

**Part 1:** **TITLE, AUTHORS, APPROVALS, etc**

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| **Code assigned:** | ***2023.025D*** |  |
| **Short title:** Establishing a new order *Saturnivirales*, two new families (*Kanorauviridae* and *Mahapunaviridae*) and associated genera and species in the class *Arfiviricetes* (phylum *Cressdnaviricota*) | | |
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**List the ICTV Study Group(s) that have seen this proposal**

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**ICTV Study Group comments and response of proposer**

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**ICTV Study Group votes on proposal**

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| **Study Group** | **Number of members** | | |
| **Votes support** | **Votes against** | **No vote** |
|  |  |  |  |
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**Authority to use the name of a living person**

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| --- | --- |
| **Is any taxon name used here derived from that of a living person (Y/N)** | N |

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| --- | --- | --- |
| **Taxon name** | **Person from whom the name is derived** | **Permission attached (Y/N)** |
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**Submission dates**

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| --- | --- |
| Date first submitted to SC Chair | 14 July 2023 |
| Date of this revision (if different to above) | 5 Oct 2023 |

**ICTV-EC comments and response of the proposer**

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| The proposal was deemed acceptable in the form presented at the EC meeting. |

**Part 2:** **NON-TAXONOMIC PROPOSAL**

**Text of proposal**

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

**Name of accompanying Excel module**

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| 2023.025D.N.v2.Saturnivirales\_1no\_2nf\_35ng\_120nsp.xlsx |

**Abstract**

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| We propose to establish the order *Saturnivirales* in the class *Arfiviricetes* (phylum *Cressdnaviricota*), which includes the families *Kanorauviridae* and *Mahapunavirida*. In the family *Kanorauviridae* we propose 24 genera and 89 species, whereas in *Mahapunaviridae,* we propose 11 genera and 31 species. |

