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John R. Rowley

Joanne Rowley

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but not always, the local races are better adapted to the localities of their origin than are other races. For this reason it is important to establish homogeneous seed collection zones and to designate as to origin each lot of seed used in reforestation.

Previously, forest tree seed collections usually have been designated only as to state of origin or, on the national forests, as to forest of origin. In 1929 Bates proposed eight seed collection zones based on response of red pine seedlings. They were modified by Rudolf in 1931. In 1939 Shirley proposed a series of zones combining a number of factors. In that year also the U. S. Department of Agriculture adopted a seed policy stressing use of local or well adapted seed for forestry and related purposes.

All these zones, however, display considerable overlapping of climatic features. There is proposed here, therefore, a series of zones based on two temperature factors: (1) A summation of normal average daily temperatures per year above 50° F., and (2) mean January temperatures. The development of red pine trees of 119 seed sources 20 years after planting showed good relationships to these zones.

The use of seed collection zones will facilitate certification of forest tree seeds as to origin. To certify them also as to quality will require seed testing not now generally available for forest tree seeds. Certification as to origin, however, is a necessary first step in this process.

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VERTICAL MIGRATION OF SPHERICAL AND ASPHERICAL POLLEN IN A SPHAGNUM BOG

JOHN R. ROWLEY

Botany Department, University of Minnesota

and

JOANNE ROWLEY

The Science Museum, St. Paul

ABSTRACT

In an effort to determine the fate of pollen that settles out of the atmosphere, tagged pollen was artificially introduced into the atmosphere immediately above a Sphagnum bog.

The area to be experimentally sampled was permanently located vertically and horizontally from triangulation points on high ground using a transect.

The pollen types employed were selected for their size, shape, and ease of microscopic detection as well as their durability in peat. *Pinus resinosa* Ait. (Norway Pine) was selected as a large aspherical pollen type. Norway Pine pollen was stained in an alcoholic solution of Safranin O to tag it for future identification. *Dodonaea viscosa* Jacq. pollen provided a medium-sized spheroidal pollen type. *Dodonaea viscosa* is an exotic species, found in the United States only in the extreme Southwest, and therefore its pollen required no synthetic tagging.

The tagged pollen which was experimentally introduced was traced by analysis of vertical samples of the Sphagnum bog together with the exposure of standard oil-coated atmospheric slides. The Sphagnum control samples were taken one hour following pollen dispersal at one centimeter intervals vertically through the living moss and underlying peat to a depth of 10 centimeters. The vertical samples gave information on the relative amounts of Norway Pine and *Dodonaea* pollen settling into the moss mat and the depth to which the pollens penetrated. The oil-coated slides provided data on the ratio of Pine to *Dodonaea* near the bog surface and at varying heights above it.

Similar collections were made within a few centimeters of the control site after intervals of 12 days, 3 months, and one year following pollen dispersal.

The samples were prepared for analysis by removing the humic acids and deflocculating the organic materials through treatment in 10% KOH followed by straining and concentration of the pollen-containing residue. The concentrated samples were stored and examined in Calberla's solution without Fuchsin.

As air-borne pollen settles on a Sphagnum mat there is relatively great initial separation between those grains which adhere to the upper portions of the living plants and those which drift through the interstices of the living matter into underlying peat. As would be expected the smaller spheroidal *Dononaea* pollen penetrated deeper than the larger aspherical-vesiculate grains of Norway Pine.

Collections made at the stated intervals indicated a vertical movement of the tagged pollen grains from their original position.

Migration was suggested in two ways:

1. Absolute separation between the lowest occurrence of tagged Norway Pine pollen and that of *Dodonaea* was increased with time.
2. The ratio of *Dononaea* to Pine grains (as observed in a standard count of 500 pollen grains of all types) increased at the lower levels.

The movement of pollen due to Sphagnum growth and other factors such as the activity of animals and bog position changes should be independent of grain size and shape. It is felt, therefore, that the

increase in proportion of *Dodonaea* to Pine with depth and time represents an actual differential migration of the pollen.

Migration, however, is definitely not unlimited, but appears to be virtually restricted to the less compacted layers of the Sphagnum bog through which the pollen grains penetrated at the time of their original deposition from the atmosphere.

The profile taken one year after pollen dispersal indicates changes in the spatial range of the tagged pollen that are a product not only of migration but also of compression of the Sphagnum mat.

We hope that clues to the destiny of the introduced pollen and the relative significance of such compacting factors as rain and the winter snow cover coupled with structural weakening of the organic material due to decay, will be suggested by continued periodical analysis.

The annual introduction of different pollen types should provide more critical information from this Sphagnum area.

In connection with these studies, it has become apparent to us that the artificial introduction of tagged pollen is a research tool which contributes worthwhile information not only concerning the pollen itself but also the behavior of sediments by suggesting causes and effects of compression, local rates of sedimentation, the influence of climate on sediments, and the effectiveness of sampling methods and equipment.

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THE CYTOLOGY OF CALTHA L.

A. ORVILLE DAHL and JOHN R. ROWLEY

Botany Department, University of Minnesota, Minneapolis 14

INTRODUCTION

Caltha L. is a genus including approximately 16 species, distributed in wet, marshy areas, in arctic and north temperate regions. The genus is assigned to the Helleborus tribe of the Buttercup Family, *Ranunculaceae* Juss. Two species are native to Minnesota, *Caltha palustris* L., the common marsh marigold, and *Caltha natans* Pall., a rare aquatic plant collected only in relatively few localities in the state. The only specimens from Minnesota in the University Herbarium document collections in the Tower, Lake Vermillion, Deep Lake, Trout River areas of St. Louis County. *Caltha natans* is also found locally in moist habitats from northern Wisconsin to Alaska and in northern Asia. *C. palustris*, on the other hand, is widely distributed throughout upper North America and Eurasia.

The new information summarized here is based primarily on analysis of *C. natans*, which has not received previous cytological attention. In the interest of obtaining data which can be used for further comparative study throughout the genus, observations have been made utilizing new material of *C. palustris*.

We are indebted to Dr. Olga Lakela of the Duluth Branch of the