Three key words: clams, morphology, micro-CT

This study utilized micro-CT scanning to compare the morphologies of the subtidal clam *Glycymeris septentrionalis* and the intertidal clam *Leukoma staminea*. Three subtidal clams (*Glycymeris septentrionalis*) were collected from Van Veen grabs on the Kittiwake in the San Juan Channel (48 32.491' N, 122 58.940' W) on July 3rd, 2025. Three intertidal clams (*Leukoma staminea*) were collected from Argyle Lagoon (48°31'15.2"N, 123°00'48.7"W) on June 26th and July 10th, 2025. Clam species were identified based on their size and location compared to iNaturalist to preserve morphology for micro-CT scanning. All six clams were relaxed in magnesium chloride before being preserved in formalin overnight. The clams were stained in iodine, with small holes drilled in ones that did not relax open under the magnesium chloride. Staining the clams with iodine allowed the soft tissues to be imaged by the scanner. To this end, the clams were soaked in iodine for at least 18 hours. All six clams were scanned using a micro-CT scanner at a resolution of 45 μm under a continuous scan. Based on a previous literature search, this was the first time these two clam species were scanned using a micro-CT scanner. The software 3D slicer was used to examine the six clams. Each clam was segmented into its own file. Threshold values 89.25 and 255.0 were used to only render the clam shells. This study had two aims for the micro-CT scans: a qualitative review of what morphology features were modeled by the scans, and a quantitative study of shell thickness with the hypothesis that subtidal clams would have a thicker shell than intertidal clams, since the intertidal is a harsher environment that could wear down the shells. Radial ribs, hinge ligaments, hinge teeth, lateral teeth, and some of an adductor muscle for an intertidal sample were observable

in the micro-CT scans. Shell thickness was measured in 3D Slicer for all six clams. An F-test was conducted to determine if the T-test for mean shell thickness should assume equal or unequal variance. The p-value was 0.17. A T-test of two samples assuming unequal variance was conducted in excel to determine if the difference in average shell thickness for the two species was statistically significant. The p-value was greater than 0.05 ($p=0.60$), indicating a failure to reject the null hypothesis that the average shell thickness between the two species was different. As such, the hypothesis that the subtidal clams would have thicker shells than the intertidal clams was not supported. Still, this study demonstrates how micro-CT scanning allows for measurements to be conducted without sample destruction.

Morphological Comparisons between the subtidal clam *Glycymeris septentrionalis* and the intertidal clam *Leukoma staminea* using micro-CT scanning

Marine Invertebrate Zoology Summer A 2025, FHL 432

Isabella Robinson

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Glycymeris septentrionalis

- California Bittersweet Clam
- Intertidal to 135m depth in San Juan Channel
- Length up to 4.5 cm

Taxonomy

Phylum: Mollusca

Class: Bivalvia

Subclass: Pteriomorphia

Order: Arcoida

Family: Glycymerididae

Leukoma staminea

- Pacific Littleneck Clam
- Intertidal to 10 m depth
- Length up to 7 cm long

Taxonomy

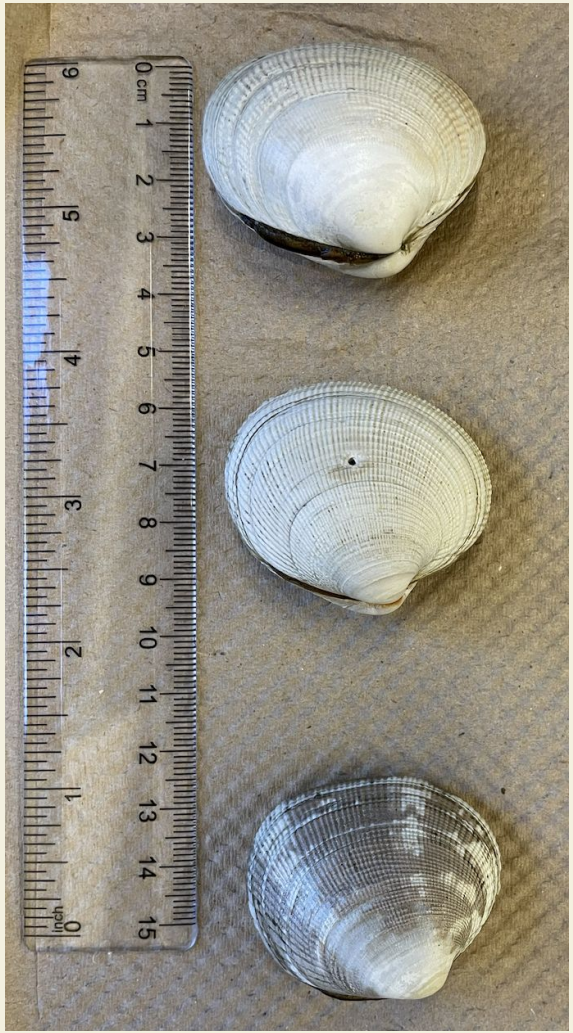
Phylum: Mollusca

Class: Bivalvia

Subclass: Heterodonta

Order: Veneroida

Family: Veneridae



Qualitative Goals

- How can micro-CT scanning be used to observe clam morphology?
  - What clam features will show up on a micro-CT scan?

