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## ICTV Virus Taxonomy Profile: *Nanoviridae*

John E. Thomas<sup>1,\*</sup>, Bruno Gronenborn<sup>2</sup>, Robert M. Harding<sup>3</sup>, Bikash Mandal<sup>4</sup>, Ioana Grigoras<sup>5</sup>, John W. Randles<sup>6</sup>, Yoshitaka Sano<sup>7</sup>, Tania Timchenko<sup>2</sup>, H. Josef Vetten<sup>8</sup>, Hsin-Hung Yeh<sup>9</sup>, Heiko Ziebell<sup>10</sup> and ICTV Report Consortium

### Abstract

*Nanoviridae* is a family of plant viruses (nanovirids) whose members have small isometric virions and multipartite, circular, single-stranded (css) DNA genomes. Each of the six (genus *Babuvirus*) or eight (genus *Nanovirus*) genomic DNAs is 0.9–1.1 kb and is separately encapsidated. Many isolates are associated with satellite-like cssDNAs (alphasatellites) of 1.0–1.1 kb. Hosts are eudicots, predominantly legumes (genus *Nanovirus*), and monocotyledons, predominantly in the order Zingiberales (genus *Babuvirus*). Nanovirids require a virus-encoded helper factor for transmission by aphids in a circulative, non-propagative manner. This is a summary of the ICTV Report on the family *Nanoviridae*, which is available at [ictv.global/report/nanoviridae](https://ictv.global/report/nanoviridae).

**Table 1.** Characteristics of members of the family *Nanoviridae*

Example:	subterranean clover stunt virus [AU;2534B] (MK035728–MK035735), species <i>Subterranean clover stunt virus</i> , genus <i>Nanovirus</i>
Virion	17–19 nm isometric particles, containing a single capsid protein
Genome	Multipartite, cssDNA, comprising six (each 1.0–1.1 kb; <i>Babuvirus</i> ) or eight (each 0.9–1.0 kb; <i>Nanovirus</i> ) components
Replication	Nuclear, by rolling-circle replication using host DNA polymerase
Translation	From transcripts of dsDNA intermediates, with the aid of host DNA and RNA polymerases
Host range	Eudicots, mainly Fabaceae (genus <i>Nanovirus</i> ); monocotyledons, order Zingiberales (genus <i>Babuvirus</i> ); transmitted by specific aphid vectors
Taxonomy	Realm <i>Monodnaviria</i> , kingdom <i>Shotokuvirae</i> , phylum <i>Cressdnaviricota</i> , class <i>Arfiviricetes</i> , order <i>Mulpavirales</i> ; two genera including >10 species

### VIRION

Nanovirid virions are small isometric particles 17–19 nm in diameter, with a probable  $T=1$  symmetry and often displaying a hexagonal profile (Table 1, Fig. 1) comprising DNA and a single species of capsid protein.

### GENOME

Based on infectivity studies, the genomes of members of the genus *Nanovirus* are thought to comprise eight independently encapsidated circular, single-stranded (css)DNA components, each of 0.9–1.0 kb [1]. Babuviruses have six such

components, each of 1.0–1.1 kb. Viruses in the two genera share a set of five homologous DNA components, referred to as DNA-R (encoding M-Rep), DNA-S (capsid protein), DNA-C (Clink), DNA-M (movement protein) and DNA-N (nuclear shuttle protein) (Fig. 2). DNAs encoding proteins of unknown function have been identified from nanoviruses (DNA-U1, DNA-U2 and DNA-U4) and babuviruses (DNA-U3, potentially expressed in some banana bunchy top virus isolates only) [2]. Autonomously replicating, independently encapsidated alphasatellite molecules of 1.0–1.1 kb are associated with many isolates of viruses in both genera [3]. Nanovirids are unique among circulatively and non-propagatively

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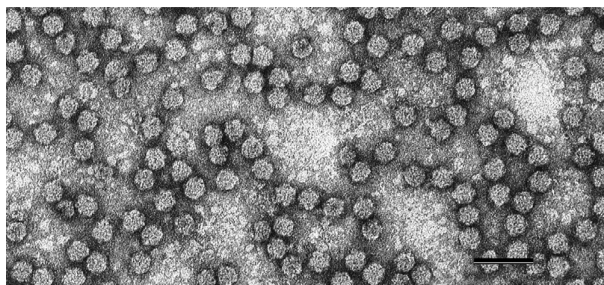
**Keywords:** Nanoviridae; ICTV Report; taxonomy.

