

## Revised proposal for naming geminiviruses

C. M. Fauquet<sup>1</sup>, D. P. Maxwell<sup>2</sup>, B. Gronenborn<sup>3</sup>, and J. Stanley<sup>4</sup>

<sup>1</sup> ILTAB/Donald Danforth Plant Science Center, St. Louis, Missouri, U.S.A.

<sup>2</sup> Department of Plant Pathology, University of Wisconsin, Madison, Wisconsin, U.S.A.

<sup>3</sup> CNRS, Institut des Sciences Végétales, Gif sur Yvette, France

<sup>4</sup> John Innes Centre, Norwich, U.K.

### Introduction

Geminiviruses are plant viruses that belong to the family *Geminiviridae* and have circular, single-stranded DNA genomes packaged within geminate particles. The genome organization and biological properties of geminiviruses allow them to be divided into four genera [1, 4, 6, 11]. Those that have a monopartite genome and that are transmitted by leafhopper insect vectors to monocotyledonous plants are members of the genus *Mastrevirus*, of which *Maize streak virus* is the type species. The genus *Curtovirus* comprises viruses that have a monopartite genome and are transmitted by leafhoppers to dicotyledonous plants; *Beet curly top virus* is the type species. The genus *Topocuvirus* has only one member (also the type species): *Tomato pseudo-curly top virus*, which has a monopartite genome and is transmitted by tree hoppers to dicotyledonous plants. The fourth genus, *Begomovirus*, includes viruses that are transmitted by whiteflies to dicotyledonous plants; *Bean golden yellow mosaic virus* is the type species. These viruses have bipartite genomes (A and B components), with some exceptions (e.g., *Tomato yellow leaf curl virus*, *Cotton leaf curl virus*, *Tomato leaf curl virus*...) for which no B components have been found.

Infection by geminiviruses can cause significant yield losses to many crop plants throughout the world [8]. Because of their economic importance and the relative ease with which their DNA genomes can be cloned, many geminiviruses are now being characterized. Yet, at present, virologists have no definitive guidelines for naming geminiviruses. Traditionally, viruses are named according to the host, the symptoms produced, and/or geographical origin (e.g., *Wheat dwarf virus* and *African cassava mosaic virus*), but it is becoming increasingly difficult or even impossible to name new geminiviruses because different species often cause similar symptoms in the same crop (e.g., Tomato yellow leaf curl viruses from Thailand, Israel, and Sardinia). Naming is especially difficult when different species infect the same crop in the same geographical region (e.g., the tomato leaf curl viruses in India). Moreover, many isolates are now being characterized within a given virus species, adding a level of complexity to the system. This complexity is compounded by the recent discovery that recombination between species of geminiviruses happens relatively frequently [7].

We present here a system for naming geminiviruses and provide a list of geminiviruses together with suggested names. This paper does not provide guidelines for identifying geminivirus species or strains; this will be done elsewhere. Here we aim only to propose a nomenclature system that is simple and flexible enough to accommodate the current situation and future discoveries in the family *Geminiviridae*. It is the result of numerous discussions over the GeminiNet and of an evening workshop discussion at the International Workshop on Bemisia and Geminiviral Diseases, Puerto Rico, June 1998. The authors felt it was important to begin a new millennium with a proposal for geminivirus nomenclature system being available.

### Proposed nomenclature guidelines

The general goal of our proposals is to keep existing names in place so as to create a minimum of changes. All our proposals comply with the International Committee on Taxonomy of Viruses (ICTV) Universal Code for Nomenclature [5, 11] and the abbreviations have been cross-checked with the official list published by the ICTV [2]. The ICTV Universal Code for Nomenclature stipulates that a virus name should comprise more than one word in addition to the word “virus.” These additional words may include, but are not restricted to, host name, symptom descriptors, or location of isolation, but should not include the name of the discoverer. The word “virus” should be the last word in the name, but additional words, letters, and numbers may be added to characterize strains, serogroups, genotypes, or isolates of viruses.

For geminiviruses, to avoid confusion and provide as many names as possible for the increasing number of species, it is proposed that the geographical location of the first isolation of the virus be added within the core of the virus name before the word “virus” (e.g., *Tomato yellow leaf curl Sardinia virus*, TYLCSV). This method retains much of the usual nomenclature, and, in a list of virus names, those of the viruses causing yellow leaf curl in tomato will be listed together. This system is widely used for animal and human viruses, and therefore should be readily accepted by the ICTV. Because the location of isolation can be the names of rivers, cities, regions, or countries, it offers a great deal of freedom for creating new species names.

It is proposed that the first published name of a virus species be retained without any additions; for example, *Tomato yellow leaf curl virus* (TYLCV) will be the name of the virus isolated in Israel, and *Tomato leaf curl virus* (ToLCV) will be the name of the virus isolated in Australia.

It is also proposed to keep names with a significant history, such as *African cassava mosaic virus* (ACMV), even though they may not follow the guidelines that we propose here.

The list of virus names given below (Table 1) follows these guidelines, and location names already in use have been integrated into the names. However, in some instances, when more than one species was isolated in one location (e.g., cotton leaf curl viruses from Faisalabad in Pakistan), we have used the names of nearby cities. The importance of the name of the location of the first isolate is only in differentiating one virus from another. It is well understood that a virus species can be found in much larger areas than a single city or even a single country. The names of nations have been avoided wherever possible to increase variety and to avoid political complications.

Table 1. Family *Geminiviridae*

<b>Genus <i>Mastrevirus</i></b>		
<b>List of Species</b>		
<i>Bean yellow dwarf virus</i>	Y11023	(BeYDV)
<i>Bromus striate mosaic virus</i>		(BrSMV)
<i>Chloris striate mosaic virus</i>	M20021	(CSMV)
<i>Digitaria streak virus</i>	M23022	(DSV)
<i>Digitaria striate mosaic virus</i>		(DiSMV)
<i>Maize streak virus</i>		(MSV)
Maize streak virus – [Ethiopia]	X71956	(MSV-[ET])
Maize streak virus – [Ghana1]	X71953	(MSV-[GH1])
Maize streak virus – [Ghana2]	X71959	(MSV-[GH2])
Maize streak virus – [Kenya]	X01089	(MSV-[KE])
Maize streak virus – [Kom]	AF003952	(MSV-[Kom])
Maize streak virus – [Malawi]		(MSV-[MW])
Maize streak virus – [Mauritius]	X71963	(MSV-[MU])
Maize streak virus – [Mozambique]	X71962	(MSV-[MZ])
Maize streak virus – [Nigeria1]	K02026, X01633	(MSV-[NG1])
Maize streak virus – [Nigeria2]	X71957	(MSV-[NG2])
Maize streak virus – [Nigeria3]	X71961	(MSV-[NG3])
Maize streak virus – [Port Elizabeth]	U20893	(MSV-[PEI])
Maize streak virus – [Reunion1]	X01633, X71954	(MSV-[RE1])
Maize streak virus – [Reunion2]	X94330	(MSV-[RE2])
Maize streak virus – Reunion [N2AR2]	AJ224504	(MSV-RE[N2AR2])
Maize streak virus – Reunion [N2AR3]	AJ224505	(MSV-RE[N2AR3])
Maize streak virus – Reunion [N2AR4]	AJ224506	(MSV-RE[N2AR4])
Maize streak virus – Reunion [N2AR5]	AJ224507	(MSV-RE[N2AR5])
Maize streak virus – Reunion [N2AR6]	AJ224508	(MSV-RE[N2AR6])
Maize streak virus – Reunion [N2AR8]	AJ225006	(MSV-RE[N2AR8])
Maize streak virus – Reunion [SP1]	AJ224999	(MSV-RE[SP1])
Maize streak virus – Reunion [SP1R10]	AJ225007	(MSV-RE[SP1R10])
Maize streak virus – Reunion [SP2R11]	AJ225009	(MSV-RE[SP2R11])
Maize streak virus – Reunion [SP2R12]	AJ225010	(MSV-RE[SP2R12])
Maize streak virus – Reunion [SP2R13]	AJ225011	(MSV-RE[SP2R13])
Maize streak virus – Reunion [SP2R7]	AJ225008	(MSV-RE[SP2R7])
Maize streak virus – [South Africa]	Y00514	(MSV-[ZA])
Maize streak virus – [Tas]	U20905, AJ012636	(MSV-[Tas])
Maize streak virus – [Uganda]	X71958	(MSV-[UG])
Maize streak virus – [Vaalhart maize]	U20769, AJ012637	(MSV-[Vma])
Maize streak virus – [Vaalhart wheat]	U20768, AJ012638	(MSV-[Vwh])
Maize streak virus – [Wheat-eleusian]	U20871	(MSV-[We])
Maize streak virus – [Zaire]	X71964	(MSV-[ZR])
Maize streak virus – [Zimbabwe1]	X71955	(MSV-[ZW1])
Maize streak virus – [Zimbabwe2]	X71960	(MSV-[ZW2])
<i>Miscanthus streak virus</i>	D00800, D01030	(MiSV)
<i>Panicum streak virus</i>		(PanSV)
Panicum streak virus – Karino	L39638	(PanSV-Kar)
Panicum streak virus – Kenya	X60168	(PanSV-KE)
<i>Paspalum striate mosaic virus</i>		(PSMV)

