

THE HORSE IN MOTION.*



16 17 18 19 20

FIG. 1.



17 18 19 20 21

FIG. 2.



18 19 20 21 22

FIG. 3.

Those curious in such matters were much interested, a few years ago, by the circulation of a few sets of photographs, taken at the private race-course of Governor Leland Stanford, of California, by Mr. Muybridge, a photographer of San Francisco. The consecutive positions of the legs in the stride of a running horse, as revealed by these photographs, seemed ludicrous and almost impossible. Indeed, it required the combination of the positions given by the reproduction of the pace in the zoetrope to convince



22 23 24 25

FIG. 4.

the skeptical that the analysis of the movement was correct. The testimony of the zoetrope, and, later, of the zoepraxiscope, has silenced all skepticism, and one can no longer hesitate to concede the truth and simplicity of what, at first, seemed complicated and absurd. Since the first appearance of these photographs, the processes for securing them have been much improved, and Mr. Muybridge's public and private representations, here and abroad, have been received with the greatest favor. Meissonier, who has made a specialty of the action of the horse, is announced as an adherent of the new theory, and it is said that he has recently modified a painting in conformity with it.

While great credit is due to Mr. Muybridge for the ingenuity and skill with which he has applied his art to the production of these

pictures, they would not have been taken, nor could the world have had the full benefit of them which it now receives, but for the intelligent liberality of Governor Stanford, who, at much cost and with no chance for pecuniary reward, has carried the investigation to great lengths, and who now presents its results in a large quarto volume, containing more than a hundred plates, which bear over a thousand figures of animals in motion. These illustrations are accompanied by an elaborate essay, in which Dr. Stillman explains their application to the locomotion of quadrupeds, of horses especially.

The method by which these photographs have been taken—the result of years of experiment—is substantially as follows: At one side of the track is a long building arranged for photographic work, containing a battery of twenty-four cameras, all alike and standing one foot apart. On the other side of the track is a screen of white muslin and a foot-board. The screen is marked with vertical and horizontal lines, and the foot-board bears numbers indicating separate intervals of one foot each. The instantaneous shutters of the cameras are operated by electricity, and their movement is governed by such powerful springs that the exposure is estimated to be about one five-thousandth of a second. The contact by which the shutters are sprung is made by the breaking of a thread drawn across the track at about the height of the horse's breast, there being one thread for each camera. In his flight through



24 25 26 27 28

FIG. 5.



27 28 29 30 31

FIG. 6.



29 30 31 32 33

FIG. 7.

*"The Horse in Motion, as Shown by Instantaneous Photography, with a Study on Animal Mechanics. Founded on anatomy and the revelations of the camera. In which is demonstrated the theory of quadrupedal locomotion. By J. D. B. Stillman, A. M., M. D. Executed and published under the auspices of Leland Stanford." Boston: James R. Osgood and Co. 1882.

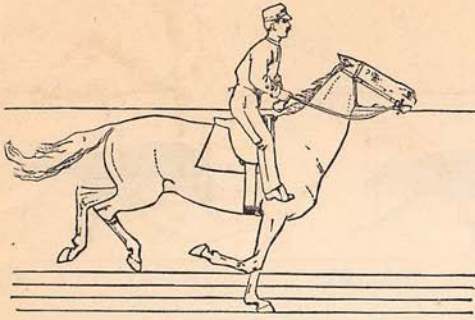


FIG. 8.

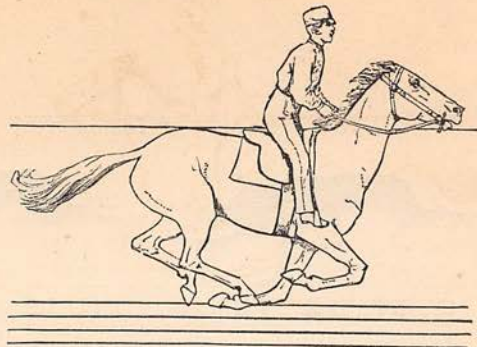


FIG. 9.

the air, therefore, he brings each of the twenty-four cameras to bear upon him at the moment when he passes in front of it, and that camera represents his position at that instant. The series of representations indicates the consecutive positions at each of the twenty-four feet covered by the instruments. In a series showing a horse trotting at speed the spokes of the sulky are shown as distinct lines quite to the felloe of the wheel, indicating an extremely short exposure. In a fast run, the tufts of the horse's tail, as it waves with his stride, are clearly marked. The distinctness of the silhouettes thus produced is well illustrated in Figures 1, 2, 3, 4, 5, 6, 7, showing a hound running with a stride of twenty-one feet. These and the other silhouettes illustrating this article are copied from heliotypes taken from the original photographs.

