

Tracking the changes in virus taxonomy

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Abstract A database and website (<http://www.ictvonline.org/taxonomyReleases.asp>) have been established where the history of changes in virus taxonomy from 1971 to the present day can easily be traced. Each change is linked to a source document confirming the change or, for most changes since 2002, to the taxonomic proposal approved by the International Committee on Taxonomy of Viruses (ICTV).

Introduction

The attempt to create a universal taxonomic scheme for all viruses began in earnest at the IXth Congress of the International Association of Microbiological Societies (IAMS), held in Moscow in 1966. Meetings at the congress formally established what was termed the International Committee on Nomenclature of Viruses (ICNV). The Committee was so constituted that, wherever practicable, each country was represented by at least one member nominated by the microbiological society of that country. The first Executive Committee (EC) was also appointed

with Professor Peter Wildy as its President. Members of the EC were appointed to chair subcommittees to develop taxonomy for the viruses of bacteriophage, invertebrates, plants and vertebrates, all of which would need the approval of the EC and of the entire ICNV.

While there have been some changes, this pattern of operation has largely continued to the present day. The ICNV was renamed the International Committee on Taxonomy of Viruses (ICTV) in 1974 and is today a committee of the Virology Division of the International Union of Microbiological Societies (IUMS).

Virus taxonomy differs from other types of biological classification because the ICTV not only regulates a Code of Nomenclature but also considers and approves the creation of virus taxa (currently orders, families, sub-families, genera and species). Priority of publication is not the determining factor. The names of all recognized taxa are nowadays written in italics with an initial capital letter. All changes in taxonomy must first be approved by the EC and then by the entire voting membership of the ICTV. In the early years, the final vote was taken at an ICTV plenary session at an International Congress of Virology. These congresses have generally been held every three years, and the original intention was then to publish a report setting out the revised taxonomy following the Congress. With the passage of time, the ICTV reports developed into large reference works, requiring major efforts in editing and publication, and it has become impractical to publish them every three years. In addition, the explosion in virus discovery has meant that taxonomic changes need to be made more frequently. The current pattern is for annual changes, with the final ratification vote being conducted by e-mail.

The first formal report on virus classification was published in 1971 [25]. This report, which laid the foundation for viral taxonomy, covers the period from the formation of

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Table 1 Time points and references for changes in virus taxonomy

Date	Event	Reference
1971	ICNV 1 st Report	[25]
1974	Postal vote April-May 1974	[8]
1975	Plenary session vote September 1975 in Madrid	See footnote*
1976	ICTV 2 nd Report	[7]
1978	Plenary session vote August 1978 in The Hague	See footnote*
1979	ICTV 3 rd Report	[11]
1981	Plenary session vote August 1981 in Strasbourg	See footnote*
1982	ICTV 4 th Report	[12]
1984	Plenary session vote September 1984 in Sendai	See footnote*
1987	Plenary session vote August 1987 in Edmonton	See footnote*
1990	Plenary session vote August 1990 in Berlin	See footnote*
1991	ICTV 5 th Report	[9]
1993	Plenary session vote August 1993 in Glasgow	[18]
1995	ICTV 6 th Report	[17]
1996	Plenary session vote August 1996 in Jerusalem	[19]
1997	Postal vote autumn 1997	[20]
1998	Postal vote autumn 1998	[21, 23]
1999	ICTV 7 th Report	[24]
1999	Plenary session vote August 1999 in Sydney	[22]
2002	Postal vote spring 2002	[13, 14]
2002	Plenary session vote July 2002 in Paris	[15]
2004	Postal vote 2004	[16]
2005	ICTV 8 th Report	[6]
2008	Postal vote March 2008	[5]
2009	E-mail vote July 2009	[4]
2011 [†]	ICTV 9 th Report	[10]
2011	E-mail vote February 2012	[1]
2012	E-mail vote February 2013	[3]
2013	E-mail vote March 2014	[2]

* Minutes of these Plenary Sessions are available online: https://talk.ictvonline.org/files/ictv_documents/m/plenary_minutes/default.aspx

[†] The ICTV 9th Report was published in 2011 but its taxonomy is unchanged from 2009

the ICNV in 1966 until 1970. Since then, there have been 27 occasions on which official taxonomy has changed. These changes may be traced by consulting the published reports of the ICTV and various articles (most of them in Archives of Virology) that have summarised the changes agreed by voting at virology congresses or by postal or e-mail ballots (Table 1). To make this information readily accessible, we have now developed a database and website where the entire history of taxonomic changes from 1971 to the present day can easily be traced. Each change is linked to a source document confirming the change or, for most changes since 2002, to the taxonomic proposal approved by the ICTV.