Continued

Table 1 (continued)

<i>Setaria streak virus</i> (Maize streak virus – <i>Setaria</i> ; MSV-[Set])	AF007881, U20870	(SetSV)
<i>Sugarcane streak virus</i> Sugarcane streak virus – [Natal]	M82918, S64567	(SSV)
Sugarcane streak virus – [Mauritius]	D00597, AF088881	(SSV-[Nat])
<i>Sugarcane streak Egypt virus</i> Sugarcane streak Egypt virus – [Aswan]	AF039528	(SSV-[MU])
Sugarcane streak Egypt virus – [Giza]	AF037752	(SSEV)
Sugarcane streak Egypt virus – [Ben]	AF039529	(SSEV-[Asw])
Sugarcane streak Egypt virus – [Man]	AF039530	(SSEV-[Giza])
<i>Sugarcane streak Reunion virus</i> (Sugarcane streak virus – [Reunion])	AF072672	(SSEV-[Ben])
<i>Tobacco yellow dwarf virus</i>	M81103	(SSEV-[Man])
<i>Wheat dwarf virus</i> Wheat dwarf virus – [Czech Republic]	X02869	(SSREV)
(Wheat dwarf virus – CJI, WDV-CJI)		(TYDV)
Wheat dwarf virus – [France]	X82104	(WDV)
Wheat dwarf virus – [Sweden]		(WDV-[CZ])
<b>List of Tentative Species</b>		
Bajra streak virus		(BaSV)
Chickpea chlorotic dwarf virus		(CpCDV)
Millet streak virus	X86705	(MISV)
<b>Genus <i>Curtovirus</i></b>		
<b>List of Species</b>		
<i>Beet mild curly top virus</i> (Beet curly top virus – Worland; BCTV-Wor)	U56975	(BMCTV)
<i>Beet severe curly top virus</i> Beet severe curly top virus – Cfh	U02311	(BSCTV)
(Beet curly top virus – CFH; BCTV-Cfh)		(BSCTV-Cfh)
Beet severe curly top virus – Cfh [Beta]	X97203	(BSCTV-Cfh[Beta])
(Beet curly top virus – CFH; BCTV-Cfh[Beta])		
<i>Beet curly top virus</i> Beet curly top virus – California	M24597	(BCTV)
Beet curly top virus – California [Logan]	X04144	(BCTV-Cal)
<i>Horseradish curly top virus</i>	U49907	(BCTV-Cal[Log])
<b>List of Tentative Species</b>		
Tomato leaf roll virus		(HrCTV)
<b>Genus <i>Topocuvirus</i></b>		
<b>List of Species</b>		
<i>Tomato pseudo-curly top virus</i>	X84735	(TLRV)
<b>Genus <i>Begomovirus</i></b>		
<b>List of Species</b>		
<i>Abutilon mosaic virus</i> Abutilon mosaic virus – HW	X15983, X15984	(AbMV)
<i>Acalypha yellow mosaic virus</i>	U51137, U51138,	(AbMV-HW)
<i>African cassava mosaic virus</i> (Cassava latent virus)		(AYMV)
African cassava mosaic virus – [Cameroon]	AF112352, AF112353	(ACMV)

Continued

Table 1 (continued)

African cassava mosaic virus – [Ghana]		(ACMV-[GH])
African cassava mosaic virus – [Ivory Coast]	pita	(ACMV-[IC])
African cassava mosaic virus – Kenya	J02057, J02058	(ACMV-KE)
African cassava mosaic virus – [Nigeria]	X17095, X17096	(ACMV-[NG])
African cassava mosaic virus – [Uganda]	Z83252, Z83253	(ACMV-[UG])
African cassava mosaic virus – Uganda Mild	AF126800, AF126801	(ACMV-UGmld)
African cassava mosaic virus – Uganda Severe	AF126802, AF126803	(ACMV-UGSvr)
<i>Ageratum yellow vein virus</i>	X74516	(AYVV)
<i>Althea rosea enation virus</i>	AF014881	(AREV)
<i>Asystasia golden mosaic virus</i>		(AGMV)
<i>Bean calico mosaic virus</i>	AF110189, AF110190	(BCaMV)
<i>Bean dwarf mosaic virus</i>	M88179, M88180	(BDMV)
<i>Bean golden mosaic virus</i>	M88686, M88687,	(BGMV)
(Bean golden mosaic virus – Brazil; BGMV-BR)	AF173555, AF173556	
<i>Bean golden yellow mosaic virus</i>		(BGYMV)
(Bean golden mosaic virus – Puerto Rico; BGMV-PR)		
Bean golden yellow mosaic virus [Dominican Republic]	L01635, L01636	(BGMV-[DO])
(Bean golden mosaic virus – Puerto Rico [Dominican Republic]; BGMV-PR[DO])		
(Bean golden mosaic virus – Dominican Republic; BGMV-DO)		
Bean golden yellow mosaic virus – [Guatemala]	M91604, M91605	(BGMV-[GT])
(Bean golden mosaic virus – Puerto Rico [Guatemala]; BGMV-PR[GT])		
(Bean golden mosaic virus – Guatemala; BGMV-GT)		
Bean golden yellow mosaic virus – [Mexico]	AF173555, AF173556	(BGYMV-[Mex])
Bean golden yellow mosaic virus – [Puerto Rico]	M10070, M10080,	(BGYMV-[PR])
(Bean golden mosaic virus – Puerto Rico; BGMV-[PR])	D00200, D00201	
<i>Cabbage leaf curl virus</i>	U65529, U65530	(CaLCuV)
<i>Chayote mosaic virus</i>	AJ223191	(ChaMV)
<i>Cotton leaf crumple virus</i>		(CLCrV)
<i>Cotton leaf curl Multan virus</i>		(CLCuMV)
(Cotton leaf curl virus – Pakistan1; CLCuV-Pk1)		
Cotton leaf curl Multan virus – Faisalabad1	X98995	(CLCuMV-Fai1)
(Cotton leaf curl virus – Pakistan1 [Faisalabad1]; CLCuV-PK1[Fai1])		
Cotton leaf curl Multan virus – Faisalabad2	Aftab	(CLCuMV-Fai2)
(Cotton leaf curl virus – Pakistan1 [Faisalabad2]; CLCuV-PK1[Fai2])		
Cotton leaf curl Multan virus – Faisalabad2 [26]	AJ002448	(CLCuMV-Fai2[26])
Cotton leaf curl Multan virus – Faisalabad2 [62]	AJ002449	(CLCuMV-Fai2[62])
Cotton leaf curl Multan virus – Multan	AJ002459	(CLCuMV-Mul)
(Cotton leaf curl virus – Pakistan1 [Multan]; CLCuV-PK1[Mul])		
Cotton leaf curl Multan virus – Okra	AJ002458	(CLCuMV-Ok)
(Cotton leaf curl virus – Pakistan1 [Okra]; CLCuV-PK1[Ok])		
<i>Cotton leaf curl Lahore virus</i>		(CLCuLV)
(Cotton leaf curl virus – Pakistan3; CLCuV-Pk3)		
Cotton leaf curl Lahore virus – [802a]	AJ002452	(CLCuLV-[802a])
Cotton leaf curl Lahore virus – [804a]	AJ002455	(CLCuLV-[804a])

