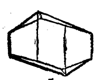
as to its source. The report was, "It seems to be mostly calcium oxalate, with some carbonate and organic matter." The crystals pertain to the monoclinic system, like the mineral whewellite. In another decayed white oak examined, the pulverulent liber, of darker appearance than in the former, consisted of crystals, cellular *débris*, with no bast-fibres, but with numerous long, dark-brown, many-celled sporidia of a fungus, and a few dead rotifers. Under similar circumstances, the same kind of crystals, equally abundant, were observed in a dead chestnut-tree.

The liber of the fresh or undecayed white oak and chestnut exhibits the calcium-oxalate crystals arranged in close longitudinal rows, as represented in fig. 3, situated among the bast-fibres, and nearly as abundant. The crystals are smaller, approaching the ends of the series; and the spaces occupied by the latter taper at the extremities. Each crystal occupies a separate cuboidal cell, or at least a distinct compartment of a long fusiform space, bounded by the bast-cells. In the rows of crystals of the white oak, from twenty-five to thirty-five were counted, occupying a space of about the fiftieth of an inch in length. In the chestnut liber, from twenty-five to forty-five crystals were counted in different rows. In the liber of the butternut the crystals are compounded in spheroidal clusters, and form rows arranged in the same manner as in the preceding trees.



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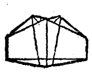

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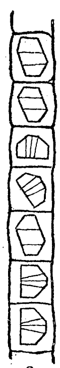

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FIG. 1. — Calcium-oxalate crystal.
FIG. 2. — Twin form of the same. Both from decayed liber of the white oak, magnified 250 diameters.
FIG. 3. — Portion of a series of crystals from fresh liber, magnified 300 diameters.

Without having had any intention of investigating the occurrence of crystals in plants, I have been led to make the present communication on what, to botanists, may be a familiar fact, under the impression that many, like myself, have heretofore been ignorant of it; and this for the reason that sufficient notice of the matter has not been given. Our ordinary manuals, while referring to the occurrence of crystals in plants, and giving a few illustrations of those observed in herbaceous plants, take almost no notice of the beautiful forms in the inner bark of our forest-trees. The 'Micrographic dictionary' mentions the occurrence of raphides in the bark and pith of many woody plants, as the lime and vine, but makes no reference to, nor gives illustrations of, such as occur in oaks, the chestnut, the hickory, etc. No more beautiful example of plant-crystals can be so readily obtained than that exhibited in thin slips of the liber of the oak or chestnut.

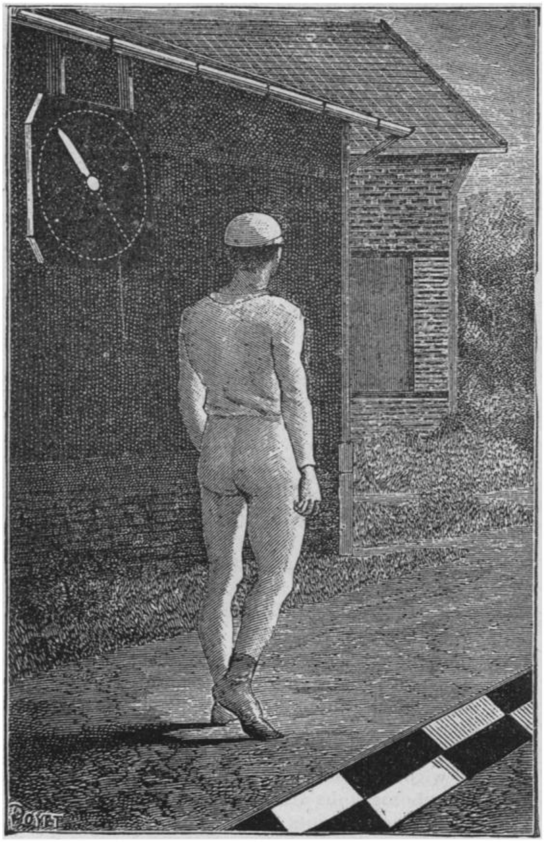
Although the occurrence of crystals in vegetable tissues was observed and described by Payen in 1841 (*Comptes rendus de l'académie des sciences*), the first and fullest account of the crystals of the liber of forest and fruit trees was given by Prof. J. W. Bailey, in a communication to the American association of geologists and naturalists, in 1843, afterwards published, with a plate, in the *American journal of science* for 1845, p. 17. Sanio subsequently described the same crystals in the *Monatsberichte* of the Prussian academy of sciences for 1857. JOSEPH LEIDY.

THE PHYSIOLOGICAL STATION OF PARIS.[1] — II.

