POLAR TREC
Learning Resources

Details

Completion Time: Less than a week

Permission: Download, Share, and Remix

Approximate Proxies

Overview

The sediment in Lake El'gygytgyn, (pronounced EL-ge-GIT-gin) located in NE Siberia, holds one of the longest records of climate change anywhere in the continental Arctic. How does sediment (clay and mud) tell us something about past climate? Proxy data! By studying the microfossils of diatoms and pollen in the sediment, we can re-construct the lake environment millions of years ago. We can also apply the same methods to investigate sediment in neighborhood lakes and ponds.

Objectives

Students (and adults) frequently find it difficult to understand how scientists can reconstruct past climate records without direct measurement of weather conditions. By completing these lessons, students should have a basic understanding of several types of proxy data and how scientists are using proxies to understand our changing climate.

Lesson Preparation

Note: This Lesson will ideally be taught in the spring during pollen season.

These activities are associated with the El'gygytgyn Drilling Project and are most helpful placed in context. In the winter of 2009, an international team of scientists traveled to the NE province of Chukotka, Russia to Lake El'gygytgyn to drill and extract the lake sediment cores. After preliminary studies, scientists discovered that Lake El'gygytgyn contained the longest undisturbed record of climate change anywhere in the continental Arctic.

We extracted over 300 meters of sediment that recorded approximately 3.5 million years of climate history. Throughout the next several years scientists from around the world will study the sediment samples to reconstruct the climate history of this region of the Arctic. Two of

Materials

- Microscope images of Diatoms
- Microscope (magnification up to 400X)
- Microscope slides or scotch tape
- Zip-lock bags

the foci of study will be diatoms and pollen. Different species and the relative abundance of these biological sediments will give clues to the climate and environmental conditions of the lake.

Once the sediment cores were extracted from the lake, they were packaged in insulated and temperature-controlled shipping containers. The cores are maintained at approximately 4° C (the temperature of the lake bottom.) In June of 2009 the cores were shipped from Siberia to St. Petersburg and in the fall of 2009, the cores were shipped to Germany. In Germany, the cores will be split in half. The science team will sample and study one half of the cores and the other half will be preserved for archive and study at a later date.

The basic scientific concepts are really quite simple. Although the NE corner of Siberia (Part of Beringia – the western side of the land bridge to N. America) was never covered by large continental glaciers, during the last several ice ages, we know that the lake was frozen throughout the year. During these cold periods, there was considerably less biological activity in the lake. Scientists have correlated times of low diatoms with the ice ages. During the interglacial times (warm periods), we have been able to track changes in the plant communities around the lake by the pollen grains and other organic matter in the sediment.

For a full account of the expedition, read the expedition journals at:
http://polartrec.com/geologic-climate-research-in-siberia

Day 1
For Students:
Two Key words: Diatoms and Proxy
I started this lesson with a simple assignment. The day before, have students look up and write down a definition of the word Proxy. Have them research and be able to describe "What is a diatom." (Note: Many students will relate the word proxy to a web-proxy server. Be familiar with the Wikipedia page on both proxies and Diatoms, found here:
http://en.wikipedia.org/wiki/Proxy and http://en.wikipedia.org/wiki/Diatom

For Teachers:
It is great if you can find a few diatoms and put them under microscopes for students to see (this will increase the reality of the rest of the lesson). Diatoms are found in most fresh and salt water bodies. Simply take a dropper of green lake or pond water scum and you will likely find some (they can be identified on 100X but will show up better on 400X). I start the lesson by giving the students a few minutes to view diatom fossils from Lake El'gygytgyn sediments that we collected on the expedition.

Print out the microscope images of diatoms or have some way to share the images electronically.

Day 2 (this is the part that needs to be completed in the spring)

Homework For Students:

- Using a small zip-lock bag, Bring in a sample of pollen from a tree, shrub, or grass. Do your best to identify the type of plant from which you collected your sample.

For Teachers:

- Download attached PowerPoint or better yet, photograph similar images from near your community/school.
- Collect a generalized pollen sample from lake or puddle.
- Collect specific pollen types from dominant plants in your area (in my area, I collected oak, pine and grass).
- Prepare microscope slides with each pollen sample to use as a key for the students.

Procedure

Day 1

1. Begin with a discussion of what students have learned about the meaning of the term Proxy. What ideally will emerge as a theme, whether related to climate, computing, law, voting, or war is that Proxies are "stand-ins" or "substitutes" or an indirect way of accomplishing something.
2. Next have the students discuss what they have learned about diatoms (basic understanding: single celled producer that is VERY abundant in both fresh and salt water).
3. If you have samples, have the students view diatoms that you collected from a lake or pond thorough the microscope OR view various examples of diatoms online. Some great images may be found here: http://www.bgsu.edu/departments/biology/facilities/algae/html/SEM.html
4. In groups of 4-5 students, distribute the microscope images from Lake El'gygytgyn sediments. Have the students identify the diatoms in the images. In student journals (or some other form of writing), compile either a list of questions or hypotheses as to why in some images there are more and in other slides there are fewer diatoms. If the groups need some direction, tell them that the lake sediments represent a 3 million year history. Consider the following: Ice cover (Ice age / interglacial), Nutrient supply (what does a diatom need?)

Day 2 (this is the part that needs to be completed in the spring)

1. Have students view pollen samples under a microscope. Depending on the time you want to take, you may prepare microscope slides OR simply take a piece of scotch tape (approximately 4-5 cm), fold an end (1 cm) [this will allow you to hold the tape without it sticking to your fingers] and gently touch the tape to the pollen sample and place it on the microscope stage sticky side up.
2. Identify different pollen sources.
3. View generalized pollen sample from lake or puddle. Try to identify different plant pollen types in the generalized sample.
4. View attached PowerPoint (or better yet, make a similar one using images from your local area)

Learning Resources

5. Discuss what will happen to the pollen after a rain storm (pollen becomes incorporated with sediment).
6. Discuss how this activity would be different in different areas of the country, different biomes or geographic regions.
Example questions:
• How would you expect the pollen to be different 500 km North or South of your present location?
• If the climate warmed significantly, how would the pollen change?
• During an Ice age, how may the pollen be different?
7. Discuss how pollen in lake sediments can be used as proxy data for understanding climate.
8. At the conclusion of the lesson or as an assignment, have the students watch the videos on these two journal entries: http://polartrec.com/node/9882 and http://polartrec.com/node/9885 These videos will give students a perspective on an additional climate proxy; magnetic susceptibility.

Extension
If your school is near a body of water or even a small pond/aquatic habitat, have students go out and collect/identify diatoms.

One graduate student who participated in the Lake E drilling project will be studying trace chemicals in the sediment that were originally part of plant leaf waxes. Have the students brainstorm other possible climate proxy indicators that would potentially be found in lake sediments.

Note: If any teachers or students take images of pollen from your local area, (creating your own images to go along with the attached pollen PowerPoint) please send them to me... I would like to show pollen examples from beyond the Piedmont of central North Carolina.

Resources
These activities are associated with the El'gygytgyn Drilling Project and are most helpful placed in context. For a full account of the expedition, read the expedition journal at: http://polartrec.com/geologic-climate-research-in-siberia

For a minimal summary of the scientific drilling and coring, view these journal entries and watch the coring videos:
http://polartrec.com/node/9643 (Video)
http://polartrec.com/node/9654
http://polartrec.com/node/9877 (Video)
http://polartrec.com/node/9862

Helpful summary of Diatoms: http://en.wikipedia.org/wiki/Diatom
Helpful summary of Proxy climate data with additional lesson plans:

Learning Resources

Paleoclimatology: How can we Infer Past Climates? Created by Monica Bruckner, Montana State University. http://serc.carleton.edu/microbelife/topics/proxies/paleoclimate.html

Electron Micrographs of Diatoms: http://www.bgsu.edu/departments/biology/facilities/algae/html/SEM.html

Assessment
At the conclusion of the second day I gave students this individual writing assignment: Write a short essay, longer than 5 sentences but less than one page. Use specific examples to describe how proxies are used to understand past climates.

If you would like examples of 8th grade student responses, please contact me, I would be happy to share examples of student work.

Credits
Created by Tim Martin, 2009 Polar TREC teacher, tmartin@greensboroday.org
Thanks to Lake El'gygytgyn Drilling Project - Principle Investigator: Dr. Julie Brigham-Grette University of Massachusetts, Kristina Brady: Sediment core curator LacCore, University of Minnesota and Dr. Volker Wenrich, University of Köln, Germany.

Learning Resources

National Science Education Standards (NSES):

Content Standards, Grades 5-8

Content Standard A: Science As Inquiry
b. Understandings about scientific inquiry

Content Standard C: Life Science
d. Populations and ecosystems

Content Standard D: Earth and Space Science
b. Earth's history

Content Standards, Grades 9-12

Content Standard A: Science As Inquiry
b. Understandings about scientific inquiry

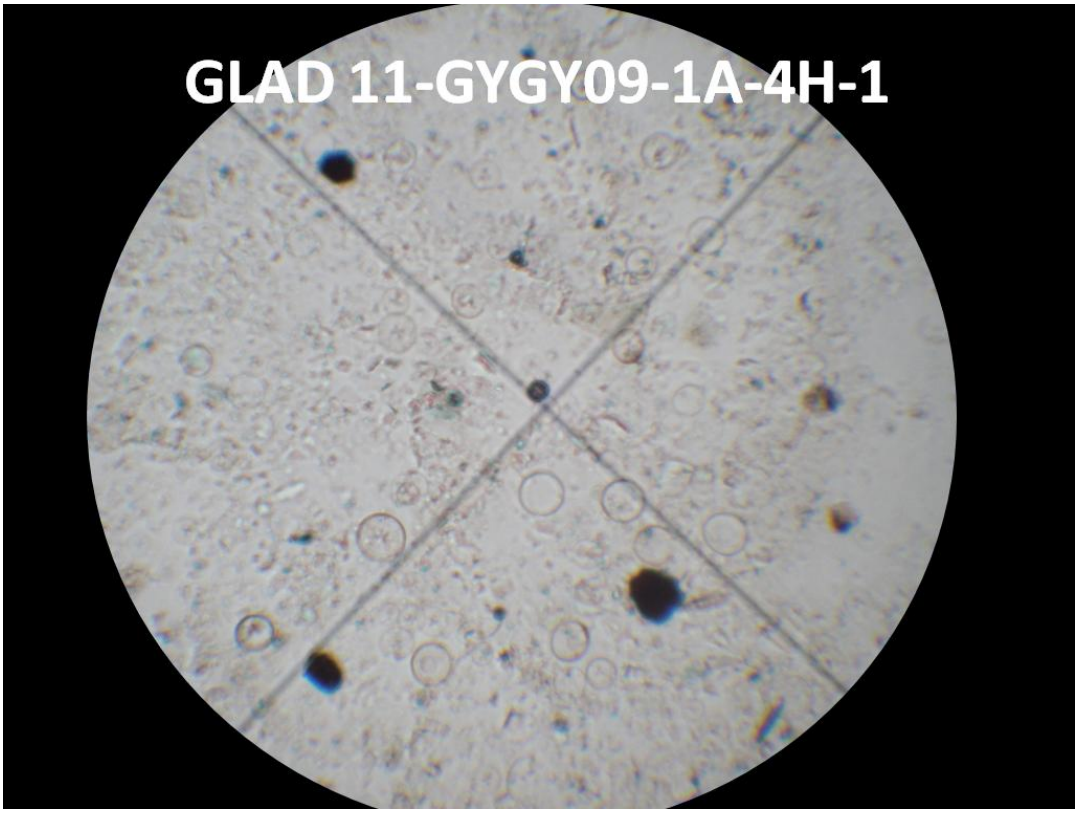
Content Standard C: Life Science
e. Matter, energy, and organization in living systems

Content Standard D: Earth and Space Science
a. Energy in the earth system

Content Standard F: Science In Personal and Social Perspectives
d. Environmental quality

