ties which are largely responsible for the education of these students continue to have more or less of an influence on the lives of those who have now become attached to the profession of pharmacy; at any rate, they are concerned in their welfare and good behavior. The students have been impressed with these facts and encouraged by counsel and advice to uphold the ideals of pharmacy.

We are prone to say that the necessity for adhering to a certain policy or teaching has never been greater; whatever the significance, it is probably safe to say that it is a repeated relative statement of our forefathers—they had their problems which were paramount in their time, and have been solved or thrown aside as faulty; we have ours, some of which disturb us; others are about to be solved, while our activities are productive of others; both our duties and opportunities are in the adjustment of them for our uplift and advancement and the better service of humanity.

The credentials given to the recent graduates in pharmacy not only testify to their educational qualifications, but also to their fitness for assuming professional obligations. The encouragement will be permitted—that they can best carry out the duties assumed by them, achieve success and contribute to the advancement of pharmacy and its service, by coöperating with those who now welcome them as associates and invite them to share in the work of local, state and national organizations. It is expected that many of the novitiates will prefer business to professional activities and so direct their efforts; all of the bodies referred to subserve these interests and within the American Pharmaceutical Association all the members of the represented associations have their "home." E. G. E.

RAILROAD RATES TO THE BUFFALO MEETING OF THE AMERICAN PHARMACEUTICAL ASSOCIATION.

Summer tourist rates are given in Board of Directors Letter, printed in this issue, p. 570. Rates from other cities follow:

Wichita	$68.90	Asheville	$49.85	Memphis	$53.65
Tulsa	65.60	Atlanta	52.85	Mobile	68.45
Oklahoma City	72.35	Augusta	59.20	New Orleans	73.60
Fort Worth	80.30	Charleston	58.23	Savannah	64.33
San Antonio	94.45	Chattanooga	44.95	Tampa	86.10
Galveston	91.00	Jacksonville	72.40	Winston-Salem	45.05
Dallas	80.30	Knoxville	42.40	Birmingham	53.20

Slightly lower rates can be obtained from Chicago and St. Louis on the Wabash, and New York on the Lehigh. Tickets must be validated at Niagara Falls.

A STUDY IN PHARMACY.*

NATURE'S PERCOLATION PROCESSES IN CONNECTION WITH THE FORMATION AND EXCRETION OF DEW, VERSUS ARTIFICIAL PERCOLATION.

(*Continued from p. 422, May issue.*)

BY JOHN URI LLOYD.

* The first part of this contribution by J. U. Lloyd ended on p. 422 of the May number, which please refer to so as to have the continuity. The article is continued on next page.

General Conclusions. The foregoing experiments (1 to 39) collectively point to the conclusions that exuded water of vegetation is important in weight, as well as an air moistener. Also that under different conditions, varying amounts of moisture are liberated, also that different forms of vegetation vary in their exhalations of vapor.[1] Accepting that the amount of vegetation's water of exhalation can be established after these processes, the question arises—How much water is exhaled as dew in the growth of a plant? In this object, we shall, as an introduction, reproduce in part[2] from a contribution printed in 1880.[3]

DEW.

"All are familiar with the bright transparent beads, known as dew, that form upon the grass and other forms of vegetation during spring, summer and autumn, and that disappear each day just after sunrise.

"We are cognizant of the fact that only upon certain nights may we expect a fall of dew; that still, bright, starry or moonlight nights are favorable; that cloudy nights forbid.

"Works upon science inform us that dew is moisture condensed from the atmosphere, writers relying wholly on conditions related thereto for the fact that there is no dew on cloudy nights or when the wind blows. A piece of cold iron or a glass of ice water will condense moisture upon its surface from the atmosphere on a warm day, so in like manner will vegetation at night, when the temperature of the earth's surface falls below that of the overlying atmosphere. This is true, but dew-drops upon the blades of grass are not gathered in this manner.

