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DESIGNATING HYBRID FOREST TREES

Elbert L. Little, Jr. (Washington D. C.)

A uniform policy of designating or naming artificial and natural hybrid forest trees is needed, particularly for the many new kinds originating in tree breeding investigations. For example, how should fifty new interspecific hybrid pines be distinguished? Early agreement among forest geneticists, foresters, and plant taxonomists is desirable to establish uniform usage and avoid unnecessary confusion.

The Committee on Forest Tree Improvement of the Society of American Foresters, Richard T. Bingham, chairman, representing forest geneticists and foresters in the United States, took the following action in 1958: (1) to designate interspecific hybrid forest trees, both artificial and natural, by formulas, not by Latin binomials; (2) to name cultivated varieties (cultivars) of forest trees, including those of hybrid origin, according to the International Code of Nomenclature for Cultivated Plants (1958).

The second point, designating cultivated varieties of forest trees as well as other plants by common names in modern languages under that code, should be universally approved. The first point is controversial, but perhaps early agreement on designating artificial interspecific hybrid forest trees by formulas can be reached by the relatively few active investigators concerned. I wish to review the problem and beg the cooperation of both plant taxonomists and foresters toward a common solution.

Review of problem. How to name interspecific hybrids has been discussed by many investigators, among them, William Trelease (Amer. Phil. Soc. Proc. 16: 44-52, illus. 1917), H. H. Allan (Bot. Rev. 3: 593-615. 1937; 15: 77-105. 1949; Chron. Bot. 5: 205-209. 1939), C. X. Furtado (Chron. Bot. 4: 32-36. 1938; Repert. Sp. Nov. Fedde 44: 244-255. 1938), T. A. Sprague (Chron. Bot. 5: 209-212. 1939), W. H. Camp and C. L. Gilly (Brittonia 4: 325-385. 1943), H. W. Rickett and W. H. Camp (Torrey Bot. Club Bull. 75: 496-501. 1948), and Charles B. Heiser, Jr. (Bot. Rev. 15: 645-687. 1949).

Opinions have differed from suppressing hybrids and recognizing intermediate forms only as species and varieties (H. Uittien, Chron. Bot. 5: 212-214. 1939) to giving Latin binomials to artificial hybrids (Wray M. Bowden, Canad. Jour. Bot. 36: 101-123, illus. 1958). A few have urged restraint and cautious exercise of judgment in naming hybrids.

Alphonse de Candolle in his Lois de la Nomenclature Botanique (1867) designated experimentally demonstrated hybrids with the ending of the specific epithet of the pollen parent changed to *i* or *o* and joined to the second epithet by a hyphen. Hybrids of doubtful origin were to be named as species with the multiplication sign prefixed to the generic name.

From the first edition of the International Rules in 1905, the International Code of Botanical Nomenclature (1956) has provided for designating interspecific hybrids "by a formula and, whenever it seems useful or necessary, by a name." However, names of hybrids have been relegated to Appendix I (Arts. H. 1-5, also Arts. 40, 50), and arrangements to avoid duplication with the International Code of Nomenclature for Cultivated Plants (1958) are pending. The first cited code (Arts H. 1-2, Notes) states also that greater precision may be achieved by the use of formulas.

Most floras and manuals in the United States mention interspecific hybrids briefly or not at all. Hybrids may be indicated by Latin binomial, if any, or by formula or by numerals of parent species. However, in a list, hybrids cited as binomials appear as important as species.

Characteristics of hybrid trees. Hybrid trees have certain obvious differences from most hybrid plants which affect nomenclature. Being large and conspicuous, wild hybrid trees have long attracted the attention of plant taxonomists and have been given Latin binary names perhaps to a greater extent than other hybrids. Even single trees have been named. Because trees are long lived, the putative hybrid tree (or type tree) from which the type was collected can be studied in detail over a period of years, and its progeny from open and controlled pollination can be tested. However, the long period before maturity and seed production makes subsequent progeny tests slow. As generations are long, an isolated intermediate tree probably is a first generation hybrid (F_1). Most hybrids commonly recognized by taxonomists probably are first generation hybrids though intermediate populations, backcrosses, and hybrid swarms also occur.