Other Standards

North Carolina Earth Science Standards
1.01, 1.02, 1.06, 2.03, 3.01, 4.01, 5.03
Competency Goals
Analyze global atmospheric climate change, Fossil evidence of past life, Nature of sediments, Relationships between rock cycle and atmosphere/hydrosphere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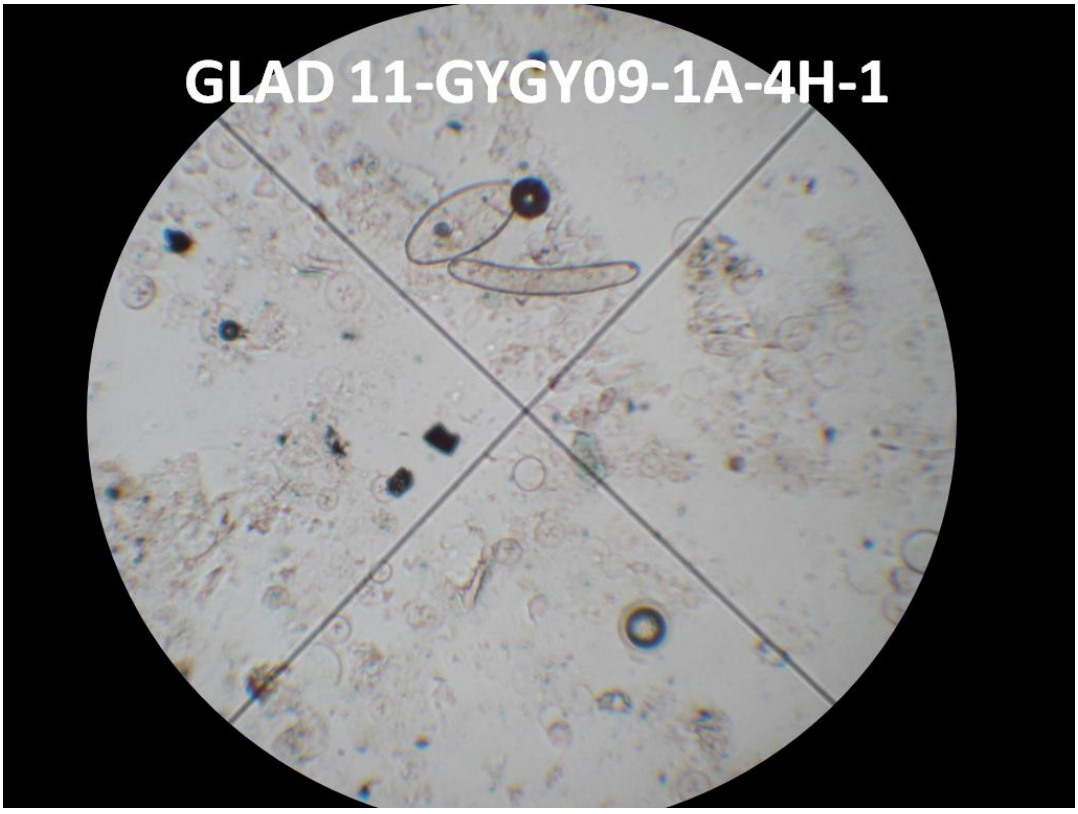
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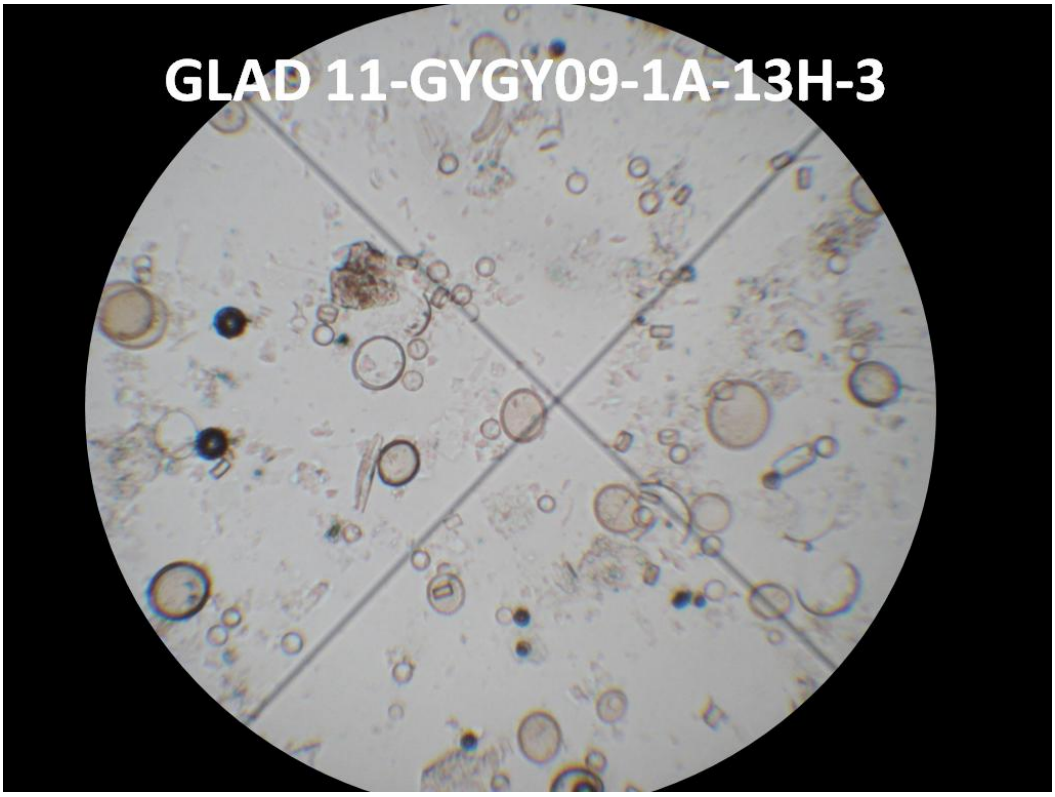
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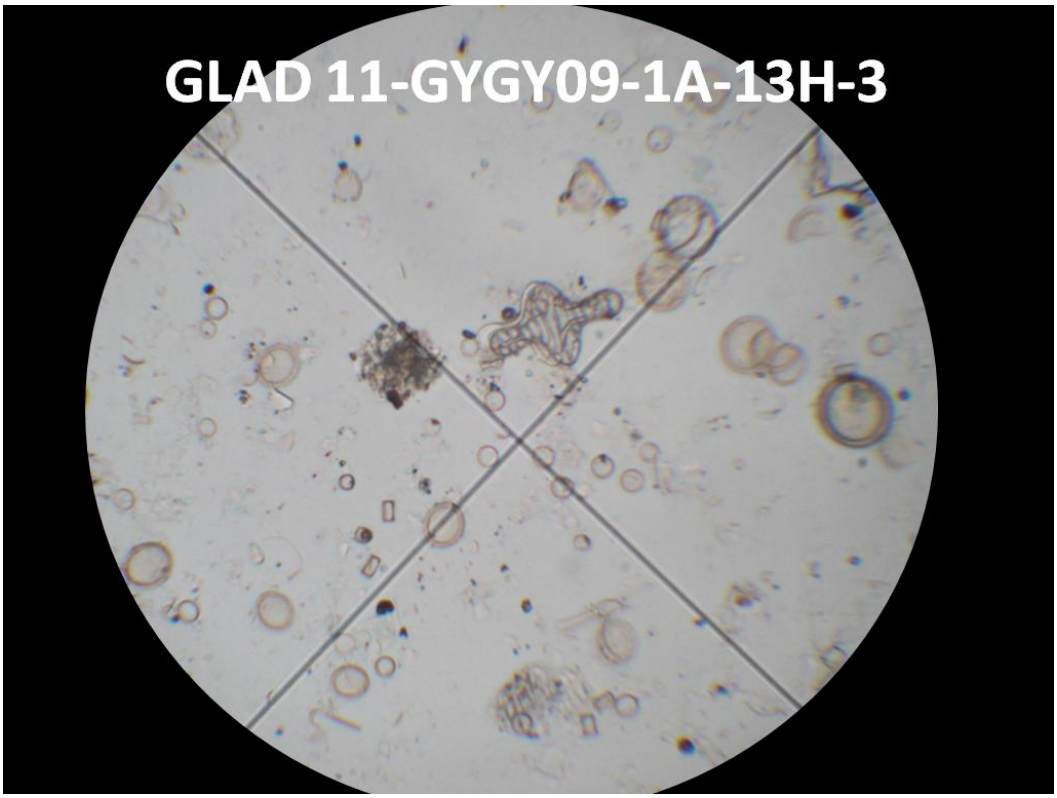
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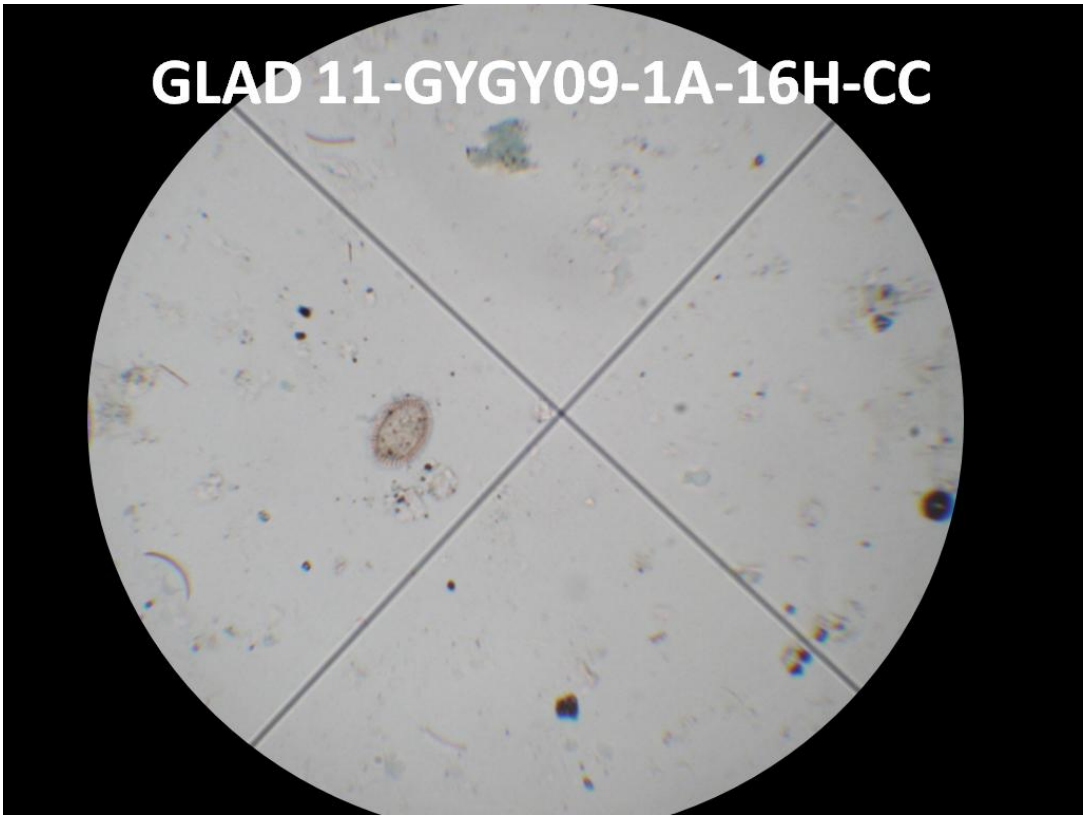
