



# DEVELOPMENT OF METHODS TO ORALLY DELIVER BIOCIDES TO CONTROL OR LIMIT INVASIVE AQUATIC ANIMALS

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# Outline

- Introduction
- UMESC
- ABN MicroMatrix™ Technology
- Research Program
- Summary

The Upper Midwest Environmental Sciences Center (UMESC) is an integrated research facility within USGS.

*Research and Monitoring*

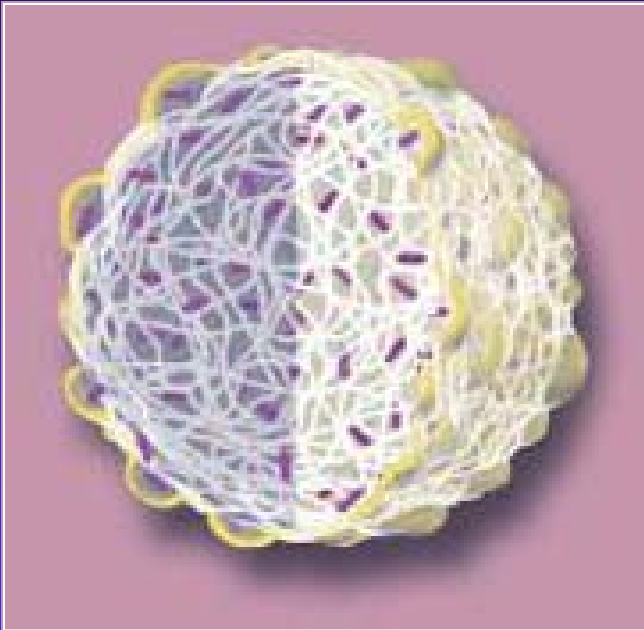


Aerial view of UMESC, La Crosse, WI

