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FACULTY OF AGRICULTURE SCIENCES AND ALLIED INDUSTRIES

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FACULTY OF AGRICULTURAL SCIENCES & ALLIED INDUSTRIES

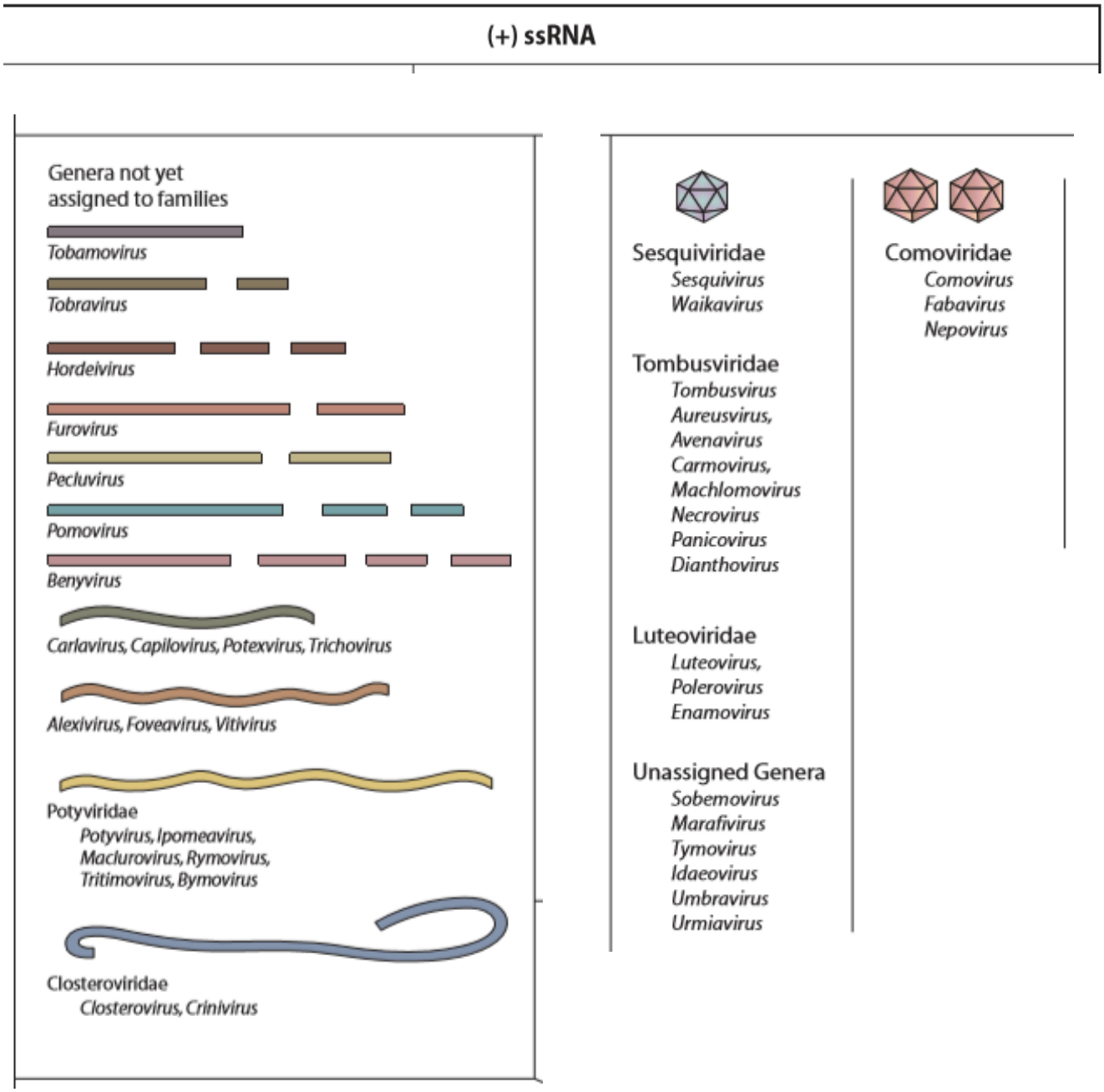
Lecture 11

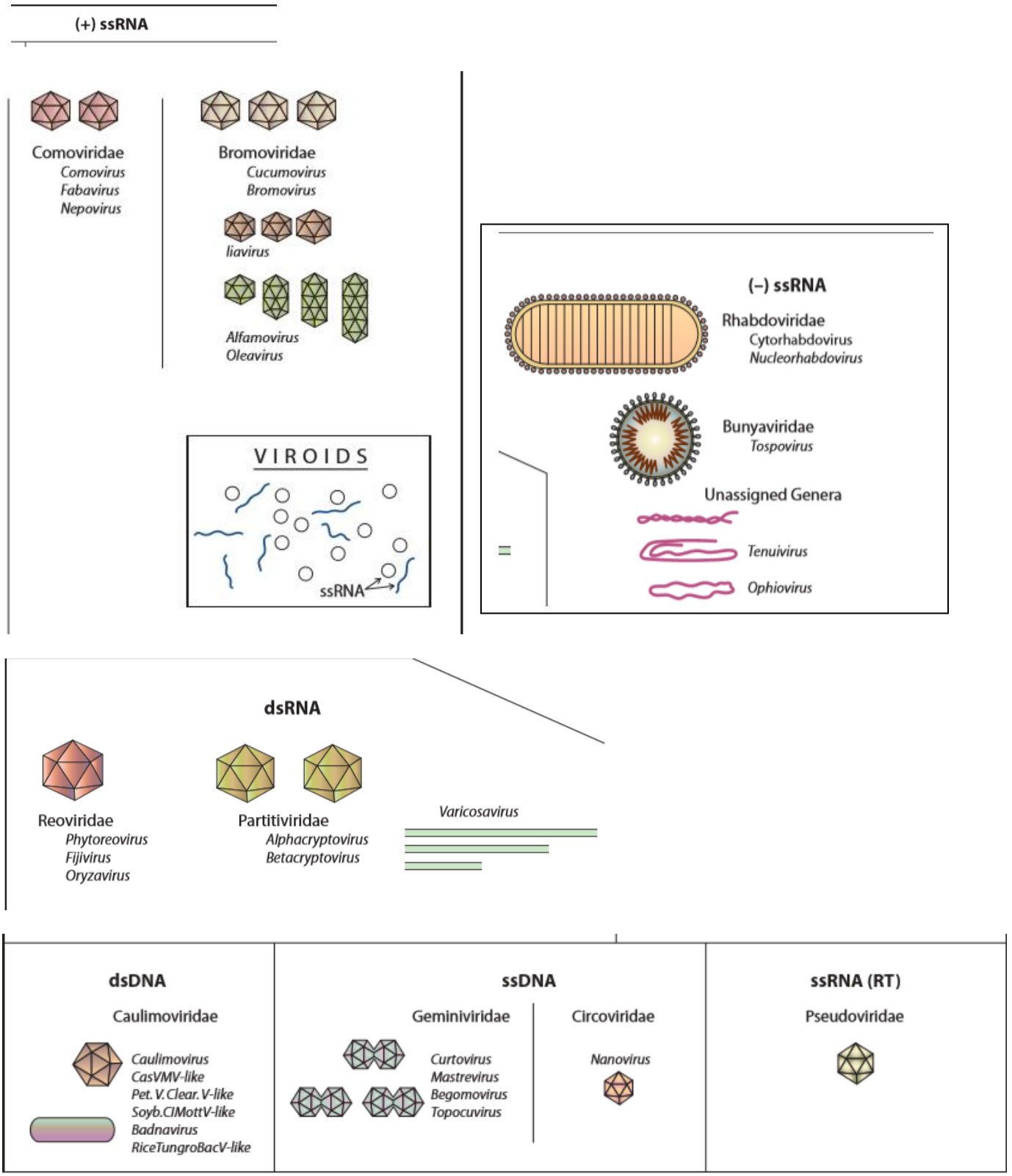
NOMENCLATURE AND CLASSIFICATION OF PLANT VIRUSES

Many plant viruses are named after the most conspicuous symptom they cause on the first host in which they have been studied. Thus, a virus causing a mosaic on tobacco is called tobacco mosaic virus, whereas the disease itself is called tobacco mosaic; another virus causing spotted wilt symptoms on tomato is called tomato spotted wilt virus and the disease is called tomato spotted wilt, and so forth.

All viruses belong to the kingdom Viruses. Within the kingdom, viruses are distinguished as RNA viruses and DNA viruses, depending on whether the nucleic acid of the virus is RNA or DNA. Viruses are further subdivided depending on whether they possess one or two strands of RNA or DNA of either positive or negative sense, either filamentous or isometric. Within each of these groups there may be viruses replicating via a polymerase enzyme (+RNA or DNA viruses) or via a reverse transcriptase (-RNA or DNA viruses).

