



Overview of Freshwater Fish Diseases Situation in Western Balkans - Serbia, North Macedonia, and Bosnia and Herzegovina

**Radosavljevic Vladimir¹, Cvetkovikj Aleksandar², Zuko Almedina³,
Jazic Adnan³, Markovic Zoran⁴**

**1 Institute of Veterinary Medicine of Serbia, Janisa Janulisa 14, 11000 Belgrade, Serbia
e-mail: vladimiradosavljevic@yahoo.co.uk**

2 Faculty of veterinary medicine, Ss. Cyril and Methodius University Skopje, North Macedonia

3 Faculty of Veterinary Medicine, University of Sarajevo, Zmaja od Bosne 90, 71000 Sarajevo, Bosnia and Herzegovina

4 Faculty of Agriculture, University of Belgrade, Nemanjina 6, 11081 Belgrade, Serbia

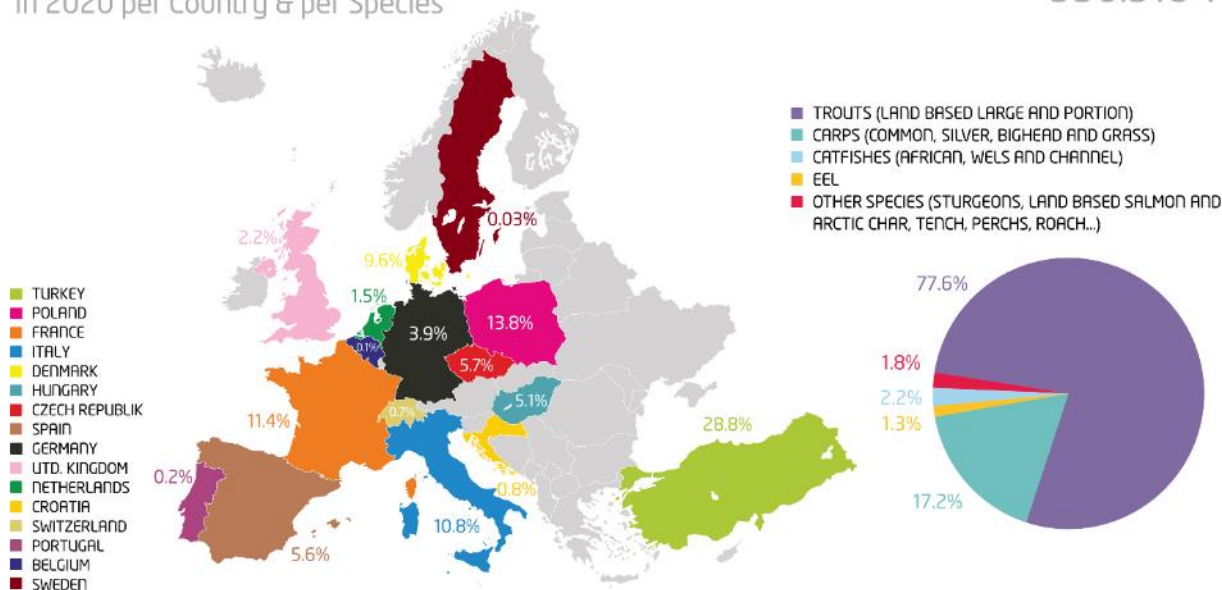
**„14th International Aquaculture
Conference “
Vukovar, Croatia
March 29-31. 2023**

Aquaculture - Europe - Western Balkans

- The freshwater aquaculture sector is represented through a wide range of production methods ranging from the most extensive ones (i.e. pond farming) to the high technological intensive methods.
- While trout is reared in intensive systems, carp is produced through more extensive and traditional techniques.

Freshwater Production
in 2020 per Country & per Species

356.318 T



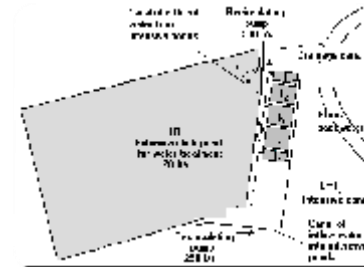
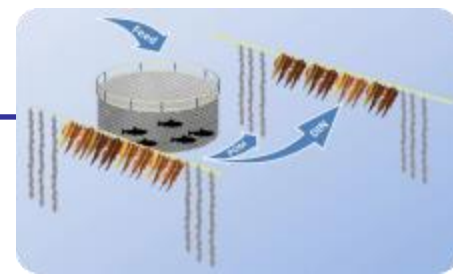
- Rainbow trout and common carp are the most important produced species in freshwater within the EU (77.6% and 17.2% of the EU production volume, respectively).

The European aquaculture strategy

- **FURTHER INCREASE OF THE FISH PRODUCTION.**

- **Through INNOVATIVE technologies**

- Freshwater Integrated Multitrophic Aquaculture (IMTA).
- Aquaponics systems.
- Recirculating Aquaculture System (RAS).
- Combined Intensive-Extensive (CIE) system.
- Multifunctional pond farming.



