

## Coming to grips with the naming of viruses; continuing discord, or a way out?

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I read with much interest this journal's recent editorial on *Virologists, taxonomy and the demands of logic* by MHV Van Regenmortel [30], and also his more detailed article on *Virus species and virus identification: Past and current controversies* [31]. These texts largely repeat Van Regenmortel's earlier papers, especially that written with BWJ Mahy [33] on *Emerging Issues in Virus Taxonomy*. Most of his earlier articles on the naming of viruses were published as President of ICTV, but the recent article is written by him as Editor-in-Chief of this journal. He correctly advocates logic and linguistic precision in communication [30], but it is important to understand where he has been, and still is, attempting to lead us.

In these papers he promotes two distinctly controversial views that I discuss in this paper. Firstly, that viruses are so different from all other biological entities that their taxonomy can ignore mainstream biological taxonomy, even when they intersect. Secondly, that the common vernacular names of viruses refer to "concrete" entities, whereas the taxonomic scientific names of viruses refer to "abstract" man-made entities.

### Should the naming of viruses differ from that of other biological entities?

Time and again, the ICTV and Van Regenmortel have argued that biological nomenclature does not hold for viruses [e.g., 21, 27]. They stress that viruses are different from organisms in that the latter are 'living', whereas the former 'borrow life'

from their hosts. However not all agree with this distinction, as the number of criteria distinguishing viruses from cellular organisms steadily decreases, indeed some now consider it irrelevant to make this distinction and consider viruses merely to be sub-cellular organisms [17]. Either way, taxonomically, viruses are treated as organisms, particularly after the species concept adopted for viruses [21, 24, 25, 22] is essentially the same as that of cellular organisms. Viruses indeed do behave like organisms in that they reproduce, their nucleic acid mutates, and they evolve independently from their hosts and adapt to ecological niches. Still, ICTV claims that the naming of viruses should be independent from bio-nomenclature at large [21].

Once, however, one has accepted a species concept for viruses that closely resembles the species definition of organisms, there is no justification for inventing a special nomenclature (including typography) for viruses, especially while it clashes with bio-nomenclature in general [4–7]. The established practice for centuries in mainstream biological nomenclature has been to use italicized binomials as the scientific names of organisms. This makes the names taxonomically meaningful and, as they are written in Latin or are latinized, they are instantly recognized as internationally acceptable scientific names. They are italicized exclusively to indicate their nature, that they are distinct from everyday languages, and to prevent linguistic contamination producing unwanted hybrid words [e.g., 7]. In the past, the aversion of virologists to binomials [23, 26] was caused by premature attempts to introduce a binomial latinized nomenclature based on mere phenotypic characters of viruses such as the types of symptoms, hosts and vectors [19, 20]. With increasing knowledge of the genetic and biochemical properties of viruses, and their use for classification, this argument no longer holds.

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### What is wrong with the italicization of scientific virus names?

When the ICTV decided to make the international scientific names of viruses distinct from the existing common vernacular virus names [21], they chose to adopt only one of the two practices of the other branches of biological nomenclature; they italicized the names but did not convert the names to latinized binomials. This had two immediate consequences. First, the scientific and common names became, in essence, the same. Secondly, the *in toto* italicization of scientific virus names, and de-italicization of common names, conflicts with biological nomenclature when the common name of the virus includes the name of a host, a place, etc., especially in the names of virus species not yet recognized by ICTV [4–7, 16].

Van Regenmortel [29, 31] dismisses my arguments about the italicization of scientific names of non-viruses as of little importance and only referred to the case of *Nasturtium* versus nasturtium, which, by the way, are entirely different botanical species and must therefore be distinguished by typography no matter where written. He also ignores the need of precision in distinguishing between biological and geographic names included in virus names. As examples of these I had listed *Cestrum* yellow leaf curling caulimovirus and Epirus cherry Ourmiavirus, where *Cestrum* is a botanical name and Epirus and Ourmia are geographic names [4–7]!

