Living Organisms Morphologically Consistent with Gunflint Chert Microfossils (ca. 1.9 Ga) Recovered in South End, Boston, Massachusetts.

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Abstract: Live environmental samples collected from the South End neighborhood of Boston, Massachusetts (Worcester Square, on the tidelands and marsh along the Roxbury Canal/Fort Point Channel), between January and June 2025, contain microbial forms displaying striking morphological correspondence to described taxa from the Gunflint Chert of Ontario, Canada (ca. 1878 ± 1.3 Ma).

Forms were identified in live wet-mount preparations that are consistent with *Kakabekia, Eosphaera, Huroniospora,* and *Eoastrion*. *Mariprofundus ferrooxydans* was also identified including in a development stage or morphological form that appears to overlap with *Eosphaera*. Proposed provisional species names for the Boston organisms are with *Kakabekia bostonensis, Eosphaera bostonensis, Huroniospora bostonensis, Eoastrion bostonensis*, *Mariprofundus bostonensis,* and *Echinosphaera bostonensis.*

Further investigation is required to understand why these two-billion-year-old organisms are present in the environment around South End, Boston, their taxonomic placement, and to understand further details of their morphology and physiology.

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Keywords: Gunflint Chert; Precambrian microfossils; *Kakabekia, Eosphaera, Huroniospora, Eoastrion*; Boston Basin; South End Boston; Fort Point Channel; Roxbury Canal; Boston Harbor; *Mariprofundus ferrooxydans*; iron-oxidizing bacteria; Zetaproteobacteria; Proterozoic paleobiology; microfossils.

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Introduction

The Gunflint Chert of Ontario, Canada (ca. 1878 ± 1.3 Ma) is among the oldest known fossiliferous deposits in the geological record (Barghoorn & Tyler, 1965; Fralick et al., 2002). The Gunflint Chert is a silicified sedimentary formation exposed along the northern shore of Lake Superior, Ontario (Fralick et al., 2002). Similar fossils have been found in a few other locations (Australia, Canada, China, South Africa) but all locations have been "thermally altered at least into the stage of oil window." (Javaux, 2018).

Fossils within the chert include morphologically elaborate organisms relevant to the period and that appear in the fossil record without documented precursors, persist in a geographically confined area, and disappear almost entirely from subsequent strata without confirmed descendants (Barghoorn & Tyler, 1965; Knoll, 2003).

The dominant components of this biota are segmented filaments and enclosing tubular sheaths (*Gunflintia* spp.) plus rounded, coccoid vesicles (*Huroniospora* spp.). (Wacey, 2013). Other principal taxa include *Eosphaera* (concentric double-walled spheroids), *Kakabekia* (stalked, umbrella-shaped forms), *Animikiea* (broader hollow filaments), and *Eoastrion* (star-rosette forms). (Tyler and Barghoorn, 1954, 1965).

The biological samples studied in this paper were collected in the South End of Boston, Massachusetts, on the tidelands of the South Bay and Roxbury Canal. This paper reports the recovery of live organisms from these Boston-environmental samples which display close morphological correspondence to multiple Gunflint taxa.

Materials and Methods

Environmental samples were collected from a residential building at Worcester Square, in the South End of Boston, approximately 365 meters from the Roxbury Canal alignment and within the tidal dispersal zone of the Fort Point Channel.

The sampling environment was an 1864-era Victorian rowhouse basement, with water and vapor intrusion, combined sewer connection to the Roxbury Canal drainage system, and strong tidal influence on subsurface hydrology.

Live environmental samples were collected from Worcester Square, South End, Boston, Massachusetts, between January and June 2025. Samples were prepared as wet mounts using glass slides and coverslips (McKesson; Karter Scientific; AmScope) and examined under two light microscopy systems: an AmScope B120 Series LED Binocular Compound Microscope (40×–2500× magnification, 3MP digital camera, 3D stage) and a Takmly Digital LED Microscope (50×–1000×, 2MP, 178° wide angle, 8-LED illumination).

Morphological features including size, wall architecture, internal organization, surface texture, and external projections were documented photographically using the integrated digital camera. Dimensional measurements were recorded in micrometers using on-screen calibrated measurement tools, calibrated against a 0.01mm stage micrometer reticle (cross-pattern calibration ruler) prior to each measurement session.

Gunflint-like Morphological Observations

Sustained live observation sessions were conducted across the sampling period to capture dynamic biological processes including active motility, internal reorganization, and apparent assembly behavior. Morphological comparisons were made against published descriptions, photomicrographs, and three-dimensional reconstructions of Gunflint Chert taxa from Barghoorn and Tyler (1965) and subsequent literature including Knoll (2003) and Schopf (1999).

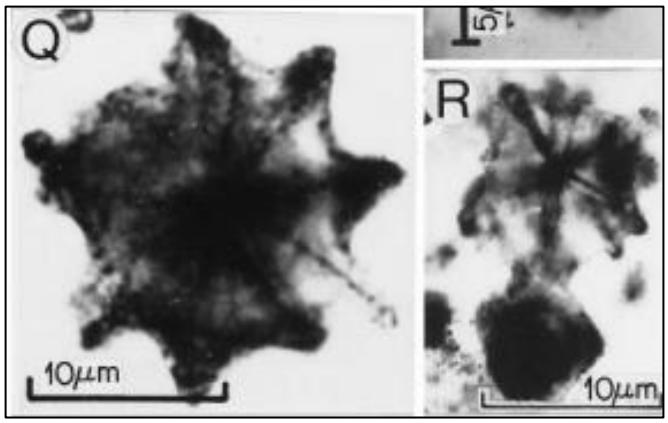
Kakabekia-like Forms

Kakabekia umbellata is a "rare" microfossil that presents tripartite morphology with an umbrella canopy, stalk, and basal bulb (Javaux, 2018).

Barghoorn described it as "consisting of a spheroidal bulb, slender stipe, and crown or mantle of umbrella-like shape." The stipe ranges from 12-30 um and the umbrella has a diameter of around 5-30 um. (Barghoorn & Tyler, 1965).

This Gunflint chert fossil lacks phylogenetic affinities

and documented descendants (it was "difficult to assign an affinity of *Kakabekia umbellata* to a living counterpart") (Barghoorn & Tyler, 1965).

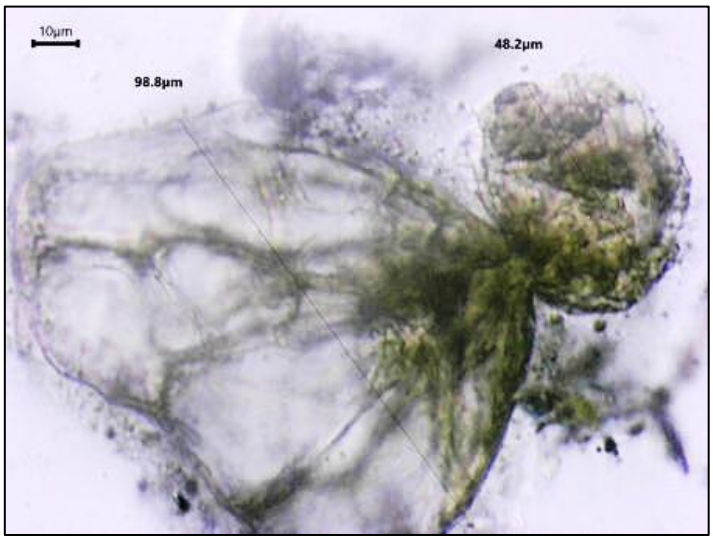


Kakabekia, Gunflint chert (Schopf, 2000).

