The Implications of Plant Taxonomy for Agricultural Research

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Plant taxonomy

The main objectives of plant taxonomy are to describe the Vegetable Kingdom, and to classify it in distinguishable unities (taxa, sing. taxon). The resulting classification has to reflect biosystematic relationships as revealed between taxa by modern botanical research, and unequivocal nomenclature rules have to be applied. Plant taxonomy has three aspects: identification, classification and nomenclature.

Identification

Plant taxonomy as a science is making use of similarities and differences. Based on similarities plants are grouped in one taxon. Separate taxa as such can be described by differences. The distinction, recognition and, as a consequence, identification of taxa are thus made possible by differences.

Classification

The process of comparison that will result in the hiërarchical arrangement of all taxa forming the Vegetable Kingdom is named classification.

The degree, in which differences determine the distinction of a taxon, is indicated by the rank of that taxon, or - to put it otherwise - by the systematic position of that taxon in the classification system. Some well-known ranks are: family, genus and species. Several genera can be attributed to a family; several species to a genus etc.

The rank of species is basal. Each individual plant can be assigned to a species. Although it seems to be almost impossible to define the term species, a species is generally considered as a population, within which individuals are capable to exchange genes freely, resulting in a fertile progeny. Consequently, evolutionary studies with respect to mutation, recombination, selection and isolation are commonly starting from the species. In some cases, it is possible to subdivide a species in infraspecific taxa (subspecies, botanical variety and forma).

Infraspecific taxa are based on discontinuities in the species variation, but the species continues to act as a genetic entity.

Nomenclature

It is necessary to have internationally agreed principles and rules for the nomenclature of taxa to warrant an unequivocal communication about plants.

These nomenclature principles and rules are laid down in the International Code of Botanical Nomenclature (ICBN, latest edition 1983). E.g. a genus name has to be a Latin or latinized substantif, starting with a capital (e.g. *Cucumis*). The names of species belonging to that genus are formed by adding a Latin epithet (e.g. *Cucumis sativus*), written in lower case.

In order to be legitimate, botanical names are subject to a number of conditions laid down in the ICBN:

- Concerning form and orthography, the name must be in accordance with the ICBN;
- The name must be validly published:
  a) it must be effectively published (e.g. in a well-distributed journal);
  b) it must be accompanied by a description or diagnosis (from January 1st 1935 onwards in Latin);
  c) the author must have indicated a nomenclatural type (from January 1st 1958 onwards this type must be cited in the publication).

The type method connects plant material and its name. In case of the name of a family, a genus, a species or a taxon of lower rank, the type is a well conserved specimen or, if this is not available, an illustration.

Illegitimate names do not satisfy the above mentioned conditions and are not taken into consideration in botanical nomenclature. In case several legitimate names exist for one taxon (synonymy), the principle of priority states that the first published name is the correct one for that taxon. In case one legitimate name has been assigned to several taxa (homonymy), the name must be attributed to that taxon for which it was first published. The priority does not date back further than May 1st 1753, the publication date of Species Plantarum ed. 1 by Linnaeus. In this book binomials were consequently applied for the first time to all included species names.

Taxonomy of cultivated plants

Cultivated plants are derived from wild or weedy plants. This process, domestication, means adaptation of plants to the man-made habitat. The way in which domestication proceeds depends on different factors:

- The duration and locality of human influence;
- The mode of human influence (direct-plant breeding; indirect);
- The human usage(s) of plants.

Therefore, the domestication effect can be expressed in a very different way and to a very different extent. Some cultivated plants so much resemble their wild or weedy parents, that they can hardly be distinguished.

Others, however, differ from their ancestors to such an extent that only detailed studies can reveal their biosystematic relationships.

Classification of cultivated plants

The classification of cultivated plants - and consequently their nomenclature - is complex, both because domestication effects can be interpreted in different ways and because they are subject to two essentially different approaches of classification:

- Botanical classification, reflecting biosystematic relationships between cultivated plants and their relatives;
- Agricultural classification, emphasizing characteristics significant in cultivation.

Nomenclature of cultivated plants

As far as not regulated by the ICBN, nomenclature of cultivated plants is governed by the

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Intenational Code of Nomenclature for Cultivated Plants (ICNCP, 1980). With respect to the term cultivar the ICNCP reads (art. 10): 'The international term cultivar denotes an assemblage of cultivated plants which is clearly distinguished by any character (morphological, physiological, cytological, chemical or others) and which, when reproduced (sexually or asexually) retains its distinguishing characters'.

The term cultivar has been introduced after the desirability was felt to make a clear distinction between botanical varieties and cultivars (cultivated varieties).

Botanical varieties are of a certain rank. They can be distinguished within a species, if the infraspecific variation is discontinuous to such an extent that naming of separate entities within that species makes sense.

A cultivar is an assemblage of cultivated plants obtained after selection and/or even botanical varieties dependent on their descendance. That is why they have no certain rank. Anyhow, they are always the lowest ranking entity to be distinguished. The mode of reproduction of cultivars may differ per crop. After reproduction the distinguishing characters must not be changed.

