Plant Names in Botanical Databases

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International Working Group on

Taxonomic Databases for Plant Sciences (TDWG)

TDWG was started in 1985 as an international working group to explore ideas on standardization and collaboration between major plant taxonomic database projects. Members include institutions and individuals responsible for botanical databases. TDWG is affiliated with the International Union of Biological Sciences (IUBS) as the Commission on Plant Taxonomic Databases. The goal of TDWG is to establish international collaboration among plant taxonomic database projects so as to promote wider and more effective dissemination and exchange of information.

TDWG recognizes that existing taxonomic databases will use different software, hardware, and file structures. The primary objective of the organization has been to promote common use and interpretation of terminology, data fields, dictionaries, and common logical rules and data relationships. To further this aim, TDWG forms working subgroups to develop standards and considers other standards developed independently by institutions and individuals. TDWG annual meetings provide a forum for discussing the form and content of the proposed standards, for voting on the adoption of standards, and discussing other aspects of taxonomic databases. The standards adopted by TDWG are made available in published form so that those responsible for taxonomic databases may consider them, both in the planning of new projects and in the management of existing ones.

For those initiating a new project, the standards illustrate how at least several other databases have thought it best to go about a task avoiding repetition of design effort and illustrating how to overcome difficulties that may be encountered. If the decision is made to use a standard for a particular database (a completely voluntary decision, of

course), it becomes easier to exchange data or collaborate with a growing community of other databases using the same standard. Organizers of established databases may find that the standards suggest ways of organizing data for communication and may want to consider these internationally developed standards in future revisions of their data structure and content.

The standards published by TDWG will be enhanced and updated when considered necessary. All correspondence should be sent to the TDWG Secretariat. Anyone interested in the development of plant taxonomic databases is encouraged to become a member of TDWG (there are both institutional and personal members), to attend the annual discussion meetings, and to receive the TDWG Newsletter.

A list of TDWG members and a list of standards published or endorsed by TDWG follows.

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Xu Kexue (China)

Standards Currently Endorsed by TDWG

TDWG Publication Series

Data Exchange

Botanic Gardens Conservation Secretariat. 1987. The International Transfer Format for Botanic Garden Plant Records. Plant Taxonomic Database Standards No. 1. Pittsburgh: Hunt Institute for Botanical Documentation. (*A standard adopted by botanic gardens for recording and exchanging specimen data.*)

Geography

Hollis, S. and R. K. Brummitt. 1992. World Geographical Scheme for Recording Plant Distributions. Plant Taxonomic Database Standards No. 2. Pittsburgh: Hunt Institute for Botanical Documentation. (*A system of geographical units for recording plant distributions*.)

Other Published Standards

Adopted by TDWG

Authors

Brummitt, R. K. and C. E. Powell, Eds. 1992. Authors of Plant Names. Kew: Royal Botanic Gardens. 731 p. (*Names and abbreviations for botanical authors.*)

Bibliographic Citations

Bridson, G. D. R. and E. R. Smith. 1991. Botanico-Periodicum-Huntianum/Supplementum Pittsburgh, Hunt Institute for Botanical Documentation. 1068 pp. (*Supplement to 1968 Edition.*)

Lawrence, G. H. M., et al., Eds. 1968. Botanico-Periodicum-Huntianum. Pittsburgh: Hunt Botanical Library. 1063 pp. (*Abbreviations for titles of periodicals.*)

Stafleu, F. A. and R. S. Cowan. 1976 *et seq.*. Taxonomic Literature, 2nd Ed. Vols. 1-7. Utrecht: Bohn, Scheltema & Holkema. (*Abbreviations for titles of books.*)

Data Exchange

Dallwitz, M. J. and T. A. Paine. 1986. User's Guide to the DELTA System, pp. 3-6. Canberra: CSIRO Division of Entomology Report No. 13. (*TDWG has endorsed the DELTA format for recording and exchanging descriptive data. Several suites of identification and description-writing programs use this format.*)

Standards in Preparation

Data Exchange

TDWG Subgroup seeking an accessions exchange format for specimen data. Contact the convener, Jim Beach, through the TDWG Secretariat.

XDF. A Language for the Definition and Exchange of Biological Data Sets. (TDWG has adopted this standard prepared by Bob Allkin, Royal Botanic Garden, Kew, and Richard White, University of Southampton working with a TDWG Subgroup. XDF is a data definition language that can serve as a medium for defining transfer formats for use between databases with incompatible formats.)

Economic Use Descriptors

TDWG Subgroup seeking a simple system of wide applicability to categorize the economic uses of plants. Contact the convener, Frances Cook, through the TDWG Secretariat.

Habitat, Soil and Landscape Descriptors

TDWG Subgroup seeking a simple system that can be used worldwide to categorize the habitat, soil type and landscape in which a plant occurs. Contact the convener, Mike Lock, through the TDWG Secretariat.

Life-form Descriptors

TDWG Subgroup attempting to identify a small set of universal descriptors that can be applied to the life- forms of plants. Contact the convener, Richard Pankhurst, through the TDWG Secretariat.

Plant Occurrence Descriptors

Plant Occurrence and Status Scheme (POSS). (TDWG has adopted the standard prepared by Christine Leon, Duncan Mackinder, Peter Rooney and Hugh Synge, at the World Conservation Monitoring Centre, working with a TDWG subgroup. It provides a scheme for recording the status of a plant in an area.)

