SCOPE AND PROBLEMS OF CULTIVAR GROUP FORMATION AS EXEMPLIFIED IN B R A S S I C A R A P A L.

E.H. Oost
Department of Plant Taxonomy
Agricultural University
Wageningen
The Netherlands

H. Toxopeus
Foundation for Agricultural Plant Breeding
Wageningen
The Netherlands

Abstract

A brief historical review is given of the taxonomic treatment of infraspecific classification of cultivated plants. The inadequacy of hierarchical classification for polymorphous cultivated plant species is outlined. The rapid change in the range of cultivars as a result of breeding to adapt to changing cultivation practices, and the creation of new cultivars and crops, complicates such classification.

Attention is focused on the use of cultivar groups for infraspecific classification. The scope of this system is illustrated with an example in B r a s s i c a r a p a L.

1. Introduction

The Symposium on Infraspecific Classification of Wild and Cultivated Plants, which was held at Oxford in September 1984, clearly showed that infraspecific classification, especially of cultivated plants, should be considered as one of the most important and urgent problems facing plant taxonomy.

The main problem is how to deal effectively with the wide variation present in cultivated plants; a variation that is continiously and, at times, rapidly changing. The purpose of this paper is to focus attention to the usefulness of cultivar groups for infraspecific classification.

There are some clear advantages in cultivar group formation:

- Firstly, the number of ranks between the species and the cultivar level may be reduced to one: the cultivar group.
- Secondly, this system of classification is flexible and therefore well adapted to its purpose.

These aspects are illustrated in the following with an example of cultivar group formation in B r a s s i c a r a p a L. (syn. B. c a m p e s t r i s L.), after a short review of how variation in crops has been created, and how taxonomists have tried to deal with it.

2. Consequences of domestication and breeding for plant taxonomy

Under influence of domestication certain plant species gave rise to crops (Fig. 1).

Figure 1 - The creation of crops under influence of domestication.

The variation within and between crops is determined by many factors, such as:

- the initial genetic variation in the species
- the introgression of new genes
- the period and intensity of domestication

The evolving knowledge of breeding techniques enabled man to select and maintain more homogenous populations with improved adaptation to ecological factors and cultivation practices (Fig. 2).
These populations are in fact the first cultivars.

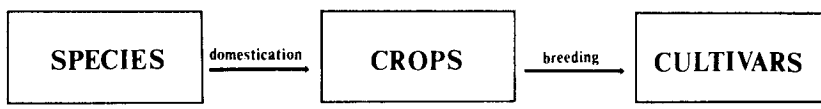

Figure 2 - The creation of cultivars in domesticated crops through breeding.

By the time taxonomists started to deal with infraspecific variation, taking the publication of Linnaeus Species Plantarum (1753) as a cautious beginning, many species were already in cultivation and a great deal of these species contained several crops.
Although the number of what we nowadays call cultivars was rapidly increasing, there was no actual cultivar concept, nor was there any form of registration or formal naming. Therefore, the attention of the taxonomist was primarily focused at the crop level. Linnaeus was the first to use the rank varietas, presently considered equivalent to botanical variety, to distinguish crops in cultivated plants.
But, as has been stated by Stearn, Jarvis and Wijnands at this Symposium, Linnaeus' attitude towards distinction and naming of varieties was ambivalent and this is reflected in the unbalanced way he used this rank.

However, many Linnean variety names are still used in present day nomenclature of cultivated plants, for instance in B r a s s i c a o l e r a c e a L.

After Linnaeus' time, the study of infraspecific variation became more extensive and profound. This resulted in the distinction of more and more infraspecific ranks, that were arranged into hierarchical systems. On the other hand some taxonomists described crops at the species level, attaching more importance to morphological differences than to biosystematic relationships. The consequence was, of course, a kind of rank inflation.

The biggest inconvenience to both kinds of classification was and still is hybridisation as a result of plant breeding. The great increase of breeding activities since about 100 years ago, resulted in the creation of many new cultivars and even new crops. As a consequence, the existing classifications had to be constantly rearranged, with accompanying nomenclatural problems and proportionate confusion. This situation will be illustrated by an example in B r a s s i c a .

3. Infraspecific classification in B r a s s i c a r a p a

The so-called B r a s s i c a traingle of U (1935) is one of the classical examples where cytology has made a major contribution to the understanding of biosystematic relationships between species.

One of the basic diploid species of the triangle is B. r a p a L. This is a very polymorphous species with 2n=20 chromosomes. It contains many crops that have been domesticated over a very long period in Europe as well as in Asia. Little is known about its true existence in the wild. Plants found under natural conditions seem to be escapes from cultivation.

