AN ADDRESS ON THE LIFE AND SCIENTIFIC WORK OF ALBRECHT VON GRAEFE.

*Delivered on the occasion of the Presentation of the Graefe Medal to
PROFESSOR VON HELMHOLTZ.*

By PROFESSOR DONDERS, OF UTRECHT.

[THIS medal, recently instituted by public subscription, in perpetual memory of Albrecht von Graefe, is awarded every ten years by the Ophthalmological Society, meeting annually at Heidelberg, to the man of whatever nation who may be designated as having rendered the greatest service to ophthalmology.

The ceremony of the first presentation of the medal took place at the close of the Quincentenary Festival of the University of Heidelberg, on the 9th of August, 1886, Professor von Zehender, of Rostock, presiding, in presence of the Pro-Rector, Professors, and many distinguished visitors. The President, having opened the assembly in a few appropriate words, called on Professor Donders, of Utrecht, who spoke as follows.]¹

The days have but just passed in which the University of Heidelberg has brilliantly celebrated its quincentenary festival. From a brilliant present, it can look back with pride upon a glorious past, which displays in every field of human knowledge, both great men and great results. Here on the beautiful banks of the Neckar, has ophthalmology, too, been wont annually to pitch its tent from the dawn of its most modern era. Under the shade of Alma Mater, the Ophthalmological Society was born. It invites you this year to a festival commemoration, and to me has been entrusted the honourable task of addressing you.

It was in the autumn of 1857 that Albrecht von Graefe met here for the first time with some of his followers, among whom were Horner von Zehender and Weber, in order to discuss the most recent advances in ophthalmology. In the next year there appeared also by von Graefe's invitation, Arlt, Müller, and myself. From Heidelberg, there were also present, Kussmaul and many others. In 1859, the publication of the transactions was resolved on. So far, the assemblage had the form of a congress: every member had the right to introduce friends, and every member of the profession might enter. In 1863, it first formed itself into a "Society," but with very liberal rules, by which the committee was empowered to admit into the society, on the nomination of two members, those oculists who had given evidence of scientific aims. In 1864, it counted already more than 80 members, and among them, Baum, Reute, Coccius, Busch, and Forster, from Germany; Arlt, Gulz, Schellwag von Carion, and Hasner von Artha, from Austria; Sichel and Desmarres, from France; Bowman, Crichtett, and Mackenzie, from the United Kingdom; besides von Zehender, Horner, Hairion, Worlomot, Snellen, Hoyack, MacGawly, Junge, and Szokalsky, from the other countries of Europe. Soon their numbers were swelled by the presence of Williams, Agnew, and others from America, and thus the society had assumed already an international character.

Albrecht von Graefe both was and remained the soul and centre of the Society till his strength failed him. He died on July 20th, 1870, on the eve of the great struggle with France, at a time when Germany could spare comparatively little sympathy for the quiet death at home of one of her eminent sons. But when, in the following year, peace having been restored, the members of the Society again gathered here, a universal desire was expressed to do homage to his memory. In the first place, so thought his nearest friends, the opportunity must be widely afforded of contributing to a monument to the great ophthalmic surgeon who had made all mankind his debtors; and, as the result of their united exertions, under the presidency of von Langenbeck, they may look upon the statue, raised in 1882, near the chief scene of his activity, his native city, Berlin. But, beyond this, the Society desired to render a special homage to its founder. Should they endow scholarships in ophthalmology? Should they seek to perpetuate his name by a charitable institution—an Eye Hospital? But then came the idea of founding a Graefe medal, to be presented every tenth year to the man who, among his con-

temporaries, should have most powerfully contributed to the development of ophthalmology; and this idea was almost universally approved. And must not every doubt as to the wisdom of the decision be silenced, when we see to-day Hermann von Helmholtz "thankful," as his telegram puts it, "that his old work should be remembered with fresh honours," ready to accept the medal thus unanimously awarded to him?

A double task is now imposed upon me. The statutes decree that the presentation of the medal, with an address to the recipient, must be preceded by a discourse commemorating the merits of Albrecht von Graefe. This task I joyfully undertake. On the one hand, it will always be easy to connect the results of the present day with those of the man whose grand figure stands at the commencement of an era of which we seem to see no end. I have the privilege of being able to speak to you, and in this intimate circle I may venture to speak in the first place from my own personal recollections.

Albrecht von Graefe himself showed me the house in which, on May 22nd, 1828, he first saw the light, a stately mansion which his father, the first Director of the Surgical *Clinique* of the University, owed to the munificence of his King, Frederick William the Third. His father remained his guide only up to his twelfth year, but his mother was spared to exert a happy influence over his career for eighteen years more. No pains were spared in his education. After receiving private instruction from the best tutors, he attended the French gymnasium. Chance has thrown into my hands a report of the Director Kramer upon our Graefe. Two significant words in it struck me, "Attention in the classes intense and searching."

Intense and searching—these characteristics of the boy of 14, marked also the man. The next year he quitted the gymnasium. After busying himself for another year, principally with mathematics, philosophy and chemistry, he entered at the University, where he could count among his teachers, Müller, Dieffenbach, Schönlein, Romberg, and also Rudolf Virchow, who later became his great and true friend.

But his education was to take a wider range. As a young Doctor, scarcely 19 years old, he set out for the most part in the company of his early friends, first towards Prague, which then stood in the van of scientific progress. He was chiefly attracted by the *clinique* and by the person of Ferdinand Arlt. With him he learned to understand how much ophthalmology could do, and how much it had still to accomplish. And at once his choice was determined; he would become an ophthalmic surgeon. This decision brought him, in the winter of 1848-49 to Paris, where he hoped to learn and see much in the *cliniques* of Sichel and Desmarres. And in this he was not mistaken. At Sichel's he was captivated by the wealth of the material; at Desmarres' by the eye and hand of the master. Sichel was delighted with his pupil; Desmarres soon learned to appreciate his worth. When, occasionally, Desmarres himself could not attend to his *clinique* or, as often happened, when he could not complete it in the time at his disposal, it was his young German colleague who took his place. Everything, including operations, was entrusted to him, and that in presence of a swarm of specialists, for the most part senior to himself, who were wont to resort to the *clinique* from all countries.

