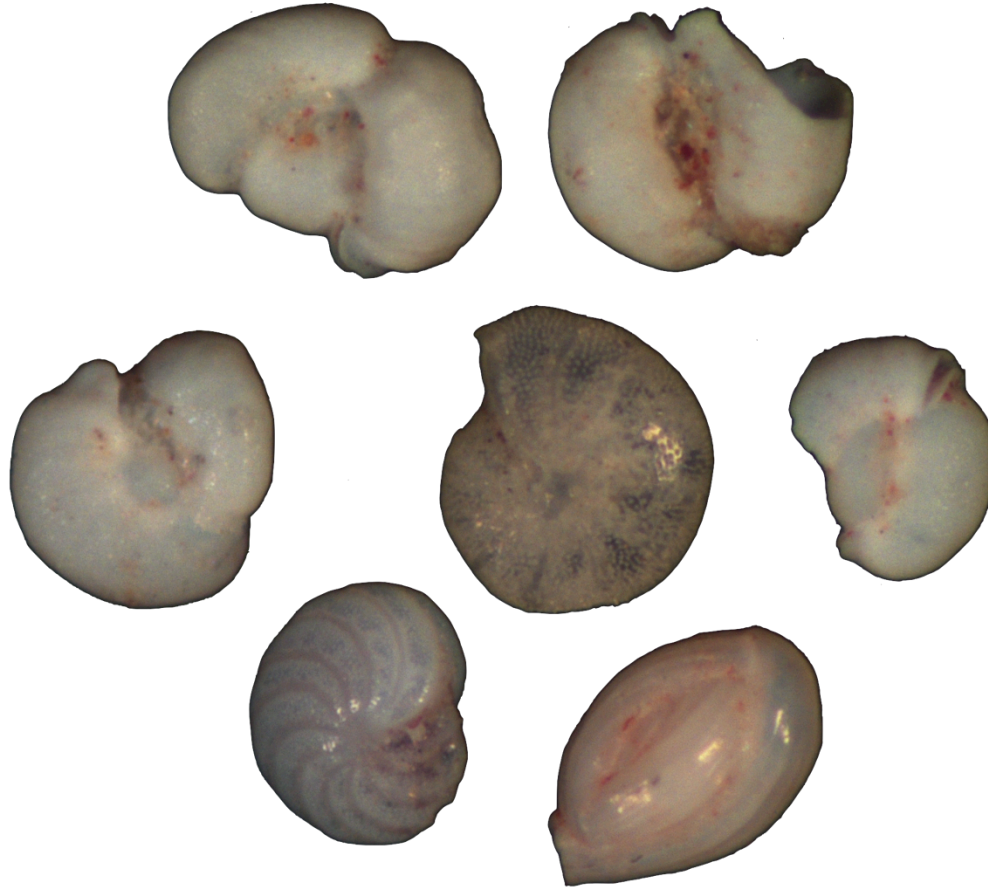


Utilizing image recognition technology for foraminiferal assemblage analyses

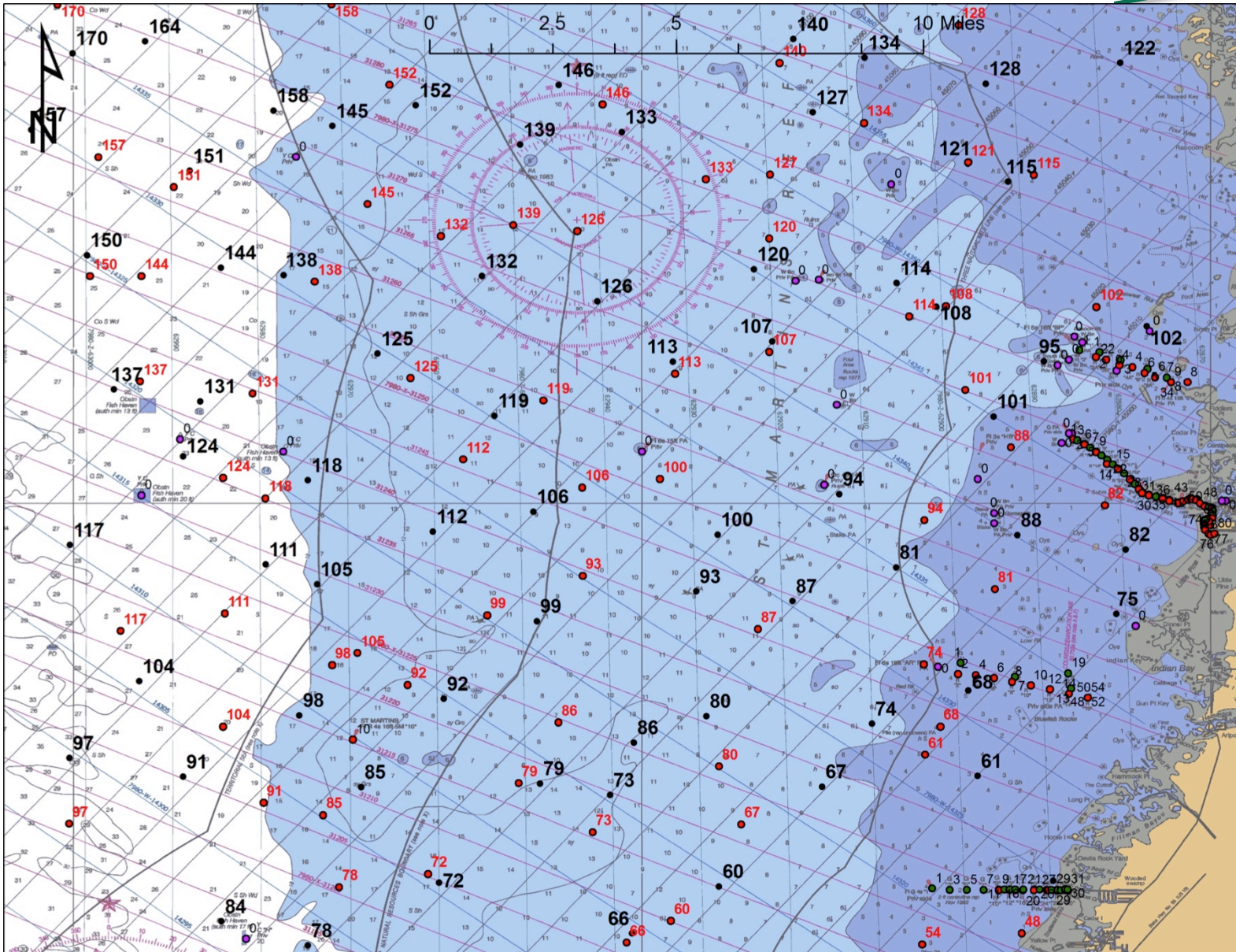
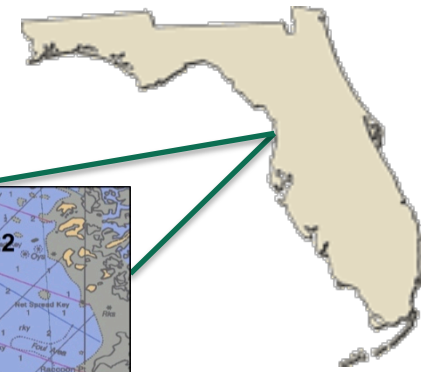