Continued

Table 1 (continued)

<i>Cotton leaf curl Faisalabad virus</i>		(CLCuFV)
(Cotton leaf curl virus – Pakistan2; CLCuV-Pk2)		
(Pakistani cotton leaf curl virus)		
Cotton leaf curl Faisalabad virus – [Faisalabad1]		(CLCuFV-[Fai1])
(Cotton leaf curl virus – Pakistan2 [Faisalabad1]; CLCuV-PK2[Fai1])		
Cotton leaf curl Faisalabad virus – [72b]	AJ222703	(CLCuFV-[72b])
(Cotton leaf curl virus – Pakistan2 [72b]; CLCuV-PK2[72b])		
Cotton leaf curl Faisalabad virus – [806b]	AJ002447	(CLCuFV-[806b])
(Cotton leaf curl virus – Pakistan2 [806b]; CLCuV-PK2[806b])		
<i>Cowpea golden mosaic virus</i>		(CPGMV)
Cowpea golden mosaic virus – [Nigeria]	AF029217	(CPGMV-[NG])
Cowpea golden mosaic virus – [Brazil]	AF188708	(CPGMV-[BZ])
<i>Croton yellow vein mosaic virus</i>		(CYVMV)
Croton yellow vein mosaic virus – [Lucknow]		(CYVMV-[Luc])
<i>Dicliptera yellow mottle virus</i>	AF170101, AF139168	(DiYMoV)
<i>Dolichos yellow mosaic virus</i>		(DoYMV)
<i>East african cassava mosaic virus</i>		(EACMV)
East african cassava mosaic virus – Cameroon	AF112354, AF112355	(EACMV-CM)
East african cassava mosaic virus – Cameroon [Ivory Coast]	AF259896, AF259897	(EACMV-CM[CI])
East african cassava mosaic virus – [Kenya]	Z83258	(EACMV-[KE])
East african cassava mosaic virus – Malawi	AJ006461	(EACMV-MW)
East african cassava mosaic virus – Malawi [K]	AJ006460	(EACMV-MW[K])
East african cassava mosaic virus – Malawi [MH]	AJ006459	(EACMV-MW[MH])
East african cassava mosaic virus – Tanzania	Z83256	(EACMV-TZ)
East african cassava mosaic virus – [Uganda1]	AF230375	(EACMV-[UG1])
East african cassava mosaic virus – Uganda2	Z83257	(EACMV-UG2)
(Uganda variant)		
East african cassava mosaic virus – Uganda2 Mild	AF126804	(EACMV-UG2Mid)
East african cassava mosaic virus – Uganda2 Severe	AF126806	(EACMV-UG2Svr)
East african cassava mosaic virus – Uganda3 Mild	AF126805	(EACMV-UG3Mid)
East african cassava mosaic virus – Uganda3 Severe	AF126807, AF230374	(EACMV-UG3Svr)
<i>Eclipta yellow vein virus</i>		(EYVV)
<i>Euphorbia mosaic virus</i>		(EuMV)
<i>Honeysuckle yellow vein mosaic virus</i>		(HYVMV)
<i>Horsegram yellow mosaic virus</i>		(HgYMV)
<i>Indian cassava mosaic virus</i>	Z24758, Z24759	(ICMV)
<i>Ipomea yellow vein virus</i>	AJ132548	(IYVV)
<i>Jatropha mosaic virus</i>		(JMV)
<i>Leonurus mosaic virus</i>	U92532	(LeMV)
<i>Limabean golden mosaic virus</i>		(LGMV)
<i>Macroptilium golden mosaic virus</i>		(MGMV)
Macroptilium golden mosaic virus – [Jamaica1]	AF098940	(MGMV-[JM1])
Macroptilium golden mosaic virus – [Jamaica2]	AF098939	(MGMV-[JM2])
Macroptilium golden mosaic virus – [PR]	AF176092, AF176093, AF176094	(MGMV-[PR])
<i>Macrotyloma mosaic virus</i>		(MaMV)

Continued

Table 1 (continued)

<i>Malvaceous chlorosis virus</i>		(MCV)
<i>Melon leaf curl virus</i>		(MLCuV)
<i>Mungbean yellow mosaic Indian virus</i>	AF126406, AF142440	(MYMIV)
<i>Mungbean yellow mosaic virus</i>	D14703, D14704	(MYMV)
Mungbean yellow mosaic virus – Thailand	AB017341	(MYMV-TH)
Mungbean yellow mosaic virus – Vigna	AJ132575	(MYMV-Vi)
<i>Okra leaf curl India virus</i>		(OLCuIV)
(Okra leaf curl virus – India; OLCV-IN)		
<i>Okra leaf curl virus</i>		(OLCuV)
(Okra leaf curl virus – [Ivory Coast]; OLCV-[CI])		
<i>Okra yellow vein Faisalabad virus</i>		(OYVVFV)
Okra yellow vein Faisalabad virus – [301]	AJ002453	(OYVVFV-[301])
Okra yellow vein Faisalabad virus – [India]	AF241579	(OYVVFV-[Ind])
(Bhendi yellow vein mosaic virus)		
<i>Okra yellow vein virus</i>		(OYVVV)
Okra yellow vein virus – [201]	AJ002451	(OYVVV-[201])
<i>Papaya leaf curl virus</i>	Y15934, Y07962	(PaLCuV)
<i>Pepper golden mosaic virus</i>	U57457	
(Serrano golden mosaic virus; SGMV)	AFO75591	
(Texas pepper virus; TPV)		
Pepper golden mosaic virus – [GTS8]	AF136404	(PepGMV-[GTS8])
Pepper golden mosaic virus – [CR]	AF149227	(PepGMV-[CR])
<i>Pepper huasteco yellow vein virus</i>	X70418, X70419	(PHYVVV)
(Pepper huasteco virus; PHV)		
<i>Pepper leaf curl virus</i>	AF134484	(PepLCV)
<i>Pepper mild tigré virus</i>		(PepMTV)
<i>Potato yellow mosaic virus</i>		(PYMV)
Potato yellow mosaic virus – Panama	Y15034	(PYMV-PA)
(Tomato leaf curl virus – Panama; ToLCV-PA)		
Potato yellow mosaic virus – Trinidad and Tobago	AF039031, AF039032	(PYMV-TT)
Potato yellow mosaic virus – Venezuela	D00940, D00941	(PYMV-VE)
Potato yellow mosaic virus – [Guadeloupe]		(PYMV-[GP])
Potato yellow mosaic virus – [Tomato]	AF026553	(PYMV-[Tom])
<i>Pseuderanthemum yellow vein virus</i>		(PYVVV)
<i>Rhynchosia golden mosaic virus</i>	AF239671	(RhGMV)
<i>Sida golden mosaic Costa Rica virus</i>	X99550, X99551	(SiGMCRV)
<i>Sida golden mosaic Florida virus</i>	AF049336, AF049341	(SiGMFV)
Sida golden mosaic Florida virus – [A1]	U77963	(SiGMFV-[A1])
Sida golden mosaic Florida virus – [A11]	U77964	(SiGMFV-[A11])
<i>Sida golden mosaic Honduras virus</i>	Y11097, Y11098	(SiGMHV)
Sida golden mosaic Honduras virus – Yellow vein	Y11099, Y11100, Y11101	(SiGMHV-YV)
<i>Sida golden mosaic Jamaica virus</i>	U67926, U69601, U68177,	(SiGMJV)
Sida golden mosaic Jamaica virus – [3]	U69157, U69158, U69602,	(SiGMJV-[3])
Sida golden mosaic Jamaica virus – [Macroptilium 19]	U69159, U70386	(SiGMJV-[Mac19])
<i>Solanum tomato leaf curl virus</i>	U51893, U51894	(SToLCV)
<i>Solanum yellow leaf curl virus</i>		(SYLCV)
<i>South African cassava mosaic virus</i>	AF155807, AF155808	(SACMV)
<i>Squash leaf curl China virus</i>	AB027465	(SLCCV)
<i>Squash leaf curl virus</i>	M38182, M38183	(SLCV)

