Watson's "Holoscopic Immersion Paraboloid" which gives excellent dark-ground effects with high-apertured lenses. While engaged in working out the life history of the *Monas sarcophaga* I frequently observed small organisms somewhat resembling this monad, but of considerably less size and possessed of a peculiar jerky motion in swimming. The difficulties in working out this organisms' life history were not a few, but at length I have been able to accomplish it. This monad is an entirely new one, and on account of its peculiar vibratory motion in swimming I have named it *Monas vibrans*. This organism is closely related to, and belongs to the same sub-tribe as the *Monas sarcophaga*, viz., the Paramastigoda. It varies slightly in size, but not nearly so much as the *Monas sarcophaga*, the average size being about one four thousandth of an inch in length. The shape is bluntly triangular or conical, and the organism is very granular. It possesses two flagella, one long and one short (hence Paramastigote). The long flagellum is not as long in proportion to the body as that of the *Monas sarcophaga*, and is bent round somewhat like a fish hook; the small flagellum, which is exceedingly minute, and generally rather difficult to observe, arises from the base of the long one, and on its convex side (see Fig. 1). A nucleus, which stains somewhat irregularly with Hæmatoxylin, and a contractile vacuole are present. Swimming occurs by lashing of the long flagellum, aided by the smaller one. The long flagellum is vibrated with a peculiar whip-like motion which makes swimming very jerky and irregular. On following one of these forms by means of the mechanical stage, never losing sight of it in all its wanderings, it is found after a varying period to come to a standstill, and to adhere to the slide, apparently by means of a pseudopodial appendage. On coming to rest, the long flagellum is vibrated with great rapidity, thus causing small protoplasmic particles and bacteria to be swept toward the monad, many of which on touching the body, near the flagella, are engulfed by an amœboid action of the protoplasm. This stage of feeding may last for hours; in fact, the monad spends a large part of its existence in feeding in this way, swimming about at intervals apparently in search of pastures new. After some time two new flagella slowly appear near the normal pair. At first, these are very minute but rapidly grow larger and are in intense vibration; they swiftly diverge and at length get to the opposite pole to the normal pair. During this duplication of the flagella, the nucleus of the organism has become strongly developed and a division takes place; one of the two daughter nuclei now passes into each polar region, and with the two pairs of flagella now

pulling from opposite ends a constriction suddenly appears across the body of the monad. From this time onward the constriction rapidly deepens, the two pairs of flagella pulling the organism into an hour glass shape, shown in Fig. 4. Finally, only an exquisitely-fine strand of protoplasm connects the two halves; this strand gradually gets thinner till at length it snaps, and the two organisms go free. Usually one of the two remains in the place where division took place, and at once commences to feed, while the other swims about for a time, till it also becomes stationary, and commences feeding operations. In a few instances I have observed feeding to go on during the actual process of division. The time occupied in this division is usually from fifteen to twenty minutes. For many months this was the only method of reproduction which I could observe. At length, however, I found that a certain proportion of the organisms, after swimming and feeding in the manner already described for many hours, became very sluggish and usually sank to the bottom of the drop of fluid under examination; the flagella lashed feebly, and the body of the monad became very pale and rather indistinct, the nucleus becoming considerably more prominent than usual and situated toward the posterior end of the monad. In several specimens I have noticed that the nucleus became somewhat striated at this stage. Finally, the flagella ceased movement, and the whole organism was perfectly motionless. At first, I came to the conclusion that some deleterious influence had killed the monad, and it was only after I had again and again failed to find any other method of reproduction than the asexual, that I determined to study these motionless forms further. A peculiarity of this monad is the length of time that it may remain in this quiescent condition. In four specimens I observed the average duration was about three and a half hours. The flagella then suddenly commence to lash again, at first very feebly, but finally rapidly, and the organism swims off. During the quiescent period, the body of the monad has become swollen and very pale, and the nucleus dense and glistening. These organisms now swim about with great rapidity. If one is now carefully followed, it will be found, after a varying lapse of time, to seize on one of the normal forms, to which it adheres, violent lashings of the flagella taking place. It is soon evident, however, that the larger organism is absorbing the smaller. Finally, this is accomplished, and very soon after this the monad, or more properly speaking the product of the fusion of the two organisms, comes to a standstill, rapidly gets globular, the nuclei disappearing and the flagella melting into the sarcode. A motionless globular sac is now left, of a