Of French surgeons, he liked best to hear Malgaigne; of physicians, Louis; and of specialists, "the most characteristic feature of Paris," Trousseau on children's diseases; and Ricord, who especially charmed him. Later on, he almost exclusively employed himself under the direction of Claude Bernard, in the Collège de France, with experimental physiology, and especially with the intracranial section of nerves and the ocular muscles.

The winter of 1849-50 found him in Vienna, where in Friedrich von Jaeger he found his father's friend, who received him with open arms. In order to perfect himself as an oculist, he turned to the best account the *cliniques*, courses, laboratories, and everything else of the kind that Vienna afforded. Of von Brücke's lectures on physiology he spoke with great appreciation.

In August, 1851, at the first International Exhibition, chance threw von Graefe and myself together in London. I had already enjoyed there for some days the companionship of Friedrich von Jaeger when one morning a young man in Alpine costume rushed into Guthrie's eye-hospital—he had reached London but about two hours before—and threw himself into von Jaeger's arms. With the words, "You are made for each other," the latter literally threw him into mine. And he was not mistaken. From early morning when, on our way to Moorfields Hospital, we took our modest breakfast in Oxford Street amongst the workmen going to their work, till late evening, when we gratefully quitted the hospitable home of our friend William Bowman, we remained inseparably united in common objects of pursuit. Von Graefe was my guide in practical work, of which I had as yet but little

¹ We are indebted to Professor Donders and Sir William Bowman for condensing and revising this most interesting address.

experience, and I again could impart to him much from the physiological side. This mutual instruction constituted for us a great attraction. These days in which von Graefe unfolded the whole charm of his fine nature belong to the happiest recollections of my life.

Abundantly qualified and eager for work, he returned to his native town. Though everyone here had prophesied for him a splendid future, the event surpassed his most sanguine expectations. At his own cost, he established a *clinique* on the French system, consisting of an out-patient department, together with some beds intended chiefly for operation cases. "Since I started," he wrote to me two months later, "I have registered 230 patients." And he thought then that, within the year, these would amount to at least 1,000. After ten months, there were already more than 1,900; and, after eight months more, though not yet 25 years old, he had at his disposal thirty-six beds, and a material of eye-disease which, as he writes, "could well compare with the largest in either London or Paris"; "for," continues he, "if our out-patient department only amounts to 4,000 patients a year, the perfectly regular attendance of the patients, the exact observations and the clinical experimental aim in the treatment constitute in my opinion points of some value." A few years later, the annual number reached the astounding figure of 10,000.

During his stay at Vienna, he began a short course on ophthalmology to some of his friends. When these asked him if he would also speak of therapeutics, he gave the following significant reply, "That we will study together in Berlin." And this time had now arrived. What course he was to strike out has been above related. If he put value on his *clinique*, it was on account of the absolutely regular attendance of his patients, the exact observation, and the careful experimental investigation of the results of treatment. These include everything. At first, he gave special attention to the anomalies of the muscles. This inquiry was a continuation of the researches already begun in Paris, and which were, perhaps, further excited by our discussions and inquiries in London. I need not remind you how he has again brought into repute the operation for strabismus, and what he showed to be attainable by advancement and setting back of the tendons in the most varied forms of muscular contraction and paralysis. And then there appeared from his hand a classical investigation of the mode of action of certain remedies; first, of nitrate of silver; later on, of chlorine water, atropine, eserine, etc. And in diphtheritic ophthalmia, the clinical determination of which is one of his greatest services, his suggestions as to treatment are the crowning merit of the work. He followed now a more surgical method of cure than he had been able to employ with Desmarres, and he was especially studying the mode of action of iridectomy and paracentesis, the pressure-bandage, and also scarification as a means of cure. In cataract extraction, even under the most favourable circumstances, a considerable percentage of cases was lost through suppuration. Surgeons accepted this as inevitable. Von Graefe did not rest till he had discovered the safest method, and reduced the risk to a minimum. For the obstructive *Absterne si modum nescis*, he substituted the rule of progress, "Observe and act;" and yet he was on his guard against every rash proceeding. He removed cysticercus from the vitreous, incised retinal detachments, and, even in central scotoma from myopia, sought for and arrived at operative remedies. Thus, also, he encountered glaucoma. After all attempts to cure or to avert this, the most terrible of all diseases of the eye, had failed, oculists had abandoned it in despair; but it was von Graefe alone who could not rest there. Again he began to track the evil in all its manifestations, and he became more and more convinced that the destructive effects depend upon the increased tension of the eye. Against this he now concentrated his forces. Paracentesis gives, as was already known, only transitory relief of the symptoms, and even that, as he discovered, only for the first time.

Could iridectomy do anything? The idea gained strength with him. He remembered cases where ulceration and infiltration of the cornea were improved by iridectomy. After this operation, he had seen corneal and scleral staphylomata diminish. He therefore thought himself justified in trying it against glaucoma. The difficulties of execution did not frighten him. Anxiously he awaited the result, and, behold! the goal was won. This was von Graefe's greatest triumph, undeniably the greatest which ophthalmology can boast in our century. May no literary strife soil this fair page in the history of our science. The truth is, as Hoffmann has already recorded, that von Graefe had been anticipated more than thirty years before by Mackenzie, who, however, had not followed up the practice so as to establish it; and his track, long neglected, had remained unknown to our Graefe. To have followed the track to the goal, and to have laid it open to others, is the immortal merit of Albrecht von Graefe.

Together with the eye *clinique*, the school which bears von Graefe's name, was opened. Even before the *clinique* had attained great proportions, von Graefe's fame had penetrated far and wide, and from all sides young and old flocked to see and hear the youthful master. Those who still mistrusted his renown came, saw, and were conquered.

