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Light Sensitivity of the Seeds on the Distribution of *Cecropia glaziovi* SNETHLAGE (*Moraceae*)

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With 3 figures

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Summary

Seeds of *Cecropia glaziovi* SNETHLAGE are photosensitive. Red light promotes and far-red light and darkness inhibit germination. The filtered light inside the leaf canopy inhibits germination of the seeds but not the growth of the seedlings.

The fact that this species is not found inside established forests suggests seed germination as the main responsible for the distribution of this species.

Key words: Cecropia, phytochrome, leaf canopy, plant distribution.

Introduction

Cecropia is a genus very common in secondary forests of Brazil (JOLY, 1970). It is not found in established forests but it is one of the first and main pioneers in cleared areas caused by nature or man.

Dispersal of the seeds appears to be done mainly by small mammals such as bats and marsupials.

The intriguing fact of the massive presence of this species in recently cleared areas and absence in established forests, the natural environment of the animal dispersers, led us to investigate the causes of this rather unusual plant distribution.

It is known that as sunlight filters through the canopy its spectral distribution is changed because of selective absorption of the leaves. A leaf canopy filters out visible light more effectively than infra-red light, so causing a drastic change in the red/far-red ratio (FEDERER and TANNER, 1966; FRANKLAND and LETENDRE, 1978).

The effect of this filtered light upon seed germination has been known for a long time (MEISCHKE, 1936; CUMMING, 1963).

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This fact led us to investigate seed germination as a possible cause of the distribution of this species.

Material and Methods

Fresh seeds of *Cecropia glaziovi* Snethlage *(Moraceae)* were used throughout the experiments. Seeds were incubated in Petri-dishes on wet filter paper or in plastic boxes on washed sand. Red and blue cellophane papers were used as filters for red light (red cellophane) and far-red light (red plus blue cellophane). Layers of hessian were used to reduce light energy. Small seedlings planted in pots were maintained outside and inside a leaf canopy of *Psophocarpus tetragonolobus* (L.) DC. Irradiance was measured by a spectroradiometer model SR ISCO or a pyranometer Eppley.

Results and Discussion

Germination of the seeds

Bats are considered to be one of the main dispersers of seeds of this species. In order to verify the possible effects on germination of the seeds which had been passed through the animal digestive tract, seeds were collected from faeces and tested for germination. Fig. 1 shows that no differences in germination were detected between seeds collected from fruits or from bat faeces.

Germination and light energy

In these experiments seeds were sown on sand in plastic boxes, under natural conditions, protected from direct sunlight, in a temperature range of 17–27 °C.

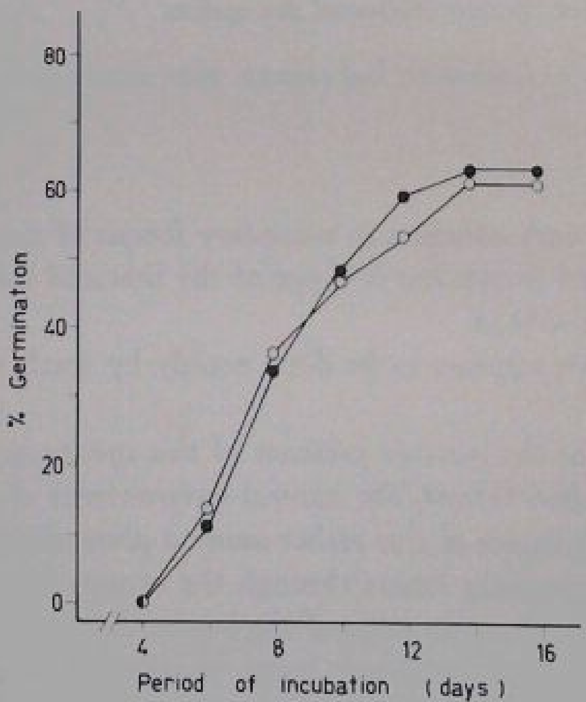

Fig. 1: Seed germination of *C. glaziovi*. Three replicates of 30 seeds. Growth chamber at 25 °C, continuous fluorescent light. ○ seeds collected from bat faeces; ● seeds collected from fruits.

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Light energy was reduced by covering the boxes with layers of hessian. Control boxes had to be covered with transparent polyethylene, which does not reduce light energy, to avoid desiccation. All the boxes were subirrigated.

