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A NOTE ON THE SPECTRAL TRANSMISSION OF LIGHT BY TROPICAL RAINFOREST

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SUMMARY

The transmission spectrum of montane rainforest on Java is similar to that of temperate wood. The ratio near red/far red is somewhat higher than in the temperate wood. This can be explained by the more irregular canopy structure of the rainforest.

1. INTRODUCTION

Light measurements in tropical forest are still scarce, especially as regards the spectral composition of the light transmitted by the canopy. In this paper some data are given on the transmission in the wavelengths between 400 and 900 nm by virgin forest in Indonesia.

2. DISCUSSION OF THE MEASUREMENTS

Most of the measurements were made in the montane rainforest of the Tjibodas nature reserve on the north slope of the volcano Gedeh inside the sample plot described by MEIJER (1959). For the present purpose the structure of the forest is of more importance than its floristic composition. Trees of all height classes occur, with numerous epiphytes. Many climbers and shrubs are present, as well as palms, tree ferns, *Pandanaceae*, *Zingiberaceae* and herbs of various height. The transmission curves given in the graphs are representative for the light received by the lower herbs on the forest floor. They were computed from two to four series of comparative measurements inside and outside the forest. The measurements were made under stable conditions, either bright or overcast. This was necessary as measurements inside and outside the forest had to be compared. This method has the disadvantage that the number of useful data is rather small. On the other hand, the data as such can be considered reliable and free from instrumental errors, which naturally is more difficult to achieve in extensive series of measurements.

The measurements were taken in virtually the same way as described by STOUTJESDIJK (1972). Between 400 and 725 nm a 'wedge' interference filter was used, between 770 and 900 nm a set of normal interference filters.

All graphs (*fig. 1-4*) show, generally speaking, the same situation as found in a temperate wood: the visual part of the spectrum (up to 700 nm) is much more strongly absorbed than the infrared and there is a weak maximum in the green part of the spectrum between 500 and 600 nm. Quantitatively, however, there are considerable differences.

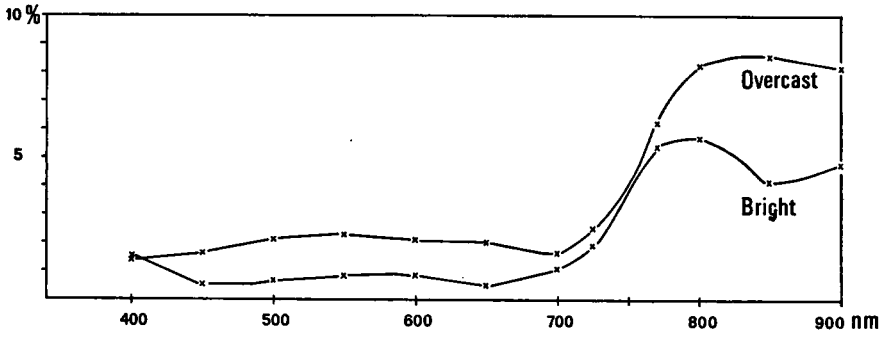

Fig. 1. Transmission curves of montane rainforest taken in the same spot with bright and overcast conditions.

Considering in particular the transmission curve for bright weather in the mountain forest (*fig. 1*), we see in the first place that the general transmission level in the wavelengths 400–700 nm, roughly said: the visible light, is rather high as compared with dense forest in the Netherlands (STOUTJESDIJK 1972) and this is also the impression from visual observation. In the second place the difference in transmission between visible and infrared light is not so extreme as in the temperate wood. We found for instance in temperate oak wood about 0.5% transmission in the short wavelengths and about 10% in the infrared. In the rainforest a transmission of about 0.7% in the short wavelengths is combined with a transmission of 5% in the long wavelengths. Probably this is due to differences in canopy structure.

The planted wood has a closed homogeneous regular canopy structure, practically all the light that reaches the forest floor is filtered through the leaves. The natural rainforest has a more irregular structure. Of the radiation reaching the forest floor we may assume that the major part is filtered very strongly so as to lose almost all the short-wave radiation and even most of the infrared. This radiation is mixed with radiation of a less extreme composition: either transmitted through holes in the canopy or through a thin layer of leaves only or reflected by leaves and branches. The mixture of both components gives light of a less extreme visible/infrared ratio than in the temperate wood. This opinion is also supported by the rather high transmission in the violet (400 nm) in the rainforest, which effect is absent in the temperate wood.

With an overcast sky the relative intensities are higher than with a bright sun. This is in accordance with what was found in temperate beech wood by TRAPP (1938). It can be understood from the fact that the intensities outside the forest are greatly reduced when the sun is covered. Inside the forest, when measurements are made on spots with no or only weak sunflecks, most of the radiation comes from the sky and this is less reduced, sometimes rather enhanced, when the sun is covered. It can be understood along the same lines that the transmission maximum at 400 nm is absent with overcast conditions, the skylight being

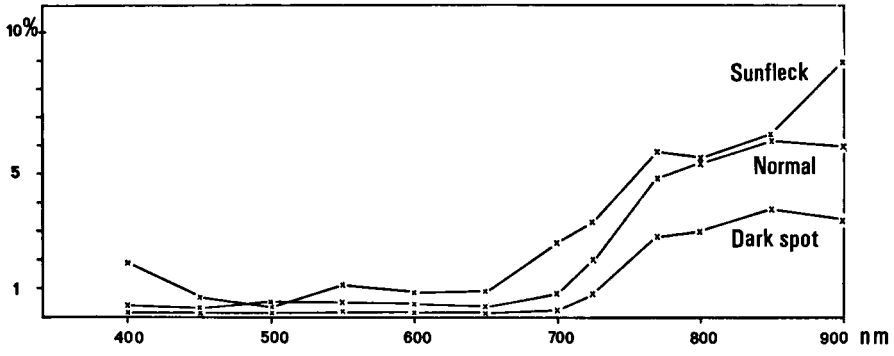

Fig. 2. Transmission curves of montane rainforest taken simultaneously in three adjoining spots.

the main source of illumination inside and outside the forest. Also the absolute intensities inside the forest change much less than outside the forest when the sky becomes overcast or cloudy.

