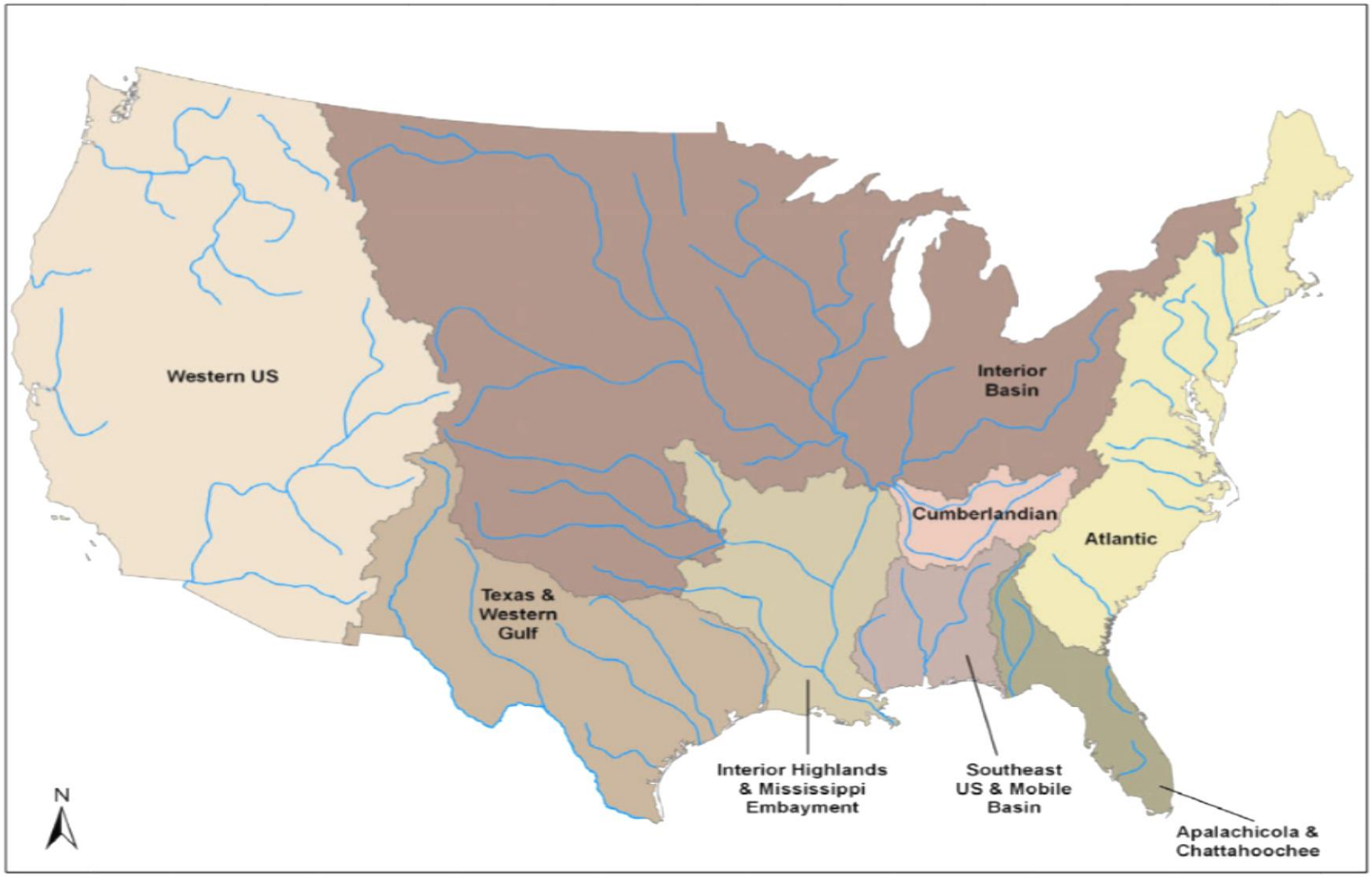
PA AFS Mussel Identification Workshop

February 9, 2018

Rick Spear, Nevin Welte, Jordan Allison
Mary Walsh, Ryan Miller



North American mussel faunal regions.

Haag, W.R. 2010. A hierarchical classification of freshwater mussel diversity in North America. *J. Biogeography* 37: 12-26.

Where are they?

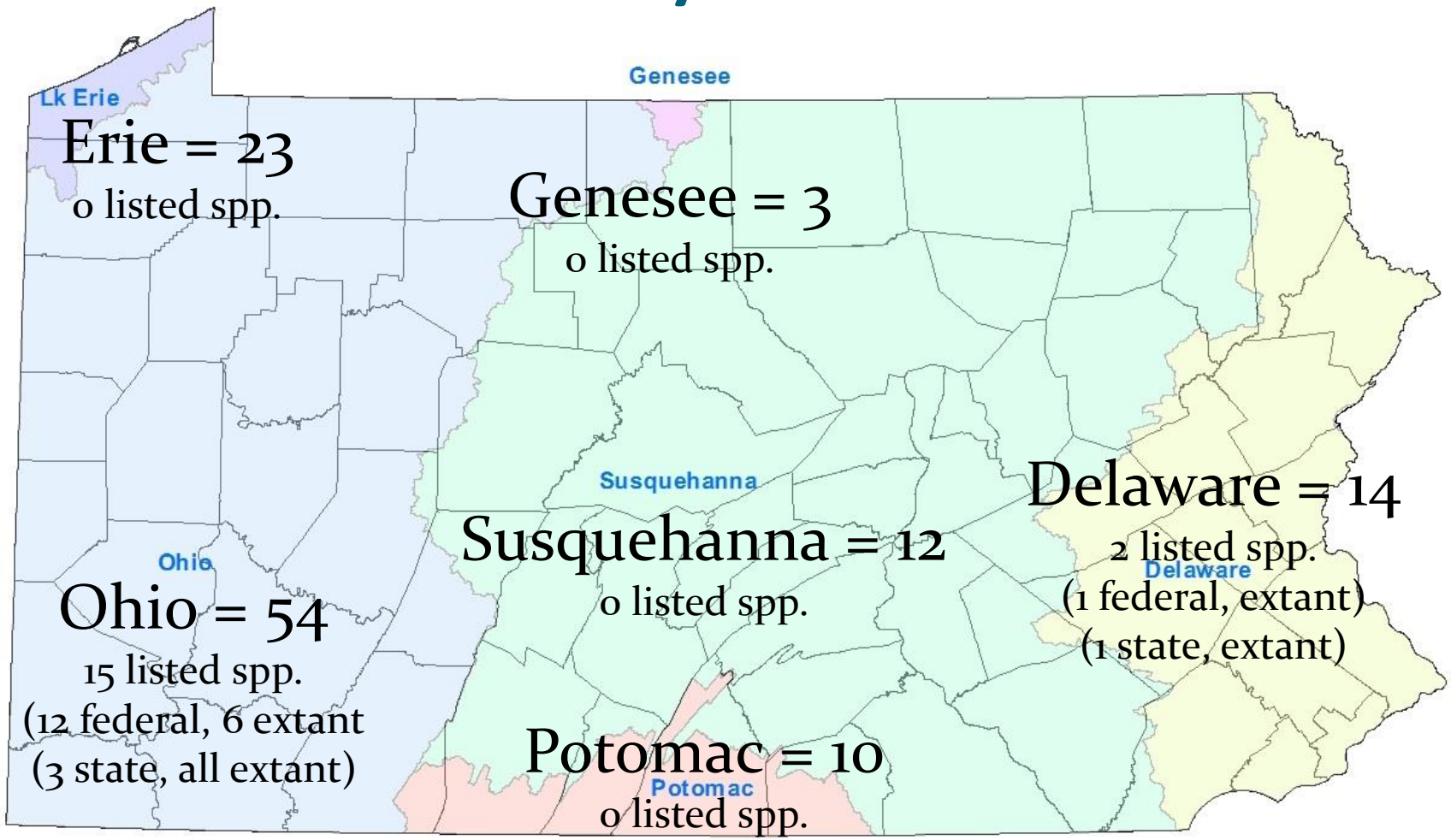


Image credit: *Kathy Gipe*

67 species, 11 protected

	Common Name	Scientific Name	PA Status	Federal Status
1	Dwarf Wedgemussel	*Alasmidonta heterodon*	Endangered	Endangered
2	Northern Riffleshell	*Epioblasma rangiana*	Endangered	Endangered
3	Snuffbox	*Epioblasma triquetra*	Endangered	Endangered
4	Eastern Pearlshell	*Margaritifera margaritifera*	Endangered	
5	Round Hickorynut	*Obovaria subrotunda*	Endangered	
6	Sheepnose	*Plethobasus cyphyus*	Threatened	Threatened
7	Clubshell	*Pleurobema clava*	Endangered	Endangered
8	Rabbitsfoot	*Theliderma cylindrica*	Endangered	Threatened (CH)
9	Pistolgrip	*Tritogonia verrucosa*	Endangered	
10	Salamander Mussel	*Simpsonaias ambigua*	Endangered	
11	Rayed Bean	*Villosa fabalis*	Threatened	Threatened

- 6 additional species federally listed but considered historical (all from Ohio, Allegheny, and Mon mainstems)

Atlantic Slope ET spp.

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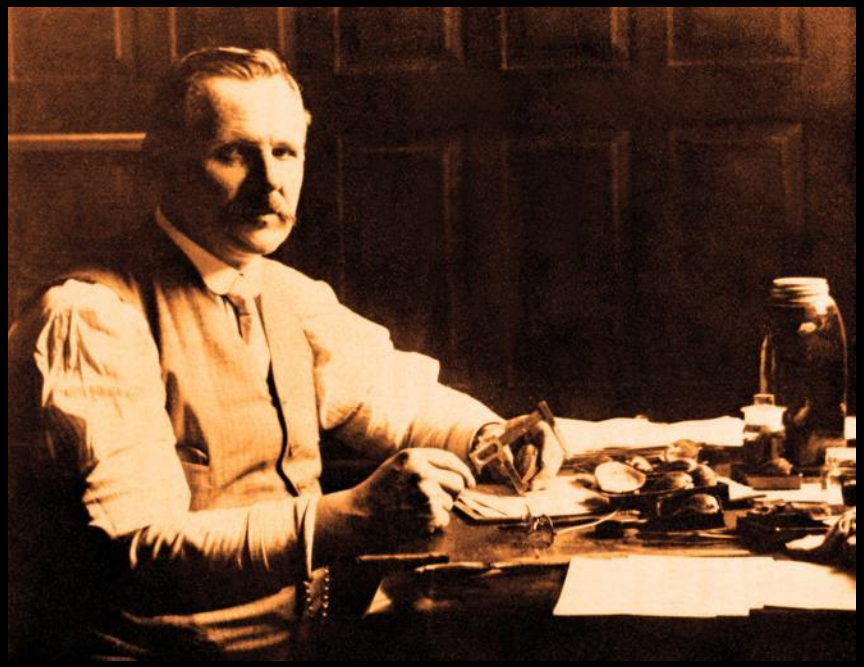
The science (and art) of mussel identification

Mussel shell ID is challenging…

- High variability
  - Ortmann's law
  - Systems, e.g., stream vs. lakes
- No meristics!
- Characteristics inside
- Sexually dimorphic
- Happenstance

The foundation for identification



- Ortmann 1911
  - Internal anatomy

VOL. IV. NO. 6.

A MONOGRAPH OF THE NAJADES OF PENNSYLVANIA.

By Arnold E. Ortmann, Ph.D.

- Ortmann 1919
  - External shell characters

Vol. VIII. No. 1.

A MONOGRAPH OF THE NAIADES* OF PENNSYLVANIA. PART III. SYSTEMATIC ACCOUNT OF THE GENERA AND SPECIES.[1]

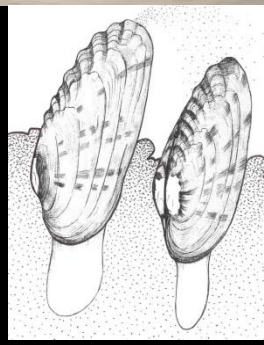
By Arnold E. Ortmann, Ph.D., Sc.D.

Note on dichotomous keys…

"After much thought, several headaches, and much gnashing of teeth, we have decided that it is probably impossible to write a simple, friendly, reliable key to the species of unionoids found in New York. It is certainly impossible for us. Keys based on shell characters are inevitably filled with vague, subjective terms, are frustrating for beginners to use, and misidentify many shells… Our solution to this dilemma has been to write a frustrating, sometimes unreliable key based upon shell characters and filled with vague, subjective terms, but to make it the friendliest and most reliable vague, frustrating key that we could. **Users should know that if they rely solely on this key, they will misidentify many shells**."

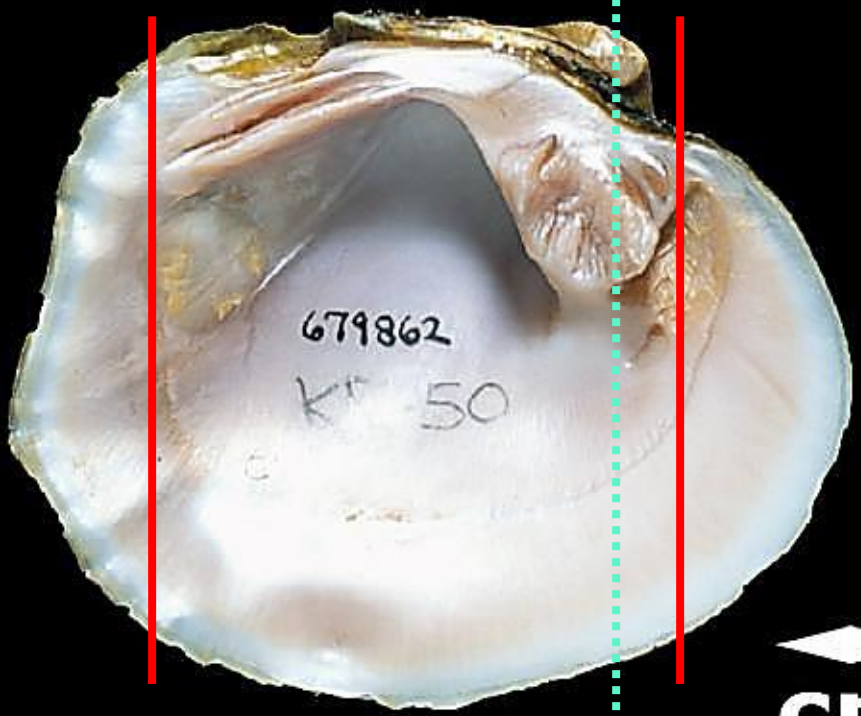
From Strayer and Jirka's 1997 *The Pearly Mussels of New York State*