Preliminary considerations

Because the taxonomic categories recognised by the ICTV have changed over the years, some approximations or

conventions have been adopted to ensure that all changes can be tracked.

The early published reports consisted of brief summaries of the genera officially recognized by the ICTV (and a small number of families), with lists of viruses that were considered ‘members’, ‘probable members’ and ‘possible members’ of these genera. One of the member viruses was identified as the ‘type member’ or ‘type species’. Plant viruses were presented in ‘groups’ until more data were available to determine whether these groups corresponded to genera or families. All such groups had disappeared by 1993, most of them being recognised and renamed as genera. Before about 1996, there were not usually specific proposals and ballots of ICTV members to establish new member viruses (or species) and the lists were revised (sometimes extensively) by the relevant study groups when each ICTV Report was published. Until this stage in the history of the ICTV, there had been no agreement on the need for, or definition of, virus species, but species were

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Forty Years of Virus Taxonomy

Taxonomy lies at the uneasy interface between biology and logic. The processing of information follows somewhat different rules in these two systems and the role of taxonomy is to reconcile them as tidily as possible. To this end, the [Virology Division](#) of the [International Union of Microbiological Societies](#) (IUMS) charged the International Committee on Taxonomy of Viruses (ICTV) with the task of developing, refining, and maintaining a universal virus taxonomy. The goal of this undertaking is to categorize the multitude of known viruses into a single classification scheme that reflects their evolutionary relationships, i.e. their individual phylogenies.

The most recent report of the ICTV: "Virus taxonomy: classification and nomenclature of viruses: Ninth Report of the International Committee on Taxonomy of Viruses. (2012) Ed: King, A.M.Q., Adams, M.J., Carstens, E.B. and Lefkowitz, E.J. San Diego: [Elsevier Academic Press](#)", is the standard and definitive reference for virus taxonomy. Taxonomy updates are provided on this web site.

Useful Links

- [Virus Taxonomy: Current Release](#)
- [Virus Taxonomy: Historical Releases](#)
- [How to write virus names](#)

Support

ICTV gratefully acknowledges financial support from the [American Society for Virology \(USA\)](#), [Society for General Microbiology \(UK\)](#), and the [Virology Division of IUMS](#). ICTV also very gratefully acknowledges the support it receives from all its Executive Committee members, Study Group members and National Representatives who volunteer a huge amount of their time and financial support to ensure that ICTV continues to function for the good of virology.

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Fig. 1 Screen shot of the ICTV web site home page, <http://www.ictvonline.org>

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Taxa name search: Search Reset

Select to search across all ICTV releases

Virus Taxonomy: 2013 Release

EC 45, Edinburgh, July 2013;
Email ratification 2014 (MSL #28)

Using the taxonomy tree

Click on the to display "child" levels

Click on **history** to view the modification history of this taxon

The taxonomic level (Family)
Family *Poxviridae* has 2 subfamilies (*Chordopoxvirinae* and *Entomopoxvirinae*)

Symbols

- The type species in each genus
- This taxa has been modified from the previous release
- This taxa is modified in the next release

Order: <i>Caudovirales</i>	(3 Families)	history
Order: <i>Herpesvirales</i>	(3 Families)	history
Order: <i>Ligamenvirales</i>	(2 Families)	history
Order: <i>Mononegavirales</i>	(5 Families)	history
Order: <i>Nidovirales</i>	(4 Families)	history
Order: <i>Picornavirales</i>	(5 Families)	history
Family: <i>Dicistroviridae</i>	(2 Genera)	history
Genus: <i>Aparavirus</i>	(6 Species)	history
★ Species: <i>Acute bee paralysis virus</i>		history
Species: <i>Israeli acute paralysis virus</i>		history
Species: <i>Kashmir bee virus</i>		history
Species: <i>Mud crab virus</i>		history
Species: <i>Solenopsis invicta virus-1</i>		history
Species: <i>Taura syndrome virus</i>		history
Genus: <i>Cripavirus</i>	(9 Species)	history
Family: <i>Iflaviridae</i>	(1 Genus)	history
Family: <i>Marnaviridae</i>	(1 Genus)	history
Family: <i>Picornaviridae</i>	(26 Genera)	history
Family: <i>Secoviridae</i>	(1 Subfamily and 5 Genera not in a Subfamily)	history
Family: <i>Unassigned</i>	(2 Genera)	history
Order: <i>Tymovirales</i>	(4 Families)	history
Virus families not assigned to an order	(77 Families)	history

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Fig. 2 Screen shot of the ICTV web site current taxonomy release, <http://www.ictvonline.org/virusTaxonomy.asp>

systematically introduced for the Seventh Report [24]. In many cases, these species lists corresponded to the viruses listed earlier as genus members, but in some genera closely related viruses were classified into a single species. Possible or probable members of genera and families were then listed as ‘tentative species’.

