

The International Committee on Taxonomy of Viruses

Taxonomy Proposal Form, 2024

**Part 1a: Details of taxonomy proposals**

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| **Title:** | Establish 4 new genera, 70 new species and abolish one genus in the family *Anelloviridae* | |
| **Code assigned:** | 2024.009D.N.v1.Anelloviridae\_4ngen\_70nsp |

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| **Author(s), affiliation and email address(es):** | | | |
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**Part 1b: Taxonomy Proposal Submission**

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| **ICTV Subcommittee:** | | | |
| Animal DNA Viruses and Retroviruses | **X** | Bacterial viruses |  |
| Animal minus-strand and dsRNA viruses |  | Fungal and protist viruses |  |
| Animal positive-strand RNA viruses |  | Plant viruses |  |
| Archaeal viruses |  | General - |  |

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| **List the ICTV Study Group(s) that have seen or have been involved in creating this proposal:** |
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| **Optional – complete only if formally voted on by an ICTV Study Group:** | | | |
| **Study Group** | **Number of members** | | |
| **Votes in support** | **Votes against** | **No vote** |
| Anelloviridae study group | 6 | 0 | 0 |
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| **Submission date:** | 14/06/2024 |

**Part 1c: Feedback from ICTV Executive Committee (EC) meeting**

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| **Executive Committee Meeting Decision code:** | **X** |
| A – Accept |  |
| Ac – Accept subject to revision by relevant subcommittee chair. No further vote required |  |
| U – Accept without revision but with re-evaluation and email vote by the EC |  |
| Uc – Accept subject to revision and re-evaluation and email vote by the EC |  |
| Ud – Deferred to the next EC meeting, with an invitation to revise based on EC comments |  |
| J - Reject |  |
| W - Withdrawn |  |

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| **Comments from the Executive Committee:** |
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**Part 1d: Revised Taxonomy Proposal Submission**

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| **Response of proposer:** |
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| **Revision date:** | DD/MM/YYYY |

**Part 3:** **TAXONOMIC PROPOSAL**

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| **Name of accompanying Excel module:** |
| 2024.009D.N.v1.Anelloviridae\_4ngen\_70nsp.xlsx |

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| **Taxonomic changes proposed:** | | | |
| Establish new taxon | **X** | Split taxon |  |
| Abolish taxon |  | Merge taxon |  |
| Move taxon |  | Promote taxon |  |
| Rename taxon |  | Demote taxon |  |
| Move and rename | **X** |

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| **Is any taxon name used here derived from that of a living person:** | | **N** |
| **Taxon name** | **Person from whom the name is derived** | **Attached X** |
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| **Abstract of Taxonomy Proposal:** |
| *Taxonomic rank(s) affected*:  New genera (n=4) and species (n=70).  *Description of current taxonomy*:  The family *Anelloviridae* currently comprises of 34 genera and 173 species [1]. Over the last few years a large number diverse of anelloviruses have been identified in various animals. Here we update the current anellovirus taxonomy by undertaking an analysis of anelloviruses whose full genome sequences have been determined. Classification is based on the species demarcation criteria of 69% ORF1 nucleotide pairwise identity and phylogenetic analyses [1].  *Proposed* *taxonomic change(s):*  Based on our analyses we propose to establish 70 new species to accommodate the unclassified anelloviruses. Further we propose the establishment of 4 new genera.  *Justification*:  These changes are based on the species demarcation criteria of 69% ORF1 nucleotide pairwise identity and updated phylogenetic analyses of the ORF1 protein sequences. |