Shell margins



Dorsal

Posterior margin



Anterior margin

Ventral

LEFT VALVE

Posterior anterior

Photo credit: *Robert Warren*

External morphology

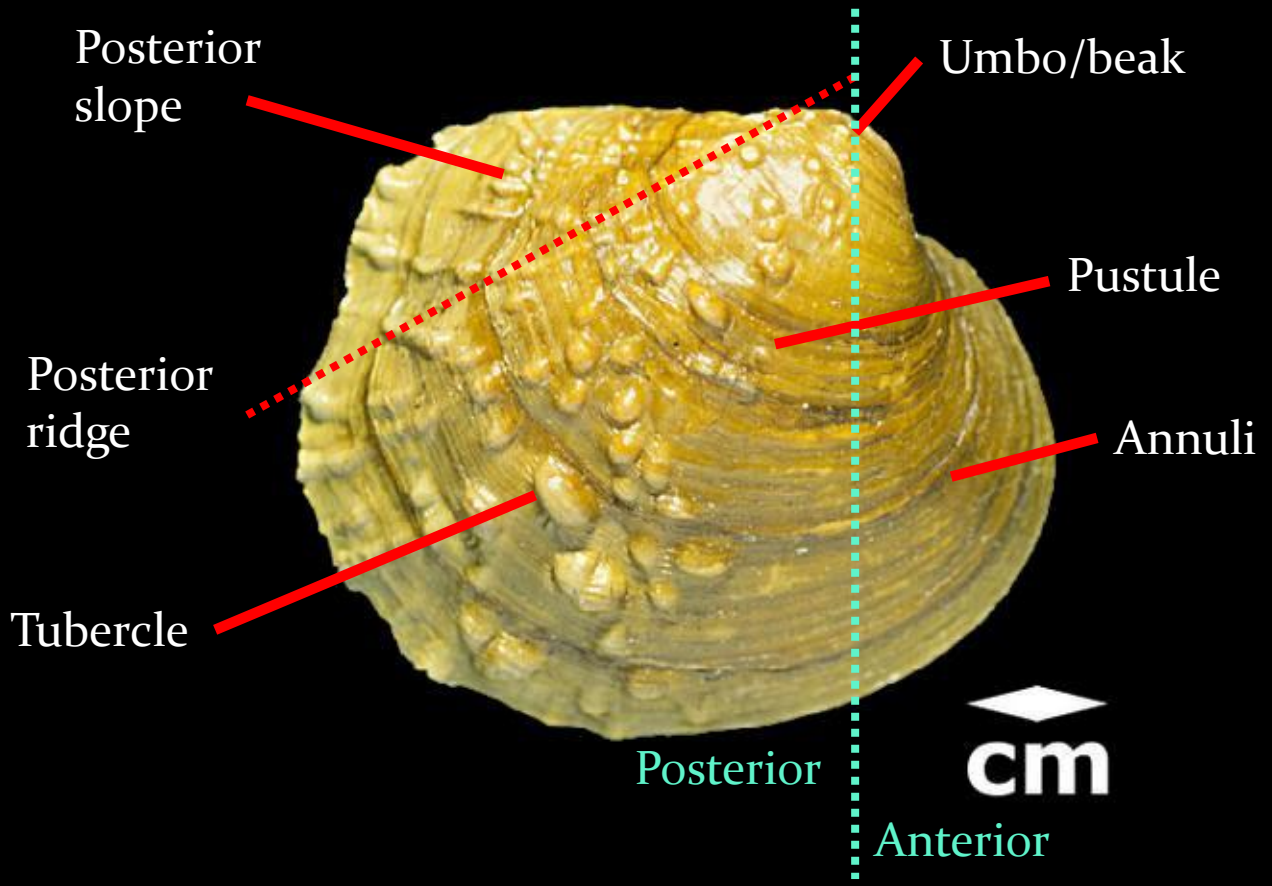


Photo credit: *Robert Warren*

Rays and other color markings

- Helpful, but not always reliable!!!

Green blotch

Chevrons

Bundles of rays

Wavy rays

Rays

Blotchy rays

Internal morphology

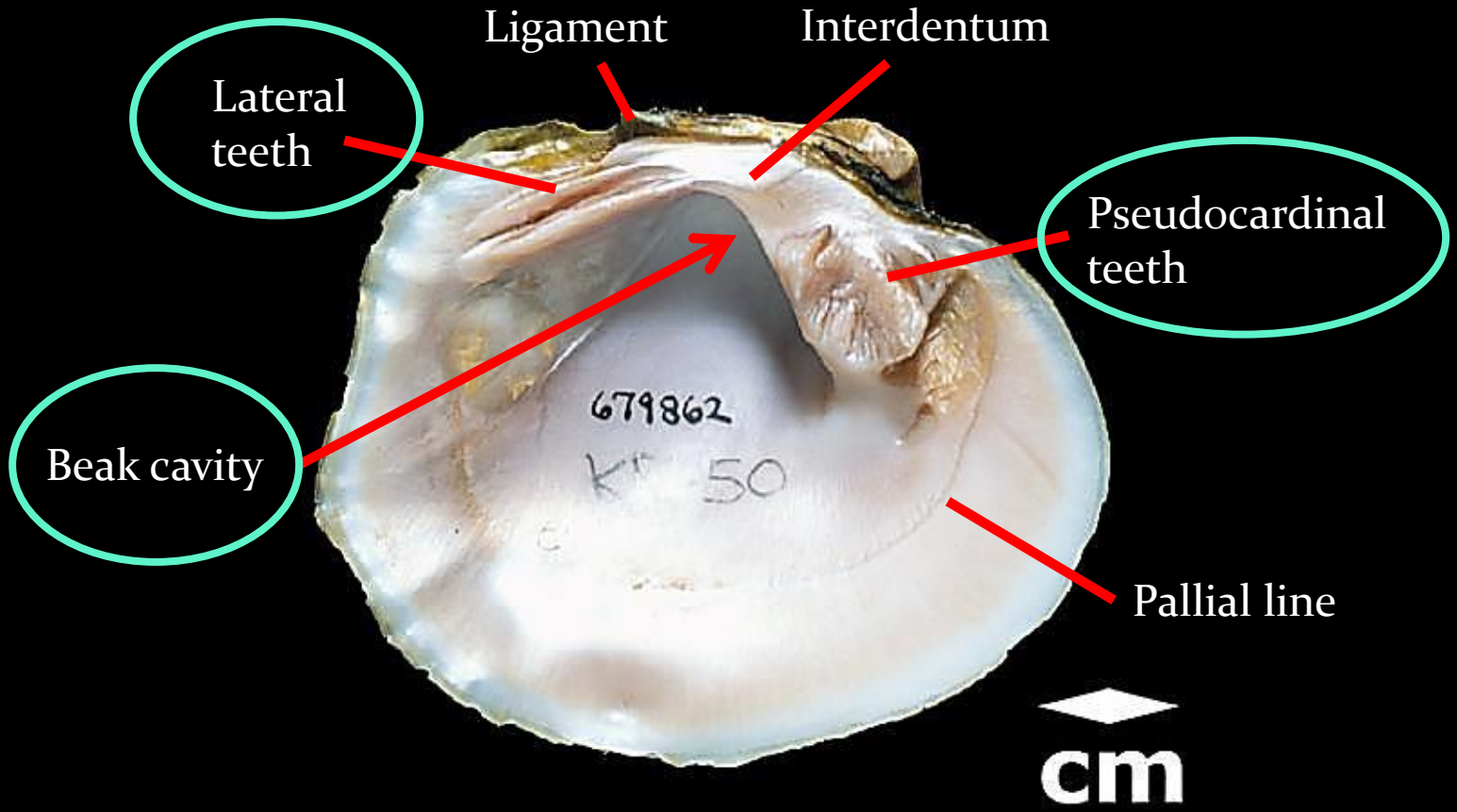
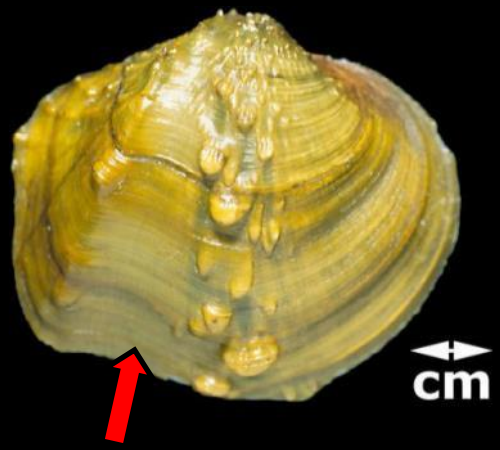


Photo credit: *Robert Warren*

External shell features

plications

knobs



sulcus

beak sculpture & compression!

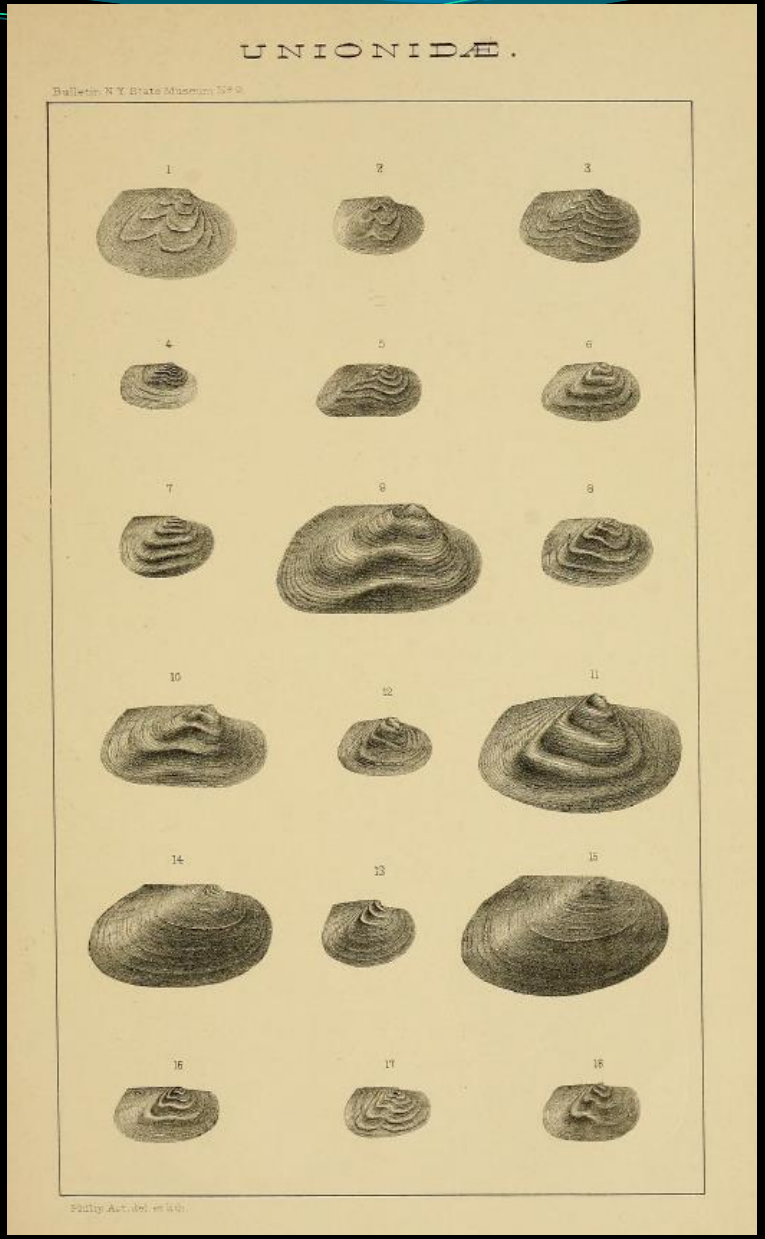
Slide courtesy of: *Rick Spear*,
ISM photo credits: *Robert Warren*

Beak sculpture

- Rare to observe in adults
- Helpful with identification of juveniles

- or -

individuals that occur in well-buffered and/or silty/sandy environments



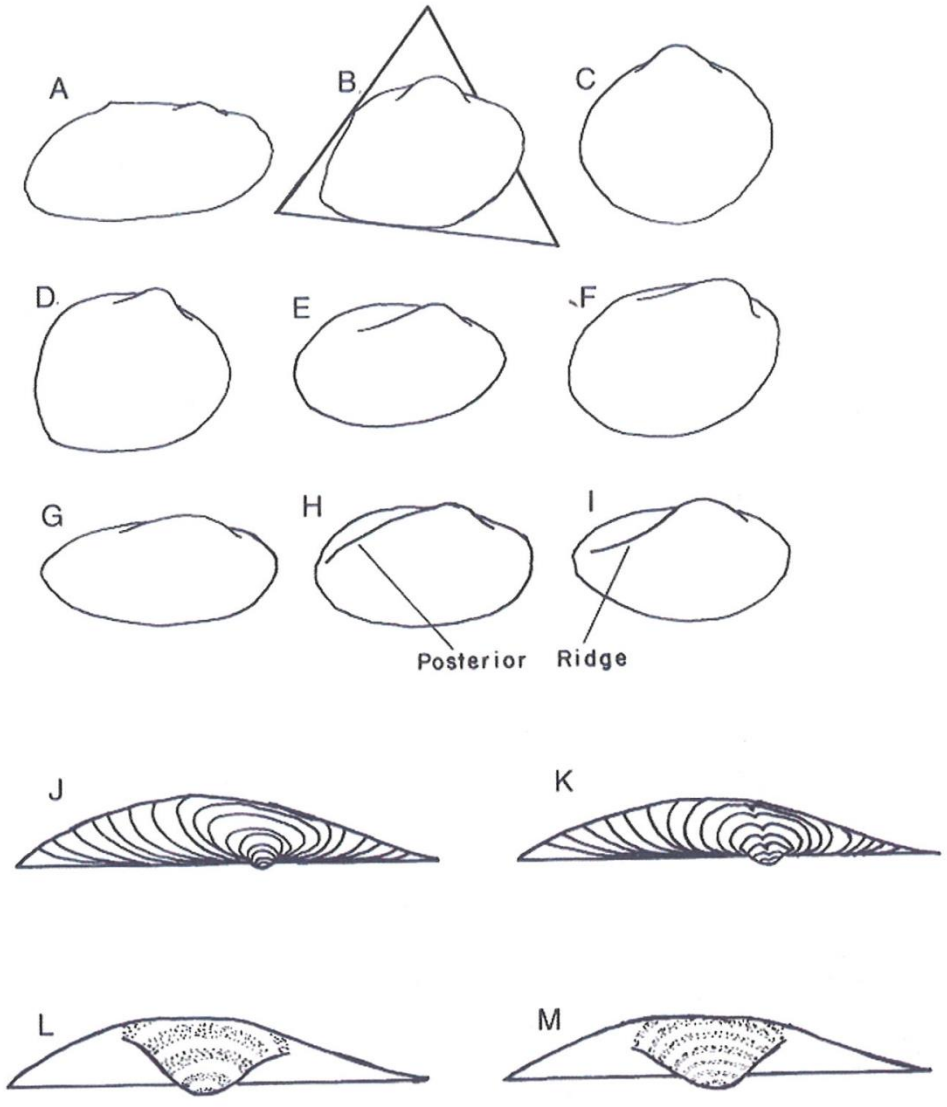
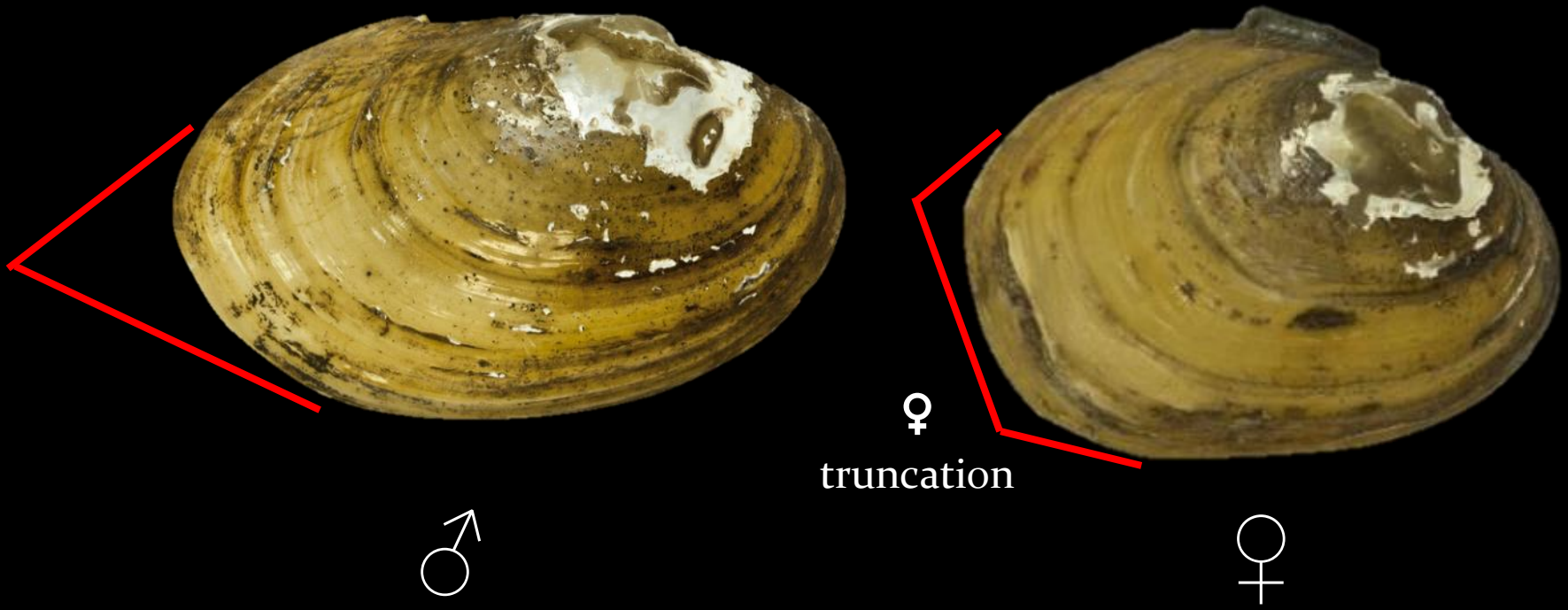


Figure 3. Illustrations of shell shape and umbo sculpture. Shell shape descriptions: (A) rhomboidal; (B) triangular or trigonal; (C) round; (D) quadrate; (E and F) oval or ovoid; and (G) elliptical. Posterior shell-ridge morphology: (H) posterior ridge convex; and (I) posterior ridge concave. Concentric ridge structures of umbos: (J) single-looped concentric ridges; (K) double-looped concentric ridges; (L) coarse concentric ridges; and (M) fine concentric ridges. (Reproduced from McMahon and Bogan 2001).

