









Biology and Genetic Characterization of Fish and Amphibian Herpesviruses

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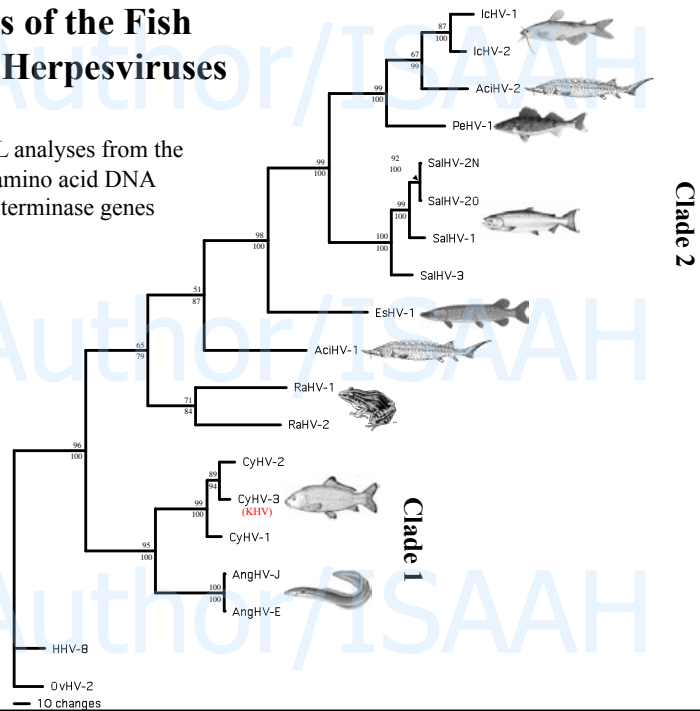
Herpesviruses from Fish and Amphibians

List in accordance with the 8th Report of the ICTV

Designation	Host	Reference
<i>Cyprinid herpesvirus 1</i> (CyHV1, CHV)	<i>Cyprinus carpio</i> 	Sano et al. 1985
<i>Cyprinid herpesvirus 2</i> (CyHV2, GFHNV)	<i>Carassius auratus</i>	Jung & Miyazaki 1995
<i>Cyprinid herpesvirus 3</i> (CyHV3, KHV, CNGV)	<i>Cyprinus carpio</i>	Hedrick et al., 2000
<i>Ictalurid herpesvirus 1</i> (IcHV1, CCV)	<i>Ictalurus punctatus</i> 	Fijan et al. 1970
<i>Ictalurid herpesvirus 2</i> (IcHV2)	<i>Ameiurus melas</i> & <i>I. punctatus</i>	Hedrick et al. 2003
<i>Anguillid herpesvirus 1</i> (AngHV1)	<i>Anguilla japonicus</i> & <i>anguilla</i> 	Sano et al. 1988
<i>Acipenserid herpesvirus 1</i> (AciHV1)	<i>Acipenser transmontanus</i> 	Hedrick et al. 1991
<i>Acipenserid herpesvirus 2</i> (AciHV2)	<i>Acipenser transmontanus</i>	Watson et al. 1995
<i>Salmonid herpesvirus 1</i> (SalHV1)	<i>Oncorhynchus mykiss</i>	Wolf & Taylor 1975
<i>Salmonid herpesvirus 2</i> (SalHV2)(NeVTA)	<i>Oncorhynchus nerka</i> 	Sano, 1976
<i>Salmonid herpesvirus 2</i> (SalHV2)(OMV)	<i>Oncorhynchus masou</i>	Kimura et al., 1981
<i>Salmonid herpesvirus 3</i> (SalHV3, EEDV)	<i>Salvelinus namaycush</i>	McAllister & Herman, 1989
<i>Esocid herpesvirus 1</i> (EsHV1)	<i>Esox lucius</i> & <i>masquinongy</i> 	Yamamoto et al., 1983
<i>Percid Herpesvirus 1</i> (PeHV1)	<i>Sander vitreus</i> 	Kelley et al., 1983
<i>Ranid herpesvirus 1</i> (RaHV1)	<i>Rana pipiens</i> 	Granoff et al. 1989
<i>Ranid herpesvirus 2</i> (RaHV2)	<i>Rana pipiens</i>	Rafferty, 1965

