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.

theory, but before considering them let us see how Hering's theory affects our ideas of variation.

In the first place it gives an explanation of the definite variation which we see in the development of non-adaptive or useless characters. A variation, once started, would in the future have a tendency to be reproduced, and this tendency would get stronger and stronger as the memory is reinforced by repetition, and when once established the variation would be quite definite. New variations may be indefinite, but they must either die out or become definite; and we see by Hering's theory why useless characters may be as constant as useful ones, for constancy depends upon the number of repetitions and not on the nature of the variation or on the reason for its survival. This includes, of course, use-inheritance, for according to the theory, when an organ is constantly exercised the memories of the component parts are strengthened, and in the next generation the organ is reproduced better developed than in the last. It is the same with instincts; they are the inherited modifications of mental operations, while a structural development is due to the inherited modifications of physical operations. When an organ is not used the memories of the parts are weakened, and in the next generation the organ is reproduced in a more feeble condition, until at last it is not developed at all, the memory of the operation having been lost. The process is exactly the same as the gradual loss of an instinct from disuse; both are due to forgetfulness.

With regard to the action of external causes, Hering says that each generation endows its germ with some characters acquired during life. But we cannot suppose that adaptations to new circumstances are directly produced by the action of the surrounding conditions. For example, the fur in many animals gets thicker in cold climates and some plants get spiny coverings in dry climates. These cannot have been directly produced by the action of the climate, but must be due to the action of the protoplasm resisting the climate. Dry air could not directly produce the spines on a plant any more than it could produce the water-pouches in the stomach of a camel. Neither could feeding on nectar have produced the honey-bag of a bee, for it would be absurd to suppose that sucking liquid through a tube could cause a projection to grow out of it. We might as well say that rain and wind build houses or that snowstorms make great-coats as to suppose that the action of external influences made the cell-wall or the thick fur. Evidently it is the living protoplasm which originates these adaptations to protect itself from the rough elements or to prevent itself from being poisoned or starved. But how variations originate, whether they be intelligent and purposive, or whether they be blind, haphazard gropings after some change when the protoplasm feels uncomfortable, Hering's theory does not tell us.

There are other facts connected with variation which are explained by Hering's theory. As the germ contains two different memories, derived from its two parents, these may clash and antagonise each other, and so allow an older but dormant memory to be stimulated into activity. This is atavism. Or degraded characters which have suffered from disuse can, on a renewal of the old stimulus, again be recalled, as we see in proteus, which gets dark in colour when kept in the light. Prepotency can also be explained on the supposition that the germ of one parent has stronger memories than that of the other; and the reproduction of lost parts may perhaps be due to the memory of the remaining portions trying to replace the lost portion. In the same way we see that mutilations could not produce degeneration or the loss of a part, no matter for how many generations they may be carried on, because the part develops and the stimulus has been given before the part is removed. Again, the fact that variations appear at an earlier stage in the offspring than in the parent may be taken as evidence that they are due to an excited memory which anticipates events. But I do not see how Hering's theory can explain the infertility of hybrids. Conflicting memories might lead to inaction, but I cannot see why these conflicting memories should arise until the time had come to differentiate the embryo into the form of one or other of the parent species. This would give rise not to sterility, but to abortion, while it is thought that the fœtus generally perishes at an early stage of development.

Now let us consider the obstacles to believing in Hering's theory.

In the first place it may be objected that it is impossible to suppose that the small ovum, or still smaller spermatozoid, could contain all the memories necessary for building up the adult organism. This is an objection which applies to all hypotheses except epigenesis, and it is of considerable weight. However, the capacity of the germ-cells for storing up memories is not unlimited. It is only very few indeed of the impressions stored in the brain that are also registered in the germ-cells, and this, I think, is favourable evidence.