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| * **Text of Taxonomy proposal:** |
| *Taxonomic rank(s) affected*:  New genera (n=3) genus and species (n=70).  *Description of current taxonomy*:  Anelloviruses are circular negative sense single-stranded DNA viruses with genomes ranging in size from 1.6-3.9 kb. Anelloviruses encode at least one large and typically 2-3 smaller open reading frames. The *Anelloviridae* family is currently comprised of 173 species that fall into 34 genera:   |  | | --- | | 1. *Aleptorquevirus* | | 1. *Alphatorquevirus* | | 1. *Betatorquevirus* | | 1. *Chitorquevirus* | | 1. *Dalettorquevirus* | | 1. *Deltatorquevirus* | | 1. *Epsilontorquevirus* | | 1. *Etatorquevirus* | | 1. *Gammatorquevirus* | | 1. *Gimeltorquevirus* | | 1. *Gyrovirus* | | 1. *Hetorquevirus* | | 1. *Iotatorquevirus* | | 1. *Kappatorquevirus* | | 1. *Lambdatorquevirus* | | 1. *Lamedtorquevirus* | | 1. *Memtorquevirus* | | 1. *Mutorquevirus* | | 1. *Nutorquevirus* | | 1. *Omegatorquevirus* | | 1. *Omicrontorquevirus* | | 1. *Pitorquevirus* | | 1. *Psitorquevirus* | | 1. *Rhotorquevirus* | | 1. *Samektorquevirus* | | 1. *Sigmatorquevirus* | | 1. *Tettorquevirus* | | 1. *Thetatorquevirus* | | 1. *Upsilontorquevirus* | | 1. *Wawtorquevirus* | | 1. *Xitorquevirus* | | 1. *Yodtorquevirus* | | 1. *Zayintorquevirus* | | 1. *Zetatorquevirus* |   Classification guidelines for anelloviruses is based on the species demarcation criteria of 69% ORF1 nucleotide pairwise identity threshold coupled with phylogenetic analyses [1].  *Proposed* *taxonomic change(s)*:  Here we undertook an analyses of unclassifiedfull anellovirus genome sequences by compiling a dataset of the ORF1 nucleotide sequences from these genomes together with those from representative anellovirus species from GenBank. A pairwise identity analyses of this ORF1 nucleotide dataset (n=243) was undertaken using SDT1.3 [2] (Figure 1). Further, since the pairwise identity analysis alone does not give a clear demarcation threshold for genus a phylogeny-based approach was taken using the ORF1 amino acid sequences of the representative member of each species. This dataset was then aligned using MAFFT [3], trimmed with TrimAL v 1.4.1 [4] using the 0.2 gap option and a maximum-likelihood tree was constructed with PhyML 3.0 [5] and the best fit substitution model LG+F+G4 (Figure 2).  Based on this phylogenetic analysis (figure 1), 4 additional genera (Ayintorquevirus, Sadetorquevirus Petorquevirus and Qoptorquevrius) need to be established, see table 1 for summary.  The *A*yintorquevirus genus will be comprises of species Ayintorquevirusursid28.  The Sadetorquevirus and Petorquevirusgenera are being proposed to be established for two groups of anelloviruses that in the updated phylogeny sit outside their previously assigned genus grouping and therefore will be moved into a new genus. For the proposed Sadetorquevirusgenus this will encompass the anellovirus species previously known as Hetorquevirus hominid8 and Hetorquevirus hominid7which are supported phylogenetically in a new genus*,* and for the  Petorquevirus genus this will encompass the anellovirus species that are being moved and renamed to (species *Thetatorquevirus ixodi1*, *Thetatorquevirus canid1*, *Thetatorquevirus viver4*) Petorquevirus ixodi1, Petorquevirus canid1 and Petorquevirus viver4which are also phylogenetically supported.  The species *Dalettorquevirus ursid6* is being moved and rename to Upsilontorquevirus ursid6 in the genus *Upsilontorquevirus* as this better supports its classification with strong phylogenetic support. (Table 1).  As a result of this *Dalettorquevirus* no longer has a species assigned to it and therefore we propose the new species, *Dalettorquevirus ursid28,* be assigned to this genus (we are repurposing the genus name) (Table 1). As a result of this *Dalettorquevirus* will be abolished to avoid future confusion.  The newly proposed genus Qoptorquevrius will comprised of 69 anelloviruses from various Delphinidae species.  Based on the species demarcation criteria of 69% ORF1 nucleotide pairwise identity 70 new species have been established. Distribution plot of pairwise identities for representative species supports that this 69% threshold has been maintained (Figure 1).  *Demarcation criteria:*  Classification guidelines for anelloviruses is based on the species demarcation criteria cutoff of 69% ORF1 nucleotide pairwise identity and phylogenetic analyses [1].  *Justification*:  The proposed changes are in accordance with the stipulated anellovirus classification guidelines stated above. |

