

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

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| **Code assigned:** | **2020.001D** |  |
| **Short title:** Create one new species (*Spodoptera exigua multiple nucleopolyhedrovirus B*) and rename one species in the genus *Alphabaculovirus* (*Lefavirales*: *Baculoviridae*) | | |
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**List the ICTV Study Group(s) that have seen this proposal**

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| *Baculoviridae* and *Nudiviridae* Study Group |

**ICTV study group comments and response of proposer**

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**Submission dates**

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| Date first submitted to SC Chair | January 7, 2020 |
| Date of this revision (if different to above) | July 16, 2020 |

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

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

**Name of accompanying Excel module**

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| 2020.001D.R.Alphabaculovirus\_1nsp.xlsx |

**Abstract**

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| We propose to create a new baculovirus species, *Spodoptera exigua multiple nucleopolyhedrovirus B*, in the genus *Alphabaculovirus*. The exemplar isolate for this new species originates from the same host (beet armyworm; *Spodoptera exigua*) as isolates of the current alphabaculovirus species *Spodoptera exigua multiple nucleopolyhedrovirus*, but has diverged from other S. exiguaalphabaculovirus isolates to an extent that mandates classification into a new species. We further propose to change the name of *Spodoptera exigua multiple nucleopolyhedrovirus* to *Spodoptera exigua multiple nucleopolyhedrovirus A*, to distinguish it from the proposed species *Spodoptera exigua multiple nucleopolyhedrovirus B*. |

**Text of proposal**

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| |  | | --- | | Isolate of the proposed species can be identified as belonging to the genus *Alphabaculovirus* on the basis of three or more of the following criteria:   * host species of the insect order Lepidoptera; * circular double-stranded DNA genome (128,525 bp) (GenBank Accession number MH370144) ranging in size from 110-170 kbp with a gene content characteristic of other alphabaculoviruses; * relationships to other baculoviruses as inferred by molecular phylogeny; * occlusion bodies formed within the nucleus with a characteristic shape and size (polyhedral, 1.39 μm in diameter); * rod-shaped virions consisting of nucleocapsids enveloped singly or in bunches, with multiple virions embedded in each occlusion body.   Figure 1 shows the relationships of representative isolate of the proposed species (SeMNPV-QD; [1]) to representative isolates of other recognized species in the genus *Alphabaculovirus* (Table 1), as well as a selection of representative isolates for the other three genera of *Baculoviridae* (*Betabaculovirus*, *Gammabaculovirus*, and *Deltabaculovirus*), determined from the concatenated alignment of the predicted amino acid sequences of 38 baculovirus core genes [2, 5]. The tree shows the relationship between the representative of the proposed *Alphabaculovirus* species group with other alphabaculoviruses.  Distinctions among species of the *Baculoviridae* have been based on host range, DNA restriction endonuclease fragment patterns, and comparisons of nucleotide and predicted amino acid sequences from various genes. In addition, species demarcation criteria for baculoviruses have been proposed that rely upon pairwise nucleotide distances estimated with the Kimura 2-parameter substitution model from partial sequences of three conserved baculovirus genes: *lef-8* and *lef-9* (encoding viral RNA polymerase subunits), and *polh* (encoding the viral occlusion body matrix protein) [6]. If nucleotide distances between two viruses are less than 0.015 substitutions/site, the two baculoviruses are considered to be the same species. If nucleotide distances between two viruses are greater than 0.05 substitutions/site, the viruses are considered to be different species. If the nucleotide distances lie between 0.015 and 0.050 substitutions/site, additional characteristics of the two viruses (*i.e.* host range) must be considered to make a decision about their taxonomic status. The proposed criterion was originally based on an alignment of sequences from 117 separate baculovirus isolates and the phylogeny inferred from this alignment. Researchers have applied this criterion to other isolates to identify many new baculovirus species and variants of currently recognized species.  Pairwise nucleotide distances for *lef-*8, *lef-9*, and *polh* are shown in Tables 2 and 3. The distances between the sequences of the proposed species’ representative isolate and other alphabaculovirus isolates are >0.05 substitutions/site for each locus, indicating that the isolate under consideration is representative of new, previously unrecognized species and not variant of members of currently existing species.  The representative of proposed species, SeMNPV-QD, was isolated from naturally diseased larvae of *Spodoptera exigua* in Qingdao, China [1]. The species *Spodoptera exigua multiple nucleopolyhedrovirus* was previously established for the American isolate of Spodoptera exigua multiple nucleopolyhedrovirus US1 (SeMNPV-US1) [3, 4]. After finding that SeMNPV-QD should belong to a different species, we propose to rename species *Spodoptera exigua multiple nucleopolyhedrovirus* (the original one) to *Spodoptera exigua multiple nucleopolyhedrovirus A* and to establish a new species *Spodoptera exigua multiple nucleopolyhedrovirus B*, for the one isolate, SeMNPV-QD. | |

