In some weight-clocks the striking-train and bell comprise the driving-weight. The striking mechanism is released by pins projecting from the back of the little plates carrying the hour-signs. These pins trip a small lever as the train passes. Clocks drawn by a spring have the spring-barrel located in the lower part of the case

A clock of this type in my possession has the general appearance of a hall clock of our grandfathers' days except for its diminutive size. It is eight inches high, three-fourths of an inch deep, and one and one-fourth inches wide. The case is beautifully made of dark wood. The upper part of it, enclosing the works, has glass front and sides, the cap over the balance-wheel, as well as the front plate of the works, which are of brass, is open-work of graceful design and is gilded. Another clock of this type, also in my possession, is still more diminutive in size, being only three and three-fourths inches high, one-fourth inch deep, and three-fourths inch wide. It is made entirely of brass except the numerals, which are of silver, and is beautifully engraved and gilded. At the bottom of the case there is a small compartment closed by a hinged door. This contains the key. The numerals are fitted into a dovetail groove in the front of the case, and the hand is carried on a sliding-piece attached in the manner before mentioned to the fusie chain. There are no divisions to indicate the fractions of the hour.

Another interesting example of this type has a dial engraved with a series of logarithmic curves. On the faces of these clocks there are two rows of characters; when the dials are rectilinear, the characters are arranged in two vertical columns; when circular, in two concentric circles. These rows are some little distance apart, and the characters are unequally spaced. Each numeral is connected to its opposite one by a logarithmic curve. The space between the columns is divided into twelve equal parts by parallel vertical lines, each line having at its upper extremity the sign of a month. The space included between the intersections of one of these lines with two successive logarithmic curves, will indicate the length of the corresponding hour for the first day of the month which is indicated by that line. In this clock the index is borne on a cross-bar, which extends across the dial from one column to the other and is attached to the weight-cord. The index is so affixed to this bar that it can be moved along its length, thus passing from one line to the other as the months elapse. When this kind of clock is provided with a circular dial, the logarithmic curves are laid out in the same manner and intersected by parallel concentric circles. The hand moves over the dial and is constructed so as to slide through its attachment to its arbor, thus being lengthened and shortened.

Another clock of this type has a much more complicated structure. Its circular dial revolves and is furnished with movable hour-signs, which are arranged in concentric circular grooves on its face. A pin projecting from the posterior face of each opposite hour-sign enters the groove in a slotted arm which extends across the back of the dial. These arms are acted upon by an eccentric, which in its turn is driven by a train of wheels completing its cycle in a year. The action of this mechanism is such that the opposite ends of the arms and consequently the hour-signs are separated and approximated as the days and nights vary in length.

It only remains to describe the clocks of the second class, viz., those in which the rate is made to vary in accordance with the seasons. None of these clocks, as far as I am aware, have the balance-wheel and hairspring, but they have its forerunner and immediate ancestor, the escapement of Huygens, which consists of a vertical staff suspended by a fine silk thread attached to its upper end. This staff is provided with lugs which engage the teeth of a crown-escapement wheel, and it bears a horizontal arm from which small weights are suspended like a scale-beam. The rate of the clock is regulated by the adjustment of these weights. In general form, these clocks are rectangular or cube-shaped. The gong is placed on top of the case. The dial is circular and revolves from right to left, the hand being stationary. The case is of brass and is usually highly ornamented. The variation of rate in these clocks is accomplished in two ways, viz., (1) entirely by the adjustment of the weights borne on the arm of the escapement, and (2) partly in the foregoing manner and partly by the mechanism itself; the latter form having a double escapement, which will be described later.

The specimen of the former kind which I have is two and one-half inches wide, two and one-half inches deep, and seven inches high over all. The case is of brass, and is beautifully ornamented by chasing, and the wheels, which are cut by hand, are very accurately made. The characters are engraved on the dial in two circles, the outer one being composed of the signs of the Chinese Zodiac, and the inner one, of the hour-signs. Below the dial, on the face of the clock, are two openings, through each of which may be seen an astrological character. These characters change once in twenty-four hours. The weight-cords run over spiked pulleys and have small counter-weights. The clock has a striking-train and a going-train.