**Text of proposal**

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| |  | | --- | | We propose establishing a new order, *Saturnivirales,* in the class *Arfiviricetes* (phylum *Cressdnaviricota*).  The order *Saturnivirales* is named after planet Saturn, which is also known as the Ringed Planet due to its pronounced and complex ring system.  The family name *Kanorauviridae* is derived from Kanorau meaning to be diverse in Māori.  In this family, we establish 24 genera and 80 species.  The family name *Mahapunaviridae* is derived from **maha puna** meaning many sources in Māori. In this family, we establish 11 genera and 31 species.  **Genus and species demarcation**  We undertook comparative genomics and phylogenetic analyses of the Rep proteins of members of this group to determine their relationships. Genera were delineated based on phylogenetic analyses coupled with pairwise identities and also the genome organization relative to the *rep* open reading frame (Figures 2 - 5).  For species demarcation, we used a 78% pairwise nucleotide genome-wide sequence identity which is similar to that used for other cressdnaviruses [1-3].  **Genera for *Kanorauviridae***  Etymology of genus names   1. *Sakkuthvirus: named after Sak′kuth, a synonym of the star-god Saturn* 2. *Kaiwanvirus: named after Kai′wan, a synonym of the star-god Saturn* 3. *Kajamanuvirus: named after Kajamānu, the ancient Mesopotamian name for the planet Saturn* 4. *Sagusvirus: named after Lubat-saguš, the ancient Mesopotamian name for the planet Saturn* 5. *Shabtayvirus: named after Shabtay, the current Hebrew name of Saturn* 6. *Chiunvirus: named after Chiun, a name used in the Bible (Amos 5:26) to refer to Saturn* 7. *Doseivirus: named after 土星 (Dosei), meaning Saturn in Japanese* 8. *Shanivirus: named after Shani (Sanskrit: शनि, Śani), the divine personification of the planet Saturn in Hinduism* 9. *Phainonvirus: named after Phainon (Φαίνων) for Saturn in ancient Greek* 10. *Sickelvirus: named after* sickel*, a symbol of Saturn, as Saturn was the god of seed-sowing and also of time.* 11. *Scythevirus: named after* scythe*, a symbol of Saturn, as Saturn was the god of seed-sowing and also of time.* 12. *Ninurtavirus: named after Ninurta, Sumerian and Babylonian name for the planet Saturn* 13. *Sanivirus: named after Sani, Sanskrit name for the planet Saturn* 14. *Saothovirus: named after Sao Tho, Vietnamese name for Saturn* 15. *Chinseivirus: named after Chinsei, an older Japanese name for Saturn* 16. *Sanchirviurs: named after sanchir garig, Mongolian name for saturn* 17. *Kronovirus: named after Kronos, equivalent of Saturn in Greek mythology* 18. *Zohali: named after Zohali for Saturn in Swahili* 19. *Raagevirus: named after Raage for Saturn in Somali* 20. *Seetinvirus: named after Séetin for Saturn in Navajo* 21. *Savurvirus: named after savur for Saturn in Kashmiri (Arabic script)* 22. *Tuxingvirus: named after 土星 (Tǔxīng) for Saturn in Chinese (Traditional and Simplified)* 23. *Sadornvirus: named after Sadorn for Saturn in Breton* 24. *Zuhalvirus: named after zuḥal for Saturn in Arabic*   Etymology of species epithets   1. *acrenis: Amphibola crenata* 2. *airbis: airborne particulate matter* 3. *auroris: Phoenicurus auroreus* 4. *batchis: bat china* 5. *bortici: airborne particulate matter* 6. *bowris: Rainbow Spring* 7. *brolerae: Brassica oleracea var. gongylodes* 8. *chesapis: Chesapeake Bay* 9. *crassaminis: after crassaminis, Latin for sediment, source of origin* 10. *crownis: red-crowned crane* 11. *cruti: crucian tissue* 12. *cryonitae: Cryoconite holes* 13. *culiziae: Musculium novaezelandiae* 14. *dianchis: Freshwater lake (Dianchi) sample* 15. *duliaris: Procordulia grayi* 16. *floridaense: reclaimed water; USA: Southwest Florida* 17. *gruidis: Gruidae* 18. *grujae: Grus japonensis* 19. *hydris: Hydrochoerus hydrochaeris* 20. *jaringis: Jackson Spring* 21. *lawatis: Lake water sample* 22. *libraris: library preparation reagents* 23. *lophus: Rhinolophus hipposideros* 24. *manatis: Manatee Spring* 25. *maramis: Mareca americana* 26. *maringis: Manatee Spring* 27. *melani: Ailuropoda melanoleuca* 28. *mintis: minnow tissue* 29. *monetis: Palaemonetes kadiakensis* 30. *moutis: mouse tissue* 31. *muliumi: Austrosimulium australense* 32. *musmis: Mus musculus* 33. *napperis: red snapper* 34. *natringis: Manatee Spring* 35. *neozealandicus: water sample from New Zealand* 36. *oceanis: ocean water* 37. *particulae: airborne particulate matter* 38. *partimae: airborne particulate matter* 39. *pintis: minnow (known as pinkeens in Ireland) tissue* 40. *pintis: sediment:* 41. *pondae: sewage oxidation pond* 42. *procoris: Procordulia grayi* 43. *raringis: Rainbow Spring* 44. *rhiphus: Rhinolophus hipposideros* 45. *sainlis: Saanich Inlet, British Columbia, Canada* 46. *sewoxi: sewage oxidation pond* 47. *suspensae: Forsythia suspensa* 48. *tersae: Lake water sample* 49. *wagopi: sewage oxidation pond* 50. *waseris: wastewater*   **Genera for *Mahapunaviridae***  Etymology of genus names   1. *Acamarivirus: Acamar - star in the Eridanus constellation* 2. *Cursavirus: Cursa - second-brightest star in the Eridanus constellation* 3. *Fuluvirus: Fulu - variable star in the Cassiopeia constellation* 4. *Elnathivirus: Elnath - second-brightest star in the Taurus constellation* 5. *Enifivirus: Enif - brightest star in the Pegasus constellation* 6. *Garivirus: Gar - red dwarf star in the Virgo constellation* 7. *Amalthevirus: Amalthea gossamer ring - one of the outer rings of Jupiter* 8. *Thebevirus: Thebe gossamer ring - one of the outer rings of Jupiter* 9. *Himalivirus: Himalia ring - recently formed ring of Jupiter* 10. *Janusivirus: Janus ring - one of the outer rings of Saturn* 11. *Anthevirus: Anthe Ring Arc - a faint ring arc detected around Saturn*   Etymology of species epithets   1. *apogeeis: apogee - the furthest point of orbit from Earth* 2. *cometis: comet - small, icy body with visible coma* 3. *faculaes: facula - bright spot on the photosphere of a star* 4. *solis: sol - Spanish word for Sun* 5. *lunaes: lunar - relating to Earth's moon* 6. *nebulais: nebula - interstellar cloud of dust* 7. *parsecis: parsec - unit of length equal to 3.3 light years* 8. *perigeeis: perigee - the closest point of orbit from Earth* 9. *rocheis: Roche limit - distance at which tidal force matches self-attraction* 10. *nadis: nadir - point of the celestial sphere directly below the observer* 11. *zenis: zenith - point of the celestial sphere directly above the observer* 12. *siderealis: sidereal - of or relating to the stars* 13. *stellaris: stellar - of or relating to star systems* 14. *orbitis: orbit - path of a celestial body - orbitis* 15. *asteris: Asterism - Any prominent star pattern that isn’t a whole constellation, such as the Northern Cross or the Big Dipper* 16. *zodis: Zodiac - Greek for “circle of animals.” It’s the set of constellations situated along the ecliptic in the sky, through which the Sun, Moon, and planets move* 17. *altais: Altair - The eleventh brightest star in the sky has a celestial feel, but also could be the name of a commercial airline* 18. *arielis: Ariel - a moon of Uranus* 19. *celestis: Celeste - French, Italian, means “of the sky, heavenly”* 20. *cordelis: Cordelia - a moon of Uranus* 21. *chandais: Chanda - Hindu Mythology, goddess of the moon* 22. *halles: Halley - a comet* 23. *ophels: Ophelia - a moon of Uranus* 24. *portis: Portia - a moon of Uranus* 25. *cielois: Cielo - Italian, means “sky”* 26. *archis: Arche - a moon of Jupiter* 27. *kuiperis: Kuiper - a belt of asteroids in our solar system* 28. *beronis: beron - a moon of Uranus* 29. *rigelis: Rigel - the star that forms the left foot of the constellation Orion* 30. *eris: Eris - a dwarf planet; Greek Mythology, goddess of discord* 31. *perseuis: Perseus - a constellation* | |

