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In his recent address to the Royal Microscopical Society of London, the President, Dr. Lionel S. Beale, F. R. S., introduced some interesting facts relating to the present limits of microscopic vision, and indicated the advance that may be anticipated for the future in this direction.

Within five years it has been often asserted by those who make the Physics of the Microscope their special study, that the limits of microscopic vision had been almost reached by modern objectives, and that further advance was barred by insuperable difficulties. Since this time the record of progress contains numerous instances of advances made beyond these barriers which authorities considered until now insurmountable. Dr. Beale claims that "he only who is quite ignorant of the many and great improvements made in our methods of research, and in the instruments required for investigation, would think of fixing any limit to the advance of microscopical inquiry."

With improved instruments, the Microscopists have discovered improved methods of preparing objects for examination, and subtle agents united with the most delicate manipulation are now employed to develop structure, requiring the highest power of microscopic definition and amplification. We remember with Dr. Beale the time (within ten years) when in many branches of inquiry it was truly said that the optical instruments were in advance of the methods of making examinations, when our magnifying powers were higher than we could use, without losing, rather than gaining, as regards the definition of delicate structure. All this has now changed; the power of definition of objectives has been more than doubled, but the Biologist, in his investigations, anxiously demands higher powers and more perfectly corrected objectives.

Until recently the Histologist was satisfied with powers of five to six hundred diameters. Dr. Beale, in his recent address, states: "Our present limit of observation in investigations on the structure and action of the tissues of man and the higher animals, in my opinion, includes the use of magnifying powers of 2000 diameters. Objects considerably less than the hundred-thousandth of an inch can be studied with advantage, but how much less than these dimensions cannot, I think, be determined with accuracy at this time; for so much depends upon the character of the object, and a number of small points of detail as regards mode of examination.

But in other departments of Microscopical research our present means of investigation enable those familiar with the requisite methods of inquiry to demonstrate characteristics of structure far more intricate and minute than the above remark would infer. Various modifications of immersion lenses and in immersion media have greatly contributed to advance our knowledge of structure and action in the lower forms of life, and there is every reason to think that, as time goes on, methods of observation will be still improved and new methods discovered."

Another aid to perfect Microscopy is Photography, for by its use "things dimly seen by the eye may be very distinctly and correctly delineated, and with a perfection of accurate detail which a few years ago we should not have supposed possible." In this direction Dr. Beale states that "in all probability the application of photography to investigations upon minute structural details will be carried far beyond anything yet reached, although it is really wonderful how much has been achieved up to this time."

It will thus be seen that a variety of circumstances is steadily leading the way to what may be termed A NEW MICROSCOPY.

Both the Microscope and objectives, as also methods of manipulation, are being *revolutionized*, producing entirely new results. Even a new style of literature of the subject is developing. As far back as June, 1875, the editor of this journal, in a paper prepared for *Popular Science Monthly*, then foreshadowed this change. The article was headed, "*The Microscope and its Misinterpretations.*" A happy satisfaction then reigned among Microscopists, both with their instruments and their work, and the article was criticised as an assault upon the integrity of Microscopical research. It is some satisfaction to the present writer to find that those who then came forward as champions of the perfect microscopical work of that day, are now the most active leaders of the *new reform.* We refer to Mr. John Phin, the present editor of *The American Journal of Microscopy*, who can claim the honor of having established the first successful microscopical journal in the United States, and Professor J. Edwards Smith, of Cleveland, the author of the recent book "How to see with the Microscope," a work which is a valuable addition to Microscopical Literature; both wrote articles against "*The Misinterpretation of the Microscope.*" In that article we gave very strong illustrations of the "*misrepresentations*" referred to, but the paper was written some years in advance of the present developments, which have made the case much stronger. The disputed resolution of the "Podura" scale was then quoted as an instance of an objective giving two distinct resolutions of an object, one of which was clearly an erroneous one, but who would have then anticipated that the spherules on "*Angulatum*" which we have for so many years religiously regarded as the true ultimate resolution of that diatom, would prove to be an illusion? While to make the case more complicated, Professor E. Abbe states that "while it is not my opinion that the *Angulatum* valve is composed of spherules, yet even if such should exist, they would not have a different effect."