Natural hybrids of forest trees. Nearly all known interspecific natural hybrid forest trees in the United States now have been given Latin binary names. Camillo Schneider (Arnold Arboretum Jour. 3: 78-84. 1922) listed formulas of more than 50 natural interspecific hybrids and 3 trihybrids among the North American willows (*Salix*), mostly shrubby, and cited also 10 Latin binomials, 4 by himself.

Precedent for uniform Latin binomials for hybrid forest trees in the United States was set by William Trelease (Amer. Phil. Soc. Proc. 16: 44-52, illus. 1917), who listed the North American hybrid oaks (*Quercus*) under 41 binomials. However, nearly all of his 25 new names were *nomina nuda* until validated in 1924. In a thorough review of the hybrid oaks of North America, Ernest J. Palmer (Arnold Arboretum Jour. 29: 1-48. 1948) listed 78 binomials in *Quercus*, naming the few without Latin epithets.

The 1953 Forest Service Check List of Native and Naturalized Trees of the United States by Elbert L. Little, Jr., accepted 101 Latin binomials of interspecific natural hybrids, an increase from 87 in the 1927 Check List and 20 in the 1898 edition, though a few additional hybrids without binary names were omitted. The 1953 Check List (p. 13) stated also: "Use of binomials for hybrids is not to be encouraged ecxept in special studies, such as tree breeding investigations. It is much simpler and clearer to designate supposed hybrids merely by the names of the two parent species joined by the times sign."

Artificial hybrids of forest trees. Most forest geneticists have designated their interspecific artificial tree hybrids by formulas rather than by new Latin binary names. In reviewing forest genetics work in the United States, Ernst J. Schreiner (U. S. Dept. Agr. Yearbook 1937: 1242-1279, illus. 1937) listed formulas and remarked: "Hybrids are not species and naming them as such can only lead to confusion."

L. P. V. Johnson (Canad. Jour. Res. Sect. C, Bot. Sci. 17: 411-444. 1939) compiled by formulas more than 400 natural and articifial hybrids, mostly interspecific, of North American forest tree genera, listing common name, if any, and Latin binomials for more than half.

Complex artificial crosses in *Salix,* mostly designated by formulas, have been reported in Europe. Heribert Nilsson (Hereditas 40: 517-522, illus. 1954) designated by formulas the multispecific hybrids from as many as 8 and 13 species.

In *Populus,* where each hybrid clone corresponds to a single plant propagated vegetatively, the poplar specialists have preferred formulas. A. B. Stout and E. J. Schreiner (N. Y. Bot. Gard. Jour. 24: 216-229, illus. 1933; Torrey Bot. Club Bull. 61: 449-460. 1934) designated by formulas the seedlings from 99 crosses between 34 species, varieties, and hybrids and gave distinctive common names, such as Maine poplar, Geneva poplar, and Rochester poplar, to 10 of their most promising hybrids. However, a few taxonomists have given scientific names to artificial hybrids. For example, the three mentioned were named *Populus* × *mainensis, P.* × *genevensis,* and *P.* × *rochesterensis* by H. N. Moldenke (Rev. Sudamer. Bot. 10: 229. 1956). The International Poplar Commission (F. A. O., Rept. 8th Sess. 85 pp., illus. 1956) has adopted the International Code of Nomenclature for Cultivated Plants for naming hybrid poplar clones in modern languages.

Comparison of Latin binomials and formulas. Differences between Latin binomials ("specific" names of Latin form) and formulas for interspecific hybrids are listed in Table 1, from which the advantages and disadvantages of each method may be noted. Formulas are simpler, clearer, more easily learned, and more flexible. Latin binomials are indexed like specific names, better recorded, and more easily found and traced. The formula is easily changed if later workers should employ a different name for one parent because of nomenclatural or taxonomic reasons. Being permanently fixed to a type specimen, the Latin binomial is stable. However, if progeny tests from the type tree reveal one parent had been incorrectly identified, then other specimens may be shifted to a different binomial. For example, H. H. Bartlett (Rhodora 53: 249-264, illus. 1951) submitted evidence from open pollinated progeny of the type tree that *Quercus* × *deamii* represents the cross *Q. macrocarpa* × *muehlenbergii,* rather than *Q. alba* × *muehlenbergii,* as originally believed.