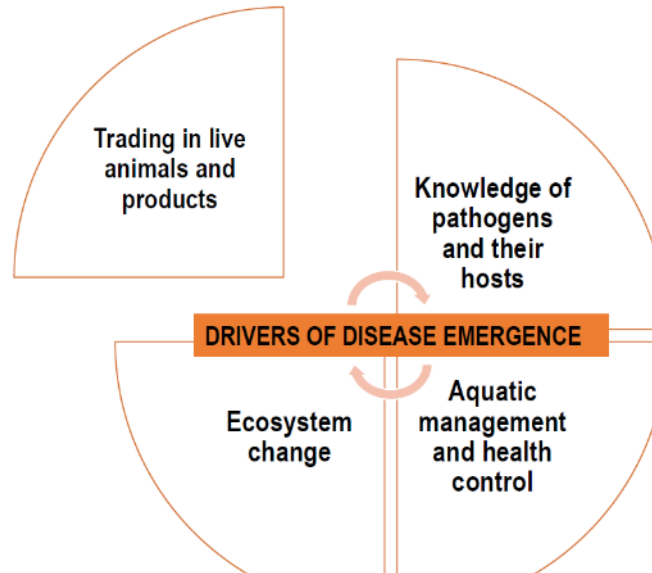
- **Through DIVERSIFICATION of the production with the introduction of new aquaculture species.**

- pike-perch, sturgeon, tench, crayfish, African catfish, black carp, Arctic char, other char species, tilapia, shrimps, European eel, etc.
- Hungary - European catfish
 - African catfish
 - pike-perch



Drivers and factors affecting emergent disease in aquaculture

- Highly traded commodity (70% exposed to international trade)
- Hyper-diverse species range (>500) farmed compared to terrestrial systems
- Live animals (larvae, fry, adults) and their products (live, fresh, frozen) traded internationally
- Many species farmed outside of native range
- Invasive animals and pathogens can be traded with primary host
- Ornamental aquaculture trade is large and growing
- Some diversion to unintended usage (e.g. angling baits)



Diseases in aquaculture: examples from largest aquaculture-related epizootics

Disease (observation in the field)	Diagnosis	Reporting /communication (national or OIE)	Containment (vaccine, treatment, husbandry)	Management (cost-effective)	Disease freedom	National and international confidence to the sector
EUS (1970s): fungi	1980s					
WSSV (1980s): virus	mid-1990s					
KHV (2000s): virus	mid-2000	OIE: 2006				
AHPND (2009): bacteria	2013	OIE: 2016				
TILV (2009): virus	2014	Still being assessed	2018 ?			

Long time lapse: years

\$\$\$\$ losses: production, market = livelihoods, export earnings, food supply = socio-economic and environmental impacts

\$\$\$ spent: producers/government/academe: biosecurity (policies, prevention, diagnosis, surveillance, containment, training/education, research, trade disputes, etc); compensation; alternatives)

World Organisation for Animal Health (WHO/OIE) listed pathogens

Disease	Etiology	OIE	EU	Status
Epizootic ulcerative syndrome (EUS)	<i>Aphanomyces invadans</i>	+	-	Never detected
Epizootic haematopoietic necrosis (EHN)	Epizootic haematopoietic necrosis virus (EHNV)	+	+	Never detected
Infection with ranavirus - Ranavirosis	European catfish virus (ECV), European sheatfish virus (ESV)	+	-	Detected in SRB , HU, SLO
Gyrodactylosis	<i>Gyrodactylus salaris</i>	+	-	Detected in MAK , BIH, RO
Infectious salmon anaemia (ISA)	(HPR)-deleted or HPR0 infectious salmon anaemia virus (ISAV)	+	+	Never detected
Infectious haematopoietic necrosis (IHN)	Infectious haematopoietic necrosis virus (IHNV)	+	+	Detected in CRO, SLO, MAK
Viral haemorrhagic septicaemia (VHS)	Viral haemorrhagic septicaemia virus (VHSV)	+	+	Detected in CRO, SLO, RO
Salmonid alphavirus infection Sleeping disease (SD)	Salmonid alphavirus (SAV2 FW)	+	-	Detected in CRO, BIH , SRB
Spring viraemia of carp (SVC)	Carp sprivivirus - Spring viraemia of carp virus (SVCV)	+	-	Detected in SRB , CRO, HU, RO
Koi herpesvirois (KHVD)	Koi herpesvirus (KHV)	+	+	Detected in SRB , CRO, HU, RO
Red sea bream iridoviral disease (RSIVD)	Red sea bream iridovirus (RSIV)	+	-	Never detected
Emerging disease - Tilapia lake virus disease (TiLVD)	Tilapia lake virus (TiLV)	+	-	Never detected
Emerging disease - Carp edema virus disease (CEVD)	Carp edema virus (CEV)	+	-	Detected in SRB , CRO, HU

Epizootic hematopoietic necrosis (EHN) caused by european catfish virus (ECV)