Relationships of the Fish & Amphibian Herpesviruses

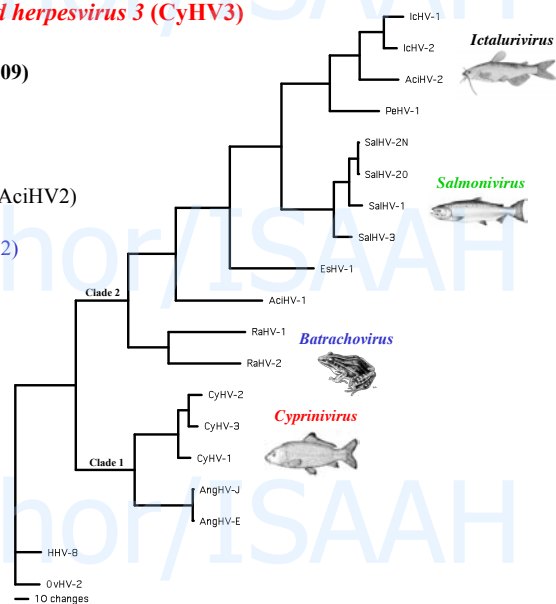
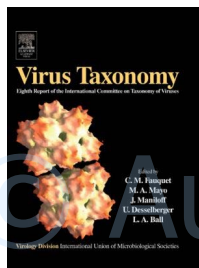
- Bayesian and ML analyses from the partial deduced amino acid DNA polymerase and terminase genes

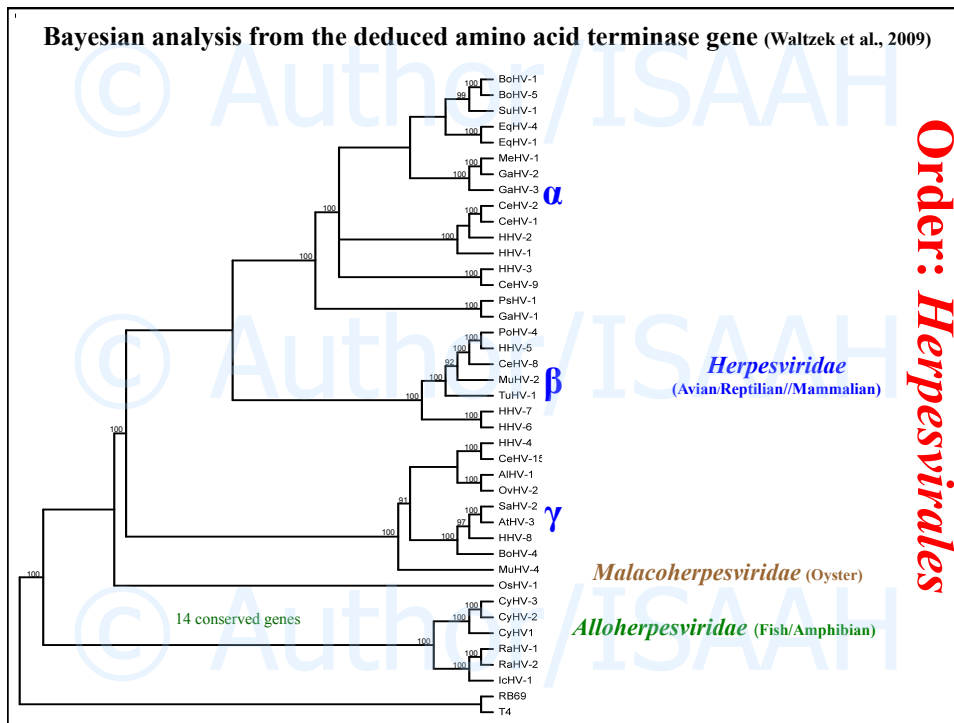
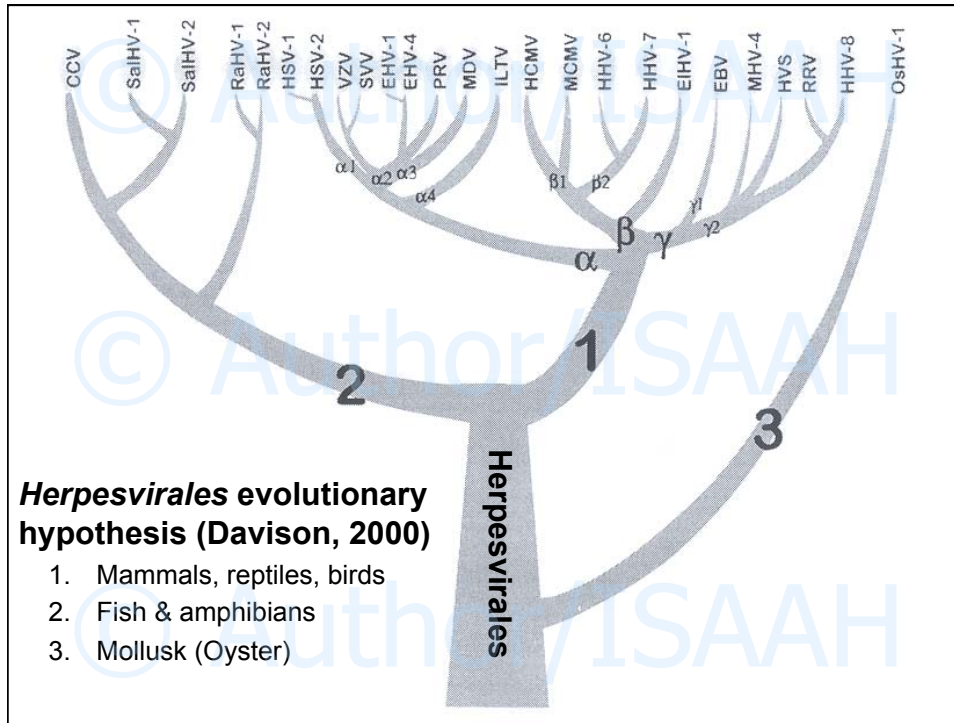


