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# A COMPARISON OF LEAVES OF QUERCUS COCCINEA MUENCH. AND BETULA LENTA L. FROM HEATH BALD AND MESOPHYTIC RAVINE HABITATS

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## Introduction

An ecological study of the leaves of *Quercus coccinea* Muench. and *Betula lenta* L. was undertaken by the writer during the summer of 1945 at the Mountain Lake Biological Station of the University of Virginia in Giles County, Virginia. The writer wishes to express his appreciation to Dr. I. F. Lewis, Director of the Mountain Lake Biological tSation, and Mr. Ruskin S. Freer of the Department of Biology of Lynchburg College, Lynchburg, Virginia, for their invaluable aid in the pursuance of this problem.

## Procedure

Leaves of *Quercus coccinea* Muench. and *Betula lenta* L. trees were collected on the heath bald on the summit of Bald Knob (elevation 4363 ft.), August 6, 1945. Leaves of *Q. coccinea* Muench. and *B. lenta* L. trees were collected in mesophytic ravines along Little Stony Creek (elevation 3553 ft.) and Hunters Branch Creek (elevation 3821 ft.) respectively, on August 10, 1945. These locations are in Giles County, Virginia, and are indicated on the Virginia-West Virginia Pearisburg Quadrangle map issued by the Virginia Geological Survey of the Conservation and development Commission of the State of Virginia.

Forty mature, well-formed leaves were selected from an individual tree of each species concerned in each habitat, for measurements. After gross measurements of length and width, a portion 10 mm. wide and 40 mm. long, along each side of the midvein in the middle of the leaf, was removed for sectioning. These pieces of leaf tissue were cut into strips about 3 mm. wide and placed in 70% thyl alcohol for two days to harden the tissues and remove the chlorophyll.

After the allotted time in the 70% ethyl alcohol the strips of leaf tissue were sectioned on a hand microtome at about 17 microns by means of a sharp razor blade. The microscopic sections were dropped into 70% ethyl alcohol immediately after being cut. After a sufficient number of sections had been cut for each species from each habitat the sections were transferred to a saturated solution of Sudan III in 70% ethyl alcohol to stain the upper and lower cuticle. The sections were heated for one hour over a 60 watt lamp while in the straining solution. Then the sections were placed in 50% ethyl alcohol to partly destain them and finally placed in glycerol. While in glycerol the sections were heated over a 60 watt lamp for 12 hours to remove any remaining ethyl alcohol and water. Lastly, 40 mea-

surements were made, by means of a microscope equipped with a calibrated ocular micrometer, of the thickness of the upper and lower cuticle, the upper and lower epidermis, and the total thickness of the leaf blade, of each species in each habitat. The results of the measurements are shown in the following tables.

## Results

(In microns unless otherwise indicated)

QUERCUS COCCINEA Muench.

| | Heath Bald | | | Mesopthytic Ravine | | |
|---|---|---|---|---|---|---|
| | Max. | Min. | Ave. | Max. | Min. | Ave. |
| Upper Cuticle | 8.5 | 5.1 | 5.69 | 5.1 | 2.72 | 3.33 |
| Upper Epidermis | 29.7 | 19.8 | 13.01 | 22.1 | 13.6 | 18.66 |
| Lower Epidermis | 13.53 | 9.9 | 11.32 | 13.6 | 8.5 | 11.31 |
| Lower Cuticle | 5.1 | 3.06 | 3.91 | 2.04 | 1.36 | 1.58 |
| Total Blade | 256.62 | 197.4 | 225.99 | 189.0 | 140.0 | 161.0 |
| Blade Length (in mm.) | 146.0 | 103.0 | 122.925 | 162.0 | 103.0 | 119.075 |
| Blade Width (in mm.) | 174.0 | 131.0 | 151.925 | 160.0 | 98.0 | 126.425 |
| No of Layers of Palisade Tissue | | 3 | | | 2 | |
| Hypodermis | Present (1 layer) | | | Absent | | |

BETULA LENTA L.

