

## DNA Vaccine against North American Spring Viremia of Carp Virus (SVCV)

**Background.** Spring viremia of carp virus (SVCV) is a rhabdoviral pathogen that frequently decimates common carp (*Cyprinus carpio carpio*) stocks throughout Europe is an emerging disease in Asia, and it recently invaded the United States. In fish that succumb to infection by SVCV, the spleen, kidney, intestines, and air bladder are typically inflamed, hemorrhaging, or swollen. Disease progression leads to necrosis of the internal organs and eventually death. Outbreaks at common carp farms normally occur in the spring, as the water temperature begins to rise after a cold winter period. Common carp belonging to the *Cyprinidae* family are the principal host species of SVCV. However, fish species from other families of *Poeciliidae*, *Esocidae*, *Centrarchidae*, *Siluridae*, and *Salmonidae* have also been infected by SVCV. SVCV is one of only eight piscine viruses recognized worldwide by the World Organization for Animal Health (OIE) as a notifiable animal disease. Researchers at USGS have made a novel SVCV DNA vaccine utilizing the North Carolina SVCV glycoprotein G-gene. During trials experiments in an aquatic biosafety level 3 laboratory (BSL-3), scientists at the USGS designed and tested the vaccine in koi.

**Abstract.** A DNA vaccine with an SVCV glycoprotein (G) gene from a North American virus isolate was constructed. To test the vaccine a challenge model utilizing a specific pathogen-free domestic koi stock and a cold-water stress treatment was developed. The inventors conducted four trial studies demonstrating that the SVCV DNA vaccine (pSGnc) provided protection in vaccinated fish against challenge at low, moderate, and high virus doses of the homologous virus. The protection was significant ( $p < 0.05$ ) as compared to fish receiving a mock vaccine containing a luciferase reporter gene and to non-vaccinated controls, in fish ranging in age from 3 to 14 months. In all trials, the SVCV-G DNA immunized fish were challenged 28-days post-vaccination (546 degree-days) and experienced low mortalities varying from 10 to 50%, with relative percent survivals ranging from 50 to 88%. The non-vaccinated controls and mock vaccinated fish had high cumulative percent mortalities ranging from 70 to 100%. This is the first report of an SVCV DNA vaccine successfully tested in koi. These experiments prove that the SVCV DNA (pSGnc) vaccine can elicit specific reproducible protection and validates its potential use as a prophylactic vaccine in koi and potentially other vulnerable North American fish species.

**Opportunity.** Aquaculture is a global industry and the most rapidly growing segment of the world livestock production, representing a \$70B industry. Production and sales of Carp and Koi support a global industry with an economic value exceeding \$3B. Carp and other cyprinids are highly susceptible to two viral pathogens, SVCV and koi herpes virus

(KHV). These two pathogens are associated with production losses and mortality in cultured and wild carp populations.

The emergence of SVCV in the United States constitutes a potentially serious alien pathogen threat to susceptible fish stocks in North America. In April 2002, at one of the largest koi production facilities in the United States, yearling koi in one pond began dying from SVCV. Subsequently the virus was detected in other ponds at the facility, fifteen thousand fish died from SVCV and another 135,000 fish were euthanized from ponds located in North Carolina and Virginia. There have been reports of six other deadly outbreaks involving SVCV across the United States since the first outbreak in 2002. Isolations of this exotic virus in recent years and the import restrictions placed on SVCV susceptible fish are warnings of the potential invasiveness and impact SVCV could have on vulnerable fish stocks.

SVCV has caused devastating losses to carp aquaculture worldwide. There is potential for the virus to spread rapidly throughout the hobby and trade industries, and to fish in the wild. Prevention is essential in order to curtail the spread to populations of common and koi carp. Because the number and value of koi kept as pets continue to increase, it is essential that fish medicine enter the realms of traditional small and large animal medicine.

### Keywords

- Fish Vaccine
- Spring Viremia of Carp Virus (SVCV)
- SVCV DNA Vaccine
- Koi
- Common Carp
- Fish Disease

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This technology is protected under U.S. patent 8,030,287. The US Geological Survey is looking for a partner to further the commercialization of this technology through a license agreement. Interested parties should contact:

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