At first von Graefe continued to give some theoretical lectures, of which Horner speaks with admiration, but soon he restricted himself to the *clinique*, and capable assistants were entrusted with the different courses. In addition to his eye *clinique*, his private practice increased. From all sides, from all countries, the sufferers swarmed to Berlin to their saviour, as they called our hero. And this was quite explicable. As a physician, a therapist, von Graefe stood in the first rank. Horner has stated this, and Schweigger and many others have confirmed it: "Von Graefe accomplished more of a perfect and sterling kind than had ever been done before." He himself knew it. "In many respects (perhaps in elegant, not in good, operating—I recognise none other) I must yield to my colleagues; but give me a couple of wards and some patients, and a fortnight's treatment will show that I can hold my own." Thus von Graefe, in everything so modest, expressed to me his self-confidence on this point. This was the sacred goal of all his efforts, and why should he not dare to cherish within his breast his satisfaction in having obtained it?

In the year 1857, after von Graefe and some professional friends had first met together in Heidelberg, the first International Ophthalmological Congress was to be held at Brussels. In August he wrote to me: "I have no great longing for Brussels." I convinced him that he ought not to be absent, and he accordingly came. A genuine ovation awaited him there. The entire ophthalmological world was there, and every eye was turned to him. When he had finished his communication on Glaucoma in his own fresh and graphic manner, yet still so earnest and impressive, the storm of applause broke forth. And in the evening von Graefe and a few colleagues were found with lamp and ophthalmoscope at the Eye Institute at Brabant, where he demonstrated the still little known instrument, and the method of its use, to many of his colleagues from the South of Europe.

Could von Graefe go on satisfying the ever-increasing claims upon him? Already, in 1853, he had written to me how one morning in August, wearied in body and still more in mind, handing over both *clinique* and private practice to his assistants, he had gone away secretly to seek for restoration where he had always found it before—among the beautiful Alps—and how he, already in a few weeks a different man, had felt "what a load of cares weighed upon his young soul, and threatened the balance of his mind." And each succeeding year that exhaustion returned. And every year, after spending some days here in Heidelberg, his longing drove him to the Alps. Once—it was in the year 1859—Arlt and I were able to accompany him there, days never to be forgotten. On the beautiful high peaks he was just as sure a guide as in the field of ophthalmology, and the charm of his character was at its height.

But his restoration each year was incomplete. As early as 1856, he speaks of an illness, and of a heavy oppressive period following upon it. To set him up again, he needed nothing else than another cure of glaucoma, which had indeed made him happy, and another visit from Arlt, who had "rejoiced like a child at his happy results." But still worse was to follow. In the year 1861, Switzerland was not his most cherished aim. A fortunate star smiled on him from the North. In a few weeks he was to be united to the lovely and gifted Countess Anna Knuth, whose charms had won his heart. One more meeting with his friends in Heidelberg, and he would be off to Roeskilde for the realisation of his best hopes. But no! there was waiting us in Heidelberg the crushing news that von Graefe was detained by sickness in Baden-Baden. At his request, the usual scientific meetings were held; then we hastened to Baden-Baden to learn more particulars. Three days previously, von Graefe, perceiving himself, had discovered an extensive pleuritic effusion, which had developed gradually without febrile symptoms; and his friend, Traube, summoned from Berlin, had confirmed the diagnosis. I found him lying peacefully on his bed, in quiet submission, and with comparatively little difficulty in breathing. "My poor friend," said I, pressing his hand. "Yes, poor friend," repeated he, and added, "It took me a full hour to give up all my illusions. But now I am all right again. Tell me about Heidelberg." And when I had talked of this for an entire hour, his longing was still unsatisfied; he took up Goethe, which lay by his side, and pointed out to me the words, the deep meaning of which had so often struck us as we read them on Jaeger's test-types, "One cannot too early realise how superfluous one is in the world." At the outset sufficiently serious, his illness assumed in October and November a very ominous character. "I myself," wrote von Graefe, "barely

wavered between the prospect of succumbing and becoming permanently an invalid." And his physicians were of the same opinion, though rather inclining towards the worst. At last, in December, his condition assumed a more cheerful aspect; and at the commencement of February, after five months' terrible confinement, he was able to quit Baden-Baden as convalescent, in order to seek at the Mediterranean the fresh air for which he had earnestly longed; and he inhaled it in full draughts and with splendid results. "You can scarcely form an idea," so he wrote me from Nice, "how splendidly invigorating the air is here. I took my first walk with the greatest apprehension; my limbs and lungs seemed to fail me. For the first quarter of an hour, I crept along only with great effort; then it got easier and easier, so that at last I reached home actually stronger than when I started." On April 15th, he left Nice to return by way of Paris to Berlin, where, on June 6th, his long-deferred marriage took place.

We now enter on the second period of von Graefe's active life, which is separated from the first by his illness and his marriage. I shall occupy but a short time with it. Was this second period, which began with von Graefe's 34th year, and was to last but eight years, very unlike to the first?

He entered upon it with the firm resolve of limiting very much the sphere of his activity in Berlin, especially in his lectures and hospital work during the first summer session, and of attending the *clinique* only twice a week. But soon his life returned to the old grooves; external circumstances and inward impulse prevailed over the best resolutions. His young wife behaved very bravely. He could devote but a few hours to her; she was content with them. He cared little for comfort, nor did she. He did not tie himself to time, a disturbing element in every house, but not in theirs. She lived by and for him, always subordinating her wishes to his. On his journeys, he took—yea dragged—her everywhere with him. She, proud and happy to belong to him, wished for nothing better. But what a love was his too. I have never observed her make a serious attempt at any real change in his mode of life. Sometimes he was heard to complain when the pressure of work became too great; but he never shirked it. With all the disinterestedness of his nature, the homage offered to the surgeon-therapist still did him good. Be this as it may, patients were to him a daily necessity. When they were wanting, he felt a void which perhaps only the Alps could fill. Even at Nice, when scarcely convalescent, he saw patients daily for a few hours before sauntering about in the fresh air.

