Characterizing *Sulfolobus* spindle-shaped viruses from Yellowstone National Park and Kamchatka, Russia

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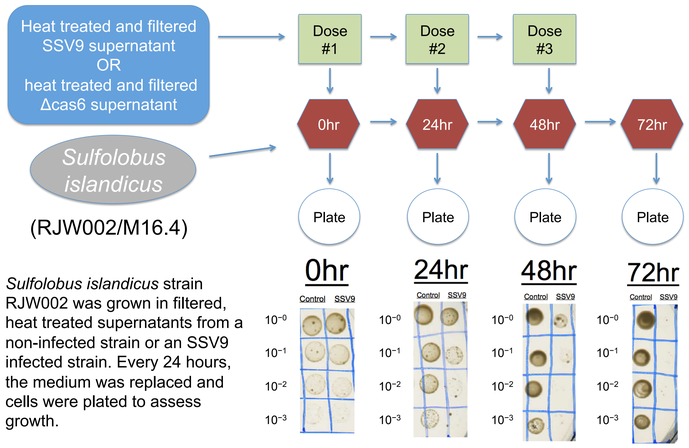
Abstract

Viruses are important drivers of evolution for organisms across the three domains of life. We study how microbes co-evolve with their viruses using the model thermoacidophilic archaea *Sulfolobus islandicus*, which is found in hot springs around the world and is commonly infected by *Sulfolobus* spindle-shaped viruses (SSVs). SSV9, from Kamchatka, Russia, exhibits a unique phenotype that causes non-infected *S. islandicus* cells to go dormant and die while infected cells survive. To explore if this phenotype is broadly functional, we tested the effect of SSV9 on multiple *S. islandicus* strains and *Sulfolobus* species. We also investigated whether other SSVs from Kamchatka or Yellowstone National Park possess the ability to inhibit the growth of non-infected cells. The results from these experiments inform us of how broadly applicable the killing of non-infected cells is among SSVs and provide an improved understanding of the ways that viruses affect the evolution of their microbial hosts.

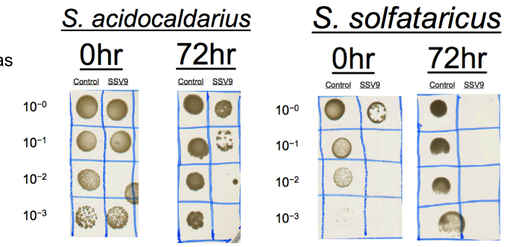
Supernatants from SSV9 infected cells inhibit growth of non-infected cells



Sulfolobus islandicus strain RJW002 was grown in filtered, heat treated supernatants from a non-infected strain or an SSV9 infected strain. Every 24 hours, the medium was replaced and cells were plated to assess growth.

SSV9 supernatants affect other *Sulfolobus* species

Using similar experimental methods as before, we tested species that are closely related to *S. islandicus*. SSV9 supernatants completely or partially inhibit the growth of these strains.

