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1 **TAXONOMY OF THE ORDER *MONONEGAVIRALES*: UPDATE 2016**

2
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15 *Rhabdoviridae* Study Group

16
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20 *Rhabdoviridae*; *Sunviridae*; virus classification; virus nomenclature; virus taxonomy

1 **ABSTRACT**

2 In 2016, the order *Mononegavirales* was emended through the addition of two new families
3 (*Mymonaviridae* and *Sunviridae*), the elevation of the paramyxoviral subfamily *Pneumovirinae*
4 to family status (*Pneumoviridae*), the addition of five free-floating genera (*Anphevirus*, *Arlivirus*,
5 *Chengtivirus*, *Crustavirus*, and *Wastrivirus*), and several other changes at the genus and species
6 levels. This article presents the updated taxonomy of the order *Mononegavirales* as now accepted
7 by the International Committee on Taxonomy of Viruses (ICTV).

8 **INTRODUCTION**

9 The viral order *Mononegavirales* was established in 1991 to accommodate related viruses with
10 nonsegmented, linear, single-stranded negative-sense RNA genomes. These viruses were initially
11 assigned to three mononegaviral families: *Filoviridae*, *Paramyxoviridae*, and *Rhabdoviridae* [20,
12 21]. In subsequent years, these families continued to grow through the inclusion of numerous
13 novel species and genera, and the order was therefore emended in 1995 [4], 1997 [23], 2000
14 [24], 2005 [25], and 2011 [8]. The families *Bornaviridae* and *Nyamiviridae* joined the other three
15 mononegaviral families in 1996 [22] and 2014 [1, 11], respectively. In 2015, the Study Groups
16 of the International Committee on Taxonomy of Viruses (ICTV) responsible for the taxonomy of
17 the order and its five families embarked on a joint effort to assign unclassified mononegaviruses
18 to existing or novel taxa and to streamline order nomenclature. Here we present a brief overview
19 of the first round of these efforts, which by now is accepted by the ICTV Executive Committee
20 and, thereby, is official taxonomy.

21 **TAXONOMIC CHANGES AT THE ORDER LEVEL**

1 In recent years, several mononegaviruses have been described that are only distantly related to
2 the members of the families *Bornaviridae*, *Filoviridae*, *Nyamiviridae*, *Paramyxoviridae*, and
3 *Rhabdoviridae*. These viruses include Sclerotinia sclerotiorum negative-stranded RNA virus 1
4 (SsNSRV-1) found in an ascomycete in China [16]; Sunshine Coast virus (SunCV; previously
5 called Sunshine virus) isolated from Australian carpet pythons [10]; and Líshí spider virus 2
6 (LsSV-2), Sānxiá water strider virus 4 (SxWSV-4), Tǎchéng tick virus 6 (TcTV-6), Wēnzhōu
7 crab virus 1 (WzCV-1), and Xīnchéng mosquito virus (XcMV) detected in Chinese arthropods
8 [15]. To accommodate these viruses in the order and to appropriately reflect their phylogenetic
9 relationships to other mononegaviral taxa, two new families and four free-floating genera were
10 established: *Mymonaviridae* (accommodating SsNSRV-1), *Sunviridae* (SunCV), *Anphevirus*
11 (XcMV), *Arlivirus* (LsSV-2), *Chengtivirus* (TcTV-6), *Crustavirus* (WzCV-1), and *Wastrivirus*
12 (SxWSV-4). In addition, the paramyxoviral subfamily *Pneumovirinae* was elevated to family
13 status (*Pneumoviridae*) because the members of this taxon are as closely related to filoviruses as
14 to the members of the paramyxoviral subfamily *Paramxyovirinae* (now dissolved) (Table 1).

15 TAXONOMIC CHANGES AT THE FAMILY LEVEL

16 The monogeneric family *Bornaviridae* was reorganized in 2015 by establishing five distinct
17 species in the genus *Bornavirus* [2, 12] following a non-Latinized binomial species name format
18 [29]. These efforts were continued in 2016 by expanding the genus by an additional two species
19 (*Elapid 1 bornavirus* for Loveridge's garter snake virus 1 [27] and *Psittaciform 2 bornavirus* for
20 parrot bornavirus 5 [9, 18]) (Table 1).