The illustrations 8 to 18, which follow, are not absolute reproductions; but in drawing them the greatest care was taken to preserve the outlines of the original. Their essential correspondence with the photographs of an animal running at speed show they may be taken as an unquestionable analysis of that gait. It is to be understood that the horse is at full speed, and that the illustrations here given represent alternate photographs of a series of twenty-four; that is, that they represent positions at intervals of two feet.

The eleven cuts cover a trifle more than one stride, the supporting fore leg in the last being a little further to the rear than in the first. In Figure 8 the whole weight is borne by the left fore leg, the pastern of which is nearly horizontal, and which is nearly under the center of gravity. The hind feet are about twelve and fifteen inches from the ground,

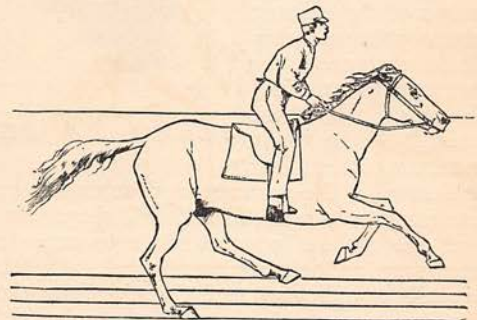


FIG. 12.

and the croup and withers are about two inches below the gauge line. Figure 18 shows this supporting foot just before leaving the ground. The extreme lengthening of the leg, by straightening the angles between the shoulder and the forearm, has raised the body about an inch nearer to the gauge line. The effect of that thrust, and of the straightening

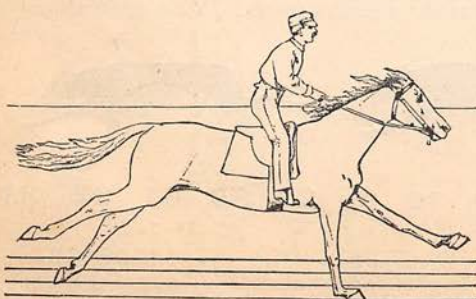


FIG. 15.

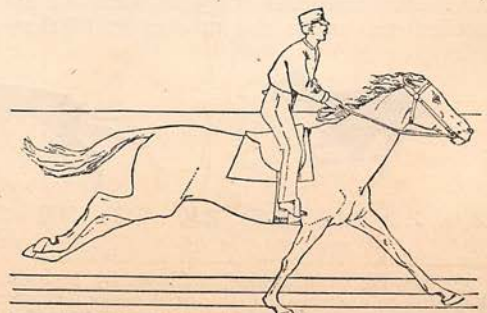


FIG. 16.

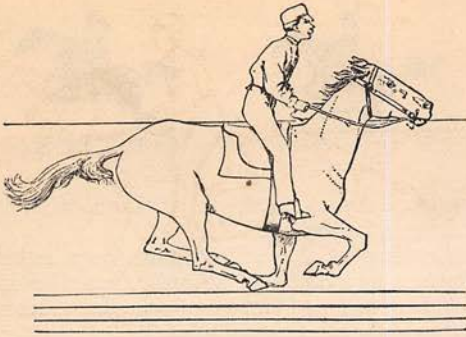


FIG. 10.