Another clock of this form in my possession is of more complicated construction. It has two escapements, the horizontal arms of which are of different lengths. In this clock the variation of rate is accomplished partly by hand and partly by the automatic operation of the mechanism itself. One escapement remains idle during the day and the other during the night, the staff of one being lifted from its engagement with the escapement-wheel at the same time that the other is brought into gear. This is accomplished by two levers which lie directly below the ends of the vertical staves of the balance. The opposite ends of these levers are acted upon by two cams on the same arbor which cause one of them to rise and the other to fall at the proper moment.

I have omitted to say anything of the fantastic astrological meanings of the various characters found on these clocks and of the intimate connection between the astronomy, astrology, and horology of the Japanese, and will only add that if they are children in imagination they are certainly giants in mechanical execution.

In writing this article I have availed myself of the articles written by Emil James, Journal Science D'Horology, Vol. VIII.; Aneè and Thomas Eggleston, Ph.D., in the School of Mines Quarterly for July, 1882.

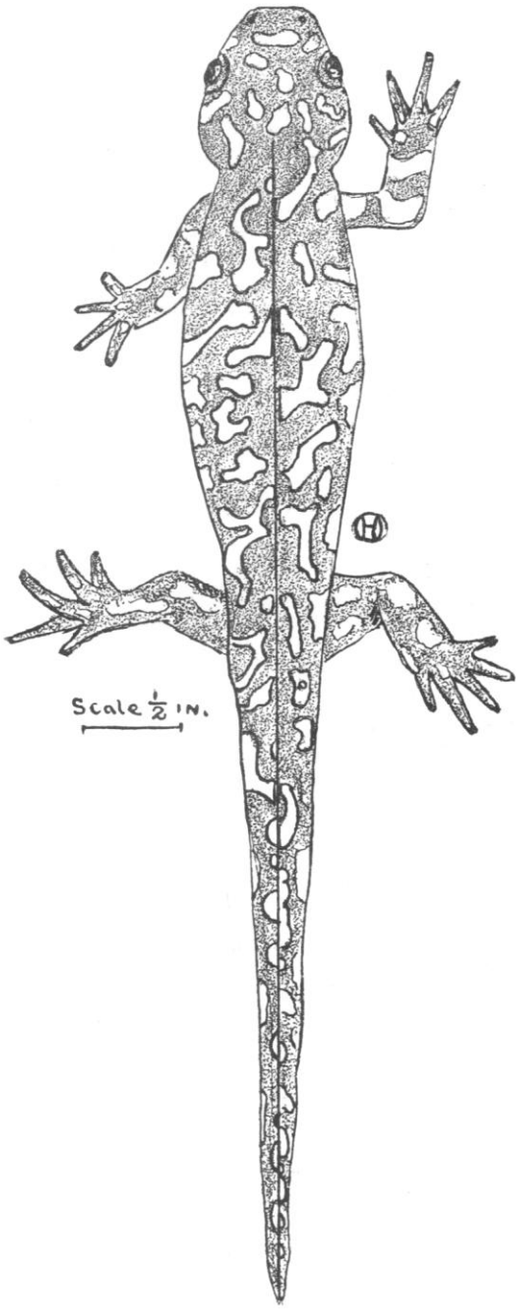
SOME BIOLOGICAL NOTES ON AMBLYSTOMA TIGRINUM I.

BY HENRY LESLIE OSBORN, PH.D., ST. PAUL, MINN.

THERE is a salamander, most probably of the species named above, which is very common in this vicinity. In the autumn months, especially during September, it can be found abundantly in cellars or in damp, dark, or semi-dark places about buildings. I have often seen it on the railroad tracks imprisoned between the rails, and many specimens which had been run over and killed by the cars can be found at this season. Occasionally they are seen creeping about on the walks or in the grass, where they are frightened by man's approach and run actively away. They are familiarly called lizards, and the use of that word among the people of this vicinity can almost always be understood to refer to this animal. It lives in aquaria for an indefinite time, remaining on the bottom, and coming to the surface for renewal of air of the lungs rarely.

