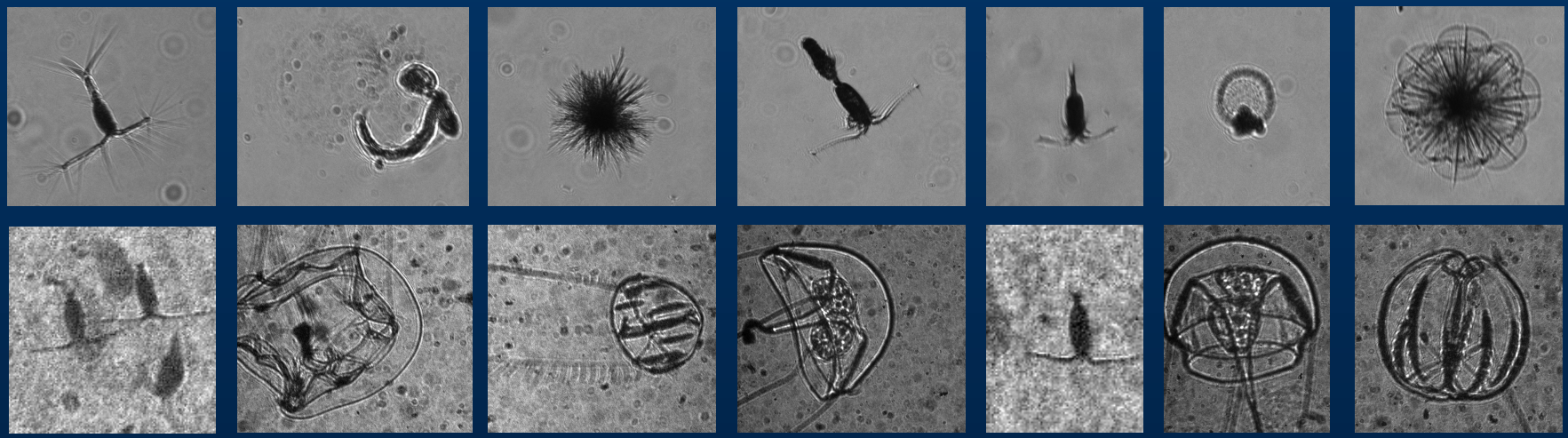
Insights from an underwater imaging system: ZOOVIS deployments in the northern Gulf of Mexico and the Chesapeake Bay



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[1]Louisiana State University, Department of Oceanography and Coastal Sciences

[2]University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory,

Why Use Imaging Systems?

- Save Time
  - Reduce lag between sampling and interpretation
  - Capitalize on opportunities at sea
- Additional Information
  - Scale of the individual
  - Documentation of fragile taxa/structures
  - Behavior and associations
- Collect Data with High Spatial Resolution
- Much more fun than nets or pumps!

There's No Universal Net









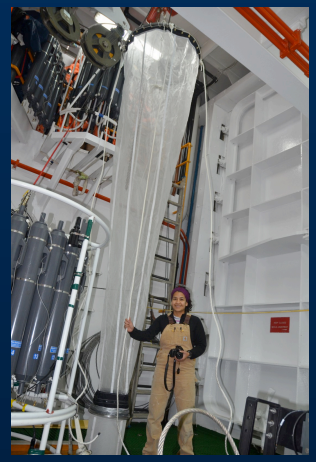
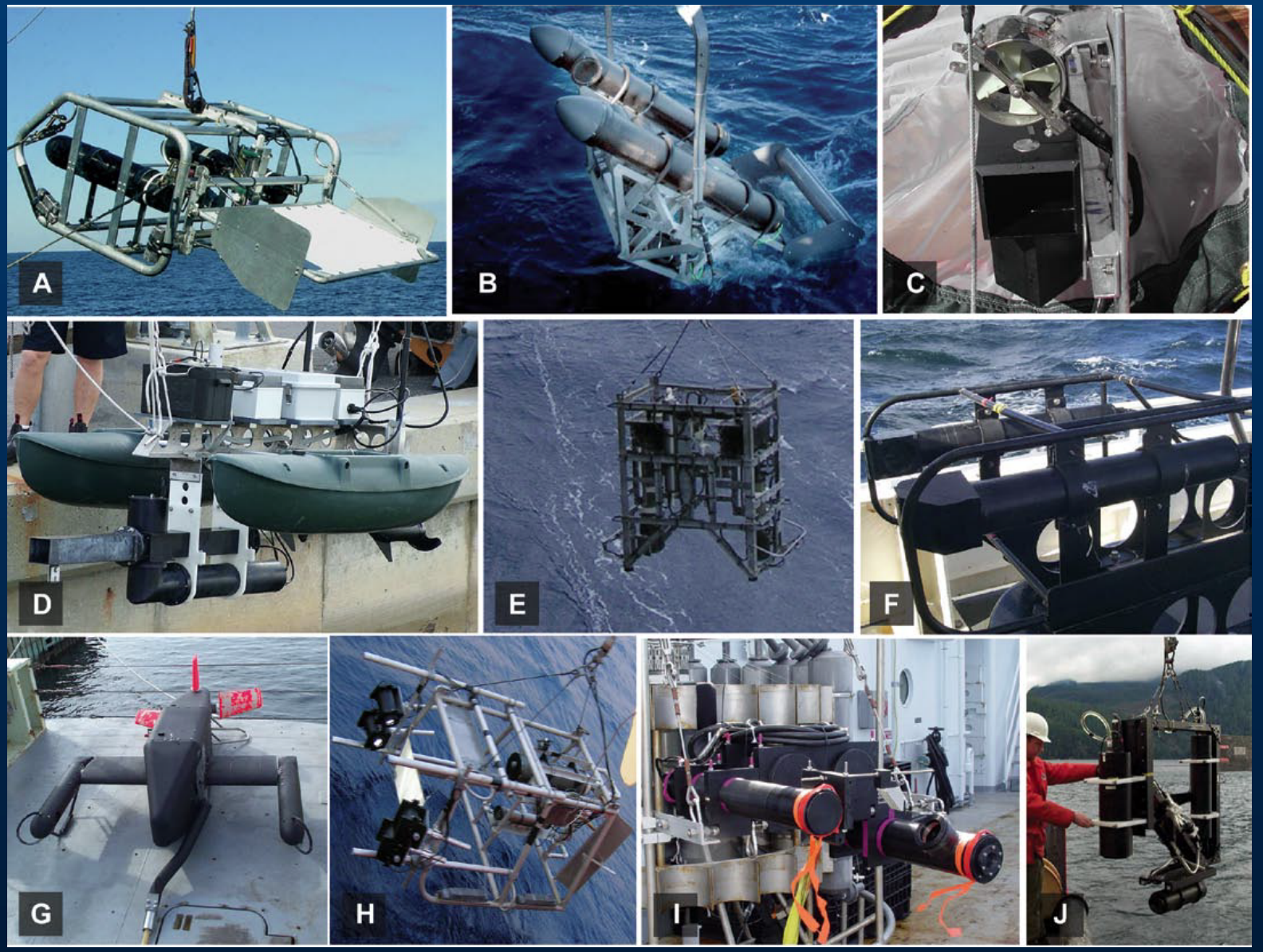


Image Credits: (Top Row) NOAA, Mar-Eco, WHOI, M. Benfield (Bottom Row) SIO, Palmer LTER, D. Haggarty (DFO Canada), NOAA, P. Wiebe (WHOI)

There's Also No Universal Imaging System

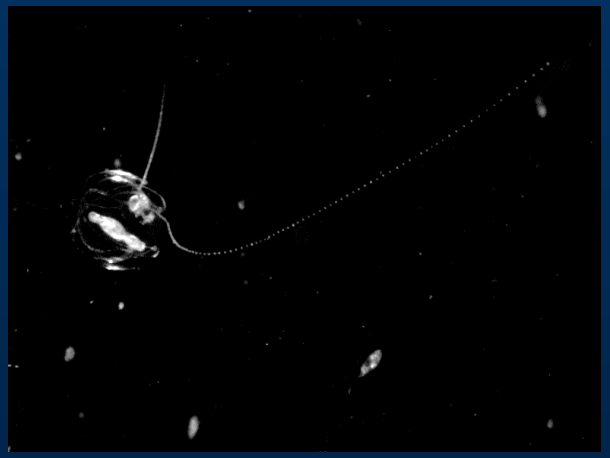
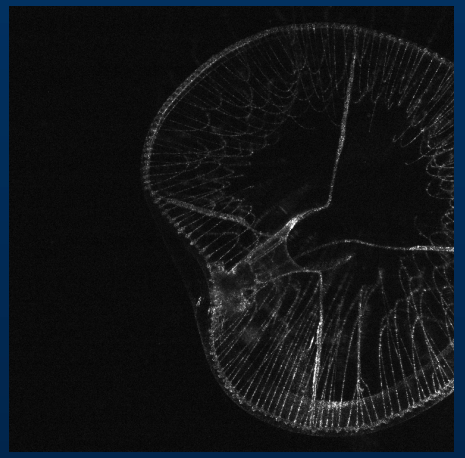
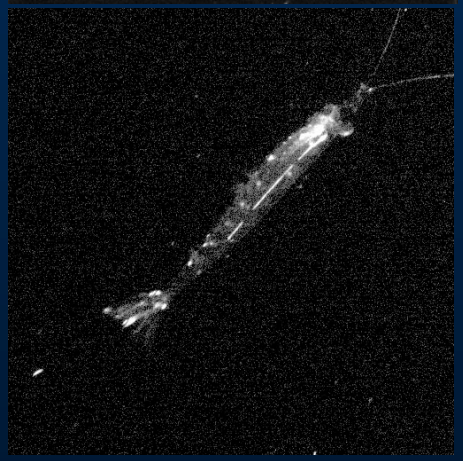


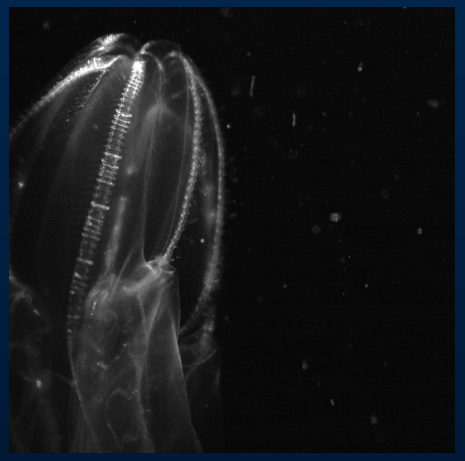
Benfield et al. 2007 Oceanography

Prior ZOOVIS Systems



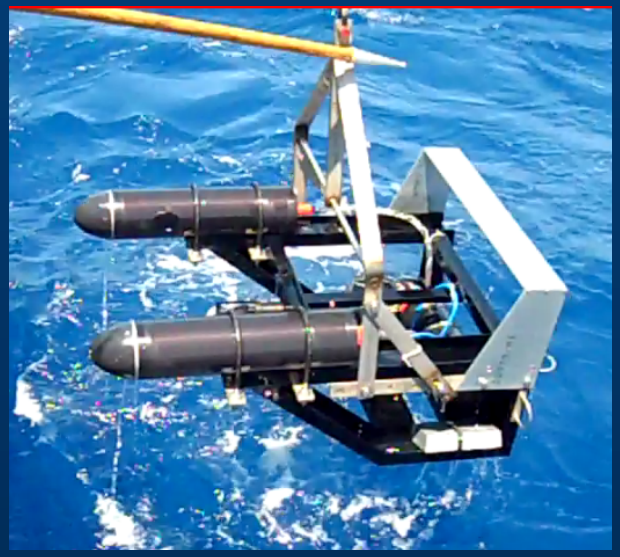




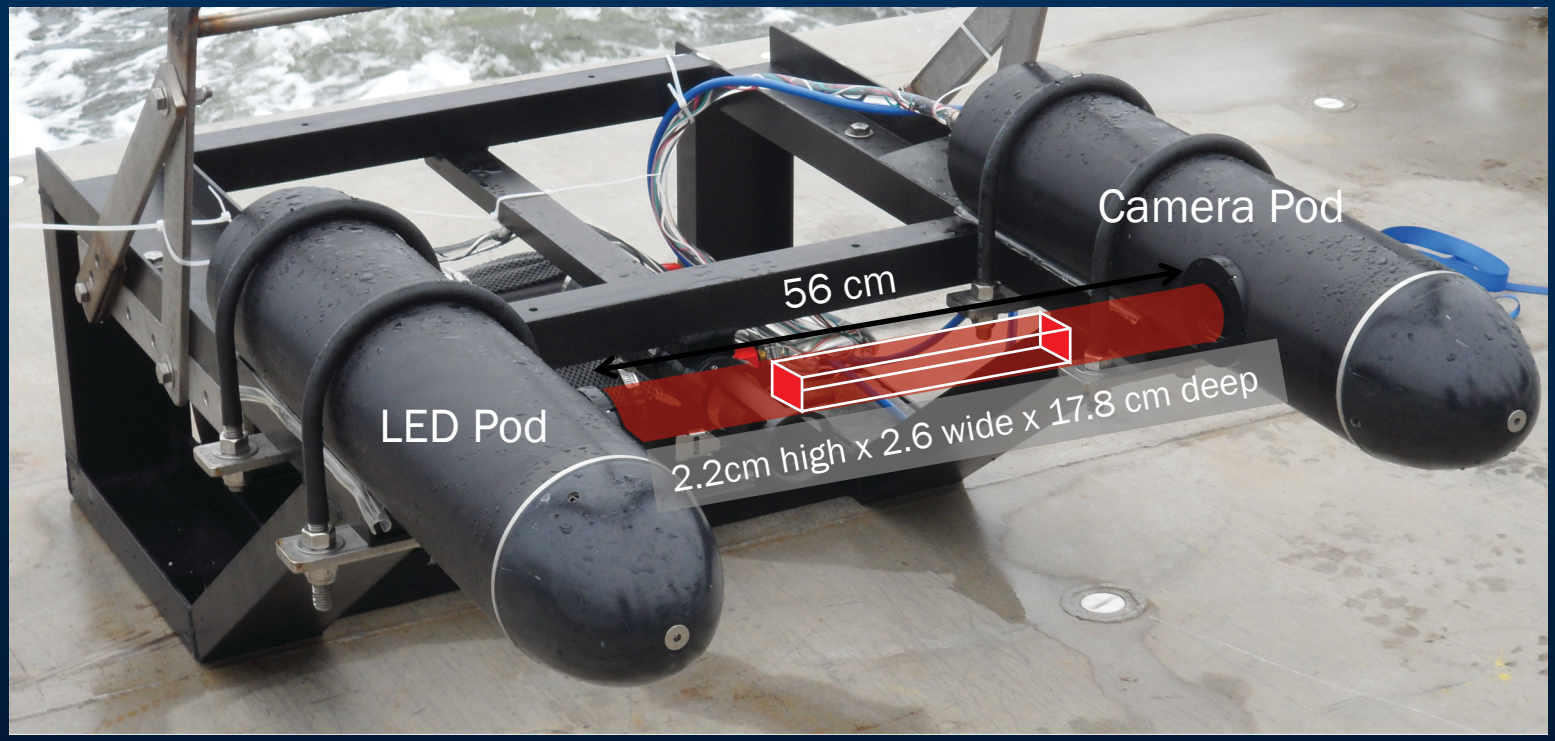
ZOOVIS-Deep Motivation and Funding

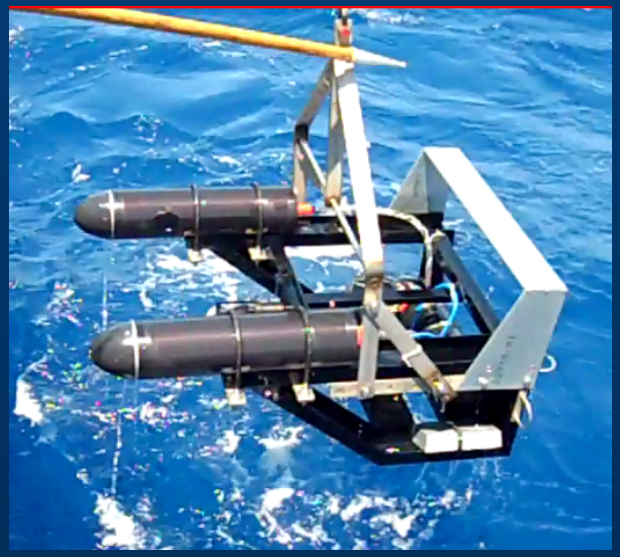




Design

- Shadowgraph imaging
- 650 nm red LED
- 5 µs pulse width
- Long depth of field (Telecentric)
- Large image volume (~100 ml)
- 1.5 L s^{-1}
- 12.5 micron pixel resolution



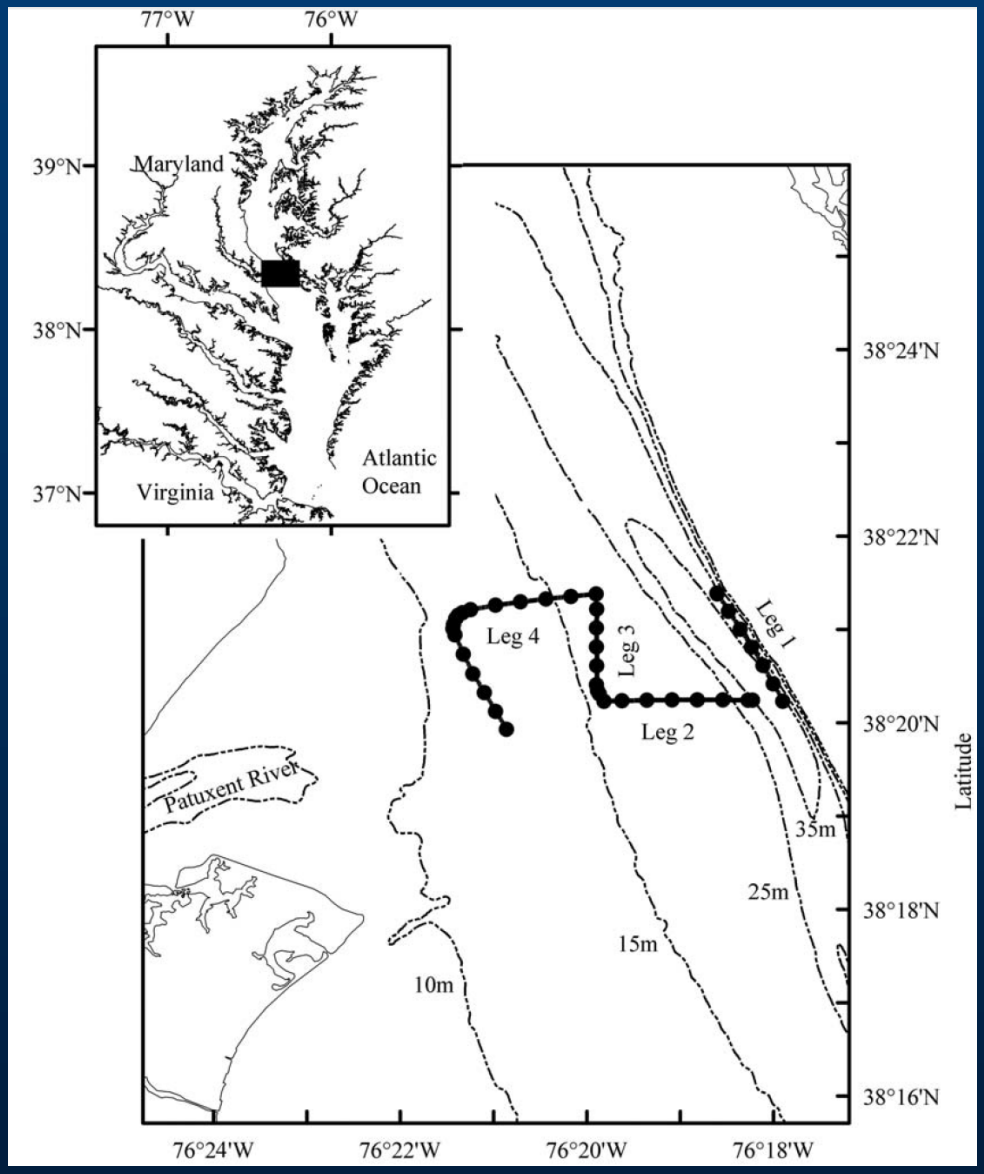


Design ...