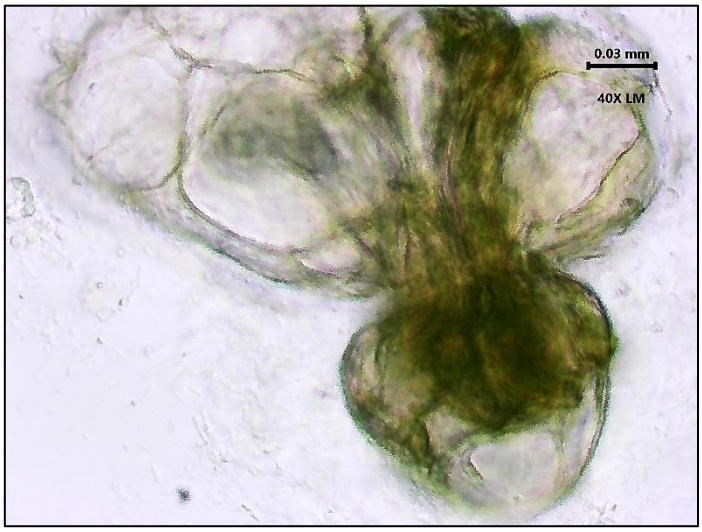
However, a proposed living member of the genus, *Kakabekia barghoorniana,* was isolated from soil samples at Harlech Castle, Wales in 1964 (Siegel & Siegel, 1968), and subsequently additional samples from high-elevation soils in Alaska near Point Barrow and Mendenhall Glacier near Junea. This new species had a smaller 5 µm umbellate, 6- to 8- parted, margins umbellate or circular, single or double rings, and often a mantle without stipes. The umbellate form is thought to be a mature development stage (Siegel & Siegel, 1970).

Examination found the 1964 *Kakabekia barghoorniana* to be obligately dependent on ammonia as its sole nitrogen source, oxygen indifferent with few heme enzymes, has no ability to store lipid or polysaccharide, and is found globally only at elevations of 1,000–2,000 meters where competition from the oxygenated terrestrial biosphere is reduced. It's thought to be a prokaryote due to lack of nuclear body form (Siegel & Siegel, 1970).

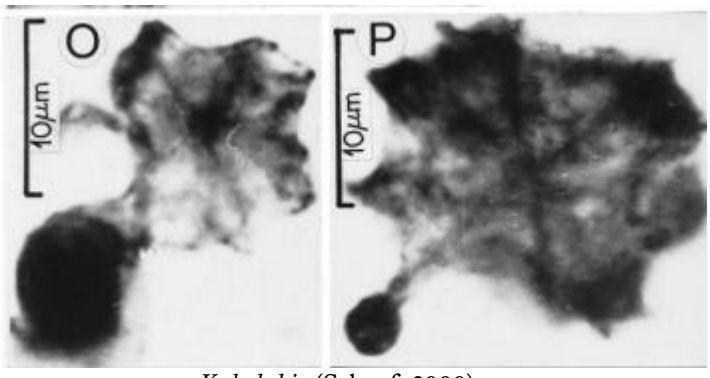
In the Boston samples, multiple specimens resembling *Kakabekia umbellata* were observed and two are featured here. Both Boston samples feature a spheroidal bulb, narrowed but thick stipe, and the stipe transitions to webbed mantle shaped like a reversed cup or round skirt. The first Boston sample (April 19 2025) measures around 99 µm width wise across the mantle and 48.2 µm across the width of the bulb. The second sample (March 10 2025) is photographed at 40X with the bar equaling 30 µm. The width of the stipe appears to be around 65 µm and the width of the bulb around 120 µm. This is much larger then the measurements for *Kakabekia umbellata* and especially *Kakabekia barghoorniana*.



Kakabekia bostonensis, South End, Boston (April 19 2025)



Kakabekia bostonensis, South End, Boston (March 10 2025)



Kakabekia (Schopf, 2000).

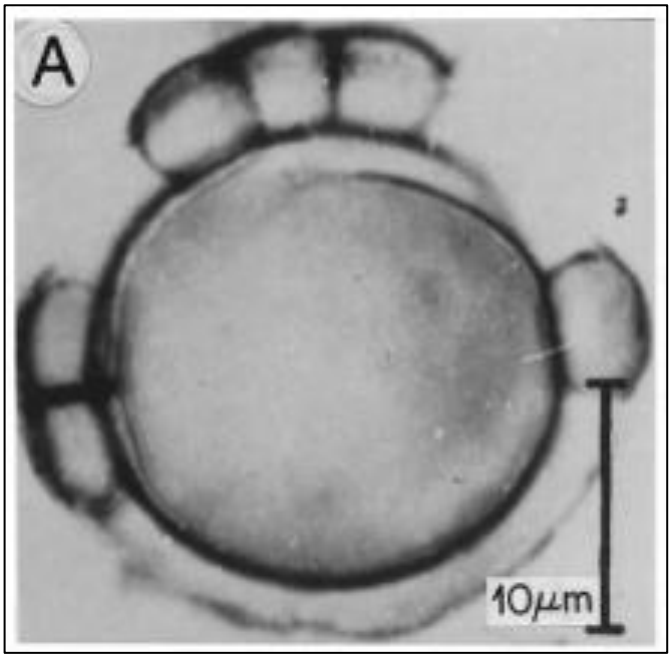
Eosphaera-like Forms

Eosphaera presents as 24-115 um diameter microspheres, generally sideritic and ferriferous,

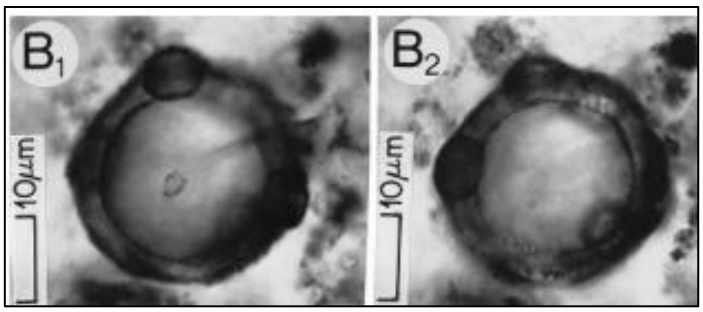
enclosing globular bodies homologous with algae. (Kaźmierczak, 1979). *Eosphaera tyleri* uses a ~28–32 µm in diameter "complex sphere-within-sphere" construction and "each sphere is separated by a regular intervallar space containing from 0 to 15 small tubercle-like spheroids without regular arrangement." The spherical tubercles are around 1–7 µm in diameter (Brasier, 2015).

The outersphere is more "membranous," the inner sphere "rather rigid and cyst like," and the tubercles present in and outside the outer sphere suggesting "outward expulsion facilitated by thinning of the outer sphere membrane." (Brasier, 2015). Siderite microspheres in iron formations are sometimes attributed to Eosphara replaced by siderite. (Javaux, 2018). It may have a siliceous test and may use the test for photosynthesis or akin to *Leptothrix'* encasement in ferric hydrate. (LaBerge, 1986).