Most viruses consist of nucleic acid surrounded by coat protein, but some also have a membrane attached to them. Some viruses have all their genome in one particle (monopartite viruses), but the genome of other (multipartite) viruses is divided among two, three, or, rarely, four particles. Other characteristics in the classification of viruses include the symmetry of helix in the helical viruses, or number and arrangement of protein subunits in the isometric viruses, size of the virus, and, finally, any other physical, chemical, or biological properties.


(+) ssRNA
Genera not yet assigned to families
Tobamovirus
Tobravirus
Hordeivirus
Furovirus
Pecluvirus
Pomovirus
Benyvirus
Carlavirus, Capilovirus, Potexvirus, Trichovirus
Alexivirus, Foveavirus, Vitivirus
Potyviridae
Potyvirus, Ipomeavirus, Maclurovirus, Rymovirus, Tritimovirus, Bymovirus
Closteroviridae
Closterovirus, Crinivirus
Sesquiviridae
Sesquivirus
Waikavirus
Tombusviridae
Tombusvirus
Aureusvirus,
Avenavirus
Carmovirus,
Machlomovirus
Necrovirus
Panicovirus
Dianthovirus
Luteoviridae
Luteovirus,
Polerovirus
Enamovirus
Unassigned Genera
Sobemovirus
Marafivirus
Tymovirus
Idaeovirus
Umbravirus
Urmiavirus
Comoviridae
Comovirus
Fabavirus
Nepovirus



Schematic diagram of families and genera of viruses and of viroids that infect plants

Kingdom: Viruses

Virus genera not yet assigned into families
RNA viruses
Single-stranded positive RNA [(+) ssRNA]

Rod-shaped particles	Family	Genus	Type species	Remarks
1 ssRNA	—	*Tobamovirus*	*Tobacco mosaic virus*	Contact transmission
2 ssRNAs	—	*Tobravirus*	*Tobacco rattle virus*	Nematode transmission
3 ssRNAs	—	*Hordeivirus*	*Barley stripe mosaic virus*	Seed transmission
2 ssRNAs	—	*Furovirus*	*Soilborne wheat mosaic virus*	Fungal transmission
	—	*Pecluvirus*	*Peanut clump virus*	Fungal and seed transmission
3 ssRNAs	—	*Pomovirus*	*Potato mop-top virus*	Fungal transmission, dicots
4 ssRNAs	—	*Benyvirus*	*Beet necrotic yellow vein virus*	Fungal transmission
Filamentous particles				
1 ssRNA	—	*Allexivirus*	*Shallot virus X*	Eriophyid mite transmission
	—	*Carlavirus*	*Carnation latent virus*	
	—	*Foveavirus*	*Apple stem pitting virus*	No vector
	—	*Potexvirus*	*Potato virus X*	By contact only
	—	*Capillvirus*	*Apple stem grooving virus*	No vector. Some seed transmission
	—	*Trichovirus*	*Apple chlorotic leafspot virus*	No vector. Some seed transmission
	—	*Vitivirus*	*Grapevine virus A*	Mealybugs, scale insects, aphids

Isometric particles

1 ssRNA				
	—	*Sobemovirus*	*Southern bean mosaic virus*	Seedborne, beetles, myrids
	—	*Marafivirus*	*Maize rayado fino virus*	In Gramineae, leafhoppers
	—	*Umbravirus*	*Carrot mottle virus*	Do not code coat proteins Aphids w/ helper virus
	—	*Tymovirus*	*Turnip yellow mosaic virus*	By beetles
2 ssRNAs	—	*Idaeovirus*	*Raspberry bushy dwarf virus*	By pollen and seed

Bacilliform particles

3 ssRNAs	—	*Ourmiavirus*	*Ourmia melon virus*	No vectors known

Virus families

Filamentous viruses

1 ssRNA				
	Potyviridae	*Potyvirus*	*Potato virus Y*	Aphids, w/ helper virus
	Potyviridae	*Ipomovirus*	*Sweet pot mild mottle*	Whitefly *Bemisia tabaci*
	Potyviridae	*Macluravirus*	*Maclura mosaic virus*	Aphids
	Potyviridae	*Rymovirus*	*Ryegrass mosaic virus*	Eriophyid mites
	Potyviridae	*Tritimovirus*	*Wheat streak mosaic virus*	Eriophyid mites
	Potyviridae	*Bymovirus*	*Barley yellow mosaic virus*	Gramineae, fungal transmission