Taxonomic Changes to the Fish & Amphibian Herpesviruses

- KHV ICTV designation is *Cyprinid herpesvirus 3 (CyHV3)*
- Three new genera (Waltzek et al., 2009)

- * Clade 1
 - *Cyprinivirus* (CyHV1-3)
- * Clade 2
 - *Ictalurivirus* (IcHV1 & 2, AciHV2)
 - *Salmonivirus* (SalHV1-3)
 - *Batrachovirus* (RaHV1 & 2)





Herpesvirus Taxonomy

- Distant relationships of the fish & amphibian, oyster, and mammalian, avian, & reptilian herpesviruses supports the erection of a new order (Waltzek et al., 2009)

Herpesvirales

Herpesviridae (mammalian, avian, & reptilian HVs)

Alphaherpesvirinae

Betaherpesvirinae

Gammapherpesvirinae

Alloherpesviridae (Fish and amphibian HVs)

Ictalurivirus

Cyprinivirus

Salmonivirus

Batrachovirus

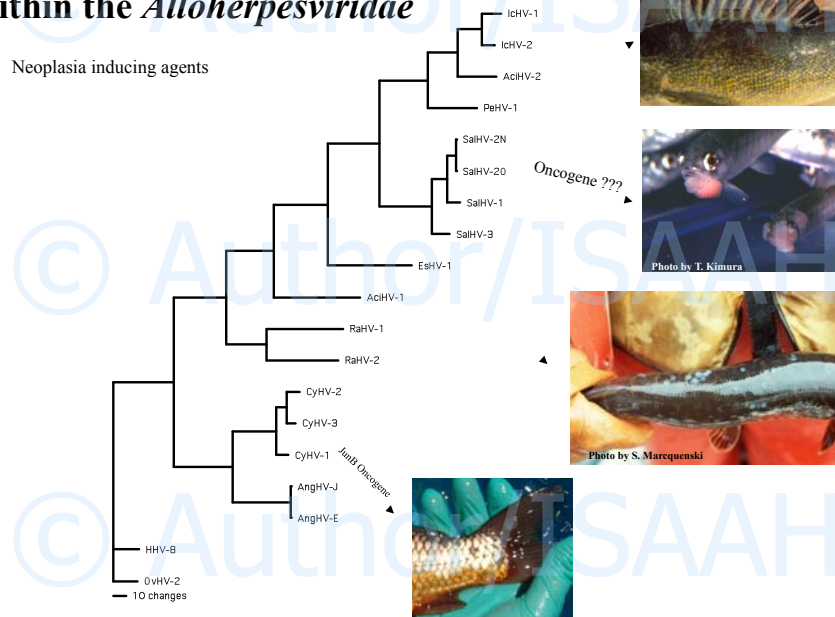
Malacoherpesviridae (Oyster HV)

