VARIABILITY IN WISCONSIN IN TRIENTALIS BOREALIS RAF.

Roger C. Anderson

In North America Trientalis borealis extends from the Great Slave Lake to the east coast. Its distribution approximates that of the boreal forest in Canada and the northern conifer hardwoods in the United States. Its range extends into the Appalachian Mountains and on to the New Jersey coastal plain (Anderson, 1968).

During an autecological study of Trientalis borealis in Wisconsin, the great morphological plasticity of this species became apparent. Studies were undertaken to examine the range of variability of Trientalis in Wisconsin and compare it with the variability reported for the European species of Trientalis (Trientalis europaea L.). A further objective was to determine if morphological differences existed between different sectors of the state, specifically between the area north of the tension zone (Curtis, 1959) and the southern portion of the state. The tension zone divides the state into two floristic provinces, the prairie forest and the northern hardwoods. Trientalis has been reported for all but 6 of 72 counties in Wisconsin; however, it is most abundant north of the tension zone (Anderson, 1968).

The morphological variation of T. europaea in Great Britain has been discussed by Matthews and Roger (1941) and in Poland, Norway, and Finland by Medwecka-Kornas (1963). In Canada, Lepage (1946) delineated three forms of T. borealis based largely on leaf shape and plant growth form, and Curtis (1959) comments on the variability of T. borealis in Wisconsin.

METHODS AND MATERIALS

Pressed specimens from the University of Wisconsin herbarium were used to obtain the variability data across the state. Data pertaining to the fruits and seeds was obtained from material collected at a single site, the University of Wisconsin Arboretum Finnerud Forest, in Oneida County. The information collected from the herbarium specimens included the stem length in centimeters (from the point on the stem where it would be out of the soil to the major leaf whorl), the number of leaves in the major whorl, the number of flowers per plant, and the number of floral

1 University of Wisconsin Arboretum, 1207 Seminole Highway, Madison, Wis. 53711.
parts. For any one flower, the number of stamens, sepals and petals was constant. However, multi-flowered plants occasionally had flowers with different numbers of floral parts so that each flower had to be counted separately. For some specimens it was not possible to obtain all the information due to lack or damage of stem, leaves or flowers. For each specimen, collection north or south of the northern tension zone boundary was noted. Chi-square tests were used to determine whether there were significant morphological differences between northern and southern specimens. Fruit and seed size were determined by measuring the longest dimension with the aid of a microscope ocular micrometer.

RESULTS

Figure 1 shows the results of several measures of variability on Wisconsin Trientalis. Plant height is the only measured feature that does not differ significantly between northern and southern specimens. In Figure 1a plant height has been divided into five stem height classes (4–8 cm, 9–10, 11–12, 13–14, 15–19). Northern plants tend to be slightly taller, whereas the southern specimens have more individuals that are in the shortest group and proportionately fewer tall plants, Figure 1a. The average height of the northern specimens was 11.9 cm compared to 11.1 cm for the

![Diagram](image-url)

**Figure 1.** Some aspects of the variability of *Trientalis borealis.*
southern plants. Considering all the specimens, plant height ranges from 4 cm to 19 cm with an average of 11.6 cm.

The number of leaves on the major whorl varied from 4 to 10 leaves with an average for the complete sample of 6.8 and a mode of 7 leaves. Figure 1b shows that for the northern specimens six leaves was as common as seven. The average number of leaves for the northern specimens was 6.5 leaves compared to 7.1 for the southern. A chi-square test indicates that there is a significant difference (.01 level) in the number of leaves between locations of collection. For the test statistics, specimens having five leaves or fewer per whorl were combined. Similarly those with nine or more leaves were grouped, because of the smaller number of specimens in these groups.

A significant difference (.005 level) in the number of flowers and the number of floral parts (.025 level) was found between northern and southern specimens. Figure 1d shows that northern plants commonly produced only a single flower (75 per cent of the specimens) and the usual number of flowering parts was seven (77.6 per cent), Figure 1c. In the south, specimens with 6 flower parts were more numerous, accounting for 22.9 per cent of all the southern specimens, compared to 4.0 per cent for the northern plants.

The capsules of *Trientalis* vary in size from 1.66 mm to 2.66 mm with an average of 2.2 mm. The capsules contained from 2 to 14 seeds, Figure 1e, with a mode of 10 and an average of 9.4 seeds. Seed length, Figure 1f, ranged from .56 mm to 1.43 mm with an average of 1.18 mm. The weight of 233 air dried seeds was 111 mg with an average weight of .476 mg.