slightly yellowish color. The time the sac remains in this condition apparently varies a good deal, perhaps owing to temperature, but thirteen to fifteen hours seems about an average. It then suddenly and without the slightest warning bursts, and a glairy fluid, containing excessively minute granules, is poured out. These granules at first show only Brownian movement, but later (about three hours) they grow somewhat larger, and then exhibit amœboid movements. From this time they rapidly grow larger, minute flagella are developed, and they swim away, small but perfect counterparts of their parents. It will be seen that this organism, both in its microscopic appearance and development, bears a striking resemblance to the *Monas sarcophaga*. It is easily distinguished, however, by its much smaller size, and the difference in the flagella. The average size of these organisms is very uniform, while the *Monas sarcophaga* shows considerable variations. Although I have specially and carefully looked for it, I have never found this monad to ingest other monads either of the same or different species. This, I think, is to be accounted for by two reasons. Firstly, the small size of the organism, and secondly, the flagella being smaller, do not appear to set up sufficient current to draw bodies of much greater size than bacteria toward the monad. A large number of these organisms furnish the *Monas sarcophaga* with food, and on several occasions I have had many hours' work spoilt by the monad under investigation finding a grave within the body of the former organism. Both these monads are, I believe, found exclusively in putrefying vegetable infusions and ponds in which much vegetable matter is in process of decomposition. The *Monas vibrans* multiplies far more freely and rapidly than the *Monas sarcophaga*. Both organisms may be cultivated in infusions of grass, but both rapidly die out as soon as the larger infusoria appear. The *Monas vibrans* almost invariably disappears from an infusion before the *Monas sarcophaga*, and from a large number of experiments I have come to the conclusion that both these organisms produce substances in the culture medium, which act deleteriously on them, and ultimately inhibit growth. I have recently found that if a quantity of an old culture, in which the organisms are dying out, be exposed to a temperature of 60 deg. Cent. and then filtered, the filtrate possesses markedly toxic properties toward these monads, a minute quantity added to a hanging drop preparation soon causing death. I am inclined to think that the toxic substances are of the nature of ferments, though at the present stage of my researches I cannot bring forward any direct evidence to support the view.

A Projection Lantern Without Objective

By Dr. A. Gradenwitz

IN projection lanterns so far designed for opaque objects, a very powerful source of light had to be used or the size of projection to be reduced to a minimum on

placed as close as possible to the condenser *C*. To prevent stray light from reaching the screen, and there interfering with the regular image, a certain number of opaque partitions are provided to separate the different portions of the apparatus, and the conical beam coming from the

mirror *M* passes through an opening *O* of very small dimensions, fitted with a shutter which is closed during manipulations.

Fig. 3 shows the arrangement of the carriage serving to carry the object or photograph plate to be projected.

Fig. 1.—General View of Reflecting Stereopticon.

account of the enormous losses of light occurring in the optical system.

The projection lantern without objective designed by a Paris constructor, M. G. Massiot, for opaque objects and particularly for colored photographs as obtained by Prof. Lippmann's process, eliminates this drawback and has, in the case of Lippmann photographs, the additional advantage that the angle formed by the incident beam with the beam reflected by the plate is very small, which corresponds with the maximum accuracy of color reproduction.

This lantern consists of a sheet-metal case provided with a double condenser in the focus of which an electric arc is placed. The parallel beam coming from the condenser *C* lights the object to be projected which is placed in *A*. After reflection there the beam strikes a concave mirror *M*, 15 centimeters in diameter and 1 meter in focus, which forms on the screen an enlarged image of the object.

In order to reduce as far as possible the angle between the incident beam and the reflected beam received and thrown back by the object *A*, the mirror *M* should be

Fig. 2.—Diagram of Optical System of Lantern.

Fig. 3.—Carriage for the Object.

Its regulation can be effected from a distance by means of a rack and gearing. The orientation required to give a correct image is obtained by causing the carriage to rotate round two axes *X*, *Y*.

The advantages afforded by the mirror are the absence of any loss of light by absorption or reflection on lens surfaces. Moreover, the image is projected in its real orientation without any inversion as in the case of objectives, thus avoiding any alteration in the appearance of projected photographs, especially landscapes.

The mirror should be silvered at its surface and kept in good condition; it may be protected by a varnish. In case of need it can be resilvered by a very simple process.

It is a well-known fact that reflecting optical instruments present a number of advantages over refracting instruments. In the field of projecting lanterns these advantages have not hitherto been extensively made use of. The apparatus here described seems a move in the right direction, since, especially for the projection of opaque objects, reflection commends itself as the most natural principle to follow.