It is to elucidate this question that the experiments of M. Forel tend. They were referred to in NATURE, vol. xii. p. 134, and a paper on them was read at the Physical Society, May 27, 1876 (NATURE, vol. xiv. p. 164). Working with an artificial basin, then on several Swiss lakes, he has proved the constancy of the duration of the wave of libration; the increase of this duration with increase of length of the basin; its diminution with increase of depth. The character of the wave of libration is, that the water rises at one extremity of the basin while it sinks at the other, and *vice versâ*. As to the intensity of the wave it varies much, either under the influence of the mysterious cause which produces it, or according to the region of the basin where it extends. The *seiches* are much more pronounced at Geneva than in the broader part of the lake, either on account of the contraction of the mass of the water on the south-west shore, or of the considerable decrease in its depth.

If we examine the *seiches* at Morges, their theory becomes infinitely more complicated, because, besides the phenomenon of the longitudinal *seiche*, mainly visible at the two extremities of the lake, the changes of level present other periods in relation with the transverse libration of the liquid mass. They are also modified by oblique or cross reflections of waves in motion, which are connected with the form of the basin. We may only expect a real regularity in the form of the waves of libration if that form of the basin is regular.

In order to be able to base his conclusions on more varied observations, M. Forel has measured the duration of the *seiches* of seven other Swiss lakes, besides that of Geneva, and he has been able to draw the following inference:—The duration of the wave increases with the length of the basin, and diminishes in proportion as the depth increases. In other words, the rhythm of the longitudinal *seiches* is a direct function of the length of the different lakes and an inverse function of their depth. From the figures which have permitted the inference of this general law, we may, by neglecting the influence of the depth, approximately conclude the duration of a *seiche* corresponding to a lake of a given length; and reciprocally infer the probable kilometric length of a *seiche* whose duration is known. It will then be possible to infer the direction of any particular wave, among those which show themselves on the shore of the Lake of Geneva, for example. The above enunciation is then generalised, and is thus modified:—The duration of *seiches* is a direct function of the length and an inverse function of the depth of the section of the lake along which they oscillate.

M. Forel has found a mathematical formula relative to the movement of liquids in basins in the works of a Bâle *savant*, Dr. J. R. Mérian (1828), completing the formula given by Prof. Guthrie, and applicable to the movement of *seiches* (NATURE, vol. xv. p. 91). It may be stated thus:—The duration of *seiches* is proportional to the length of lakes and inversely proportional to the square root of their mean depth.

By experiments made in the first place on the Lake of Neuchâtel, it was found that the movements of libration of the water were alternate and simultaneous. The water rises at one of the extremities, while it falls at the other. The amplitude of these movements is very variable, but their constancy is proved, preserving the same rhythm; their cessation or their absence would be the abnormal fact.

These conclusions have been extended and confirmed in a remarkable manner since the establishment of automatic instruments, intended to take a graphic tracing of these phenomena. A pencil in constant connection with the level of the lake draws a line on an endless paper, which is unrolled by a clockwork movement. Following the forms of this line, we discern in a very exact manner the influence of the various waves of oscillation, whose amplitude may vary from a few millimetres to a metre and more, if it has to do with the extremity of the lake, near Geneva. At Morges the first model of this apparatus was set to work, named by its inventor "registering limnimetre;" the curves obtained are compounded of the actions of various categories of *seiches*. They are more or less difficult to discern, but ordinarily recognisable and in connection with the rhythm corresponding to each. At Sécheron, near Geneva, where M. Ph. Plantamour has had an apparatus of the same kind constructed, the longitudinal *seiche* shows itself in a much more sensible manner, corresponding to a duration of about seventy-three minutes. The vibrations which affect the level of the lake under the influence of the wind or the passing of steamers disturb here much less than at Morges the study of the rhythm of libration, and above all, the measurement of the amplitude of this libration, which is, as we have said, much more considerable than at Morges.

This second registering limnimetre has only been working regularly since June, 1877. It has already served to confirm the fact of the alternation of the movement of the water, which rises at Geneva, while it falls at Morges, and *vice versâ*, following the period of seventy-three minutes for the great longitudinal *seiche* of the lake, thus confirming the presumption of an oscillation of the liquid mass around a median line, normal to its length. Morges, being situated at a short distance to the east of this line, offers a movement of the water of very inferior extent to that of the terminal part of the lake near Geneva. It is desirable that a similar apparatus be set up at the eastern extremity of the lake, between Vevey and Villeneuve, with a barometer comparable to that at Geneva, and giving constant indications.

