Foundation, Raymond C. Shannon was sent to Peru to study the insect life

of the valleys in which verrugas and Oroya fever abound. He was to collect and send insects falling under suspicion to New York, where the inoculation and culture experiments were to be made. All this was carried out precisely as Noguchi had arranged it, with the result that the vectors of Carrion's disease have now been determined to be insects of the class of phlebotomi, as Townsend believed, and Shannon has succeeded in identifying two species, *P. verrucarum* and *P. noguchii,* which certainly carry *Bartonella bacilliformis,* and a third species, *P. peruensis,* which is in this respect still in doubt.

Noguchi's investigations of trachoma fall into two periods. The first one dates from 1910 to 1913, in which he studied cases of the disease in New York. Nothing especially significant came from this study. But the investigation made in 1926 of cases of Indian trachoma at Albuquerque, New Mexico, led to a wholly different result. This investigation was promoted by Dr. F. I. Proctor and Dr. Polk Richards, who gave invaluable aid. The plan which Noguchi followed was to make cultures on specially prepared media and to isolate and test by inoculation into the conjunctiva of the monkey all bacteria growing in the cultures. He decided not to overlook any microorganism, no matter how banal it appeared to be. This determination in itself is illuminating as to Noguchi's method of attacking a new, complex problem. To most bacteriologists the labor involved would seem not only futile, but devastating. Just here we observe not only the rigid system of research which Noguchi had developed, but we note also the effect of his incomparable industry, because the mere technical operations of the plan proved prodigious. They did not, however, abate his decision, and the end result is that he discovered a new bacterial species called *Bacterium granulosis,* which on injection into the conjunctival mucous membrane of the chimpanzee, baboon and *Macaccus rhesus* induces a chronic granular infection, which clinically and pathologically is indistinguishable from trachoma in man. From the inoculated conjunctiva of one eye, the granular infection spreads of itself to the uninoculated other eye. This experimental trachoma in monkeys persists for many months, gradually producing in certain animals the deforming scar-like changes so commonly met with in man. As is so common an experience when a disease native in one animal species is grafted on a species in which it does not naturally occur, there are certain distinctions, usually of intensity, to be detected, but the essential trachomatous process arises in the monkeys as the result of the inoculation of a particular bacterial species hitherto unknown, and obtained by Noguchi from undoubted cases of trachoma as it exists on a wide and destructive scale among the American Indian population.

From time to time, Noguchi undertook the investigation of other problems than those already noted, with which he made progress. Thus the cultivation of the "globoid bodies" from the filter-passing virus disease poliomyelitis was a definite achievement. He contributed to the knowledge of Rocky Mountain spotted fever, both in respect to the Rickettsia-like organisms present in the insect vector, the wood tick, and in human tissues, and also in respect to an antiserum capable of neutralizing the virulent incitant, and thus making the effective treatment of the fatal disease a matter of hopeful further pursuit. His study of the protozoan organism causing kala-azar, a disease of the Eastern world, led to the perfection of methods for cultivating the class of flagellated organisms and among them the interesting species inhabiting the latex of the milkweed, which are found also in the intestines of the insects feeding on the milk. Having secured a wide variety of flagellates in pure culture, he developed methods for their distinction by serological and other means such as are used in the differentiation of bacteria.

In October, 1927, Noguchi sailed for Africa. This was the consummation of a wish he had long entertained, but which uncertain health had caused to be deferred. He wished naturally to study and compare the yellow fever of Africa with that of South America. The investigation of yellow fever by the Rockefeller Foundation as a world problem had led to the dispatch of a series of pathologists to Africa, among whom was Adrian Stokes, who, just before his death from yellow fever, had determined the existence of a filter-passing virus in the African disease. On the other hand, the leptospira had not been found in the blood of cases, as had been done in South America. This discrepancy only served to increase Noguchi's desire to study the African fever at first hand. As his health had meanwhile improved, there seemed no sufficient reason for denying him this satisfaction.

