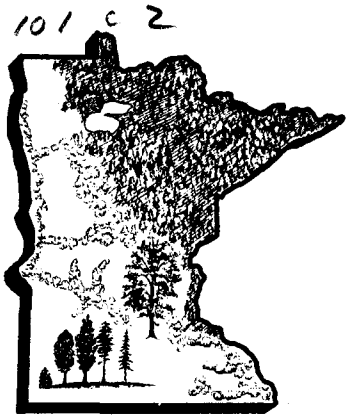

MINNESOTA FORESTRY NOTES

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SOME CHARACTERISTICS OF GEOGRAPHICAL AND SYNECOLOGICAL DISTRIBUTION OF BALSAM FIR (ABIES BALSAMEA (L.) MILL.) IN MINNESOTA[1/]

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Balsam fir has been shown to be among the most demanding species in the Boreal Forest Region (See Minnesota Forestry Notes No. 92). In the Lake Forest Region, particularly in the western part, balsam fir is not able to compete with northern hardwoods for the mesic-rich sites. According to Buell (1), reproduction of balsam fir cannot become permanently established in sugar maple-basswood communities in Itasca State Park (Clearwater County), nor can sugar maple reproduction permanently invade spruce-fir communities. Further east, in Itasca County, Grant (2) found mixed balsam fir-basswood-sugar maple communities of permanent character on clay soils. The increasing significance of balsam fir growth from west to east and south to north is supported by the forest survey data of the Iron Range Resources Rehabilitation Office (3) which were used to prepare Fig. 1.

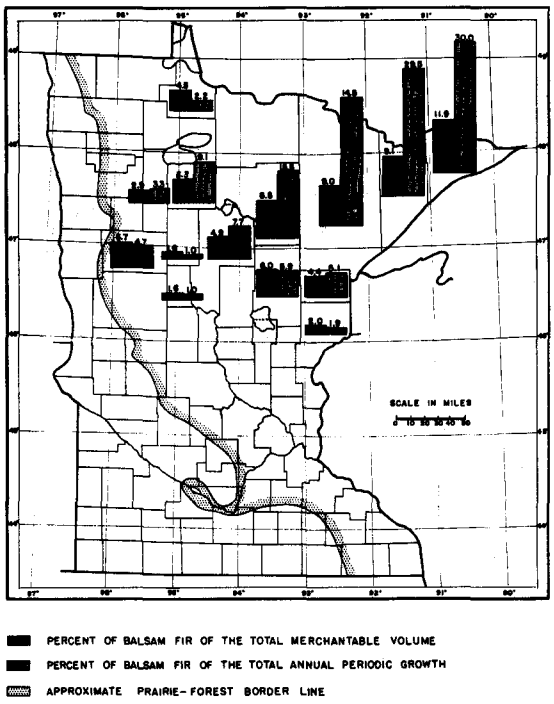

Figure 1. Percent of balsam fir in the total growing stock compared with the percent of periodic growth by counties in Minnesota.

An analysis of 356 Minnesota forest communities with the aid of synecological coordinates (see Minnesota Forestry Notes 84, 90, 91, 99 and 100) provides further information on characteristics of balsam fir. The upper part of Fig. 2 shows frequency distributions of balsam fir in all six bivariate combinations of moisture, nutrient, heat, and light coordinates in a relative scale from 1 to 5. Balsam fir shows greatest relative adaptability to moisture and light, less along the nutrient axis, and is least adaptable to heat variation. Out of 25 Minnesota tree species, only paper birch has a wider range along the moisture axis, but 12 species have greater adaptability than balsam fir along the heat axis. In the six bivariate scales balsam fir ranks between the second and tenth; in the four trivariate scales between second and fourth, while in the four-dimensional scale balsam fir has a range of adaptation second only to paper birch. Balsam fir grows predominantly in association with species having lesser moisture requirements, but higher requirements for light, nutrients, and heat. This places

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balsam fir in the second story on most of its sites, below pine, white spruce and hardwood overstories.

The lower graphs (Fig. 2) show the average requirements for a third factor complex when the bivariate coordinates are known, using techniques similar to contour mapping. An analysis of corresponding pairs of graphs (e.g., a comparison between the requirements of balsam fir for heat and light within moisture-nutrient axes) indicates that in certain parts of synecological fields two different requirements may be highly correlated, while in other parts the reverse is true. This reveals some of the intricacies of biological relationships and the need for extreme care in experimental design and in the application of statisical methods to such complicated phenomena.