The most important crops in B. r a p a are:

- Turnips, exhibiting a great range of variation
- Turnip rape, used for oil extraction
- Chinese cabbage or pe tsai
- Pak choi, a Chinese leaf vegetable
- Asiatic leaf vegetables such as mizuna, tendergreen and different forms of turnip greens

Most of above mentioned crops have once been described as separate species, but crossing experiments have shown that they readily intercross and belong to one genepool (Olsson, 1954; Oost, 1985). The transfer of these "species" to B. r a p a resolved problems at the specific level, but this caused a proportional increase of infraspecific taxa.

Figure 3 illustrates one of these problems, also showing the important role of infraspecific hybridisation. The picture, taken from Li (1981), represent the evolution of chinese cabbage in Asia. Li recognizes four botanical varieties, one of which contains three formae. Furthermore, there are five new chinese cabbage forms that are denoted by infraspecific hybrid formulae. Similar examples can be given for almost all of the other crops in B r a s s i c a r a p a and even in other B r a s s i c a species.

This example clearly demonstrates the effects of infraspecific hybridization on botanical classification and nomenclature: a complicated array of hybrid forms carrying hybrid epithets.

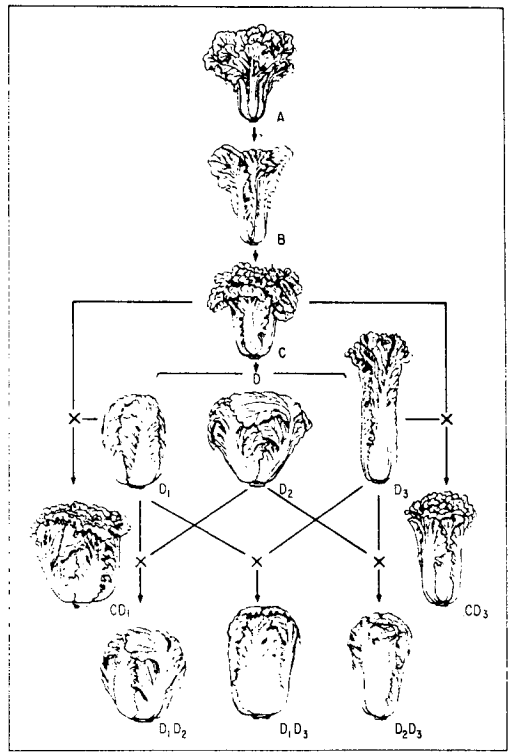

Figure 3 - The evolution of Chinese cabbage (*Brassica campestris* ssp. *pekinensis*).

A. var *dissoluta*, B. var *infarcta*, C. var *laxa*,
D. var *cephalata*, D_1. f *ovata*, D_2. f *depressa*,
D_3. f *cylindrica*, CD_1. var *laxa* x f *ovata*,
CD_3. var *laxa* x f *cylindrica*, D_1D_2. f *ovata* x f *depressa*,
D_1D_3. f *ovata* x f *cylindrica*, D_2D_3. f *depressa* x f *cylindrica*.
(From Li, 1981)

4. Cultivar group formation

Is there a solution to this problem? The present authors think that infraspecific classification of cultivated plants on the basis of cultivar group formation may provide an adequate answer.

If we look at our crops carefully, and consider what is actually cultivated in fields and greenhouses, we will see that these items are cultivars. Crops are in fact assemblages of cultivars, and this holds for many crops in developing countries too.

Cultivars are clear-cut entities, with a name and a description. Furthermore, they have to be distinct, uniform and stable. These properties render the cultivar a very useful unit for classification.

If all the cultivars of a certain species are listed, and classified into an appropriate number of cultivar groups, additional infraspecific ranks will not normally be required.

The authors have worked out a preliminary proposal for a convenient cultivar group classification in B r a s s i c a r a p a (Toxopeus et al., 1984). At the same time all persons interested have been invited to comment on nomenclature and formation of the groups. Several replies were received and reactions are still coming in. As a consequence the classification that is presentated in Table 1 is already different from the one published earlier.

Table 1 - Example of a cultivar group classification for B r a s s i c a r a p a L. (Based on Toxopeus et al., 1984).

CULTIVAR GROUP (NAME)	SHARED CHARACTERS	USE
VEGETABLE TURNIP	TURNIP	VEGETABLE
FODDER TURNIP	FORMS LEAF ROSETTE, WITH OR WITHOUT TURNIP	FODDER
WINTER TURNIP RAPE	BIENNIAL	OILSEED
SPRING TURNIP RAPE*	ANNUAL	OILSEED
YELLOW SARSON	ANNUAL, SEEDS YELLOW, SILIQUES OFTEN MULTIVALVED	OILSEED
PE TSAI	HEADING, PETIOLES WINGED	VEGETABLE
PAK CHOI	NON-HEADING, PETIOLES CONSPICIOUS, FLESHY	VEGETABLE
MIZUNA	NON-HEADING, LEAVES PINNATE	VEGETABLE

*Inclusion of Brown Sarson and Toria cultivars in this cultivar group is still under discussion.

