

21st International Conference on Aquatic Invasive Species

A Research Path to Achieving Control of Dreissenid Mussels throughout Entire Lakes

Dan Molloy

Molloy & Associates, LLC

Invasive dreissenid (zebra and quagga) mussels cause ecological disruption and pose a significant fouling challenge to infrastructures. Unfortunately there is no affordable and environmentally safe method for large-scale control of dreissenid populations once they have become established throughout an entire water body. This presentation reports on a research project that may offer a potential solution to this seemingly intractable problem. The key to the low, affordable cost of this proposed control approach is that it does not require treatment of the entire infested water body. In contrast to traditional control programs: 1) only a small portion of the infested water body would need to be treated (“seeded”) with the control agent; and 2) the control agent would subsequently amplify itself and self-spread throughout the remainder of the water body. There is only one type of control agent with the latter two characteristics – a live one, a biological control agent. Based in Eurasia and funded by the Bureau of Reclamation (US Department of the Interior), the three-year research project to be discussed was launched in fall 2018 and is specifically designed to find a hypervirulent (i.e., extremely lethal), highly-specific dreissenid parasite that one day – following years of exhaustive environmental safety studies – would be considered for introduction into North American water bodies.

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Daniel P. Molloy, Ph.D.
Molloy & Associates, LLC

October 30, 2019

Montreal, Canada

21st International Conference on Aquatic Invasive Species

Funding Acknowledgement



This bold new control approach could be used to control dreissenids throughout small lakes.....



....and even throughout the Great Lakes.



....and even throughout the Great Lakes.

Yes, if our research is successful, its impact could be that huge.



Need a couple of minutes now to explain something

Need to define some esoteric terminology:

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“Novel parasites & naïve hosts”

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This is especially true when "naive" populations are exposed to "novel" parasites that they have been geographically separated from for millions of years

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Infectious disease caused by hypervirulent parasites can have long-term, devastating impacts on populations

This is especially true when "naive" populations are exposed to "novel" parasites that they have been geographically separated from for millions of years

Such naive host populations can be ravaged by the virulence of these novel parasites since they have not co-evolved with them and thus have little to no resistance to infection

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How about some examples?

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“Novel parasites & naïve hosts”



How about some examples?

Any example of a
naïve **bivalve**
&
novel parasite?

Eastern oyster
Crassostrea virginica



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



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...and guess what?

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Until a spore forming parasite killed 95% of these oysters
...and guess what?

That killer spore was actually a parasite of a “cousin” species,
the Pacific oyster!

Getting back to my *Dreissena* presentation.....

Treating an entire large water body is currently:

- Too expensive

and/or

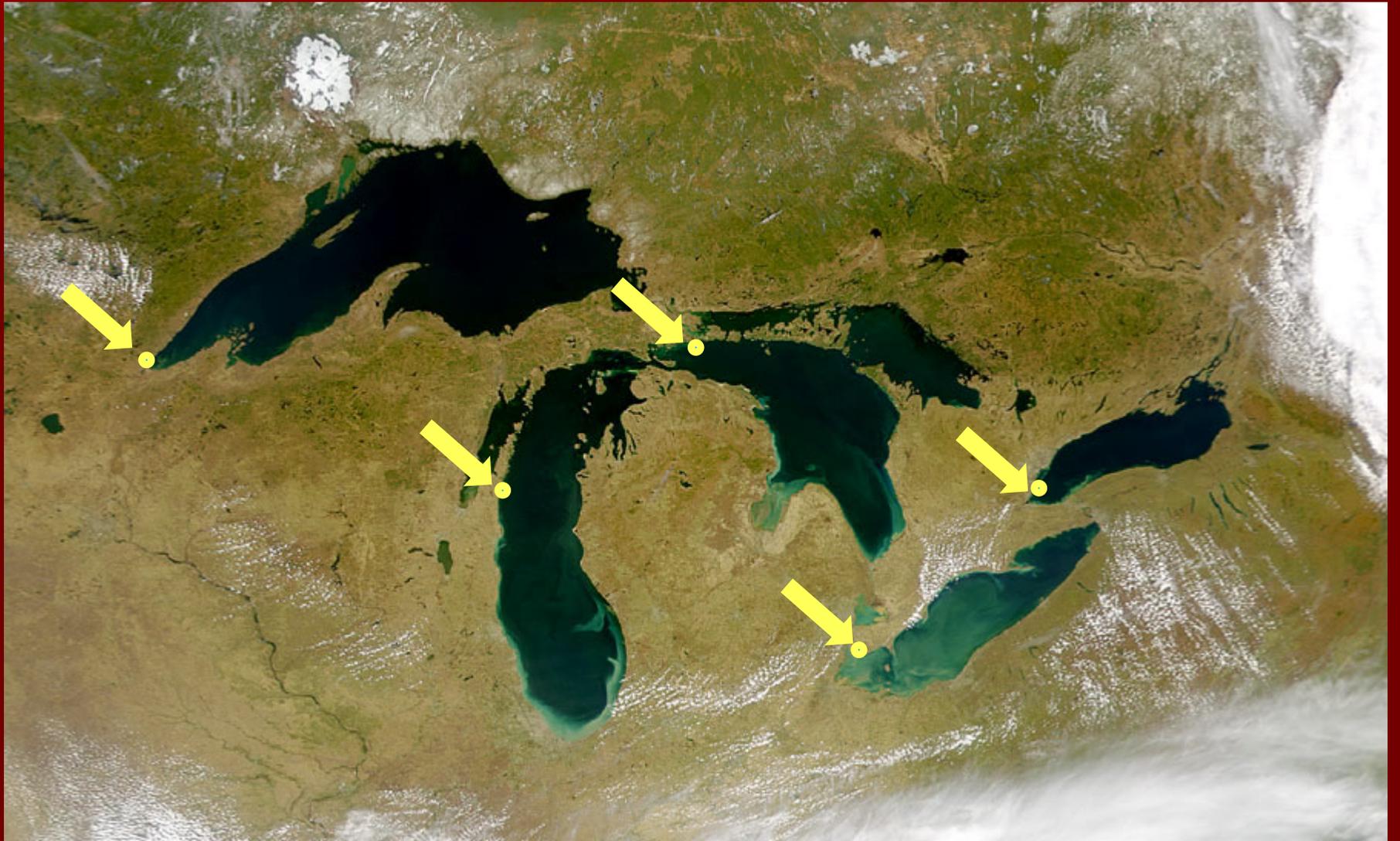
- Too environmentally degrading

To be **economically feasible** a control agent ideally must be:

