A Brief Guide to Establishing Phylogenetically Defined Names under the *International Code of Phylogenetic Nomenclature (PhyloCode)*

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We have noticed that some recent publications attempting to establish names under the *PhyloCode* have not included all the required elements. Because the requirements for establishing clade names under the *PhyloCode* differ from those for establishing taxon names under the rank-based codes, and because some authors may not be familiar with the rules of the *PhyloCode*, we thought it would be useful to outline those requirements in the form of a checklist.

Articles and Recommendations cited below refer to *PhyloCode* version 6 (2020). When consulting them, the associated Notes and Examples should also be read. The *PhyloCode* is easily consulted at http://phylonames.org/code/.

Only the rules pertinent to establishment of clade names are covered in this checklist. Not included are the rules pertaining to (for example) determining precedence among names after they are established (Arts. 12–15), the use of species names (which are not governed by the *PhyloCode*) in conjunction with clade names (Art. 21), and governance of the *PhyloCode* (Art. 22).

Publication Requirements

The following requirements apply to the publication in which the name is to be established:

- It must be peer-reviewed (Art. 4.2).
- It may be in printed and/or electronic form but must satisfy the conditions detailed in Art. 4.2. There are additional recommendations regarding electronic publication (Rec. 4.4A, 4.4B).
- Printed works and other materials that do *not* count as publications under the *PhyloCode* are listed in Art. 4.6.

Requirements and Recommendations pertaining to the Protologue

The protologue comprises everything associated with a name when it is first established in a publication—e.g., description, illustrations, geographic distribution. The use of tables as a protologue format, especially when multiple clade names are defined, is strongly discouraged. Under the *PhyloCode*, the following information must be included in the protologue:

- The clade name that is being established, with the names of the nominal author(s) and—if it is a preexisting name that is being converted to a phylogenetically defined name—the date of the original publication (Art. 9.15).
- Designation of the clade name as new or converted (Art. 9.2)
- Registration number (Art. 7.2e)
- Phylogenetic definition (Arts. 9.3, 9.4)

- Citation of a reference phylogeny or statement about the distribution of supporting apomorphies (Art. 9.13); if more than one reference phylogeny is cited, one of them should be designated as the primary reference phylogeny (Rec. 9.13B).
- If the specifiers in the definition are not shown on the reference phylogeny, then it must be stated how the specifiers are related to the taxa that that are included in the reference phylogeny (Art. 11.11).
- Hypothesized composition of the clade (Art. 9.14)
- For converted names, bibliographic citations (including all the information detailed in Art. 9.16) demonstrating prior application of the name to a taxon approximating the clade for which it is being established (Art. 9.15).
- In cases where more than one preexisting name has been applied to a group approximating the clade to be named, the rationale for choice of a name must be provided (Recs. 10.1A, 10.1B).
- It is recommended (Rec. 9C) that the protologue include a description, diagnosis, or list of apomorphies.

Requirements pertaining to the Defined Name

- The name must be a single word, begin with a capital letter, be composed of more than one letter, and consist exclusively of letters of the Latin alphabet as used in contemporary English (Art. 17.1).
- Other letters, ligatures, numerals, apostrophes, or diacritical signs are not allowed, except that a hyphen is to be included in the following cases (Art. 17.1):
    - The name is a panclade name (Art. 10.3).
    - the name has an apomorphy-based definition and is formed in accordance with Article 10.8 (involving use of the prefix *Apo-*).
    - the name is based on the preexisting name of a subdivision of a genus (see Rec. 10F).
    - the name is based on a preexisting name preceded by a taxon-related prefix such as *Phyto-*, *Phyco-*, *Myco-*, *Prokaryo-*, or *Zoo-* in the situation covered by Recommendation 10D.
- It must be registered in RegNum (Art. 8.1). See registration instructions at the bottom of this document.
- It must apply to a clade that either appears on the reference phylogeny or is delimited by the cited apomorphies (Art. 9.13).
- If a preexisting name has been applied to a taxon approximating the clade to be named or to a paraphyletic group originating in the same ancestor, that name must be chosen (Art. 10.1) except under conditions described in Article 10.2; a new name may be used if the clade has no preexisting name or all preexisting names (or their homonyms) have already been established for other clades (for these and other conditions see Art. 10.2). See also Recs. 10.1A, 10.1B, 10A, 10B, 10C, 10D, 10E, and 10F).
- A clade name may not be converted from a preexisting specific or infraspecific epithet or name in the species group (Art. 10.10).