**Supporting evidence**

**Table 1.** *Alphabaculovirus* isolates used in pairwise distance estimation

| **Isolate** | **Species** | **Accession no.** | **Abbreviation** |
| --- | --- | --- | --- |
| Adoxophyes honmai nucleopolyhedrovirus ADN001 | *Adoxophyes honmai nucleopolyhedrovirus* | AP006270 | AdhoNPV-ADN001 |
| Agrotis ipsilon multiple nucleopolyhedrovirus Illinois | *Agrotis ipsilon multiple nucleopolyhedrovirus* | EU839994 | AgipMNPV-Illinois |
| Agrotis segetum nucleopolyhedrovirus A | *Agrotis segetum nucleopolyhedrovirus A* | DQ123841 | AgseNPV-A |
| Agrotis segetum nucleopolyhedrovirus B | *Agrotis segetum nucleopolyhedrovirus B* | KM102981 | AgseNPV-B |
| Antheraea pernyi nucleopolyhedrovirus Liaoning | *Antheraea pernyi nucleopolyhedrovirus* | DQ486030 | AnpeNPV-Liaoning |
| Anticarsia gemmatalis multiple nucleopolyhedrovirus 2D | *Anticarsia gemmatalis multiple nucleopolyhedrovirus* | DQ813662 | AgMNPV-2D |
| Autographa californica multiple nucleopolyhedrovirus C6 | *Autographa californica multiple nucleopolyhedrovirus* | L22858 | AcMNPV-C6 |
| Bombyx mori nucleopolyhedrovirus T3 | *Bombyx mori nucleopolyhedrovirus* | L33180 | BmNPV-T3 |
| Buzura suppressaria nucleopolyhedrovirus Hubei | *Buzura suppressaria nucleopolyhedrovirus* | KF611977 | BusuNPV-Hubei |
| Choristoneura fumiferana DEF multiple nucleopolyhedrovirus | *Choristoneura fumiferana DEF multiple nucleopolyhedrovirus* | AY327402 | CfDEFNPV |
| Choristoneura fumiferana multiple nucleopolyhedrovirus Ireland | *Choristoneura fumiferana multiple nucleopolyhedrovirus* | AF512031 | CfMNPV-Ireland |
| Choristoneura rosaceana nucleopolyhedrovirus NB1 | *Choristoneura rosaceana nucleopolyhedrovirus* | KC961304 | ChroNPV-NB1 |
| Chrysodeixis chalcites nucleopolyhedrovirus | *Chrysodeixis chalcites nucleopolyhedrovirus* | AY864330 | ChchNPV |
| Choristoneura murinana alphabaculovirus Darmstadt | *Choristoneura murinana nucleopolyhedrovirus* | KF894742 | ChmuNPV-Darmstadt |
| Clanis bilineata nucleopolyhedrovirus DZ1 | *Clanis bilineata nucleopolyhedrovirus* | DQ504428 | ClbiNPV-DZ1 |
| Dasychira pudibunda nucleopolyhedrovirus ML1 | *Orgyia pseudotsugata multiple nucleopolyhedrovirus* | KP747440 | DapuNPV-ML1 |
| Ectropis obliqua nucleopolyhedrovirus A1 | *Ectropis obliqua nucleopolyhedrovirus* | DQ837165 | EcobNPV-A1 |
| Epiphyas postvittana nucleopolyhedrovirus | *Epiphyas postvittana nucleopolyhedrovirus* | AY043265 | EppoNPV |
| Euproctis pseudoconspersa nucleopolyhedrovirus Hangzhou | *Euproctis pseudoconspersa nucleopolyhedrovirus* | FJ227128 | EupsNPV-Hangzhou |
| Helicoverpa armigera nucleopolyhedrovirus C1 | *Helicoverpa armigera nucleopolyhedrovirus* | AF271059 | HearNPV-C1 |
| Hyphantria cunea nucleopolyhedrovirus N9 | *Hyphantria cunea nucleopolyhedrovirus* | AP009046 | HycuNPV-N9 |
| Lambdina fiscellaria nucleopolyhedrovirus GR15 | *Lambdina fiscellaria nucleopolyhedrovirus* | KP752043 | LafiNPV-GR15 |
| Leucania separata nucleopolyhedrovirus AH1 | *Leucania separata nucleopolyhedrovirus* | AY394490 | LeseNPV-AH1 |
| Lymantria dispar multiple nucleopolyhedrovirus 5-6 | *Lymantria dispar multiple nucleopolyhedrovirus* | AF081810 | LdMNPV 5-6 |
| Lymantria xylina multiple nucleopolyhedrovirus-5 | *Lymantria xylina nucleopolyhedrovirus* | GQ202541 | LyxyMNPV-5 |
| Mamestra brassicae multiple nucleopolyhedrovirus K1 | *Mamestra brassicae multiple nucleopolyhedrovirus* | JQ798165 | MabrNPV-K1 |
| Mamestra configurata nucleopolyhedrovirus A 90/2 | *Mamestra configurata nucleopolyhedrovirus A* | U59461 | MacoNPV-A 90/2 |
| Mamestra configurata nucleopolyhedrovirus B 96B | *Mamestra configurata nucleopolyhedrovirus B* | AY126275 | MacoNPV-B 96B |
| Maruca vitrata nucleopolyhedrovirus Taiwan | *Maruca vitrata nucleopolyhedrovirus* | EF125867 | MaviNPV-Taiwan |
| Orgyia leucostigma nucleopolyhedrovirus CFS-77 | *Orgyia leucostigma nucleopolyhedrovirus* | EU309041 | OrleNPV-CFS77 |
| Orgyia pseudotsugata multiple nucleopolyhedrovirus | *Orgyia pseudotsugata multiple nucleopolyhedrovirus* | U75930 | OpMNPV |
| Pseudoplusia includens single nucleopolyhedrovirus-IE | *Chrysodeixis includes nucleopolyhedrovirus* | KJ631622 | PsinNPV-IE |
| **Spodoptera exigua multiple nucleopolyhedrovirus Qingdao** | ***Spodoptera exigua multiple nucleopolyhedrovirus B*** | **MH370144** | **SeMNPV-QD** |
| **Spodoptera exigua multiple nucleopolyhedrovirus US1** | ***Spodoptera exigua multiple nucleopolyhedrovirus A*** | **AF169823** | **SeMNPV-US1** |
| Spodoptera frugiperda multiple nucleopolyhedrovirus 3AP2 | *Spodoptera frugiperda multiple nucleopolyhedrovirus* | EF035042 | SfMNPV-3AP2 |
| Spodoptera littoralis nucleopolyhedrovirus II | Unclassified | EU780426 | SpliNPV-II |
| Spodoptera litura nucleopolyhedrovirus G2 | *Spodoptera litura nucleopolyhedrovirus* | AF325155 | SpltNPV-G2 |
| Sucra jujuba nucleopolyhedrovirus 473 | *Sucra jujuba nucleopolyhedrovirus* | KJ676450 | SujuNPV-473 |
| Thysanoplusia orichalcea nucleopolyhedrovirus P2 | *Thysanoplusia orichalcea nucleopolyhedrovirus* | JX467702 | ThorNPV-P2 |
| Trichoplusia ni single nucleopolyhedrovirus Canada | *Trichoplusia ni single nucleopolyhedrovirus* | DQ017380 | TnSNPV-Canada |

Isolates for newly proposed species are indicated in bold type and yellow background.



**Figure 1.** Relationships of alphabaculovirus isolates (Table 1) and other baculovirus isolates, inferred from the predicted amino acid sequences of baculovirus core genes. The phylogenetic tree was constructed from the concatenated alignments of 38 baculovirus core gene amino acid sequences using the minimum evolution method using the James-Taylor-Thornton substitution model. Clades corresponding to the four genera of *Baculoviridae* are indicated. The representative isolate of the proposed species is marked with a red dot. In addition to alphabaculoviruses listed in Table 1, representatives from the other baculovirus genera are included in the analysis, including Adoxophyes orana granulovirus English (AdorGV-English), Cydia pomonella granulovirus M1 (CpGV-M1), Culex nigripalpusnucleopolyhedrovirus Florida/1997 (CuniNPV-Florida/1997), Neodiprion lecontei nucleopolyhedrovirus (NeleNPV), Neodiprion sertifer nucleopolyhedrovirus (NeseNPV) and Xestia c-nigrum granulovirus α4 (XecnGV- α4).