Continued

Table 1 (continued)

Squash leaf curl virus – Extended host	M63157, M63158	(SLCV-E)
Squash leaf curl virus – [Los Mochis]	L27272, L27273	(SLCV-[Lmo])
Squash leaf curl virus – Restricted host	M63155, M63156, L20240	(SLCV-R)
<i>Sweet potato leaf curl virus</i>	AF104036	(SPLCV)
<i>Tobacco leaf curl Japan virus</i> (Tobacco leaf curl virus – Japan; TbLCV-IN)	E15418	(TbLCJV)
<i>Tomato golden mosaic virus</i>		(TGMV)
Tomato golden mosaic virus – Common	M73794	(TGMV-Com)
Tomato golden mosaic virus – [GT94-R2]	AF132852, AF138298	(TGMV-[GT94-R2])
Tomato golden mosaic virus – Yellow vein	K02029, K02030	(TGMV-YV)
<i>Tomato leaf crumple virus</i> (Chino del tomate virus; CdTV)	U57458, AF007823 L27267, L27268	(ToLCrV)
Tomato leaf crumple virus – [H8]	AF101476, AF101478 AF266664	(ToLCrV-[H8])
Tomato leaf crumple virus – [H6]	AF266665	(ToLCrV-[H6])
Tomato leaf crumple virus – [B52]	AF266666	(ToLCrV-[B52])
<i>Tomato leaf curl Bangalore virus</i> (Tomato leaf curl virus – Bangalore 1; ToLCV-Ban1) (Indian tomato leaf curl virus – Bangalore 1; IToLCV-BanI)	L12739 Z48182, X78956, X89653	(ToLCBV)
Tomato leaf curl Bangalore virus – [Ban4]	AF165098	(ToLCBV-[Ban4])
<i>Tomato leaf curl Bangladesh virus</i>	AF188481	(ToLCBDV)
<i>Tomato leaf curl Karnataka virus</i> (Tomato leaf curl virus – Bangalore 2) (Indian tomato leaf curl virus – Bangalore II)	U38239	(ToLCKV)
<i>Tomato leaf curl Laos virus</i>	AF195482	(ToLCLV)
<i>Tomato leaf curl New Delhi virus</i> (Tomato leaf curl virus – New Delhi; ToLCV-ND) (Tomato leaf curl virus – India2; ToLCV-IN2)		(ToLCNdV)
Tomato leaf curl New Delhi virus – Mild (Tomato leaf curl virus – New Delhi [Mild]; ToLCV-Nde[Mld])	U15016	(ToLCNdV-Mld)
Tomato leaf curl New Delhi virus – [Severe] (Tomato leaf curl virus – New Delhi [Severe]; ToLCV-Nde[Svr])	U15015, U15017	(ToLCNdV-Svr)
Tomato leaf curl New Delhi virus – [Lucknow] (Tomato leaf curl virus – New Delhi [Lucknow]; ToLCV-ND[Luc])	X89653, X78956, Y16421	(ToLCNdV-[Luc])
Tomato leaf curl New Delhi virus – [Luffa] (Tomato leaf curl virus – New Delhi [Luffa]; ToLCV-ND[Luf]) (Angled Luffa leaf curl virus; ALLV)	AF102276	(ToLCNdV-[Luf])
<i>Tomato leaf curl Senegal virus</i> (Tomato leaf curl virus – Senegal; ToLCV-SN)	D88800	(ToLCSV)
<i>Tomato leaf curl Sinaloa virus</i> (Tomato leaf curl virus – Sinaloa; ToLCV-Sin) (Sinaloa tomato leaf curl virus; STLVCV)	AF040635	(ToLCSinV)
<i>Tomato leaf curl Taiwan virus</i> (Tomato leaf curl virus – Taiwan; ToLCV-TW)	U88692	(ToLCTWV)

Continued



Table 1 (continued)

<i>Tomato leaf curl Tanzania virus</i> (Tomato leaf curl virus – Tanzania; ToLCV-TZ)	U73498	(ToLCTZV)
<i>Tomato leaf curl virus</i> (Tomato leaf curl virus – Australia; ToLCV-AU)	S53251	(ToLCV)
Tomato leaf curl virus – [Solanum species D1]	U51893, AF084006	(ToLCV-[SpD1])
Tomato leaf curl virus – [Solanum species D2]	U51894, AF084007	(ToLCV-[SpD2])
<i>Tomato mild mottle virus</i> Tomato mild mottle virus – [Honduras 96 – H5kw]	AF131071	(ToMMoV) (ToMMoV-[HN96-H5])
<i>Tomato mosaic Havana virus</i> (Havana tomato mosaic virus)		(ToMHV)
Tomato mosaic Havana virus – [Honduras 96 – H5]	AF139078	(ToMHV-[HN96-H5])
Tomato mosaic Havana virus – [Jamaica]	AF035224, AF03525	(ToMHV-[JM])
Tomato mosaic Havana virus – [Quivican]	Y14874, Y14875	(ToMHV-[Qui])
<i>Tomato mottle Taino virus</i> (Tomato mottle virus – Taino; ToMoV-Tai)	AF012300, AF012301	(ToMoTV)
(Taino tomato mottle virus; TTMoV)		
<i>Tomato mottle virus</i> Tomato mottle virus – [Florida]	L14460, L14461, U65506, U65507, U65508	(ToMoV)
Tomato mottle virus – [Florida – B1]	M90495, L02618	(ToMoV-[FL-B1])
<i>Tomato severe leaf curl virus</i> Tomato severe leaf curl virus – [Guatemala96 – 1]	AF130415	(ToSLCV)
Tomato severe leaf curl virus – [Guatemala97 – Cu1]	AF131735	(ToSLCV-[GT96-1]) (ToSLCV-[GT97-Cu1])
Tomato severe leaf curl virus – [Honduras96 – T1]	AF130416	(ToSLCV-[HN96-T1])
Tomato severe leaf curl virus – [Nicaragua]		(ToSLCV-[NI])
<i>Tomato yellow dwarf virus</i>	U82829	(ToYDV)
<i>Tomato yellow leaf curl China virus</i> (Tomato yellow leaf curl virus – China; TYLCV-CN)	D88773 AF186753, AF186752	(TYLCCV)
<i>Tomato yellow leaf curl Nigeria virus</i> (Tomato yellow leaf curl virus – Nigeria; TYLCV-NG)		(TYLCNV)
<i>Tomato yellow leaf curl Sardinia virus</i> (Tomato yellow leaf curl virus – Sardinia; TYLCV-Sar)	X61153	(TYLCSV)
Tomato yellow leaf curl Sardinia virus – Sicily (Tomato yellow leaf curl virus – Sardinia [Sicily]; TYLCV-Sar[Sic])	Z28390	(TYLCSV-Sic)
(Tomato yellow leaf curl virus – Sicily, TYLCV-SY)		
Tomato yellow leaf curl Sardinia virus – Spain [1] (Tomato yellow leaf curl virus – Sardinia [Spain1]; TYLCV-Sar[ES1])	Z25751	(TYLCSV-ES[1])
(Tomato yellow leaf curl virus – Spain, TYLCV-Sp)		
Tomato yellow leaf curl Sardinia virus – Spain [2] (Tomato yellow leaf curl virus – Sardinia [Spain2]; TYLCV-Sar[ES2])	L27708	(TYLCSV-ES[2])
(Tomato yellow leaf curl virus – Almeria, TYLCV-Almeria)		
Tomato yellow leaf curl Sardinia virus – Spain [3] (Tomato yellow leaf curl virus – Sardinia [Spain3]; TYLCV-Sar[ES3])	Z86067, Z86068, Z92670, Z92671	(TYLCSV-ES[3])
(Tomato yellow leaf curl virus – European strain)		