- The names of total clades can either be preexisting names (applied to groups approximating the clade to be named) or new names formed by adding the prefix *Pan-* (including the hyphen) to the previously- or simultaneously-established name of the corresponding crown clade (for details see Arts. 10.3, 10.4, 10.6, 10.7 and Rec. 10.4A).
- In addition, there are rules and recommendations that apply only to names of crown clades that, under rank-based nomenclature, correspond to a monogeneric "higher" taxon (Rec. 10G) and certain apomorphy-based clades (Arts. 10.8, 10.9).

Requirements and Recommendations pertaining to the Phylogenetic Definition

- It must be written in English or Latin (Art. 9.3)
- It is recommended (Rec. 9.4A) that the wordings provided in Arts. 9.5–9.7 and 9.9–9.10 be used; if an alternative wording is used, a standard abbreviated definition (as provided in Arts. 9.5–9.7 and 9.9–9.10; see also Note 9.4.1) should be included. Examples of recommended wordings:
    - minimum-clade definition—"the smallest clade containing A and B";
    - maximum-clade definition—"the largest clade containing A but not Z";
    - apomorphy-based definition—"the clade for which M, as inherited by A, is an apomorphy".
- If an apomorphy-based definition is used, and if the apomorphy is a complex character that could have evolved in a stepwise fashion, then the author should identify which aspect(s) of that apomorphy must be present for an organism to be considered to belong to the clade thus defined (Rec. 9.7B).
- If a panclade name is used, its definition must follow Article 10.5: for example, "the total clade of the crown clade [name of the crown clade]" (see Art. 10.5 for alternative wordings).
- Specifiers must be species, specimens, or apomorphies, *not* subordinate clades (Art. 11.1).
- When a species is used as a specifier, the author and publication year of the species name must be cited (Art. 11.3).
- When a type specimen is used as a specifier, the species name it typifies and the author and publication year of that species name must be cited (Art. 11.5).
- Specimens that are not types may be used as specifiers only in the situations listed in Article 11.7, and additional information must be provided (Arts. 11.8, 11.9).
- When a clade name is converted from a preexisting name that is typified under a rank-based code or is derived from the stem of a typified name, then the type species or type specimen of that typified name must be an internal specifier (Art. 11.10).
- Either the specifiers must be included in the reference phylogeny or a statement must be included indicating how the specifiers are related to the taxa that are included in the reference phylogeny (Art. 11.11).
- If the definition is intended to prevent the use of the defined name under certain hypotheses of relationships, composition, or both, see Articles 11.12–11.14.
- Definitions of converted clade names should attempt to capture the spirit of traditional use to the degree that it is consistent with the contemporary concept of monophyly. To

accomplish this goal, internal specifiers of converted clade names should be chosen from among taxa that have traditionally been considered part of the taxon associated with the name being converted, and they should not include members of subtaxa that have traditionally been considered not to be part of that taxon (Rec. 11A).

- Ichnotaxa and ootaxa should not be used as specifiers (Rec. 11C).
- In a minimum-clade definition, it is best to use a set of internal specifiers that includes representatives of all subclades that plausibly may be sister to the rest of the clade being named (Rec. 11D), unless doing so would be contrary to Rec. 11A and/or 11B.
- In a maximum-clade definition, it is best to use a set of external specifiers that includes representatives of all clades that plausibly may be sister to the clade being named (Rec. 11E).
- If it is important to establish two names as applying to sister clades regardless of the phylogeny, guidance on constructing the definition is provided in Recommendation 11F.
- When defining the names of low-level clades that coincide with or overlap the boundaries of species, see Recommendation 11H.

Basic guidelines to register a name in RegNum

- Visit www.phyloregnum.org
- Create an account and wait for approval.
- Once approved, login and click on “Create a submission”.
- Enter the proposed clade name and click on “Create”.
- Fill all the fields in the three main tabs: “Clade name”, “Specifiers”, “Definition”
- Upon entering all required information (except information that would be unknown prior to publication, such as article date and page numbers), submit the record (only submitted records are public and can be searched and viewed), preferably after the article including the protologue is officially accepted for publication.
- Upon publication of the article, inform the database administrator, who will approve the record or request additional information from the author, such as article page numbers, year of publication, figure number(s), or any data that might have changed during the revision and/or proofing process.

