Theor. Appl. Genet. 63, 282 (1982)

A Discussion of the Effect of Test Environment on Expression of Clines and on Delimitation of Seed Zones in Douglas-Fir

E. R. Falkenhagen
South African Forestry Research Institute, Pretoria (Republic of South Africa)

It seems that Morgenstern and Roche (1969), Campbell and Sorensen (1978) and Morgenstern (1978) do not distinguish between functional relationships, and causal, experimentally induced relationships, once the former relationships are expressed as regression equations (Falkenhagen 1972 and 1979). However, in a regression or correlation model, there is no implication that Y, say, depends necessarily on X, say, in a causal or explanatory sense. In other words, changing the value of X will not necessarily change the value Y.

In their article, Campbell and Sorensen (1978) accept that "zone dimensions or provenance transfer rules can then be devised, the limits depending on regression line slope in conjunction with a criterion of acceptable adaptation" (p. 233, three last lines, at right. They proceed to calculate regression equations of different traits on elevation, latitude and distance from ocean of place of origin and their different combinations at the first and second degree of 40 Douglas-fir provenances growing under factorial combinations of three experimental factors: fertilizer level (F), air temperature (A) and soil temperature (S), of seedbeds, in one nursery, in Corvallis, Oregon, USA.

I want to point out, that these regression equations relate the average provenance values of different characteristics such as bud set, dry top weight, etc., as expressed in one peculiar test environment, with the elevation, latitude and distance from the Pacific ocean of the place of origin of these provenances and that these "independent variables" are not experimentally controlled but fixed, beyond the control of the experimenter. As I have already shown earlier (Falkenhagen 1972 and 1979) and as Campbell and Sorensen (1978) try to show in their article, these regression equations vary according to the test environment where the provenances are growing, but also according to the age of the estimations.

These equations cannot be used to predict the change, in dry top weight at 2 years, of a Douglas-fir provenance, when the latter is transferred from its place of origin and planted, say, 1 degree of latitude north or south of the place of origin. Thus the "steepness of clinal regression" is not a "measure of increased risk in population transfer" (Campbell and Sorensen, 1978; p. 245).

On the contrary, the "steepness" is a measure of the average change to be expected, when, in the test environment where the provenances were growing and which was used to estimate the actual trait values, one provenance from, say, latitude 44° N and elevation 600 m is replaced by a provenance of same latitude of origin but elevation of 1,100 m.

This interpretation has been developed elsewhere (Falkenhagen 1979). There are a number of remarks that need to be made:

1. The clinal relationships as shown by the Figures 1 to 9 are very difficult indeed to explain. For instance, one would expect that provenances from higher latitude or higher elevation, from colder climes with shorter vegetative period, would set their bud before the provenances from lower latitude or lower elevation, but that does not seem to be the case for the coastal Range provenances: Fig. 5 shows that the higher the latitude of place of origin, the larger the number of days to set bud in cool air and soil and the steeper the increase with elevation.

2. Finally, there is another worrying problem coming from the statistical methodology used by Campbell and Sorensen (1978): three geographical characteristics of the place of origin (latitude, elevation and distance in km from the ocean) were used simply and in combination of first and second power to create 18 "independent" variables. These 18 variables raise the question of multicollinearity (strong correlation between "independent" variables in a regression model) and the consequent erratic variation and large sampling variance of the coefficients of regression. Multicollinearity is furthermore combined with what appears to be a simplistic if step wise model building method (p. 235, Campbell and Sorensen's material and method). For a discussion of these problems see Besley et al. (1980).

Whatever the interpretation of the regression trends presented by Campbell and Sorensen (1978) they certainly cannot be used for "model building" of "seed transfer zones" and "provisional transfer models" in Douglas-fir but they point out the sensitivity of the usual regression of provenance traits on place of origin to environment of estimation.

Literature

Besley, D.A.; Kuh, F.; Welsh R.E. (1980): Regression diagnostics: identifying influential data and sources of collinearity. New York: J. Wiley

Campbell, R.K.; Sorensen F.C. (1978): Effect of test environment on expression of clines and on delimitation of seed zones in Douglas-fir. Theor. Appl. Genet. **51,** 233–246

Falkenhagen, E.R. (1972): Is this the right approach to seed zone delimitation in Canada? For. Chron. **48,** 9–10

Falkenhagen, E.R. (1979): Range-wide genetic variation of black spruce: discussion. Can. J. For. Res. **9,** 547–548

Morgenstern, E.K. (1978): Range-wide genetic variation of black spruce. Can. J. For. Res. **8,** 463–473

Morgenstern, E.K.; Roche L. (1969): Using concepts of selection to delimit seed zones. Doc. Second World Conf. For. Tree Bred. Washington. **1,** 203–215

Received December 29, 1980; Accepted July 14, 1982
Communicated by H. F. Linskens

Prof. Dr. E. R. Falkenhagen
South African Forestry Research Institute, P.O. Box 727
Pretoria, 0001 (Republic of South Africa)

0040-5752/82/0063/0282/$ 01.00