

II.—*Reminiscences of the Early Times of the Achromatic Microscope.* By J. S. BOWERRANK, LL.D., F.R.S., F.R.M.S., &c.

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THE excellent annual address of your President, and the accompanying interesting Memoir of the late venerated J. J. Lister by his son, Professor Lister, of the University of Edinburgh, published in the 'Monthly Microscopical Journal,' renders quite superfluous any attempt, on my part, to detail the early history of the improvements of the modern achromatic microscope. I shall therefore restrict my communication to the reminiscences of its early application to scientific investigation.

My first introduction to Mr. William Tulley was in 1828, at the house of a friend to whom he was showing some of his favourite test objects; and before we parted that evening he had kindly engaged to make me such another instrument as the one through which we had been looking. Shortly afterwards, as he was unable, from press of other business, to complete my instrument, he placed in my hands his own, and the original combinations with which to work until he could complete the one ordered by me. He told me that but four such as I had ordered had been made, and that they were in the hands of Mr. Lister, Dr. Birkbeck, Lord Ashley, and himself. Dr. Birkbeck's instrument, after the decease of that gentleman, passed into the hands of my late friend, Mr. George Loddiges, and from that time forward, until his death, we worked together in concert. Every new improvement in combinations by Lister, Ross, and Powell, were examined carefully and critically by us; with Mr. A. White and Mr. J. Page we measured their angular apertures, and tested their centering and definition with minute globules of mercury, and other test-objects, and so did our best to incite the makers to aspire to the greatest possible perfection in the construction of their object-glasses. As the object-glasses increased in power and perfection, we found it necessary to increase the steadiness of the brasswork. Many anxious consultations were held on this part of the subject, and numerous experiments were tried. In this branch of our endeavours at improvement we received important assistance from our late talented friend, Mr. Jackson, to whose mechanical genius and practical dexterity as a workman we are in a great measure indebted for the admirable stability of the best of our modern instruments. The solid bar, with a rabbited groove, carrying the body and stage on one mass of metal, and the rabbited grooved stage, were the inventions of that able mechanic. The first mountings of this description, after the construction of his own instrument, were ploughed by Mr. Jackson for my new microscope, with his beautiful little ploughing machine; the remainder of the work was

completed by Mr. Smith; and although the instrument has been in constant use from that time to the present, its working powers, of both the carrier and the White's lever-stage, are as smooth and steady as when first from the manufacturer's hands. And here I may remark, that when the instrument was constructed a rack and pinion stage was also made for it, so that should the lever-stage get out of order the reserved stage might readily be applied in place of it; but from that day to this the lever-stage has never been removed from its original position; all that has been required to keep it in perfect working order being, about once a year, to touch the exposed portions of the working surfaces with a little oil; and then, after working the stage about to spread the oil, to wipe the surfaces with a piece of wash-leather. These progressive improvements in the definition and beauty of the combinations, and in the facility of the mechanical portions of the instrument, tended greatly to the extension of a taste for microscopical investigation, and microscopes rapidly increased in number; but amidst these incitements to a taste for the study of the minute beauties of creation we must not forget the powerful influence arising from the invaluable method of mounting in Canada balsam, which has rendered permanent thousands of interesting objects that would otherwise have served but for a momentary exhibition of their beauties, and have then been wiped off the glass, and lost to future admirers.

This valuable and effective mode of mounting microscopical objects, I am informed by Mr. Topping, was originally suggested by Mr. J. T. Cooper, an eminent analytical chemist, and it was first applied to the preparation of large objects for exhibition by the solar microscope by a person of the name of Newth, who was employed by the late Mr. Carpenter, the optician, of Regent Street, to exhibit them with the microscope, and who subsequently carried on a very profitable trade in objects so mounted. Mr. Bond afterwards obtained the recipe from Newth, and supplied the microscope at the Adelaide Gallery with such objects for a considerable period, but the process still remained a secret.

Some of the objects thus prepared were brought to one of my Monday evening meetings at Critchill Place about thirty years ago by Mr. Goadby, who exhibited them to Messrs. Alfred White, Page, and myself; and you may imagine how much we were interested and delighted by the distinct and beautiful view which we obtained, for the first time, of preparations of wings of butterflies, moths, and other specimens. Having viewed several of them, Mr. White turned to Mr. Goadby, and said, "Well, but how are these splendid things mounted?" "Ah," said Goadby, "that is a profound secret known only to one other gentleman and myself, and I am pledged not to divulge it." This was a sad announcement, but there was no help for it, and so we continued our examination of the

