CLASSICS OF SCIENCE: Muybridge on Attitudes of Animals

Moving Pictures

Among the many interesting devices for the study of motion, which may be considered ancestral forms of the modern movie, the simple plan of taking one picture after another at short intervals with a battery of cameras can scarcely lay claim, perhaps, to close kinship with the present-day compact apparatus. But the attitudes of animals, which Muybridge set out to show, were revealed by this method, to the great satisfaction of its inventor and his patron, Leland Stanford, and to the delight of large audiences who responded, to quote a contemporary, with "plaudit after plaudit."

THE ATTITUDES OF ANIMALS IN MOTION

By Eadweard Muybridge, of San Francisco

(*A lecture delivered before the Franklin Institute, February 13th,* 1883.)

Journal of the Franklin Institute, April, 1883.

The problem of animal mechanism has engaged the attention of mankind during the entire period of the world's history. Job describes the action of the horse; Homer, that of the ox; it engaged the profound attention of Aristotle, and Borelli devoted a lifetime to its attempted solution. . . .

While the philosopher was exhausting his endeavors to expound the laws that control and the elements that effect the movements associated with animal life, the artist, with a few exceptions, seems to have been content with the observations of his earliest predecessors in design, and to have accepted as authentic without further inquiry, the pictorial and sculptural representations of moving animals bequeathed from the remote ages of tradition.

When the body of an animal is being carried forward with uniform motion, the limbs in their relations to it have alternately a progressive and a retrogressive action, their various portions accelerating in comparative speed and repose as they extend downwards to the feet, which are subject to successive changes from a condition of absolute rest, to a varying increased velocity in comparison with that of the body.

The action of no single limb can be availed of for artistic purposes without a knowledge of the synchronous action of the other limbs; and to the extreme difficulty, almost impossibility, of the mind being capable of appreciating the simultaneous motion of the four limbs of an animal, even in the slower movements, may be attributed the innumerable errors into which investigators by observation have been betrayed. When these synchronous movements and the successive attitudes they occasion are understood, we at once see the simplicity of animal locomotion, in all its various types and alterations. The walk of a quadruped being its slowest progressive movement would seem to be a very simple action, easy of observation and presenting but little difficulty for analysis, yet it has occasioned interminable controversies among the closest and most experienced observers. . . .

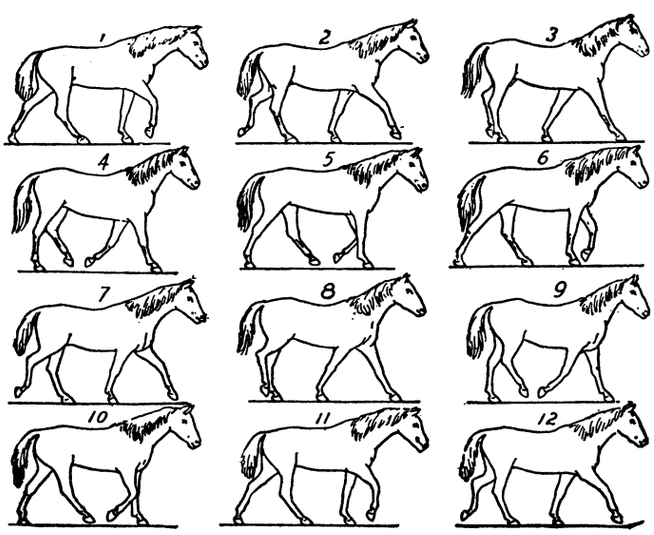
Photography, at first regarded as a curiosity of science, was soon recognized as a most important factor in the search for truth, and its more popular use is now entirely subordinated by its value to the astronomer, the anatomist, the pathologist, and other investigators of the complex problems of nature. The artist, however, still hesitates to avail himself of the resources of what may be at least acknowledged as a handmaiden of art, if not admitted to its most exalted ranks.

Having devoted much attention in California to experiments in instantaneous photography, I, in 1872, at the suggestion of the editor of a San Francisco newspaper, obtained a few photographic impressions of a horse during a fast trot.

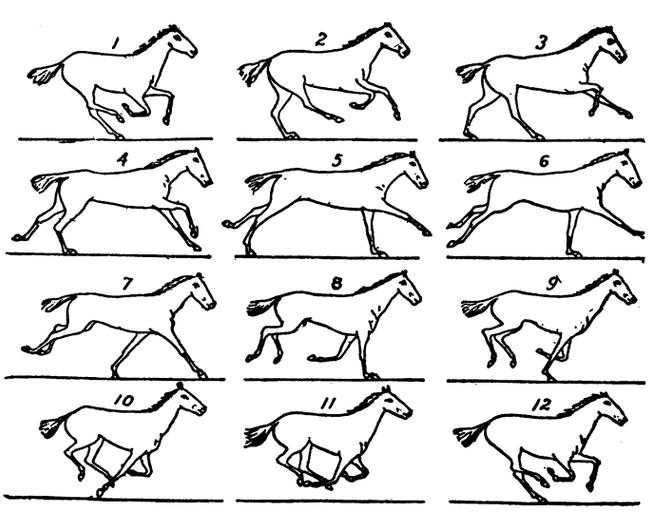
At this time much controversy prevailed among experienced horsemen as to whether all the feet of a horse while trotting were entirely clear of the ground at the same instant of time. A few experiments made in that year proved a fact which should have been self-evident.