Two Sample Protologues adapted from *Phylonyms
The literature cited and addresses of the authors are excluded in these examples but would be included in the larger paper of which the protologue is a part.

*de Queiroz, K., P. D. Cantino, and J. A. Gauthier. 2020. Phylonyms: A Companion to the PhyloCode. CRC Press, Boca Raton, FL.

Campanuloideae Burnett 1835: 942, 1094, 1110 [N. Cellinese], converted clade name

Registration Number: 21

Definition: The crown clade originating in the most recent common ancestor of *Campanula latifolia* Linnaeus 1753, *Wahlenbergia linifolia* A. de Candolle 1830, and *Platycodon grandiflorus* (Jacquin) A. de Candolle 1830.

Reference Phylogeny: Cellinese et al. (2009: Fig. 2-3). See also Eddie et al. (2003: Fig. 1), Haberle et al. (2009: Fig 3).

Composition: The clade *Campanuloideae* comprises mainly temperate taxa, with approximately 1,050 species, mostly occurring in the Old World. Two large taxa within the *Campanuloideae* are *Campanula* (approximately 420 species) and *Wahlenbergia* (approximately 260 species).

Diagnostic Apomorphies: Possible non-DNA synapomorphies for *Campanuloideae* include scalariform vessel perforations and verrucose pollen surface (Gustafsson and Bremer, 1995), and stylar hair invagination (Erbar and Leins, 1989, 1995, Leins and Erbar, 1990, Judd et al., 2008), although basal taxa such as *Platycodon* have not been thoroughly investigated.
The invagination of stylar hairs is a process occurring during a late stage of the secondary pollen presentation mechanism. In *Campanuloideae*, this syndrome involves pollen being deposited onto stylar hairs, which subsequently invaginate, leaving a glabrous, pitted style (Erbar and Leins, 1989, 1995).

Comments: The monophyly of *Campanuloideae* is strongly supported by molecular phylogenies (Eddie et al., 2003; Cellinese et al., 2009; Haberle et al., 2009). These studies also revealed that the species of *Campanuloideae* fall into three clades: one including the campanuloids, another the wahlenbergioids, and a third including the platycodonoids (Eddie et al., 2003; Cellinese et al., 2009; Haberle et al., 2009). Because these three clades are well supported and include all of the *Campanuloideae*, a minimum-crown-clade definition with three specifiers works well.
The name *Campanulaceae* was applied to this clade by Shetler and Morin (1986), Kolakovsky (1994), and Takhtajan (1997). However, following Wagenitz (1964) and Cronquist (1981), most authors have used the name *Campanuloideae* for this clade, applying the name *Campanulaceae* to a more inclusive clade. The latter application of these two names is adopted here.

Pan-Bovidae F. Bibi and E. S. Vrba, new clade name

Registration Number: 262

Definition: The total clade of the crown clade *Bovidae*.

Reference Phylogeny: Figure 1 in Hassanin et al. (2012).

Composition: The crown clade of *Bovidae* and all extinct organisms that are more closely related to *Bovidae* than to any other extant pecorans. For taxa contained in the crown, and for potential stem species, see *Bovidae* and *Cavicornia* in this volume.

Diagnostic Apomorphies: Although extant species can easily be distinguished from other crown pecorans, no unambiguous stem bovids are known. The problem is that the same apomorphy—un-branched, non-deciduous cranial appendages covered with a permanent keratin sheath (= bovid horns *sensu* Janis and Scott, 1987)—that diagnoses *Cavicornia* relative to all other fossil and Recent pecorans also diagnoses *Bovidae* relative to all other crown pecorans. Furthermore, 'bovid horns' are unlikely to diagnose *Pan-Bovidae* even though all currently known extinct taxa that might qualify as stem bovids possess such horns (e.g., *Eotragus spp.*). These three nested taxa have different theoretical compositions, and their diagnoses are expected to eventually differ accordingly. As a practical matter, however, it is currently impossible to differentiate *Pan-Bovidae* from either *Cavicornia* or *Bovidae*.

Comments: Although *Bovidae* is arguably the name most commonly associated with this clade, that is largely a consequence of having failed to distinguish clearly between the crown clade (*Bovidae*; this volume), its total clade (*Pan-Bovidae*), and the origin of its distinctive horns (*Cavicornia*; this volume). *Pan-Bovidae* is proposed to make a distinction between names applied to crown vs. total clades in keeping with the broader goals of the *ICPN* to develop a general nomenclatural system for all biologists.