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



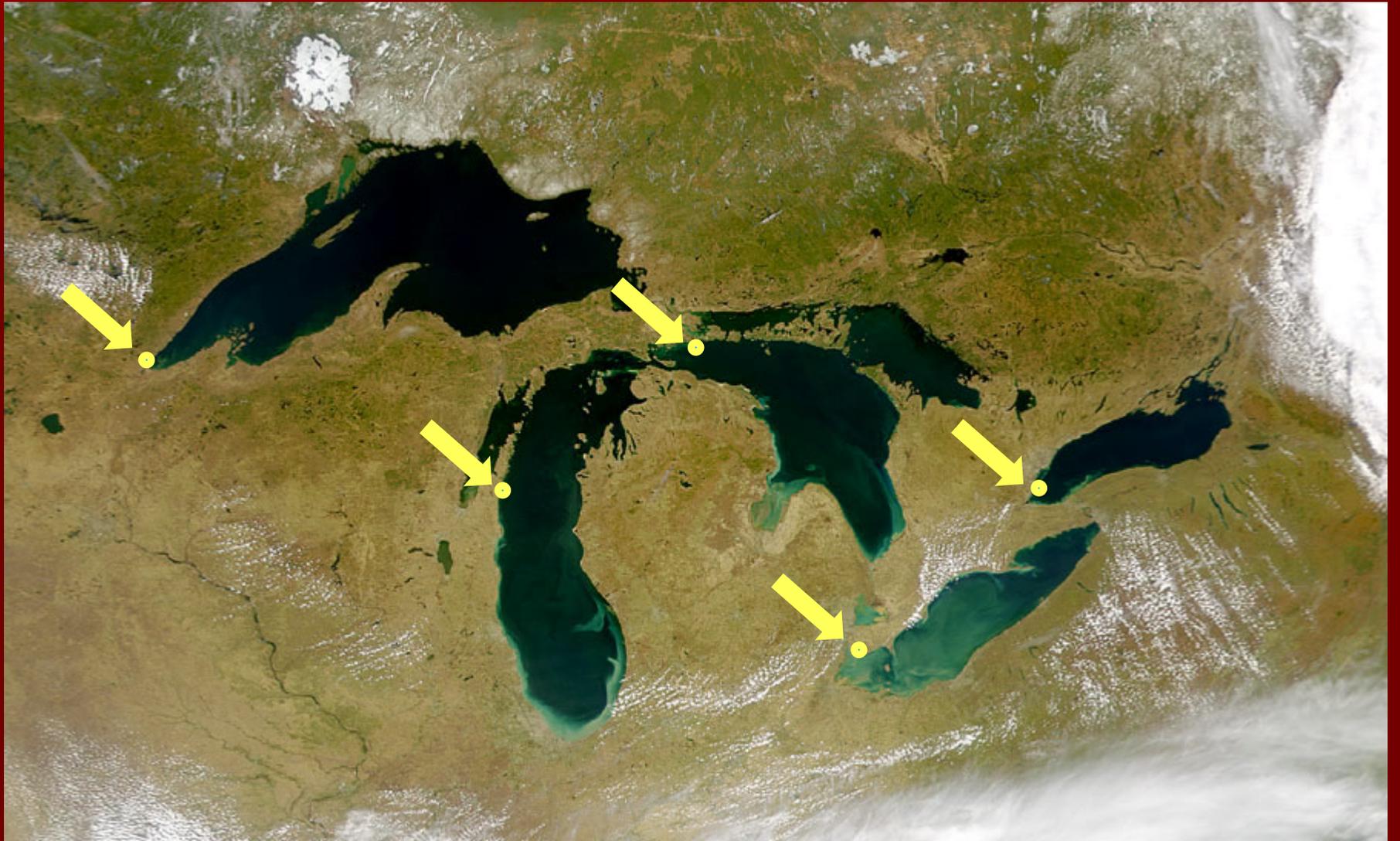


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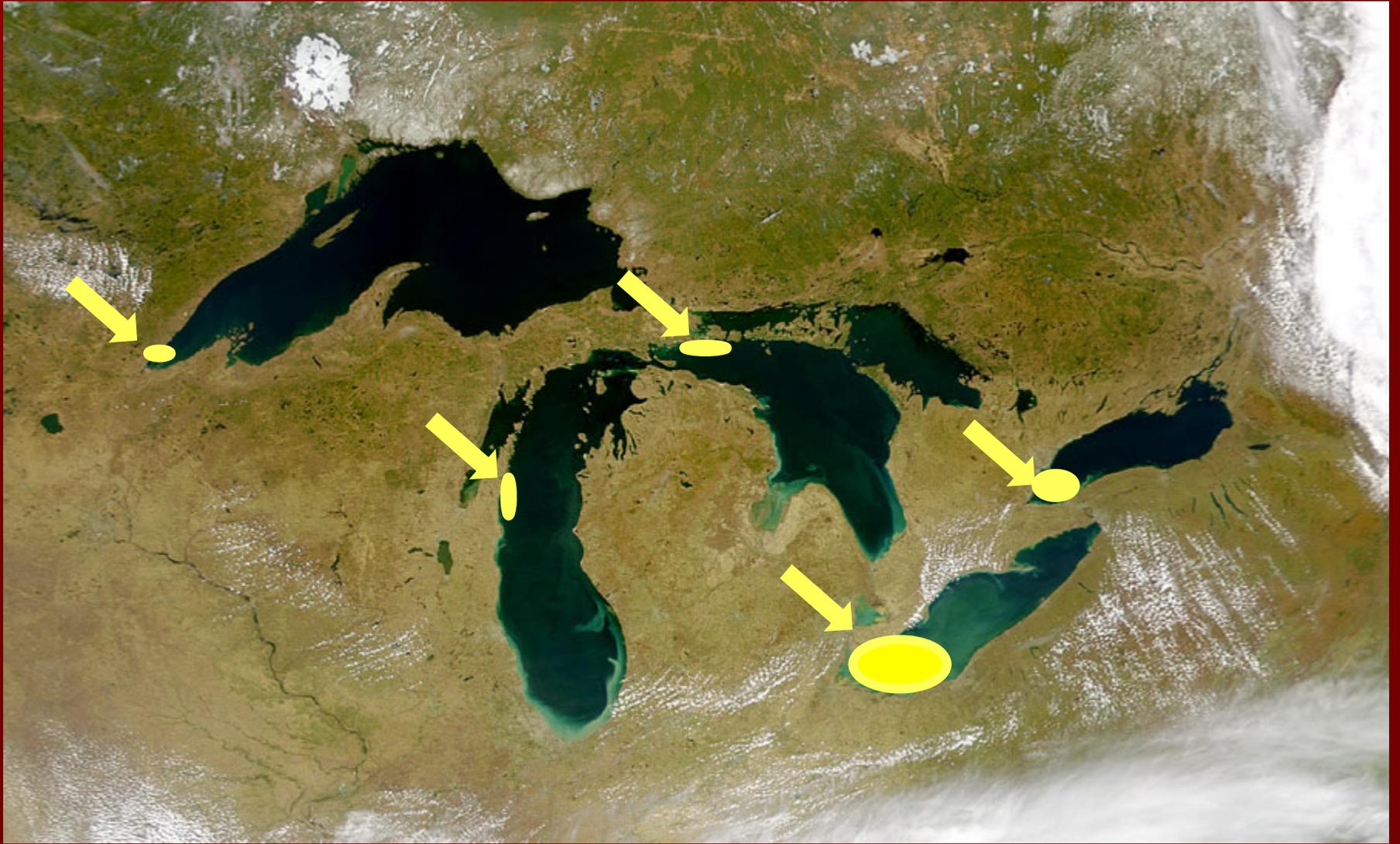
To be economically feasible a control agent ideally must be:

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



To be economically feasible a control agent ideally must be:

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



To be economically feasible a control agent ideally must be:

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

To be economically feasible a control agent ideally must be:

- applied only in a small part of the water body
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This control agent must be **LIVE**

To be economically feasible a control agent ideally must be:

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

This control agent must be **LIVE**

It must be a **BIOCONTROL** agent...

.....but what kind of biocontrol agent...???

Must be a **PARASITE**

Must be a **PARASITE**

.... because among all types of natural enemies,
parasites are the most host-specific killing agents

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?



Area in past that we have focused on looking for parasites in the same two *Dreissena* spp. as we have in North America:

- *D. polymorpha* (zebra)
- *D. rostriformis* (quagga)

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

A map of Europe and the Mediterranean region. A blue outline highlights a specific area of interest, starting from the Iberian Peninsula, moving east through France, Italy, and the Balkans, then curving north through the Black Sea region, and finally extending east towards the Caspian Sea. The highlighted area includes parts of Spain, France, Italy, Greece, Turkey, Georgia, and Azerbaijan. A text box is overlaid on the map, containing the text: "Area we have switched to... focusing on possible 'novel' parasites from other 'cousin' dreissenid species".

