

Mr. Preston Edwards makes the hypothesis that a weak larynx tone arouses a complex of resonance tones in the vocal cavities, and that these are then heard with a strong lower tone corresponding to the larynx tone. We can sing all the vowels with a single strong larynx tone; that all the varied resonance tones should coincide in producing this single strong larynx tone is quite beyond imagination. It is scarcely necessary to follow this thought out; the fact remains that the larynx tone is by far the strongest tone in the vowel, both physically and for the ear.

A comparison of vowels with tones from reed instruments is inadmissible. The resonating cavities in the latter have hard walls and can force their periods on the reeds, whereas the vocal cavities have soft walls and cannot do so.

Helmholtz's theory of the vowels rests on three assumptions:—(1) The vibrations from the larynx are of the form of a simple sinusoid or of the sum of a harmonic series of simple sinusoids. (2) The vocal cavities act like resonators with hard walls. (3) The larynx tone is maintained at constant pitch. This is the condition exemplified in Helmholtz's vowel apparatus, in which tuning-forks (representing the larynx tone) are maintained electrically in vibration before brass resonators (representing the vocal cavities). Such resonators can respond only to harmonics of the fork tone. If the three suppositions are true, the harmonic theory necessarily follows.

In an interesting apparatus devised by Dr. H. Hartridge a series of weights is hung by threads of different lengths from a bar that can be set in sinusoid vibration. When the bar is started all the pendulums begin to swing, but after a few vibrations all become still except the one that corresponds to a harmonic of the period of the bar. It takes, therefore, several vibrations before the period of the bar is forced on the appropriate pendulum, and the others are forced to become still. Remembering the first fact—that a single movement of the bar starts all the pendulums—let us now drop the third supposition above and conform to the truth that the voice tone is never of a constant pitch for a single instant. In speech it changes so rapidly up and down that two successive vibrations are rarely of the same pitch. Each single vibration must start all the pendulums—that is, all the tones of the resonators—and there is no possibility that the tone of the voice can force itself on the resonators. Even retaining the first two suppositions, we are forced to conclude that any harmonic adjustment of the vocal resonators to the voice tone is impossible, because it takes at least two like periods of the voice tone to force its frequency on a resonator, whereas in actual speech the voice tone does not have two like periods in succession. The Helmholtz theory is thus impossible, because the third supposition is contrary to fact.

Let us now examine the effect of retaining the first and third suppositions while modifying the second to fit the facts. The resonators have soft walls, and any vibration aroused in them will die away rapidly. Even if the laryngeal vibration were of the sinusoid form, the resonance vibration aroused by one positive (or negative) phase would die away before the corresponding phase occurs again. To a simple sinusoid or a tuning-fork tone there is at the best only a weak response. With more complicated sinusoids or sharper tones there may be rapidly repeated overtones that evoke some response. The result is utterly different from the loud responses evoked by forks held in front of resonators with hard walls.

The moment we give up the first assumption and accept the fact that the tone from the larynx consists of a series of sharp blows, and not of continuous

vibrations, all possibility of the harmonic hypothesis vanishes. A sharp blow can arouse only the free vibration of the cavity, whether hard or soft. The tones aroused are those of the cavities themselves. Their periods have no relation to the period of the blow, simply because the blow itself has no period. Even in a cavity with hard walls the aroused vibration dies away so quickly that the blow would have to be repeated rapidly in order to catch any of the dying motion.

As explained in my account in NATURE (January 13 and 20, pp. 632 and 664), every one of the three assumptions is contrary to fact. If Helmholtz had had the data we possess to-day the Helmholtz theory of the vowels would assert that the cavity tones may bear any relation to the larynx tone. The whole thing follows so easily and naturally from the facts that he would have drawn the unavoidable conclusion, and not have become involved in the difficulties and impossibilities caused by asserting that this relation must be harmonic.

Of course, this has nothing to do with the Fourier analysis. This method gives us a plot of what harmonics might be used to reconstruct a curve. The profile of a face can be resolved into a series of harmonics. The blunder occurs when someone supposes that this mathematical analysis proves anything physical. The analysis of the profile does not prove that the face was constituted of harmonics. As explained in my first article, the harmonic plot of a vowel wave represents a mathematical formula. As soon as we attempt to give a physical interpretation to this formula we are forced to reject the harmonic theory and to assert that the vowel tones may bear any relation whatever to the fundamental. The Fourier analysis still remains the only way of analysing vowel curves, and its results prove the independent theory of the vowel tones.

E. W. SCRIPTURE.

#### The Generation of Heath-fires.

Is Mr. Martin (NATURE, August 25, p. 811) certain that the fire seen by him had not spread through the peat from a neighbouring area recently ablaze? That such subterranean combustion may persist for many days and spread a long distance is common knowledge.

Experience shows that the surest way of preventing fires is to cut away the heather; whereas, on Mr. Martin's hypothesis, by exposing the loose soil to the direct rays of the sun this procedure should add a new risk.

HENRY BURY.

Mayfield House, Farnham, Surrey, August 26.

#### Life and Mind.

DURING the past six months NATURE has published many articles and reviews about life and mind, but there has been no clear and precise definition of these two terms; so permit me to submit for the serious consideration of your scientific readers a brief statement of what appears to be the true position of affairs:—

(1) We depend only upon evidence of what is called "matter" and its various states.

(2) Life is a state of certain kinds of matter when physical conditions are favourable.

(3) Mind is the state of some portion of a living organism—in man the cerebral cortex, where thousands of nerve-endings are concentrated.

This is no attempt to explain the *how* and *why*; but can the facts, if facts they be, be expressed more simply or concisely and with greater precision? The question may appear trivial, but it has an important bearing on other subjects which are alluded to from time to time in NATURE.

SESAMY.