


ARTICLE

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A dsRNA virus with filamentous viral particles

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& Wenxing Xu ^{1,2,3}

Viruses with double-stranded RNA genomes form isometric particles or are capsidless. Here we report a double-stranded RNA virus, *Colletotrichum camelliae* filamentous virus 1 (CcFV-1) isolated from a fungal pathogen, that forms filamentous particles. CcFV-1 has eight genomic double-stranded RNAs, ranging from 990 to 2444 bp, encoding 10 putative open reading frames, of which open reading frame 1 encodes an RNA-dependent RNA polymerase and open reading frame 4 a capsid protein. When inoculated, the naked CcFV-1 double-stranded RNAs are infectious and induce the accumulation of the filamentous particles in vivo. CcFV-1 is phylogenetically related to *Aspergillus fumigatus* tetramycovirus-1 and *Beauveria bassiana* polymycovirus-1, but differs in morphology and in the number of genomic components. CcFV-1 might be an intermediate virus related to truly capsidated viruses, or might represent a distinct encapsidating strategy. In terms of genome and particle architecture, our findings are a significant addition to the knowledge of the virosphere diversity.

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Totiviridae

Partitiviridae

Chrysoviridae

Reoviridae

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Betaflexiviridae *Closteroviridae* *Potyviridae* *Alphaflexiviridae*
Gammaflexiviridae

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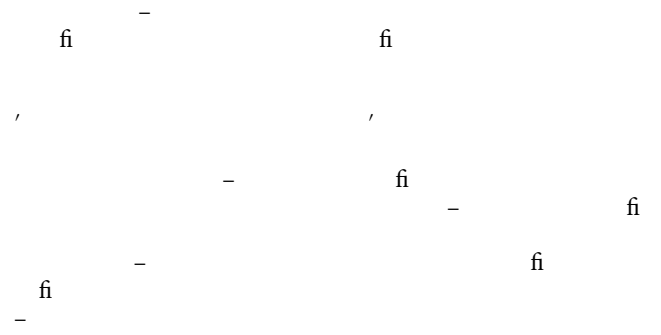
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Complete sequence and genomic organization of dsRNAs 1-8