**Supporting evidence**

**Table 1:** Summary of the viruses classified in the new order *Saturnivirales* and family *Kanorauviridae*

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| **Genus** | **Species** | **Accession #** | **Virus** | **Year** | **Country** | **Host /source** | **Isolate** |
| *Sakkuthvirus* | *Sakkuthvirus raringis* | MN582092 | CRESS virus sp. ctjUS5 | 2017 | USA | Rainbow Spring | ctjUS5 |
| *Sakkuthvirus* | *Sakkuthvirus napperis* | MH616921 | CRESS virus sp. ctbc431 | 2017 | USA | red snapper | ctbc431 |
| *Sakkuthvirus* | *Sakkuthvirus batchis* | JF938078 | Bat circovirus ZS/China/2011 YN-BtCV-1 | 2009 | China | bat | YN-BtCV-1 |
| *Sakkuthvirus* | *Sakkuthvirus donghis* | KT149408 | Circovirus-like genome DHCV-2 | 2010 | China | Freshwater lake (Donghu) sample (< 0.5 m) | DHCV-2 |
| *Sakkuthvirus* | *Sakkuthvirus culiziae* | KP153500 | Lake Sarah-associated circular virus-44 | 2013 | New Zealand | *Musculium novaezelandiae* | LSaCV-44-LSCO-2013 |
| *Kaiwanvirus* | *Kaiwanvirus raringis* | MN582056 | CRESS virus sp. cte1G3 | 2017 | USA | Rainbow Spring | cte1G3 |
| *Kaiwanvirus* | *Kaiwanvirus sewoxi* | KM821751 | sewage-associated circular DNA virus-16 | 2012 | New Zealand | sewage oxidation pond | SaCV-16\_NZ-BS3759-2012 |
| *Kajamanuvirus* | *Kajamanuvirus cryonitae* | MN328279 | Antarctic virus COCH21\_47 | 2016 | Antarctica | Cryoconite holes | COCH21\_V\_47 |
| *Kajamanuvirus* | *Kajamanuvirus cruti* | MK012494 | CRESS virus sp. ctdb55 | 2017 | USA | crucian tissue | ctdb55 |
| *Kajamanuvirus* | *Kajamanuvirus moutis* | MH617369 | CRESS virus sp. ctbb55 | 2017 | USA | mouse tissue | ctbb55 |
| *Kajamanuvirus* | *Kajamanuvirus lawatis* | MW697525 | Arizlama virus AZLM\_719 | 2012 | USA | Lake water sample | AZLM\_719 |
| *Kajamanuvirus* | *Kajamanuvirus musmis* | JF755408 | Rodent stool-associated circular genome virus RodSCV\_M-44 | 2008 | USA | *Mus musculus* | RodSCV\_M-44 |
| *Sagusvirus* | *Sagusvirus jaringis* | MN582110 | CRESS virus sp. ct0Vt4 | 2017 | USA | Jackson Spring | ct0Vt4 |
| *Sagusvirus* | *Sagusvirus crownis* | KY312554 | Circovirus sp. yc-15 | 2014 | China | red-crowned crane | yc-15 |
| *Shabtayvirus* | *Shabtayvirus lawatis* | MW697555 | arizlama virus AZLM\_610 | 2012 | USA | Lake water sample | AZLM\_610 |
| *Shabtayvirus* | *Shabtayvirus brolerae* | MN891788 | Brassica caulorapa CRESS virus pt079-cirl-1 | - | China | *Brassica oleracea* var. gongylodes | pt079-cirl-1 |
| *Shabtayvirus* | *Shabtayvirus brolerae* | MN891825 | Euonymus alatus CRESS virus pt168-cirl-4 | - | China | *Euonymus alatus* (Thunb.) Sieb. | pt168-cirl-4 |
| *Shabtayvirus* | *Shabtayvirus brolerae* | MN891789 | Toona sinensis CRESS virus pt109-cirl-2 | - | China | *Toona sinensis* (A. Juss.) Roem. | pt109-cirl-2 |
| *Chiunvirus* | *Chiunvirus sainlis* | JX904478 | uncultured marine virus clone SI00898 | - | Canada | Saanich Inlet, British Columbia, Canada | SI00898 |
| *Chiunvirus* | *Chiunvirus muliumi* | MK433226 | blackfly DNA Virus 12 SF02\_422 | 2015 | New Zealand: Canterbury | *Austrosimulium australense* | SF02\_422 |
| *Chiunvirus* | *Chiunvirus auroris* | MN928931 | CRESS virus sp. hbl169cir1 | 2018 | China | *Phoenicurus auroreus* | hbl169cir1 |
| *Chiunvirus* | *Chiunvirus grujae* | MN928928 | CRESS virus sp. cra070cir1 | 2018 | China | *Grus japonensis* | cra070cir1 |
| *Chiunvirus* | *Chiunvirus melani* | MF327573 | Giant panda circovirus 1 gpci001 | 2015 | China | *Ailuropoda melanoleuca* | gpci001 |
| *Doseivirus* | *Doseivirus sewoxi* | KJ547632 | Sewage-associated circular DNA virus-8 | 2012 | New Zealand | sewage oxidation pond | SaCV-8\_NZ-BS4075-2012 |
| *Shanivirus* | *Shanivirus maringis* | MW202578 | CRESS virus sp. ctghP836 | 2019 | USA | Manatee Spring | ctghP836 |
| *Shanivirus* | *Shanivirus maringis* | MW202521 | CRESS virus sp. ctBLi026 | 2019 | USA | Manatee Spring | ctBLi026 |
| *Shanivirus* | *Shanivirus cryonitae* | MN328268 | Antarctic circular DNA molecule CAA\_003\_V\_40 | 2016 | Antarctica | Cryoconite holes | CAA\_003\_V\_40 |
| *Shanivirus* | *Shanivirus neozealandicus* | KP153393 | Lake Sarah-associated circular virus-1 | 2013 | New Zealand | water | LSaCV-1\_LSWA-2013 |