Some sunny years still awaited von Graefe. In quick succession, his wife presented him with three children; and his spacious handsome house in the Bellevue Strasse, in which he brought together every comfort for his family, gave him great gratification—more, indeed, than I had anticipated.

As his guest—it was permitted to me to be the first—I was not only a witness of his domestic happiness, but I also saw him by the side of his amiable and hospitable wife in a select circle of friends, beaming with joy and felicity. But too soon came an end to so much that was bright and beautiful. The loss of one of his beloved children deeply affected him. More than once he wrote to me about it in most pathetic terms; nor could he any longer conceal from himself the approaches of the dreaded consequences of his late illness. In the meantime, little of this was externally visible, and he fulfilled his duties as before, with unwearied devotion. Regularly every day, for hours together, he visited his out-patient room, with its unwholesome atmosphere, and he delivered his clinical lectures with the same ardour and under the same stormy applause as heretofore. He also continued to record regularly in the *Archives* the fruits of his investigations and experience, which he for the most part prepared in the holidays, dictating them in his well-known expressive style. In this second period, he treated still further of tuberculosis of the choroid, and referred again to intra-ocular tumours; he examined the calabar bean, the compress bandage, and hypodermic injections as means of cure. And in this period fell almost entirely the invention of his modified linear extraction. More than once he recurred to muscular anomalies—the operation for strabismus and muscular asthenopia—and wrote in addition two masterly treatises on glaucoma, the first as the earliest work of this second period, the second as his death-song only a few months before his end.

From 1857, his letters, with all their charms and interest, breathe more and more some heaviness of mind. One can feel the reason of it; yet he still continued his work as if there were to be no end to it. The *clinique* did not fall off, for here the need was ever greater than the opportunity of satisfying it. Also his voice, though somewhat less resonant, was still heard in the lecture-theatre with the old applause. And he was still at the service of everyone who required his help, with the same willingness as in the first days of his practice. Nevertheless,

he took refuge, at the entreaties of his medical friends—especially in the last two years, when his chest-symptoms became almost insupportable—at Inselbad, by Paderborn.

I will not relate what grief I saw there in the summer of 1869, when he, with his own little promising case, saw the life of his wife threatened by an embolic pneumonia, which broke her health for ever, and his youngest born fatally stricken with a rapidly increasing malady. And yet, on his return home, he began anew the old work with the old courage, and as much strength as still was left to him.

The end came in 1870. On May 23rd, he wrote: "My state of health continues to be wretched. Fever I have none, it is true, but I am excessively exhausted. I spend about twelve hours a day out of bed, of which four are devoted to clinical pursuits. I have also begun my lectures, perhaps more for my own entertainment than for that of my auditory. That, as a rational man and a physician, I can cherish for myself no great hopes, is self-evident; but occupation up to the last moment appears to me the best, and holds me back from useless questionings." His last letter, still written with his own pen, some days before his death, is about a consultation, and is a pattern in style, a masterpiece in precision. The conclusion is heartrending: "My health grows worse and worse, but enough of that to-day. I look upon each day as my last, and I am especially concerned at the grief of my wife. In inseparable friendship, thine old friend, Graefe."

At last the hour was come. On July 19th, 1870, after a charming summer's evening, he was to pass the night in his garden-saloon. A couch was put up for him. Scarcely had he lain down, when he felt the death anguish. Everything possible was done. "Agony," said he; "nothing to be done." Slowly the night-hours wore away. Once more he longed to see the gleam of breaking day. Then he passed away gently.

Albrecht von Graefe leaves with us the impression of a man to whom a mission had been entrusted, and who left us after fulfilling it. Sixteen years have gone by since his death, and his successors have followed in his footsteps; and thus tens, and even hundreds, of years may pass, and thousands may still come to follow in the same track. For men with a mission to fulfil but rarely make their appearance in any particular department. Von Graefe has been regarded by some as one born under a propitious star; the value of his services having been attributed to the fortunate relation in which they stood to the invention of the ophthalmoscope. Those who so judge run the risk of overlooking his true greatness. The ophthalmoscope has raised the level of ophthalmology; but it has raised to the same level the achievements, the merits of all its representatives. Each glance into the eye with the ophthalmoscope was a revelation; but every observer made his discoveries at his own time. The most competent observer, who gave the most correct atlas, carried off the palm. But, even in this, von Graefe has his special merit—in the discovery of the cysticercus; in the diagnosis of embolism of the arteria centralis; and in the optic neuritis consequent on intracranial pressure. But his chief services—the teaching of anomalies of the muscles; diphtheritic ophthalmia; the improvement of the method of cataract extraction; not omitting the cure of glaucoma—lie outside the sphere of the ophthalmoscope. Without the ophthalmoscope, he would have surpassed his contemporaries still more than with it.

Love and trust so great, with such grand talents, must, at any period and at any point of our knowledge, have brought about great results and worked wonders.

I turn now from our dear departed friend to Hermann von Helmholtz, whom we have the happiness of seeing amongst us in the full vigour of his manhood. It would be superfluous for me to enter fully into a description of his merits or to sound his praises before you. Everyone knows that of living natural philosophers none surpass, and but few equal him, and that he has taken a permanent place among the great men of all time. Two years older than he, I have followed from the beginning all that he has achieved. His contributions to science when a young army surgeon in Potsdam garrison, where his mathematical talent was already conspicuous, at once attracted the attention of physiologists. They proved how strongly he was inclined to devote his powers to the solution of problems, either entirely new or already abandoned as incapable of solution; a bold critical task, but all the more glorious if accomplished. I may remind you of his inquiries on the nature of putrefaction and fermentation, on the waste of tissue, as well as on the development of heat in muscular action, of his measurement of the waves of muscular contraction and of his determination of the velocity of nervous impulses produced by stimulation. In the meanwhile, he wrote the article "Heat" in the *Encyclopædic Dictionary of the Medical Sciences*, followed by the "Report on the Theory of the Physiological Phenomena of Heat." Both already foreshadowed the fruitful principle of the conservation of energy, which, independently of Julius

Robert Mayer, he was soon afterwards to develop in a vigorous form, accurately describing all the facts relating to it; the power of that theory to explain the origin of light and heat in the first development of the solar system (according to the theory of Kant and Laplace) he fully demonstrated and confirmed by calculation. In the same way a practised eye could already discover in his reports on "Theoretic Acoustics" and on "Physical Optics," just as in his first researches in the latter field, the germ of the great things which he was afterwards to unfold to our view.