In agreement with the Mitscherlich-Lundegardh law of biological relativity, the variability approaches zero at the margins of the total distribution field of a species. This should be taken into account in evaluating the graphs of the lower part of Fig. 2.

DISTRIBUTION OF BALSAM FIR IN SYNECOLOGICAL COORDINATES IN MINNESOTA

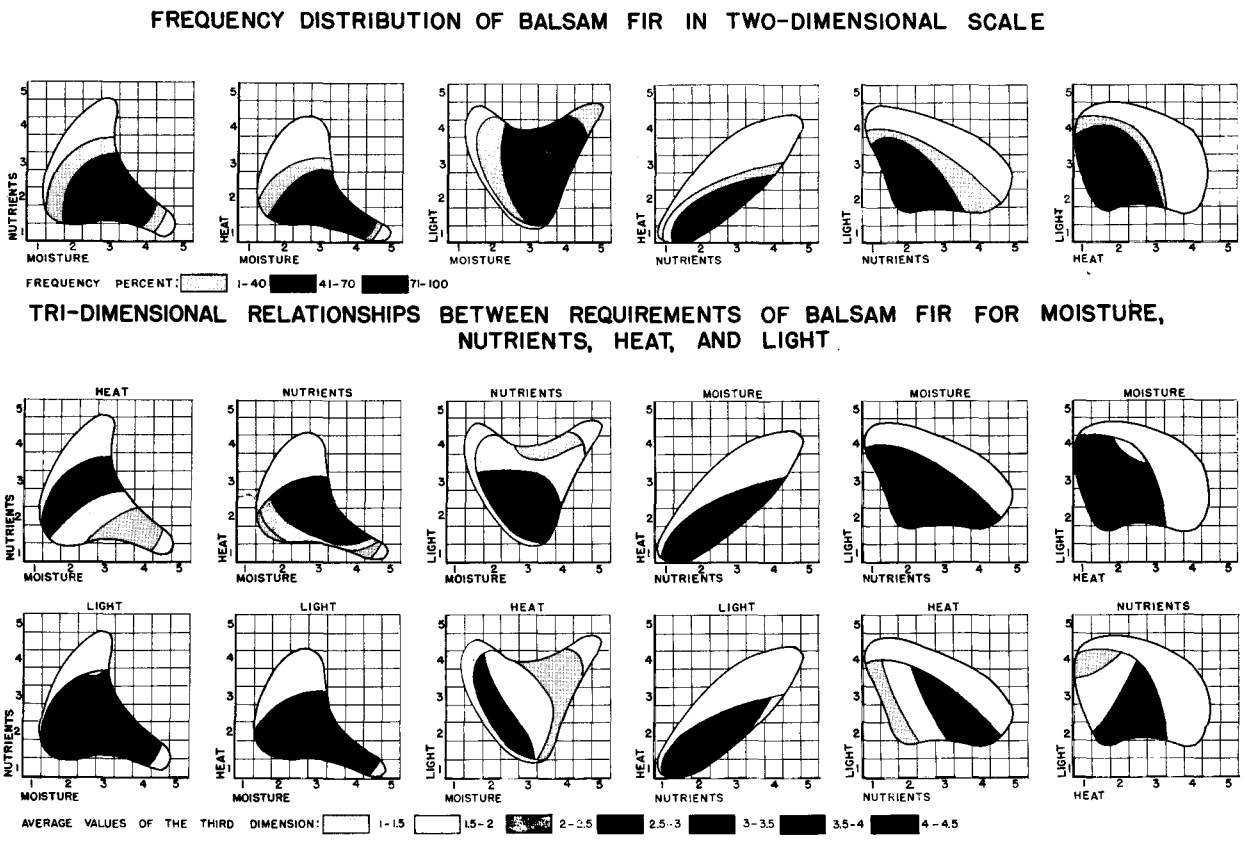

Fig. 2. Synecological requirements of balsam fir in Minnesota. Balsam Fir is shown in the shaded areas of the outlines of the synecological fields of all Minnesota forest communities.

Literature Cited

(1) Buell, M.P. 1956. Spruce-fir, maple basswood competition in Itasca State Park, Minnesota. Ecology 37:606.

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(3) Iron Range Resources Rehabilitation Office, 1950-1954. (Forest resources of Minnesota counties.) Office of Iron Range Resources and Rehabilitation, St. Paul, Minnesota.

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