Sexual dimorphism



♀
truncation

♂ ♀

Photo credits: *Arthur Bogan, www.discoverlife.org*

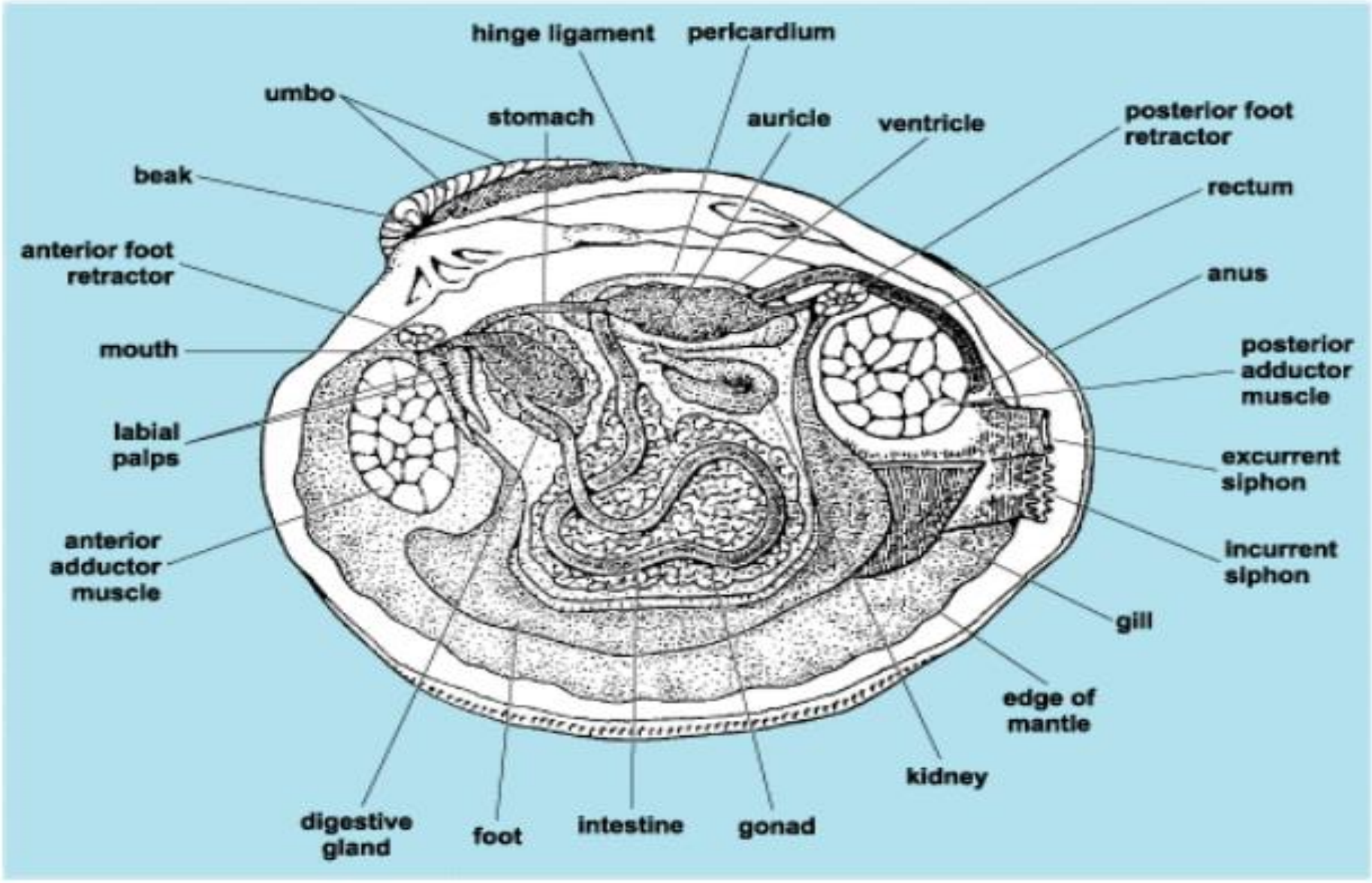
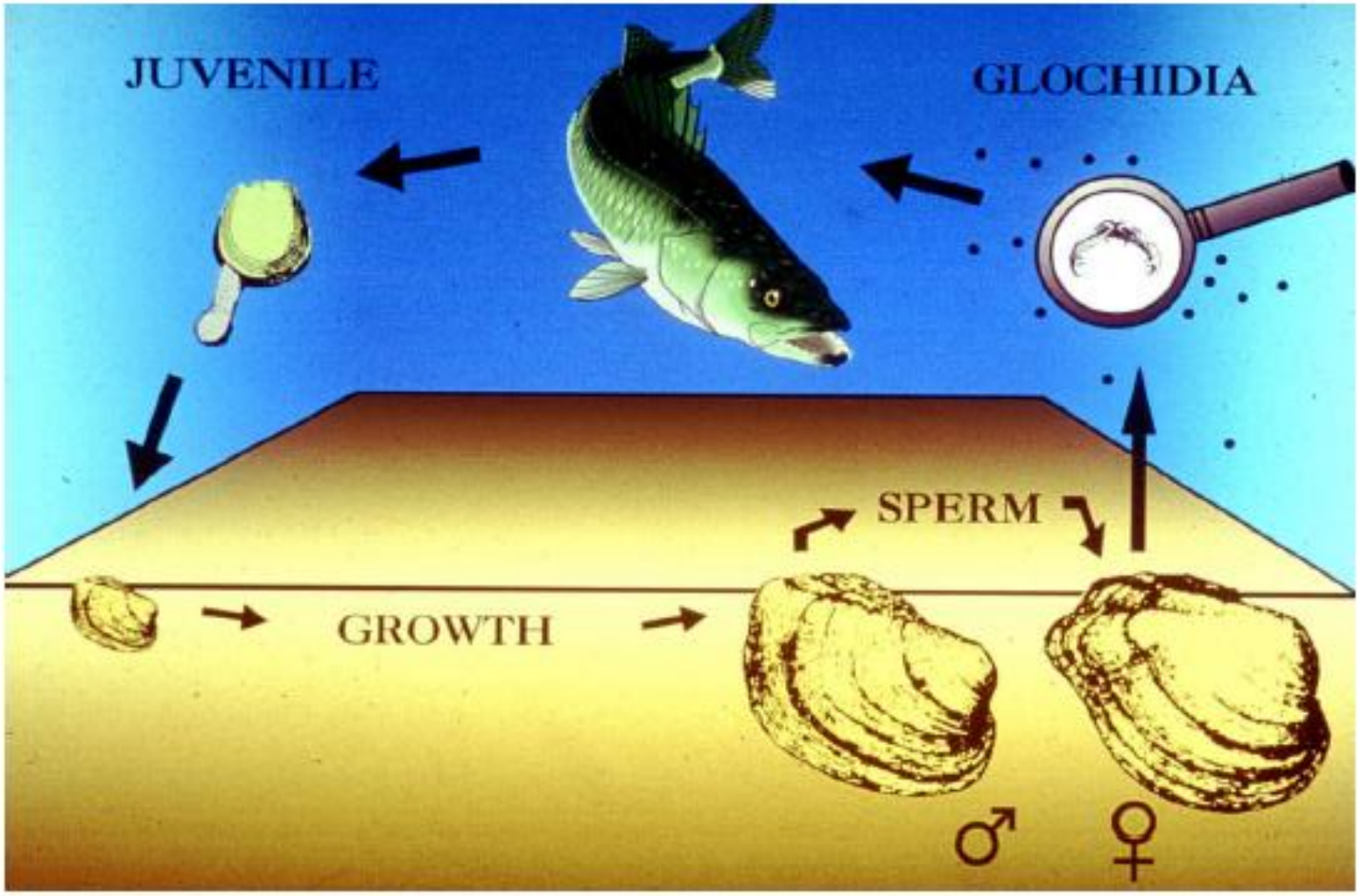
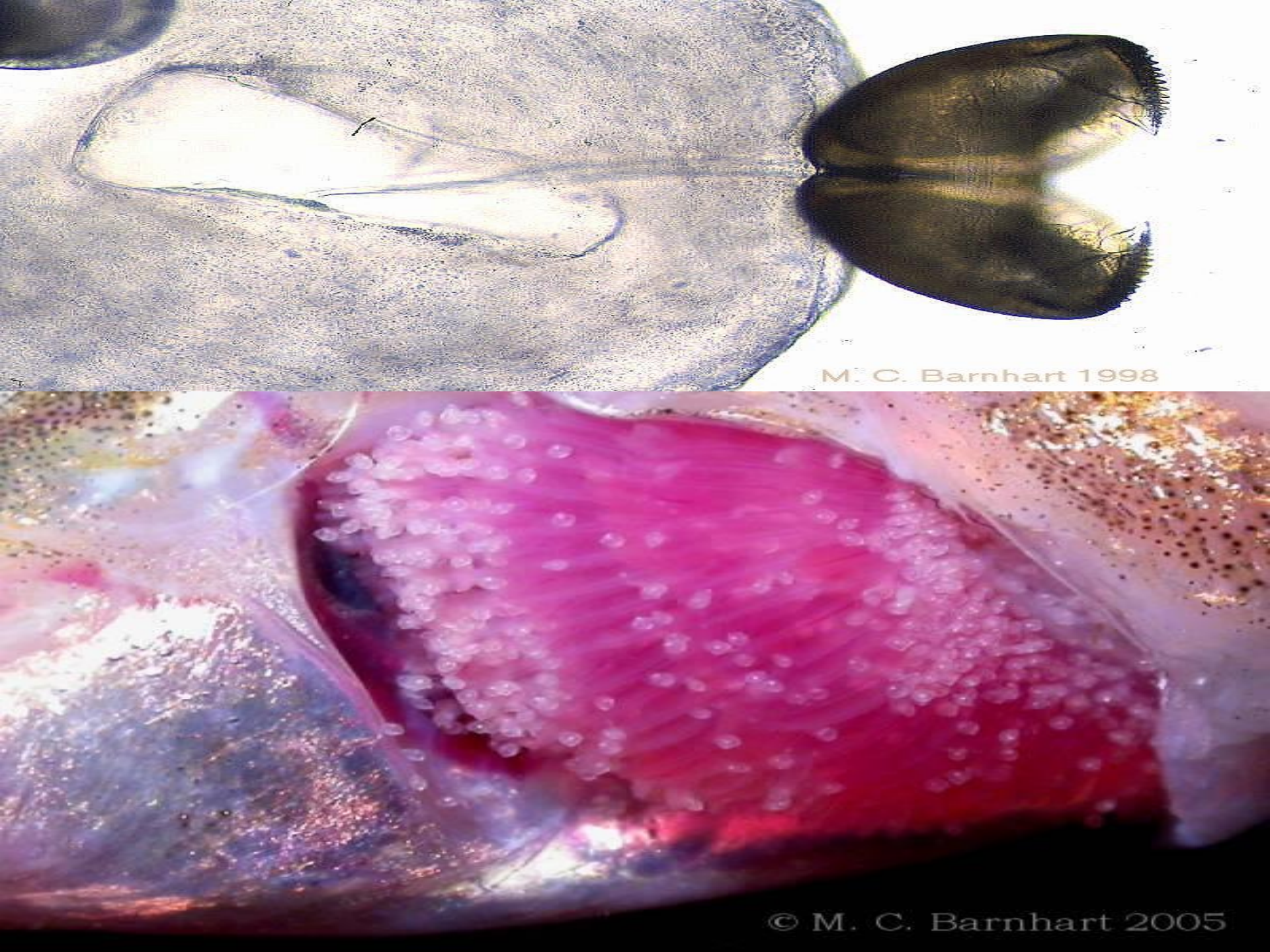


Figure 1. Diagram of a unionid shell (modified from Watters, Hoggarth, and Stansbery, 2009).

Why are mussels important?

- Provide clean water by filtering bacteria and sediment out of the water.
- Anchor and stabilize substrate
- Food source for animals
- Dietary supplement for Native Americans
- Sentinels Like a “Canary in the Coal Mine”
- Currency for early Americans
- Pearl and Button Industry


JUVENILE
GLOCHIDIA
SPERM
GROWTH
♂
♀


M. C. Barnhart 1998
© M. C. Barnhart 2005

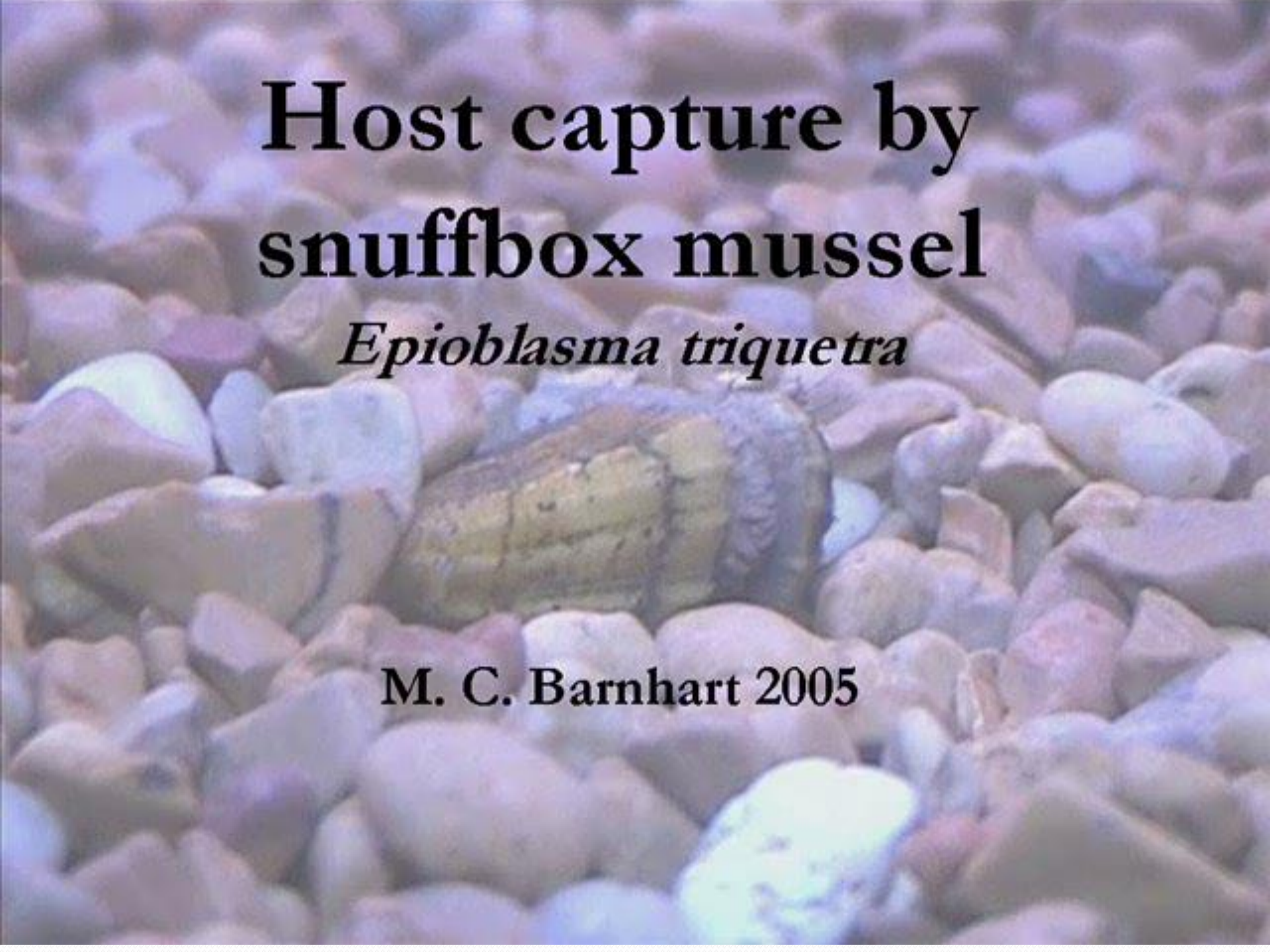
Snuffbox. The foreboding view above is a female snuffbox brooding glochidia and "displaying" her mantle. Non-brooding females do not gape so widely. The central rows of ridges on the mantle may act as a lure for the host fish. Also note the tooth-like serrated edges of the shell. Displaying females are reluctant to close unless touched on the mantle, but then snap shut within 1/15 of a second.