Table 2. Pairwise nucleotide distances calculated from partial *lef-8* and *lef-9* sequence alignments\*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| *lef-9* | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** |
| *lef-8* |
| **1.**AdhoNPV-ADN001 |  | 0.530 | 0.545 | 0.522 | 0.656 | 0.592 | 0.555 | 0.550 | 0.478 | 0.586 | 0.626 | 0.630 | 0.460 | 0.644 | 0.503 | 0.623 | 0.462 | 0.571 | 0.477 | 0.499 | 0.619 | 0.514 | 0.532 | 0.572 | 0.560 | 0.501 | 0.472 | 0.503 | 0.538 | 0.444 | 0.619 | 0.501 | **0.559** | 0.563 | 0.547 | 0.536 | 0.563 | 0.481 | 0.513 | 0.491 |
| **2.** AgipMNPV-Illinois | 0.880 |  | 0.205 | 0.087 | 0.541 | 0.600 | 0.613 | 0.606 | 0.490 | 0.595 | 0.560 | 0.554 | 0.415 | 0.557 | 0.559 | 0.513 | 0.492 | 0.598 | 0.497 | 0.514 | 0.575 | 0.438 | 0.405 | 0.407 | 0.421 | 0.313 | 0.278 | 0.315 | 0.578 | 0.456 | 0.509 | 0.429 | **0.347** | 0.255 | 0.282 | 0.229 | 0.468 | 0.534 | 0.602 | 0.429 |
| **3.** AgseNPV-A | 0.960 | 0.231 |  | 0.218 | 0.534 | 0.546 | 0.584 | 0.567 | 0.484 | 0.551 | 0.557 | 0.539 | 0.420 | 0.546 | 0.537 | 0.514 | 0.477 | 0.605 | 0.479 | 0.548 | 0.553 | 0.426 | 0.438 | 0.435 | 0.431 | 0.303 | 0.305 | 0.301 | 0.574 | 0.468 | 0.514 | 0.426 | **0.317** | 0.234 | 0.264 | 0.236 | 0.521 | 0.535 | 0.543 | 0.444 |
| **4.** AgseNPV-B | 0.865 | 0.098 | 0.276 |  | 0.546 | 0.600 | 0.623 | 0.604 | 0.483 | 0.583 | 0.561 | 0.544 | 0.452 | 0.547 | 0.594 | 0.518 | 0.493 | 0.603 | 0.487 | 0.511 | 0.559 | 0.449 | 0.413 | 0.431 | 0.446 | 0.335 | 0.301 | 0.340 | 0.580 | 0.447 | 0.518 | 0.438 | **0.344** | 0.259 | 0.281 | 0.234 | 0.480 | 0.517 | 0.590 | 0.441 |
| **5.** AnpeNPV-Liaoning | 1.458 | 0.866 | 0.902 | 0.939 |  | 0.283 | 0.446 | 0.441 | 0.575 | 0.272 | 0.265 | 0.266 | 0.608 | 0.260 | 0.629 | 0.243 | 0.581 | 0.333 | 0.571 | 0.646 | 0.254 | 0.530 | 0.564 | 0.502 | 0.505 | 0.573 | 0.581 | 0.576 | 0.446 | 0.559 | 0.242 | 0.615 | **0.574** | 0.579 | 0.572 | 0.553 | 0.562 | 0.608 | 0.443 | 0.598 |
| **6.** AgMNPV-2D | 1.249 | 1.012 | 0.995 | 1.058 | 0.366 |  | 0.373 | 0.372 | 0.517 | 0.079 | 0.258 | 0.252 | 0.545 | 0.247 | 0.577 | 0.249 | 0.545 | 0.247 | 0.513 | 0.566 | 0.223 | 0.491 | 0.560 | 0.507 | 0.518 | 0.573 | 0.564 | 0.573 | 0.376 | 0.516 | 0.251 | 0.548 | **0.551** | 0.572 | 0.555 | 0.565 | 0.569 | 0.542 | 0.358 | 0.538 |
| **7.** AcMNPV-C6 | 1.099 | 0.926 | 0.919 | 0.955 | 0.727 | 0.618 |  | 0.044 | 0.472 | 0.393 | 0.423 | 0.456 | 0.552 | 0.446 | 0.586 | 0.406 | 0.505 | 0.380 | 0.535 | 0.591 | 0.401 | 0.540 | 0.614 | 0.590 | 0.579 | 0.551 | 0.567 | 0.549 | 0.118 | 0.505 | 0.411 | 0.536 | **0.573** | 0.568 | 0.597 | 0.550 | 0.586 | 0.511 | 0.207 | 0.499 |
| **8.** BmNPV-T3 | 1.097 | 0.963 | 0.920 | 0.983 | 0.750 | 0.617 | 0.028 |  | 0.473 | 0.386 | 0.421 | 0.439 | 0.531 | 0.435 | 0.588 | 0.401 | 0.488 | 0.380 | 0.519 | 0.551 | 0.401 | 0.533 | 0.578 | 0.562 | 0.551 | 0.537 | 0.550 | 0.537 | 0.117 | 0.503 | 0.403 | 0.522 | **0.552** | 0.565 | 0.590 | 0.545 | 0.551 | 0.487 | 0.199 | 0.502 |
| **9.** BusuNPV-Hubei | 0.770 | 0.813 | 0.812 | 0.802 | 1.150 | 1.076 | 1.071 | 1.080 |  | 0.534 | 0.537 | 0.535 | 0.480 | 0.552 | 0.440 | 0.554 | 0.326 | 0.504 | 0.363 | 0.494 | 0.508 | 0.398 | 0.515 | 0.495 | 0.494 | 0.457 | 0.477 | 0.457 | 0.482 | 0.329 | 0.554 | 0.472 | **0.483** | 0.498 | 0.491 | 0.506 | 0.521 | 0.356 | 0.506 | 0.496 |
| **10.** CfDEFNPV | 1.220 | 0.982 | 0.961 | 1.029 | 0.351 | 0.041 | 0.621 | 0.617 | 1.113 |  | 0.235 | 0.192 | 0.600 | 0.225 | 0.578 | 0.221 | 0.540 | 0.257 | 0.529 | 0.556 | 0.218 | 0.507 | 0.564 | 0.498 | 0.500 | 0.576 | 0.562 | 0.578 | 0.391 | 0.532 | 0.221 | 0.569 | **0.556** | 0.570 | 0.561 | 0.541 | 0.568 | 0.558 | 0.359 | 0.577 |