Ostreavirus



Multiple origins of oncogenesis within the *Alloherpesviridae*

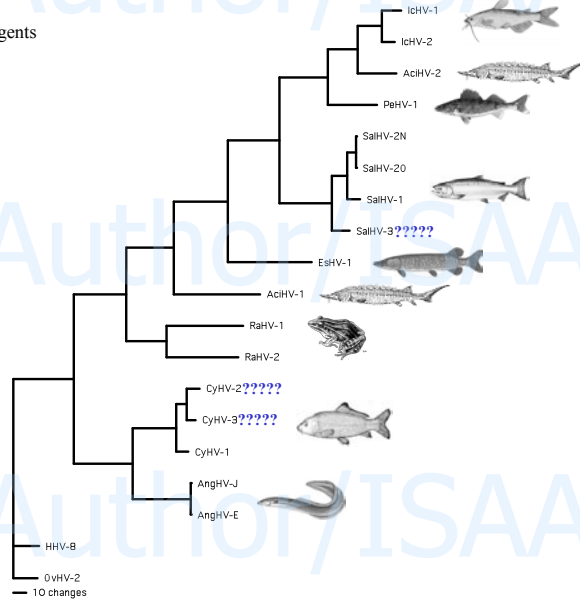
Neoplasia inducing agents



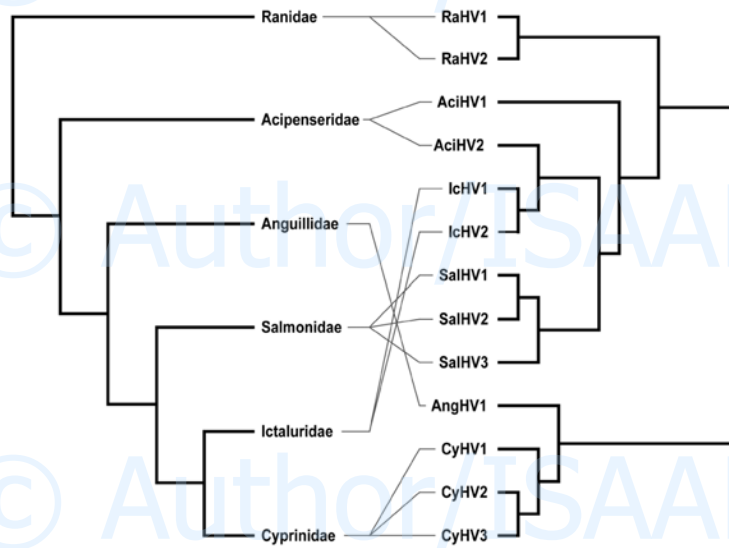
Latency within the *Alloherpesviridae*

Neoplasia inducing agents

Latent infection



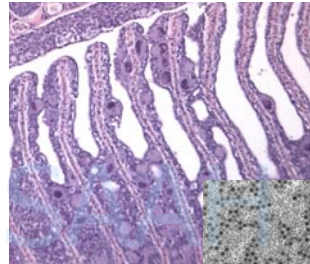
Host fidelity within the *Alloherpesviridae*



Future directions: characterization of emerging alloherpesviruses

- Marine finfish epizootics
 - Flounder HV
 - Pilchard HV
 - Smooth dogfish HV
 - White sea bass HV
 - Atlantic cod HV (ACHV)

H&E illustrating gill lesions associated with ACHVD



- Freshwater ornamental epizootics
 - Discus and angelfish HV
 - Guppy HV
 - et al...

Gross photo illustrating discus HV epizootic



Future directions: functional phylogenomics

- Current genome sequencing projects
 - SalHV1 (Davison et al., in prep.)
 - CyHV1 & 2 (Hedrick et al., in prep.)
 - Others alloherpes, irido, pox, & adeno soon...
- Test gene function by gene KO
 - CyHV3 immunomodulatory genes (pathogenesis)
 - CyHV1 JunB oncogene (oncogenesis)



Wild type virus



Mutant virus

Thank you for your attention!
Questions?



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