equivalents for such groups as the hawks and doves within its limits. Whereas it seems to me that the truer parallel is between the whole class Insecta and Birds, and that the equivalent groups for hawks, doves, &c., are to be looked for, not in one of the sections, but in the whole of the class. He looks for both hawks and doves in the *Lepidoptera*. I find nothing but doves. If you want hawks you must go to the dragon-flies, which are their equivalent; and, of course, if we are only dealing with doves, there is nothing in the known phenomena of hybridisation opposed to such a cross having taken place.

It is impossible in the brief space that you would allow me, even to glance at the many arguments that I could adduce to show that this is the true position of the *Lepidoptera*. I hope to do so elsewhere. But I would only remind entomologists, especially lepidopterists, of the trifling characters on which their genera have been established, and how difficult it has been to find any generic characters at all. This is frankly acknowledged as the great difficulty attending the study of *Lepidoptera*, consequently characters which would never for a moment be looked on as generic in any other group of animals, are there allowed that value. If any specialist in another group objects, what is the answer? "We have no better characters, and we must do the best we can with the slight ones we possess." Quite right, in a systematic point of view. If the species of doves came to be reckoned by thousands, the ornithologist would just have to do the same thing; but that would not alter the position of doves in the animal kingdom—they would still bear the same relation that they do now to hawks, and be equally open to hybridisation among themselves, indeed, more so; for such great numbers of one type would be a presumption in favour of every mode by which species could be increased having been resorted to; and this by the way is an additional indirect argument in favour of hybridisation sometimes taking place among *Lepidoptera*.

Of course, I do not mean to say that there is nothing more than specific distinction between the Danaids and Nymphalids. I recognise them as good genera, but only as genera sufficiently nearly akin to allow of hybridisation taking place between them—and *ecce signum*—the mimics in question partaking of the characters of each in all respects as other hybrids do.

ANDREW MURRAY

67, Bedford Gardens, Kensington, Dec. 30, 1870

Measurement of Mass

THE favourite definition of *mass* in the text-books seems to be that the mass of a body is the *quantity of matter* it contains. If we had to do with but one kind of matter this would be intelligible, but I am at a loss to know what is meant when it is said that a piece of cork contains as much matter as a piece of lead. The only satisfactory method of explaining what is meant by the mass of a body, is to define it as a constant belonging to the body, which expresses the proportion between the force (measured statically) acting upon it and the acceleration produced; that every body has such a constant is the result of experiment. The mass of a body has no necessary connection with its weight. We employ weight to measure mass simply because gravity is a convenient constant force. If then we adopt a pound as our unit of *weight*, and use g to denote the force of gravity in reference to a foot and a second as the units of length and time, our unit of mass becomes the mass of g pounds, and this is not variable, although the unit of weight employed is variable; since if a true pound, as determined at London, were carried to the North Pole, it would weigh more than a pound, precisely in the proportion in which gravity at the Pole is greater than gravity at London.

THE REVIEWER OF EVERETT'S "DESCHANEL"

PHOTOGRAPHIC PROCESSES OF THE PRESENT DAY

THE last two or three years will certainly mark an era in Photography, for not only have several novel and important printing methods been discovered during that period, but other processes of less recent origin have of late been so elaborated and improved as to have become at the present moment practical and easy of manipulation. All of these are, without exception, based upon the action of light upon the bichromates of potash and ammonia; in no single case is the use of a silver salt involved—the agent employed for securing the photographic image in ordinary paper printing—and this is, in truth, a point whose value cannot be too greatly insisted on; for the silver print, be it washed and freed as thoroughly as possible from any deleterious bodies, will always suffer, more or less, from attacks of an impure atmosphere, the delicate metallic film of which the image consists being peculiarly liable to change, from the sulphur compounds and other impurities not unfrequently contained in the air we breathe. And even those silver pictures which do not at first show actual traces of fading or discoloration, will very soon be found, on careful examination, to have parted with some of their original brilliancy, and to lack the pristine freshness which always characterises newly-produced albumenised prints.

It is a great step onwards, then, to have at our disposal practical processes in which the employment of silver may be altogether dispensed with, by the substitution of another material of a more permanent character, either in the form of a chromium compound, or, what is better still, in the shape of gelatinous or greasy ink; and so clear and promising does the photographic horizon appear just now in this direction, as to leave little ground for doubting that before long the practice of printing in silver will be generally abandoned.