- 5 megapixel 12 bit monochrome camera
- Single-board computer, 2 x 750 Gb HDD, strobe controller, power supplies
- Li-Ion Battery (8 h duration)
- WiFi or cabled communication for setup
- RBR CTD
- Housings 6000 m (viewports 2000 m)



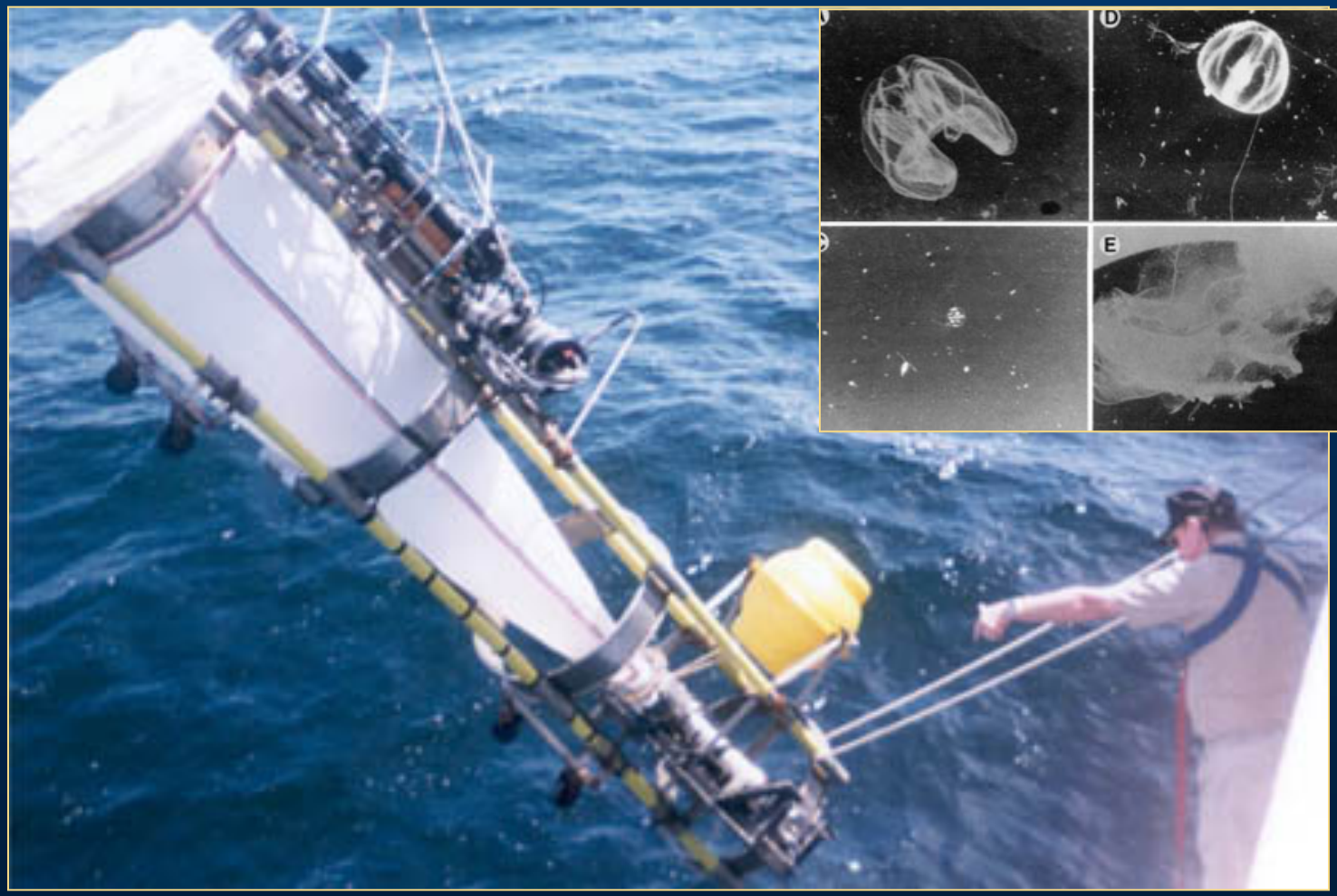
Estuarine Deployment





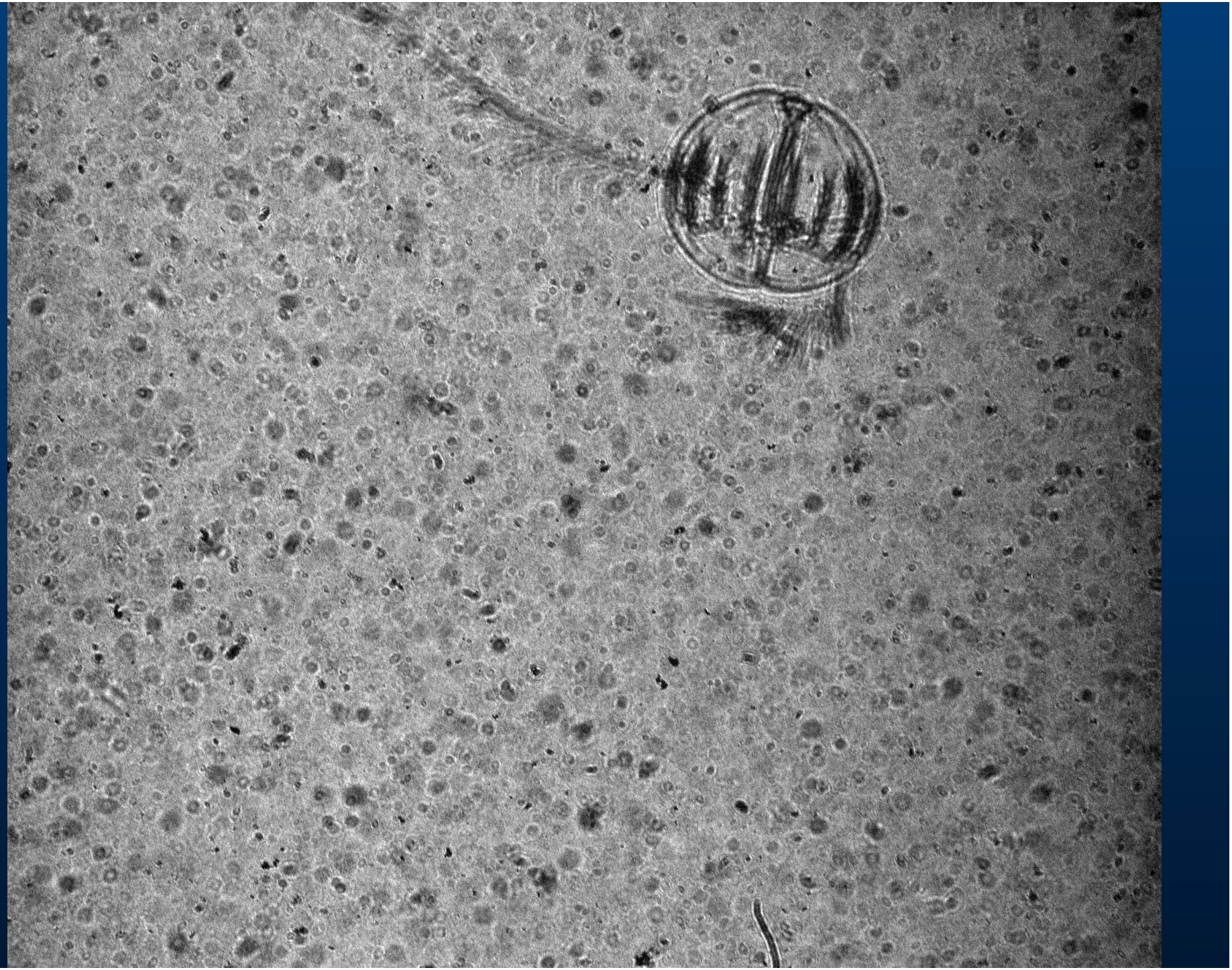
Bi et al. 2012. Journal Plankton Res., doi:10.1093/plankt/fbs094

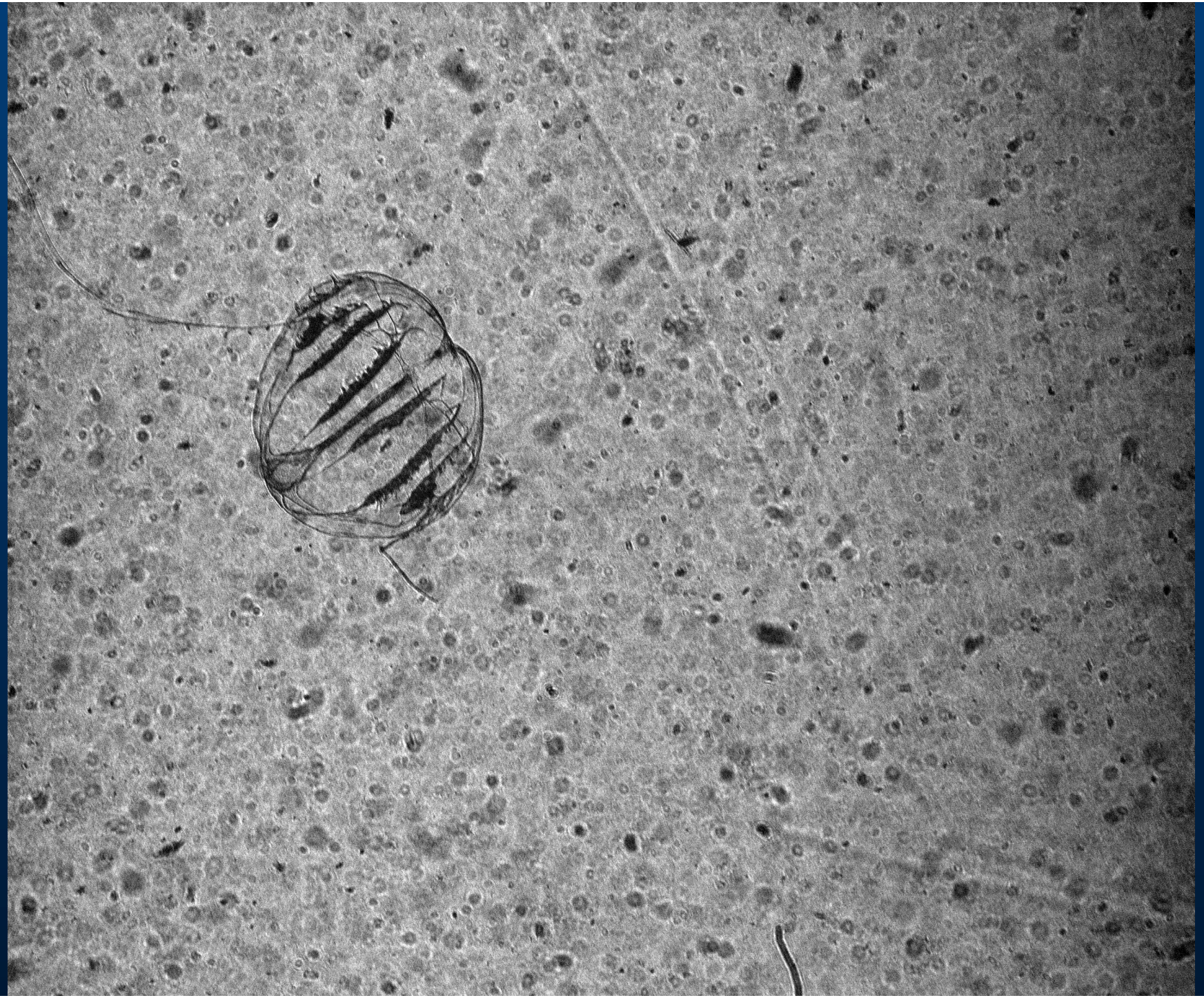
Estuarine Deployment

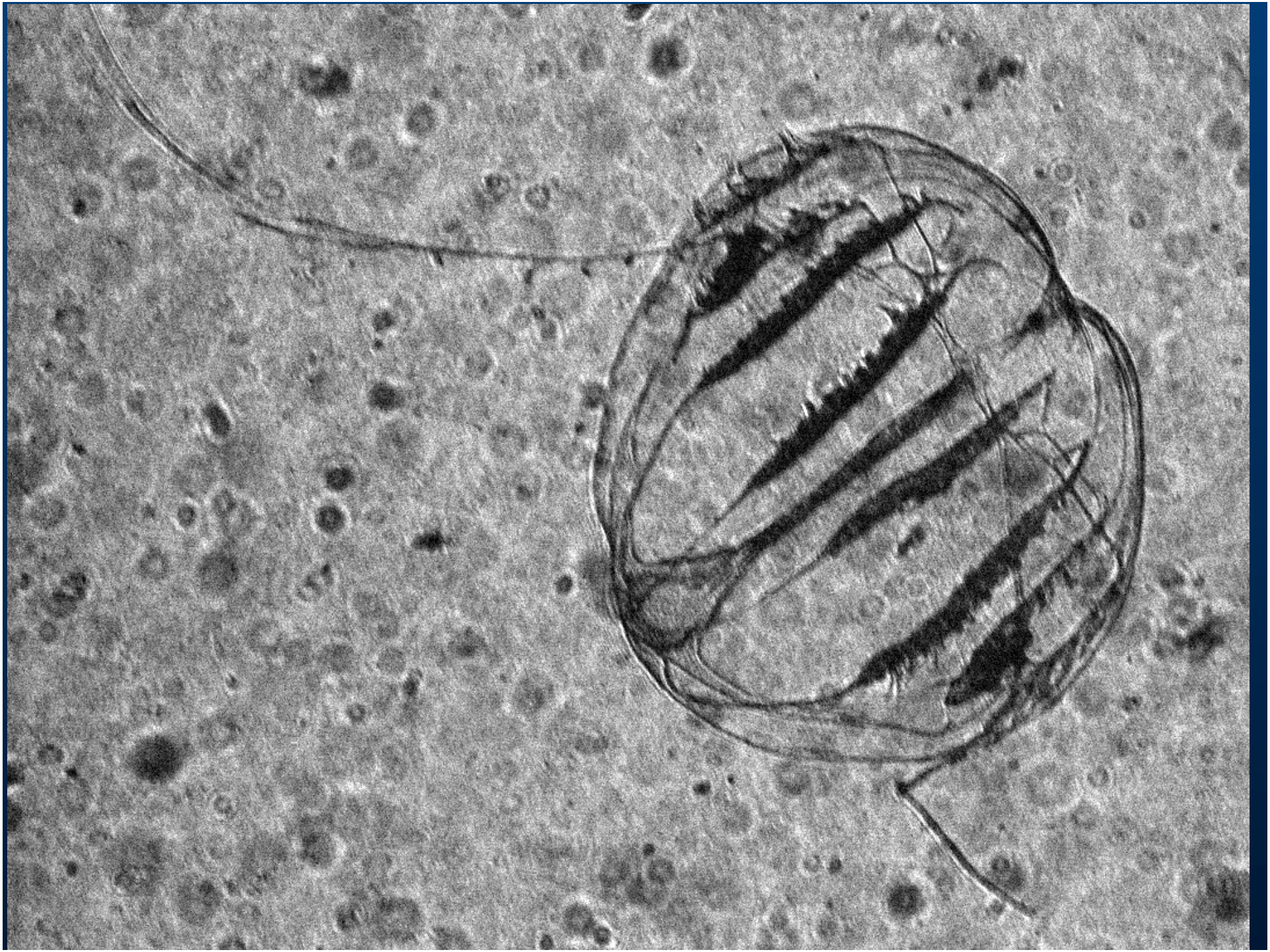


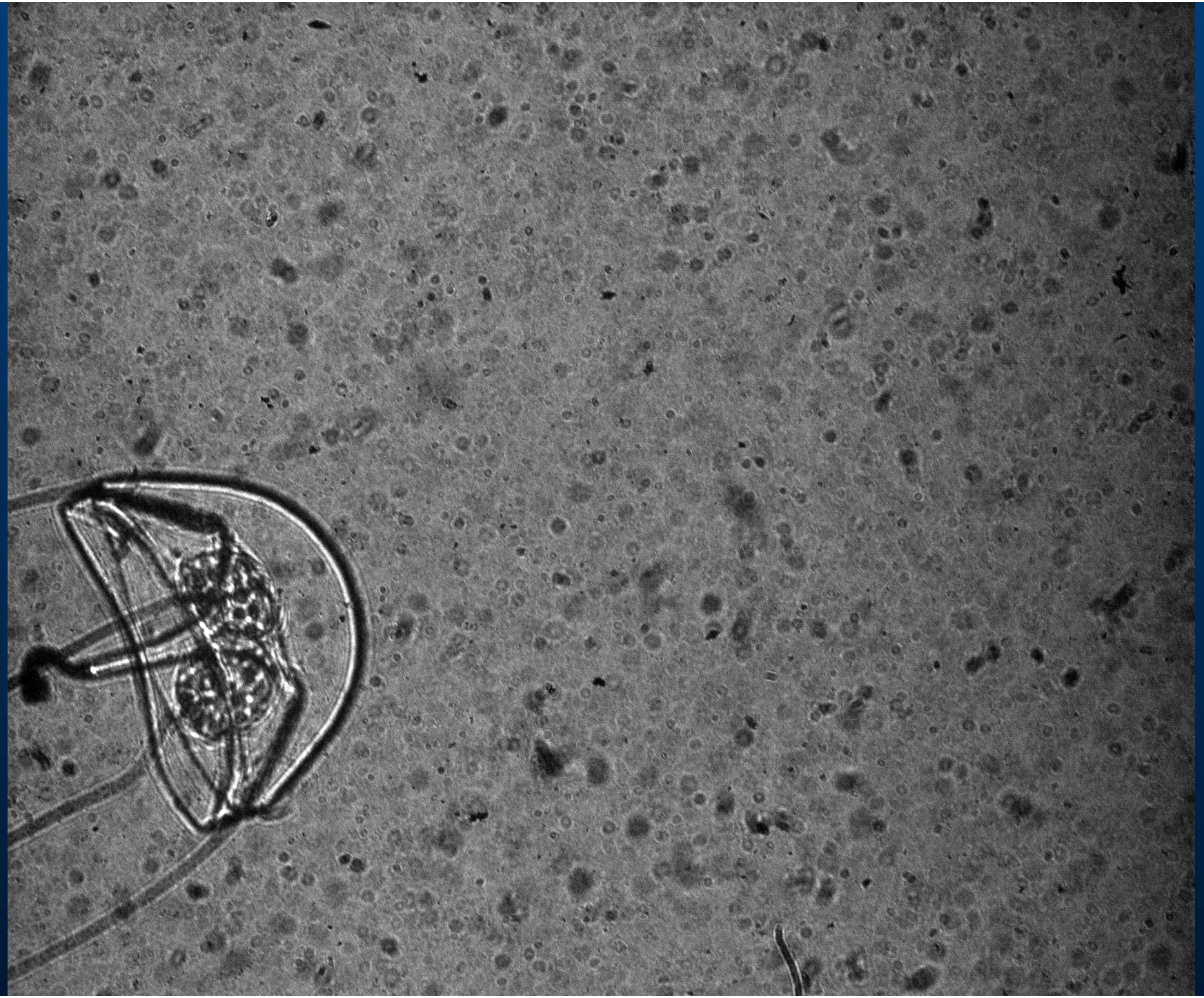
Olney & Houde (1973)