| *Shanivirus* | *Shanivirus neozealandicus* | KP153392 | Lake Sarah-associated circular virus-1 | 2013 | New Zealand | *Chironomus zealandicus* | LSaCV-1-LSWO-2013 |
| *Shanivirus* | *Shanivirus neozealandicus* | KP153391 | Lake Sarah-associated circular virus-1 | 2013 | New Zealand | *Potamopyrgus antipodarum* | LSaCV-1-LSGA-2013 |
| *Shanivirus* | *Shanivirus neozealandicus* | KP153390 | Lake Sarah-associated circular virus-1 | 2013 | New Zealand | *Musculium novaezelandiae* | LSaCV-1-LSCO-2013 |
| *Shanivirus* | *Shanivirus culiziae* | KP153458 | Lake Sarah-associated circular virus-30 | 2013 | New Zealand | *Musculium novaezelandiae* | LSaCV-30-LSCO-2013 |
| *Shanivirus* | *Shanivirus culiziae* | KP153457 | Lake Sarah-associated circular virus-30 | 2013 | New Zealand | *Potamopyrgus antipodarum* | LSaCV-30-LSGA-2013 |
| *Shanivirus* | *Shanivirus culiziae* | KP153456 | Lake Sarah-associated circular virus-30 | 2013 | New Zealand | sediment | LSaCV-30-LSSO-2013 |
| *Shanivirus* | *Shanivirus sewoxi* | KM821767 | sewage-associated circular DNA virus-32 | 2012 | New Zealand | sewage oxidation pond | SaCV-32\_NZ-BS4194-2012 |
| *Shanivirus* | *Shanivirus yangris* | MW347479 | Circoviridae sp. 4zj-CRESS-1 | 2017 | China: Yangtze River | water samples from river ports along the Yangtze River in China | 4zj-CRESS-1 |
| *Shanivirus* | *Shanivirus lawatis* | MW697497 | arizlama virus AZLM\_839 | 2012 | USA | Lake water sample | AZLM\_839 |
| *Shanivirus* | *Shanivirus waseris* | KY487785 | uncultured virus clone CG114 | 2015 | USA | wastewater | CG114 |
| *Shanivirus* | *Shanivirus particulae* | MW678994 | Virus sp. D10\_6684 | 2009 | USA: Pinal County, Arizona | airborne particulate matter | D10\_6684 |
| *Shanivirus* | *Shanivirus airbis* | MW678995 | Virus sp. D3\_581 | 2009 | USA: Pinal County, Arizona | airborne particulate matter | D3\_581 |
| *Shanivirus* | *Shanivirus pondae* | KM821754 | Sewage-associated circular DNA virus-19 SaCV-19\_NZ-BS4128-2012 | 2012 | New Zealand | sewage oxidation pond | SaCV-19\_NZ-BS4128-2012 |
| *Shanivirus* | *Shanivirus partimae* | MW678991 | virus sp. D3\_648 | 2009 | USA: Pinal County, Arizona | airborne particulate matter | D3\_648 |
| *Shanivirus* | *Shanivirus bortici* | MW678999 | virus sp. D3\_523 | 2009 | USA: Pinal County, Arizona | airborne particulate matter | D3\_523 |
| *Shanivirus* | *Shanivirus acrenis* | KM874297 | Avon-Heathcote Estuary associated circular virus 3 | 2012 | New Zealand | *Amphibola crenata* | AHEaCV-3-NZ-3887G-2012 |
| *Shanivirus* | *Shanivirus acrenis* | KM874296 | Avon-Heathcote Estuary associated circular virus 3 | 2012 | New Zealand | *Austrovenus stutchburyi* | AHEaCV-3-NZ-3030C3-2012 |
| *Shanivirus* | *Shanivirus acrenis* | KM874295 | Avon-Heathcote Estuary associated circular virus 3 | 2012 | New Zealand | *Austrovenus stutchburyi* | AHEaCV-3-NZ-3030C2-2012 |
| *Phainonvirus* | *Phainonvirus cryonitae* | MN328267 | antarctic circular DNA molecule CAA\_003\_V\_32 | 2016 | Antarctica | Cryoconite holes | CAA\_003\_V\_32 |
| *Phainonvirus* | *Phainonvirus hydris* | MK570195 | capybara virus 33\_cap3\_6684 | 2016 | Brazil | Hydrochoerus hydrochaeris | cap3\_6684 |
| *Phainonvirus* | *Phainonvirus libraris* | LC671626 | Cressdnaviricota sp. 2020-AMS-TS DNA | 2020 | Netherlands | library preparation reagents | 2020-AMS-TS |
| *Sickelvirus* | *Sickelvirus maringis* | MW202831 | Circoviridae sp. ctRbk103 | 2019 | USA | Manatee Spring | ctRbk103 |
| *Sickelvirus* | *Sickelvirus hydris* | MK570187 | capybara virus 25\_cap1\_1914 | 2016 | Brazil | *Hydrochoerus hydrochaeris* | cap1\_1914 |
| *Scythevirus* | *Scythevirus maringis* | MW202805 | CRESS virus sp. ct3IM547 | 2019 | USA | Manatee Spring | ct3IM547 |
| *Scythevirus* | *Scythevirus maringis* | MW202715 | CRESS virus sp. ctxwf270 | 2019 | USA | Manatee Spring | ctxwf270 |
| *Scythevirus* | *Scythevirus maringis* | MW202538 | CRESS virus sp. ctUHN991 | 2019 | USA | Manatee Spring | ctUHN991 |
| *Scythevirus* | *Scythevirus maringis* | MW202488 | CRESS virus sp. ctSRL579 | 2019 | USA | Manatee Spring | ctSRL579 |
| *Scythevirus* | *Scythevirus maringis* | MW202438 | CRESS virus sp. ct18Y395 | 2019 | USA | Manatee Spring | ct18Y395 |