The following groups still need further study before they will be incorporated: Turnip Greens, Brocoletto, Komatsuna (=Tendergreen), Mibuna and Taku Tsai.

The groups are formed on the basis of shared characters of the cultivars that constitute the group. These characters are to be clear and simple, and there are to be as few as possible. The way the cultivars of a certain group are being used, is of great value for characterization of the group.

When making cultivar groups the existing crop concept in a certain species should be examined and analysed, to see in how far the concept agrees with acceptable cultivar group limits.

If so, the internationally most acceptable crop name may be taken to denote the corresponding cultivar group. Most of the proposed cultivar group names in Table 1 were already in use for crop names, but in this concept the future use of each of these names will be attached to a certain, specified group of cultivars.

The release of new cultivars leads to one of the following situations:

- inclusions of the cultivar(s) in an already existing group
- formation of a new cultivar group
- merging of two groups into one

5. Discussion

We are well aware that there are many characters - some of them highly sophisticated - that could be used for cultivar group formation, but, in order to keep the system flexible and easy to adapt, the characters should be kept as simple as possible.

Numerical analysis of especially quantitative characters might sometimes prove to be useful for classifying cultivars into groups. A drawback of this method is that every time a new cultivar has to be incorporated the whole numerical procedure has to be repeated.

In order to acquire more characters, one could also use electrophoresis or unravel the phylogeny of cultivars (and these aspects should certainly be studied since they can supply valuable information for plant breeding and registration). These aspects, however, require considerable expertise and time, and it is doubtful if they are really indispensable for creating a sensible cultivar group formation.

However, one of the main requirements for the successful introduction and acceptance of cultivar group formation will be the adoption of cultivar group names by an International Registration Authority. The registration of a name by this Registration Authority, of course after it has been amply discussed and agreed upon, will make this the official name of the cultivar group, which should not be changed.

The pro's and con's of translations (i.e. synonyms) of cultivar group names in other languages will have to be studied in further detail, before definitive rules can be given. The names should preferably be formed in a modern language. No typification or latin

description will be necessary, since the group is sufficiently characterized by the cultivars that constitute the group.

It is obvious that similar proposals as the one made for B r a s s i c a r a p a can be set up for other species in B r a s s i c a as well as in other genera. Of course this should be worked out in dialogue between the users of nomenclature, such as taxonomists, plant breeders, geneticists, and registration authorities.

Article 26 of the ICNCP (1980), concerning cultivar groups, has to be revised into a good set of rules and recommendations. The rules will provide the official scientific bases for the cultivar group system and serve as a guide for cultivar group classifications in any species.

Existing registration authorities (especially the statutory ones) can be of great help by taking up responsability to register cultivar group names for one or more cultivated species.

References

ICNCP, 1980. International Code for Nomenclature of Cultivated Plants. Formulated and adopted by the International Commission for the Nomenclature of Cultivated Plants of the IUBS (Eds. C.D. Brickell et al). Regn. Veg. 104:1-32.

Li, C.W., 1981. The origin, evolution, taxonomy, and hybridization of Chinese cabbage. In: Chinese cabbage, Proceedings of the First International Symposium 1981 (Eds. N.S. Takar and T.D. Griggs) AVRDC, Taiwan:1-10.

Linnaeus, C., 1753. Species Plantarum. ed. 1. Holmiae. Stockholm.

Olsson, G., 1954. Crosses within the c a m p e s t r i s group of the genus B r a s s i c a. Hereditas 40: 398-418.

Oost, E.H., 1985. A proposal for an infraspecific classification of B r a s s i c a r a p a L. In: Infraspecific Classification of Wild and Cultivated Plants (Ed. B.T. Styles). Oxford Univ. Press, Oxford:309-315 (in press).

Toxopeus, H., Oost, E.H., and Reuling, G., 1984. Current aspects of the taxonomy of cultivated B r a s s i c a species. The use of B r a s s i c a r a p a L. versus B. c a m p e s t r i s L. and a proposal for a new infraspecific classification of B. r a p a L. Cruc. Newsl. 9: 55-58.

U, N., 1935. Geonomic analysis in B r a s s i c a with special reference to the experimental formation of B. n a p u s and peculiar mode of fertilization. Jap. J. Bot. 7:389-452.