- Epizootic haematopoietic necrosis is caused by a large DNA virus (EHNV) which is classified in the genus Ranavirus of the family Iridoviridae.
- Initially discovered in Australia in rainbow trout and the redfin perch.
- Later it became clear that EHNV was but one of a large pool of ranaviruses having a broad host and geographic range that included amphibians, fish and reptiles.
- European catfish virus is the most important ranavirus that causes disease of fish in Europe.
- Germany - farmed sheatfish (Ahne et al. 1989, 1991)
- France - wild black bullhead (Pozet et al. 1992)
- Italy – wild black bullhead and farmed brown bullhead (*A. nebulosus*)
- Hungary – wild and farmed brown bullhead in 2008 (Juhász et al. 2013)
- **Serbia** – wild brown bullhead in 2008 (Jeremic & Radosavljevic, 2009).
- Since then, outbreaks of the disease have been noticed in brown bullhead (*Ameiurus nebulosus*) in carp farms but also in wild populations.



SRB – Detected

BIH, MKD – Not detected

Gyrodactylosis - *Gyrodactylus salaris*

- The causative agent for gyrodactylosis is *Gyrodactylus salaris* (a small parasitic flatworm).
- High mortality in Atlantic salmon (85 - 100%)
- Mortality in other susceptible host species usually low or not observed.

- Fish known to be susceptible to gyrodactylosis:
 - Atlantic salmon* (*Salmo salar*)
 - brown trout* (*Salmo trutta*)
 - Ohrid trout* (*Salmo letnica*)
 - grayling* (*Thymallus thymallus*)
 - rainbow trout* (*Oncorhynchus mykiss*)
 - Arctic char (*Salvelinus alpinus*)
 - brook trout (*Salvelinus fontinalis*)
 - lake trout (*Salvelinus namaycush*)

*naturally susceptible (other species have been shown to be experimentally susceptible)

 - *Gyrodactylus salaris* is restricted in its distribution to Europe.
 - *Gyrodactylus salaris* is more common in farmed rainbow trout than previously thought.
 - **Detected in North Macedonia, Bosnia and Herzegovina**
(unconfirmed)
 - **Not detected in Serbia**

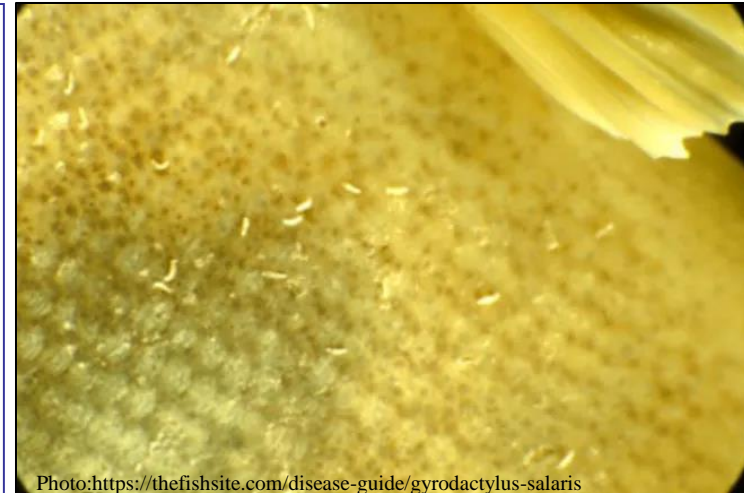


Photo:<https://thefishsite.com/disease-guide/gyrodactylus-salaris>



Photo:<https://www.sciencephoto.com/media/887553/view/gyrodactylus->

MKD, BIH – Detected
SRB – Not detected

Infectious hematopoietic necrosis - IHN

Infectious hematopoietic necrosis virus distribution in the world (1950s-2020)



- Kosovo 2011.
- Croatia 2013/14/15/20/21.
- Macedonia 2018/19/20/21/22.
- Slovenia 2021.
- Austria 2019.
- Slovakia 2020.

MKD - Detected

SRB / BIH FREE OF IHN

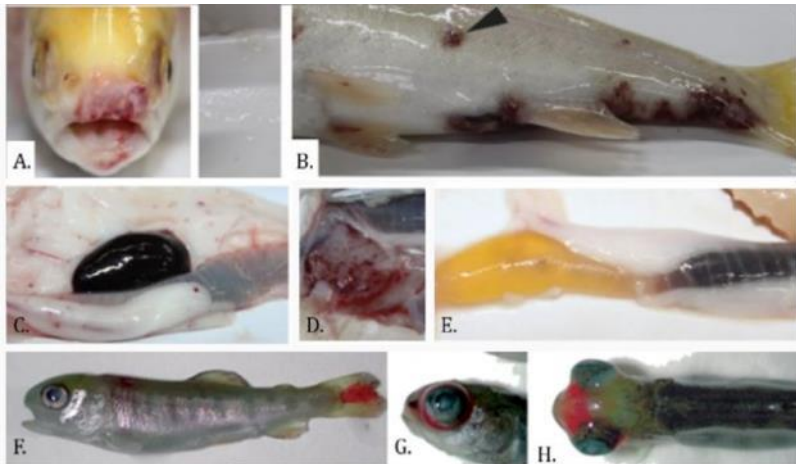
Viral hemorrhagic septicemia - VHS

Viral hemorrhagic septicemia virus distribution in the world (1930s-2020)



- Croatia 2013/2018.
- Slovenia 2021.
- Romania 2022.
- Austria 2019.
- Czech R. 2021.
- Poland 2019.
- Germany 2020.

