AN INTERNATIONAL COLLABORATIVE PROJECT DOCUMENTING THE PARASITES OF *DREISSENA* SPP. MUSSELS THROUGHOUT EURASIA

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North American freshwater ecosystems have been ravaged by high densities of two invasive bivalve species from Eurasia, Dreissena rostriformis bugensis and Dreissena polymorpha. In addition, the fouling of infrastructures by these bivalves has had an economic impact in the billions of dollars. Unfortunately, there is currently no environmentally safe and economically feasible method of controlling them throughout infested waterbodies. In an attempt to develop such a control agent, a project is now underway examining parasites in Eurasian Dreissena populations. Several new parasites have already been discovered and will be evaluated for their virulence and host specificity. It is timely that this invasive species conference is being held in the Balkans since a very high priority of this project is to sample the parasites from Dreissena spp. endemic to the Balkans (e.g., D. blanci, D. carinata) and nearby Turkey (e.g., D. caputlacus, D. anatolica). These samples will be particularly valuable because North American dreissenid populations have not likely encountered the parasites from these latter four Dreissena spp., and thus infection may prove highly virulent to them. This project is an ambitious and challenging one and the collaborators participating in it will be highlighted in this presentation as their diverse expertise brings valuable contributions to it.

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Keynote Presentation

An International Collaborative Project Documenting the Parasites of *Dreissena* spp. Mussels throughout Eurasia

Daniel P. Molloy, Ph.D.

September 3, 2019

Joint ESENIAS and DIAS Scientific Conference and 9th ESENIAS Workshop

Ohrid, Republic of North Macedonia

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Only freshwater mussels now in North American with byssal threads enabling them to attach on to ANY hard surface











































BASICALLY THREE MAIN TYPES OF IMPACTS WITHIN WATER BODIES....

ECOLOGICAL

RECREATIONAL

INDUSTRIAL

Ecological Impacts



Mussels can filter 1 liter/day

Millions of mussels in water body filtering



Decrease in phytoplankton

Decrease in phytoplanktonDecrease in zooplankton

Decrease in phytoplankton
Decrease in zooplankton
Increase in water transparency

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Increase in macrophytes

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Alteration of fish community

Decrease in phytoplankton
Decrease in zooplankton
Increase in water transparency
Increase in macrophytes
Alteration of fish community
Alteration of benthic community

Example of infested unionid clams





Example of infested unionid clams



Recreational Impacts







Fouling of recreation equipment.... boats, docks, boat lifts, etc.



Closure of recreational areas due to quarantine



San Justo Reservoir, California

Industrial Impacts









Specific Problem to Discuss Today: Inability to control these two invasive mussels in "open waters" (lakes, rivers, etc.)



Reservoir in California



~100 hectares: More then a million dollars to treat





Impossible - Too costly to treat: Billions of dollars

So North American water bodies obviously have a problem with these invasive mussels....

No control method: -- ecologically benign enough -- economically affordable enough

to control mussels throughout <u>entire large water bodies</u>.

Treating an <u>entire water body</u> is currently:

Too expensive

and/or

Too environmentally degrading

To be ECONOMICALLY FEASIBLE a control method has to be VERY INEXPENSIVE (~ one thousand times less expensive)

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To be ENVIRONMENTALLY SAFE a control method has to be VERY HOST SPECIFIC (the control agent should only kill dreissenid mussels)
How to reduce the cost one thousand fold?

To be economically feasible the control agent ideally must be: -- applied only in a <u>small</u> part of the water body



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<u>self-perpetuating</u>



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- -- applied only in a small part of the water body
- -- self-perpetuating

-- self-spreading



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This control agent must be LIVE

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- -- <u>self-perpetuating</u>
- -- self-spreading

This control agent must be LIVE

It must be a **BIOCONTROL** agent...but what kind of biocontrol agent...???

Natural Enemies of Zebra Mussels: Predators, Parasites, and Ecological Competitors

Daniel P. Molloy,¹ Alexander Y. Karatayev,² Lyubov E. Burlakova,² Dina P. Kurandina,³ and Franck Laruelle¹

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The control agent must be a **PARASITE**

.... because among all types of natural enemies, parasites are the most host-specific killing agents And not any host-specific parasite will do...

.... Ideally it is a HYPERVIRULENT PARASITE

This project is an extremely ambitious one.

This project is an extremely challenging one.

But I am confident there is a parasite already existing in nature that could be this future biocontrol agent

So where have we concentrated on looking to find this parasite.... this control agent?



... and we have found a variety of parasites in zebra and quagga populations... but none with evidence of hypervirulence



"novel" parasites & "naïve" species

What happened to American chestnut trees?



What happened to American chestnut trees?





Fungus : American chestnut blight

What happened to elm trees?



What happened to elm trees?



Fungus: Dutch elm disease

Eastern oyster *Crassostrea virginica*



Up until the 1950s, eastern oyster populations were abundant and the industry thrived





Within a few years in the 1950s, 95% of the eastern oysters were lost in high salinity areas to a spore-forming disease called MSX.....

Now we know why this disease rapidly caused <u>catastrophic</u> declines in eastern oyster *Crassostrea virginica* populations

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The parasite that caused this disease was actually a species that normally infects a related oyster, the Pacific oyster, *Crassostrea gigas,* in Asia. Now we know why this disease rapidly caused <u>catastrophic</u> declines in eastern oyster *Crassostrea virginica* populations

The parasite that caused this disease was actually a species that normally infects a related oyster, the Pacific oyster, *Crassostrea gigas,* in Asia.

The eastern oyster was a <u>naïve</u> host and it was exposed to a <u>novel</u> parasite !!!

YES, THAT'S THE BOLD NEW BIOCONTROL

APPROACH I'M TAKING

INTRODUCE A <u>NOVEL</u> PARASITE THAT OUR NORTH AMERICAN DREISSENIDS WILL BE <u>NAÏVE</u> TO




"cousin" Dreissena spp......

-- the Balkans (e.g., *D. blanci*, *D. carinata*)

-- Turkey (e.g., *D. caputlacus*, *D. anatolica*)

The Balkans



Lake Ohrid



Skadar Lake

There's only one dreissenid species in these lakes: D. carinata





Turkey











Collecting





Dissecting







Histological Examination





Next logical research step is to try to infect zebra and quagga mussels with parasites that have coevolved with *D. carinata*

Could some relatively harmless parasite from *D. carinata* be hypervirulent to "naïve" zebra/quagga mussels and kill them?







ZEBRA MUSSEL

QUAGGA MUSSEL

D. carinata

International Team of Collaborating Scientists







MACEDONIA Sasho Trajanovski



ALBANIA Spase Shumka



ITALY Sergei Fokin



TURKEY Zeki Yildirim







MONTENEGRO Mihailo Jovićević

MONTENEGRO



Vladimir Pešić



MONTENEGRO Milena Iković



USA

Yale Passamaneck





USA Sherri Pucherelli

TAKE HOME MESSAGE

Will there ever be lake-wide biocontrol of dreissenids in North American waterbodies?

Don't give up on the use of parasites for that purpose, as they can have long-term devastating impacts on naïve host populations.

To achieve this goal, I believe the solution will involve exposing our North American dreissenid populations to a parasite they possibly have never ever encountered before...

...quite possibly a parasite from a distant Eurasian dreissenid cousin.

Thanks for your attention !