

2003.224 and 252V

Note from Mike Adams: The revision of the family *Papillomaviridae* was a last-minute effort largely involving the ICTV Secretary, Claude Fauquet, and the *Papillomaviridae* Study Group. We have been able to trace what happened but the documentation is not completely satisfactory. The proposal papers now available do not exactly reflect the taxonomy that was finally adopted for the ICTV 8th Report (and beyond). A further complication is that the changes reported [Mayo, M. A. (2005). Changes to virus taxonomy 2004. Arch Virol 150: 189–198] appear to have a few mistakes and therefore differ in some respects from the list in the ICTV 8th Report. Some parts of the proposals are appended to this document but can be summarized as follows:

Proposal 2003.224V

To designate as species in the family *Papillomaviridae*:-

Bovine papillomavirus 1

Bovine papillomavirus 5

Canine oral papillomavirus

Cottontail rabbit papillomavirus

Deer papillomavirus

Equus caballus papillomavirus (Other papillomavirus types: EcPV1)

European Elk Papillomavirus (EEPV) (Other papillomavirus types: *Reindeer papillomavirus*)

Feline domesticus papillomavirus

Fringilla coelebs papillomavirus (chaffinch papillomavirus)

Hamster oral papillomavirus

Human papillomavirus 1

Human papillomavirus 10 (Other papillomavirus types: HPV3, HPV28, HPV29, HPV77, HPV78, HPV94)

Human papillomavirus 16 (Other papillomavirus types: HPV31, HPV33, HPV35, HPV52, HPV58, HPV67)

Human papillomavirus 18 (Other papillomavirus types: HPV39, HPV45, HPV59, HPV68, HPV70, HPV85)

Human papillomavirus 2 (Other papillomavirus types: HPV27, HPV57)

Human papillomavirus 26 (Other papillomavirus types: HPV51, HPV69, HPV82)

Human papillomavirus 32 (Other papillomavirus types: HPV42)

Human papillomavirus 34 (Other papillomavirus types: HPV73)

Human papillomavirus 4 (Other papillomavirus types: HPV65, HPV95)

Human papillomavirus 48

Human papillomavirus 49 (Other papillomavirus types: HPV75, HPV76)

Human papillomavirus 5 (Other papillomavirus types: HPV8, HPV12, HPV14, HPV19, HPV20, HPV21, HPV25, HPV36, HPV47)

Human papillomavirus 50

Human papillomavirus 53 (Other papillomavirus types: HPV30, HPV56, HPV66)

Human papillomavirus 54

Human papillomavirus 6 (Other papillomavirus types: HPV11, HPV13, HPV44, HPV74, PcPV)

Human papillomavirus 60

Human papillomavirus 61 (Other papillomavirus types: HPV72, HPV81, HPV83, HPV84, HPVcand62, HPVcand86, HPVcand87, HPVcand89)

Human papillomavirus 63

Human papillomavirus 7 (Other papillomaviruses: HPV40, HPV43, HPV91)
Human papillomavirus 71
Human papillomavirus 88
Human papillomavirus 9 (Other papillomavirus types: HPV15, HPV17, HPV22, HPV23, HPV37, HPV38, HPV80)
Human papillomavirus cand90
Human papillomavirus cand92
Mastomys natalensis papillomavirus
Ovine papillomavirus type 1 (Other papillomavirus types: OvPV2)
Phocoena spinipinnis papillomavirus
Psittacus erithacus timneh papillomavirus (parrot papillomavirus)
Rabbit oral papillomavirus
Bovine papillomavirus 3 (Other papillomaviruses: BPV4, BPV6)
Human papillomavirus 41
Rhesus monkey papillomavirus

Note from Mike Adams: a few of these species were already in existence, but most are new.

Proposal 2003.252V

Create as genera in the family *Papillomaviridae*:

Alphapapillomavirus (type species: *Human papillomavirus* 32)
Betapapillomavirus (type species: *Human papillomavirus* 5) [N.B. this is wrongly given as 55 in Mayo, 2005]
Gammapapillomavirus (type species: *Human papillomavirus* 4)
Deltapapillomavirus (type species: *European elk papillomavirus*)
Epsilonpapillomavirus (type species: *Bovine papillomavirus* 5)
Zetapapillomavirus (type species: *Equine papillomavirus* 1)
Etapapillomavirus (type species: *Fringilla coelebs papillomavirus* (chaffinch papillomavirus))
Thetapapillomavirus (type species: *Psittacus erithacus timneh papillomavirus* (parrot papillomavirus))
Ioatapillomavirus (type species: *Mastomys natalensis papillomavirus*)
Kappapapillomavirus (type species: *Cottontail rabbit papillomavirus*)
Lambdapapillomavirus (type species: *Canine oral papillomavirus*)
Mupapillomavirus (type species: *Human papillomavirus* 1)
Nupapillomavirus (type species: *Human papillomavirus* 41)
Xipapillomavirus (type species: *Bovine papillomavirus* 3)
Omikronpapillomavirus (type species *Phocoena spinipinnis papillomavirus*)
Pipapillomavirus (type species *Hamster oral papillomavirus*)