SRB / BIH/MKD FREE OF VHSV

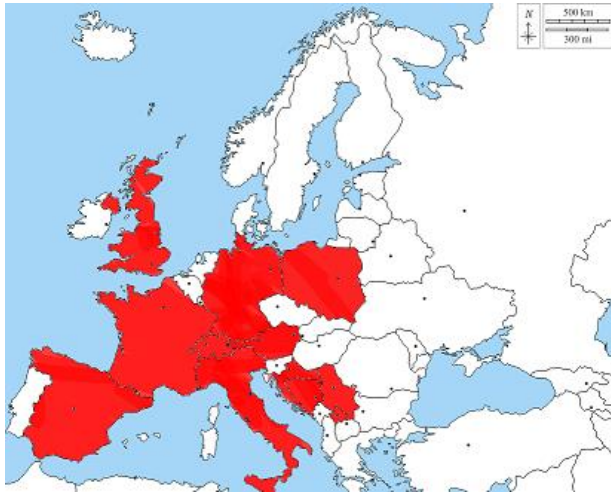


Clinical signs of IHN in infected fish. (A) Ulceration of the snout, (B) Hemorrhagic patches at the base of fins and vent, (C) Hemorrhage in adipose tissue, (D) Petechiae in cardio-coelom, (E) Yellow mucoid fluid in the gastro-intestinal tract. (F) Subdermal hemorrhage behind head and hemorrhage at the base of the fins, (G) Hemorrhage around the eye, (H) exophthalmia.



VHS Romania
2022
Costea et al.

SLEEPING DISEASE - SAV 2



The heart and the pancreas are main target organs SAV

The cumulative mortality at the farm level ranges from negligible to over 50% in severe cases

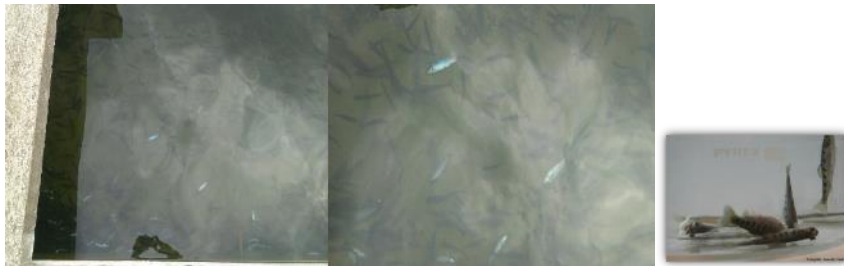
SRB, BIH – Detected
MKD – Not detected

IPN

Infectious pancreatic necrosis virus distribution in the world (1940s-2020)

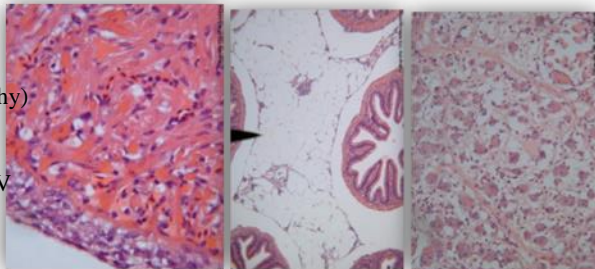


SRB, BIH, MKD – Detected



Necrosis of pancreatic acinar tissue. Salmonid Alphavirus subtype 2 (SAV 2), photo .M McLouhlin

Myocardial degeneration (cardiomyopathy) Salmonid Alphavirus subtype 2 (SAV 2), photo .M McLouhlin.



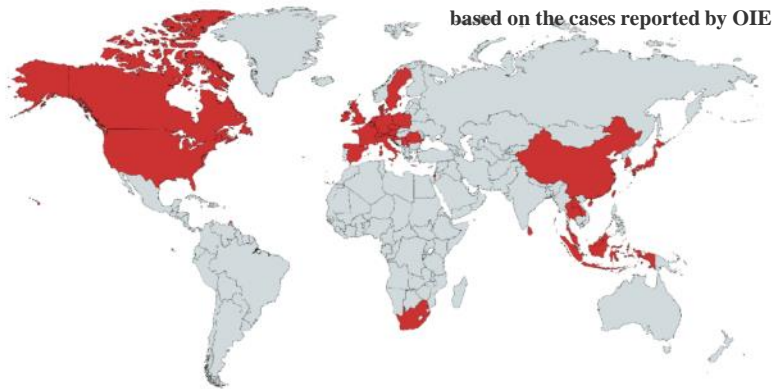
Necrosis of the skeletal red muscle: Salmonid Alphavirus subtype 2 (SAV 2), photo .M McLouhlin.