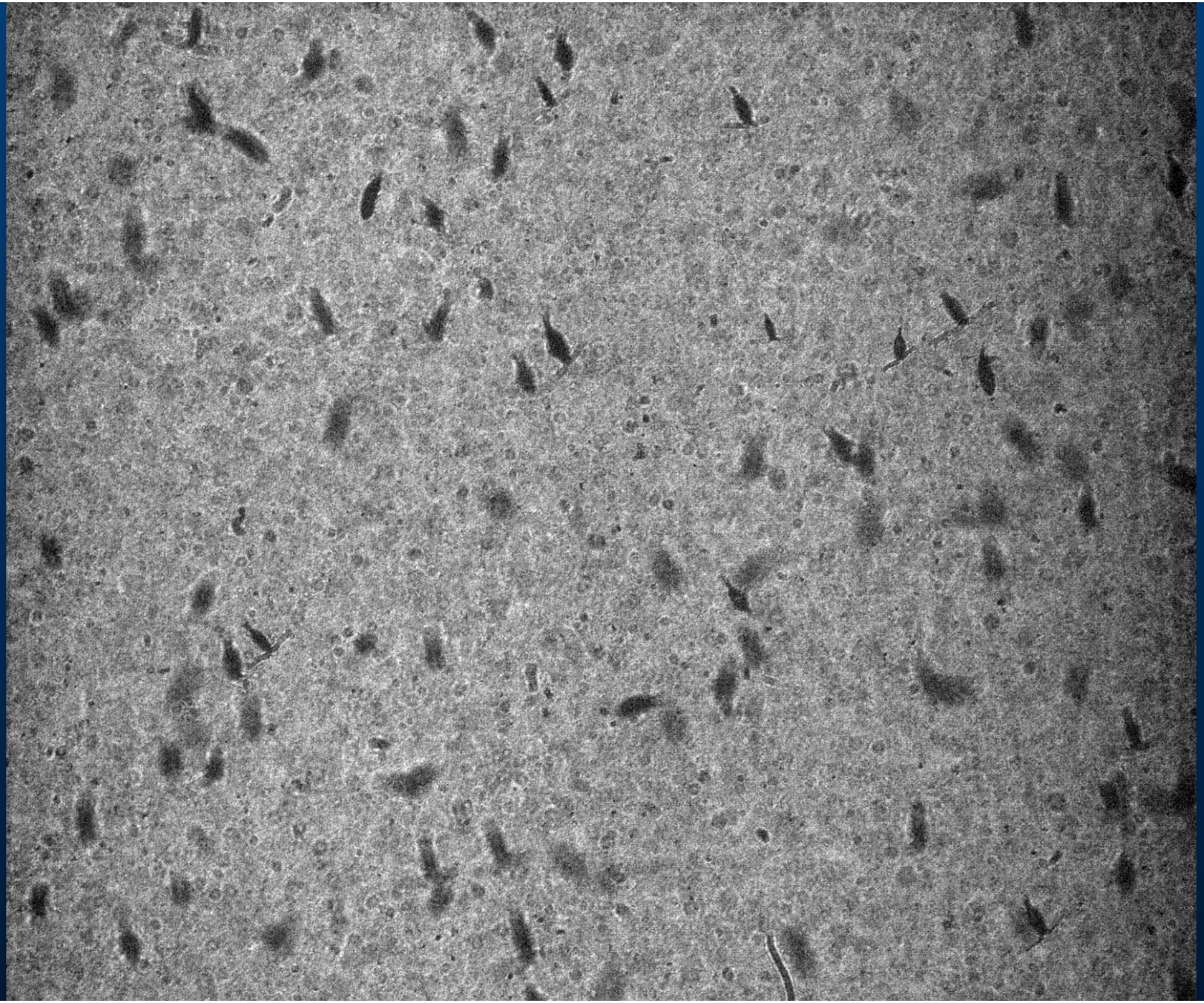
Image: S. Cummings, NOAA



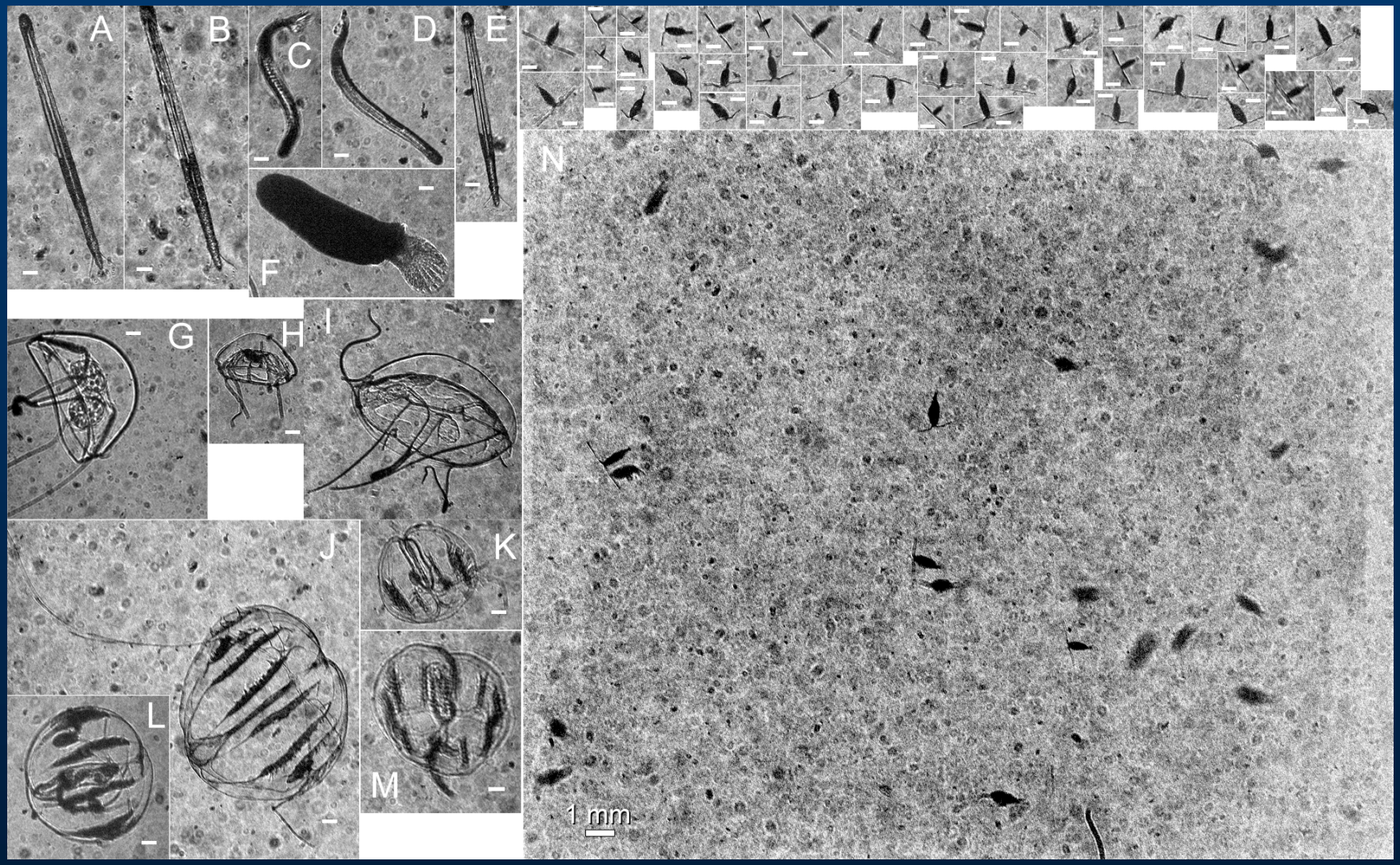








Chesapeake Bay Zooplankton

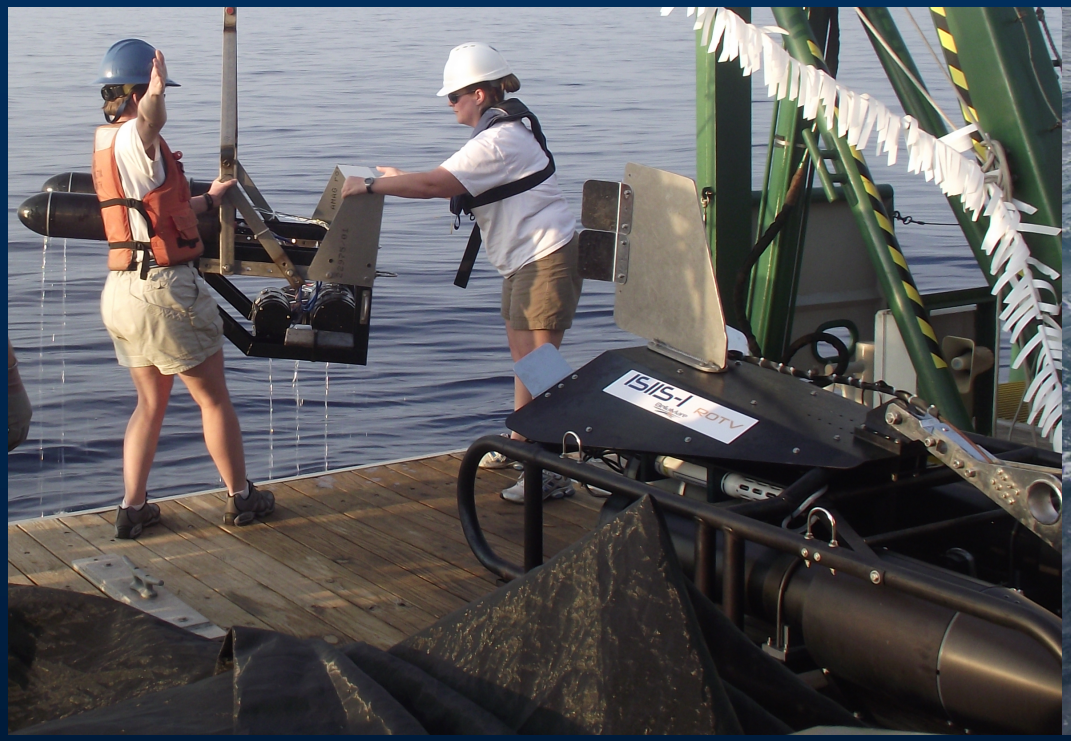


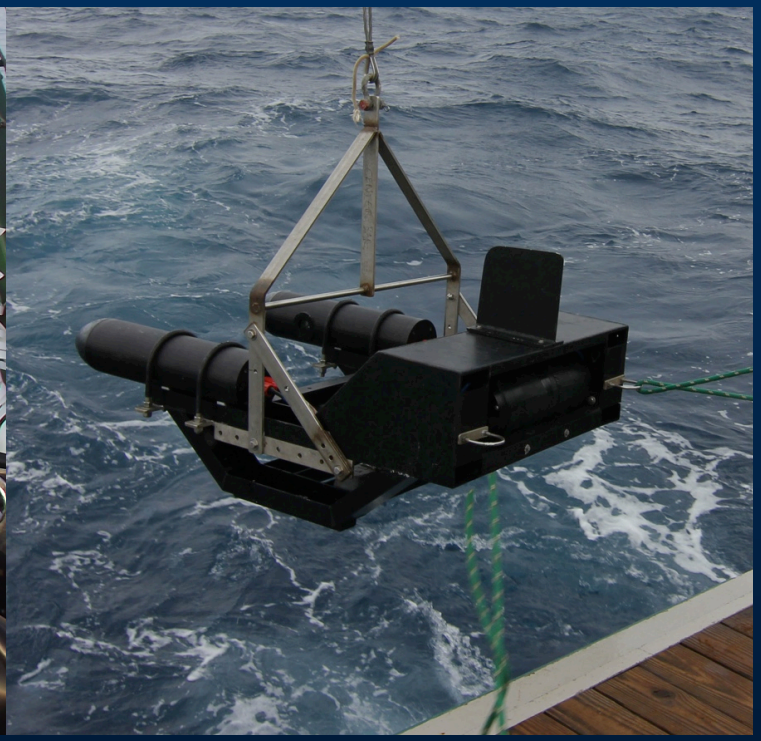
A-E: Chaetognaths; F: Juvenile Tautog; G-I: *Liriope tetraphylla*; J-M:*Pleurobrachia pileus,* N: *Acartia*?.

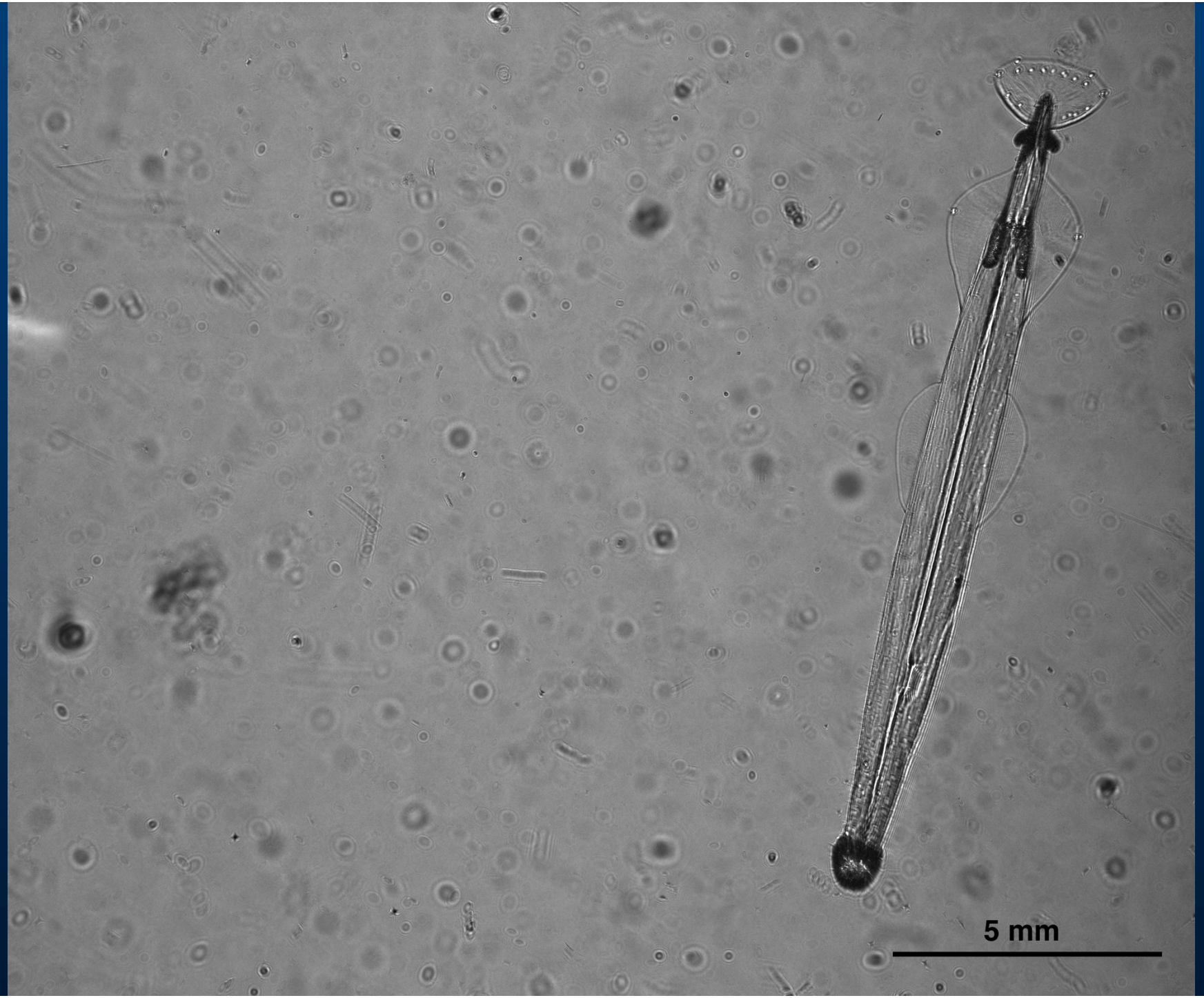

ZOOVIS-Deep #2

Gulf of Mexico Deployments

- 2012 and 2013 in northern Gulf of Mexico
- Profiles to 1500 m and towed deployments