The many cultivars extant and the rapidly changing assortments necessitate flexible rules to name cultivars:

- Since January 1st of 1959 modern cultivars have to be indicated by a fancy name consisting of at most 3 words in a modern language, every word starting with a capital and attached to the botanical name. The abbreviation cv., has to be put between the botanical name and the cultivar epithet or the cultivar epithet has to be put between single quotation marks.
  Older cultivar epithets are allowed in the Latin form.
- Commercial synonyms of cultivar epithets are allowed.
- The principle of priority will not be absolutely applied. If instead of the oldest cultivar epithet a younger synonym is generally known, that synonym has to be considered correct.
- A cultivar epithet is legitimate if the cultivar has been described and published. At the same time descendance, breeder or winner may be indicated.

The indication of a nomenclatural type is not needed. It is, however, desirable to connect cultivar and cultivar name by means of living standard samples (seeds or plants), herbarium specimens, photographs, drawings etc.

Differences between cultivars are sometimes hard to be observed. Therefore, apart from the description, information about descendance, breeder or winner is important. Identification is facilitated if the original plant material (if it still exists) can be consulted for comparison.

Problems in naming cultivated plants

The nomenclature of cultivated plants meets with some problems, for which no generally accepted solutions are found yet.

According to the ICNCP, it is possible to place similar cultivars into a cultivar group if one has a large assortment of many cultivars.

The naming of cultivar groups is not yet unequivocally regulated, and, moreover, it is not clear whether cultivar groups should be based on botanical characters, or on characters important in agriculture.

Concerning nomenclature of cultivated plants, raised after interspecific or intergeneric hybridization, authors are let free choice whether they use the relevant rules of the ICBN, or of the ICNCP. This means that in taxonomically comparable situations different systems of nomenclature can be used. This aspect will have our attention in the near future.

Cultivated plants represent economic and juridical interests. Therefore name changes caused by changed opinions as to classification or by application of the principle of priority, necessitating a replacement of worldwide accepted names by older but unknown names, are bothersome. Several international organizations (EEC, ISTA, OECD, UPOV etc.) are dealing with the stabilization of plant names. This has resulted in the ISTA List of Stabilized Plant Names containing species names of economically important plants. Names on the list are fixed for a period of six years. In 1982 the Sydney Botanical Congress allowed the possibility to conserve species names.

These initiatives should lead to a stabilization of plant names in one list, allowing changes by exception. This will be an advantage in international trade, and eases the work in legal affairs.

Taxonomy of cultivated plants does play a role in our daily life as well. Terms like grains, vegetables and fruits are remnants of old classifications as can be found in herbals from the Renaissance period.

In our daily life we use crop names such as cucumber, lettuce, tomato, etc., knowing in these cases exactly what is meant. However, common crop names can differ very much in languages and can be interpreted in a completely different way. Therefore, the connection between scientific botanical names and common crop names is sometimes hard to find, but has to be found! The Multilingual Glossary of Common Plant Names, published by the ISTA, is a compilation of common crop names and their attached botanical name.

Functions of plant taxonomy in agricultural research

So far a short survey has been given of the field of plant taxonomy. Now we may ask which role plant taxonomy plays in agriculture, horticulture and silviculture. Three situations are to be distinguished:

- Some agricultural research especially registration trials, is not only using taxonomy but can even be considered to be a form of taxonomy;
- Taxonomy functions as an aid or starting point of various types of agricultural research;
- The results of taxonomic investigations are used in extension, education, trade and commerce, so in all social situations in which vegetable products are to be dealt with.

Registration trials

Registration trials describe, classify and names plant material; so it is taxonomic research, mainly of cultivated plants. The objective of this research is the distinction of assemblages of plants (cultivars).

An essential characteristic of a cultivar is that it also conforms to its description after reproduction or propagation. In this way it is possible to attach breeders's rights to a cultivar, which is a form of patenting. Only if such rights are connected with a distinct cultivar, it can be limited and maintained, and the duties connected with such rights can be defined and controlled.

Quality control of seeds and plants requires that the work of inspection services is based on defined cultivars.

Finally also performance trials make no sense at all if the conclusions cannot be attached to describable and fixed cultivars. For many of these activities registration is a necessity and often even a legal condition as laid down in national laws and EEC regulations. In these cases official examination trials are carried out by the authorities. In these trials distinctness, homogeneity and stability of varieties are studied.

In the case of breeder's rights the novelty of a cultivar plays an important role. The question is, whether the cultivar was not brought into circulation before the time of registration. The investigation is usually restricted to the check on accounts in variety lists, and on offers in advertisements or catalogues. In cases of doubt more data are collected. This part of registration research is in fact not a form of taxonomy. Thereagainst investigations with respect to distinctness, uniformity and stability (criteria laid down in legislations) are to be considered taxonomic research.