Other species (in addition to the type species listed above):

• Assign *Human papillomavirus* 10; *Human papillomavirus* 61; *Human papillomavirus* 2; *Human papillomavirus* 26; *Human papillomavirus* 53; *Human papillomavirus* 18; *Human papillomavirus* 7; *Human papillomavirus* 16; HPV6; *Human papillomavirus* 34; *Human papillomavirus* 54; *Human papillomavirus* cand90; *Human papillomavirus* 71; *Rhesus monkey papillomavirus* to *Alphapapillomavirus*

- Assign *Human papillomavirus 9*; *Human papillomavirus 49*; *Human papillomavirus cand92* to *Betapapillomavirus*
- Assign *Human papillomavirus 4*; *Human papillomavirus 48*; *Human papillomavirus 50*; *Human papillomavirus 60*; *Human papillomavirus 88* to *Gammapapillomavirus*
- Assign *Deer papillomavirus*; *Ovine papillomavirus 1*; *Bovine papillomavirus 1* to *Deltapapillomavirus*
- Assign *Human papillomavirus 63* to *Mupapillomavirus*
- Assign *Feline domesticus papillomavirus* to *Lambdapapillomavirus*
- Assign *Rabbit oral papillomavirus* to *Kappapapillomavirus*

Note from Mike Adams: some of these are wrongly assigned in Mayo (2005) probably because there was a very late decision to split the genus *Betapapillomavirus* and the paper was prepared using an earlier version of the proposal. For the record, Mayo (2005) reports the following:

- Assign *Human papillomavirus 9*; *Human papillomavirus 49*; *Human papillomavirus cand92*; *Human papillomavirus 4*; *Human papillomavirus 48*; *Human papillomavirus 50*; *Human papillomavirus 60*; *Human papillomavirus 88* to *Betapapillomavirus*
- Assign *Deer papillomavirus*; *Ovine papillomavirus 1*; *Bovine papillomavirus 1* to *Gammapapillomavirus*
- Assign *Human papillomavirus 63* to *Iotapapillomavirus*
- Assign *Feline domesticus papillomavirus* to *Xipapillomavirus*

Template for Taxonomic Proposal to the ICTV Executive Committee Creating Species in an existing genus

Code[†] 2003.251V.02 To designate the following as species in the genus:

Panillomavirus

belonging to the family[°] : *Panillomaviridae*

See list attached
This list will replace the previous list in the VIIth Report

[†] Assigned by ICTV officers

[°] leave blank if inappropriate or in the case of an unassigned genus

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Old Taxonomic Order

Order	
Family	<i>Papillomaviridae</i>
Genus	<i>Papillomavirus</i>
Type Species	<i>Cottontail rabbit papillomavirus</i>
Species in the Genus	Just a few
Tentative Species in the Genus	
Unassigned Species in the family	

New Taxonomic Order

Order	
Family	<i>Papillomaviridae</i>
Genus	<i>Papillomavirus</i>
Type Species	<i>Cottontail rabbit papillomavirus</i>
Species in the Genus	25
Tentative Species in the Genus	too many to be listed
Unassigned Species in the family	

ICTV-EC comments and response of the SG

This proposal corresponds to the revision of the TaxoProp 2003.224V.01.
The Papillomaviridae SG took in consideration comments made by some EC members and a pairwise distribution study that I made for them. This study is clearly showing that papillomaviruses are clustered in 3 classes; 1- what can be considered like strains and isolates within species, 2- what are species of papillomaviruses, 3- what could be considered like genera of papillomaviruses.
The SG carefully examined this study considering other properties like biology, serology and others and came to the conclusion that the here attached list of species was valid.

C. Fauquet

Species demarcation criteria in the genus

Demarcation criteria for a species:

- L1 gene is the most conserved gene within the genome and has therefore been used worldwide for the identification of new papillomavirus types during the past 15 years. Sequence comparisons between the complete genomes of all papillomaviruses reveal a high diversity between viruses but a distribution similar to that found when comparing the L1 sequences between these viruses (C. Fauquet, personal communication, Fig 1).

- Information on the biological/pathogenic properties for the majority of papillomaviruses is fractional. The available characteristics for the individual species are listed below.

1. *The species within a genus share 55–67% nucleotide identity and*

2. *The strains within a species 67–100% nucleotide identity within the complete L1 ORF.*

A pairwise distribution of all taxa levels in the family are presented in Figure 1. A phylogenetic tree based on the nucleotide identity within the complete L1 ORF is presented in Figure 2. The proposed species are indicated.