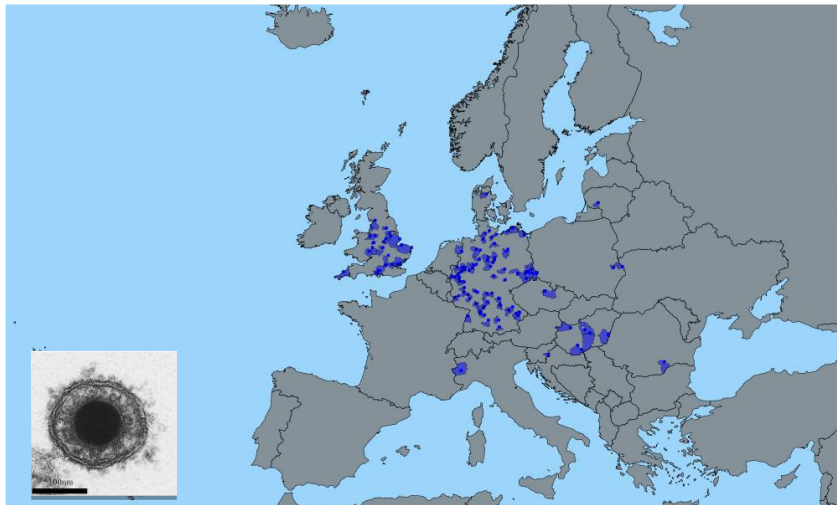
Clinical signs of IPNV in infected fish.
Swollen abdomen,
Yellow mucoïd fluid in the gastrointestinal tract,
Pale liver and severe petechiae in the viscera,
Severe petechiae in the pyloric caeca with pale and hemorrhagic liver.

Koi Herpesvirus disease (KHVD)

Koi herpesvirus distribution in the world (2004-2020)



KHVD in EU countries 2019-2022



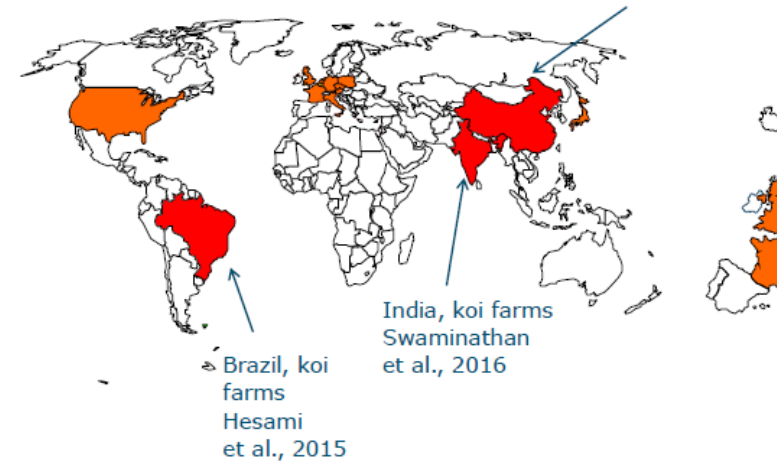
- Hungary 2021
- Croatia 2021
- Slovenia 2021
- Czech Republic 2021
- Romania 2021

MKD / BIH – NOT DETECTED

Carp edema virus disease (CEVD)