Continued

Table 1 (continued)

<i>Tomato yellow leaf curl Saudi Arabia virus</i> (Tomato yellow leaf curl virus – Saudi Arabia; TYLCV-SA) (Tomato yellow leaf curl virus – Southern Saudi Arabia; TYLCV-SSA)		(TYLCSAV)
<i>Tomato yellow leaf curl Tanzania virus</i> (Tomato yellow leaf curl virus – Tanzania; TYLCV-TZ)	U73498	(TYLCTZV)
<i>Tomato yellow leaf curl Thailand virus</i> (Tomato yellow leaf curl virus – Thailand; TYLCV-TH)		(TYLCTHV)
Tomato yellow leaf curl Thailand virus – [1] (Tomato yellow leaf curl virus – Thailand [1]; TYLCV-TH-[1])	X63015, X63016, M59838, M59839	(TYLCTHV-[1])
Tomato yellow leaf curl Thailand virus – [2] (Tomato yellow leaf curl virus – Thailand – [2]; TYLCV-TH-[2])	AF141922, AF141897	(TYLCTHV-[2])
<i>Tomato yellow leaf curl virus</i> (Tomato yellow leaf curl virus – Israel; TYLCV-IL)	X15656	(TYLCV)
Tomato yellow leaf curl virus – Jamaica (Tomato yellow leaf curl virus – Israel [Jamaica]; TYLCV-IL[JM])	U84146, U84147, U84397, U85782, U88889	(TYLCV-[JM])
Tomato yellow leaf curl virus – Mild (Tomato yellow leaf curl virus – Israel [Mild]; TYLCV-IL[Mld])	X76319	(TYLCV-Mld)
Tomato yellow leaf curl virus – [Aichi] (Tomato yellow leaf curl virus – Israel – [Aichi]; TYLCV-IL[Ai])	AB014347	(TYLCV-[Aic])
Tomato yellow leaf curl virus – [Cuba] (Tomato yellow leaf curl virus – Israel [Cuba]; TYLCV-IL[CU])	U65089 AJ223505	(TYLCV-[CU])
Tomato yellow leaf curl virus – [Dominican Republic] (Tomato yellow leaf curl virus – Israel [DO]; TYLCV-IL[DO])	AF024715	(TYLCV-[DO])
Tomato yellow leaf curl virus – [Egypt] (Tomato yellow leaf curl virus – Israel [Egypt]; TYLCV-IL[EG]) (Tomato yellow leaf curl virus – Egypt; TYLCV-EG)	L12219	(TYLCV-[EG])
Tomato yellow leaf curl virus – [Iran] (Tomato yellow leaf curl virus – Israel [Iran]; TYLCV-IL[IR])	AJ132711	(TYLCV-[IR])
Tomato yellow leaf curl virus – [Lebanon]	AF160875	(TYLCV-[LB])
Tomato yellow leaf curl virus – [Portugal] (Tomato yellow leaf curl virus – Israel [Portugal]; TYLCV-IL[PT])	AF105975	(TYLCV-[PT])

Continued

Table 1 (continued)

Tomato yellow leaf curl virus – [Saudi Arabia] (Tomato yellow leaf curl virus – Israel [Saudi Arabia1]; TYLCV-IL[SA1]) (Tomato yellow leaf curl virus – Northern Saudi Arabia; TYLCV-NSA)		(TYLCV-[SA])
Tomato yellow leaf curl virus – [Shizuokua] (Tomato yellow leaf curl virus – Israel [Shizuokua]; TYLCV-IL[Shi])	AB014346	(TYLCV-[Shi])
Tomato yellow leaf curl virus – [Spain7297] (Tomato yellow leaf curl virus – Israel [Spain7297]; TYLCV-IL[ES7297])	AF071228	(TYLCV-[ES7297])
Tomato yellow leaf curl virus – [Yucatan]	AF168709	(TYLCV-[Yuc])
<i>Tomato yellow leaf curl Yemen virus</i> (Tomato yellow leaf curl virus – Yemen; TYLCV-YE)	X79429	(TYLCYV)
<i>Tomato yellow mosaic virus</i> Tomato yellow mosaic virus – Brazil [1] Tomato yellow mosaic virus – Brazil [2]	AF150742	(ToYMV) (ToYMV-BR[1]) (ToYMV-BR[2])
<i>Tomato yellow mottle virus</i>	AF112981	(ToYMoV)
<i>Tomato yellow vein streak virus</i> (Tomato yellow vein streak virus – Brazil; ToYVSV-BR)	U79998, U80042	(ToYVSV)
<i>Watermelon chlorotic stunt virus</i> Watermelon chlorotic stunt virus – [IR] Watermelon chlorotic stunt virus – [SD]	X79430 AJ245652, AJ245653 AJ245650, AJ245651	(WmCSV) (WmCSV-[IR]) (WmCSV-[SD])
<i>Watermelon curly mottle virus</i>		(WmCMV)
<i>Wissadula golden mosaic virus</i> Wissadula golden mosaic virus – [Jamaica1]	U69280, U69281, U69603, U69604, U69732, U69733	(WGMV) (WGMV-[JM1])
<i>Zinnia leaf curl virus</i>		(ZiLCV)
<b>List of Tentative Species</b>		
Cotton leaf curl India virus		(CLCuINV)
Cotton yellow mosaic virus	AF076852	(CtYMV)
Cucurbit leaf crumple virus	AF224760, AF224761	(CuLCrV)
Eggplant yellow mosaic virus		(EYMV)
Eupatorium yellow vein virus		(EpYVV)
Lupin leaf curl virus		(LLCuV)
Sida yellow vein virus		(SiYVV)
Solanum apical leaf curl virus		(SALCV)
Soybean crinkle leaf virus		(SCLV)
Squash yellow mottle virus	AF136447, AF124846	(SYMov)
Tobacco leaf curl China virus (Tobacco leaf curl virus – China; TbLCV-CN)	S77090	(TbLCCV)
Tobacco leaf curl India virus (Tobacco leaf curl virus – India; TbLCV-IN)		(TbLCIV)
Tomato leaf curl Indonesia virus	AF189018	(ToLCIDV)
Tomato mosaic Barbados virus	AF213014, AF213013	(ToMBV)

In addition to the virus species name, it is proposed that a geminivirus name contain supplementary information for strain and isolate identification, and we propose to add it in the following sequence:

Virus species name {host-symptom-location-virus} – strain identification  
[isolate identification]

A dash (–), and brackets ([ ]) are used to separate the species name from strain and isolate identifications, respectively.