Logperch rolling snuffbox

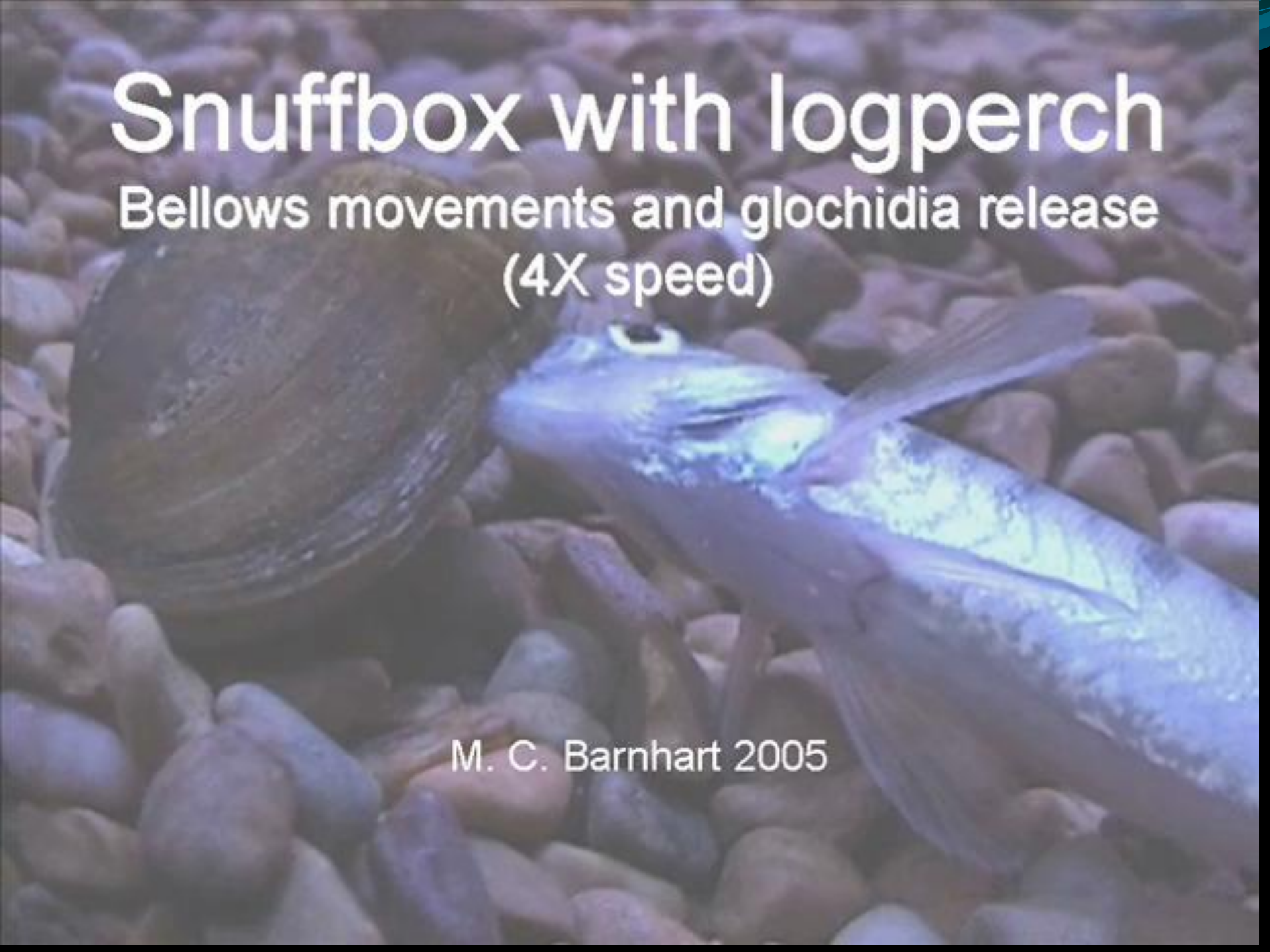
M. C. Barnhart 2005

Host capture by snuffbox mussel

Epioblasma triquetra



M. C. Barnhart 2005

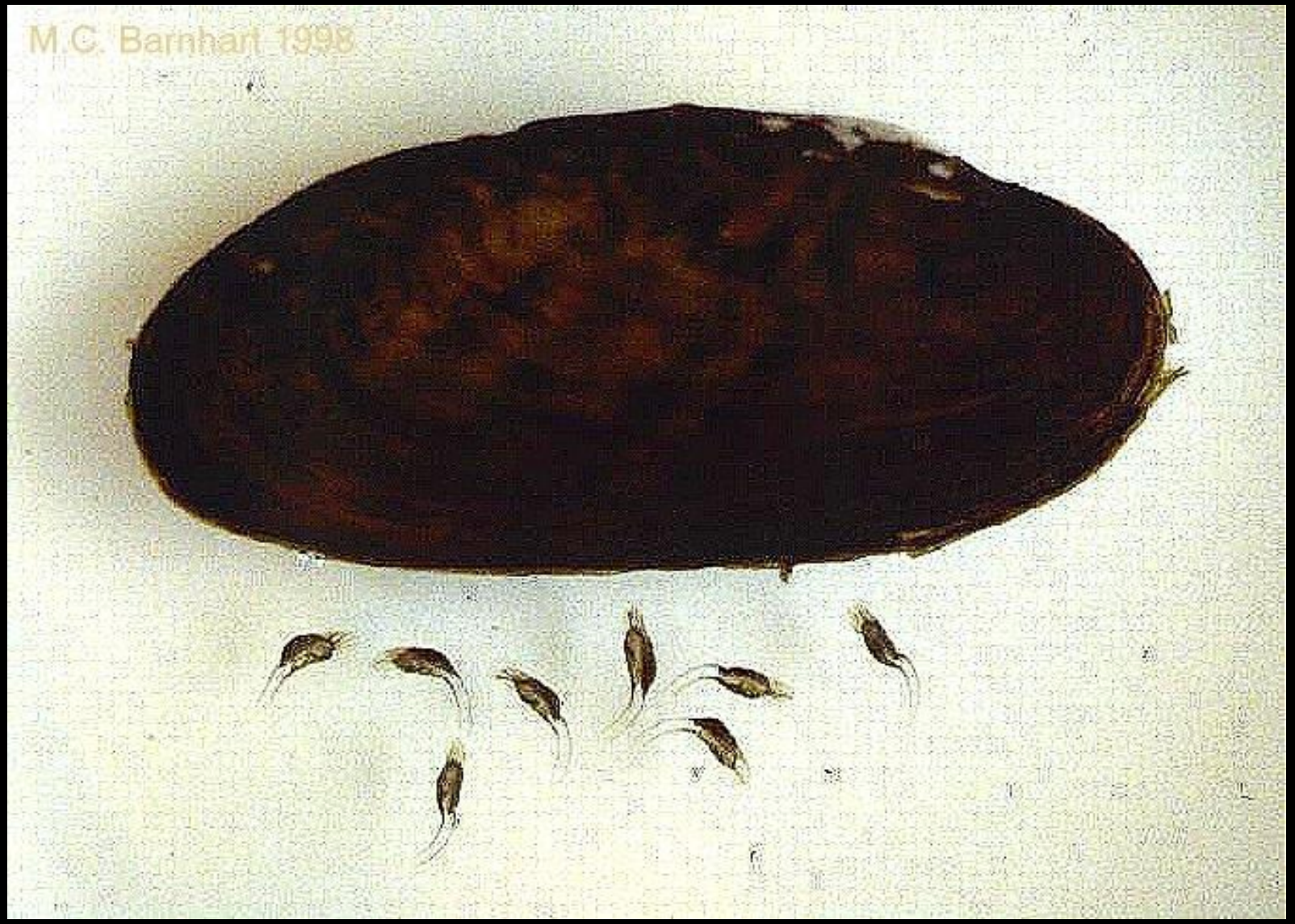

Snuffbox with logperch
Bellows movements and glochidia release
(4X speed)
M. C. Barnhart 2005

Ortmann (1911) described a peculiar feature of the mantle of female *Epioblasma*- an "inner edge" with a spongy interior. This inflatable ridge is small in snuffbox but dramatically developed in riffleshells (see below). We can now see that the function of the structure is to act as a gasket that seals the shell gape after host capture, to reduce leakage of glochidia. This video (2MB) shows the inflation of the mantle gasket or cymapallium.


How to get glochidia from *Epioblasma!*
M. C. Barnhart 2005


Villosa iris
Swan Creek, Taney Co, Missouri
Copyright © 1999 Wm. Roston

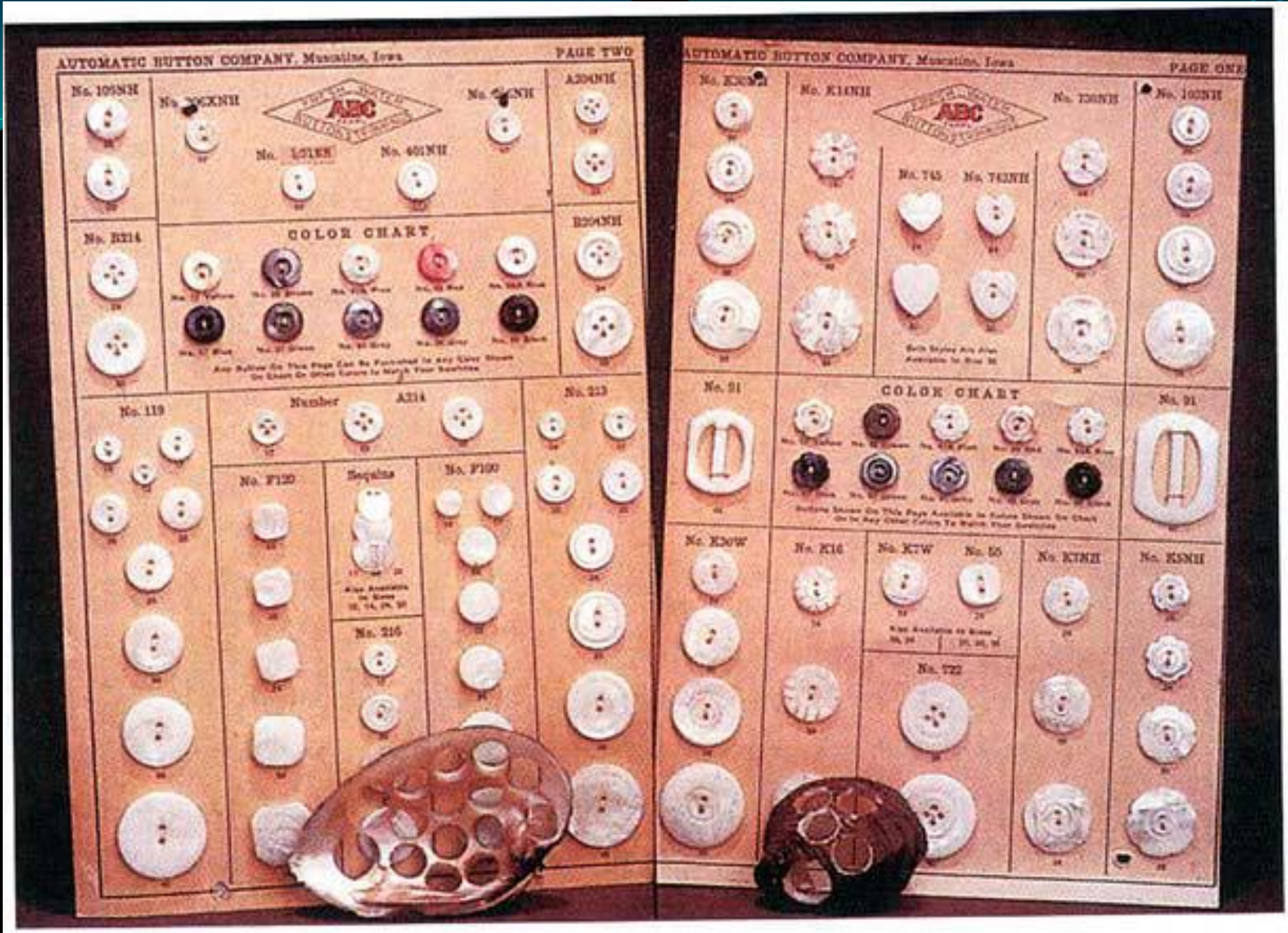

Black sandshell (*Ligumia recta*)
Sac River, Missouri
© M. C. Barnhart 2002


M.C. Barnhart 1998


From the *Unio Gallery*


M.C. Barnhart 1998


M. C. Barnhart


AUTOMATIC BUTTON COMPANY, Muscatine, Iowa
PAGE TWO
No. 109NH
No. 401NH
A204NH
No. B214
COLOR CHART
B204NH
No. 119
Number A214
No. 223
No. F120
Sequins
No. F100
No. 216
AUTOMATIC BUTTON COMPANY, Muscatine, Iowa
PAGE ONE
No. K14NH
No. 745
No. 742NH
No. 736NH
No. 102NH
No. 21
COLOR CHART
No. 21
No. K20W
No. K16
No. K7W
No. 55
No. K7NH
No. K5NH
No. 722