1. The *markings* of this salamander are vivid yellow spots upon a ground of brown-black upon the back, giving place to faint bluish ground and lighter color on the ventral surface. There is a very great deal of variation in the shape and distribution of the spots. In general, they are irregular, elongate figures of various sizes from very small rounded ones up to those of considerable size, whose length may be equal to half an inch. The directions of the long ones of the spots are not the same, while they are chiefly antero-posterior, some are oblique from behind, forward and inward, while others are oblique from behind, forward and outward. The patterns of the two sides are not "mated," they are entirely independent. Not only so, but there is a distinct line which separates them, and in the middle a black line often cuts directly through the spots, so that, while they meet, they do not match. This last-named condition is very noticeable in the tail, as shown in the accompanying figure. It is very conspicuous in many cases, but perhaps less noticeable in specimens

not so largely spotted as the one used in making the figure. This absence of bilateral symmetry in the skin markings is a more or less general phenomenon in the coloration of animals; they rarely having their two sides perfect counterparts. It is in fact a case of a general law, applying to all bilateral organs, perfect bilateraling being a very rare phenomenon, due, on modern biological views, to the preponderance of growth in the cells of one organ over its homologue of the opposite side through the operation of any of the several causes which influence vitality



of cells, e g., use, nutrition, disease, perhaps inheritance. But, in animal coloration, while perfect bilateraling of marking is unusual, and a certain independence of the opposite sides is usual, it is rarely carried so far as here. The markings of birds, etc., blend across the middle line, so, too, the blotches of snakes, frogs, and other familiar cases, and I have never seen an animal in which the independence of the color markings of the two sides is as pronounced as it is in this form. A fact of this kind would appear to have some important suggestions in relation to the ontogenetic history of the yellow color producing cells. If they are separated early in their history and continue distinct, we should expect such a separation in their ultimate products. There are facts enough to indicate that in lower forms, such as annelids, the cells of the two sides of the body in many of the organ systems are separate from an early date, even as early as in the early segmentative stage of the egg (cf., E. B. Wilson, "The Cell Lineage of Nirus," *Journal of Morphology*, vol. vi., p. 36, 1892). This supposition would not be out of accord with the fact that the independence of coloration is found in a lower rather than one of the higher animal groups and in a lower member of its group, for it is the characteristic of the higher forms to have more and more intimate relation of parts. The distribution of the color-spots I cannot as yet reduce to any law by study of adults, and I know of no observations in the embryology of Amblystoma which have been directed upon this point. There seem to be some faint suggestions of metamerism in the coloration of the area of the side walls of the body, especially between the limbs. The body wall in this region is marked on the ventral aspect and laterally by rings (Myotorms), which correspond with the attachments of the muscle fibres, and the color spots are rather noticeably located upon the rings rather than on the spaces between them. The rings look like somites of an annelid, and it would be interesting to know if they correspond with the segmentation of the vertebræ and nervous system.