| **11.** CfMNPV-Ireland | 1.243 | 0.856 | 0.858 | 0.886 | 0.327 | 0.383 | 0.672 | 0.665 | 1.127 | 0.346 |  | 0.135 | 0.636 | 0.084 | 0.658 | 0.187 | 0.573 | 0.303 | 0.556 | 0.615 | 0.210 | 0.527 | 0.613 | 0.505 | 0.501 | 0.599 | 0.579 | 0.601 | 0.417 | 0.544 | 0.187 | 0.613 | **0.620** | 0.572 | 0.569 | 0.572 | 0.555 | 0.603 | 0.401 | 0.641 |
| **12.** ChroNPV-NB1 | 1.288 | 0.906 | 0.906 | 0.994 | 0.332 | 0.387 | 0.692 | 0.697 | 1.087 | 0.363 | 0.151 |  | 0.625 | 0.123 | 0.637 | 0.164 | 0.586 | 0.292 | 0.524 | 0.618 | 0.201 | 0.526 | 0.560 | 0.482 | 0.492 | 0.567 | 0.542 | 0.567 | 0.450 | 0.525 | 0.167 | 0.608 | **0.588** | 0.546 | 0.574 | 0.540 | 0.589 | 0.576 | 0.419 | 0.603 |
| **13.** ChchNPV | 0.888 | 0.735 | 0.740 | 0.730 | 1.284 | 1.184 | 1.051 | 1.023 | 0.834 | 1.231 | 1.201 | 1.224 |  | 0.661 | 0.486 | 0.614 | 0.452 | 0.577 | 0.434 | 0.465 | 0.597 | 0.451 | 0.459 | 0.569 | 0.579 | 0.417 | 0.405 | 0.419 | 0.559 | 0.487 | 0.603 | 0.111 | **0.404** | 0.412 | 0.417 | 0.421 | 0.504 | 0.523 | 0.540 | 0.117 |
| **14.** ChmuNPV-Darmstadt | 1.290 | 0.801 | 0.857 | 0.903 | 0.300 | 0.354 | 0.701 | 0.715 | 1.082 | 0.322 | 0.086 | 0.125 | 1.188 |  | 0.659 | 0.180 | 0.574 | 0.332 | 0.564 | 0.619 | 0.208 | 0.528 | 0.574 | 0.499 | 0.507 | 0.586 | 0.571 | 0.586 | 0.439 | 0.553 | 0.177 | 0.613 | **0.617** | 0.554 | 0.574 | 0.555 | 0.548 | 0.587 | 0.406 | 0.622 |
| **15.** ClbiNPV-DZ1 | 0.862 | 0.910 | 0.869 | 0.818 | 1.088 | 1.106 | 1.023 | 1.028 | 0.883 | 1.114 | 1.224 | 1.137 | 0.823 | 1.182 |  | 0.628 | 0.474 | 0.635 | 0.479 | 0.502 | 0.586 | 0.477 | 0.526 | 0.555 | 0.551 | 0.517 | 0.522 | 0.521 | 0.572 | 0.473 | 0.623 | 0.483 | **0.522** | 0.565 | 0.563 | 0.555 | 0.501 | 0.467 | 0.603 | 0.466 |
| **16.** DapuNPV-ML1 | 1.416 | 0.789 | 0.837 | 0.891 | 0.245 | 0.364 | 0.644 | 0.665 | 1.126 | 0.337 | 0.183 | 0.190 | 1.224 | 0.178 | 1.085 |  | 0.594 | 0.305 | 0.563 | 0.587 | 0.195 | 0.497 | 0.519 | 0.455 | 0.473 | 0.562 | 0.535 | 0.564 | 0.393 | 0.522 | 0.011 | 0.615 | **0.610** | 0.561 | 0.570 | 0.512 | 0.552 | 0.576 | 0.404 | 0.601 |
| **17.** EcobNPV-A1 | 0.848 | 0.768 | 0.696 | 0.749 | 1.168 | 1.124 | 0.935 | 0.935 | 0.704 | 1.118 | 1.102 | 1.194 | 0.819 | 1.176 | 0.775 | 1.145 |  | 0.533 | 0.351 | 0.493 | 0.558 | 0.438 | 0.524 | 0.530 | 0.512 | 0.459 | 0.455 | 0.459 | 0.509 | 0.367 | 0.594 | 0.473 | **0.488** | 0.467 | 0.458 | 0.476 | 0.523 | 0.340 | 0.483 | 0.453 |
| **18.** EppoNPV | 1.133 | 1.059 | 0.986 | 1.068 | 0.437 | 0.323 | 0.645 | 0.651 | 1.049 | 0.319 | 0.418 | 0.467 | 1.101 | 0.424 | 1.083 | 0.442 | 1.027 |  | 0.550 | 0.588 | 0.279 | 0.545 | 0.619 | 0.623 | 0.602 | 0.582 | 0.582 | 0.591 | 0.384 | 0.528 | 0.312 | 0.597 | **0.545** | 0.596 | 0.574 | 0.592 | 0.606 | 0.515 | 0.387 | 0.588 |
| **19.** EupsNPV-Hangzhou | 0.758 | 0.719 | 0.670 | 0.730 | 0.933 | 0.991 | 0.874 | 0.904 | 0.549 | 1.020 | 0.901 | 0.931 | 0.802 | 0.957 | 0.671 | 0.951 | 0.554 | 0.967 |  | 0.491 | 0.525 | 0.409 | 0.447 | 0.481 | 0.495 | 0.441 | 0.452 | 0.443 | 0.521 | 0.343 | 0.566 | 0.428 | **0.493** | 0.488 | 0.487 | 0.489 | 0.501 | 0.407 | 0.509 | 0.464 |
| **20.** HearNPV-C1 | 0.734 | 0.673 | 0.671 | 0.685 | 1.208 | 1.179 | 0.969 | 1.000 | 0.711 | 1.197 | 1.101 | 1.088 | 0.716 | 1.098 | 0.850 | 1.171 | 0.716 | 1.088 | 0.654 |  | 0.601 | 0.519 | 0.459 | 0.541 | 0.566 | 0.486 | 0.477 | 0.490 | 0.560 | 0.529 | 0.592 | 0.508 | **0.486** | 0.510 | 0.484 | 0.510 | 0.469 | 0.463 | 0.506 | 0.474 |