Argumentation to justify the designation of new species in the genus

General characteristics:

1. Papillomaviruses are highly host-species- and tissue-restricted. All known members of the human papillomavirus (HPV) group require terminal differentiation for replication and virion production.
2. The genomes of all known members of the *Papillomaviridae* have been sequenced. They contain 9-10 ORFs, labelled E1-E8 and L1-L2. The E1, E2 and L1, L2 ORFs are well conserved among all members of the family. Proteins encoded by the E ORFs, with the possible exception of E4, represent non-structural polypeptides involved in transcription, DNA replication and transformation, whereas those encoded by the L ORFs represent structural proteins.
3. Replication of the viral genome is initiated bi-directionally by specific binding of the E1 and E2 proteins at a unique origin of replication. Except for inefficient replication of HPVs in raft cultures of human keratinocytes or more efficiently in human skin or mucosal heterografts in immunocompromised rodents, HPV replication has not been achieved in tissue culture systems.
4. Serologic analysis of antigenic properties of papillomaviruses is still in an early phase. The L1 protein reveals type-specific domains, the L2 proteins contains group-specific epitopes. The availability of papillomavirus-like particles, resulting from the expression of L1 or L1 and L2 in Baculo-, Vaccinia-, or yeast systems, permits presently a detailed analysis of antigenic characteristics.
5. Papillomavirus types are ubiquitous in their global distribution. They cause benign tumors (warts, papillomas) in their natural host and occasionally in related species. Frequently the infection leads to microlesions, barely or not at all visible without optical aid. Papillomas are induced in the skin and mucous membranes, often at specific sites of the body. Some papillomatous proliferations induced by specific types of papillomaviruses bear a high risk for malignant progression. Specific human cancers (e.g. cervical carcinoma, anal, vulva and penile cancers, specific squamous cell carcinomas of the skin) have been linked to certain types of HPV infection (e.g. HPVs 16 and 18, HPV 5 and 8 and several others).

List of created Species in the genus

Species 1: Type species: *Human papillomavirus 32* (HPV32)

Other papillomavirus types: HPV42.

Species 2: More often found in cutaneous lesions than in the mucosa.

Type species: HPV10

Other papillomavirus types: HPV3, HPV28, HPV29, HPV77, HPV78, HPV94.

Species 3: Contain several larger uncharacterised ORFs within the L1 region.

Type species: HPV61

Other papillomavirus types: HPV72, HPV81, HPV83, HPV84, HPVcand62, HPVcand86, HPVcand87, HPVcand89.

Species 4: Several larger uncharacterised ORFs scattered throughout the genome.

Type species: HPV2

Other papillomavirus types: HPV27, HPV57

Species 5: Found in benign and malignant mucosal lesions.

Type species: HPV 26

Other papillomavirus types: HPV51, HPV69, HPV82.

Species 6: Found in benign and malignant mucosal lesions.

Type species: HPV53

Other papillomavirus types: HPV30, HPV56, HPV66.

Species 7: More frequently found in malignant lesions

Type species: HPV18

Other papillomavirus types: HPV39, HPV45, HPV59, HPV68, HPV70, HPV85.

Species 8: More frequently associated with cutaneous lesions.

Type Species: HPV7

Other papillomaviruses: HPV40, HPV43, HPV91.

Species 9: Mostly associated with malignant mucosal lesions.

Type species: HPV16

Other papillomavirus types: HPV31, HPV33, HPV35, HPV52, HPV58, HPV67

Species 10: Mostly associated with benign mucosal lesions.

Infections by HPV 6 and HPV11 can be distinguished through the respective neutralizing antibodies.

Papillomaviruses isolated from Primates belong to this species.

Type species: HPV6

Other papillomavirus types: HPV11, HPV13, HPV44, HPV74, PcPV (Previously described HPV55 shares 93% identity to HPV 44 and therefore not included here – similarly for the Common chimpanzee papillomavirus sharing 93% nucleotide identity within the L1 ORF with the Pimee chimpanzee papillomavirus).

Species 11: Type species: HPV34

Other papillomavirus types: HPV73

Species 12: Papillomavirus associated with mucosal lesions in Rhesus monkeys

Type species: *Rhesus monkey papillomavirus* (RhPV)

Other papillomavirus types: none

Species 13: Type species: HPV54

Other papillomavirus types: none

Species 14: Type species: HPVcand90

Other papillomavirus types: none

Species 15: Type species: HPV71

Other papillomavirus types: none

Species 16: Papillomaviruses commonly associated with the disease Epidermodysplasia verruciformis.

Type species: HPV5

Other papillomavirus types: HPV8, HPV12, HPV14, HPV19, HPV20, HPV21, HPV25, HPV36, HPV47

Species 17: Papillomaviruses commonly associated with the disease Epidermodysplasia verruciformis.

Type species: HPV9

Other papillomaviruse types: HPV15, HPV17, HPV22, HPV23, HPV37, HPV38, HPV80.