Results

A complex pattern of dsRNAs in *C. Camelliae* strain LT-3-1

C. camelliae



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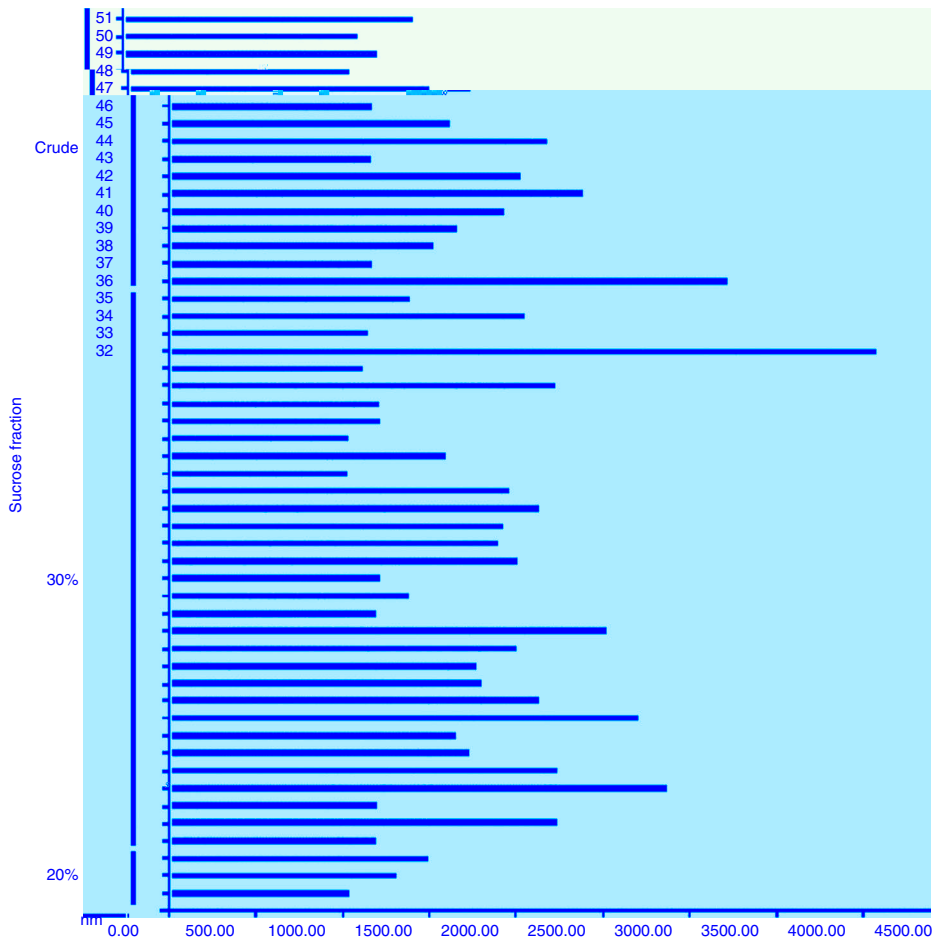
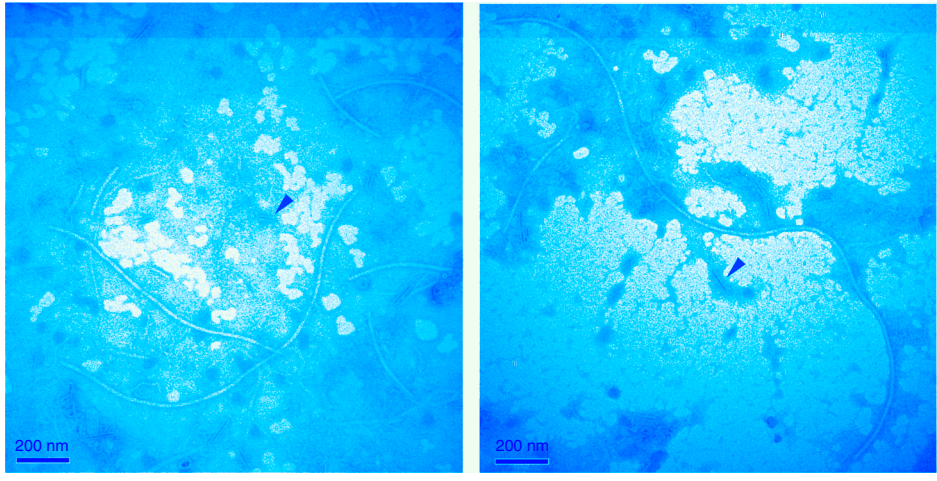
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Alternaria