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Name element 4: Species epithet

Name element 5: Aggregate marker

Name element 6: Species author string

Name element 7: Infraspecific epithet or cultivar group name

Name element 8: Cultivar group marker

Name element 9: Infraspecific marker

Name element 10: Infraspecific author string

Name element 11: Cultivar marker

Name element 12: Cultivar name

Introduction

The purpose of this standard is to specify how the scientific names of plants may be organised in botanical databases. Most botanists are not only aware that plant species are specified by latinised binomial scientific names, but also that more detailed specification may be achieved by giving the subspecies name for a wild plant or the cultivar name for a cultivated one. But they may be less confident on how to deal precisely with hybrids, species aggregates or cultivar groups. These are plant categories which may be completely absent from some databases, of significance in others, and occurring as rare nuisances in yet others. The value or otherwise of including authors of names may be uncertain. Or the way in which synonyms should be treated may present several possibilities. For all of these situations the purpose of the standard is to clarify what may be needed to specify the plants in a database and to suggest a common logical organisation within the database.

One important question is the choice of elements of scientific names needed in a database to specify precisely the plants referred to, and how they are to be represented. These name elements are as laid down for general use in the International Code of Botanical Nomenclature (Greuter et al., 1994) and the International Code of Nomenclature for Cultivated Plants (ICNCP, 1980), of which there are invaluable summaries in Jeffrey (1989). A second important question is how to organise the chosen elements logically so that they function correctly in a database. And lastly, if the same level of precision and the same logical structure can be adopted as standard by several botanical databases, then it may be possible to exchange, merge or compare data from different databases. TDWG is very much aware that a document such as this will only become a genuine standard if its content comes to be endorsed and used in the botanical database community.

The standard needs to be flexible as it is evident that the needs of databases may be very diverse. At one extreme are systems where the decision is whether or not to include scientific names at all: Some natural history societies, some nature reserves and city parks, some conservation centres may be embarked on databases where they require the absolute minimum to specify a plant species. At the centre of the scale may be elaborate databases in which specifying plants is a side issue: databases of chemicals, of world climate and vegetation zones, of land use and farming, or of plant physiology, in which the desire is to use precise specific names but without close attention to absolute precision as regards authors and homonymy, synonymy, species aggregates etc. At the other extreme are the taxonomic reference databases designed as sources giving as near as is possible absolute precision over details of taxonomy. As these databases will be used as sources for taxonomic data, every feature needed to dispel ambiguity must be used.

To accommodate these variations and yet give a precise system that can be uniformly applied, the standard is divided into four variants.

1) Level 1A (Limited Standard) - Species (with aggregates & hybrids) only.

2) Level 1B (Limited Standard) - Species, aggregates, hybrids, with infraspecific taxa.

3) Level 2A (Full Standard) - Species (with aggregates & hybrids) only, with authors and references.

4) Level 2B (Full Standard) - Species, aggregates, hybrids, with infraspecific taxa, and with authors and references.

The Level 1 (Limited Standard) differs from the Level 2 (Full Standard) primarily by the omission of authors of names. References may also be used in Level 2. While the omission of authors may save much effort and simplify the database created, it must be recognised that there are cases where Level 1 does not allow complete taxonomic precision as to which plant is meant. In particular the assumption must be made that every plant name occurring in the dataset has been used in the correct taxonomic usage of

that name: an assumption which may be correct in the majority of instances of ambiguities (such as homonyms), but will not be true in all cases.

The Summary section of this introduction gives examples of plant names as they would be used under the various levels of this standard followed by a table listing the name elements covered in this standard and whether they are "required," "not required," or "optional" at each level.

Technical Content

This standard defines the taxonomic and nomenclatural concepts associated with the names of plants. It describes the component parts, their functions and their interrelations of significance in structuring a database. The appendices provide an outline of a preliminary data dictionary illustrating possible elements and their properties. It does not provide a data model or a data format. A data model will be considered at a later date by the TDWG Sub-group considering this standard. Another TDWG Sub-group is preparing XDF, an EXchange Data Format (Allkin & White,1989; White & Allkin, 1992), which provides a language for defining a range of exchange formats for use between taxonomic databases.

In the examples given in the text, the Latin parts of plant names are printed in italics, as is traditional in much botanical literature. It should be noted, however, that the ASCII character set of most computers does not contain italic symbols, and these names are normally held in the computer as ordinary letters. There is similarly, a need to represent the multiplication sign of hybrid names as the letter x when there is no multiplication sign in the character set.

Relationship to Other Data Standards

Several of the elements in this standard overlap with those specified in the first TDWG Standard, the International Transfer Format for Botanic Garden Plant Records (IUCN/WWF, 1987). The names fields in that document constitute a more restricted fixed format intended for specialist use in botanic gardens, corresponding to Level 1A (Limited Standard) of this document. This document defines concepts rather than any particular implementation. It is intended for use in a much wider range of contexts including taxon-based databases such as taxonomic databases, species diversity and species conservation databases, as well as all manner of databases which refer to taxa or to accessions and specimens.

Two other standards cover some of the same fields although in more restricted contexts, HISPID (Herbarium Information Standards and Protocols for Interchange of Data, Croft, 1990, unpublished) and CHIN (Natural Sciences Data Directory of the Canadian Heritage

Information Network, Delroy et al., 1988). The CHIN Standard contains a number of implementation specific features and only partly meets the requirements. The HISPID standard is more complete and cross-references earlier editions of this document. Cross-reference is made to both of these for comparison under entries in the Appendix.

