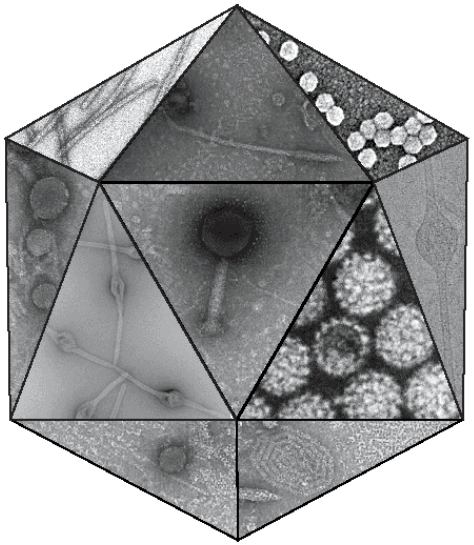

Virus Taxonomy

The ICTV Report on
Virus Classification and Taxon Nomenclature

ICTV Virus Taxonomy Profile: Hantaviridae 2024

Steven Bradfute *et al*., 2024 Journal of General Virology (IF 3.8 H-Index 187, Q2)

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Introduction

Hantaviridae is a family for ssRNA (-) viruses

The family includes four subfamilies and seven genera:

1. Actantavirinae → Genus *Actinovirus*

2. Agnatavirinae → Genus *Agnathovirus*

3. Repantavirinae → Genus *Reptillovirus*

4. Mammantavirinae →
- Genus *Loanvirus*
- Genus *Mobativirus*
- Genus *Totthimvirus*
- Genus *Orthohantavirus*

These viruses are transmitted by small mammals, fish and reptiles.

Piscine Hosts

Genus *Actinovirus*.

Infect actinopterygian (ray-finned) fish.

Perca flavescens
(Yellow Perc)

Genus *Agnathovirus*.

Infect jaw-less fish.

Lampetra fluviatilis
(European river lamprey)

Reptilian Hosts

Genus *Reptillovirus*.
Infect gekkonid and possibly scincid reptiles.

Gekko albofasciolatus
(Common Gecko)

Scincus scincus
(Common lizard)

Mammalian Hosts

Genus *Loanvirus.*

Infect rhinolophid, verspertillionid, and possibly nycterid bats and possibly murid rodents.

Rhinolophus ferrumequinum
(Greater horseshoe bat)

Insectivore

Myotis mystacinus
(Whiskered bat)

Insectivore

Nycteris thebaica
(Egyptian slit-faced bat)

Insectivore

Rattus norvegicus
(Brown rat)

Omnivore

Mammalian Hosts

Genus *Mobatvirus.* Infect emballonurid, hipposiderid, pteropodid and possibly molossid, and vespertillionid bats.

Emballonura semicaudata
(sac-winged bat)

Insectivore

Hipposideros commersoni
(leaf-nosed bats)

Insectivore

Pteropus scapulatus
(Flying foxes)

Frugivore

Tadarida mops
(Free-tailed Bat)

Inscetivore

Plecotus auritus
(long-eared bat)

Insectivore

Mammalian Hosts

Genus *Thottimvirus.* Infect soricid and possibly talpid eulipotyphla.

Sorex araneus
(Common shrew)

Carnivorous and
insectivorous

Talpa europaea
(common mole)

Carnivorous and
insectivorous

Mammalian Hosts

Genus *Orthohantavirus.* Infect soricid and talpid eulipotyphla and muroid and possibly dipodoid rodents.

Sorex araneus
(Common shrew)

Carnivorous and insectivorous

Talpa europaea
(common mole)

Carnivorous and insectivorous

Microtus arvalis
(Meadow voles)

Granivore and Herbivore

Sicista betulina
(Birch mouse)