Species 18: Type species: HPV49

Other papillomavirus types: HPV75, HPV76

Species 19: Types species: HPVcand92

Other papillomavirus types: none

Species 20: Histologically distinct homogenous intracytoplasmic inclusion bodies.

Type species: HPV4

Other papillomavirus types: HPV65, HPV95

Species 21: Type species: HPV48

Species 22: Type species: HPV50

Species 23: Type species: HPV60

Species 24: Type species: HPV88

Species 25: E9 ORF within the ELR with transforming properties.

Type species: *European Elk Papillomavirus* (EEPV)

Other papillomavirus types: *Reindeer papillomavirus* (RPV)

Species 26: E9 ORF within the ELR with transforming properties.

Type species: *Deer papillomavirus* (DPV)

Species 27: Type species: *Ovine papillomavirus* type 1 (OvPV1)

Other papillomavirus types: OvPV2

Species 28: The E5 gene within the ELR has transforming properties.

Type species: *Bovine papillomavirus* type 1 (BPV1)

Species 29: Type species: BPV5

Species 30: Type species: *Equus caballus papillomavirus* (EcPV)

Other papillomavirus types: EcPV1

Species 31: Type species: *Psittacus erithacus timneh papillomavirus* (PePV, parrot papillomavirus)

Species 32: Type species: *Fringilla coelebs papillomavirus* (FcPV, chaffinch papillomavirus)

Species 33: Type species: *Mastomys natalensis papillomavirus* (MnPV)

Species 34: Type species: *Human papillomavirus* 1 (HPV1)

Histologically distinct heterogenous intracytoplasmic inclusion bodies

Upper regulatory control (URR) region within the genome is large – 982bp

Species 35: Type species: HPV63

Histologically distinct filamentous intracytoplasmic inclusion bodies.

URR within the genome is 558bp in length

Species 36: Associated with benign mucosal lesions

ELR 1500bp in length

Type species: *Canine oral papillomavirus* (COPV)

Species 37: Associated with benign cutaneous lesions

ELR 1271bp in length

Type species: *Feline domesticus papillomavirus* (FdPV)

Species 38: Type species: *Cottontail rabbit papillomavirus* (CRPV)

High divergence within the E6 and E7 ORFs described for different isolates

Associated with cutaneous lesions

Species 39: Type species: *Rabbit oral papillomavirus* (ROPV)

Associated with mucosal lesions

Species 40: Type species: BPV 3

Other papillomaviruses: BPV4, BPV6

Species 41: Several larger uncharacterised ORFs scattered throughout the genome.

The E2 binding sites in the URR characteristic for other papillomaviruses, are all modified.

Type species: HPV41

Species 42: Does not have an E7 ORF.

Harbors several larger undefined ORFs within the L1 ORF region.

Type species: *Phocoena spinipinnis papillomavirus* (PsPV)

Species 43: No ELR region – overlap between the E2 and L2 ORFs

Type species: *Hamster oral papillomavirus* (HaOPV)

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Annexes:

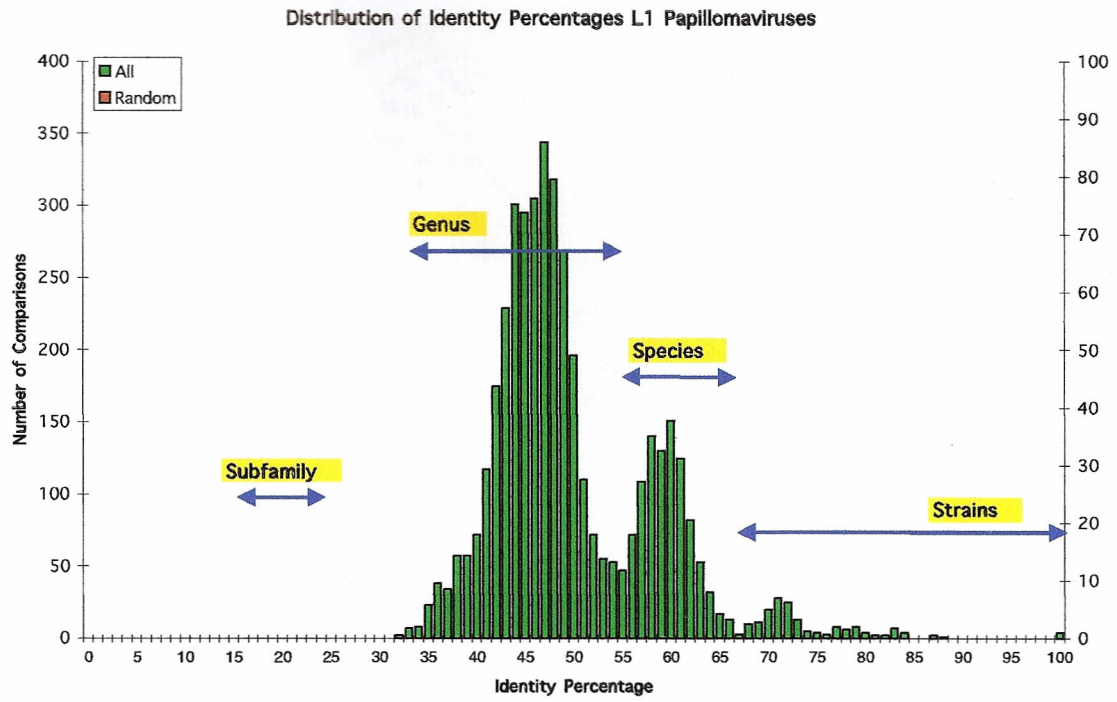


Figure 1: Frequency distribution of Pairwise identity percentages from sequence comparison of L1 nucleotide sequences of papillomaviruses.

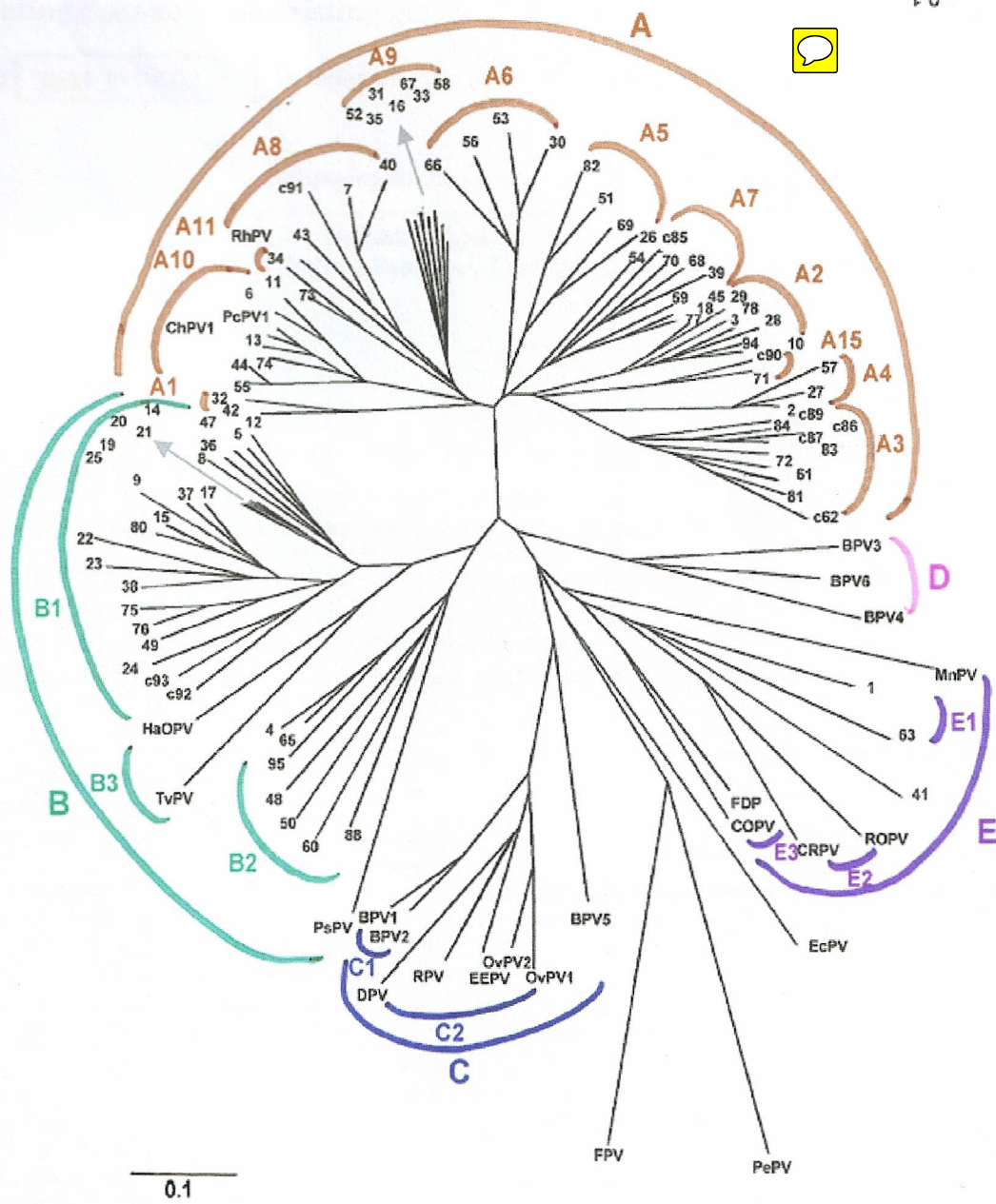


Figure 2: Cladogram of papillomaviruses using the complete L1 nucleotide sequences. Numbers represents HPV isolates, other viruses are indicated by their accepted abbreviation.