THE black screen shown in fig. 4 is a kind of shed, three metres in depth, fifteen long, and four high. This height is necessary in photographing birds on the wing; for, on rising, they immediately leave the dark field. When the walk of a man or an animal is being studied, the opening of the screen is limited by a frame covered with black cloth suspended from its upper part: this regulates the ingress of light under the shed, and makes its cavity darker. In addition, a long strip of velvet two metres and a half broad fills all the lower part of this cavity. Thus the light coming through the bottom of the screen is almost entirely cut off.

In fig. 4 a man dressed entirely in white is walking before the dark screen. The course on which he walks is slightly inclined, in such a way that a visual ray, proceeding from the objective, passes very near the surface of the ground without meeting it anywhere. This is necessary in order that in the picture the feet of the walker may be entirely visible, while the ground is not: otherwise the light reflected from the ground would make an impression on the sensitive plate at the very points where the images of the feet should be produced, and make them obscure. The course is raised about twenty centimetres above the surrounding ground; and along the full length of this relief there runs a plank on which alternate divisions, each a metre and a half long, are painted black and white. The plank thus divided is seen in the photographs, and is useful in measuring the distance run between two successive images, and in estimating the size of the subject, the amplitude of his reactions, and the extent of displacement of each part of his body. In order to know the rapidity of movement, the time consumed in traversing the various spaces must be measured. Now, if the machinery which

[1] Concluded from No. 42.



F IG. 4.

turns the disk always worked with the same speed, and if the number of openings were the same for all experiments, we should only have to determine once for all the interval of time which elapses between two images, and we should immediately have the expression of the rapidity: in short, if the successive illuminations were separated by one-tenth of a second, and if the interval in long measure between the images were five-tenths of a metre, it is evident that in one second five metres would be traversed. But the rapidity of the disk varies with the experiment: it must, then, be controlled. This control can be obtained by means of a chronograph which shall indicate the interval of time between the various turns of the disk during the experiment. But this method would give two kinds of independent indications, — that of the spaces on the photographic plate, and that of the times on a revolving cylinder. It seemed to us better to obtain, also on the plate, the indications of the times elapsing between the successive images. This result was obtained in the following manner. In order to know the frequency of rotation of the disk, we have only to photograph the successive positions of a body moving with a uniform and known velocity. Fig. 4 shows, above the head of the walker, an apparatus which answers this purpose, and which we will call a *photographic chronograph.* It is a black velvet dial, on which bright nails, arranged in a circle, divide the circumference into a certain number of equal parts. A bright needle on the face of this dial is in continual motion, turning at the rate of a revolution a second. It is evident, that, if the disk of the photographic apparatus revolve only once a second, we shall have only one image of the needle on the dial; if the disk make six revolutions a second, we shall have six images, etc. Since the velocity of the disk is uniform, the images on the dial are separated by equal distances. These divisions allow us to easily estimate the fraction of a second corresponding to the interval between the images.

This method will be better comprehended if we consider its application. Fig. 5 represents a runner jumping a bar. The series of photographs commences at the moment when the leaper started on the preliminary spurt, and ends when the leap is finished, and the fall to the ground has partly destroyed the velocity. Let us analyze this figure. We see the subject represented nine times; that is, the disk revolved nine times during the experiment. Each rotation, bringing the opening of the disk in front of the objective, has permitted light to enter for a brief instant, which has sufficed each time to give an image. These successive images were produced at different points on the plate, because the leaper himself occupied different positions before the screen when each of the illuminations took place. The space traversed either on the ground

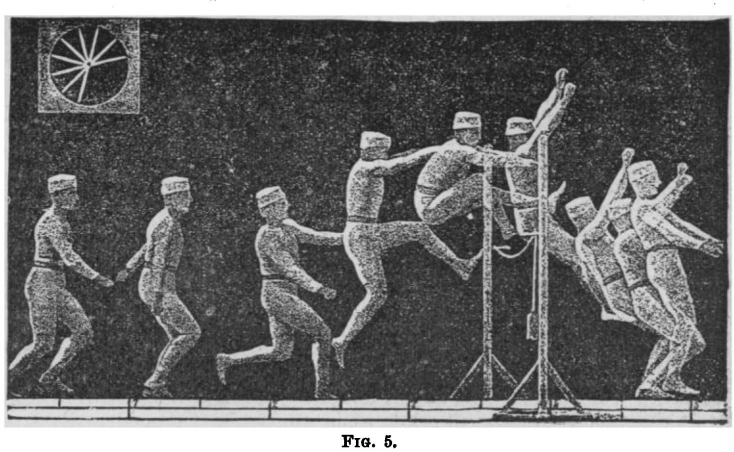


FIG. 5.

or in the air, between successive images, is easily measured by means of the divisions in the planks