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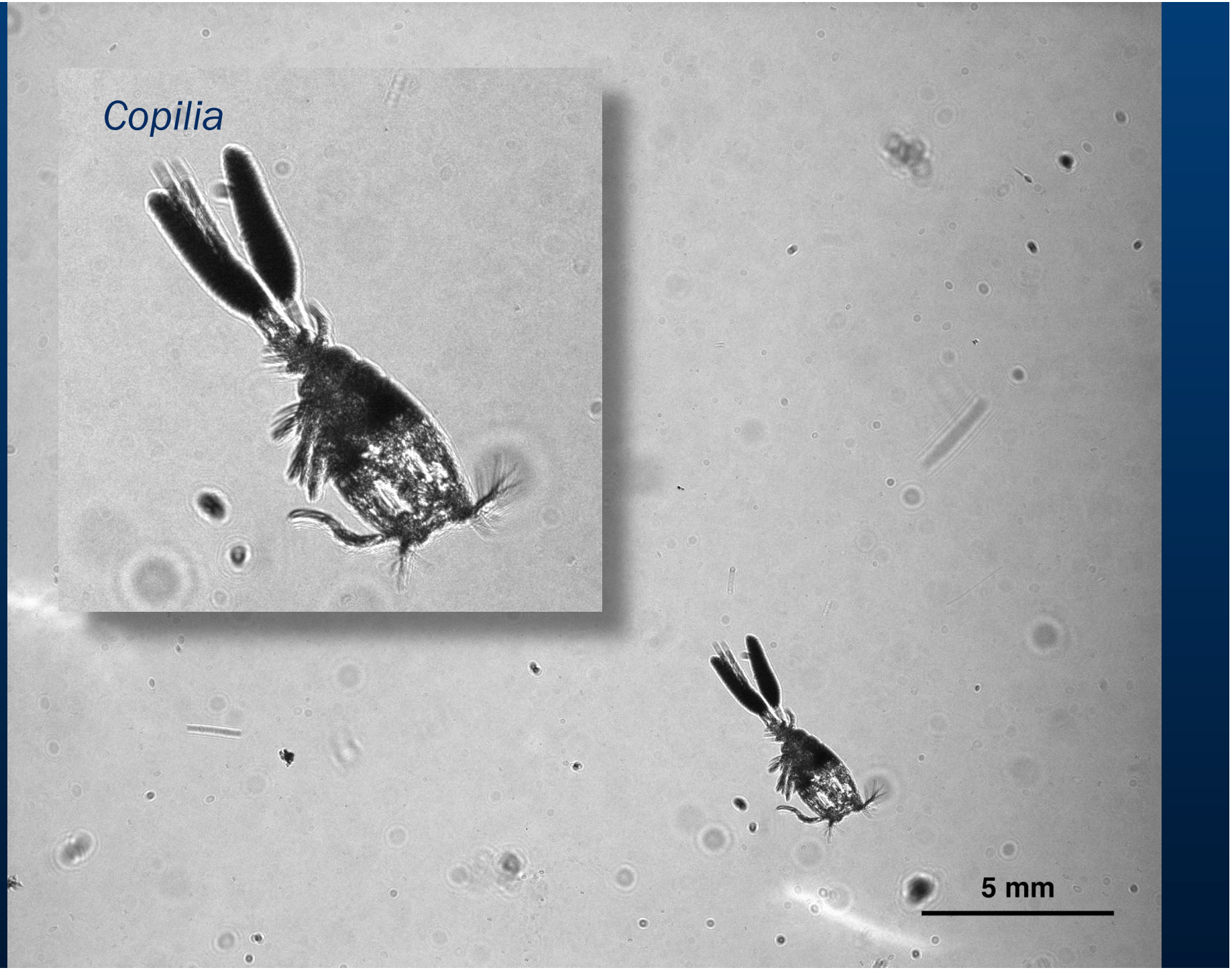
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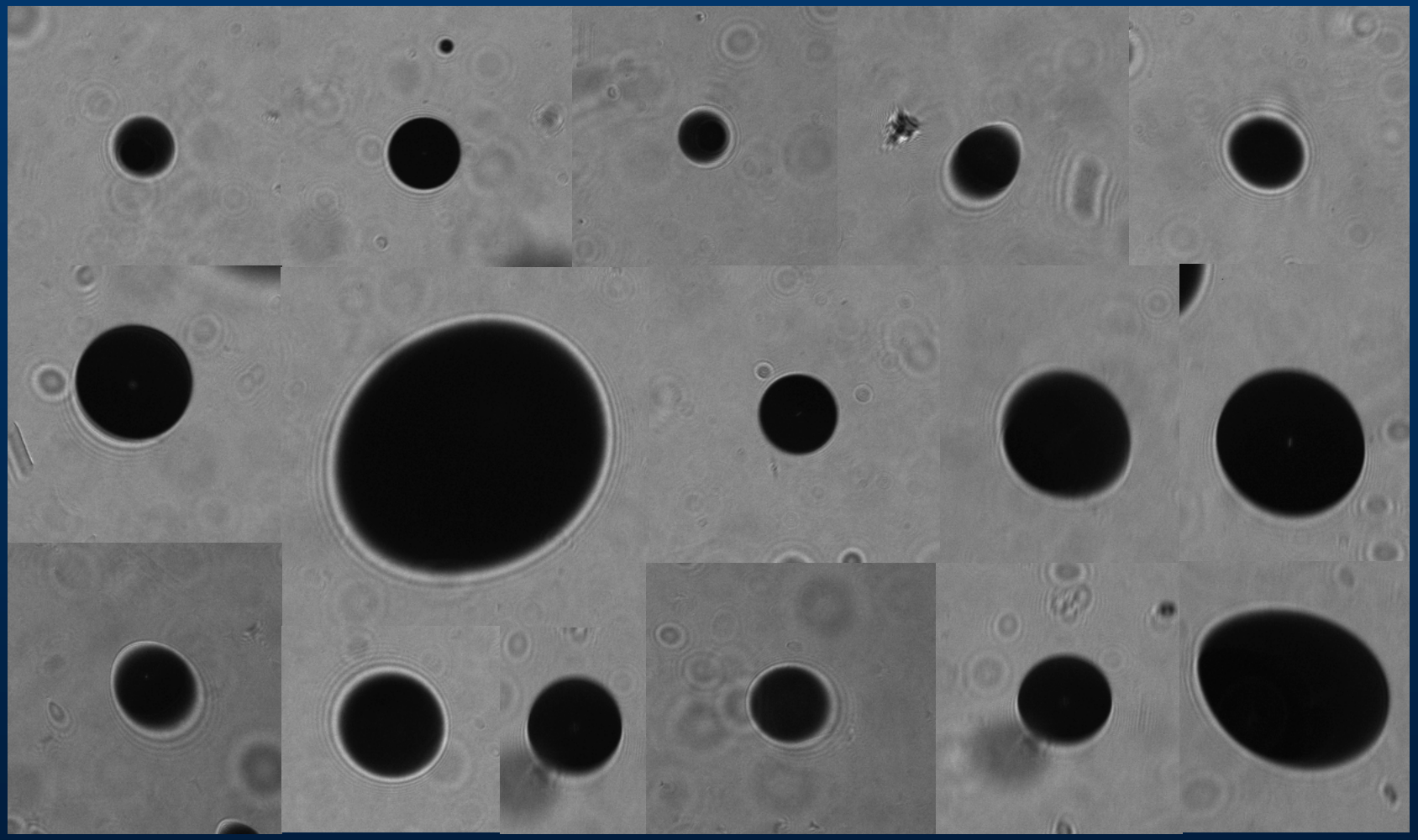
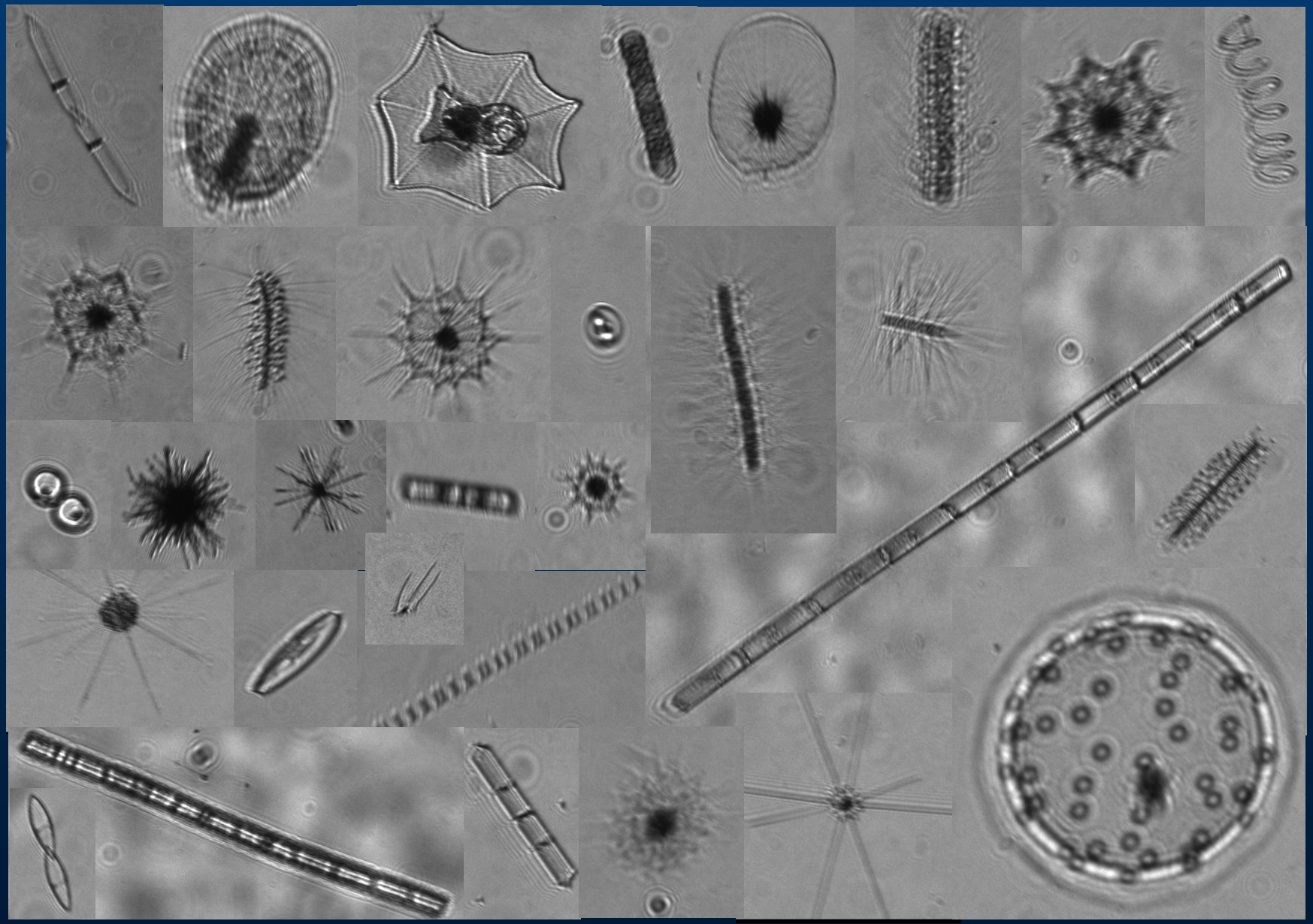
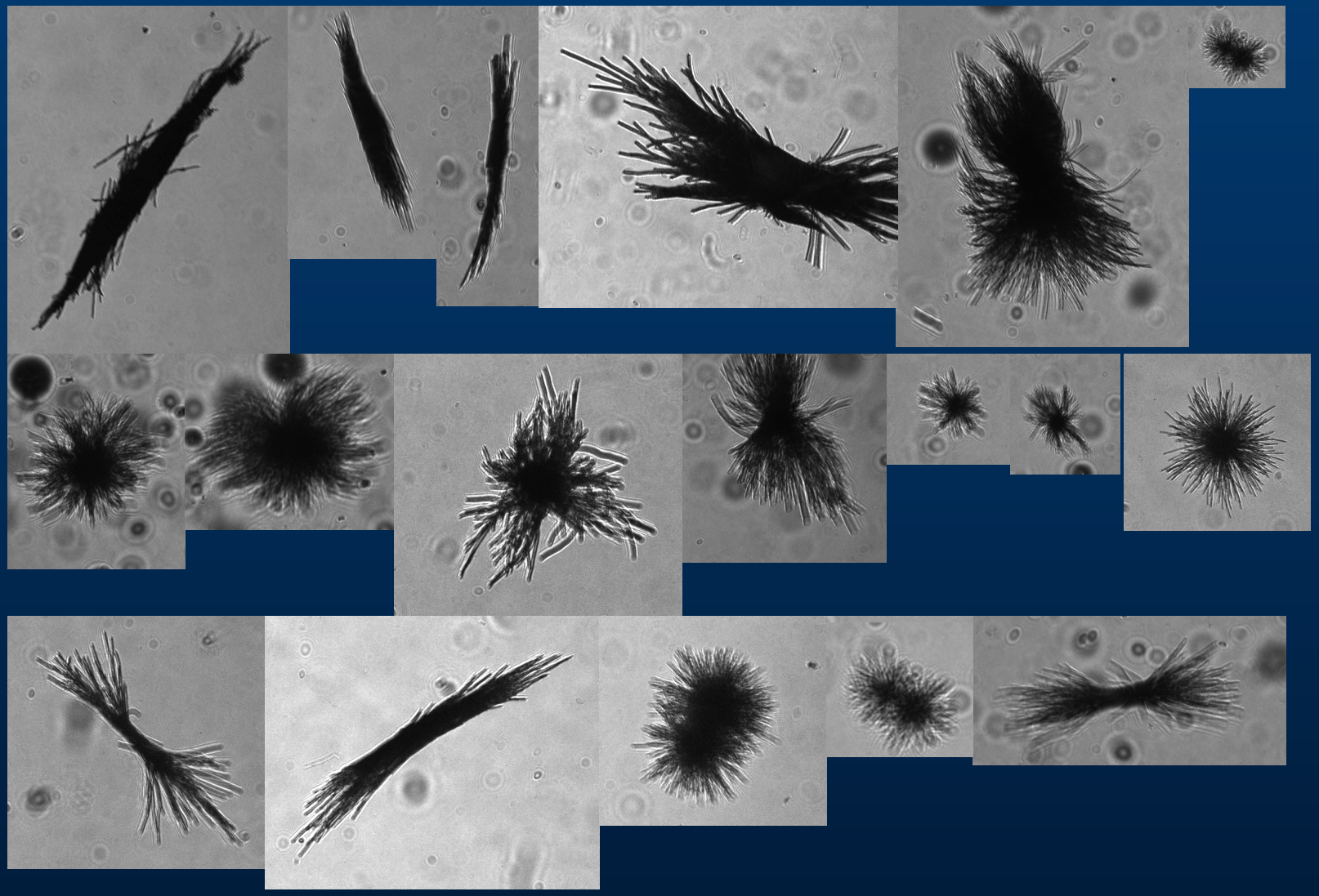
Bubbles