Brasier and colleagues explicitly noted that *Eosphaera* is not found "much earlier, or indeed much later" in the fossil record — an observation they could not explain within the conventional framework. (Brasier et al., 2015). *Eosphaera* shows no documented participation in the trophic relationships that characterize the rest of the Gunflint chert assemblage (Wacey et al., 2013).

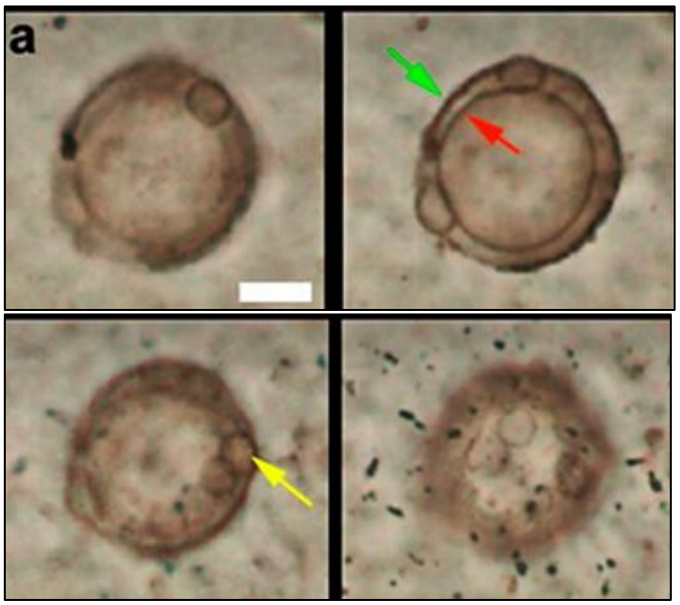


Eosphaera, Gunflint chert (Schopf, 2000).



Eosphaera, Gunflint chert (Schopf, 2000).

Its further hypothesized *Eosphaera* is either extinct clade, or a clade whose multicellular morphospace has changed with time, or something very unique – "symbiotic association between two different kinds of cell: a single large host cell, preserved as the outer sphere (cell wall) plus an inner sphere (i.e., an endocyst with excystment opening), and multiple small endosymbionts preserved as internal and external tubercles (cell membranes)." (Brasier, 2015). It could also be a "symbiotic consortium." (Javaux, 2018).



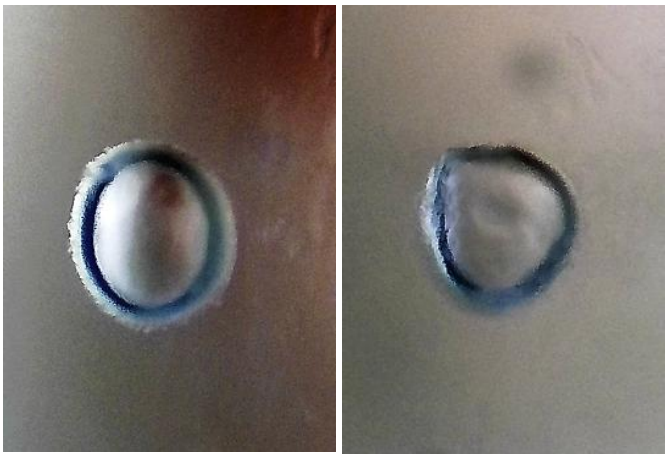
Eosphaera tyleri from the Gunflint chert, Schreiber Beach, Ontario. Four levels of optical focus through a thin section in nonstromatolitic microfabric, showing a well-preserved *Eosphaera* complete with inner sphere (red arrow) and outer sphere (green arrow) plus several rounded tubercles (e.g., yellow arrow). (Brasier, 2015).

It's hypothesized *Eosphaera* may be eukaryotic and related to coenobial or colonial phytoflagellates, making it one of the oldest eukaryotes on earth. (Kaźmierczak, 1979).

Multiple Boston specimens were observed. The most

morphologically homogenous was a stage that is round oval or tear drop shaped, smooth dark metallic gray in color, except for a blue band around the boundary of the rounded disk which was solid, symmetrical, and appeared to be a seal for the enclosure.

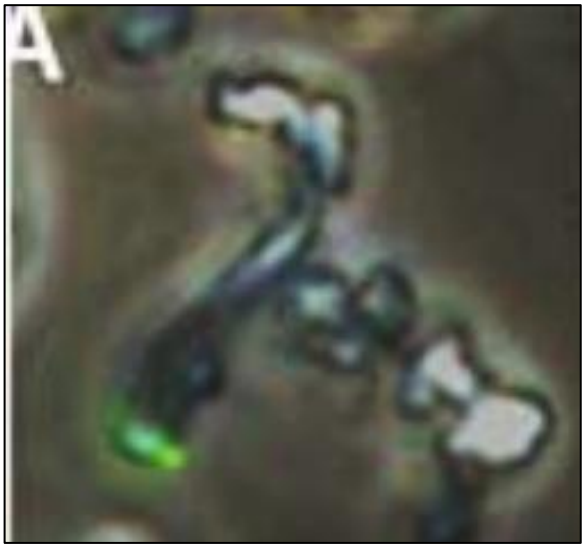
These observations create the basis for a proposed species of *Eosphaera bostonensis*. The suggested placement is in the Eukaryotes.



Eosphaera bostonensis, South End, Boston (Feb. 21 2025)

Mariprofundus-like Forms

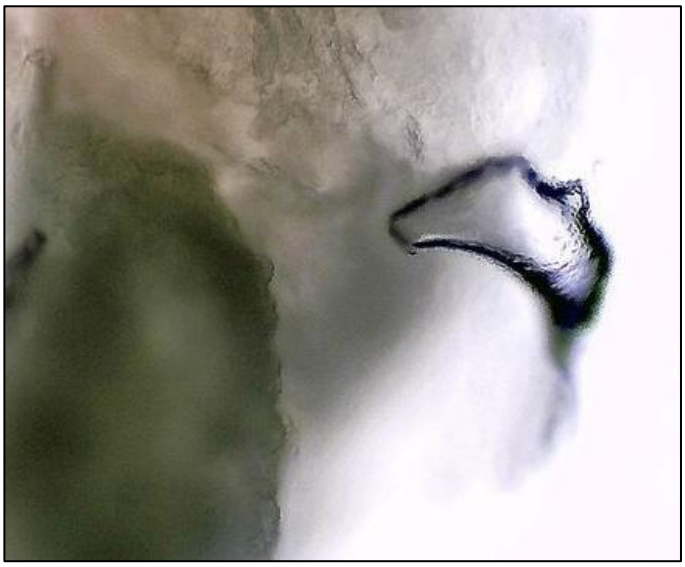
Mariprofundus ferrooxydans was first described by Emerson and colleagues (2007) from iron-rich microbial mats at Loihi Seamount. The organism has subsequently been documented at the Chesapeake Bay impact crater (Chiu et al., 2017) and in coastal salt marsh environments (McBeth et al., 2011).



Mariprofundus ferrooxydans (Emerson, 2007). (cells attached at the end of the filaments were stained with Syto and composite epifluoresence).

The published type description characterizes cells as motile curved rods, obligately lithotrophic, requiring Fe^{2+} as sole energy source and marine salts for growth, producing filamentous stalk-like structures of poorly crystalline iron oxyhydroxide composed of nanometer-sized fibrils aligned parallel to stalk length, with twisted stalks sometimes appearing helical (Emerson et al., 2007).