**DISCUSSION**

The variability described by Matthews and Roger (1941) for *T. europaea* in Great Britain was largely variation in plant height and the number of leaves per whorl. They report that plants with 6 leaves are most frequent, accounting for 42.4 per cent of all the specimens examined. For Wisconsin specimens, 20.1 per cent of the plants had 6 leaves per whorl, while plants with seven leaves per whorl were the most common, 30.6 per cent of the specimens. Table 1 compares the number of leaves per plant for the Wisconsin specimens with *T. europaea* as reported by Matthews and Roger (1941).

The table shows that all three groups differ in the number of leaves per whorl, with the southern Wisconsin *T. borealis* plants having the most leaves. However, the variation between the two *T. borealis* groups is less than that between the species. Medwecka-Kornas (1963) reports that in northern Europe the number of
leaves per whorl varies from 4 to 11, but Hegi (1927) gives a range of 5 to 12 leaves for *T. europaea*. In Wisconsin, plants of *T. borealis* with 12 leaves have been observed. Thus, the variation in number of leaves between the two species is about the same.

For *Trientalis europaea* in Great Britain the variation in stem length was 3 to 20 cm (Matthews and Roger, 1941), and for northern Europe .6 to 27.5 cm (Medwecka–Kornas, 1963) compared with 4 to 19 cm for the Wisconsin plants. The height of the European species is influenced by environment; plants exposed to severe environments are smaller. In Wisconsin, plant height is also related to environment, with shorter plants generally associated with drier habitats.

Itis and Shaughnessy (1960) indicate that the star-shaped flowers of *T. borealis*, 12–20 mm in diameter, are usually 7-merous. In this study the southern specimens were more variable than the northern. The 7-merous flowers were found to be the most common throughout the state, but the 6-merous flowers were more frequent south of the tension zone.

For the Eurasian species, the number of seeds per capsule ranged from one to eighteen with an average of eight seeds per capsule (Matthews and Roger, 1941). Capsules of *Trientalis borealis* contain two to fourteen seeds with an average of 9.4. Matthews and Roger (1941) report the average seed weight to be .680 mg, 30 per cent heavier than *T. borealis* seeds, .476 mg.

Another variation in *Trientalis* is the “ramose” form that is characterized by having an additional verticil of leaves above the main whorl. The earliest published record of this growth form is by Hegi (1927). Lepage (1946) recognized three forms of *T. borealis* in Canada, one of which is the “ramose” form. Three morphological forms were delineated by Medwecka–Kornas (1963) in northern Europe: a normal form distributed south of the tree

<table>
<thead>
<tr>
<th>Number of Plants</th>
<th>No. Leaves Per Whorl</th>
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<tbody>
<tr>
<td></td>
<td>3</td>
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<tr>
<td><em>T. europaea</em></td>
<td>3</td>
</tr>
<tr>
<td>North Wis. <em>T. borealis</em></td>
<td>3</td>
</tr>
<tr>
<td>South Wis. <em>T. borealis</em></td>
<td>1</td>
</tr>
<tr>
<td>Combined Wisconsin</td>
<td>4</td>
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</tbody>
</table>

Average North—6.5 leaves.
Average South—7.1 leaves.
Average combined—6.8 leaves (Wisconsin).
line, a diminutive form with a northern range beyond the limits of the boreal forest of the field field of Lapland, and a "ramose" form growing on the peripheries of the distribution of the normal form in disturbed or open habitats. The morphological forms intergrade, and she suggests that the forms are the results of environmental modifications. Individuals of the normal form were found to develop additional verticals of leaves after being transplanted to an open garden (Hiirsalmi, 1960). In Wisconsin, plants with this form were occasionally encountered in the field, but they are more common among plants grown under greenhouse conditions.

Because of the morphological variability of Trientalis in Wisconsin and the diverse habitats in which it grows, Curtis (1959) suggested that there may be ecotypes within the population of Trientalis borealis in Wisconsin. Some of this variation may be due to environmental differences. However, near the edge of a species range it seems likely that there may be selection for genetic combinations that are better adapted to conditions that differ from those in the main part of the range. In Wisconsin the tension zone delineates areas that have climatic and edaphic differences. When plants collected north and south of the tension zone are examined, significant morphological variations between the two are found. However, the differences are quantitative rather than qualitative, and nearly all the variability found in Wisconsin Trientalis occurs both north and south of the tension zone. The Wisconsin specimens of Trientalis appear to be a single taxon displaying the same kind of variation from north to south within the state.

LITERATURE CITED