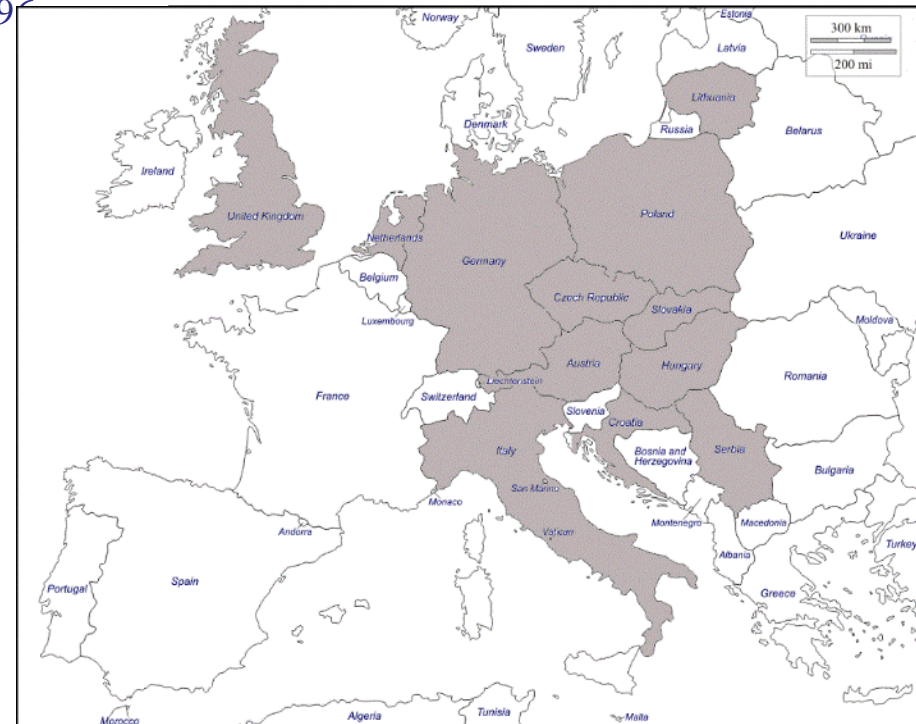
China, koi farms
Zhang et al., 2017

- DNA Poxvirus (fam. Poxviridae).
- Susceptible species : *Cyprinus carpio*, *Cyprinus carpio koi*.
- disease episodes at water T between 6 - 15°C.
- Japan 1970's - juvenile *Cyprinus carpio* koi – koi sleeping disease (KSD)
- USA - koi at import sites and in hobby ponds since 199
- Europe - KSD and CEV-like virus 2009
- Brazil - **koi** 2015.
- India - **koi** 2016.
- China - **koi** 2016.

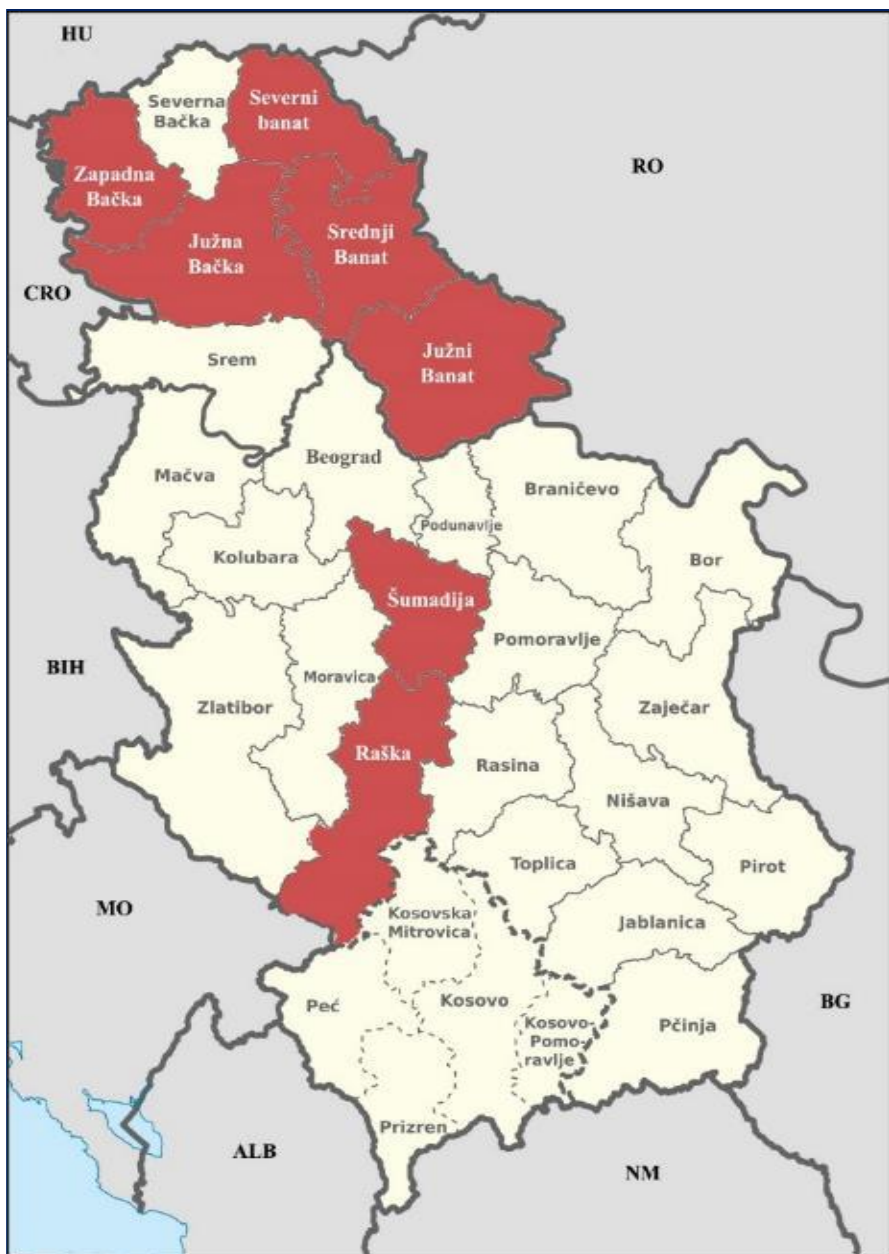


• Europe – CEVD in *Cyprinus carpio*

- 2012 - UK (Way and Stone 2013)
- 2012 - the Netherlands (Haenen et al. 2014)
- 2013 – Czech Republic (Vesely et al. 2015)
- 2013 – Poland (Matras et al. 2017)
- 2014 – Germany (Schroers et al. 2015)
- 2014 - Austria (Lewis et al., 2015)
- 2014 - Italy (Pretto et al. 2015)
- 2016 – Hungary (Adamek et al. 2018)
- 2017 – Serbia (Radosavljevic et al., 2018)
- 2018 – Lithuania (Adamek et al., 2018)
- 2018 – Croatia (Adamek et al., 2018)



