

ness similar to that which caused Kirkham to miscalculate the thickness in Squaw Butte.

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Competitive Exclusion Principle

It may seem unwarranted to extend the series of comments on the competitive exclusion principle, which has now proceeded from Hardin [*Science* 131, 1292 (1960)] to Cole [132, 348 (1960)] to Savile [132, 1761 (1960)], with asides by Van Valen versus Cole [132, 1674 (1960)]. However, two points in the discussion by Savile deserve comment.

He asserts that "the absence of clearly defined associations" emphasizes the reduced importance of competition in the arctic flora. Considerable recent vegetational research, some of which I summarized in an article in *Science* [128, 115 (1958)], suggests that clearly defined associations may not be characteristic and that the vegetation in an area may be regarded as changing in a manner most effectively treated as a continuous variable. It is, therefore, questionable whether the absence of clearly defined associations emphasizes anything. Savile's suggestion that the flora, or better the vegetation, be described in terms of major habitats, if these are discernible independently of the vegetation itself, certainly has merit.

Secondly, Savile refers to "closely related species with identical ecological requirements." If we must beware of assuming that species have different ecological environments because they do coexist, we must also beware of speaking of two species' having identical ecological requirements. The ecological demands of well-known species are not usually known in detail, and there is always the possibility that some essential requirement of a species may escape our most careful observation or experimentation. It may be argued that the plant as it integrates the multiple and undetermined components of the environment is the most, and perhaps the only, adequate measure of its environmental requirements. In any event, the assertion of ecological identity is fraught with at least as many difficulties as the assumption of lack of identity.

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McIntosh's first point concerns the permanence of associations. With our currently ameliorating climate I feel certain that all plant associations are changing throughout temperate Canada, but that does not rob the association concept of its usefulness, if we use it

with discretion. The lack of such associations in most arctic habitats, whether we use this term or indulge in circumlocution, still reflects meager biological competition—as others with arctic field experience have agreed since my note appeared.

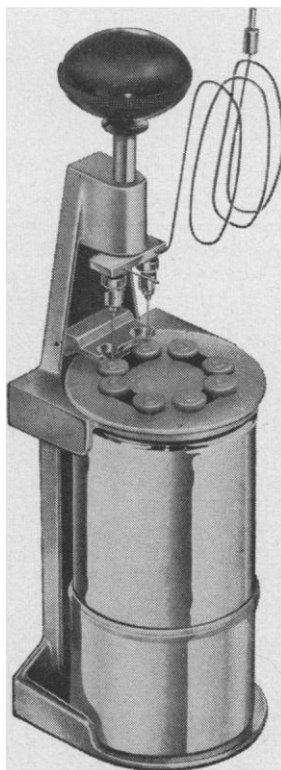
In his final paragraph McIntosh questions my phrase "identical ecological requirements" used in connection with disease resistance. I used the words, following ecological practice, with some misgiving, realizing that a semantic wrangle might ensue. Consider the extreme case of a single plant species with two populations differing by a single

gene that governs disease resistance. The parasite being part of the environment, these populations have different ecological requirements. Thus, if we insist on complete precision, no two species will ever have identical requirements, and the exclusion principle becomes completely meaningless, whereas, if we realize that usable definitions of biological phenomena must generally be flexible, the principle can be moderately useful under many, but not all, circumstances.

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