objects before us. During the time Mr. Page and I were at the microscope Mr. White was examining some of the specimens with a hand-lens; and as he held up a large-sized one between his finger and thumb on the broad surfaces of the glasses, Goadby said to him, "Don't hold them in that manner, but by the opposite edges, as they have only recently been mounted and will not bear the pressure of the glasses together;" so Mr. White shifted his hold on the glasses to the manner directed by Mr. Goadby, and quickly soiled his fingers by a small portion of the fluid that he had pressed out by his first mode of handling them. Having exhibited the whole of his treasures, Mr. Goadby departed, promising to come again on the following Monday evening with a fresh stock of beautiful objects. After his departure Mr. White said, "Well, I think I know the material in which Goadby's specimens are mounted." I had observed Mr. White repeatedly smelling his fingers, and my curiosity was somewhat excited by his actions; he then allowed us to participate in the odour, and expressed his opinion that the material in question was neither more nor less than Canada balsam. We then arranged to meet at my house on the following Thursday; Mr. White undertaking to find the Canada balsam and I the other necessary materials. On the appointed evening we proceeded to work; Mrs. Bowerbank providently supplying us with a large old iron tea-tray to hold our materials, and well it was that this precaution was taken, as the sequel will prove. Mr. White produced his Canada balsam, and poured out an ample supply on one of the usual sized glass slips, and we then adjusted on the convex surface of the fluid one of the wings of a butterfly, and gently pressed it into the fluid, so as to expel the air from beneath; a further quantity of the balsam was poured over the upper surface until the object was completely immersed in the fluid. A second crown-glass slip was then laid over the first, for thin glass had not then been brought into use, and the two slips were gently but firmly pressed together, and secured in their places by thread bands, and so we proceeded to prepare six or eight objects in succession, and by that time we were fairly brought to a standstill, our fingers being Canada balsamed up to the knuckles, and our hands like the feet of a web-footed animal when we attempted to separate our fingers from each other, so we were compelled to strike work and adjourn to the regions below, where, by a liberal use of spirit of turpentine, yellow soap, and hot water, we cleaned the objects we had mounted and restored our hands to a comparatively clean condition; we then commenced an examination of our specimens, and were amply rewarded by finding that they were in every respect equal to some of those exhibited to us by Mr. Goadby. On the following Monday he made his appearance with a new series of objects, and after having examined the greater portion of them, while one of us was talking to Mr. Goadby, Mr.

White quietly removed his object from beneath the microscope, and substituted one of ours in the place of it, and then invited Mr. Goadby to look at it. He gazed at it for a few seconds with a puzzled expression of countenance, and then throwing himself back in the chair, exclaimed, "Where the devil did you get that object from?" Mr. White, with a look of extreme gravity, replied, in his own words, "That is a profound secret known only to us three, and we are bound not to divulge it." A hearty laugh was the result, and further explanation convinced Mr. Goadby that his secret had been detected, although he would not at the time acknowledge it. Having thus possessed ourselves of the mystery of mounting in Canada balsam without any of the restrictions of secrecy, we spread the knowledge we had acquired far and wide among microscopists, and it quickly became the favourite mode of mounting objects. We soon learned to make our preparations without soiling our fingers, and to clean our mounted objects with a few drops of cold water and a thin knife-blade, without the use of turpentine or any other odorous fluids. I gradually became possessed of a considerable number of beautiful and interesting natural history objects, and their exhibition by the achromatic combinations of Tully contributed in no small degree to the growing popularity of the microscope.

The fame of Tully's beautiful combinations spread far and wide, and I was favoured by the visits of numerous eminent men of science of the period, and among them Dr. Marshall Hall, Mr. George Newport, Mr. Kiernan, Mr. Gulliver, Dr. Mantel, Professor Owen, and others, who brought their specimens with them, and verified their more laborious investigations by the Tullian facile combinations. It was at one of these meetings with Professor Owen, while we were examining the human blood, and the learned Professor was speaking of its "globules," that I objected to the term as not being descriptive of double concave circular discs. Professor Owen concurred with my observation, and exclaimed, "From this time forth then they are discs of the human blood." Mr. Kiernan also verified his observations on the structure of the human liver, before the reading of his celebrated paper at the Royal Society, in 1833, by the Tullian combinations in my possession. But, perhaps, one of the most remarkable of my visitors was the great French naturalist Geoffroi St. Hillaire, who paid a short visit to England in 1833. He had read my paper "On the Circulation of the Blood in the Larva of *Ephemera marginata*," and doubted the possibility of seeing the valvular action of the great dorsal vessel described therein. I had fortunately in my possession some very favourable subjects for exhibiting these beautiful phenomena, and when all was in order, and the great man applied his eye to the instrument, he at once saw the very facts he had doubted, and without removing