**Template for Taxonomic Proposal to the ICTV Executive Committee
To create new Genera in an existing Family**

Code[†] To create new genera in the family*

Code[†] To name the new genus*

Code[†] To designate the species
As the type species of the new genus*

Code[†] To designate the following as species of the new genus*:

Code[†] To designate the following as tentative species in the new genus*:

† Assigned by ICTV officers

* repeat these lines and the corresponding arguments for each genus created in the family

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Old Taxonomic Order

- Order
- Family *Papillomaviridae*
- Genus *Papillomavirus*
- Type Species
- Species in the Genus
- Tentative Species in the Genus
- Unassigned Species in the family

New Taxonomic Order

- Order
- Family *Papillomaviridae*
- Genus *----papillomavirus (re attached list)*
- Type Species *--- Papillomvirus (re attached list)*
- Species in the Genus
- Tentative Species in the Genus
- Unassigned Species in the family

Species demarcation criteria in the genus

The genomes of all known members of the *Papillomaviridae* have been sequenced. They contain 9-10 ORFs, labelled E1-E8 and L1-L2 (Fig.1). The E1, E2 and L1, L2 ORFs are well conserved among all members of the family. Proteins encoded by the E ORFs, with the possible exception of E4, represent non-structural polypeptides involved in transcription, DNA replication and transformation, whereas those encoded by the L ORFs represent structural proteins.

- Although the overall genome organization is conserved within the family (including the early genes E1 and E2 and the late L1 and L2 ORFs), differences exist regarding the characteristics, presence or absence and number of smaller open reading frames (figure 2).

Functional analyses for the majority of these latter genes have not been performed and their characterization is based on conserved sequence elements within genes.

- L1 gene is the most conserved gene within the genome and has therefore been used worldwide for the identification of new papillomavirus types during the past 15 years. Sequence comparisons between the complete genomes of all papillomaviruses reveal a high diversity between viruses but a distribution similar to that found when comparing the L1 sequences between these viruses (C. Fauquet, personal communication).

- As mentioned, information on the biological/pathogenic properties for the majority of papillomaviruses is fractional. The available characteristics for the individual genera are listed below.

1. *The genera listed, all share >23% and <43% nucleotide sequence identity between the complete genome sequence*
2. *The genera listed, all share >30% and <55% nucleotide sequence identity between the L1 ORFs*
3. *The species within a genus share 55-67% nucleotide identity and*
4. *The strains within a species 67-100% nucleotide identity within the complete L1 ORF.*

The representative genome organizations for each genus and type species are presented in Figure 2. A pairwise distribution of all taxa levels in the family are presented in Figure 1. A phylogenetic tree based on the nucleotide identity within the complete L1 ORF is presented in Figure 3. The proposed genera and species are indicated.

ICTV-EC comments and response of the SG

This is a new proposal attempting to build a genus taxonomic level in the *Papillomaviridae* family. There has been a previous attempt in 2000 that was rejected by the EC because built on a small 290nts fragment of the L1 gene. This proposal was offering genera and subfamilies. I have performed a pairwise distribution analysis on the complete genome of 103 papillomaviruses, on the L1 gene and on the 390 fragment previously used in 2000. My conclusion is that the L1 gene reflect very accurately the complete genome but the 390 did not. I also concluded that there were only 3 taxonomic levels at the complete genome and at the L1 gene levels and that is Strains/isolates – Species – Genera. I could not identify a subfamily, level (figure 1).

The SG took this study and looked into the genome organization, the phylogenetic tree and other properties of the papillomaviruses and discovered that my proposal was fitting with the “genus” participation commonly used in the field for 15 years! And they accepted the absence of subfamilies!?

Since papilloma virologists adopted their own “genera” partition, they called them A, B, C, D... and the only names they could considered among a set that I proposed was to replace the A, B, C... by the greek letters I front of the word “papillomavirus”, this is ending up in very long names but they are following the ICTV rules and therefore are acceptable?

Formally each genus should have been presented in a different TaxoProp with a code number for each item, but because of the time pressure, because of the number of genera and because they all follow the same principles for their determination and nomenclature they have been all lumped into this single TaxoProp.

I want also to mention that the ICTV made a mistake twice for this family; 1- in 1999 we discarded all the species of HPV to reduce it to isolates of the same and unique species and that obviously a big mistake, 2- the second time in 2000 because when the SG proposed species, genera and subfamilies, we have not establish a line of communication with the SG to let them understand what our concern was!

Conscious of this situation when I look at the immense diversity of papillomaviruses, I personally re-established the contact with the SG and they came up with the two proposals

Argumentation to choose the type species in the genus

The type species in each genus have been chosen either because they are better know or because they do represent best the genus or because there is only one species in that genus.