"Moisture, as we all know, will condense from any atmosphere that is saturated with aqueous vapor, if the temperature be reduced to a sufficient extent. This is according to the law that vapor of water is held in a larger amount by warm air than by cold air, and accounts for the moisture deposited upon inanimate objects when the nights are favorable. This law is the basis for the theory of the dew-drop, and it is generally accepted to apply as a whole. If such be the case, the blades of grass should naturally receive the condensed vapor evenly whether they are growing or are severed from the earth, providing they are in the same locality. All kinds of vegetation should receive the dew in about the same manner, under like conditions. Nor should a modification of this aqueous deposit result when the grass is severed from connection with the earth.

"And yet, dew gathers differently upon different species of grass, but it does not gather upon grass that is freshly severed from the earth until it will condense upon dead leaves and twigs in a similar location. On certain species of grass, dew will be found in the evening, in drops, upon the tip-end of each

---

[1] Difficulty in making rubber tight around the grass blade may have caused air vapor complication.

[2] *The Christian Standard*, Cincinnati, July 31, 1880.

[3] I must beg the reader's indulgence in case better explanations and better terms of expression now suggest themselves. I might even at this date (1923) do better—for forty years these notes have rested. To the above I will add that Mr. Russell Errett, Editor of *The Christian Standard*, took much interest in these investigations and for him I aimed to make the summaries in a rather popular form.

thrifty blade, before the remainder of the blade is moistened, and before there is moisture upon any inanimate object near, however good a conductor or radiator of heat the latter may be. Upon further observation, it will be found that these drops are continually falling off and are constantly being replaced—time, of course, being necessary for their reproduction.

"It is evident that this water is *not* condensed from the atmosphere, for certain species of grass will be dropping water, while others alongside are dry.

"One species first shows the drop upon the very tip of each blade; another will be covered on the edges with beads, along its entire length. Some herbs and the leaves of certain shrubs will be perfectly dry (this is especially true of evergreens and species of the cactus family) while under like conditions—even with branches and leaves interlaced with them—others will be covered with moisture.

"This form of dew sometimes appears at the tips of the leaves of shrubs which are several feet in height, before it exhibits itself upon others nearer the surface of the earth. During early spring we have seen the high-set leaves of grape-vines dropping with this dew, while other members of the spring vegetation near to the earth were scarcely moist, inanimate objects being dry.[1] Can we argue that these exceptions are due to a difference in the radiating or condensing properties of different species of plants?

"Our experiments teach us that, under certain conditions governing these experiments, the moisture condensed from the atmosphere during the night forms but an inconsiderable portion as compared with the *aqueous excretion from the plant.*[2]

"We must distinguish between the dew which condenses from the atmosphere and that which is cast from herbs.

"The larger share of dew upon the grass is excreted by the grass. This can be demonstrated by those who choose to investigate. Examine the grass within the door-yard, early during a clear summer evening, and each tip of thrifty blue grass will be found to hold a round drop—not a dew-drop, if dew is *only* moisture precipitated from the atmosphere."

AMOUNT OF WATER (DEW) EXCRETED BY VEGETATION.

The Dew of Vegetation.

In these experiments (based upon the results of experiments cited) glass tubes of small caliber, with expanded openings, were employed to collect the water of excretion (Fig. 12). The experiments were made by slipping the very tip of the grass blade through a sheet of wax and then firmly pressing the wax about the blade. The sheet of wax was then pressed against the mouth of a glass tube so that the tip of grass was within the tube. The

[1] The activity of some forms of vegetation, such as the growing grape leaf of springtime, or the young caladium leaf, is such as to liberate water in air not fully saturated with moisture. —J. U. L.

[2] The fact that water flows through the tissues of plants has been a matter of record for upward of two hundred years, and certain works on Structural Botany mention the fact that some leaves may even occasionally throw off drops of water. But in none, to the writer's knowledge, has attention been previously called to the connection between this water and the dew.—J. U. L.

opposite end of the tube was covered with a sheet of wax through which a capillary glass tube with expanded mouth (Fig. 12) was projected, the mouth resting against

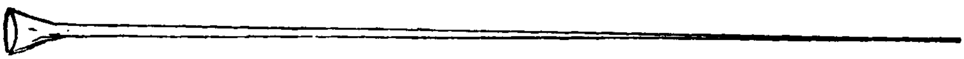

Fig. 12.

the tip of grass (see Fig. 10).[1] As the liquid exuded from the grass blade it passed into the tube and in the morning was weighed.