Area we have switched to... focusing on possible “novel” parasites from other “cousin” dreissenid species

Just completed the first year of this project



Albania

Montenegro

Macedonia

TURKEY

Which “cousin” *Dreissena* spp. are we focusing on?

-- the Balkans: *D. carinata* & *D. blanci*

-- Turkey: *D. caputlacus* and *D. anatolica*



Albania

Montenegro

Macedonia

Balkans

Montenegro, Albania & Macedonia



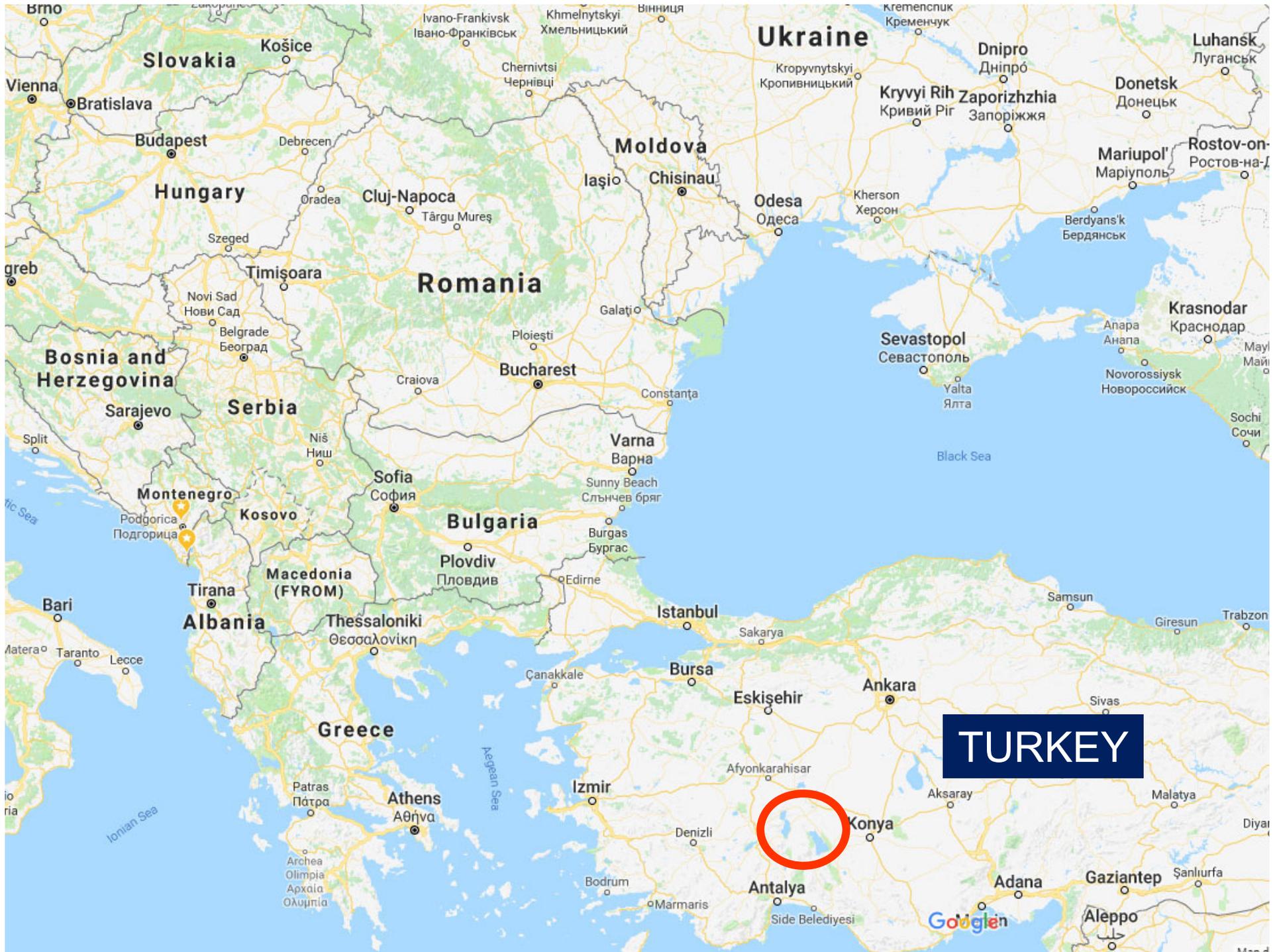
Lake Ohrid
Macedonia/Albania



Skadar Lake
Montenegro/Albania

