Prymnesium parvum – An overview and Questions

Carmelo R. Tomas

Center for Marine Science

University of North Carolina at Wilmington

Presently recognized Prymnesium species:

Prymnesium parvum – first described by Carter 1937

P. patelliferum – now considered a form of P. parvum

P. saltans – described by Massart and Conrad 1926

P. calathiferum – Chang 1987

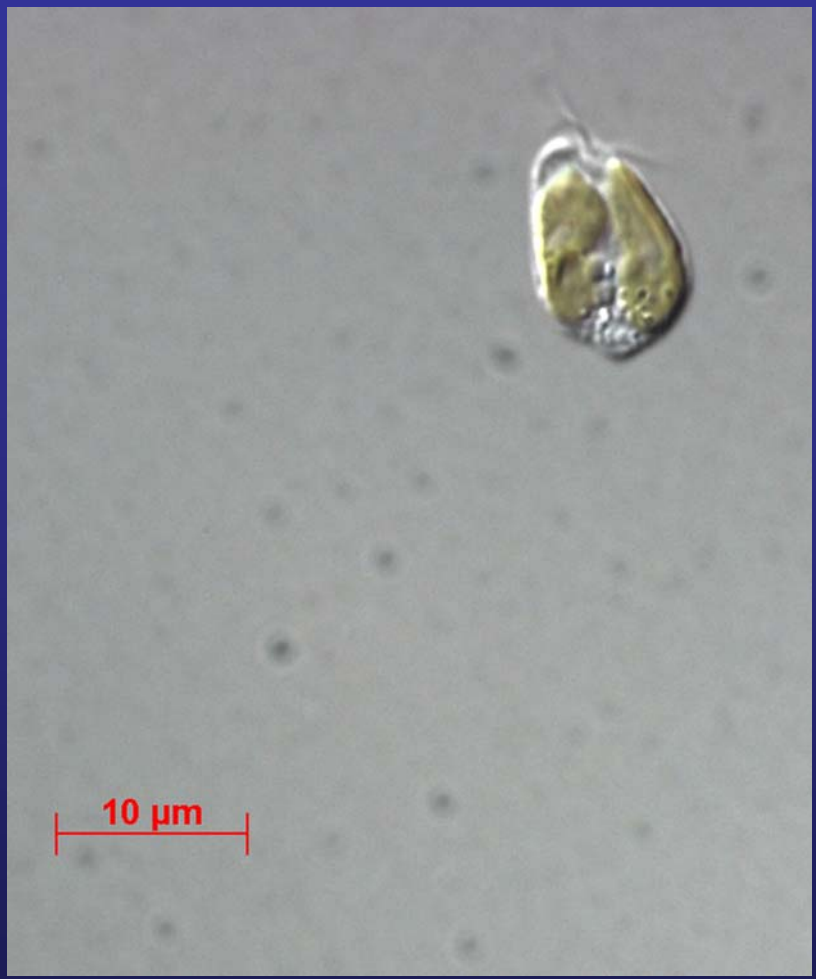
P. zebrinum – Billard 1983

Size : < 20 µm

Grow rapidly : > 1 div/day

Maximum densities:

> 100 million cells/liter



Cell Characteristics

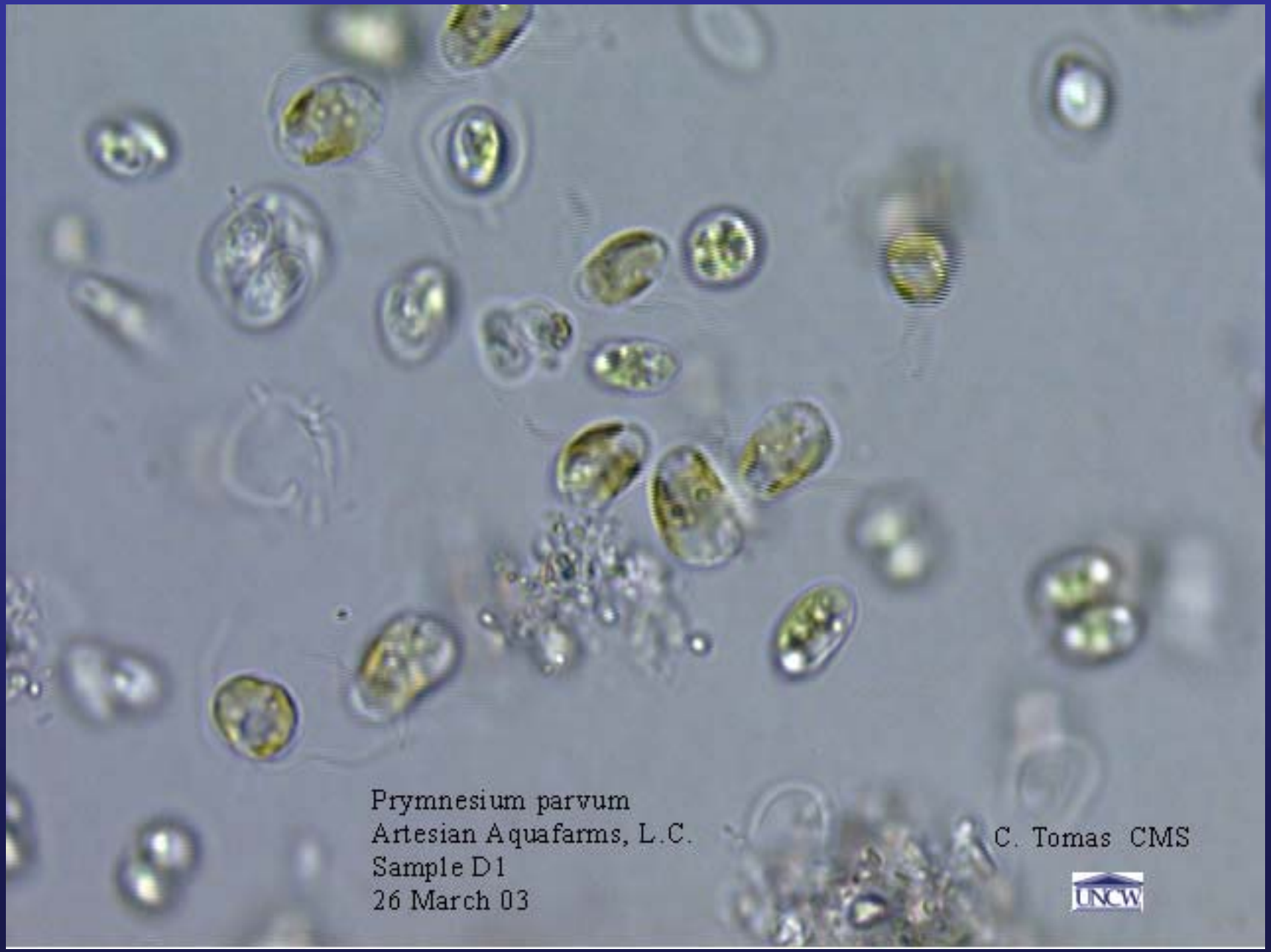
- Cells less than 10 µm
- Highly motile
- 2 flagella with haptonema
- 2 chloroplasts
- body scales (EM)

Bloom History

- Within a decade of its initial description, P. parvum was identified as causing massive fish kills in Israel's Lake Kenneret (Sea of Galilee) and in aquaculture ponds.
- Prymnesium species were identified from
  - German lakes 1920
  - Holland 1920
  - Denmark – 1938

Presently Prymnesium species are now identified from 14 different countries from Scandinavia, Europe, Asia, New Zealand, North and South America.

P. Parvum bloom in Possum Kingdom Lake, Texas 2001 – courtesy of TPWD


Prymnesium parvum
Artesian Aquafarms, L.C.
Sample D1
26 March 03
C. Tomas CMS
UNCW

Blooms were episodic:

- Appearing and developing rapidly
- Reaching maximum densities of >100 million cells/liter
- Once established became permanent
- Indicates a survival stage functioning in a similar was as do cysts in dinoflagellates

Bloom conditions:

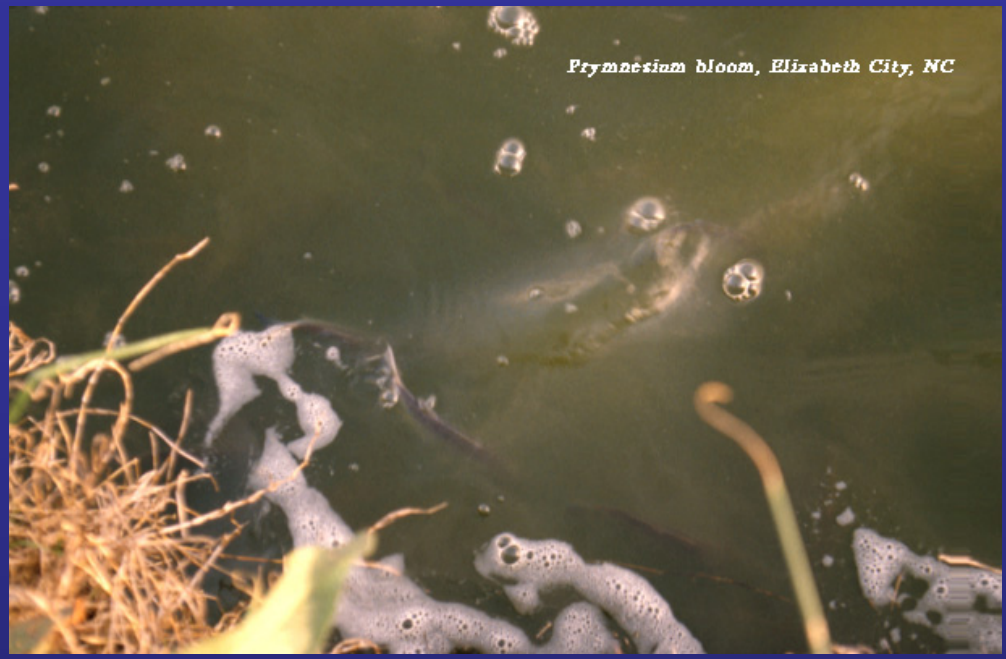
- Wide salinity range (1 to > 35 PSU)
- grow in highly enriched waters (aquaculture ponds, eutrophic coastal embayments, lakes, ponds and rivers)
- Photosynthetic – mixotrophic, auxotrophic, phagotrophic
- Allelopathic

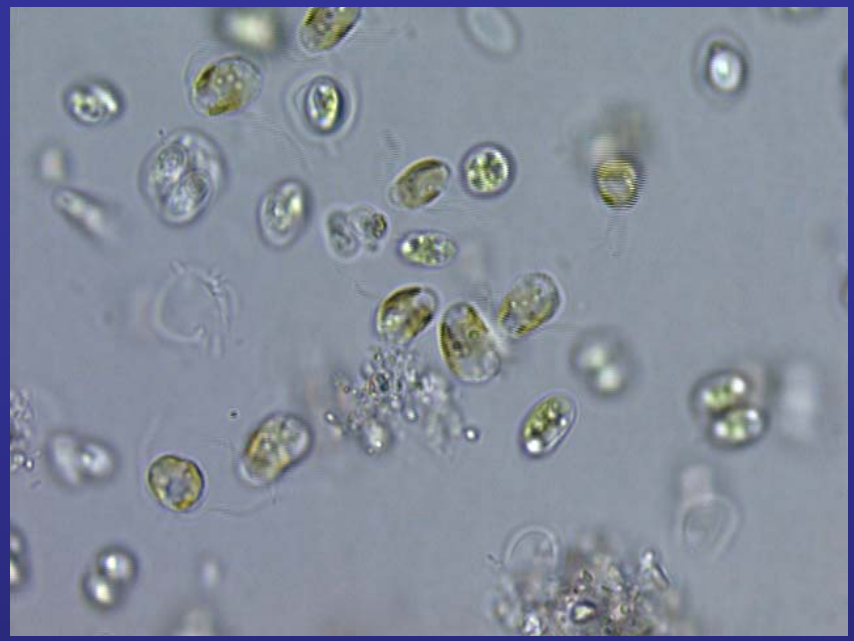
Dying Shad – Texas - courtesy of C. Contraras

Elizabeth City, NC May 2002

Prymnesium parvum bloom

Toxin - prymnesin


Prymnesium bloom, Elizabeth City, NC




Elizabeth City, NC
Prymnesium parvum bloom kill


Prymnesium parvum

Possum Kingdom Lake, Texas - courtesy of the Texas Parks and Wildlife

Dead fish at a dam site in Texas - courtesy of C. Contraras

Hemolysis symptoms

Fish showing hemmoragic areas from exposure to Prymnesium parvum toxins

Toxins: (Lethal Cocktail)

There is presently evidence for the presence of more than one toxin from P. parvum.