August 19, 1880, four experiments in the open air gave as follows:

8 P.M. to 6 A.M.

1—Weight of water 0.29 gr., weight of grass blade 0.28.
2—Weight of water 0.42 gr., weight of grass blade 0.31.
August 20th, under glass shade; rain all night.
3—Weight of water 0.35 gr., weight of grass blade 0.35.
4—Weight of water 0.59 gr., weight of grass blade 0.60.

These experiments indicate that whether the night be clear or rainy, water-excretive processes continue. Twenty-nine experiments according to this process (the four foregoing included) gave the following results, August 19th to September 1st, inclusive:

		Gr.		Gr.
(5)	Weight of grass	0.35	Weight of liquid in tube	0.28
(6)	Weight of grass	0.17	Weight of liquid in tube	0.27
(7)	Weight of grass	0.29	Weight of liquid in tube	0.28
(8)	Weight of grass	0.21	Weight of liquid in tube	0.25
(9)	Weight of grass	0.36	Weight of liquid in tube	0.51
(10)	Weight of grass	0.17	Weight of liquid in tube	0.52
(11)	Weight of grass	0.10	Weight of liquid in tube	0.10
(12)	Weight of grass	0.32	Weight of liquid in tube	0.30
(13)	Weight of grass	0.23	Weight of liquid in tube	0.62
(14)	Weight of grass	0.18	Weight of liquid in tube	0.26
(15)	Weight of grass	0.17	Weight of liquid in tube	0.22
(16)	Weight of grass	0.31	Weight of liquid in tube	0.47
(17)	Weight of grass	0.18	Weight of liquid in tube	0.31
(18)	Weight of grass	0.33	Weight of liquid in tube	0.32
(19)	Weight of grass	0.38	Weight of liquid in tube	0.22
(20)	Weight of grass	0.46	Weight of liquid in tube	0.19
(21)	Weight of grass	0.41	Weight of liquid in tube	0.22
(22)	Weight of grass	0.29	Weight of liquid in tube	0.39
(23)	Weight of grass	0.40	Weight of liquid in tube	0.53
(24)	Weight of grass	0.32	Weight of liquid in tube	0.28
(25)	Weight of grass	0.38	Weight of liquid in tube	0.50
(26)	Weight of grass	0.25	Weight of liquid in tube	0.25
(27)	Weight of grass	0.31	Weight of liquid in tube	0.50
(28)	Weight of grass	0.25	Weight of liquid in tube	0.54
(29)	Weight of grass	0.41	Weight of liquid in tube	0.43
		7.23		8.76

Remarks. It will be noticed that in the majority of experiments, the weight of water excreted was greater than the weight of the blade of grass. In some instances it amounted to more than twice its

[1] Only very small blades were employed, these being very active. As maturity approaches, the flow of water decreases.

weight, and in one case (No. 10) more than three times its weight. The comparison as a whole shows that 7.23 grains of grass excreted 8.76 grains of water. Let us pass to other forms of vegetation, less troublesome in details of experiment.

Experiments with Caladium.

This plant is exceedingly active. So abundant is water of excretion as to necessitate a capacious receptacle instead of a capillary tube. On a hot night the young leaf, as it forces itself from its sheath, if the plant be well watered, excretes water from its tip in a flow of drops. One, timed at 7:30 P.M., threw out 120 drops per minute. In one case, the force was such as to squirt the liquid *in a pulsating stream*, casting it two inches from the orifice of escape. These pulsations were as regular as the beating of the heart.