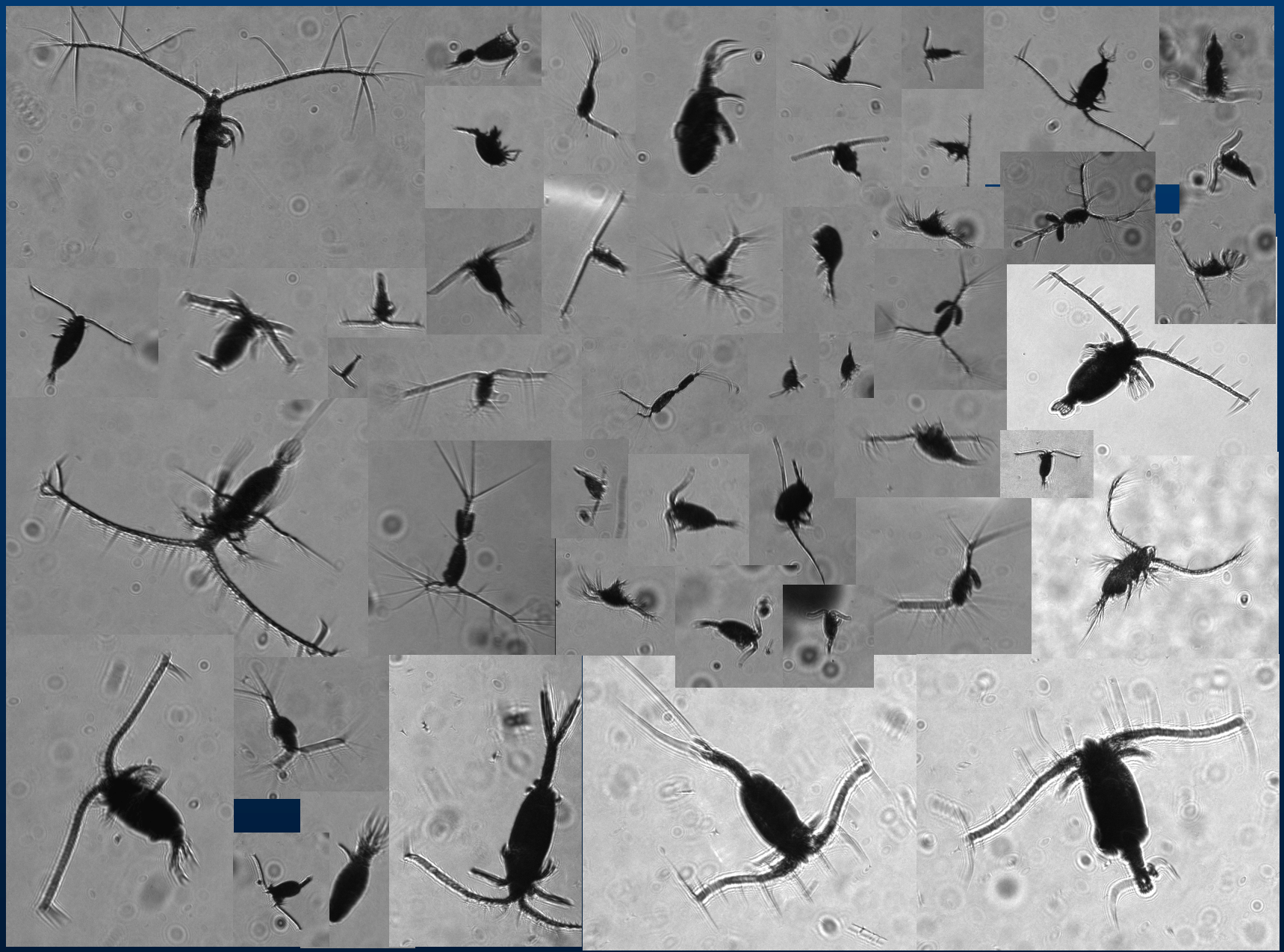
Phytoplankton/Microzooplankton



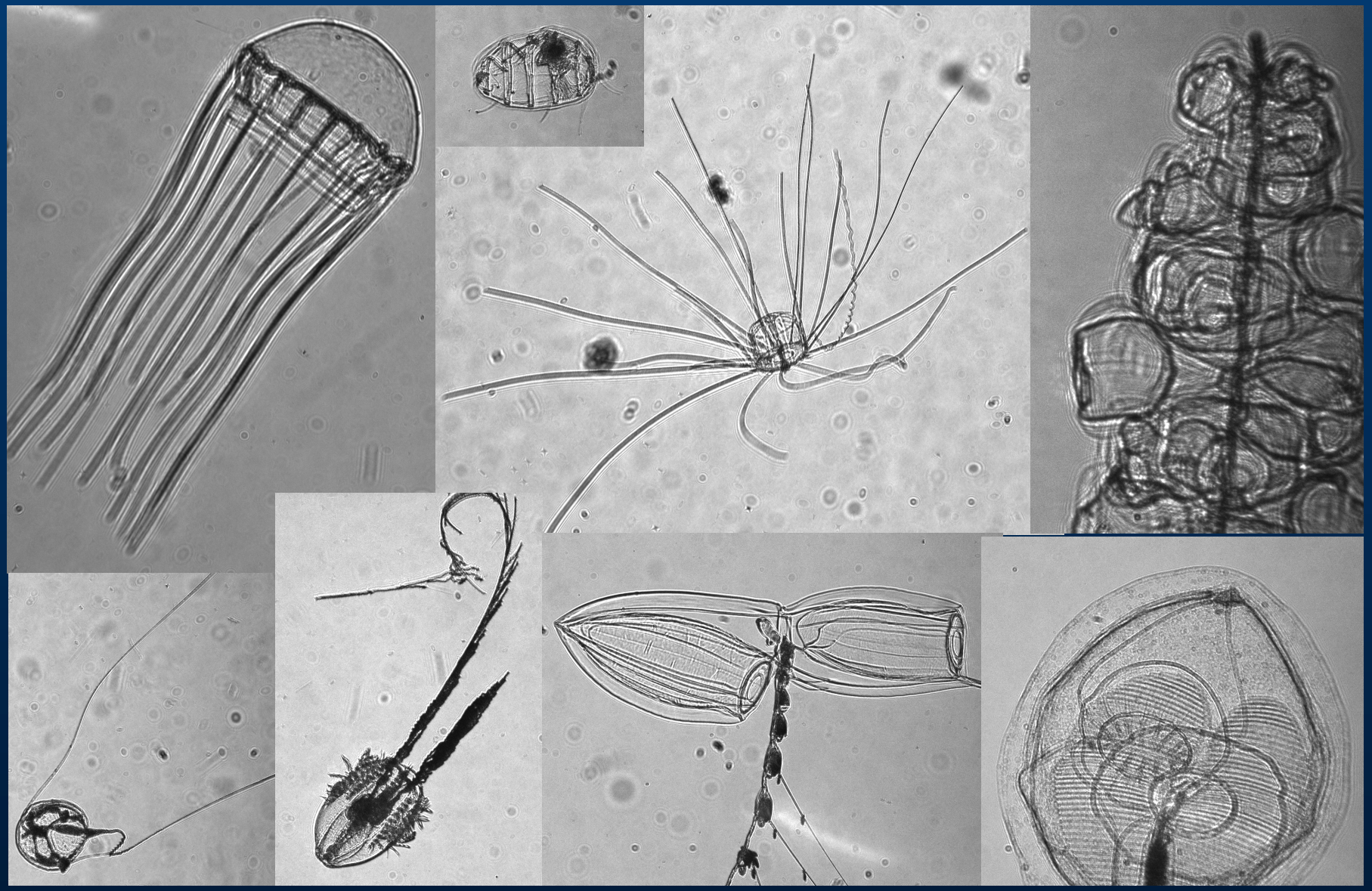
Trichodesmium



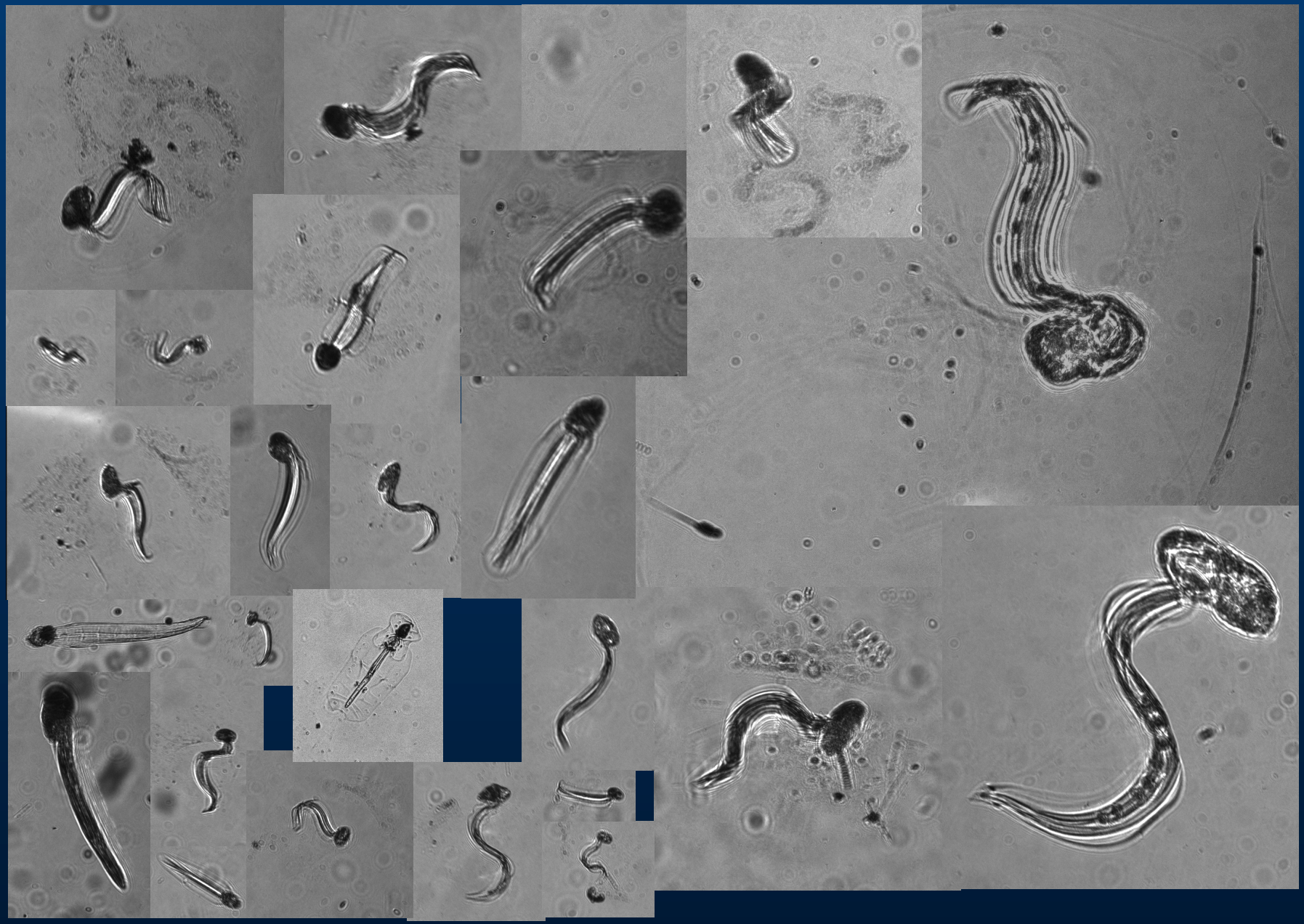
Copepods



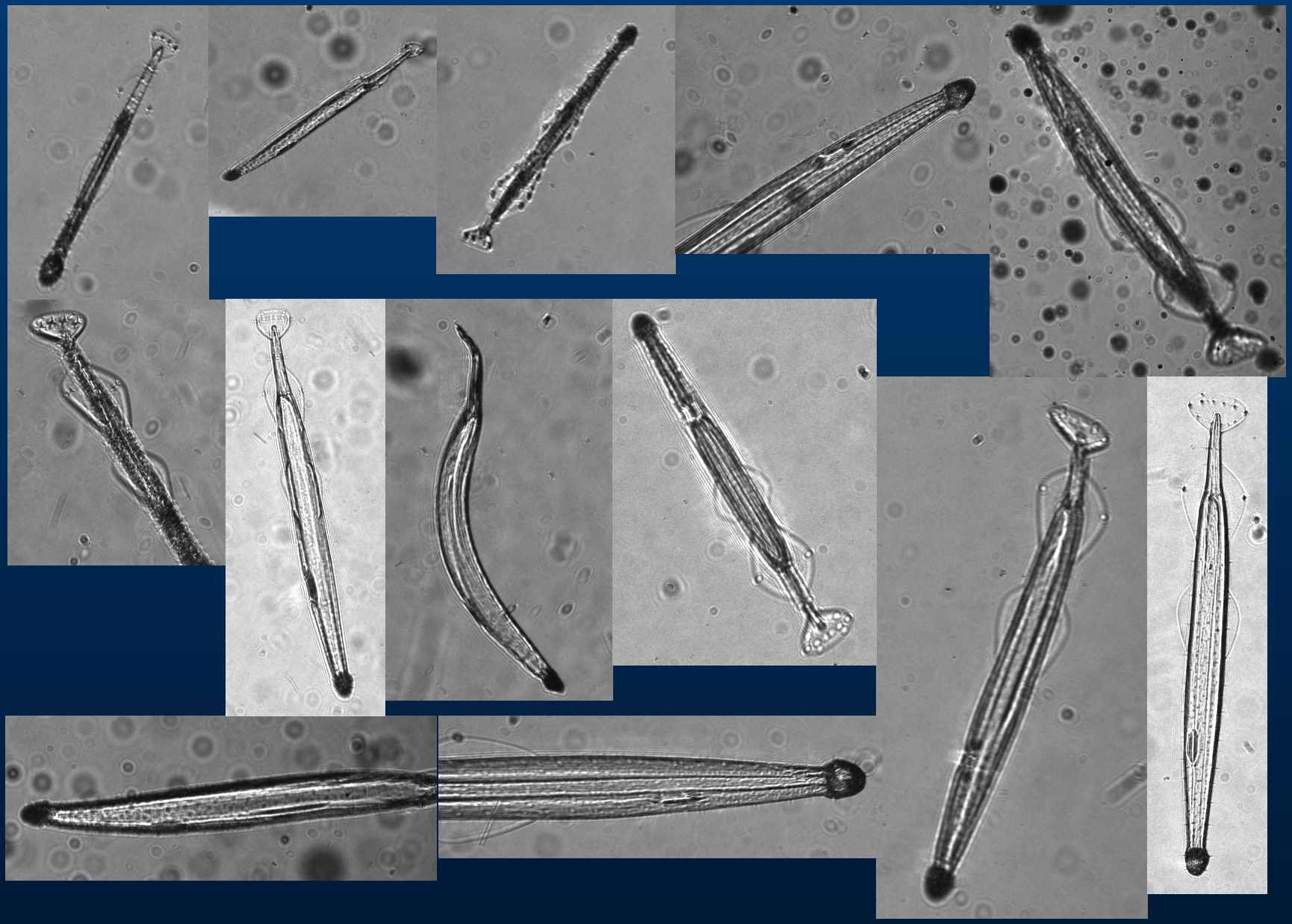
Gelatinous Taxa



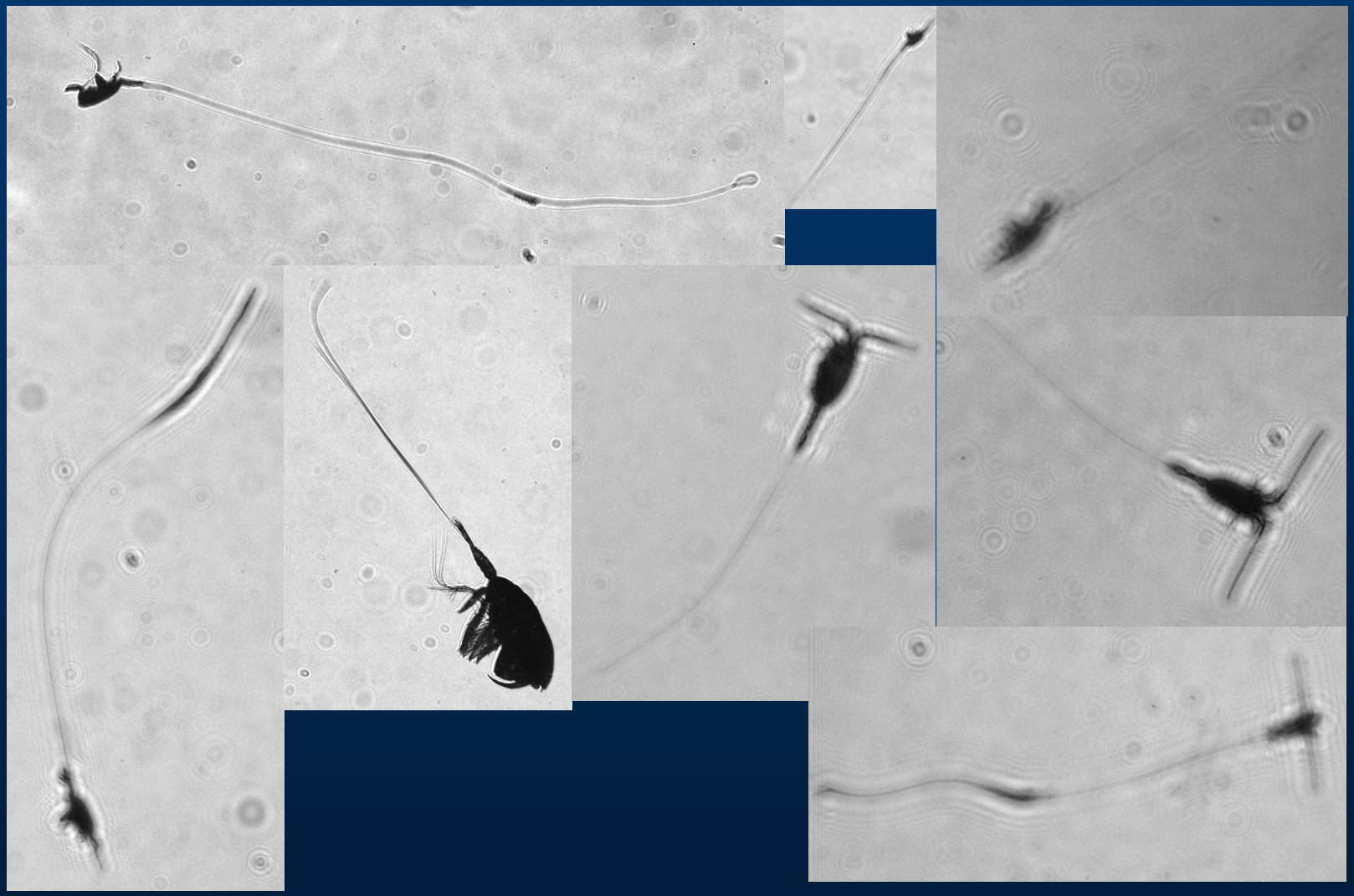
Appendicularians



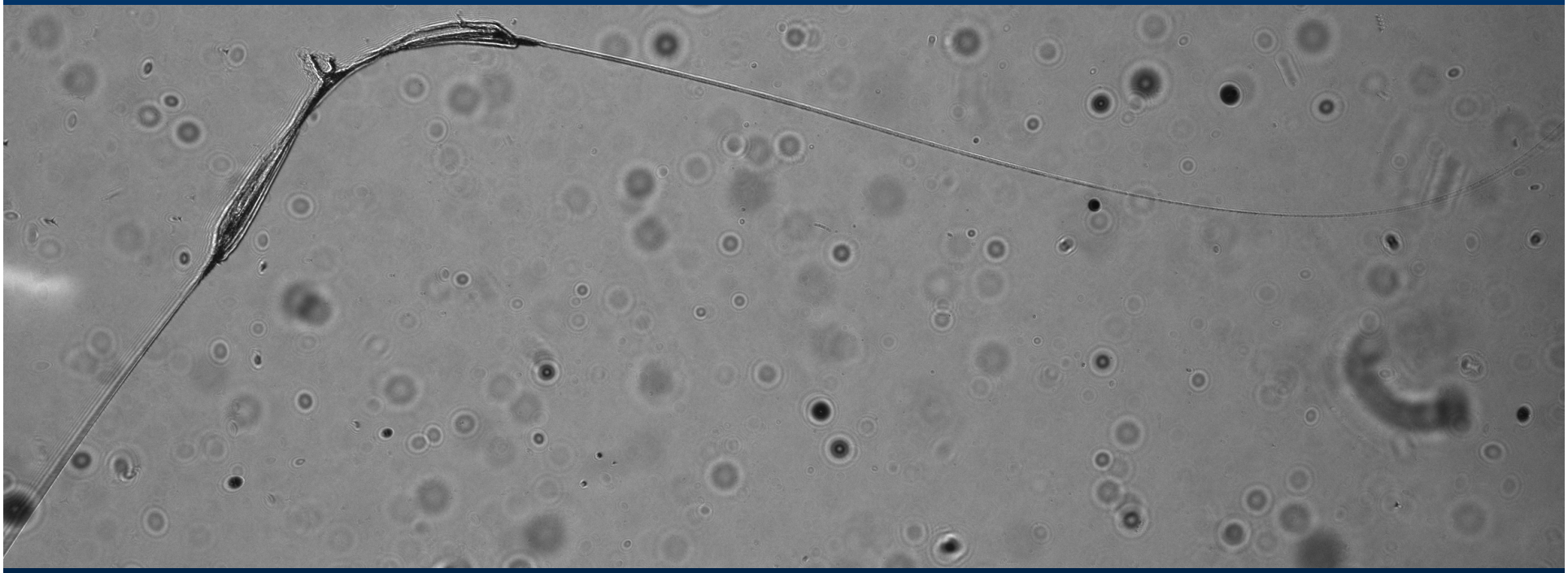
Chaetognaths

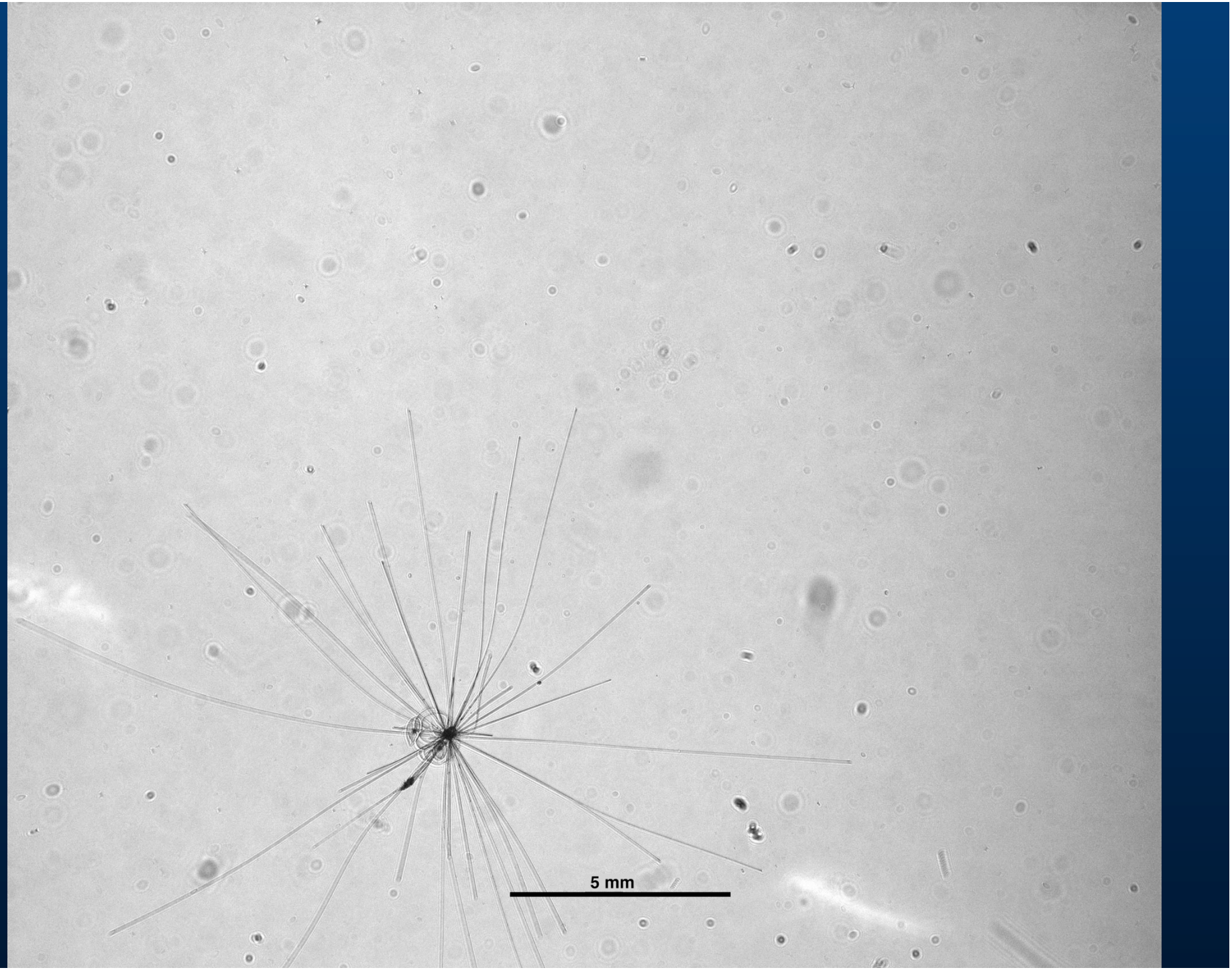