In Table 1, standard virus name abbreviation and Genbank accession numbers follow the virus name. Names in parentheses underneath virus names indicate synonyms or previously used names.

### **Taxonomic considerations**

ICTV has agreed [9] to add virus species to the categories of genus, subfamily, family, and order in the universal classification of viruses and has endorsed the following definition of virus species: “A virus species is a polythetic class of viruses that constitutes a replicating lineage and occupies a particular ecological niche” [10]. Inherent in the definition of virus species is the requirement that more than one discriminating character should be considered for distinguishing species. There is no official definition for strain, but it is usually considered that strains are viruses belonging to the same species and having stable and heritable biological, serological, and/or molecular differences.

Strain identification could include, but is not restricted to, a particular symptom descriptor, a different host, a different vector, or a significant genetic difference such as a deletion, repetition, or recombination. In the latter, any combination of letters, numbers, or words could be used to characterize the strain.

An isolate name refers to a virus when it is isolated and isolates can be classified into a strain when sufficient information is available. If an isolate lacks taxonomic status, any geographical identification, any letter, number, or combination thereof, the year of isolation, or any lab code can be used (e.g., *East african cassava mosaic virus* strain from Malawi, isolate MH; EACMV-MW[MH]).

### **Stylistic considerations**

As made clear in the VIIth Report of the ICTV [11], virus species names are international taxonomic names, and as such are written in italics with the first letter of the species name capitalized (e.g., *Tomato leaf curl virus*). This orthography does not apply to strain or isolate names, but, to reinforce the importance and the existence of virus names, it has been decided that the first letter of a virus name, whatever its taxonomic status is, should remain capitalized, for example Sugarcane streak Egypt virus from Aswan (SSEV-[Asw]).

### **Examples of geminivirus names**

The following examples illustrate the proposal.

1. When only one geminivirus species is known to infect the host:  
*Horseradish curly top virus*

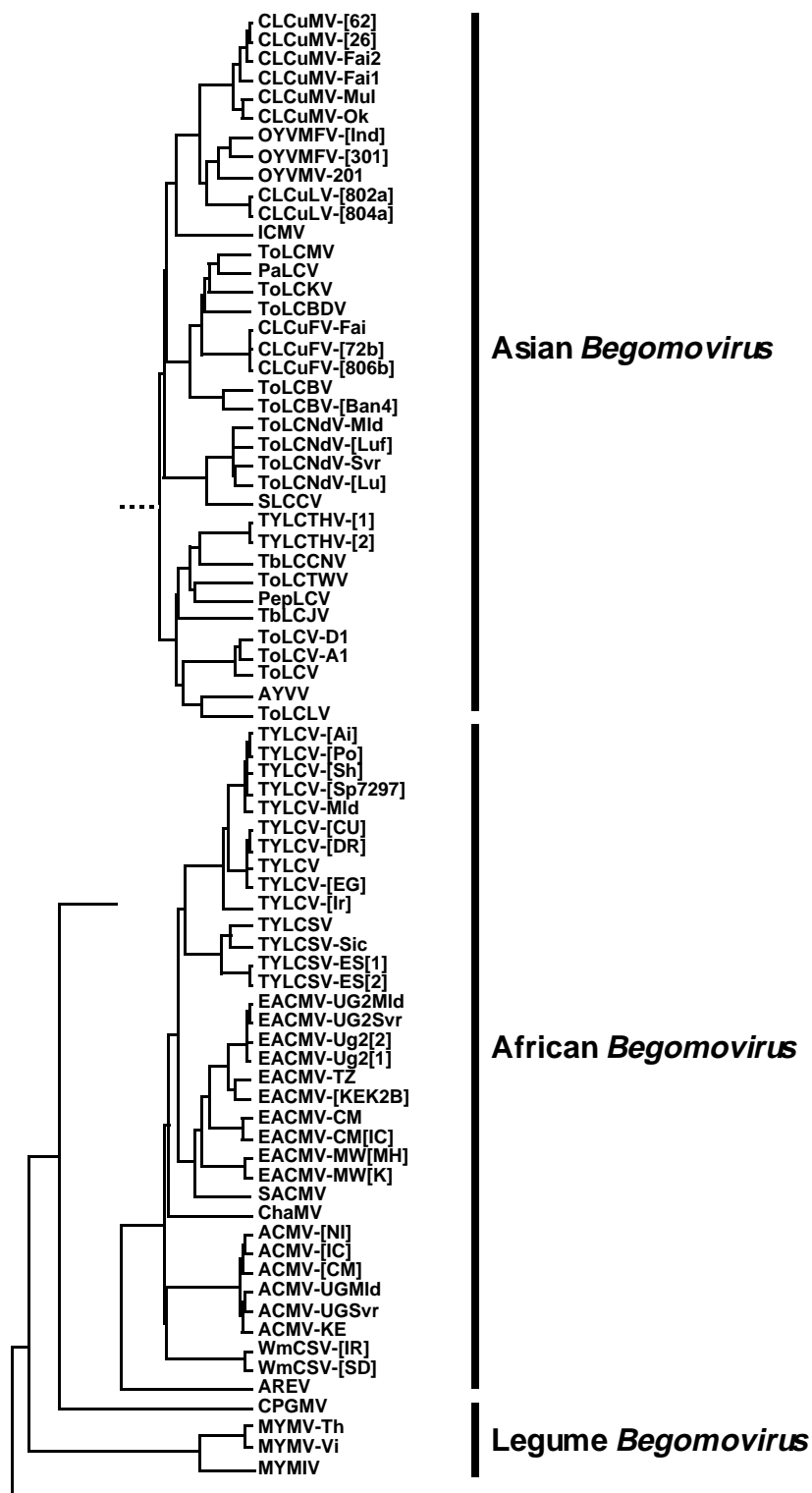
2. When more than one geminivirus species infects the host and each virus induces different symptoms:  
*Digitaria streak virus*  
*Digitaria striate mosaic virus*
3. When more than one isolate or strain causes similar symptoms in a host and there is no species identification:  
 African cassava mosaic virus – Kenya\*  
 African cassava mosaic virus – [Uganda]\*  
 Tomato golden mosaic virus – common strain  
 Tomato golden mosaic virus – yellow vein strain
4. When more than one isolate from the same location causes similar symptoms in a host and there is no species or strain identification:  
 Maize streak virus – [Nigeria1]  
 Maize streak virus – [Nigeria2]  
 Maize streak virus – [Nigeria3]
5. When more than one strain of a given species causes similar symptoms in a host and there is a strain identification:  
 Tomato leaf curl New Delhi virus – Severe  
 Tomato leaf curl New Delhi virus – Mild
6. When more than one isolate causes similar symptoms in a host and there is a species identification:  
*Tomato yellow leaf curl Sardinia virus*  
*Tomato yellow leaf curl Taiwan virus*  
*Tomato yellow leaf curl Thailand virus*
7. When more than one isolate of a given strain of a given species causes similar symptoms in a host:  
 Tomato yellow leaf curl Sardinia virus – Spain [1]  
 Tomato yellow leaf curl Sardinia virus – Spain [2]

