

THE AMERICAN MISTLETOE WITH RESPECT TO CHLOROPHYLL AND PHOTOSYNTHESIS¹

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(WITH ONE FIGURE)

Introduction

In numerous botanical texts one may find a paragraph or so devoted to mistletoe. The context is very much the same whether the books are of old or recent vintage. The authors usually state, among other things, that mistletoe is parasitic upon the host plant for water and minerals but may be only partially parasitic with respect to food since it contains an abundance of chlorophyll and can make its own food.

It is obvious that American mistletoe, *Phoradendron flavescens*, is attached to the host and that it contains green plastids. HEINRICHER (2) found that the green pigment did not develop in mistletoe in the absence of light. But the author has never seen any published evidence that this group of plants can carry on photosynthesis or that the green pigment is chlorophyll. It is felt that the data included in this paper might help to substitute facts for speculation. It is also hoped that someone living in an area where mistletoe is common may follow up this work with ringing, dark-box, and other experiments which may clarify the problem of relative dependence or independence of mistletoe with respect to the host plant.

Green pigments

In the preparation of the leaves of mistletoe for extraction they were first dried at 80° C. and then powdered. The pigments were dissolved from 5 gm. of the leaf powder with warm 95 per cent. ethyl alcohol. The alcohol plus the pigments was then diluted to 82 per cent. with water. To this latter solution 200 ml. of petroleum ether were added. After being shaken the green pigments largely separated with the petroleum ether layer. Then to this ether fraction with the green pigments an equal volume of 92 per cent. methyl alcohol was added. After being shaken together these two solvents separated into two layers, each containing a fraction of the green pigments.

Each of the two solutions obtained was quite green in transmitted light and showed red fluorescence in reflected light. By trial it was found that one-half centimeter depths of each solution gave the most distinct differences in light absorption. So using this depth of solution and solvent, respectively, the extinction coefficients of each of these fractions were determined at short intervals in the visible portion of the spectrum. The results are recorded in table I and figure 1.

¹ Paper from the Department of Botany, Northwestern University.

TABLE I

EXTINCTION COEFFICIENTS (NEGATIVE LOGARITHM OF THE PERCENTAGE OF LIGHT TRANSMISSION) FOR SOLUTIONS OF GREEN PIGMENTS OF AMERICAN MISTLETOE LEAVES.
(A) THE PETROLEUM ETHER FRACTION; (B) THE METHYL ALCOHOL FRACTION

SPECTRUM	EXTINCTION COEFFICIENT		SPECTRUM	EXTINCTION COEFFICIENT	
	A	B		A	B
<i>mμ</i>			<i>mμ</i>		
440	1.28	2.42	590	0.20	0.27
450	1.24	1.90	600	0.32	0.43
460	1.20	1.95	610	0.29	0.40
470	1.12	1.95	620	0.31	0.40
475	.....	1.61	625	.....	0.50
480	0.69	1.12	630	0.39	0.58
485	.....	0.65	635	0.67	.....
490	0.34	0.39	640	1.22	1.04
495	.....	0.27	645	.....	1.33
500	0.19	0.19	650	1.70	1.40
510	0.09	0.15	655	1.11	1.18
520	0.09	0.10	660	0.52	0.83
530	0.13	0.14	670	0.12	0.14
540	0.08	0.13	680	0.05	0.12
550	0.02	0.14	690	0.02	0.03
560	0.12	0.12	700	0.07	0.06
570	0.11	0.21	710	0.07	0.03
580	0.18	0.23	720	0.07	0.03

