PHYSICS

Early Steps in Photography

"A Classic of Science"

Wedgwood Made the Picture, Herschel Fixed It, and Eastman Took Experimental Error Out of Photography

Wedgwood, 1802

AN ACCOUNT OF A METHOD OF COPYING PAINTINGS UPON GLASS, and of making Profiles, by the agency of Light upon Nitrate of Silver. Invented by T. Wedgwood, Esq. With Observations by H. Davy. In Journals of the Royal Institution of Great Britain, June, 1802.

WHITE paper, or white leather, moistened with solution of nitrate of silver, undergoes no change when kept in a dark place; but, on being exposed to the day light, it speedily changes colour, and, after passing through different shades of grey and brown, becomes at length nearly black.

The alterations of colour take place more speedily in proportion as the light is more intense. In the direct beams of the sun, two or three minutes are sufficient to produce the full effect. In the shade, several hours are required, and light transmitted through different coloured glasses, acts upon it with different degrees of intensity. Thus it is found, that red rays, or the common sunbeams passed through red glass, have very little action upon it: yellow and green are more efficacious; but blue and violet light produce the most decided and powerful effects.

The consideration of these facts enables us readily to understand the method by which the outlines and shades of paintings on glass may be copied, or profiles of figures procured, by the agency of light. When a white surface, covered with solution of nitrate of silver, is placed behind a painting on glass exposed to the solar light; the rays transmitted through the differently painted surfaces produce distinct tints of brown or black, sensibly differing in intensity according to the shades of the picture, and where the light is unaltered, the colour of the nitrate becomes deepest.

When the shadow of any figure is thrown upon the prepared surface, the part concealed by it remains white, and the other parts speedily become dark.

For copying paintings on glass, the solution should be applied on leather; and, in this case, it is more readily acted upon than when paper is used.

After the colour has been once fixed upon the leather or paper, it cannot be removed by the application of water, or water and soap, and it is in a high degree permanent.

The copy of a painting, or the profile, immediately after being taken, must be kept in an obscure place. It may indeed be examined in the shade, but, in this case, the exposure should be only for a few minutes; by the light of candles or lamps, as commonly employed, it is not sensibly affected.

No attempts that have been made to prevent the uncoloured parts of the copy or profile, from being acted upon by light have as yet been successful. They have been covered with a thin coating of fine varnish, but this has not destroyed their susceptibility of becoming coloured; and even after repeated washings, sufficient of the active part of the saline matter will still adhere to the white parts of the leather or paper, to cause them to become dark when exposed to the rays of the sun.

Besides the applications of this method of copying that have been just mentioned, there are many others. And it will be useful for making delineations of all such objects as are possessed of a texture partly opaque and partly transparent. The woody fibres of leaves, and the wings of insects, may be pretty accurately represented by means of it, and in this case, it is only necessary to cause the direct solar light to pass through them, and to receive the shadows upon prepared leather.

When the solar rays are passed through a print and thrown upon prepared paper, the unshaded parts are slowly copied; but the lights transmitted by the shaded parts, are seldom so definite as to form a distinct resemblance of them by producing different intensities of colour.

The images formed by means of a camera obscura, have been found to be too faint to produce, in any moderate time, an effect upon the nitrate of silver. To copy these images, was the first object of Mr. Wedgwood, in his researches on the subject, and for this purpose he first used the nitrate of silver, which was mentioned to him by a friend, as a substance very sensible to the influence of light; but all his numerous experiments as to their primary end proved unsuccessful.

In following these processes, I have found, that the images of small objects, produced by means of the solar microscope, may be copied without difficulty on prepared paper. This will probably be a useful application of the method; that it may be employed successfully however, it is necessary that the paper be placed at but a small distance from the lens.

With regard to the preparation of the solution, I have found the best proportions those of 1 part of nitrate to about 10 of water. In this case, the quantity of the salt applied to the leather or paper, will be sufficient to enable it to become tinged, without affecting its composition, or injuring its texture.

In comparing the effects produced by light upon muriate of silver, with those produced upon the nitrate, it seemed evident, that the muriate was the most susceptible, and both were more readily acted upon when moist than when dry, a fact long ago known. Even in the twilight, the colour of moist muriate of silver spread upon paper, slowly changed from white to faint violet; though under similar circumstances no immediate alteration was produced upon the nitrate.

The nitrate, however, from its solubility in water, possesses an advantage over the muriate: though leather or paper may, without much difficulty, be impregnated with this last substance, either by diffusing it through water, and applying it in this form, or by immersing paper moistened with the solution of the nitrate in very diluted muriatic acid.

To those persons not acquainted with the properties of the salts containing oxide of silver, it may be useful to state, that they produce a stain of some

permanence, even when momentarily applied to the skin, and in employing them for moistening paper or leather, it is necessary to use a pencil of hair, or a brush.