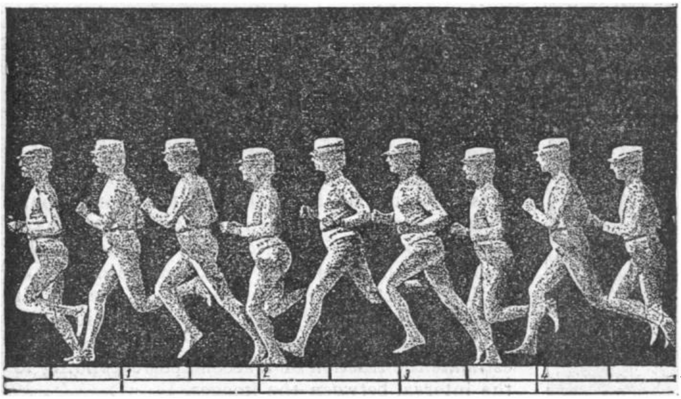


FIG. 6.

seen at the bottom of the picture. We see that the interval is not always the same, and that, if we suppose equal intervals of time to separate successive images, the greatest velocity occurs in the run which preceded the leap, and that there was a diminution of speed while the leaper was in the air: in fact, this diminution is still increased after the fall, the velocity being partly lost the very moment the body touches the ground. In order to know whether the images have been produced at equal intervals of time, and the duration of these intervals, the dial of the chronograph must be consulted. It is then seen that the luminous needle is represented as many times as there have been illuminations, namely, nine times; that the interval between the illuminations was uniform, for the images of the needle whose rotation was uniform form equal angles : in short, the absolute value of the time-intervals between the illuminations is expressed by the angle which the images of the needle on the dial make. This angle is about 36°, which shows that the time-interval between successive illuminations is one-tenth of a second. From these measures of time and space we easily deduce the velocity of the leaper in the various phases of the experiment. This speed was seven metres a second during the preliminary run, five metres during the leap, and fell to three metres and a half after the fall.

When one takes on the same plate a series of photographs representing the successive attitudes of an animal, he naturally tries to multiply these images in order to know the largest number possible of the phases of movement ; but when the latter is not rapid, the frequency of the images is soon limited by their superposition, and by the confusion which results. Thus, a man running even at moderate speed can be photographed nine or ten times a second (fig. 6) without confusion of the images. If sometimes one limb is depicted where the other limb has already left an impression, this superposition does not at all affect the images: the white only becomes more intense where the plate has received two impressions, so that the contours of the two members are still easily distinguishable. But when a man walks slowly, as in fig. 7, the images present so many superpositions that confusion results. This inconvenience is remedied by *partial photography ;* that is, by suppressing certain parts of the image in order that the rest may be more easily distinguished. As by our method white and bright objects only make an impression on the sensitive plate, it is necessary merely to clothe in black the parts of the body which we wish to exclude from the image. If a man dressed half in white and half in black is walking on the track, and turns toward the photographic apparatus the part clothed in white, the right, for instance, there will appear in the picture only the right half of his body. These images allow us to observe in their successive phases, first, the pivot-like turning of the lower limb around the foot during the time of support; and second, as the foot rises, the turning of the same limb around the hip-joint, while at the same time this joint is moving forward without cessation.

Partial photographs are also serviceable in an analysis of rapid movements, because by this means the number of attitudes represented may be many times increased. Nevertheless, when the image of a limb is moderately large, the partial photographs cannot be too much increased without confusion through superposition. We must therefore diminish the size of the image, if we desire to repeat them at very short intervals. For this purpose the walker is clothed

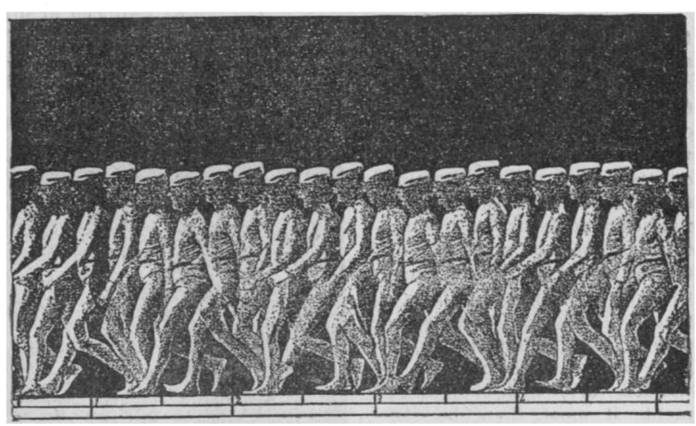


FIG. 7.