Two images photographed during the same sampling session on February 13, 2025 document morphological correspondence to this organism alongside what is interpreted as an associated cyst and excystment sequence.



Mariprofundus bostonensis, South End, Boston (Feb. 13 2025)

The first image presents a near-identical morphological match to the "face" in one of the *M. ferrooxydans* type images from Emerson et al. (2007). The primary bases for the *Mariprofundus bostonensis* provisional designation is the correspondence in curvature geometry, color, shading, texture and what appears to be a "look" at the scientist.

The second image shows two distinct features within a single frame. First, below, a metallic cyst strongly resembling the *Eosphaera bostonensis* images, with the rounded disk in a tear drop shape, and the top of the disk connecting to a long upward stipe culminating in a rounded club shape.

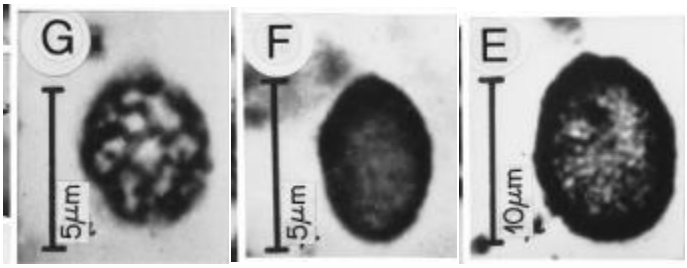
The stipe has irregular boundaries, non-straight lines, and appears like grey, metallic liquid metal pouring out of the cyst into a longer, oblong, non-cyst morphology. This photo was taken in close proximity to the first

Mariprofundus bostonensis photo implying this may be another form of the same species. This also raises the question if *Eosphaera* could be a cyst-like form for certain *Mariprofundus*-related species.

Mariprofundus bostonensis, South End, Boston (Feb. 13, 2025).

Huroniospora-like Forms

Huroniospora is a Gunflint chert fossil unicells, spheroidal to elliptical, 1-20um, smooth to coarsely reticulate, and zero to two apertures. They are observed to reproduce through fission and budding. (Darby, 1974; Strother, 1987).



Huroniospora, Gunflint chert, (Schopf, 2000).

Huroniospora can be divided into at least two groups. The first group is characterized by thin walls (40–60 nm thick and around 2.5 and 7–9 µm in diameter. The second group comprises thicker walls (110–600 nm) and around 7–12 µm across in diameter. Both groups have walls that "locally pinch and swell in correlation with the disposition of surrounding quartz crystals." (Lepot et al, 2017).

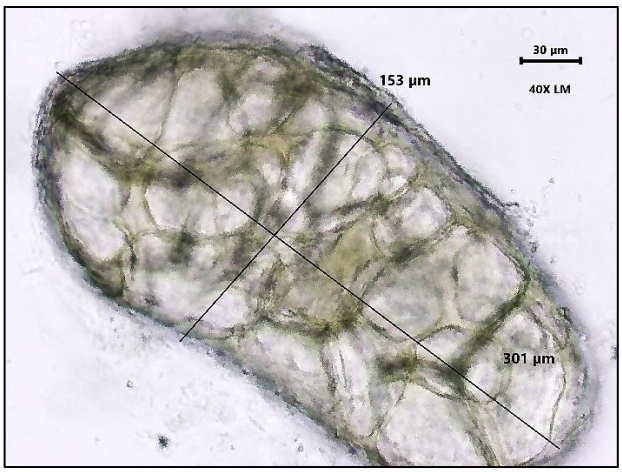
The thicker the walls the more dense the internal Fe mineralization and to present "intra-microfossil Fe nanocrystals occur mainly as plate-like greenalite ($Si_2O_5(OH)_4Fe^{2+}{}_3$), together with rhombohedron- or rod-shaped siderite ($Fe^{2+}CO_3$), and rare Fe^{2+} sulfides systematically embedded in organic matter." However, thinner walled *Huroniospora* may still present "a few plate-like (likely also greenalite) intra-microfossil Fe nanocrystals." (Lepot et al, 2017; Shirozu, 1965).

They are thought to possible be microbial spores, specialized cells like heterocysts, encysted cells, unicellular algae, and/or free-swimming dinoflagellates. Darby considered placement around or between blue green algae and Mucorales fungi. (Darby, 1974; Strother, 1987). Lepot et al suggests it represents "a composite morphospecies." (Lepot et al, 2017).

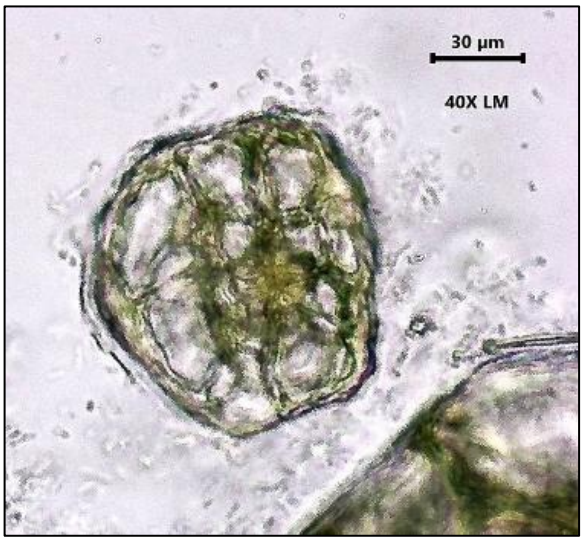
Huroniospora bostonensis, South End, Boston (April 7 2025).

In the Boston samples, one specimen was approximately 106 µm in diameter with an oval body and a reticulate polygonally partitioned wall network. Another was a similar shape but 153 µm by 301 µm. The walls are organized with compartmentalization: distinct cell-like units defined by darker boundary material.

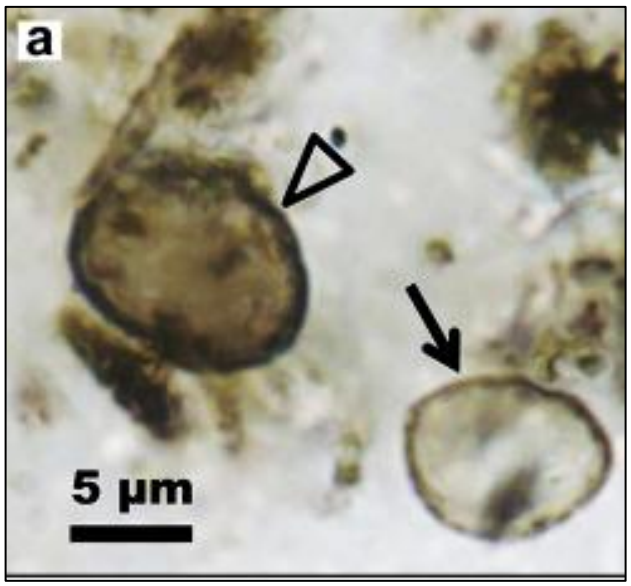
This size and morphology is consistent with larger forms in the Gunflint assemblage including some of the more elaborate spheroidal taxa (McMenamin, 2019).