2. The *movements* and *locomotion* of the salamander are very interesting to observe. They suggest an animal which is passing from the use of the back-bone and its curvatures as a mechanism for locomotion to the use of limbs. The locomotive movements are of two classes, the first are those performed under ordinary circumstances, the second those performed to escape from a pursuer, as when one attempts to seize the creature. The former are made by means of a combined use of the back-bone, which is thrown into gentle curvatures, and the legs, which are the chief instruments in the act. The curvature of the back-bone is such as to throw the limb to be used forward further than it would be with the spine kept straight. The limbs are used in strict alternation, the right front leg and the left hind leg going forward together, and then backward together, while the spine has a convexity toward the right in the brachial region and toward the left in the sacral region. The creature, in water, when disturbed by one's hand generally either makes a disorderly scramble with the limbs, which has but little result, or it swims swiftly with a truly fish-like sinuation of the body, including the large post-anal region or "tail," which is much compressed and forms a very efficient organ of swimming. It has seemed to me that this swimming motion may be a case of physiological reversion. We know that the vertebral musculature is far more ancient phylogenetically than the limb musculature, and we may suppose that hence the power to control it nervously is far greater than that to control the more recently acquired limb musculature. It is a case of the tendency to fall back on the ancestral mode of action so long as the structure will permit, especially under circumstances in which the animal is under the influence of strong excitement, which would tend to weaken the more recently acquired powers and allow the ancient lines of habit to become dominant. This tendency can be discerned in many other cases; thus, for instance, I regard the case of the crayfish as precisely similar to the one just cited. It commonly moves by a walking motion, not using the flexion of the abdomen, but under excitement of escape it reverts to this ancestral action, and the familiar "crawfish" movement results. I do not think it is at all beyond the range of reason to include the tendency of people to lapse into a native language from an acquired one in moments of excitement under the same principle of physiological reversion. In this connection, I may speak of a specimen of *Necturus*, which I had for some time in an aquarium in the laboratory, in which the swimming movements were even more noticeable than in the salamander, a fact co-ordinated with its more piscine peculiarities in other respects.

It is possible to discover in the movements a suggestion of the origin of limbs. The limbs are usually in a line, and the front right leg is thrown forward by the curvature of the body at the same time that the left hind leg is thrown forward by the curvature in its level. Limbs at these points, if at first mere stumps,

would be of advantage by the hold they would give to the squirming body. Then elongation would increase the advantage. No loss of this function would be necessary, but a gain, if the limb acquired some independent motion, and this might be developed enough to render it capable of officiating as the sole locomotive organ. If such a history of the limb were true, the salamander is midway in the line of descent.

3. The *post-anal region* of the salamander is piscine, while the anterior portions of the body are not, but are distinctly higher. This fact is more or less familiar in a general way and called by Professor Hyatt, who pointed it out many years ago, by the name "cephalization." This advance of the anterior part of the body of the salamander has left the "tail" to be in many respects not amphibian so much as piscine. Of course the term tail here means post-anal region of the body and the portion, roughly speaking, homologous with the post-anal region of the fish. In the higher fishes this region has acquired a "tail," while the amphibia have not shared the acquisition of a structure supported by five rays, which does not belong to the ancient vertebrate stock. In this sense the tail of the salamander and its correlate, the post anal region of the fish, are not only similar in function, being organs of locomotion, but they are comparable in their anatomy. The back-bone is acentrum with bi-concave surfaces with two equally developed arches, a neural arch containing the spinal cord, and an haemal arch containing a vein and an artery with oblique intervertebral muscles forming the back of the organ. In vertebrates above the urodela, with the loss of its locomotor function and the development of arms and legs, the post-anal region becomes of less and less importance, though not always disappearing; thus in many lizards it is large at its origin, as large as the body before it, and it has the peculiar power of *autotony*, as it has been called; that is, of breaking off in the hands of a captor, whereby the animal escapes capture. There is a gradual degeneration of the region among the higher vertebrates, with many varieties of direction and degree of development and occasional utilities in peculiar directions, and the salamander stands at the bottom of this series.

4. The *death of the salamander* is accompanied by a loss of powers of movement, which is first manifest in the last acquired (phylogenetically) of the powers, i.e., in the limbs, and finally in the vertebræ muscles. In specimens killed under the influence of chloroform, after all movement had ceased in the limbs, the sinuations of the back-bone continued for some time, and were the last movements observed to take place.

REFLEX ACTION IN TURTLES.

BY M J ELROD, ILLINOIS WESLEYAN UNIVERSITY, BLOOMINGTON, ILL.

