
Classification and Nomenclature of Viruses

**Fourth Report of the
International Committee on
Taxonomy of Viruses**

**Report prepared by the
International Committee on
Taxonomy of Viruses
and published for the
Virology Division of the
International Union of
Microbiological Societies
(IUMS)**

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(IUMS)**

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Preface

The main section of this report summarizes the state of approved virus taxonomy and nomenclature as it was following the Plenary meeting of the International Committee on Taxonomy of Viruses (ICTV) at Strasbourg in August 1981. There are now 54 approved families and groups of viruses. In addition, I have included five proposed or possible families or groups. The data on the viruses, the lists of member viruses, and the literature references have been updated. The information given under the 'Main characteristics' section has been substantially expanded for many families and groups. For convenience, the data are presented in a standard order under a series of headings. Four pages of outline drawings are included as a visual index to remind the reader of the main morphological features of the various families and groups.

I have included a new section summarizing the procedures involved in the initiation and processing of new taxonomic proposals by ICTV for the coming 3 years. I hope that this will prove useful to new members of subcommittees and study groups.

I wish to thank all members of the Executive Committee of ICTV for their help and support, especially the Secretaries, Dr. *J. Maurin* and Dr. *V. Valenta*, and the chairmen of subcommittees, Dr. *H.-W. Ackermann*, Dr. *J. G. Atherton*, Dr. *R. I. B. Francki*, Dr. *M. Hollings*, Dr. *F. A. Murphy*, Dr. *T. W. Tinsley* and Mr. *J. F. Longworth*. ICTV could not progress without their enthusiasm and their knowledge of both viruses and virologists.

The virus descriptions came from the work of many members of Study Groups and their

colleagues, too numerous to name; I thank them all most sincerely for their help and support for the work of ICTV.

For financial support for individual members to attend the meetings of the Executive Committee of ICTV, I wish to thank the following organizations: University of Missouri (*A. Eisenstark*); Clive and Vera Ramaciotti Foundation and University of Queensland, Australia (*J. G. Atherton*); The Royal Society, London (*K. W. Buck*); 'Centre National de la Recherche Scientifique', Paris (*M. Bergoin*); The Royal Society of New Zealand and Department of Scientific and Industrial Research, New Zealand (*J. F. Longworth*); University of Adelaide, Australia (*R. I. B. Francki*); Agricultural University, Wageningen, The Netherlands (*J. P. H. van der Want*); Slovak Academy of Sciences, Bratislava, Czechoslovakia (*V. Valenta*); University of Auckland Research Committee and the Royal Society of New Zealand (*R. E. F. Matthews*); Virology Division, IUMS (*F. A. Murphy*); Department of Virology, Karolinska Institute, Stockholm (*E. Norrby*). In addition I thank The Royal Society of London for providing committee room facilities for the mid-term meeting of the Executive Committee in 1980.

I also wish to thank the Clive and Vera Ramaciotti Foundation, Australia, for a grant to Dr. *J. G. Atherton* of \$A 23,000 to assist in the development of a computer-based virus data storage and retrieval system; and the Natural Sciences Engineering and Research Council of Canada for a grant of Can\$ 23,000 per year for 3 years to set up a phage reference center. In due course, work carried out under

these grants will be of considerable assistance in the activities of ICTV.

'*Intervirology*' is the journal of the Virology Division of the International Union of Microbiological Societies. Publication of this report as a special issue of '*Intervirology*' follows pre-

vious practice. I thank the Editor-in-Chief, Professor *J.L. Melnick*, for his help during the production process.

Auckland, 1981

R. E. F. Matthews

List of Officers and Members of the International Committee on Taxonomy of Viruses

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J.-F. Vieu

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R. Ushiyama	R. Ushiyama
H. A. Wood	H. A. Wood

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J. Maurin	H. E. Varmus
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P. K. Vogt	E. G. Westaway
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Code and Data Subcommittee
(since August 1981 called the
'Standing Subcommittee for Virus Data').