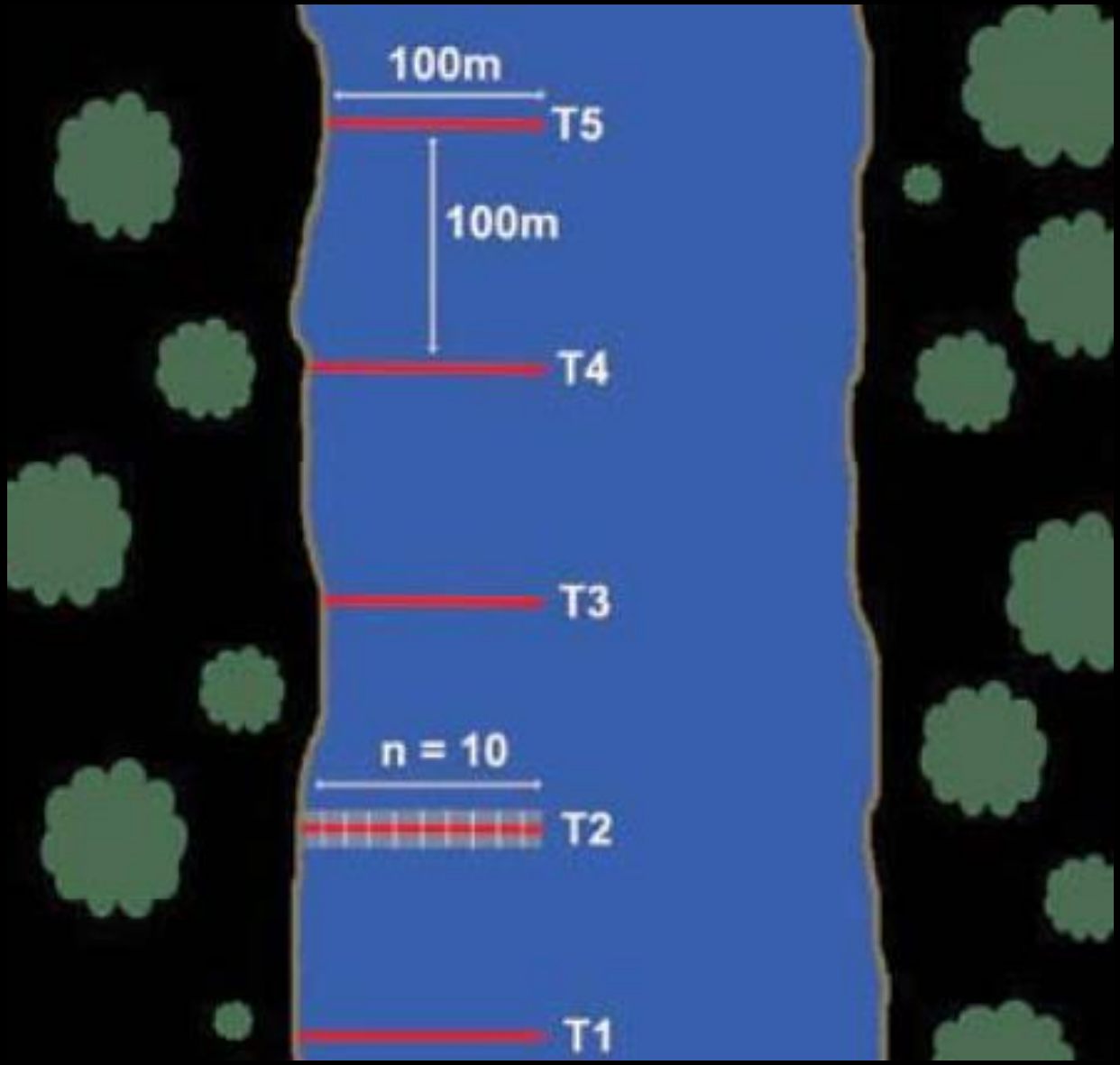
Mussel Sampling

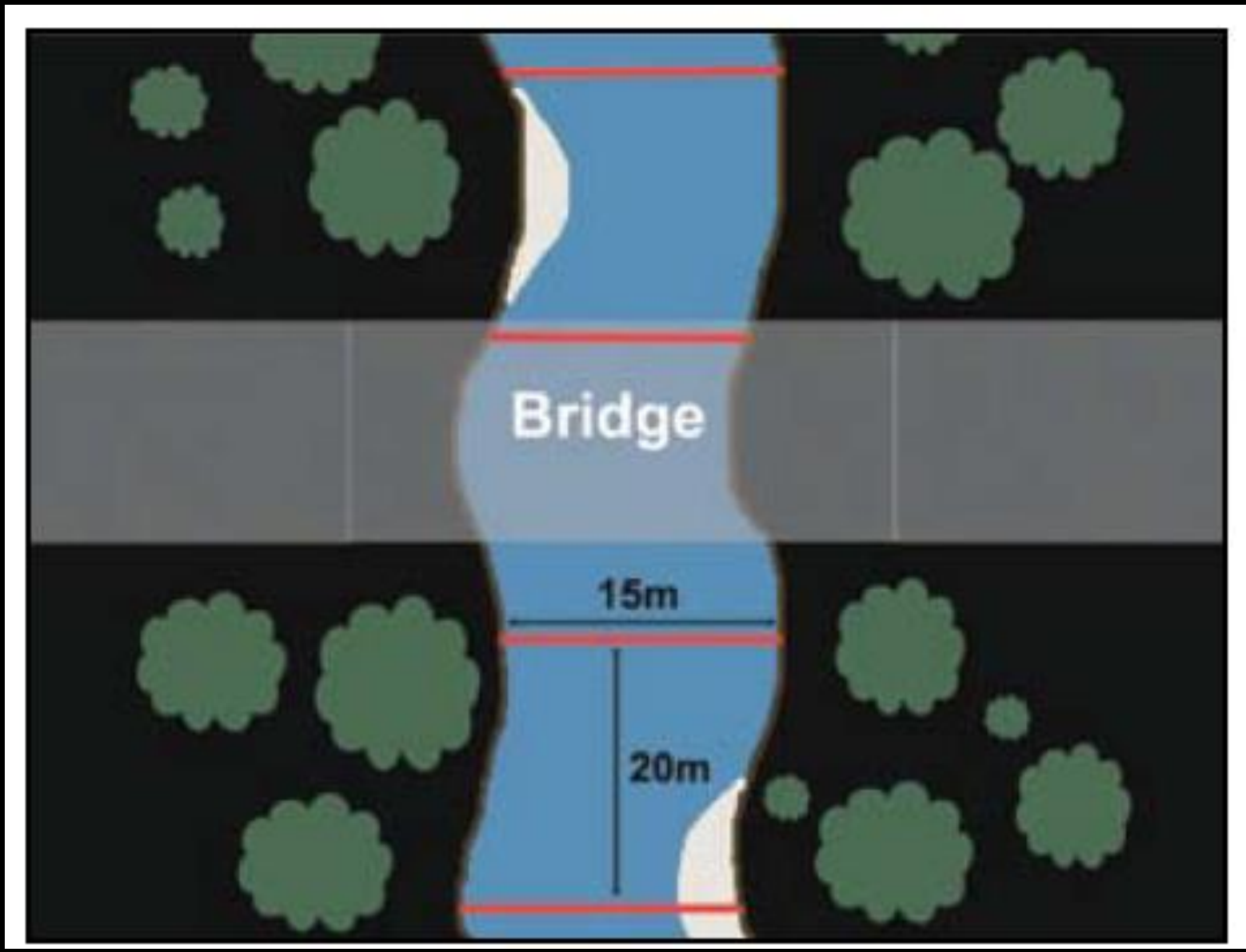
Harvesting mussels on the Illinois River with a crowfoot bar (brail). Close-up of the "crow feet" that mussels clamp onto.

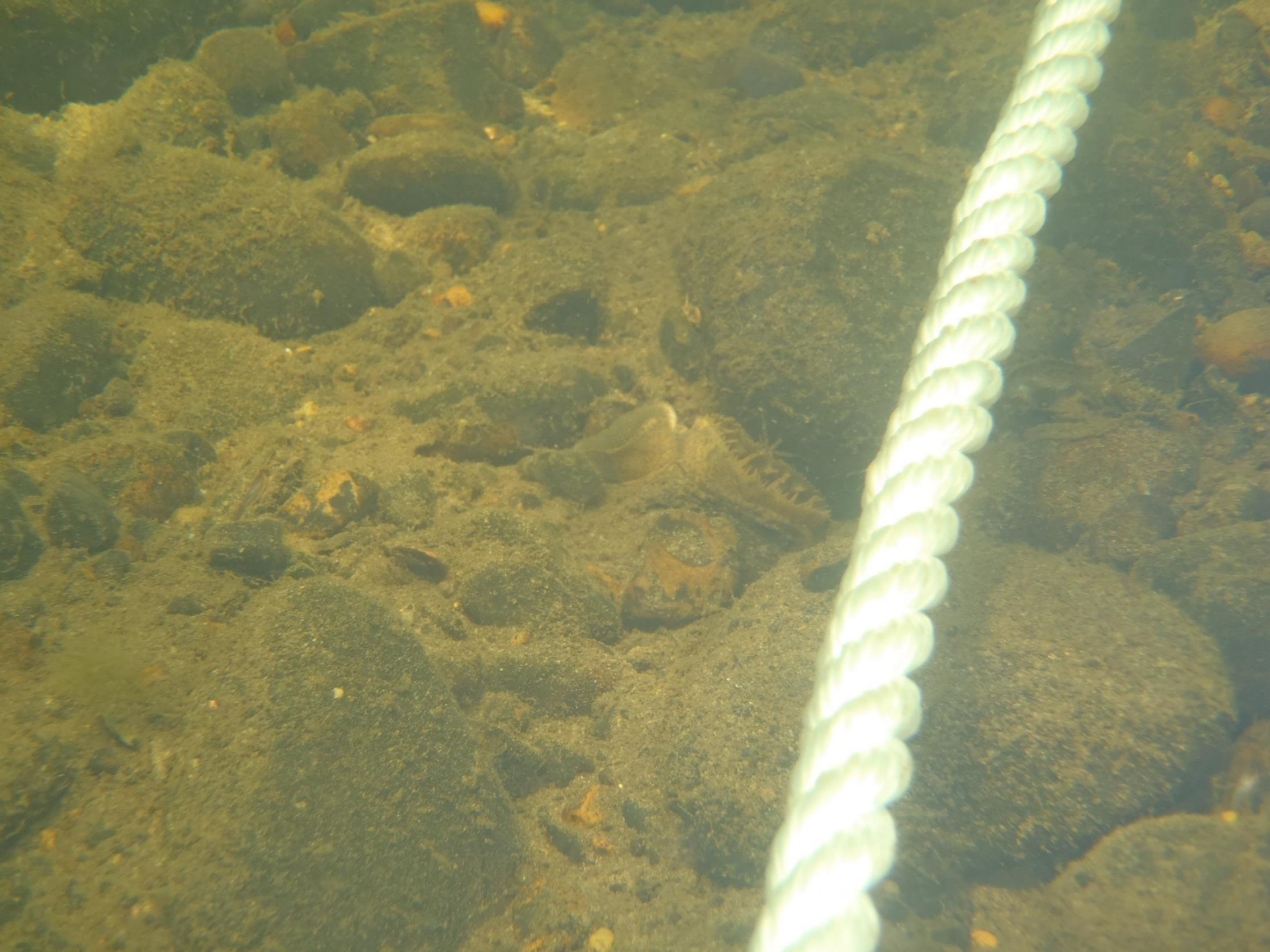
Source: Marshall County Historical Society, Illinois; G. Andrashko, Illinois State Museum

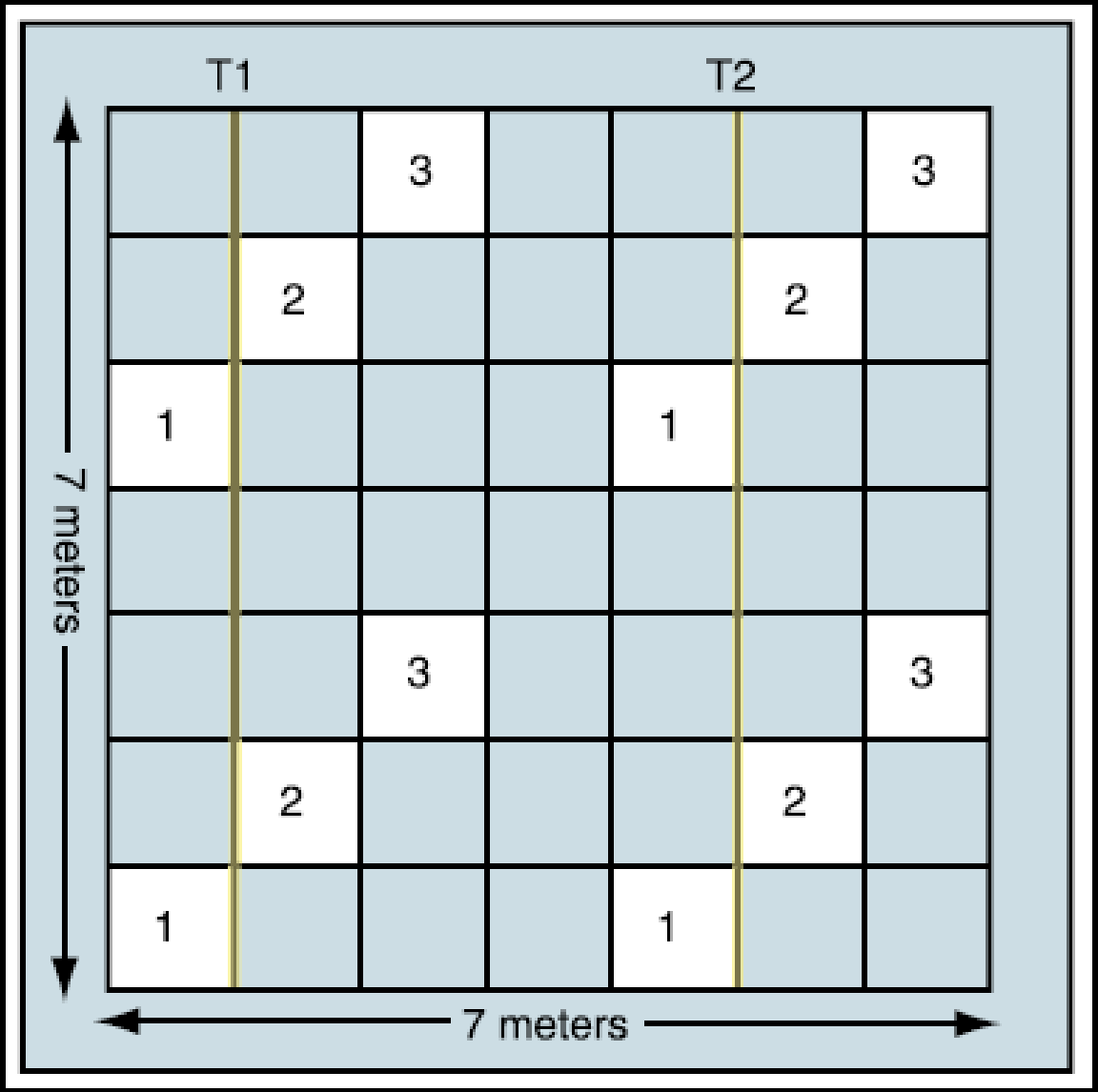
Qualitative Surveys
- Timed Searches -

View Buckets


100m
T5
100m
T4
T3
n = 10
T2
T1


Bridge
15m
20m





Quadrat Sampling (Smith)

systematic sampling design along 2 transects with 3 random starts (see Strayer and Smith 2003). Generally, 0.25 m^2 quadrats are used for quantitative work; 1 m^2 sampling units are used here for simplicity.

12 random sites are chosen. They are from the shoreline and from the downstream point.


