Letters to the Editor.

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Limbs and Pigment-Cells.

I NOTICE in a review of Franz's "Geschichte der Organismen" which appeared in NATURE of December 20 a reference to the interesting evolutionary problem of the origin of the limbs of vertebrates. I have no intention of essaying the futile task of endeavouring to influence those whose minds are already made up regarding this problem, but I should like to direct the attention of others to the point that new facts having important bearings upon the problem have come to light in the investigation of the development of these relatively archaic types of vertebrate, Lepidosiren, Protopterus, and Polypterus. A short summary of these facts, and of the conclusions they suggest, will be found in my volume on vertebrate embryology, and the perusal of this summary will, I think, suffice to indicate the grounds for my belief that the older hypotheses referred to by the reviewer will, as knowledge of the relevant facts becomes diffused, be replaced as working hypotheses by the newer view that the limb of the vertebrate has evolved out of a projection from the body-wall which was primitively respiratory in function.

I take this opportunity of directing attention to another statement in recent literature which is liable to cause misunderstanding. It occurs in a book by Dr. L. T. Hogben entitled "The Pigmentary Effector System," where he refers (p. 93) to "Kolliker's work on the South American mud-fish, Lepidosiren." The creature upon which Kölliker worked was of course not the creature known to us to-day as Lepidosiren, not the South American "mud-fish," but the African Protopterus which for a brief period after its discovery was called Lepidosiren. As Dr. Hogben does not refer in his summary of our knowledge regarding the pigment-cells of fishes either to what I have published on the subject, or to what I made known to him by word of mouth, I will state very shortly the attitude that my work upon Lepidosiren caused me to take up, and which I have consistently adopted in teaching for many years. I adhere to the view that the colour change, so beautifully exemplified by the young Lepidosiren—of a deep rich black during the day and practically colourless during the hours of darkness (see Phil. Trans. Roy. Soc. B, 192, 1900, and *Quart. Journ. Micr. Sci.* 46, 1902), is due to actual change in the form of the black pigment-cells which, under the influence of light, push out their finely branched pigment-laden pseudopodia in a direction parallel to the surface of the body so as to provide a light-proof coat, and, when night falls, draw in their pseudopodia and shrink up to spheres so relatively small as to be without effect upon the general colouring. The considerations which induced this opinion were (1) the appearances presented under the microscope, (2) the fact that the pigment-cells changed their position in the body and therefore necessarily had the power of moving their pseudopodia, and (3) the fact that it was possible by teasing up the night skin to isolate individual chromatophores without their going to pieces as they would be liable to do were peripheral extensions of their body torn through in the operation.

As regards the active functioning of the pigment-cells there is, I think, a tendency towards over-emphasis of one or other of the factors involved. There is, first of all, the fact that the healthy activity of the chromatophores, as of all other cells in the body, is dependent upon the internal medium of the body being of approximately "normal" composition, and recent work by various investigators, including Hogben, has served to emphasise the special importance of particular components of the internal medium provided by the adrenal or the pituitary organ, slight fluctuations in the proportion of this particular component evoking specific functional responses. There is, secondly, the nervous factor, and there is, thirdly, the direct influence of light.

As regards the latter, I may quote an observation made by me in South America. I happened to be watching a green tree-frog in the sunlight and admiring the extraordinarily perfect agreement between its colour and that of the surrounding leaves. Across its back fell a dark narrow bar of shadow caused by a blade of grass close by. When I caused the tree-frog to change its position it appeared, to my astonishment, to carry the shadow with it, the position where it had been remaining for some little time clearly indicated by a dark band across the green surface. That observation served to impress upon my mind very vividly the fact of response by the skin chromatophores to localised light stimulus, and while such responses may turn out to be complicated reflexes involving the central nervous system, it seems to me simpler, until convincing evidence to the contrary is produced, to regard them as direct cellular reactions to changes in the incidence of light rays.

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Muscular Action.

DURING the last few years a considerable number of papers have appeared bearing on this subject. They may be divided roughly into two classes, the first dealing with the fatigue caused by muscular action, together with the nature of the accompanying waste products; the second, with the behaviour of isolated muscles under the action of artificial stimulus.

From a mechanical point of view, a muscle is a single-acting engine which can exert a pull but not a thrust: and with regard to any class of engines, some of the most important questions which can be asked are: What is (1) their efficiency; (2) their weight for unit of power; (3) how does the efficiency vary with the rapidity of the stroke (*i.e.* piston speed); (4) how do these quantities vary with absolute size? The physiologist may further inquire: (5) What is the nature of the nervous stimulus and how does it effect the required longitudinal contraction and lateral dilation of the muscular fibres? Electricity will act as a stimulus, but (6) is it certain that nervous stimulus is of the same nature? (7) Does an excised muscle behave in the same way as the muscle in a living animal?

Striped muscle wherever met with—from mammal to insect—varies very little in appearance or in the cross-section of the individual fibres. (8) Is the contractile force which can be exerted by each fibre the same or nearly the same in all orders?

These questions are not answered by any of the papers to which allusion has been made.

In a letter which appeared in NATURE of April 15, 1920, I said: "When muscular force is exerted, power is expended and fatigue is produced, even when the muscle remains stationary. Again, when no external force opposes the contraction of the muscle, physiological causes set a limit to the speed at which contraction can take place. In both cases the whole power