Christian H Gfatter



UNIVERSITY OF
SOUTH FLORIDA
COLLEGE OF MARINE SCIENCE

Florida Springs Coast

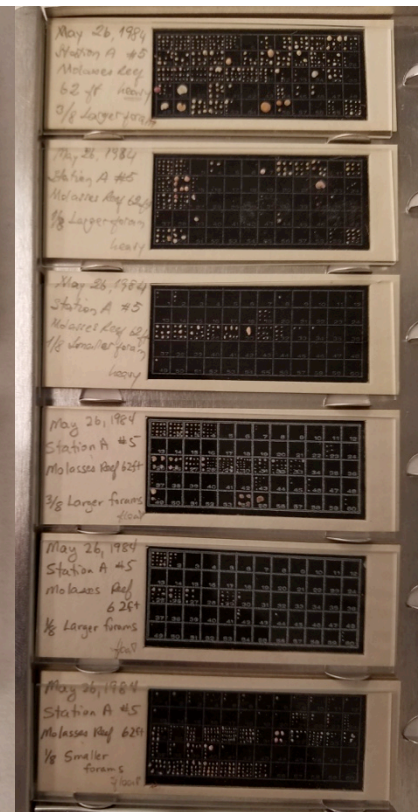
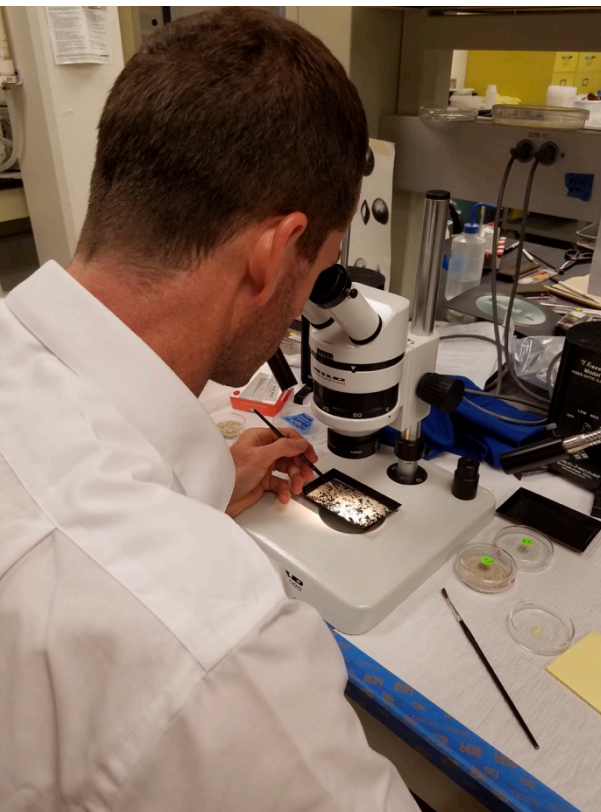


Traditional picking

Pick

Arrange

Store



Identification

Requires skill developed over years

Novice

Expert

familiar with > 100
genera or species

| Identified | using pictures | using electronic dichotomous key | using available resources |
|-------------------|----------------|-------------------------------------|------------------------------|
| Genera | 57 of 60 | 56 of 60 | 60 of 60 |
| species | 7 of 57 | 14 of 56 | 30 of 60 |
| time | 2 hours | 3 hours | 1.5 hours |
| estimated correct | TBD | TBD | > 95% |

The Big Idea



Add sediment containing foraminifera

Machine sorts & processes particles

Software generates data which allows writing detailed Thesis

Data

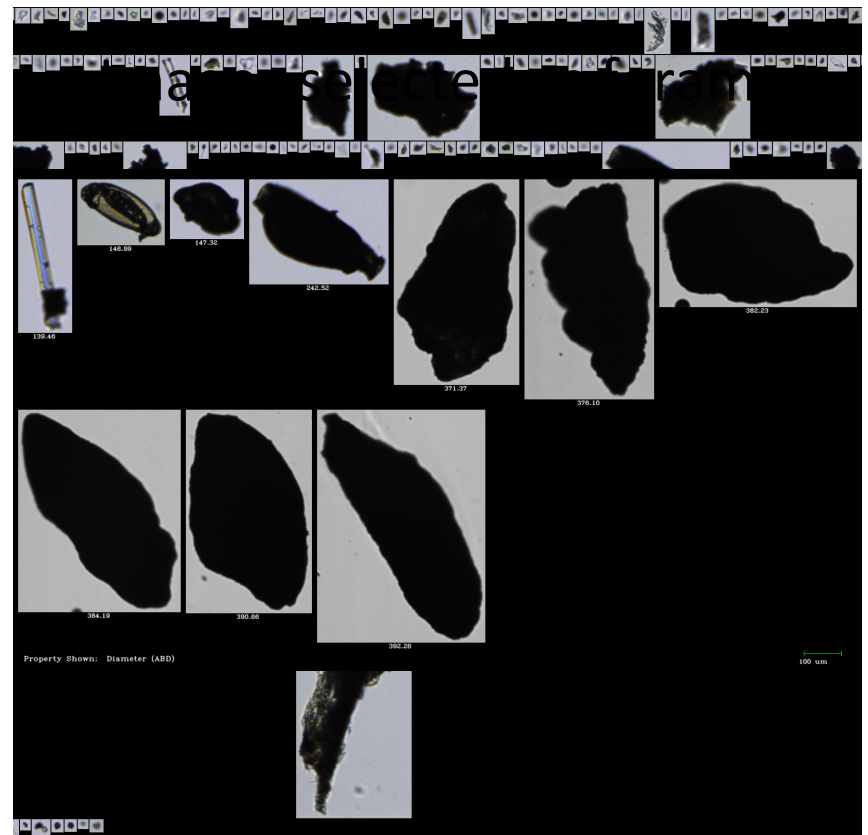
=====

Imaging Instruments

FlowCam® VS Series (2 μm to 2 mm particles)