This document does not give details for the contents of the author citations or of bibliographic citations as these are documented by other standards being developed or adopted by TDWG. For details of author citations the "abbreviations" of Meikle (1984) should be replaced by the "recommended forms" in Brummitt & Powell (1992). For bibliographic citations of older books use the "short titles" in TL-2 (Stafleu & Cowan, 1976-1986). For journal citations use BPH/s (Bridson,1991) in association with BPH (Lawrence *et al*., 1968).

Contributions to this Document

The idea of a "minimum standard for names in botanical databases" arose at the Taxonomy Laboratory at Southampton University in discussions involving R Allkin, R J White, F A Bisby and a number of others-R M Polhill, J M Lock (RBG Kew), J L Zarucchi (St. Louis), H Synge & D C Mackinder (WCMC), P J Winfield (DAFS, Edinburgh) and S Hollis (ILDIS, Southampton). A formal sub-group was appointed at the 3rd meeting of TDWG and discussion has continued since 1988. Because of some debate as to the correct purpose and title for the standard, the earlier documents are listed here:

Allkin. TDWG 1986. Minimum function nomenclator

Bisby, White & Allkin. TDWG 1987. Minimum species checklist module

Bisby. TDWG 1988. Minimum function nomenclator

Bisby. TDWG 1989. Plant names in botanical databases

Acknowledgements

Thanks are due to the many people who have assisted with the document: J C R Alexander, S Andrews, R Allkin, W Berendsohn, R K Brummitt, D F Chamberlain, M J E Coode, E Farr, W R Greuter, S Hollis, J M Lock, D C Mackinder, R E Magill, J McNeill, D H Nicolson, R M Polhill, G F Russell, H Synge, R J White, P J Winfield, J L Zarucchi, C Zellweger.

Summary

Examples of plant names in botanical databases

1) Level 1A - Species, Aggregates & Hybrids only

Vicia faba
Taraxacum officinale agg.
Spartina ×townsendii

2) Level 1B - Species, Aggregates & Hybrids with infraspecific taxa

Vicia sativa subsp. *nigra*
Vicia johannis var. *procumbens*
Pisum sativum cv. Meteor

3) Level 2A - Species, Aggregates & Hybrids only, with Authors and References

Vicia faba L.
Taraxacum officinale agg.
Spartina ×townsendii H.Groves & J.Groves

4) Level 2B - Species, Aggregates and Hybrids with Infraspecific Taxa, and with Authors and References.

Vicia sativa subsp. *nigra* (L.) Ehrh.
Vicia johannis var. *procumbens* H.I. Schäf.
Pisum sativum L. cv. Meteor

	Limited Standard		**Full Standard**	
	1A	**1B**	**2A**	**2B**
For each taxon				

Taxon name (a full plant name)	+	+	+	+
Synonym (a full plant name)	(+)	(+)	(+)	(+)
Parts of a full plant name				
Intergeneric hybrid marker	(+)	(+)	(+)	(+)
Genus name	+	+	+	+
Interspecific hybrid marker	(+)	(+)	(+)	(+)
Aggregate marker	(+)	(+)	(+)	(+)
Species epithet	+	(+)	+	(+)
Species author string	-	-	+	(+)
Infraspecific marker	-	(+)	(*)	(+)
Infraspecific epithet/Cultivar group name	-	(+)	(*)	(+)
Cultivar group marker	-	(+)	(-)	(+)
Infraspecific author string	-	-	(*)	(+)
Cultivar marker	-	(+)	-	(+)
Cultivar name	-	(+)	-	(+)
Name status flags if name is a taxon name				
Flag 1: Taxon name status flag	-	-	(+)	(+)
Flag 2: Homonyms	-	-	(+)	(+)
Name status flags if name is a synonym				
Flag 2: Homonyms	-	-	(+)	(+)
Flag 3: Doubtful synonym	-	-	(+)	(+)
Flag 4: *Pro Parte* synonym	-	-	(+)	(+)
Flag 5: Misapplied name	-	-	(+)	(+)

Reference citations for each full plant name				
Original publication	-	-	opt.	opt.
Name status reference	-	-	opt.	opt.
Usage reference	-	-	opt.	opt.

+ = required in all taxa

- = not required

opt. = optional

(*) = infraspecific names occurring in synonyms

(+) = required when appropriate

The Structure and Organisation of Plant Names

1 Taxa

The standard defines elements needed to specify the binomial scientific names of plant species, species aggregates, named interspecific hybrids and named intergeneric hybrids with precision. It also accommodates the trinomials needed for infraspecific taxa, cultivar groups and cultivars.

2 Name Elements

This section of the text specifies the name elements needed to compose the full names of taxa at all plant categories from species aggregate down to cultivar. The list of categories covered is:

Species aggregate
Species
Intergeneric hybrid
Interspecific hybrid
Subspecies
Botanical variety (Subvariety, Forma etc.)
Cultivar group
Cultivar

As explained in the text section 4 (Classes of names), each such full name may be the name of a taxon (the "taxon name") or a synonym for the name of a taxon.

Species

The full name of a species is composed of two parts, the genus name and the specific epithet, plus the author string.

Pisum sativum L.

Pisum	genus name
sativum	species epithet
L.	author string

Species aggregate

The full name of a species aggregate is composed of two parts plus the aggregate marker "agg.". Species aggregate names do not have an author string.

Taraxacum officinale agg.

Taraxacum	genus name
officinale	species epithet
agg.	ggregate marker

Intergeneric hybrids (and graft chimaeras)

The full name of an intergeneric hybrid has in addition an "x" (lower case alphabetic x symbol) preceding the generic name as a generic hybrid marker. Similarly the name of an intergeneric graft-chimaera is preceded by a "+" (plus symbol). The lower case x symbol is used instead of the multiplication sign, which is not available in the ASCII character set of most computers. Wherever possible this symbol should be converted back to a multiplication sign in typesetting or printing operations. To distinguish the marker from the following name, a space should separate them in data files.