Distinctness

The term distinctness means that the concerning cultivar is clearly distinguished by one more important character from any other cultivar that was known at the time of registration. In this definition three complications are hidden asking for further explanation. The question whether a character is important, is usually approached as follows: It is a character which is important for identification. This answer does not help us very much. Maybe it is better to say that it concerns a character which shows clear states which can be properly described. This character should have played a role in the selection of the cultivar or should at least correlate with such characters. From this definition it is clear that the group important characters is subject to change and therefore has to be studied permanently.

How clear a difference has to be is somewhat more complicated, apart from qualitative characters showing discontinuous states. Two cultivars showing a difference for such a character are clearly distinguishable. This is not the case with quantitative characters. They show a gradual transition from state to state. Although within-cultivar variation must be smaller than between-cultivar variation, it is clear that the minimum distance

between cultivars is questionable and often subject to different opinions! Therefore research on distinctness asks for investigators of a comparable level of training and expertise. Characters to be measured such as sizes can be numerically analized. They are then influenced by the size of trials in place and time. International agreement on this point is desirable and for that reason an important subject of study for the International Union for the Protection of New Varieties of Plants (UPOV). Furthermore it has to be stated that although the difference between two cultivars is botanically obvious, their distance is at the same time so minimal that the legal effect of distinction can be doubtful.
Another more practical difficulty concerns the reference cultivars in the trials. Many crops contain a huge worldwide assortment of cultivars of which the survey is not easy, apart from the fact that it is not easy to have at one's disposal a living collection containing all these cultivars. For such crops an effective cultivar classification should be designed. With effective is meant, that the limits of classes are clear, that these limits can be maintained even after new developments in plant breeding, that the cultivars are equally divided over the classes and the number of cultivars within classes is restricted. Such classifications would ease registration work considerably.
For generatively reproduced crops, conservation is possible by means of seed storage. Vegetatively propagated crops are often conserved by means of descriptions, herbarium specimens, photographs, drawings, etc., although it can never replace the storage of living plant material.

Uniformity and stability
A cultivar must be uniform. This warrants the possibility to circumscribe the cultivar and it informs the user about the characteristics of the cultivar. Uniformity is of importance for the breeder too, because in case of heterogeneity it is relatively easy for his competitors to develop new cultivars from his cultivar.
Moreover, uniformity is a reasonable warrant for stability of the cultivar: If a breeder is capable to deliver a uniform sample to the registration office, he is mostly also capable to keep the variety stable.

Nomenclature
Naming is a typical taxonomic activity and is important for registration. In all cases in which plant material of cultivars is to be dealt with, names stand for an identifying description. Such names should not be confusing with respect to characters, provenance or origin of cultivars and should not resemble names of other cultivars in a confusing way. An important task of registration research is to screen the names on the mentioned conditions. Thereby data are collected from catalogues, registers, variety lists and other publications. In the near future the computer will play an important role in this work.

Plant taxonomy as an auxiliary science
The use of plant taxonomy as an auxiliary science has been formulated earlier as a situation distinct from registration trials which are in themselves taxonomic investigations. Theoretically this distinction is easy to make, but in practice it is hardly possible. This is illustrated by evaluation research which has registration as starting point, and which is descriptive. Registration implies, an objective procedure, whereas evaluation is more subjective. At registration one deals with descriptive terms like height, size, etc., at evaluation with terms like beautiful or ugly, good and bad, and tasteful, etc.
Taxonomy is obviously an auxiliary science where it concerns her relations to plant breeding: collecting, ordening and recognition of crossing populations enlarge the possible variation which can be used by the plant breeder. An example of co-operation is provided by the research programs of the Institute of Horticultural Plant Breeding (IVT) and the AU Department of Plant Taxonomy, both at Wageningen. Wild and weedy relatives of lettuce, cucumber, tulip and lilies are studied taxonomically, before designing interspecific hybridization programs. An example of interdisciplinary activity between plant taxonomy and plant breeding is provided by the research in Genetic Resources Centres. The main activities there are collecting, conserving, describing and ordening: typical taxonomic activities providing plant breeders with data on which they can rely for future breeding programs.
Concerning further agricultural research, it can generally be stated, that in all cases where plants are subject of investigations the results depend on the identity of the plant material concerned. This identity must therefore be determined, described and connected with a name and furthermore with voucher plant material to be stored. Then only a repeatability of the results is warranted.

Taxonomy in our daily life
Taxonomy is also important outside the field of research. Man wants to give a name to everything what he uses. He is also forced to classify to find his way between so many of plant species and cultivars.
Without names we cannot do much: plant products are asked and offered for sale under crop names or cultivar names. A name acts as an important bridge between plant and its performance. Therefore it seems logical that legislations, which make possible to attach rights and obligations to cultivars, make regulations with respect to nomenclature to protect consumer and user.
Nomenclature rules for botanical taxa, cultivars and cultivar groups as well are important for the relatively small group of botanists, and bear a general effect on human society.

Conclusion
Taxonomy deals with identification, classification and nomenclature. Parts of agricultural research like registration work must be considered a special form of taxonomy. In various other types of agricultural research dealing with plants, taxonomy acts as a basal auxiliary science.
The taxonomy of cultivated plants is in need of further research and refinement.

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Please find below the accounts we have outside the Netherlands:

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