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H.-W. Ackermann	H.-W. Ackermann
P. Bachmann	J. G. Atherton
A. Eisenstark	A. J. Gibbs
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C. Vago	

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J. G. Atherton	P. Bachmann
R. I. B. Francki	K. W. Buck
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	W. K. Joklik
	D. W. Kingsbury
	J. F. Longworth
	P. Scotti
	R. E. Shope
	G. Siegl
	D. Willis

President's Report

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I. Introduction

The development of an internationally agreed taxonomy for viruses is detailed in the three previous reports of the International Committee on Taxonomy of Viruses (ICTV) and its predecessor, the International Committee on Nomenclature of Viruses [Wildy, 1971; Fenner, 1976; Matthews, 1979]. This report incorporates 51 new taxonomic proposals approved by ICTV at its meeting held during the Fifth International Congress of Virology at Strasbourg in August 1981. In addition, the data for all the approved virus families and

groups have been brought up-to-date with respect to the main characteristics of the viruses, the list of member viruses, and literature references. In a report of this size it is not possible to provide extensive reference lists. References have been chosen to provide ready access to: (i) very recent papers, (ii) important review papers, and (iii) occasional papers that could be difficult to locate. The overall form of this report follows that of the Third Report.

In the Third Report I devoted some space to a discussion of the problem of 'species' in virus taxonomy. Highlights in the work of ICTV over the past 3 years relate to this question. ICTV has clarified and expanded the rules concerning the naming of virus species (p. 23) and has developed guidelines for virologists or study groups wishing to delineate and name virus species (p. 24). The first virus species, and names for them, were given provisional approval at Strasbourg. These are in the family *Adenoviridae* (p. 59).

II. Composition of ICTV and Its Executive Committee

A. National Members of ICTV

The rules of the International Union of Microbiological Societies (IUMS) allow each National Society that adheres to IUMS to nominate one member to ICTV. The National Membership for the period 1978-1981 is given on p. 7. As in previous years, there has been considerable difficulty in obtaining nominations from some National Societies. In order to ensure that the decisions of ICTV fairly

reflect international opinion, it is most important that the officers of National Societies use their right to take part in the work of ICTV by (i) nominating a person for membership and (ii) nominating a voting proxy if that member is unable to attend the ICTV meeting which will take place in conjunction with the Sixth International Congress of Virology to be held in Sendai, Japan, in August 1984.

B. Chairmen of Subcommittees

The chairmen of subcommittees are elected by the Executive Committee of ICTV (ECICTV). The membership of these subcommittees must also be confirmed by ECICTV. The new procedure introduced during the last term has again worked effectively to minimize delays in the operation of the subcommittees. New chairmen were elected for all subcommittees at the mid-term meeting of ECICTV in London in April 1980. Membership of the new subcommittees was approved in Strasbourg in August 1981. Membership lists are given on pp. 8–10.

C. Elected Members of the Executive Committee

At the meetings in Strasbourg, August 1981, the following members retired, having served two terms: *R.E.F. Matthews* as President; *H.G. Pereira* as Vice-President; *A. Eisenstark*, *H. Fraenkel-Conrat*, *E. Norrby* and *J.P.H. van der Want*. *W.K. Joklik* retired after serving one term. *J.F. Longworth* had been elected Chairman of the Invertebrate Virus Subcommittee. *F. Brown* was elected President; and *J.P.H. van der Want* Vice-President. Thus, there were seven vacancies for elected members of the Executive Committee. *T.H. Graf*, *D.C. Kelly*, *M.B. Korolev*, *S. Matsumoto*, *J.A. Mayo* and *A.F. Murant* were elected. For the seventh vacancy on the Committee, *L. van*

Vloten-Doting was elected following a postal ballot.

D. Ex officio Members

In order to ensure adequate coordination with the work of the World Health Organization (WHO) in vertebrate virology, the Executive Committee agreed that the Director of the WHO Center for the Collection and Evaluation of Data on Comparative Virology in Munich, should be *ex officio* a member of the Executive Committee of ICTV.

E. Life Members of ICTV

News was received that a life member, *V.L. Ryzhkov*, had died. Dr. *Ryzhkov* had been associated with the founding of ICNV in Moscow in 1966. The retiring President *R.E.F. Matthews* was elected a life member of ICTV. *H.G. Pereira* was also elected a life member in recognition of his many contributions to the development of viral taxonomy. He had been involved with the work of ICTV and its predecessor ICNV since its inception in Moscow in 1966.