| *Scythevirus* | *Scythevirus dianchis* | KT149406 | Circovirus-like genome DCCV-13 | 2010 | China | Freshwater lake (Dianchi) sample (< 0.5m) | DCCV-13 |
| *Scythevirus* | *Scythevirus lawatis* | MW697550 | arizlama virus AZLM\_25947 | 2012 | USA | Lake water sample | AZLM\_25947 |
| *Scythevirus* | *Scythevirus manatis* | MW202443 | CRESS virus sp. ctFVx272 | 2019 | USA | Manatee Spring | ctFVx272 |
| *Scythevirus* | *Scythevirus natringis* | MW202436 | CRESS virus sp. ctKNF714 | 2019 | USA | Manatee Spring | ctKNF714 |
| *Scythevirus* | *Scythevirus monetis* | KR528560 | Palaemonetes kadiakensis Mississippi grass shrimp associated circular virus I0099 | - | USA | *Palaemonetes kadiakensis* | I0099 |
| *Ninurtavirus* | *Ninurtavirus muliumi* | MK433229 | blackfly DNA Virus 15 SF02\_403 | 2015 | New Zealand: Canterbury | *Austrosimulium australense* | SF02\_403 |
| *Ninurtavirus* | *Ninurtavirus floridaense* | FJ959081 | Circovirus-like genome RW-E | - | USA: Southwest Florida | reclaimed water | RW-E |
| *Ninurtavirus* | *Ninurtavirus lawatis* | MW697516 | arizlama virus AZLM\_757 | 2012 | USA | Lake water sample | AZLM\_757 |
| *Ninurtavirus* | *Ninurtavirus jaringis* | MN582084 | CRESS virus sp. ctf7a5 | 2017 | USA | Jackson Spring | ctf7a5 |
| *Ninurtavirus* | *Ninurtavirus cruti* | MK012442 | CRESS virus sp. ctbi59 | 2017 | USA | crucian tissue | ctbi59 |
| *Ninurtavirus* | *Ninurtavirus mintis* | MK032730 | CRESS virus sp. ctci503 | 2017 | USA | minnow tissue | ctci503 |
| *Ninurtavirus* | *Ninurtavirus procoris* | KF738873 | dragonfly larvae associated circular virus-1 | 2012 | New Zealand | *Procordulia grayi* | DflaCV-1\_NZ-PG11-LD |
| *Ninurtavirus* | *Ninurtavirus momolo* | OL704855 | Molossus molossus associated CRESSDNA virus MAVG-30 | - | Argentina | *Molossus molossus* | MAVG-30 |
| *Ninurtavirus* | *Ninurtavirus sewoxi* | KM821762 | sewage-associated circular DNA virus-27 | 2012 | New Zealand | sewage oxidation pond | SaCV-27\_NZ-BS4103-2012 |
| *Ninurtavirus* | *Ninurtavirus waseris* | KY487776 | uncultured virus clone CG105 | - | USA | wastewater | CG10 |
| *Ninurtavirus* | *Ninurtavirus pondae* | KJ547630 | Sewage-associated circular DNA virus-6 | 2012 | New Zealand | sewage oxidation pond | SaCV-6\_NZ-BS4017-2012 |
| *Ninurtavirus* | *Ninurtavirus wagopi* | KJ547631 | Sewage-associated circular DNA virus-7 | 2012 | New Zealand | sewage oxidation pond | SaCV-7\_NZ-BS3976-2012 |
| *Ninurtavirus* | *Ninurtavirus oceanis* | KF133825 | Circoviridae 18 LDMD-2013 | 2009 | USA | ocean water | 18 LDMD-2013 |
| *Ninurtavirus* | *Ninurtavirus oceanis* | KF133819 | Circoviridae 12 LDMD-2013 | 2009 | USA | ocean water | 12 LDMD-2013 |
| *unclassified* | *unclassified* | KP153376 | Lake Sarah-associated circular molecule 8 | 2013 | New Zealand | *Echyridella menziesii* | LSaCM-8-LSMU-2013 |
| *unclassified* | *unclassified* | KP153371 | Lake Sarah-associated circular molecule 8 | 2013 | New Zealand | *Potamopyrgus antipodarum* | LSaCM-8-LSGA-2013 |
| *unclassified* | *unclassified* | KP153373 | Lake Sarah-associated circular molecule 8 | 2013 | New Zealand | *Chironomus zealandicus* | LSaCM-8-LSWO-2013 |
| *unclassified* | *unclassified* | KP153372 | Lake Sarah-associated circular molecule 8 | 2013 | New Zealand | *Musculium novaezelandiae* | LSaCM-8-LSCO-2013 |
| *unclassified* | *unclassified* | KP153374 | Lake Sarah-associated circular molecule 8 | 2013 | New Zealand | sediment | LSaCM-8-LSSO-2013 |
| *unclassified* | *unclassified* | KP153375 | Lake Sarah-associated circular molecule 8 | 2013 | New Zealand | water | LSaCM-8-LSWA-2013 |
| *Ninurtavirus* | *Ninurtavirus nowtis* | MH616738 | CRESS virus sp. ctcf175 | 2017 | USA | minnow tissue | ctcf175 |
| *Ninurtavirus* | *Ninurtavirus particulae* | MW678993 | Virus sp. D3\_606 | 2009 | USA: Pinal County, Arizona | airborne particulate matter | D3\_606 |
| *Ninurtavirus* | *Ninurtavirus maringis* | MW202638 | CRESS virus sp. ctg8o776 | 2019 | USA | Manatee Spring | ctg8o776 |
| *Ninurtavirus* | *Ninurtavirus rhiphus* | KJ641736 | Bat circovirus BtRh-CV-5/Tibet2013 | 2013 | China | *Rhinolophus hipposideros* | BtRh-CV-5/Tibet2013 |
| *Ninurtavirus* | *Ninurtavirus lophus* | KJ641735 | Bat circovirus BtRh-CV-1/Tibet2013 | 2013 | China | *Rhinolophus hipposideros* | BtRh-CV-1/Tibet2013 |
