90. *Bidens trichosperma* (Michx.) Britton. Tickseed Sunflower.

(*Coreopsis trichosperma* Michx.)

Occurs sparingly in Monroe county in swamps along the bottom lands of Bean Blossom Creek. August 10, 1886.

Recorded in B. & C. Flora from Jefferson county.

91. *Hymenopappus caroliniensis* (Lam.) Porter.

(*H. scabiosæus* L'Her.)

Found sparingly on the side of a sandy ridge northeast of Seventh Street Bridge across Lost Creek, Vigo county. May 31, 1890.

The first record for the State, its range being given in the Manual as "Illinois and Southward."

92. *Senecio lobatus* Pers. Butterweed.

Taken on several occasions in 1891 and 1892 from low, damp places about ponds and ditches in Vigo county. The first Indiana record, its Manual range being "North Carolina to Southern Illinois, Missouri and Southward."

93. *Lactuca hirsuta* Muhl. Hairy Wild Lettuce.

(*Lactuca sanguinea* T. & G.)

Borders of prairies and dry, sandy fields in Vigo county; scarce. Recorded from Gibson county by Dr. Schneck.

Periodicity of Root Pressure. By M. B. Thomas.

The fact that the roots of plants absorb water and force it up through the stem, producing bleeding whenever the stem is injured, was discovered by Hales in 1721, and since that time numerous investigators have examined this phenomenon of root absorption in a more or less exhaustive way until we have to concern ourselves only with an inquiry into its daily variations and see if there is not some law governing the changing phenomenon that will give us a more complete insight into this important physiological problem in plant growth.

The general matter of the periodicity of root pressure in forcing water through stems in opposition to gravity was studied by Sachs, and his observations form a basis for our present work. He made experiments regarding the time of maximum and minimum pressure with a few common plants, and his results are too well known to need extended description. The conclusions of his experiments have been to fix the time of maximum pressure at 9–11 A. M., with a decrease

through the P. M. and early night, when a minimum was reached. After this the pressure increased until it attained the maximum during the following A. M. Sachs further showed that the periods of maximum and minimum pressure were independent of small variations in temperature.

The work of Sachs was done by the use of crude instruments that required constant attention, and it seemed that an instrument of precision, making automatic records, would enable one to add something to the work already done on the subject of root pressure. In 1890 a rude instrument was made of wood and iron, and some few experiments conducted on the subject. Later a machine of more accurate working was constructed at the college workshop in Crawfordsville, and this formed a pattern for the one made at Lafayette under the supervision of Dr. Arthur. In the evolution of the apparatus to its present condition changes have been introduced that brings the machine into a form easily used by the average student and capable of giving accurate results.

For our work on the subject of root pressure many plants were grown from seeds in the greenhouse, and were used when the stems were 4–5 mm. in diameter. With those plants secured from out of doors or at other green houses, they were brought in weeks before the experiments and given ample time to adjust themselves to any changes in their surroundings. The results show that the latter plants corresponded in their records with those grown in the green house from seeds. For the experiments the attachment of the plant to the machine was made in the usual way under water, and the apparatus placed on an iron pier to prevent jarring. The records of temperature were made by a self-recording thermometer. The clock used in the root pressure machine would run for eight days, and an experiment when properly started needed no attention until its completion, or until the time when the pressure was insufficient to show itself on the rods of the instrument. The increasing weight of the column of mercury usually produced this result in 4–5 days. The smoked rods with the record of the periodicity were placed on sensitive paper, and the lines printed for permanent preservation. Temperature cards were preserved along with these for comparison. The plants experimented upon were fuchsia, bean, geranium, grape, sunflower, tomato, etc.

Occasionally upon the attachment of the plant a decided negative pressure in the stem would be observed. This was especially noted in the grapevine growing out of doors, where the records were made. The negative pressure was so great that the water and part of the mercury were pulled down into the stem and the particles of mercury could be found in the ducts upon splitting the twigs an inch or more from the top, where the attachment was made. This phenomenon was

observed by Sachs, and is, no doubt, due to the fact that where active transpiration is going on no root pressure exists, but transpiration or other current do not permit the ducts to become filled with water, but, rather, they contain rarified air that allows the water poured in on top of the cut surface to be drawn down in the stem.

A study of the records warrant the following general statements regarding the relation between temperature and root pressure: Under usual conditions there can be no relation between the periodicity of root pressure and the daily variations in temperature, the latter being between 50° F. and 90° F., as determined in the course of the experiments. Even where the periods of maximum and minimum temperature were reversed in the test, and the reversed condition continued for several successive days, no appreciable effect was noticed in the periodicity of root pressure.

The changes in temperature above or below certain limits may alter the regularity of the times of maximum and minimum pressure periodicity, but do not interfere with the main cycles of greater or less pressure.

The time element is the all important one, and for most plants the period of maximum pressure is 12 M., with the limits between 9 A. M. and 1 P. M.

No appreciable difference exists between the times of maximum pressure in the variety of plants studied and certainly none whatever in a large number of specimens of the same species even though they may have been grown under different conditions.

