Oura

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On the Capture of Fog Particles by a Forest (II)

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In the summer of 1952 investigations were performed at *Akkeshi*, where the forest was grown with only broad-leaved trees and, as compared with that at *Ochiishi*, the trees were much taller while their density was smaller. The fog-capturing efficiency of the forest proved to be of the same order as that of the forest at *Ochiishi*. It was further found that the amount of fog water caught by the forest was as much as from six to ten times that caught by the open field.

§1. Main Object of the Research and Description of the Forest

In the investigation at *Akkeshi* in 1952, special attention was devoted to the fog-capturing function of a grassy field, in order that we may be able to compare it with that of the upper surface of the forest. It was further intended to make some "microscopic" study of the forest as to the capturing efficiency, since it was well anticipated that the motion of fog particles might largely depend on the local character of the forest, so that the measured amount of fog water might show wide variation according to the locality of the measuring apparatus.

The wire screen for collecting fog water was somewhat improved in its construction and was reduced in size to one-third of that formerly used. We prepared three pairs of wire screens (each pair consisting of screens with and without mosquito curtain) and one pair was set above the tree crowns at Y_1 (Fig. 1), while the other two were set at Y_2 (Fig. 2)—cf. the chart given in the "General Survey" [1]. In addition to these, two umbrellas were put upside-down on the forest ground at Y_1 and Y_2, in order to collect the fog water deposited on and dripping from the foliage of trees. In the open near the observatory house, a screen without curtain was set on the bare ground (Fig. 3) and another screen with curtain was

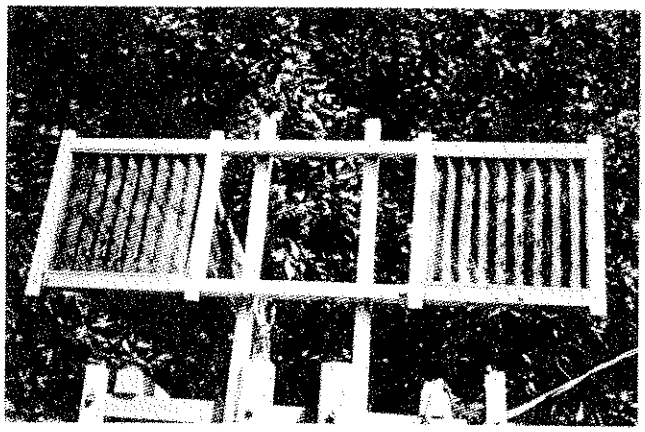

Fig. 1. The wire screen at Y_1.

placed in the field on a level with the top of rank grass about 80 cm high.

Fig. 2. The wire screen at Y_2.

The height of trees near Y_1 and Y_2 was about from 15 m to 17 m. The density of large trees at Y_1 was 0.043 per m^2: In the area of 400 m^2, there were 17 trees more than 10 m in height (*Betula Ermani*), 8 trees 6~10 m in height (*Fraxinus Sieboldiana*, etc.), and 17 trees 2~6 m in height (chiefly, *Acermono*). Around Y_2 the density was 0.028 per m^2 with 11 trees higher than 10 m (*Betula Ermani*), 9 trees 6~10 m high (*Fraxinus Sieboldiana*, etc.), and 10 trees 2~6m high (*Acermono*, etc.) in 400 m^2. General features of the forest will be

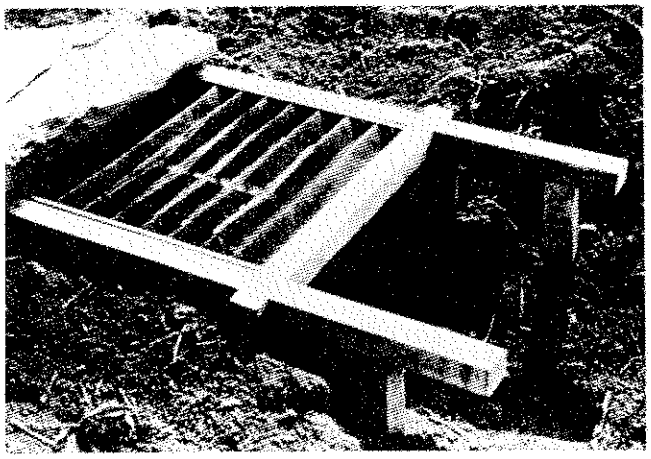

Fig. 3. The screen on the ground.

seen from the illustrations given in the "General Survey" [1].