RECENTLY I had a number of map turtles (*Malaclemys geographicus* Le Sueur) for student work, and observed, what is to me, a remarkable instance of reflex muscular action, both in the head and limbs. In one specimen the head had been severed from the body fully an hour, when I observed the students amusing themselves by tapping the nose of the severed head, when almost as quickly as in life the jaws would open, and when a pencil or other hard object was thrust in would close upon it with seemingly as much viciousness as in life, continuing to hold for some time, gradually relaxing, when the experiment would be tried over again. This was the case not only with the one in question, but with a half-dozen others of the same lot. Taking a specimen with the head cut off and all the viscera cleared away, leaving the legs attached to the carapace, the legs manifested sensitiveness to a marked degree. In one specimen the four legs extended from the body almost straight; a very gentle touch with the point of a pencil on the tip of a claw caused that leg to be drawn within the shell, so to speak, as quickly as in life. This was done alternately with each foot to the first again, all giving the same results. Several other specimens tested showed as much and as sudden movement, and one killed at 2 P.M., when touched at 11 A M. the day following, withdrew its feet instantly. While these observations are common for turtles, I have not observed such marked results in other species.

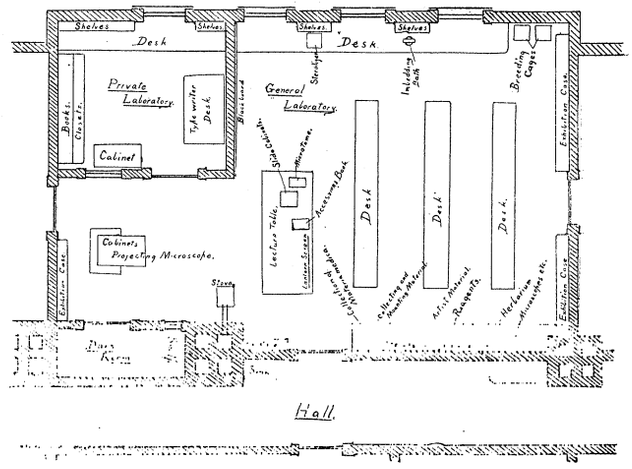
A LABORATORY OF PLANT DISEASES.

BY C. W. WOODWORTH, BERKELEY, CAL.

THERE has recently been equipped at the University of California a laboratory for the study of the subject of plant diseases in its broadest sense; and, as there are but few if any others where the whole subject is taught as a unit, it may be well to give an outline of the equipment for this class of work.

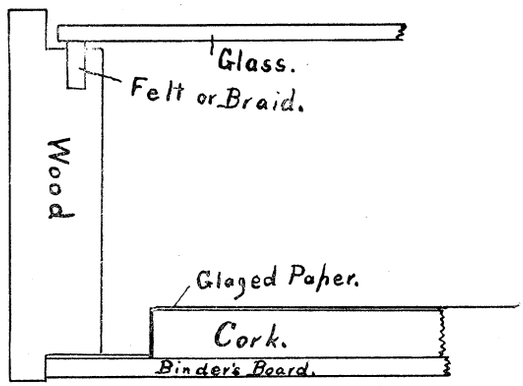
We will not consider that part of the equipment for this work afforded by the grounds, orchard, nursery, gardens, and greenhouses of the agricultural department, but confine ourselves to the laboratory proper. The subject of plant diseases is now, and will continue to be, associated with that of entomology, so that the same equipment, to a considerable extent, serves for the two subjects.

The laboratory-room is something over twenty by thirty feet, and is situated on the north side of the Experiment Station building. It is lighted by four windows, having an entirely unobstructed view, and so giving ample light for microscope work. A corner of the room is partitioned off for a private laboratory, and a closet is fitted with a ruby window, affording an opportunity for photo and blue-print work. The figure below will give a good idea of the arrangement of the room.



The windows are all fitted with heavy shades working in grooves, enabling one to darken the room very easily and quickly when the lantern is to be used for illustration. The views are projected on a screen of tracing-cloth, which is mounted on an ordinary spring-roller and is ordinarily rolled up out of the way.

Besides the benches near the windows, which are used by advanced students, there are also three long desks, one and a half feet wide by twelve in length, that have proven themselves so convenient that a sketch of one is presented. As can be seen on the plan, these are so constructed that at the side of each student boxes, the size of those of the collection, may be used as drawers, or boards may be inserted forming shelves.



The boxes used for the collection are made as shown in the accompanying figure, and are from their peculiar construction not liable to warp or crack, and so remain perfectly insect-proof.