1 or 2 ssRNA				
	Closteroviridae	*Closterovirus*	*Beet yellows virus*	Aphids, mealybugs, or whiteflies
	Closteroviridae	*Crinivirus*	*Lettuce inf. yellows virus*	Whiteflies
Isometric viruses				
1 ss(+)RNA				
	Sequiviridae	*Sequivirus*	*Parsnip yellow fleck virus*	Aphids
	Sequiviridae	*Waikavirus*	*Rice tungro spherical virus*	Leafhoppers or aphids
	Tombusviridae	*Tombusvirus*	*Tomato bushy stunt virus*	Soilborne, but vector unknown
	Tombusviridae	*Aureusvirus*	*Pothos latent virus*	Soilborne
	Tombusviridae	*Avenavirus*	*Oat chlorotic stunt virus*	Soilborne
	Tombusviridae	*Carmovirus*	*Carnation mottle virus*	—
	Tombusviridae	*Dianthovirus*	*Carnation ring spot virus*	Soilborne, unknown
	Tombusviridae	*Machlomovirus*	*Maize chlorotic mottle virus*	Seed, beetles, thrips
	Tombusviridae	*Necrovirus*	*Tobacco necrosis virus*	Fungal transmission
	Tombusviridae	*Panicovirus*	*Panicum mosaic virus*	Gramineae, mechanical
	Luteoviridae	*Luteovirus*	*Barley yellow dwarf virus*	Gramineae, aphids
	Luteoviridae	*Polerovirus*	*Potato leafroll virus*	Monocot or dicot plants
	Luteoviridae	*Enamovirus*	*Pea enation mosaic virus*	Mechanically, aphids
2 ss(+)RNAs				
	Comoviridae	*Comovirus*	*Cowpea mosaic virus*	Chrysomelid beetles
	Comoviridae	*Fabavirus*	*Broad bean wilt virus*	Aphids
	Comoviridae	*Nepovirus*	*Tobacco ring spot virus*	Nematodes
3 ss(+)RNAs				
	Bromoviridae	*Bromovirus*	*Brome mosaic virus*	Beetles, mechanically
	Bromoviridae	*Cucumovirus*	*Cucumber mosaic virus*	Aphids
	Bromoviridae	*Alfamovirus*	*Alfalfa mosaic virus*	Aphids
	Bromoviridae	*Ilarvirus*	*Tobacco streak virus*	Pollen, seed
	Bromoviridae	*Oleavirus*	*Olive latent virus 2*	No vector known

(–) ssRNA

Bacilliform particles

	Rhabdoviridae	*Cytorhabdovirus*	*Lettuce necrosis yellows virus*	Leafhoppers, planthoppers, aphids
	Phabdoviridae	*Nucleorhabdovirus,*	*Potato yellow dwarf virus*	Same

Membranous circular particles

	Bunyaviridae	*Tospovirus*	*Tomato spotted wilt virus*	Thrips

Thin flexuous multipartite viruses

	—	*Tenuivirus*	*Rice stripe virus*	Gramineae, planthoppers
	—	*Ophiovirus*	*Citrus psorosis virus*	No vector known

dsDNA

Isometric	Caulimoviridae	*Caulimovirus*	*Cauliflower mosaic virus*	Aphids
	Caulimoviridae	*Soybean chlorotic mottle virus-like*		Aphids
	Caulimoviridae	*Cassava vein mosaic virus-like*		Aphids
		Petunia vein clearing virus-like		Aphids
	Caulimoviridae	*Badnavirus*	*Commelina yellow mottle virus*	Mealybugs
	Caulimoviridae	*Rice tungro bacilliform virus-like*		Leafhoppers

(+)ssDNA

	Geminiviridae	*Mastrevirus*	*Maize streak virus*	Gramineae, leafhoppers
	Geminiviridae	*Curtovirus*	*Beet curly top virus*	Dicot, leafhoppers
	Geminiviridae	*Begomovirus*	*Bean golden mosaic virus*	2 DNAs, whiteflies
	Geminiviridae	*Topocuvirus*	*Tom. pseudocurly top vrius*	*Treehopper*
	Circoviridae	*Nanovirus*	*Subteranean clover stunt virus*	6 DNAs

ssRNA (RT) Pseudoviridae: retrotransposons

I. NOMENCLATURE

A. Historical aspects

In all studies of natural objects, humans have an innate desire to name and to classify. Virologists are no exception. Virus classification, as with all other classifications, arranges objects showing similar properties into groups and, even though this may be a totally artificial and human- driven activity without any natural base, it does have certain properties:

- It gives a structured arrangement of the organisms so that the human mind can com- prehend them more easily.
- It helps with communication between virologists.
- It enables properties of new viruses to be predicted.
- It could reveal possible evolutionary relationships.