Granivore and *insectivore*

Orthohantavirus

Family: *Hantaviridae*

Subfamily: *Mammantavirinae*

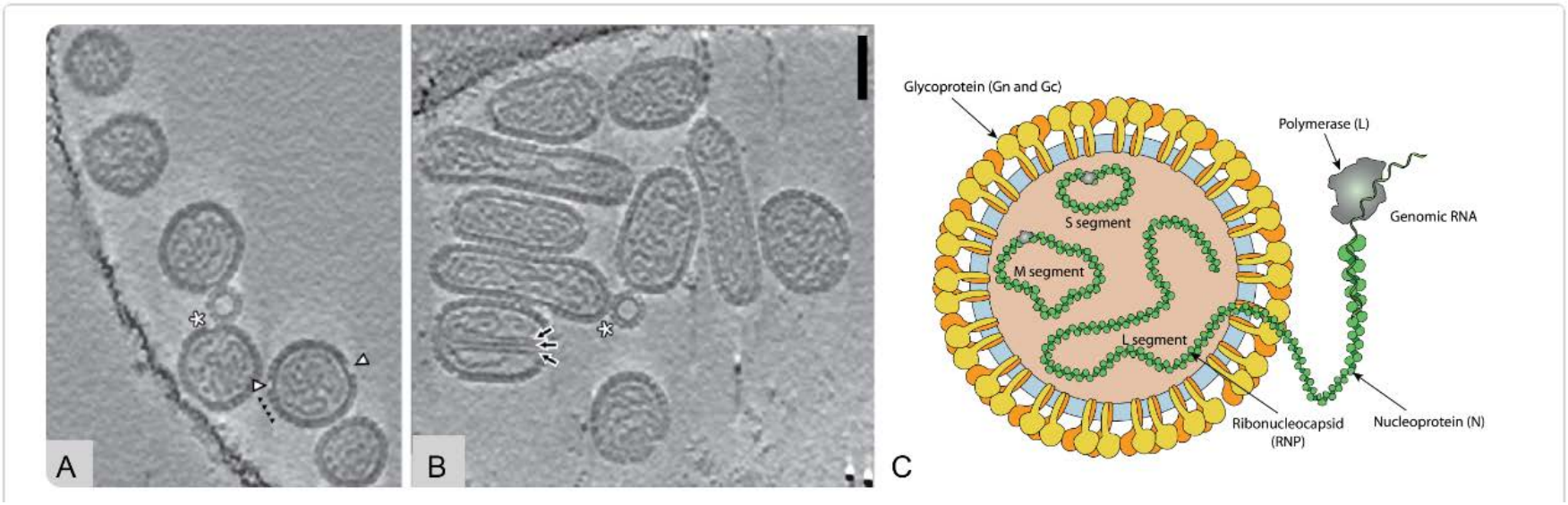
Genus: *Orthohantavirus*

- Includes 38 species for 60 distinct viruses
- These viruses typically infect specific rodents.
- Are spread worldwide, however, individual geographic distribution is dependent on host range.
- Are the only hantavirids known to cause disease in humans.
- Infection occurs after inhalation of aerosolized excreta or secreta of infected rodents or direct rodent contact.
- HFRS, NE and HCPS

Morphology

Orthohantavirions are pleomorphic in shape.

Surrounded by a membrane envelope that is decorated with glycoprotein (GP) spikes composed of G_N and G_C subunits.



Genome organization

The orthohantavirus genome consists of three negative-sense RNA molecules: S (small), M (medium), and L (large).

The genomic segments assume circular forms via non-covalent binding of complementary and highly conserved 3′- and 5′-terminal sequences.

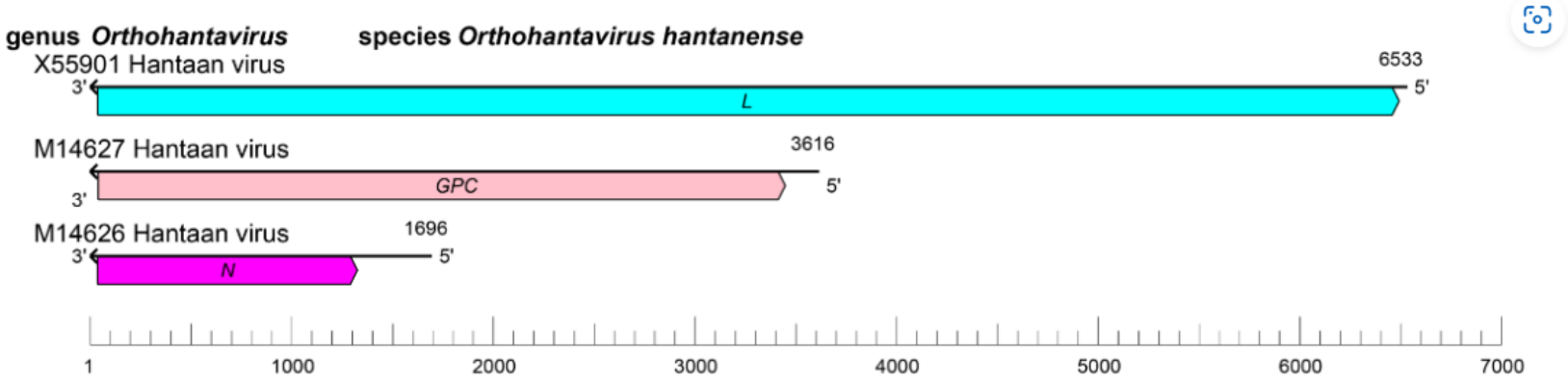


Figure 2 *Orthohantavirus.* Schematic representation of orthohantavirus genome organization.