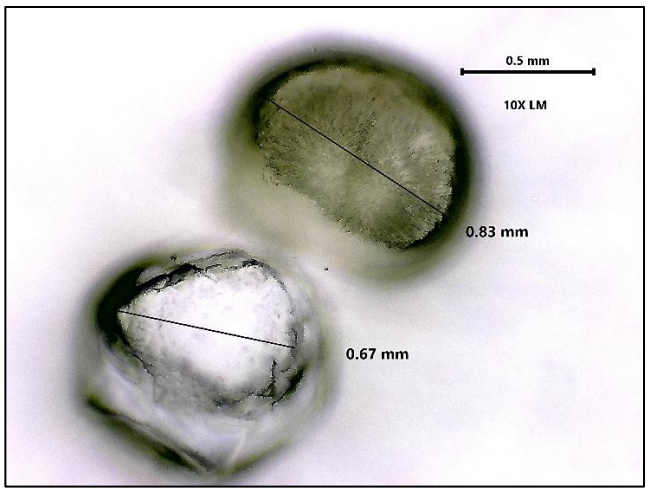
Huroniospora bostonensis, South End, Boston (April 9 2025).



Huroniospora bostonensis, South End, Boston (March 9, 2025).



Huroniospora (Javaux 2018).

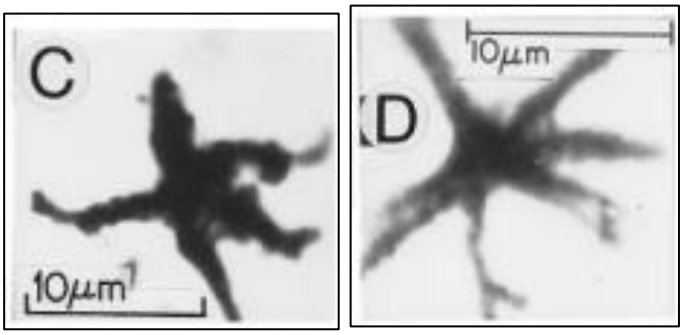


Huroniospora bostonensis, South End, Boston (Feb. 16 2025)

They are also known to be opaque, semi-opaque, and covered with layers. Below is an image with thick-walled *Huroniospora* (arrowhead) distinguished by a dark black organic wall creating an opaque microstructure. Thin-walled *Huroniospora* (arrow) in contrast appear transparent. These observations create the basis for a proposed species of *Huroniospora bostonensis.*

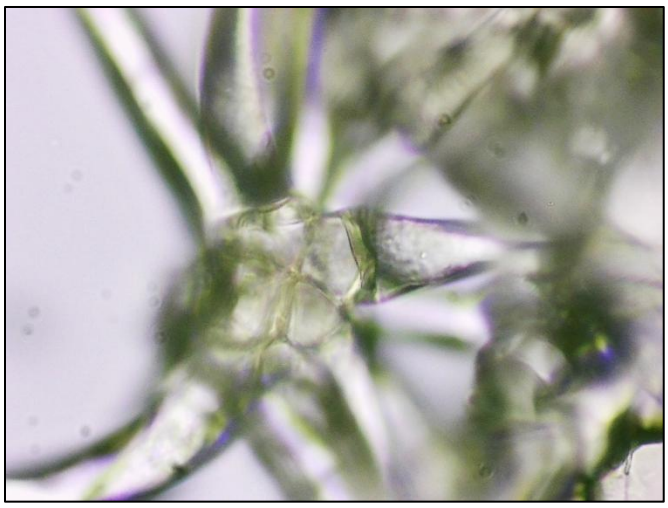
Eoastrion-like Forms

Eoastrion "comprises uncommon to abundant radiate (star-shaped) structures that resemble micro-colonies of *Metallogenium* (Javaux, 2018). It's "branching, thread-like structures with individual filaments typically 0.6 to 1 pm in diameter, as long as 23 pm, straight or bent to curved; filaments commonly occur in simple to complex radiating bodies 5 to 250 um in diameter." Manganese oxide encrusts the trichospherical colonies (Allison, 1988).



Eoastrion, Gunflint chert,

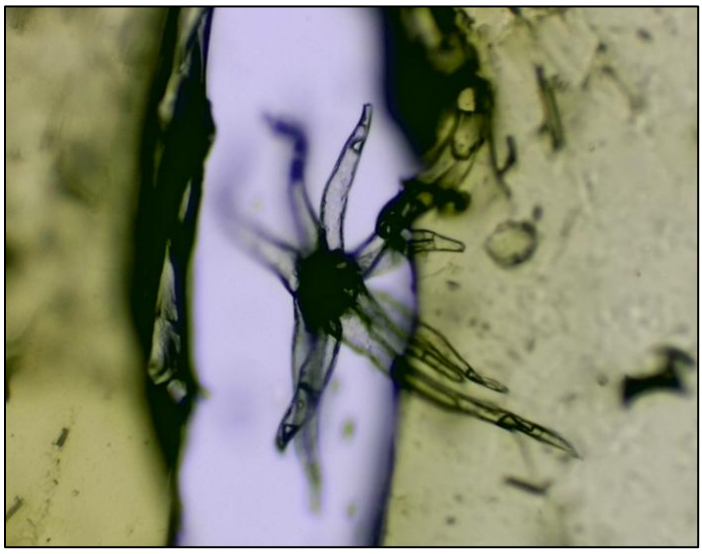
Kline concluded that *Eoastrion* represents a budding bacterium that is morphologically most comparable to the modern iron- and manganese-sequestering Metallogenium (1975).



South End, Boston (Feb. 5 2025)

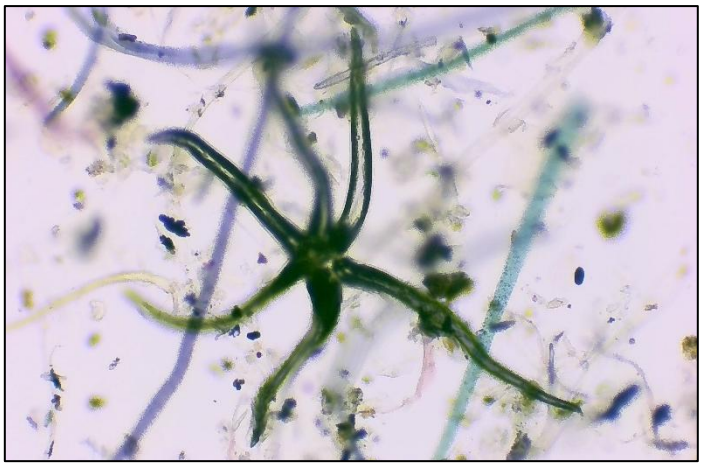
The *Eoastrion* sort of body form presented repeatedly and ongoing in the Boston environmental samples. However, the organism in the Boston samples appeared far more complex, the filaments appeared more like arms, and the center appeared to be the core of the body form.

Additionally, the organism frequently appeared to be moving around including traveling across a distance, navigating obstacles, and climbing over surfaces. Accordingly, the Boston organism's proposed naming is *Eoastrion bostonensis* but with placement in the Eukaryotes.