When von Helmholtz turned his official activity from the field of physiology to that of physics, we understood, respected, and even heartily welcomed the change; for after having in the field of physiology shed light on nearly every question of a physical kind, we should have regretted to see him entering the field of microscopy, of physiological chemistry, or of experimental physiology, where time and diligence are the great factors, and where talents such as his could not attain their proper proportions.

And in the field of mathematical physics, in that of pure mathematics, and, on the border line where philosophy and mathematics meet, he continues with undiminished powers to astonish the world by his contributions—contributions of which the special importance is implied in this, that they are appreciable by the intelligent public, without any special knowledge, and admit of popular demonstration as von Helmholtz himself has fully proved.

But what has caused us, ophthalmologists, to indicate the great natural philosopher as the man to whom, among all now living men, ophthalmology is most indebted? You know the reason. Von Helmholtz has a double claim to this distinction; first, for the greatest work of scientific research, and, second, for the most fruitful invention.

This greatest work is his *Manual of Physiological Optics*, with which, in this field of intellectual labour, only one other can compare, one of less ample range, but just as profound and, perhaps, as inspired, the *Science of Musical Sensations*. But, in the author of that work, von Helmholtz has, as you know, no rival to fear.

In the composition of his *Physiological Optics*, von Helmholtz imposed upon himself the colossal task of testing every important statement by his own observation and researches; and this task he has fulfilled to the letter. A glance into his laboratory will show how, beginning with acute questioning, then controlling and experimenting, he makes everything clear to himself, and writes it all down in a clear, broad style, in order now to examine more closely what has been contributed by others towards the attainment of these results, and to record their names and researches, careless whether, in doing so, he clothes them with a share of his own proper merit.

Only the man strong in the consciousness of gigantic powers can be so independent, so negligent of his own deserts. And if we open the *Manual*, now some thirty years after its first appearance, we are, even at the present stage of science, astonished at the correctness of the insight and of the statements, so that we might almost be tempted to believe in his infallibility. This greatest work, next to the *Anatomy of the Eye*, is the foundation of our knowledge of the pathological processes and the key to our explanation of the symptoms. And this is his first claim to our distinction; his second claim, the most fruitful discovery.

The year 1851 will always be marked with golden letters in the annals of ophthalmology, as that of the discovery of the seat of the accommodative power, and as the year of the invention of the ophthalmoscope. If it be a satisfaction to me to venture to claim the first for my countryman, Dr. A. Cramer, I must not here omit to state that von Helmholtz shortly afterwards arrived independently at the same result. With a noble modesty, for which I thank him, he declared himself convinced, after an examination of the treatises sent to him, that the enigma of accommodation, upon which so many enquirers had in vain exhausted their ingenuity, was in reality solved as to the main points, and that little more remained for him to do in the researches he still contemplated. But, as concerns the invention of the ophthalmoscope, that belongs to von Helmholtz, and to von Helmholtz alone. Further, we see him define the conditions under which the eye can be illuminated—conditions which were not as yet distinctly determined. And he soon discovers that it must be possible to see the fundus of the eye by reflected light. From this moment dates the invention of the ophthalmoscope. It had merely to be constructed—a thing easy enough for von Helmholtz. And even this construction displays the accomplished physicist. Later alterations may facilitate its use, and the employment of the inverted image may have its incontestable advantages, but, in truth, the instrument in its original form is optically more complete than any other, and was so considered by that finest of all observers, Edward von Jaeger, and made use of for his won-

derful drawings and exact determinations of refraction. How the ophthalmoscope could be serviceable to ophthalmologists, how the eye under examination, whilst its fundus becomes visible, constitutes for the emmetropic examiner a lens (a Stanhope lens), too weak in myopia, in hypermetropia too strong; and how, simultaneously with the examination of the fundus, the refraction can be determined; all this was clearly indicated by von Helmholtz. But he never thought, or, at least, he never said, that the new instrument implied the dawning of a new era for ophthalmology. Von Graefe felt it immediately. When he, for the first time, saw the background of the eye, with its nerve-entrance and its blood-vessels, his cheeks reddened, and he called out excitedly, "Helmholtz has unfolded to us a new world!" and then, "What remains there to be discovered?" added he, thoughtfully. It was, indeed, humiliating to hear it said, banteringly, that black cataract was that disease in which the patient saw nothing, nor the surgeon either. Treatment was then but a groping in the dark. Under the same name were thrown together the most diverse affections of the fundus oculi and of the nerve-apparatus; and even disturbances of refraction and accommodation, such as astigmatism and muscular asthenopia, were reckoned with amblyopia. And against these most diverse disturbances the same empirical remedies were employed—many of them a real torment to the patient—not only with little beneficial result, but sometimes at the cost of health.

