length of each which responds to radiation is a kind of measure of specific intensity. They form (speaking sensationally) an electric eye with a definite range of colour sensation. It would be easy to supply it with a pitch or paraffin lens.

There is no need to suppose the retinal bodies to be conducting: a body of high refractive index should be subject to electric vibrations, and its surface to spurious electrifications, when radiation falls upon it; and the optical density of the rods and cones is known to be high. They may, however, be electrolytic conductors; and I find that a liquid sphere—e.g. a flask of inky water—responds to radiation, giving a glow to a point touching its glass.

The diameters of the rods, as measured by various physiologists, are not very different from dimensions adapted to respond to actual light-vibration frequency; and if this idea substantiates itself, these bodies can be supposed to constitute a sort of Corti's organ responding to etherial instead of to aerial vibrations, and stimulating in some still unknown, but possibly mechanical, manner, the nerve-fibre and ganglion with which each appears to be associated. OLIVER J. LODGE.

University College, Liverpool, March 11.

"Peculiar Ice-forms."

MAY I add another to the long series of communications which from time to time have been addressed to you under the above heading? Most of them have described and discussed the occurrence of ice in the form of filaments. One signed by J. D. Paul (NATURE, vol. xxxi. p. 264) seems (the description is somewhat vague) to refer to a mode of ice formation which is of somewhat frequent occurrence here, and is the only reference to this mode which I can find in that portion of the literature of physics which is accessible to me.

It happens now and again in our variable climate that a loose porous soil which has been thoroughly soaked with rain is made by a sudden and a sharp frost to produce a crop of little columns of ice. I observed a striking instance lately on a piece of hard compact ground, which, not being quite smooth, had been covered with an inch or so of loose pebbly soil for levelling purposes. Before the loose soil had been rolled or trampled upon, it became saturated with water through two days of continuous rain; and while it was still saturated, a sharp frost set in at night. In the morning the ground, to the extent of 60 square yards, was found to be covered with little columns of ice, some of them about two inches in length. They were roughly circular in section; and each column had approximately the same section throughout. Their diameters ranged from one-tenth to one-third of an inch. They were not transparent, but were whitish in appearance, and carried on their summits pebbles or frozen earth. They were thus obviously not ice crystals, such as Brewster describes in the *Edinburgh Journal of Science*, vol. ix. p. 122, as occurring in similar circumstances. The columns started from the ground at various inclinations to the vertical, and in the great majority of cases they curved upwards to a greater or less extent. I had never noticed this upward curving of the ice columns before, but other persons familiar with the phenomenon assure me they have observed it.

The explanation of this mode of ice formation seems pretty obvious. The sudden frost solidifies the crust of the soil; and it may therefore sometimes happen (in the above case it clearly must happen) that water becomes imprisoned between the frozen crust and the impervious sub-soil. Further freezing enables nature to perform Major Williams's experiment for us. If the crust does not give way as a whole, it must at its weak points; and the internal pressure is relieved by the protrusion of ice columns through apertures formed at these points. These columns would naturally carry portions of the crust on their summits, and during their protrusion might be expected to have innumerable minute fissures or cracks produced in them so as to exhibit a whitish snowy appearance. At the base of any column, at points where the freezing-point has been lowered by the pressure to the actual temperature, melting is continually occurring, and the water thus formed will flow into the fissures referred to. If the axis of the column is inclined to the vertical, and if we assume that the fissures and the points at which melting occurs are pretty uniformly distributed, more water will flow into the fissures of the lower side of the column than into those of the upper side. When the water re-freezes therefore, the lower side must elongate more than the upper, and the column

must consequently in general curve upwards. That in exceptional cases the upward curving may not occur is obvious.

J. G. MACGREGOR.

Dalhousie College, Halifax, N.S., March 1.

On a Certain Theory of Elastic After-Strain.

IN a recent paper (Proc. Lond. Math. Soc., April 11, 1889), Prof. Karl Pearson has discussed at some length the possible forms of the additional terms which may be introduced into the general equations of elasticity by a consideration of the mutual action of the molecules and the ether, and has examined what physical phenomena may admit of explanation in this way. In particular, certain terms which thus appear admissible are made to yield a theory of the phenomenon known as "*elastische Nachwirkung*," or "after-strain." The attempt to explain such a comparatively slow process by the intervention of the ether certainly invites scrutiny, and in fact a very slight examination serves, I think, to show that the theory in question rests on a mistake. The author, after writing down the equations which (on his view) represent the steady application of stress to a portion of matter, proceeds to integrate them in the usual way by assuming a time-factor e^{mt} , and arrives at a quadratic in m^2 whose roots are μ/μ' and $(3\lambda + 2\mu)/(3\lambda' + 2\mu')$, where λ, μ are the ordinary elastic constants of Lamé, and λ', μ' are the coefficients of the additional terms referred to. He continues:—"Now m cannot be *positive*, so long at least as we are dealing with elastic-strain. For λ' and μ' are small as compared with λ and μ , the effects we are considering being only of the second order. Hence m^2 is large, and if m were positive the strain would rapidly grow immensely large, which is contrary to experience. Thus, we must give m the negative values $-\sqrt{(\mu/\mu')}$ and $-\sqrt{\{(3\lambda + 2\mu)/(3\lambda' + 2\mu')\}}$." The positive values of m are certainly inconvenient, but they are on the same footing with the negative ones; all are solutions of the author's equations, and all are required for the purpose of satisfying arbitrary initial conditions. The proper inference is surely that the substance is unstable, so long as the constants μ/μ' and $3\lambda' + 2\mu'$ are (as the author has tacitly assumed them to be) positive. If, to avoid this disaster, we change the signs of these constants, we get circular instead of exponential functions, and all analogy to elastic after-strain of course disappears. In its place we have *vibrations* (not molecular, but "molar") whose period is intrinsic to the substance and independent of the dimensions of the portion considered. To what physical reality these may correspond I do not undertake to say.

HORACE LAMB.

The Owens College, March 4.

Foreign Substances attached to Crabs.

IF, as Mr. Garstang seems to suppose, the presence of tunicates on a crab is to be regarded as a danger-signal to its enemies, then *Hyas* must belong equally to both his groups α and β . I have found simple tunicates (*A. sordida*) on two small specimens of *H. coarctatus*. In one example they almost completely hid, and several were larger than, the crab. I do not know if anyone has observed *Hyas* "dressing" itself with tunicates. I should think it was an operation of some difficulty, at least in the case of *A. sordida*, which adheres pretty tightly to stones and shells. It cannot be said to be brilliantly coloured, so that its assumption by *Hyas* might be regarded as only an adaptation for concealment, as in the case of *Alga*—belonging, therefore, to group α . It seems to me, however, very doubtful whether a small *Hyas* would, even if it could, willingly burden itself with such a serious incubus as half a dozen tunicates. Probably their presence is in no way due to any act of the crab's.

The shore-crab, as pointed out long ago by Prof. McIntosh, frequently suffers loss of sight by the usurpation of its orbit by a growing mussel, and the Norway lobster has been found with one eye grown over by a Polyzoan. Such foreign bodies are surely rather hurtful than protective, and the same may perhaps be said of the tunicates on *Hyas*. It is also a question whether the crab likes the smell of tunicates any better than its neighbours.

I think Mr. Garstang is wrong in assuming the inedibility of tunicates. Prof. McIntosh, in "The Marine Invertebrata and Fishes of St. Andrews," speaks of *Molgula arenosa* as being found abundantly, and of *Pelonia corrugata* as occasionally in the stomach of the cod and haddock; and Mr. W. L. Calder-