There is no rule for deciding when a Latin binomial is "useful or necessary". Any taxonomist could name an interspecific hybrid made by a geneticist by publishing a Latin diagnosis and indicating a type specimen. An extremist could make crosses merely to create new binomials.

One of the most serious objections to Latin binomials for interspecific artificial tree hybrids is the enormous number of possible new names. The number of hybrid binomials in a genus could exceed greatly the number of species, thus complicating binomial nomenclature. Pages of future Supplementa of Index Kewensis could be filled with lists of hybrids.

If all species of a genus were interfertile, the maximum number of possible interspecific hybrids after reduction of half for reciprocal crosses would be almost one-half the square of the number of species or $\frac{1}{2}$ n (n — 1). For example, 3 interspecific hybrids are possible in a genus of 3 interfertile species, 10 in a genus of 5 species, 45 in a genus of 10 species, and 190 in a genus of 20 interfertile species!

If used alone without formulas, how many binomials would be recognized? Would the different parentages be remembered without the formulas?

Somewhere the Latin binomials would have to stop and give way to formulas or variety (cultivar) names in modern languages for complex hybrids. If applied to

Table 1. Comparison of Latin binomials ("specific" names of Latin form) and formulas for interspecific hybrids of forest trees.

Subject compared	Latin binomials	Formulas
International Code of Botanical Nomenclature	"Specific" names of Latin form authorized "whenever it seems useful or necessary" and subject to same rules as names of species (Arts. 40, H. 1).	Formulas authorized (Art. H. 1) but are not names and not subject to rules. When polymorphic species are involved and if infraspecific taxa are recognized, greater precision may be achieved by formulas (Art. H. 1, Note 1).
International Code of Nomenclature for Cultivated Plants	Names of Latin form authorized but subject of International Code of Botanical Nomenclature (Art. 41).	Formulas authorized (Arts. 38, 39). Collective names in modern languages authorized also (Arts. 40, 42, 43).
Relation to specific names	Distinguished from specific names only by multiplication sign (×).	Composed of two specific names or epithets connected by multiplication sign (×).
Publication, citation, date	Have valid publication with citation and date.	Have no formal publication with citation or date.
Priority	Priority established by date.	Priority not established or needed.
Name	Latin binomial consists of two words, generic name and "specific" epithet with multiplication sign (×) before the latter. Epithet is an additional Latin word similar to specific epithet but distinguished only by multiplication sign (×). May be descriptive or dedicated to a person associated with hybrid.	Formula consists of specific names or epithets of the two parents connected by multiplication sign (×) and following the generic name. No additional Latin word like specific epithet. Descriptive in that the hybrid usually is intermediate between the named parents. Formulas cannot be dedicated to persons.
Description	Latin diagnosis required. Description may be difficult because of variability.	No description required.
Author	Author is stated and may be credited as discoverer or originator.	No author; discoverer or originator may not be known and is not credited.
Specimens	Type specimen required. Herbarium specimens may be filed under binomial.	Type specimen not required. Herbarium specimens are filed after a parent species.
Availability	New names of Latin form cannot be used until formally published.	New formulas are always available for immediate use when needed.
Change of status	When binomial is changed from species to hybrid or vice versa, the original status should be indicated in parenthesis (Art. 50). Multiplication sign is inserted (or deleted).	Formula replaces Latin binomial when status is changed from species to hybrid, and vice versa.

