normal trees acting as controls under similar growth conditions. The term mutation may be conveniently applied to the sudden appearance of an inheritable peculiarity, whether due to an immediately preceeding change in the germ plasm or to the rare kaleidoscopic combination of unit characters already present. The form variant of the sugar maple here described therefore, may be provisionally classed as a mutant.

A CLASSIFICATION OF BOTANICAL SCIENCE IN TWO DIMENSIONS

By Roland M. Harper

The classifications of knowledge relating to the vegetable kingdom which one finds in encyclopedias, text-books, library manuals, etc., usually arrange the ultimate units in a linear sequence (a space of one dimension), and almost necessarily so, for the parts of a written or spoken discourse, such as a lecture course, are consecutive rather than simultaneous. But a classification of science, books, plants, life-zones, or anything else, that has but one dimension can not as a rule place all the units in their proper relation to each other, for in a linear sequence each unit can be adjacent to not more than two others.*

An ideal classification should have several dimensions, but any system represented on a sheet of paper or other plane surface is limited to two. This answers fairly well for classifying sciences, though, for it allows us to classify them by subject matter and by point of view at the same time.

The subjoined table represents a crude attempt to arrange the botanical sciences in two dimensions. The columns represent the objects studied, and the horizontal divisions the points of view or methods of investigation. The columns form a regular series of increasing complexity, from vegetable matter in general to plant associations; but there is no such simple relation between the horizontal rows, and if a third dimension were available the points of view might advantageously be grouped in two dimensions instead of one, so as to bring the study of environment,

* One of the latest and most elaborate linear classifications of pure and applied botany is that of Harshberger in Science, II. 36: 521–525. Oct. 18, 1912.

Table of Botanical Sciences

Points of view \ Objects	Vegetable matter	Cells	Tissues	Organs	Plants	Associations
General (functions, classification, etc.)	Botany	Cytology	Histology	Organography	Phytology?	Sociology
Composition	Plant chemistry	Pharmacology?				?
Physical properties	Specific gravity etc.	Osmotic pressure	Strength of wood, etc.	?		
Structure		Morphology				?
Nutrition, respiration, photosynthesis, etc.		Physiology				
Germination and growth, or life history			Physiology			Invasion?
Seasonal or other periodic changes			Physiology	Physiology Phenology		?
Movements and responses				Physiology		
Reproduction					Physiology	
Descent or inheritance					Genetics	
Evolution or history				?	Phylogeny Paleobotany	Succession
Interrelations			?	?	Competition symbiosis, parasitism, etc.	Zonation, etc.
Environment (influence of)			Ecology			Synecology
Areal distribution					Geography	

for example, next to that of seasonal changes and movements and responses, as well as to interrelations and distribution.

The rectangular spaces left blank are those in which no laws can be placed. For example, we can hardly conceive of the nutrition of plant associations, or the geographical distribution of cells. Spaces occupied only by interrogation points are those in which there seem to be a few laws, but not enough to have received a special name as yet.

The last four or five columns should each be regarded as made up of a multitude of smaller ones, corresponding to the different kinds of tissues, plants, etc. Organs can be subdivided twice, first into kinds of organs, and then into different forms of each kind. Plants may be classified either by their supposed phylogenetic relationships, as in taxonomy, or by structure and adaptations (this sometimes called ecological classification), or in various other ways. For the taxonomic subdivisions there are numerous minor "-ologies," such as mycology, bryology, agrostology, and even batology and ionology; and for the structural subdivisions there are a few terms, of which dendrology is probably the most familiar.

Some of the horizontal rows, especially the last two, can be similarly subdivided. The subdivisions of ecology are the various environmental factors, and those of geography the divisions of the earth's surface; and each of these systems may be arranged in more than one way.

In studying any portion of the field we may proceed either by rows or by columns. For example, most ecological treatises use the environmental factors for the primary subdivisions, and consider the effect of each one separately on organs, plants, etc. But the Chicago text-book, published about two years ago, considers the organs first, and then the relation of each to different environmental factors. Each method of course has its advantages.

In a general way this table might be said to indicate the order of historical development of the sciences named. If such a table had been prepared in the time of Linnaeus it would probably have lacked most of the lower half. The last column and

the last row but one received very little recognition anywhere until the last decade of the nineteenth century (and even yet very little attention has been paid to them in some of the older states where botanists are most numerous).

The best order for teaching these sciences in a complete botanical course—if such a course is ever given—is not so obvious, principally because a course of instruction cannot very well proceed in two directions simultaneously, but must follow rows, or columns, or first one and then the other. Perhaps the best way around this difficulty would be to subdivide the field along horizontal lines into several parts, and then take a column at a time, transgressing the upper or lower limits occasionally to make certain points clearer. Then too it is customary to teach along with the pure sciences more or less of certain applied sciences or arts which have no place in the table, such as economic botany, forestry, plant breeding, and agriculture.

It will be observed that systematic botany or taxonomy, which was once the largest feature in botanical text-books, is absent from the table. Classification is not peculiar to plants or organisms of any kind, and in itself is not a science at all, but rather an art, a method or a convenience. The earlier classifications of plants were very artificial and not scientific, but the scientific basis of modern taxonomy is phylogeny, which has its proper place in the table.

Some botanists are inclined to regard physiology and ecology as essentially one, while others have difficulty in drawing the line between ecology and geography.* But the above table and explanation should make the relations between these three sciences clear. Although they are more or less interdependent, they consider plants from three fundamentally distinct points of view. Plant sociology, which is sometimes regarded as a part of ecology, is still more distinct.

It is scarcely necessary to remark that the sciences dealing with the animal kingdom in general and those dealing with mankind in particular could be classified in a very similar way.

* Human ecology and human geography have been even more persistently confused than the corresponding botanical sciences, and a great deal of modern so-called geography is nothing but ecology. For additional notes on the scope of geography see Science II. **38**: 816. Dec. 5, 1913.