SCUBAPRO

Quick tips - How to get really good at mussel ID

- Handle lots of specimens!
- Dig through shell middens
- Spend time at the museum
- Learn about species and their distribution
- Get to know your local streams and their fauna

Approach and schedule

- Approach
  - Address 2 common identification scenarios:
    1. You find a shell, or;
    2. You find a live mussel
  - Facilitate rapid ID of specimen using a few shell features *or* simple internal anatomy
- Schedule
  - Atlantic Slope species
  - Endangered species

Atlantic Slope – invasives/introduced

1. *Dreissena polymorpha*
2. *Dreissena bugensis*
3. *Corbicula fluminea*
4. *Lampsilis cardium*
5. *Pyganodon grandis*
6. *Utterbackia imbecillis*
7. *Villosa iris*

Invasives

- *Dreissena polymorpha* (Zebra Mussel)

flattened ventral margin (lays flat)

- *D. bugensis* (Quagga Mussel)

free-swimming veliger larvae

rounded ventral margin (tips over)

- *Corbicula fluminea* (Asian Clam)

raised “annuli”
2 serrated lateral teeth

Lampsilis cardium *"heart-shaped"*

- Plain Pocketbook
  - Introduced into the upper Potomac River
  - Rounded posterior slope
  - Rays on anterior portion of shell

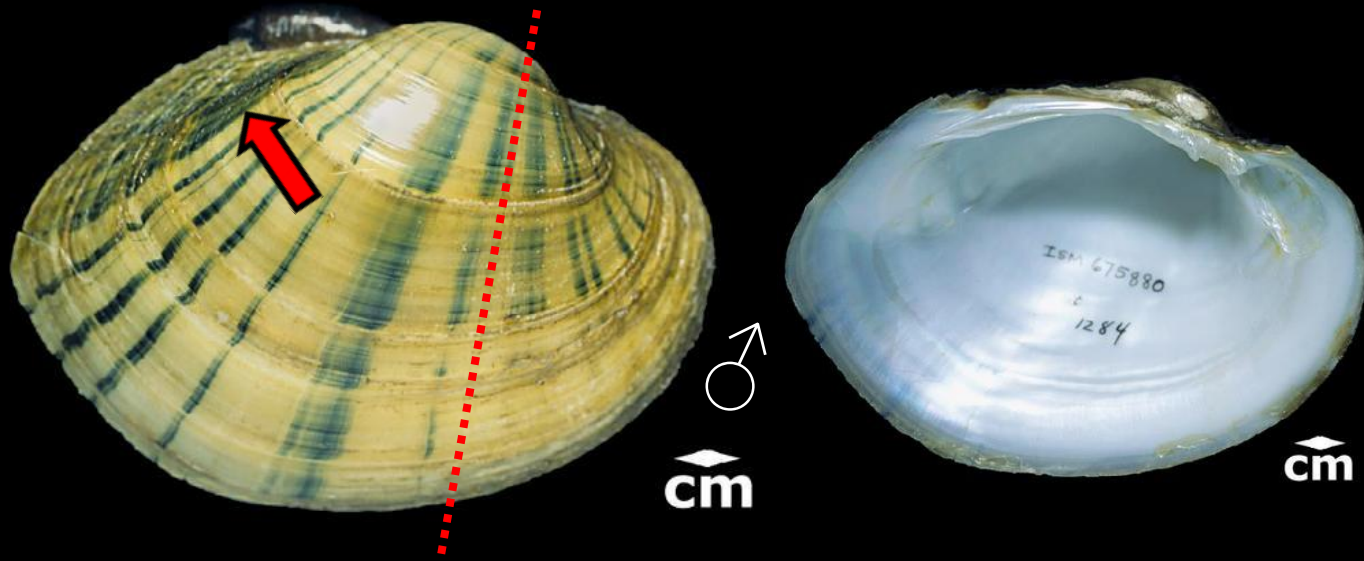
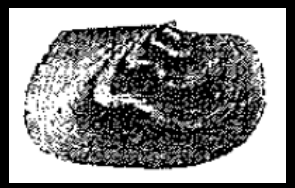


Photo credits: *Robert Warren, Grabarkiewicz & Crail*

Pyganodon grandis

"giant buttocks, without teeth"

- Giant Floater
  - beak sculpture consists of several nodulous, double-looped ridges



beak sculpture
vs. *P. cataracta*
From Strayer & Jirka (1997)

Photo credits: *Robert Warren, Grabarkiewicz & Crail*

Utterbackia imbecillis

"patronym for Utterback, weak, fragile shell"

- Paper Pondshell
  - umbo not above hinge line
  - very thin, greenish shell

Photo credits: *Nevin Welte*

Villosa iris *"shaggy goddess of the rainbow"*

- Rainbow
  - invasive to the Susquehanna River basin
  - crayfish lure

posterior iridescence

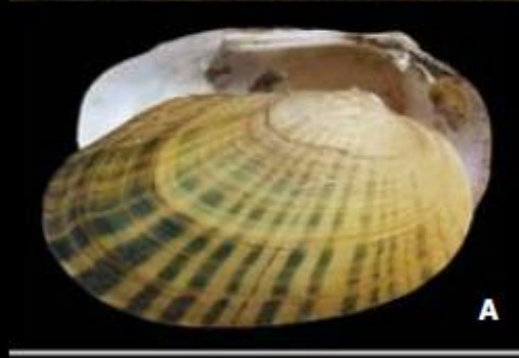


Photo credits: *Karen Little, Grabarkiewicz & Crail*

Villosa iris *"shaggy goddess of the rainbow"*

- Rainbow

Atlantic Slope - natives

1. *Alasmidonta heterodon*
2. *Alasmidonta marginata*
3. *Alasmidonta undulata*
4. *Alasmidonta varicosa*
5. *Elliptio complanata*
6. *Elliptio fisheriana*
7. *Elliptio producta*
8. *Lampsilis cariosa*
9. *Lampsilis radiata*
10. *Leptodea ochracea*
11. *Lasmigona subviridis*
12. *Ligumia nasuta*
13. *Margaritifera margaritifera*
14. *Pyganodon cataracta*
15. *Strophitus undulatus*
16. *Utterbackiana implicata*
17. *Villosa iris*

Eastern Pearlshell stream
(Little Schuylkill River)

Upper Delaware River

Alasmidonta heterodon

"the one with lateral teeth"

- Dwarf Wedgemussel
  - < 38 mm

no lateral teeth

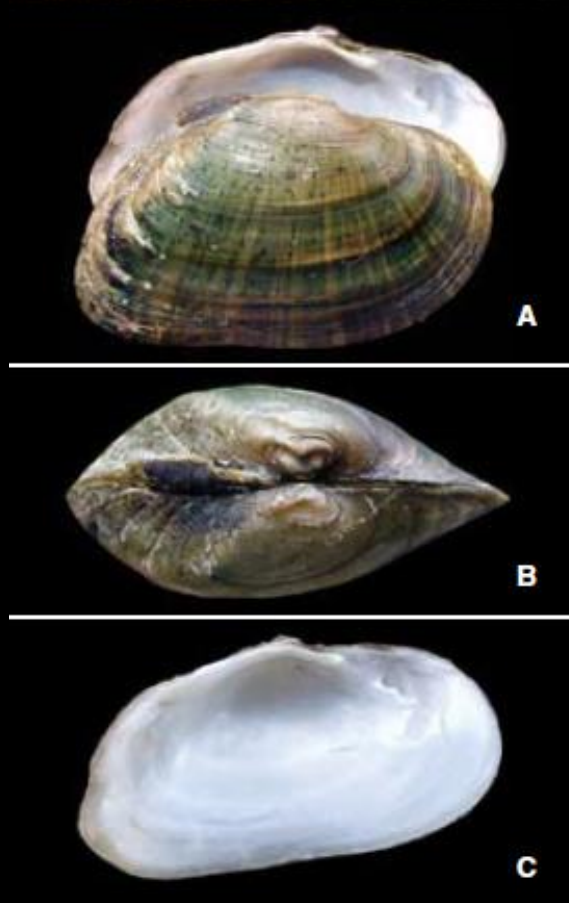
shell erosion typical for PA specimens

Photo credits: *Arthur Bogan, www.discoverlife.org, Ethan Nedeau, Grabarkiewicz & Crail*

Alasmidonta marginata

"without lateral teeth, with border"

- Elktoe
  - (~ 100 mm)



sharp posterior ridge

rounded ventral margin

border

Photo credits: *Karen Little, Grabarkiewicz & Crail*

Alasmidonta undulata

"without lateral teeth, having nature of a wave"

- Triangle Floater
  - (< 70 mm)

heavy erosion in front of umbos

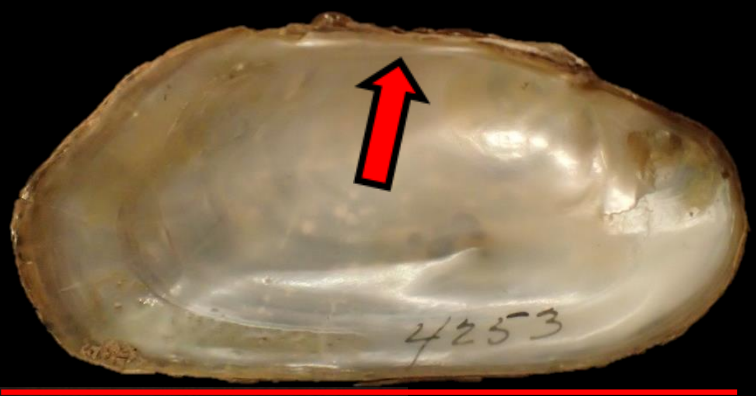
large pseudocardinal teeth

Photo credits: *Nevin Welte*

Alasmidonta varicosa

"without lateral teeth, having ridges"

- Brook Floater
  - rounded posterior slope, < 70 mm



flattened ventral margin

fine flutings / ridges

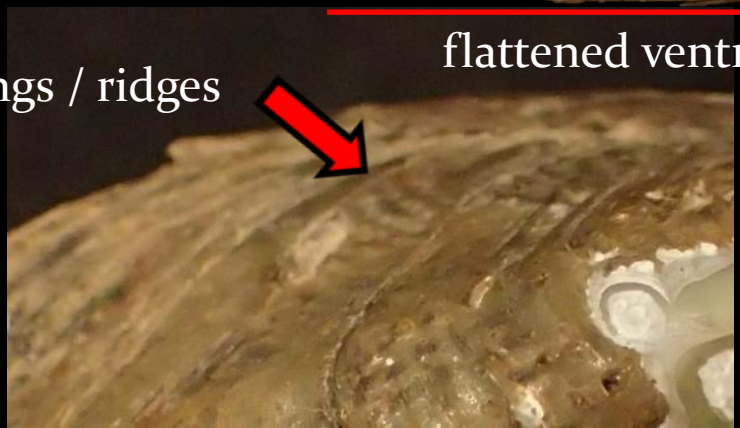


Photo credits: *Nevin Welte*

A. varicosa *vs* *A. marginata*

- Brook Floater

rounded posterior ridge

flattened ventral margin

smaller, < 70 mm

- Elktoe

sharp posterior ridge

rounded ventral margin

larger, up to 100 mm

Elliptio complanata

"flattened ellipse"

- Eastern Elliptio
  - 50-80 mm

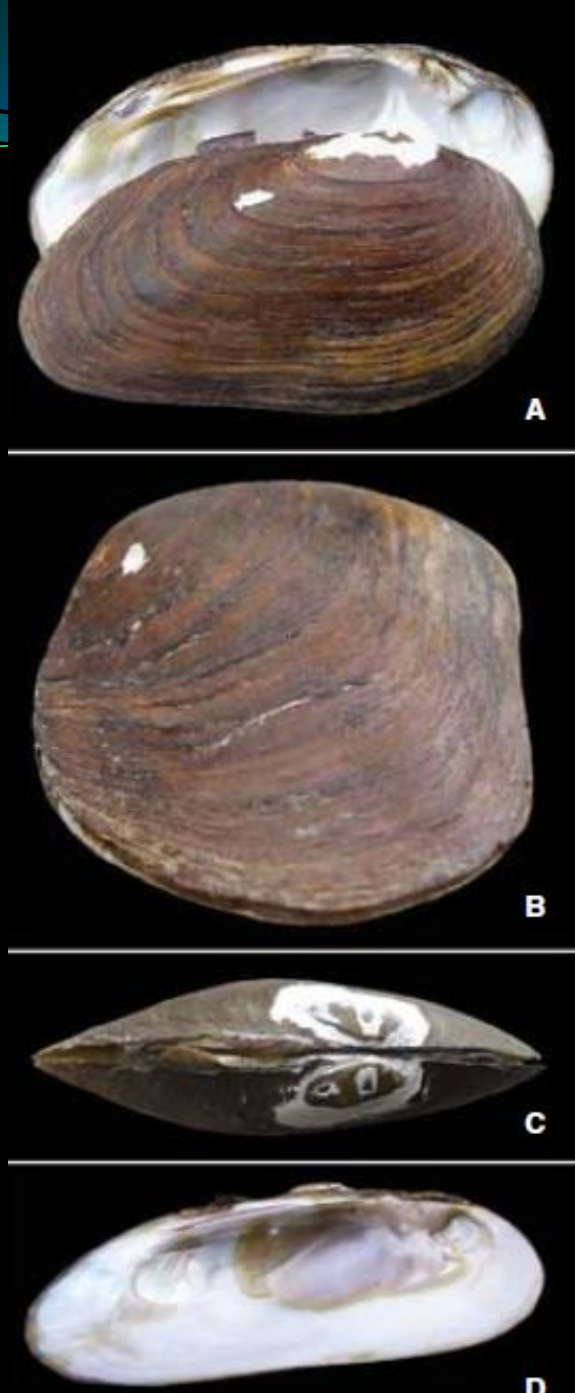


Photo credits: *Nevin Welte, Grabarkiewicz & Crail*

Elliptio fisheriana *"patronym for Fisher"*

- Northern Lance
  - Elongated, lance-shaped shell (~100 mm)
  - Shell compressed, thin
  - Atlantic coastal streams (single PA specimen, Delaware R.)

Photo credits: *Nevin Welte*

Elliptio producta

- Northern Lance
  - Characterized by elongated, lance shape (~ 100 mm)
  - Similar to *E. fisheriana*, but smaller
  - Potomac River drainage

Photo credits: *Nevin Welte*

Lampsilis cariosa *"rotten, decayed"*

- Yellow Lampmussel
  - (~ 75 mm)

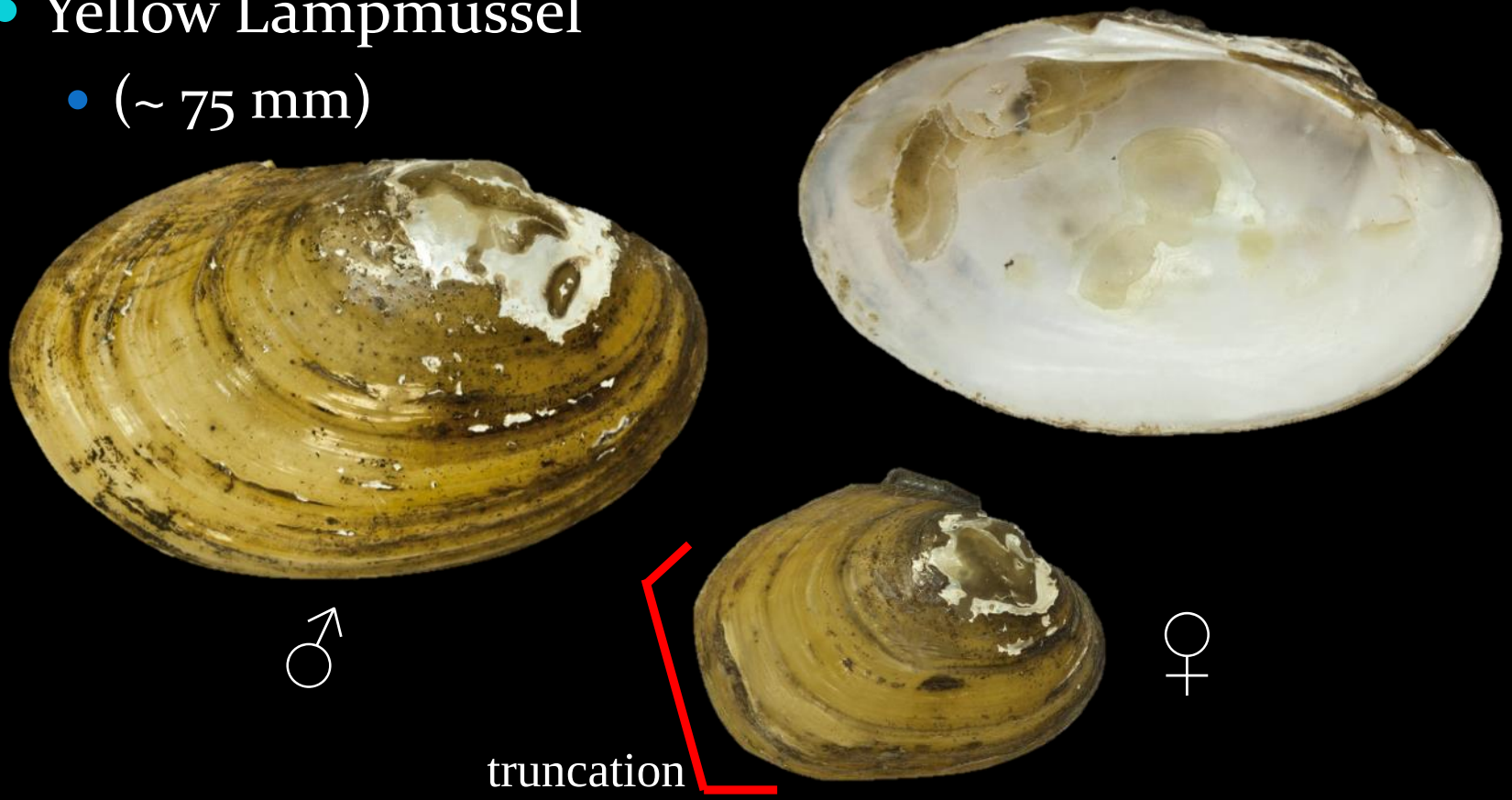


Photo credits: *Arthur Bogan*, www.discoverlife.org

Lampsilis radiata *"furnished with rays"*

- Eastern Lampmussel
  - ~100 mm

♂

Photo credits: *Nevin Welte*

Lasmigona subviridis *"less green"*

- Green Floater
  - small, thin shell (typically < 50 mm)
  - hermaphroditic

Photo credits: *Nevin Welte*

Leptodea ochracea

"fine, delicate teeth, pale yellow"

