plosions are actually dust explosions was first stated in England by Mr. Watson Smith, editor of the Journal of the Society of Chemical Industry, in a letter which appeared in *The Glasgow Herald* on July 12, 1872, immediately after the Tradeston disaster. The priority of Mr. Watson Smith was recognised at the time by the Royal Society of Edinburgh, and later (in 1882) by Sir Frederick Abel in a lecture at the Royal Institution.

It is interesting to know that nearly six years ago Mr. Watson Smith read a paper at Liverpool (the scene of the latest dust explosion) in which stress was laid on the fact that any kind of carbonaceous dust might, under certain conditions, become a source of danger (see Journ. Soc. Chem. Ind., January 31, 1906).

ALBERT SHONK.

10 Dartmouth Road, Hendon, December 5.

I MUCH regret that I had entirely forgotten the fact, stated in Mr. Shonk's letter, that Mr. Watson Smith had attributed the disaster at the Tradeston Flour Mills to an explosion of dust in a letter to *The Glasgow Herald*, published before the report of Profs. Rankine and Macadam appeared, or I would certainly have mentioned it in the article referred to.

W. G.

The Feeding Habits of Crepidula.

WITH reference to the note on Crepidula in NATURE of December 7 (No. 2197, p. 187) it may be of interest to your readers to know that during some recent researches on this animal I have been able to confirm the necessity for investigating how far the presence of the slipper-limpet (*Crepidula fornicata*) is a menace to successful oyster-culture on the Kent and Essex coasts. It has been believed by various naturalists that Crepidula takes the same kind of food as the oyster, but on this point there exists no definite information. During an investigation of this matter I discovered the manner in which the animal feeds, from which there can be no doubt whatever as to the nature of its food. The mode of feeding in Crepidula is the same in principle as that of the oyster, that is, there is an ingoing and an outgoing current of water kept up in the mantle-cavity, while between the two currents the gill acts as a strainer, retaining even very fine particles of suspended matter, which eventually—by one of two ways—reach the mouth.[1]

Thus it is established beyond doubt that Crepidula feeds on the same material as the oyster, that is, on the food-material found on or floating near the sea-bottom, and the danger apprehended from this intruder is confirmed: Crepidula is competing successfully with the oyster for food and space. Whether there is enough food and space for both Crepidula and oysters is another matter which must be determined by local researches. Thus the problems for the Kent and Essex oyster-farmers are to keep up the food supply of oysters and to reduce the numbers of Crepidula and the many other animals which take the same food as oysters.

J. H. ORTON.

Marine Biological Laboratory, Plymouth, December 10.

Tadpole of Frog.

AT the beginning of April last I collected some frog ova for the purpose of making observations on development. Tadpoles appeared about April 9, and from time to time from that date until July 17, when young frogs were developed, I took batches away for preservation and sectioning. On July 17 only one tadpole was left of the original stock, and that one, though in water out of doors and with a supply of waterweed, has not developed farther, but is a tadople still and is still alive. Some years ago I had a similar case with a frog tadpole. Can any of your readers suggest the reason of this phenomenon?

T. PLOWMAN.

Nystuen, Bycullah Park, Enfield, December 8.

[1] It is proposed to publish a full account of how Crepidula feeds in the next number of the Journal of the Marine Biological Association.

MICROKINEMATOGRAPHY.

WITHIN the last few months we have been shown a new appplication of the kinematograph, which indicates yet another stage of technical attainment, and another field in which it may supplement our knowledge. Its range has been extended to the representation of objects as seen through high powers of the microscope. Apart from any positive increase to knowledge which may be obtained by its means, this is a technical achievement of a very high order. In the usual microscopic preparation it is impossible to obtain a high degree of illumination, and the greater the magnification the less the illumination becomes. It is only by artificially increasing the contrast by means of stains and so forth that we can obtain a clear differentiation of even a motionless object. To take in one minute some thousands of successive photographs of a living, unstained object, magnified six hundred or a thousand times, an object, moreover, which is moving rapidly, and therefore continually altering its focal plane, is a task which might easily seem impossible.

