VIBRATIONS AND PARTICLES

PROFESSOR COMPTON in *The Scientific Monthly* for April tells us that light is alternately a particle and a vibration. Would it not interest some of your readers if some physicist would now tell us why it can not be a particle and a vibration at the same time? Some minds are so constituted that they like not only to have an explanation of why a thing is so, but also a further explanation of why it is not something else. This is particularly true when one is unable to picture the first in one's mind, and the second is obvious.

Thus imagine water dripping from a swinging hose, resembling plane polarized light of a single wavelength. If we seize the hose and shake it irregularly we should have ordinary light. Or again, if instead of letting the hose swing, let the spheroidal drops change their ellipticities in various directions. These simple suggestions must have already occurred to many minds. In what way do they fail to satisfy recorded observations so completely that it is necessary to adopt a solution that it is difficult or impossible to conceive? It is quite possible that this matter has been treated in full elsewhere, but many of your readers do not have access to all the technical magazines, and I think a simple statement by some one in authority might be of general interest.

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QUOTATIONS

THE CENTENARY OF THE LONDON ZOOLOGICAL GARDEN

ONE of the most famous institutions in the whole world—the Zoo—keeps its centenary to-day; but perhaps no formal celebration will be able to do justice to the place which the Zoo has made for itself in the national life. When history has recorded its progress, and science assayed its services to zoology and kindred studies, there remain influences and consequences much less amenable to statistics—an immense sum of human enjoyment, a vast body of popular literature, innumerable pictures and drawings serious and light, a continuous stream of humor, pathos and allegory of which the Zoo has been almost from the first an unfailing source. Of what other comparable institution can anything like the same be said? The honored originator of the Zoo, Sir Stamford Raffles, though he died before the gardens were actually opened, could have as little foreseen the developments of his new world as Columbus foresaw modern America. The centenary coincides with the highest peak of the Zoo's prosperity, for its rate of growth, when measured by income and numbers of fellows and visitors, has been in the last nine or ten years out of all proportion to the past. For this no doubt there are several causes, and they interact upon one another; but among them must certainly be reckoned good business management, the full recognition (though not until after a long struggle) of the value of light and open air for animals in captivity, with the consequent abolition of old, dark and airless places of confinement, the establishment of special new buildings like the aquarium and the reptile house, and the greater mobility of the age which enables many more visitors to go to Regent's Park than before, and so to bring in the resources necessary for improvements. The Zoo is unrivaled for the variety of specimens which it contains. It has developed, moreover, in a typically English way, for alone of important national collections of animals it receives no state subsidy. A few friends of zoology got together in the first place, formed a society and induced the government of the day to grant them a site on crown land; ever since then the Zoological Society has managed its own affairs, paid rent and rates, and lived entirely on subscriptions of the fellows, bequests and entrance fees. By its charter it can divide no profits; whatever it earns goes to the benefit of science and popular spectacle, and, as every one knows, its present prosperity is about to lead to new extensions on a much larger acreage at Whipsnade.

Through its hundred years the Zoo has, of course, been something much more than an exhibition of animals. The Zoological Society was founded for scientific purposes, and it has served them steadily. It now owns one of the most catholic libraries of zoology in existence. Its output of learned literature has been unceasing; its research continuous; its response to the calls made upon it prompt. The zoology, it need hardly be said, which was familiar to its founders is not the zoology of to-day. One of the projects which Raffles and his contemporaries had in mind was the domestication of more animals; here, however, zoology has been able to do next to nothing, for at best domestication at the Zoo means the taming of wild animals and not the creation of such conditions as will allow them to breed freely. In this respect, therefore, the dreams of the founders may be said to have been fruitless. In other respects the developments of science have outstripped their program. The zoology of their time, though systematic in its way, was in some aspects nearer that of Pope in his Essay than to Darwin's: the contemplation of the forms of life led directly to a natural theology, though it was by the study of breeding and acclimatization—one of the society's objects—that Darwin's thought was given its direction. The founders, however, hardly foresaw in their institution the present school of anatomy, cen-

ter for laboratory work and clearing house of zoological knowledge generally, with bearings on animal and human interests in all parts of the world. But such has the Zoo grown to be, and, in view of the shrinkage of space and the development of countries unopened a century ago, its importance can hardly be overestimated.