21 The monogeneric family *Nyamiviridae* was expanded to include a second genus (*Socyvirus*) for
22 the until-then free-floating nyamivirus species *Soybean cyst nematode virus*. This species name

1 was changed to *Soybean cyst nematode socyvirus* to adhere to the non-Latinized binomial
2 species name format [29] (Table 1).

3 The family *Paramyxoviridae* was emended by expanding the genus *Avulavirus* by three species
4 (*Avian paramyxovirus 10-12* for avian paramyxoviruses 10-12, respectively [5, 19, 28]), the
5 genus *Henipavirus* by three species (*Cedar henipavirus* for Cedar virus [17], *Ghanaian bat*
6 *henipavirus* for Kumasi virus [GH-M74a] [7], and *Mojiang henipavirus* for Mòjiāng virus [31]),
7 the genus *Morbillivirus* by one species (*Feline morbillivirus* for feline morbillivirus [30]) and the
8 genus *Respirovirus* by one species (*Porcine parainfluenza virus 1* for porcine parainfluenza virus
9 1 [14]). The species *Simian Virus 10* was dissolved on the evidence that simian virus 10 is an
10 isolate of human parainfluenzavirus 3 rather than a distinct virus [13]. The genus *Pneumovirus*,
11 now included in the new family *Pneumoviridae*, was renamed *Orthopneumovirus* to avoid
12 confusion between family and genus members (Table 1).

13 The family *Rhabdoviridae* was expanded by two genera: *Dichorhavirus* (new; [6]) and
14 *Varicosavirus* (previously free-floating outside of the order) to accommodate bisegmented plant
15 viruses (coffee ringspot virus and orchid fleck virus; lettuce big-vein associated virus). The
16 species *Alfalfa dwarf cytorhabdovirus* (for alfalfa dwarf virus [3]) was added to the genus
17 *Cytorhabdovirus*. Finally, the non-Latinized binomial species name format [29] was applied
18 throughout the family (Table 1).

19 A summary of the current, ICTV-accepted taxonomy of the order *Mononegavirales* is presented
20 in Table 1.

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- 1 **Table 1. Taxonomy of the order *Mononegavirales* as of 2016.** Listed are all mononegaviruses that have been classified into species.
- 2 Asterisks denote type species.

Genus	Species	Virus (Abbreviation)
Family <i>Bornaviridae</i>		
<i>Bornavirus</i>	<i>Elapid 1 bornavirus</i>	Loveridge's garter snake virus 1 (LGSV-1)
	<i>Mammalian 1 bornavirus</i> *	Borna disease virus 1 (BoDV-1)
		Borna disease virus 2 (BoDV-2)
	<i>Passeriform 1 bornavirus</i>	canary bornavirus 1 (CnBV-1)
		canary bornavirus 2 (CnBV-2)
		canary bornavirus 3 (CnBV-3)
	<i>Passeriform 2 bornavirus</i>	estrildid finch bornavirus 1 (EsBV-1)
	<i>Psittaciform 1 bornavirus</i>	parrot bornavirus 1 (PaBV-1)
		parrot bornavirus 2 (PaBV-2)
		parrot bornavirus 3 (PaBV-3)
		parrot bornavirus 4 (PaBV-4)
		parrot bornavirus 7 (PaBV-7)