Output from sediment sample



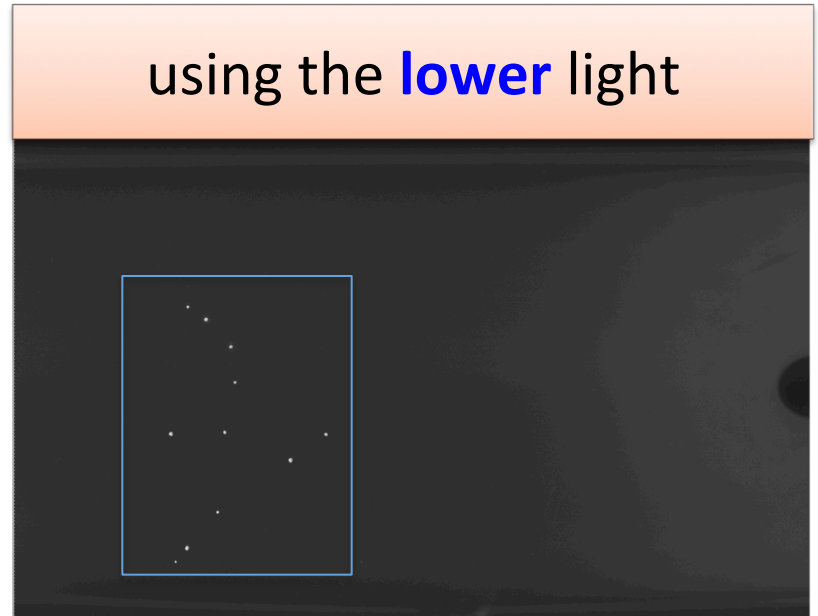
Imaging Instruments

ZooSCAN
(liquid zooplankton)



Images of 11 forams

using the **lower** light



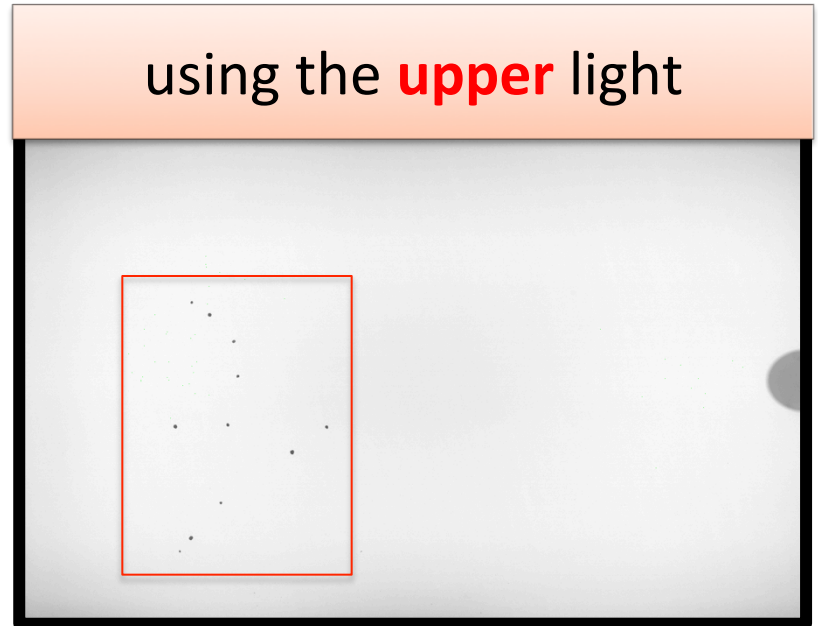
Imaging Instruments

ZooSCAN (liquid zooplankton)



Images of 11 forams

using the **upper** light

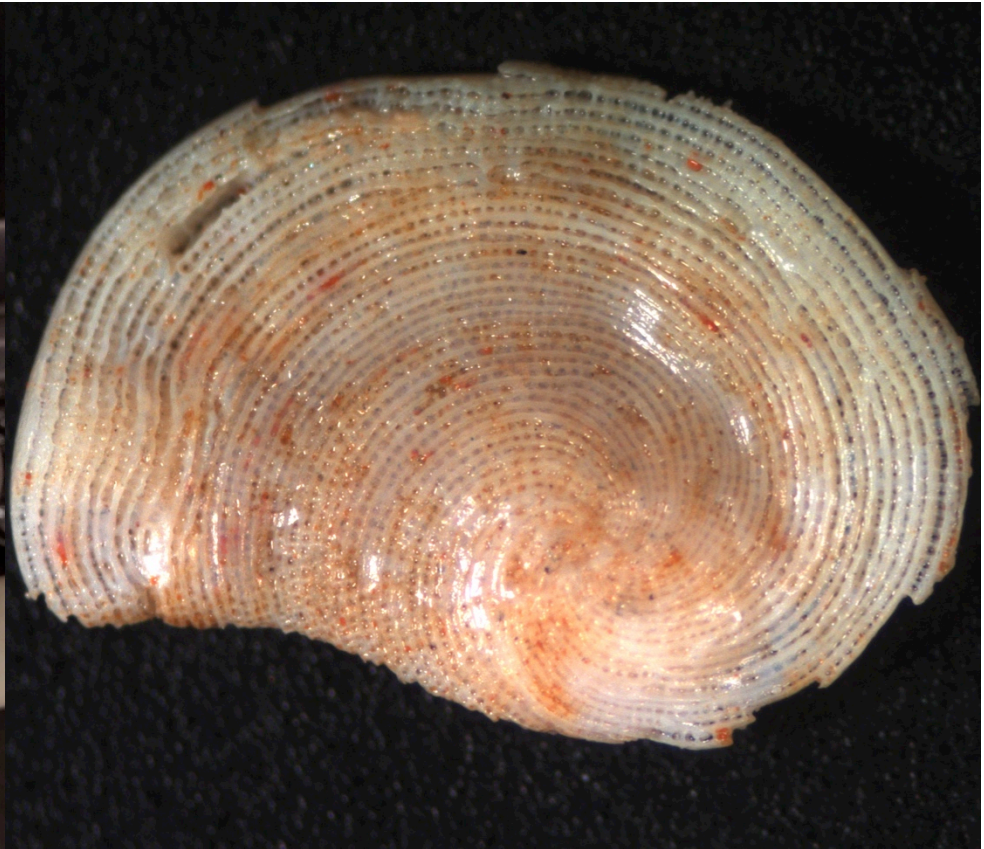
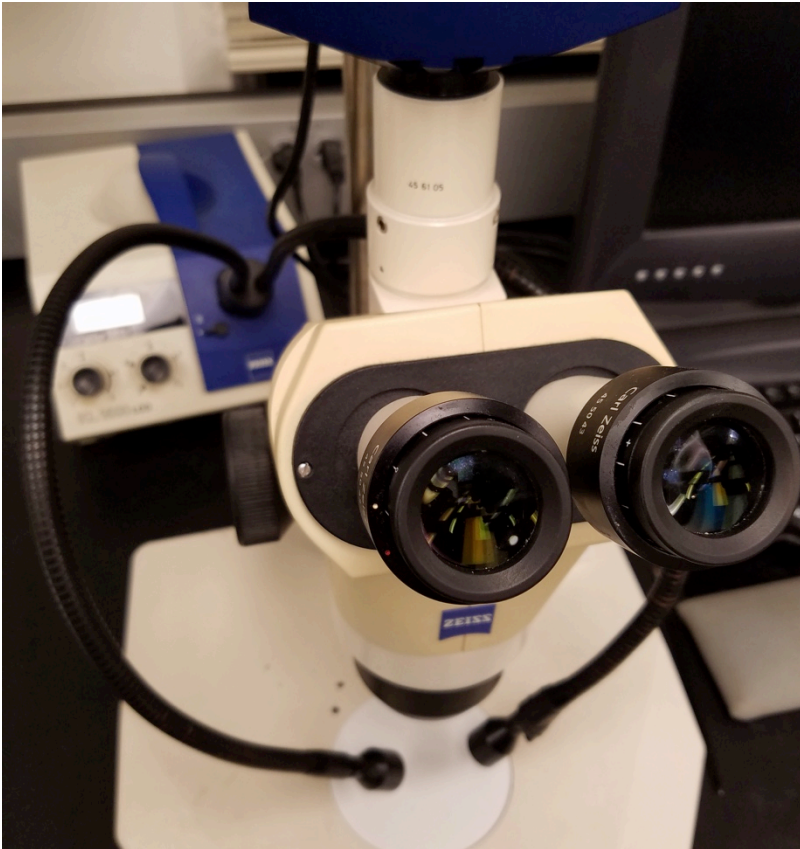