In 1858, von Helmholtz exchanged Bonn for Heidelberg, where he hoped soon to see his desire for a laboratory gratified. Here we had special pleasure in welcoming him on the occasion of the meeting of our Society. At our invitation, he was to join us at our meetings, and honour our festive board with his presence. The thought occurred to von Graefe of testifying our respect and gratitude by the presentation of a small gift. A silver goblet was soon found, and the names of the members present engraved upon it. At von Helmholtz's side, von Graefe arose, and described in animated language how the invention of the ophthalmoscope, which adorned the name of von Helmholtz with the laurel of immortality, elevated and rendered happy the ophthalmologist. "Under our eyes," this was the tenour of his speech, "we see the mists disperse, which for hundreds of years have clouded the view of our best observers, and an unexampled field is won for the healing art, from which even already, after a few brief years, have been reaped most admirable fruits." And, turning to von Helmholtz, he handed him, in the names of all of us, the goblet, with the words of the inscription, "To the creator of a new science, to the benefactor of mankind, in thankful remembrance of the invention of the ophthalmoscope." Von Helmholtz was visibly moved by this unaffected proof of our gratitude. It was, as he said, the first public acknowledgment of his merits. In his own home, beloved lips said, "Better than a decoration." And von Helmholtz replied, "Certainly! it is a decoration on the part of competent judges."

And now, twenty-eight years after that memorable day, highly esteemed and honoured von Helmholtz, I turn to you in the name of that Society for which von Graefe then spoke, and, so to say, in his name, the name of our Master and Patron, offer you the first honorary medal instituted in his memory. May this gift hereafter—when, following the first modest tribute which our Society long since ventured to offer you, Science in her highest embodiments, and your Emperor, whom you reverence and esteem, shall have heaped upon you all the distinctions suitable to great endowments associated with great deserts—may this gift still remain to you a gratifying symbol of the privilege you enjoy of living in a generation that honours you as its benefactor.

May this happy knowledge, which is not granted to every man of genius, illumine with its gentle light the evening of your life, in which you may see yourself always surrounded in unfading freshness of mind and body by the love of all that are dear to you.

Professor VON HELMHOLTZ replied in the following terms:—Gentlemen,—You have, by the exceptional honour which you have conferred upon me, called for an expression of gratitude to which I hardly know how to give utterance. When, a year ago, I was made acquainted with your determination to select me as the first recipient of the medal which has been dedicated to our ever-memorable Master, I was agreeably surprised, but, at the same time, placed in a difficulty. Agreeably surprised, naturally, that after the rapid flight of fifteen years, which I have had to devote to other studies, you still so vividly remember the assistance that I was once able to render to ophthalmology; and the more joyfully so, since, in the meantime, what I have contributed has, through the wonderfully rapid development of ophthalmology, been subjected to the most numerous and searching tests, and has been in a measure modified and superseded by newer inventions and investigations.

And now my difficulty begins. When I myself calmly review the real history of my ophthalmological discoveries, I cannot help saying to myself:—Some of them were due to good fortune, and the rest was but the work of a well-instructed workman, who had learned rightly to employ the ready-made means and knowledge of his predecessors. I have previously—at the first festival in memory of von Graefe, when we unveiled his statue at Berlin—expressed the same thoughts before you. “The ophthalmoscope,” I said, “was a discovery rather than an invention”; that is to say, when a well-trained physicist came and once grasped the importance of such an instrument, nothing more was wanted, since all the knowledge had been developed which was required for its construction. As regards the good fortune, it has so far favoured me by forcing me into a position which I did not at the time regard as good fortune at all. My inclination and my interest were from early youth directed towards physics. My father, a teacher in the gymnasium, living in very straightened circumstances, but a man who had strikingly exemplified in his life the lofty scientific enthusiasm of Fichte’s philosophy, and of the war of liberation, explained to me, sorry as he was to do it, that physics did not constitute a science by which a livelihood could be obtained—and, indeed, at that time this was so—but that, if I would study medicine, I might combine with it the natural sciences. Well, as a man of these days, who has no leisure to grieve over lost opportunities, but must try and make the best of any situation—and has moreover learned to wait—I accepted the situation as it was, and in the meanwhile studied medicine. But this ultimately proved an advantage. Apart from the fact that I thus attained to a much wider knowledge of the science of nature than would usually have been the lot of students of physics and mathematics, and, independently of the favourable circumstances which that period afforded to a young medical man trained in physical science, I have by this study become, in my later ophthalmological work, deeply sensible how vast an amount of useless science, as well as of printer’s ink, has been wasted on the theory of accommodation, and what an abyss of ignorance has been comprised under the name of “the black cataract,”—an abyss which, indeed, proved by subsequent illumination to have been far deeper than could have been at that time imagined.

The ophthalmoscope has unfolded itself to me simply out of the necessity of discussing, in my lectures on physiology, the theory of emission of light by the eye. Why does the human eye not glisten under ordinary circumstances, since in its background there is situated a spot—small, indeed—but clear white; that is to say, the end of the optic nerve, which must reflect light in the same way as the most sparkling tapetum of animals’ eyes? Why do animals’ eyes sometimes shine with such remarkable lustre, though they may only be illuminated by a small distant flame? These questions, when once proposed, were not difficult to answer, and now the answer is known to everybody. Once answered, they furnished the means of lighting up the eye of another human being, and of seeing it plainly.

Ophthalmometry, on the other hand, developed itself out of the question of the theory of accommodation, of which numberless views have been expressed, most of which were very easy of refutation, while none admitted of proof. Having read that the weak reflections of light from the lens, the so-called images of Sanson, had been seen by others, I myself sought them. As soon as I for the first time undoubtedly did see them, and had found them even less feeble than I had expected, I became conscious that the process of accommodation could be cleared up in all its details. Meanwhile, Cramer, under Donders’s guidance, had anticipated me; he had already fully recognised the alteration in the anterior surface of the lens. The determination of the very minute changes of the posterior lens surface required more exact observations, and these led to the system of ophthalmometry which I have worked out. Only after the alterations of shape of the lens had been established from every point of view could a proper theory of the mechanism of accommodation be given.