List of Genera in the family

List of Genera - each with type species and other species

GENUS ALPHAPAPILLOMAVIRUS:

Papillomaviruses associated with mucosal and cutaneous lesions.

Genome organization conserved containing an E5 ORF within the region separating the early and late genes (ELR, ca. 300-500nt in length).

Species 1: Type species: *Human papillomavirus 32* (HPV32)

Other papillomavirus types: HPV42.

Species 2: More often found in cutaneous lesions than in the mucosa.

Type species: HPV10

Other papillomavirus' types: HPV3, HPV28, HPV29, HPV77, HPV78, HPV94.

Species 3: Contain several larger uncharacterised ORFs within the L1 region.

Type species: HPV61

Other papillomavirus types: HPV72, HPV81, HPV83, HPV84, HPVcand62, HPVcand86, HPVcand87, HPVcand89.

Species 4: Several larger uncharacterised ORFs scattered throughout the genome.

Type species: HPV2

Other papillomavirus types: HPV27, HPV57

Species 5: Found in benign and malignant mucosal lesions.

Type species: HPV 26

Other papillomavirus types: HPV51, HPV69, HPV82.

Species 6: Found in benign and malignant mucosal lesions.

Type species:-HPV53.

Other papillomavirus types: HPV30, HPV56, HPV66.

Species 7: More frequently found in malignant lesions

Type species: HPV18.

Other papillomavirus types: HPV39, HPV45, HPV59, HPV68, HPV70, HPV85.

Species 8: More frequently associated with cutaneous lesions.

Type Species: HPV7

Other papillomaviruses: HPV40, HPV43, HPV91.

Species 9: Mostly associated with malignant mucosal lesions.

Type species: HPV16

Other papillomavirus types: HPV31, HPV33, HPV35, HPV52, HPV58, HPV67

Species 10: Mostly associated with benign mucosal lesions.

Infections by HPV 6 and HPV 11 can be distinguished through the respective neutralizing antibodies.

Papillomaviruses isolated from Primates belong to this species.

Type species: HPV6

Other papillomavirus types: HPV 11 , HPV13, HPV44, HPV74, PcPV (previously described HPV55 shares 93% homology to HPV 44 and therefore not included here - similarly for the Common chimpanzee papillomavirus sharing 93% nucleotide homology within the L1 ORF with the Pigmea chimpanzee papillomavirus).

Species 11: Type species: HPV34

Other papillomavirus types: HPV73

Species 12: Papilloma virus associated with mucosal lesions in Rhesus monkeys

Type species: *Rhesus monkey papillomavirus* (RhPV)

Other papillomavirus types: none

Species 13: Type species: HPV54

Other papilloma virus types: none

Species 14: Type species: HPVcand90

Other papilloma virus types: none

Species 15: Type species: HPV71

Other papillomavirus types: none

List of Genera - each with type species and other species

GENUS BETAPAPILLOMAVIRUS:

Papillomaviruses associated mainly with cutaneous lesions. Infections often activated during immunosuppression. The ELR does not harbor an E5 ORF and is generally less than 100nt in length.

Species 1:

Papillomaviruses-commonly associated with the disease Epidermodysplasia verruciformis.

Type species: HPV5

Other papillomavirus types: HPV8, HPV12, HPV14, HPV19, HPV20, HPV21, HPV25, HPV36, HPV47

Species 2:

Papillomaviruses commonly associated with the disease Epidermodysplasia verruciformis.

Type species: HPV9

Other papillomavirus types: HPV15, HPV17, HPV22, HPV23, HPV37, HPV38, HPV80.

Species 3:

Type species: HPV49

Other papillomavirus types: HPV75, HPV76

Species 4:

Type species: HPVcand92

Other papilloma virus types: none

GENUS GAMMAPAPILLOMAVIRUS:

Histologically distinct homogenous intracytoplasmic inclusion bodies.

Species 1:

Type species: HPV4

Other papillomavirus types: HPV65, HPV95

Species 2:

Type species: HPV48

Species 3:

Type species; HPV50

Species 4:

Type species: HPV60

Species 5:

Type species: HPV88

List of Genera - each with type species and other species

GENUS DELTAPAPILLOMAVIRUS:

Induces fibropapillomas in respective host.

Species 1:

E9 ORF within the ELR with transforming properties.

Type species: *European Elk papillomavirus* (PEPV)

Other papillomavirus types: *Reindeer papillomavirus* (RPV)

Species 2:

E9 ORF within the ELR with transforming properties.

Type species: *Deer papillomavirus* (DPV)

Species 3:

Type species: *Ovine papillomavirus* type 1 (OvPV1)

Other papilloma virus types: OvPV1

Species 4:

The E5 gene within the ELR has transforming properties.