J. Johnson in 1927 and in subsequent work stressed the need for using some criteria other than disease symptoms and host plants for identifying viruses. He suggested that a virus should be named by adding the word virus and a number to the common name for the host in which it was first found; for example, tobacco virus I for TMV.

Johnson and Hoggan (1935) compiled a descriptive key based on five characters: modes of transmission, natural or differential hosts, longevity in vitro, thermal death point, and distinctive or specific symptoms. About 50 viruses were identified and placed in groups.

K. M. Smith (1937) outlined a scheme in which the known viruses or virus diseases were divided into 51 groups. Viruses were named and grouped according to the generic name of the host in which they were first found. Successive members in a group were given a number. For example, TMV was Nicotiana virus 1, and there were 15 viruses in the Nicotiana virus group. Viruses that were quite unrelated in their basic properties were put in the same group. Although Smith's list served for a time as a useful catalog of the known viruses, it could not be regarded as a classification.

Holmes (1939) published a classification based primarily in host reactions and methods of transmission. He used a Latin binomial- trinomial system of naming. For example, TMV became Marmor tabaci, Holmes (Marmor meaning marble in Latin). His classification was based on diseases rather than the viruses, and thus 53 of the 89 plant viruses considered by Holmes fell in the genus Marmor, which contained viruses known even at that time to differ widely in their properties.

At the International Congress for Microbiology held in Moscow in **1966**, the first meeting of the **International Committee for the Nomenclature of Viruses** was held, consisting of 43 people representing microbiological societies of many countries. An organization was set up for developing an internationally agreed taxonomy and nomenclature for all viruses. Rules for the nomenclature of viruses were laid down. The subsequent development of the organization, now known as the **International Committee for Taxonomy of Viruses (ICTV)**, has been summarized.

B. Systems for classification

1. Most of the virus families delineated by the ICTV, mainly on morphological grounds, can now be seen to represent clusters of viruses with a relatively close evolutionary origin.

I. Virion properties

A. Morphology properties of virions

1. Size
2. Shape
3. Presence or absence of an envelope or peplomers
4. Capsomeric symmetry and structure

B. Physical properties of virions

1. Molecular mass
2. Buoyant density
3. Sedimentation coefficient
4. pH stability
5. Thermal stability
6. Cation (Mg 2+, Mn 2§ Ca 2§ stability
7. Solvent stability
8. Detergent stability
9. Radiation stability

C. Properties of the genortze

1. Type of nucleic acid, DNA or RNA
2. Strandedness: single-stranded or double-stranded
3. Linear or circular
4. Sense: positive, negative or ambisense
5. Number of segments

6. Size of genome or genome segments
7. Presence or absence and type of 5' terminal cap
8. Presence or absence of 5' terminal covalently-linked polypeptide
9 Presence or absence of 3' terminal poly(A) tract (or other specific tract)
10. Nucleotide sequence comparisons

D. Properties of proteins

1. Number
2. Size
3. Functional activities (especially virion transcriptase, virion reverse transcriptase, virion hemagglutinin, virion neuraminidase, virion fusion protein)
4. Amino acid sequence comparisons

E. Lipids

1. Presence or absence
2. Nature

F. Carbohydrates

1. Presence or absence
2. Nature

II. Genome organization and replication

1. Genome organization
2. Strategy of replication of nucleic acid
3. Characteristics of transcription
4. Characteristics of translation and post-translational processing
5. Sites of accumulation of virion proteins, site of assembly, site of maturation and release
6. Cytopathology, inclusion body formation

III. Antigenic properties

1. Serological relationships
2. Mapping epitopes

IV. Biological properties

1. Host range, natural and experimental
2. Pathogenicity, association with disease

3. Tissue tropisms, pathology, histopathology
4. Mode of transmission in nature
5. Vector relationships
6. Geographic distribution

ICTV initiated a rationalization of plant virus acronyms and has subsequently updated the list regularly. The designation of the abbreviations is based on the following principles:

- Abbreviations should be as simple as possible.
- An abbreviation must not duplicate any other previously coined and still in current usage.
- The word 'virus' in a name is abbreviated as ‘V’.
- The word 'viroid' in a name is abbreviated as 'Vd’.