# UMESC Overview

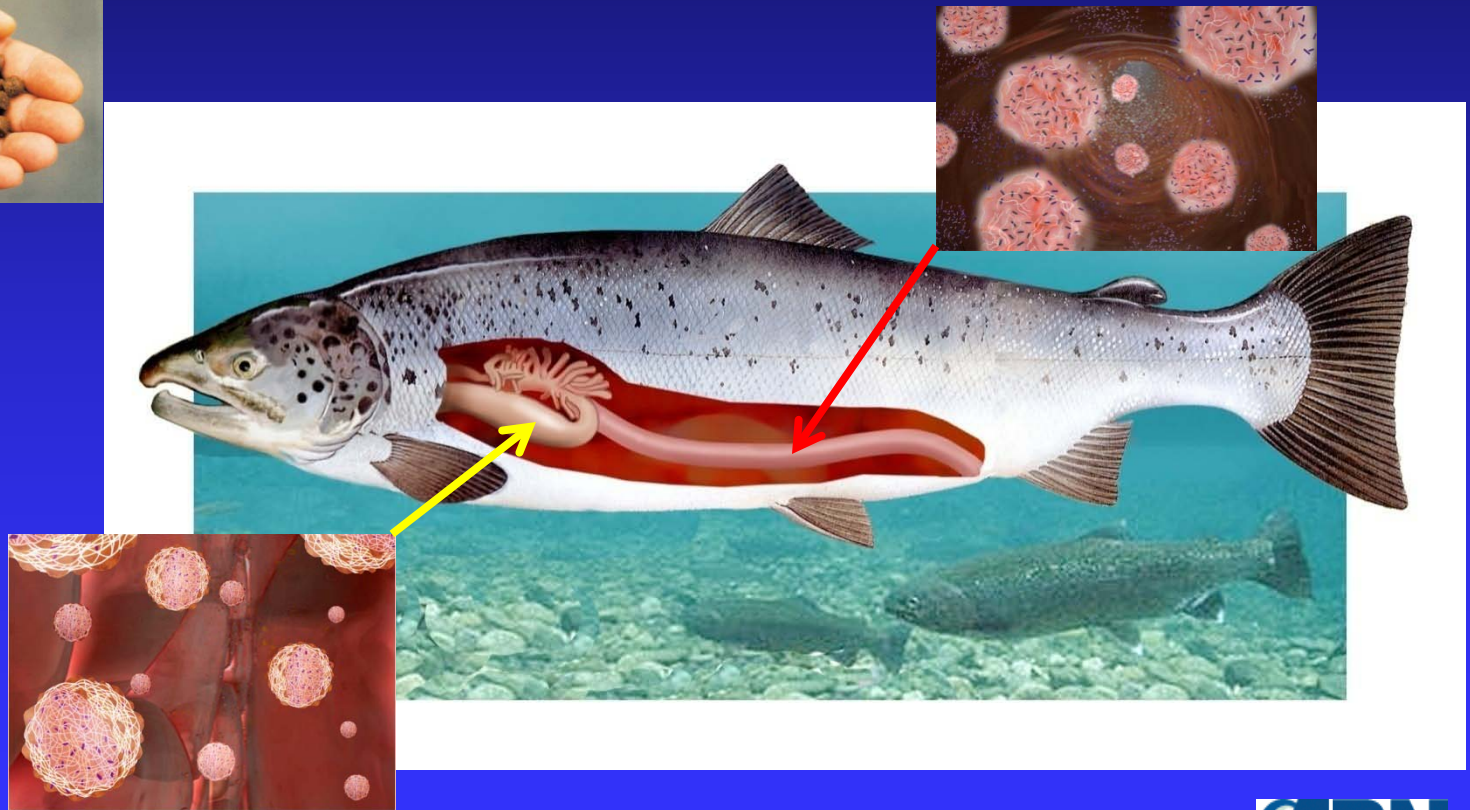
- Roots in aquatic invasive species control since early 1960's
- Sea Lamprey Management
  - TFM and niclosamide
- Fish management and resource restoration
  - Antimycin and rotenone
- Sea lamprey, common carp, goby, ruffe, crayfish, Asian carps

# Advanced BioNutrition: MicroMatrix™

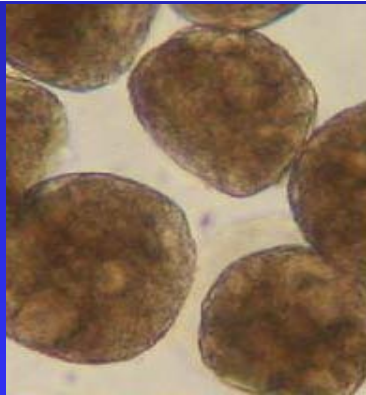
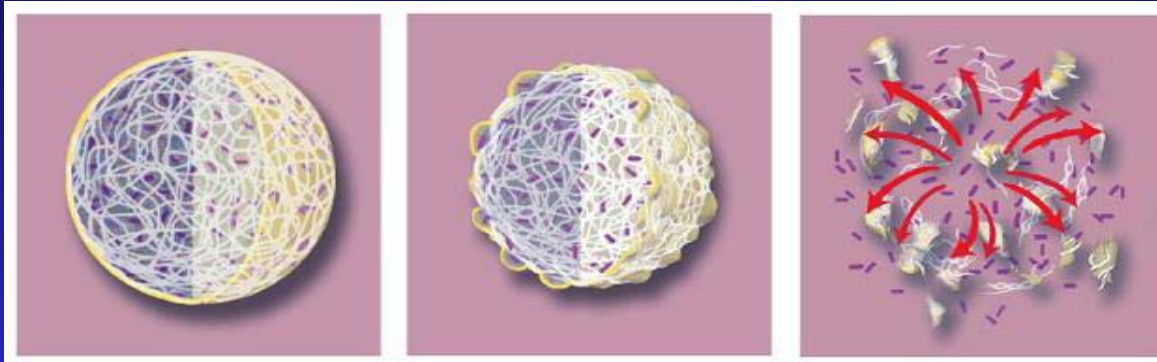