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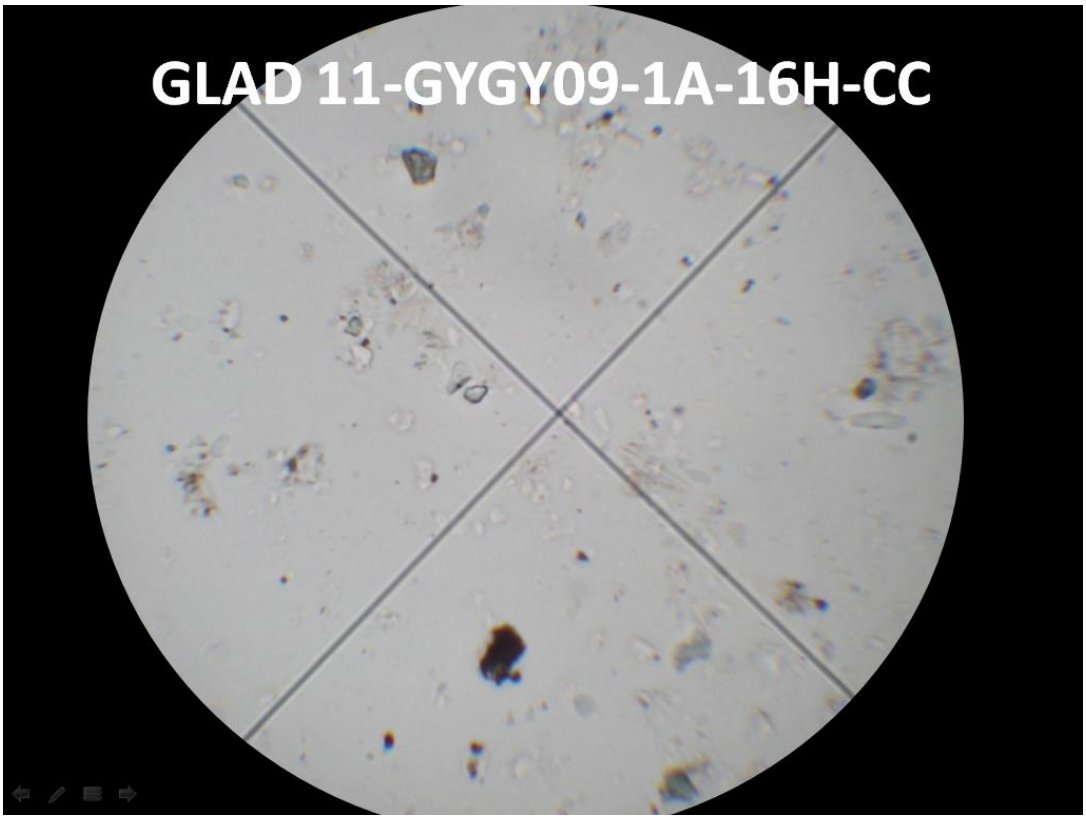
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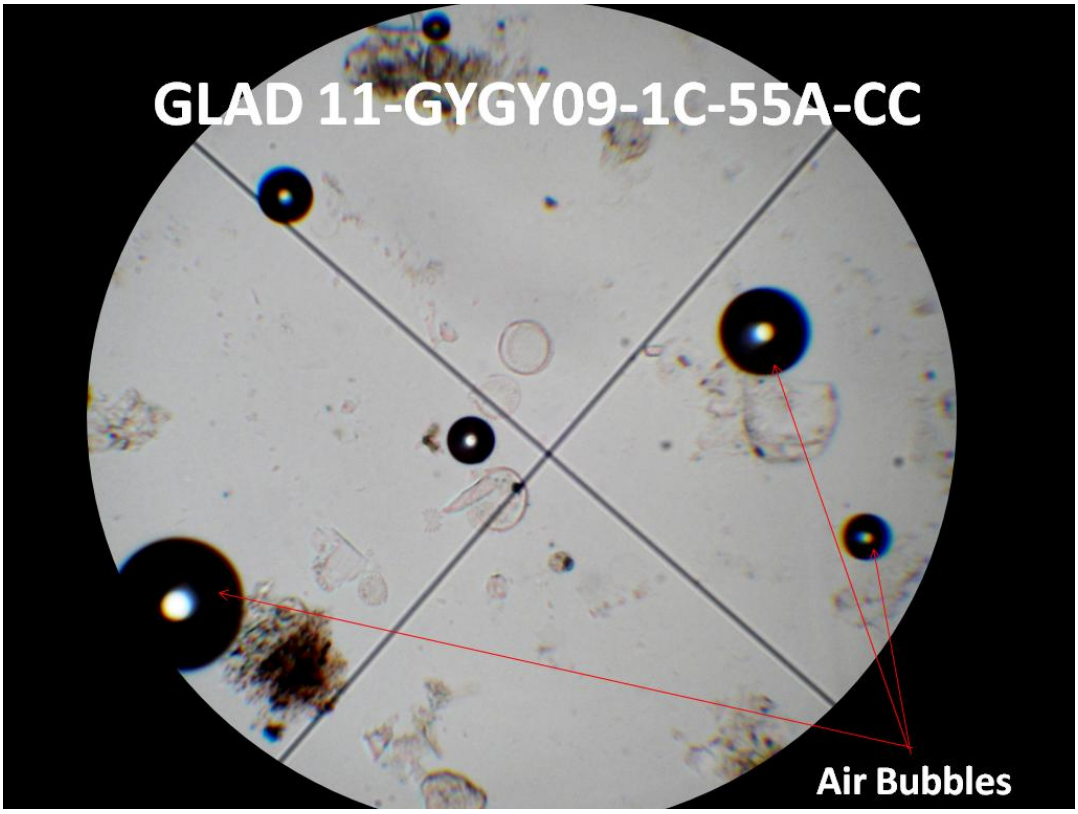
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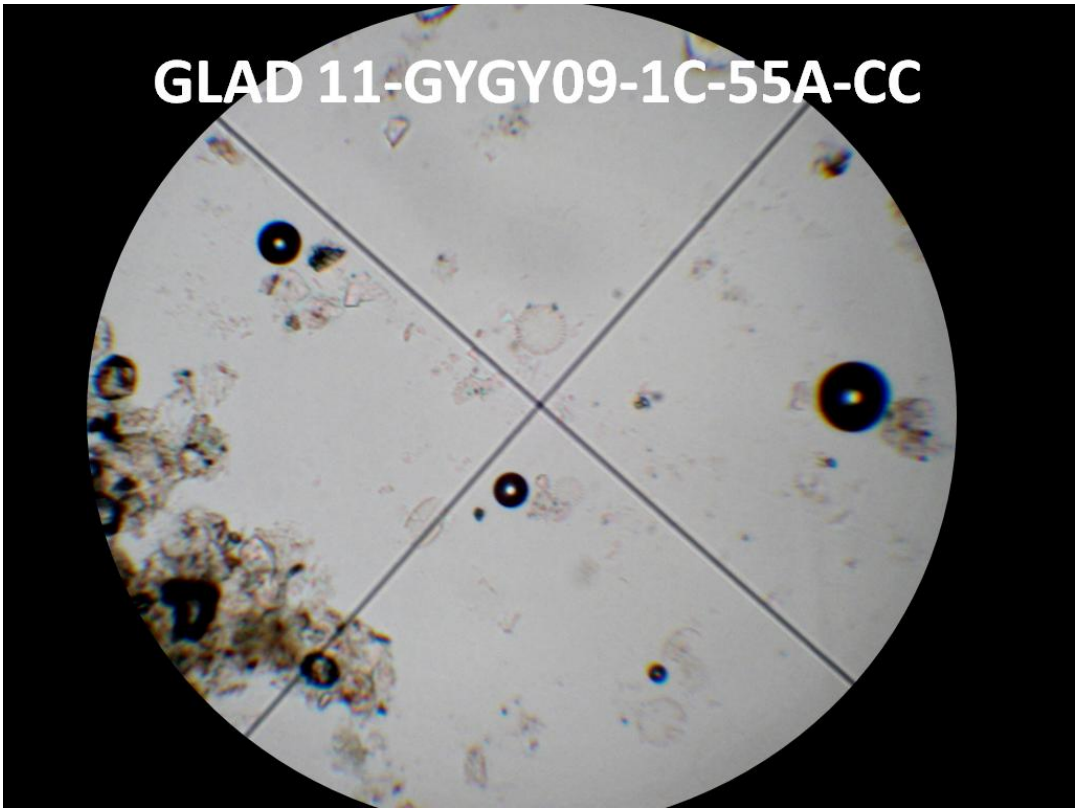
Air Bubbles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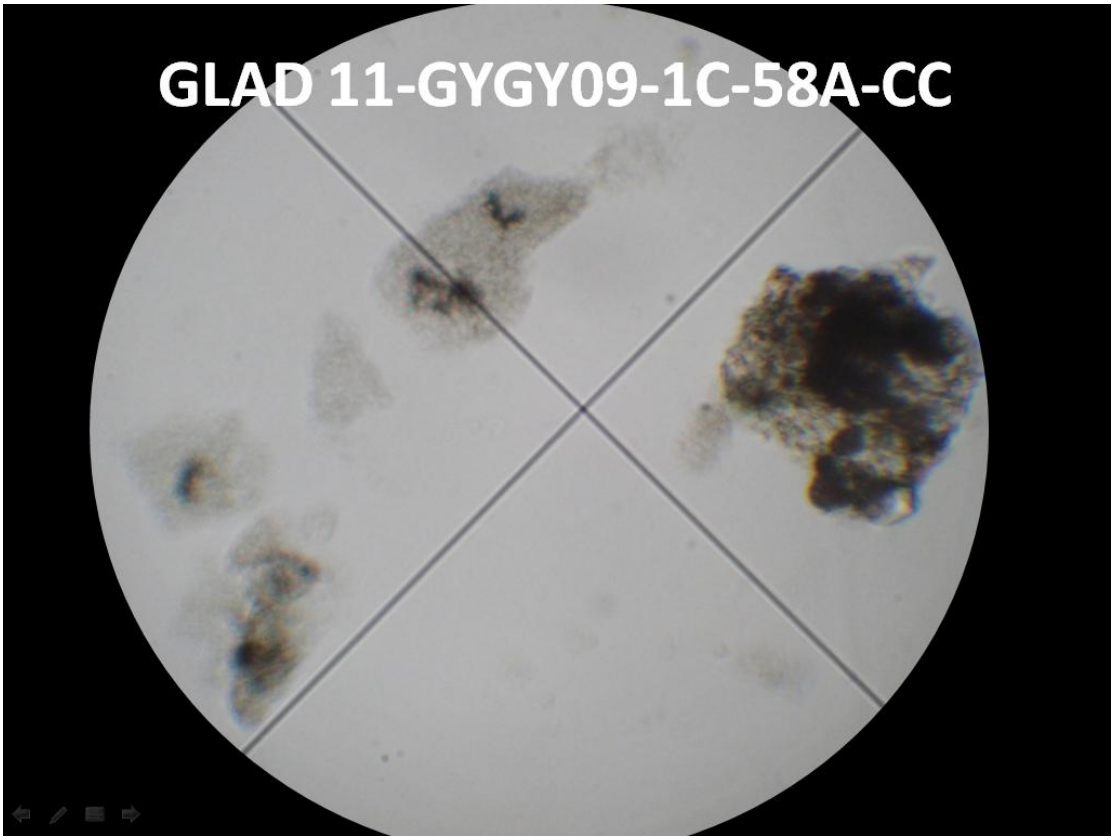
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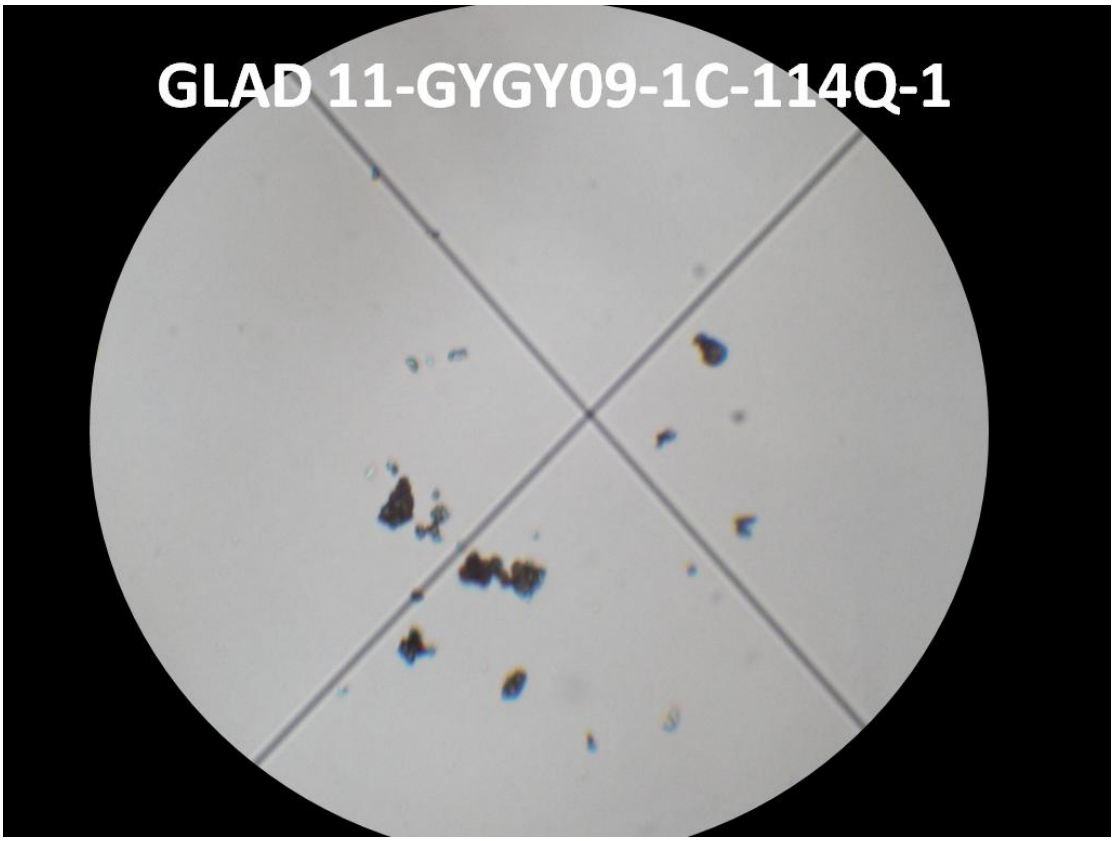
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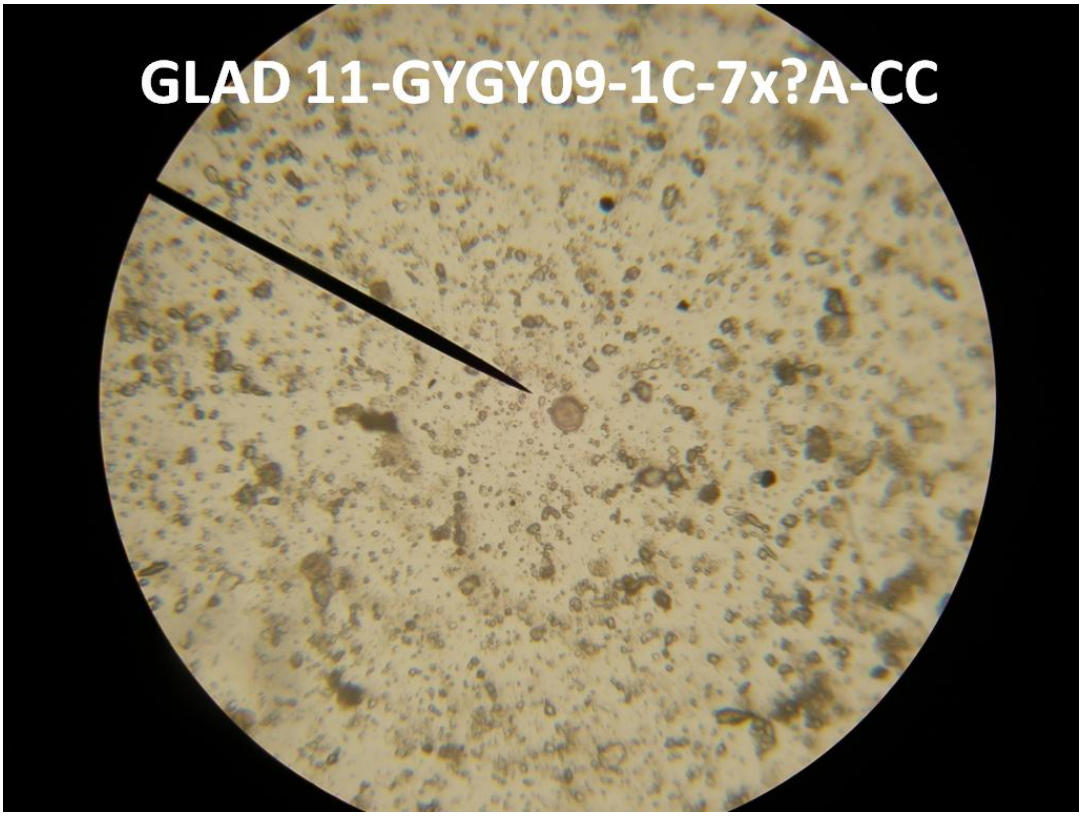
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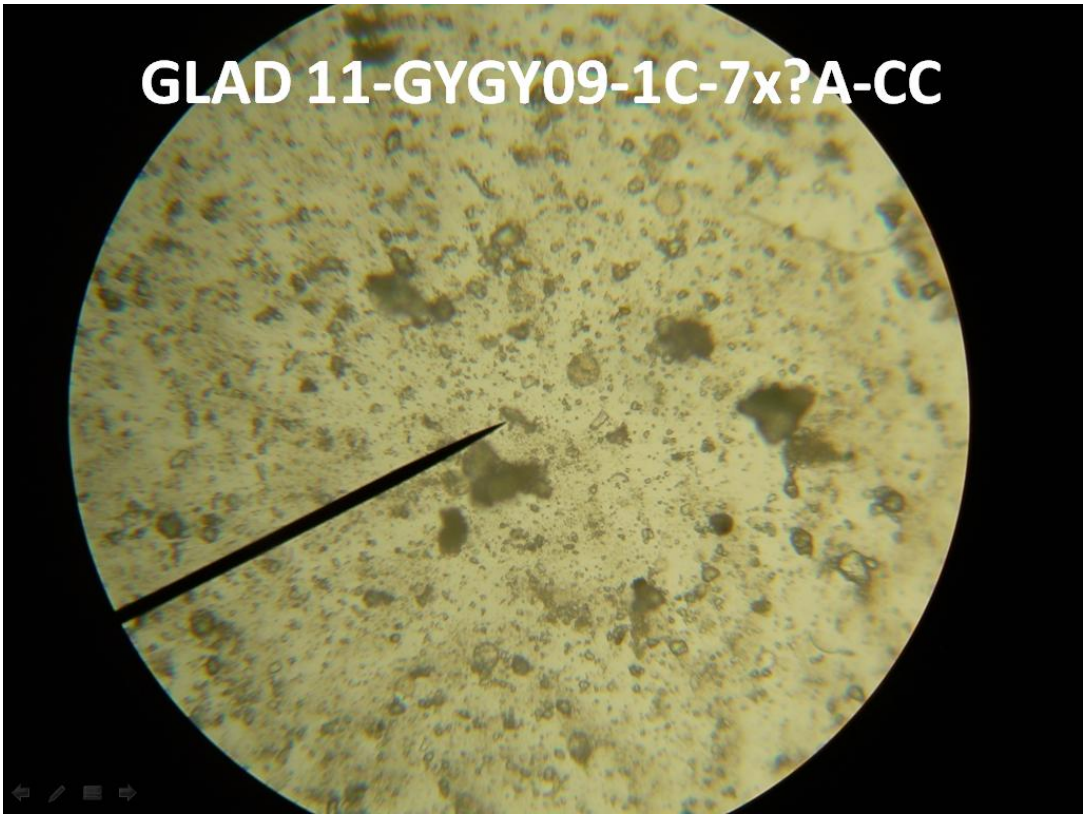
GLAD 11-GYGY09-1C-7x?A-CC