	<i>Psittaciform 2 bornavirus</i>	parrot bornavirus 5 (PaBV-5)
	<i>Waterbird 1 bornavirus</i>	aquatic bird bornavirus 1 (ABBV-1)
		aquatic bird bornavirus 2 (ABBV-2)
Family Filoviridae		
<i>Cuevavirus</i>	<i>Lloviu cuevavirus*</i>	Lloviu virus (LLOV)
<i>Ebolavirus</i>	<i>Bundibugyo ebolavirus</i>	Bundibugyo virus (BDBV)
	<i>Reston ebolavirus</i>	Reston virus (RESTV)
	<i>Sudan ebolavirus</i>	Sudan virus (SUDV)
	<i>Tai Forest ebolavirus</i>	Tai Forest virus (TAFV)
	<i>Zaire ebolavirus*</i>	Ebola virus (EBOV)
<i>Marburgvirus</i>	<i>Marburg marburgvirus*</i>	Marburg virus (MARV)
		Ravn virus (RAVV)
Family Mymonaviridae		
<i>Sclerotimonavirus</i>	<i>Sclerotinia sclerotimonavirus*</i>	Sclerotinia sclerotiorum negative-stranded RNA virus 1 (SsNSRV-1)

Family <i>Nyamiviridae</i>		
<i>Nyavirus</i>	<i>Midway nyavirus</i>	Midway virus (MIDWV)
	<i>Nyamanini nyavirus</i> *	Nyamanini virus (NYMV)
	<i>Sierra Nevada nyavirus</i>	Sierra Nevada virus (SNVV)
<i>Socyvirus</i>	<i>Soybean cyst nematode socyvirus</i> *	soybean cyst nematode virus 1 (SbCNCV-1)
Family <i>Paramyxoviridae</i>		
<i>Aquaparamyxovirus</i>	<i>Atlantic salmon paramyxovirus</i> *	Atlantic salmon paramyxovirus (AsaPV)
<i>Avulavirus</i>	<i>Avian paramyxovirus 2</i>	avian paramyxovirus 2 (APMV-2)
	<i>Avian paramyxovirus 3</i>	avian paramyxovirus 3 (APMV-3)
	<i>Avian paramyxovirus 4</i>	avian paramyxovirus 4 (APMV-4)
	<i>Avian paramyxovirus 5</i>	avian paramyxovirus 5 (APMV-5)
	<i>Avian paramyxovirus 6</i>	avian paramyxovirus 6 (APMV-6)
	<i>Avian paramyxovirus 7</i>	avian paramyxovirus 7 (APMV-7)
	<i>Avian paramyxovirus 8</i>	avian paramyxovirus 8 (APMV-8)
	<i>Avian paramyxovirus 9</i>	avian paramyxovirus 9 (APMV-9)

	<i>Avian paramyxovirus 10</i>	avian paramyxovirus 10 (APMV-10)
	<i>Avian paramyxovirus 11</i>	avian paramyxovirus 11 (APMV-11)
	<i>Avian paramyxovirus 12</i>	avian paramyxovirus 12 (APMV-12)
	<i>Newcastle disease virus*</i>	avian paramyxovirus 1 (APMV-1) ¹
<i>Ferlavirus</i>	<i>Fer-de-Lance paramyxovirus*</i>	Fer-de-Lance virus (FDLV) ²
<i>Henipavirus</i>	<i>Cedar henipavirus</i>	Cedar virus (CedV)
	<i>Ghanaian bat henipavirus</i>	Kumasi virus (KV) ³
	<i>Hendra virus*</i>	Hendra virus (HeV)
	<i>Mojiang henipavirus</i>	Mòjiāng virus (MojV)
	<i>Nipah virus</i>	Nipah virus (NiV)
<i>Morbillivirus</i>	<i>Canine distemper virus</i>	canine distemper virus (CDV)
	<i>Cetacean morbillivirus</i>	cetacean morbillivirus (CeMV)
	<i>Feline morbillivirus</i>	feline morbillivirus (FeMV) ⁴
	<i>Measles virus*</i>	measles virus (MeV)
	<i>Peste-des-petits-ruminants virus</i>	peste-des-petits-ruminants virus (PPRV)