Carp edema virus disease - emerging – non reportable -



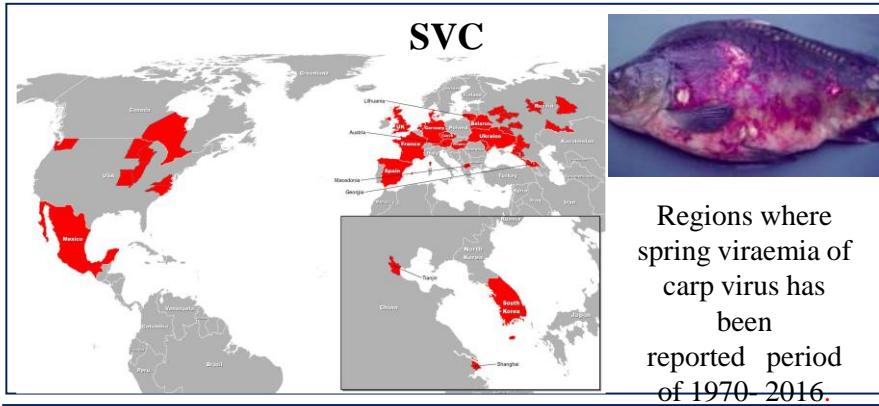
Isolate no.	Year	Sample name	Location	Facility no.	Case details Month/water T % mortality age of fish
1	2017	3405	Južnobački	1	May beg. 14°C / Low ≤ 20% / C1
2	2017	3406	Južnobanatski	2	May beg. 15°C / Low ≤ 20% / C1
3	2017	3407	Zapadno bački	3	May beg. 16°C / Low ≤ 20% / C1
4	2017	2775	Južnobanatski	4	May beg. 17°C / Low ≤ 20% / C1
5	2017	3386	Raški	5	May beg. 18°C / High ≥ 50% / C1
6	2017	3394	Severno banatski	6	May beg. 16°C / Low ≤ 20% / C1
7	2017	3900	Srednjo-banatski	7	May end 18°C / Low ≤ 20% / C1
8	2018	2820	Šumadijski	8	April beg 8°C / Low ≤ 20% / C1
9	2018	2885	Srednjo-banatski	7	April end 9°C / Low ≤ 20% / C2
10	2018	4600	Južnobački	9	July beg. 23°C / Low ≤ 20% / C3
11	2018	4698	Srednjo-banatski	10	July beg. 25°C / Low ≤ 20% / C2
12	2018	4997	Južnobanatski	4	July beg. 24°C / Low ≤ 20% / C1
13	2019	3578	Srednjo-banatski	7	April beg. 8°C / Low ≤ 20% / C1 & C2
14	2019	3659	Severno banatski	11	April beg. 7°C / Low ≤ 20% / C1 & C2
15	2019	3861	Južnobački	12	April beg. 16°C / Low ≤ 20% / C1
16	2019	4550	Severno banatski	13	May end 18°C / Low ≤ 20% / C1 & C2
17	2019	4556	Srednjo-banatski	10	May end 17°C / Low ≤ 20% / C1
18	2019	4592	Južnobanatski	14	May end 17°C / Low ≤ 20% / C2
19	2019	4683	Srednjo-banatski	10	June beg. 18 °C / Low ≤ 20% / C1
20	2019	4706	Srednjo-banatski	15	June beg. 17°C / Low ≤ 20% / C1 & C2
21	2019	6771	Zapadnobački	16	Sept beg. 19°C / Med 20 – 50% / C1
22	2019	6844	Severno banatski	11	Sept beg. 19°C / Low ≤ 20% / C2
23	2019	6874	Zapadnobački	17	Sept beg. 22°C / High ≥ 50% / C1 & C2
24	2019	6977	Južnobački	18	Sept end 21°C / High ≥ 50% / C1
25	2019	7022	Zapadnobački	19	Sept beg. 19°C / Low ≤ 20% / C1
26	2019	7168	Srednjo-banatski	7	Sept beg. 18°C / Low ≤ 20% / C1
27	2019	7279	Srednjo-banatski	7	Sept end 20°C / Low ≤ 20% / C1
28	2019	7331	Srednjo-banatski	15	Sept end 19°C / Low ≤ 20% / C1
29	2019	7427	Zapadnobački	19	Oct beg. 16°C / Low ≤ 20% / C1
30	2019	7724	Zapadnobački	19	Oct end 14°C / Low ≤ 20% / C1
31	2020	2653	Zapadnobački	3	April end 12°C / Low ≤ 20% / C1
32	2020	2902	Severno banatski	11	May beg. 15°C / Low ≤ 20% / C1
33	2020	2939	Severno banatski	11	May end 16°C / Low ≤ 20% / C3
34	2020	2973	Srednjo-banatski	20	May end 16°C / Low ≤ 20% / C2
35	2020	3316	Zapadnobački	19	May end 15°C / Low ≤ 20% / C1
36	2020	3573	Zapadnobački	16	June beg. 19°C / Low ≤ 20% / C1
37	2020	9299	Zapadnobački	16	Oct end 13°C / Low ≤ 20% / C2
38	2020	10231	Zapadnobački	21	Nov end 7°C / Low ≤ 20% / C2