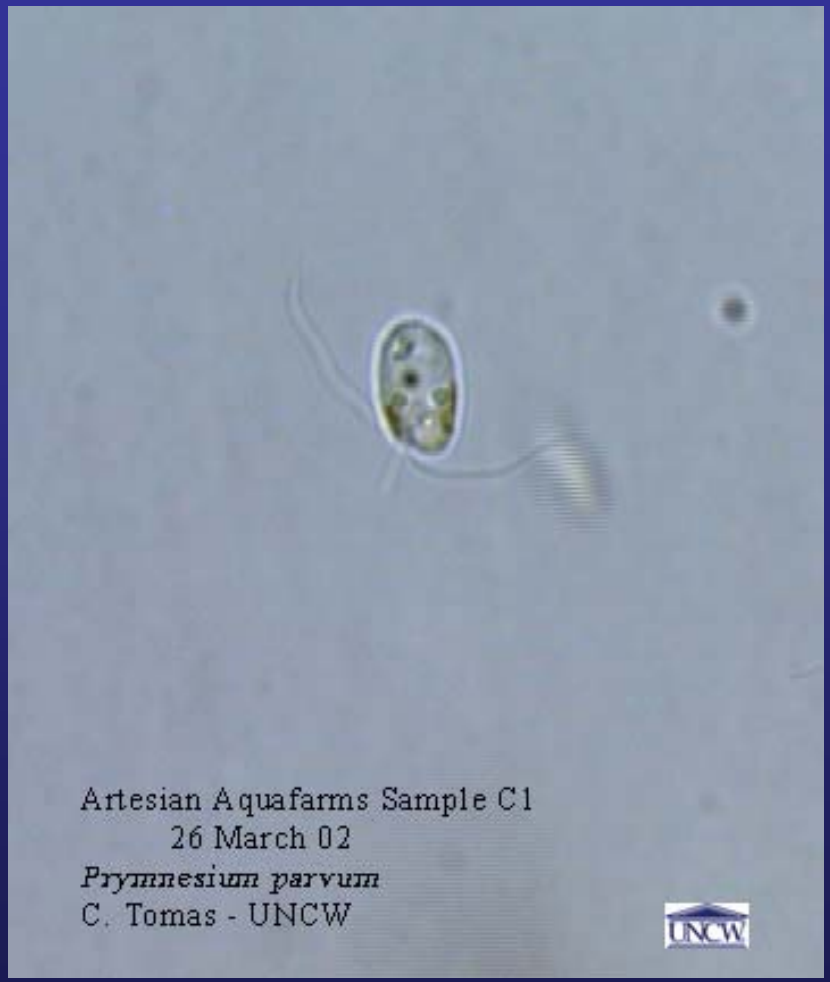
They include:

- **Hemolysins**
- **Neurotoxins**
- **Fast Acting Ichthyotoxins (Cyclo amines)**
- **Reactive oxygen species (ROS) H_2O_2, O_2^- and OH^-**
- **DMSP**
- **Toxic fatty acids**

Problem in identifying what regulates toxins:

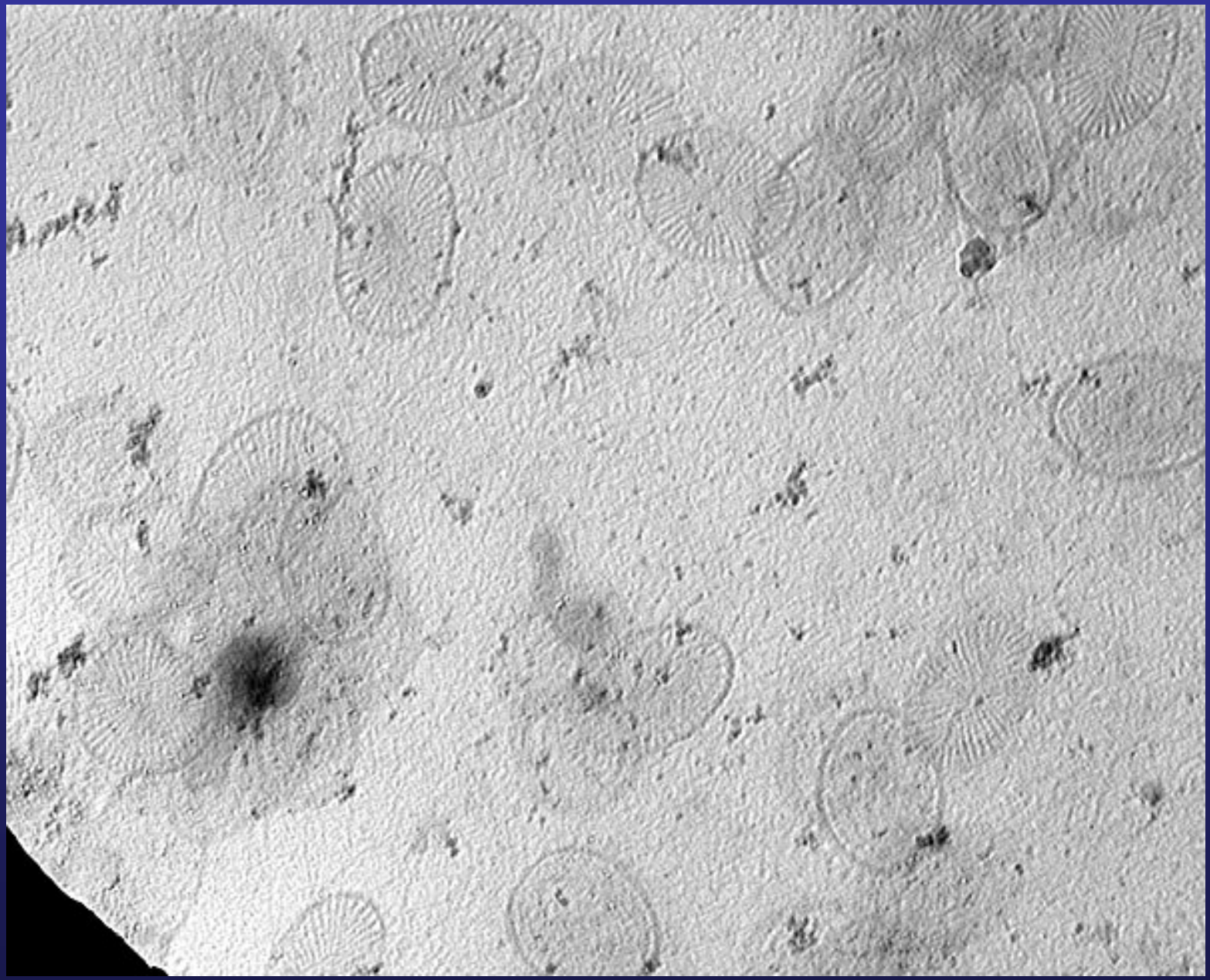
Conflicting evidence:

- **Toxin mixtures make it difficult to extract what is influence what toxin component**
- **Detection of toxins (except for hymolysins) difficult**
- **Structures of toxins (prymnesins 1 & 2, difficult to resolve)**
- **Conditions for toxin production also confusing**
  - **obligate need for a dark cycle**
  - **nutrients and their interactions**
  - **conflicting temperature/salinity evidence**
  - **fish stimulated production**