In *fig. 2* comparative measurements in three adjoining spots are given to show the variation within a few square metres. On the darkest spot only ferns are found. It is remarkable that the maximum at 400 nm is more pronounced in the weak sunfleck than in the shade light. This might have been a pure accident but the same effect was observed by DIRMHIRN (1964) under *Juglans* trees in Austria. We would suggest as an explanation that in the sunfleck there is also much light received from the sky near the sun. Unexplained, however, is the fact that the maximum is so sharply situated at 400 nm which is not the case in the skylight itself.

In *fig. 3* the situation is shown on a very dark spot in the forest, surrounded

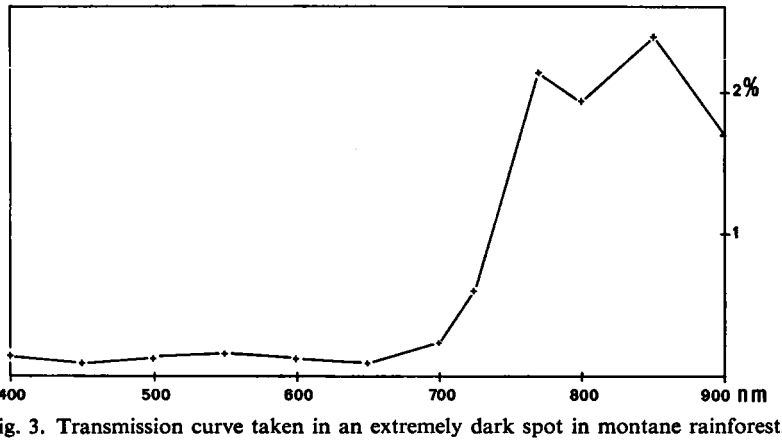

Fig. 3. Transmission curve taken in an extremely dark spot in montane rainforest.

at three sides by walls of rock. The vegetation consisted of mosses and ferns only. The discrepancy between the shorter (< 700 nm) and the longer wavelengths is more extreme than in the lighter parts of the forest but less than in dark temperate forest. The transmission in the visible range is comparable with what is found in the darkest spots in European conifer or beech wood. The absence of higher vegetation at this level of light intensity is in accordance with what was found generally in temperate and tropical forest (WALTER 1960).

In *fig. 4* the transmission curve is represented for young primary forest (on the West point of Java) developed after the eruption of Krakatau in 1883. The measurements were made in shade light. The forest floor is practically bare but for some young saplings. The canopy has a more regular structure than in the Tjibodas forest. The transmission curve is not so extreme as in the temperate beech wood but more so than in the Tjibodas forest.

As mentioned, for comparison only few measurements are available in the tropics. This is doubtless mainly due to the circumstances that really suitable equipment has only recently become available.

ORTH (1939) made the best measurements possible in his time by using an extensive set of glassfilters in combination with a photocell. Orth measured the intensity distribution over the spectrum between 375 and 730 nm. In those measurements that are comparable with ours as to the type of forest and the intensity levels measured, he also found an increase in the short wavelengths near 400 nm and between 650 and 730 nm (e.g. Orth's curve 44). That the transmission curves start to rise at 650 nm instead of 700 nm as found by us is probably due to the less sharp transmission bands of the glassfilters used by Orth.

SCHULZ (1960), working in Suriname, measured the intensities in three wide wavelength bands which reveal an increase in the short-wave part of the spectrum. The high transmission in the infrared could not be detected by the method used. EVANS (1966) found a high transmission in the 'red' but this included part of the infrared as well.

One may ask in how far the data given here are representative for tropical rainforest in general. As mentioned above for a straightforward comparison only the measurements by Orth are available.

However, from the transmission curves in this paper it is clear that inside the range 400–700 nm the transmission percentage is not too variable. The non-selective measurements in this range can therefore be compared mutually

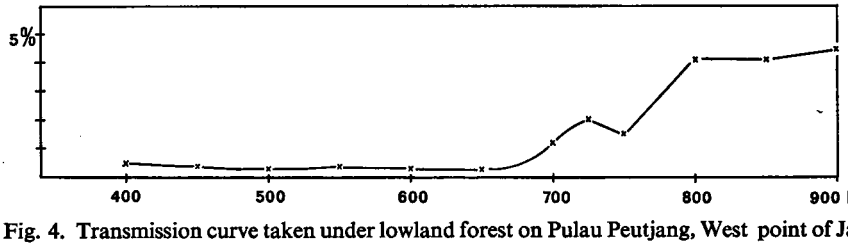

Fig. 4. Transmission curve taken under lowland forest on Pulau Peutjang, West point of Java.

and with the present measurements as for the mean level of transmission in this range. The compilation by Schulz shows that the light transmission in the range 400–700 nm varies from 0.3% to 3% for tropical rainforest. The data from Tjibodas fit well into this range and the irregular structure mentioned is also typical for virgin rain forest in general.

Thus, we may assume that the present measurements give a good impression of the spectral transmission characteristics of tropical rainforest.

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