Only one *Dreissena* species in these water bodies
D. carinata





TURKEY



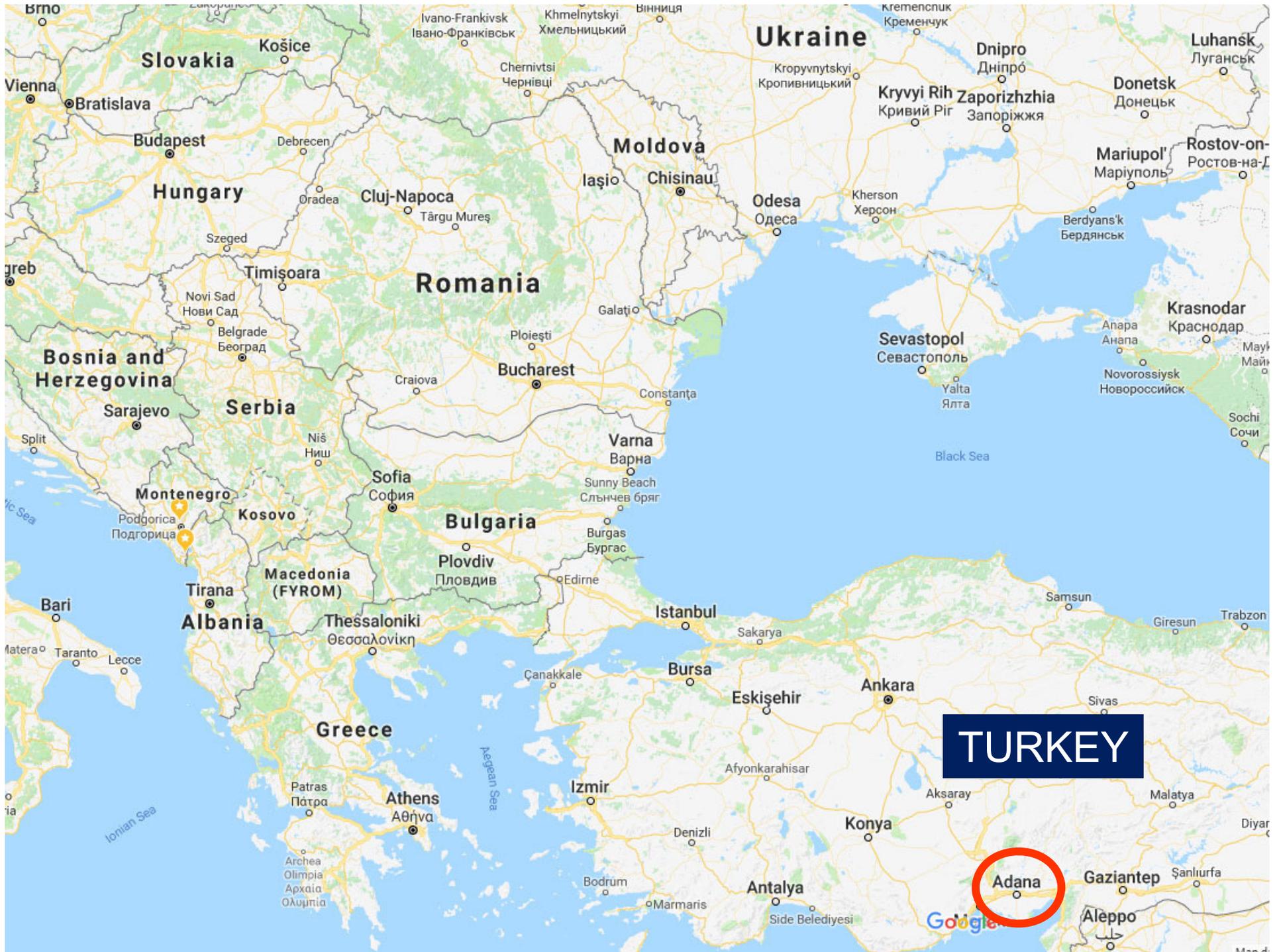
Turkey

Eğirdir Lake
Likely *D. anatolica*



Beyşehir Lake
Likely *D. anatolica*



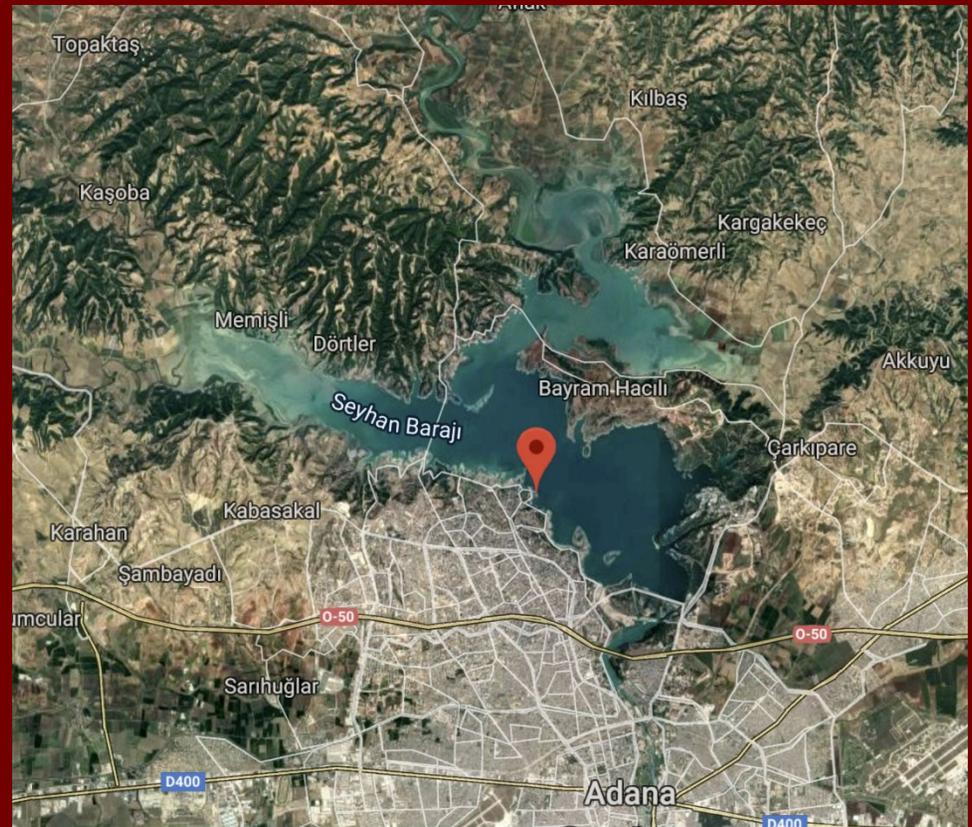


TURKEY

Adana

Turkey

Seyhan Reservoir at Adana
Likely mix of *D. anatolica* and *D. caputlacus*

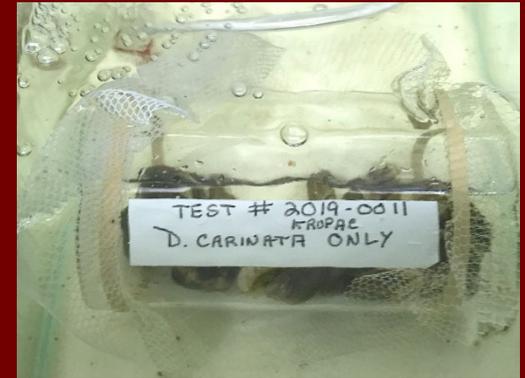


OK, we took the samples.....

But what did we do next?

A field lab in Montenegro has proven itself to be a critically important asset







Mihailo Jovicevic