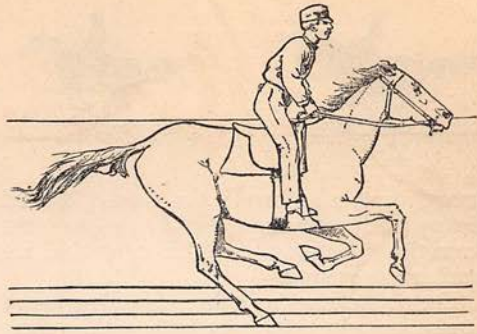


FIG. 11.

of the pastern, is continued after the foot leaves the ground, so that in Figure 9 the croup and shoulder have been thrown quite to the gauge line. In Figure 10, the horse being still off the ground, the croup has gone an inch above the line. It has hitherto been the general belief that when the horse descends from his bound he lands on one of his

both fore feet being still more than a foot from the ground, both hind feet are in firm contact with it. In Figure 14, the right hind foot is ten inches from the ground and far to the rear. The left hind foot is performing the functions of the right in Figure 12, and the right fore foot is on the ground. The leading fore leg is extended to its utmost in Figure 15.

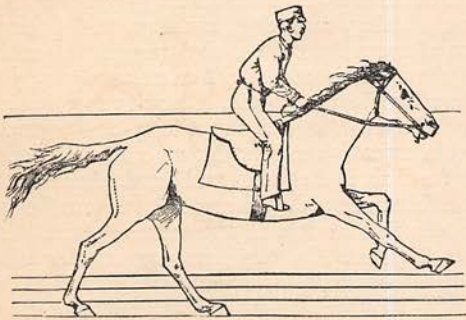


FIG. 13.

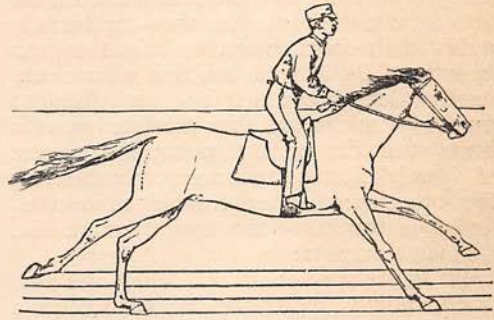


FIG. 14.

fore feet. Figure 11 shows that the right hind foot first reaches the ground, the other three feet being more than twelve inches above it. As this hind leg passes to the rear in Figure 12 the pastern is parallel with the ground, the left hind foot is preparing to take its position, and both fore feet are moving to the front. At the next position, Figure 13,

The two hind legs are extended, and the left fore leg is still four inches from the ground (Figure 16), when the right, the only one in contact, is nearly at the end of its stroke. In Figure 17, eighteen feet in advance of Figure 1, the left fore foot is still somewhat in advance of the position there shown. Figure 18, as above stated, finishes the stride, the leg,

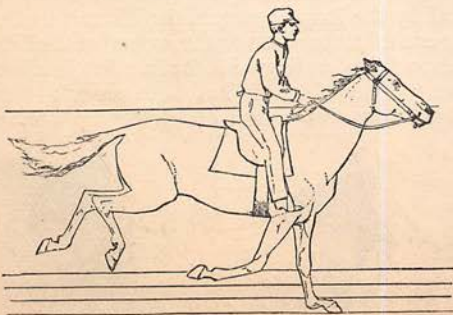


FIG. 17.

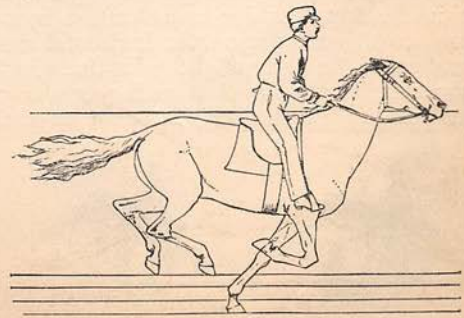


FIG. 18.



FIG. 19.



FIG. 20.



FIG. 21.



FIG. 22.

strongly extended to the rear, having started the upward propulsion that is to carry the horse through the air until his right hind leg reaches the ground.

The deductions from these few illustrations cannot be adequately set forth within these limits. The most curious of them, anatomically, relates to the fact that the horse's withers are much further from the gauge line when one of his fore legs is almost directly under him (Figure 15) than when that leg is extended to the utmost, and when the other feet are in the air (Figure 18), the whole body being strongly thrown upward, as if by the force with which this one leg is extended. This thrust—which shows a wonderful flexibility and strength of the whole mechanism, from the top of the shoulder to the toe—involves the action of muscles whose relations to this movement Dr. Stillman explains in his notes. Another deduction which it seems difficult to avoid is this: Not only are the fore legs of a horse something more than mere supporters of his weight between successive thrusts of the hind-quarters: they are themselves most effective in propelling the body forward. Dr. Stillman even says:

"It will be apparent * * * that each limb is required to support the body and act as a propeller in turn, and that the *anterior one does more than its share of both offices.*" (The italics are mine.)