All recent printing processes rest, as we have before said, on the action of light upon the bichromates, and here we would parenthetically refer to a simple and familiar experiment which will help very materially to simplify our subsequent remarks. The well-known plan pursued by school-boys for printing fern-leaves and other objects by the aid of the sun, will readily be called to mind by many of us, and this simple manipulation it is that forms the groundwork of the whole series of inventions before us. A sheet of ordinary paper, which has of course been sized, or, in other words, received a thin coating of gelatine, is rubbed over with a solution of bichromate of potash; the latter, as we know, when mixed with any organic body renders the same sensitive to light, and the sizing or gelatine upon the paper becomes in this way endowed with excitable properties. Having been dried in the dark, our sheet of paper is next placed in the sun with the fern-leaf, or other object to be copied, pressed down upon it, and the light acting upon all such portions of the sheet as are not covered up, browns the gelatine there and renders it insoluble; the sizing underneath the leaf, and screened therefore from the light, escapes this reaction and remains soluble, and this, on the printing being completed and the paper washed in water, is at once dissolved away, there remaining a white image of the leaf upon a brown ground composed of bichromated gelatine rendered insoluble by the sun's rays. This experiment may be regarded as the key to the whole question of photographic printing, and by bearing it in mind the reader will have no difficulty in at once comprehending the various inventions of the kind just now being made public.

The first method claiming our attention is the so-called carbon process. Photographic printing of this nature in one form or another has been carried on probably for upwards of fifteen years; but in its experimental stage the mediocre character of the results furnished by it were such as to deprive the system of any material support from photographers, and until, in fact, Mr. J. W. Swan, of Newcastle, made known his method, no easy or reliable *modus operandi* can be said to have existed. The plan followed by Mr. Swan was to prepare a warm solution of gelatine and bichromate of potash mixed with some finely divided pigments, such, for instance, as Indian Ink, and apply this mixture in the form of a coating to a sheet of paper,

so that when dry, the tissue, as it is called, assumed the form of a thin, black cake with a paper backing. This sensitive tissue was placed under a negative to print in the ordinary manner, the light penetrating in parts to a greater or less degree, and thereby rendering the surface partially insoluble. On removing the tissue from the printing frame, it might, if it were desired, be forthwith washed to remove the soluble portions (as in the case of the fern-leaf experiment), but by so doing the picture would be hard and deficient in detail, and therefore a slight modification is here instituted. Instead of washing away from the face of the tissue, the operation is pursued from the back, the film being in the first place cemented face downwards upon a sheet of india-rubber, and in this condition put into a tank of warm water. The original paper backing of the tissue is in this way at once washed off, as is also every part of the gelatine mixture not rendered insoluble, which latter, constituting the image itself, remains attached to the india-rubber sheet before mentioned. The picture is now sufficiently developed, and indeed quite perfect, except that it is reversed to our view, for we are looking at it, it must be remembered, from the back; this defect is, however, easily remedied by attaching to the image another sheet of paper by means of gum or gelatine, and then dissolving off the india-rubber facing by means of benzole or turpentine, when the finished image is obtained resting upon a support of white paper. The object of washing the carbon tissue from the reverse side and not from the front, or surface exposed to the sun, is to secure the finer details in the picture by fixing at once to a basis such portions of the tissue as may have been but very slightly acted upon, and thus prevent them from being ruthlessly washed away when placed in warm water.

The actual composition of pictures produced in this manner consists of gelatine, pigment, and a stable chromium compound, the gelatine being in a fixed or tanned condition, by a subsequent immersion of the prints in a solution of alum, and thus there is every reason to believe in the permanent character of such prints. A more simple and ready method of carbon printing has been lately invented by Mr. Johnson, and termed the Autotype process, but the principles involved therein are nearly the same.

