5.1145 Protoplasmic movements, irritability.
5.11451 Heliotropism, geotropism, hydrotropism, etc.
See also growth.
5.1146 Germination.
See also 4.11151, 4.12, and 5.1143.
5.12 Reproductive processes.
5.121 Vegetative propagation.
Subdivided, when desired, either on morphological lines or by plant groups. Morphology, Organography and Ecology would be frequently consulted here.
5.122 Sexual reproduction.
5.1221 Differentiation of sex.
5.1222 Heterospory, alternation of generations.
5.1223 Fecundation.
5.1224 Reproduction of Thallophytes
5.12241 Conjugation.
5.12242 Oophytic fertilization.
5.12243 Carpophytic fertilization.
5.1225 Reproduction of Archegoniatæ.
5.12251 Bryophytes and Pteridophytes.
5.122511 Antherozoids.
5.122512 Egg cells.
5.12252 Gymnosperms.
Subdivided like preceding.
5.1226 Reproduction of Siphonogamæ.
5.12261 Pollen and pollen plants.
5.12262 Ovules.
General morphology, Embryology, and Germination, to be consulted.
5.2 Ecology.
5.21 Vegetative interrelations.
5.211 Phenology.
5.212 Nutritive adaptations.
5.2121 Plankton, aquatics, ice plants, dew plants, etc.
5.2122 Climbing plants.
5.2123 Carnivorous plants.
5.2124 Parasites, symbionts.
5.213 Protective adaptations.
5.2131 Compass plants, epiphytes, halophytes, xerophytes, sleep of plants, etc.
Chloroplast movements and the protective adjustment of stomata would be sought under Physiology proper. This may be subdivided as needed.
5.2132 Spines, secretions, raphides.
See also 4.11, 4.222, and 5.1132.
5.2133 Myrmecophilism, acarophilism.
5.22 Reproductive interrelations.
5.221 Pollination.
5.222 Dissemination.
6. Vegetable pathology including the injuries of plants, and therapy.
7. Evolution, natural selection, etc.
8. Man's influence on plants, artificial selection, etc.
Economic botany would be consulted here.
9. Phytogeography, floras, etc.
9.1 Geographical botany.
Ecological considerations would be sought under Physiology.
9.2 Floras.
Subdivided, according to abundance in each area, geographically like periodicals, etc. Travelers' journals of restricted scope, and similar works directly or indirectly throwing light on a local flora, reports of geological surveys, and even local maps and guide books, in a botanical library are brought together here for convenience in use. Fossil floras excluded from taxonomy would find place here.

WILLIAM TRELEASE.
MISSOURI BOTANICAL GARDEN.

ON THE CAUSE OF DARK LIGHTNING AND THE CLAYDEN EFFECT.

I HAVE been criticized in a letter which appeared recently in *Nature* for not alluding in my letter on dark lightning to the peculiar photographic reversal known as the Clayden effect. I must confess that at the time of writing my letter I was unaware of this effect, a description of which has only appeared, so for as I know, in one of the photographic journals. Mr. Clayden has certainly explained dark lightning, and it only remains to explain his explanation. As I think that this effect is not generally known, I believe that it may be worth while to devote a few words to the statement of the case, before describing the experimental work by which I have determined the factors which play a part in this very curious photographic phenomena.

Mr. Clayden showed that if a plate, which had received an impression of a lightning flash or electric spark, was subsequently

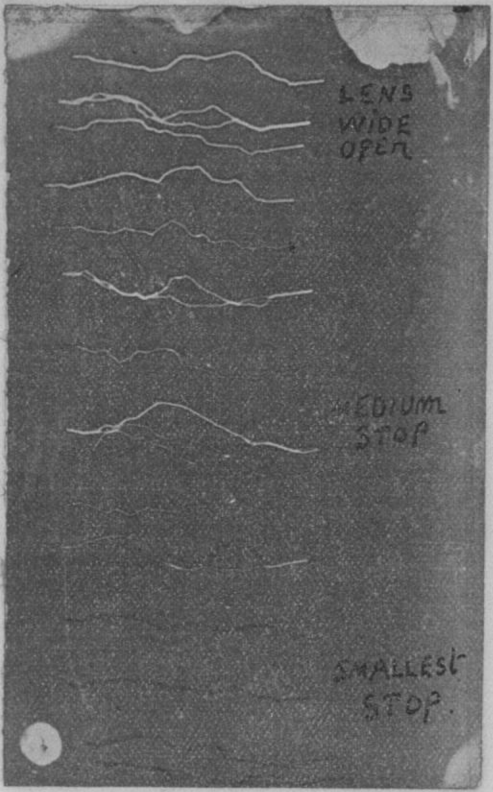

FIG. 1.

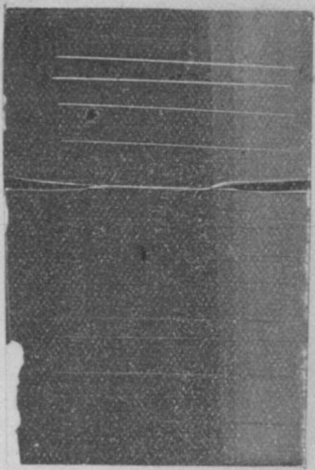

FIG. 3.

