NATURE

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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH

THURSDAY, MAY 5, 1870

TO OUR READERS

THE opportunity afforded by the commencement of a new volume is one we cannot allow to pass by without a few remarks on the work on which we are engaged, although it may be that such a course is not strictly in accordance with precedent, but our excuse lies in this—our journal is not according to precedent.

For, in fact, six months ago a scientific journal, in which the leaders of scientific thought, in this and other lands, gave week by week an account of their own and others' labours to their fellows and the general public, was a thing of the future, and, in the general opinion, to attempt to start such a journal was almost certain to end in signal failure. "Science is so small, her victories are so few," said some, "that a weekly account of them is altogether beside the question—the well would run dry." Others said: "Science is large, it is true, but her followers are not numerous. You may perhaps number your readers by hundreds, if you take care to appeal to scientific men only; but as for the outside world, they care nothing for science." On the other hand it was held that a popular scientific weekly journal would, be a certain success under certain conditions—some such as these: in the first place, the articles were to be light as air; each fact was to be clothed in a delicate atmosphere of adjective and imagery; next, each page was to be studded with beautiful pictures, correctness both in text and illustration giving way to a certain more or less subdued sensationalism; and lastly, and above all, every care was to be taken to spare the reader the least trouble in the matter of thinking.

We confess that we should have shrunk from our task in the face of such advice as this, had there not been certain Signs of the Times which did not seem difficult to read, and which were more in harmony with the encouragements we received to undertake it; and now that the first volume has been completed, we have the satisfaction of knowing that none of these gloomy forebodings have been realised.

A consideration of the facts brings us at once to our first duty, which is to tender to the scientific men, both at home and abroad, who have assisted us, our best thanks for all their help in the work we have undertaken. We willingly acknowledge the small part we have borne in what has been done. Thanks are due, not only for criticism and the contributions which have already appeared, but for many others which—Nature is so large, and our journal is so small —we have not as yet been able to place before our readers. It has been our endeavour to carry out our programme by making the journal useful to workers in science; worthy therefore of their perusal, and therefore, again, worthy of their contributions: and by thus extending our appeal beyond the limits of the scientific world on the one hand, and endeavouring to keep up the dignity of science herself on the other, we have already met with an encouraging response. Our subscribers now number nearly five thousand; that is, we have, on a moderate estimate, fifteen thousand readers. Though we think this an emphatic success, we shall not be satisfied if the increasing interest in Science, and an increased knowledge of the periodical, do not in a short time double our present circulation, and we trust not only that each worker will urge his neighbours to send us facts, but that each of our present readers will form a nucleus of new ones.

We state this, not only because the statement is almost due to our contributors as a justification of our demands upon their time, but because it indicates the work—we had almost said the noble work—which lies before them. Surely at a time when England would gain so much by the scientific education, not only of her Workmen but of her Ministers, an attempt to place Science before the Public, week by week, as Politics, Art, Music, and a hundred other things are placed before them, must not be suffered to flag; when the number of science-teachers and science-students is daily increasing, and the necessity for combined action and representation among scientific men themselves is being more and more felt, the popularisation of science becomes more important than ever, and every effort to gain these ends deserves a larger encouragement, for the most "practical man" will now soon be made to feel that Science dogs his every footstep, meets him at every turn, and twines itself round his life; nay, it may soon become evident that such a practical thing as a stagnation of trade may in some way be traced to the neglect of science.

Hence our endeavour in the future will be not only to make our journal a necessity in the Studies of the more thoughtful, and in our Schools, but a welcome visitor in the Homes of all who care for aught that is beautiful and true in the world around them.

EDITOR

THE VELOCITY OF THOUGHT

"AS quick as thought" is a common proverb, and probably not a few persons feel inclined to regard the speed of mental operations as beyond our powers of measurement. Apart, however, from those minds which take their owners so long in making up because they are so great, rough experience clearly shows that ordinary thinking does take time; and as soon as mental processes were brought to work in connection with delicate instruments and exact calculations, it became obvious that the time they consumed was a matter for serious consideration. A well-known instance of this is the "personal equation" of the astronomers. When a person watching the movement of a star, makes a signal the instant he sees it, or the instant it seems to him to cross a certain line, it is found that a definite fraction of a second always elapses between the actual falling of the image of the star on the observer's eye, and the making of the signal—a fraction, moreover, varying somewhat with different observers, and with the same observer under differing mental conditions. Of late years considerable progress has been made towards an accurate knowledge of this mental time.

A typical bodily action, involving mental effort, may be regarded as made up of three terms; of sensations travelling towards the brain, of processes thereby set up within the brain, and of resultant motor impulses travelling from the brain towards the muscles which are about to be used. Our first task is to ascertain how much time is consumed in each of these terms; we may afterwards try to measure the velocity of the various stages and parts into which each term may be further subdivided.

The velocity of motor impulses is by far the simplest case of the three, and has already been made out pretty satisfactorily. We can assert, for instance, that in frogs a motor impulse, the message of the will to the muscle, travels at about the rate of 28 metres a second, while in man it moves at about 33 metres. The method by which this result is obtained may be described in its simplest form somewhat as follows:—

The muscle which in the frog corresponds to the calf of the leg, may be prepared with about two inches of its proper nerve still attached to it. If a galvanic current be brought to bear on the nerve close to the muscle, a motor impulse is set up in the nerve, and a contraction of the muscle follows. Between the exact moment when the current breaks into the nerve, and the exact moment when the muscle begins to contract, a certain time elapses. This time is measured in this way:—A blackened glass cylinder, made to revolve very rapidly, is fitted with two delicate levers, the points of which just touch the blackened surface at some little distance apart from each other. So long as the levers remain perfectly motionless, they trace on the revolving cylinder two parallel, horizontal, unbroken lines; and any movement of either is indicated at once by an upward (or downward) deviation from the horizontal line. These levers further are so arranged (as may readily be done) that the one lever is moved by the entrance of the very galvanic current which gives rise to the motor impulse in the nerve, and thus marks the beginning of that motor impulse; while the other is moved by the muscle directly this begins to contract, and thus marks the beginning of the muscular contraction. Taking note of the direction in which the cylinder is revolving, it is found that the mark of the setting-up of the motor impulse is always some little distance ahead of the mark of the muscular contraction; it only remains to be ascertained to what interval of time that distance of space on the cylinder corresponds. Did we know the actual rate at which the cylinder revolves this might be calculated, but an easier method is to bring a vibrating tuning-fork, of known pitch, to bear very lightly sideways on the cylinder, above or between the two levers. As the cylinder revolves, and the tuning-fork vibrates, the latter will mark on the former a horizontal line, made up of minute, uniform waves corresponding to the vibrations. In any given distance, as for instance in the distance between the two marks made by the levers, we may count the number of waves. These will give us the number of vibrations made by the tuning-fork in the interval; and knowing how many vibrations the tuning-fork makes in a second, we can easily tell to what fraction of a second the number of vibrations counted corresponds. Thus, if the tuning-fork vibrates 100 times a second, and in the interval between the marks of the two levers we count ten waves, we can tell that the time between the two marks, *i.e.* the time between the setting-up of the motor impulse and the beginning of the muscular contraction, was $\frac{1}{10}$ of a second.

Having ascertained this, the next step is to repeat the experiment exactly in the same way, except that the galvanic current is brought to bear upon the nerve, not close to the muscle, but as far off as possible at the