- *C. camelliae*

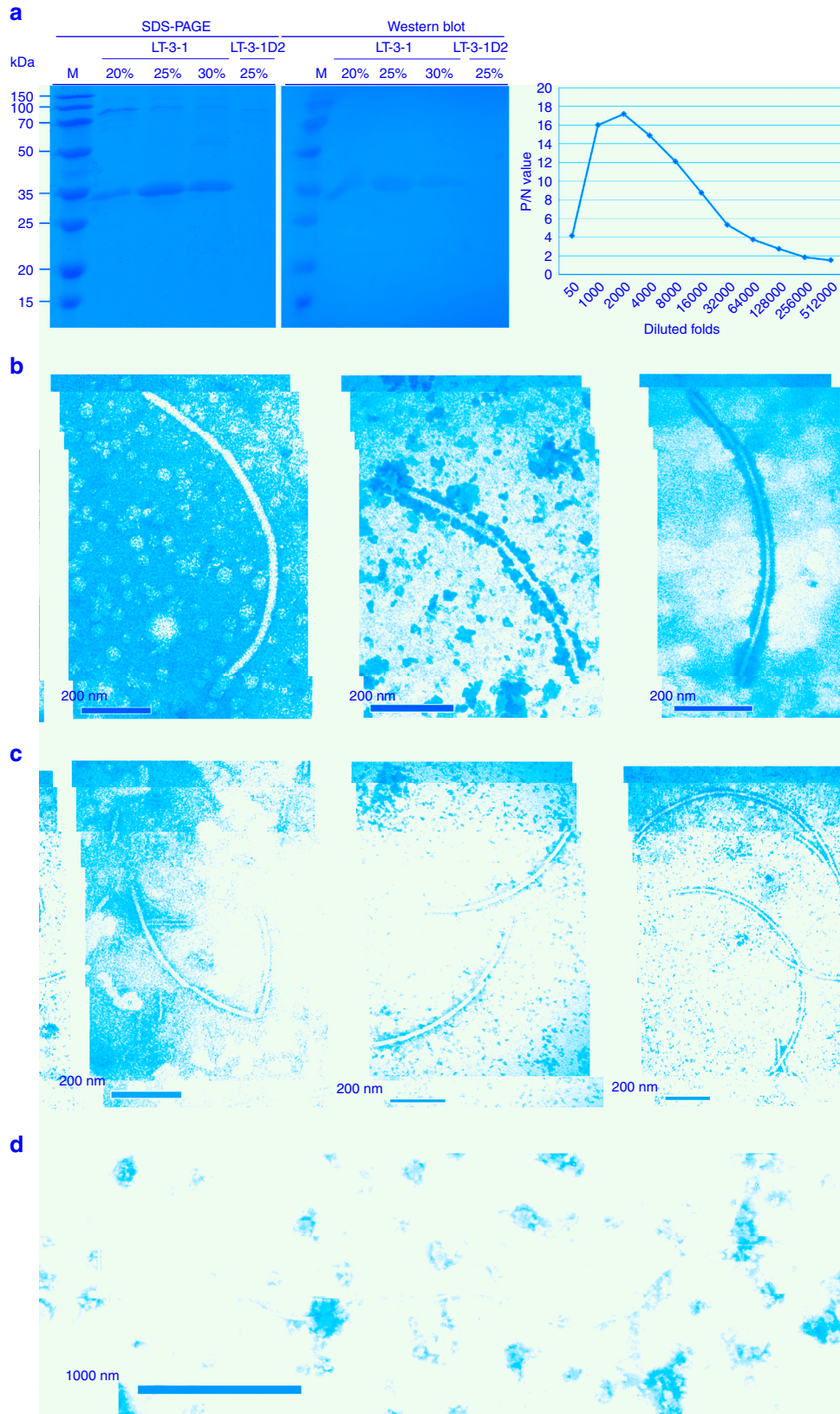
» "*Colletotrichum camelliae* fi

Putative proteins encoded by the CcFV-1 genome

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Caliciviridae

Bacillus subtilis *Methanococcus maripaludis* *Escherichia coli*
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Virus-like particles associated with CcFV-1 dsRNAs

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The dsRNAs and proteins composing the virus-like particles