DIATOMS

Samples from 2009 deep drilling of Lake El'gygytgyn

El'gygytgyn Drilling Project

icdp

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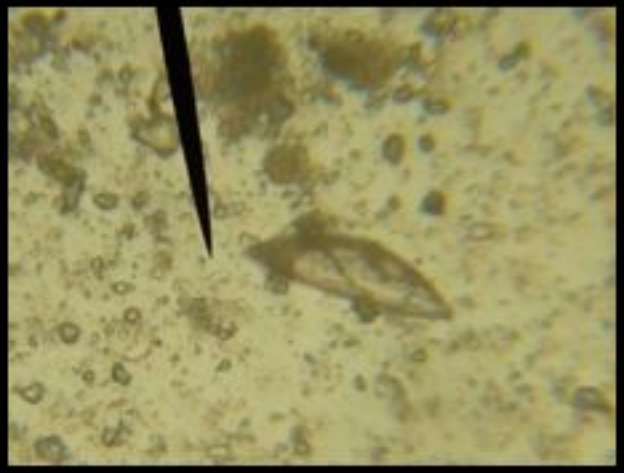
El'gygytgyn Drilling Project

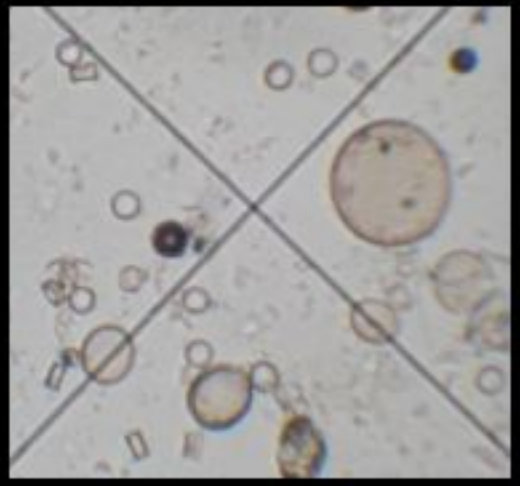
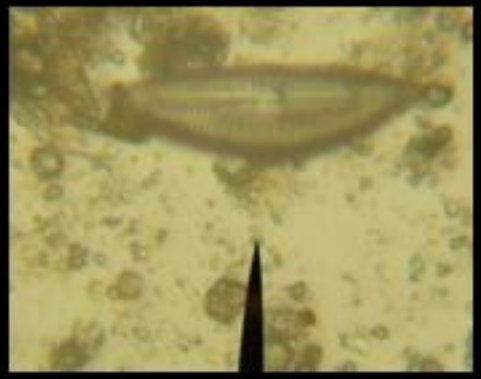
Julia Gotschalk, from Germany,
preparing sediment-smear slides

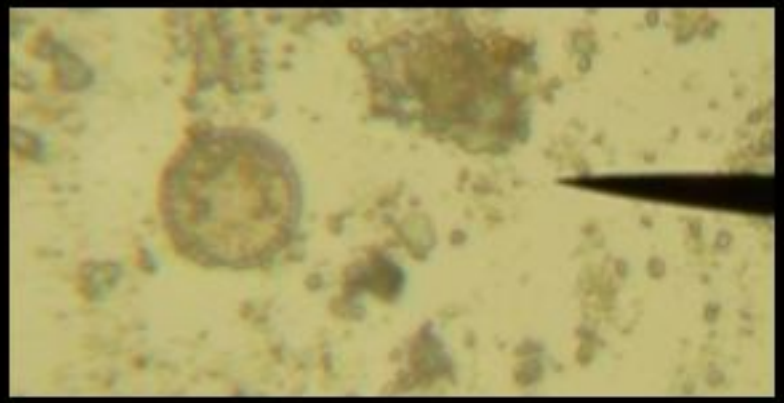

Köln
1C-58A-cc
GLAD11-GYGY09
0 cm


1C-114Q-1
GLAD11-GYGY09
0 cm

Example El'gygytgyn Fossil Diatoms



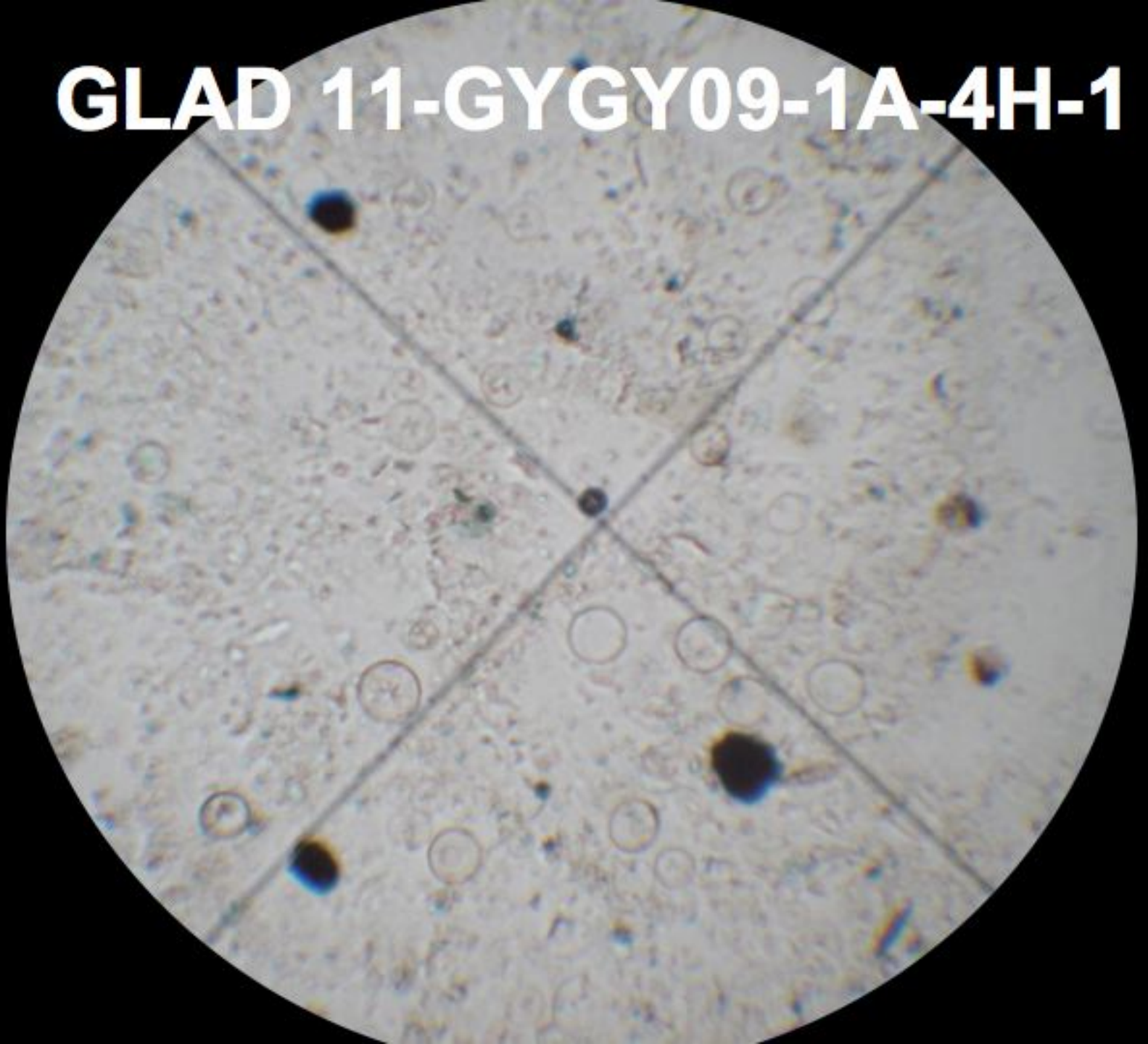


Sample Identification Code

- Every scientific sample from Lake El'gygytgyn had a unique code such as this:

GLAD 11-GYGY09-1A-4H-1

- GLAD 11 – This was the 11th **G**lobal **LA**ke **D**rilling
- GYGY09 – Short for El'gygytgyn 2009
- 1A – Bore hole number D1 was the primary drill site, D3 was the permafrost drill hole. 3 holes A, B, and C were all drilled at D1
- 4 – This was the 4th drilling "shot" in this hole
- H – Stands for the drilling tool used
  - H- hydraulic piston corer
  - A – alien corer
  - Q – HQ coring tool
- 1 – Stands for the segment of the drilling shot 1, 2, 3, or cc (core catcher)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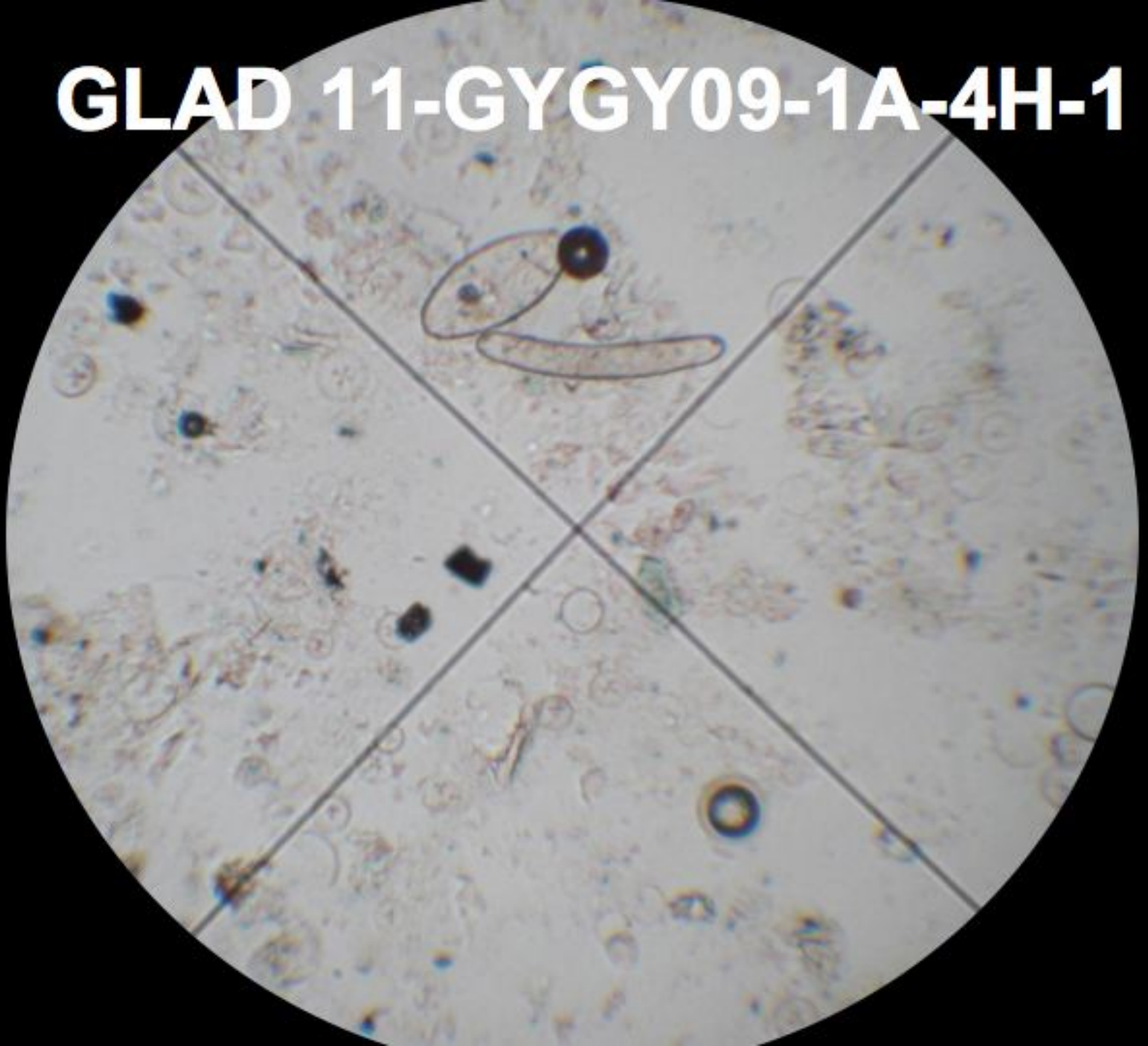