### The distinction between abstract and concrete with respect to the naming of viruses

Van Regenmortel and the ICTV have sought to justify the distinction between scientific and common names of viruses indicated by italicization of the former by characterizing an approved species as something “abstract”, whereas the virus it represents is considered to be tangible and thus “concrete” [29, 30, 32]. Van Regenmortel’s editorial [30] begins by saying that “*the Editorial Board of Archives of Virology tries to enforce correct typographic usage in its columns, which requires the names of virus species be written in italics and the names of viruses in Roman characters*”. It is thus claimed that there is a clear distinction between virus species and viruses and that this has a bearing on the way their names have to be written. So the crucial issue is how to distinguish a *virus species* from a *virus*. Van Regenmortel [29] states “*only the viruses are real, virus species are man-made taxonomic constructions, they are man-made abstractions*”. But do others agree? Why do the other branches of biological nomenclature not make this distinction? Is a virus really a thing or object which can be handled individually like most cellular organisms? Or is it in fact something like a *type*, for example a type of parasite that meets certain characteristics? Where is the line between concrete and abstract viruses?

Let us see whether this division is evident in the history of viral nomenclature. Viral taxonomy started with mere nomenclature, and eventually the *International Committee on the Nomenclature of Viruses* was established in 1966 [34], and became the *International Committee on Taxonomy of Viruses* (ICTV) in 1973 [15]. The struggle to make virus names more meaningful by reflecting the intrinsic properties of viruses, which in those days were largely unknown, is well reflected by the history of research on viruses of leguminous crops [3], which I summarize below.

#### *What is in a legume virus name?*

From the beginning of my career in plant virology I vividly remember how prior to viral taxonomy viruses were merely listed by their common names. These names referred to the viral pathogens in an abstract sense because very little was known about their exact identity (‘individuality’). Hired by an agricultural research institute as an applied virologist during the late 1950s, I had to find ways to control viral diseases of legume crops, also using results already found helpful elsewhere. At the time, however, when referring to viruses, we hardly knew what we were talking about, as we were largely ignorant about the viruses themselves or their components as concrete objects. That is why the common or vernacular names then in vogue were merely used in a taxonomic sense, though not yet defined according to rules and definitions. International standardization of procedures for a more uniform description of viruses, and increasing emphasis on their intrinsic properties was strongly advocated for the study of legume viruses [8].

For that purpose and to make results obtained in different countries comparable, international cooperation was considered to be useful and this led to the establishment in 1961 of an *International Working Group on Legume Viruses* (IWGLV) for the exchange of materials and information, probably the first of its kind. A first outcome for tackling the confusing synonymy was the *Tentative list of viruses reported from naturally infected leguminous plants* [2], but most of the intrinsic “concrete” properties of those *viruses, sensu* Van Regenmortel, were still unknown. The pioneering work on legume viruses soon drew wider attention and this led to suggestions for standardizing the identification of other viruses as well [11]. The IWGLV initiative to set up a world survey of legume viruses was soon incorporated into the computerized *Virus Identification Data Exchange* project (VIDE) organized by one of the Group members, Adrian Gibbs. The first microfiche version and later printed publication *VIDE Viruses of Legumes* [9] was followed by *Viruses of Plants in Australia* [14] and *Viruses of Tropical Plants* [12]. An extensive volume on *Viruses of Plants* was produced thereafter [13], and this was also distributed on the World Wide Web. But it all was judged to have started with the IWGLV (Adrian Gibbs, personal communication 1996).