Another side of ophthalmology to which my attention had been already directed by the doctrine of J. Müller concerning the specific sense energies, was the theory of colours. Not being inclined to speak in my lectures of things that I had not myself seen, I made experiments in which I blended together the spectral colours in pairs. To my astonishment, I found that yellow and blue gave not green, as had up till then been generally asserted, but white. Yellow and blue pigments, when mixed, give green, and, till then, the mixing of these coloured materials was regarded as corresponding with that of the spectral colours; that produced at once an important change in all the previously accepted laws of colour admixture, but it comprised something still more important. Two master minds of the first rank, Goethe and David Brewster, were of opinion that the yellow and the blue could be directly seen in green. They had seen the result of

the gradual mixture of the two colours with the brush, and they believed that they were able to divide their perception of the resulting colour into two parts, neither of which, in reality, was there at all. This was one of the circumstances which first drew me over to the empirical theory of perceptions. It indicates even now the contrast between my position in the theory of colour-perception and that of Hering and his adherents, who hold firmly by the opinion that from the perception one can directly read off its several component parts.

This series of investigations led me at last to the determination to work afresh through the entire subject of physiological optics, which work I have recorded in the manual which I have published. Looking back over this series of investigations, I cannot see, speaking quite candidly, that in this department (I will not speak of others) I have been more, even at the best and under the most charitable view, than an attentive, diligent, and well-trained worker, who has done, shall we say “well?”—what he had learned to do, and just what a person can be taught to do. Now to such, do not the claims of others stand in contrast who have accomplished something further, namely, done for themselves what one cannot be taught to do?

This question reminds me of certain considerations as to the different characters which scientific activity exhibits in the various branches of science. If we confine ourselves here to those branches devoted to the observation and regulation of the material world, we find the one extreme most accurately represented in theoretical physics. Here we find matter regulated by exactly defined, undeviating laws, whose consequences can be worked out with the utmost accuracy of mathematical thought. So far as our knowledge extends will the origin and relation of things be freed from all darkness and all mysticisms. The forces of Nature, thus subdued, not only submit themselves theoretically to the knowledge of man, but are also the ministers of his will. Consequently, new conquests in this direction require, for the most part, the highest stretch of the human intellect, of which but few individuals are capable. But whatever of such knowledge has once been conquered, and stereotyped in the exact and clearly understood form of science, can be certainly and completely transferred to future generations. But the area which can be subjected to the unconditional command of perfect knowledge is, unfortunately, very limited; and, indeed, the organic world for the most part lies without it. But in numberless cases we are obliged to act, though we have no clear idea of the relative bearings of things—in politics, in war, in every act of intercourse of men, and also in medicine. Here is prominently displayed another phase of intellectual endowment, whose purest form we see embodied in the artist. Rich experience gives a knowledge of the typical course of phenomena, which he who possesses it cannot describe in words; and lo, when he is called on for action, he is found competent for it, though unable to state the precise reason for his action. I have always regarded great physicians as artists in this sense, and the mode in which they sought to transmit their knowledge to others as a sort of allegorical representation, which is treated unjustly if we regard it as a physiological theory, and apply to it a standard of that kind. The gifted physicist sees in these departments only the easily recognisable defects of such quasi-theories; he practises unsafely and unsuccessfully; he feels himself discontented and unhappy, and is therefore without moral influence on the patients and their friends; in short, he recognises here the limit of his powers.

Now permit me to convey my conclusions also in an allegorical form, so that I may not wound any personal susceptibilities. Let us suppose that up to the time of Phidias nobody has had a chisel sufficiently hard to work in marble with perfect control of the form. At least they could mould clay or carve wood. But now a clever smith discover how a chisel can be tempered. Phidias rejoices over the improved tools, fashions with them his god-like statues and controls the marble as none have done before. He is honoured and rewarded. But great geniuses are most modest just in that in which they most excel others. That very thing is so easy for them, that they can hardly understand why others also cannot do it. But there is always associated with high endowments a correspondingly great sensitiveness for the defects of one’s own work. Thus, says Phidias to the smith, “Without your aid I could have done nothing of that. The honour and glory belong to you.” But the smith can only answer him, “But I could not have done it even with my chisels, whereas you, without my chisels, could at least have moulded your wonderful works in clay; therefore I must decline the honour and glory, if I will remain an honourable man.”

But now Phidias is taken away, and there remain his friends and pupils, Praxiteles, Paionios, and others. They all use the chisel of the smith. The world is filled with their works and their fame. They

determine to honour the memory of the deceased with a garland which he shall receive who has done the most for the art and in the art of statuary. The beloved Master has often praised the smith as the author of their great success, and they finally decide to award the garland to him. "Well," answers the smith, "I consent. You are many, and among you are clever people. I am but a single man. You assert that I singly have been of service to many of you, and that many places teem with sculptors who decked the temples with divine statues, which, without the tools that I have given you, would have been very imperfectly fashioned. I must believe you; as I have never chiselled marble, and I accept thankfully what you award to me. But I myself should have given my vote to Praxiteles or Paionios."

THE BRADSHAW LECTURE ON BACTERIOLOGY IN ITS RELATIONS TO SURGERY.

Delivered at the Royal College of Surgeons, on Thursday,
December 2nd, 1886.

By HENRY POWER, M.B.LOND., F.R.C.S.,

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GENTLEMEN.—I propose in the lecture which you have this year done me the high honour of electing me to deliver in commemoration of Mr. Bradshaw, to place before you the knowledge which has been recently gained by the new science of bacteriology, in its relations to surgery. In beginning to work at the subject, I immediately found myself confronted with a difficulty which arose from the great confusion that at present exists in regard to nomenclature; and though I probably do great wrong to some of those who are now my auditors, I am convinced that many surgeons have only hazy and indistinct ideas in regard to the classification of these minute beings, and will not be ungrateful to me if I place before them a succinct account of the arrangement that is accepted provisionally by the best authorities in Germany and France, as well as in this country, and add a brief outline of the chief facts that are known in regard to their life history.