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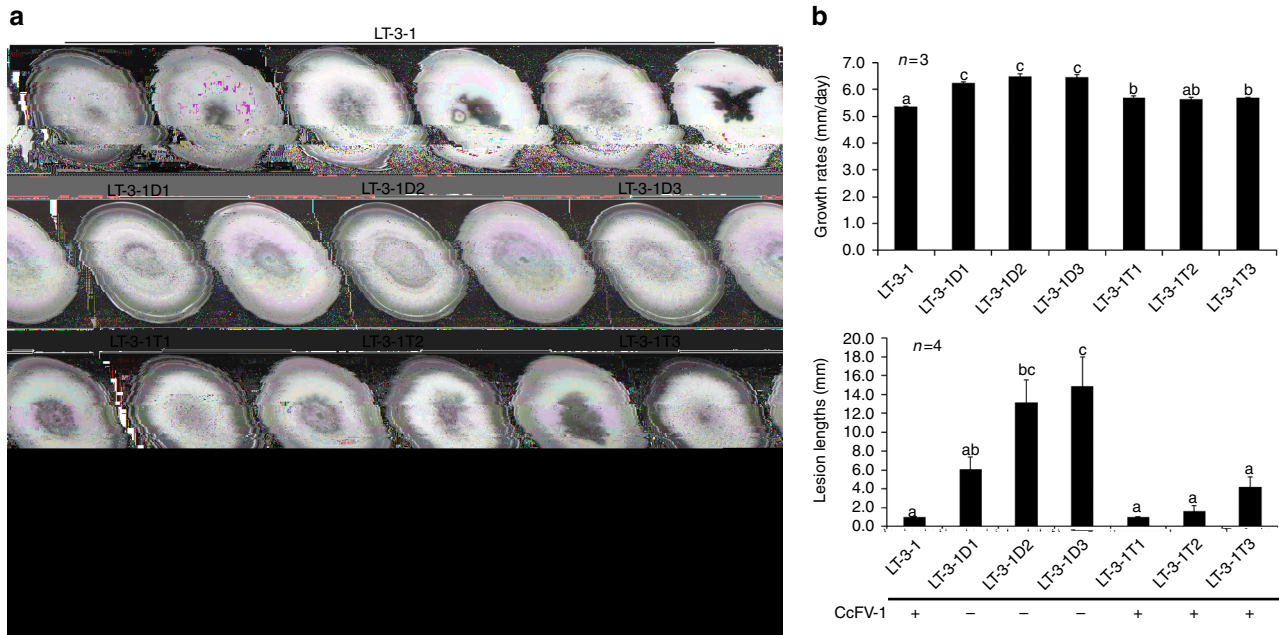


Fig. 6 Colony morphology, growth rate on PDA, and lesion length of different strains of *Colletotrichum camelliae* on tea leaves. **a** Colony morphology of strain LT-3-1, the LT-3-1 subisolates (LT-3-1D1, -D2, and -D3) with CcFV-1 dsRNAs eliminated, and the subisolates (LT-3-1T1, -T2, and -T3) transfected with dsRNAs 1-8 cultured at 25 °C in the dark at 5 dpi and these subisolates cultured at 18 dpi. **b** A histogram of the growth rates of strain LT-3-1 and the subisolates ($n = 3$) and the lesion lengths induced on tea (*Camellia sinensis* cv. 'Taicha 12') leaves ($n = 4$) inoculated with mycelial plugs of these isolates at 4 dpi under non-wounded conditions. The numbers following the "n=" refer to the treatment replicates. The presence of CcFV-1 in these isolates is indicated below the histograms. Symbols "+" and "-" indicate the presence and absence of CcFV-1 based on the results of dsRNA detection obtained by 1.2% agarose gel electrophoresis. Data were analyzed with SPSS Statistics 21.0 (WinWrap Basic; <http://www.winwrap.com>) by one-way ANOVA, and means were compared using Tukey's test at a significance level of $p = 0.05$. Letters (a, b, and c) over the bars indicate the significant difference at $p = 0.05$. Bars in each histogram labeled with the same letters are not significantly different ($p > 0.05$). Error bars indicate \pm standard deviation (SD)