It is generally presumed, in fact, that it is to changes of pressure on various parts of the lake that the variations in the intensity of the oscillatory movement of the water are due. These variations are nearly always marked during stormy weather. Before the storm comes on, before even the barometric column is disturbed, the libration increases in amplitude. But concordant observations at the two ends of the surface which is agitated have not yet been made to furnish data to determine if an increase of pressure at one of the extremities of the lake coincides with a depression at the other. The point remains, meantime, very doubtful, and very worthy of being investigated.

As to the oscillations of exceptional amplitude, such as those of October 3, 1841, when the difference of level observed at Geneva exceeded 2·14 metres, the presumption was that we ought to seek for the cause in some movement of the earth's crust, of the basin of the mass of oscillating fluid. Great, then, was the anxiety of Swiss observers, when, on October 8, 1877, they were awakened at 5·16 A.M. by a strong shock of earthquake, on running to their limnimetre, which they found working very regularly. But no trace of the action of that violent commotion was shown by the registering pencil. Not only must that absence of effect make us seek elsewhere for the cause of these mysterious accidents, but we have reason to be astonished at the insensibility of a liquid surface which remains calm though balanced on ground which was so agitated as to crack the woodwork of houses, ring bells, and displace furniture in all the neighbouring region. This disappointment is a new motive to continue this interesting research, and to enlist the physicists of every nation, all the more that wherever there are lakes there ought to be *seiches*. E. G.

EXAMINATION OF THE PHONOGRAPH RECORD UNDER THE MICROSCOPE[1]

MR. FRAZER referred to previous results obtained by him of some examinations of the tin foil which had been indented by the stylus, or needle point, of the pho-

[1] Abstract of paper presented at the meeting of the Franklin Institute April 17, 1878, by Persifor Frazer, Jun., A.M.

nograph. His object was to ascertain the shapes of the indentations made by different known sounds. The vowels and diphthongs were spoken into the mouthpiece of the apparatus with small panels in the order seen on the diagram.

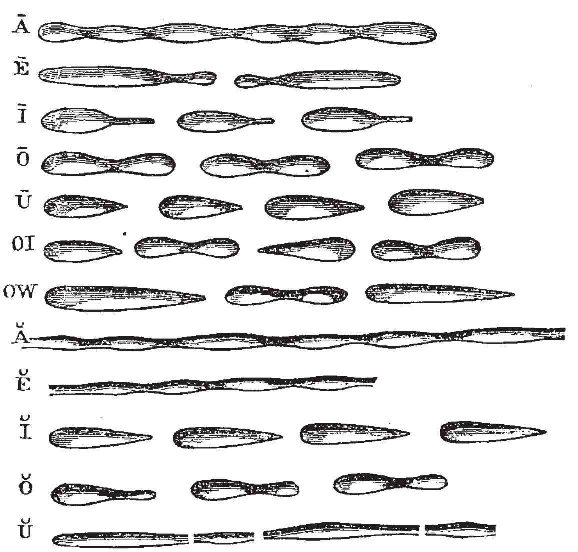
These sounds were repeated thrice on each of three foils. They were then mounted on glass plates, separated, and labelled. Finally, they were cut out and mounted on another piece of glass vertically, instead of horizontally, in order that a number of the dents produced by any given sound might be on the screen at once.

Lissajous, Leon Scott, and König have provided the means of transforming sounds into form, in various ways, viz., by bright points on the ends of steel bars of different thicknesses; by vibrating membranes at the extremity of a "phonautograph," and by flames reflected in a rotating mirror. It was natural to conclude that the same vibrations, imparted to a steel point by means of a metal diaphragm, would leave an equally characteristic trace.

The same voice (that of Dr. Plush), speaking the following vowels and diphthongs as nearly as possible at the same distance from the mouthpiece, was relied upon for the matrices.

The first records tried, to ascertain whether the pronunciation was perfect, were afterwards thrown away, and the records which were studied were not in any way injured by a second passage of the point of the stylus.