Truth, says Lord Bacon, is more easily educed from error than from confusion, and no better illustration could be adduced of the maxim than the advantages that are to be gained from even a provisional and incomplete arrangement of these minute organisms into genera and species. Botanists have divided plants into two great groups: phanerogamous plants, with more or less showy flowers and conspicuous organs of generation and fructification; and cryptogams, which propagate in a secret, inconspicuous, and mysterious method by spores. The cryptogams are again divided into those which have a stem and leaves like ferns, and those which produce flat expansions on or in which the spores grow, and which are termed thallophytes. The thallophytes were formerly divided into fungi, algae, and lichens, the broad distinctions between which were that the fungi were destitute of chlorophyll, contained much nitrogen in their composition, and lived on organic substances, whether dead or living, and in air; that algae contained chlorophyll and lived in water, building up their bodies from inorganic material; and, finally, that the lichens consisted of a mixture of cells, some containing, some destitute of, chlorophyll, nourishing themselves on inorganic substances, and usually living in air. Late researches by Schwendener and others have rather tended to show that the lichens are really algae which have been invaded by fungi; and, at all events, it has been found that neither lichens nor algae bear any very important relation to disease, and that those minute organisms which are really influential in the production of a very considerable number of the maladies incidental to man and animals, and especially those which are of an infectious or contagious nature, belong to the fungi. Now the fungi have been subdivided by Flügge—looking at them essentially from a hygienic, and not from a botanical, standpoint—into four groups: (1) the fungi proper; (2) the mycetozoa; (3) the blastomycetes; and (4) the schizomycetes.

Many of the true fungi play an important part in the economy of

nature, and are of great importance to man in their industrial relations. To mention only two of them. The *Ustilago carbo* forms the black smut of wheat and other cereals, and *Tilletia caries* or bran forms a similar substance in the interior of the grain, and gives a fetid odour to it. *Peronospora infestans* is the fungus of the potato disease. *Botrytis bassiana* is the muscardine disease of the silkworm. *Uredo* or *æcidium* (of which *puccinia graminis* is an example) forms the red rust of wheat, which is perhaps one of the most important and interesting fungi, and the singular history of which in connection with the barberry, is now well known from De Bary's observations. Then come the *aspergilli*, interesting because some of them can grow in the bodies of warm-blooded animals, and are capable of producing attacks of pneumonia in man and animals. The spores of these fungi are everywhere so abundant that it is only requisite to expose a piece of black bread to the air for a short time, and then place it in a moist warm chamber, and one or other form of *aspergillus*, according to the temperature, to appear with certainty. The *erysiphe-oidium*, or mildews, are found in the grape disease, caused by *oidium tuckeri* and *oidium lactis*, which forms a white covering to milk, bread, and dung; and closely allied to these are the fungi causing the parasitic skin diseases known as favus, herpes tonsurans, and pityriasis versicolor. The mucors and penicillium complete the list, these being the most common of all. None of them are of particular importance to the surgeon, except perhaps to the army surgeon, to whom the quality of the food, and especially of the bread, supplied by the commissariat, is a subject of unflinching interest.

The *Mycetozoa* may be passed over, as so little is known in regard to their relation to disease.

The *Blastomycetes* are represented by the yeasts and organised ferments which convert sugar into alcohol and carbonic acid, and the examination of which, in the hands of M. Pasteur, may be said to have led the way to all recent research on the subject of microbes.

From them we pass to the *Schizomycetes*, which have been differently grouped by different observers, and I here exhibit to you the classifications of Zopf and of Flügge, and also of Klein, whose excellent little work on Micro-organisms, just published, should be in everyone's hands. Klein divides the schizomycetes into micrococci, bacteria, bacilli, and spirilla, and each of these he subdivides into those that are septic, those that are zymogenic, those that are chromogenic, and those that are pathogenic. Septic microbes are those which excite, or at least accompany, the putrefaction of organic matters. Their action on proteids, as Hoppe-Seyler has pointed out, resembling digestion: the first products being peptones, then leucine, tyrosine, and the fatty acids; and, finally, indol, phenol, scatol, hydrogen sulphide, ammonia, carbonic acid, and water. From putrefying animal substances there may be obtained a material which is certainly not living, —for it can dialyse through a membrane,—but capable of exciting septicæmia when introduced into the healthy body of animals, a condition which must be carefully distinguished from pyæmia. Septic poisons produce an effect commensurate with the quantity of the poison introduced; if the quantity be small, only slight and transient effects are produced; if it be large, the effects are more severe, and vomiting, rigors, spasms, and collapse ending in death, may occur. *Post-mortem* examination shows congestion and hæmorrhage of the lungs, and intestinal mucous membrane. In pyæmia, on the other hand, a poisonous agent is also introduced into the system, but it so far differs from the poison of septicæmia that it appears to be living, and capable of multiplication, so that a very small quantity may prove fatal by the formation of numerous and widespread abscesses. It is possible, however, that, as Klein argues, large open wounds may become the seat of the multiplication of various organisms, which, by producing a septic poison, may produce septicæmia when absorbed in sufficient quantity.

Zymogenic Microbes.—The term zymogenic action is only another term for the induction of fermentation, and upon the whole of this subject a flood of light has been thrown by the labours of Pasteur. The chief forms are (1) the alcoholic, (2) the lactic, (3) the viscous, (4) the acetic, (5) the ammoniacal, (6) the butyric, and (7) the putrid fermentation. The agents are always microbes destitute of chlorophyll, and are generally anaerobic, obtaining the oxygen they require for growth and activity from the oxidised compounds in the liquid in which they grow. The micrococcus of urea and that of the phosphorescence of putrid meat and fish are, however, aerobic. The ammoniacal and the putrid fermentations are of the greatest interest to the surgeon. The former is exemplified in the action of the micrococcus ureæ and the bacillus ureæ in converting urea into ammonium carbonate. The micrococcus ureæ appears, when cultivated, in the form of minute spherical cells, either separate or united in diplococci, or in