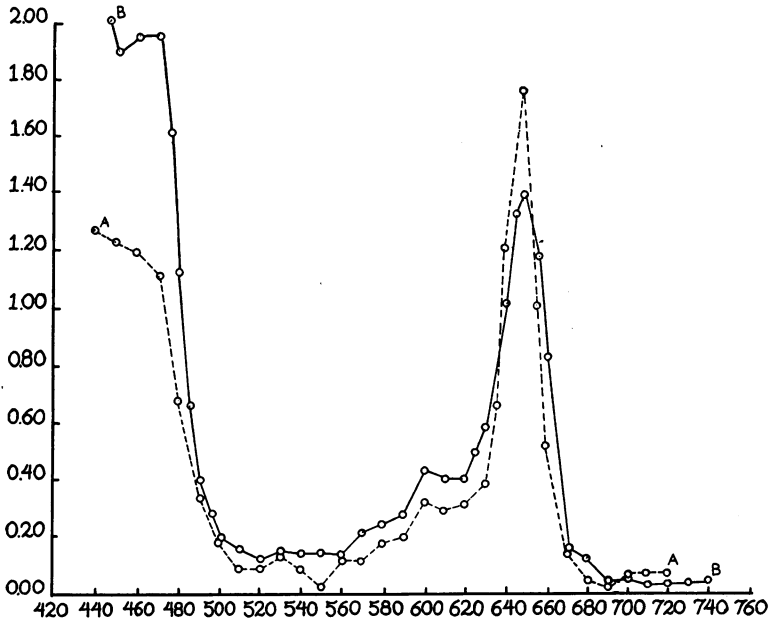


FIG. 1. Curves for light absorption for solutions of the green pigments of American mistletoe leaves. A, petroleum ether fraction; B, methyl alcohol fraction. Extinction coefficient values on the ordinate. Wave length of light in $m\mu$ on the abscissa. From data in table I.

From what is known of the relative solubility of the chlorophylls, chlorophyll *a*, if present, should be in the petroleum ether fraction and chlorophyll *b* in the methyl alcohol. From the tabulated results it is clear that the green pigments in the methyl alcohol gave strong absorption bands at 440–445 and 645–655 $m\mu$ with lesser ones at 530 and 600–620 $m\mu$; whereas the principal absorption bands for the pigments in the petroleum ether fraction were at 440–470 and 640–655 with lesser ones at 530, 560, and 600 $m\mu$. The absorption bands for the two solutions are somewhat similar (fig. 1), except that the principal bands for the petroleum ether fraction are shifted toward the red end of the spectrum as compared with the methyl alcohol fraction.

A comparison of these results with the known absorption bands for chlorophyll leads the writer to conclude that chlorophyll *a* and chlorophyll *b* were present in the petroleum ether and methyl alcohol, respectively.

Photosynthesis

Determinations of carbon dioxide used or produced by mistletoe were made during the months of March, April, July, and August. Short sec-

TABLE II

DATA RELATIVE TO THE RATES OF PHOTOSYNTHESIS IN THE AMERICAN MISTLETOE, BASED UPON THE AMOUNT OF CO₂ USED. FROM 25 TO 50 CC. OF MISTLETOE WERE USED IN EACH EXPERIMENT

TRIAL	TEMPERATURE	TIME	CARBON DIOXIDE CONSUMPTION*	
			APPARENT	CALCULATED TOTAL
	<i>C.</i> °	<i>hr.</i>	<i>mg.</i>	<i>mg.</i>
1	29–33	2.5	0.0	1.8
2	32–37	3.0	1.5	4.5
3	29–33	2.5	5.0	6.8
4	33–38	3.0	4.0	7.0
5	25–37	3.0	0.0	2.0
6	36–35	3.5	0.0	3.3

* Milligrams CO₂ per 10 ml. mistletoe per hour.

tions of the host tree branches were sawed off, leaving the clumps of mistletoe intact. The amputated stems were submerged in water with the parasitic plants in the air. Under these conditions the plants were kept in the greenhouse and showed no signs of deterioration in the few days while they were being used. During the experiments the plants were inclosed in bell jars, through which a continuous flow of air passed, before going through absorption towers containing potassium hydroxide solution after the manner of HEINICKE and HOFFMAN (1). Thus changes in carbon dioxide were measured under the conditions of light and temperature incident in the greenhouse and then with the belljar covered with a light-proof hood. These latter measurements of respiration were considered advisable because of the rather large bulk of host stem in the experimental chambers. Although

the rates of respiration were probably not the same in the light and dark, the amount of apparent photosynthesis was corrected for these rates of respiration in an attempt to find the approximate total photosynthesis. The rates were all calculated on the basis of the total volume of leaves plus stems of mistletoe, since both are green. Obviously the values would be larger if only the leaves had been used as a basis for calculation.

Many determinations were made under different light intensities and temperatures such as normally occur from day to day in a greenhouse. The results of a few of these separate trials are given in table II. It will be noted that the values for apparent photosynthesis vary from zero to positive. Some of the low values for apparent photosynthesis were undoubtedly due to the large amount of respiration found for the section of host stem and mistletoe plants. The approximate total photosynthesis (apparent photosynthesis corrected for respiration) was always positive; therefore, the data indicate that this species of mistletoe can and does carry on photosynthesis.

Summary

1. The American mistletoe, *Phoradendron flavescens*, was examined with respect to the identification of the green pigments and possible photosynthesis.
2. Extinction coefficients for the green pigments indicate the presence of chlorophylls *a* and *b*.
3. Photosynthesis was found to occur in this species of mistletoe.

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LITERATURE CITED

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