

THEORY OF RELATIVITY, SOIL SCIENCE,
AND FOREST MENSURATION

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In the opinion of EINSTEIN (1933), the general laws on which the structure of theoretical physics is based »should be valid for any natural phenomenon whatsoever. With these laws it ought to be possible to arrive by means of pure deduction at the description, that is to say, the theory, of every natural process, including life. . .»

No other manifestation of life is allied more conspicuously to the theory of relativity as the growth of forest stands which is a function of the inherent growth potential of trees, the productive capacity of environment, and time. The height and volume increments in combination with annual rings of trees present an overt record of a process taking place within four coordinates.

The height over age quotient of a forest stand is usually the most reliable indicator of the productive forces of the habitat. Like in classical mechanics, the rate of height growth is independent of horizontal influences; with no change in site conditions, the average height of trees is not affected by the density of the stand. On the other hand, the height growth readily reflects the physical and chemical composition of separate soil layers encountered by the growing root systems (WILDE, 1964).

About 80 years ago, soil science was enriched by a new concept of climate-imposed differentiation of soils into genetic horizons (DOKUCHAEV, 1879). Since then, the morphology of the soil profile has become a major concern of pedologists, but it received only casual attention of specialists interested in the relationships of plants to environment. Regardless of its vertical diversity, the soil is often treated by foresters as a homogeneous entity endowed with a certain productive potential. Considering the growth of trees, disregard of soil stratification is not in agreement with biological reality. As revealed by stem analyses, the increment of a tree at different ages is closely correlated with the extension of roots into individual genetic or geologic horizons of different productive

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capacity. As common to dynamic processes, the growth of trees takes place in small lots of varying amplitudes in accord with the quantum theory. In turn, the site index exhibited by a stand at a certain age is the summary growth attained at significantly different current increments.

For example, red pine plantations established on outwash sands of quartzitic matrix exhibit a reasonably rapid early growth deriving the nutrients largely from the surface humus-enriched layer. At the age of 15 to 20 years, however, the available supply of nutrients in this layer fails to satisfy the demands of older trees whose roots can extend only into infertile substratum of quartz sand. In consequence, the height increment is gradually retarded and in extreme cases the tree crowns form so-called »stork nests.» Contrarywise, plantations on sandy soils underlain by substrata with admixture of feldspathic, micaceous and ferromagnesian minerals progressively increase their rate of growth in accordance with the extension of roots into deeper strata (WILDE *et al.*, 1964). Thus, the growth of these two soil-forest types is expressed by disparate curves of variable slopes (Figure 1).

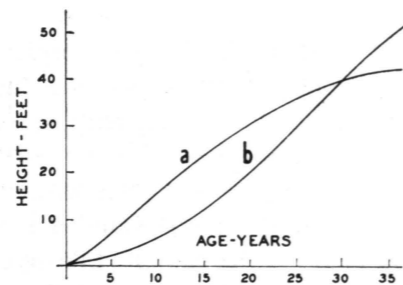


Fig. 1. Chronological growth patterns of 30-year-old plantations of red pine, *Pinus resinosa*, supported by non-podzolic outwash sandy soils underlain by quartzitic (a) and silicate (b) substrata.

The temporal variability of tree growth on different sites is of prime importance in the construction of yield tables, i.e., a record of the growth of forest stands indispensable for planned forest management.

Most yield tables were constructed in the past by analyses of random forest stands of different ages. The results of these analyses, performed without regard to soil conditions, were then plotted against the age abscissa and generalized by a series of conventional monomorphic curves. Obviously, such a procedure could be applied only to a four-dimensional phenomenon in which all factors are either

constant or are subject to functional changes. Because the heterogeneous soil profiles inflict a variable flow of energy, the monomorphic curves distort the polymorphism of the natural chronological pattern of forest growth and represent statistically incongruous averages of unrelated data.

Investigations of natural plant communities of Finland (CAJANDER, 1909) provided one rational approach toward the construction of yield tables. By confining mensuration analyses to definite floristic types, the Finnish foresters harmonized their records with EINSTEIN'S formula for space-time matrix of material events. The polymorphic growth curves registered by ILVSSALO (1923) express the temporal flow of energy from soil profiles of differential productive potential, as well as the corresponding height and volume increments of stands.

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