F. The Present State of ICTV Membership

Since the Fourth International Congress for Virology in 1978, the membership of ICTV has increased slightly from 118 to 128. This increase has been mainly due to an enlargement of some subcommittees. In August 1981 the membership was made up as follows:

Executive Committee members	12 (plus chairmen of 6 subcommittees)
Life members	8
National members	42 (39 countries)
Subcommittee (SC) members	
Vertebrate Virus SC	14
Invertebrate Virus SC	11

Plant Virus SC	15
Bacterial Virus SC	12
Fungal Virus SC	8
Code and Data SC	6

III. Translations of the Third Report

A French translation of the Third Report of ICTV by *J. Maurin* is available from Masson SA, 120, bld. Saint-Germain, 75280 Paris Cedex 06 (France).

A Spanish translation supervised by *R. Najera* is published by the Virology Group of the Spanish Society for Microbiology and distributed in Spain by Microbiological Associates Inc.

It is hoped that similar translations of the present report will be available in due course.

IV. Work of the Subcommittees of ICTV

The host-oriented subcommittees dealing with viruses infecting bacteria, fungi, invertebrates, plants or vertebrates are the key units involved in generating new taxonomic proposals for consideration by ICTV. In addition, the Coordination Subcommittee has responsibility for viruses infecting more than one kind of host. Five families so far fall into this category – *Poxviridae*, *Reoviridae*, *Rhabdoviridae*, *Parvoviridae* and *Iridoviridae*.

In the sections below I summarize the work of these subcommittees over the period 1978 to 1981. The 51 specific taxonomic proposals approved by ICTV are incorporated in the descriptions of the families and groups of viruses. These proposals were summarized recently in a short publication [*Matthews*, 1981].

A. Bacterial Virus Subcommittee

Eight genus names for cubic, filamentous and pleomorphic phages, and two family names for tailed phages were approved.

Members of the subcommittee have published or submitted for publication several further papers relating to bacterial virus taxonomy.

A survey completed by Dr. *H.-W. Ackermann* in January 1981 listed about 2,100 phages of known morphology not counting phage-like 'bacteriocins' and defective phages. Over 2,000 are tailed phages. Only 109 (5%) are cubic, filamentous or pleomorphic. Table I shows the numbers of phages which belong or probably belong to the ten bacterial virus families.

Most phages have been described from a relatively few bacterial groups, particularly enterobacteria (562), *Bacillus*, *Streptococcus* and *Pseudomonas*.

The number of phage descriptions was about 150 in 1978. The annual rate has fallen,

Table I. Numbers of phages belonging to (or probably belonging to) the ten families of bacterial viruses

Nucleic acid	Family	Number of phages
DNA	<i>Myoviridae</i>	603
	<i>Styloviridae</i>	1,050
	<i>Podoviridae</i>	372
DNA	<i>Microviridae</i>	26
	<i>Corticoviridae</i>	2?
	<i>Tectiviridae</i>	8
RNA	<i>Leviviridae</i>	34?
	<i>Cystoviridae</i>	1
DNA	<i>Inoviridae</i>	
	Genus <i>Inovirus</i>	20
	Genus <i>Plectrovirus</i>	13
	<i>Plasmaviridae</i>	3

and is now around 100. Most new descriptions are still for phages of bacteria of medical or veterinary interest. Many 'new' phages have been described for streptococci used in the fermentation industry. No phages requiring the designation of a new family have been found.

Classification of cubic, filamentous, and pleomorphic phages is relatively easy, because the groups contain relatively few viruses and many data are available. The major difficulties occur with the tailed phages where classification critically depends on good electron microscopy, special features such as unusual bases, and comparative serology and nucleic acid hybridization. Ackermann et al. [1978] analyzed the criteria used for describing and classifying phages. Major difficulties with the various criteria remain as follows.

Morphology. Unrelated phages may have identical morphology. Reported dimensions depend on the calibration of the electron microscope and are often unreliable.