wholly in black, and narrow bands of some bright metal are placed down his arm, thigh, and leg, following precisely the direction of the bones of these parts. This arrangement allows us to easily increase tenfold the number of images received in a given time on the same plate: hence, instead of ten photographs a second, we can obtain one hundred. For this, the rapidity of rotation of the disk is not altered; but, instead of one opening, there are ten, equally distributed on the circumference. One of these openings must have a diameter twice that of the others. The result is a much larger size for one of the images; and this renders the estimation of the time easy, and also furnishes data to compare the movements of the lower and upper limbs. The images obtained under these circumstances are so close, that one is present, as it were, at all the successive changes of place of the limbs and body. Thus, in fig. 8, between two successive touches of the ground by the right foot, there are twenty-one different positions of the lower limb. As the foot meets the ground, the knee is bent perceptibly; then it straightens as the foot, resting on the toes, prepares to leave the ground. After the raising of the foot, the knee bends again, and the leg forms with the thigh a right angle; then it gradually becomes straight, and the sole of the foot, which was at

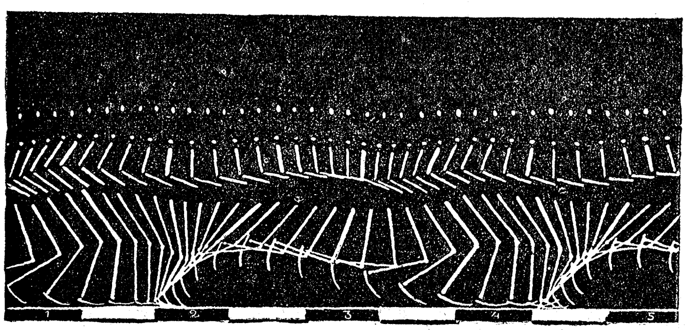


FIG. 8.

first in a vertical plane, is apparently parallel to the ground which it touches for some time before it rises again. The scale at the bottom of the figure shows that the total length of the step was 2.6 metres. The chronograph was not used in this experiment, but we may estimate the number of images at about sixty a second. The movements of bending and extending the fore-arm are obtained in the same manner as those of the leg. The turnings of the head are expressed by the undulatory motion of a bright point placed on a level with the ear. In short, the diminutions and the accelerations of each part are expressed by the crowding or separation of the images. To ascertain the corresponding positions of the arm and leg at a given instant, we take for data every fifth figure, which is larger than the others. These images are formed at the moment of passage before one of the larger openings; and they correspond, therefore, to the same instant of time. This is not the place to analyze in detail the various types of locomotion. The few examples just given sufficiently explain the method, and show its exactness. For a complete study of human locomotion, photographs under the most diverse circumstances must be obtained. The subject must be photographed not only from the side, but also from the front and rear, in order to show the lateral oscillations of the different parts of the body. Finally, after studying the mechanism of the various motions produced in walking or running, the final result — the more or less rapid transportation of the man — must be studied, either as he walks freely, or as he bears or draws a burden.

These researches have a practical interest, even as those having for their object the determination of the product of machines, and the most favorable conditions for this production. Experiments in regard to this are in process; and it is with this object in view that the circular course with telegraphic signals, to note the phases of the walking or running, has been established.

THE FUNDAMENTAL CATALOGUE OF THE BERLINER JAHRBUCH.

A VERY important comparison by Dr. Auwers, of the fundamental catalogue of the *Berliner jahrbuch* with those of the *Nautical almanac*, the *Connaissance des temps*, and the *American ephemeris*, appears as a supplement to the *Jahrbuch* for 1884; and the following abstract of it is given. The year 1883 is the first in which such a comparison is possible.

The *Berliner jahrbuch* contains at present, and will contain for the future, 450 stars whose apparent places are given, and 172 stars for which only mean places are printed; i.e., 622 in all. The places of these stars, both in R. A. and Dec., depend strictly on the system of the Fundamental catalogue of the *Astronomische gesellschaft* (publ. xiv.). They lie between the north pole and — 31°.3 declination.

The *American ephemeris* contains the mean places of 383 stars, for 208 of which ephemerides are given: 44 of these stars lie south of —31°. The *Nautical almanac* has 197 stars (15 south of —32°), and ephemerides are given for all. The *Connaissance des temps* has 310 stars between the north pole and — 70°, and gives an ephemeris for each.

Dr. Auwers's account of the sources from which the star-places of the various almanacs are taken we omit. It shows how various these are. 450 stars have ephemerides in the *Jahrbuch*; 149 stars (mostly southern) which have ephemerides in the three other almanacs are not contained in the *Jahrbuch*.

A table is given in Dr. Auwers's paper, showing the comparison between each star of each almanac and the *Jahrbuch*. From this table the elements by which the catalogue of each almanac can be reduced to the system of the *Jahrbuch* are deduced. A subsequent table gives the two reductions which must be added