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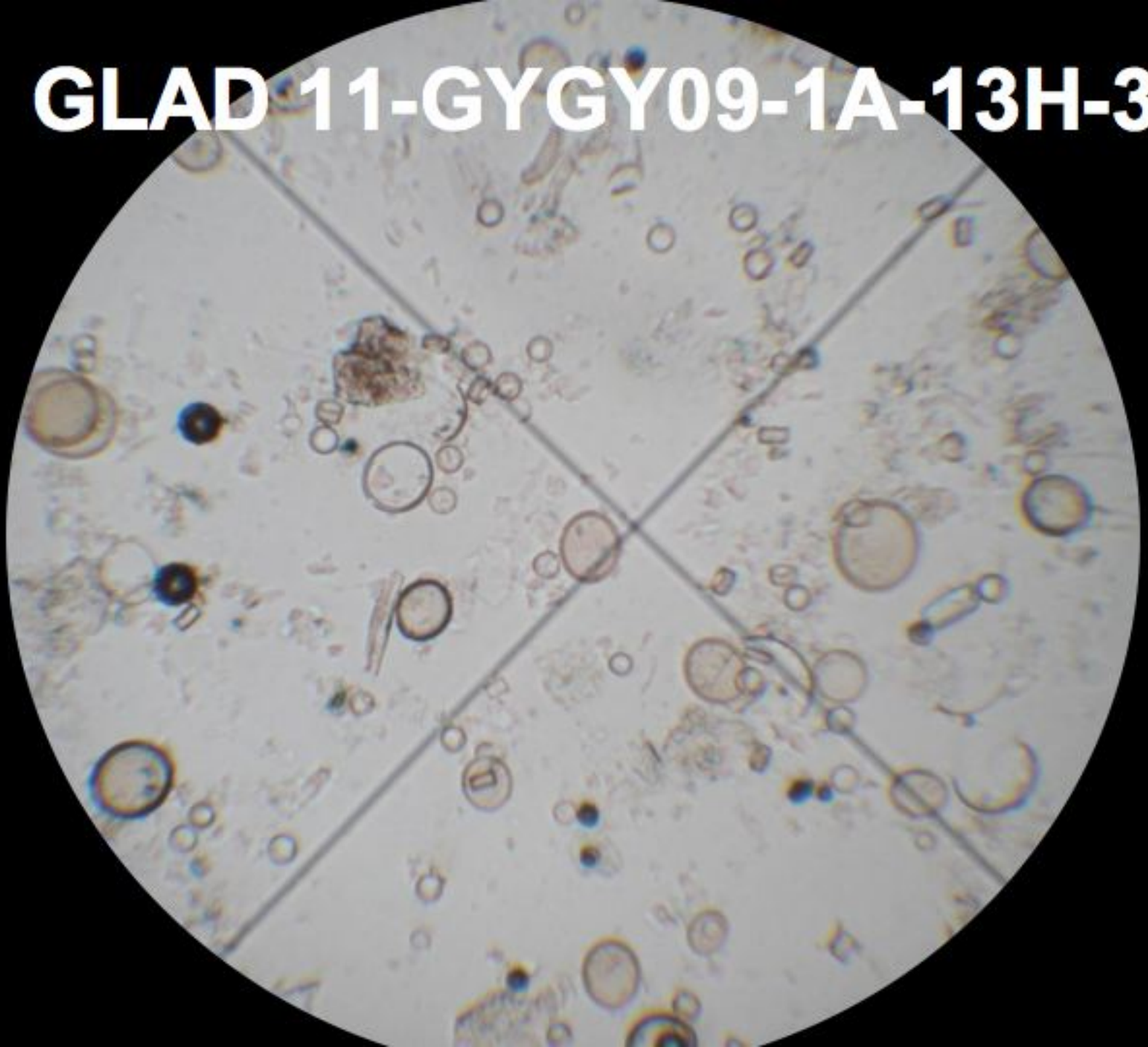

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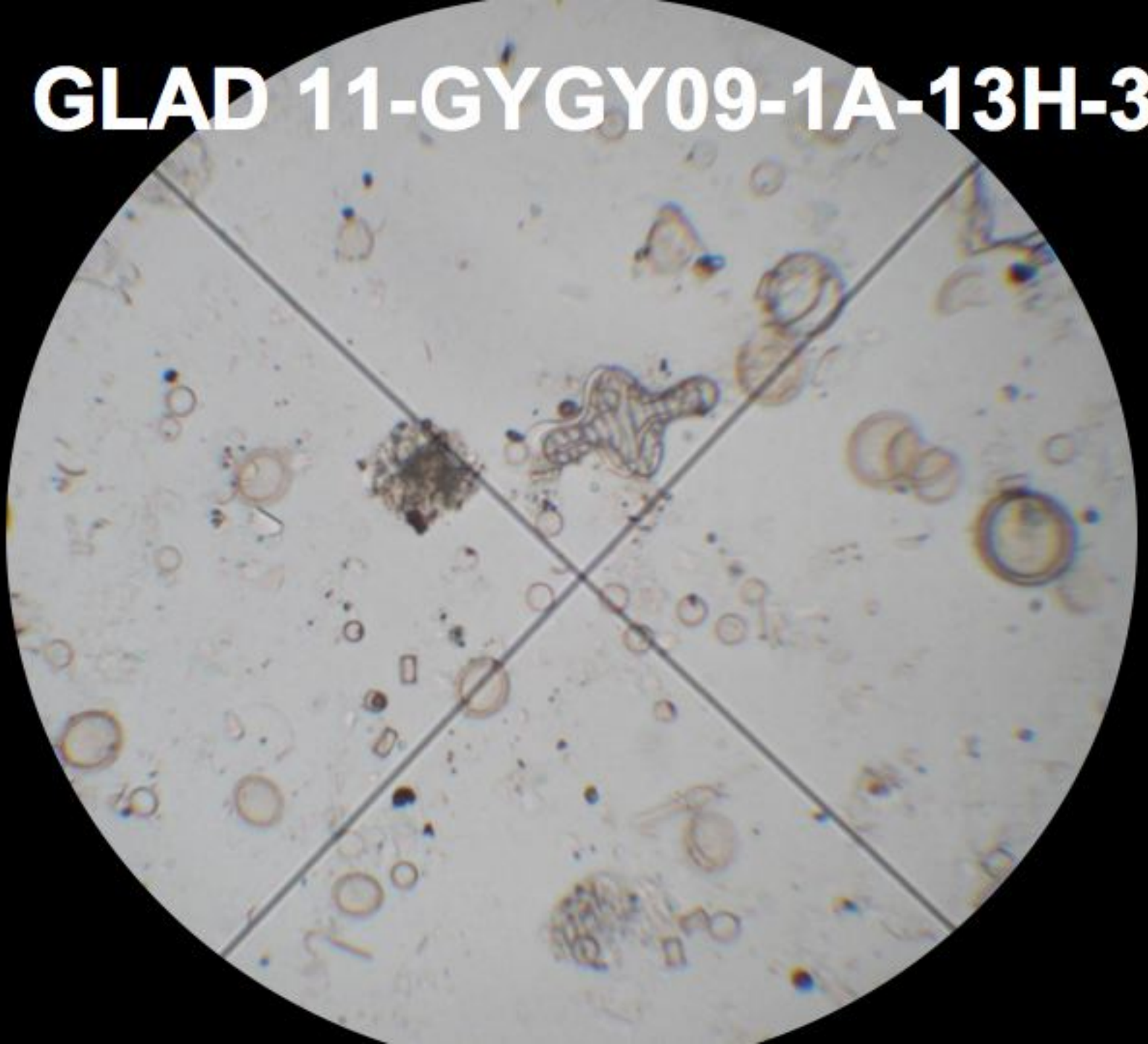

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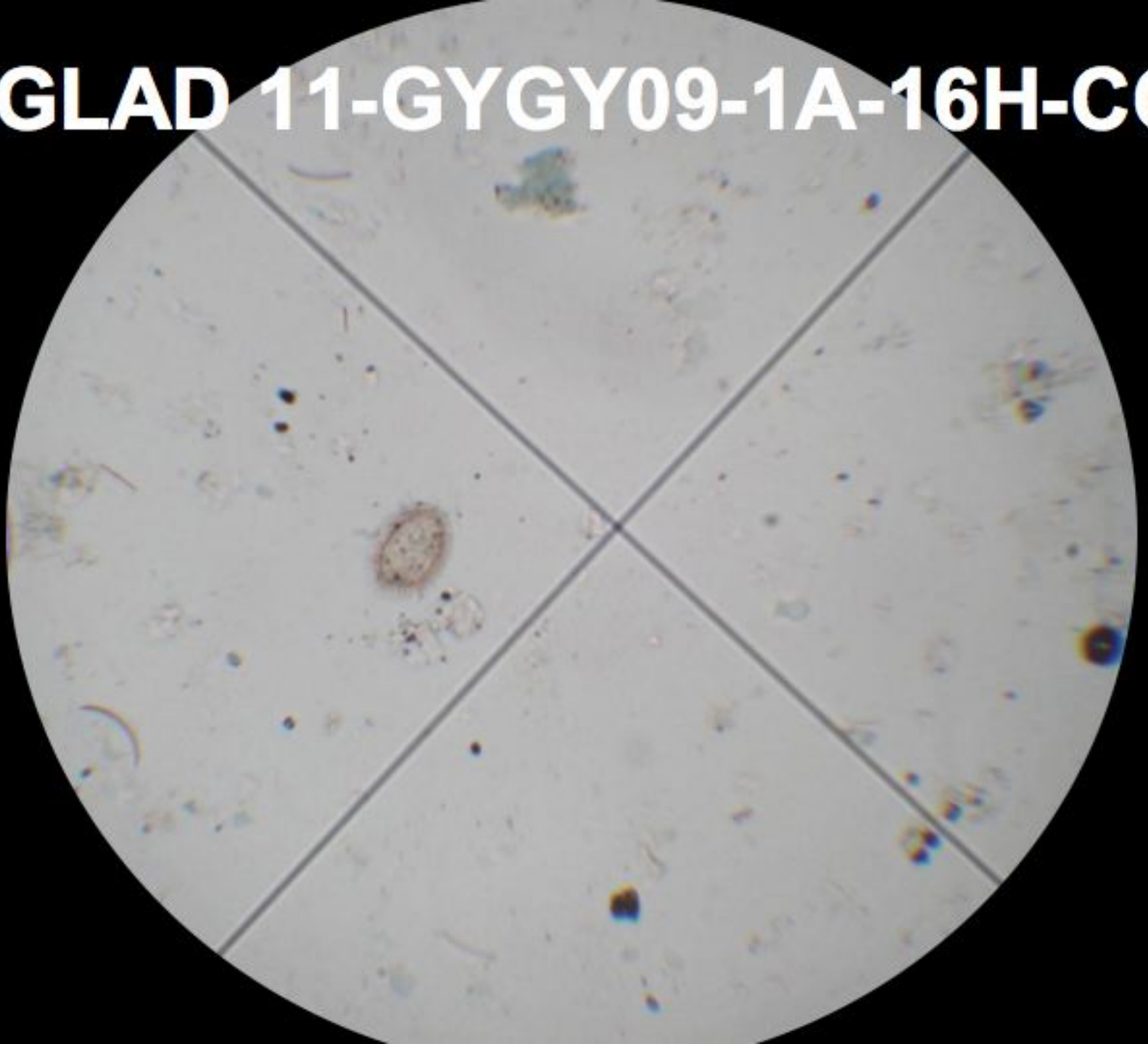

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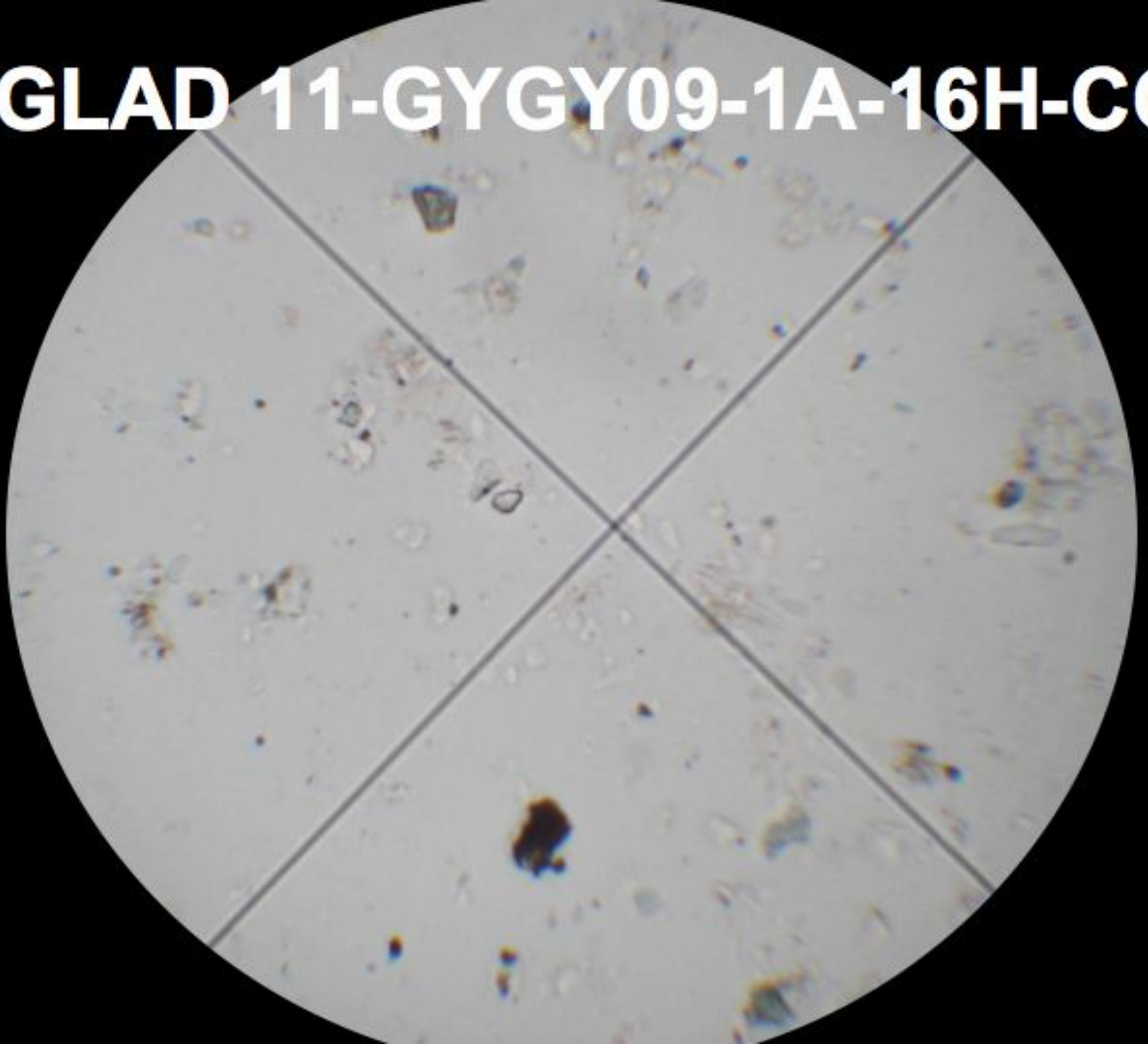