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| **References:** |
| 1. Varsani, A.; Kraberger, S.; Opriessnig, T.; Maggi, F.; Celer, V.; Okamoto, H.; Biagini, P., Anelloviridae taxonomy update 2023. *Arch Virol* **2023,** 168, (11), 277.  2. Muhire, B. M.; Varsani, A.; Martin, D. P., SDT: a virus classification tool based on pairwise sequence alignment and identity calculation. *PLoS One* **2014,** 9, (9), e108277.  3. Katoh, K.; Standley, D. M., MAFFT multiple sequence alignment software version 7: improvements in performance and usability. *Molecular biology and evolution* **2013,** 30, (4), 772-780.  4. Capella-Gutierrez, S.; Silla-Martinez, J. M.; Gabaldon, T., trimAl: a tool for automated alignment trimming in large-scale phylogenetic analyses. *Bioinformatics* **2009,** 25, (15), 1972-3.  5. Guindon, S.; Dufayard, J.-F.; Lefort, V.; Anisimova, M.; Hordijk, W.; Gascuel, O., New algorithms and methods to estimate maximum-likelihood phylogenies: assessing the performance of PhyML 3.0. *Syst. Biol.* **2010,** 59, (3), 307-321. |

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| **Tables, Figures:** |

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A screen shot of a graph

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**Figure 1:** Percentage pairwise identity distribution plot of ORF1 sequence for representative anellovirus species (n=243).

**A screenshot of a computer

Description automatically generated**

**Figure 2:** Maximum likelihood phylogenetic tree of the ORF1 amino acid sequences of representative anelloviruses species. The sequences of gyroviruses were used to root the phylogeny. Those in blue denote newly proposed genera.