Imaging Instruments

Zeiss AxioCam MRc5

(5 megapixel digital microscope camera)

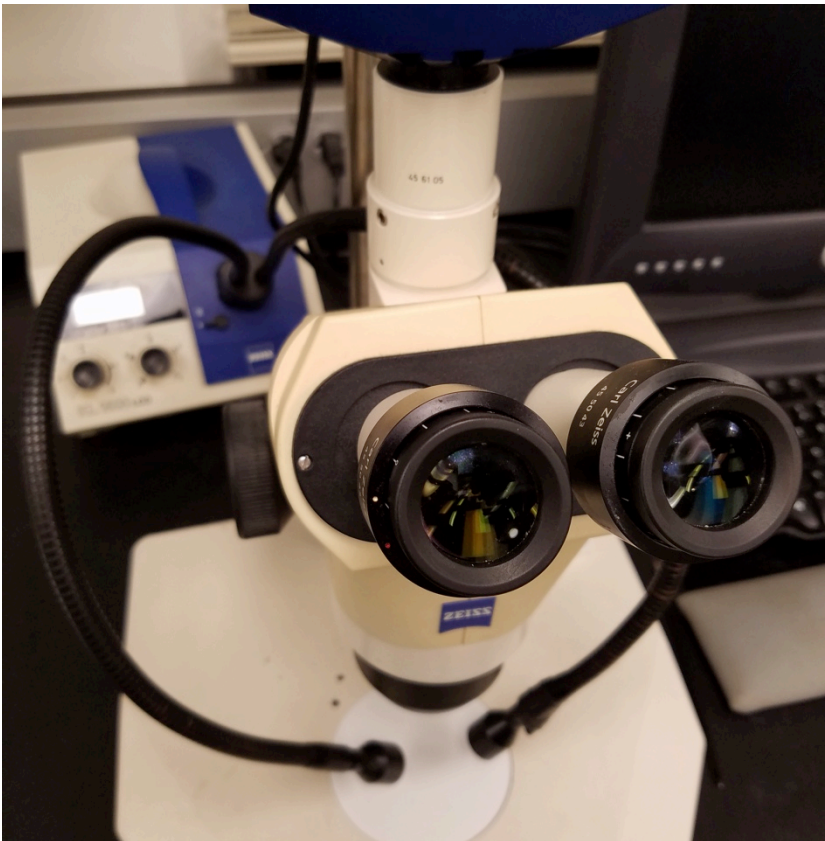
Archaias angulatus



Imaging Instruments

Zeiss AxioCam MRc5

(5 megapixel digital microscope camera)



Magnification

20 x

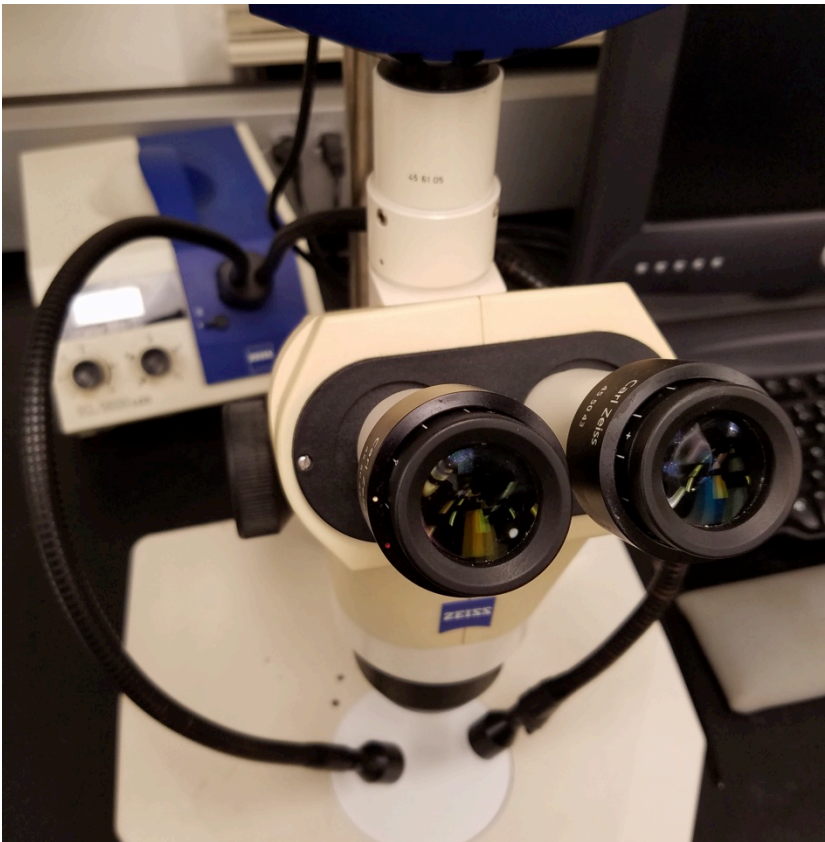
focused on largest foram



Imaging Instruments

Zeiss AxioCam MRc5

(5 megapixel digital microscope camera)