Three layers of hessian which totally impeded light transmission also inhibited germination. The reduction of $^3/_4$ of the incident light energy by one layer of hessian practically had no effect on the germination (Table 1). This shows that these seeds are light sensitive, and a very low light energy is sufficient for germination while darkness inhibits this process.

Table 1: Seed germination of *C. glaziovi*. Effect of different incident light energy. Natural conditions (13.30 h photoperiod, temperature range 17–27 °C). Seeds on washed sand in plastic boxes. 100 seeds per box. Results after 20 days of treatment.

Treatments	Energy Ly/min	Germination %
transparent polyethylene	0.140	86
1 layer of hessian	0.034	83
3 layers of hessian	0.000	0

Germination and light of different wavelengths

To test light quality on germination, seeds were incubated in growth chambers at 25 °C under continuous red, far-red and white fluorescent light. Red and white light promoted germination (74 % and 64 % respectively) while under far-red and darkness germination was completely supressed. Fig. 2 shows the light spectra under which the seeds were incubated.

Similar experiments were carried out under natural conditions (13.30 h photoperiod, temperature range 15–32 °C). Results shown in Table 2 confirm the promotive effect of the natural daylight and red light and the inhibitory effect of far-red and darkness on germination of this species.

Thus phytochrome seems to be involved in germination since red promotes and far-red inhibits this process.

Germination inside the leaf canopy

Seeds of *C. glaziovi* were placed outside and inside the leaf canopy of *Psophocarpus tetragonolobus*.

Petri-dishes placed outside the canopy were protected from direct sunlight. Inside the canopy germination fails to occur (0 % inside and 75 % outside). This is probably not due to the low light energy inside since germination was not affected by the even lower levels of energy transmitted through one layer of hessian. Fig. 3 shows the light spectra outside and inside the leaf canopy of *P. tetragonolobus*.

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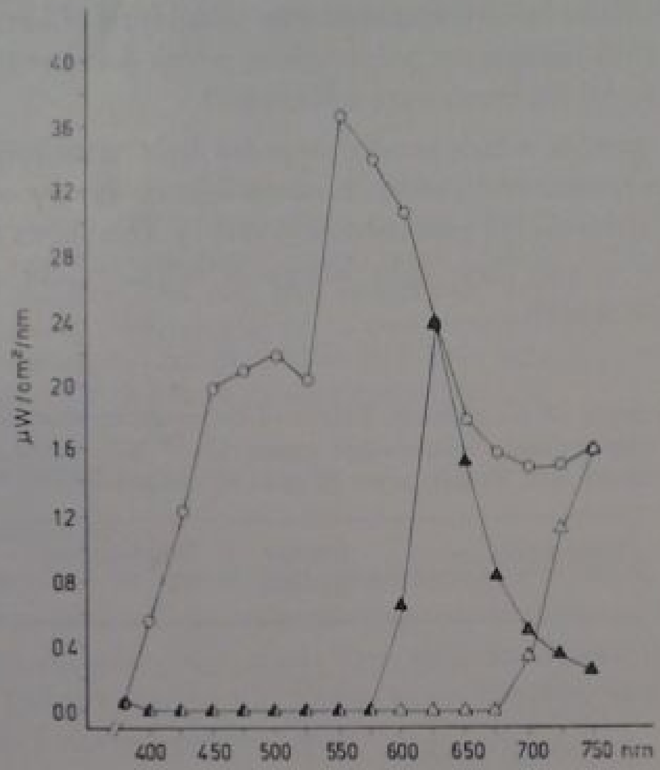

Fig. 2: Light spectra used on the germination of seeds of *C. glaziovi*. ○ white fluorescent light; ▲ red light; △ far-red light. Growth chamber at 25 °C; three replicates of 30 seeds; results after 14 days of incubation: white light = 64 %; red = 74 % far-red = 0 %; darkness = 0 % of germination.

Table 2: Seed germination of *C. glaziovi*. Effect of light of different wavebands. Natural conditions (13.30 h photoperiod, temperature range 15–32 °C). Seeds in Petri-dishes. Three replicates of 30 seeds per treatment. Results after 14 days of treatment.