The amount of water collected in a bottle each night by placing the tip of the leaf in its neck, for fourteen successive evenings, was as follows:

August 23rd (Leaf appeared from sheath)	1 fluidounce
August 24th	$1^3/_8$ fluidounces
August 25th	2 fluidounces
August 26th (Leaf dropped from sheath)	4 fluidounces
August 27th	$4^5/_8$ fluidounces
August 28th	$4^3/_4$ fluidounces
August 29th (Cloudy, hot damp night)	$5^5/_8$ fluidounces
August 30th	$4^7/_8$ fluidounces
August 31st	$4^1/_2$ fluidounces
September 1st	$4^5/_8$ fluidounces
September 2nd (Clear, windy)	$2^1/_4$ fluidounces
September 3rd	$3^1/_2$ fluidounces
September 4th	$3^3/_8$ fluidounces
September 5th	$3^1/_2$ fluidounces

Explanation.—This experiment showed that the young leaf excreted, increasingly, for seven days, then decreasingly. The variations were probably influenced by irregular water supply, as well as variable moisture in the air. Leaves, same size, were weighed to parallel those dropping water. They gave, respectively, $^1/_4$ ounce, $^1/_2$ ounce and $1^1/_4$ ounces at the three stages.

Other Forms of Vegetation.

August 16, 1880, young shoot of *Cactus grandiflorus* through a rubber sheet into a glass tube, gave 4.83 gr. water. Growing bud of *Lilium tigrinum* gave 9.04 gr.

Experiment No. 40.—August 16, 1880, 7 P.M. to 6 A.M.

Young shoot of the Cactus grand. through rubber,	6 A.M.	112.44
	7 P.M.	107.61
		4.83
Lilium tigrinum bud,	6 A.M.	227.44
	7 P.M.	218.40
		9.04
Crystal $CaCl_2$ in same sized tube,	6 A.M.	142.12
	7 P.M.	141.90
		0.22

This shows that each specimen excreted moisture—Cactus 4.83 gr., Lilium bud 9.04 gr. The surprising feature of this experiment is the Cactus dew. This plant has the power of withstanding drought, but yet, under these conditions, exhaled moisture freely. The control experiment the same night showed that the air in a closed tube, size of those employed, gave to calcium chloride 0.22 gr.

Textural Material Also Abstracted.

In connection with the foregoing it occurs that part of the moisture must have been textural water of the grass that, by reason of the more powerful affinity of the calcium chloride, was taken from its substance. The following experiments indicate that such is the case, and that corrections need be made in accordance therewith.

Experiment No. 41.—Eight blades of grass were projected through a rubber cover into a beaker glass containing a watch glass of $CaCl_2$.

7 P.M.	5.10
Almost dry, 6 A.M.	1.15
	8) 3.95
	0.49

Experiment No. 42.—August 17, 1880. Sixteen blades of grass were projected through rubber cover into a beaker glass containing a watch glass of $CaCl_2$, 8 P.M. to 6 A.M., all very nearly dry,

8 P.M.	7.00
6 A.M.	1.90
	16) 5.10
	0.32

Conclusion.—It is seen that one set of 8 blades lost each 0.49 gr. of moisture, the other of 16 blades lost each 0.32 gr. of moisture, the average being 0.40 gr. The average weight of the grass blades was 0.5 gr.

Variations of Experimentation.

August 16, 1880, clear weather. At sundown, leaves of orchard grass were painted with collodion, the entire blades being covered. None were damp at 10:00 P.M., nor did the globules of water burst the collodion film.

Some were painted over the tip only, and these did not exude globules of water from the tip (repeated with like results, Aug. 17th). Some were painted excepting the tip. From the tips of these, globules of water appeared, the same as on adjacent grass (repeated with like results, Aug. 17th).

Experiment No. 43.—One blade covered with coating of collodion was put in vial and cotton stuffed into mouth

stuffed into mouth	42.00
Grass 0.26	41.92
Moisture in vial	0.08
One blade tip covered with wax was placed in vial	43.73
Grass 0.08	43.56
Moisture in vial	0.17
One blade *natural* was placed in vial	54.40
Grass 0.13	54.15
Moisture in vial	0.25

One blade covered, excepting point, placed in vial	47.27
Tip of grass 0.01	47.01
Moisture in vial	0.26

These show that the surface of the grass, as well as the main exit, are active, and that to the water of tip excretion must be added the water of surface exhalation. Each experiment, 8 P.M. to 6 A.M.

Experiment No. 44.—Four vials, top covered with sheet of wax, through which tips of orchard grass, were thrust; two of the blades (1 and 2) having been severed from the stalk.