Things you won't see with nets



Lots of Unidentified Targets

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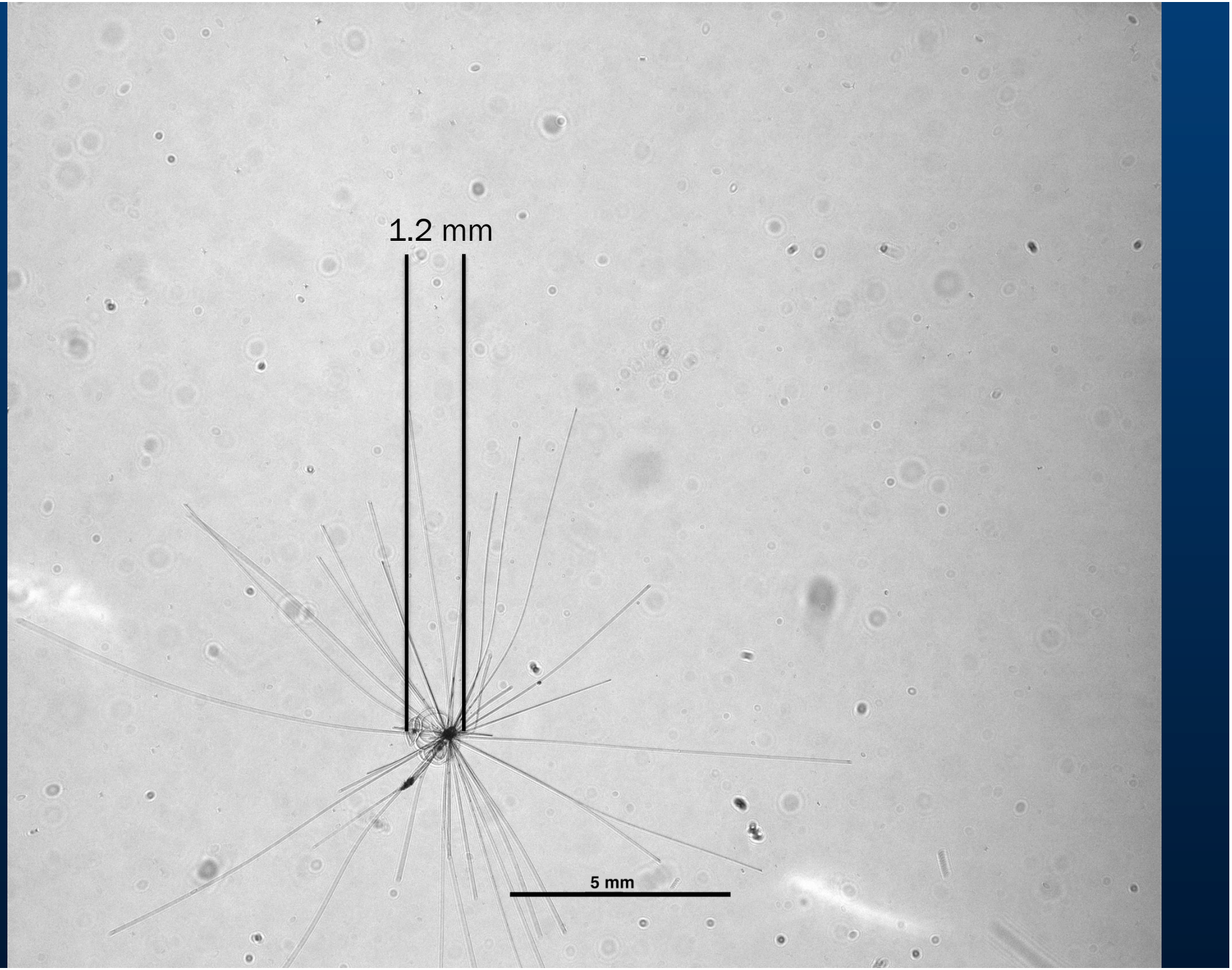
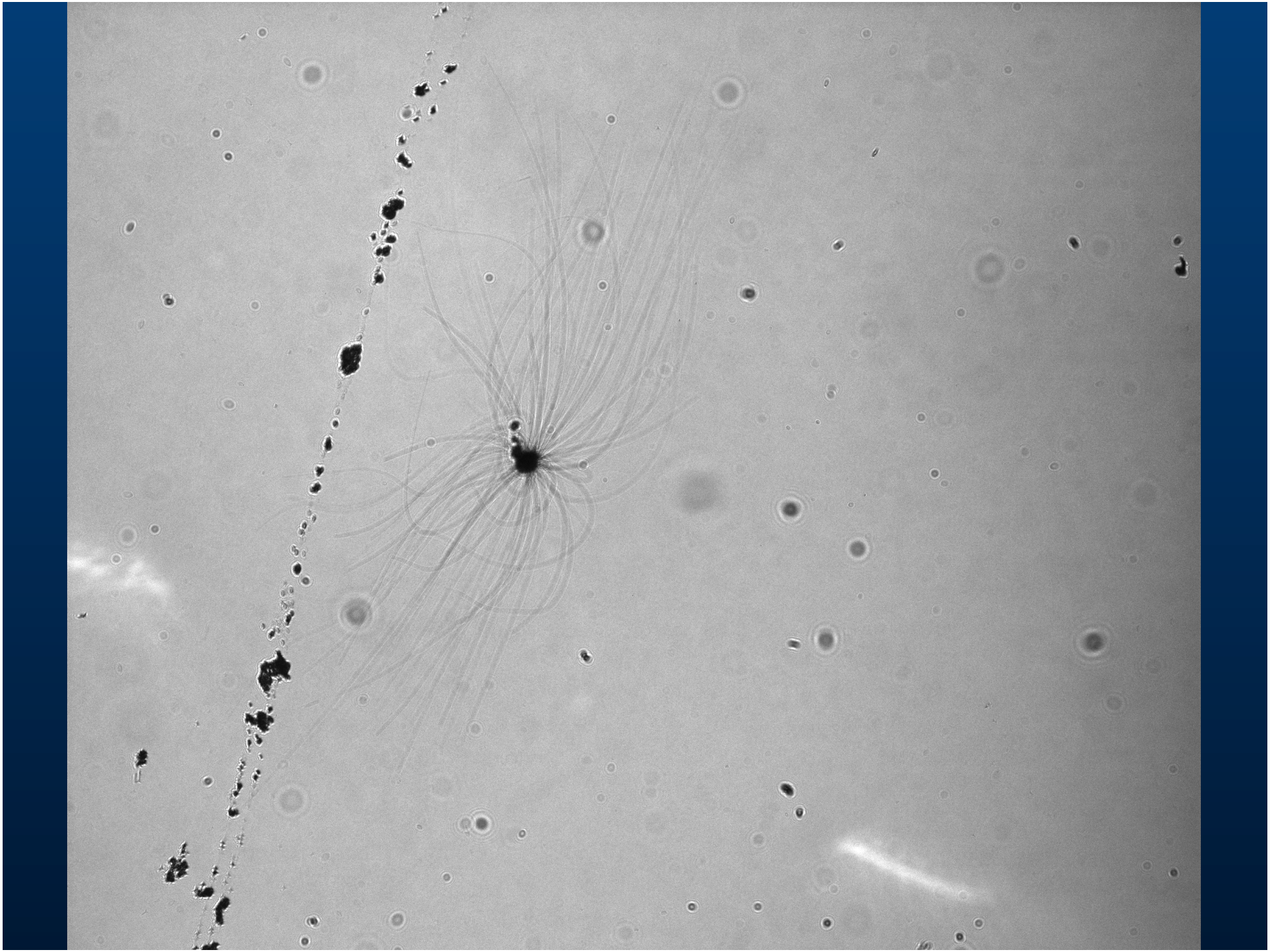
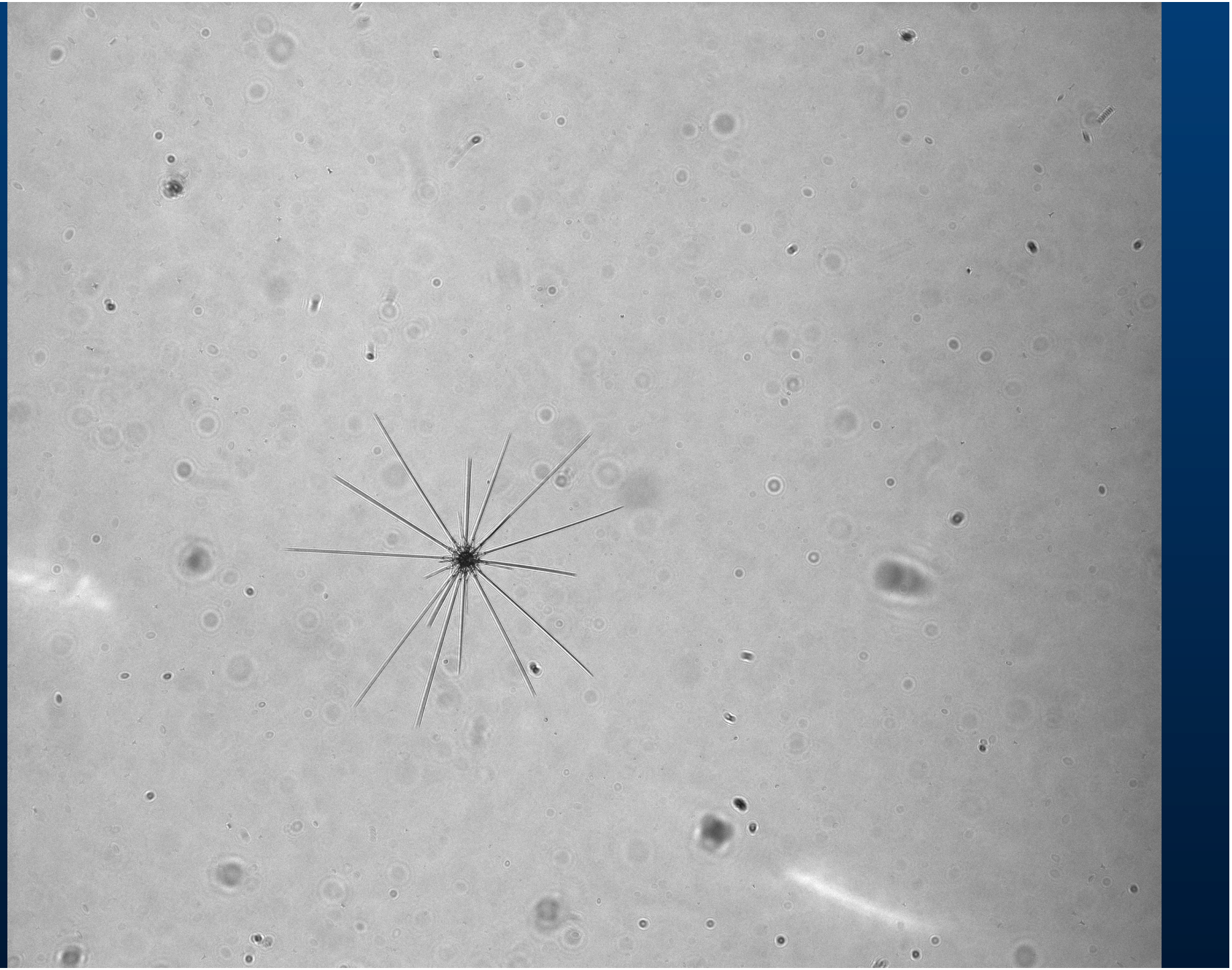
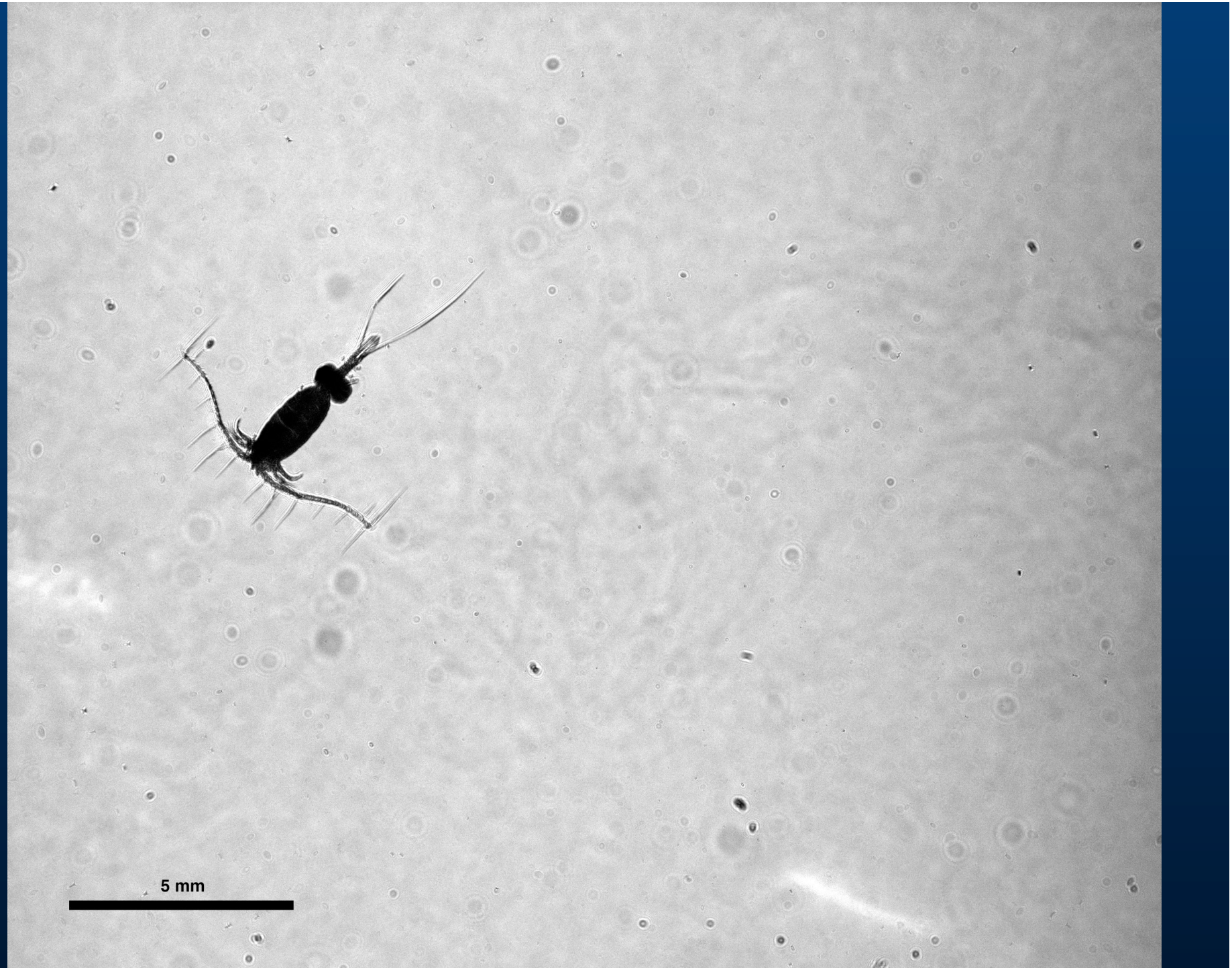

1.2 mm
5 mm



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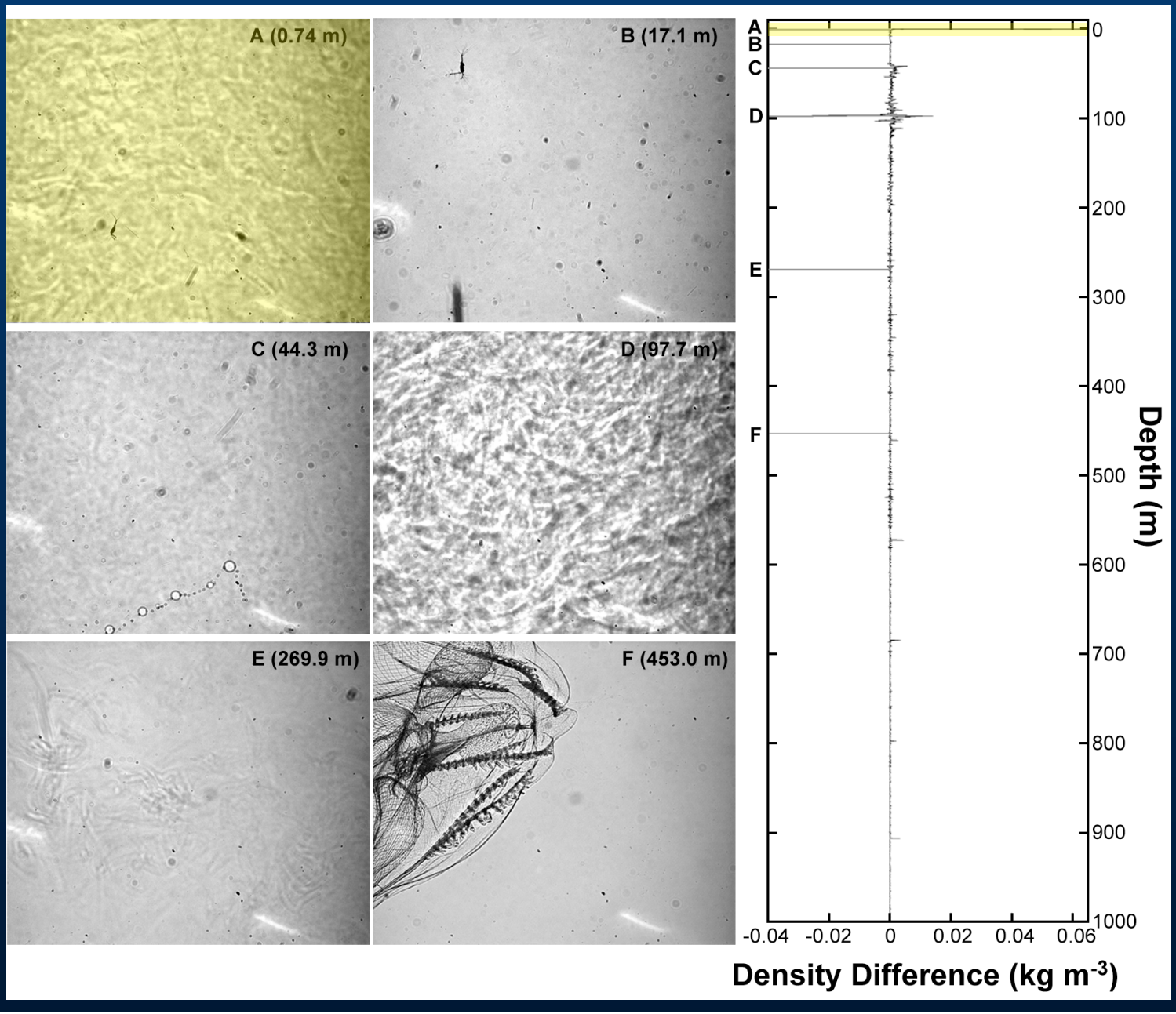
Optical “CTD”