South End, Boston (Feb. 5 2025)

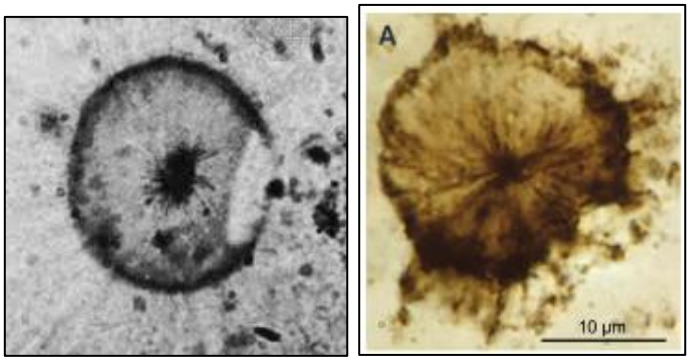
South End, Boston (June. 20 2025)



South End, Boston (Feb. 26 2025)

Gunflint Spheroidal Forms (Echinosphaera)

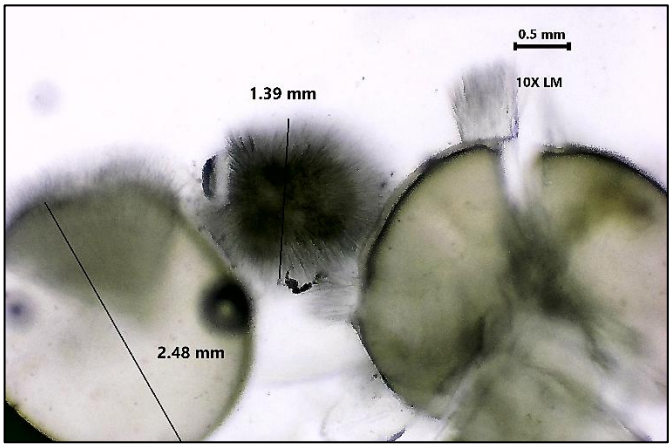
There are other Gunflint chert fossil presentations – some are named and some are not. One apparently unnamed presentation has been photographed and the Boston samples repeatedly included observed specimens matching the 1950s photos of this species.



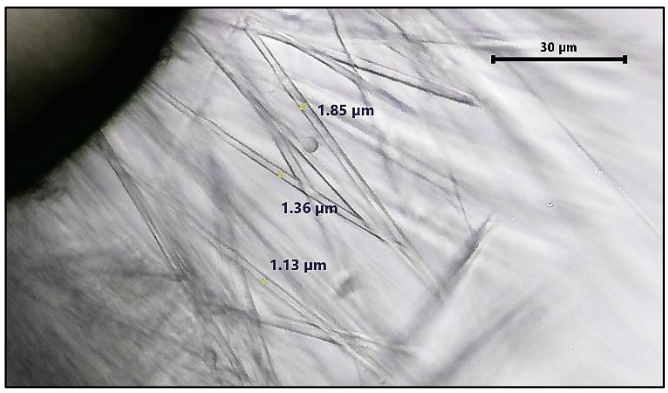
International News Photos (1954). | (González-Flores, 2022)

Echinosphaera bostonensis, South End, Boston, Feb 16 2025

Several Boston specimens displayed a globular body with fibrous or filamentous projections extending through and beyond the sphere wall. Internal fibrous material was visible erupting outward in a pattern inconsistent with simple decay or artifact, and consistent with active biological process — possible reproductive expulsion, budding, or motility structure extension.



Echinosphaera bostonensis, South End, Boston, Feb. 16 2025



Echinosphaera bostonensis, South End, Boston, Feb. 16 2025

This example of the Gunflint chert collection does not appear to have been named. Accordingly, in providing a provisional name for the species observed in the Boston samples, a genus name must also be proposed. I propose to name this genus *Echinosphaera* and the observed species *Echinosphaera bostonensis.*

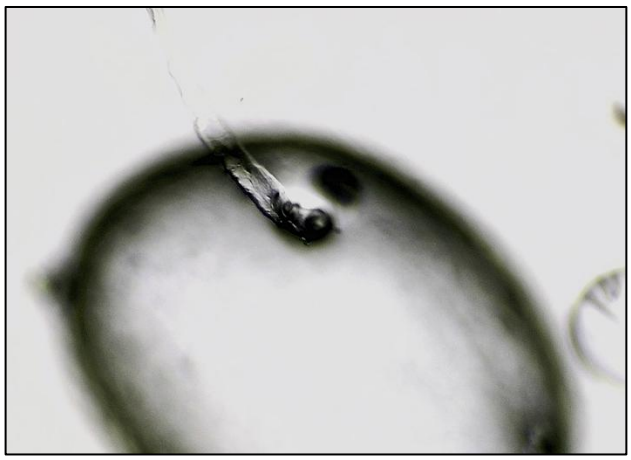
Echinosphaera bostonensis, South End, Boston Feb 18, 2025

Other Forms of Cysts, Tests, & Eggs

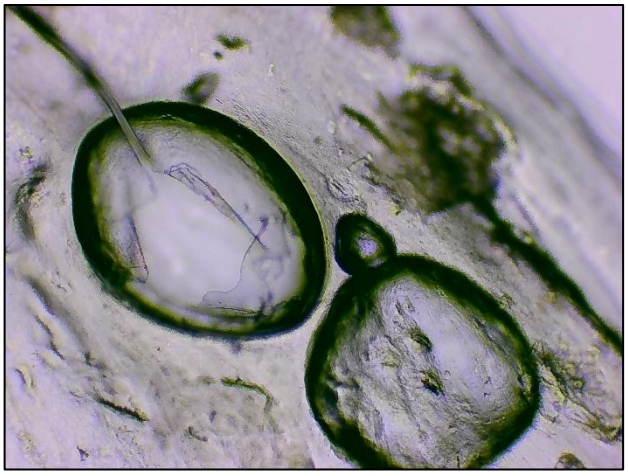
In addition to the unique Gunflint-like cysts and tests, the Boston environmental samples also frequently presented organizations, morphology, and development stages with a variety of cysts and tests, frequently resembling "eggs."

This bridged morphological homogeneity with Ediacaran biota, in addition to the Gunflint chert microfossils. For example, *Rangea* and *Charniodiscus* are both shaped with an egg-like bulb at their base. Related research arising from these investigations also identified the *Pseudocolus* "stinkhorn" as living Ediacaran biota and proposed to be reclassified as Demospongiae *incertae sedis* and renamed as *Tribrachia*. This species, like many other Stinkhorns is known to "hatch" from eggs. (Gjøvik, June 16, 2025).

In the Boston environmental samples, the microscopic "eggs" frequently presented as white and smooth -- similar to that of bird eggs. They sometimes would "hatch" for a larger, complex organism to be released but also sometimes were coated in a dark substances (perhaps a protective cyst) or included egress where a filament or other form could enter/exit the egg to interact with the environment around it.