M. Comandon, however, has succeeded in this extremely difficult problem. The illumination-difficulty he avoided by using what is known as the ultra-microscope or dark-ground illumination, in which the object is seen against a black background, being lit itself by rays of light striking it from the side, and thence deflected upwards towards the lens of the microscope. This method gives an extremely brilliant contrast-illumination of the outlines of the object against a black ground and makes it possible to take on a properly sensitised film photographs of exceedingly short exposure. The resulting picture naturally shows comparatively little of the internal structure of the object under examination; the bulk of the rays of light are deflected from its surface. But it is surprising how much does appear. The nucleus of a cell, for example, is frequently quite distinct, and some structures, such as the kineto-nucleus of a trypanosome, can sometimes be seen perfectly clearly and be followed as the organism moves from place to place. A large number of films prepared under the direction of M. Comandon has been exhibited during the present year by Messrs. Pathé Frères, and the realism and vitality of these kinematograph pictures can scarcely be imagined by anyone who has not seen them thrown on the screen.

An interesting film is one which displays the blood actually circulating in the vessels of the living body. The preparation, which is from the tail of the tadpole, shows a number of tiny blood-vessels, which measure about one-hundredth part of a millimetre in diameter. Crowded together in the larger of these, the individual corpuscles of the blood can be seen to pass out one by one into minute branches, for which they seem almost too large, and within which they make their way here and there through the surrounding tissue, not apparently without occasional difficulty. Even in the larger vessels, along which the bulk of the corpuscles are hurrying, the rate of progress varies considerably, and the direction may actually be reversed for a time and the blood apparently flow backwards. The coloured corpuscles of the blood, from which it derives its red tint, have, of course, no independent motion of their own, and are simply carried along by the stream in which they are suspended. But the colourless cells or leucocytes have such independent motion, and in another film we are shown a white cell gradually altering its shape, throwing out a long filament into which the rest of the corpuscle slowly flows, until the whole cell has altered its position and moved from one place to another. By aid of this motion these leucocytes are able to fulfil one of their best-known functions, which is to act as

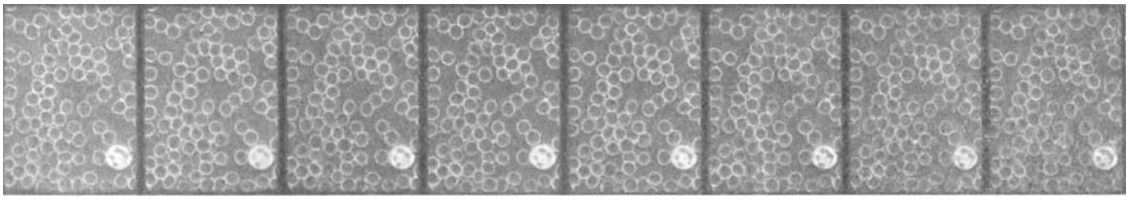

FIG. 1.—Series of pictures of normal human blood. From a kinematograph film.

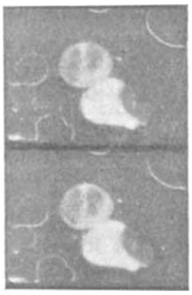

FIG. 2.—Amœboid movement of leucocytes.

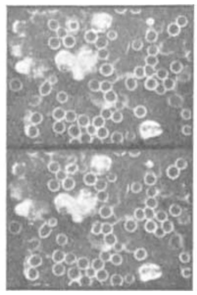

FIG. 3.—Trypanosomes in the blood.

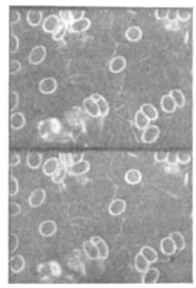

FIG. 4.—Spirillosis of fowls.

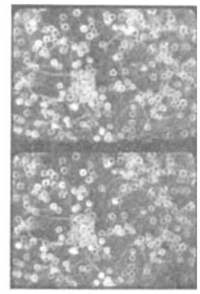

FIG. 5.—Relapsing fever.

scavengers of the vascular ways of the body, and to take up into themselves abnormal substances with which they come in contact, whether microbes, diseased cells, or granules of inert matter; and this process is illustrated for us by a series showing the gradual surrounding and ingestion of a red corpuscle by a white cell. This is the phenomenon of phagocytosis, which has of late been brought so prominently before the public in its relation to the cure of infectious disease.