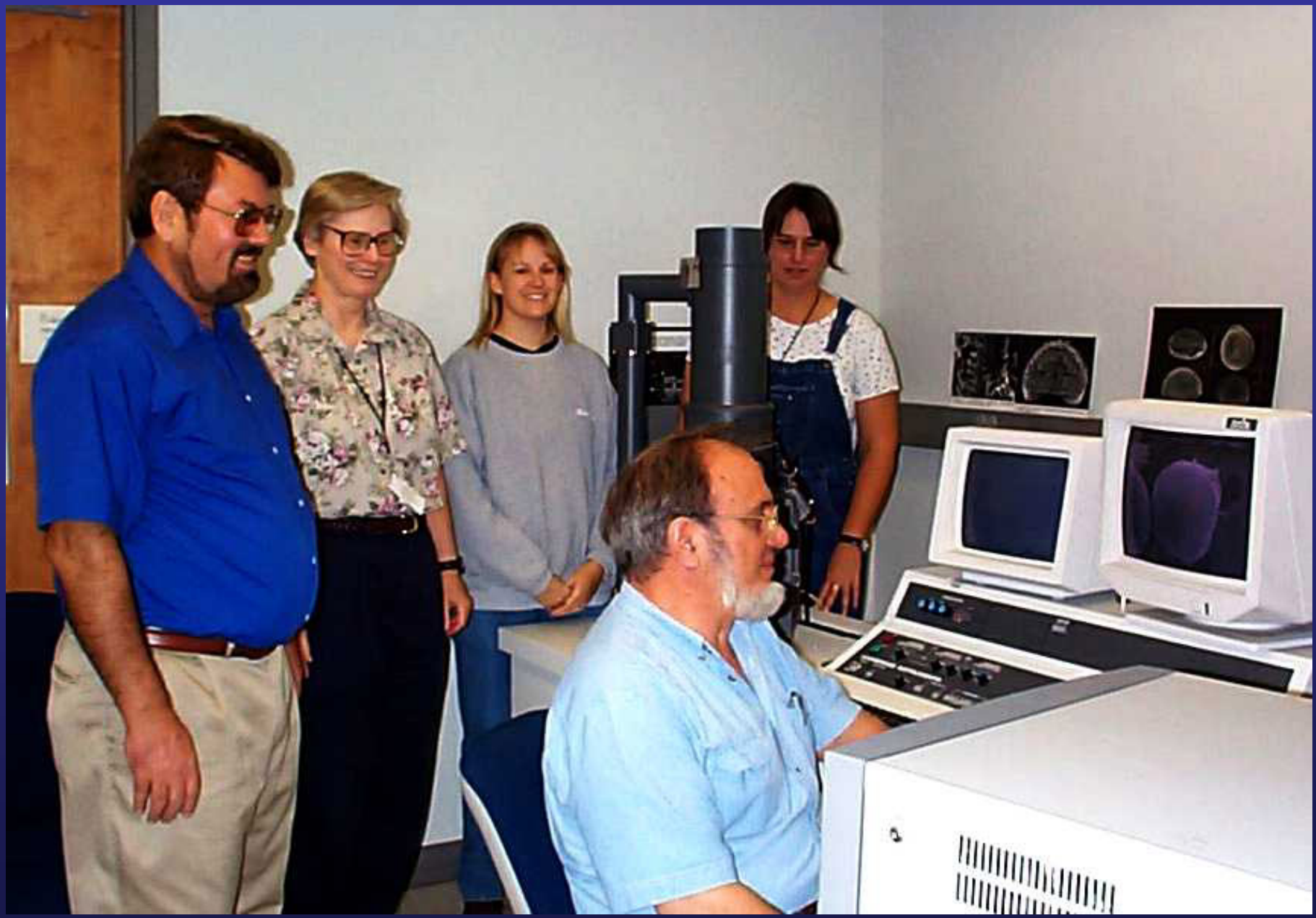


How easily can they be identified from field samples?