- Tidewater Mucket
  - (~ 75 mm)

Photo credits: *Arthur Bogan*, *www.discoverlife.org*

Ligumia nasuta *"bean pod resembling a nose"*

- Eastern Pondmussel
  - nose shape (~ 75 mm)
  - tidal Delaware

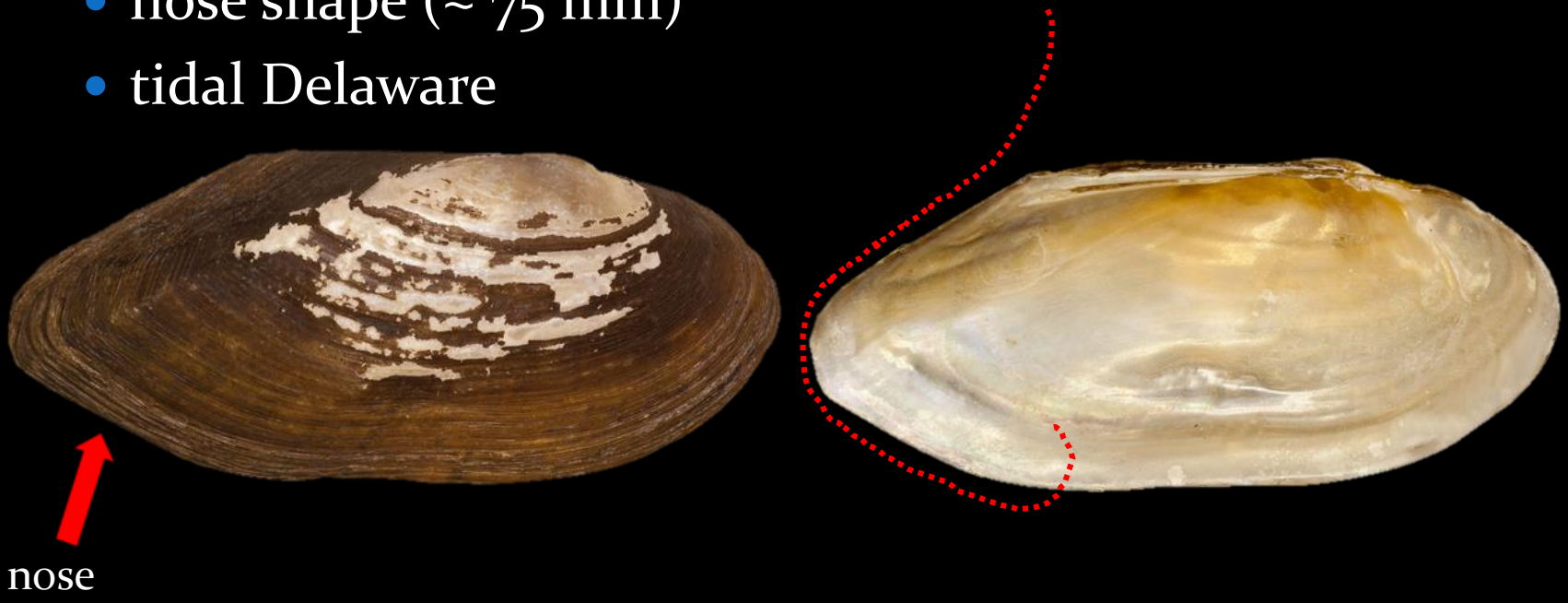


Photo credits: *Arthur Bogan*, www.discoverlife.org

Margaritifera margaritifera *"pearl bearer"*

- Eastern Pearlshell
  - unique gills
  - mantle scars = "shooting stars"
  - 120-150 mm

Photo credits: *David Fenwick, Nevin Welte*

Pennsylvania pearls

- The Pennsylvania Pearl Rush
  - 1897
  - Devastated Little Schuylkill River *M. margaritifera* populations
  - "*…At present time there is as far as known only one stream in Pennsylvania in which the Margaritana is found. It is a trout stream in Schuylkill County, but seekers after pearls have so depleted the stream that last year (1907), my collectors were unable to find a single live specimen, though they found many shells.*"

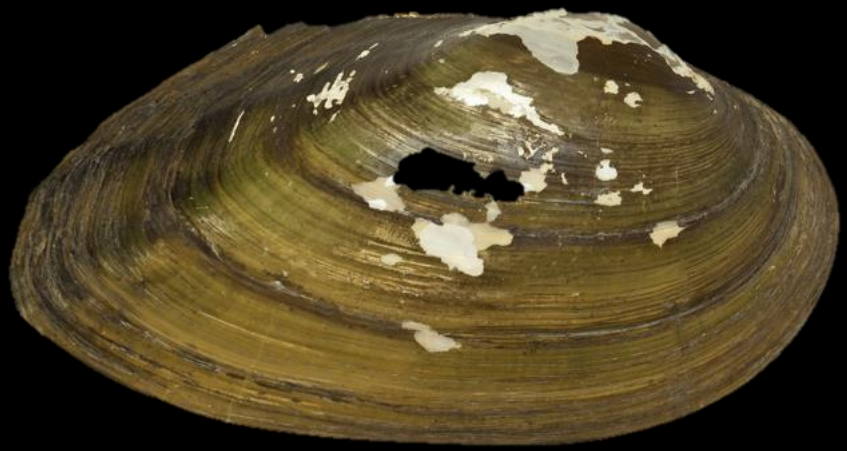
    – William Meehan, Pennsylvania Department of Fisheries (1906/1907)

- PFBC Spruce Creek hatchery
  - 1907 - 50 live specimens received from MA

Little Schuylkill River basin, Schuylkill Co.

Pyganodon cataracta *"buttocks without teeth"*

- Eastern Floater
  - beak sculpture consists of 5 – 7, low, evenly raised concentric double-looped bars, > 100 mm



beak sculpture
vs. *P. cataracta*
From Strayer & Jirka (1997)

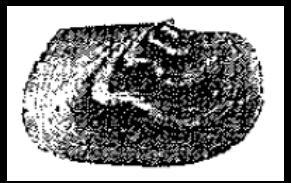


Photo credits: *Arthur Bogan, www.discoverlife.org*

Strophitus undulatus

"having an undulating hinge line"

- Creeper
  - ~ 100 mm

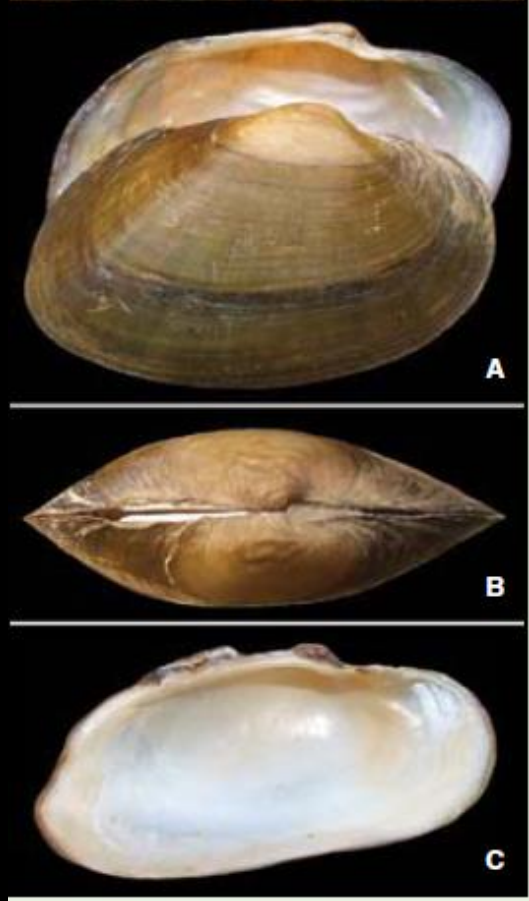
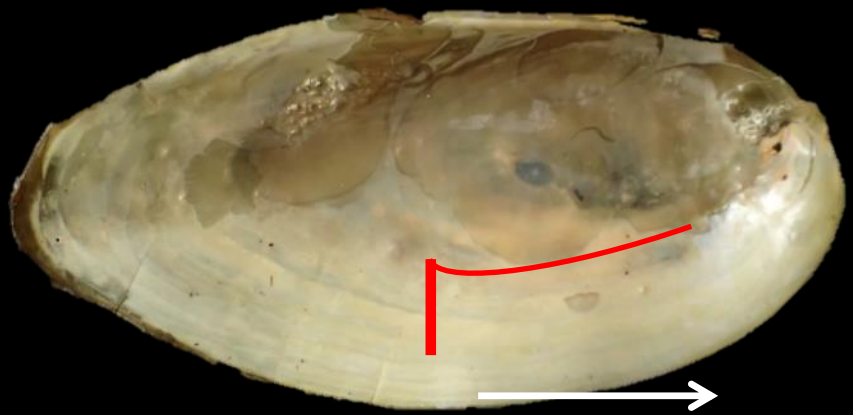


Photo credits: *Karen Little*

Utterbackiana implicata *"folded in"*

- Alewife Floater
  - coppery shell, nacre
  - (> 100 mm)



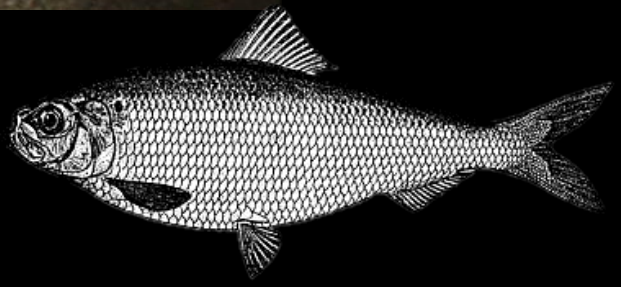


Photo credits: *Nevin Welte*

Anodontoides ferussacianus

"resembles Anodonta*, patronym for Baron de Ferussac"*

- Cylindrical Papershell
  - (< 75 mm)

Photo credits: *Nevin Welte*

Interior Basin – endangered spp.

1. *Epioblasma rangiana*
2. *Epioblasma triquetra*
3. *Obovaria subrotunda*
4. *Plethobasus cyphyus*
5. *Pleurobema clava*
6. *Simpsonaias ambigua*
7. *Theliderma cylindrica*
8. *Tritogonia verrucosa*
9. *Villosa fabalis*
10. *Cyprogenia stegaria*
11. *Hemistena lata*
12. *Lampsilis abrupta*
13. *Obovaria retusa*
14. *Plethobasus cooperianus*
15. *Pleurobema plenum*

Allegheny River at PFBC Parker access

Photo credits: *Nevin Welte*

Epioblasma rangiana

- Northern Riffleshell

♂

sulcus

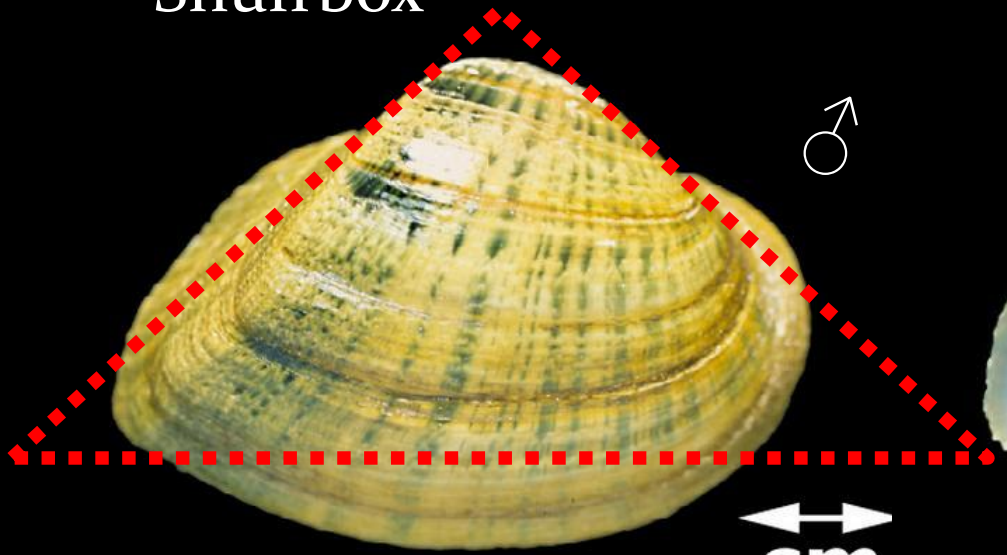
lobe

♀

Photo credits: *Nevin Welte, Chris Barnhart, Grabarkiewicz & Crail*

Epioblasma triquetra

- Snuffbox



cm

cm

♀

denticles

♀

Photo credits: *Robert Warren. Chris Barnhart, Nevin Welte*

Obovaria subrotunda

"egg-shaped, almost perfectly round"

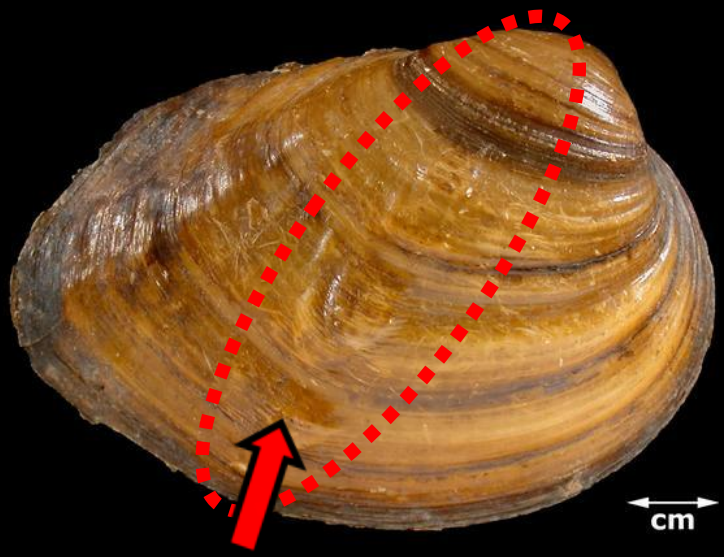
- Round Hickorynut
  - umbo centralized

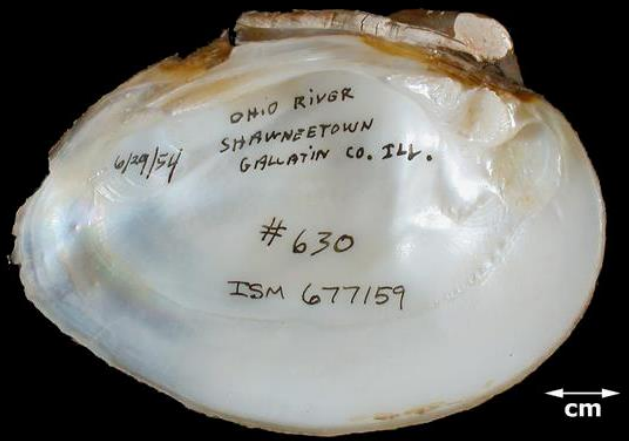
Photo credits: *Robert Warren*

Plethobasus cyphyus

"Swollen, or full in the middle." "Hump-backed"

