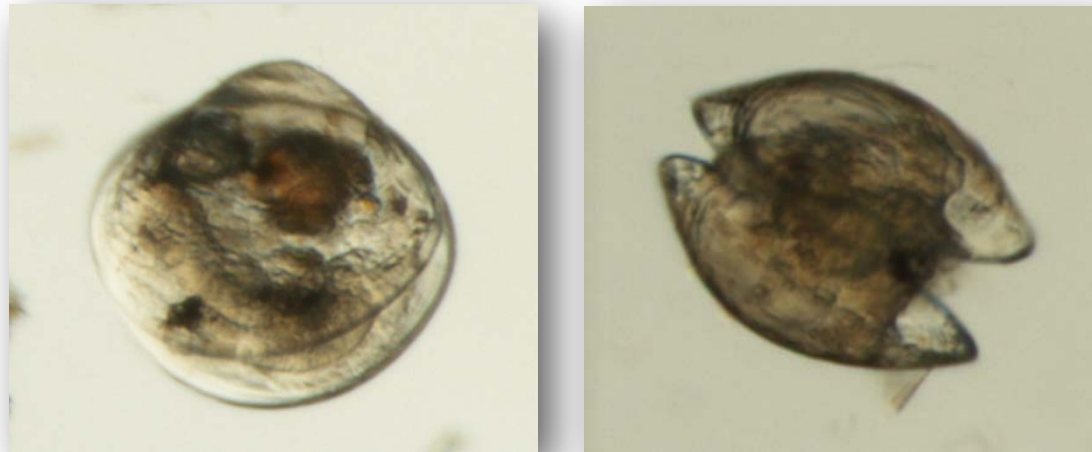


Searching for an Effective Hammer to Squash an Aquatic Cockroach



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2009 Research

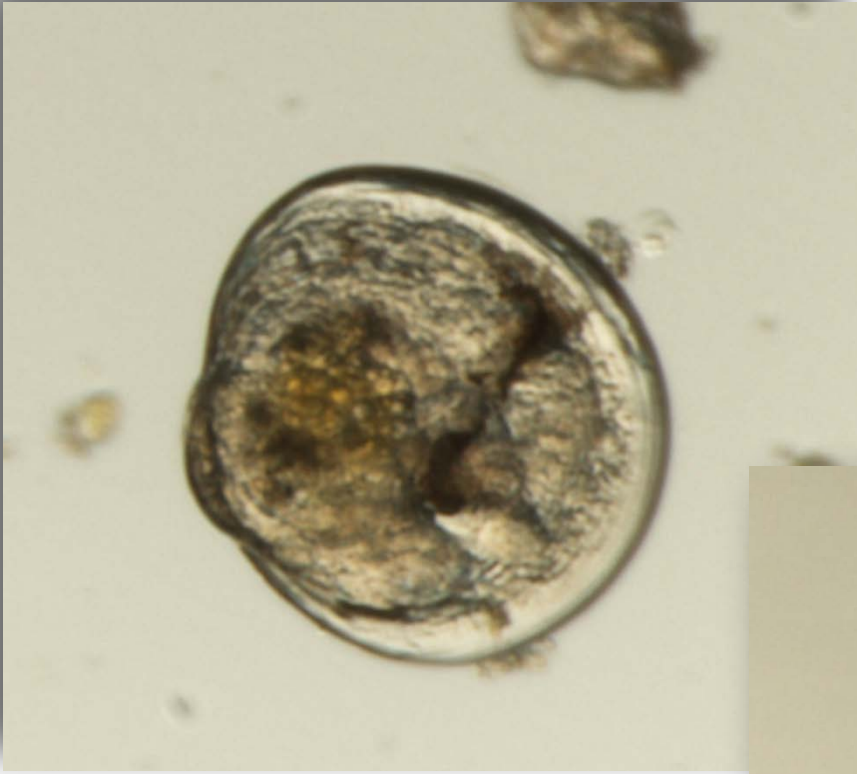


Determine the efficacy of potassium chloride and formalin for removing motile life stages of quagga mussel from transport tanks at Willow Beach National Fish Hatchery at Lake Mohave in Arizona



First Trials Conducted w/o Recovery Period

KCl (mg/L):	Formalin (mg/L):	Mortalities (%)
750	25	0
1500	25	0
	50	0
2000	25	3
	50	2
2250	25	27
	50	25
	100	100
3500	25	20
	50	13
	100	60
4250	25	39
	50	93
	100	50



Differences
observed between
immobile veligers

Are they really
dead?