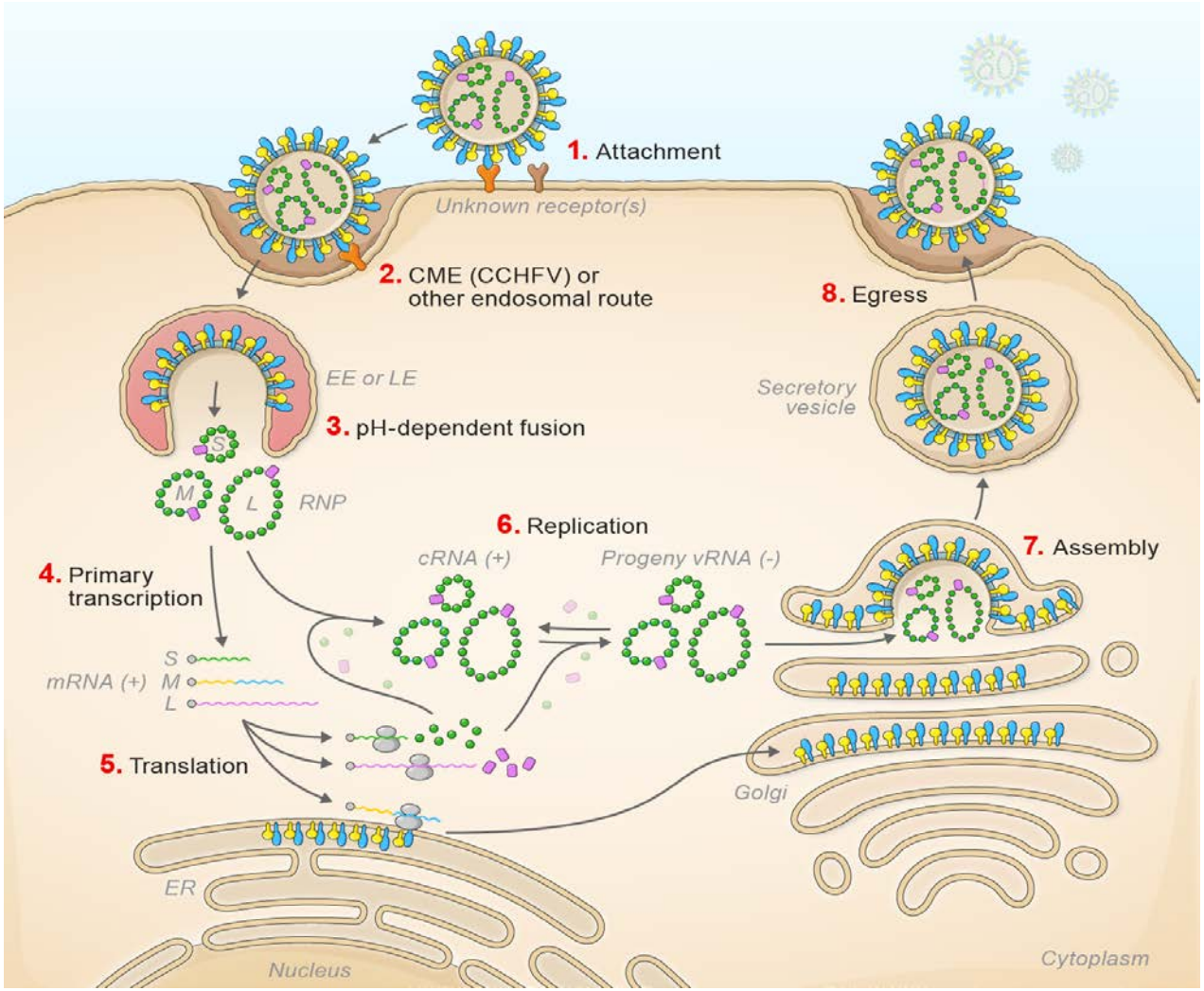
Proteins

The small (S), medium (M), and large (L) genomic segments encode four structural proteins:

Table 1 *Orthohantavirus*. Location and function of orthohantavirus structural proteins.