(1) Severed; 47.01 gr.; no gain.
(2) Severed; 39.00 gr.; no gain.
(3) Grass tip less than 0.01 gr., moisture in vial 0.07 gr.
(4) Grass tip 0.01, moisture in vial 0.57 gr.

The current of supply being interrupted (1 and 2), no *water* is excreted.

Experiment No. 45.—Into two watch crystals were severally placed calcium chloride, each in a beaker glass closely tied over with a sheet of rubber. Time, 7:30 P.M. to 7:00 A.M. Through the rubber sheet of No. 1 a blade of orchard grass was projected. The $CaCl_2$ in the confined air abstracted 0.59 gr. of moisture, that with the blade of grass extracted 1.25 gr. The grass blade weighed 0.5 gr., showing that it excreted more than its weight of moisture. These experiments were repeated as follows:

		(1) Weight of grass. Gr.		(2) Moisture in air.	(3) Total in glass and air.	(4) Excreted moisture.
August 5, 1880, first experiments. Dates of others omitted from notes	A	0.93		0.63	2.53	1.90
	B			1.26	2.14	1.12
	C			0.9	2.23	1.14
	D			1.26	2.14	0.88
	E			0.9	2.23	2.14
	F	1.06	Wire grass	1.43	2.13	0.70
	F	2.18	Orchard grass	1.43	3.06	1.63
	G	0.94	Wire grass	0.36	2.92	2.56
	G	1.32	Orchard grass	0.36	2.76	2.40
	H	0.65	" "	0.19	1.46	1.27
	H	0.95	" "	0.19	2.63	2.44

In like manner a small oleander leaf (weight not recorded) was employed in contrast with a blade of orchard grass.

Moisture in Air.	*Oleander leaf exhaled.*	*Orchard grass exhaled.*
0.20 gr.	3.34 gr.	1.51 gr.

In this experiment the oleander leaf excreted twice as much moisture as did the blade of grass.

Remarks.—The uneven results of these experiments are due to several factors that need be mentioned. The beaker glasses were not uniform in capacity, atmospheric conditions were different, which probably accounts for the variation of Column 2. The varying sized grasses probably also gave up different portions of their structural water by reason of the suction of the dry air influence of the

$CaCl_2$. The total result, however, supports preceding conclusions, to the effect that in humid climates vegetation is a prolific moistener of air.

What Is Dew of Vegetation?

Let us now revert to No. 2 of our original publications on dew, reproducing in part, as follows:[1]

"The rootlets of each clump of grass are constantly absorbing water from the earth, and the grass blades are continually exhaling it into the atmosphere. Water, we may say, is the support of vegetation, but it is not absorbed as pure water. It is charged with soluble salts from the earth, and with its dissolved matters passes on through the plant.

"The cells of the plant seize upon desirable nutritive principles, appropriating them to their own support, as well as to the formation of substances necessary for new cellular tissue and content. In this way the plant is supported, new growth developed, and future plant life provided for. Thus, it is a necessity for the depleted water to escape, and by laws most beautifully adapted, vegetation is enabled to cast off the water which has served the purpose designated.

"Let us now consider some structural conditions of the blade of grass. Running lengthwise throughout it are strings of fibro-vascular bundles. Each apparently extends continuously throughout the entire length of the grass blade imbedded in cellular tissue, which resembles to our eyesight an amorphous mass of green pulp.

"It is unnecessary for our present purpose to enter further into the microscopic structure of plants. Suffice it to say that, through these bundles of fibrous matter, in reality also cellular tissue, and between if not also through, the cells of other parts of the leaf, a constant flow of water (fluid) toward the terminus of the leaf is taking place.[2] At last this escapes, when conditions are favorable, at the apex of the blade of grass where the fibers meet and end. This constitutes mainly the water tears upon the grass blades, which we have been accustomed to call *dew*, and to consider as moisture condensed from the atmosphere.

Fig. 16.

"It is also water of this description that, when conditions are satisfactory, flows from the apices of the leaves, that exudes from the surfaces of the leaves and along the margins of the grass blades, as well as from their surfaces, and that, becoming visible under certain conditions, is known as dew.[3]

[1] *The Christian Standard*, Cincinnati, July 31, 1880.