Physicochemical Properties. The usefulness of such properties with the tailed phages is limited because of (i) parallelisms between capsid size and molecular weight of the DNA; the relative DNA content is mostly around 50%; (ii) parallelisms between GC content of phage and host cell; (iii) the size of tailed phages varies over a wide range without clear size classes; and (iv) particle density in CsCl is usually close to 1.5 g/cm³.

Serology. Serological tests are usually carried out by neutralization of infectivity, which involves only the tip of the tail.

Resistance Tests. Tests involving resistance to various agents are performed in different laboratories under such variable conditions as to be almost meaningless.

Nucleic Acid Hybridization. At present the main problem is lack of data. Data are currently available for some 85 phages, mainly infecting enterobacteria. The threshold of relatedness is ill-defined. Several methods and many modifications of procedure have been reported. In general the data confirm relationships established by morphology, serology and other procedures.

Dr. Ackermann has received from the Natural Sciences and Engineering Research Council of Canada funds for a phage reference center. The grant is for 3 years and will provide for a technician and some material (\$ 23,000 per year). The funding organization has suggested that the center be named after *Félix d'Hérelle*. The center will be taxonomically oriented and devoted to the preservation of type viruses. The center plans to: (i) collect and preserve type viruses of phage species, certain typing and teaching phages, and phages specific for resistance plasmids; (ii) check the identity of these viruses by electron microscopy or otherwise; (iii) provide on request reference phages and electron microscopical expertise for the identification of new phages; and (iv) publish a catalogue.

If adequately supported by bacterial virologists, this center should develop into a most useful tool for bacterial virus taxonomy.

B. Fungal Virus Subcommittee

The Chairman of this subcommittee, Dr. M. Hollings, retired at the end of 1980, and the chairman-elect K.W. Buck became Acting Chairman for the period January–August, 1981.

The main thrusts in mycovirus research at the present time are in four areas. (i) *Fungal killer systems*: There is now good evidence that killer proteins (fungal analogues of bacteriocins) are encoded by satellite double-stranded (ds) RNAs, the encapsidation and replication of which are dependent on dsRNA helper viruses. (ii) *Viruses of plant pathogenic fungi*: Evidence for the association of dsRNA with transmissible hypovirulence in *Endothia parasitica*, the causative agent of chestnut blight, has renewed interest in the effect of dsRNA and viruses on other plant pathogenic fungi. (iii) *Viruses of edible fungi*: Work on diseases

of mushrooms is continuing. In view of reports of virus-like particles in healthy, as well as diseased, mushrooms, much more work is required in this area. (iv) *Viruses of human pathogenic fungi*: A start in this area has been made in a number of laboratories. Although none of the above areas of research is directed specifically towards virus taxonomy, nevertheless useful taxonomic data are being accumulated. A large number of variants of some viruses obtained from different fungal isolates has been discovered, and this has helped to solve some taxonomic problems, while creating others.

Many mycoviruses have no obvious biological effects on their hosts and there is usually no reliable method of infecting fungi with their viruses. For these reasons the *in vitro* properties of the virus particles are of particular taxonomic importance. Many of the viruses infecting fungi have small isometric particles and contain dsRNA. Sufficient information is now available for many of these to allow the delineation of three families and of genera within them. Although these families have not yet been considered by ICTV, I have included them in the virus descriptions as proposed families to indicate the way in which fungal virus taxonomy is developing.

C. Invertebrate Virus Subcommittee

Arrangements have been made to ensure that the membership of vertebrate virus study groups includes at least one invertebrate virologist.

Two new families of viruses infecting invertebrates were proposed through the Coordination Subcommittee and were approved. The family *Nodaviridae* encompasses a group of small icosahedral viruses with divided single-stranded (ss)RNA genomes. The type genus is *Nodavirus* and the type species is *Nodamura*

virus. The second family, which does not yet have an approved name, encompasses a group of small icosahedral ssRNA viruses with $T = 4$ symmetry. The type species for the new family is the *Nudaurelia* β virus. These two new families are now the responsibility of the Invertebrate Virus Subcommittee.

Proposals will be brought forward in the near future for another new family to include viruses whose genomes consist of ds, circular, polydisperse DNA. These viruses are associated with parasitic Braconid wasps.