- **What it is:**
  - not a typical encapsulation
  - structural matrix for integrity, stability and protection
  - can hold multiple entities
  - GRAS components
  - Delivers varied bioactives

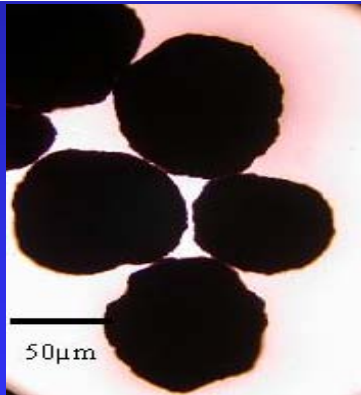
# Delivery of bioactive agents



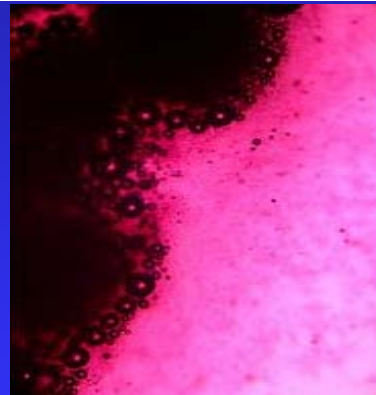
# The MicroMatrix™ Way – Stabilize and Deliver



MicroMatrix™



Gastric Juice



Duodenal Juice

## Applications

Probiotics

$\omega$ -3 oils

Vitamins

Antibiotics

Vaccines

Carotenoids

**Piscicides!?**

# How *could* this be applied?

- Selective delivery of toxicants
  - ◆ Rotenone
  - ◆ Antimycin
  - ◆ GD-174
  - ◆ KCl
  - ◆ Bayluscide
- Selective delivery biological toxins
  - ◆ *Bacillus thuringiensis*
- Combination of strategies
  - ◆ Attractant + toxicant
  - ◆ Attractant + biological

# Research Program

## GOAL:

A biocide incorporated into a targeted delivery system that takes advantage of the physiological characteristics of the target invasive animal

- » Potential to target specific invasive species
- » Advantage over current methods of application

## INITIAL OBJECTIVE:

Characterize the physiology of gills and digestive glands

# Research approach

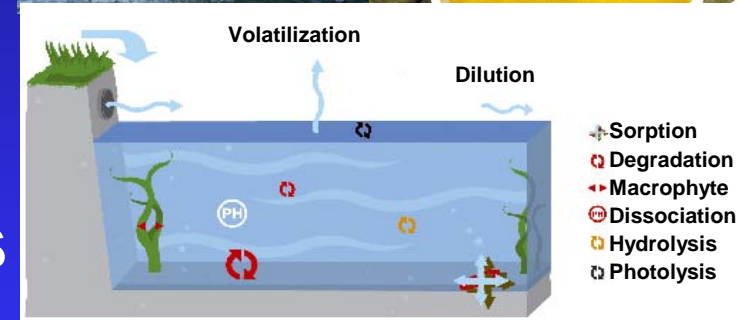
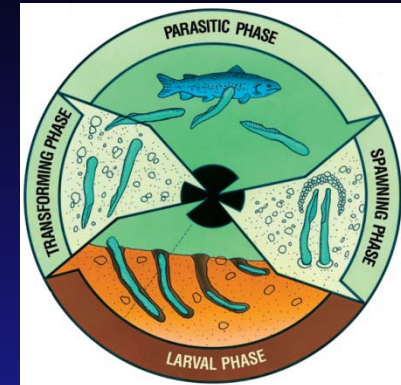
I. Life history

II. Identification of target sites

III. Application strategies

IV. Identification of new agents

v. Registration activities



# Initial Research



## Looking for differences in:

- digestive tract pH
- digestive enzymes
- particle size
- particle shape
- Nutrient composition