Milena Ikovic





What methods are we using to search for parasites?

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1. Slow meticulous dissection of live mussels

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2. Histological examination of tissues

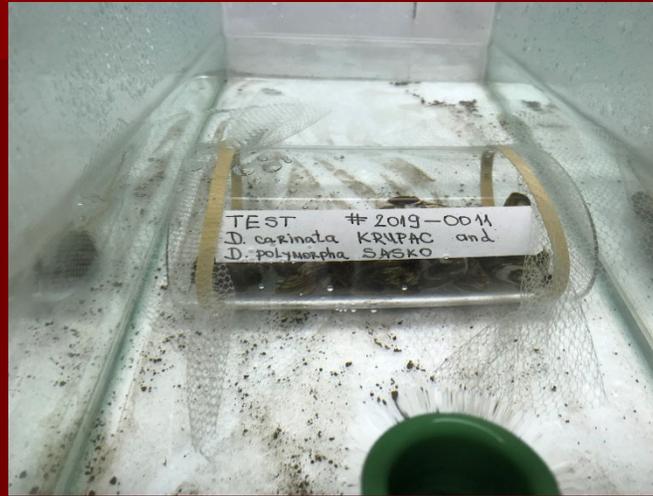
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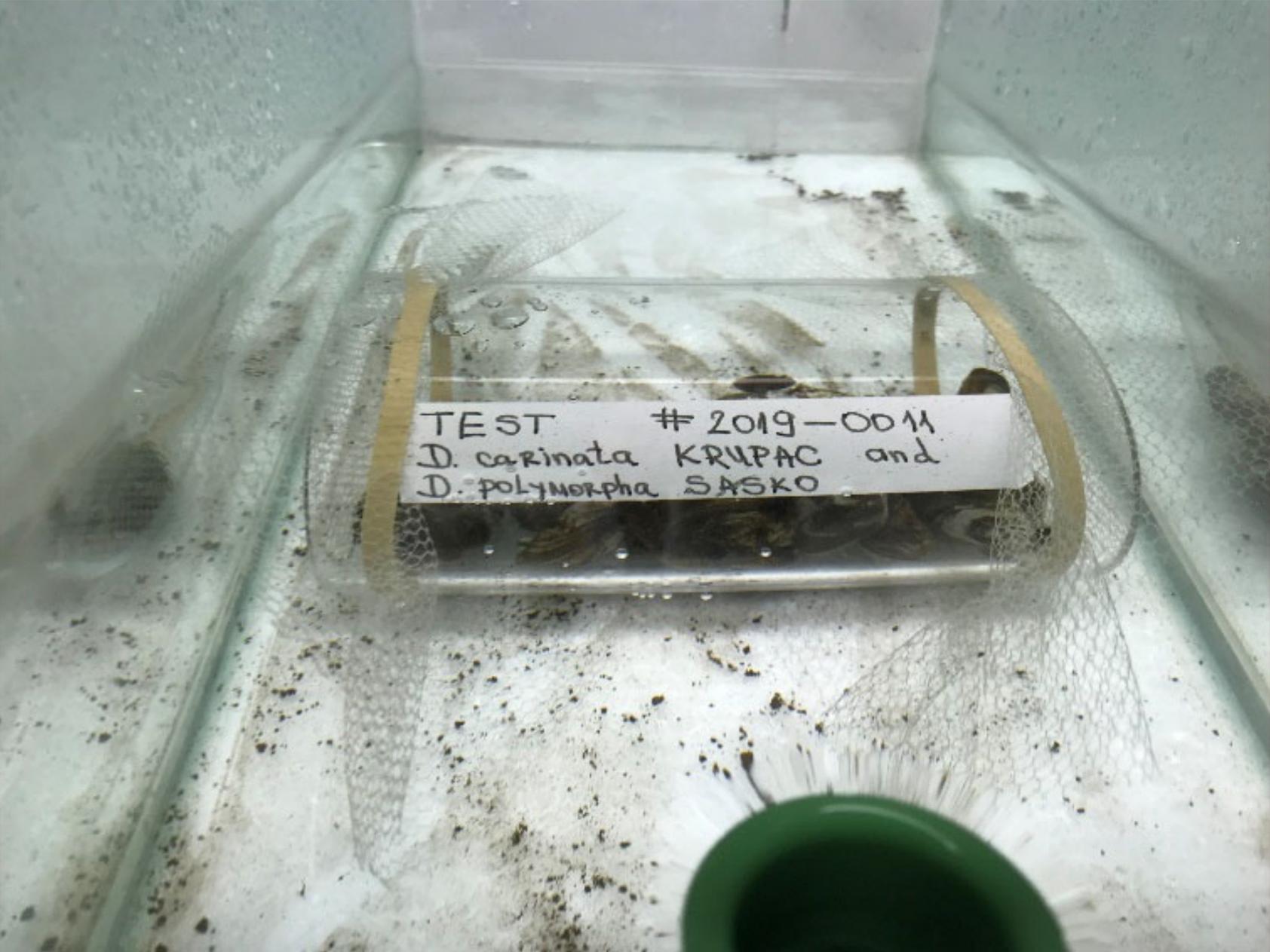
1. Slow meticulous dissection of live mussels
2. Histological examination of tissues
3. Rapid observation of “shucked” live mussels