For the purpose of the database, the viruses listed as genus ‘members’ from 1971–1995 are treated as species. The ‘groups’ are usually treated as genera. No attempt has been made to list ‘possible members’, ‘probable members’ or ‘tentative species’. Where changes to taxonomy occurred, links are provided to proposal documents or other

Taxonomy Releases

The following list represents all ICTV taxonomy releases to date. To view the corresponding taxonomy tree, click on the hyper-linked year next to the release.

Year	Release Info	Orders	Families	Subfam.	Genera	Species
2013	EC 45, Edinburgh, July 2013; Email ratification 2014 (MSL #28)	7	103	22	455	2827
2012	EC 44, Leuven, July 2012; Email ratification 2013 (MSL #27)	7	96	22	420	2617
2011	EC 42: Paris, June, 2010; EC43: Sapporo, September 2011; Email ratification 2012 (MSL #26)	6	94	22	395	2480
2009	ICTV 9th Report; EC41: Leiden, June 2009; Email ratification 2009 (MSL #25)	6	87	19	349	2285
2008	EC 39: Kingston, June, 2007; EC 40: Istanbul, August 2008; Email ratification 2008 (MSL #24)	5	82	11	307	2078
2005	ICTV 8th Report (MSL #23)	3	73	11	289	1898
2004	Postal vote 2004 (MSL #22)	3	73	11	290	1832
2002	Plenary session vote 30 July 2002 in Paris (MSL #21)	3	70	11	251	1619
2002	Postal vote spring 2002 (MSL #20)	3	70	9	247	1602
1999	Plenary session vote August 1999 in Sydney (MSL #19)	3	64	9	239	1550
1999	ICTV 7th Report (MSL #18)	3	64	9	234	1551
1998	Postal vote autumn 1998 (MSL #17)	3	63	9	233	2370
1997	Postal vote autumn 1997 (MSL #16)	2	56	9	197	2267
1996	Plenary session vote August 1996 in Jerusalem (MSL #15)	2	53	9	182	2253
1995	ICTV 6th Report (MSL #14)	1	50	9	166	2220
1993	Plenary session vote 10 August 1993 in Glasgow (MSL #13)	1	49	9	160	1700
1991	ICTV 5th Report (MSL #12)	1	40	9	142	1674
1990	Plenary session vote 29 August 1990 in Berlin (MSL #11)	1	40	9	137	1290
1987	Plenary session vote 12 August 1987 in Edmonton (MSL #10)	0	37	8	116	1275
1984	Plenary session vote 5 September 1984 in Sendai (MSL #09)	0	35	8	103	1222
1982	ICTV 4th Report (MSL #08)	0	29	8	97	1209
1981	Plenary session vote 4 August 1981 in Strasbourg (MSL #07)	0	29	8	93	1091
1979	ICTV 3rd Report (MSL #06)	0	24	8	84	1008
1978	Plenary session vote 30 August 1978 in The Hague (MSL #05)	0	24	7	76	760
1976	ICTV 2nd Report (MSL #04)	0	17	3	67	754
1975	Plenary session vote 12/16 September 1975 in Madrid (MSL #03)	0	17	1	63	309
1974	Postal vote April-May 1974 (MSL #02)	0	5	0	49	298
1971	ICTV 1st Report (MSL #01)	0	2	0	43	290

Fig. 3 Screen shot of the ICTV web site historical taxonomy releases, <http://www.ictvonline.org/taxonomyReleases.asp>

records (e.g. minutes recording the results of ICTV ballots) where available. As explained above, the recognition of new member viruses (or species) before 1996 can usually only be traced to the publication of a particular report. It is helpful to remember that while the taxonomic levels of

orders, families, subfamilies, genera and species are recognised in virus taxonomy, not all these levels are necessarily used. Each species is a member of a higher taxon; this is usually a genus, but sometimes a species may be placed within a family or subfamily but not assigned to

www.ictvonline.org/virusTaxonomy.asp

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Taxa name search: Search Reset

Select to search across all ICTV releases

(338 results found)