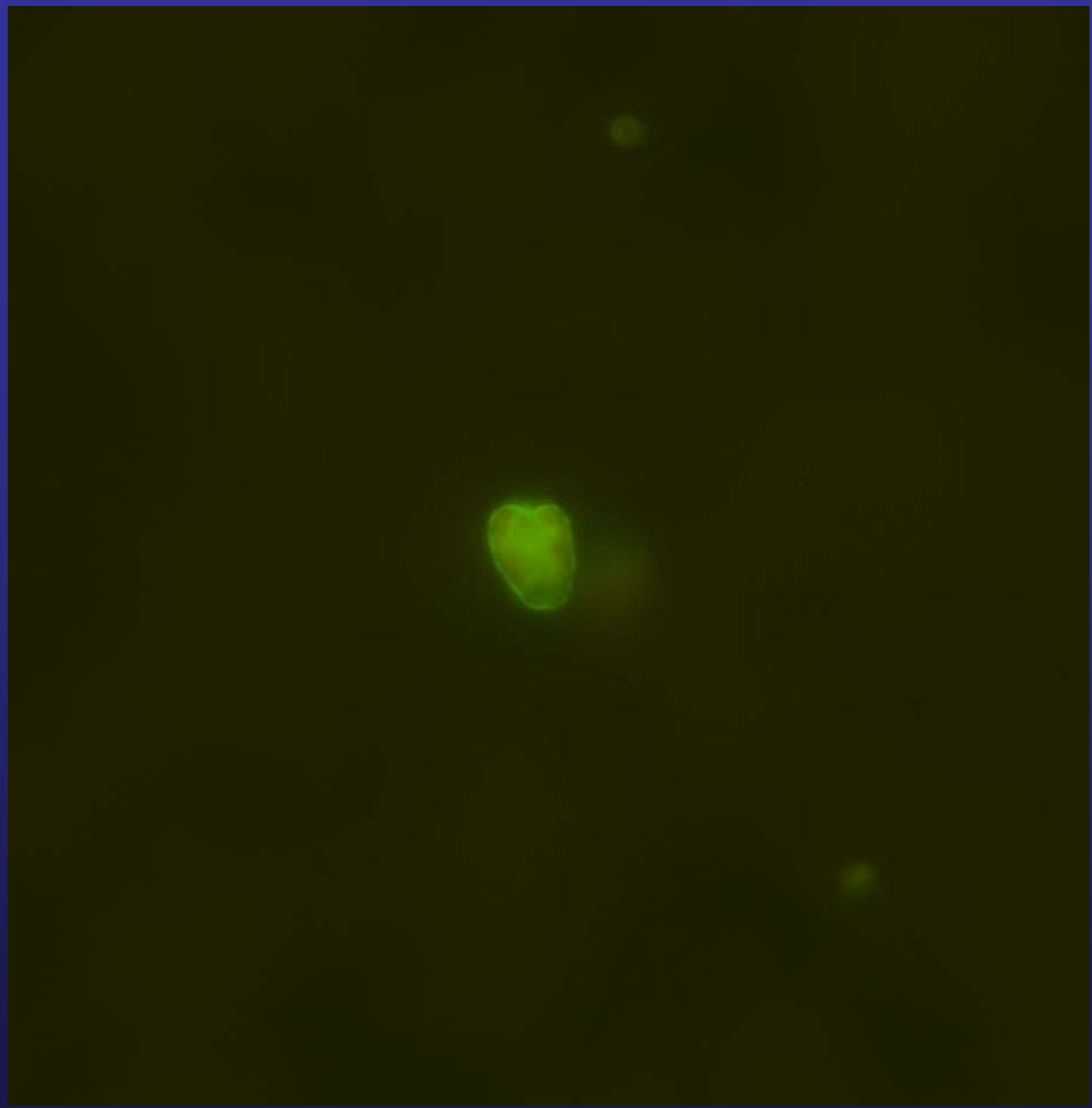

Body Scales
Haptonema
Flagellum



Body Scales of P. parvum



SEM facility at FMRI, St. Petersburg, FL



Fluorescent labeled

P. parvum cell

Surface recognition

Probes

Can be used in conjunction with flow cytometry for ID, isolation and counting

Courtesy of Nyree West

Mitigation and Control:

- **Accurate and rapid detection of P. parvum in natural waters**.
  - Confirms species presence prior to blooms or fish-kills
  - Can be indicative of distribution of the species
  - Detecting resting stages and mapping their distribution

- Detection of toxins – various components at low ambient levels
  - Guides mitigation efforts for destruction of toxins via chemical means
  - Determines the level of risk for cultured fish

- Mechanical removal of P. parvum and neutralization of toxins

Priorities:

Cells:

- accurate and rapid detection, identification, quantification
- detecting and mapping resistant (dorment) stages

Toxins:

- detection and quantification of different toxin components
- factors regulating those toxin elements
- understanding the synthesis of these toxin elements

Mitigation:

- development of means for cell removal (including lysis)
- using toxin and cell detection guided methods for mitigation
- developing agents against the specific toxins