CcFV-1 induces phenotypic changes on its fungal host

CcFV-1 dsRNAs are infectious and produce virus particles

C. camelliae

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C. camelliae fi
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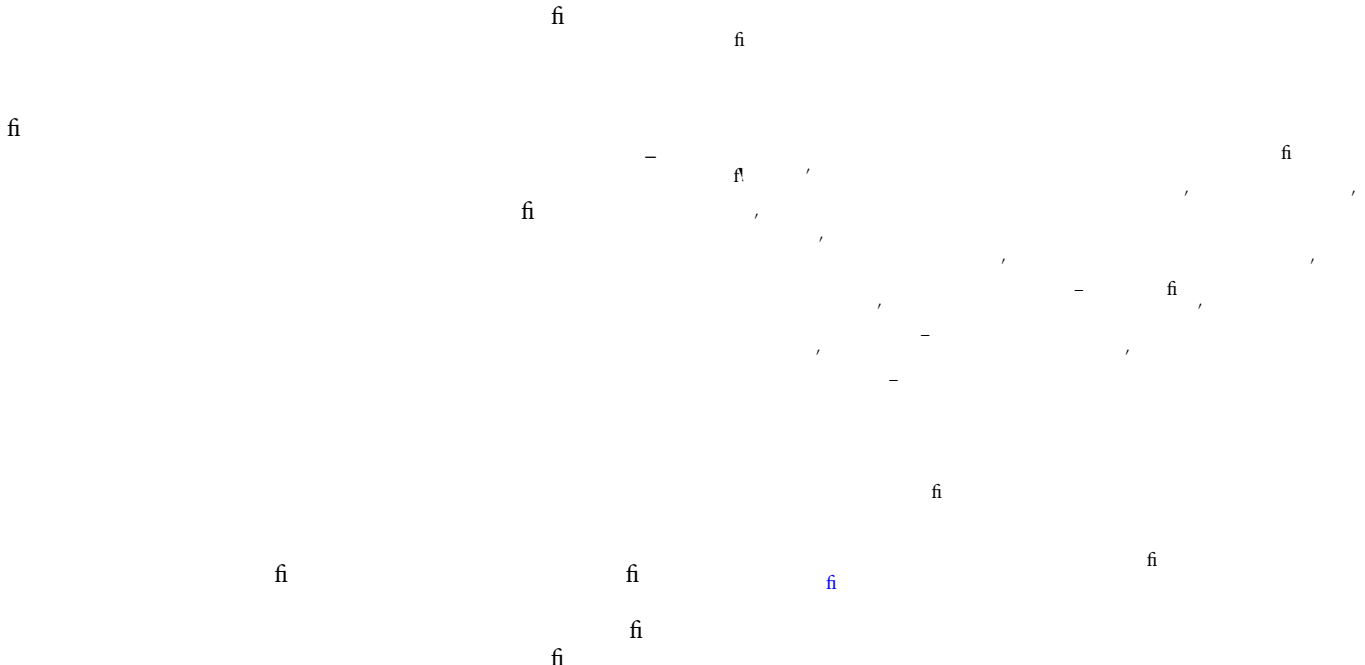
Discussion

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fi fi *Closteroviridae* fi *Flexiviridae Potyviridae*



Methods

Fungal isolates

C. sinensis

C. camelliae

Extraction of the dsRNAs and enzymatic treatments

Purification of virus particles from mycelia

Analysis of the dsRNAs and proteins from the viral particles

Ethics statement

Polyclonal antibody production and ISEM examination

Cloning and sequencing

Elimination of CcFV-1 dsRNAs

C. camelliae

Biochem. Mol. Biol. 28 -

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Virology

184 -

Virology 479-480 -

Aspergillus fumigatus

Proc. Natl Acad. Sci. USA 112 -

Virology 479-480 -

Analysis of the biological features of the fungal strains

Viol. 87 -

J. Gen.

-

C. sinensis

Beauveria bassiana

PLoS Pathog. 13

J. Virol. 83 -

C. camelliae

Sclerotinia sclerotiorum Virology 418 -

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Transfection with CcFV-1 dsRNAs and virus-like particles

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C. camelliae

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Data analysis

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Data availability

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Published online: 01 August 2017

References

Virus taxonomy: ninth report of the International Committee on Taxonomy of Viruses

J. Mol. Biol. 78 -

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Nat. Rev. Microbiol. 6 -

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Author contributions



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Supplementary Information

Competing interests:

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