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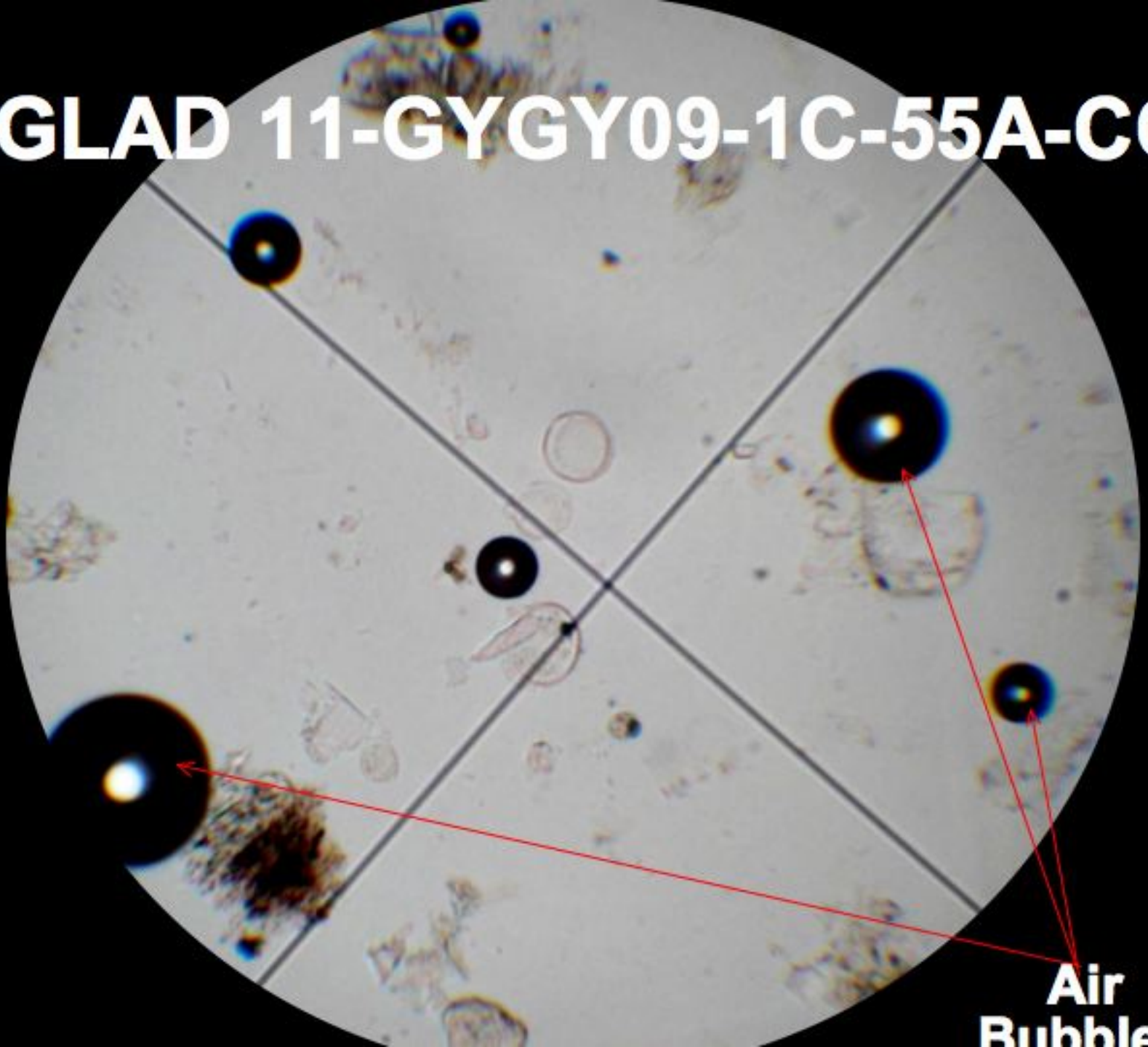

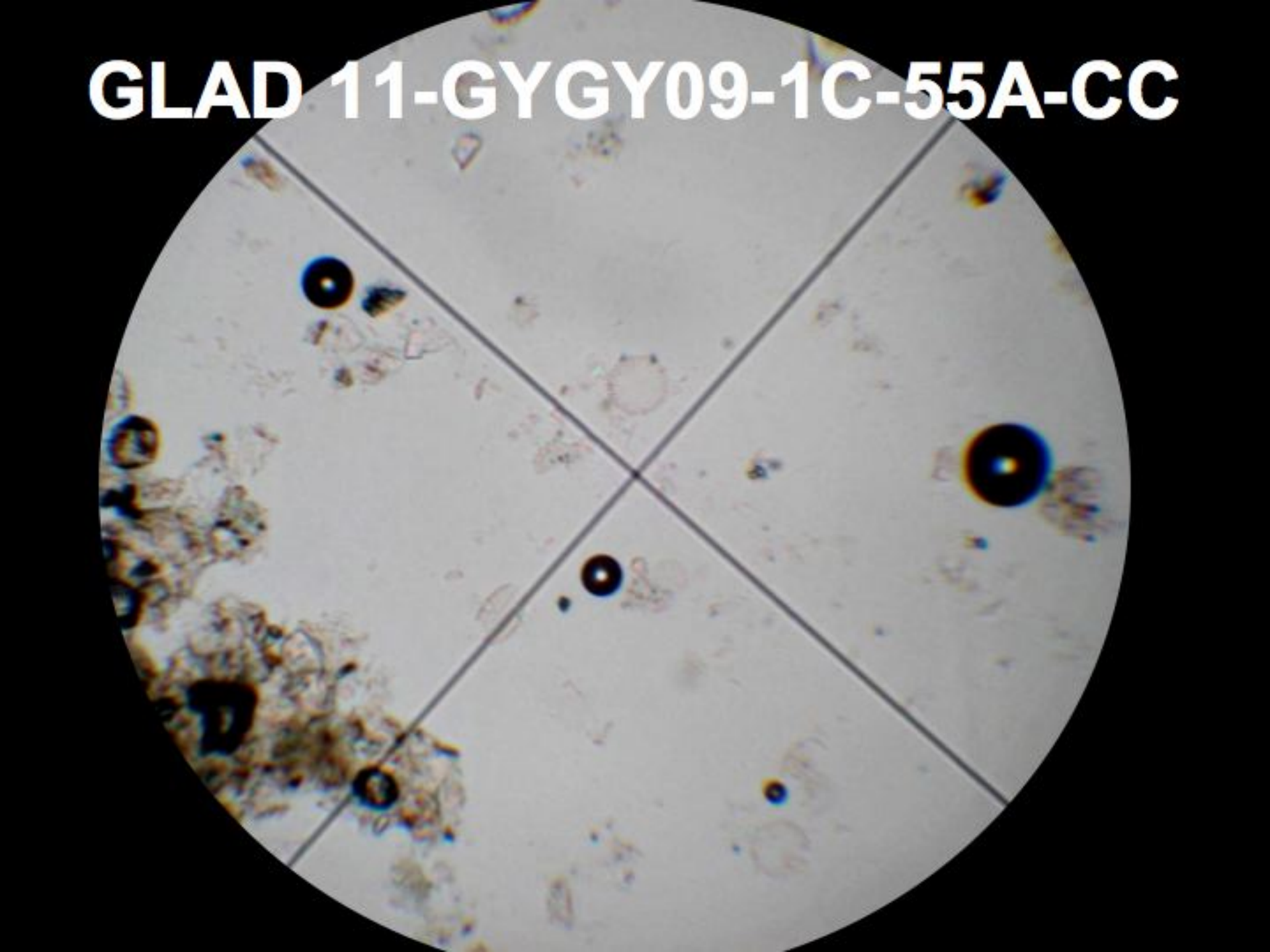
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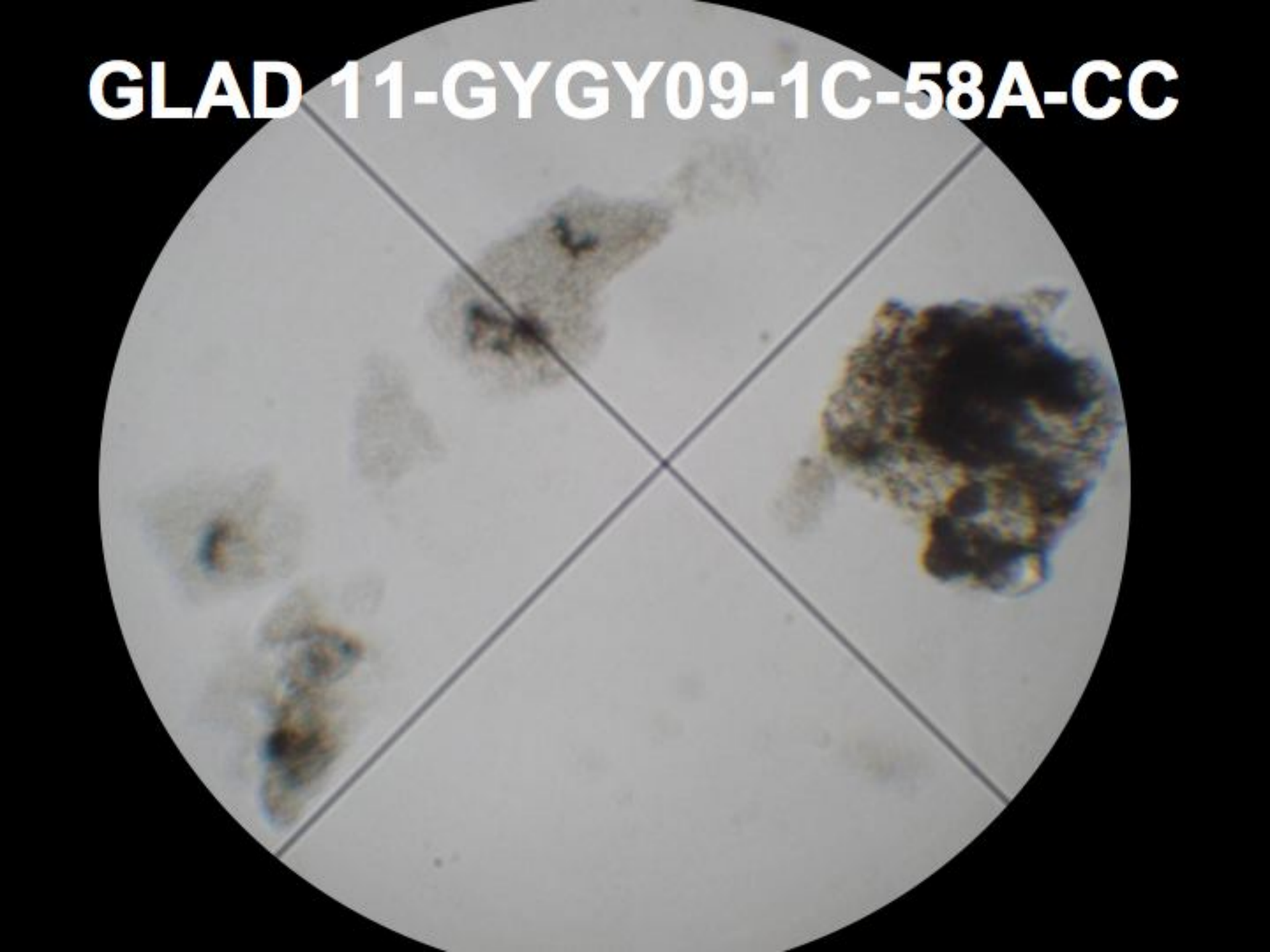
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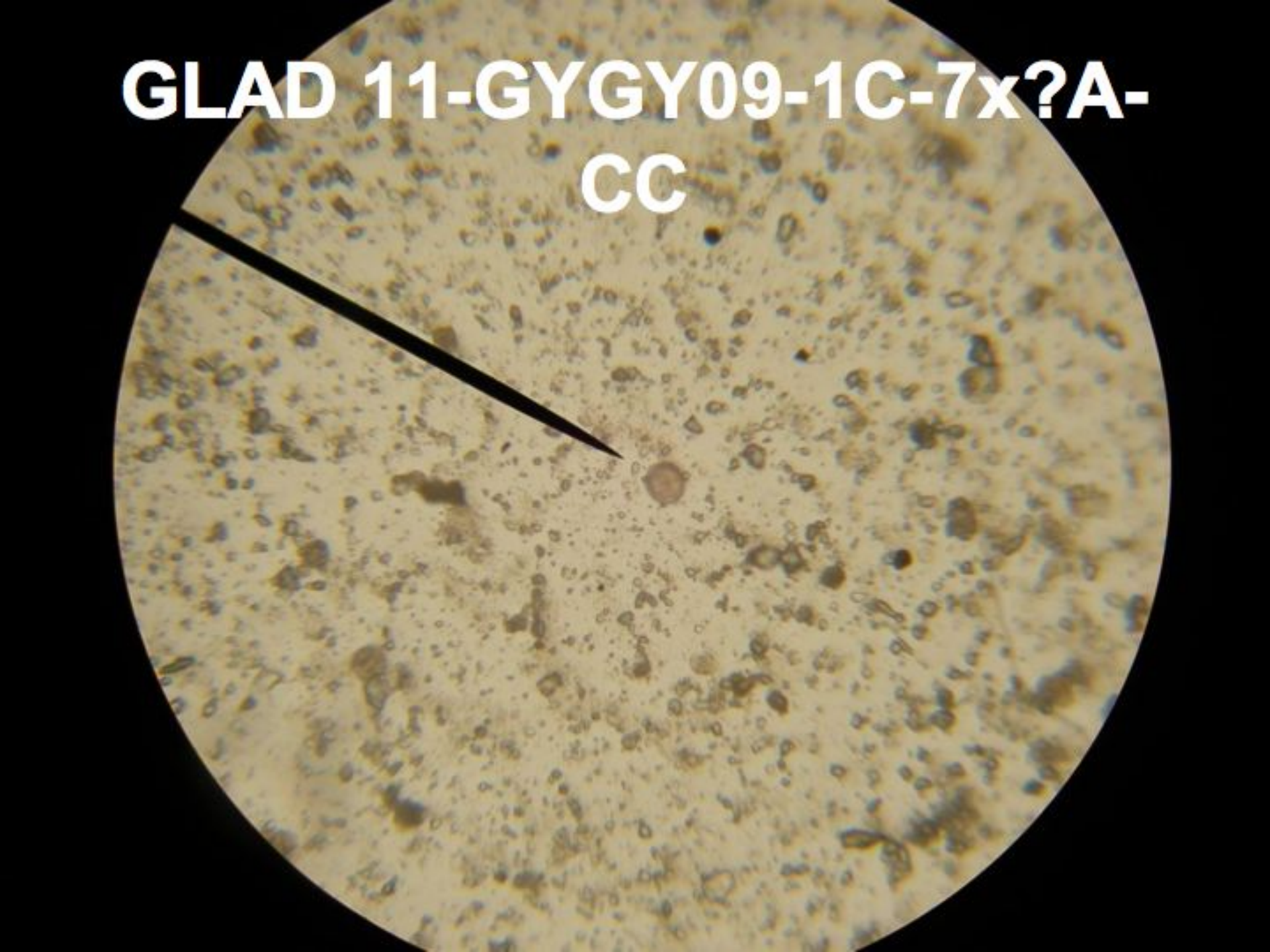
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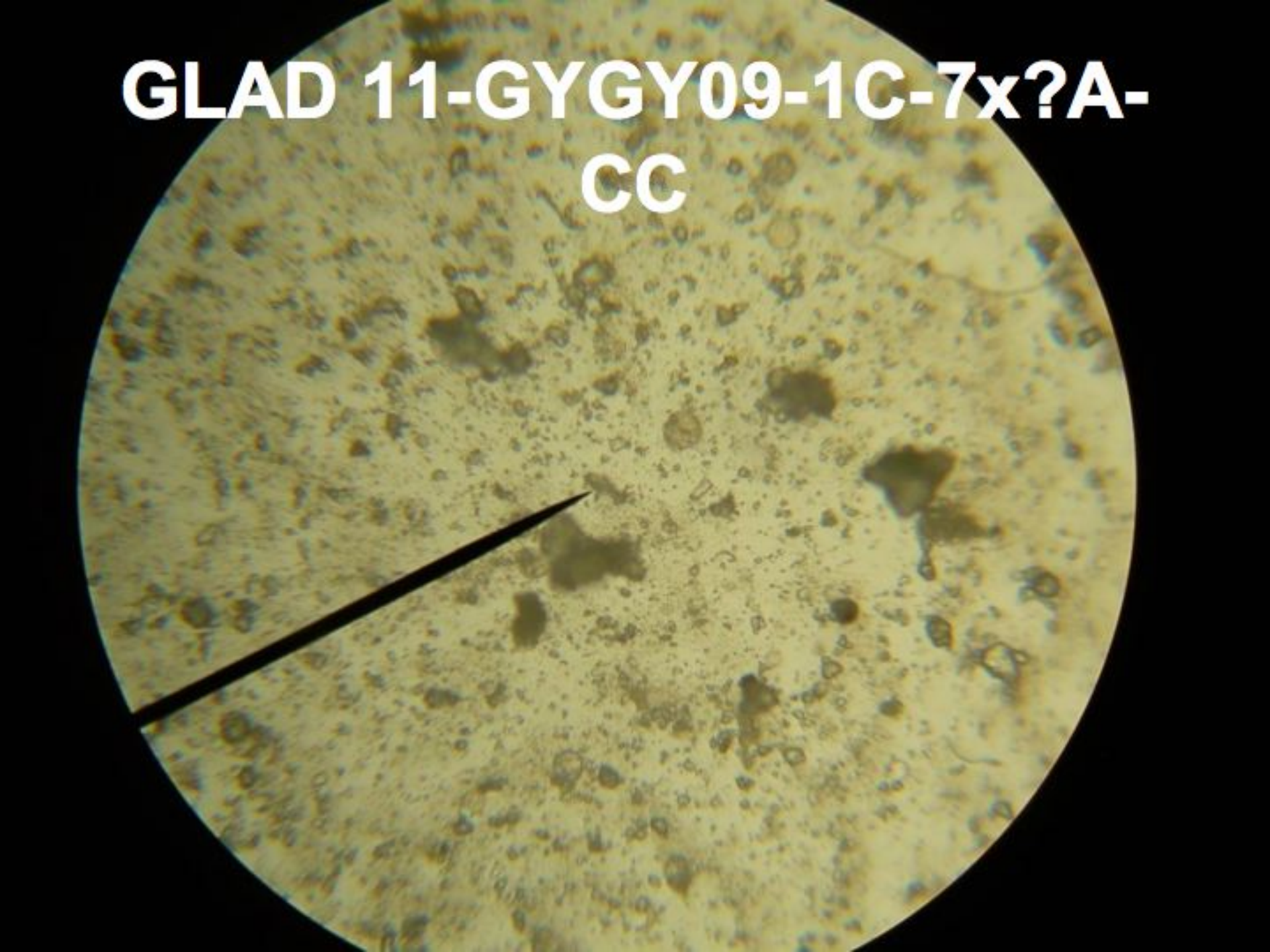
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GLAD 11-GYGY09-1C-114Q-1