[2] I am quite satisfied that counter currents due to osmosis as well as cell activities also prevail. Probably a growing bit of vegetation has a complexity of liquid currents.

[3] Reference is here made to ordinary blue grass (*Poa pratensis*) or the crab grass (*Digitaria sanguinalis*). Under similar circumstances one of the common wire grasses (*Eleusine indica*) remains perfectly dry along the entire length, and it will be some time afterward before the moisture will appear upon this species. The entire upper surface of grape leaves is beaded.

Fig. 16 represents a blade of blue grass (*Poa pratensis*) with a drop of water magnified.

"The sap within the plant has served its purpose. It was absorbed by the rootlets, not as pure water, but as water charged with substances upon which that plant must live.

"From this liquid the various constituents and textures of the plant are produced. As it passes through and around the cellular tissues the cells take from it substances desirable for their support.[1] It thus travels onward in its tortuous journey, carrying plant cell excretions and its own earth-sucked salts to other cells, becoming thus continually more depleted of substances upon which plants live, until at length having served its purposes it is cast off as an exhausted excretion.

Animals like Plants Utilize Their Excretory Water.

"In animals there is also constant circulation, the blood moving in obedience to the action of the heart, and in this case also there is waste and reproduction of both the aqueous part and the other constituents. As in plants, the aqueous surplus must be expelled. When (in plants) it does not evaporate from the stomata (breathing pores) of the leaves, it is thrown off as water and we call it dew. When in animals it does not evaporate from the skin pores, but exudes on its surface, we call it sweat. When in plants the excess is thrown out as water from the tip of the leaf, we call it a dew-drop.[2] In animals surplus water carrying its load of worn-out tissue products is excreted from the bladder.

The Caladium as a Specimen of Plant Activity.

"Let us now pass from the blade of grass to another leaf, the consideration of which has already taken our care (page 512), and which exhibits more forcibly this expulsion of water from vegetation.

"The common large-leafed species of caladium, growing in tropical countries and marshy districts, familiar in some localities under the name of "elephant's ear," is raised in clumps on our lawns for ornamental purposes. It is of succulent growth, demands much water, under favorable circumstances absorbing enormous quantities. This water, entering the roots, is carried upward with considerable force, passing through the leaf stalk, enters the leaf, and, passing through it, escapes at night from the very tip of the leaf. During the day it escapes as vapor from the open stomata of the surfaces of the leaf, which, we are told, open during the warm weather and close when it is cool. They also open more freely in light than in darkness.

"Fig. 17 represents by a transverse section the tip of the leaf, showing the divided, woody fibers and the cavity where they terminate.

[1] It is generally accepted that the water which is lost from the plant is drawn directly from the root through the fibro-vascular bundles and is not the water of assimilating cells. Yet this cellular tissue of the leaf is connected with the fibro-vascular system through which the water is flowing, and it is probable that, by dialysis, there is an interchange of liquids.

[2] During daylight the cellular tissue of the leaf which contains the chlorophyl is actively engaged in transforming the constituents in the water drawn from the earth, into organized matter, such as starch, sugar, etc. While this is progressing, the myriads of stomata of the leaf are open and exhaling vapor as well as oxygen. This vapor is the water brought by the fibro-vascular system, and the organic constituents produced by the green cells are obtained from it. When the sun's rays are withdrawn, the action of the chlorophyl cells cease, the stomata close, and the water is not freely excreted as vapor. Then it passes on through the bundle of fibers and escapes as dew in the manner we have indicated.

"Each leaf is bounded by a raised margin extending in a circle around the entire leaf, and through this we find continuous woody matter, excepting at the tip, where the threads terminate in a sac which is formed of the epidermis of the leaf puffed up by the pressure of juice beneath; here the water escapes. Upon further examination we find that the ribs of the leaf terminate in the margin before named, and that the fibers of each rib connect with the fibers of the margin of the leaf (Fig. 18). Thus from bulb to the tip of the leaf there is an undivided network of cellular woody matter (fibro-vascular tissue), arteries subdividing into veins and cell capillaries, to again unite to further final excretion. The flow is onward from the root, for if a rib or a leaf margin be broken when dew is being excreted, the part towards the leaf stalk exudes liquid, but not the opposite side.