| *Ninurtavirus* | *Ninurtavirus duliaris* | KF738874 | dragonfly larvae associated circular virus-2 | 2012 | New Zealand | *Procordulia grayi* | DflaCV-2\_NZ-PG8-LS |
| *Ninurtavirus* | *Ninurtavirus raringis* | MN582072 | CRESS virus sp. ctczB4 | - | USA | Rainbow Spring | ctczB4 |
| *Ninurtavirus* | *Ninurtavirus tersae* | MW697552 | Arizlama virus AZLM\_25953 | 2012 | USA | Lake water sample | AZLM\_25953 |
| *Ninurtavirus* | *Ninurtavirus bowris* | MN582083 | CRESS virus sp. cta0f7 | - | USA | Rainbow Spring | cta0f7 |
| *Ninurtavirus* | *Ninurtavirus pintis* | MH616769 | CRESS virus sp. ctcg234 | 2017 | USA | minnow tissue | ctcg234 |
| *Ninurtavirus* | *Ninurtavirus pintis* | KP153495 | Lake Sarah-associated circular virus-41 | 2013 | New Zealand | sediment | LSaCV-41-LSSO-2013 |
| *Ninurtavirus* | *Ninurtavirus culiziae* | KP153494 | Lake Sarah-associated circular virus-41 | 2013 | New Zealand | *Musculium novaezelandiae* | LSaCV-41-LSCO-2013 |
| *Sanivirus* | *Sanivirus maringis* | MW202411 | CRESS virus sp. ct3I9170 | 2019 | USA | Manatee Spring | ct3I9170 |
| *Sanivirus* | *Sanivirus suspensae* | MN891791 | Forsythia suspensa CRESS virus pt110-cirl-3 | - | China | *Forsythia suspensa* | pt110-cirl-3 |
| *Saothovirus* | *Saothovirus lawatis* | MW697518 | Arizlama virus AZLM\_746 | 2012 | USA | Lake water sample | AZLM\_746 |
| *Saothovirus* | *Saothovirus lawatis* | KM598395 | odonata-associated circular virus-12 | 2012 | USA | *Libellula quadrimaculata* | OdasCV-12-US-1518LM1-12 |
| *Saothovirus* | *Saothovirus maringis* | MW202707 | CRESS virus sp. ctsVI820 | 2019 | USA | Manatee Spring | ctsVI820 |
| *Saothovirus* | *Saothovirus cruti* | MK012512 | CRESS virus sp. ctba54 | 2017 | USA | crucian tissue | ctba54 |
| *Saothovirus* | *Saothovirus dianchis* | KT149401 | Circovirus-like genome DCCV-8 | 2010 | China | Freshwater lake (Dianchi) sample (< 0.5m) | DCCV-8 |
| *Saothovirus* | *Saothovirus mintis* | MK032700 | CRESS virus sp. ctbd169 | 2017 | USA | minnow tissue | ctbd169 |
| *Saothovirus* | *Saothovirus manatis* | MW202813 | CRESS virus sp. ctmKE188 | 2019 | USA | Manatee Spring | ctmKE188 |
| *Saothovirus* | *Saothovirus manatis* | MW202652 | CRESS virus sp. cttdt362 | 2019 | USA | Manatee Spring | cttdt362 |
| *Chinseivirus* | *Chinseivirus sewoxi* | KM821759 | Sewage-associated circular DNA virus-24 | 2012 | New Zealand | sewage oxidation pond | SaCV-24\_NZ-BS4091-2012 |
| *Sanchirviurs* | *Sanchirviurs lawatis* | MW697509 | Arizlama virus AZLM\_785 | 2012 | USA | Lake water sample | AZLM\_785 |
| *Kronovirus* | *Kronovirus crassaminis* | KP153508 | Lake Sarah-associated circular virus-49 | 2013 | New Zealand | sediment | LSaCV-49-LSSO-2013 |
| *Kronovirus* | *Kronovirus crassaminis* | KP153509 | Lake Sarah-associated circular virus-49 | 2013 | New Zealand | *Musculium novaezelandiae* | LSaCV-49-LSCO-2013 |
| *Kronovirus* | *Kronovirus crassaminis* | KP153510 | Lake Sarah-associated circular virus-49 | 2013 | New Zealand | water | LSaCV-49-LSWA-2013 |
| *Kronovirus* | *Kronovirus crassaminis* | KP153507 | Lake Sarah-associated circular virus-49 | 2013 | New Zealand | *Potamopyrgus antipodarum* | LSaCV-49-LSGA-2013 |
| *Zohali* | *Zohali maramis* | OP549819 | wigfec virus K19\_432 | 2021 | USA | *Mareca americana* | K19\_MH\_432 |
| *Raagevirus* | *Raagevirus napperis* | MH617563 | Circoviridae sp. ctda199 | 2017 | USA | red snapper | ctda199 |
| *Raagevirus* | *Raagevirus napperis* | KM874359 | Avon-Heathcote Estuary associated circular virus 26 | 2012 | New Zealand | *Paphies subtriangulata* | AHEaCV-26-NZ-2311TU-2012 |
| *Seetinvirus* | *Seetinvirus maringis* | MW202873 | CRESS virus sp. ctP9b653 | 2019 | USA | Manatee Spring | ctP9b653 |
| *Savurvirus* | *Savurvirus yangris* | MW347481 | CRESS virus sp. 4zj-CRESS-3 | 2017 | China: Yangtze River | water samples from river ports along the Yangtze River in China | 4zj-CRESS-3 |
| *Tuxingvirus* | *Tuxingvirus gruidis* | MN928956 | CRESS virus sp. hftoti49cir1 | 2016 | China | Gruidae | hftoti49cir1 |
| *Sadornvirus* | *Sadornvirus chesapis* | FJ959083 | Circovirus-like genome CB-B | - | USA | Chesapeake Bay | CB-B |
| *Zuhalvirus* | *Zuhalvirus cruti* | MK012507 | CRESS virus sp. ctdb57 | 2017 | USA | crucian tissue | ctdb57 |