Pollen

Understanding samples from 2009 deep drilling of Lake El'gygytgyn

Local application with North Carolina Pollen

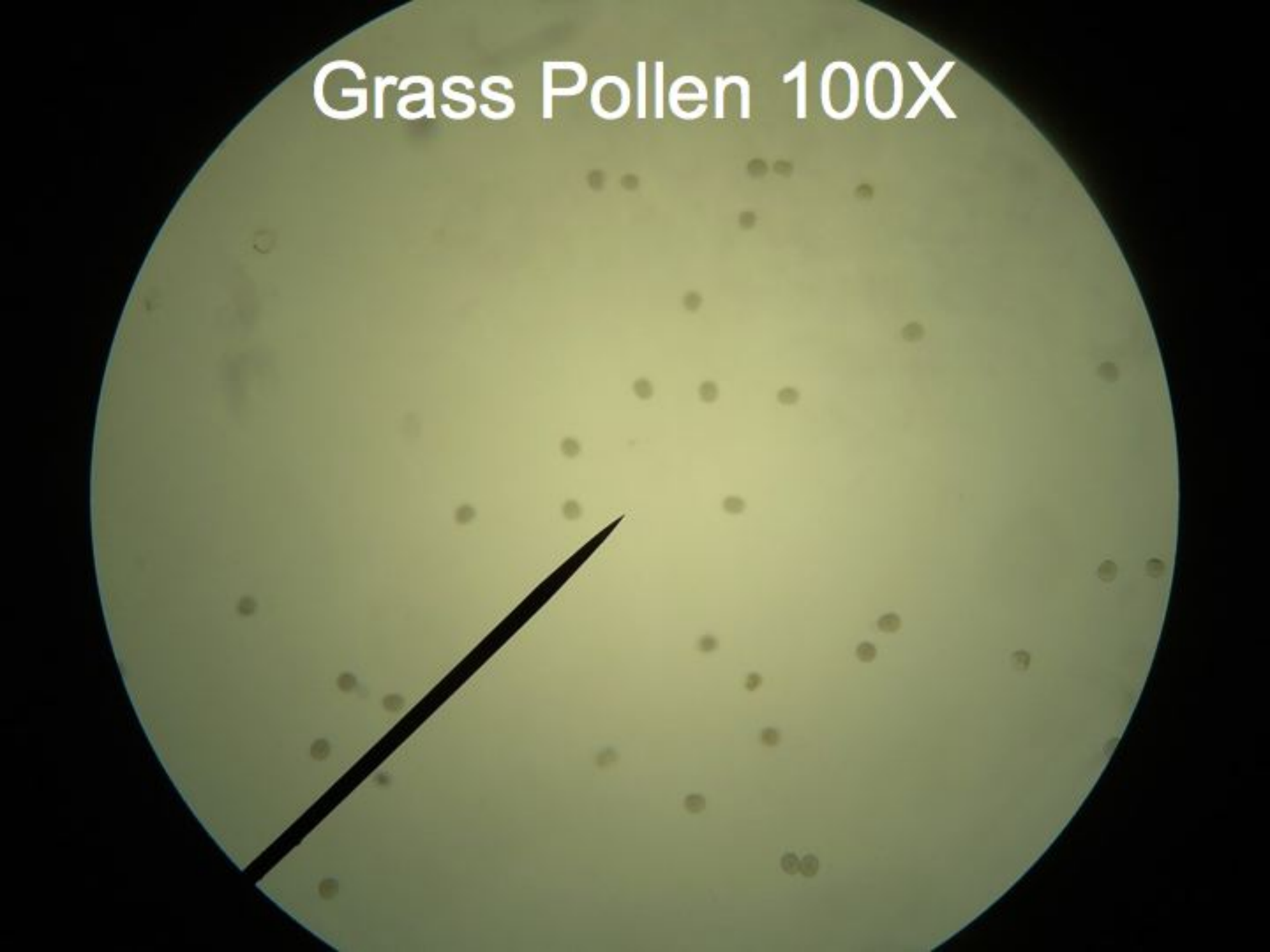
El'gygytgyn
Drilling Project

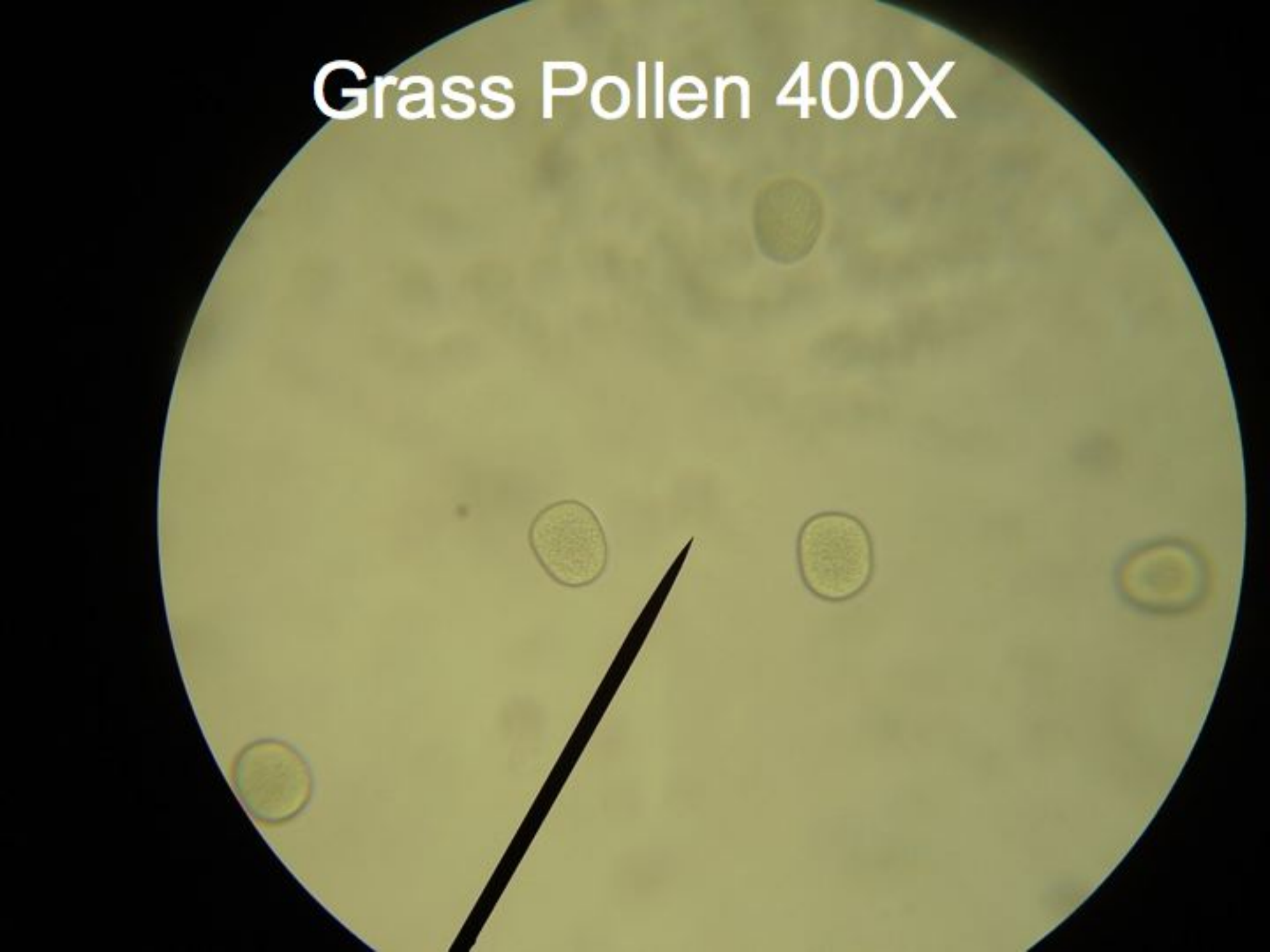
icdp

POLAR TREC


Grass Pollen


Grass Pollen


Grass Pollen 100X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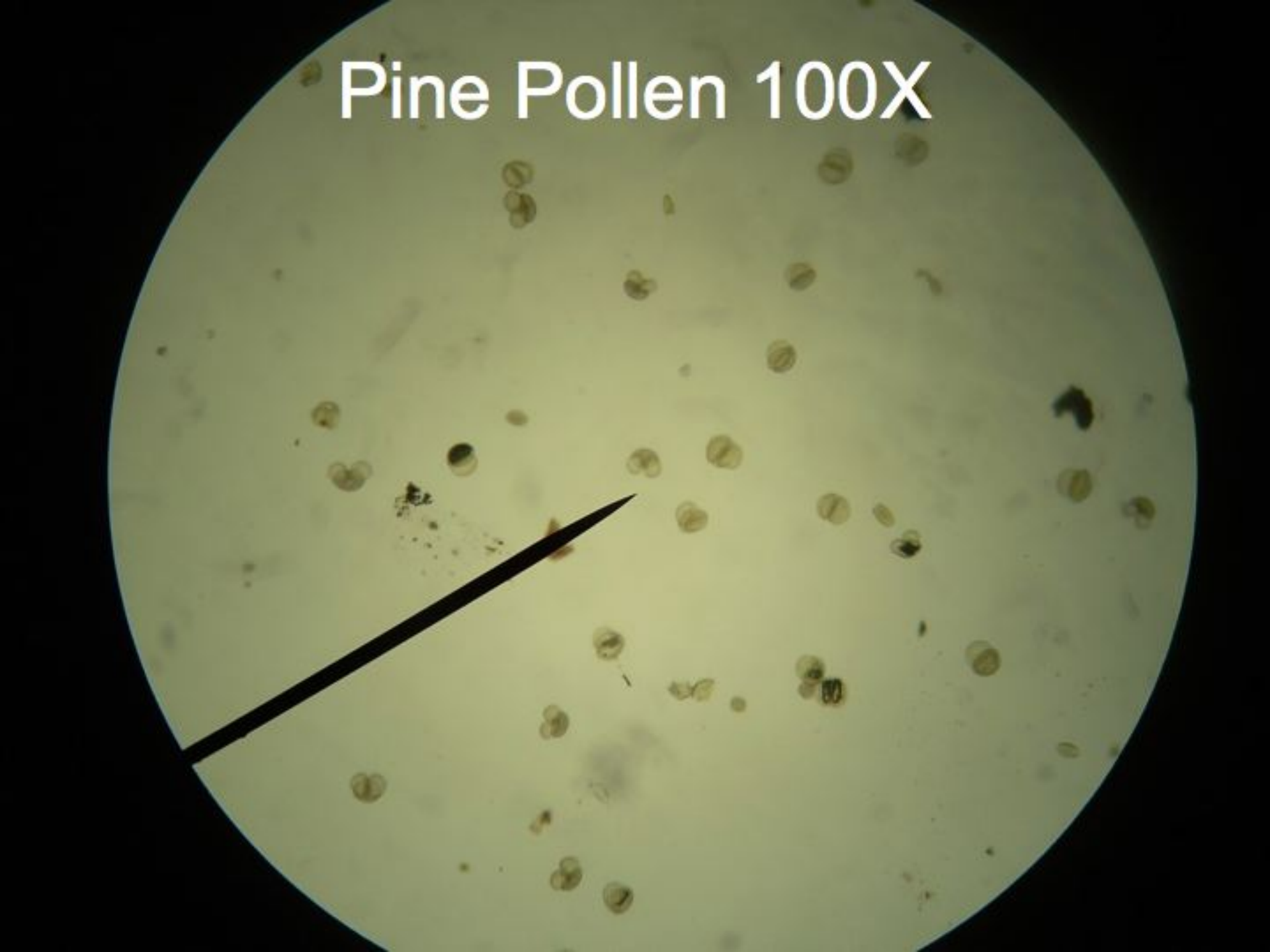
Pine Pollen

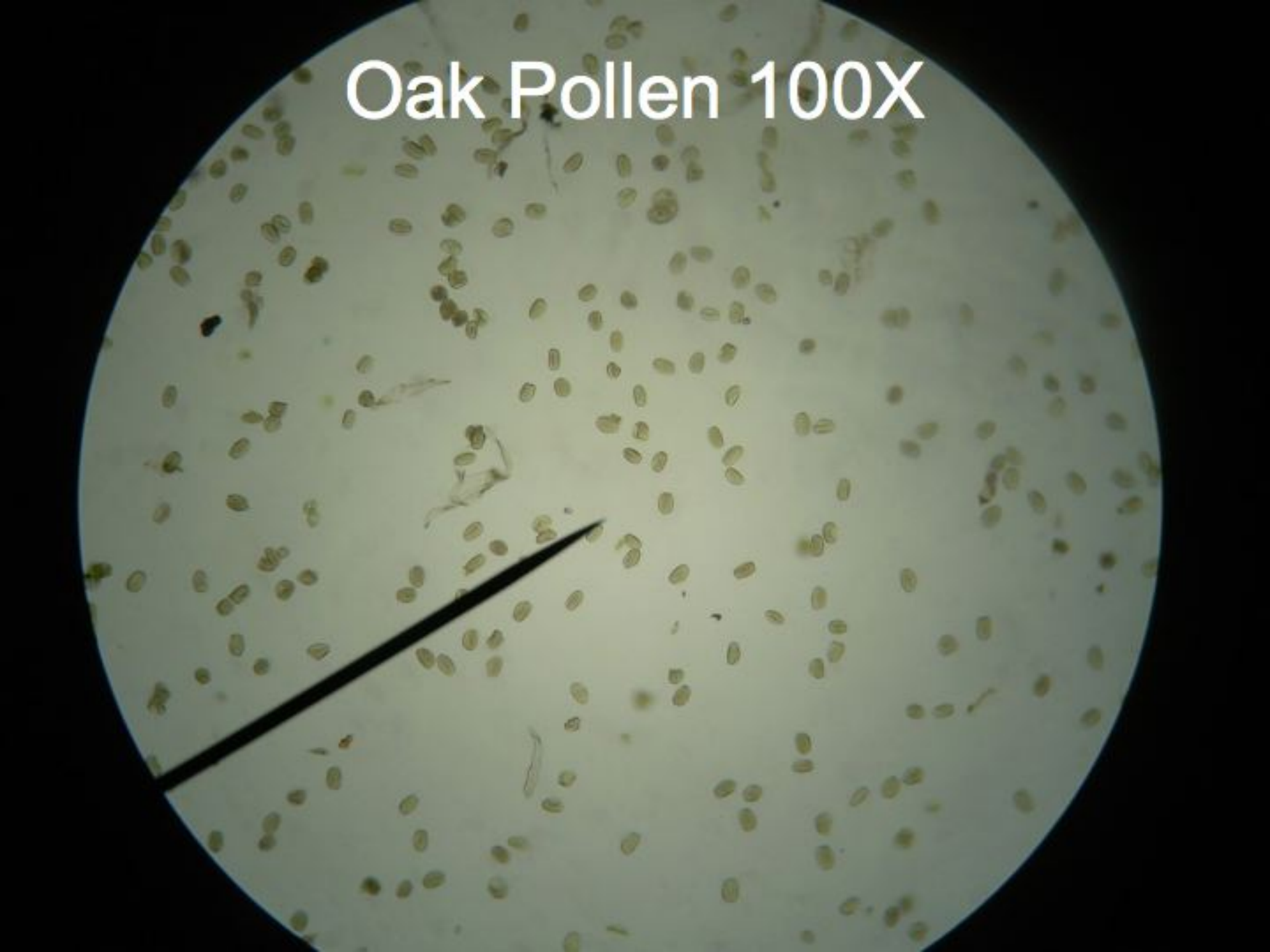