From the impossibility of removing by washing, the colouring matter of the salts from the parts of the surface of the copy, which have not been exposed to light; it is probable, that both in the case of the nitrate and muriate of silver, a portion of the metallic oxide abandons its acid, to enter into union with the animal or vegetable substance, so as to form with it an insoluble compound. And, supposing that this happens, it is not improbable, but that substances may be found capable of destroying this compound, either by simple or complicated affinities. Some experiments on this subject have been imagined, and an account of the results of them may possibly appear in a future number of the Journals. Nothing but a method of preventing the unshaded parts of the delineation from being coloured by exposure to the day is wanting, to render the process as useful as it is elegant.

Herschel, 1840

"ON THE CHEMICAL ACTION OF THE RAYS OF THE SOLAR SPECTRUM ON PREPARATIONS OF SILVER AND OTHER SUBSTANCES, both metallic and non-metallic; and on some Photographic Processes," by Sir John F. W. Herschel. In Proceedings of the Royal Society, Read Feb. 20, 27, *Mar* 5, 1840.

The object which the author has in view in this memoir is to place on record a number of insulated facts and observations respecting the relations both of white light, and of the differently refrangible rays, to various chemical agents which have offered themselves to his notice in the course of his photographic experiments, suggested by the announcement of M. Daguerre's discovery. After recapitulating the heads of his paper on this subject, which was read to the Society on the 14th of March, 1839, he remarks, that one of the most important branches of the inquiry, in point of practical utility, is into the best means of obtaining the exact reproduction of indefinitely multiplied facsimiles of an original photograph, by which alone the publication of originals may be accomplished; and for which purpose the use of paper, or other similar materials, appears to be essentially requisite. In order to avoid circumlocution, the author employs the terms *positive* and *negative* to express, respectively, pictures in which the lights and shades are the same as in nature, or as in the original model, and in which they are the opposite; that is, light representing shade; and shade, light. The terms *direct* and *reverse* are also used to express pictures in which objects appear, as regards right and left, the same as in the original, and the contrary. In respect to photographic publication, the employment of a camera picture avoids the difficulty of a double transfer, which has been found to be a great obstacle to success in the photographic copying of engravings or drawings.

The principal objects of inquiry to which the author has directed his attention in the present paper, are the following. First, the means of fixing photographs; the comparative merits of different chemical agents for effecting which, such as hyposulphite of soda, hydriodite of potash, ferro-cyanate of potash, etc., he discusses at some length; and he notices some remarkable properties, in this respect, of a peculiar agent which he has discovered.

2. The means of taking photographic copies and transfers. The author lays great stress on the necessity, for this purpose, of preserving during the operation, the closest contact of the photographic paper used with the original to be copied.

3. The preparation of photographic paper. Various experiments are detailed, made with the view of discovering modes of increasing the sensitiveness of the paper to the action of light; and particularly of those combinations of chemical substances which, applied either in succession or in combination, prepare it for that action. The operation of the oxide of lead in its saline combinations as a mordent is studied; and the influence which the particular kind of paper used has on the result, is also examined, and various practical rules are deduced from these experiments. The author describes a method of precipitating on glass a coating possessing photographic properties, and thereby of accomplishing a new and curious extension of the art of photography. He observes, that this method of coating glass with films of precipitated argentine, or other compounds, affords the only effectual means of studying their habitudes on exposure to light, and of estimating their degree of sensibility, and other particulars of their deportment under the influence of reagents. After stating the results of his trials with the iodide, chloride, and bromide of silver, he suggests that trials should be made with the fluoride, from which, if it be found to be decomposed by light, the corrosion of the glass, and consequently an etching, might possibly be obtained, by the liberation of fluorine.

As it is known that light reduces the salts of gold and of platinum, as well as those of silver, the author was induced to make many experiments on the chlorides of these metals, in reference to the objects of photography; the details of which experiments are given. A remarkable property of hydriodic salts, applied, under certain circumstances, to exalt the deoxidating action of light, and even to call into evidence that action, when it did not before exist, or else was masked, is then described . . .

Eastman, 1880

U. S. PATENT NO. 226,503, *filed Sept.* 9, 1879, *issued Apr.* 13, 1880.

Be it known that I, George Eastman, of Rochester, New York, have invented an Improved Process of Preparing Gelatine Dry-Plates for use in Photography and in Apparatus therefor . . .

In the preparation of gelatine dry-plates great difficulty has heretofore been encountered in spreading the gelatine emulsion evenly over the glass. This has ordinarily been accomplished by a glass rod, the action of which was assisted by inclining the plates slightly in different directions, causing the emulsion to flow toward the edges. It has been found difficult by this means to cover the margins of the glass or to secure an even coating on the whole surface, while the process of coating the plates in this way was necessarily slow and tedious, and therefore expensive.

By my improved process plates are covered with a perfectly uniform coating of gelatine emulsion, extending entirely out to the edges of the plate, and this result is accomplished very much more rapidly than inferior plates are produced by the old method.

In the operation of my improved process of preparing gelatine plates I

employ bromide-of-silver gelatine emulsion prepared according to any well-known formula . . .