The history of the IWGLV illustrates the struggle of plant virologists to increase the significance of virus

names by digging into the physico-chemical characteristics of their virions wherever possible and of other macromolecules produced by viruses. The objective was to come to grips with viruses, that is to better define viruses as species including their variation [3]. This is how the study and comparison of virions, etc. led to virus taxonomy. Drs. Jürgen Brandes and Carl Wetter in Germany were the first to classify elongate plant viruses on the basis of particle morphology and size [10]. The concise loose-leaf *Descriptions of Plant Viruses*, started in Britain in 1970 [18] and later transferred to the Internet (<http://www.dpvweb.net/>) involved most of the international plant virus community and was instrumental in making the common names of plant viruses more meaningful. Gibbs and colleagues in Australia also piloted the fully computerized *Virus Identification Data Exchange (VIDE)* project that, together with *Viruses of Plants* by Brunt et al. [13], provided the initial data and basis of the database (<http://www.ncbi.nlm.nih.gov/ICTVdb/>) of the Committee on Taxonomy of Viruses (ICTV). All those involved with these pioneering ventures of the pre-molecular era, and I am one of them, are certainly entitled to question what the ICTV is doing with viruses and their names.

### The essence of common names

The ICTV helped to standardize and internationalize the criteria and procedures used to define virus species. Specialists in the ICTV Study Groups resolve synonymies and decide by consensus which names should be used as *official species names* for each accepted virus species. This process gives such names *scientific*, that is taxonomic, *status*. For instance, the current name *Bean yellow mosaic virus*, which is italicized by a decision of the ICTV, is now the scientific equivalent of the common non-italicized name 'bean yellow mosaic virus', and also of 'bonenscherpmozaïekvirus' in Dutch, 'Buschbohngengelbmozaïkvirus' in German, and 'virus de la mosaïque jaune du haricot' in French. These were the common names already used in the pre-taxonomic era to denote the species, and their equivalence will be clearly shown in a Dutch report, for example, where the virus would be listed as "bonenscherpmozaïekvirus (*Bean yellow mosaic virus*)". This fact was dismissed by Van Regenmortel and Fauquet [32, 29, 31], although it is essential to allow communication with growers and breeders, where species must be designated by their local vernacular name, as well as their scientific name.

Thus it is entirely logical to consider that the common names of viruses have a taxonomic abstract meaning as we do not, for example, isolate bean yellow mosaic virus from an infected plant but only its virions. We determine the properties of the virions, but these are themselves a population of variable genome sequences, a quasi-species [31]. Hence, at the level of 'concrete' virions, the blurring abstraction already begins.

### Bionomenclatural irrelevance of the distinction between concrete and abstract

Van Regenmortel [30, 31] and ICTV ignored the botanical examples I have given in past papers contrasting the "concrete" and "abstract" aspects of the daisy (*Bellis perennis*) and dandelion (*Taraxacum officinale*) plants that occur in my lawn [6, 7], so I repeat them here. To be precise, as editor Van Regenmortel advocates [30], the words 'daisy' and 'dandelion' are purely taxonomic concepts. However, when weeding my garden I can remove "daisy and dandelion plants", and it would also be quite clearly understood if I stated that I removed "daisies and dandelions" because they are the individual plants that are tangible and thus concrete. Thus the words may have both abstract and concrete meanings, but it is the article that makes the difference: "daisy" as the abstract concept, and "a daisy" or "the daisy" is a concrete individual. Likewise, the farmer next door grows wheat, potato and sugarbeet, but at the time of harvest he reaps wheat kernels, potatoes (potato tubers) and sugarbeets (tap roots of sugarbeet); these are tangible, can be touched.

Similarly, the well-known *Manual of Cultivated Plants* by L. H. Bailey [1] files cultivated plants as species, not as individuals. They are briefly described in an abstract sense and all descriptions (in fact, definitions) are headed by two names, e.g., "*Sinapis alba* – White Mustard", and "*Solanum tuberosum* – Potato". In the manual these paired names are equivalent and refer to the same abstraction. The descriptions are provided for identifying individual plants and for determining their name. To clearly indicate that the common names are proper names, they are often written with capital initials, but in modern scripts the initials may be omitted, and this converts the names into common words: white mustard and potato. The title of Bailey's manual is slightly confusing. It is a manual of species of which representatives are cultivated, but the book is meant to be used for recognizing plants as handled commercially and cultivated in gardens.