Next we have the difficulty of understanding the transmission of variations from different parts of the body to the germ-cells. This difficulty also is not peculiar to Hering's theory, but is common to all, and however difficult it may be to understand, we know that, with instincts, it is a fact. Darwin certainly said that it was an error to suppose that instincts were inherited habits, for they were due to natural selection. Romanes, following him, said that some instincts owed their origin to natural selection, while others were inherited habits. But natural selection, as Darwin also often said, cannot originate anything. It can only develop characters which are transmitted, and if habits—which are only mental variations—were not transmitted, natural selection could not develop them. These mental variations must have been transmitted by some physical process from the brain to the germ-cells, and adaptations of all kinds must in like manner have been transmitted, or there would have been no progress in the animal and vegetable kingdoms.

For instincts in animals must have been acquired either by inheritance or by imitation, and we have only to select instances where imitation is impossible to prove that instincts are inherited. For example, when a newly born baby cries, it is not imitating anyone in the room. It is repeating what its father and mother did in similar circumstances. It is the same with breathing. This must have commenced as a semi-conscious act which quickly passed into a habit and then became instinctive. When the crying of babies first began I do not know, but breathing has been instinctive ever since the Carboniferous period. Millions of generations, one after the other, have performed the operation, and it is now out of our power to stop it. Again, young fish never see their parents, yet they follow their habits, as also do young cuckoos and many insects. But I need not multiply examples; these are sufficient to prove that instincts are transmitted. If instincts are transmitted it must be through physical modifications made in the brain, and if this is the case there can be no doubt but that other physical modifications, not in the brain, can be transmitted also.

Prof. Hering says that the nervous system, which collects impressions from all parts of the body and transmits them to the brain, transmits them also to the germ-cells. But in plants and in animals without a nervous system the protoplasm itself must do the work, and it is therefore possible that the nervous system may not be used for this purpose in the higher animals. This is a question for future biologists to solve. But whatever the explanation may be, we must recognise as a fact that variations in external characters influence the germ-cells, and that the germ-cells reproduce these variations. If we call the analogous process in the brain memory, we must either apply the same term to the process in the germ or invent a new one.

Now we come to the last great difficulty, that of believing mind and memory to exist in the tissues of animals and plants. The best way of examining this difficulty is to ask ourselves What we mean by life? and How we recognise living matter?

As everyone knows, we recognise its presence by certain movements which are distinguished, without much difficulty, from movements due solely to physical energy. A bird flying through the air is alive, as also is a seed if, when placed under certain conditions, it commences to grow. Assimilation, or feeding, is the basis of all these movements. It supplies the materials for growth and the energy necessary for the movements.

This process of assimilation is only found in protoplasm, but it is not an essential property of that substance. We have dead protoplasm which has been killed by heat or starvation, by poison or by violence of some kind. These agencies, however, may cause disorganisation either in the structure or in the composition of the protoplasm, so that protoplasm so killed ought possibly to have another name. But this does not apply to all cases. When the oöspore of some of the lower plants—such as Chara—begins to germinate, the contents divide into two portions of unequal size, and while the smaller cell goes on developing the larger one never again moves, but its contents are gradually absorbed by the smaller cell. The larger cell of the two contains only dead protoplasm which has been separated from the living substance by the process of cell-division. Each contains part of the old nuclear plasm and part of the cytoplasm, and it is not supposed that they differ either in structure or in composition. It is the same with the polar bodies which are extruded by reproductive cells when they are maturing. They also are composed of dead protoplasm which has been pushed out by the living protoplasm remaining in the cell. The polar bodies cannot move by themselves, nor can they assimilate; they are dead protoplasm. Consequently we must assume that life is an adjunct and not a necessary quality of protoplasm.

Neither are the movements themselves life. When we speak about gravitation we do not mean the fall of bodies to the earth, nor do we call the movements of the mariner's compass magnetism. In both cases it is the *cause* of the movements which we designate as gravitation or magnetism, and it is the same with life. Now what do we know about the cause of these movements?