Noguchi arrived in Accra, on the Gold Coast, on November 17, and decided to establish his laboratory there. The British officials cooperated in every way, and through the aid of the Rockefeller Foundation staff at Lagos, who lent all assistance, he soon had provision for monkeys and for laboratory work meeting all his requirements. Noguchi had completed his African studies which, among other things, confirmed Stokes' discovery of a virus and failed to yield *Leptospira icteroides;* and he was all but ready to embark for home when he was himself attacked by yellow fever. He paid a visit to the Lagos station on May 10, being apparently in perfect health and showing the greatest interest in the work going on there. He returned to Accra on May 12 and was already ill. The symptoms increased in intensity, and although there

was a temporary improvement, alarming symptoms reappeared and his death occurred on May 21, 1928. Dr. William A. Young, the British pathologist at the Accra station who undertook to look after Noguchi's incomplete experiments, himself fell a victim to yellow fever, from which he died on May 29. Stokes, Noguchi, Young gave their lives in the pioneer work of establishing the nature of African yellow fever which had hitherto been one of the baffling problems of tropical pathology.

Noguchi was an international figure much beloved. His sudden death, therefore, came as a shock to the whole world. In virtue of the world-wide scale on which he carried out his fruitful investigations, he had become known as a leader and pathfinder in bacteriology. Messages of sympathy and admiration were sent from far and near, and the circumstances of his courageous and tragic death became the theme of writers in innumerable lay and technical journals.

As is often observed among men of his race, Noguchi was of small stature and slender build, but his physical movements were extraordinarily alert and precise. He carried his well-shaped head surmounted by a heavy growth of black hair erect on strong shoulders, and his well-moulded features were dominated and lit up by eyes of unusual eagerness and quickness of glance. His expression was genial and almost never severe, although Mr. Konenkov has caught the latter mood in the portrait bust for which Noguchi sat during the last days before sailing for Africa. There was striking disproportion between the slight body and the dynamic energy which characterized Noguchi's years of devotion to the main passion of his life—science.

During Noguchi's eventful life, learned societies and governments may almost be said to have vied with one another in doing him honor. The emperor of his own country decorated him twice; in 1915, on his only return to his native country, when he was hailed as one of the most famous Japanese of all time; and again after his death, in special recognition of his eminence and meritorious service to the cause of science, the Order of the Rising Sun of the highest class was conferred upon him posthumously. Noguchi's simple origin and inauspicious beginnings as well as his amazing career in science have been seized upon and held up to his countrymen as worthy of admiration and emulation. His example of filial piety to his family and his teacher, and the story of his visit to his home in 1915, which became virtually a triumphant tour through the country, are being woven into a legend of singular beauty so precious to the heart of the East.

The birthplace of Noguchi has been acquired and will be saved to posterity. As a shrine in which personal effects, mementoes and records of his scientific work will be deposited and preserved, it will become an object of pilgrimage and veneration for the intellectually devout from far and near. The spirit of science will surely hover over this shrine, and in accordance with the genius of his countrymen, it will attract worshipers to whom the name of Hideyo Noguchi will be a sacred emblem of love of his fellow man.

SIMON FLEXNER

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
NEW YORK

THE IMPORTANCE OF NATURAL AREAS TO FORESTRY OFFICIALLY RECOGNIZED

SEVEN years ago a foresighted American forester, W. W. Ashe, made a well-grounded proposal in a paper entitled "Reserved Areas of Principal Forest Types as a Guide in Developing American Silviculture,"[1] the scope of which is evident from the title. Since that time the indispensability of natural areas for forestry and for all kinds of ecological study has become increasingly recognized the world over. In this country the Ecological Society of America has made the establishment of carefully chosen natural areas a point on its program, and has accomplished the great and justly deserving task of making a rough inventory of the nature types of the Americas[2]—a perfectly logical first step towards a solution of the difficult question of how to preserve representative natural conditions to a sufficient extent with a reasonable economic effort.

Few people realize the full gravity of this question, which can not be said to have reached a perfect solution thus far in any country, but which certainly should be solved by the present generation, if it is to come near to a satisfactory solution. A great responsibility rests upon this generation as to just what shall remain to the future of the few remnants of virgin nature still left. This should not be left to chance. All that is wasted is lost for ever. Many natural units—forest types, plants, animals, etc.—are already exterminated. Others will be in the near future, unless preserved. And every unit lost means an irreparable loss to science and may, in many cases, directly check or hamper some line of general progress. To take a salient example: if the larger whales

[1] *Journal of Forestry*, 20: 276–283. 1922. *Cf.* also G. A. Pearson, "Preservation of Natural Areas in the National Forests," *Ecology*, 3: 284. 1922.

[2] "Naturalist's Guide to the Americas," Baltimore. 1926. Here Mr. Ashe has again stressed the value to silviculture of reserved areas of natural forest types (pp. 10–11).