By following along the nearly vertical line of impressions, which are at the same time in focus, it will be observed that this line consists of one long followed by two shorts (or two shorts followed by one long), the indentations bearing a general resemblance to each other and to seeds. This is long A, or "Ah." A glance at



[Note.—In the wood-cut, the forms made by the excursions of the stylus for the short letters are wider than they should be.]

short ă (as in "bat"), will show the same thing, but the seed-shaped hollows are narrower, and there are no abrupt terminations of the hollows by intervening parts of the foil, which have not been touched by the needle-point.

Ē (or ay), on the screen, looked like the magnets of two Bell telephones, with the small ends turned towards each other. In the diagram they look like two Indian clubs with the handles together. The same general resemblance is observed in E short, except that, as in ă short, the volume of sound being less, the intensity was less, or (what is the measure of intensity) the path of the needle-point was shorter, and it seldom entirely cleared the foil, the consequence being a continuous groove of irregular, but normally irregular, width.

Ī and Ĭ are much alike in general form, as also are Ō and Ŏ, the coupling of the pairs of the latter being the most striking feature. Ū and Ŭ, in the drawing, best show the difference in shape produced by less intensities, the short being drawn out, and more acicular.

OI is very interesting. The diphthong consists of ŎĬ, and the very moulds which characterise their sounds are to be observed in the cut.

OW presents a composite character, but its derivation has not yet been made out.

The above presentation of the subject is necessarily crude and imperfect, but will illustrate the possibilities of an exhaustive investigation.

THE LIFE-HISTORY OF A SEPTIC ORGANISM[1]

THIS was an account of a hitherto unrecorded organism, belonging to the septic series, which was found in the earlier stages of the decomposition of the macerating body of a vole. It was studied by the aid of the "continuous stage" used by the author and Dr. Drysdale in their "Researches on the Life History of the Monads,"[2] by means of which a drop of the septic fluid containing the organism can be kept under examination for an indefinite time, without evaporation; and be studied with the most delicate and powerful lenses. The method pursued was continuous study, first of the details of the several metamorphoses, and by the light thus gained, a continuous study, subsequently, of their sequences in the same individual form.

The majority of the most difficult and delicate work was done with a new $\frac{1}{35}$-inch lens, made for the author, with a special view to this class of observation, by Messrs. Powell and Lealand. He also had the advantage of the fine "new formula" lenses, made by the same firm recently, that is to say, two $\frac{1}{8}$ths, a $\frac{1}{12}$th, and a $\frac{1}{16}$th. He also used their $\frac{1}{25}$th and $\frac{1}{50}$th inch objectives.

The organism never exceeds the $\frac{1}{4000}$th of an inch in long diameter: it is oval, with a constriction slightly in front of its short diameter: and at its anterior extremity has a head-like protrusion, to which is attached a long delicate flagellum. At the sides of the shorter, or front segment of the oval, somewhat in the position of "shoulders," two long fine flagella proceed, and as a rule trail with exquisite grace behind; one on either side. It swims with great rapidity and has every variety of motion in the fluid: and in the accomplishment of its evolutions its lateral flagella are largely concerned. But besides its swimming power, it has the capacity to anchor both its trailing flagella to the floor, or the stage, or to a decomposing mass, and by coiling these flagella, and bringing itself down upon the body to which it is anchored, and then suddenly darting up so as to make its flagella, together, the radius of a circle, it darts down on the decomposing substance, and by the enormous numbers that are constantly doing it, aids in the rapid breaking up of the tissues.

By steadily following it in the free-swimming condition it was seen to undergo fission or self-division, which was a very complex and extremely delicate process; the division beginning in the front flagellum and proceeding until, by longitudinal division, a new lateral flagellum was, in the act of self-division, made for each half; and by the snapping of this both halves went free as perfect organisms, soon to commence the process again. A great deal of close and careful detail was given of this process, and was accompanied by illustrations drawn from nature. There were also accounts of a series of

[1] Abstract of Paper read before the Royal Society on the Life-History of a Minute Septic Organism: with an Account of Experiments made to determine its Thermal Death Point. By the Rev. W. H. Dallinger, F.R.M.S.

[2] *M. M. J.*, vol. xi. pp. 97—99.