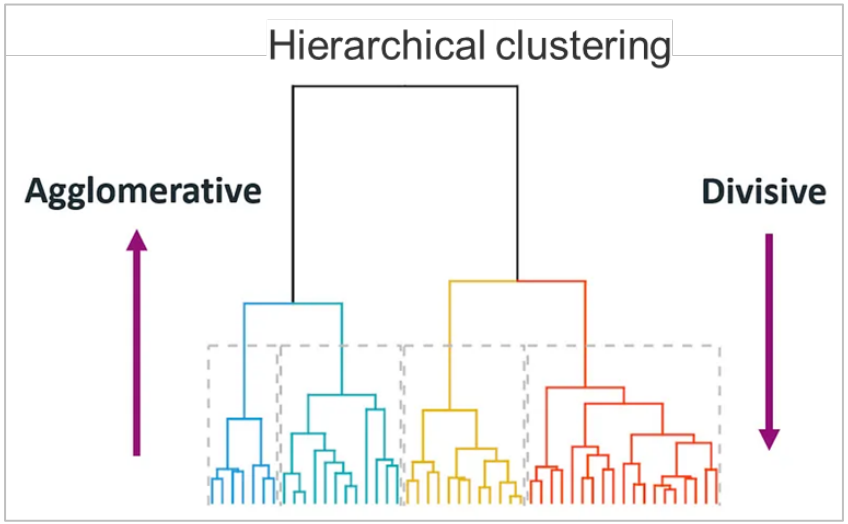
Protein	Location, mass, and function	Reference
Nucleoprotein (N)	Structural virion protein (about 48 kD). Oligomerizes and encapsidates orthohantaviral genomic segments and hence component of RNPs. Binds to L and G_N	(Mir *et al.,* 2010, Reuter and Krüger 2018, Arragain *et al.,* 2019)
Nonstructural protein (NSs)	Non-structural protein encoded by some orhtohantaviruses. Has type I interferon inhibitory activity. May occur as multiple isoforms.	(Vera-Otarola *et al.,* 2020, Binder *et al.,* 2021)
Glycoprotein (GP)	Structural virion protein consisting of two subunits (G_N: about 70-75 kD, G_C: about 50-55 kD). Produced via proteolytic cleavage from the genome-encoded precursor GPC. Projects from virion membranes as tetrameric GP spikes composed of G_N and G_C heterodimers. GP mediates cell- receptor binding; as a class II fusion machine it induces virion-cell membrane fusion and, thereby cell entry. G_N binds to N and RNA	(Spiropoulou *et al.,* 2003, Tischler *et al.,* 2005, Cifuentes-Muñoz *et al.,* 2014, Li *et al.,* 2016, Willensky *et al.,* 2016, Rissanen *et al.,* 2017, Zhu *et al.,* 2018, Bignon *et al.,* 2019, Sperber *et al.,* 2019)
Large protein (L)	Structural virion protein (246 kD) with RdRP, helicase, and endoribonuclease domains. Component of the RNP inside virions. Binds to N and RNA. Oligomerizes and mediates transcription and replication of viral RNA segments. Mediates cap-snatching for viral mRNA capping.	(Kukkonen *et al.,* 2005, Cheng *et al.,* 2014, Rothenberger *et al.,* 2016, Jeeva *et al.,* 2019, Durieux Trouilleton *et al.,* 2023)

Lifecycle of Orthohantavirus



Species demarcation criteria

Based upon diversity partitioning by hierarchical clustering (DEmARC) analysis using concatenated deduced S, M, and L segment expression product sequences.



Phylogenetic relationships across the genus have been estimated using maximum likelihood trees generated from complete N, GPC and L amino-acid sequences

Similar topologies are obtained with concatenated N and GPC sequences

Species demarcation criteria

The ninth ICTV report of 2011 states the following demarcation criteria for hantavirid species classification:

> "Species usually found in unique ecological niches, and reservoirs.
>
> Species exhibit at least **7% difference** in amino acid identity of the complete glycoprotein precursor and nucleocapsid protein sequences.
>
> Species show at least four-fold difference in two-way cross neutralization tests. Species do not naturally form reassortants with other species."

>10% amino acid differences of the **nucleoprotein**

>12% amino acid difference of the **glycoprotein**

Laenen, L. *et al.* (2019) 'Hantaviridae: Current classification and future perspectives', *Viruses*, 11(9), p. 788.