Magnification

25 x

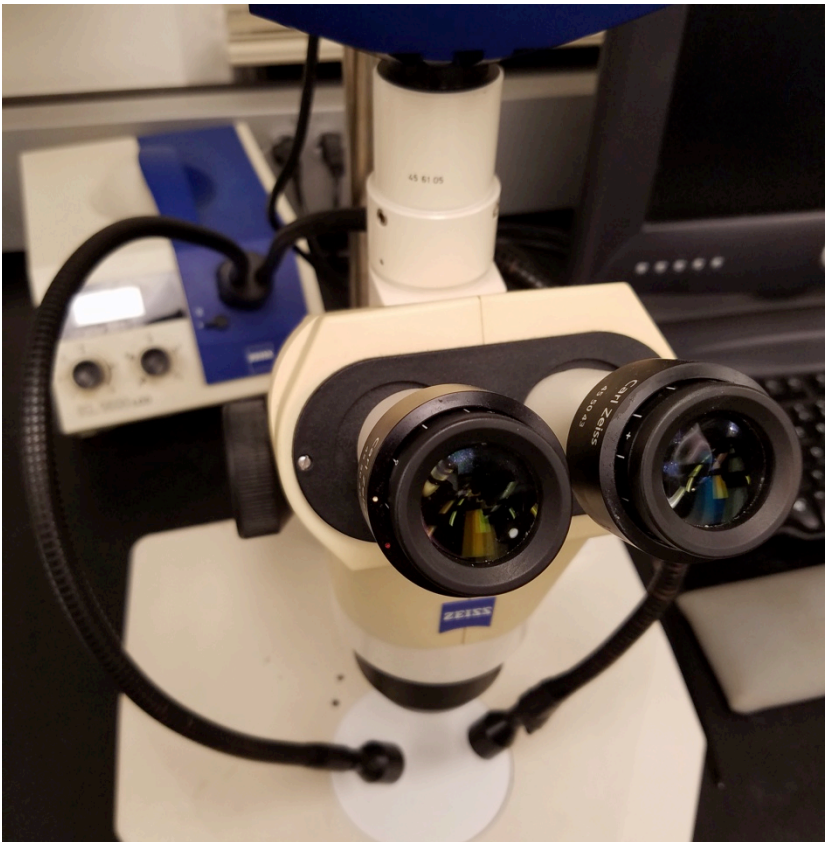
focused on largest foram



Imaging Instruments

Zeiss AxioCam MRc5

(5 megapixel digital microscope camera)



Magnification

32 x

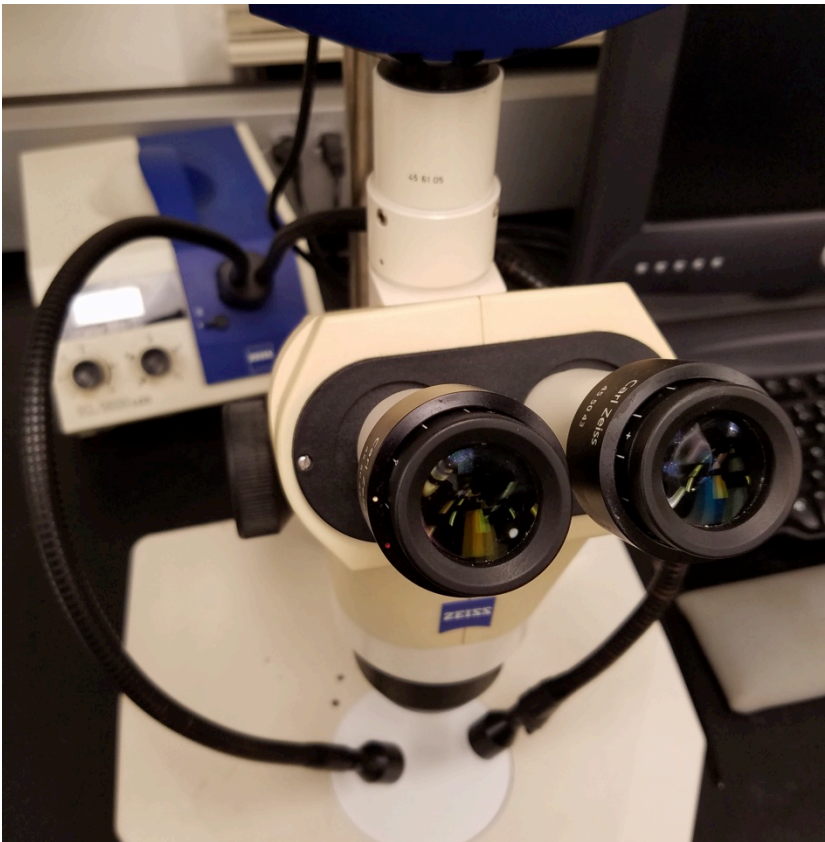
focused on mid-sized foram



Imaging Instruments

Zeiss AxioCam MRc5

(5 megapixel digital microscope camera)