| **21.** HycuNPV-N9 | 1.226 | 0.999 | 0.935 | 0.983 | 0.404 | 0.339 | 0.616 | 0.604 | 1.071 | 0.331 | 0.286 | 0.286 | 1.169 | 0.282 | 1.165 | 0.243 | 1.020 | 0.415 | 0.917 | 1.078 |  | 0.524 | 0.577 | 0.506 | 0.514 | 0.589 | 0.582 | 0.590 | 0.402 | 0.544 | 0.196 | 0.587 | **0.580** | 0.615 | 0.585 | 0.572 | 0.590 | 0.552 | 0.382 | 0.603 |
| **22.** LafiNPV-GR15 | 0.743 | 0.644 | 0.632 | 0.654 | 0.864 | 0.859 | 0.793 | 0.799 | 0.700 | 0.874 | 0.873 | 0.941 | 0.831 | 0.864 | 0.730 | 0.854 | 0.555 | 0.920 | 0.551 | 0.646 | 0.829 |  | 0.449 | 0.433 | 0.428 | 0.429 | 0.393 | 0.430 | 0.538 | 0.439 | 0.498 | 0.438 | **0.480** | 0.454 | 0.487 | 0.479 | 0.483 | 0.432 | 0.509 | 0.451 |
| **23.** LeseNPV-AH1 | 1.072 | 0.540 | 0.610 | 0.611 | 0.936 | 1.173 | 1.013 | 1.073 | 1.044 | 1.147 | 0.961 | 1.016 | 0.914 | 0.946 | 1.047 | 0.942 | 0.917 | 1.158 | 0.778 | 0.845 | 1.074 | 0.741 |  | 0.418 | 0.444 | 0.471 | 0.462 | 0.471 | 0.609 | 0.500 | 0.517 | 0.470 | **0.466** | 0.431 | 0.467 | 0.432 | 0.367 | 0.516 | 0.602 | 0.485 |
| **24.** LdMNPV 5-6 | 1.125 | 0.528 | 0.604 | 0.657 | 0.778 | 1.078 | 1.049 | 1.080 | 0.898 | 1.045 | 0.850 | 0.894 | 0.971 | 0.846 | 0.925 | 0.744 | 0.946 | 1.109 | 0.698 | 0.896 | 0.997 | 0.666 | 0.638 |  | 0.071 | 0.489 | 0.484 | 0.489 | 0.564 | 0.456 | 0.452 | 0.529 | **0.550** | 0.471 | 0.524 | 0.457 | 0.507 | 0.515 | 0.552 | 0.558 |
| **25.** LyxyMNPV-5 | 1.132 | 0.575 | 0.617 | 0.682 | 0.819 | 1.070 | 0.944 | 0.984 | 0.836 | 1.068 | 0.853 | 0.894 | 0.934 | 0.882 | 0.926 | 0.754 | 0.892 | 1.095 | 0.632 | 0.865 | 0.969 | 0.661 | 0.696 | 0.069 |  | 0.527 | 0.498 | 0.527 | 0.538 | 0.453 | 0.468 | 0.542 | **0.559** | 0.483 | 0.524 | 0.480 | 0.514 | 0.480 | 0.527 | 0.556 |
| **26.** MabrNPV-K1 | 0.829 | 0.459 | 0.483 | 0.497 | 1.216 | 1.200 | 0.959 | 0.938 | 0.795 | 1.189 | 1.165 | 1.199 | 0.680 | 1.176 | 0.903 | 1.214 | 0.760 | 1.038 | 0.737 | 0.709 | 1.091 | 0.708 | 0.827 | 0.925 | 0.882 |  | 0.096 | 0.005 | 0.552 | 0.489 | 0.560 | 0.431 | **0.340** | 0.342 | 0.313 | 0.317 | 0.507 | 0.473 | 0.531 | 0.431 |
| **27.** MacoNPV-A 90/2 | 0.843 | 0.435 | 0.468 | 0.468 | 1.232 | 1.178 | 0.939 | 0.944 | 0.832 | 1.231 | 1.186 | 1.147 | 0.658 | 1.155 | 0.861 | 1.188 | 0.744 | 1.117 | 0.782 | 0.715 | 1.066 | 0.707 | 0.807 | 0.859 | 0.854 | 0.101 |  | 0.096 | 0.555 | 0.494 | 0.534 | 0.424 | **0.343** | 0.323 | 0.322 | 0.311 | 0.495 | 0.478 | 0.545 | 0.402 |
| **28.** MacoNPV-B 96B | 0.818 | 0.449 | 0.486 | 0.493 | 1.202 | 1.211 | 0.967 | 0.946 | 0.782 | 1.199 | 1.174 | 1.190 | 0.682 | 1.167 | 0.897 | 1.205 | 0.758 | 1.049 | 0.740 | 0.695 | 1.108 | 0.701 | 0.824 | 0.923 | 0.876 | 0.005 | 0.104 |  | 0.549 | 0.489 | 0.562 | 0.432 | **0.340** | 0.344 | 0.316 | 0.319 | 0.505 | 0.470 | 0.528 | 0.432 |
| **29.** MaviNPV-Taiwan | 1.039 | 1.051 | 0.985 | 1.095 | 0.788 | 0.672 | 0.107 | 0.122 | 1.063 | 0.670 | 0.744 | 0.741 | 1.035 | 0.761 | 1.019 | 0.700 | 0.939 | 0.686 | 0.939 | 0.979 | 0.615 | 0.899 | 1.111 | 1.151 | 1.067 | 1.014 | 1.043 | 1.024 |  | 0.508 | 0.403 | 0.557 | **0.550** | 0.585 | 0.587 | 0.554 | 0.556 | 0.492 | 0.214 | 0.541 |
| **30.** OrleNPV-CFS77 | 0.911 | 0.700 | 0.697 | 0.744 | 0.992 | 1.009 | 0.873 | 0.849 | 0.607 | 1.042 | 0.936 | 0.967 | 0.888 | 0.915 | 0.776 | 0.936 | 0.600 | 0.999 | 0.470 | 0.688 | 0.833 | 0.554 | 0.828 | 0.690 | 0.660 | 0.789 | 0.797 | 0.782 | 0.906 |  | 0.525 | 0.466 | **0.482** | 0.470 | 0.482 | 0.465 | 0.518 | 0.388 | 0.506 | 0.479 |