My improved process consists in coating the plates from the lower side by means of suitable apparatus hereinafter described. The apparatus may be varied in construction, but in any case the operation remains the same, the plate being drawn over a device which covers its surface with a uniform supply of the emulsion, and being then immediately reversed and placed upon a level support to set . . .

It is unnecessary to remark that the operation of coating the plates must be performed in a sufficiently non-actinic light. In preparing very sensitive plates, which require a very subdued light, the advantages of my improved apparatus will be most appreciated, as the operation of coating the plates as herein described can be performed with rapidity and certainty in almost entire darkness . . .

Emulsions made with any other colloid soluble in water may be used in place of gelatine in my improved apparatus for coating plates . . .

Science News Letter, March 26, 1932

CALENDAR REFORM

League of Nations Acting To Abolish March Easters

MARCH EASTERS may soon be things of the past.

The State Department, with the aid of other interested offices of the government and individuals, is framing a reply to a circular letter from the Council of the League of Nations dealing with the stabilization of the date for Easter.

This reply, which is to be made before May 1, will not commit the United States to any action, but will merely indicate whether or not the government approves the "Easter act" which declares that "the common good calls for the stabilization of movable feasts." The letter has gone to all governments, whether members of the League or not, which have not already endorsed the act.

Varies 35 Days

Under the present method for fixing the date of Easter, this feast may occur any time during a 35-day period from March 22 to April 26. This year the Sunday following the "first full moon after the vernal equinox" comes on March 27. Next year it will not arrive until April 17—three weeks later.

The proposed plan is to fix the date of Easter as the Sunday coming within the seven-day period from April 9 to April 15. This arrangement would make Easter fall on April 9 in the event that the fixed calendar of thirteen 28-day months were adopted.

It is thought that religious bodies will, in general, have no objection to the plan, because, in addition to the advantage of providing for Easter and the various church days dependent upon Easter to come regularly at the same time each year, the new plan will bring the celebration of this great holy day nearer to the anniversary of the first Easter.

April 9 is the date generally accepted by church historians as the date of the resurrection of Christ, and this date has recently been verified by exhaustive researches by a German scientist, Prof. D. Oswald Gerhardt.

Two statements in the Bible gave Prof. Gerhardt clues to the date of the original Easter. One is in the Gospel according to St. Luke to the effect that the baptism of Jesus occurred in the "fifteenth year of the reign of Tiberius Caesar." The other is in the Gospel according to St. John which places the visit of Jesus to the temple as being made when the temple was 46 years from its foundation.

These two statements indicate that the year of the resurrection came somewhere between 29 and 33 A. D. Gospel accounts also state that the crucifixion took place on the eve of the Sabbath of the Passover, on the fifteenth day of the month Nisan. The remaining problem for Prof. Gerhardt was then to determine by astronomical calculations just when this day fell on a Friday. He determined the date as April 7 in the year 30 A. D. Thus the first Easter was on April 9 of that year.

There has been so little opposition in this country to the stabilization of Easter that it is generally expected that the State Department will make a favorable reply. Of course, the matter of making the change is one for the Christian churches to take action on.

Science News Letter, March 26, 1932

ANTHROPOLOGY

Woman's Face More "Toothy" Than Man's

A WOMAN'S face is more "toothy" than a man's. This discovery was reported before the American Association of Physical Anthropologists by Dr. Milo Hellman of the American Museum of Natural History. Dr. Hellman termed his discovery "a curious fact."

In all the races that he has studied, Dr. Hellman said, the faces of females give relatively more space to teeth.

The role played by the teeth as a portion of the face has not been sufficiently recognized, the speaker declared.

As the face of a child grows, a good deal of the increase in size is really due to acquisition of teeth. At birth, the height of the face includes no teeth. At about three years, the two jaws which were in contact at birth, have been separated by a set of teeth taking up 5.5 per cent. of the height of the face. At about twenty years, when the permanent teeth are all present, teeth occupy about eight per cent. of the entire height of the face.

Teeth also influence the dimensions of the face from front to back, Dr. Hellman pointed out. As the child grows and his teeth increase in number, the jaws and face continue to project more forward.

Racial as well as sex differences were described by Dr. Hellman, who compared the faces of East African Negroes, European whites, and Buriats from Central Mongolia. In the Negro faces, teeth take up relatively more space than in the faces of the whites, he has found. The Asiatics measured had higher faces than the whites, but the relative height of their teeth was much less, showing that the height of their faces was due to larger bones than were found in the whites.

Science News Letter, March 26, 1932

ENTOMOLOGY

Fierce Caterpillar Monkey-Faced in Sleep

THE HABITS of a ferocious caterpillar that lives as a little beast of prey, and marks its back with the face of a monkey twisted into a mocking grin when it becomes a chrysalis for its winter sleep, have been studied by Austin H. Clark of the U. S. National Museum.

The species is known scientifically as *Feniseca tarquinius*. The caterpillars certainly are fierce little creatures, feeding exclusively on the flesh of insects, in-