- What are the observational morphological differences between *Glycymeris septentrionalis* and *Leukoma staminea*?

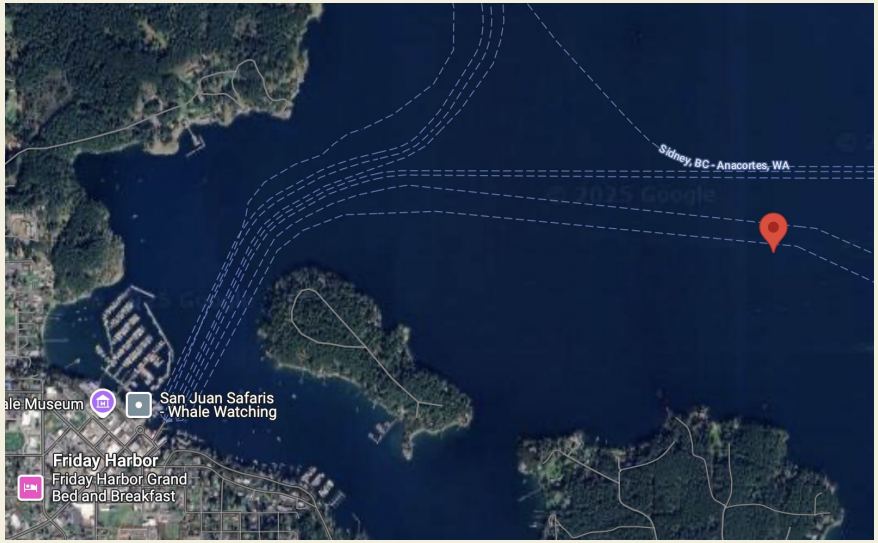
Quantitative Goals

- Is there a measurable difference in shell thickness between *Glycymeris septentrionalis* and *Leukoma staminea*?

- **Hypothesis:** *Glycymeris septentrionalis* will have a thicker shell than *Leukoma staminea.*
  - Intertidal = harsh environment

Sampling Locations

San Juan Channel



48 32.491′ N
122 58.940′ W

Argyle Lagoon

48°31′15.2″N 123°
00′48.7″W

Sample Collections

- Van Veen grab off the Kittiwake in San Juan Channel on July 3rd
- Clams collected on June 26th and July 10th from Argyle Lagoon at low tide
  - -3.18 and -1.95 low tides
- 3 replicates per species
- Similarly sized clams per species

Micro-CT Scanning

- First time these two clam species have been scanned with a micro-CT!
- Holes drilled in unopened shells
- Stained in iodine for at least 18 hours
- Continuous Scanning at 45 µm

3D Slicer

- Software used to visualize micro-CT scans
- Segmented the scan by full clam -> observe morphology
- Further segmented by halving the clams -> measure shell thickness
- Threshold Range: 89.25, 255.00