That such abnormal substances may occur in the blood is shown in a beautiful series of pictures of its condition in relapsing fever. After we have been made familiar with the appearance of normal blood, in which the red corpuscles appear as brilliant rings and the larger white cells as cloudy masses with shadowy nucleus and brightly shining granules, we see the blood as it may appear at the height of an attack of the disease. It is now full of foreign organisms, long, slender spiral threads, which dart hither and thither upon the screen, now hooking themselves together and again disentangling themselves, impinging on the red cells and recoiling in amazing numbers and activity. The whole blood history of an attack is shown on these films, from the interval between the crises when no organisms are present, through the period of multiplication to the termination of the attack with the tendency of the spirals to aggregate together and eventually disappear. Several such blood-pictures may be seen, including a most beautiful preparation of an infection with a trypanosome, a close ally of the organism which produces sleeping sickness. Here the parasite is seen in quite perfect distinctness, swarming in enormous numbers in a drop of blood with an incredible activity and energy of motion.

Technically perhaps the greatest triumph of these microkinematograph pictures are the films which show us the *Spirochaeta pallida*, the causal organism of syphilis. This delicate thread, with its many tiny spirals, is so exceedingly minute that even when motionless and stained it is difficult to see with the best of ordinary microscopes. But here it appears alive and moving, with its coils all clear and sharp, a perfectly distinct picture. Only those who know the careful pains, which are necessary to obtain a satisfactory demonstration of this tiny object, can fully appreciate the skill which has gone to the making of such photographic films as these.

We have dwelt chiefly upon the microscopic preparations which Messrs. Pathé Frères have exhibited, because they seem to us the most remarkable of those

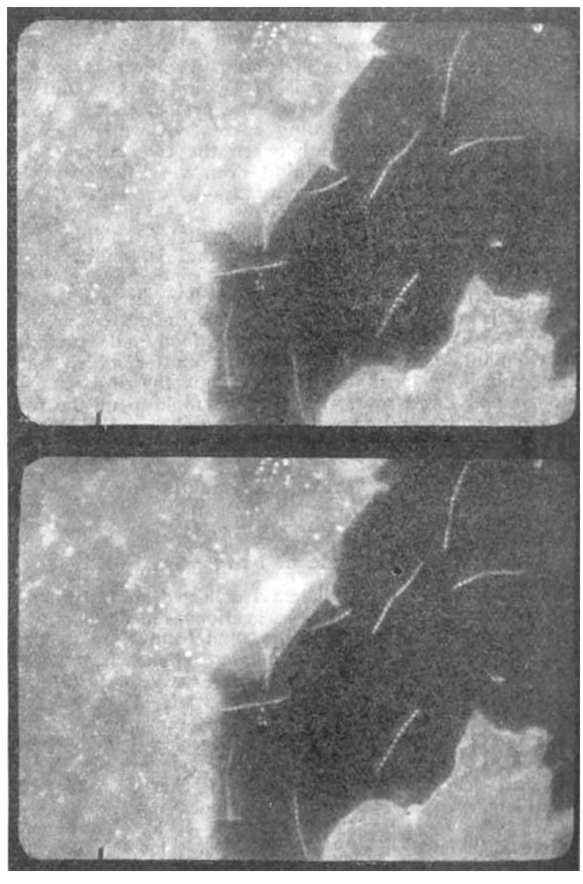

FIG. 6.—Spirochæta of Syphilis (from the cornea of the eye) enlarged.

which we have seen. But there are many other applications of kinematography to biological subjects which are of great interest and value. Many movements in nature proceed at a rate such that we cannot successfully follow them with the eye and brain. The slow movements of a leucocyte, the gradual unfolding of a flower-bud or upward growth of a plant advance so leisurely that we cannot readily follow the change —it is only by observing them from time to time that we can appreciate that alteration is occurring. A succession of photographs, however, taken at considerable intervals, and passed rapidly in review before us, shows us as occurring in a few minutes the whole process which may take hours or days in reality, and we are better able to appreciate the nature of the phenomena because the sequence becomes more obvious. Conversely, many motions occur too fast for us to analyse them. The fact that our retina can clearly distinguish only impressions which reach it at a comparatively slow rate makes it impossible for our unaided eye to follow the sequence of many natural phenomena. By reproducing at a slower pace the changes which do occur, the kinematograph can assist us to attain a clearer perception of the nature of the alteration which is taking place, or, even if we are still unable to grasp the successive phases, a study of the film itself will enable us to follow the sequence and analyse the motion with a greater detail and a greater accuracy than any number of examinations of the natural phenomenon can possibly supply. The kinematograph therefore can give us a positive addition to the sum of our knowledge, as well as diffuse through wider circles knowledge already gained.