Nevertheless, it will need more than the photographs and diagrams shown in this book, and the reasoning with which the proposition is advanced, to convert to full belief in this theory one who has watched from a coach-box the tremendous action of the dorsal muscles of a pulling horse. If there is a weak point in the reasoning, it may, perhaps, lie in the fact that due consideration is not given to the effect upon the horizontal momentum of the body of the "dirt-throwing" movement of the fore foot as it passes over the toe—an effect somewhat akin to that

produced by a match on a billiard-table in making a ball "hop."

Looking at these illustrations as a series, the first impression of absurdity must be inevitable; but, as I have had occasion to learn through the perfect reproduction of a graceful and vigorous stride, on placing them in the zoetrope and there studying their combinations at low speed, they lose, in time, their extravagant appearance, and are easily associated in the mind with the natural action of a rapidly moving horse. To what extent they may be useful in modifying the pictorial representation of animals in motion it is not easy to determine. This part of the subject will have consideration further on.

The numerous illustrations given of walking, trotting, cantering, running, and pacing are all most instructive and suggestive, none of them more so than the series 19 to 30, showing a leaping horse. These twelve figures are selected from a series of forty-eight, which begin twenty-one feet before a hurdle three feet and six inches high, and terminate twenty-one feet beyond it. The selected figures begin sixteen feet in advance and terminate nineteen feet beyond. As the horse approaches the leap he slackens his speed, puts one fore leg far in advance, throws his weight upon that leg, and advances his hind legs (19), which pass the position of the supporting fore foot, and strike the ground about two feet in advance of it (20); as the fore leg is about leaving the ground it gives an upward thrust for the rise to the leap (21), a simultaneous spring from the hind legs carrying the animal into the air and over the hurdle (22, 23, 24, 25, 26, 27), until he lands on his fore legs differently advanced (28), and gathers himself (29), ready to begin a fresh stride (30). The distance covered by the leap shown in the illustration between the last position on the ground of the hind feet and the landing with the fore feet is about twenty-seven feet. It has been asserted that when a horse lands from a high leap he touches



FIG. 31.



FIG. 32.



FIG. 33.



FIG. 34.



FIG. 23.



FIG. 24.

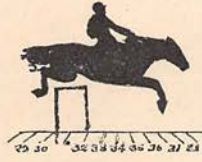


FIG. 25.

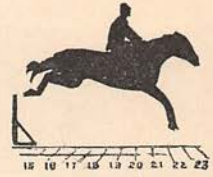


FIG. 26.

the ground with his fore feet, and makes another step forward, with them both, before his hind feet come to the ground. Muybridge's illustrations of leaping all show that the horse lands on one fore foot, the other taking its position immediately afterward, a little in advance. The quickness of the movement has probably misled observers to the idea that both feet take first one position and then the other. The illustrations 31 to 37 show an unpremeditated standing leap. The horse baulked at the hurdle, and was forced over it with great difficulty. It seems hard to believe that, having forced himself into the position

focus. Figures 38, 39, 40, 41, and 42 show one picture of each of five series. These are not immediate reproductions of the photographs, but the drawings from which they are taken were accurately made on enlargements of the same horse leaping, but are parts of five different leaps. In the approach (38), the horse is in the position next preceding that shown in Figure 19. In 39 he is in that shown in Figure 21; in 40 in the position shown in Figure 23; in 41 in the position shown in Figure 27; and in 42 in the position succeeding that shown in Figure 28. Corresponding represen-



FIG. 27.



FIG. 28.



FIG. 29.



FIG. 30.

shown in 34, he could, with his legs thus extended, spring to the position in 35. The positions of the rider in 36 and 37 indicate a general disturbance of forces which, to one who has made a standing leap for which he was unprepared, will seem very truthful.

tations of a leaping horse are not recalled as appearing in Leech's and other illustrations; that they are, however, entirely true to nature must be at once recognized by any one who, bearing them in mind, will watch the actual leaping of a well-trained horse.

