Studies on the Viscous Substance Dripping from the Leaves of Shiia-Trees

Part 4

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The dripping phenomenon of secretion from leaves of Shiia-trees was reported on the previous paper.[1,2,3] And the predominate compounds of viscous substance dripped were α-glucose, β-glucose, fructose, myo-inositol, sorbitol, sucrose, and raffinose. Now, the dripping phenomenon which was influenced with an environmental condition, microclimatic condition, was observed again. One factor of microclimatic condition was recognized with the apparence chance of secretion term a year.

Experimental and Results

These trees which were classified to *Shiia cuspidata Makino* and *Lithoe carpus glabra Nakai* were in the authors' university campus.

The amount of secretion dripped on each glass plate $(30 \times 30, cm^2)$ was estimated with the reported procedure[2] for this experimental period, from the latter part of February to the latter part of March. This term was a maximun limited dripping period of this year. However, the length of dripping term was about one month a year. Namely, the apperance chance of secretion a year was approximately once only. Of course, an unit of term was about one month. Then, one day was too short to call a term like a case of several hours.

The dripping condition was influenced by various environmental conditions, microclimatic conditions, air temperature, humidity, wind, sunlight, weather, a composition of gaseous phase, soil temperature, and other kind of factor. But the physiology of secretion was very difficult problem. Then, some consideration which was not complete was described using model.

Now, the estimated results of dripping of secretion were listed in Table 1. And the air temperature and the relative humidity during sampling term were listed in Table 2.

Moreover, the integral values of air temperature, relative humidity and dripping were listed in Table 3.

The various states of dripping were photographed as shown in Fig. 1∼8.

The dripping secretion was observed when the air temperature and the relative humidity

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rised to about 10-15℃ and to about 40-70% respectively under the restricted conditions that the integral values of the air temperature and the relative humidity were about 100-180 units and about 200-300 units. This integration method was completely new estimation method. The integration was carried on about two elements, air temperature and relative humidity in the present case. And, the ranges of about 100-180 units for air temperature integration and of about 200-300 units for relative humidity integration were better condition to drip the secretion. But, in the upper or lower range from the better condition, the dripping decreased.

This integration of two elements in the present experiment induced one satisfactory results at the first step.

Then, the appearance of dripping term of secretion from leaf was once a year.

Table 1
The estimated results of dripping of secretion

Date	drip
Feb. 25	282
26	318
28	158
Mar. 1	89
2	235
7	206
8	85
10	112
11	134
12	5
14	57
15	96
16	45
18	38
25	15
28	9

Table 2
The air temperature and the relative humidity

Date	air temperature (℃)	relative humidity (%)
Feb. 25	14.4	40
26	18.8	40
28	12.6	58
Mar. 1	14.5	51
2	10.0	83
7	11.8	43
8	15.0	46
10	11.8	41
11	11.7	24
12	12.1	35
14	15.3	48
15	17.5	46
16	12.1	31
18	14.0	65
25	11.3	60
28	9.8	56

Table 3

The integral values of air temperature, relative humidity and dripping

Date		air tempreature	relative humidity	dripping
Feb.	25	167. 0	200. 0	294. 5
	26	172. 0	221. 0	273. 0
	27	132. 5	266. 5	194. 0
	28	133. 0	269. 5	120. 0
Mar.	1	123. 0	273. 5	156. 0
	2	100. 0	293. 5	230. 0
	3	101. 0	274. 5	225. 0
	4	102. 0	254. 5	219. 0
	5	102. 5	231. 0	213. 0
	6	103. 0	221. 0	207. 0
	7	125. 0	210. 0	133. 0
	8	139. 0	218. 0	93. 5
	9	123. 5	223. 0	109. 5
	10	115. 0	209. 0	127. 5
	11	117. 5	158. 0	71. 5
	12	127. 0	146. 0	19. 0
	13	147. 0	187. 5	42. 0
	14	165. 0	215. 0	75. 0
	15	145. 0	229. 0	70. 0
	16	125. 0	190. 0	42. 0
	17	133. 0	208. 0	38. 0
	18	135. 0	381. 0	33. 0
	19	132. 5	325. 0	32. 0
	20	127. 5	322. 0	27. 5
	21	125. 0	319. 0	22. 5
	22	120. 0	313. 0	21. 0
	23	117. 5	312. 5	19. 0
	24	112. 5	303. 0	17. 0
	25	104. 0	295. 0	17. 0

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

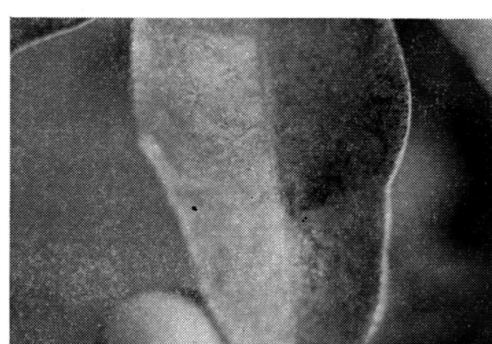

Fig. 6

Fig. 7

Fig. 8

A plant responds to its environment according to the internal environment and the external environment.

