SOME PROBLEMS AT THE CULTIVAR LEVEL

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Summary

Some of the reasons, both sociological and biological, for the taxonomic difficulties found in modern cultivated species are enumerated. The relevance of numerical techniques is discussed, and contrasted with their usage in classical taxonomy. Some new approaches are suggested.

Cultivar taxonomy, the poor relation of its classical superiors, receives scant attention. Generally ignored even by those working on the minuter aspects of subspecific variation, the problems that it poses could, if resolved, throw considerable light on those of its better known and more polished relations. Classical taxonomists maintain that they are the objective observers of the enticing and subtle web of Nature’s variation. This may be true, but cultivar taxonomy lies inescapably at the interface between natural evolution and Man’s mind and motive. Here, it is impossible to ignore the way in which (taxonomic) Man imposes his internal and hierarchic modes of thought on external and frequently non-hierarchic reality. Here, too, lies the remarkable power (and one which many a classical taxonomist must have secretly wished to invoke), to alter, create, or remove the very material on which the work is based.

The fundamental problem of cultivar taxonomy seems to be, of course, how to define what a cultivar is. In a Utopian world this would present no difficulty, and cultivars could reasonably be expected to be distinct, uniform and stable, and to have one name. The four attributes, inter-related as they are, could be maintained in spite of the various genetic and propagative complexities presented by the crop species concerned; whether inbreeding or outbreeding, clonal, F1’s (of whatever parental complexity), whether they showed great plasticity from season to season and place to place. But Utopia has not yet been achieved, and it is worth examining briefly the groups of people who play a major part in the evolution and adaptation of crop species, and the way in which they affect cultivar classification. There are four such groups; breeder, seed merchant, grower and consumer, although two or more may be combined in the same person, and perhaps a fifth group would be constituted by the legislator/taxonomists.

The plant breeder produces new plant material, exploiting mechanisms that under more natural conditions take infinitely longer. The new material may have increased yield, disease resistance, flavour, or be more beautiful. It may be especially adapted to new technologies (freezing, mechanical harvesting), or may exploit, or even create, new markets. To a large extent, the commercial success of a new cultivar will depend both on its “betterness” and the dependent quality of distinctness (there is no dependence in the reverse direction). Although many are successful, the need to realise the

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profitability of new material may occasionally work against its distinctness, its uniformity, and sometimes its stability. The merchant is subject to a different set of pressures. Although his custom is related to the range, fitness, and exclusivity of his merchandise, his profitability depends on the cost of maintaining cultivars, storage and labour. Catalogues demand many names, warehouses do not. Further, merchants may have maintained some cultivars for a considerable period, and through deliberate or unconscious selection, the cultivar may have drifted considerably away from its original state. Where there have been several maintainers, the drift may not have been in the same direction. This is of some advantage to the merchant-maintainer because each can claim his stock of a cultivar to be superior to all others, but it has given rise to, for a considerable percentage of older cultivars, a complex infrastructure of variation. In some cases this is so extensive as to suggest that the original cultivar name be used in a more general way for a group of cultivars in their own right. Breeders generate a similar effect when they begin to develop a very restricted part of a crop's range. On the other hand, merchants may drop a particular series of cultivars because of changes in fashion or finance, but the next links in the chain, the growers and consumers, may sometimes be unwilling to change their habits. Names remain in catalogues for which no authentic stock of seed remains. Substitutes collect names of similar but extinct types, and the nomenclature becomes very confused. Older cultivars also often have regional names, and a number may be known by various national ones. Of the grower and the consumer little can be said. Some clamour for novelty, others for tradition. Some know precisely what they want, others are less demanding. If some of the nomenclatural and biological difficulties are generated by the breeders and merchants, they are amplified by the grower and consumer. The legislator/taxonomist adds a further set by imposing a series of values developed within a discipline which has paid little attention to cultivated plants.

Because of current interest in plant breeders' rights schemes and other legislative innovations (particularly in EEC countries), it is now necessary to ensure that new cultivars conform to rather ill-defined distinctness, uniformity and stability criteria. Before this can be done, it is essential to carry out what is, in essence, a taxonomic revision of each of the crop species concerned (although with some differences that might startle a classical taxonomist). Some major ones have had such a classification for some years; others, of less economic importance but sometimes greater complexity, have none. As it is necessary to have these classifications ready by 1980, and because traditional techniques are difficult to apply, we decided to test some of the newer multivariate analysis methods on the problem.

Before embarking on a discussion of numerical approaches to cultivar taxonomy, it is worth considering some necessary differences of approach between systematists working on cultivated plants and those working on wild material. The most fundamental element in these differences is time. The classical taxonomist assumes, in general, that the group under study is more or less static; that new groups evolve infinitely less slowly than the taxonomist works; that extant groups will remain both unchanged and extant, and that groups will not suddenly coalesce with others. These groups are, by well-established convention, ordered and ranked into hierarchic relationships. It is only rarely conceded that variation in Nature may not fit easily into such a system, particularly at the lower levels of the hierarchy,
for the classical taxonomist aims to produce a system that will classify every piece of “substrate”. His only hostage to time and change is the discovery of new material, and the opinions of other taxonomists. To work on cultivated plants needs a very much shortened timescale. New material is unceasingly produced (the number of cultivars in some crops may expanded by ten percent annually). Whole sections of a crop may drop out of use in a matter of years. Cultivars vanish, change, are hybridised with others, may be expanded to become important groups of new types. So, although under these circumstances it is still possible to maintain a “global” taxonomic approach (allowing that possibly large sectors of a crop species may be unclassifiable because there are no discontinuities in the variation), it becomes doubtful if it is of any general use. Such a classification might only be needed for the rather specialised needs of breeder or gene conservationist. Indeed, a “global” classification could only handle the continuous parts of a crop’s variation by subdividing and zoning the sorts of multidimensional spaces produced by principal components and canonical analyses. A classification of more general application is one which appears rather specialised, even circular, being strongly biased towards “distinctness”. While classifying the classifiable parts of a crop in the usual way, a number of selective factors are imposed on the unclassifiable parts. These selective factors may be either historical (discerning which maintainer has authentic material of a particular cultivar, analogous to “priority” in classical taxonomy), or practical (which segment of the variation gives the best yield, is most disease resistant, etc). The factors may also be used on new cultivars, for of all the continuously variable material that may exist, only parts are put on the market, but even so, it is not uncommon for so many cultivars to proclaim themselves that they become unclassifiable (i.e. A B C D in Fig. 1). Cultivar taxonomy is, like politics, the art of the possible.

