THE TECHNIQUE AND USE OF MASS COLLECTIONS IN PLANT TAXONOMY

EDGAR ANDERSON

Geneticist to the Missouri Botanical Garden

Engelmann Professor in the Henry Shaw School of Botany of Washington University

A slight extension of ordinary herbarium techniques promises to increase the accuracy of herbarium studies and greatly to widen their scope. Attention was called to the possibility in 1935.[1] Since that time its potentialities have become increasingly evident and details of its technique have been considerably improved. The method consists in supplementing ordinary specimens by mass collections made as described in detail below. For small plants these mass collections may well consist of the entire plant. For larger plants considerations of space require the selection of some critical portion, as the leaves, the infloresence, or the fruits. For instance, in studying sugar maples (*Acer saccharum* and its relatives) a mass collection will consist of one leaf per tree (carefully selected from the same kind of non-fruiting branch) from thirty to fifty trees, and complete specimens of the usual sort, from two or three of the trees. Properly made and filed (see below) mass collections require only a little more space than ordinary herbarium specimens.

Such a collection is a record of a population as well as of the individuals which make up that population, and it therefore gives the facts about variation which can be obtained from populations but not from individuals. In other words, it would bring into the herbarium information which now we can get only in the field. This information can be grouped under three different heads.

(1) *Frequency of the variation.*—The most important defect of the ordinary herbarium material, in biometrical terminology, is that, while it may give a reliable estimate of the

[1] Anderson, Edgar, and W. B. Turrill. Biometrical studies on herbarium material. Nature **136**: 986.

range of variation, it does not allow an estimate of the frequencies within that range. That is to say, in non-mathematical language, that it may give a good idea of extremes but it does not indicate the relative prevalence of the extremes or of any particular intermediate. It is not enough to know that a variant exists; for its complete interpretation one needs to know how often it occurs in the places where it has been reported. As Dr. Fassett has put it in a homely analogy: "there are Democrats and Republicans in both Mississippi and Vermont but their comparative frequency varies significantly between these two regions."

(2) *Discontinuity of variation.*—This is potentially one of the greatest sources of error with present-day techniques. The chief criterion for separating taxonomic entities is the degree of morphological discontinuity between them. At the present time it takes good judgment and often field experience to decide if the discontinuity shown by a group of herbarium specimens is real or only apparent. This is particularly true for categories smaller than the species.

(3) *Correlation between variables.*—While an estimate of this correlation can be obtained from ordinary herbarium specimens, it can be derived much more precisely from mass collections and can be perceived more readily and its perception requires less biological judgment. Those who have undertaken monographic work will have encountered complexes in which variation was so extreme and involved so many different characters that it was difficult to comprehend. Mass collections make it possible to study such complexes analytically and to determine precisely the extent to which the variation in different characters is correlated. Anderson and Turrill,[2] for instance, by using mass collections, were able to resolve the variation in the *Fraxinus Pallisae* complex into two elements and to relate these elements to species of *Fraxinus* from southeastern Europe.

There are two problems in making mass collections: what

[2] Statistical studies on two populations of Fraxinus. New Phytol. **37**: 160–172. 1936.

part of the plant to collect and the selection of a random sample of the population. The first is not as difficult as it may seem to anyone who has not tried it. Taxonomic studies on the customary herbarium material are a necessary foundation for the making of mass collections intelligently, and the study of a taxonomic revision will tell what parts are significant and should be collected in quantity. The portion of the plant chosen for intensive collection should provide good morphological criteria; it should be easy to press and store in quantity; and its selection should be definable in precise terms. The following examples may make these points clear: *Tripsacum,* the terminal inflorescence of each plant; *Monarda,* an average flower-head from each plant, with its subtending bracts; *Veronica peregrina,* the entire plant. Wherever possible mass collections should be a series of one sample from each plant. Occasionally a single vegetatively reproduced individual (technically known as a clone) may cover a very large area, and it may be difficult or impossible to know where one individual leaves off and another begins. This is particularly true in such plants as *Sanguinaria canadensis* whose rhizomes grow and branch vigorously and the organic connection between two branches usually rots away after a few years leaving them physically separate. In most cases a careful study of flower and leaf variation will reveal the probable extent of each clone, and a careful collector can minimize the chances of gathering a disproportionate number of samples from a single clone.