### Comments

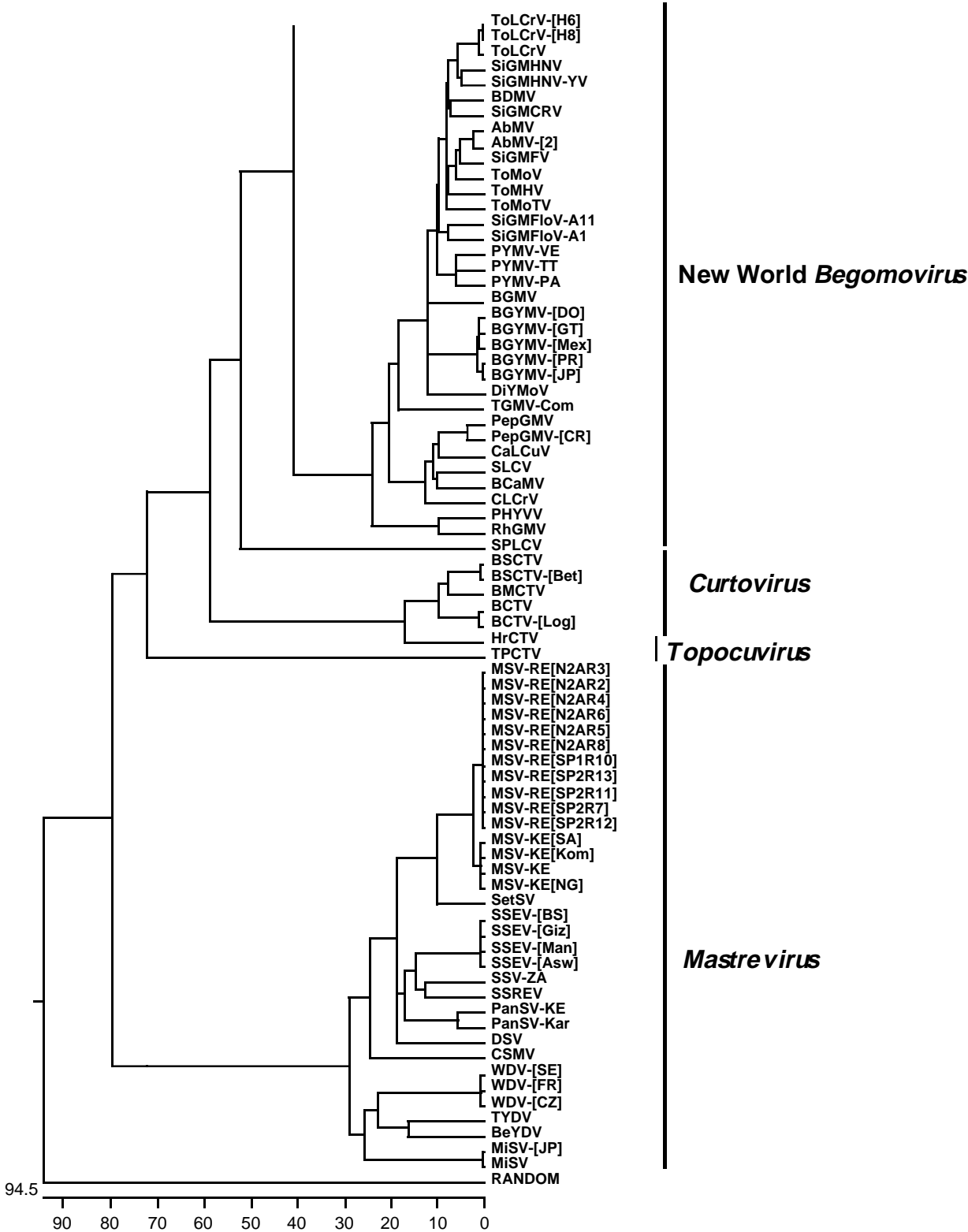
The advantage of the proposed geminivirus nomenclature system is that many species and strains causing identical symptoms in a host in the same location can be named without ambiguity (see Fig. 1). By building the name of a geminivirus with the primary host and symptom description and finishing with the strain and isolate description, the system moves from general to specific identification. In addition, names can be extended to include subsequent isolates or other information. This type of nomenclature has been in use to name animal viruses (e.g., members of family *Orthomyxoviridae* [11]). Our proposal also takes into account the current practice adopted by the plant virology community (and accepted by the Executive Committee of the ICTV) for naming the plant viruses [11].

---

\* The fact that ACMV-KE was the first described ACMV automatically provides it the status of reference strain (hence did not require brackets) and therefore the indication of the country of origin is not absolutely required, but we felt that its indication was informative. In the case of the ACMV isolate from Uganda, as we currently do not have means to differentiate this isolate as a separate strain from the one from Kenya, we can only indicate its isolate origin and consequently we use the brackets. If later it becomes possible to identify it as a separate strain of ACMV, it would suffice to drop the brackets, and thus the name would be unchanged.



**Fig. 1.** Phylogenetic tree based on complete component A nucleotide sequences of 151 geminiviruses with names as in this paper. Sequences were aligned using the Clustal algorithm (MegAlign, DNASTar)



**Table 2.** List of country 2-letter codes

Afghanistan	AF	Czech Republic	CZ
Albania	AL	Denmark	DK
Algeria	DZ	Djibouti	DJ
American Samoa	AS	Dominica	DM
Andorra	AD	Dominican Republic	DO
Angola	AO	East Timor	TP
Anguilla	AI	Ecuador	EC
Antarctica	AQ	Egypt	EG
Antigua and Barbuda	AG	El Salvador	SV
Argentina	AR	Equatorial Guinea	GO
Armenia	AM	Eritrea	ER
Aruba	AW	Estonia	EE
Australia	AU	Ethiopia	ET
Austria	AT	Falkland Islands (Malvinas)	FK
Azerbaijan	AZ	Faroe Islands	FO
Bahamas	BS	Fiji	FJ
Bahrain	BH	France	FR
Bangladesh	BD	France, Metropolitan	FX
Barbados	BB	French Guiana	GF
Belarus	BY	French Polynesia	PF
Belgium	BE	French Southern Territories	TF
Belize	BZ	Gabon	GA
Benin	BJ	Gambia	GM
Bermuda	BM	Georgia	GE
Bhutan	BT	Germany	DE
Bolivia	BO	Ghana	GH
Bosnia and Herzegovina	BA	Gibraltar	GI
Botswana	EW	Greece	GR
Bouvet Island	BV	Greenland	GL
Brazil	BR	Grenada	GD
British Indian Ocean Territory	IO	Guadeloupe	GP
Brunei Darussalam	BN	Guam	GU
Bulgaria	BG	Guatemala	GT
Burkina Faso	BF	Guinea	GN
Burundi	BI	Guinea-Bissau	GW
Cambodia	KH	Guyana	GY
Cameroon	CM	Haiti	HT
Canada	CA	Heard and McDonald Islands	HM
Cape Verde	CV	Honduras	HN
Cayman Islands	KY	Hong Kong	HK
Central African Republic	CF	Hungary	HU
Chad	TD	Iceland	IS
Chile	CL	India	IN
China	CN	Indonesia	ID
Christmas Island	CX	Iran	IR
Cocos (Keeling Islands)	CC	Iraq	IQ
Colombia	CO	Ireland	IE
Comoros	KM	Israel	IL
Congo	CG	Italy	IT
Cook Islands	CK	Jamaica	JM
Costa Rica	CR	Japan	JR
Cote D'Ivoire (Ivory Coast)	CI	Jordan	JO
Croatia (Hrvatska)	HR	Kazakhstan	KZ
Cuba	Cu	Kenya	KE
Cyprus	CY	Kiribati	KI

*Continued*



Table 2 (continued)