The age of the plant seems to make no difference in the times of maximum and minimum periodicity or its general behavior in the experiment, except, as would be expected, a large and vigorous plant shows more difference between the amount of maximum and minimum pressure than a small and less vigorous one.

In different genera marked differences exist as to the maximum amount of root pressure and in some it is so small that at no time can it be measured except with great difficulty.

The amount of water present in the soil within certain limits does not affect the time of periodicity or amount discharged, but in very dry soil, where the roots become wilted, changes are evident as the result of the loss of the turgidity of the root.

A consideration of the relation between root pressure and the other phenomena in living plants will be interesting in this connection. With regard to its relation to transpiration, the latter can not be explained by the former, since, at the most, it is not sufficient to lift the water above 80–90 feet. Root pressure furnishes only a part of the water used in transpiration, as was shown by our own

and previous experiments,[1] and no root pressure was found in plants during rapid transpiration. The time of greatest transpiration seems to bear no relation to the time of greatest or least root pressure, and changes in temperature that affect the former do not influence the latter to any degree.

Where no transpiration is going on the root pressure may produce sufficient pressure in the plants of medium height to force the water out through the water pores of the leaves, or in some cases producing blistering in the tissues of the stem, as in the well-known case of the Oedema of the tomato.[2]

The relation of the root pressure with growth does not warrant any statement as to the influence of one upon the other. The time of either the maximum or minimum periods of each do not correspond, and changes in temperature that affect growth produce no changes in the constancy of the root pressure.

Studies regarding the relation between root pressure and assimilation show all negative results, and the changes producing variations in the latter have no effect on the former. The same may be said of the relation between root pressure and respiration.

In view of these facts we are warranted in the following general conclusions.

The periodicity of root pressure seems to be inherent in the plant, and has either been acquired by previous adaptation to environments, or as the results of the action of some constant or periodic changes in the plant. As with the periodicity of growth and other periodic phenomena it does not always follow that a periodic change has not been produced by some constantly or continuously acting agent.

Root pressure does not seem to have any relation to the previous periodicities of the vital activities of the plant when the top was connected with the roots.

The measure of the root pressure seems to be the osmotic activity of the root hairs, and is probably due to the presence of organic acids and other substances in the rhizoids that show great affinity for water.[3]

Although the organic acids increase in the cells at 50°–60° F., yet their increase does not seem to make any appreciable difference in the periodicity. This is true even when the temperature of the soil is brought up to 55° F., approaching the time of minimum pressure.

The fact that seems inexplicable is that, when the temperature is raised above the point where the organic acids decompose (60° F.) [4]in most plants, the roots may show an increase in their osmotic activity at the daily period of maximum

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[1]DeVries, Arb. Les. Bot. Inst. (B. I , p. 228).
[2]Atkinson, G. F., Bull. Cornell Exp. Station, No. 83, 1893.
[3]DeVries, Bot. Zeitung, 1877, S. 1-10.
[4]DeVries, Bot. Zeitung, 1883, S. 850.

pressure. The absence of a top to the plant, and its consequent loss of periods of maximum and minimum oxidation, which are the real causes of the variation in the quantity of organic acids in the cell,[5] [6]may be the reason for the failure to produce the expected results. The time of periodicity of root pressure is constant in the same genus, but some species may show greater absolute pressure than others. This may be due to accidents in growth, etc. The fact of the periodicity of root pressure seems to be established beyond the possibility of a doubt, and capilarity and similar phenomena, as suggested by Prof. C. B. Clark[7] and others, can not account for the facts observed.

Notes on the Flora of the Lake Region of Northeastern Indiana.

By W. W. Chipman.

A glance at any map of Indiana showing the lakes and marshes will convince one of their special abundance in the north part of the State; and many more will be observed in the northeastern counties than in the northwestern.

In the Fifteenth Report of the State Geologist of Indiana[1], Dr. John M. Coulter divides the State into seven botanical regions, one of which he calls the "Lake Region." Included in this "Lake Region" are the sixteen northernmost counties of the State, with the exception of the very northwestern counties, Lake and Porter.

I would separate from his Lake Region some of the most northeastern counties, and claim for this territory sufficient peculiar conditions for plant growth to merit its being considered a distinct botanical region, and would call it "The Lake Region of Northeastern Indiana."

OUTLINE OF THE REGION.

A line drawn from the vicinity of Warsaw, Kosciusko County, north along the line of the C., C., C. & St. L. R. R. to its intersection with the northern boundary of the county, and from thence northeast through LaGrange, LaGrange County, to the northern boundary of the State; and a line drawn from the vicinity of Warsaw east along the line of the P., Ft. W. & C. R. R. to its intersection

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[5]Ward, Proceedings of Royal Soc., Vol. XLVII, pp. 393-443.
[6]Warbung, Untersuchungen, etc., pp. 77-92.
[7]Linnean Soc. Journal.
[1]15th Rep. State Geologist Ind., p. 256.