The illustrations thus far given serve to show the method adopted to indicate the consecutive positions in the measured movements of the horse and of other animals. Their value is very much enhanced by the later series, where five views are given of each of many positions in different gaits. The cameras for this purpose were arranged so as to take one broadside view and four quartering views, looking, for example, to the right shoulder, the left shoulder, the right quarter, and the left quarter, the contact for each being made by the breaking of a single thread struck by the horse when he came into the

The truth to nature of most of the illustrations given in the work under consideration, while it cannot be questioned, must be considered with reference to the fact that the horses under examination were nearly all highly bred animals, mainly thorough-bred race-horses. The photographs would necessarily show some modification, if representing horses in common use and of less graceful and vigorous conformation. But, modified as they may be, they can never by any ordinary process be reconciled with the conventional horse of the artist, ancient or modern. The horse in full gallop is almost invariably shown either, as in racing plates, extended to the utmost, or with an equal and uniform disposition of the limbs, as shown in Figure 43, which is a fair example of the representation of a strong and regular gallop. Not



FIG. 35.



FIG. 36.



FIG. 37.

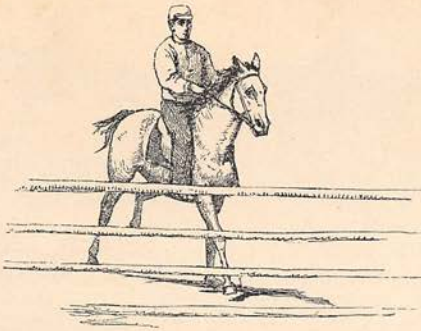


FIG. 38.

one of the series of cuts Nos. 8 to 18 gives, by itself, an idea of great speed. Figure 44, however, corresponding with Figure 18, has a strong headlong movement, and may easily be imagined to be a picture of a horse running at great speed. It becomes now a curious and not unimportant question to discuss whether or not artists should abandon their old method of representing the galloping horse, and show him always in some one of his actual positions.

Dr. Stillman is very strongly of the opinion that they should do so. Perhaps, after all, it resolves itself into a question as to whether an artist whose purpose it is to represent things as they *seem*, is justified in adapting his methods to the limitations of the human vision, or whether he should show things exactly as they *are*, and appeal only to human reason. Dr. Stillman says: "It seems to many unaccountable that the horse, whose movements are so open, should play such a *léger-de-pied* as to deceive all eyes and give rise to controversies as earnest as did the colors of the chameleon in the fable." But Dr. Stillman seems, himself, to account satisfactorily for what he suggests as unaccountable. He says:

"It is difficult at a glance to conceive how the eye could be so deceived; but a little consideration

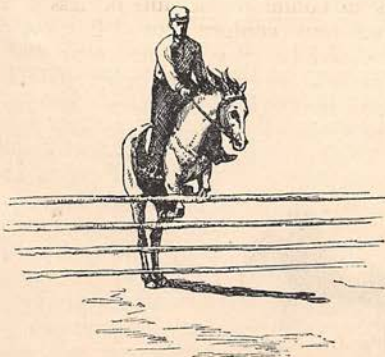


FIG. 39.

of the physiology of that organ will teach us that no dependence can be placed on it to interpret the motion of an object moving irregularly, even at a comparatively slow rate of speed.

"It has been shown that the retina of the eye is capable of receiving a distinct image of an object in almost inconceivably short space of time, as that of the flash of an electric spark or a millionth part of a second, and that the impression remains for the space of a third to a seventh of a second, according to the experiments of D'Arcy and Plateau; and the mind is incapable of distinguishing between the first impression and the last made during that space of time, and the images run together and are confused. A familiar illustration of this phenomenon is furnished by the spokes of a wheel in motion; yet these spokes will appear stationary if, revolving in the dark, they are suddenly illuminated by an electric flash; or if the end of a stick be ignited, and moved rapidly, a continuous line of fire will appear. Here there is a continuous line of impressions made upon the retina, and so conveyed to the mind * * *. The reader may ask why it is that the artists of all time, with the full accord of all men,—and our own eyes confirm the tradition,—represent the horse in galloping as extending his feet to the utmost, as seen in all the pictures

