

and others don't notice it.' This man was very nervous about crossing the divide at all while it was thundering, and plainly said if there was lightning he must wait for fair weather."

Possibly, sound might have accompanied this discharge, but the noise of our wheels would have drowned it.

Holmwood, Putney Hill, May 19.

DAN. PIDGEON.

Rain-Clouds.

THE rain-cloud which Mr. Abercromby sketches in NATURE of May 2 (p. 12) is often seen in Upper Austria in summer. I have given a rough sketch of these thunder-clouds in the Austrian *Meteorological Journal*, vol. viii., 1873, p. 104.

Vienna, Hohe Warte 38.

JULIUS HANN.

THE MUYBRIDGE PHOTOGRAPHS.¹

MR. MUYBRIDGE is of English birth, a citizen of the Great Republic, and a professional photographer. Long before he applied his knowledge and skill to the subject of instantaneous photography of moving animals and human beings, he had obtained recognition by his work in producing valuable views of Californian scenery, of Panama and the West Indies. In 1872 he made the first lateral photograph of a horse trotting at full speed, for the purpose of settling a controversy among horsemen as to "whether all the feet of a horse while trotting were entirely clear of the ground" at any one instant of time. It was not until 1877, however, that he conceived the idea that animal locomotion, which was then attracting considerable attention through the experiments of Prof. Marey, of the Collège de France, might be investigated by means of instantaneous photography, with results of value both to the artist and to the naturalist.

Marey's investigations were made by means of elastic cushions, or *tambours*, which were placed on the feet of the moving animal, and connected by flexible tubes to pencils writing on a chronograph. A record of the impact of each foot on the ground was thus obtained, and important information was deduced from these records as to the succession of footfalls and the time-intervals separating them in the various "gaits" of the horse.

Mr. Muybridge proposed to settle this and similar problems once for all by a complete and demonstrative graphic method. He arranged a number of cameras side by side, parallel to the track along which a horse was to be ridden. Each camera was provided with a specially contrived "exposer" (the word suggested by Mr. Muybridge in place of "shutter"), which could be let go by the pulling of a string. The strings connected with the "exposers" were placed across the path of the horse, so that they must be broken by him successively in his passage. At the instant of the breaking of the string, the exposer was brought into play in the corresponding camera, and thus the horse was photographed in a succession of intervals of about 14 inches, representing, according to the rate of progression of the horse, a time-interval of more or less than one-twentieth of a second.

In this way, in 1878, with the wet plates then in use a few sets of horses moving with various gaits were taken by Mr. Muybridge. The results were astonishing and conclusive. They were published at the expense of Mr. Leland Stanford, under the title of "The Horse in Motion," and were exhibited in Europe in 1882 by Mr. Muybridge, together with other photographs taken in 1879. The reception which Mr. Muybridge met with on his visit to Paris and London was a great encouragement to him to proceed with his work. Meissonier, the great French painter, was enthusiastic in his admission of the value of the photographs as a guide to the observation required for all true artistic work, and the story goes that

¹ "Animal Locomotion: an Electro-photographic Investigation of Consecutive Phases of Animal Movements." By Eadweard Muybridge. (Published under the auspices of the University of Pennsylvania, 1883.)

a particular attitude of the horse presented by him in one of his best known pictures which had been objected to by the critics as unnatural, was demonstrated by the Muybridge photographs to be perfectly correct. The series of little black *silhouettes*, which were at that time the form in which Mr. Muybridge obtained his pictures, were so contradictory of all preconceived notions as to what were the actual phases of attitude passed through by a trotting or a galloping horse, and so difficult to reconcile with the conventional representations of what is of course a totally different thing, viz. what we see when a trotting or galloping horse crosses our field of vision, that Mr. Muybridge determined on his return to America in 1883 to pursue the subject, and to apply improved methods of photography to the study of the rapid movements of a variety of animals and of man. The new dry plates now made it possible to obtain in exposures of 1/5000 of a second and less an amount of detail which was previously impossible. New automatic methods of registration and exposure were to be employed, larger pictures obtained, and the selected series printed without re-touching by a permanent photogravure process. The funds necessary to carry out this scheme were beyond Mr. Muybridge's own resources, and he for some time failed to obtain the necessary aid from any publisher or scientific institution. A Committee of the University of Pennsylvania thereupon came forward and placed £6000 at Mr. Muybridge's disposal, solely on condition that the first proceeds of the sale of the photographs when ready for publication should be assigned to the reimbursement of this sum. The words of Dr. William Pepper, the Provost of the University, in recording this most worthy action, are remarkable, and ably state that conception of the part of the University in the life of the State which we have so often advocated in these pages. "The function of a University," says Dr. Pepper, "is not limited to the mere instruction of students. Researches and original investigations, conducted by the mature scholars composing its Faculties, are an important part of its work; and in a larger conception of its duty should be included the aid which it can extend to investigators engaged in researches too costly or elaborate to be accomplished by private means. When ample provision is made in these several directions, we shall have the University adequately equipped and prepared to exert fully her great function as a discoverer and teacher of truth."

As a result of the action of the University of Pennsylvania in providing Mr. Muybridge with the means to carry out his experiments, we have a really marvellous set of plates—781 in number—each containing a series of from twelve to thirty pictures representing successive instantaneous phases of movement. About 500 of the plates represent men, women, and children, nude and semi-nude, in successive phases of walking, running, jumping, dancing, bathing, fencing, wrestling, boxing, and other such exercises. The rest of the plates give similar studies of the various gaits of horses, asses, mules, oxen, deer, elephants, camels, raccoons, apes, sloths, and other quadrupeds, as well as of the flight of birds. Many of these photographs have been, this spring, exhibited in London by Mr. Muybridge, projected on the screen by electric light—at the Royal Society, the Royal Institution, the Royal Academy, and the South Kensington Art School. The whole series can now be obtained by those who desire to possess them, and to assist the University of Pennsylvania by bearing a portion of the expense of their production. Series of not less than one hundred plates are also to be disposed of, and may be seen on application to Mr. Muybridge, who is at present in London.

The interest which these photographs present from the scientific point of view is threefold:—

(A) They, first of all, are important as examples of a very nearly perfect method of investigation by photographic and electrical appliances.