In the higher animals we recognise that vital movements are due to mind, that is, to intelligent action, where means are adapted to a definite purpose. We can only recognise mental action in others by the movements it produces, and it is by the nature of these movements that we judge of its presence. One great characteristic of mental action is cooperation, by means of which work is done which could not be accomplished by isolated action. This gives rise to harmonised movements either of different parts of the body or of different individuals.

Another characteristic of mental action is that it is capable of improvement by repetition. This is due to memory, which, by repetition, converts the irresolute movements, which are undertaken for the first time, into automatic or resolute movements. These automatic or reflex actions we recognise by their indefinite relation to the stimulus. The same stimulus may produce different effects in different parts of the body, or different stimuli may produce the same effect upon the same part of the body. Again, by constant repetition a stimulus may either fail to produce any effect owing to the protoplasm having got accustomed to it, or repetition may intensify the first effect. This is very different from the action of the physical and chemical forces, which act as resolutely the first time as afterwards; yet we sometimes see it stated that reflex action is purely mechanical, and that it is a proof that living matter is as much under the influence of fixed laws as is inert matter. A little consideration, however, will show us that such is not the case, for if reflexes were mechanical actions they would act with as much certainty the first time as the last. But it is not so. The truth is that in the higher animals when a new stimulus arrives at the brain it is examined by the mind and certain action is taken. When the same stimulus arrives a second time, the mind comes to a decision more quickly, and constant repetition makes the brain act unconsciously. Also reflexes are not immutable. The degree of difficulty in changing them depends upon the number of repetitions to which they have been subject. A habit may be formed and become reflex, but we can generally alter the habit if we try. Even the instincts of insects are not altogether unchangeable, and we occasionally see reason come in and alter them. It is only very old instincts, like breathing or the beating of the heart, which are quite fixed. This, again, is very different from physical law. Reflex action is only pseudo-mechanical. It is law which mind has imposed upon itself to save itself from trouble, and if the action has not gone on too long it can be varied. This, indeed, constitutes the difference between physics and physiology. In physics we have to do with fixed law only, but in physiology we find both law and custom.

Much interest has lately been aroused by the demonstration that in the ova of some animals the centrosomes can be produced and development started by the action of certain reagents, such as magnesium chloride, and this has been taken as a proof that physical can be changed into physiological energy. But the chemical reagents cannot form the centrosomes; the materials must be there and the stimulus merely starts them into action. The protoplasm of the ovum, on being stimulated, whether by the natural stimulus of fertilisation or by an artificial one, sets to work in the only way it knows, that is, by preparing for the process of mitosis. This, and the growth of the pollen-tube when stimulated by an application of sugar, are merely cases of reflex action.

These unconscious movements often have a harmonised action, as if they had originally been intelligent, and in the higher animals we rarely have any difficulty in distinguishing movements due to mind from those due to the physical energies.

In the lower animals and plants the action of conscious mind is not evident; but we recognise the presence of life by movements which correspond closely with those due to unconscious mind in the higher animals, that is, we can recognise harmonised action and changeability.

First we have movements which are called spontaneous, that is, they are not directly connected with external causes. These may be voluntary, that is, due to the will, or reflex, that is, are performed unconsciously on the application of a stimulus. What is called irritability in protoplasm is merely reflex action, and if reflexes are due to experience they imply the presence of both mind and memory.

Secondly we have, in all living protoplasm, the phenomena of growth and reproduction. Growth by assimilation is considered to be an attribute of living matter, because it is a process which, at present, cannot be imitated by chemists. But increase in size also takes place in minerals, and it is the characteristic direction of growth to which assimilation gives rise by which we recognise living substance. This direction of growth undergoes gradual changes, but new variations are inconstant; they may not be repeated, or only partly repeated. But if they are repeated, then they become constant, and will remain so for many generations, notwithstanding varying external conditions.