Experiments:

Transmitting parasites from *D. carinata* to *D. polymorpha*

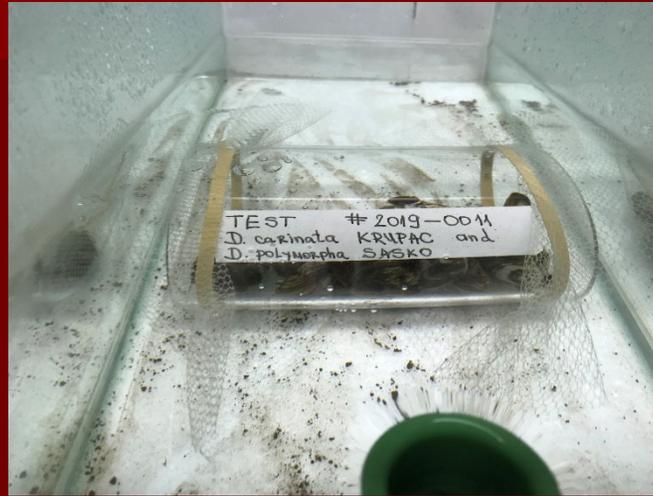




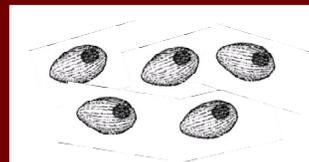
TEST # 2019-0011
D. carinata KRUPAC and
D. polymorpha SASKO

Experiments:

Transmitting parasites from *D. carinata* to *D. polymorpha*



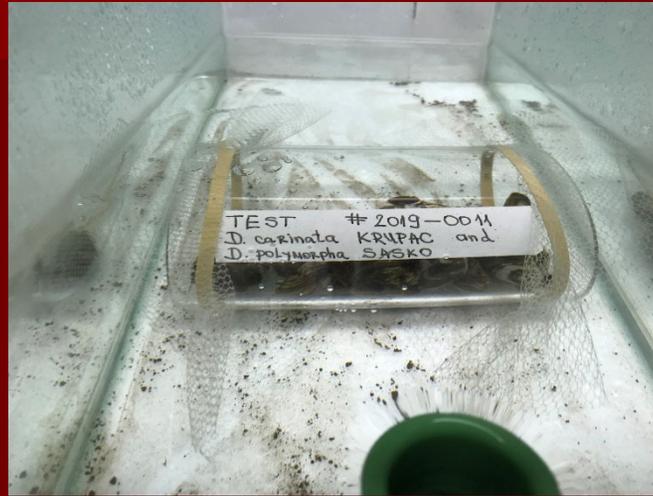
D. carinata



D. polymorpha

Experiments:

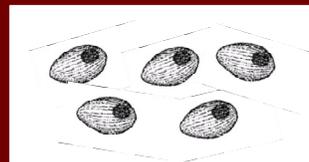
Transmitting parasites from *D. carinata* to *D. polymorpha*



Success with all 5 ciliate species of parasites in *D. carinata* were transmitted into *D. polymorpha* !!