*Goal: identify differences (e.g., delivery site pH and/or enzyme activity) among genera to determine desired delivery system characteristics to enhance specificity and toxicity of candidate biocides to the target invasive organism.*

# Registration activities

## **i. Experimental use permit**

- i. begin discussion with EPA and state DNRs (e.g. IL, MO, AR?) to identify potential experimental application locations**

- EUP application ~24 mo after initiation**

## **ii. Host AIS Management Chemical meeting**

- i. Research agencies**
- ii. Management agencies**
- iii. Regulatory agencies**
- iv. Industry**

# Zebra Mussel Research

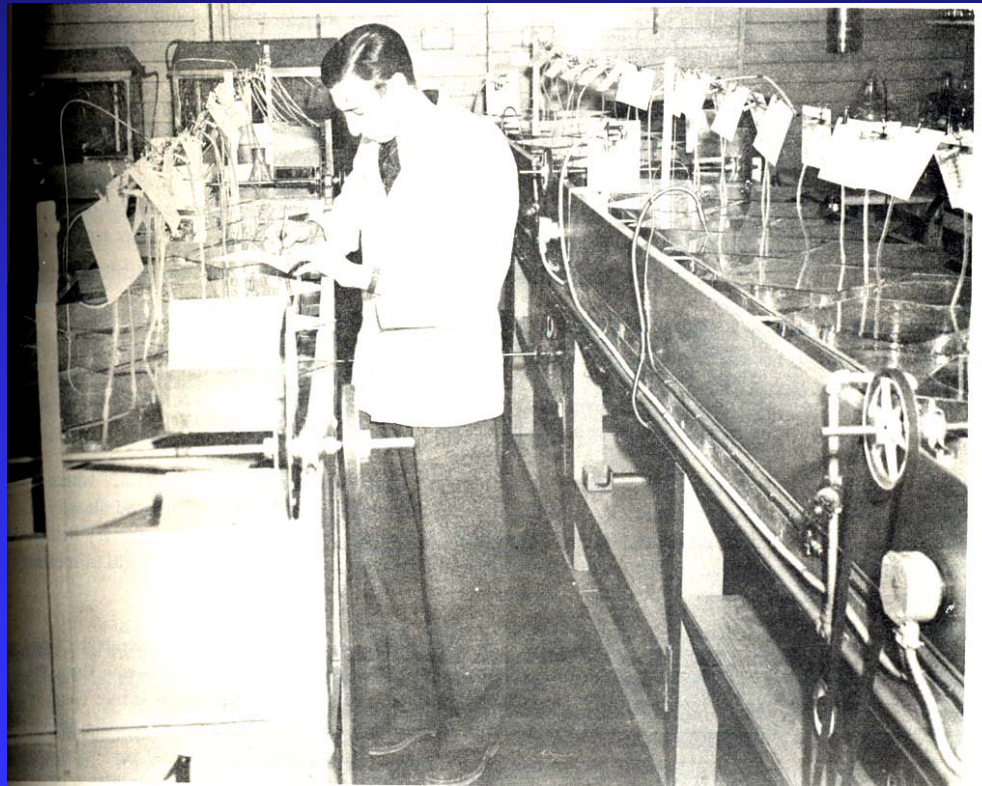
- FWS Science Support Project
- Particle size preference research
- Filtration rate research
- Digestive enzymes

# Screening Chemicals to Identify New Fish Toxicants

- ◆ Currently only 4 registered fish toxicants
  - ☞ TFM, Niclosamide, Rotenone, Antimycin A
- ◆ Screening carried out in 50s, 60s, and 70s
  - ☞ Very little recent research
- ◆ Hundreds of thousands of organic compounds developed since the early years
- ◆ Green chemistry
  - ☞ Last ~20 years shift has been toward development of environmentally benign pesticides