| **31.** OpMNPV | 1.432 | 0.802 | 0.850 | 0.901 | 0.248 | 0.368 | 0.642 | 0.657 | 1.101 | 0.342 | 0.187 | 0.195 | 1.235 | 0.175 | 1.084 | 0.013 | 1.149 | 0.444 | 0.958 | 1.204 | 0.257 | 0.850 | 0.949 | 0.738 | 0.762 | 1.238 | 1.220 | 1.228 | 0.726 | 0.937 |  | 0.604 | **0.620** | 0.559 | 0.571 | 0.517 | 0.539 | 0.573 | 0.409 | 0.596 |
| **32.** PsinNPV-IE | 0.894 | 0.686 | 0.721 | 0.752 | 1.231 | 1.119 | 1.007 | 0.994 | 0.832 | 1.156 | 1.174 | 1.229 | 0.173 | 1.145 | 0.880 | 1.234 | 0.828 | 1.041 | 0.763 | 0.685 | 1.165 | 0.790 | 0.851 | 0.901 | 0.875 | 0.667 | 0.672 | 0.661 | 1.072 | 0.827 | 1.235 |  | **0.401** | 0.424 | 0.424 | 0.435 | 0.486 | 0.518 | 0.525 | 0.111 |
| **33.** SeMNPV-QD | **0.930** | **0.464** | **0.494** | **0.456** | **1.352** | **1.174** | **0.971** | **0.947** | **0.842** | **1.211** | **1.177** | **1.214** | **0.754** | **1.230** | **0.916** | **1.212** | **0.757** | **1.141** | **0.730** | **0.787** | **1.104** | **0.763** | **0.827** | **1.002** | **0.891** | **0.530** | **0.518** | **0.531** | **1.075** | **0.767** | **1.243** | **0.774** |  | **0.299** | **0.299** | **0.302** | **0.481** | **0.497** | **0.550** | **0.414** |
| **34.**SeMNPV-US1 | 0.999 | 0.332 | 0.352 | 0.356 | 0.917 | 1.061 | 0.920 | 0.955 | 0.792 | 1.025 | 0.907 | 0.982 | 0.784 | 0.955 | 0.874 | 0.869 | 0.785 | 0.984 | 0.686 | 0.758 | 0.923 | 0.789 | 0.718 | 0.703 | 0.704 | 0.533 | 0.483 | 0.524 | 1.063 | 0.737 | 0.895 | 0.737 | **0.462** |  | 0.203 | 0.129 | 0.479 | 0.521 | 0.596 | 0.419 |
| **35.** SfMNPV-3AP2 | 1.012 | 0.454 | 0.459 | 0.465 | 1.084 | 1.111 | 0.943 | 0.941 | 0.757 | 1.103 | 1.061 | 1.057 | 0.734 | 1.104 | 0.785 | 1.106 | 0.819 | 1.060 | 0.760 | 0.760 | 1.037 | 0.702 | 0.832 | 0.895 | 0.839 | 0.582 | 0.565 | 0.567 | 1.032 | 0.758 | 1.106 | 0.718 | **0.470** | 0.321 |  | 0.207 | 0.466 | 0.487 | 0.574 | 0.419 |
| **36.** SpliNPV-AN1956 | 0.964 | 0.300 | 0.373 | 0.343 | 0.933 | 1.084 | 0.948 | 1.006 | 0.774 | 1.042 | 0.912 | 0.967 | 0.783 | 0.949 | 0.849 | 0.885 | 0.787 | 1.079 | 0.729 | 0.706 | 0.959 | 0.720 | 0.692 | 0.648 | 0.673 | 0.538 | 0.486 | 0.529 | 1.041 | 0.723 | 0.910 | 0.722 | **0.453** | 0.149 | 0.272 |  | 0.490 | 0.552 | 0.563 | 0.419 |
| **37.** SpltNPV-G2 | 1.083 | 0.746 | 0.765 | 0.786 | 1.086 | 1.236 | 0.875 | 0.891 | 1.054 | 1.215 | 1.153 | 1.169 | 0.963 | 1.147 | 1.010 | 1.081 | 0.907 | 1.149 | 0.852 | 0.803 | 1.103 | 0.820 | 0.651 | 0.830 | 0.777 | 0.920 | 0.909 | 0.915 | 0.924 | 0.900 | 1.073 | 1.037 | **0.789** | 0.782 | 0.807 | 0.767 |  | 0.533 | 0.592 | 0.493 |
| **38.** SujuNPV-473 | 0.878 | 0.840 | 0.847 | 0.801 | 1.107 | 1.154 | 0.916 | 0.957 | 0.496 | 1.202 | 1.148 | 1.096 | 0.859 | 1.217 | 0.850 | 1.195 | 0.630 | 1.084 | 0.575 | 0.747 | 1.024 | 0.707 | 0.958 | 0.859 | 0.778 | 0.826 | 0.835 | 0.839 | 0.971 | 0.594 | 1.209 | 0.854 | **0.756** | 0.757 | 0.728 | 0.789 | 1.038 |  | 0.507 | 0.493 |
| **39.** ThorNPV-P2 | 1.070 | 0.966 | 0.960 | 0.956 | 0.708 | 0.625 | 0.225 | 0.231 | 0.977 | 0.609 | 0.653 | 0.646 | 1.055 | 0.645 | 1.117 | 0.646 | 0.873 | 0.626 | 0.827 | 1.018 | 0.592 | 0.842 | 1.031 | 1.068 | 0.997 | 0.972 | 1.040 | 0.985 | 0.269 | 0.887 | 0.651 | 1.024 | **1.049** | 0.948 | 0.929 | 0.934 | 0.931 | 0.929 |  | 0.511 |
| **40.** TnSNPV-Canada | 0.854 | 0.674 | 0.657 | 0.730 | 1.182 | 1.037 | 1.030 | 0.993 | 0.784 | 1.068 | 1.177 | 1.134 | 0.152 | 1.200 | 0.832 | 1.132 | 0.792 | 1.040 | 0.783 | 0.731 | 1.112 | 0.734 | 0.907 | 0.925 | 0.911 | 0.661 | 0.633 | 0.655 | 1.072 | 0.814 | 1.157 | 0.172 | **0.716** | 0.700 | 0.647 | 0.749 | 0.922 | 0.839 | 0.938 |  |