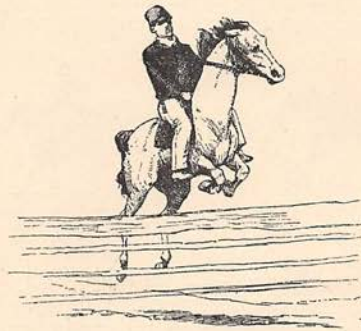


FIG. 40.

of horses racing. My answer is this: We now know that it is not true that a horse ever did put himself in the position portrayed by the best artists; and the explanation that I have to offer is, that in the gallop the horse always moves his feet alternately, and to the same extent; at the limit of extension there is a change of direction given to them, and their image dwells longer upon the retina, and the impressions are more lasting than of the intermediate and more rapid movements which the mind is unable to distinguish any more than the order in which they are made."

This looks like an unconscious undermining of the whole structure that he has labored to erect.

If a painting showed four horses harnessed to a coach, each of them in certain of the intermediate positions that instantaneous photography shows to be true, they would look as though they were dangling their legs at a stand-still. Whatever position might be given to a trotting horse in a picture intended to show great speed, its effect would be lost if he were shown as harnessed to a sulky of which the spokes of the wheel were visible, as we are told that they become when illuminated

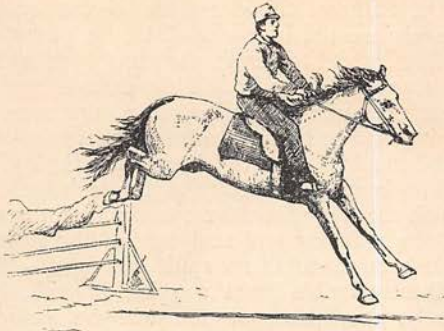


FIG. 41.

in the dark by an electric flash. We need the confused whirl of the wheels to complete the impression.

A somewhat curious illustration of the difference between what is and what seems to be, is given by the quarter-second hand on a racing time-piece. Watching this hand we see it jump to the quarters and stop, and watching its consecutive movement, we see its sweep around the center. If, however, three of the positions are covered,—that is, if we cover a little more than the lower half of the dial,—the effect produced on the eye is that of a needle darting straight out from the center to the top, and darting straight back again. The sweep is entirely undetected. The same principle, perhaps, holds good with a running horse, at least so far as any given position of the legs is concerned. The only position in which it is possible to see the fore feet or the hind feet is when they are extended to the utmost, that is, when they come to a stop. A painting or a statue can show only position; it cannot show movement. The fault in the artistic representation of the gallop seems to me to be inherent. The gait is not a position at all, but ceaseless motion. It is, indeed, to be questioned whether the strongest impression produced on the eye is derived from the extension of the limbs in the

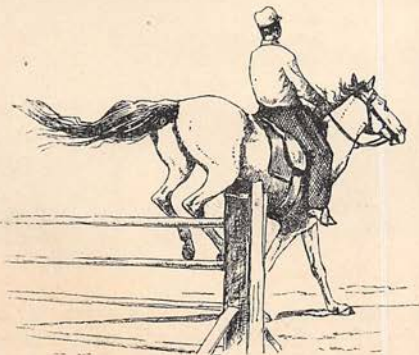


FIG. 42.

full strides, or from the vigor with which they are gathered after extension. On the race-track, or in the use of the zoetrope, it is the rapid flexion of the legs which most attracts my attention, and the absence of which, from the impression given by a picture, seems to me to mark its greatest limitations. If this line of reasoning is correct, it is not so much a question whether the artist shall reproduce the positions of Muybridge's photographs, as whether he shall attempt to paint a galloping horse at all, since he cannot indicate the *action*, which is the essence of the gallop.