Korea (North)	KP	Peru	PE
Korea (South)	KR	Philippines	PH
Kuwait	KW	Pitcairn	PN
Kyrgyzstan	KG	Poland	PL
Laos	LA	Portugal	PT
Latvia	LV	Puerto Rico	PR
Lebanon	LB	Qatar	QA
Lesotho	LS	Reunion	RE
Liberia	LR	Romania	RO
Libya	LY	Russian Federation	RU
Liechtenstein	LI	Rwanda	RW
Lithuania	LT	Saint Kitts and Nevis	KN
Luxembourg	LU	Saint Lucia	LC
Macau	MO	Saint Vincent and The Grenadines	VC
Macedonia	MK	Samoa	WS
Madagascar	MG	San Marino	SM
Malawi	MW	Sao Tome and Principe	ST
Malaysia	MY	Saudi Arabia	SA
Maldives	MV	Senegal	SN
Mali	ML	Seychelles	SC
Malta	MT	Sierra Leone	SL
Marshal Islands	MH	Singapore	SG
Martinique	MO	Slovak Republic	SK
Mauritania	MR	Slovenia	SI
Mauritius	MU	Solomon Islands	SB
Mayotte	YT	Somalia	SO
Mexico	MX	South Africa	ZA
Micronesia	FM	S. Georgia and S. Sandwich Islands	GS
Moldova	MD	Spain	ES
Monaco	MC	Sri Lanka	LK
Mongolia	MN	St. Helena	SH
Montserrat	MS	St. Pierre and Miquelon	PM
Morocco	MA	Sudan	SD
Mozambique	MZ	Suriname	SR
Myanmar	MM	Svalbard and Jan Mayen Islands	SJ
Namibia	NA	Swaziland	SZ
Nauru	NR	Sweden	SE
Nepal	NP	Switzerland	CH
Netherlands	NL	Syria	SY
Netherlands Antilles	AN	Taiwan	TW
New Caledonia	NC	Tajikistan	TJ
New Zealand	NZ	Tanzania	TZ
Nicaragua	NI	Thailand	TH
Niger	NE	Togo	TG
Nigeria	NG	Tokelau	TK
Niue	NU	Tonga	TO
Norfolk Island	NF	Trinidad and Tobago	TT
Northern Mariana Islands	MR	Tunisia	TN
Norway	NO	Turkey	TR
Oman	OM	Turkmenistan	TM
Pakistan	PK	Turks and Caicos Islands	TC
Palau	PW	Tuvalu	TV
Panama	PA	Uganda	UG
Papua New Guinea	PG	Ukraine	UA
Paraguay	PY	United Arab Emirates	AE

Continued

**Table 2** (*continued*)

United Kingdom	UK	Virgin Islands (British)	VG
United States	US	Virgin Islands (US)	VI
US Minor Outlying Islands	UM	Wallis and Futuna Islands	WF
Uruguay	UY	Western Sahara	EH
Uzbekistan	UZ	Yemen	YE
Vanuatu	VU	Yugoslavia	YU
Vatican City State (Holy City)	VA	Zaire	ZR
Venezuela	VE	Zambia	ZM
Vietnam	VN	Zimbabwe	ZW

Our proposal calls for keeping the host and symptom description at the beginning of the name. It is common for all the plant virus names to include terms referring to symptoms and therefore each time a new virus species is described, one must consider the most typical and frequent symptoms induced by the virus. There are many terms available for describing symptoms: for example, leaf curl, yellow leaf curl, yellow mosaic, mottle, severe leaf curl, and leaf crumple (for an updated list, see [2]). It should be noted that the ICTV does not recommend a virus genus or family name as a part of species name (e.g., tomato geminivirus) and also that a geographical origin and a plant name are not enough to name a virus (e.g., Texas pepper virus).

If a particular host and symptom description (i.e., vernacular name) has already been used for a virus, the two identical names can be distinguished by adding a geographical location name before the word “virus.” When abbreviating the new virus name, the list of previously used abbreviations for plant viruses [2] should be consulted to avoid repetitions. For abbreviating the country of isolation, the standard two-letter (uppercase) code (Table 2) may be used. When abbreviating names of locations that are not country names or any other word (symptoms, hosts...) a three-letter code (upper- and lowercase) may be used (e.g., Ban for Bangalore, Mul for Multan, Sin for Sinaloa, Sar for Sardinia, Mld for Mild, Com for common, etc.).

There is a general agreement among virologists that a taxonomic level need not necessarily be associated with a virus name. Our proposal allows the flexibility of using isolate names between brackets when one is not sure if the newly identified isolate is a strain of a previously characterized virus. The nomenclature system for geminiviruses proposed here allows the addition of species and strain information when available.

### **List of geminivirus names**

The virus list of species and tentative species provided here (Table 1) is based on the one published in the VIIth Report of the ICTV [11]. The purpose of this list is only to supply a unique set of names and abbreviations in accordance with the “species – strain [isolate]” system proposed. However, when a new geminivirus sequence clearly showed that a particular virus isolate was in fact a strain of a previously described species, we changed the name to a more logical one (for example, Bhendi yellow vein mosaic virus has been changed to *Okra yellow vein Faisalabad virus* isolate India; OYVFV-[Ind]). Similarly when the sequence was clearly indicating a new virus species we upgraded it to the species

status (for example *Rhynchosia golden mosaic virus*; RhGMV). An official and approved taxonomic list of geminiviruses will be provided at a later date, by the *Geminiviridae* Study Group of the ICTV, after using the species demarcation criteria for geminiviruses [10] to indicate the species.

We also provide a phylogenetic tree based on the available complete A component nucleotide sequences of 151 geminiviruses, aligned using a Clustal algorithm (Fig. 1). The names of the viruses are correlated to the taxonomic status of the viruses and their respective position in the tree.

### References

1. Davies JW, Stanley J (1989) Geminivirus genes and vectors. *Trends Genet* 5: 77–81
2. Fauquet CM, Mayo MA (1999) Abbreviations for plant virus names – 1999. *Arch Virol* 144: 1249–1273
3. Frischmuth T, Stanley J (1993) Strategies for the control of geminivirus diseases. *Semin Virol* 4: 329–337
4. Lazarowitz SG (1992) Geminiviruses: genome structure and gene function. *Crit Rev Plant Sci* 11: 327–349
5. Mayo MA, Horzinek M (1998) A revised version of the International Code of Virus Classification and Nomenclature. *Arch Virol* 143: 1645–1654
6. Padidam M, Beachy RN, Fauquet CM (1995) Classification and identification of geminiviruses using sequence comparisons. *J Gen Virol* 76: 249–263
7. Padidam M, Sawyer S, Fauquet CM (1999) Possible emergence of new geminiviruses by frequent recombination. *Virology* 265: 218–224
8. Polston JE, Anderson PK (1997) The emergence of whitefly-transmitted geminiviruses in tomato in the western hemisphere. *Plant Dis* 81: 1358–1369
9. van Regenmortel MHV, Bishop DHL, Fauquet CM, Mayo MA, Maniloff J, Calisher CH (1997) Guidelines to the demarcation of virus species. *Arch Virol* 142: 1505–1518
10. van Regenmortel MHV (1990) Virus species, a much overlooked but essential concept in virus classification. *Intervirology* 31: 241–254
11. van Regenmortel MHV, Fauquet CM, Bishop DHL, Carstens E, Estes MK, Lemon S, Maniloff J, Mayo MA, McGeoch D, Pringle CR, Wickner RB (eds) (2000) *Virus taxonomy: seventh report of the International Committee on Taxonomy of Viruses*. Academic Press, London, San Diego

Authors' address: Dr. C. M. Fauquet, ILTAB/Donald Danforth Plant Science Center, UMSL, CME R308, 8001 Natural Bridge Road, St. Louis, MO 63121-4499, USA; E-mail: ILTAB@danforthcenter.org