Like plant names such as "potato – *Solanum tuberosum*", virus names, either common (e.g., bean yellow mosaic virus) or scientific (*Bean yellow mosaic virus sensu ICTV*), both refer to an abstract concept of the same species. Viruses are abstractions, and all names given to them are abstractions, however general or specific they may be. The italicization of some of those names merely indicates that the ICTV has examined and approved those taxa and their name. The claimed distinction between the "abstract" and "concrete" status of such names is false. Moreover, one may ask, why should the names of viruses not yet officially recognized remain non-italicized so that their names can only be used in a supposedly concrete sense? Why also is it wrong for virus names in languages other than English to be used in a taxonomic sense?

***In summary, the proposition that only italicized names of viruses have a taxonomic meaning [32] is nonsensical. Each virus that has a scientific name has common names***

as well, and all have taxonomic meaning, including the non-English names [7].

### Non-latinized binomials as the solution

One solution to the problems caused by the italicization of virus names is to revert to the non-latinized binomial names *sensu* Fenner et al. [15] for all viruses. For plant viruses these have been in use for some decades, and I was among the first to strongly advocate the use of such non-latinized binomials, although I did not and still do not exclude the possible future use of Latin binomials [4, 6, 7]. After Van Regenmortel agreed that viral binomials in a non-latinized form have certain advantages [27, 28], I am happy to see that, at the end of his latest paper, he now firmly endorses this view [31]. Such binomials imply inclusion of the genus name (e.g., Bean yellow mosaic potyvirus) and this would clearly distinguish such binomials from common names. It would render the *in toto* italicization of ICTV-accepted names wholly superfluous and would avoid the conflict with scientific biological nomenclature at large. Surprisingly, Van Regenmortel states that “*In a scientific paper, it is necessary to refer only once, for instance in the Materials and methods section, to the taxonomic species name written in italics while in the remainder of the text the virus* (bold lettering by present author) *can be referred to by its common name written in Roman*” [31]. Obviously, we have already come a long way toward finalizing our dispute on the matter. The result may be the use of non-latinized binomials for viruses, with italics only used for the scientific names of organisms included in the virus names, common as well as scientific.

Drs. Mahy and Van Regenmortel, are now editing the third edition of the prestigious *Encyclopedia of Virology*. It is reassuring that they state that writing species names in italics and the virus names in Roman script “*might change in the near future (probably in 2005–2006) at least for plant viruses, since the ICTV is considering introducing a binomial system for the names of virus species so that the names of species would differ from the names of viruses*”, to the effect that “*the genus affiliation would appear in the species name*”. The wording should only be partially changed into “*so that the scientific (or official) names of the virus species would clearly differ from their common (or vernacular) names*”.

### Conclusions

There is no need for a nomenclature of viruses that is entirely different from bionomenclature at large. The *in toto* italicization to identify the official or scientific names of viruses accepted as species by the ITCV conflicts with the bionomenclature of cellular organisms. It unacceptably hinders the proper typography of the names of organisms that are included in virus names and also blurs the distinction between the scientific names of organisms and geographic names.

The supposed distinction between concrete and abstract states that discriminate between viruses and virus species, respectively, is unjustified and is irrelevant to the typography of virus names. In virology, common or vernacular names and scientific names both refer to viruses as abstract entities. Common names remain essential for communication in everyday speech and may be written differently according to language.

To be of scientific value, virus names must contain taxonomic information, that is, they must indicate taxonomic affiliation and must therefore be binomial. I fully support the proposal that the official or scientific species names of viruses be non-italicized, non-latinized binomials. In biological texts, common names of viruses, like those of organisms, have taxonomic value only when directly referenced to the scientific names of the viruses concerned.

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