Member species

★ Type species

Species	Virus (Abbrev.)
Orthohantavirus andesense	★ Andes virus (ANDV) Castelo dos Sonhos virus (CASV) Lechiguanas virus (LECV; LECHV) Orán virus (ORNV)
Orthohantavirus artybashense	Artybash virus (ARTV)
Orthohantavirus asamaense	Asama virus (ASAV)
Orthohantavirus asikkalaense	Asikkala virus (ASIV)
Orthohantavirus bayoui (BAYV)	★ Bayou virus (BAYV) Catacamus virus (CATV)
Orthohantavirus nigrorivense	Black Creek Canal virus (BCCV)
Orthohantavirus boweense	Bowé virus (BOWV)
Orthohantavirus brugesense	Bruges virus (BRGV)
Orthohantavirus delgaditoense	Caño Delgadito virus (CADV)
Orthohantavirus caobangense	★ Cao Bằng virus (CBNV) Liánghé virus (LHEV)
Orthohantavirus chocloense	Choclo virus (CHOV)
Orthohantavirus dabieshanense	Dàbiéshan virus (DBSV)
Orthohantavirus dobravaense	★ Dobrava virus (DOBV) Kurkino virus (KURV) Saaremaa virus (SAAV) Sochi virus (SOCV)
Orthohantavirus carrizalense	Carrizal virus (CARV) Huitzilac virus (HUIV)
Orthohantavirus chocloense	Choclo virus (CHOV)
Orthohantavirus fugongense	Fúgòng virus (FUGV)
Orthohantavirus hantanense	Amur virus (AMRV) ★ Hantaan virus (HTNV) Soochong virus (SOOV)
Orthohantavirus jejuense	Jeju virus (JJUV)

Member species

☆ Type species

Species	Virus (Abbrev.)
Orthohantavirus kenkemeense	Kenkeme virus (KKMV)
Orthohantavirus khabarovskense	☆ Khabarovsk virus (KHAV) Topografov virus (TOPV)
Orthohantavirus mamorense	Maripa virus (MARV) Laguna Negra virus (LANV) ☆ Rio Mamoré virus (RIOMV)
Orthohantavirus lankaense	Lanka virus (LNKV)
Orthohantavirus luxiense	Lúxı virus (LUXV)
Orthohantavirus maporalense	Maporal virus (MAPV)
Orthohantavirus montanoense	Montaño virus (MTNV)
Orthohantavirus prospectense	Prospect Hill virus (PHV)
Orthohantavirus puumalaense	Hokkaido virus (HOKV) Muju virus (MUJV) ☆ Puumala virus (PUUV)
Orthohantavirus rockportense	Rockport virus (RKPV)
Orthohantavirus sangassouense	Sangassou virus (SANGV)
Orthohantavirus seoulense	Seoul virus (SEOV) gōu virus (GOUV)
Orthohantavirus sinnombreense	New York virus (NYV) ☆ Sin Nombre virus (SNV)
Orthohantavirus tatenalense	Tatenale virus (TATV)
Orthohantavirus thailandense	☆ Anjozorobe virus (ANJZV) Serang virus (SERV) Thailand virus (THAIV)
Orthohantavirus tigrayense	Tigray virus (TIGV)
Orthohantavirus tulaense	☆ Tula virus (TULV) Adler virus (ADLV)
Orthohantavirus wufangense	Wùfeng Chodsigoa smithii orthohantavirus 1 (WfCsOHV1)

Related, unclassified viruses

Virus name	Virus abbreviation
Academ virus	ACDV
Alto Paraguay virus	APV
Amga virus	
Anajatuba virus	ANAJV
Ash River virus	ARRV
Asturias virus	ASTV
Azagny virus	AZGV
Belgrade virus	
Biya river virus	
Bloodland Lake virus	
Blue River virus	BRV
Boginia virus	BOGV
Calabazo virus	
Camp Ripley virus	RPLV
CGRn9415 virus	
Dode virus	
Fox Creek virus	
Hantavirus sp. strain Tamarin/BRA/SM22/2014	
HoJo virus	
Iamonia virus	
Isla Vista virus	ILV
Jemez Springs virus	JMSV
jerboa hantavirus	JEHV
Jurong virus	
Kielder hantavirus	
Landiras virus	LDRV

Virus name	Virus abbreviation
Leakey virus	LEAV
Lohja virus	
Malacky virus	MCV
Muleshoe virus	MULEV
Osark virus	OZV
Playa de Oro virus	OROV
Powell Butte virus	
Prairie vole virus	
Qiān Hú Shān virus/Qiāndǎo Lake virus	QHSV
Rio Mearin virus	RIMEV
Río Segundo virus	
Sapporo rat virus	SRV
Sarufutsu virus	
Shěnyáng virus	
Taimyr virus	
Tanganya virus	TGNV
Tualatin River virus	
Uurainen virus	
Vladivostok virus	
Yuánjiāng virus	

Yellow highlight shows hantaviruses of historical research interest for our lab as they are either American or are related to hantaviruses identified in Mexico.

RVPVE

Red de Vigilancia de Patógenos Virales Emergentes

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