Numerical taxonomy, in its multifarious forms, claims not to be an art at all. It seems to offer two basic qualities; the ability to produce objective and repeatable classifications that incorporate a minimum of human value judgements, and the ability to handle the sort of data structure that the human mind finds difficult to grasp. (Almost any sort of data structure is an admission of defeat on the part of a taxonomist). Although these two virtues make numerical taxonomy seem ideally suited to the study of cultivated plants, it has generally been used at much higher hierarchic
levels where there are major discontinuities in the variation and where, as a consequence, ideas of a “best” classification both exist, and are entrenched. Further, some of the numerical methods are used for constructing hierarchic rankings of units up to any specified level. It is questionable whether this is of any use, for although various suggestions for the naming of ranks of cultivars within a species have been proposed (1966, 68, 71), the speed with which the structure of a crop may change is so fast, that they seem somewhat superfluous.

One further hope for numerical taxonomy was that it would provide a rational and quantitative means of defining what a species, genus or cultivar actually is. Some of the earliest methods produced results in the form of dendrograms, a visually arresting and easily assimilable way of showing similarity relationships. Initially, it was hoped that lines drawn straight across a dendrogram could be used to define a particular level in the taxonomic hierarchy. However attractive such a once-for-all solution seemed, it was soon found to be unrealistic. In most cases it was found that there was no clear place at which a line could be drawn; in fact, that Nature paid scant attention to concepts of hierarchic level. Fig. 2 illustrates this. Group A may be excellent, uniform, recently bred cultivars, while group B may be more widely spaced ancient ones, and so the concept of “cultivar” (and its “distinctness”, related to both its uniformity and its taxonomic distance from other cultivars) will vary throughout the crop. Any line drawn across a dendrogram should not, therefore, be straight.

![Dendrogram](image-url)
This, together with the realisation that dendrograms occasionally produce distortions of relationships, affects a number of clustering techniques, for the same objection applies even to those methods that will leave some of the OTU's as “unclassifiable”. Whenever the same distance or similarity criteria are used over the whole OTU space, then inevitably distortions or lapses will occur. Of course, a crop species can be broken down into subgroups and a separate standard of “distinctness” used in each one, but, in practice, the entire crop would have to be frequently monitored to ensure that each of the groups remained valid. (There is, however, a recently published technique (1973) which will overcome these objections, but which we have not yet fully tested). The continuous addition of new cultivars (at the A level in group A, Fig. 2), may well invade the variation-space of other groups. Although mathematical standards of distinctness can be imposed on the cultivars, any stipulated levels will have to be under constant review if they are not to severely restrict developments in crops whose nature and function are changing. It may even be difficult to impose a minimum level. Distinctness, after all, depends on its distinctness “for what”. Cultivars destined for an only moderately efficient agriculture, or a moderately discriminating market, need large differences if they are to be noticed. Cultivars for very precise cultivation or discriminating markets will differ much less. Markets and cultivation change. Thus, concepts of “cultivar” and “distinctness” depend on market forces operating on a crop species at any given time. Numerical methods, while showing up clearly some of the taxonomist’s false hopes, do provide means for objectively determining degrees of similarity. The hope of reaching an abstract and all embracing definition of what a cultivar “is” becomes, on examination, increasingly distant, for the system of which cultivars form a small, evanescent part is constantly changing. If the legislator and taxonomists bear this in mind, then a Utopian solution may be achieved.

If, then, the cultivar may never be rigorously defined, what of the higher levels? Because the rate of change here is so very much slower, there are many advantages in constructing classifications, or hierarchical rankings of units. These may demonstrate phylogenetic relationships, act as information storage systems, or simply to aid identification of unknown material. Because such systems of rank are so useful, arguments about precise definitions of each rank often rage with some ferocity. The heat is surely generated because these arguments are incapable of resolution for reasons analogous to those concerning cultivars. Symptomatic is both the amazing proliferation of ranks, sub-ranks and quasi-ranks since the original few that were proposed at the beginning of the eighteenth century, and also the way in which new disciplines (cytology, breeding systems, chemical constituents and DNA structure), are eagerly heralded as the end of our taxonomic problems. Nature is neutral; the neutrality of polyvalence. Any aspect of it may be isolated, turned into an ideology, and used, falsely, to reinterpret the whole. Further, taxonomists, believing now in evolution, seem to believe that there is a right, final, and absolute classification for any given group. Undoubtedly classifications have improved rapidly since the eighteenth century, but this progression does not imply an ultimate and final solution. There may well be no best answer, or, if there is, it will not be reached by using the notions of rank and hierarchy with which the eighteenth century first encumbered it.
References