× *Cupressocyparis leylandii* (A.B. Jacks. & Dallim.) Dallim.

×	intergeneric hybrid marker
Cupressocyparis	genus name
leylandii	species epithet
(A.B. Jacks. & Dallim.) Dallim.	author string

Interspecific hybrids (and graft chimaeras)

The full name of a named interspecific hybrid or chimaera has in addition an "x" (lower case alphabetic x) or "+" (plus sign) preceding the species epithet. As above, the alphabetic x substitutes for a multiplication sign.

Spartina × *townsendii* H.Groves & J.Groves

Spartina	genus name
×	interspecific hybrid marker
townsendii	species epithet
H.Groves & J.Groves	author string

The full name of an interspecific hybrid that has not been named, that is one given by hybrid formula, is composed of two parts, the genus name and the hybrid formula. The hybrid formula is given in place of the species epithet element. Again an alphabetic x substitutes for a multiplication sign.

Primula veris × *vulgaris*

Primula	genus name
veris × *vulgaris*	hybrid formula

Infraspecific Categories

The three most widely used infraspecific categories are subspecies, botanical variety (both applicable to wild plants or wild plants brought into cultivation), and cultivar group (for groups of man-made cultivars). The phrase "botanical variety" is used here to avoid confusion with the cultivar: both are referred to as "varieties" in common parlance amongst botanists.

Other infraspecific ranks permitted by the ICBN but rarely used are subvar. (botanical subvariety, beneath the botanical variety), forma (form, beneath the botanical subvariety) and subforma (subform, beneath the form). Trinomial names for these are constructed in the same way as for subspecies and botanical varieties.

a) Subspecies

The full name of a subspecies is composed of three name parts plus the subspecies marker "subsp." plus the species author string and the subspecies author string. The name parts are: genus name, species epithet, subspecies epithet. An exception is that where the subspecies epithet is the same as the species epithet (an autonym), there is no subspecies author.

Pisum sativum L. subsp. *arvense* Poir.

Pisum	genus name
sativum	species epithet

L.	species author string
subsp.	infraspecific marker - subspecies
arvense	infraspecific epithet
Poir.	infraspecific author string

b) Botanical Variety (Subvariety, Forma etc.)

The full name of a botanical variety is composed of three name parts plus the variety marker "var." plus the species author string and the variety author string. An exception is that where the variety epithet is the same as the species epithet (an autonym), there is no variety author.

Vicia johannis Tamamsch. var. *procumbens* H.I.Schäf.

Vicia	genus name
johannis	species epithet
Tamamsch.	species author string
var.	infraspecific marker - botanical variety
procumbens	infraspecific epithet
H.I.Schäf.	infraspecific author string

It is correct and precise to reduce a name that gives several infraspecific categories to only one infraspecific category. Thus a botanical variety or forma name given as a quadrinomial or pentanomial should be entered as a trinomial using only the lowest infraspecific category of those given.

For: *Heracleum sphondylium* subsp. *sibiricum* var. *lecokii*

enter: *Heracleum sphondylium* var. *lecokii*

A similar trinomial structure is used for subvariety, forma and subforma.

c) Cultivar group

The full name of each cultivar group is composed of three name parts (genus name, species epithet and cultivar group name) plus the cultivar group marker and the species author. However, in some cases where the cultivar group is of interspecific or uncertain origin, it is composed of just two parts, the genus name and cultivar group name. (The "cultivar group" is widely used as the principal recognisable grouping of cultivars within plant species where there are many cultivars. However this is an informal usage and the present ICNCP refers only to "groups"). There is no author string for a cultivar group name.

Vicia faba L. Longpod Group

Vicia	genus name

faba	species epithet
L.	species author string
Longpod	cultivar group name
Group	cultivar group marker

Rosa Hybrid-Tea Group

Rosa	genus name
Hybrid-Tea	cultivar group name
Group	cultivar group marker

Cultivar

The full name of a cultivar can have three different forms. The commonest is three name parts (genus name, species epithet, and cultivar name) plus the cultivar marker and the species author string.

Vicia faba L. cv. Aquadulce

Vicia	genus name
faba	species epithet
L.	species author string
cv.	cultivar marker
Aquadulce	cultivar name

An alternative presentation of the same name is to use single quotation marks as the cultivar marker, so that the name would appear in printout as follows:

Vicia faba L. 'Aquadulce'

The full name of a cultivar can also require the inclusion of the cultivar group where there is the possibility of identical cultivar names occurring in several cultivar groups of the same species. In such a case the cultivar group and cultivar group marker are given in round brackets.

Pisum sativum L. (Sugar Pea Group) cv. Olympia
or
Pisum sativum L. (Sugar Pea Group) 'Olympia'

Pisum	genus name
sativum	species epithet
L.	species author string
Sugar Pea	cultivar group name
Group	cultivar group marker

cv.	cultivar marker
Olympia	cultivar name

There are also cases where the cultivar is of hybrid or uncertain origin and the full name is composed of just two parts, genus name and cultivar name plus cultivar marker.

Rhododendron cv. Christmas Cheer
or
Rhododendron 'Christmas Cheer'

Rhododendron	genus name
cv.	cultivar marker
Christmas Cheer	cultivar name

There is no author string for a cultivar name.