Fig. 17.

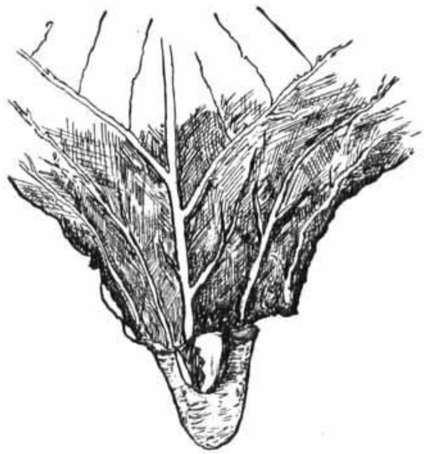

Fig. 18.

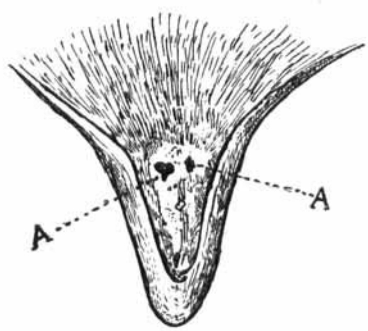

Fig. 19.

"Fig. 19 represents the tip of a caladium leaf magnified several diameters. It shows the orifices burst through the puffed skin of the leaf, from which the drops of water flow in the evening, or when conditions are favorable.[1]

Distinctions between Dew of Vegetation and Dew of Air Condensation.

"When vapor condenses, the result is almost pure water. True, there are some foreign constituents, plant exhalations, traces of gases, some ammonia or carbonate of ammonium; but rain water collected at a distance from a city is very pure.

"A constituent of the water excreted by vegetation which is *never* present in pure dew condensed from the atmosphere, nor in rain water, is sugar or glucose. Experiments placed by the writer upon the water of excretion of different species of plants demonstrate by chemical analysis,[2] in every instance, the presence of grape sugar.

"Some species, notably grasses, yielded this sugar quite abundantly; blue grass (*Poa pratensis*) at one time, during the autumn, excreting so large a pro-

[1] If the caladium be well watered about an hour before sundown, the drops will appear from young leaves shortly after sunset, and continue to flow until sunrise.

[2] Sugar (grape) is detected by several processes. That most used by the writer is known as "Fehling's test;" it depends upon the reduction of a solution of sulphate of copper, whereby cuprous oxide is thrown down in the proportion to the amount of glucose present.

portion of sugar as to render its presence perceptible to the taste. Since cattle prefer grass when it is covered with dew, it seems not unreasonable to suppose that the presence of the sugar may be one of the attractions.

"When the aqueous part of the dew evaporates this sugar is deposited upon the leaves. At certain seasons of the year, usually during autumn, when the leaves as well as texture of the forest trees have lost a portion of their vitality, this sugar may be deposited so abundantly as to attract bees and serve as a source of honey. It is known then under the familiar name "honey-dew.[1] In a Kentucky beech wood I have known the leaves to be so attractive to bees as to make a continuous overhead hum, as they flew from leaf to leaf, sucking the sugar from their surfaces.

Excretions of Poisonous Plants not Contaminated with Poisons.

"As far as my experiments extend poisonous plants, as well as plants possessed of marked characteristics, excrete a fluid apparently *free from deleterious substances.* As an example, the water collected from species of the Arum, of which the well-known Indian turnip (*Arisaema triphyllum*) is a specimen, is perfectly void of acrid principles. The juice of plants, found within the cells of the various structural parts, must not be confused with the fluid which flows through adjacent capillary passages of the fibro-vascular tissue. Possibly, too, water may in part pass by endosmosis, directly into and out of the cells containing water-soluble proximate energetics without carrying their contents beyond their locations. Chew a small piece of a caladium leaf, even a part of a grain—an intense acrid irritating sensation is imparted to the tongue and fauces. Water of excretion which flows from the tip of the leaf at the same time is tasteless. This water has passed through the acrid bulb, the leaf-stalk and the leaf. It has traveled along and through the cell walls of the woody bundles of fibers which extend from the mid-rib to the extremity of the leaf. And yet, it is so pure as to leave a nearly tasteless sediment by evaporation.