§2. Apparatus

The effective area of the wire screen was $30.3 \times 27.3\,cm^2$, about one-tenth of that used in the previous year. But, inclusive of the ineffective part which was intended for avoiding the rim effect, the total area amounted to $45.5 \times 49.1\,cm^2$. The features of the screen will be seen in Fig. 4.

The guide plate attached to the bottom of each valley of the screen (see the preceding paper) was shielded with extended walls of conduit, in order that the fog particles might be prevented from being caught directly by the guide plate. The collected fog water was led through conduits to a spout, from which it dropped down in the form of droplets. The method of counting the number of droplets was the same as that in the case of fog meters [2].

The catching area of the umbrella set upside-down under the tree crowns was about $0.93\,m^2$. Since it was unavoidable that the water collected in the umbrella leaked out through

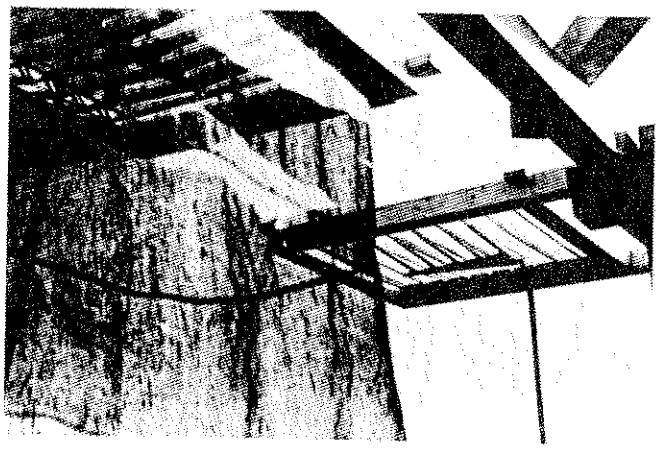

Fig. 4. The screen at Y_2.

the cloth, the leaking water was further collected by means of a funnel and a bottle put underneath the umbrella.

§3. Results

Some examples of the data obtained at several posts of observation are given in Tables 1, 2 and Fig. 5. From Table 1 it will be observed that the fog that appeared on July 26 and 27 was caught at the top of the forest about ten times as much as in the open. It seems that there is no appreciable difference

Table 1. *Amount of Collected Fog Water in kg/m²*

Date	Time	Y_1		Y_2		Bare ground	Grassy field
		Screen	Umbrella	Screen	Umbrella	Screen	Screen
July 26	$7^h\ 15^m$	5.8	1.64	7.9	0.23	0.73	0.09
	$8^h\ 30^m$						
	$20^h\ 00^m$						
July 27	$4^h\ 40^m$		1.75		1.37		
	$5^h\ 15^m$					0.06	0.07
	$10^h\ 00^m$		0.04		0.03		

between the capturing efficiencies of the bare ground and the grassy field. On one occasion in the daytime we happened to observe the fact that, when the fog began to invade the land, the water drops were deposited on the screen in the grassy field before no water drops were perceived on the screen upon the bare ground. This phenomenon is, in all probability, to be attributed to larger humidity or lower temperature in the grassy zone.

TABLE 2.

c: Amount of fog water captured by the forest per unit area of its upper surface ($g/m^2 \cdot hour$);
φ: Fog water content at 3 m above the forest (g/m^3);
c/φ: Amount of fog water to be captured for unit fog water content (m/hour);
v: Mean wind velocity for one hour at 3 m above the forest (m/sec);
K: Eddy diffusivity (cm^2/sec).