Now it will be noticed that these characteristics of living matter are practically the same as the characteristics of mental action in the higher animals. We have changeableness, learning by experience, cooperation and harmonised action, and we cannot help associating life with mind. Not only is it true that where there is mind there is life, but the converse is also true, where there is life there is mind. Mind seems to be the cause of the movements by which we recognise living substance. It is the "vital principle" of some physiologists. Life has no entity of its own; what we call by that name is the movements of protoplasm under the direction of mind. Or life may be said to be mind made manifest to us by the movements of protoplasm. Or life is a special kind of motion caused by the action of mind on the molecules of protoplasm, the characteristics of which are spontaneity and adjustment. This mental action is active and often conscious in the higher animals, sluggish and subconscious in the lower animals, and passive in plants, but it is there in all.

Thus we have come by a different line of argument to the same conclusion as that of Prof. Hering, namely, that mind exists in all living cells, and where there is mind we must suppose that there is the capacity for memory also. Thus we see that biology is a branch of psychology. It is the study of the growth and development of protoplasm under the influence of mind, and this influence ought never to be forgotten when studying the fundamental problems of biology.

But this is not all, for, if the theory be true, it necessarily follows that mind must be, to some extent, a free agent capable of controlling the physical energies. For if it were not so it could not superintend the process of assimilation, neither could it defend protoplasm from the action of external agencies. Mind is only subject to those laws which it has imposed upon itself. However much we may marvel, we must allow that this is a fact of experience, and as inductive science is founded on all the facts that can be obtained, the spontaneous movement of living protoplasm can no more be omitted than the absence of initiative in non-living matter. So that, although we cannot explain how mind influences protoplasm, we must acknowledge that it does do so. Variations may depend upon the amount of stimulus received by the mother cell, and they may be developed automatically by selection, but neither selection nor stimulus can originate new processes or new structures. It is impossible to suppose that the external physical agencies, when they act upon protoplasm, antagonise their actions by forming chemical or physical combinations, for this is so different from what happens with dead matter. Dead protoplasm can no longer resist the attacks of other organisms, and it is only by undergoing the process of assimilation that it can be revivified. If there is any truth in Mr. Herbert Spencer's definition of our conception of life as the continuous adjustment of internal to external relations, it follows that living protoplasm must be free to adjust itself. But whether these adjustments were intelligent and purposive or whether they were due to haphazard gropings after change is a separate problem which still requires solution. All that we can say at present is that while dead matter is subject altogether to fixed laws, living protoplasm is, to a certain extent, free to act. To it has been given the power of adaptation or antagonism to the physical laws which the rest of nature obeys implicitly. Ever since living matter appeared on the earth a constant war has been waged between dead and living matter, and mind has won, the result being biological evolution. Chemical affinity has been taken advantage of by mind to protect itself from enemies. Physical energy has been used to break down chemical affinity, and then mind has been able to lay up a store of potential energy. But it has overcome the physicochemical laws only by obeying them, and this has given rise to the illusion that it is not free but subject to fixed law, like dead matter. This, however, cannot be the case. At first mind was free to act, but constant repetition of the same experiences made it an apparent slave to the physical forces, although when attention was occasionally called into action by new external irritants it again reasserted itself. But this was followed by relapse. The cooperation and concentration of nervous matter, however, still went on until, in the brain-cortex, attention developed into consciousness, and in the large cerebrum of man, mind has once more passed into its original free state. It is this form of volition that we call free-will.

Such I believe to be the full scope of Prof. Hering's theory. I must confess that I have gone beyond his address, and I do not know that he would agree to all that I have said. But it is evident that we must either assume a freely acting mind as the mainspring of organic development, or we must try to explain it on a purely mechanical basis, a task which appears to me to be quite hopeless. F. W. HUTTON.

Canterbury Museum, Christchurch, New Zealand.

Curious Shadow Effects.

I THINK that the following is probably the explanation of the phenomenon referred to in NATURE of February 4—the seeing of more shadows than your own.

A and B are neighbouring observers; their shadows make dark tunnels in the illuminated mist.