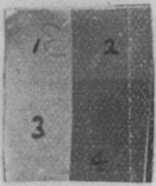

FIG. 4a.

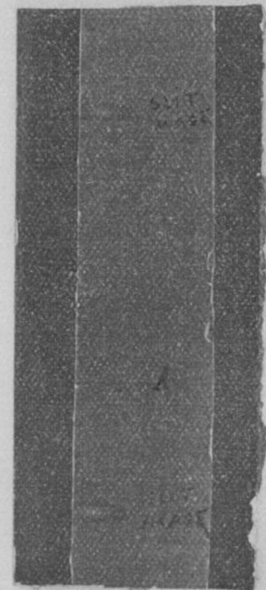

FIG. 5.

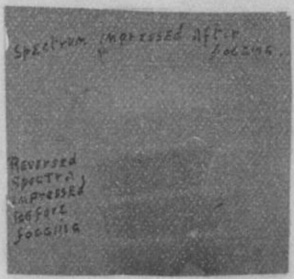

FIG. 2.

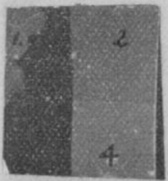

FIG. 4b.

slightly fogged, either by exposing it to feeble diffused light or by leaving the lens of the camera open, the flash on development came out darker than the background. If, however, the plate was fogged before the image of the flash was impressed, it came out brighter than the background, as in the ordinary pictures of lightning. I refer to the appearance in the positive print in each case. This is quite different from ordinary reversal due to the action of a very intense light, for the order in which the lights are applied is a factor, and the phenomenon lies wholly in the region of under exposure. I repeated Mr. Clayden's experiment, and obtained dark flashes without any difficulty.

The effect cannot, however, be obtained by impressing an image of a filament of an incandescent lamp on a plate and subsequently fogging the plate. Clearly there is something about the light of the electric spark which is essential to the production of the reversal. It is not intensity, however, for I found it was impossible to obtain reversed images or bright sparks with the lens wide open.

Fig. 1 shows a series of spark images, some normal, some partly reversed and others wholly reversed. The sparks are those of a large inductorium, with a good sized Leyden jar in circuit. The sparks were all of equal intensity, but after each discharge the iris diaphragm of the lens was closed a little. It will be seen that the borders of the bright sparks are reversed. In some the image is reversed with the exception of a narrow thread down the core. The images were impressed in succession on the plate by moving it in the camera. A plate holder was dispensed with, an opening being made in the ground glass back by removing a strip a few centimeters wide. The plate was held against this opening and a large number of exposures made in a few moments. Of course, the room was in total darkness. After exposure the plate was exposed to the light of a candle for a second or two and then developed.

In this series of pictures it will be seen that the edges of the bright images of the sparks are reversed, the intensity on the border of the image being less than at the core. As the intensity of the spark becomes less and less, the bright central core dwindles down to a mere thread and eventually disappears, the spark's image being feeble enough to reverse over its entire area.

This explains why the dark lightning flashes are usually ramifications of the main flash. The ramifications are less brilliant discharges and reverse, while the main one is too bright to cause the effect.

The first thing that occurs to one is that it may be some peculiar radiation which the spark emits, which is wanting in the light coming from other bodies. If a small photographic plate is partly screened by a piece of black paper and illuminated by the light of a small spark at a distance of two or three feet, and a similar plate, screened in the same manner, is illuminated for a moment by candle light of sufficient intensity to produce the same amount of blackening on development, we shall have the means of showing that the spark light differs in its action on the plate from that of the candle. If these two plates before development be half screened in a direction at right angles to the former one, and exposed to the light of a candle for a second or two, the part of the plate which has been illuminated by spark light plus candle light, does not become as black on developing as the part which has only received candle light, whereas the part which has twice been exposed to candle light is blacker than that which has been only exposed once. This shows that the light of the spark does not act in the same way as the light of the candle. Wherein does it differ? It seemed possible that the peculiarity lay in the nature of its radiation. To test this a prism was placed before the lens of the camera which broke up the image of the spark into a series of spark images of different color. The plate was exposed to the spectrum flash of a single spark, then removed from the camera and exposed to the candle light, and developed. If the reversing effect was due to any peculiar radiation or wave length, we should find the reversal at the part of the spectrum where the effective radiation belonged, say in the infra red, if the reversing power lay in long waves given out by the spark. It was found that the entire spectrum came out lighter on the negative than the fogged background. A second plate was exposed to the spectrum flash, then slightly fogged, and a second spectrum impressed on it. On developing one spectrum came out light and the other dark, as shown in Fig. 2. Clearly the effect does not depend on wave length. It then occurred to me that the time element might enter into the problem. The light of the spark is over in about 1/50000 of a second and it did not seem impossible that a bright light of exceeding short duration might act quite differently on a plate from a weaker light of longer duration. This may be tested in a variety of ways. We may open the lens wide, impress the image of a single spark on the plate, and then stop the lens down and superimpose a number of spark images sufficient to make the total exposure the same in each case. This was the first method which I tried. In order to compel the successive sparks to pass over the same path, that their images might be superposed, I shut them up in a capillary tube. With the lens open wide enough to give the maximum reversing action, I passed a single discharge through the capillary. Stopping the lens down to one-quarter of its former aperture, four discharges were passed through the tube. The plate was then fogged in the usual manner, and on development the single discharge was reversed, but the composite one was not.