\*The number of base substitutions per site between pairs of sequences are shown. Abbrevations of the taxa are as listed for Table 1. Analyses were conducted using the Kimura 2-parameter model in MEGA7. Pairwise distances for *lef-8* sequences are listed below the diagonal lines, and *lef-9* distances are listed above the diagonal lines. Values for the proposed species are in red bold type.

Table 3. Pairwise nucleotide distances calculated from partial *polh* sequence alignments\*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** |
| *polh* |
| **1.**AdhoNPV-ADN001 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.** AgipMNPV-Illinois | 0.453 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **3.** AgseNPV-A | 0.450 | 0.220 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **4.** AgseNPV-B | 0.588 | 0.116 | 0.278 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.** AnpeNPV-Liaoning | 0.548 | 0.466 | 0.448 | 0.533 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **6.** AgMNPV-2D | 0.450 | 0.220 | 0.000 | 0.278 | 0.448 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **7.** AcMNPV-C6 | 0.484 | 0.357 | 0.418 | 0.480 | 0.428 | 0.418 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **8.** BmNPV-T3 | 0.631 | 0.438 | 0.491 | 0.518 | 0.287 | 0.491 | 0.403 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **9.** BusuNPV-Hubei | 0.341 | 0.455 | 0.485 | 0.429 | 0.562 | 0.485 | 0.498 | 0.675 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **10.** CfDEFNPV | 0.578 | 0.430 | 0.448 | 0.499 | 0.197 | 0.448 | 0.475 | 0.285 | 0.566 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **11.** CfMNPV-Ireland | 0.496 | 0.500 | 0.529 | 0.591 | 0.254 | 0.529 | 0.401 | 0.318 | 0.563 | 0.269 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **12.** ChroNPV-NB1 | 0.457 | 0.469 | 0.510 | 0.553 | 0.233 | 0.510 | 0.390 | 0.315 | 0.539 | 0.258 | 0.016 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **13.** ChchNPV | 0.450 | 0.353 | 0.385 | 0.445 | 0.474 | 0.385 | 0.293 | 0.527 | 0.376 | 0.451 | 0.519 | 0.497 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **14.** ChmuNPV-Darmstadt | 0.492 | 0.409 | 0.447 | 0.468 | 0.262 | 0.447 | 0.387 | 0.381 | 0.628 | 0.295 | 0.155 | 0.147 | 0.506 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **15.** ClbiNPV-DZ1 | 0.518 | 0.519 | 0.567 | 0.609 | 0.628 | 0.567 | 0.555 | 0.556 | 0.494 | 0.693 | 0.543 | 0.519 | 0.443 | 0.660 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **16.** DapuNPV-ML1 | 0.419 | 0.404 | 0.459 | 0.532 | 0.231 | 0.459 | 0.367 | 0.291 | 0.620 | 0.212 | 0.188 | 0.171 | 0.436 | 0.179 | 0.560 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **17.** EcobNPV-A1 | 0.395 | 0.399 | 0.454 | 0.425 | 0.543 | 0.454 | 0.449 | 0.532 | 0.373 | 0.536 | 0.492 | 0.475 | 0.456 | 0.460 | 0.578 | 0.435 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **18.** EppoNPV | 0.571 | 0.495 | 0.452 | 0.474 | 0.216 | 0.452 | 0.533 | 0.307 | 0.630 | 0.181 | 0.244 | 0.233 | 0.578 | 0.236 | 0.682 | 0.211 | 0.441 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **19.** EupsNPV-Hangzhou | 0.500 | 0.633 | 0.594 | 0.503 | 0.645 | 0.594 | 0.694 | 0.636 | 0.316 | 0.667 | 0.603 | 0.546 | 0.539 | 0.599 | 0.467 | 0.624 | 0.354 | 0.602 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **20.** HearNPV-C1 | 0.505 | 0.591 | 0.611 | 0.580 | 0.593 | 0.611 | 0.584 | 0.639 | 0.395 | 0.626 | 0.576 | 0.555 | 0.470 | 0.648 | 0.426 | 0.539 | 0.477 | 0.565 | 0.451 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **21.** HycuNPV-N9 | 0.443 | 0.472 | 0.511 | 0.570 | 0.262 | 0.511 | 0.434 | 0.327 | 0.585 | 0.223 | 0.264 | 0.236 | 0.536 | 0.253 | 0.678 | 0.186 | 0.470 | 0.232 | 0.551 | 0.558 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **22.** LafiNPV-GR15 | 0.415 | 0.417 | 0.464 | 0.382 | 0.511 | 0.464 | 0.482 | 0.519 | 0.336 | 0.473 | 0.473 | 0.456 | 0.374 | 0.534 | 0.441 | 0.433 | 0.260 | 0.489 | 0.353 | 0.393 | 0.486 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **23.** LeseNPV-AH1 | 0.523 | 0.354 | 0.392 | 0.472 | 0.484 | 0.392 | 0.442 | 0.464 | 0.581 | 0.397 | 0.436 | 0.427 | 0.473 | 0.525 | 0.605 | 0.430 | 0.437 | 0.485 | 0.632 | 0.602 | 0.492 | 0.506 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **24.** LdMNPV 5-6 | 0.530 | 0.499 | 0.520 | 0.584 | 0.507 | 0.520 | 0.488 | 0.508 | 0.751 | 0.492 | 0.543 | 0.525 | 0.529 | 0.503 | 0.723 | 0.448 | 0.478 | 0.534 | 0.753 | 0.741 | 0.548 | 0.557 | 0.454 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **25.** LyxyMNPV-5 | 0.588 | 0.574 | 0.594 | 0.659 | 0.569 | 0.594 | 0.540 | 0.517 | 0.758 | 0.634 | 0.579 | 0.553 | 0.558 | 0.609 | 0.680 | 0.467 | 0.535 | 0.621 | 0.625 | 0.664 | 0.561 | 0.521 | 0.531 | 0.086 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **26.** MabrNPV-K1 | 0.361 | 0.287 | 0.362 | 0.363 | 0.440 | 0.362 | 0.298 | 0.473 | 0.328 | 0.465 | 0.434 | 0.401 | 0.345 | 0.429 | 0.429 | 0.413 | 0.297 | 0.458 | 0.419 | 0.502 | 0.434 | 0.385 | 0.419 | 0.501 | 0.475 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **27.