3 Author Strings

Specific and, where appropriate, infraspecific author strings are part of the Level 2 (Full Standard) so that it is possible to distinguish between homonyms, between the correct and misapplied versions of a misapplied name, and between *pro parte* synonyms. Note that there is no infraspecific author string for cultivar names, or for infraspecific autonyms. Also there is no author string for a species aggregate name or cultivar group.

The minimum required by the Level 2 (Full standard) is just the validating author or authors names, or "sensu… " for misapplications, and not what a taxonomist would think of as the full author citation.

i) "non" and following authors should be omitted

ii) "ex" and preceding authors may be omitted if so desired

iii) "in" and following phrases can be omitted and, if required, the reference be placed in the bibliography

iv) parenthetical author strings should be retained.

Author names are often abbreviated in author strings, although the full author names are permitted. The TDWG-adopted standard used until recently was the system of "approved abbreviations" given in Meikle, 1984. TDWG has now adopted the "standard forms" given in Brummitt and Powell, 1992 and it is expected that this will gradually replace the former system.

4 Classes of Names

The two classes of names are taxon names and synonyms.

Taxon names

Each taxon must have one taxon name (and only one). When taken as a whole, including the author string, this name must be unique amongst the taxon names and synonyms in the database. Exceptions to this rule, which can be handled at Level 2 (Full Standard), are that the identical name may also occur amongst the synonyms of another taxon as a *pro parte* synonym or as a misapplied name.

There are two classes of taxon name, the accepted name and the provisionally accepted name. Each taxon must have either one accepted name or one provisionally accepted name.

The taxon name is the preferred name by which the compiler, or compilers, of the dataset intend the taxon to be known.

Acceptance/Provisional Acceptance (Flag 1)

The accepted name is the name currently accepted for referring to the taxon by the compiler or editor of the dataset. A taxon may have at most one.

The provisionally accepted name is the name currently accepted for the taxon by the dataset compiler, but with some element of doubt. This could be taxonomic doubt, about say the existence or distinctness of the taxon, or nomenclatural doubt, say if there is a technical problem with the name. This tentative status provides a device for keeping data for this taxon despite doubt about its taxonomy or its nomenclature. It may serve to alert others that clarification is needed, or be used by the database compilers as a temporary status. There may be occasions when it is judicious to omit these taxa from printouts etc.

A taxon may have only one provisionally accepted name, and then only if there is no accepted name.

Synonyms

Synonyms are defined loosely to include true synonyms, orthographic variants and misapplied names.

a) True Synonyms

A synonym is a full name different from the taxon name and which is, or has been, used elsewhere for a taxon (or for part of a taxon, or for another taxon which is now included in the present taxon).

Each synonym (with the exception of *pro parte* synonyms) is linked to one taxon. There may be from zero to many synonyms linked in this way to one taxon. It is usual that the

database be capable of handling synonyms, but the degree of completeness in entering synonyms is optional. For many botanical databases just the few synonyms commonly encountered will suffice. Full enumeration as used by taxonomists is possible, but will only rarely be needed by botanists in general.

A number of subclasses of synonym exist. The software used should be capable of flagging these independently. The subclasses are not mutually exclusive although only a few combinations are likely to occur and even those rarely. For example a name can be both a doubtful synonym and a *pro parte* synonym.

b) Orthographic Variants

An orthographic variant is an incorrect spelling variant of a name. This may occur either because the original spelling was wrong and has been corrected, or because spelling variants introduced subsequently are wrong and the original is correct. An orthographic variant may be included because it is a variant of either the taxon name, or a synonym.

A compromise is adopted: Incorrect orthographic variants are linked as if synonyms to the taxon with its taxon name. (Strictly the orthographic variant is only a variant of the name and might be linked just to that name, but if that name is itself a synonym, this leads to chained links which have some disadvantages.)

Homonym (Flag 2)

Homonyms occur when two full names have the same genus name and species epithet, but different author strings. Most arise by the accident of different taxonomists giving the same name to different plants. At most, one of them can be a taxon name (either accepted or provisional): others are synonyms. (Very rarely the author string can be the same, in which case the year of publication, or even the page of publication should be included in the author string to make the homonyms distinguishable. There are also some very rare cases where the ICBN rules that slightly different spellings are treated as homonyms.) In the case of a misapplied name there will normally be one homonym, the same name in its correct usage. Homonyms cannot be distinguished in the Level 1 (Limited Standard), a shortcoming of omitting author strings. The homonym flag is set for each full name partner in a homonymy.

Doubtful Synonym (Flag 3)

A doubtful synonym is a name thought by the compiler to be a synonym but with some element of doubt. Examples would be an unpublished name, or when the synonymy has never been published, or when the type cannot be traced. It may be appropriate to include these in a database, to avoid losing associated information, but also on occasion to omit them from the printouts or publications.

Pro Parte synonym (Flag 4)

A polymorphic taxon is sometimes subsequently split into several taxa. The name of the original taxon is then a *pro parte* synonym of the two or more new taxon names, because part of the original group of plants is now in one taxon, part in another. Nomenclatural rules require that one of the new taxa (the one to which the original type belongs) takes the same name as the original, the other takes a new name. The *pro parte* synonym should be entered two or several times, once for each *pro parte* synonym. All of the name entries (including the one involving the type, that would not be marked in normal usage) must have the *pro parte* flag set.

Misapplied Name (Flag 5)

A misapplied name is treated similarly to a synonym-it is linked to a taxon with another name as its taxon name, the taxon to which it has at some time been wrongly applied. The misapplied name is entered to the database twice, and marked by setting the misapplied name flag for the one, always a synonym, which is misapplied. The homonym flag is set for both the correct and the misapplied entries of the name. By using the two flags in concerted fashion it is possible for software to warn the user that when a certain name has been located, this name has been used elsewhere in a misapplication.