Magnification

40 x

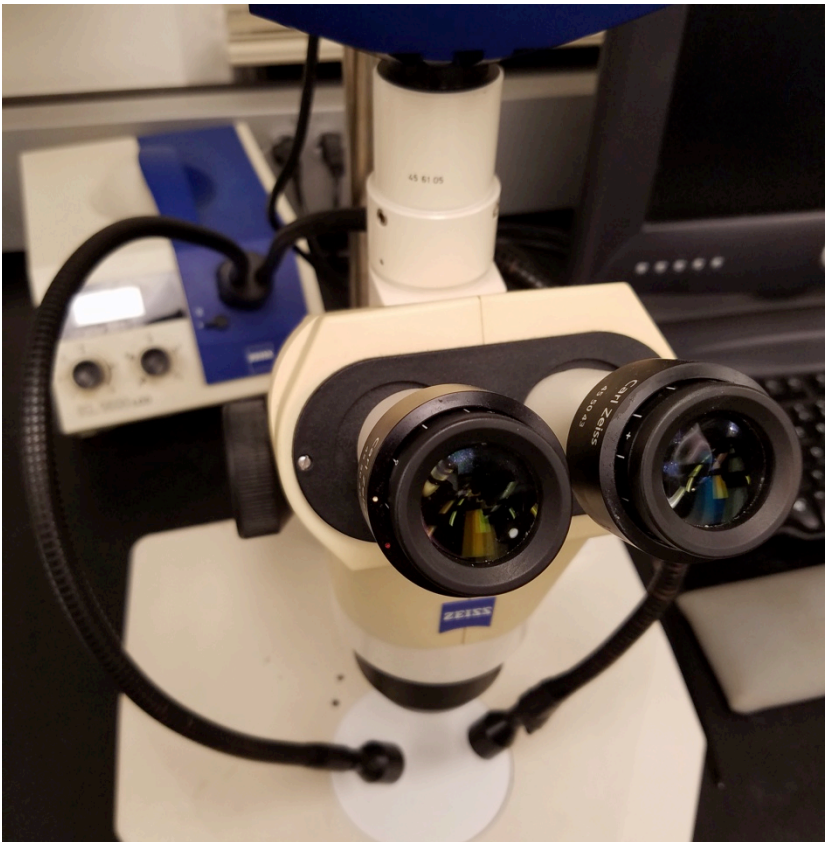
focused on mid-sized foram



Imaging Instruments

Zeiss AxioCam MRc5

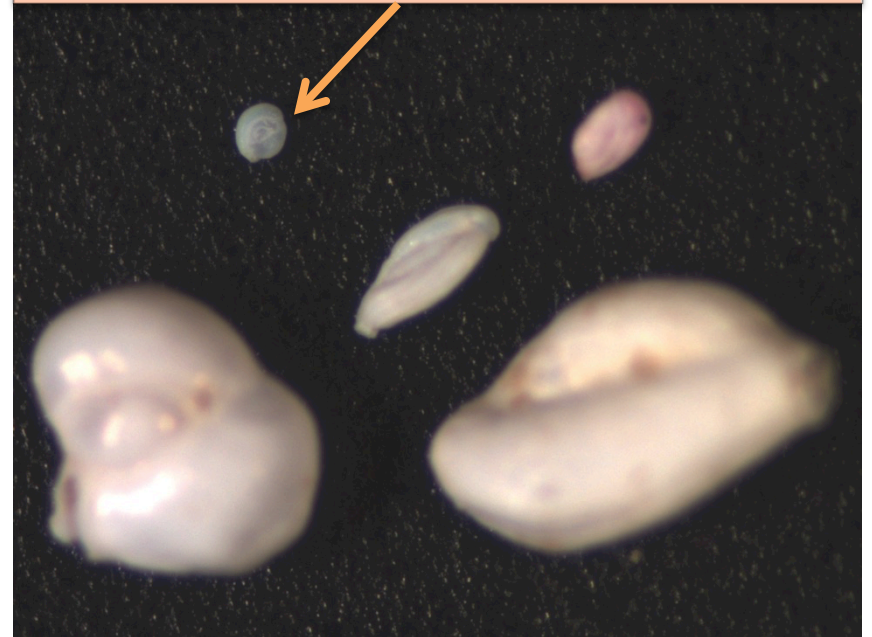
(5 megapixel digital microscope camera)



Magnification

40 x

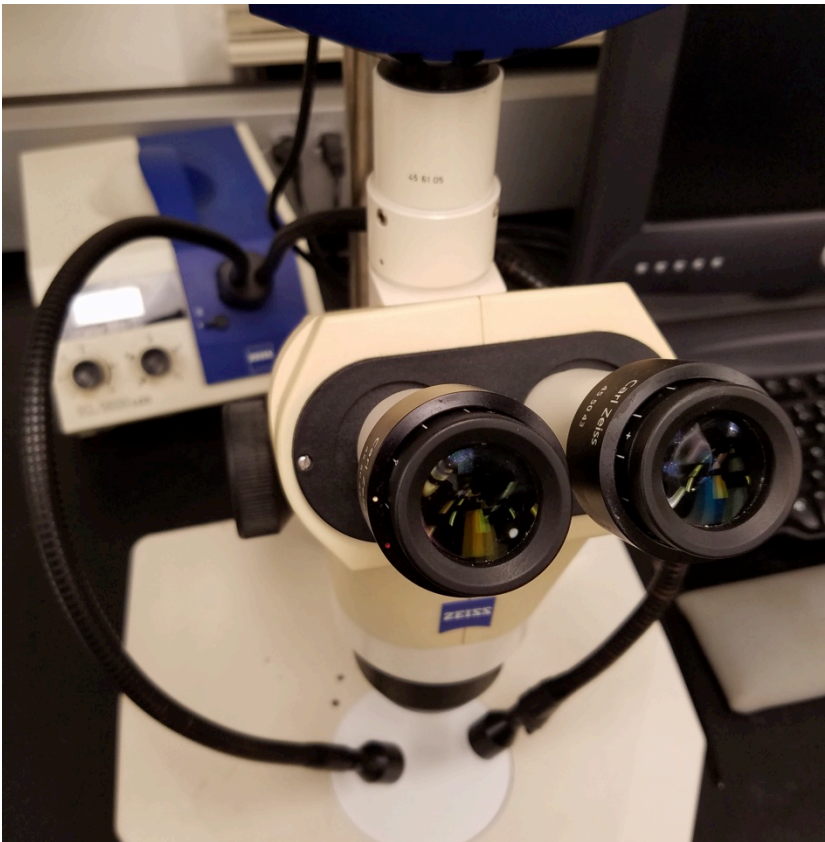
focused on smallest foram



Imaging Instruments

Zeiss AxioCam MRc5

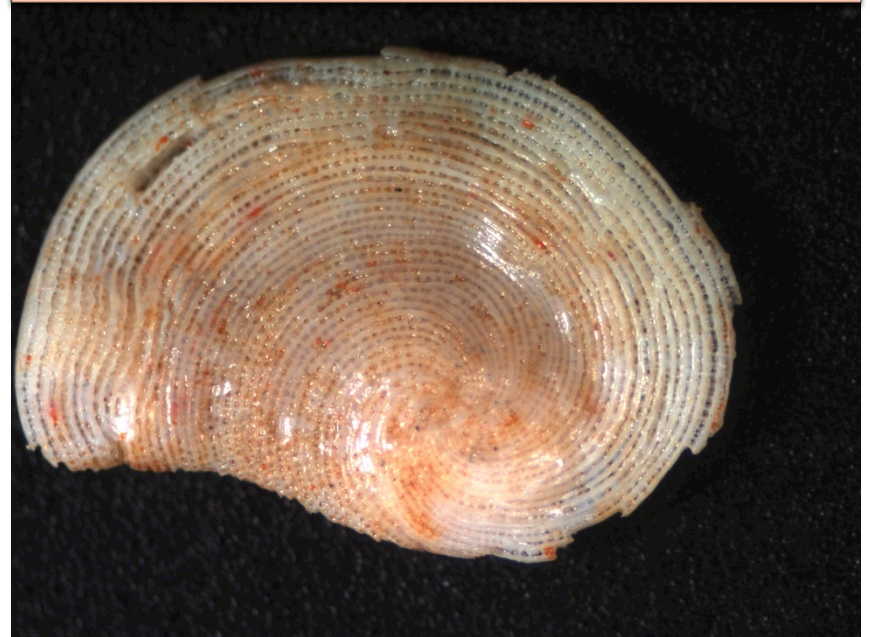
(5 megapixel digital microscope camera)