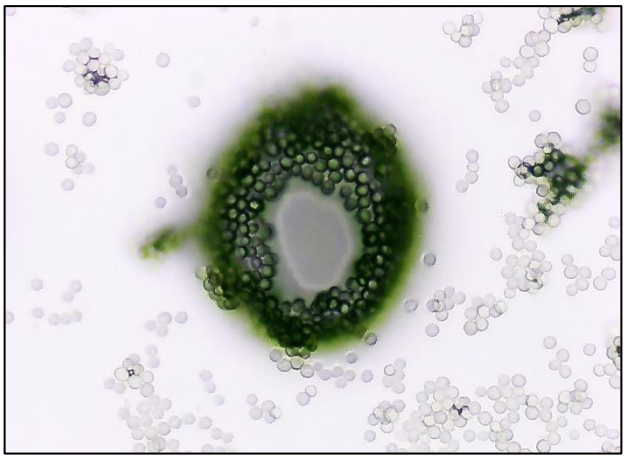


unidentified organism, South End, Boston, Feb. 9 2025

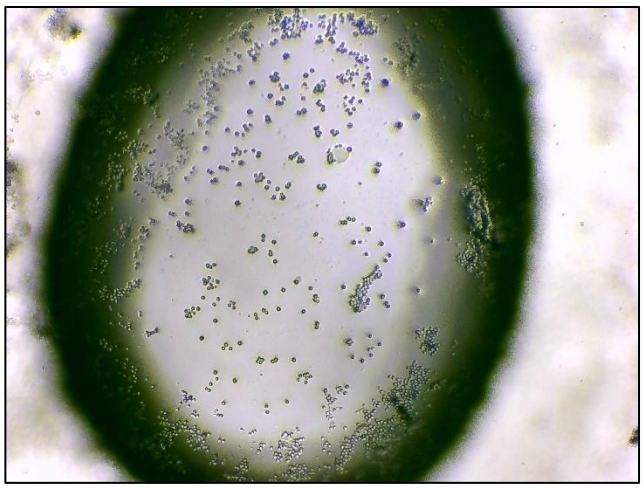


unidentified organism, South End, Boston, Feb. 7 2025

Another unusual trait observed was that when the "eggs" were covered in a metallic sort of encasement, the process could be observed in real time with individual cells gathering around the egg and combining into a sort of metallic film that could cover the egg.



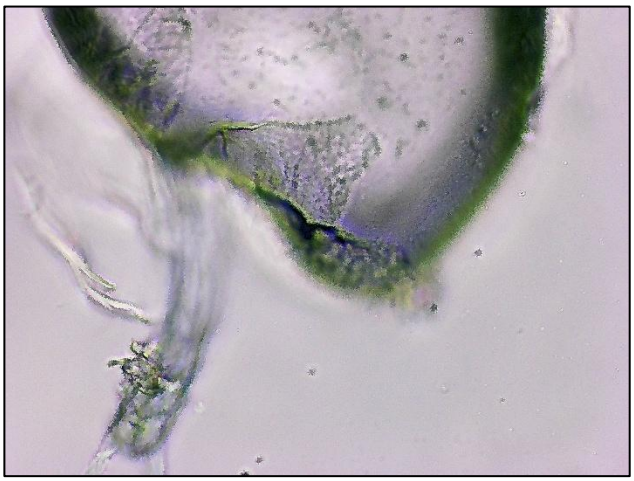
unidentified organism, South End, Boston, Feb. 14 2025



South End, Boston, Feb. 2 2025

Then, when the organism wanted to leave the egg, the metallic film would disappear, and it could then exit the "egg" and/or release filaments to interact through the egg's "shell."

The primary catalyst for the author's extensive research into the Stinkhorns in 2025 was due to the lack of comparators for the observed morphology and behavior of the Boston environmental sample organisms other than several unique traits in the Stinkhorn family ("hatching" from "eggs," aseptate filaments, internal crystallization and biomineralization, emissions of hydrogen sulfide and other deep sea-type VOCs, etc.)



unidentified organism, South End, Boston, Feb. 2 2025

Now understanding that some of the basal Stinkhorns appear to be Ediacaran biota more closely related to Demospongiae than fungi, it stands to reason the comparative morphology and physiology observed represents Precambrian biology of novel organisms

that appear to be more complex than prokaryotes but not quite Metazoan.

Conclusion

Further investigation is needed to confirm the identity of the Boston sampled organisms, and to understand their relationship with the Gunflint-chert taxa, and the seeding and ecology in South End Boston that's allowed them to emerge and thrive. Analysis and discussion is required to determine proper taxonomic placement for most of these novel species.

Additionally, multiple other unusual, unidentified, and highly suspicious organisms were observed in the same Boston environmental samples that have yet to be identified. Twelve examples are provided in Appendix A at the end of this paper. Additional environmental testing and sampling is needed generally – both as part of the CERCLA assessment and also ongoing.

The organisms observed in the Boston biological samples appear to be extremely old, without clear affinity or extant relatives other than Gunflint chert and Ediacaran biota, and present novel and previously undocumented physiology and capabilities. There is currently no explanation where these organisms came from or why they are appearing now, but their unexpected presence and persistence provides an extremely rare and critical opportunity to observe and studies these incredible life forms.

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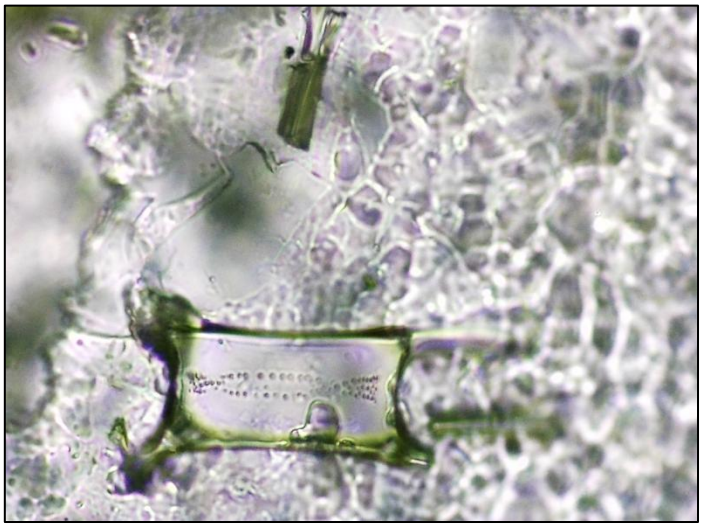
Appendix A: Additional Boston Microscopy Photos

unidentified organism, South End, Boston, Jan. 2, 2025



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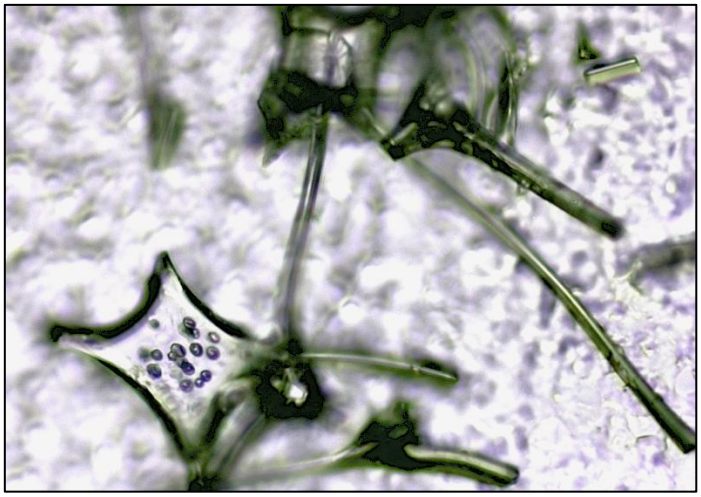
unidentified organism, South End, Boston, Jan. 17 2025