5 Citation of References

An optional feature is to link one or more references to a full name. There are three classes of citation.

Original Publication:

Reference is made to the original publication of the full name as entered to the database. This is the original or "validating" publication of the binomial, or trinomial combination and not of the basionym.

Status Reference:

This is a reference to the publication establishing the status of the name as adopted by the compiler. In the case of an accepted name this may sometimes be the same as the original publication although some database projects prefer modern Floras or monographs. In other cases it may be a paper that makes a synonymy or corrects a misapplication or orthographic variant. A misapplication is only made precise if the publication committing the misapplication is listed as well.

Usage Reference:

This a reference to a work (often a recent, much-used or much-respected work) to cite taxonomic opinion or usage.

There are separate TDWG standards for the citation and abbreviation of references. Books are cited with the short titles given in TL-2 (Stafleu & Cowan, 1976-1986).

Journals are cited using abbreviations from the recently published BPH/S (Bridson,1991) used in conjunction with BPH (Lawrence *et al*., 1968).

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APPENDIX 1:

TABULATION OF CONCEPTS AND FLAGS

No. 1. Concept: Taxon name

Content:	• The full name considered by the compiler of the dataset to be the one by which the taxon should be known.			
Composed of:	• Any full name (see definition No.6, Full name)			
Example:	(Full Standard)		*Vicia faba* L.	
		or	(Limited Standard)	*Vicia faba*
Rules:	• Each taxon must be represented by one taxon name only. • The taxon name must be unique amongst taxon names in the dataset. • The taxon name may be identical to a synonym elsewhere in the dataset in all elements except the author strings, provided that the homonym marker is set.			
Other Standards:	• Implied but not specified in ITF, CHIN, HISPID.			

No. 2. Flag 1: Taxon name status flag

Content: • A flag to indicate whether the taxon name is according to the compiler:
i) the Accepted Name for the taxon
or ii) the Provisionally Accepted Name for the taxon

Composed of: • An internal flag with values such as A and T.

Other Standards: • No equivalent.

No. 3. Flag 2: Taxon name homonym flag

Content: • A flag to indicate that the taxon name is a homonym of a synonym elsewhere in the dataset.

Other Standards: • No equivalent.

No. 4. Concept: Synonym

Content: • Any full name that has been applied to a particular taxon, that differs from the taxon name, and which the compiler of the dataset wishes to enter. This is a loose definition and includes all sorts of synonyms, alternative usable names, incorrect orthographic variants of both the taxon name and other synonyms, and misapplied names and orthographic variants.

Composed of: • Any full name (see definition no. 6, Full name).

Other Standards: • Field 2450 in CHIN allows multiple entries.
• Synonym may occur in Prior name field in HISPID.

No. 5. Synonym status flags

Flag 2: • Set if the synonym is a homonym of either one or more synonyms or one taxon name elsewhere in the dataset.

Flag 3: • Set if the synonym is doubtful.

Flag 4: • Set if the synonym is a *pro parte* synonym, including the case of the *pro parte* synonym that includes the type.

Flag 5: • Set if the synonym is a misapplied name.

Rules: • A synonym can only be entered to the dataset if it can be assigned to a particular taxon whose taxon name is already in the dataset. The provisionally accepted name (Flag 1) and doubtful synonym (Flag 3) may be used to allow data to be entered even where there is doubt.
• All partners in a homonymy must be marked with synonym Flag 2, whether they be other synonyms or a taxon name.
• All partners in a *pro parte* synonym must be marked with Synonym Flag 4.
• A Synonym must be uniquely attached to one taxon in the dataset unless it has Flag 4 set (it is a *pro parte* synonym), or it has Flag 5 set in all but one of its occurrences (it has been misapplied).
• The Latin elements in a synonym must be unique in the dataset amongst synonyms and taxon names, unless it is a homonym (flag 2 set), a *pro parte* synonym (flag 4 set), or a name misapplied here (flag 5 set) or elsewhere.

Other Standards: • No equivalent.

No. 6. Concept: Full Name

Content: • The full name is the complete name of a plant composed of all its name elements.

Composed of: • Two or more of the following name elements in the following order:

1 Intergeneric hybrid (or chimaera) marker
2 Genus name
3 Interspecific hybrid (or chimaera) marker
4 Species epithet
5 Aggregate marker
6 (Species author string) - Full Standard only
7 Infraspecific epithet or cultivar group name
8 Cultivar group marker
9 Infraspecific marker
10 (Infraspecific author string) - Full Standard only
11 Cultivar marker
12 Cultivar name

• Each name element is separated from the next in output by one or more spaces.

Examples: Full Standard Limited Standard

Vicia faba L.	*Vicia faba*
Taraxacum officinale agg. × *Cupressocyparis leylandii* (A.B. Jacks & Dallim) Dallim.	*Taraxacum officinale* agg. × *Cupressocyparis leylandii*
Spartina × *townsendii* H. Groves & J. Groves	*Spartina* × *townsendii*
Vicia sativa subsp. *nigra* (L.) Ehrh.	*Vicia sativa* subsp. *nigra*
Vicia johannis var. *procumbens* H.I. Schäf	*Vicia johannis* var. *procumbens*
Pisum sativum L. cv. Meteor	*Pisum sativum* cv. Meteor

Rules:
- The full name is composed of the genus name plus other name.
- Elements as appropriate under rules for each name element.