A (0.74 m)
B (17.1 m)
C (44.3 m)
D (97.7 m)
E (269.9 m)
F (453.0 m)
A
B
C
D
E
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100
200
300
400
500
600
700
800
900
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Depth (m)
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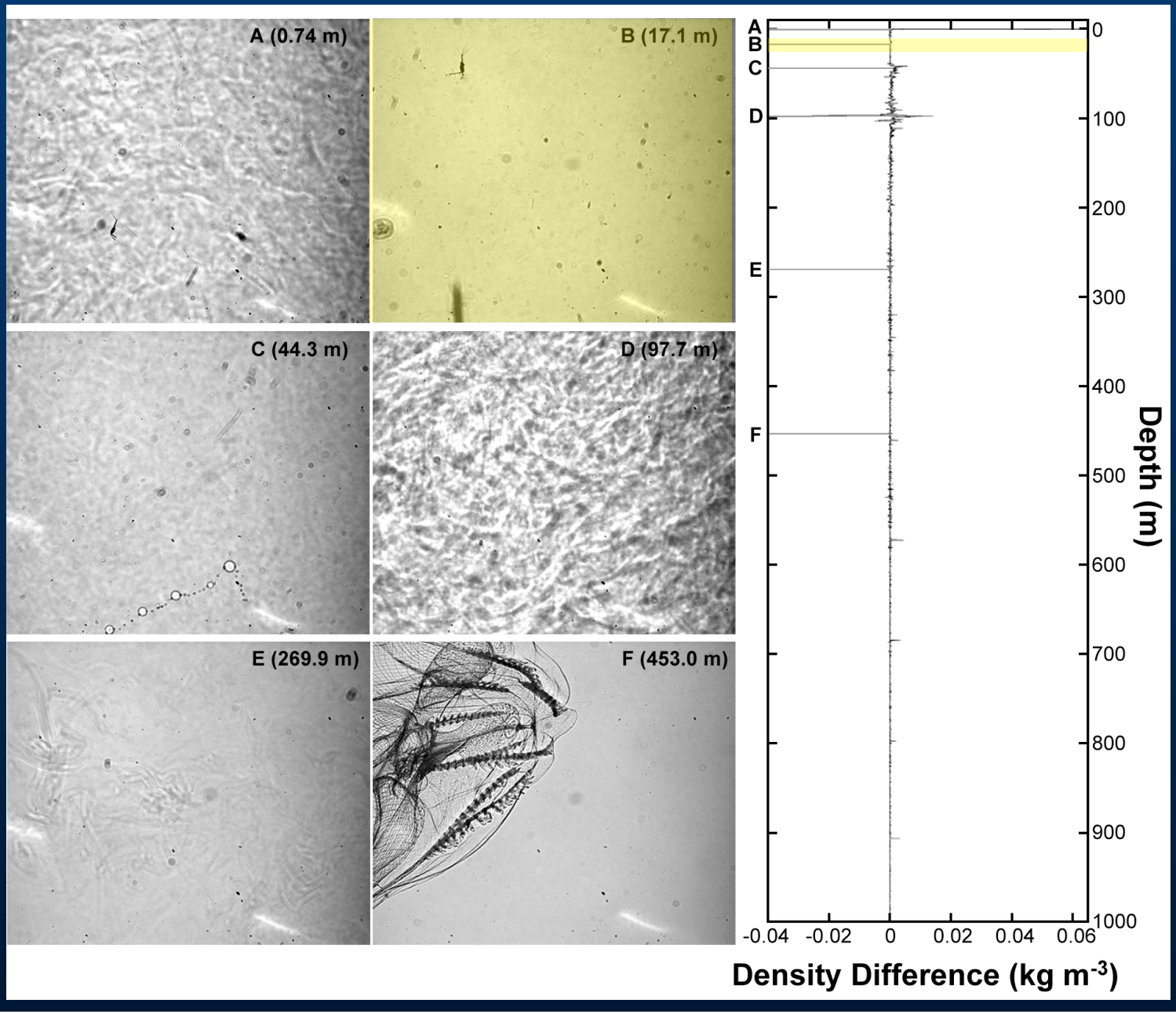
-0.02
0
0.02
0.04
0.06
Density Difference (kg m-3)

Optical “CTD”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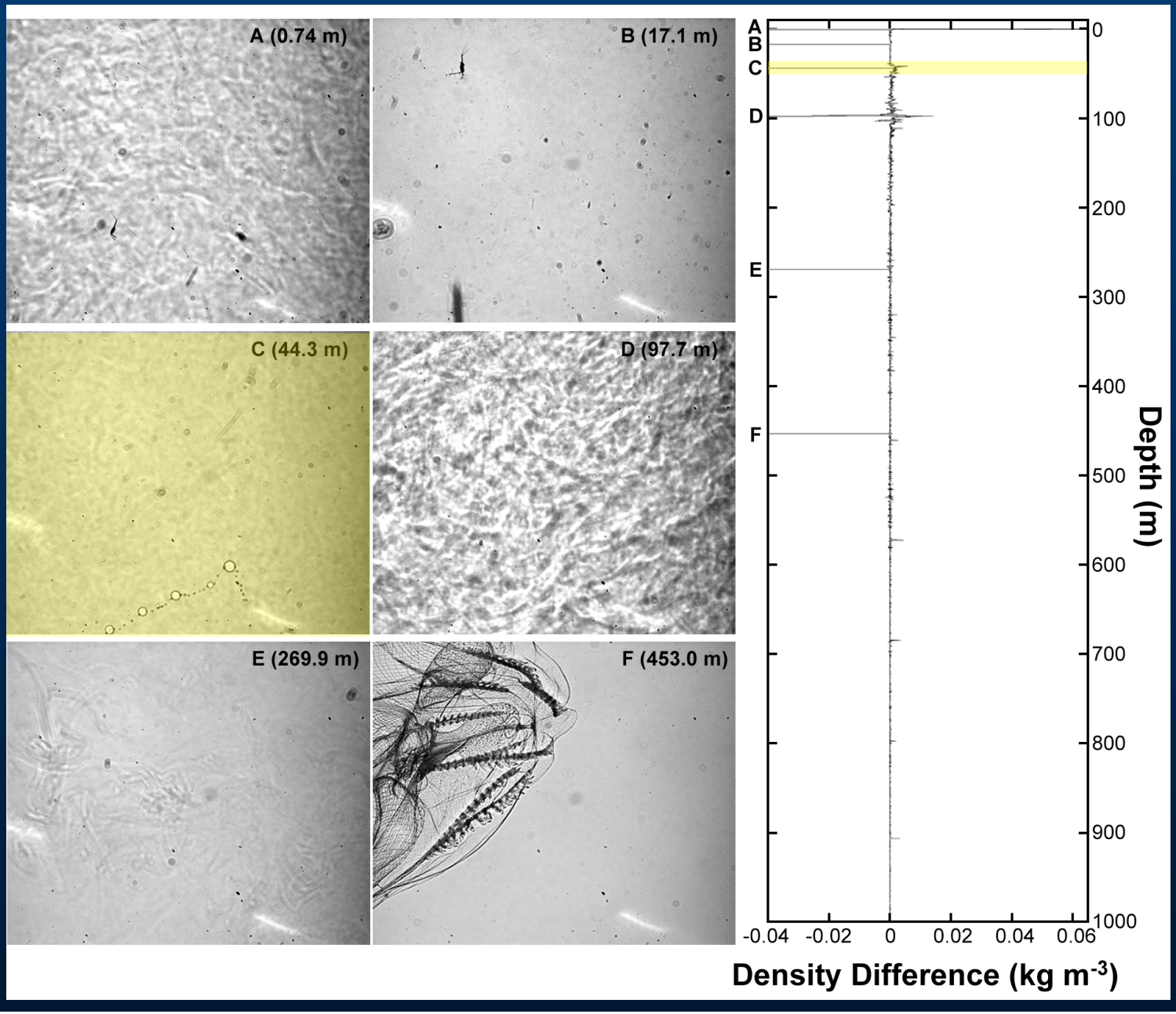
Density Difference (kg m-3)

Optical "CTD"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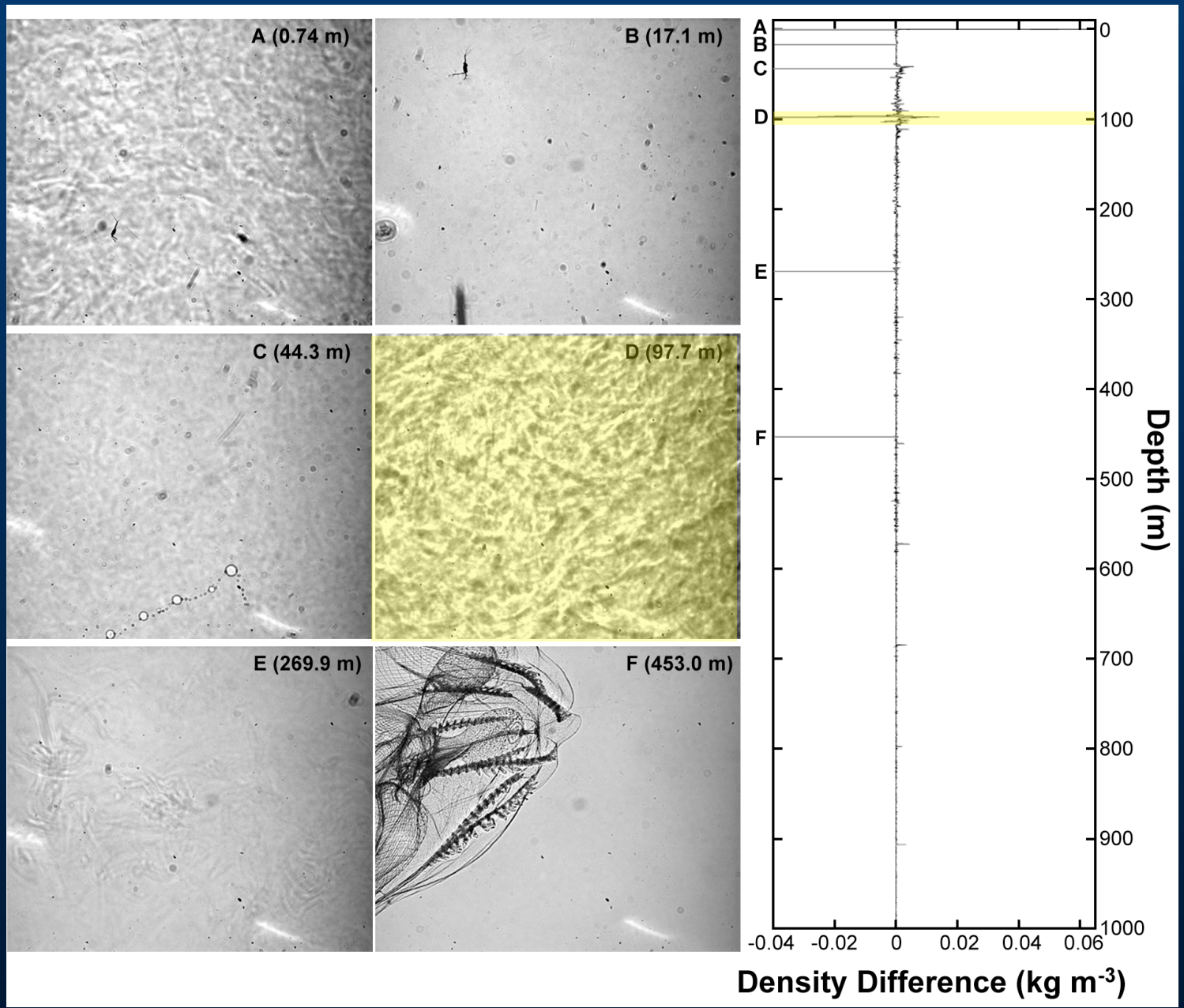
Density Difference (kg m-3)

Optical “CTD”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900
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Depth (m)
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0.02
0.04
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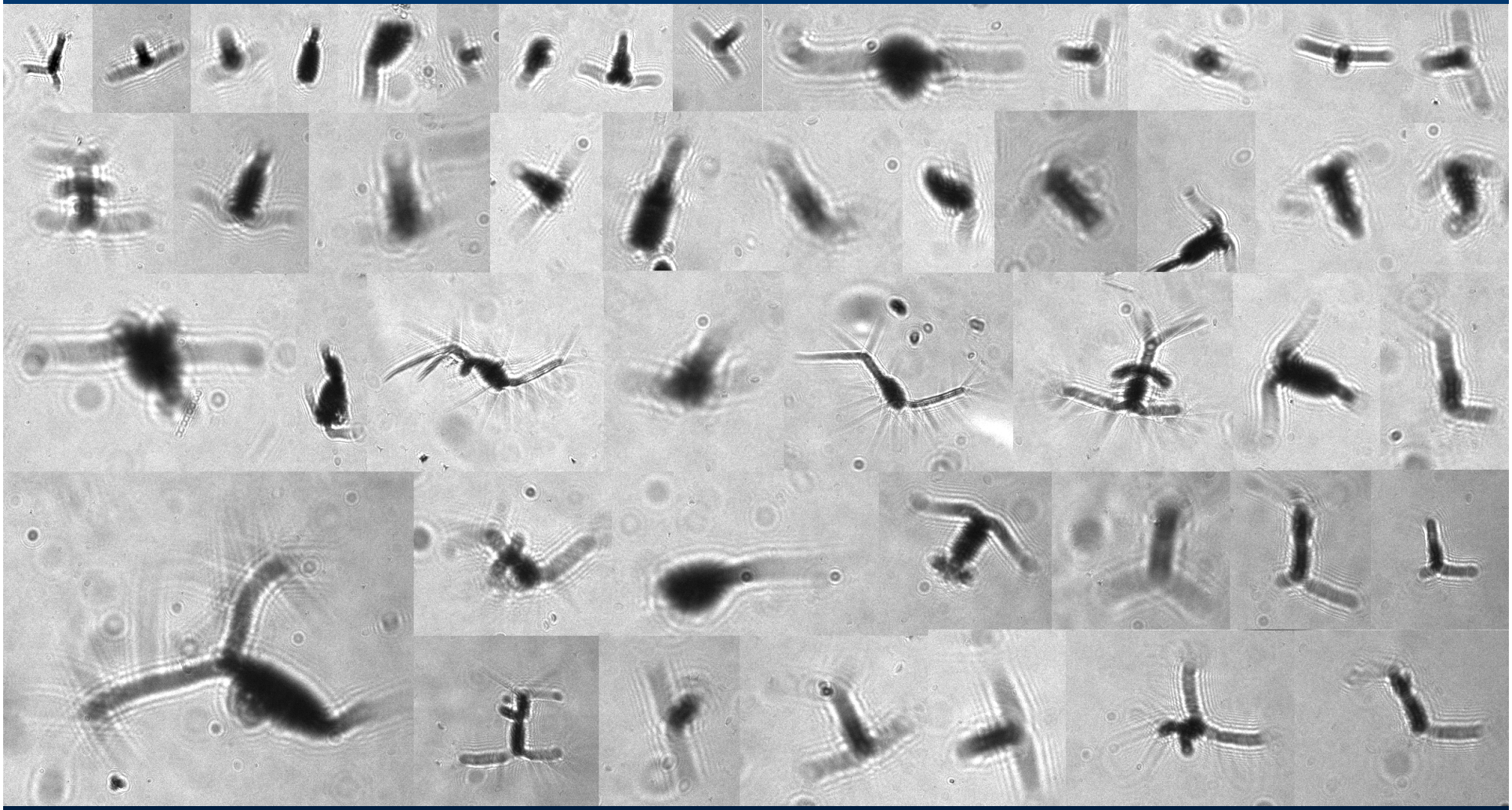
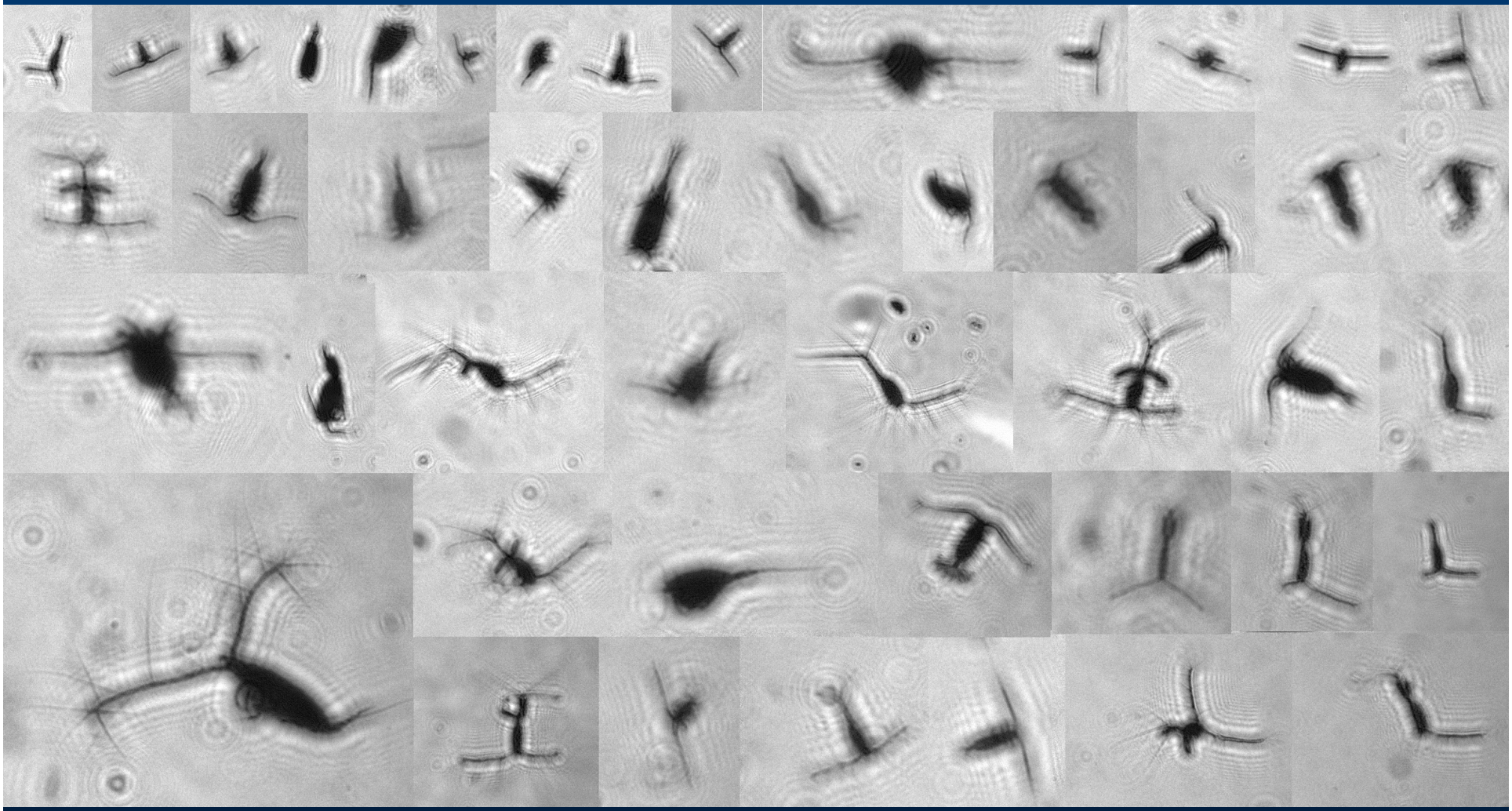
Density Difference (kg m-3)