**Table 2:** Summary of the viruses classified in the new order *Saturnivirales* and family *Mahapunaviridae*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Genus** | **Species** | **Accession #** | **Virus** | **Year** | **Country** | **Host /source** | **Isolate** |
| *Acamarivirus* | *Acamarivirus apogeeis* | MT181545 | marmot associated feces virus 5 | 2018 | USA | *Marmota flaviventris* | MAR1\_1\_2070 |
| *Acamarivirus* | *Acamarivirus cometis* | KJ641730 | Bat circovirus BtMl-CV/QH2013 | 2013 | China | *Murina leucogaster* | BtMl-CV/QH2013 |
| *Acamarivirus* | *Acamarivirus faculaes* | MH617345 | CRESS virus sp. ctda86 | 2017 | USA | mouse tissue | ctda86 |
| *Acamarivirus* | *Acamarivirus faculaes* | MH552490 | CRESS virus sp. ctce55 | 2017 | USA | mouse tissue | ctce55 |
| *Acamarivirus* | *Acamarivirus solis* | KT862235 | llama faeces associated circular DNA virus-1 | 2012 | New Zealand | Lama glama | 29\_llama |
| *Acamarivirus* | *Acamarivirus lunaes* | MK433218 | blackfly DNA Virus 4 | 2015 | New Zealand: Canterbury | *Austrosimulium australense* | SF02\_664 |
| *Acamarivirus* | *Acamarivirus nebulais* | MH617097 | CRESS virus sp. ctbg966 | 2017 | USA | minnow tissue | ctbg966 |
| *Acamarivirus* | *Acamarivirus parsecis* | KP153407 | Lake Sarah-associated circular virus-9 | 2013 | New Zealand | sediment | LSaCV-9-LSSO-2013 |
| *Acamarivirus* | *Acamarivirus perigeeis* | MK433219 | blackfly DNA Virus 5 | 2015 | New Zealand: Canterbury | *Austrosimulium australense* | SF02\_839 |
| *Cursavirus* | *Cursavirus rocheis* | KP153471 | Lake Sarah-associated circular virus-34 | 2013 | New Zealand | sediment | LSaCV-34-LSSO-2013 |
| *Cursavirus* | *Cursavirus rocheis* | KP153470 | Lake Sarah-associated circular virus-34 | 2013 | New Zealand | *Potamopyrgus antipodarum* | LSaCV-34-LSGA-2013 |
| *Cursavirus* | *Cursavirus nadis* | MH616917 | CRESS virus sp. ctbb930 | 2017 | USA | minnow tissue | ctbb930 |
| *Cursavirus* | *Cursavirus zenis* | MK570199 | capybara virus 37\_cap1\_578 | 2016 | Brazil | *Hydrochoerus hydrochaeris* | cap1\_578 |
| *Cursavirus* | *Cursavirus zenis* | MK570198 | capybara virus 36\_cap1\_42 | 2016 | Brazil | *Hydrochoerus hydrochaeris* | cap1\_42 |
| *Fuluvirus* | *Fuluvirus siderealis* | MK570172 | capybara virus 10\_cap1\_55 | 2016 | Brazil | *Hydrochoerus hydrochaeris* | cap1\_55 |
| *Fuluvirus* | *Fuluvirus stellaris* | MK433217 | blackfly DNA Virus 3 | 2016 | New Zealand: Canterbury | *Austrosimulium australense* | SF02\_402 |
| *Elnathivirus* | *Elnathivirus orbitis* | MW697488 | arizlama virus AZLM\_890 | 2012 | USA | Lake water sample | AZLM\_890 |
| *Enifivirus* | *Enifivirus asteris* | MH617376 | CRESS virus sp. ctcf955 | 2017 | USA | minnow tissue | ctcf955 |
| *Garivirus* | *Garivirus zodis* | MZ556194 | Red panda feces-associated circular DNA virus 21 | 2019 | China: Sichuan Province | *Ailurus fulgens* | Rpf284cress20-12 |
| *Amalthevirus* | *Amalthevirus altais* | MT671987 | Cressdnaviricota sp. 169P | 2018 | Brazil | *Sus scrofa domesticus* | 169P |
| *Thebevirus* | *Thebevirus arielis* | OM523006 | Chifec virus UA13\_119 | 2018 | USA: Arizona | *Tadarida brasiliensis feces* | UA13\_119 |
| *Himalivirus* | *Himalivirus celestis* | MZ556184 | Red panda feces-associated circular DNA virus 14 | 2019 | China: Sichuan Province | *Ailurus fulgens* | Rpf279cress02-12 |
| *Himalivirus* | *Himalivirus cordelis* | MN928932 | CRESS virus sp. hbl169cre1 | 2018 | China | *Phoenicurus auroreus* | hbl169cre1 |
| *Himalivirus* | *Himalivirus chandais* | MH617692 | CRESS virus sp. ctbf75 | 2017 | USA | mouse tissue | ctbf75 |
| *Himalivirus* | *Himalivirus halles* | MH617488 | CRESS virus sp. ctbe77 | 2017 | USA | mouse tissue | ctbe77 |
| *Janusivirus* | *Janusivirus ophels* | MZ556154 | giant panda feces-associated circular DNA virus Gpf270cir01-12 | 2018 | China: Sichuan Province | *Ailuropoda melanoleuca* | Gpf270cir01-12 |
| *Janusivirus* | *Janusivirus portis* | MN954870 | Caesalpinia pluviosa associated gemycircularvirus DF 226 | 2014 | Brazil | *Cenostigma pluviosum* | DF 226 |
| *Anthevirus* | *Anthevirus cielois* | OP549838 | wigfec virus K19\_558 | 2021 | USA: Arizona | *Mareca americana* | K19\_558 |
| *Anthevirus* | *Anthevirus archis* | KM821752 | Sewage-associated circular DNA virus-17 | 2012 | New Zealand | sewage oxidation pond | SaCV-17\_NZ-BS4236-2012 |
| *Anthevirus* | *Anthevirus kuiperis* | MW202776 | CRESS virus sp. ctr5b272 | 2019 | USA | Manatee Spring | ctr5b272 |
| *Anthevirus* | *Anthevirus beronis* | MH545536 | giant house spider associated circular virus 2 | 2017 | Canada: Victoria, British Columbia | *Eratigena atrica* | BC\_I1657E\_H4 |
| *Anthevirus* | *Anthevirus rigelis* | KP153475 | Lake Sarah-associated circular virus-36 | 2013 | New Zealand | *Musculium novaezelandiae* | LSaCV-36-LSCO-2013 |
| *Anthevirus* | *Anthevirus eris* | KP153474 | Lake Sarah-associated circular virus-36 | 2013 | New Zealand | *Potamopyrgus antipodarum* | LSaCV-36-LSGA-2013 |
| *Anthevirus* | *Anthevirus perseuis* | MH552505 | CRESS virus sp. ctbf541 | 2017 | USA | mouse tissue | ctbf541 |