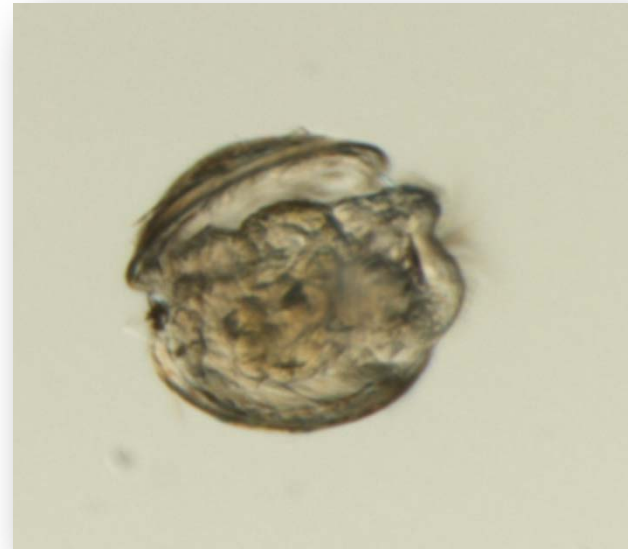
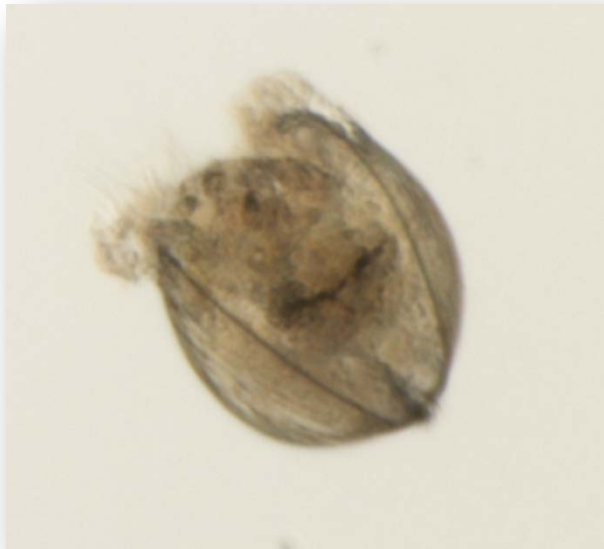


A recovery period was added to last round of tests:

4250 mg/L KCl / 25 mg/L formalin = 100% recovered*

4250 mg/L KCl / 50 mg/L formalin = 100% recovered*

4250 mg/L KCl / 100 mg/L formalin = 100% recovered*



*term “recovered” used loosely

Additional Bioassay

Tested role of water hardness in efficacy of KCl/Formalin treatment by diluting WBNFH water with RO water:

	<u>No Movement after Treatment</u>	<u>Recovered in Fresh Water</u>
50% dilution (142 mg/L as CaCO ₃)	26%	100%
75% dilution (79 mg/L as CaCO ₃)	40%	100%

The standard KCl/formalin treatment has since been tested by 3 additional agencies:

BOR – Colorado office
with quaggas (avg. 21% mortality)

Kansas Wildlife, Parks and Tourism
with zebras (avg. 25% mortality)

Iowa Department of Natural Resources
with zebras (?)

2010 Research

- **Cutrine-Ultra (copper)**
- **Peraclean 15 (peracetic acid)**
- **Spectrus CT1300 (QUAT)**



Lethality tests were designed with a 6-7 hour time frame to reflect an average fish hauling trip

Observations on condition of veligers were recorded hourly

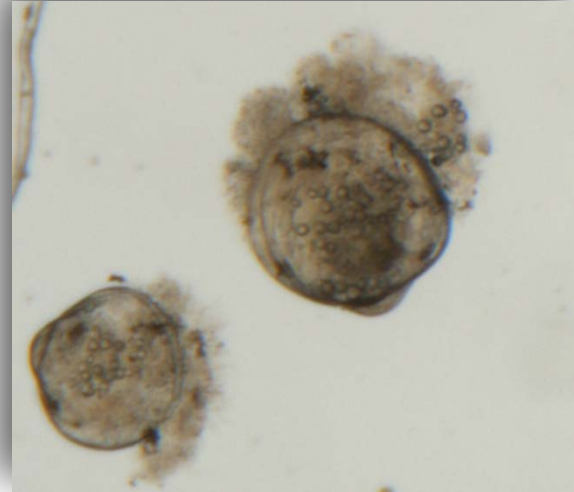


Results

Chemical	Concentration (mg/L)	% Mortality	Time (hour)
Copper	6.25	50	6
	15	80	6
	20	84	6
Peracetic acid	1.25	11	7
	2.5	23	7
	5	50	7
	10	70	7
	35	100	4
	50	100	2
QUAT	10	0	6
	25	80	6
	30	90	6
	37.5	91	6