"Consider other plants, such as Sanguinaria, that contains in its cells a blood-red, acrid juice; or Hydrastis that is prolific in the bitter alkaloid berberine; the acrid Podophyllum, and poisonous plants generally. So far as I have determined none of their cell constituents (sugar excepted) are carried to the dew-drop orifice. Otherwise vegetation would drip with dyes of many colors and death would lie in the dew of poisonous plants (*Rhus toxicodendron* a question).

SUMMARY.

Pages 407–412 introduce, in a preliminary way, the problem of plant water-excretion, establishing the relationship between moisture in the atmosphere, moisture evaporated from the earth, and moisture exuded by vegetation.

Pages 409–410 locate the principal excretory points of the grasses employed.

Pages 410–411 show that, under favorable conditions, grass excretes "dew-drops" in the daytime.

---

[1] One form of honey-dew is said to be deposited by an insect. The aphid is an example of an insect sugar excreter. My son, J. T. Lloyd of Cornell University, believes that the honey-dew I have observed is possibly more or less the product of an aphid and not residue of excreted water. He states that at certain times these aphids multiply enormously over the leaves of forest trees and so cover them as to make a drip of their excreted sugar liquid. (Note added 1917.)

Pages 411–414 are devoted to experiments connected with the dew-point temperatures of air strata under the influences of moisture.

Pages 414–416 touch upon some of the general influences of excreted water, known as dew.

Pages 416–420 are connected with temperature variations within slightly separated distances, and the influence thereon of active vegetation and stagnant air.

Pages 420–422 make detailed experiments to establish the proportion of water of excretion, the locality of same—with different forms of vegetation.

Pages 509–510 are condensations of an article published by the author on this subject, Cincinnati, July 24, 1880.

Pages 510–511 give the process by which the exact amount of dew of vegetation was established, together with descriptions of the apparatus employed. One of the objects was to determine the proportion of water excreted by the principal water outlet in the grass, as compared with the weight of the grass.

Pages 511–512 comprise comparative experiments with other forms of vegetation. These may be considered simply as suggestive of opportunities for further investigation.

Pages 512–514 consider the problem of the textural water abstracted, simultaneously, by calcium chloride. These introduce variations of experimentation and processes adapted to various problems suggested by preceding studies.

Pages 514–517 introduce part of another of the three articles published in Cincinnati, July 31, 1880. In this is made the distinction between dew of vegetation, and moisture condensed from the air, with comments concerning the excretory liquids of plants as compared with those of animals, and suggestive ideas regarding the desirability of function researches connected with such phenomena as water excretions from active alkaloidal plants and water-soluble pigments. *These secretions, having passed through (percolated) the plant from root to leaftip, are devoid of color or alkaloid.*

The author now (1923) fully comprehends his inadequacy in 1879, both as concerns mental capacity, lack of information concerning recorded researches, and deficient experimental opportunities. He believes it best, however, not to revise the manuscript. No need is there to record that dissenting research results may have been made by others, better equipped.

Conclusions. A study of the phenomena of natural percolation in growing plants leads me to accept that recondite (life) influences aside from capillarity prevail in and govern the motions and functions of both cellular and intra-cellular liquids.

Juxtaposition of cell envelopes of diversified constitution such as compose films made of deposits of fats, waxes, essential oils and other bodies, prevent and encourage endosmosis and exosmosis; perhaps simultaneously enclosing certain liquids and excluding others.

The complexity of these movements prevent parallel laboratory experiments wherein the fresh (green) vegetable structure is crushed and cell juices intermingled. *No comparison whatever can be made of Nature's percolating process with live plants, and laboratory percolating processes with the same bodies dead and dried.*

The illustrations are made by Mrs. Eda Van Guelpen Pape, from original sketches by the author.