Click to view	Release	Search results
View species	2008	Picornavirales->Comoviridae->Nepovirus->Beet ringspot virus
View species	2008	Picornavirales->Dicistroviridae->Unassigned->Acute bee paralysis virus
View species	2008	Picornavirales->Dicistroviridae->Unassigned->Kashmir bee virus
View species	2008	Unassigned->Closteroviridae->Closterovirus->Beet yellow stunt virus
View species	2008	Unassigned->Closteroviridae->Closterovirus->Beet yellows virus
View species	2008	Unassigned->Closteroviridae->Crinivirus->Beet pseudoyellows virus
View species	2008	Unassigned->Geminiviridae->Curtovirus->Beet curly top virus

Virus Taxonomy: 2008 Release [? How do I use the taxonomy tree?](#)

EC 39: Kingston, June, 2007;
EC 40: Istanbul, August 2008;
Email ratification 2008 (MSL #24)

- Order: *Caudovirales* (3 Families) [history](#)
- Order: *Herpesvirales* (3 Families) [history](#)
- Order: *Mononegavirales* (4 Families) [history](#)
- Order: *Nidovirales* (3 Families) [history](#)
- Order: *Picornavirales* (6 Families) [history](#)
 - Family: *Comoviridae* (3 Genera) [history](#)
 - Family: *Dicistroviridae* (1 Genus) [history](#)
 - Genus: *Cripavirus* (8 Species) [history](#)
 - Genus: Unassigned (4 Species) [history](#)
 - Species: *Acute bee paralysis virus* [history](#)
 - Species: *Kashmir bee virus* [history](#)
 - Species: *Solenopsis invicta virus-1* [history](#)
 - Species: *Taura syndrome virus* [history](#)
 - Family: *Iflaviridae* (1 Genus) [history](#)
 - Family: *Marnaviridae* (1 Genus) [history](#)
 - Family: *Picornaviridae* (8 Genera) [history](#)
 - Family: *Sequiviridae* (2 Genera) [history](#)
 - Family: Unassigned (2 Genera) [history](#)
- Virus families not assigned to an order (63 Families) [history](#)

Fig. 4 Screen shot of the ICTV web site taxonomy search page

any current genus. Most genera, but not all, are placed in families. Many families are not currently assigned to an order, and few of them are divided into subfamilies.

Using the web site

The ICTV web site (Fig. 1, <http://www.ictvonline.org>) provides access to a wide variety of information pertinent

to ICTV activities. This information includes copies of the ICTV Statutes and Code of Virus Classification (“The ICTV” menu); both approved and pending taxonomy proposals as well as downloadable copies of the complete virus taxonomy—the Master Species List (“ICTV Files” menu); and lists of Executive Committee, Subcommittee, and Study Group members (“ICTV Directory” menu). The current, and all past, releases of the virus taxonomy can be accessed from the ICTV taxonomic database and displayed

ICTV Taxonomy History for Acute bee paralysis virus		
2004: Postal vote 2004 (MSL #22)		
Name with lineage Order->Family->Subfamily->Genus->Species	Changes	
Unassigned->Dicistroviridae->Unassigned->Unassigned->Acute bee paralysis virus	From previous release	In next release
	New	
	Proposal PDF	
2005: ICTV 8th Report (MSL #23)		
Name with lineage Order->Family->Subfamily->Genus->Species	Changes	
Unassigned->Dicistroviridae->Unassigned->Unassigned->Acute bee paralysis virus	From previous release	In next release
		Moved
2008: EC 39: Kingston, June, 2007; EC 40: Istanbul, August 2008; Email ratification 2008 (MSL #24)		
Name with lineage Order->Family->Subfamily->Genus->Species	Changes	
Picornavirales->Dicistroviridae->Unassigned->Unassigned->Acute bee paralysis virus	From previous release	In next release
	Moved	Moved, Assigned as Type Species
		Proposal PDF
2009: ICTV 9th Report; EC41: Leiden, June 2009; Email ratification 2009 (MSL #25)		
Name with lineage Order->Family->Subfamily->Genus->Species	Changes	
Picornavirales->Dicistroviridae->Unassigned->Aparavirus->Acute bee paralysis virus ★	From previous release	In next release
	Moved, Assigned as Type Species	
	Proposal PDF	Proposal PDF
2011: EC 42: Paris, June, 2010; EC43: Sapporo, September 2011; Email ratification 2012 (MSL #26)		
Name with lineage Order->Family->Subfamily->Genus->Species	Changes	
Picornavirales->Dicistroviridae->Unassigned->Aparavirus->Acute bee paralysis virus ★	From previous release	In next release
	Proposal PDF	
2012: EC 44, Leuven, July 2012; Email ratification 2013 (MSL #27)		
Name with lineage Order->Family->Subfamily->Genus->Species	Changes	
Picornavirales->Dicistroviridae->Unassigned->Aparavirus->Acute bee paralysis virus ★	From previous release	In next release
2013: EC 45, Edinburgh, July 2013; Email ratification 2014 (MSL #28)		
Name with lineage Order->Family->Subfamily->Genus->Species	Changes	
Picornavirales->Dicistroviridae->Unassigned->Aparavirus->Acute bee paralysis virus ★	From previous release	In next release

