

been born and brought up, but to which probably not one in a hundred, even among scientific men, has given two minutes' original thought.

The great clarification of ideas which distinguishes modern science, and especially physical science, ought not to stop short of this most vital and fundamental problem which so menaces the well-being of the community. It is, indeed, a most fascinating problem for its own sake. The mathematician would enlarge his knowledge of the consequences of a mistake in sign in a field where such mistakes are of fearful import to whole nations, and the physicist, of a perpetual-motion machine fallacy underlying and destroying the hopes, not of a half-crazy would-be mechanic, but of a half-crazy would-be mechanical civilisation. In his well-known book, "Instincts of the Herd," Mr. Trotter has put one obvious point inimitably. "It is this survival, so to say, of the waggoner upon the foot-plate of an express engine, which has made the modern history of nations a series of such breathless adventures and hairbreadth escapes." I venture to suggest that the survival of the herd-instincts of the waggoner in an express age applies as much to those who have built the express as to those who try to drive it.

The British Association naturally suggests itself as providing the proper platform for this proposed re-examination of the physical basis of our economic system, since it has an Economics Section which, no doubt, would welcome as eagerly as the public the introduction of an element of science into its proceedings. One needs to be only a casual observer of the trend of events to know that the public, thoroughly alarmed by the consequences of peace, and fearfully awaiting asphyxiation in the next war, would take an interest in this question that would rival that of the palmy days of Huxley and the Bishops.

FREDERICK SODDY.

WE shall all sympathise with Prof. Soddy's desire that our industrial system should give a state of society in which the material lot of the people should be "vastly improved" by the application of science. We should differ from him in various degrees as to the extent to which this has been already secured, and the means which should be taken to accelerate the process. I gave in the article quoted some reasons for believing that considerable improvement had taken place: it seems, in fact, untrue to say that "we are perishing" under our present economic system. The only country which can be said to have come near to "perishing" is Russia, which attempted entirely to discard the system and is now, after a desperate experience, painfully and slowly retracing her steps. The next most seriously distressed country in the world is China, which has never attained to our modern industrial system.

By all means enlist the Economics Section of the British Association in a discussion of the problem—or rather the host of problems—involved. But do not antagonise the Section at starting by suggesting that it would be a good thing to introduce "an element of science into its proceedings." The Section has been proceeding on that assumption for a good many years now.

F. S. M.

#### Tactile Vision of Insects and Arachnida.

WITH reference to Commander Hilton Young's suggestion noted on p. 409 of NATURE for March 24, it may possibly be of interest to record the conclusion at which I and my colleagues arrived, when engaged, two years ago, in research on the so-called

eyes in insects and arachnida. In all the species studied, including the house-fly and red ants among the former, the house spider (*Tegenaria domestica*) and many of the Epeiræ among the latter, we were forced to the conclusion that the organs generally known as eyes do not act as organs of vision. What their main purpose is, was never *certainly* determined by us; but the many phenomena which were studied as evidence of sight could all be reduced to *touch* sensations. For example, to take perhaps the simplest illustration, if the hand be slowly advanced towards a fly on a window-pane, the insect, if it be a vigorous specimen, will evade the caress. But if the hand be advanced towards the fly when the insect is on the opposite side of the glass to the hand, it may often be necessary to tap severely in order to disturb its wanderings.

Apart from air currents due to the motion of the hand, and possibly some convection currents due to the heat of the same, it is difficult to afford any other satisfactory explanation of this simple phenomenon, which any one can examine for himself with the greatest of ease.

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March 24.

#### The Resonance Theory of Hearing.

THE difficulty expressed by Sir James Barrett in NATURE of March 24, p. 396, is probably more apparent than real. If attention is focussed on the relative dimensions of the various parts of the cochlea rather than their actual sizes, I think that the range of analysis can be explained.

In the short compass of a letter I cannot deal with a full consideration of the analytical mechanism of the cochlea. A variation in pressure applied to the *fenestra ovalis*, if it is to cause a movement of the basilar membrane, must cause movement of the liquids in the cochlea. The impedance due to the inertia of the liquid is considered by Mr. Wilkinson as a "load" on the vibrating strings. In all considerations of the action of the cochlea the influence of the viscosity of the liquid has been overlooked (see *Philosophical Magazine*, 1922, vol. 43, p. 349). The friction of the liquid against the walls of the cochlea impedes the movement of the liquid so that if the diameter of the cochlea were uniform the resistance would be proportional to the distance from the *fenestra ovalis*. As the cochlea becomes narrower this is a safe assumption. If the highest audible note acts on the basilar membrane  $5\mu$  from the commencement of the cochlea, the ratio of the impedance due to viscosity of this highest note to the lowest note might be 35,000 to 5. This is approximately the ratio given by Mr. Wilkinson without the assumption of any difference in tension in the fibres of the basilar membrane. I do not wish to imply that there is no difference in tension, but the greater bulk of the spiral ligament may be merely to resist a greater strain, and is not necessarily an indication of a greater initial tension.

If one wishes to look at this subject from the point of view of resonance, the effect of viscosity can be illustrated by narrowing the orifice of an air resonator. This lowers the note, just as the viscosity makes the note lower for the distal end of the cochlea, but the viscosity of a liquid will be much more important than the viscosity of a gas. Viscosity, however, is only one of the factors concerned in sound analysis.

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