Passing from printing in permanent pigments, in which, as in silver printing, the aid of light is necessary for the production of each separate picture, we come next to photo-mechanical methods. Of these there may be said to be two kinds partaking of the nature of lithographic and engraving methods. Of the first description we may mention three modes of working, all of which are capable of yielding very creditable specimens of printing: these are Albert-type, the Lichtdrück process, and Edwards's collographic method. The three inventions, which differ from each other and from minor plans of a similar nature only in a few details, are all based on the same principles. A sheet of patent plate glass is in the first place coated with a thick solution of bichromate of potash and gelatine; this film on drying is placed face downwards upon a sheet of black paper in the sun, and in this way the light rays penetrate the glass and act upon the sensitive compounds adherent to its under side. The bichromated gelatine becomes insoluble and firmly cemented to the glass, except on the exterior surface, for the black paper upon which this has rested absorbs the rays and leaves the outer film of gelatine still in a soluble condition. A second coating of the sensitive gelatine mixture is now applied to the former one, to which it adheres perfectly, from the fact of the first surface being unchanged, and upon the second coating an image is printed by means of a negative in the ordinary manner. After printing, the progress of which, by-the-bye, may be watched through the glass, instead of washing the surface and dissolving out all the soluble parts, a sponge dipped in cold water is simply rubbed over it, the moisture being absorbed by the gelatine where it has not been acted upon by light, and is capable therefore of swelling out; those portions of the film, on the other hand, which have been rendered quite insoluble and hard, are unable to take up any water whatever, and remain untouched therefore by the action of the sponge, while other parts again, slightly exposed to light, absorb water just to that degree to which they have remained soluble. In this condition an inked roller is passed over the surface, in the same manner precisely as in lithography, the greasy ink adhering to all the insoluble surfaces (where no water is), and to the other parts in a greater or less degree according to the amount of water present in those places. Thus the gelatinised glass is treated in every sense like a lithographic stone, being moistened, inked, and pressed in the same manner; the resulting print, however, is generally finer than that obtained in ordinary lithography, as the graining of a stone surface is always somewhat coarse, while in the present instance the breaking up of the ink by the minute pores of the gelatine impregnated with moisture is of an exceedingly fine character. Many thousand prints may be pulled off a printing block of this kind before it is destroyed, as the double layer of gelatine imparts a yielding nature to the plate which is not easily damaged; in Germany, in England, and also, we believe, in America, this process of photographic printing is extensively practised.

But by far the most important of all methods yet discovered is the Woodbury engraving process. So simple, and at the same time so perfect in its work, a casual observer cannot but fail at once to appreciate its value. A thin sheet of gelatine is sensitised by impregnation with bichromate solution, and exposed to light under a negative; subsequent immersion in warm water removes the soluble portions from the surface, and we have then a thin gelatine plate upon which the image is represented, more or less, in relief. This matrix, as it is called, is hardened by treatment with alum, and placed when dry in a hydraulic press, in contact with a plate of type metal. Subjected to considerable pressure the metal plate takes the impression of the relief, and thus becomes in every sense an engraved plate, in which the darkest shadows are represented by the deepest hollows, the half-tones by slight undulations, while in the high lights there is no depression at all. The printing off of copies from this engraved plate is very ingeniously contrived. A little pool of transparent gelatinous ink is poured upon a sheet of white paper, and the metal plate is brought down upon the same with some pressure; all superfluous ink is at once pressed out, and after a pause of a few seconds to allow the warm ink to cool and to become set, the plate is again raised, and a beautifully shaded print is the result, in which the shadows and half-tones are formed by layers of ink of different thicknesses. For inasmuch as the ink is of a transparent character, and there is more or less of it deposited upon the paper according to the depths of the hollows in the engraved plate, so the half-tones are rendered with perfect gradation and fidelity, while in the high lights almost all the ink having been pressed away and removed, there remains nothing but the white paper which forms the basis of the print.

By printing at once from many plates (for a gelatine matrix will yield several dozen of them), photographs may be printed at the rate of some thousands daily, without of course the assistance of light in any way. Moreover, the productions are of so perfect and delicate a nature as to be confounded actually with silver prints, being at the same time absolutely permanent. We are glad to say that this method is also being worked practically and extensively in this country, as also in France and America, and will, without doubt, be the process of the future; for it is indeed the only mechanical process by means of which photographs may be rapidly produced, possessing the same degree of excellence as the beautiful, but alas! too fleeting, albumenised pictures.

H. B. P.