Other Standards:
- Implied in ITF, CHIN and HISPID.

APPENDIX 2:

TABULATION OF NAME ELEMENTS AND MARKERS

Name element 1: Intergeneric hybrid (or chimaera) marker

Content:
- An "× " or "+" placed before a hybrid or chimaera genus name.

Composed of:
- x (lower case alphabetic x) or + (addition sign).

Examples:

× *Cupressocyparis leylandii*
+ *Crataegomespilus dardarii*

Rules:
- Each full name of an intergeneric hybrid must include the × marker.
- Each full name of an intergeneric chimaera must include the + marker.
- The alphabetic x substitutes in computers for the multiplication sign specified by the International Code of Botanical Nomenclature. Whenever possible it should be replaced by a multiplication sign in printed output.
- In printout the x (or multiplication sign, × , if available) or + is normally printed adjacent to the name with no intervening space.

However, in data files they should be separated by a space to ensure that the marker is not confused with the first letter of the name.

Other Standards: • In ITF and HISPID; unspecified in CHIN.

Name element 2: Genus name

Content:
- Scientific name of the genus to which the full name belongs.
- Includes hybrid genus name of intergeneric hybrids.
- Includes chimaera genus name of intergeneric chimaera.

Composed of:
- Alphabetic symbols (A-Z, a-z), optionally including a hyphen (-) and diaeresis (ë, ï).
- Initial symbol in upper case alphabetic symbol (A-Z), and sometimes the first symbol after a hyphen.
- Remaining symbols in lower case (a-z) or hyphen (-).
- There is no limit to the length of a genus name, but 22 symbols is thought to the longest.

Example:
Aloe
Pisum
Taraxacum
Cupressocyparis
Drake-Brockmannia

Rules:
- Genus name is a compulsory element in every name for species, species aggregate, intergeneric hybrid, interspecific hybrid, subspecies, botanical variety cultivar group or cultivar.
- Just one genus name in each full name.

Other Standards: • In ITF and HISPID. CHIN allows multiple entries in Field 2140.

Name element 3: Interspecific hybrid (or chimaera) marker

Content:
- The × marker for named interspecific hybrids or the + marker for named interspecific chimaeras.

Composed of:
- "× " (lower case alphabetic x) or "+" (addition sign).

Example:
Spartina × *townsendii*

Rules:

• Each full name of a named interspecific hybrid must contain the × symbol. This is placed before the species epithet without an intervening space in printed output. However, it should be separated in data files by an intervening space to ensure that it is not confused with the first letter of the name.
• Each full name of a named interspecific chimaera must contain the + symbol placed before the species epithet.

Other Standards:

• ITF, HISPID; not specified in CHIN.

Name element 4: Species epithet

Content:

• The single word epithet for the species to which the full name belongs, or occasionally the phrase sp.1 or sp.2, etc. or sp.A, etc. for as yet unnamed species, or occasionally the formula name of an interspecific hybrid.
• Includes species epithet for named interspecific hybrids.

Composed of:

• Alphabetic symbols (a-z), optionally including hyphens (-), and the diaeresis (ë,ï). Accents are forbidden.
• Alphabetic symbols all in lower case (a-z).
• Initial symbol a lower case alphabetic symbol (a-z).
• Alternatively phrases such as "sp.1" or "sp.A" including additionally a full stop (.) and a numeric symbol (1-9) or upper case symbol (A-Z).

• Hybrid formula names composed of an epithet, an "x" in lieu of a multiplication sign and a second epithet. Ideally these are printed in output with the generic name inserted twice as in the *Primula* example below.

• There is no limit on the length of species epithets, but 22 symbols is likely to be the longest encountered. Because of hybrid formulae, a maximum of 47 symbols can be anticipated.

Examples:

sativum
townsendii
sur
rosa-da-monte
sp.1
zimbabweënsis
veris × *vulgaris* (ideally printed as *Primula veris* × *Primula vulgaris*, if in the genus *Primula*)

Rules:
- Species epithet is a compulsory element in every full name for species, species aggregate, intergeneric hybrid, interspecific hybrid, subspecies, botanical variety.
- Just one species epithet in each full name.
- In cases involving sp.1, sp.2, sp.A, sp.B, etc. a check must be made that this phrase is unique in the database when taken in combination with the genus name.
- Species epithet may be omitted in the full name of some cultivar groups and cultivars.

Other Standards:
- In ITF and HISPID. CHIN allows multiple entries in Field 2180.

Name element 5: Aggregate marker

Content:
- A marker for species aggregates.

Composed of:
- agg.

Example: *Taraxacum officinale* agg.

Rules:
- "agg." is included only in the full name of a species aggregate.

Other Standards:
- In ITF and HISPID. Unspecified in CHIN.

Name element 6: Species author string

Content:
- **Either** the full name or the recommended form (often an abbreviation) of the name or names of the author or authors who originally published the species combination (genus name plus species epithet). Since 1992 the TDWG-approved standard has been the "standard form" as listed in Brummitt & Powell (1992). The earlier TDWG-approved standard was the "approved abbreviation" as listed in Meikle (1984)
- **or** phrases starting with the latin word "*sensu…* ".
- Sometimes including parenthetical author or authors, that is the author or authors of the basionym, the full name under which the species combination was first published if different to the one now used.

Composed of:
- Alphabetic symbols (A-Z, a-z) including diacritics, fullstops (.) pairs of brackets (( )), apostrophes, ampersands (&) and gaps ( ).