| | Heath Bald | | | Mesophytic Ravine | | |
|---|---|---|---|---|---|---|
| | Max. | Min. | Ave. | Max. | Min. | Ave. |
| Upper Cuticle | 2.04 | 1.36 | 1.66 | 1.7 | 1.19 | 1.64 |
| Upper Epidermis | 26.4 | 13.2 | 17.72 | 20.4 | 10.2 | 13.98 |
| Lower Epidermis | 20.79 | 9.9 | 14.88 | 20.4 | 10.2 | 14.83 |
| Lower Cuticle | 1.7 | 1.19 | 1.45 | 1.7 | .85 | 1.3 |
| Total Blade | 352.5 | 183.3 | 221.72 | 182.0 | 147.0 | 167.3 |
| Blade Length (in mm.) | 62.0 | 48.0 | 52.725 | 125.0 | 90.0 | 101.325 |
| Blade Width (in mm.) | 40.0 | 27.0 | 32.8 | 70.0 | 48.0 | 53.95 |
| No. of Layers of Palisade Tissue | | 3 | | | 2 | |
| Hypodermis | Present (1 layer) | | | Present (1 layer) | | |

## Discussion

The results obtained by this series of measurements appear to show that *Q. coccinea* Muench. accommodates itself to the apparent xerophytic conditions of the heath bald by a large increase in the amount of cuticle on the upper and lower surfaces, by an increase in the thickness of the upper epidermis, by the addition of a layer of hypodermis and an extra layer of palisade tissue. These features account for an increase of approximately 29% in the thickness of the leaves of *Q. coccinea* Muench. on the heath bald as compared with the leaves of the same species in the mesophytic ravine.

*B. lenta* L. has accommodated itself to the apparently xerophytic

conditions on the heath bald largely by a decrease in the size of the leaves. The leaves of *B. lenta* L. from the heath bald trees are approximately 48% shorter and 39% narrower than the leaves of the same species from the mesophytic ravine. The leaf blades of *B. lenta* L. from the heath bald are approximately 25% thicker than the leaf blades of the same species from a mesophytic ravine because the leaves of the heath bald trees possess an extra layer of palisade tissue and an upper epidermis which is approximately 22% thicker than the upper epidermis of the leaves of the mesophytic ravine trees of the same species.

Student members of plant ecology classes at the Mountain Lake Biological Station compiled records of the humidity of various habitats near the biological station during the summer sessions of 1939 and 1941 by means of Livingston porous cup atmometers. Their records show that the average daily loss of water from atmometers placed among the shrubs of Bald Knob for two week periods during both years was 11.32 c.c. In comparison, the average daily loss of water from atmometers placed five feet from the ground on various species of trees in mesophytic forests was 10.01 c.c. for the identical two week periods of the first portion of the experiment. Thus the amount of water evaporated from atmometers on Bald Knob is 1.31 c.c. or 11.5% in excess of the amount of water evaporated daily from atmometers in mesophytic forests. This may be considered a significant difference within the limitations imposed by the fact that humidity readings have been compiled for only two seasons.

Student members of the plant ecology classes at Mountain Lake Biological Station have also recorded pH determinations in various habitats near the biological station. The pH reading on Bald Knob three inches below the surface of the soil in the heath bald is 4.5, while ten inches below surface the pH is 4.0. In a white oak forest a half-mile north of the biological station the pH one inch below the soil surface is 5.0 Six inches below the surface of the same soil the pH is 5.4. These determinations show the extreme acidity of the heath bald of Bald Knob.

In conclusion it may be stated that *Q. coccinea* Muench is better adapted in general to dry situations than is *B. lenta* L. Gray's Manual mentions dry light soil as the habitat of *Q. coccinea* Muench. while indicating rich woods as the habitat of *B. lenta* L. The most obvious advantage of *Q. coccinea* Muench. is the thickness of the upper and lower cuticles of the heath bald trees. The upper cuticle of *Q. coccinea* Muench. of the heath bald is better than three times as thick as the upper cuticle of *B. lenta* L. from the same habitat. The lower cuticle of *Q. coccinea* Muench on Bald Knob is more than twice as thick as the lower cuticle of *B. lenta* L. of the heath bald. Another easily discerned difference lies in the upper epidermis of the leaves. The upper epidermis of leaves from *Q. coccinea* Muench. on Bald Knob is approximately 23% thicker than the upper epidermis of leaves of *B. lenta* L. from the health bald.

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## LITERATURE CITED

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