Usually, the eye cannot penetrate far, and if A is to see his neighbour's shadow he has to look *across* it, as along ACD, and the layer CD is too thin to be noticeable. Or, if he can see further, as along AEF, the glare of the illuminated mist between A and E may prevent him from noticing the thicker dark layer EF. He sees his own shadow because he looks more or less *along* it. But under suitable conditions his eye may be able to penetrate so far that he can see the thicker layer EF of his neighbour's shadow, while yet there is not much glare near at hand, *i.e.* in the part AE, to dazzle him; the mist in this region may be very thin. [The diagram does not represent clearly the way in which the shadows "tail off" and vanish at a certain distance owing to the finite angular magnitude of the sun.]

If the angle GAE be not too great, A will see B's shadow within his own halo.

This halo I have always taken to be the ordinary rainbow. It may look small, but the true criterion is its angular

magnitude. This would not, however, explain the oval bow spoken of in NATURE, January 28. W. LARDEN.

Devonport, February 5.

IT is obvious that the bow seen by Mr. Warner and described in NATURE of January 28 (p. 296) was the "Ulloa's ring," the "Nebelbild" or "Brockengespenst" of the Germans, fully explained by Fraunhofer. The oval form is a necessary consequence of our seeing the sky as a depressed vault or segment of a hollow sphere, as I have demonstrated it in my "Meteorologische Optik," I. Abschnitt, p. 29 *ff.*; see especially p. 33, Fig 5.

I beg to answer also Mr. John A. Harvie Brown's question on shadows in the "Brocken," asked in your issue of February 4. He says:—"How was it that more than one image was visible to each of our party?" Mr. Harvie Brown states that "not one of us saw more than one set of concentric rainbow bands or circles." The answer seems to be simple. The shadows are objective, and therefore visible to everyone; the coloured circles are only subjective, and consequently one person sees only one set of rings. I know that in text-books one reads the statement, "the observer of a 'Brocken' cannot see his companion's shadow," as, for example, in Müller's "Kosmische Physik" (even in the edition of 1894), but this is evidently erroneous.

Wien, Hohe Warte. J. M. PERNTER.

THE staff of the Ben Nevis Observatory have had frequent opportunities of observing the coloured shadows formed round shadows thrown on mist or fog-banks; notes descriptive of these "glories," as we termed them, with measurements of their diameter, will be found in the extracts from the log-book printed with the other Ben Nevis observations (see *Transactions* Royal Society Edinburgh, vols. xxxiv. and xlii.). In each ring of these glories the red of the spectrum colours was outside and the blue inside, as in the primary rainbow, and as many as five successive rings of colours have been observed.

The outside diameter of the largest ring never exceeded 12°, and was more usually about half that amount. Glories are thus of the same order of size as the coronæ frequently seen round the sun or moon, and are distinctly smaller than halos, the ordinary halo having a diameter of about 44° (radius 22°), while rainbows and fog-bows are, of course, larger still.

In respect to Mr. Warner's letter, I may say that no oval-shaped glories have been seen on Ben Nevis, but other observers have described them, and a possible explanation may be that a circular ring is formed on a surface at right angles to the sun's rays, but the observer assumes that the ring is formed on a vertical surface, and therefore it appears oval to him. However, the low angle of the sun's rays at Christmas time does not differ sufficiently from the horizontal to cause in this way the elongated oval shown in Mr. Warner's sketch; there must be other factors to consider.

With regard to the shadows of other persons, our experience on Ben Nevis was that if the fog-bank was a considerable distance away, the shadows of others could be seen just as on a wall; but if the fog was close to the observers, the only shadow seen resembling a human figure was one's own. Sometimes, however, when a thin fog was close to us on one side, and bright sunshine on the other, I have seen the shadow of a man standing 10 or 20 yards away as a dim dark streak running back into the fog. The shadow, in fact, was not formed on any definite surface, but was a