• Upper case alphabetic symbols (A-Z) for initials of forenames where used, including diacritics, but certain surnames starting with a prefix with an initial lower case letter.
• Upper case initial alphabetic symbol (A-Z) for surname or abbreviated surname, including diacritics.
• Recommended forms (often abbreviations) according to separate TDWG standard. Use "&" (ampersand) not "et" or "and" for joint authors.
• Names in other alphabets (cyrillic, arabic, Chinese, Georgian etc.) transliterated into the roman alphabet.
• Parenthetical author or authors in the recommended form enclosed in round brackets at the start of the string.

Examples:

L.
G. Léonard
sensu Poir.
T.C. Chen
(A.B. Jacks. & Dallim.) Dallim.
(Desf.) Kuntze
O'Brien
De Winter
de Wit

Rules:

• This field is omitted in the Level 1 Limited Standard.
• The full name of each species, intergeneric hybrid, named interspecific hybrid, subspecies, botanical variety and cultivar must include this field.
• This field is omitted for the full name of a species aggregate and from both cultivars and cultivar groups where no species is given.

Other Standards:

• In HISPID and CHIN. CHIN Field 2190 is assumed to allow multiple entries.

Name element 7: Infraspecific epithet or Cultivar group name

Content:

• **Either** the latinised epithet of a subspecies, botanical variety or forma
• **or** the name of a cultivar group.
• Alphanumeric symbols (A-Z, a-z, 0-9) including diacritics, and punctuation marks in the case of cultivar group names.

Examples:

sativa
arvense

Hybrid-Tea
Longpod
zaïrensis

Rules:
- This is a compulsory element of each full name of a subspecies, botanical variety or forma and of cultivar groups. It may be used to include formula names for hybrids between infraspecific taxa of the same species.
- This field is omitted from the full name of each species, species aggregate, intergeneric hybrid, or named interspecific hybrid.
- This field may, optionally, be omitted from the name of a cultivar.

Other Standards:
- In ITF and HISPID. CHIN has a separate set of fields for each of subspecies, botanical variety and forma.

Name element 8: Cultivar group marker

Content:
- The word "Group" to distinguish cultivar group from other parts of the name.

Form:
- Group

Rules:
- Placed after the cultivar group name.
- Omitted from names that do not show the cultivar group.

Example:
Longpod Group

Other Standards:
- In HISPID.

Name element 9: Infraspecific marker

Content:
- One of the two markers
  subsp. (subspecies marker)
  var. (variety marker)

- or more rarely
  subvar. (subvariety marker)
  f. (forma marker)
  subf. (subforma marker).

Composed of:
- Exactly the abbreviations given above (nb. not "ssp." or "fa.").

Examples:
Pisum sativum subsp. *arvense*

Vicia johannis var. *procumbens*

Rules:
• One of these markers is a compulsory element of the full name of each subspecies or botanical variety.
• Only one can occur in any one full name.
• The "subsp" marker is a compulsory element of the full name of each subspecies.
• The "var." marker is a compulsory element of the full name of each botanical variety.
• This field is omitted from the full name of a species, a species aggregate, an intergeneric hybrid, and a named interspecific hybrid.
• This field is omitted from the full name of a cultivar group or cultivar if the infraspecific epithet is also omitted.

Other Standards:
• In ITF and HISPID. HISPID has additional codes for infraspecific hybrids, grexes and cultivar groups.

Name element 10: Infraspecific author string

Content:
• **Either** the full name or the standardised abbreviated name or names of the author or authors who originally published the name of a subspecies, botanical variety or forma
• **or** phrases starting with the latin word "*sensu.*"

Composed of:
• Alphabetic symbols (A-Z, a-z), including diacritics, full stops (.), apostrophes, ampersands (&) and gaps ( ).
• Upper case alphabetic symbols (A-Z) for initials of forenames where used, including diacritics, except in certain names starting with a prefix.
• Abbreviations according to separate TDWG standard.
• Names in other alphabets (cyrillic, arabic, Chinese, Georgian etc.) transliterated into the roman alphabet.

Examples:
Tamamsch.
Poir.
Sibth. & Sm.
O'Brien
De Winter
(A.B. Jacks. & Dallim.) Dallim.

Rules:
• This field is omitted in the Limited Version of the standard.
• The field is a compulsory element in the full name of each subspecies and variety, except that it is omitted when the subspecies or variety name is an autonym (the same name as the species epithet).
• This field is omitted from the full name of each cultivar group and

cultivar.

Other Standards: • In ITF and HISPID.

Name element 11: Cultivar marker

Content: • The cultivar marker "cv."

Composed of: • cv.

Example: *Pisum sativum* L. cv. Meteor
Pisum sativum L 'Meteor'

Rules: • As this marker is always present and fixed in content when a cultivar marker name is in element 12 (Cultivar name), this is strictly speaking unnecessary as a field and thus need not be part of the data. A particular implementation could for instance arrange for software to introduce this marker when needed. It is recommended however that the marker is included in data used in data exchange to avoid any possibility of confusion with an author string or cultivar group name.

Name element 12: Cultivar name

Content: • The name of a cultivar, in any language and including older latinized cultivar names.

Composed of: • Alphanumeric symbols, including diacritics, gaps and punctuation marks.
• Names in other alphabets (cyrillic, arabic, Chinese, Georgian, etc.) transliterated into the roman alphabet.
• Capital letter for the initial symbol of the first word and for other important words, but not for minor words.

Examples: Meteor
Cox's Orange Pippin
Pride of Linlithgow

Rules: • This field is needed only for cultivar names and is omitted from all other names.

Other Standards: • In ITF and HISPID.