2021/2022. CEV still many new findings in Belgium, The Netherlands, Croatia, Denmark, England, Hungary, Ireland, Serbia, Italy, Czech Republic, France, Austria, Poland, Germany,

MKD / BIH – NOT DETECTED

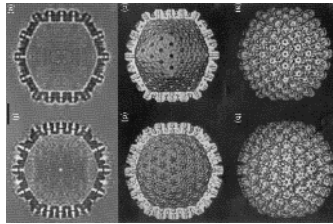
OTHER IMPORTANT CYPRINID VIRAL DISEASES



SVC – low impact in SRB / BIH / MKD

- last outbreak in Serbia 2007
- UK 2017
- Ukraine 2017/2018
- **Romania** 2016/2017/2018

CARP POX, *Epithelioma papillosum carpio*



Herpesvirus cyprini (Cyprinid herpesvirus 1)

CARP POX – low impact in SRB / BIH / MKD



- **Herpesviral haematopoietic necrosis (HVHN)** caused by CyHV-2 is detected in a population of Prussian carp in Grliško Lake in eastern Serbia in 2017.
- Fish showed a whitish slime layer over their eyes and an erythema of their skin, sometimes with haemorrhagic scales.
- New outbreaks in various locations 2017-2022

HVHN – many outbreaks in SRB not detected in BIH / MKD



Other salmonid fish disease problems – non reportable -

- **BKD** - *R. salmoninarum* – Gr+



- **Furunculosis** – *A. salmonicida subsp salmonicida* – Gr-

- **Lactococcosis** - *L. garvieae* – Gr+

- **Mycobacteriosis** - *Mycobacterium* spp. Gr+

- **Yersiniosis** - *Y. ruckeri* – Gr-

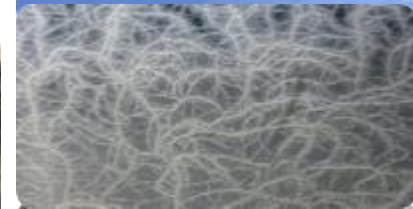
- **Flavobacterial diseases** – Gr-

F. psychrophilum - bacterial cold water disease (BCWD)

/ rainbow trout fry syndrome (RTFS)

F. columnare - Columnaris disease

F. branchiophilum - bacterial gill disease (BGD)



- ***B. mycooides* infection** – Gr+, gill ulcers/rot, asphyxiation and bloody ascites

- **MAS** – motile aeromonad septicaemia – Gr-



Other salmonid fish disease problems – non reportable -

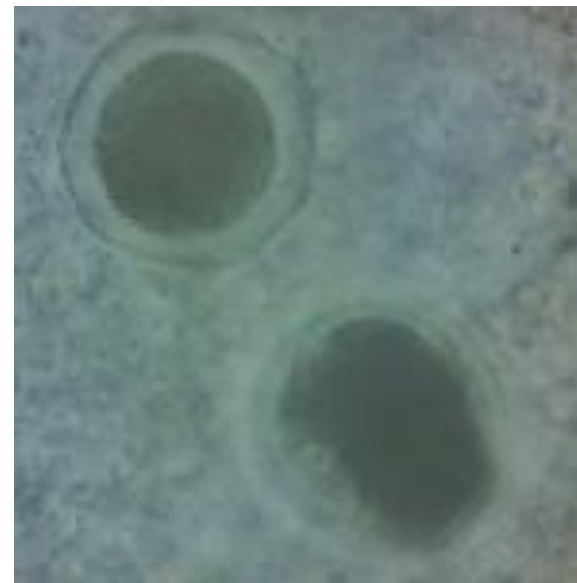
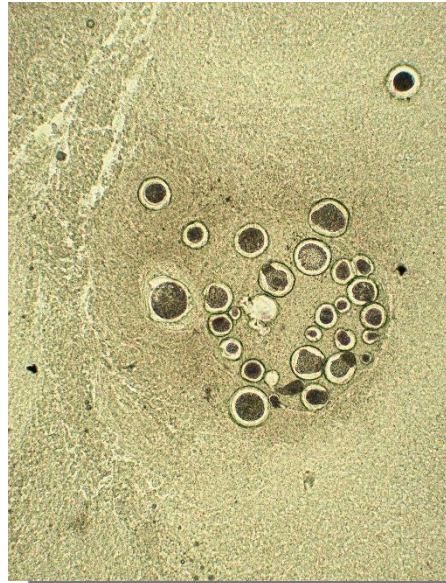


VARIOUS FUNGI & PARASITES

- wide spectrum of genera and species
- mostly low abundance
- mostly low impact

Ichthyophoniasis ICHTHYOPHONUS DISEASE *I. hoferi*

more than 80 fish hosts, including 35 marine
and 48 freshwater fishes



THANK YOU !