D. carinata



D. polymorpha

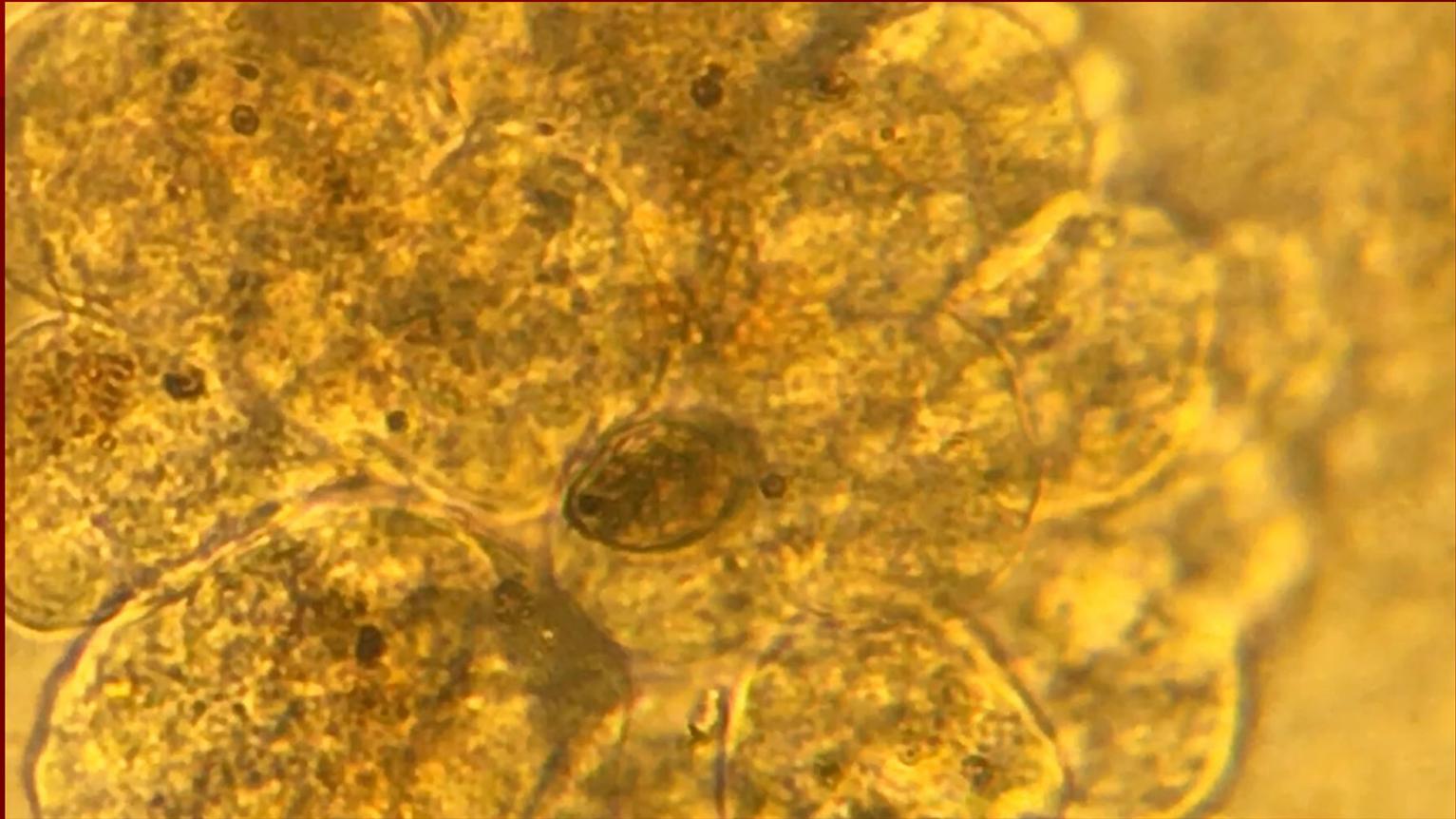
The actual first *Dreissena polymorpha* ever infected with a parasite from a different *Dreissena* sp.



The actual first *Dreissena polymorpha* ever infected with a parasite from a different *Dreissena* sp.



That actual parasite – a ciliate



International Team of Collaborating Scientists



NORTH
MACEDONIA
Sasho Trajanovski



NORTH
MACEDONIA
Tino Zdarveski



ALBANIA
Spase Shumka



ITALY
Sergei Fokin



TURKEY
Zeki Yildirim



FRANCE
Laure Giamberini



MONTENEGRO
Mihailo Jovićević



MONTENEGRO
Vladimir Pešić



MONTENEGRO
Milena Iković



USA
Jacque Keele



USA
Yale Passamaneck



USA
Sherri Pucherelli

FUTURE PLANS

- Continue collecting cousin *Dreissena* spp. (esp. Turkey)
- Keep the lab in Montenegro open year round:
 - Dissecting cousin *Dreissena* spp.
 - Conducting “novel-naïve” infection trials

TAKE HOME MESSAGE

Lake-wide control of dreissenids in North American waterbodies?

Don't give up on the use of parasites.....