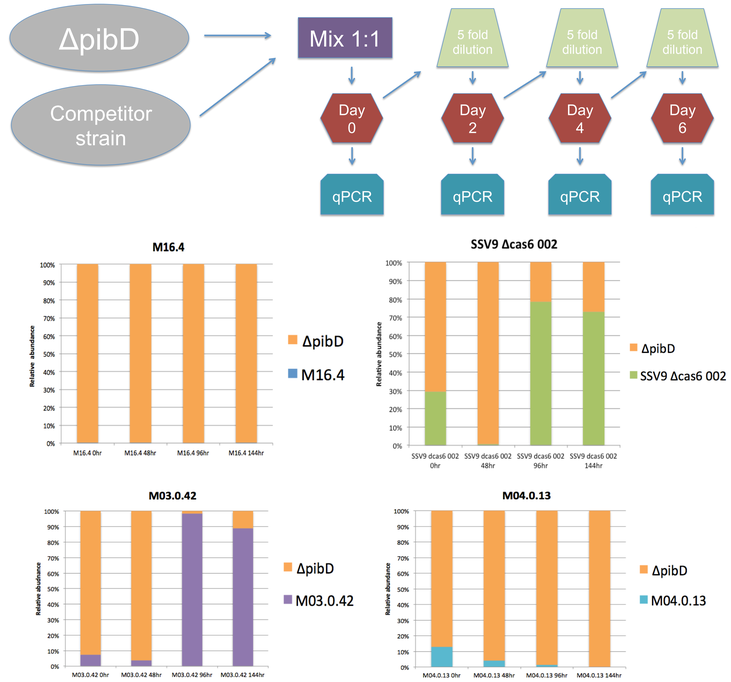


Many *S. islandicus* strains isolated from Kamchatka and Yellowstone are infected with SSVs

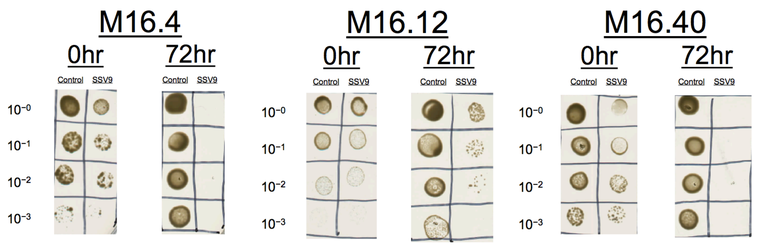
Plaque Assays were used to determine which strains produced infectious SSVs that are capable of forming plaques on a laboratory strain of *S. islandicus*. qPCR was used to diagnose which strain supernatants contained viral genomes. All tested strains contain SSV DNA integrated into their genome. If viral genomes were detected in the supernatants, that means that they have active virus production.

Region	Strain	Produces PFUs	Viral Genomes in supernatant
Kamchatka	M.03.0.42	No	Yes
	M.03.2.5	No	No
	M.04.0.13	No	Yes
	M.04.0.29	No	No
	M.04.0.37	Yes	Yes
	M.06.0.8	No	No
	M.12.04	No	No
	M.16.12	No	No
Yellowstone	NL01B.C01.03	No	Yes
	NL01B.C01.07	No	Yes
	NL01B.C01.09	No	No
	NL01B.C01.13	No	Yes
	NL01B.C01.14	No	Yes
	NL01B.C01.24	No	No
	NL03.C02.01	No	No
	NL03.C02.05	No	No

Some cells infected with SSVs have a competitive advantage over non-infected cells

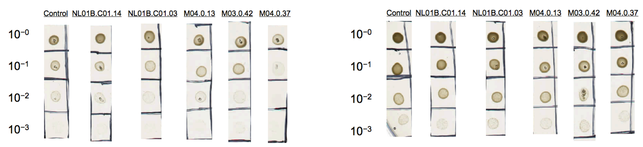


SSV9 supernatants inhibit all tested strains of *S. islandicus* from Kamchatka, Russia



An experiment similar to the one above was performed with different strains of *S. islandicus* from Kamchatka, Russia. The three strains shown are representative of eight strains that we tested.

Supernatants of SSV-infected *S. islandicus* strains from Kamchatka and Yellowstone do not inhibit growth of non-infected cells



The supernatants of *S. islandicus* strains actively producing virus particles were harvested and filtered. Strains resistant (ΔpibD), and sensitive (RJW002) to SSV9 supernatants were given a dose of each sample supernatant every 24 hours until 72 hours. The control supernatant came from a non-infected strain (Δcas6). We observe no difference between the control and the SSV-infected cell supernatants, suggesting these supernatants had no effect on the growth of these non-infected cells.

Conclusions

- Supernatants of SSV9 infected cells broadly inhibit the growth of non-infected *Sulfolobus* cells.
- Many isolated *S. islandicus* strains are infected with an SSV, but few actively produce virus particles under laboratory conditions.
- The inhibitory behaviour of SSV9 supernatants is not shared among all SSVs from Kamchatka, Russia and Yellowstone National Park.
- Some SSVs provide infected cells type with a competitive advantage.

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References

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