D. Plant Virus Subcommittee

One new plant virus group was approved with carnation ringspot virus as the type member. The name *Dianthovirus* was approved for this group, which includes several viruses with two molecules of positive-sense ssRNA and polyhedral particles 31–34 nm in diameter. The name *Sobemovirus* was approved for the Southern bean mosaic virus group.

In Australia several plant viruses have recently been discovered in which the genome consists of two pieces of RNA. One is a linear ssRNA with a molecular weight of 1.5×10^6 while the other is a circular ss viroid-like RNA with a molecular weight of 1.2×10^6 . This group is typified by velvet tobacco mottle virus. Although not yet approved by ICTV, a brief description is included in this report as a possible group.

The chairman of the subcommittee published an account of plant virus taxonomy – including a discussion of the historical background, current status, and future outlook [Francki, 1981].

E. Vertebrate Virus Subcommittee

As in previous terms, the Vertebrate Virus Subcommittee has been the most active of the host-oriented subcommittees of ICTV. How-

ever, many difficult problems remain for the future. The most innovative proposals approved by ICTV concerned the *Adenoviridae*. A definition for species within this family was approved. 87 species were approved in the genus *Mastadenovirus* and 14 in the genus *Aviadenovirus*. The proposed names for these species were also approved. They are constructed from the first three letters of the host's generic name followed by a number, the numbers being already in use by virologists. The exceptions are the human adenovirus series, where the letter 'h' followed by a number constitutes the species name. Under new rule No.18 concerning species, approval of these species proposals by ICTV is provisional. Final approval can be given in 1984. Human adenoviruses were divided into five subgenera (A-E).

Proposals that the caliciviruses be excluded from the family *Picornaviridae*, and that a new family to be called the *Caliciviridae* be established, were approved.

Proposals for a substructure within the large family *Bunyaviridae* were approved. In addition to the established genus *Bunyavirus*, there are now three new genera with the following names (type species in parentheses) *Nairovirus* (Crimean-Congo hemorrhagic fever virus); *Phlebovirus* (sandfly fever Sicilian virus); *Uukuvirus* (Uukuniemi virus).

Proposals concerning the established family *Parvoviridae* were put forward through the Coordination Subcommittee. Two taxonomic proposals were approved: (i) two additional viruses were accepted as members of the genus *Parvovirus*; (ii) the adeno-associated viruses were grouped in a genus to be called *Dependovirus*. This last decision resolved a problem of many years' standing.

F. Coordination Subcommittee

The study groups concerned with *Poxviri-*

dae, *Reoviridae*, *Rhabdoviridae* and *Parvoviridae* have worked closely with Dr. Murphy and the Vertebrate Virus Subcommittee during the period 1978-1981, as they did during the previous term. Although formally under the Coordination Subcommittee, the work of these study groups lies primarily in the vertebrate field. Some proposals put forward through the Coordination Subcommittee have already been noted under the Invertebrate and Vertebrate Virus Subcommittees.

The *Iridoviridae* study group led by Dr. D. B. Willis put forward ten taxonomic proposals which were approved by ICTV at Strasbourg. As a result, there are now five genera within this family (type species in parentheses): (i) *Iridovirus*, reserved for the 'small' iridoviruses (*Tipula* iridescent virus); (ii) *Chloriridovirus*, to include the large (180 nm) insect iridescent viruses (mosquito iridescent virus type 3); (iii) *Ranavirus*, to include a group of iridescent viruses infecting amphibians (frog virus 3); (iv) African swine fever virus genus (African swine fever virus); this is the only member of the *Iridoviridae* infecting mammals; and (v) Lymphocystis disease virus genus (the proposed type species is the lymphocystis disease virus of fish).

During the past term a new study group was set up under Dr. P. Dobos to consider viruses with genomes consisting of bisegmented dsRNA which infect vertebrates or invertebrates. No proposals from this study group have yet been approved by ICTV. However, I include in this report a possible family for these viruses that is being considered by the study group.

G. Standing Subcommittee for Virus Data (formerly the Code and Data Subcommittee)

When ICNV was first set up, a Cryptogram Subcommittee was formed to investigate the