**Table 1:** information of updated taxonomy and change that is proposed.

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| **Genus** | **Species name** | **Accession** | **Changes** | **Exemplar**  **virus name** | **Exemplar**  **isolate**  **designation** |
| *Qoptorquevirus* | - | - | New genus |  |  |
|  | *Qoptorquevirus delphin18* | PP790224 | New species | Torque teno Delphinidae virus 48 | USW2\_C1 |
|  | *Qoptorquevirus delphin14* | PP790225 | New species | Torque teno Delphinidae virus 1 | USW2\_C2 |
|  | *Qoptorquevirus delphin22* | PP790227 | New species | Torque teno Delphinidae virus 51 | USW5\_C1 |
|  | *Qoptorquevirus delphin21* | PP790229 | New species | Torque teno Delphinidae virus 52 | USW7\_C1 |
|  | *Qoptorquevirus delphin19* | PP790230 | New species | Torque teno Delphinidae virus 53 | USW7\_C2 |
|  | *Qoptorquevirus delphin16* | PP790231 | New species | Torque teno Delphinidae virus 54 | USW7\_C3 |
|  | *Qoptorquevirus delphin20* | PP790232 | New species | Torque teno Delphinidae virus 50 | USW8\_C1 |
|  | *Qoptorquevirus delphin3* | PP790249 | New species | Torque teno Delphinidae virus 40 | USW16\_C2 |
|  | *Qoptorquevirus delphin6* | PP790253 | New species | Torque teno Delphinidae virus 30 | USW18\_A1 |
|  | *Qoptorquevirus delphin4* | PP790254 | New species | Torque teno Delphinidae virus 44 | USW18\_C1 |
|  | *Qoptorquevirus delphin2* | PP790255 | New species | Torque teno Delphinidae virus 7 | USW18\_C2 |
|  | *Qoptorquevirus delphin1* | PP790261 | New species | Torque teno Delphinidae virus 45 | USW25\_C1 |
|  | *Qoptorquevirus delphin13* | PP790266 | New species | Torque teno Delphinidae virus 2 | USW28\_C1 |
|  | *Qoptorquevirus delphin8* | PP790267 | New species | Torque teno Delphinidae virus 23 | USW29\_C1 |
|  | *Qoptorquevirus delphin7* | PP790268 | New species | Torque teno Delphinidae virus 31 | USW30\_A1 |
|  | *Qoptorquevirus delphin11* | PP790269 | New species | Torque teno Delphinidae virus 4 | USW30\_C1 |
|  | *Qoptorquevirus delphin17* | PP790271 | New species | Torque teno Delphinidae virus 56 | USW35\_C1 |
|  | *Qoptorquevirus delphin15* | PP790272 | New species | Torque teno Delphinidae virus 55 | USW36\_C1 |
|  | *Qoptorquevirus delphin10* | PP790279 | New species | Torque teno Delphinidae virus 6 | USW44\_A1 |
|  | *Qoptorquevirus delphin12* | PP790288 | New species | Torque teno Delphinidae virus 3 | USW50\_C2 |
|  | *Qoptorquevirus delphin9* | PP790291 | New species | Torque teno Delphinidae virus 5 | USW54\_A1 |
|  | *Qoptorquevirus delphin5* | PP790292 | New species | Torque teno Delphinidae virus 29 | USW55\_A1 |
| *Etatorquevirus* | *Etatorquevirus felid28* | MT538050 | New species | Torque teno felis virus LSF9\_anello5 | LSF9\_anello5 |
|  | *Etatorquevirus felid25* | MT538051 | New species | Torque teno felis virus LSF12\_anello3 | LSF12\_anello3 |
|  | *Etatorquevirus felid26* | MT538062 | New species | Torque teno felis virus LSF30\_anello7 | LSF30\_anello7 |
|  | *Etatorquevirus felid17* | MT538083 | New species | Torque teno felis virus LSF125\_anello3 | LSF125\_anello3 |
|  | *Etatorquevirus felid21* | MT538084 | New species | Torque teno felis virus LSF125\_anello4 | LSF125\_anello4 |
|  | *Etatorquevirus felid27* | MT538089 | New species | Torque teno felis virus LSF129\_anello1 | LSF129\_anello1 |
|  | *Etatorquevirus felid24* | MT538121 | New species | Torque teno felis virus LSF\_162\_anello1 | LSF\_162\_anello1 |
|  | *Etatorquevirus felid18* | MT538124 | New species | Torque teno felis virus LSF\_170\_anello1 | LSF\_170\_anello1 |
|  | *Etatorquevirus felid22* | MT538131 | New species | Torque teno felis virus UoA1\_anello4 | UoA1\_anello4 |
|  | *Etatorquevirus felid19* | MT538141 | New species | Torque teno felis virus x262\_anello3 | x262\_anello3 |
|  | *Etatorquevirus felid20* | MT538175 | New species | Torque teno felis virus x1523\_anello3 | x1523\_anello3 |
|  | *Etatorquevirus felid35* | ON556614 | New species | Torque teno felis virus cov\_24.72173 | cov\_24.72173 |
| *Gimeltorquevirus* | *Gimeltorquevirus ursid26* | MZ357148 | New species | Giant panda anellovirus Gpb08AV02-5 | Gpb08AV02-5 |
|  | *Gimeltorquevirus ursid27* | OR779982 | New species | Torque teno virus UTUChV/2022 | UTUChV/2022 |
| *Gyrovirus* | *Gyrovirus chauna1* | MH016740 | New species | Gyrovirus 10 | GyV10.1 |
|  | *Gyrovirus anas1* | MT318123 | New species | Gyrovirus 9 | VC1 |