If its contributions to science are great, so also are its interests and responsibilities in other spheres. Its experience and ascertainments have a strong bearing on the conduct of men towards animals. The ethics of vivisection, of teaching animals to perform and of hunting and shooting them indiscriminately, and the provision against their ultimate extermination are all matters of concern to the society, and its opinion on them must carry great weight. Of all possibly none in certain countries is more important than the safeguarding of native fauna from the ruthless pressure of man. It is for this reason partly that photographs, such as those we are now publishing, have become for so many a welcome substitute for the traditional spoils of the hunter. In the last resort the question rests on the state of public opinion, which at home can hardly be fostered better than by a sight of the animals themselves—especially in such surroundings as approximate as nearly as confinement or restrictions will permit to natural conditions. And it is for this reason that the establishment of the Zoo's new park at Whipsnade is so happy an innovation. According to the able secretary of the Zoo, Dr. Chalmers Mitchell, it may be regarded as a link between the Zoo of an older fashion and those still larger reserves which statesmanship has already set apart as sacrosanct for native fauna in Africa, North America and elsewhere. The centenary of the Zoo and the prospect of the opening of the Whipsnade estate next year should give a new orientation to this practical branch of animal-keeping, and serve to enforce more strongly than ever upon a nation with immense zoological responsibilities the nature of its trust.—*The London Times.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN APPARATUS FOR THE STUDY OF MAT-FORMING FUNGI IN CULTURE SOLUTIONS

IN recent years considerable progress has been made in the physiological study of fungi, particularly as regards their organic nutrition. The technique usually employed in such work has been to grow the fungus in flasks containing a sterile liquid medium, and to deduce the results from the amount of growth of the fungus mats and analysis of the medium after growth. This, in principle, is the same as the methods used for the study of the inorganic nutrition of higher plants. For certain types of work with higher plants Johnston's[1] constant flow apparatus has proved of great help, and it was while trying to adopt the principle of this for the growing of mat-forming fungi that the apparatus to be described was tested out. While its use was primarily intended for the growing of fungi on liquid media under constant hydrogen-ion concentration, it can be seen that the method readily lends itself to studies regarding the inorganic and organic nutrition of micro-organisms.

There are many objections to be raised against methods now in use for the study of micro-organisms in culture solutions under constant pH. Sideris[2] enumerated some of them, but his own apparatus leaves much to be desired. By means of tubing he withdrew a sample of the medium in the flask in which the fungus was growing, titrated it to the original pH of that flask and then added acid or alkali to the remaining solution in proportion to its volume. Quite apart from the fact that it requires extreme care to adjust the pH in this manner, the important point seems to have been overlooked that the composition of the medium in the flask is being changed after each titration. While the apparatus may have been suitable for the particular work in hand, it does not lend itself to any work in which comparison of the results obtained is to be the basis of the conclusions drawn, for each flask would have contained a medium of different composition from the others.

Obviously the most desirable type of apparatus would be such that it would allow constant flow of a fresh medium of the same composition under the mats during the whole period of their growth. Since this is only practical in certain exceptional cases, the next best step would be to drain at intervals all the medium from the flask and refill from a reservoir. In this way the method adopted approaches as closely as is desired to the method of constant flow. This is the principle of the apparatus in the accompanying diagram.

The flask *A* is a reservoir containing the medium of desired composition and adjusted to any pH at which the fungus is to be grown. The glass tube *F* is connected at *C* to a Y tube, thus allowing two cultures to be grown on the same medium. Any number of these small flasks may be connected up in this manner, this being especially desirable when an average weight

[1] E. S. Johnston. "An Apparatus for Controlling the Flow of Nutrient Solutions in Plant Cultures," *Jour. of Plant Physiology*, 2: 213–15. August, 1927.

[2] C. P. Sideris. "An Apparatus for the Study of Micro-organisms in Culture Solutions under Constant Hydrogen Ion Concentrations," SCIENCE, July 4, 1924, vol. 60, No. 1540, pp. 17–19.