Pine Pollen


Pine Pollen 100X


Pine Pollen 400X


Oak Pollen


Oak Pollen


Oak Pollen 100X

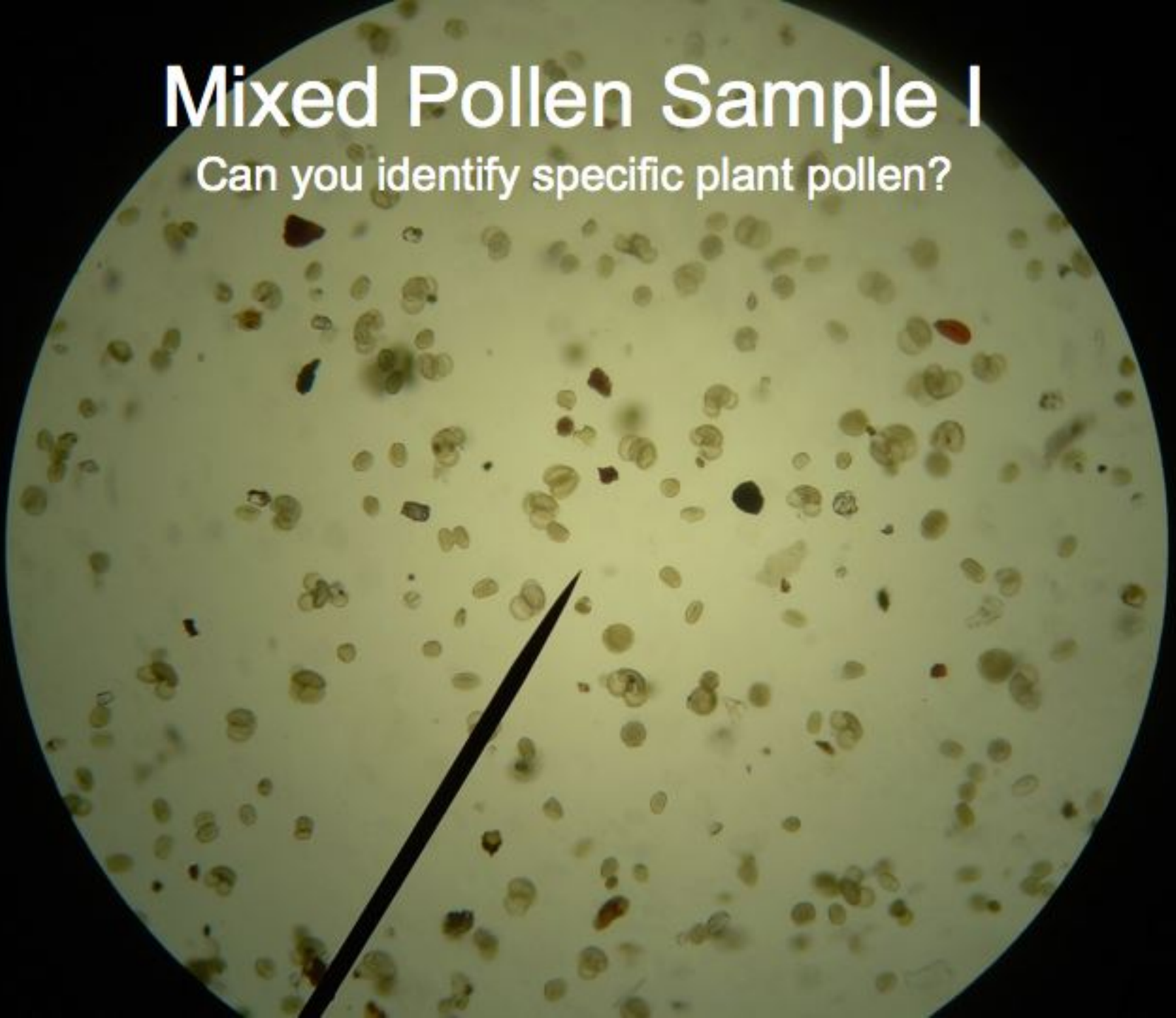

Oak Pollen 400X

Pollen on Lake


Pollen on Lake

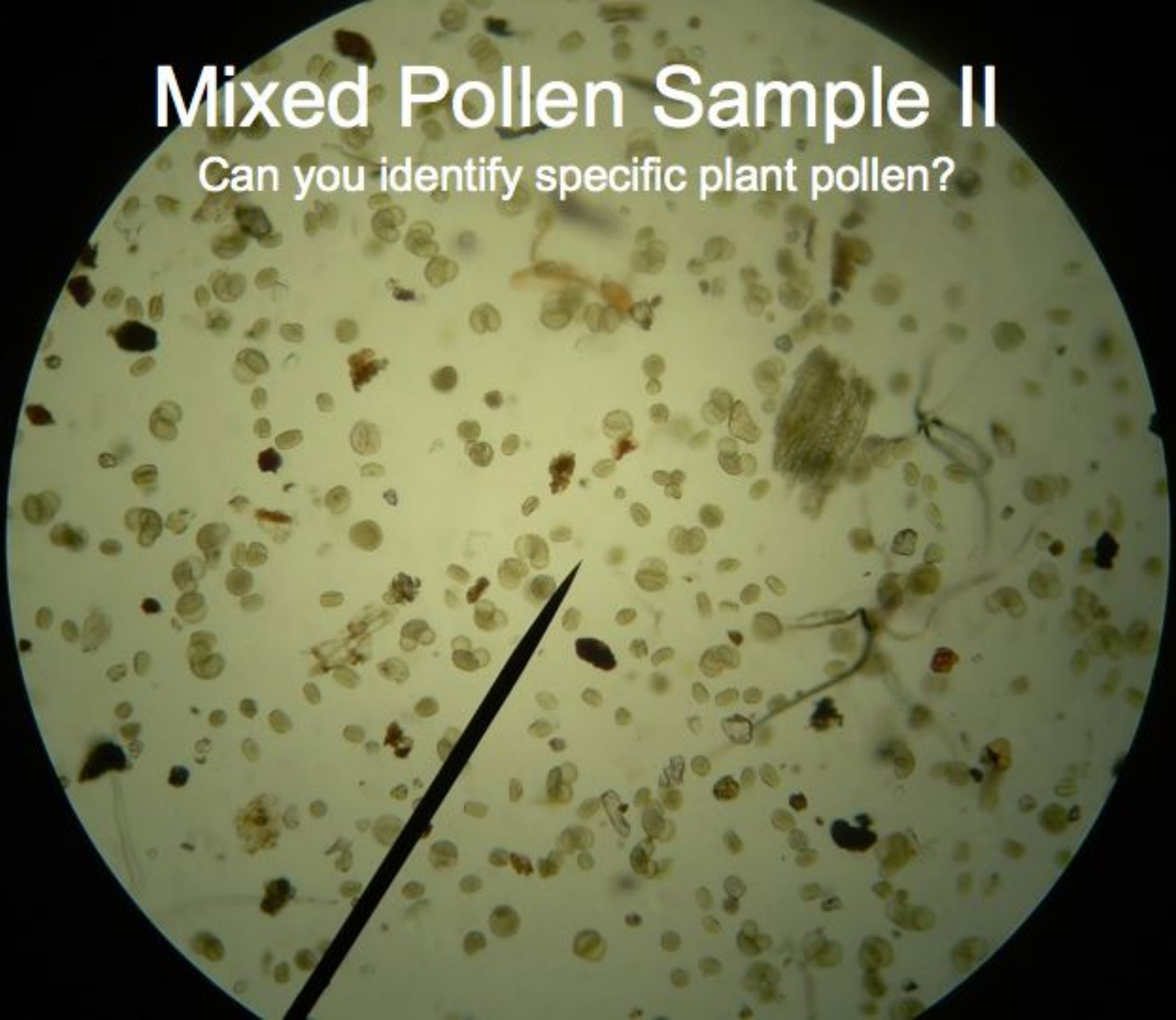
Mixed Pollen Sample I

Can you identify specific plant pollen?



Mixed Pollen Sample II

Can you identify specific plant pollen?



Mixed Pollen Sample III

Can you identify specific plant pollen?