	<i>Phocine distemper virus</i>	phocine distemper virus (PDV)
	<i>Rinderpest virus</i>	rinderpest virus (RPV)
<i>Respirovirus</i>	<i>Bovine parainfluenza virus 3</i>	bovine parainfluenza virus 3 (BPIV-3)
	<i>Human parainfluenza virus 1</i>	human parainfluenza virus 1 (HPIV-1)
	<i>Human parainfluenza virus 3</i>	human parainfluenza virus 3 (HPIV-3) ⁵
	<i>Porcine parainfluenza virus 1</i>	porcine parainfluenza virus 1 (PPIV-1)
	<i>Sendai virus*</i>	Sendai virus (SeV) ⁶
<i>Rubulavirus</i>	<i>Human parainfluenza virus 2</i>	human parainfluenza virus 2 (HPIV-2)
	<i>Human parainfluenza virus 4</i>	human parainfluenza virus 4a (HPIV-4a)
		human parainfluenza virus 4b (HPIV-4b)
	<i>Mapuera virus</i>	Mapuera virus (MapV)
	<i>Mumps virus*</i>	mumps virus (MuV)
		bat mumps virus (BMV) ⁷
	<i>Parainfluenza virus 5</i>	parainfluenza virus 5 (PIV-5) ⁸
	<i>Porcine rubulavirus</i>	La Piedad Michoacán Mexico virus

		(LPMV) ⁹
	<i>Simian virus 41</i>	simian virus 41 (SV-41)
Family <i>Pneumoviridae</i>		
<i>Metapneumovirus</i>	<i>Avian metapneumovirus</i> *	avian metapneumovirus (AMPV) ¹⁰
	<i>Human metapneumovirus</i>	human metapneumovirus (HMPV)
<i>Orthopneumovirus</i>	<i>Bovine respiratory syncytial virus</i>	bovine respiratory syncytial virus (BRSV)
	<i>Human respiratory syncytial virus</i> *	human respiratory syncytial virus A2 (HRSV-A2)
		human respiratory syncytial virus B1 (HRSV-B1)
		human respiratory syncytial virus S2 (HRSV-S2)
	<i>Murine pneumonia virus</i>	murine pneumonia virus (MPV)
Family <i>Rhabdoviridae</i>		
<i>Cytorhabdovirus</i>	<i>Alfalfa dwarf cytorhabdovirus</i>	alfalfa dwarf virus (ADV)
	<i>Barley yellow striate mosaic</i>	barley yellow striate mosaic virus

	<i>cytorhabdovirus</i>	(BYSMV)
	<i>Broccoli necrotic yellows cytorhabdovirus</i>	broccoli necrotic yellows virus (BNYV)
	<i>Festuca leaf streak cytorhabdovirus</i>	festuca leaf streak virus (FLSV)
	<i>Lettuce necrotic yellows cytorhabdovirus*</i>	lettuce necrotic yellows virus (LNYV)
	<i>Lettuce yellow mottle cytorhabdovirus</i>	lettuce yellow mottle virus (LYMoV)
	<i>Northern cereal mosaic cytorhabdovirus</i>	northern cereal mosaic virus (NCMV)
	<i>Sonchus cytorhabdovirus 1</i>	sonchus virus (SonV)
	<i>Strawberry crinkle cytorhabdovirus</i>	strawberry crinkle virus (SCV)
	<i>Wheat American striate mosaic cytorhabdovirus</i>	wheat American striate mosaic virus (WASMV)
<i>Dichorhavirus</i>	<i>Coffee ringspot dichorhavirus</i>	coffee ringspot virus (CoRSV)
	<i>Orchid fleck dichorhavirus*</i>	orchid fleck virus (OFV) ¹¹
<i>Ephemerovirus</i>	<i>Adelaide River ephemerovirus</i>	Adelaide River virus (ARV)
	<i>Berrimah ephemerovirus</i>	Berrimah virus (BRMV)
	<i>Bovine fever ephemerovirus*</i>	bovine ephemeral fever virus (BEFV) ¹²