Healthy veliger



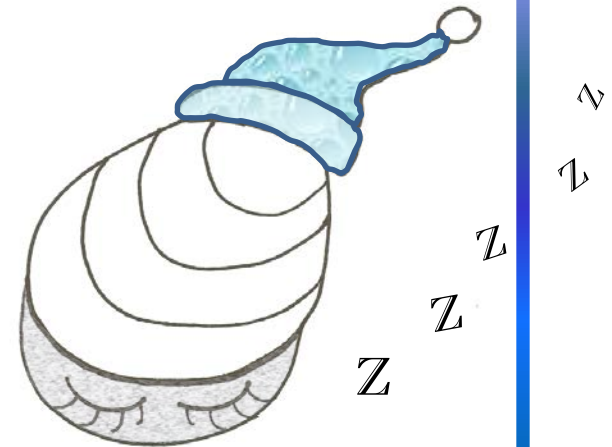
Veligers disintegrating in peracetic acid



Veliger moved to fresh water

2011 Research

Objective – find an alternative chemical that will act as a sedative to prevent quagga mussel veligers from closing their shells as a defense against molluscicides.



Potential Chemicals

2-phenoxyethanol

menthol

Aqui-S

metomidate

aspirin

MS222

benzocaine

phenoxy ethanol

chloral hydrate

procaine hydrochloride

clove oil/eugenol

propylene phenoxetol

EDTA

quinaldine

ethanol

serotonin (5-HT)

isobutynol

sodium bicarbonate

ketamine

sodium pentobarbital

magnesium chloride

tertiary amyl alcohol

magnesium sulphate

valium

5 chemicals chosen to be tested:

- **Clove Oil**
- **Menthol**
- **Benzocaine**
- **Magnesium Chloride**
- **Propylene Phenoxetol**

First Round Results

Chemical	Concentration	50 mg/L Formalin		Percent Mortality
		Pretreatment Time (hours)	Treatment Time (hours)	
Menthol	1 g/L	2	2.5	100
	1 g/L	3	n/a	100
	1 g/L	4	n/a	100
	1 g/L	6	n/a	100
Menthol/Clove oil mix	800 uL/L	1.5	2	100
Propylene phenoxytol	5 mL/L	2	n/a	100
	4 mL/L	3	n/a	100
	5 mL/L	3	n/a	100
	4 mL/L	4	n/a	100
	5 mL/L	4	n/a	100

Chemical	Concentration	Pretreatment Time (hours)	50 mg/L Formalin	Percent Mortality
			Treatment Time (hours)	
Magnesium Chloride	1 g/L	1	3	0
	3 g/L	1	3	0
	5 g/L	1	3	0
	1 g/L	2	3	0
	3 g/L	2	3	0
	5 g/L	2	2	33
	1 g/L	3	4	0
	3 g/L	3	3.5	0
	5 g/L	3	2	0
	1 g/L	4	2.5	0
	3 g/L	4	2	5
	5 g/L	4	2	55
	1 g/L	5	1.5	0
	3 g/L	5	2	0
	5 g/L	5	2	0
	1 g/L	6	2	0
	3 g/L	6	2	65
	5 g/L	6	n/a	53

Last Round of Tests

Additional testing with MgCl_2

Also threw in for grins:

- **Chloramine-T**
- **Dimilin**
- **Praziquantel**
- **Malachite Green/Formalin Mix**
- **Catch & Release[®]**

MgCl Concentration		Total Treatment Time (hours)	Percent Mortality
5 g/L	without formalin	10	100
5 g/L		12	100
5 g/L		13	100
5 g/L		15	100
6 g/L		15	100
7 g/L		15	100
	formalin - added at end		
5 g/L	50 mg/L, 2 hours	10	100
5 g/L	100 mg/L, 1 hour	10	100
5 g/L	200 mg/L, 1 hour	10	100
5 g/L	50 mg/L, 2 hours	12	100
5 g/L	100 mg/L, 1 hour	12	100
5 g/L	200 mg/L, 1 hour	12	100
	formalin - for full treatment		
5 g/L	50 mg/L formalin	6	91
5 g/L	75 mg/L formalin	6	92
5 g/L	100 mg/L formalin	6	86
5 g/L	50 mg/L formalin	7	100
5 g/L	75 mg/L formalin	7	96
5 g/L	100 mg/L formalin	7	91
6 g/L	100 mg/L formalin	7.5	100
7 g/L	100 mg/L formalin	7.5	100
8 g/L	100 mg/L formalin	7.5	96
5 g/L	50 mg/L formalin	8	100
5 g/L	75 mg/L formalin	8	96
5 g/L	100 mg/L formalin	8	95

Future Research Plans

- Test new variations of MgCl and research other chemicals as possible replacements for formalin in the treatments
- Develop a study to determine the viability of the surviving but deteriorated veligers
- Keep researching other potential chemicals to test

Thank you

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