Fig. 3 is from a plate showing this effect. The upper images are those of single discharges through the capillary, with different apertures on the lens ; the lower images are those of double or triple discharges through the same tube. The left hand side of the plate was exposed to the candle light for different amounts of time, by moving the screen over small distances during the exposure. Only the single discharges reverse, though the density of the images on the unfogged portion of the plate is the same. This is very strong evidence that the duration of the illumination was the important factor.

Some years ago I measured the duration of the flash of the exploding oxy-hydrogen, finding it about 1/12000 of a second. Possibly the flash of such an explosion would duplicate the effect. I exploded several glass bulbs filled with electrolytic gas, but found that the action was the same as that of ordinary light, it being impossible to get any reversal. The flash evidently lasted too long, or there still remained some undiscovered factor.

The difference between the action of spark light and the light of the oxy-hydrogen flash is shown in Fig. 4. Plate 'a' shows the effect of the explosion flash. Squares 1 and 2 received the light from an exploding bulb, the rest of the plate being covered. Squares 1 and 3 were then exposed to the light of the candle. Square 1, which has received the light from both sources, is the brightest, that is, the effects are additive, there being no reversal. Plate 'b' shows the action of the light from the spark. Squares 1 and 2 were illuminated by the spark light, then squares 2 and 4 were exposed to the candle. In this case square 4, which was illuminated by the candle, is brighter than square 2, which received both the spark light and candle light. In this case the effects are not additive, there being reversal.

To demonstrate conclusively that the time factor was the only one, it was necessary to secure an illumination independent of the electric spark, and of as short duration. This was accomplished in the following manner: A disc 30 cms. in diameter was furnished with a radial slit one millimeter wide near its periphery, and mounted on the shaft of a high speed electric motor. A second slit of equal width was arranged in a horizontal position close to the rim of the disc, in such a position that the two slits would be in coincidence once in every revolution. This second slit was cut in the wall of a vertical chute down which a photographic plate could be dropped. By means of a large convex lens of short focus an image of the crater of an arc-lamp was thrown on the point of coincidence of the slits. The intensity of the illumination transmitted by the slits when in coincidence was almost sufficient to char paper. The motor was then set in motion and a plate dropped down the chute. On developing this plate three images of the slit appeared, not at all overexposed, though the plate was the fastest on the market, and the intensity of the light while it lasted comparable to that at the focus of a burning glass. By measuring the distance between the images and the vertical distance through which the plate had fallen, it was an easy matter to calculate the speed of rotation, which was found to be 60 revolutions per second, the air friction of the disc preventing higher speed. The duration of the exposure will be the time occupied by the rim in traveling a distance equal to the width of the slit or 1 mm. This was found to be 1 / 55000 of a second about that of the spark. The crucial experiment now remained. A second plate was dropped and before development was exposed to the light of the candle. *The images of the slit were most beautifully reversed* except at the center where the light was too intense. A print from this plate is reproduced in Fig. 5. It seems then that we are justified in assuming that *the action of an intense light on a plate for a very brief time interval decreases the sensitiveness of the plate to light.* It is curious to contrast with this effect the fact that exposure to a dim light for a moment or two appears to increase the sensibility by doing the small amount of preliminary work on the molecules, which seems to be necessary before any change can be effected that will respond to the developer. I am not prepared to say what the nature of the change effected by the flash is. Possibly some one familiar with the theory of sensitive emulsions can answer the question. I have tried using polarized light for the reversing flash, and then fogging one-half of the plate with light polarized in the same plane, and other half with light polarized at right angles to it. As was to be expected there was no difference in the effects.

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PHYSICAL LABORATORY OF THE
UNIVERSITY OF WISCONSIN,
MADISON, Oct. 20, 1899.

ARCHITECTURAL PLANS FOR THE UNIVERSITY OF CALIFORNIA.

THE Phoebe A. Hearst International Competition for an Architectural plan for the University of California was closed on September 7th by the awarding of five prizes for the best plans. The first prize was awarded to M. E. Bénard, of Paris; the second to Messrs. Howells, Stokes & Hornbostel, of New York; the third to Messrs. Despradelle & Codman, of Boston; the fourth to Messrs. Howard & Cauldwell, of New York, and the fifth to Messrs. Lord, Hewlett & Hull, of New York.

From the outset of their inspection, the judges were attracted to the drawings which proved, after the awards had been made, to