



Additional changes to taxonomy ratified in a special vote by the International Committee on Taxonomy of Viruses (October 2018)

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Abstract

This article reports the changes to virus taxonomy approved and ratified by the International Committee on Taxonomy of Viruses (ICTV) in October 2018. Of note, the ICTV has approved, by an absolute majority, the creation of additional taxonomical ranks above those recognized previously. A total of 15 ranks (realm, subrealm, kingdom, subkingdom, phylum, subphylum, class, subclass, order, suborder, family, subfamily, genus, subgenus, and species) are now available to encompass the entire spectrum of virus diversity. Classification at ranks above genus is not obligatory but can be used by the authors of new taxonomic proposals when scientific justification is provided.

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Introduction

Changes to virus taxonomy (the universal scheme of virus classification of the International Committee on Taxonomy of Viruses [ICTV]) take place annually and are the result of a multi-stage process. In accordance with the ICTV Statutes (<http://ictv.global/statutes.asp>), proposals submitted to the ICTV Executive Committee (EC) undergo a review process that involves input from the ICTV Study Groups (SGs) and Subcommittees (SCs), other interested virologists, and the EC. After final approval by the EC, proposals are presented for ratification to the full ICTV membership by publication on the ICTV website (<http://ictv.global>) followed by an electronic vote.

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Nine proposals that were discussed at the EC meeting in July 2017 (Singapore) and subsequently at the EC meeting in July 2018 (Washington, DC, USA) [1–9] were approved by the EC and then ratified in a supplemental vote. The proposals were made publicly available on the ICTV website in August 2018, and a list of them was then emailed on August 30, 2018 to the 156 members of ICTV, i.e., EC Members, Life Members, ICTV Subcommittee Members (including the SG chairs) and ICTV National Representatives. Following this, members were requested to vote on whether to ratify the proposals, with a closing date of October 7, 2018. Since the processing of these proposals overlapped the end of the 2014–2017 EC tenure and the

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Table 1 Summary of taxonomic changes approved in October 2018

Rank	Taxonomic Change				Total ^a
	New	Abolished	Moved	Renamed	
Phylum	1	0	0	0	1
Subphylum	2	0	0	0	2
Class	6	0	0	0	6
Order	5	0	2	0	14
Suborder	7	0	0	0	7
Family	15	3	21	0	143
Subfamily	18	0	2	1	64
Genus	50	7	73	3	846
Subgenus	59	0	0	0	59
Species	107	2	504	43	4,958

^aTotal numbers of taxa now recognized, as reported in the ICTV Master Species List

start of the 2017–2020 EC tenure, members of both ECs constitute the authorship of this article.

Changes to virus taxonomy: taxa and nomenclature

The 156 members of the ICTV were contacted by e-mail and asked to vote on the ratification of the nine proposals. All nine proposals [1–9] were ratified by ICTV members. Proposal 2017.005G, introducing the additional ranks [1], was ratified by 99 votes in favor and 6 votes against. Voting on the remaining eight proposals, each of which utilizes some of the new taxonomy ranks, was contingent on ICTV members voting in favor of proposal 2017.005G, and each of these proposals received from 83 to 86 votes. A summary of the individual proposals is provided in Table 1, and the entire revised taxonomy reflecting the approved changes is shown in Supplementary file 1, with the new taxa indicated by bold type. Each proposal is cited and listed in the References to acknowledge the authors' efforts and to provide links to the specific proposal as coded on the ICTV website. These documents remain available for those who wish to see the full details of the proposals.

The introduction of the additional ranks permitted in virus taxonomy necessitates several changes in the ICTV Code. The proposed changes to the Code, approved by the EC, are posted at <http://ictv.global/code.asp> and will be submitted for ratification by ICTV in early 2019.

Conclusion

All nine proposals submitted to ratification were ratified by an absolute majority of the ICTV, and the changes proposed are now part of official ICTV taxonomy. An up-to-date list of all approved taxa can be found on the ICTV online website: <http://ictv.global/msl.htm>. The remaining taxonomic proposals approved at the EC meeting in July 2018 (Washington, DC, USA) will be offered to the ICTV for ratification in early 2019.

Compliance with ethical standards

Conflict of interest The authors declare no conflicts of interest. A.R.M. is a Program Director at the U.S. National Science Foundation (NSF); the statements and opinions expressed herein are made in a personal capacity and do not constitute endorsement by NSF or the government of the United States. Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture. USDA is an Equal Opportunity Provider and Employer. The content of this publication does not necessarily reflect the views or policies of the US Department of Health and Human Services or of the institutions and companies affiliated with the authors. This work was supported in part through Battelle Memorial Institute's prime contract with the US National Institute of Allergy and Infectious Diseases (NIAID) under Contract No. HHSN272200700016I (J.H.K.). N.J.K. is partially supported by core funding provided by the Biotechnology and Biological Sciences Research Council, UK. B.E.D. is supported by Netherlands Organization for Scientific Research (NWO) Vidi grant 864.14.004. B.H. is partially supported by National Research, Development and Innovation Office – NKFIH, NN128309. A.E.G. is partially supported by EU project EVAg 653316 and the Leids Universiteits Fonds. A.J.D. is supported by the Medical Research Council (MC_UU_12014/3). S.S. acknowledges partial support from Mississippi Agricultural and Forestry Experiment Station (MAFES), Mississippi State University.