Glycymeris septentrionalis Micro-CT Scans

Leukoma staminea Micro-CT Scans

Shell Morphology: Umbo

Leukoma staminea

Glycymeris septentrionalis

Shell Morphology: Ventral Margin

Leukoma staminea

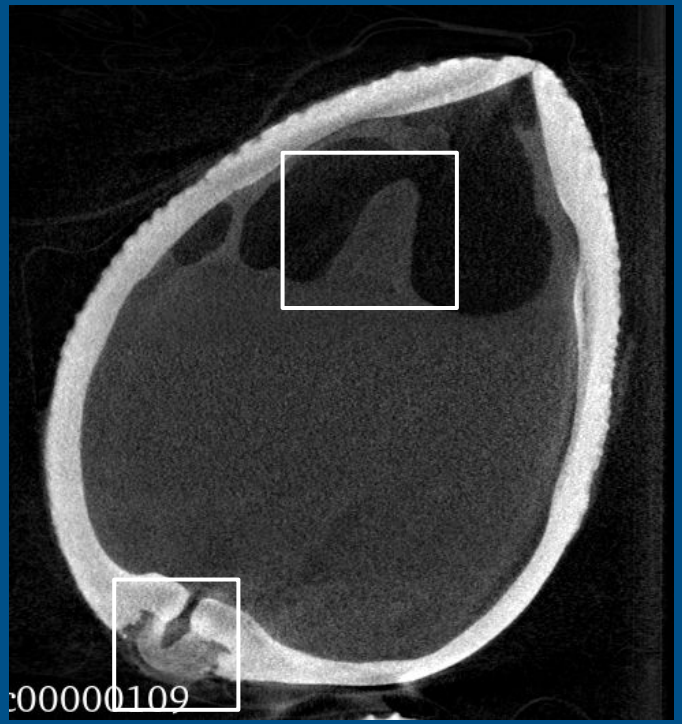
Glycymeris septentrionalis

Shell Morphology: Anterior Side

Leukoma staminea

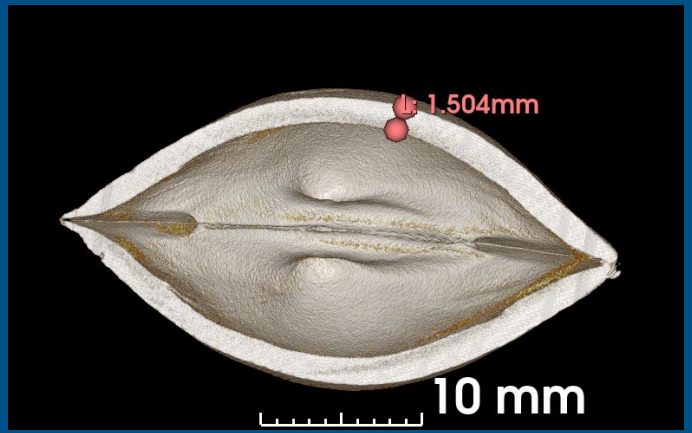
Glycymeris septentrionalis

Leukoma staminea Raw Scan

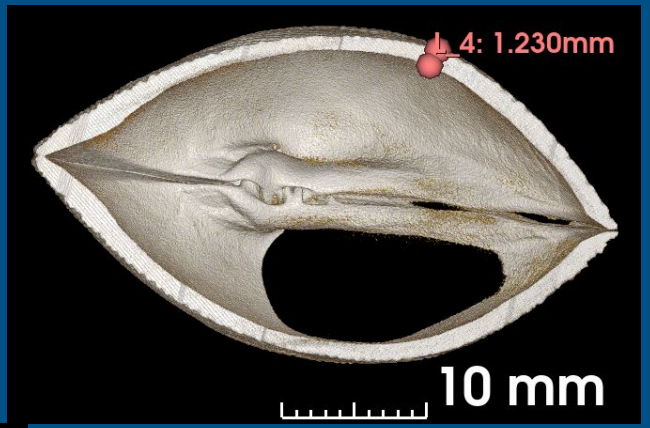


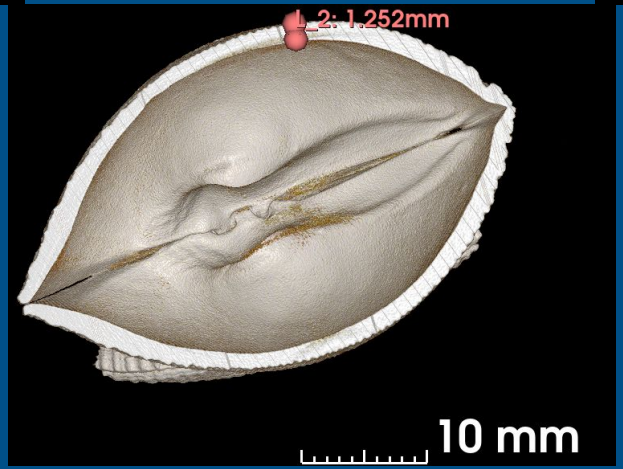
- Adductor muscle
- Hinge Ligament

Glycymeris septentrionalis Shell Thickness



Leukoma staminea Shell Thickness





Shell Thickness Measurements

Shell Thickness	*Glycymeris septentrionalis*	*Leukoma staminea*
Clam 1	1.128 mm	1.956 mm
Clam 2	1.341 mm	1.252 mm
Clam 3	1.504 mm	1.230 mm
Average	1.324 mm	1.479 mm

T-Test:Average Shell Thickness

- Null hypothesis: There is no difference between the mean shell thickness of *Glycymeris septentrionalis.*
- Alternative hypothesis: There is a difference between the mean shell thickness of *Glycymeris septentrionalis* and *Leukoma staminea.*
- Unequal or Equal Variance? -> F-test: p=0.17
- T-test: Two Sample Assuming Unequal Variance in Excel
  - p = 0.60, which is greater than p = 0.05
- Failure to reject the null hypothesis of no difference between average shell thickness.

Conclusions

- Hypothesis that *Glycymeris septentrionalis* will have a thicker shell than *Leukoma staminea* is not supported.
- BUT you can use micro CT scanning to observe specimen without destroying morphology
- Able to visualize entirety of shell, hinge ligament, part of the adductor muscle in *Leukoma staminea*
- Further measurements: hinge teeth, lateral teeth, hinge ligament, muscle adductor scar

Sources

https://inverts.wallawalla.edu/Mollusca/Bivalvia/Arcoida/Glycymeris_septentrionalis.html

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https://www.statology.org/f-distribution-calculator/