Date	Hour	Y_1			Y_2		
		c/φ	v	K	c/φ	v	K
Aug. 13	2^h	—	—	—	0.66×10^{-3}	2.7	1.6×10^4
	3^h	—	—	—	0.78 "	2.5	—
	4^h	0.06×10^{-3}	1.4	—	0.47 "	2.2	—
	5^h	0.17 "	1.6	—	0.97 "	2.5	—
	6^h	0.37 "	4.1	—	—	—	—
	21^h	1.12 "	5.3	4.4×10^4	0.83 "	2.2	2.0×10^4 "
	22^h	0.35 "	3.0	—	0.74 "	3.6	1.4×10^4 "
	23^h	0.10 "	3.2	—	0.77 "	3.7	1.4×10^4 "
	24^h	—	—	—	1.00 "	1.5	3.4×10^4 "

The values given in Tables 1 and 2 indicate that they are comparable to those obtained at *Ochiishi* in 1951. Whether the forest with needle-leaved trees or that with broad-leaved trees is more effective in capturing fogs cannot be decided at the present stage of research, although the available data seem to be in favor of the former. There remains also the question to be proved whether the variation of the value of c/φ with time is the true natural phenomenon or it arises from the de-

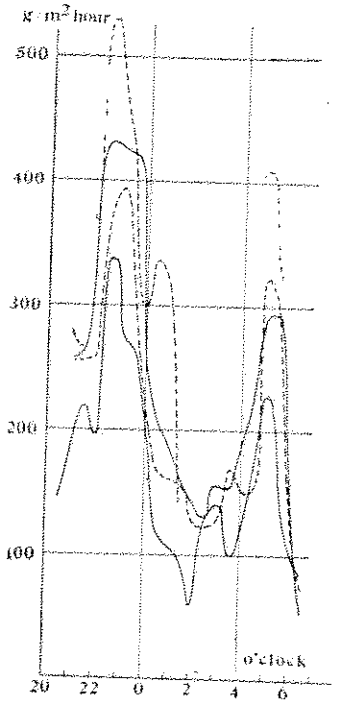

Fig. 5.

The hourly variations of the amount of fog water observed by two sets of screens with curtain (drawn as solid curves) and by two sets of screens without curtain (drawn as broken curves). The ordinate corresponding to any time indicates the value obtained through integration over the time interval from 30 min before to 30 min after that time.

pendency of the capturing coefficient of the wire screen upon the particle-size distribution of fog.

The amount of fog water collected by the screen is largely dependent on the locality of the screen. Even the two screens situated close to each other in the opening between crowns at Y_2 did not yield the same results, as illustrated in Fig. 5. Cases are also recorded here where the amount of fog water caught by the screen with curtain surpasses that caught by the screen without curtain.

The results of the direct measurement of fog drip by the use of umbrella are also subject to wide variation, while the order of magnitude is the same as that obtained by the screen. In order to gain more accurate data, it would be necessary to carry out the measurements on a much larger scale and moreover to take into account the correction for the water that is retained on foliage, branches and stems without dripping, although it is certainly comparatively small.

The values of eddy diffusivity K shown in Table 2, calculated from the observed values of e and $d\varphi/dz$ by the relation $e = K\dfrac{d\varphi}{dz}$, are in the range from 10^4 to 4.5×10^4. This seems to indicate that the eddies whose periods are not more than

a few seconds [3] play the predominant role in carrying fog particles into the forest.

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References

[1] *Yosida, Z.*: General Survey of the Study on the Fog-Preventing Forest; paper (1).

[2] *Tabata, T., Huzioka, T.* and *Matsumura, N.*: On a New Type of Recording Fog Meter; paper (10).

[3] *Ishida, T., Kusunoki, K., Kobayashi, T.* and *Imai, H.*: Measurement of Atmospheric Turbulence around a Forest; paper (9).