This latter, while perhaps the most obvious, is not the least of the functions which such moving pictures can fulfil. There are thousands of people in this country who are intimately acquainted with the cellular constituents of the blood, and their various shapes and functions, thousands who have seen the ordinary bacterial preparations or are familiar with the heart-beat and its action on the pulse, but of these thousands not one-tenth have actually seen the amœboid movements of a leucocyte or a spirillum wriggling its way between the corpuscles or the heart itself beating before their eyes. Yet these are things which it concerns them to understand, and no amount of imagination can supply the clearness and comprehension which actual seeing can give. The kinematograph might well become a most efficient aid to the teaching of very many biological, and especially medical, subjects.

The accompanying illustrations have been reproduced from kinematograph films kindly supplied for the purpose by Messrs. Pathé Frères.

THE RUBBER-PRODUCING PLANT OF THE MEXICAN DESERTS.[1]

AMONGST the botanical collections formed in 1852 by Dr. J. M. Bigelow, whilst attached to the Mexican Boundary Survey, were specimens of a shrub known to the Mexicans as "guayule," afterwards described by Prof. Asa Gray as *Parthenium argentatum.* No mention, however, was made of its rubber-bearing qualities. It was not until 1876 that public attention was directed to guayule rubber by an exhibit sent to the Centennial Exposition at Philadelphia in that year. The country peon had, it appeared, for long been in the habit of making playing balls and other articles by the "communal mastication" of the bark of this shrub, and it was by that means sufficient was obtained for the above-mentioned exhibit. Investigation showed that the plant was capable of producing in the neighbourhood of ten per cent. of its weight of dry rubber, and that it grew in vast abundance in the desert country of northern Mexico.

This discovery speedily changed the economic value

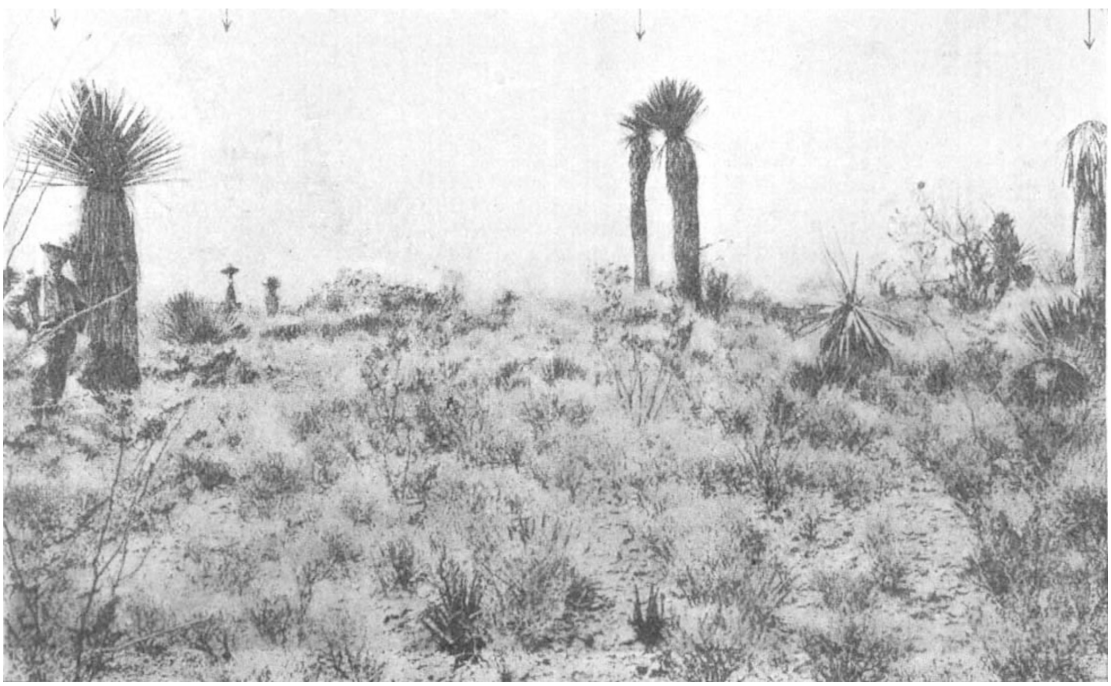

FIG. 1.—Foot-slope of Sierra Zuluaga.

1 "Guayule (*Parthenium argentatum*, Gray), a Rubber-plant of the Chihuahuan Desert." By Prof. F. E. Lloyd. Pp. viii+213+46 plates. (Washington: Carnegie Institution, 1911.) Publication No. 139.