An excess or a dificit of heat energy can have profound effects on plant functions. At first the environmental temperature influences nearly every life process and it varies in daily and seasonal patterns through one year.

Physical or chemical phenomenon influenced by temperature includes rates of diffusion, of solubility, of chemical, and of enzymatic reaction. Especially, the rates of enzyme-controlled reactions double approximately with every 10℃ of temperature increase until the enzyme is inactivated by heat.

The tempreature of a plant is influenced largely by the amount of sunlight striking it and the soil around it. The amount of incident radiation depends on latitude, altitude, season, and time of day. Leaf-surface temperature may change as much as 10℃ with a change from sunny to cloudy weather conditions. A leaf is usually maintained at 2–10℃ above the air temperature. The movement of air over a leaf surface and through the stomata removes water vapor and increases water loss.

Diffusion occurs between combinations of solids, liquids, and gases. Temperature and pressure influence the rate and direction of diffusion. A rise in temperature or a decrease in pressure increases the rate of the diffusing molecules.

Diffusing substances exert diffusion pressure.

Water enters the cell by osmosis and its contents expand and press against the cell wall. In the pressure against the wall, turgor pressure, and the pressure of the wall back against the cell, wall pressure, the latter counteracts the former. The latter ultimatery balances the former in the living cell.

Then, water and other materials may be taken into the plant cell and the wall that surrounds it by the following processes : osmosis, imbibition, passive absorption (diffusion), and active absorption.

The path of water, soil—living cell of root hair zone—dead xylem cell—living cell of leaf—air, was compared in several osmometers and an atmometer.

Transpiration from leaf pulls a column of water under tension up through xylem. Some water is pushed up from below, since the root system produces some pressure. Water loss via transpiration occurs both through the stomata and, to a lesser extent, through the cuticle. The extensive intercellular air system in the leaf and the numerous stomata permit rapid exchange of gases and the release of water vapor to the outside air. The water molecules diffuse from within the leaf, through the open stomata, into the outer air. And water loss is affected by hnmidity, temperature, and air currents, all of which influence the rate of transpiration. The rate is affected by whether the stomata are open or closed. The opening and closing of stomata is regulated by the turgidity of the guard cells. The tugor differences between guared and subsidiary cells influence the degree of stomatal opening.

The opening and closing of stomata are explained by the starch-to-sugar, sugar-to-starch theory of stomatal action. This theory is based on the observation that the formation of solid starch grains in a cell takes sugar molecules out of solution and thus reduces the osmotic concentration of the cell and its ability to take up water. The reverse also occurs. The solid starch was observed as shown in the previous paper.[2] When starch is broken down, sugars are released and osmotic concentration and the ability of the cell to take up water are increased. When starch break-down occurs in guard cells, osmotic concentration increases, more water is taken up, and the cells become more turgid and bend, opening the pores.

When starch synthesis occurs in guard cells, osmotic concentration decreases, the cells become less turgid and "unbend", thus closing the stomatal pores. This theory points out as follow :

(a) stomata in most plants open during the day and close at night

(b) an increase in CO_2 in the leaf leads to a higher concentration of carboxylic acid in the cell. This change in cell acidity influences the enzymes that convert starch into sugar and sugar into starch.

Also, the change in tugor produced by sugar-to-starch synthesis is thought to be too slow to account for the speed (as fast as 15 seconds) with which stomata can close. An energy-requiring active-transport mechanism may be operating that allows the guard cells to take up water and develop the necessary turgor to open.

Now, stomatal physiology is not yet solved.

Summary

The phenomenon of dripping of secretion from leaves of Shiia-trees was observed again and recognized.

The appearance of chance of dripping term was once only a year.

The dripping was depended upon the microclimatic condition.

The range of the microclimatic condition that the integration values of air temperature and relative humidity were about 100-180 units and about 200-300 units respectively was tolerably satisfied to drip at the first step.

Then, these two elements, air temperature and relative humidity, were important factors to drip of secretion. But, other microclimatic factors have to be added into them to solve

the difficult problem of secretion at the second step.

References

1) Takahashi. K., H. Holikawa, Y. Nagumo : Bull. Tokyo Col. Domes. Sci. **11**, 75 (1971)

2) Takahashi. K., K. Horitsu, T. Miyoshi, Y. Nagumo : Bull. Tokyo Kasei Daigaku **17**, 1 (1977)

3) Takahashi. K., K. Horitsu, Y. Nagumo, T. Miyoshi : Bull. Tokyo Kasei Daigaku **17**, 9 (1977)

〔**内容抄録**〕 椎の木の葉から滴下する粘稠性物質に関する研究（第４報）

高橋敬三　堀津圭佑　三吉淑子

椎の木の葉からの分泌物質の滴下現象を再び観察し，確認した。滴下時期は１年に１回だけであった。滴下は微気候象条件に依存した。空気温度と相対湿度積分値がそれぞれ約100～180単位と約200～300単位であった微気候象条件の範囲は第一段階として滴下に対してかなり適切であった。なお，これら２つの要素，空気温度と相対湿度は分泌物質の滴下にとり重要な因子であった。しかし，他の微気候象因子も第二段階として分泌についての難しい問題を解決するために加えられねばならない。