Additional set of images taken
for larger specimens

20 x

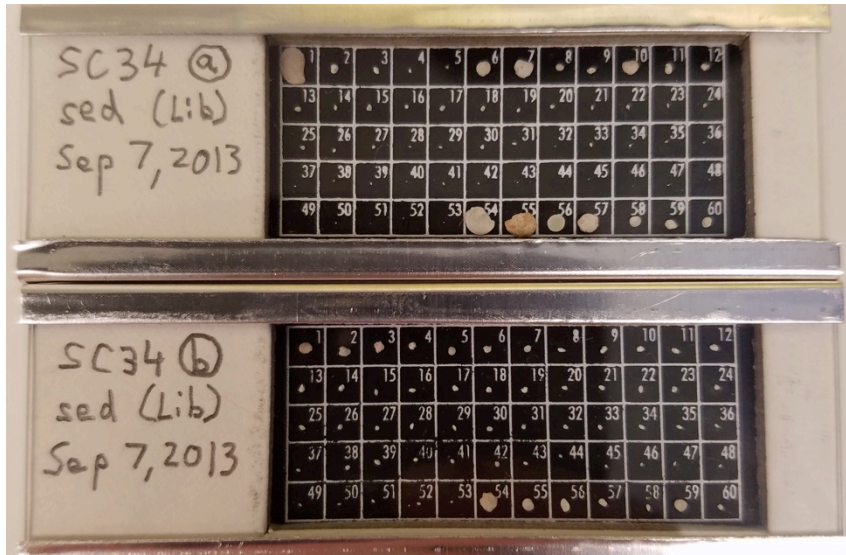
Archaias angulatus



Micropaleoslide arrangement

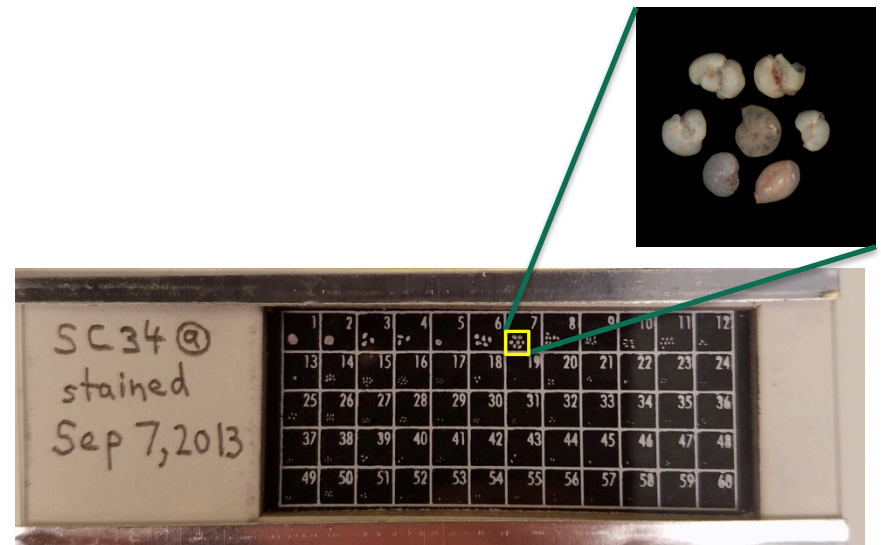
Library images from sites

- 1+ slides per site
- 1 foraminifera per grid
- Several views photographed



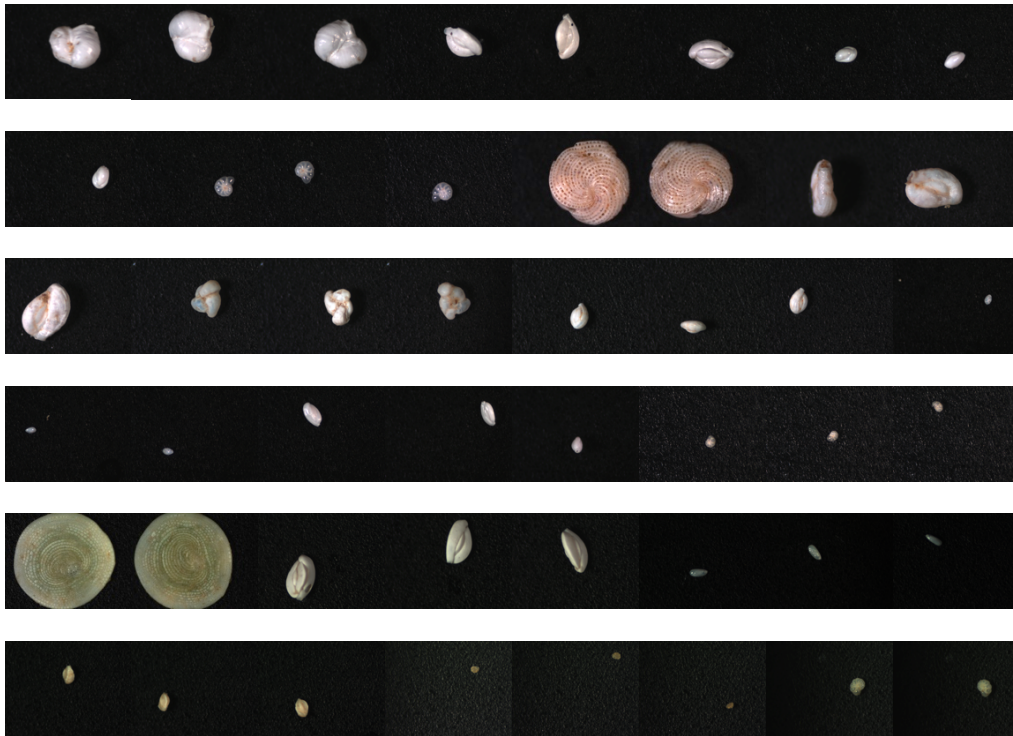
Sampling site images

- 1 slide per site
- 1+ forams per grid
- 1/4 of grid utilized with forams grouped by size