Thus "*The Misinterpretation of the Microscope*" under certain conditions, is no myth, but an admitted fact; we welcome then the improvements which shall at least partially remedy the evil. The high angle objectives of the present, although far from perfect, give great hope for the future, and we trace in Professor Smith's work, to which reference has been made, the advent of a higher intelligence among Microscopical workers. This new spirit of progress is well described by Dr. Beale when he says, the Microscopist, like the Astronomer, is ever longing to get a little beyond the point at which he has already arrived. Each new fact gained by research seems but to indicate the existence of more and more important things beyond. Limit is reached and then surmounted, but soon a new limit seems to rise from the mists in the distance towards which the worker is impelled by new hopes and desires. It is this never-halting progress which distinguishes scientific from every other kind of inquiry, and particularly microscopical investigation, for it can never be completed. It deals with the illimitable. The boundaries of to-day are found to have vanished to-morrow, and the eyes and understanding begin to penetrate into regions which but a short time before had been considered far beyond the range of possible investigation.

CONDUCTIBILITY OF GLASS FOR THE GALVANIC CURRENT.—According to A. Sewarz, if two platinum wires are interposed in the same circuit, the one passing through the free air while the other lies between two glass plates, or is melted into a thick capillary tube, at a certain temperature of the tube the former glows brilliantly, while the second remains dark. If the glass becomes heated the former grows dark, whence the author concludes that the glass has become more conductive.

THE PRODUCTION OF SOUND BY RADIANT ENERGY.*

BY ALEXANDER GRAHAM BELL.

In a paper read before the American Association for the Advancement of Science, last August, I described certain experiments made by Mr. Sumner Tainter and myself which had resulted in the construction of a "*Photophone*," or apparatus for the production of sound by light;† and it will be my object to-day to describe the progress we have made in the investigation of photophonic phenomena since the date of this communication.

In my Boston paper the discovery was announced that thin disks of very many different substances *emitted sounds* when exposed to the action of a rapidly-interrupted beam of sunlight. The great variety of material used in these experiments led me to believe that sonorousness under such circumstances would be found to be a general property of all matter.

At that time we had failed to obtain audible effects from masses of the various substances which became sonorous in the condition of thin diaphragms, but this failure was explained upon the supposition that the molecular disturbance produced by the light was chiefly a surface action, and that under the circumstances of the experiments the vibration had to be transmitted through the mass of the substance in order to affect the ear. It was therefore supposed that, if we could lead to the ear air that was directly in contact with the illuminated surface, louder sounds might be obtained, and solid masses be found to be as sonorous as thin diaphragms. The first experiments made to verify this hypothesis pointed towards success. A beam of sunlight was focussed into one end of an open tube, the ear being placed at the other end. Upon interrupting the beam, a clear, musical tone was heard, the pitch of which depended upon the frequency of the interruption of the light and loudness upon the material composing the tube.

At this stage our experiments were interrupted, as circumstances called me to Europe.

While in Paris a new form of the experiment occurred to my mind, which would not only enable us to investigate the sounds produced by masses, but would also permit us to test the more general proposition that *sonorousness, under the influence of intermittent light, is a property common to all matter*.

The substance to be tested was to be placed in the interior of a transparent vessel, made of some material which (like glass) is transparent to light, but practically opaque to sound.

Under such circumstances the light could get in, but the sound produced by the vibration of the substance could not get out. The audible effects could be studied by placing the ear in communication with the interior of the vessel by means of a hearing tube.

Some preliminary experiments were made in Paris to test this idea, and the results were so promising that they were communicated to the French Academy on the 11th of October, 1880, in the note read for me by Mr. Antoine Breguet.‡ Shortly afterwards I wrote to Mr. Tainter, suggesting that he should carry on the investigation in America, as circumstances prevented me from doing so myself in Europe. As these experiments seem to have formed the common starting point for a series of independent researches of the most important character, carried on simultaneously, in America by Mr. Tainter,

*A Paper read before the National Academy of Arts and Sciences, April 21, 1881.

†Proceedings of American Association for the Advancement of Science, Aug. 27, 1880; see, also, American Journal of Science, vol. xx, p. 305; Journal of the American Electrical Society, vol. iii, p. 3; Journal of the Society of Telegraph Engineers and Electricians, vol. ix, p. 404; Annales de Chimie et de Physique, vol. xxi.

‡ *Comptes Rendus*, vol. xcl, p. 595.