find the products of their change, but the atomic débris should rather be sought in all the materials of the earth's crust. What we have now of radio-active elements may be residues. JOHN B. COPPOCK.

Science Schools, Stroud.

Phosphorescence of Photographic Plates.

HAVING seen in NATURE several letters on the above subject recalls to my mind some experiments made by me two years ago. I first observed it after developing X-ray plates, and mentioning the matter to Prof. Poynting, of the Birmingham University, he advised me to pursue the subject further.

I subsequently found that the same phenomena were exhibited with a photographic plate, whether previously exposed to light or not. I observe that your correspondent, Mr. Bloch, says, that he "chanced to empty some spent pyro developer and a dilute solution of alum into the sink of the dark room at the same time, when the whole liquid at once glowed with a brilliant phosphorescence."

By "spent pyro," I presume that he attributes the phosphorescence to the influence of the silver salt of the plate upon the solution.

May I point out that the phosphorescence is exhibited by the mixed pyro and soda solutions in an ordinary white developing dish, without any contact whatever with any photographic plate or paper, and without adding any other salt; but that the phosphorescence is not so brilliant, and takes a longer time before it can be seen?

The phosphorescence is distinctly seen by pouring the solution of pyro and soda into the dish, allowing it to remain a few minutes, and pouring it away so that only a few drops are left on the dish.

I tried to obtain a photograph of an object between the luminous dish and the camera, but without success.

My friend, Dr. Martin Young, of Birmingham, who is an ophthalmic surgeon, and accustomed to deal with optical phenomena of a delicate nature, being particularly sensitive to the faintest luminosity, in assisting me was able to localise the position of the dishes and even of glass measures containing the solutions in the dark room where no photographic plate had been in contact with the liquid.

We concluded that the phosphorescence was entirely due to the process of crystallisation taking place in a thin layer of liquid. WALTER J. CLARKE.

Gravelly Hill, Near Birmingham, February 9.

Hering's Theory of Heredity, and its Consequences.

UNTIL lately I supposed, with most biologists, that the phenomena of heredity and variation were facts which we were quite unable to explain. But having had occasion to study the subject once more, I have found in Prof. Hering's[1] address on "Memory as a General Function of Organised Matter," delivered to the Imperial Academy of Sciences at Vienna on May 30, 1870, the germ of a theory which simplifies everything, and throws quite a new light on the problem of variation. In fact, when carried to its full extent, it reduces our difficulties almost to the everlasting mystery of the nature and mode of action of mind, a mystery which can never be solved.

This address passed almost unobserved in England at the time of its delivery. It was noticed by Prof. Ray Lankester in NATURE of July 13, 1876 (vol. xiv. p. 237), when reviewing Prof. Haeckel's "Hypothesis of Perigenesis," but it is not mentioned in Darwin's letters. In 1878 Mr. Samuel Butler published his book "Life and Habit," in which the same theory is independently advocated, followed in 1880 by "Unconscious Memory." Owing to several causes these books did little if anything to advance the theory, but in "Unconscious Memory" Mr. Butler gave a translation of Hering's address, and subsequently another translation was published in "The Religion of Science Library" (*Open Court* Publishing Co., Chicago), which reached a second edition in 1897, so that probably it is attracting more attention in the United States than in England.

Prof. Hering's theory is as follows. Memory, he says, is the faculty of reproducing old ideas or sensations. Often it is a conscious act, and we call up a memory voluntarily; but sometimes these memories come spontaneously, even when we do not wish for them. To account for this we must assume that the original idea or sensation made some material alteration in the substance of the brain, vestiges of which remain, and the nervous substance is enabled to reproduce the idea at will. These material vestiges are not permanent, but fade away unless they are strengthened by repetition, although by constant effort we can recall memories with great precision.

However, conscious memories, whether voluntary or not, form but a small part of our life. They emerge but occasionally from the mass of unconscious memories, or habits, by means of which we carry on all the daily operations of eating, moving, talking, &c. In all these cases it is the unconscious memory which tells us what to do and guides our actions. Habitual performance of an action makes it easy, and after constant repetition it becomes unconscious or automatic. This would not be possible if the nervous system was unable to remember and reproduce former states of irritation, and when habits are transmitted from one generation to another they are transformed into instincts.

But memory is not confined to the central nervous system. The unconscious memory of the sympathetic system is as strong as that of the brain, and we can recognise automatic or reflex action even in a single ganglion. Indeed, the minute Protozoa, such as Vorticella, which have no nervous tissue, show irritability, which is only a form of reflex action, so we must acknowledge that they also have memory and instincts. Even plants have instincts. The roots grow downwards and stems upwards by instinct. It is instinct that makes the ivy grow towards the shade and the clematis towards the light.

Now we cannot draw a line between instinctive action and heredity. When a corpuscle of protoplasm divides, if the two halves separate we call it an instinctive or automatic action, if they remain together it is heredity. When a gnat bursts its larval skin and flies away, the flying may be called a voluntary action; the bursting of the skin is involuntary and instinctive, but so also is the formation of the skin.

But how can habits or structural variations be transmitted from one generation to the next? Prof. Hering gives the following explanation. The nervous system, he says, is a coherent unity, probably connected with every cell. Any irritation effected in one part is repeated by the others, and these repetitions would probably be stronger in the reproductive cells than elsewhere. The reappearance of the parent in the full-grown offspring can only be due to the reproduction of such experiences as the germ had previously taken part in while still in the reproductive organs. The offspring remembers these experiences so soon as the same or a similar irritation is offered. If the germ-cells of the parent organism are affected, however feebly, by the habits of the body, then the offspring, as it grows, will reproduce the experiences it underwent as a smaller part of the body. Therefore it accurately repeats what its ancestors have repeated through innumerable generations. When the first germ divided it bequeathed its properties to its descendants, the immediate descendants added new properties, and every new germ reproduced to a great extent the *modi operandi* of its ancestors. Each generation endows its germ with some small property which has been acquired during life, and this is added to the total legacy of the race. Thus every living being of the present day is the product of the unconscious memory of organised matter.

Such is Prof. Hering's theory of heredity and variation. I have rearranged the argument, condensing in some places and enlarging in others, but it is essentially the same as when he announced it thirty-three years ago. It has been said, on high authority, that Prof. Hering has merely substituted the term "memory" for the "polarity" of Mr. Herbert Spencer. But this is hardly correct, for Prof. Hering, by showing that heredity is a series of reflexes, each one of which acts as the stimulus to the next, has substituted a fact for a metaphysical conception, and in doing so has brought heredity into line with instinct and habit, the last of which we can understand to some extent. Of course there are difficulties in the way of accepting the

[1] Prof. Ewald Hering, F.R.S., Director of the Physiological Institute at Leipzig.