Combining AxioCam pictures with FlowCam image processing software

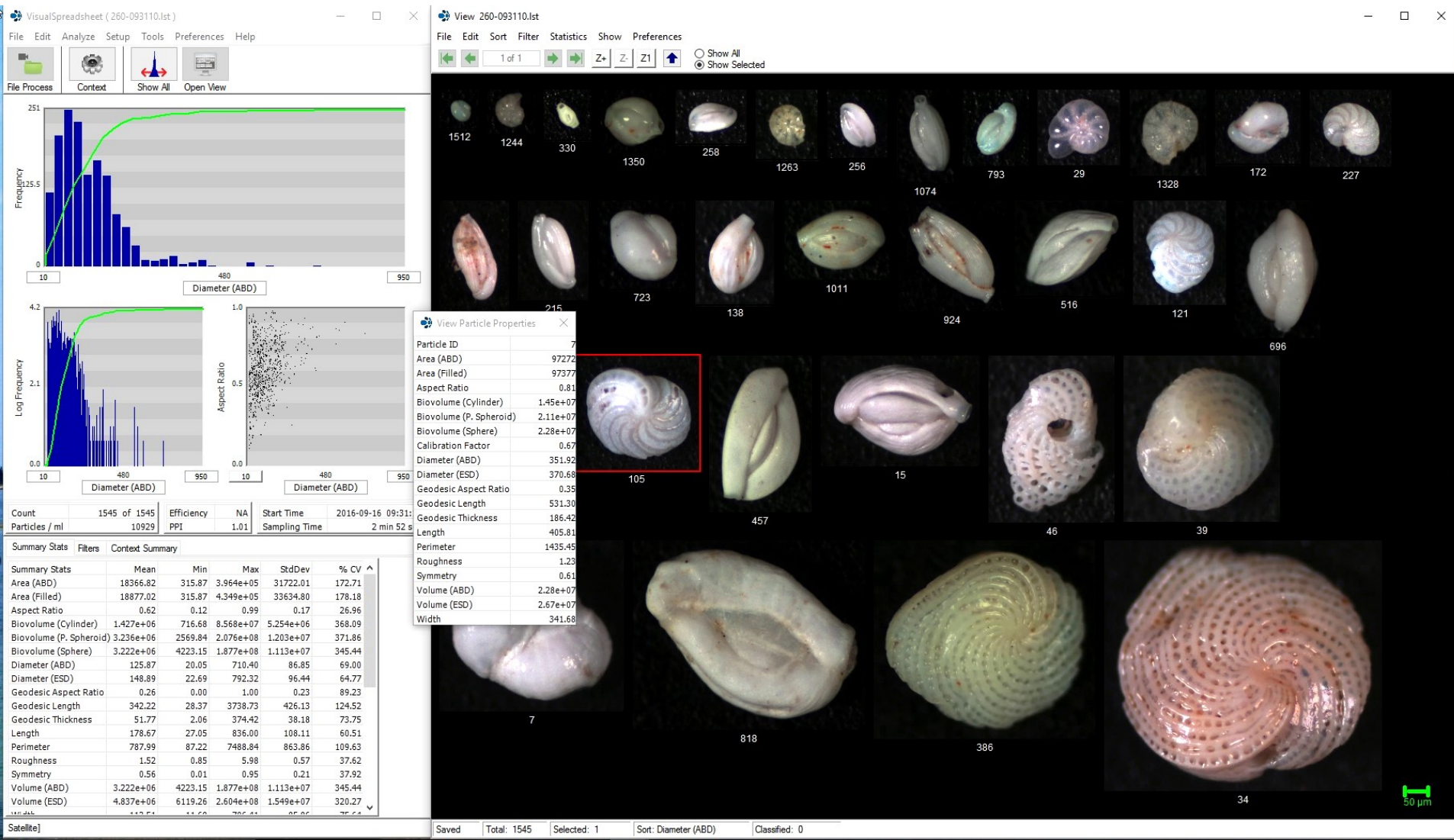
images



VisualSpreadsheet

AVI animation

VisualSpreadsheet output



Refinement

1. Initial classification and measurements **systematically made by software**
2. Manual post-processing: image rejection, **identification overrides**, etc.
3. Library grows, helping improve processing of subsequent foraminiferal samples
4. Digital data (images & records) can be shared and backed-up (physical specimens archived)

Potential Applications & Considerations

- **WHAT:** heavy mineral sands (e.g., in ancient beach sands), diatoms, ostracods, & other opaque organisms
- **HOW:** using trichloroethylene (TCE) separation technique to provide foraminiferal samples for bulk processing
- **SOFTWARE:** other programs (e.g. SIPPER) may make finer determinations, provide different data, etc.

Summary

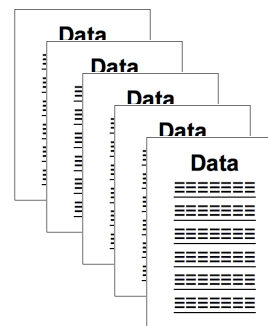
- **Identification efficiency**

- Consistency
- Error reduction



- **Additional data**

- Standardized characterization
(e.g. length)



- **Digitization**

- Accessibility
- Global sharing



Acknowledgements & Credits



- Cushman Foundation for Foraminiferal Research
- Dr. Pamela Hallock Muller
- Kyle Amergian
- Harry Nelson, VP – Aquatic Markets, Fluid Imaging Technologies
- Ian W Bishop, University of Colorado
- Kate Dubickas
- Dr Paul Carlson, Florida Fish and Wildlife Research Institute



Images:

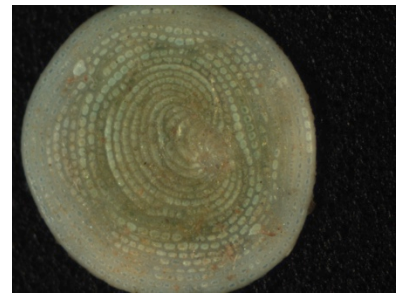
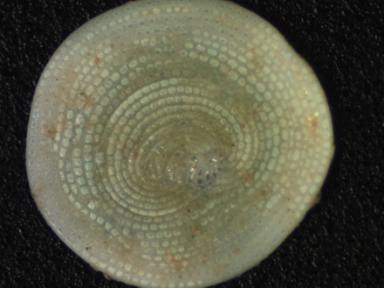
- www.fluidimaging.com/products/flowcam-vs
- www.hydroptic.com/zooscan.html
- commons.wikimedia.org
- cliparts.co



Maps:

- Florida Center for Instructional Technology, University of South Florida

Questions



Thank you!

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