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PHOTOSYNTHESIS IN ASPEN BARK

L. C. Pearson and D. B. Lawrence

QUAKING ASPEN, *Populus tremuloides* Michx., is probably the most widely distributed tree in North America (Harlow and Harrar, 1941) and therefore is exposed to a wide variety of climatic conditions. Over much of its range, which is mainly north of latitude 30 degrees north, its forest associates are evergreens capable of photosynthesis during the cold months of the year, even at temperatures below the freezing point of water as demonstrated by Parker (1953). Some populations of aspen have bark of yellow-green color as contrasted with the more familiar powdery-white bark; Cottam (1954) has observed that the former are found at the highest elevations in Utah and neighboring states and as such must be especially well adapted to life in areas of long cold winters and short summers. Marr (1947) observed in Colorado that the aspens with greenish bark were much more winter hardy than the non-green individuals.

A yellow-green aspen which seems quite similar to those described by Marr and by Cottam is common in Minnesota. Sections of the bark taken at breast height from trees a foot in diameter and about 20 years old have invariably revealed a bright green zone close below the surface. The green pigment was found to be located in plastids when hand sections were examined microscopically. We are not aware of any published study of the nature and function of this bark pigment, although the opinion had been expressed orally by a pathologist that it was a green stain produced by a parasitic fungus.

These observations suggest the possibility that the green pigment might be chlorophyll in which case it could be capable of carrying on photosynthesis even in mature stems.

To test this hypothesis, three experiments were conducted during the spring and summer of 1957 at the University of Minnesota's Cedar Creek Forest Natural History Area in northern Anoka County, Minnesota, 30 miles north of Minneapolis. One of these experiments was designed to ascertain the nature of the green pigments in aspen bark and to measure the quantity of these pigments per unit area of bark. A second was a simple and rather crude test to measure differences in amount of starch present in normal light-exposed and in artificially darkened areas of bark. The third test was designed to give a more refined measure of photosyn-

thate production, one which would have meaning even if negative results were obtained.

At the beginning of the observation period, April 1, neither flowering nor leaf expansion had begun. About April 16, the aspen reached full bloom. Leafing began May 5 on most of the trees although a few specimens growing on higher and sandier soil were about four days earlier than the others. By May 17 seed dispersal was complete. The leaves had reached maximum size by June 7 and at this time were a bright green color. On August 3 when the final observations were made the leaves had darkened to a deep almost blue-green color. At this time the bark also had changed color, being not as distinctly green as before on the south side of the stems.

Monthly maximum and minimum temperatures in the shade at the bark sampling height above the ground during the period of observation were 27° and minus 11°C. in April, 31° and minus 4° in May, 28° and 7° in June, and 33° and 12° in July.

CHLOROPHYLL DETERMINATIONS.—*Materials and Methods.*—Samples of bark were obtained by stamping them out with a steel die of 16 mm. diam. Twenty disks, each approximately 1 mm. thick, from bark of the south and of the north sides of the stem were collected. The outermost layer of bark was brown and on May 31 averaged 0.5 mm. in thickness on the north side but only 0.04 mm. on the south side. Beneath this was a green layer 0.20 mm. thick on the north side and 0.33 mm. thick on the south side. Thus all the green pigments were in the outer 1 mm. of bark from which the samples were taken. Twenty disks each were also taken from sun-exposed leaves on the south and from shade leaves on the north side of the crown; these averaged 0.18 mm. and 0.14 mm. thick respectively. All samples of bark and leaf were taken from a single pistillate tree which was 19 years old and 16 cm. in diameter at the two-meter level above ground where the bark samples were taken. The bark outside the true cambium averaged 8 mm. thick at this level.

To extract chlorophyll, two techniques were used. In the experiment of May 31, bark of a known surface area was placed in a Kenmore blender with a known quantity of 95 per cent ethanol and run at high speed for one minute. This mixture was then boiled for three minutes and stored in flasks covered with aluminum foil at 1°C. for three days until it was possible to examine with a spectrophotometer. At that time it was filtered and the volume of the green solution ascertained. Wave lengths of visible light at which maximum and minimum absorption occurred and also the amount of absorption of light at each of four different wave lengths were measured

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