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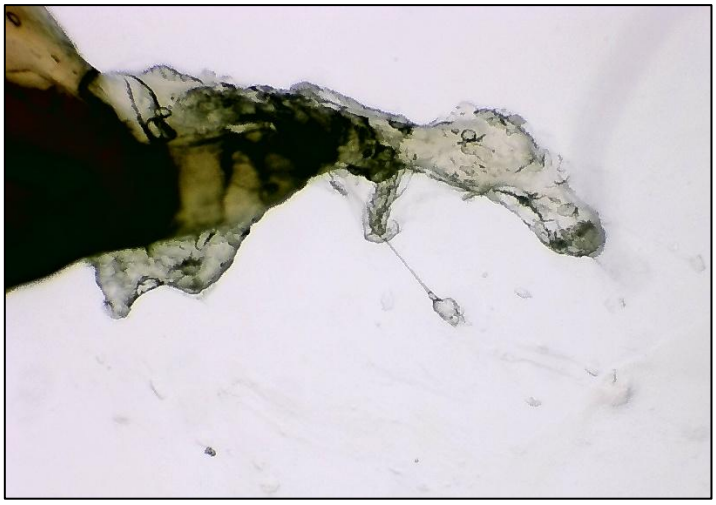
South End, Jan., 17 2025



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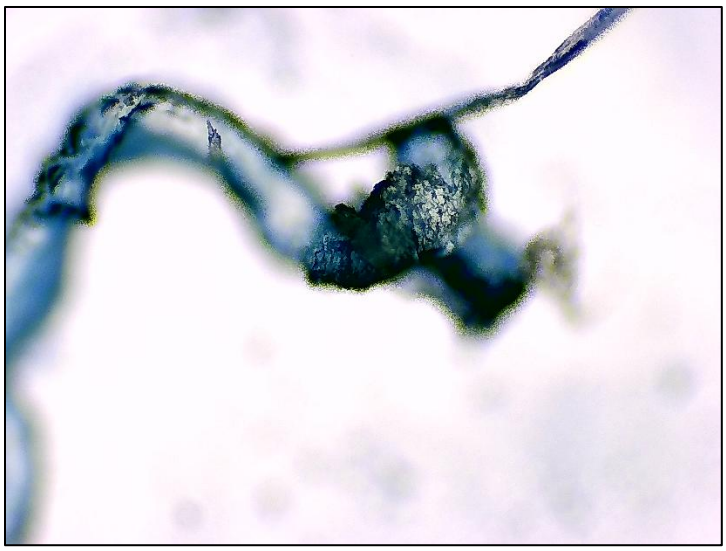
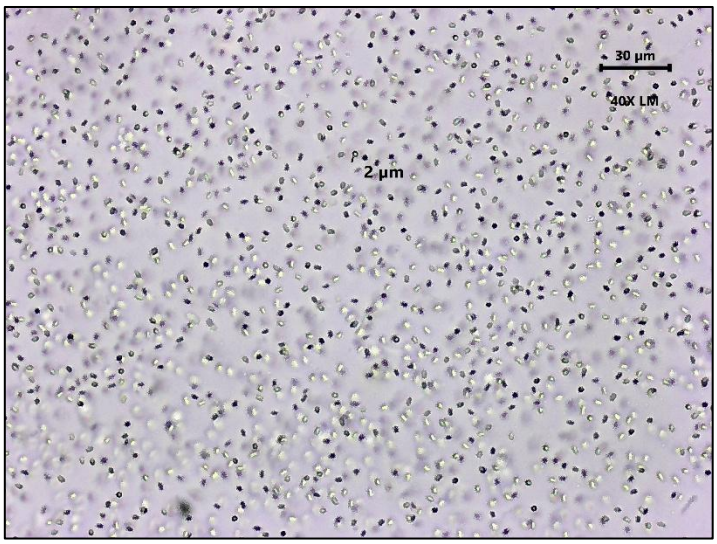


unidentified organism, South End, Boston, Feb. 9 2025



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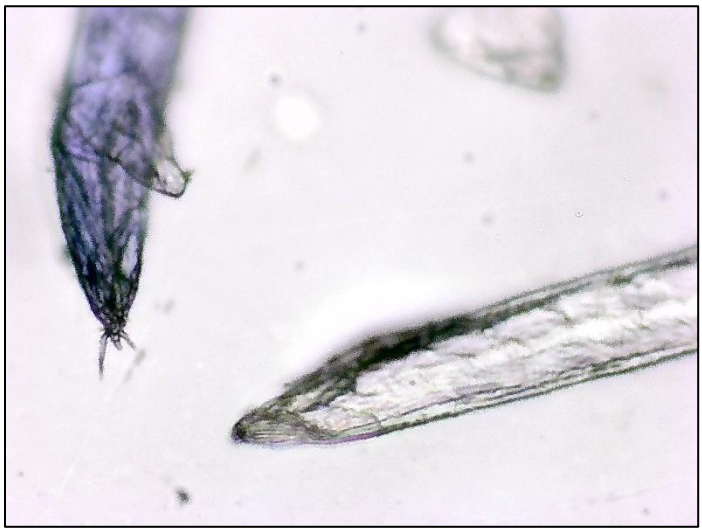

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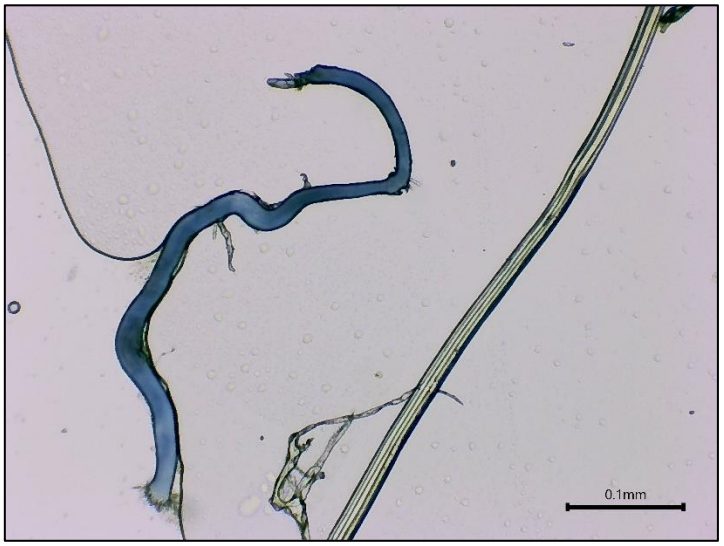

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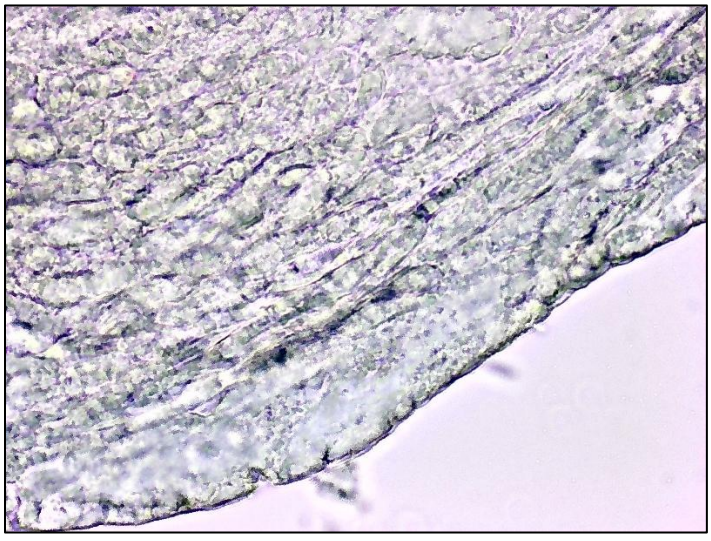

unidentified organism, South End, Boston, Feb. 17 2025

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