The problem of a truly random sample is difficult, and bristles with difficulties which are not even suspected by the uninitiated. One should bear in mind that he is trying to make a record of a population of individuals and that the record will have the greatest significance if it is chosen at random from an actual inter-breeding population. Lacking the precise information as to what an "actual inter-breeding population" may be, one can only use his biological judgment in selecting for each case an area which presents uniform conditions for that species and make his collections from that area. Even for those species which grow in definite, more or less isolated colonies, the

trained eye can often find evidence for distinctive neighborhoods within such communities, and it will be a matter of individual judgment whether these neighborhoods should be recognized or ignored in making a sample of the population. When the area has been chosen one may either collect a specimen from each individual within that area, if there be not too many, or make a random selection of thirty to one hundred or more individuals. One can walk across it in a straight line, making collections at every second or third step, or can use

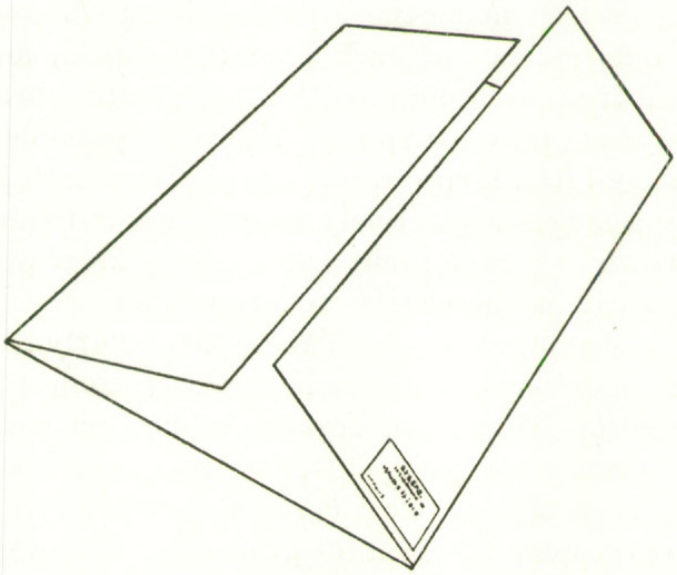

Figure 1.

strings and collect every individual which is touched by the string or is close to it.

If properly made, mass collections do not take up more space than a few herbarium sheets, and they give information which cannot be obtained from hundreds of ordinary specimens. If supplemented by complete specimens there should be no objection to their fragmentary nature. Technical improvements in storing the collections have been made by my assistant, Mr. Leslie Hubricht, and are illustrated in the accompanying figure. Since my collections are subject to intensive study but are not distributed in an ordinary public herbarium they are kept

unmounted. To prevent the specimens from scattering, the genus covers are folded so that the edges meet down the middle rather than the side. One label is made for each collection and is pasted on the genus cover. The ordinary specimens made at the same time and place are mounted and labeled and are kept in the same genus cover. Each collection is given a geographical name and all are assembled alphabetically under the genus or the species, depending upon the nature of the particular problem.

The information derived from a study of mass collections is useful in two ways. It will, in the first place, aid the systematist in cataloguing the various entities involved, species, varieties, forms, etc. While it may raise more new questions than it may solve old ones, it will aid in the production of monographs whose categories are more accurately adjusted to the variation patterns of their particular genera. Mass collections have for some time been customary in avian taxonomy (see, for instance, Mayr[3]), and Kinsey, in a series of brilliant monographs,[4] has shown their superiority in insect systematics. If taxonomy were to be nothing more than cataloguing and if taxonomists were to confine themselves to the problems raised by their herbaria, mass collections would still be a useful adjunct to herbarium technique and in many critical groups would provide more efficient working material, even when their special difficulties of collecting and filing are considered.

There is no reason, however, why taxonomy should be content to cultivate such a narrow field. If collectors and herbarium administrators could be persuaded to encourage mass collections, critically made and carefully assembled, a second kind of problem could be investigated in herbarium material. The description and analysis of geographical trends in variation, the delimitation and interpretation of centers of variation, the establishment and analysis of variation patterns in

[3] Mayr, Ernst. Speciation phenomena in birds. Amer. Nat. **74**: 249–278. 1940.

[4] Kinsey, Alfred C. The gall wasp genus *Cynips*. A study in the origin of species. Indiana Univ. Studies. **84–86**: 1–577. 1930; The origin of higher categories in *Cynips*. Indiana Univ. Publ. Sci. Ser. **4**: 1–334. 1936.