	<i>Kotonkan ephemerovirus</i>	kotonkan virus (KOTV)
	<i>Obodhiang ephemerovirus</i>	Obodhiang virus (OBOV)
<i>Lyssavirus</i>	<i>Aravan lyssavirus</i>	Aravan virus (ARAV)
	<i>Australian bat lyssavirus</i>	Australian bat lyssavirus (ABLV)
	<i>Bokeloh bat lyssavirus</i>	Bokeloh bat lyssavirus (BBLV)
	<i>Duvenhage lyssavirus</i>	Duvenhage virus (DUVV)
	<i>European bat 1 lyssavirus</i>	European bat lyssavirus 1 (EBLV-1)
	<i>European bat 2 lyssavirus</i>	European bat lyssavirus 2 (EBLV-2)
	<i>Ikoma lyssavirus</i>	Ikoma lyssavirus (IKOV)
	<i>Irkut lyssavirus</i>	Irkut virus (IRKV)
	<i>Khujand lyssavirus</i>	Khujand virus (KHUV)
	<i>Lagos bat lyssavirus</i>	Lagos bat virus (LBV)
	<i>Mokola lyssavirus</i>	Mokola virus (MOKV)
	<i>Rabies lyssavirus*</i>	rabies virus (RABV)
	<i>Shimoni bat lyssavirus</i>	Shimoni bat virus (SHIBV)

	<i>West Caucasian bat lyssavirus</i>	West Caucasian bat virus (WCBV)
<i>Novirhabdovirus</i>	<i>Hirame novirhabdovirus</i>	Hirame rhabdovirus (HIRV)
	<i>Oncorhynchus 1 novirhabdovirus*</i>	infectious hematopoietic necrosis virus (IHNV)
	<i>Oncorhynchus 2 novirhabdovirus</i>	viral hemorrhagic septicemia virus (VHSV) ¹³
	<i>Snakehead novirhabdovirus</i>	snakehead rhabdovirus (SHRV)
<i>Nucleorhabdovirus</i>	<i>Datura yellow vein nucleorhabdovirus</i>	datura yellow vein virus (DYVV)
	<i>Eggplant mottled dwarf nucleorhabdovirus</i>	eggplant mottled dwarf virus (EMDV)
	<i>Maize fine streak nucleorhabdovirus</i>	maize fine streak virus (MSFV)
	<i>Maize Iranian mosaic nucleorhabdovirus</i>	maize Iranian mosaic virus (MIMV)
	<i>Maize mosaic nucleorhabdovirus</i>	maize mosaic virus (MMV)
	<i>Potato yellow dwarf nucleorhabdovirus*</i>	potato yellow dwarf virus (PYDV)
	<i>Rice yellow stunt nucleorhabdovirus</i>	rice yellow stunt virus (RYSV)
		rice transitory yellowing virus (RTYV)

	<i>Sonchus yellow net nucleorhabdovirus</i>	sonchus yellow net virus (SYNV)
	<i>Sowthistle yellow vein nucleorhabdovirus</i>	sowthistle yellow vein virus (SYVV)
	<i>Taro vein chlorosis nucleorhabdovirus</i>	taro vein chlorosis virus (TaVCV)
<i>Perhabdovirus</i>	<i>Anguillid perhabdovirus</i>	eel virus European X (EVEX)
	<i>Perch perhabdovirus</i> *	perch rhabdovirus (PRV)
	<i>Sea trout perhabdovirus</i>	lake trout rhabdovirus (LTRV)
<i>Sigmavirus</i>	<i>Drosophila affinis sigmavirus</i>	Drosophila affinis sigmavirus (DAffSV)
	<i>Drosophila ananassae sigmavirus</i>	Drosophila ananassae sigmavirus (DAAnaSV)
	<i>Drosophila immigrans sigmavirus</i>	Drosophila immigrans sigmavirus (DImmSV)
	<i>Drosophila melanogaster sigmavirus</i> *	Drosophila melanogaster sigmavirus (DMelSV)
	<i>Drosophila obscura sigmavirus</i>	Drosophila obscura sigmavirus (DObsSV)
	<i>Drosophila tristis sigmavirus</i>	Drosophila tristis sigmavirus (DTriSV)
	<i>Muscina stabulans sigmavirus</i>	Muscina stabulans sigmavirus (MStaSV)