Subject compared	Latin binomials	Formulas
Parentage	Parentage not indicated. Latin binomial must not consist of specific epithets of parents unaltered or with ending of only one epithet changed (Art. H. 1, Note 2). However, parentage could be indicated by a contraction from the two epithets.	Specific epithets of parents in alphabetical order (or indicated by male and female signs) are connected by multiplication sign (×).
Reciprocal crosses	Reciprocal crosses not designated.	Reciprocal crosses may be designated by male and female signs or by female parent first.
Varieties of parent species	Varieties of polymorphic parental species not distinguished.	Varieties of parent species may be added to formulas for greater precision.
Progeny	All offspring from same parent species receive same binary name (Art. H. 1). Latin binomials include all generations and back crosses distinguishable from parents and may lack precision. Different hybrid forms of the same parentage, called nothomorphs, when desirable may be designated by a Latin epithet (Art. H. 5).	Expanded formulas can distinguish precisely generations and backcrosses. Different cultivated hybrids can be named as varieties (cultivars) in modern languages under International Code of Nomenclature for Cultivated Plants.
Number of new names	The number of hybrid binomials in a genus could exceed greatly the number of species. Naming of a large number of interspecific hybrids could complicate binomial nomenclature.	No new names.
Stability	Latin binomials are permanently associated with type specimen and are not affected by change in name of parent species, even if epithet is derived from that of parent species.	Formulas are as stable as specific names and are easily changed if name of one parent species is changed.
Misidentification	If parentage is uncertain, Latin binomial may be more definite than a formula. If one parent of type specimen (or type tree) was misidentified, some other hybrid specimens and trees to which the name had been applied may require a different Latin binomial.	Formulas are not affected by type specimens. If one parent was misidentified, formula is easily changed.
Synonymy	Latin binomials sometimes become synonyms, such as when the type is reduced to synonymy of a species or another hybrid.	Formulas follow synonymy of parent species and are easily suppressed without synonymy.
Indexing	Latin binomials are indexed and catalogued and are easily located. Publications are indexed, often by scientific names, and abstracted.	Formulas are not indexed or cataloged and are not easily located. Publications are indexed, often by scientific names, and abstracted.

trispecific, multispecific, bigeneric, and multigeneric hybrids, binomials could become exceedingly numerous. Should the artificial hybrids in *Salix* involving 8 or 13 parental species be named too?

Parentage of backcrosses and complex hybrids can be shown by formulas but is lost in binomials. Hui-Lin Li (Taxon 6: 216-218. 1957), James W. Hardin (Taxon 7: 52-53. 1958) and others have suggested the symbols > (greater than) and < (less than) in formulas to designate backcrosses and members of hybrid swarms. These symbols placed next to the multiplication sign were accepted in examples cited in earlier editions of the International Rules (ed. 2. 1912; ed. 3. 1935; Art. 34). Li commented further: "A Latin specific epithet for F_1 hybrids seem superfluous as it greatly complicates the already extremely burdensome botanical nomenclature."

The variability in some hybrid populations may be a serious objection to naming and description, as Trelease (1917) observed. British botanists (Internat. Bot. Congr. Fifth, Cambridge, Nomenclature proposals by British botanists. 203 pp. 1929; p. 13) proposed that groups of hybrid origin should not be named unless possessing relatively constant morphological characters. However, this proposal was not adopted, being applicable also to other taxonomic groups and outside the scope of nomenclature.

"Telescoped formulas" contracted from both parental epithets combine certain advantages of the two methods. For example, the hybrid between *Pinus attenuata* and *P. radiata* has been named *Pinus* × *attenuradiata*. However, this epithet might be regarded as a formula under the Code (Art. H 1, Note 2), because the ending of only one epithet was changed. A shorter contraction would remove this objection. It has been suggested that such contracted epithets be restricted to hybrids of known parentage produced experimentally. Bigeneric hybrids may be designated also by a generic name like a condensed formula followed by a variety (cultivar) name.

Possible solutions. One compromise, similar to past usage, would be for taxonomists to give Latin binomials to natural hybrids and for forest geneticists to use formulas for artificial hybrids. Natural hybrids would be named, but artificial hybrids not.

However, in groups such as forest trees, both natural and artificial hybrids probably should be treated alike, as the two groups overlap and are not readily separated. Many natural hybrids have been duplicated artificially, while some artificial hybrids have been discovered also in the wild state. Interspecific hybrids have been named from trees appearing spontaneously in botanical gardens and arboreta from parent trees whose natural ranges do not meet.