# A little nostalgia

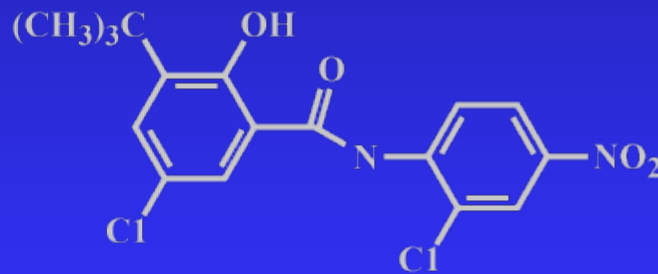
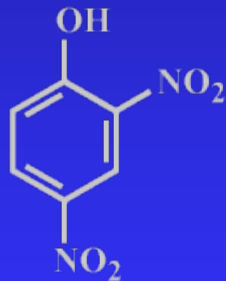
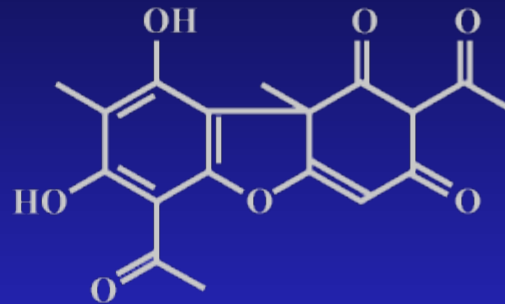
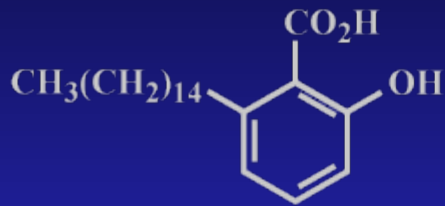
- How it was done:



# Drug Discovery

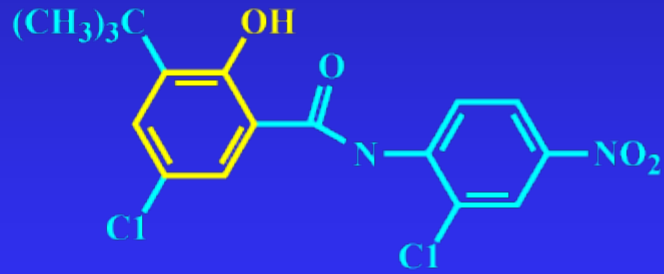
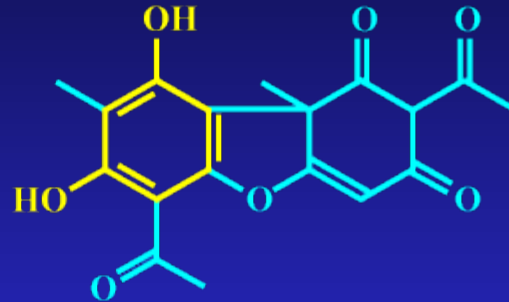
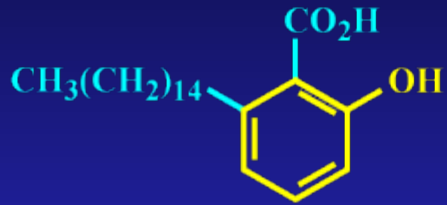
- Structure-Activity Relationships
  - ◆ Understand how disease and infection are controlled at molecular level
  - ◆ Correlate structural features (size, shape, functionality) with biological activity

# OP Uncouplers



W. H. Gingerich in *Integrated Management Techniques to Control Nonnative Fishes*.  
Dawson and Kolar 2003 U.S. Geological Survey

# OP Uncouplers



# Approach

- Review literature for known mechanisms of toxicity
- Develop correlations
- Access database of registered pesticides
- Select candidates
- Test

# Summary

- UMESC
- ABN MicroMatrix™ Technology for selective delivery/control
- GLRI carp and mussel research
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