**A diagram of different colored lines

Description automatically generated with medium confidence**

**Figure 1:** Maximum likelihood phylogenetic tree inferred from Rep proteins of members of the phylum *Cressdnaviricota*. Related sequence groups are collapsed into triangles, the side lengths of which are proportional to the distances between the closest and farthest leaf nodes. The alignment was trimmed with TrimAL [4] with gap threshold of 0.2. The maximum likelihood phylogenetic tree was constructed using IQtree [5] with automatic selection of the best-fit substitution model for a given alignment, which was Q.pfam+F+R10. Numbers at the nodes represent aLRT branch supports. The scale bar represents the number of substitutions per site.

**A screenshot of a computer screen

Description automatically generated**

**Figure 2:** Maximum likelihood phylogenetic tree of the Rep sequences of the members of thefamily *Kanorauviridae* inferred with PhyML 3.0 [6] with rtREV+I+G+F model determined as the best substitution model using ProtTest 3 [7] and rooted with representative sequences of members of the family *Nanyaviridae*. The species belonging to the same genus are indicated with the same color. Numbers at the nodes represent aLRT branch supports. The cyan line shows a proposed demarcation of genera. The genome organization relative to the *rep* ORF is shown to the right of the phylogeny.

**A screen shot of a computer screen

Description automatically generated**

**Figure 3:** A ‘two color’ pairwise identity matrix of members of the families *Kanorauviridae* with 78% species threshold *s* inferred using SDT v1.2 [8].

**A screen shot of a computer

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**Figure 4:** Maximum likelihood phylogenetic tree of the Rep sequences of the members of thefamily *Mahapunaviridae* inferred with PhyML 3.0 [6] with rtREV+I+G+F model determined as the best substitution model using ProtTest 3 [7] and rooted with representative sequences of members of the family *Nanyaviridae*. The species belonging to the same genus are indicated with the same color. Numbers at the nodes represent aLRT branch supports. The cyan line shows a proposed demarcation of genera. The genome organization relative to the *rep* ORF is shown to the right of the phylogeny.

**A screen shot of a graph

Description automatically generated**

**Figure 5:** A ‘two color’ pairwise identity matrix of members of the families *Mahapunaviridae* with 78% species threshold *s* inferred using SDT v1.2 [8].

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