** MacoNPV-A 90/2 | 0.424 | 0.261 | 0.309 | 0.345 | 0.432 | 0.309 | 0.266 | 0.479 | 0.387 | 0.462 | 0.391 | 0.378 | 0.354 | 0.415 | 0.450 | 0.396 | 0.309 | 0.480 | 0.486 | 0.548 | 0.454 | 0.385 | 0.348 | 0.424 | 0.450 | 0.104 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **28.** MacoNPV-B 96B | 0.354 | 0.287 | 0.355 | 0.363 | 0.431 | 0.355 | 0.303 | 0.464 | 0.333 | 0.464 | 0.442 | 0.409 | 0.344 | 0.421 | 0.429 | 0.412 | 0.297 | 0.457 | 0.418 | 0.501 | 0.434 | 0.388 | 0.420 | 0.492 | 0.467 | 0.003 | 0.104 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **29.** MaviNPV-Taiwan | 0.585 | 0.441 | 0.485 | 0.490 | 0.250 | 0.485 | 0.382 | 0.127 | 0.602 | 0.269 | 0.288 | 0.281 | 0.483 | 0.336 | 0.591 | 0.310 | 0.531 | 0.241 | 0.562 | 0.522 | 0.308 | 0.492 | 0.457 | 0.554 | 0.587 | 0.481 | 0.478 | 0.481 |  |  |  |  |  |  |  |  |  |  |  |  |
| **30.** OrleNPV-CFS77 | 0.435 | 0.447 | 0.448 | 0.472 | 0.605 | 0.448 | 0.521 | 0.537 | 0.308 | 0.526 | 0.523 | 0.499 | 0.405 | 0.611 | 0.425 | 0.495 | 0.318 | 0.537 | 0.330 | 0.386 | 0.494 | 0.322 | 0.473 | 0.664 | 0.558 | 0.372 | 0.355 | 0.378 | 0.503 |  |  |  |  |  |  |  |  |  |  |  |
| **31.** OpMNPV | 0.429 | 0.395 | 0.460 | 0.528 | 0.236 | 0.460 | 0.373 | 0.297 | 0.609 | 0.224 | 0.192 | 0.175 | 0.440 | 0.171 | 0.552 | 0.011 | 0.429 | 0.210 | 0.620 | 0.551 | 0.189 | 0.436 | 0.434 | 0.443 | 0.473 | 0.403 | 0.387 | 0.403 | 0.314 | 0.503 |  |  |  |  |  |  |  |  |  |  |
| **32.** PsinNPV-IE | 0.471 | 0.344 | 0.373 | 0.420 | 0.485 | 0.373 | 0.292 | 0.452 | 0.402 | 0.457 | 0.469 | 0.441 | 0.094 | 0.537 | 0.402 | 0.428 | 0.354 | 0.588 | 0.553 | 0.448 | 0.523 | 0.395 | 0.445 | 0.496 | 0.463 | 0.330 | 0.351 | 0.329 | 0.436 | 0.368 | 0.432 |  |  |  |  |  |  |  |  |  |
| **33.** SeMNPV-QD | **0.461** | **0.359** | **0.346** | **0.408** | **0.523** | **0.346** | **0.473** | **0.638** | **0.476** | **0.578** | **0.494** | **0.481** | **0.445** | **0.527** | **0.577** | **0.537** | **0.484** | **0.514** | **0.576** | **0.478** | **0.514** | **0.465** | **0.488** | **0.743** | **0.714** | **0.404** | **0.389** | **0.404** | **0.547** | **0.465** | **0.524** | **0.451** |  |  |  |  |  |  |  |  |
| **34.**SeMNPV-US1 | 0.395 | 0.251 | 0.295 | 0.280 | 0.494 | 0.295 | 0.475 | 0.505 | 0.378 | 0.501 | 0.518 | 0.485 | 0.438 | 0.562 | 0.526 | 0.432 | 0.350 | 0.463 | 0.484 | 0.503 | 0.472 | 0.350 | 0.342 | 0.565 | 0.526 | 0.294 | 0.290 | 0.294 | 0.453 | 0.376 | 0.422 | 0.363 | **0.344** |  |  |  |  |  |  |  |
| **35.** SfMNPV-3AP2 | 0.426 | 0.236 | 0.299 | 0.335 | 0.440 | 0.299 | 0.328 | 0.490 | 0.464 | 0.455 | 0.497 | 0.480 | 0.311 | 0.471 | 0.469 | 0.415 | 0.387 | 0.526 | 0.674 | 0.543 | 0.453 | 0.444 | 0.418 | 0.442 | 0.537 | 0.281 | 0.247 | 0.282 | 0.506 | 0.388 | 0.406 | 0.329 | **0.314** | 0.207 |  |  |  |  |  |  |
| **36.** SpliNPV-AN1956 | 0.356 | 0.226 | 0.306 | 0.260 | 0.458 | 0.306 | 0.400 | 0.471 | 0.549 | 0.444 | 0.461 | 0.432 | 0.354 | 0.433 | 0.512 | 0.374 | 0.342 | 0.449 | 0.583 | 0.605 | 0.468 | 0.354 | 0.321 | 0.427 | 0.502 | 0.347 | 0.295 | 0.346 | 0.461 | 0.403 | 0.374 | 0.325 | **0.420** | 0.114 | 0.198 |  |  |  |  |  |
| **37.** SpltNPV-G2 | 0.451 | 0.489 | 0.491 | 0.533 | 0.609 | 0.491 | 0.475 | 0.695 | 0.532 | 0.583 | 0.532 | 0.532 | 0.605 | 0.574 | 0.650 | 0.525 | 0.388 | 0.509 | 0.531 | 0.540 | 0.638 | 0.490 | 0.271 | 0.522 | 0.585 | 0.465 | 0.476 | 0.471 | 0.530 | 0.558 | 0.538 | 0.519 | **0.508** | 0.394 | 0.503 | 0.408 |  |  |  |  |
| **38.** SujuNPV-473 | 0.402 | 0.292 | 0.327 | 0.383 | 0.564 | 0.327 | 0.370 | 0.577 | 0.377 | 0.524 | 0.451 | 0.414 | 0.368 | 0.496 | 0.478 | 0.492 | 0.348 | 0.500 | 0.425 | 0.535 | 0.502 | 0.313 | 0.410 | 0.628 | 0.605 | 0.365 | 0.303 | 0.371 | 0.498 | 0.315 | 0.480 | 0.330 | **0.487** | 0.316 | 0.376 | 0.346 | 0.458 |  |  |  |
| **39.** ThorNPV-P2 | 0.620 | 0.506 | 0.527 | 0.561 | 0.302 | 0.527 | 0.402 | 0.205 | 0.537 | 0.264 | 0.326 | 0.315 | 0.444 | 0.332 | 0.678 | 0.256 | 0.513 | 0.249 | 0.626 | 0.599 | 0.270 | 0.539 | 0.420 | 0.572 | 0.639 | 0.481 | 0.527 | 0.481 | 0.192 | 0.567 | 0.255 | 0.415 | **0.602** | 0.565 | 0.510 | 0.484 | 0.654 | 0.505 |  |  |
| **40.** TnSNPV-Canada | 0.390 | 0.377 | 0.432 | 0.486 | 0.461 | 0.432 | 0.247 | 0.507 | 0.368 | 0.471 | 0.441 | 0.418 | 0.141 | 0.515 | 0.423 | 0.479 | 0.402 | 0.624 | 0.548 | 0.519 | 0.526 | 0.404 | 0.424 | 0.482 | 0.581 | 0.293 | 0.317 | 0.299 | 0.473 | 0.412 | 0.488 | 0.157 | **0.446** | 0.456 | 0.344 | 0.390 | 0.450 | 0.337 | 0.464 |  |

\*The number of base substitutions per site between pairs of sequences are shown. Abbreviations of the taxa are as listed for Table 1. Analyses were conducted using the Kimura 2-parameter model in MEGA7. Pairwise distances for *polh* sequences are listed below the diagonal lines. Values for the proposed species are in red bold type.

| **References** |
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