Type species: *Bovine papilloma virus* type 1 (BPV1) \

Other papillomavirus types: BPV2

GENUS EPSILONPAPILLOMAVIRUS:

Species 1:

Type species: BPV5

GENUS ZETAPAPILLOMAVIRUS:

Harbors an undefined ORF within the L2 ORF region.

Species 1:

Type species: *Equus caballus papilloma virus* (EcPV)

GENUS THETAPAPILLOMAVIRUS:

Avian papillomavirus

Contains neither an E4 nor an E5 ORF.

Does not contain a typical E6 ORF, but an "ancestral" E7 ORF with partial E6 characteristics.

Harbors an undefined X ORF distal to the E7 ORF.

Species 1:

Type species: *Psittacus erithacus timneh papillomavirus* (PePV, parrot papillomavirus)

GENUS ETAPAPILLOMAVIRUS:

Avian papillomavirus

Contains neither an E4 nor an E5 ORF.

Does not contain a typical E6 ORF, but an "ancestral" E7 ORF with partial E6 characteristics.

Harbors an undefined X ORF distal to the E7 ORF.

Species 1:

Type species: *Fringilla coelebs papilloma virus* (FcPV chaffinch papillomavirus)

GENUS IOTAPAPILLOMAVIRUS:

Rodent papillomavirus

Species 1:

Type species: *Mastomys natalensis papillomavirus* (MnPV)

List of Genera - each with type species and other species

GENUS MUPAPILLOMAVIRUS:

Human papillomaviruses

Associated with benign cutaneous lesions.

Species 1:

Type species: *Human papilloma virus 1* (HPV1)

Histologically distinct heterogenous intracytoplasmic inclusion bodies

Upper regulatory control (URR) region within the genome is large - 982bp

Species 2:

Type species: HPV63

Histologically distinct filamentous intracytoplasmic inclusion bodies.

URR within the genome is 558bp in length

GENUS LAMBDA PAPILOMAVIRUS:

The ELR within the genome is exceptionally large.

Species 1:

Associated with benign mucosal lesions

ELR 1500bp in length

Type species: *Canine oral papilloma virus* (COPV)

Species 2:

Associated with benign cutaneous lesions

ELR 1271bp in length

Type species: *Feline domesticus papillomavirus* (FdPV)

GENUS KAPPAPAPILLOMA VIRUS:

Isolated from rabbits

E6 ORF is larger than in other papillomaviruses

Harbors an uncharacterised E8 ORF within the E6 region.

Species 1:

Type species: *Cottontail rabbit papillomavirus* (CRPV)

High divergence within the E6 and E7 ORFs described for different isolates

Associated with cutaneous lesions

Species 2:

Type species: *Rabbit oral papilloma virus* (ROPV)

Associated with mucosal lesions

List of Genera - each with type species and other species

GENUS XIPAPILLOMAVIRUS:

Induces papillomas in host

Does not harbor a characteristic E6 ORF

Species 1:

Type species: BPV 3

Other papillomaviruses: BPV4, BPV6

GENUS NUPAPILLOMA VIRUS:

Human papillomavirus

Species 1:

Several larger uncharacterised ORFs scattered throughout the genome.

The E2 binding sites in the URR characteristic for other papillomaviruses, are all modified.

Type species: HPV41

GENUS OMICRONPAPILLOMAVIRUS:

Isolated from crustaceans

Species 1:

Does not have an E7 ORF.

Harbors several larger undefined ORFs within the L1 ORF region.

Type species: *Phocoena spinipinnis papillomavirus* (PsPV)

GENUS PIPAPILLOMAVIRUS:

Isolated from hamsters

Species 1:

No ELR region - overlap between the E2 and L2 ORFs

Type species: *Hamster oral papillomavirus*

Origin of the proposed genera names

This nomenclature has been applied by those in the field since it was published during the mid 90's. It is already present in many publications in the Alphabet form (A, B, C...) A further modification other than the greek alphabet will cause tremendous confusion between past and future publications.

A	α	alpha	a	"father"
B	β	beta	b	
Γ	γ	gamma	g	
Δ	δ	delta	d	
E	ε	epsilon	e	"end"
Z	ζ	zêta	z	
H	η	êta	ê	"hey"
Θ	θ	thêta	th	"thick"
I	ι	iota	i	"it"
K	κ	kappa	k	
Λ	λ	lamda	l	
M	μ	mu	m	
N	ν	nu	n	
Ξ	ξ	xi	ks	"box"
O	ο	omikron	o	"off"
Π	π	pi	p	
P	ρ	rho	r	
Σ	σ, ς	sigma	s	"say"
T	τ	tau	t	
Υ	υ	upsilon	u	"put"
Φ	φ	phi	f	
X	χ	chi	ch	"Bach"
Ψ	ψ	psi	ps	
Ω	ω	omega	ô	"grow"

Figure 2: genome organization of the **proposed genera**