Treatments	Energy Ly/min	Germination %
daylight	0.140	41
red light	0.136	32
far-red light	0.131	0
darkness	0.000	0

Similar results were obtained with experiments carried out inside the tropical forest in which *C. glaziovi* grows wildely (inside the forest = 0 %; outside the forest = 72 % germination).

This inhibition of germination under the canopy was most probably due to the quality of light rather than the energy.

It is well known that leaf canopies absorb high amounts of the blue and red wavebands and absorb low amounts of the green and far-red wavebands (Cumming, 1963; Holmes and Smith, 1977).

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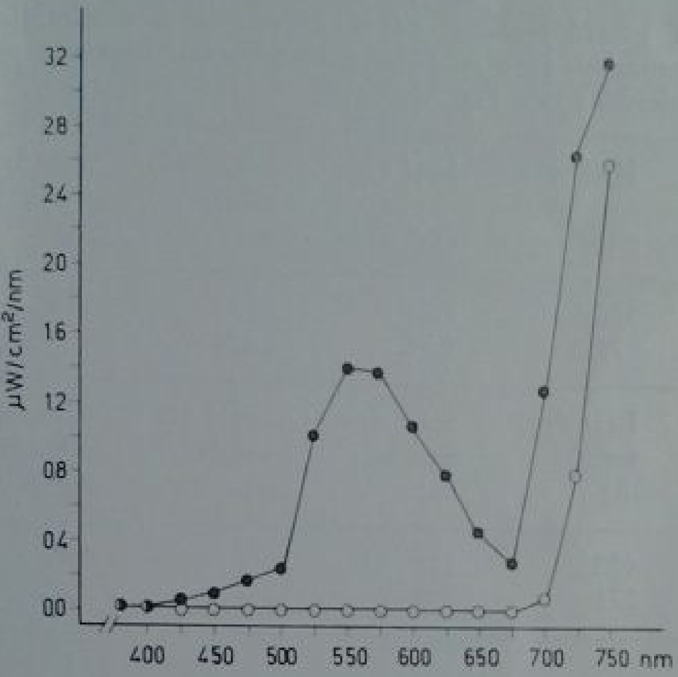

Fig. 3: Light spectra inside and outside the leaf canopy of *Psophocarpus tetragonolobus* (L.) DC.: ○ inside; ● outside. Five replicates of 30 seeds. Results after 20 days of treatment: outside the canopy = 75 %; inside the canopy = 0 % of germination.

So, light which had filtered through green leaves is depleted much more in red light than in far-red thus decreasing the equilibrium proportion of phytochrome existing as P_{fr} (see Fig. 3).

The growth of the seedlings

Seedlings planted in pots were kept for 50 days inside and outside a leaf canopy of *P. tetragonolobus* (see Fig. 3 for light spectra). The seedlings outside were protected most of the time from direct sunlight. Irradiance inside the canopy was $^1/_3$ that received by the seedlings outside.

There was a change in the pattern of growth of the seedlings growing inside the canopy (Table 3). For instance, seedlings growing inside were taller than outside; there was a substantial increase in leaf area relative to the total dry weight, i.e. leaf area ratio.

These characteristics are known to occur in plants growing in shade conditions (Blackman and Wilson, 1951; Frankland and Letendre, 1978).

Thus the leaf canopy seemed not to be an obstacle to the growth and development of the seedling of *C. glaziovi*, at least during the period of the experiments.

Our results suggest that the absence of this species inside established forests is neither due to predatory effects by animal dispersers nor to unfavourable conditions for seedling growth, but mainly to the far-red inhibition of seed germination due to an environment in which an increasing far-red to red ratio prevails.

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Table 3: Growth of potted seedlings of *C. glaziovi* outside and inside the canopy of *Psophocarpus tetragonolobus*. Five seedlings per treatment. Results after 50 days of treatment. (Light spectra similar to the Fig. 3.)

Treatments	Height mm	Leaf area dm^2	Leaf fresh weight mg	Stem fresh weight mg	Total fesh weight mg
inside the canopy	100.6	2.36	2,582	1,670	4,252
outside the canopy	73.2	1.54	2,636	1,496	4,132
	Leaf dry weight mg	Stem dry weight mg	Total dry weight mg	Chlorophyll content mg/l	Leaf area ratio
inside the canopy	432	184	616	8.46	401
outside the canopy	571	290	861	7.13	180

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