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References

- Gorbalenya AE, Krupovic M, Mushegian A, Kropinski AM, Siddell S, Varsani A, Kuhn JH (2017) Proposal 2017.005G.A.v1. Increasing the number of ranks available in virus taxonomy. <https://talk.ictvonline.org/ICTV/proposals/2017.005G.A.v1.AdditionalTaxonomyRanks.docx>. Accessed 15 Oct 2018 (**Correspondence:** stuart.siddell@bristol.ac.uk)
- Wolf Y, Krupovic M, Zhang YZ, Maes P, Dolja V, Koonin EV, Kuhn JH (2018) Proposal 2017.016 M.A.v2. Megataxonomy of negative-sense RNA viruses. <https://talk.ictvonline.org/ICTV/proposals/2017.006M.R.Negarnaviricota.zip>. Accessed 15 Oct 2018 (**Correspondence:** kuhnjens@mail.nih.gov)
- Maes P, Alkhovsky S, Beer M, Briese T, Buchmeier MJ, Calisher CH, Charre R, Ryong Choi I, Clegg CS, de la Torre JC, DeRisi JL, Digiaro M, Ebihara H, Emonet S, Elbeaino T, Gonzalez J-P, Haenni A-L, Jain R, Jonson G, Junglen S, Kormelink R, Lambert

- A, Lukashevich IS, Martelli GP, Mielke-Ehret N, Muehlbach H-P, Nunes MRT, Peters CJ, Plyusnin A, Radoshitzky SR, Romanowski V, Salvato MS, Sasaya T, Schmaljohn C, Shirako Y, Stenglein MD, Tesh RB, Wei T, Yeh S-D, Zhang Y, Zhou X, Kuhn JH (2018) Proposal 2017.012 M.A.v2. Taxonomic expansion and reorganization of the order *Bunyavirales*. <https://talk.ictvonline.org/ICTV/proposals/2017.012M.R.Bunyavirales.zip>. Accessed 15 Oct 2018 (**Correspondence: kuhnjens@mail.nih.gov**)
4. Maes P, Song T, Stenglein, Paweska J, Song Q, Ye G, Zhang, Y, Kuhn JH, Dietzgen RG, Easton AJ, Kurath G, Nowotny N, Rima BK, Rubbenstroth D, Vasilakis N, Walker P, Domier LL, Ghedin E, Jiang D, Wang, D (2018) Proposal 2017.016 M. Av1. Taxonomic expansion and reorganization of the order *Mononegavirales*. <https://talk.ictvonline.org/ICTV/proposals/2017.016M.R.Mononegavirales.zip>. Accessed 15 Oct 2018 (**Correspondence: kuhnjens@mail.nih.gov**)
 5. Vanmechelen B, Vergote V, Laenen L, Kuhn JH, Maes P (2018) Proposal 2017.001S.A.v1. One new subfamily, genus and species in the family *Arteriviridae* (*Nidovirales*). <https://talk.ictvonline.org/ICTV/proposals/2017.001S.A.v1.Crocarterivirinae.zip>. Accessed 15 Oct 2018 (**Correspondence: piet.maes@kuleuven.be**)
 6. Brinton MA, Gulyaeva A, Balasuriya UBR, Dunowska M, Faaberg KS, Goldberg T, Leung FC, Nauwynck HJ, Snijder EJ, Stadejek T, Gorbalenya AE (2018) Proposal 2017.012S.A.v1. Expansion of the rank structure of the family *Arteriviridae* and renaming its taxa. <https://talk.ictvonline.org/ICTV/proposals/2017.001S.012-017S.R.Nidovirales.zip>. Accessed 15 Oct 2018 (**Correspondence: A.E.Gorbalenya@lumc.nl**)
 7. Ziebuhr J, Baric RS, Baker S, de Groot RJ, Drosten C, Gulyaeva, Haagmans BL, Neuman BW, Perlman S, Poon LLM, Sola I, Gorbalenya AE (2018) Proposal 2017.013S.A.v1. Reorganization of the family *Coronaviridae* into two families, *Coronaviridae* (including the current subfamily *Coronavirinae* and the new subfamily *Letovirinae*) and the new family *Tobnaviridae* (accommodating the current subfamily *Torovirinae* and three other subfamilies), revision of the genus rank structure and introduction of a new subgenus rank. <https://talk.ictvonline.org/ICTV/proposals/2017.001S.012-017S.R.Nidovirales.zip>. Accessed 15 Oct 2018 (**Correspondence: A.E.Gorbalenya@lumc.nl**)
 8. Gorbalenya AE, Brinton MA, Cowley J, de Groot R, Gulyaeva A, Lauber C, Neuman B, Ziebuhr J (2018) Proposal 2017.014S.v1. Establishing taxa at the ranks of subfamily, genus, subgenus and species in six families of invertebrate nidoviruses. <https://talk.ictvonline.org/ICTV/proposals/2017.001S.012-017S.R.Nidovirales.zip>. Accessed 15 Oct 2018 (**Correspondence: A.E.Gorbalenya@lumc.nl**)
 9. Gorbalenya AE, Brinton MA, Cowley J, de Groot R, Gulyaeva A, Lauber C, Neuman B, Ziebuhr J (2018) Proposal 2017.015S.A.v1. Reorganization and expansion of the order *Nidovirales* at the family and sub-order ranks. <https://talk.ictvonline.org/ICTV/proposals/2017.001S.012-017S.R.Nidovirales.zip>. Accessed 15 Oct 2018 (**Correspondence: A.E.Gorbalenya@lumc.nl**)

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