There is, after all, another element of the discussion to which full weight must be given. That is, that not only art but man himself is conventional. We are accustomed to seeing certain things represented in a certain way. When an attempt is made to represent them



FIG. 43.

in another way our conventional natures revolt at the innovation. A familiarity of some years with Muybridge's photographs, while it has not enabled me to see in them the activity of the old type of picture, has unquestionably greatly modified the view with which I regard them. For example: Figure 44, which I should, some years ago, have regarded as absurd, is now a most satisfactory representation of motion. It is by no means improbable that the influence of these illustrations on the horse-paintings of the future, and on the minds of those who look at them, may be such as to banish from the canvas the impossible positions now shown there, and to introduce new positions, more like Muybridge's, which, though they would not now be accepted by the public, will be in entire accordance with the conventions of that day. It would be absolute truth, but it would also be very absurd truth,



FIG. 44.

to show the spokes of a wheel going at a 2:17 gait. The picture which shows it as our poor eyes must see it is really the truthful one for the purposes of art. So must it be with the horse in motion. We must see him on the canvas as we see him in life, not as he is shown when his movements are divided by the five-thousandth part of a second.

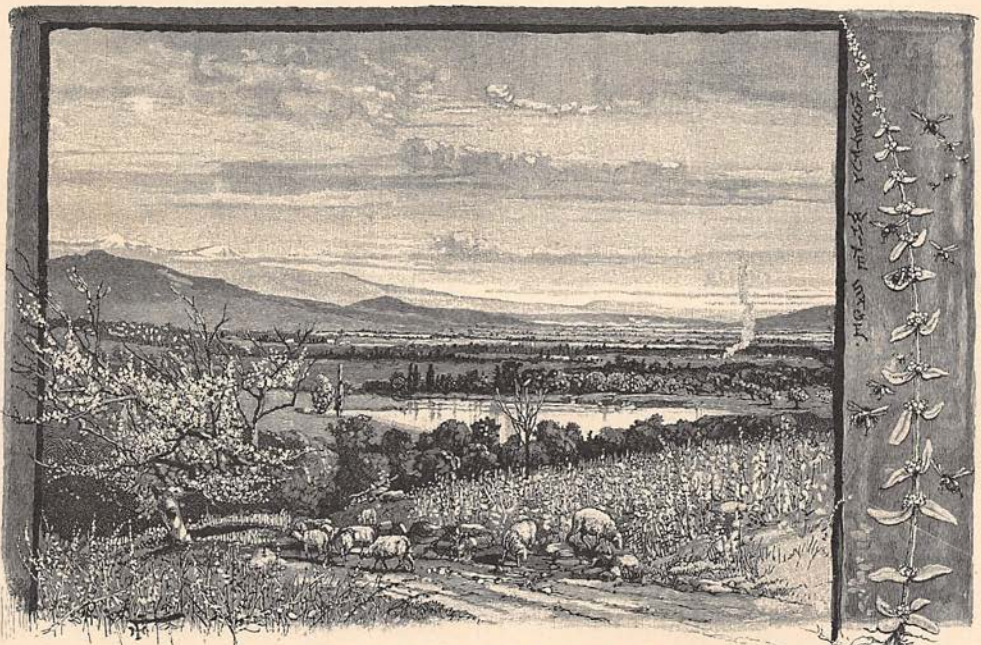
Dr. Stillman thinks "there is too much capital invested in works of art all over the civilized world to permit the innovation without a protest, and ridicule is the cheapest argument that can be employed in controversy, for it does not require truth for its foundation, and but a low order of talent for its display."

The foregoing remarks as to the influence which these revelations may or may not have on the painting and sculpture of the future have been made in no spirit of protest—the farthest possible from a spirit of ridicule. Surely, too, this question will be settled entirely without reference to the influence of invested capital. It may be that, as our ideas become trained to the analysis of quadrupedal movement, we shall accept the new light in its fullness; but let us not, in our enthusiasm over a new discovery, and in our devotion to a purely theoretical "truth," lose sight of the limitations which must always surround every attempt to represent action by passive objects and lines.

George E. Waring, Jr.

THE BEE-PASTURES OF CALIFORNIA.

IN TWO PARTS: II.



IN THE SAN GABRIEL VALLEY.—WHITE SAGE.

REGARDING Mount Shasta comprehensively from a bee point of view, encircled by its many climates, and sweeping aloft from the torrid plain deep into the cold azure, we find the first five thousand feet from the summit pretty generally snow-clad, and therefore