**Abbreviations:** CR-M, CR-II, second common region; CR-SL, common region-stem loop; css, circular, single-stranded.

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**Fig. 1.** Negative-contrast electron micrograph of particles of faba bean necrotic yellows virus. Bar, 50 nm. (Courtesy of L. Katul and D.-E. Lesemann.)

transmitted plant viruses in requiring a virus-encoded helper factor for vector transmission by aphids [4].

## REPLICATION

All nanovirid genomic DNAs have a similar structural organization, containing conserved inverted repeat sequences potentially forming a stem-loop structure within a common region-stem loop (CR-SL) that also contains three short repeated sequences (iterons), presumed to be binding sites for M-Rep. A second common region, conserved within virus genomes, is named CR-M (babuviruses) or CR-II (nanoviruses) (Fig. 2). Each DNA component encodes a single protein (with the single exception of banana bunchy top virus DNA-R which has a second smaller ORF, located within the larger ORF). Replication is thought to occur in the nucleus by a rolling-circle mechanism with synthesis of viral dsDNA by host DNA polymerase and mRNA transcribed by host RNA polymerase. M-Rep has DNA cleavage and nucleotidyl transferase activity and is thought to trigger replication initiation of all genomic DNAs.

## TAXONOMY

Current taxonomy: [ictv.global/taxonomy](https://ictv.global/taxonomy). Nanoviruses have mostly been isolated from legumes, while babuviruses infect monocots such as banana [5], abaca and cardamon [6]. Individual viruses are transmitted by one or a few aphid species [4].

## RESOURCES

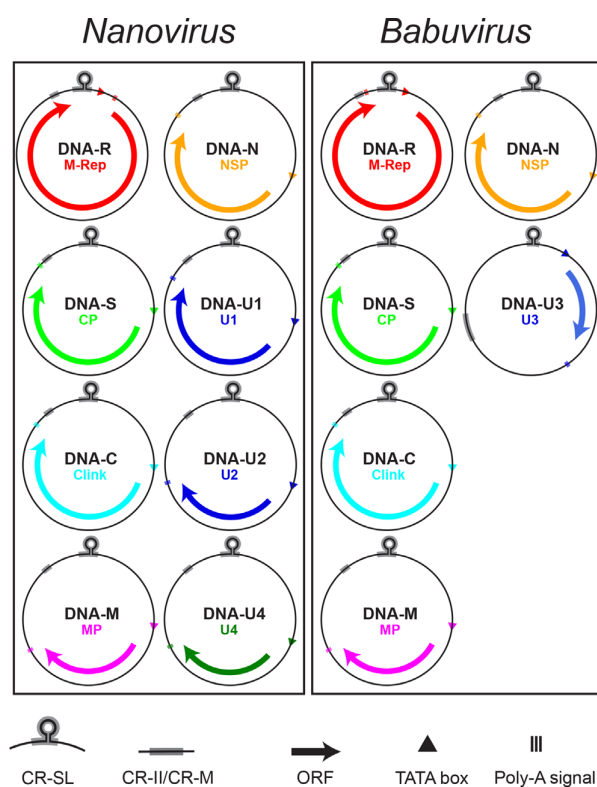
Full ICTV Report on the family *Nanoviridae*: [ictv.global/report/nanoviridae](https://ictv.global/report/nanoviridae).

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**Fig. 2.** Genomic organization of viruses of the family *Nanoviridae*. DNA circles (0.9–1.1 kb) are labelled with their designated name and that of the encoded protein, with ORFs indicated by arrows. The positions of the common stem-loop region (CR-SL) and the second common region (CR-II/CR-M) are indicated.

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### Conflicts of interest

The authors declare that there are no conflicts of interest.

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