Publication of Latin binomials for interspecific hybrids could not be prevented without amendment of the Code, but adoption of these names is not required. Both natural and artificial hybrids could be named, and each worker could choose between names and formulas. If it should be advantageous to give Latin names to artificial hybrids, then the first geneticists making the controlled crosses perhaps should accept the job independently or assisted by taxonomists.

The simplest solution, that adopted by forest geneticists and foresters in the United States and recommended here, is to designate interspecific hybrid forest trees, both artificial and natural, by formulas, not by Latin binomials. It is hoped that plant taxonomists will refrain from giving new Latin binary names to the new artificial hybrid trees produced by the geneticists.

International Code for Nomenclature of Cultivated Plants. Naming the cultivated interspecific hybrids of forest trees, as well as other plants, in modern languages is provided by the International Code for Nomenclature of Cultivated Plants (Arts. 40, 42). In the example cited above, the interspecific hybrids between *Pinus attenuata* and

P. radiata might be given the collective name Attenuradiata pine, Attenuradiata Hybrid pine, or *Pinus* Attenuradiata Hybrid instead of the binomial *Pinus* × *attenuradiata.*

Some interspecific hybrids have been given Latin names honoring persons. Similar names in modern languages without the Latin endings are more appropriate, for example, Sonderegger pine rather than *Pinus* × *sondereggeri.*

Any tree hybrids produced in quantities or commercially should be named further as varieties (cultivars) for greater precision, for example, hybrid clones in *Populus* and varieties of hybrids in *Pinus.* Under the Code (Art. 45), when a variety (cultivar) of an interspecific hybrid is introduced into cultivation, it must be given a variety (cultivar) name in addition to the collective name or formula, even if only one variety is concerned. Otherwise, the first variety would be nameless and not readily distinguishable when a second variety (different and possibly inferior) from the same two parental species is produced and named elsewhere later.

ARTICLE 59

F. C. Deighton (Kew)

The wording of the present Art. 59 (Code, 1956) was drawn up at the Seventh International Botanical Congress, Stockholm, 1950, as a result of a proposal by Drs. G. R. Bisby and J. A. Stevenson. References to previous discussions on the subject are given by Rogers in Mycologia 40: 241-254. 1948. A number of recent publications have, however, shown that there is more than one possible interpretation of the provisions of the Article.

Most difficulty has arisen in interpreting the following sentences from Art. 59:

"The type specimen of a name applied to a particular state must show the characteristics of that state."

"The author who first describes a perfect state may adopt the specific epithet of the corresponding imperfect state, but his binomial for the perfect state is to be attributed to him alone, and is not to be regarded as a transfer [i.e., new combination]."

Yet these two sentences were undoubtedly intended, when the Article was first drafted, to be of fundamental importance in clearing up earlier confusion.

Dr. M. A. Donk (Taxon 9: 171-174. 1960) has discussed certain aspects of the Article. He stresses the Rule that a name which is validly published makes a later homonym illegitimate [it must be noted that this still applies even if the earlier homonym is illegitimate: Art. 64 (2)]; and there is no precise provision in Art. 59 to amend this rule. In this connexion he discusses *Corticium microsclerotia* (Matz) Weber.

He also cites Bisby's remarks (An introduction to the taxonomy and nomenclature of fungi, I.M.I., Kew, ed. 1: 88. 1945) about *Mycosphaerella aleuritidis* (Miyake) Ou. These early remarks by Bisby were, however, made before the present Art. 59 was framed, and Bisby later (An introduction to the taxonomy and nomenclature of fungi, C.M.I., Kew, ed. 2: 117. 1953) remarked "Article 69 [= Art. 59 of Code, 1956] now eliminates most of the uncertainties which existed in its former wording as Art. 57. . . . A perfect state described as "*Mycosphaerella aleuritidis* (Miyake) Ou n. comb., syn. *Cercospora aleuritidis* Miyake" is now to be cited as a new species "*M. aleuritidis* Ou (as "(Miyake) Ou")." Bisby presumably interpreted the last sentence of para. 1 of Art. 59 (the second of the two sentences which I have quoted