<i>Sprivirus</i>	<i>Carp sprivirus*</i>	spring viremia of carp virus (SVCV)
	<i>Pike fry sprivirus</i>	grass carp rhabdovirus (GrCRV)
		pike fry rhabdovirus (PFRV)
		Tench rhabdovirus (TenRV)
<i>Tibrovirus</i>	<i>Coastal Plains tibrovirus</i>	Coastal Plains virus (CPV)
	<i>Tibrogargan tibrovirus*</i>	Bivens Arm virus (BAV)
		Tibrogargan virus (TIBV)
<i>Tupavirus</i>	<i>Durham tupavirus*</i>	Durham virus (DURV)
	<i>Tupaia tupavirus</i>	tupaia virus (TUPV)
<i>Varicosavirus</i>	<i>Lettuce big-vein associated varicosavirus*</i>	lettuce big-vein associated virus (LBVaV) ¹⁴
<i>Vesiculovirus</i>	<i>Alagoas vesiculovirus</i>	vesicular stomatitis Alagoas virus (VSAV)
	<i>Carajas vesiculovirus</i>	Carajás virus (CJSV)
	<i>Chandipura vesiculovirus</i>	Chandipura virus (CHPV)
	<i>Cocal vesiculovirus</i>	Cocal virus (COCV)

	<i>Indiana vesiculovirus</i> *	vesicular stomatitis Indiana virus (VSIV)
	<i>Isfahan vesiculovirus</i>	Isfahan virus (ISFV)
	<i>Maraba vesiculovirus</i>	Maraba virus (MARAV)
	<i>New Jersey vesiculovirus</i>	vesicular stomatitis New Jersey virus (VSNJV)
	<i>Piry vesiculovirus</i>	Piry virus (OIRYV)
Unassigned	<i>Flanders virus</i>	Flanders virus (FLAV)
	<i>Ngaingan virus</i>	Ngaingan virus (NGAV)
	<i>Wongabel virus</i>	Wongabel virus (WONV)
Family Sunviridae		
<i>Sunshinevirus</i>	<i>Reptile sunshinevirus 1</i> *	Sunshine Coast virus (SunCV)
Unassigned		
<i>Anphevirus</i>	<i>Xinchng anphevirus</i> *	Xīnchéng mosquito virus (XcMV)
<i>Arlivirus</i>	<i>Lishi arlivirus</i> *	Líshí spider virus 2 (LsSV-2)
<i>Chengtivirus</i>	<i>Tacheng chengtivirus</i> *	Tǎchéng tick virus 6 (TcTV-6)

<i>Crustavirus</i>	<i>Wenzhou crustavirus</i> *	Wēnzhōu crab virus 1 (WzCV-1)
<i>Wastrivirus</i>	<i>Sanxia wastrivirus</i> *	Sānxiá water strider virus 4 (SxWSV-4)

- 1 ¹Includes: Newcastle disease virus (NDV) and pigeon paramyxovirus; ²synonym: anaconda paramyxovirus; ³synonym: GH-M74a
2 virus; ⁴abbreviation as recently introduced in [26]; ⁵historically, an isolate from a samango monkey (*Cercopithecus mitis*) in 1963 was
3 long classified as a distinct species called simian agent 10 (SA-10), but was shown later to be HPIV-3. SA-10 was sometimes called
4 SV-10; ⁶synonym: murine parainfluenza virus 1; ⁷synonym: bat paramyxovirus; ⁸synonym: simian virus 5; ⁹synonym: porcine
5 rubulavirus; ¹⁰synonyms: avian pneumovirus, turkey rhinotracheitis virus; ¹¹synonyms: citrus leprosis virus nuclear type, citrus
6 necrotic spot virus; ¹²synonym Tzipori virus; ¹³synonyms: Egtved virus, *Paralichthys olivaceus* rhabdovirus; ¹⁴synonym: tobacco stunt
7 virus.

1 **COMPLIANCE WITH ETHICAL STANDARDS**

2 The views and conclusions contained in this document are those of the authors and should not be
3 interpreted as necessarily representing the official policies, either expressed or implied, of the US
4 Department of the Army, the US Department of Defense, the US Department of Health and
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20 **Conflict of Interest**

21 The authors have no conflicts of interest.

22 **Ethical approval**

1 This article does not contain any studies with human participants or animals performed by any of
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