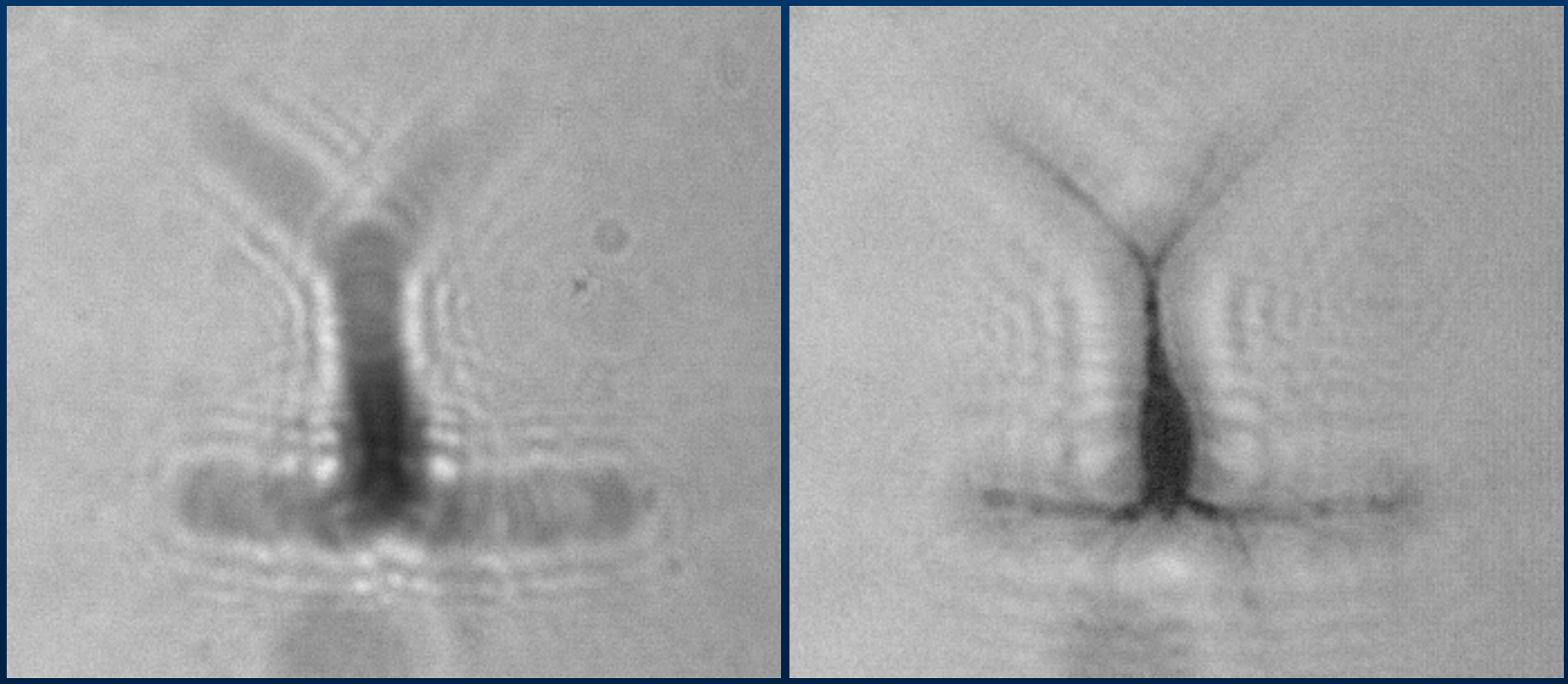
Out-of-Focus Copepods

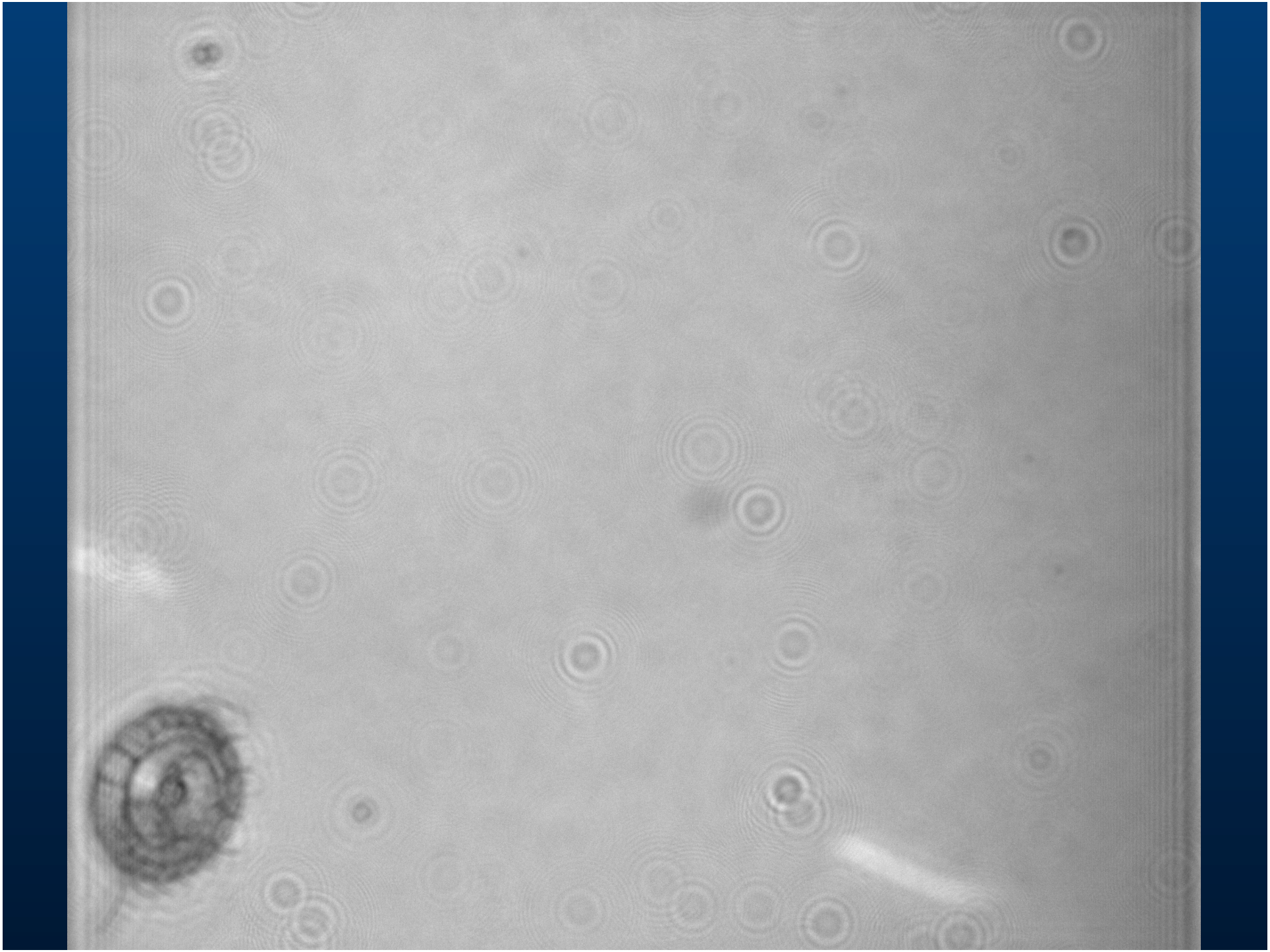


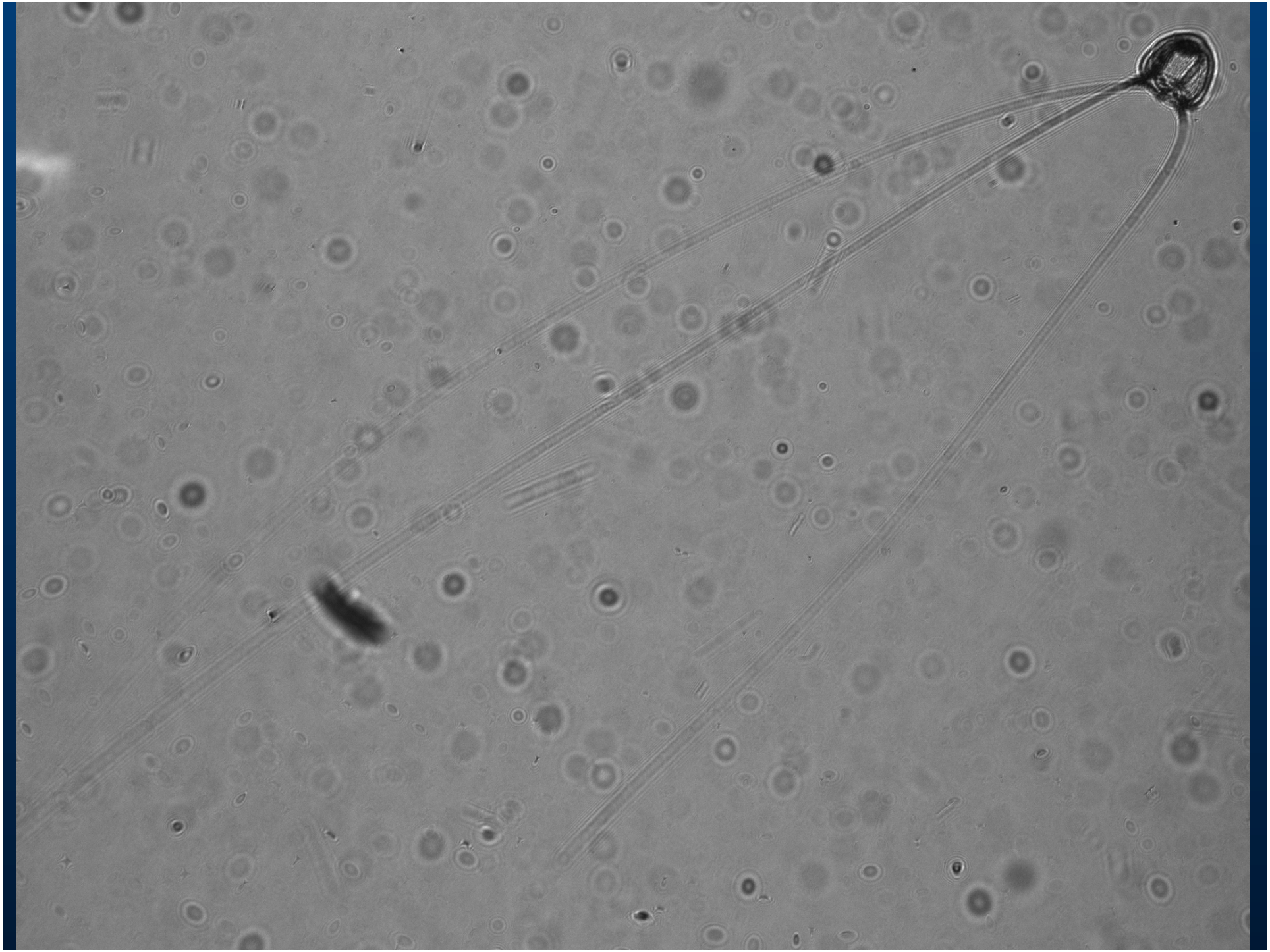
Refocused Copepods



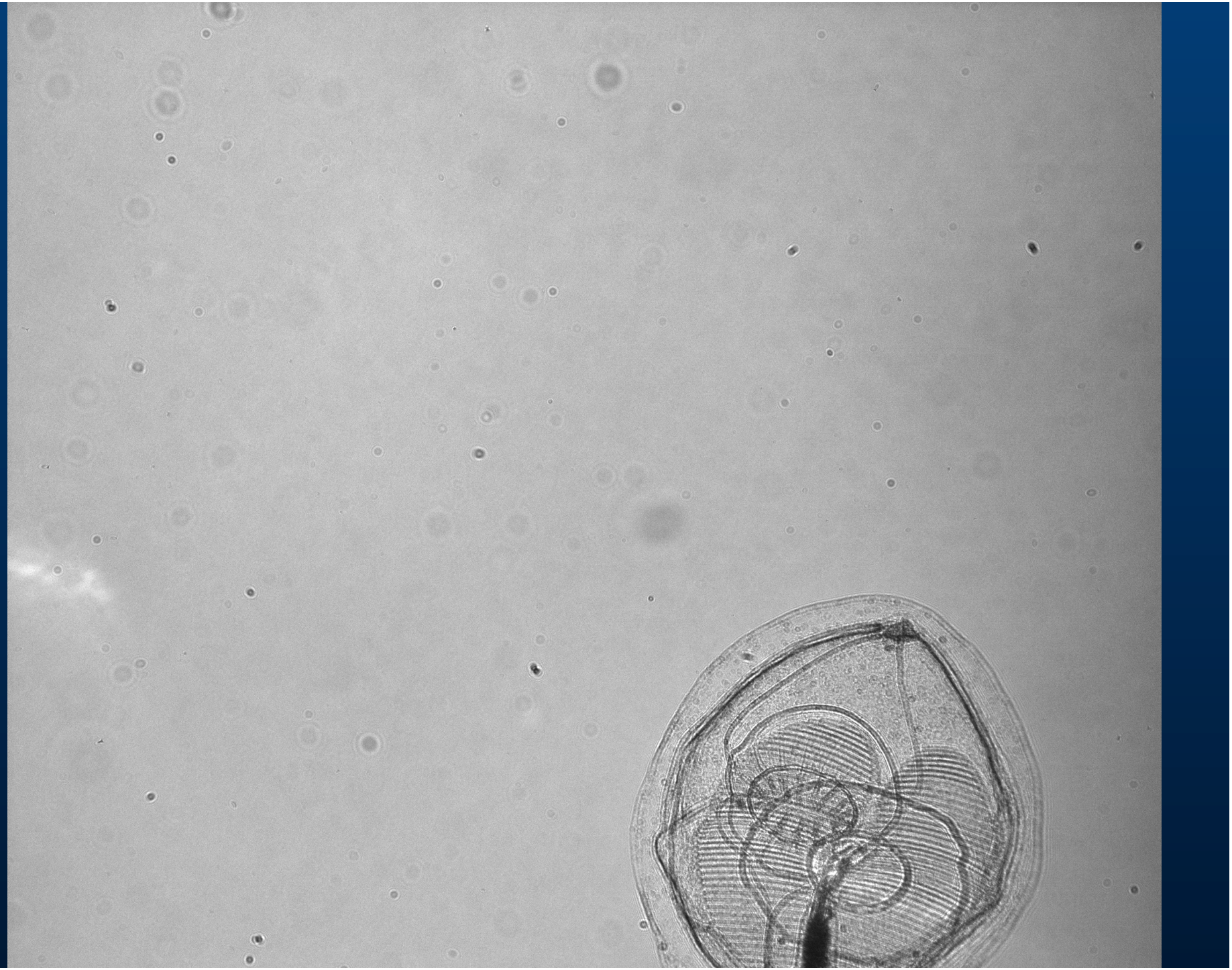
Holographic Reconstruction





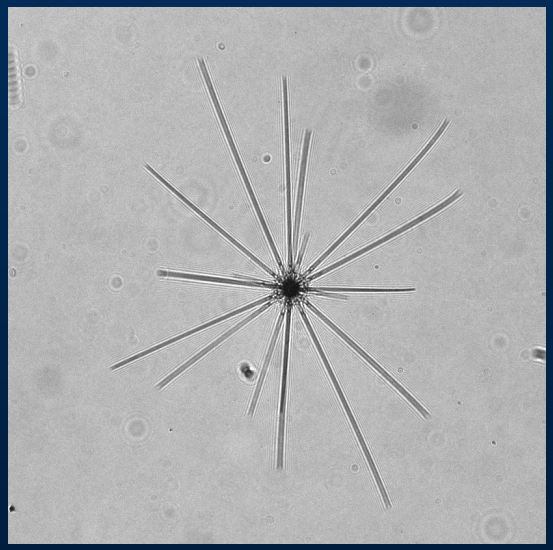
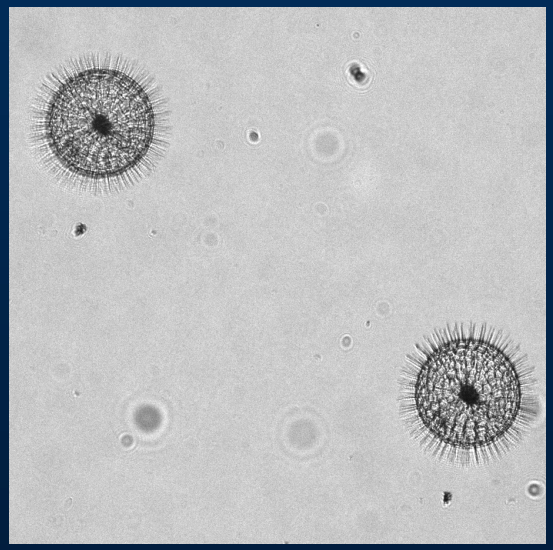
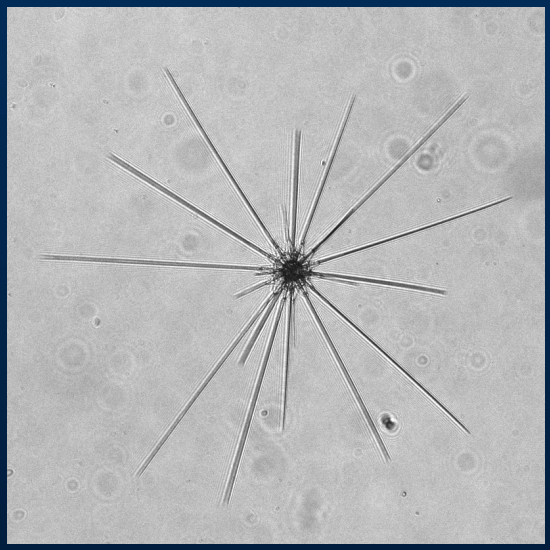






Future Work

- System badly vandalized and not currently operational
- Repair and upgrade
- Analyze data collected in 2012 and 2013
- New software (Visual Spreadsheet) from Fluid Imaging Technology

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