|  | *Gyrovirus anas2* | MT318125 | New species | Avian gyrovirus 13 | VC3 |
| *Iotatorquevirus* | *Iotatorquevirus ursid17* | OP129719 | New species | Torque teno virus GB3\_pi2 | TTV\_GB3\_pi2 |
| *Pitorquevirus* | *Pitorquevirus ursid19* | ON638692 | New species | Anelloviridae sp. gpa-20 | gpa-20 |
|  | *Pitorquevirus ursid25* | OP629190 | New species | Grizzly bear anellovirus 1 | Gbear3\_525 |
|  | *Pitorquevirus ursid21* | OP629191 | New species | Grizzly bear anellovirus 2 | Gbear3\_520 |
|  | *Pitorquevirus ursid23* | OP629192 | New species | Grizzly bear anellovirus 3 | Gbear3\_519 |
|  | *Pitorquevirus ursid24* | OP629193 | New species | Grizzly bear anellovirus 4 | Gbear3\_491 |
|  | *Pitorquevirus ursid20* | OP629194 | New species | Grizzly bear anellovirus 5 | Gbear3\_460 |
|  | *Pitorquevirus ursid18* | OP629195 | New species | Grizzly bear anellovirus 6 | Gbear3\_432 |
|  | *Pitorquevirus ursid22* | OP629196 | New species | Grizzly bear anellovirus 7 | Gbear3\_354 |
|  | *Pitorquevirus ursid29* | OP629197 | New species | Grizzly bear anellovirus 8 | Gbear3\_351 |
| *Rhotorquevirus* | *Rhotorquevirus rodfelid1* | MT538139 | New species | Torque teno felis virus UoA20\_55 | UoA20\_55 |
| *Thetatorquevirus* | *Thetatorquevirus ursid14* | MZ357157 | New species | Giant panda anellovirus Gpb09AV05-5 | Gpb09AV05-5 |
|  | *Thetatorquevirus ursid15* | MZ357160 | New species | Giant panda anellovirus Gpb10AV02-5 | Gpb10AV02-5 |
| *Omicrontorquevirus* | *Omicrontorquevirus ursid16* | OP629198 | New species | Grizzly bear anellovirus 9 | Gbear3\_304 |
| *Zayintorquevirus* | *Zayintorquevirus felid31* | MT537977 | New species | Torque teno felis virus CCB28\_anello1 | CCB28\_anello1 |
|  | *Zayintorquevirus felid8* | MT537978 | New species | Torque teno felis virus CCB29\_anello1 | CCB29\_anello1 |
|  | *Zayintorquevirus felid32* | MT537980 | New species | Torque teno felis virus CCB36\_anello1 | CCB36\_anello1 |
|  | *Zayintorquevirus felid7* | MT537993 | New species | Torque teno felis virus CCB53\_anello1 | CCB53\_anello1 |
|  | *Zayintorquevirus felid11* | MT537996 | New species | Torque teno felis virus CCB57\_anello1 | CCB57\_anello1 |
|  | *Zayintorquevirus felid9* | MT537999 | New species | Torque teno felis virus CCB61\_anello1 | CCB61\_anello1 |
|  | *Zayintorquevirus felid12* | MT538011 | New species | Torque teno felis virus CLB10\_LB135 | CLB10\_LB135 |
|  | *Zayintorquevirus felid16* | MT538013 | New species | Torque teno felis virus CLB11\_LB94 | CLB11\_LB94 |
|  | *Zayintorquevirus felid14* | MT538017 | New species | Torque teno felis virus CLB13\_LB98 | CLB13\_LB98 |
|  | *Zayintorquevirus felid10* | MT538020 | New species | Torque teno felis virus CLB16\_LB44 | CLB16\_LB44 |
|  | *Zayintorquevirus felid13* | MT538033 | New species | Torque teno felis virus CLB21\_LB131 | CLB21\_LB131 |
|  | *Zayintorquevirus felid15* | MT538127 | New species | Torque teno felis virus MAF5\_LB135 | MAF5\_LB135 |
|  | *Zayintorquevirus felid30* | ON556610 | New species | Torque teno felis virus cov\_8.67698 | cov\_8.67698 |
|  | *Zayintorquevirus felid33* | ON556611 | New species | Torque teno felis virus cov\_62.09776 | cov\_62.09776 |
|  | *Zayintorquevirus felid29* | ON556612 | New species | Torque teno felis virus cov\_16.13602 | cov\_16.13602 |
|  | *Zayintorquevirus felid34* | ON556613 | New species | Torque teno felis virus cov\_16.84873 | cov\_16.84873 |
| *Ayintorquevirus* |  |  | New Genus |  |  |
|  | *Ayintorquevirus ursid28* | OP629199 | New species | Grizzly bear anellovirus 10 | GBear3\_496 |
| *Sadetorquevirus* | *-* | - | New genus |  |  |
|  | *Sadetorquevirus hominid8* | MN769236 | Move, rename | TTV-like mini virus SAfiA-349-9 | SAfiA-349-9 |
|  | *Sadetorquevirus hominid7* | MN771248 | Move, rename | TTV-like mini virus SAfiA-410-3 | SAfiA-410-3 |
| *Petorquevirus* | *-* | - | New genus |  |  |
|  | *Petorquevirus ixodi1* | MF173068 | Move, rename | Tick associated torque teno virus tick24\_1 | tick24\_1 |
|  | *Petorquevirus canid1* | AB076002 | Move, rename | Torque teno canis virus Cf-TTV10 | Cf-TTV10 |
|  | *Petorquevirus viver4* | LC387543 | Move, rename | Paguma larvata torque teno virus Pl-TTV9-2 | Pl-TTV9-2 |
| *Upsilontorquevirus* | *Upsilontorquevirus ursid6* | MF327539 | Move, rename | Giant panda anellovirus gpan20793 | gpan20793 |
| *Dalettorquevirus* |  |  | Abolish genus |  |  |

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