Fig. 5 Screen shot of the ICTV web site taxon history web page

from web links provided by the “Taxonomy” menu. The current taxonomy release (Fig. 2, <http://www.ictvonline.org/virusTaxonomy.asp>) displays a list of the complete taxonomic hierarchy organized alphabetically according to taxonomic rank. Each rank displayed within this taxonomy tree can be expanded by clicking on the + sign to the left of the taxon name. A list of historical ICTV releases is also available (Fig. 3, <http://www.ictvonline.org/taxonomyReleases.asp>). This list displays the year that the release was

approved by the EC, the release number and location of the EC meeting during which the release was compiled, and statistics detailing the number of entries for each taxon rank. Clicking on the release year will open a web page that provides access to the corresponding taxon list. Release numbers are composed of up to three items: a MSL number that corresponds to the release number of the Master Species List, an EC number that corresponds to the Executive Committee meeting at which the proposals were

Table 2 Terminology used to describe taxon changes

Term	Description	Example
New	Creation of a new taxon	In 2004, the species <i>Acute bee paralysis virus</i> was created in the family <i>Dicistroviridae</i>
Abolished	Removal of a taxon	In 2011, the species <i>Hawaiian rubus leaf curl virus</i> was abolished
Renamed	Renamed taxon	In 2012, the species <i>Bovine enterovirus</i> was renamed <i>Enterovirus E</i>
Moved	Moving a taxon to a different higher-level taxon	In 2009, the species <i>Acute bee paralysis virus</i> was moved into the genus <i>Aparavirus</i>
Split	Splitting a taxon into two or more taxa	In 1979, the species <i>Bovine enterovirus</i> was split into <i>Bovine enterovirus 1</i> and <i>Bovine enterovirus 2</i>
Merged	Merging two or more taxa into a single taxon	In 1999, the species <i>Bovine enterovirus 1</i> and <i>Bovine enterovirus 2</i> were merged into a single species, <i>Bovine enterovirus</i>
Assigned as Type Species	Assigning a species as the type species of the genus	In 2009, the species <i>Acute bee paralysis virus</i> was assigned as the type species of the genus <i>Aparavirus</i>
Removed as Type Species	Removing a species as the type species of the genus	In 2005, the species <i>Poliovirus</i> was removed as the type species of the genus <i>Enterovirus</i>

Fig. 6 Graph showing changes to the numbers of genera, families, subfamilies and orders recognised by the ICTV, 1971-2014

discussed and approved, and an ICTV Report number that corresponds to the volume number of the ICTV Report's publication for that MSL release.

To search for a particular taxon across all taxonomy releases, a taxon name (or partial name) can be entered into the search box at the top of any taxonomy release page (Fig. 4). For example, entering the search term "bee" will result in a list of all taxon names that include the characters "bee" as a part of the name. The result set provides a list of these taxa, along with the year of each release in which

each taxon name appears. Clicking on the "View" button to the left of the taxon will expand the taxonomy tree for that particular release, and highlight the taxon name in yellow (Fig. 4). To the right of each taxon name is a "history" link. A left and right arrow brackets the history link. If these arrows are colored, this provides an indication that the taxon has been updated from the previous release (red left arrow) and/or was updated in the next release (green right arrow). The "history" link opens a web page that provides the complete history of the taxon (Fig. 5) that

summarizes all of the changes to the taxon over the years during which that taxon has existed. The terminology used to describe changes to a taxon's history is provided in Table 2.

Conclusions

Compilation of these data has provided a thorough check of the ICTV records. A small number of mistakes, mostly in the spelling of species names, that became incorporated into Reports have been identified and corrected. Such corrections have been the subject of formal proposals to maintain comprehensive records. With very few exceptions, all taxonomic changes involving genera or higher taxa have been traced to published records. Procedures for presenting, reviewing and approving taxonomic proposals have developed over time but have become increasingly detailed and transparent in the last 10–15 years. The proposals of the last 10 years have all been assembled and linked to the database, providing a detailed justification for the changes made. Since 1971, the numbers of genera have risen from 43 to 455 and families from 2 to 103 (Fig. 6). This reflects a huge amount of work in virus discovery and characterization as well as the effort involved in making and evaluating taxonomic proposals. The speed of change will likely increase in the years ahead, and it is intended that this database will provide an ongoing and updated record of those changes.

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