Being much interested with the experiments of Professor Marey, in 1877, I invented a method for the employment of a number of photographic cameras, arranged in a line parallel to a track over which the animal would be caused to move, with the object of obtaining, at regulated intervals of time or distance, several consecutive impressions of him during a single complete stride as he passed along in front of the cameras, and so of more completely investigating the successive attitudes of animals while in motion than could be accomplished by the system of M. Marey.

I explained the (*Turn to next page*)



SOME CONSECUTIVE PHASES OF THE WALK.



SOME CONSECUTIVE PHASES OF THE GALLOP.

HOW ANIMALS MOVE, as proved by Muybridge's series of instantaneous photographs

Attitudes of Animals—*Continued*

plan of my intended experiments to a wealthy resident of San Francisco—Mr. Stanford—who liberally agreed to place the resources of his stock-breeding farm at my disposal, and to reimburse the expenses of my investigations, upon condition of my supplying him, for his private use, with a few copies of the contemplated results. . . .

[*The following description of the photographic apparatus is arranged from Muybridge's account of it.—Ed.*]

In the studio are arranged 24 photographing cameras; at a distance of 12 inches from the centre of each lens an electro-exposor is securely fixed in front of each camera. Threads 12 inches apart are stretched across the track at a suitable height to strike the breast of the animal experimented with, one end of the thread being fastened to the background, the other to the spring, which is drawn almost to the point of contact.

This spring actuates the electro-exposer, which is constructed as follows: Two shutters, each comprising two panels, with an opening between them, are adjusted to move freely up and down in a frame; they are arranged ready for an exposure, and are held in position by a latch and trigger, all light being excluded from the lens. A slight extra tension of the thread will cause a contact of the metal springs and complete a circuit of electricity through the wires and the electro magnet; the consequent attraction causes the armature to strike the trigger, the latch is released, the shutters are drawn respectively upwards and downwards by means of the rubber springs, and light is admitted to the sensitised plate while the openings in the shutters are passing each other in front of the lens.

The animal in its progress over the track will strike these threads in succession, and as each pair of strings is brought into contact, the current of electricity thereby created effects a photographic exposure, and each consecutive exposure records the position of the animal at the instant the thread is struck and broken.

For obtaining successive exposures of horses driven in vehicles, one of the wheels is steered in a channel over wires slightly elevated from the ground; the depression of each wire completes an electric circuit, and effects the exposures in the same manner as the threads. . . .

The Walk

Selecting the horse for the purposes of illustration, we find that during his slowest progressive movement—the walk—he has always two, and, for a varying period, three feet on the ground at once. With a fast-walking horse the time of support upon three feet is exceedingly brief; while during a very slow walk all four feet are occasionally on the ground at the same instant.

The successive order of what may be termed foot fallings are these. Commencing with the landing of the left-hind foot, the next to strike the ground will be the left fore foot, followed in order by the right hind and right fore foot. So far as the camera has revealed, these successive foot fallings during the walk are invariable, and are probably common to all quadrupeds. But the time during which each foot, in its relation to the other feet, remains on the ground, varies greatly with different species of animals, and even with the same animal under different conditions. During an ordinary walk, at the instant preceding the striking of the left hind foot, the body is supported on the right laterals, and the left fore foot is in act of passing to the front of the right fore foot. The two hind feet and the right fore foot immediately divide the weight. The right hind foot is now raised, and the left hind with its diagonal fore foot sustains the body; the left fore next touches the ground, and for an instant the animal is again on three feet; the right fore foot is immediately raised and again the support is derived from laterals—the left instead of as before the right. One-half of the stride is now completed, and a similar series of alternations, substituting the right feet for the left, completes the other half. These movements will perhaps be more readily understood by a reference to the longitudinal elevation, which illustrates some approximate relative positions of the feet of a rapid walking horse, with a stride of 5 feet 9 inches. The positions of the feet indicated in this, and also in the other strides illustrated are copied from photographs, and from them we learn that during an ordinary walk the consecutive supporting feet are—

1. The left hind and left fore—*laterals.*
2. Both hind and left fore.
3. Right hind and left fore—*diagonals.*
4. Right hind and both fore.
5. Right hind and right fore—*laterals.*
6. Both hind, and right fore.
7. Left hind and right fore—*diagonals.*
8. Left hind and both fore.

Commencing again with the first position; it is thus seen that when a horse during a walk is on two feet, and the other two feet are suspended between the supporting legs, the suspended feet are laterals. On the other hand, when the suspended feet are severally in advance of and behind the supporting legs, they are diagonals.

These invariable rules seem to be neglected or entirely ignored by many of the most eminent animal painters of modern times.

The Gallop or Run

This movement has in all ages been employed by artists to convey the impression of rapid motion, although curiously enough, the attitude in which the horse has been almost invariably depicted is one which is impracticable during uniform progressive motion. . . .

From this analysis it will be seen, by reference to stride 9, that a horse, during an ordinary gallop, is supported consecutively by:

1. The left hind foot,
2. Both hind feet,
3. The right hind foot,
4. The right hind and left fore feet,
5. The left fore foot,
6. Both fore feet,
7. The right fore foot,

with which he leaves the ground, while the only position in which we find him entirely without support is when all the legs are flexed under his body. . . .

The employment of automatic apparatus for the purpose of obtaining a regulated succession of photographic exposures is too recent for its value to be properly understood, or to be generally used for scientific experiment; at a future time, the pathologist, the anatomist, and other explorers for hidden truths will find it indispensable for their complex investigations.

Science News-Letter, September 21, 1929

The thickness of the ice sheet which covers the center of Greenland is unknown.