- Sheepnose





odd row of tubercles down center of shell

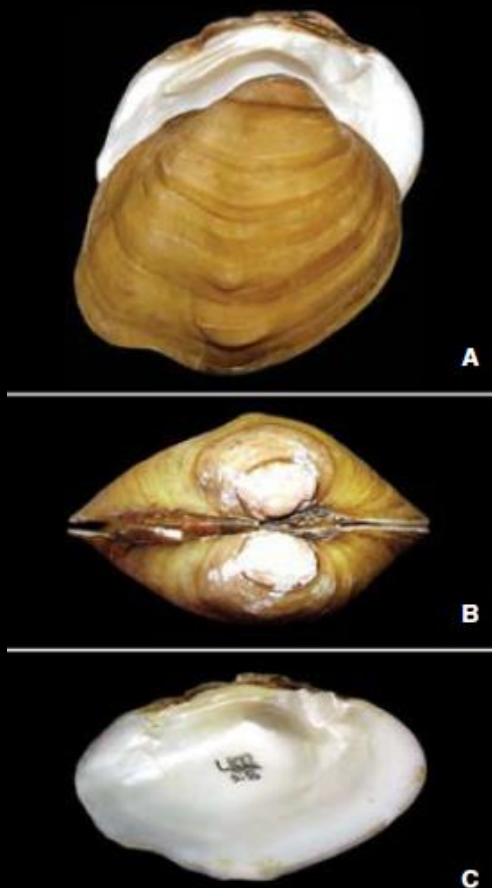


Photo credits: *Karen Little, Nevin Welte, Grabarkiewicz & Crail*

Pleurobema clava *"club-shaped"*

- Clubshell

green blotches

yellowish, brown shell

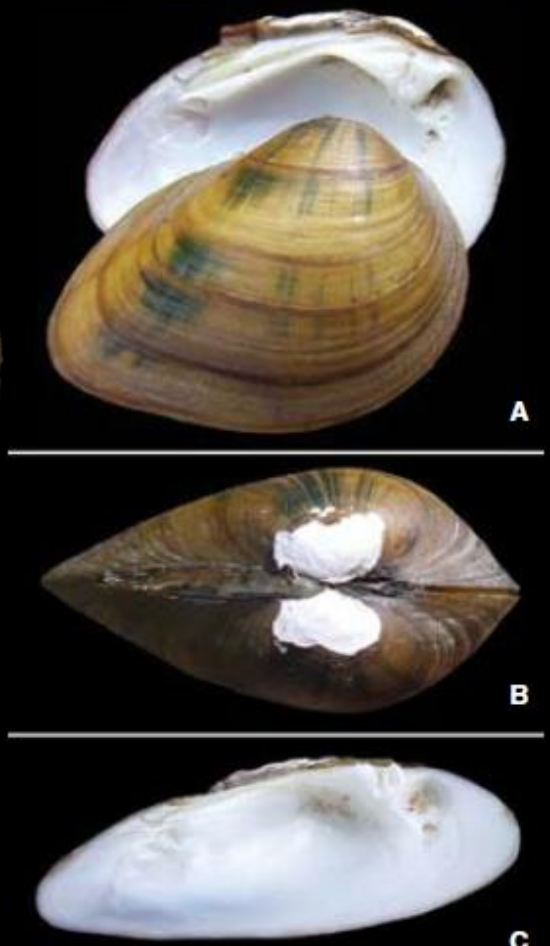


Photo credits: *Nevin Welte, Grabarkiewicz & Crail*

Simpsonaias ambigua *"Simpson's naiad"*

- Salamander Mussel
  - moderately thick shell, very elliptical

shell thickened along pallial margin

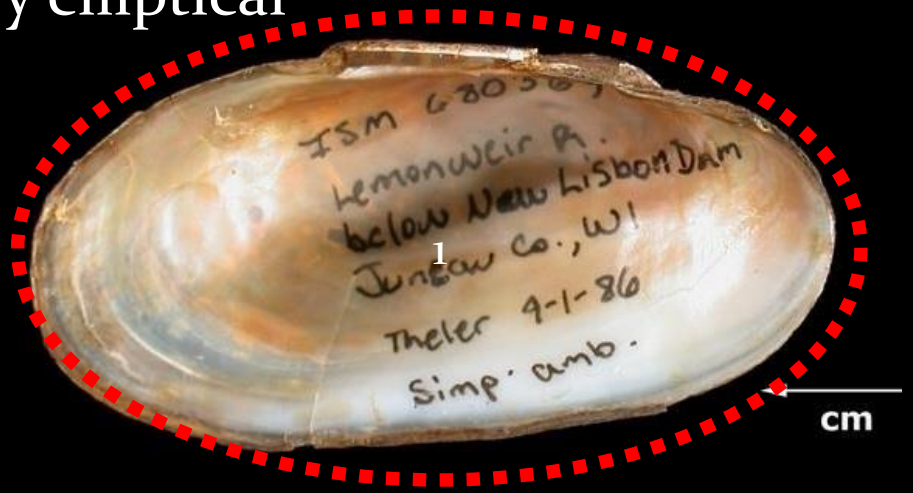


Photo credits: *Karen Little, Nevin Welte*

Theliderma cylindrica

- Rabbitsfoot

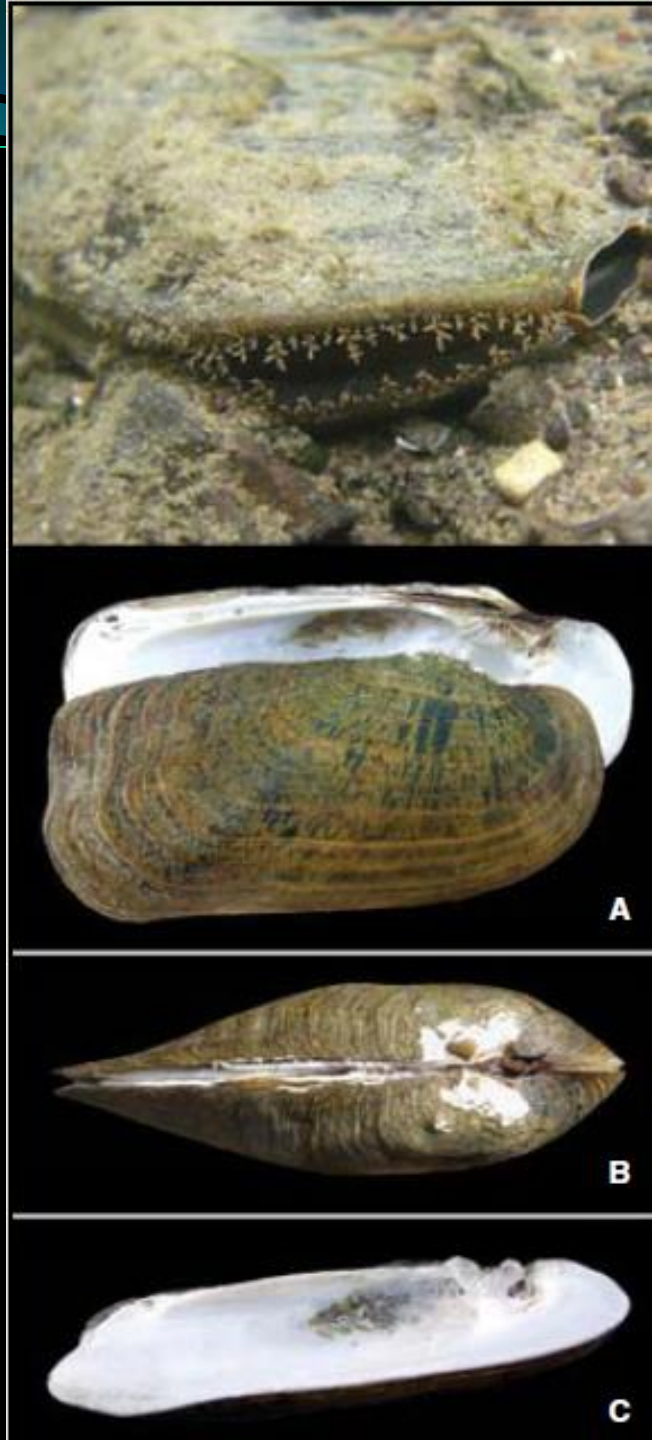


Photo credits: *Karen Little, Grabarkiewicz & Crail*

Tritogonia verrucosa *"full of warts"*

- Pistolgrip

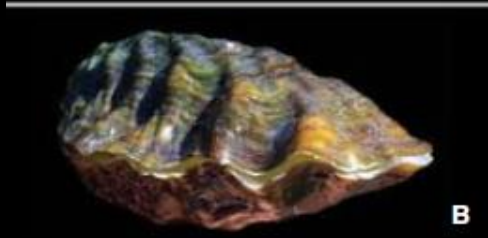


Photo credits: *Robert Warren, Grabarkiewicz & Crail*

Villosa fabalis *"shaggy, bean-like shell"*

- Rayed Bean

♀

massive teeth & thick shell for its small size!

Differences between male and female

♂ ♀

Photo credits: *Nevin Welte*

Cyprogenia stegaria *Aphrodite + shingles*

- Fanshell

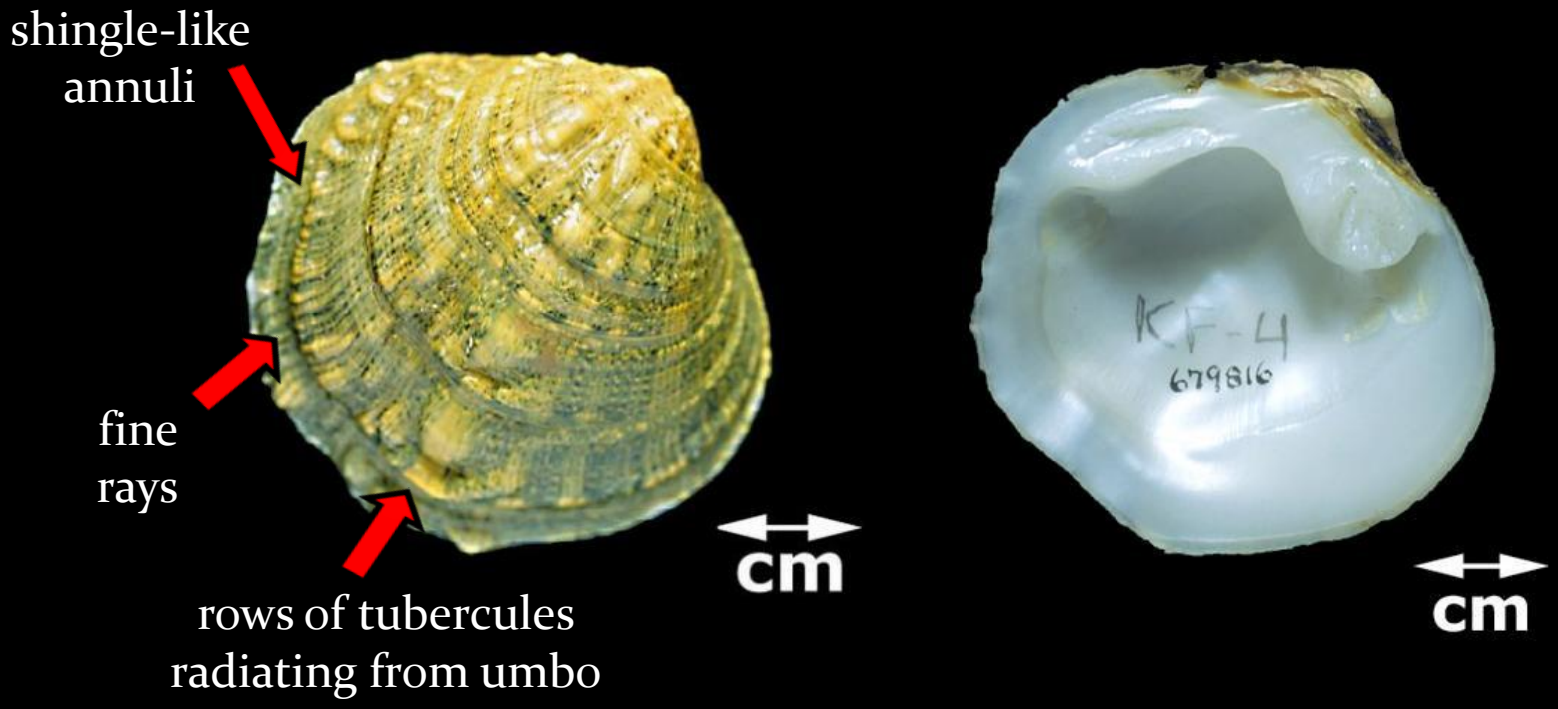
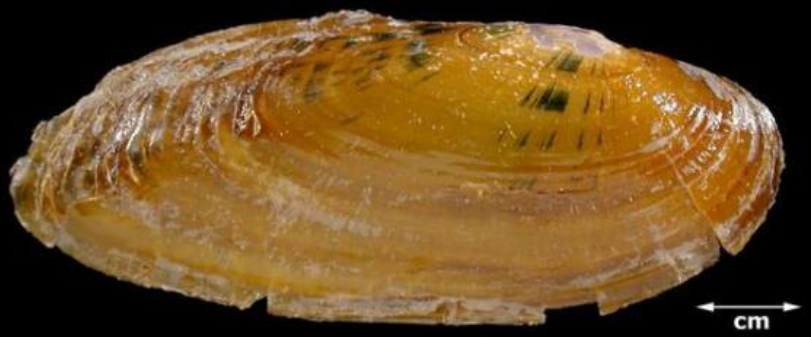


Photo credits: *Robert Warren*

Hemistena lata

- Cracking Pearlymussel
  - only one record, Allegheny River near Murphy's Bottom

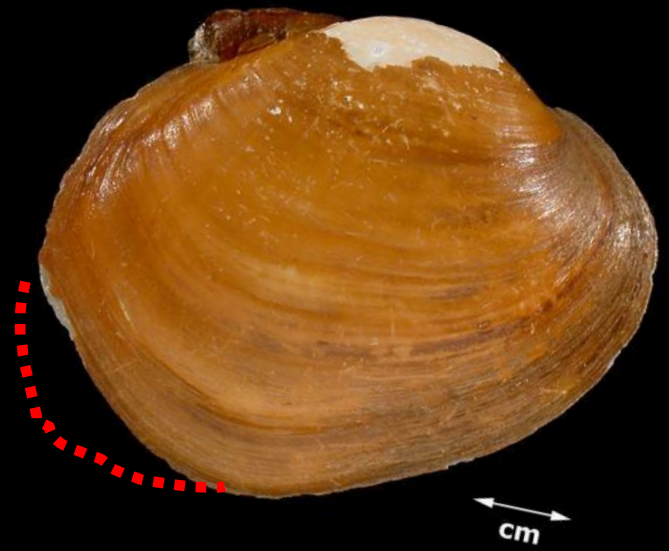


very, very thin shell with distinct green blotches and rhombus shape

Photo credits: *Karen Little*

Lampsilis abrupta *"broken off"*

- Pink Mucket



heaviest shell in the
Ohio River basin

♀

pink nacre,
but not always!!

Photo credits: *Karen Little, Grabarkiewicz & Crail*

Obovaria retusa *"blunted, nearly egg-shaped"*

- Ring Pink
  - super rare, even historically
  - extinct in our lifetime?

white "ring" around purple/pink nacre

Photo credits: *Karen Little*

Plethobasus cooperianus

"Swollen, or full in the middle." Patronym for Cooper.

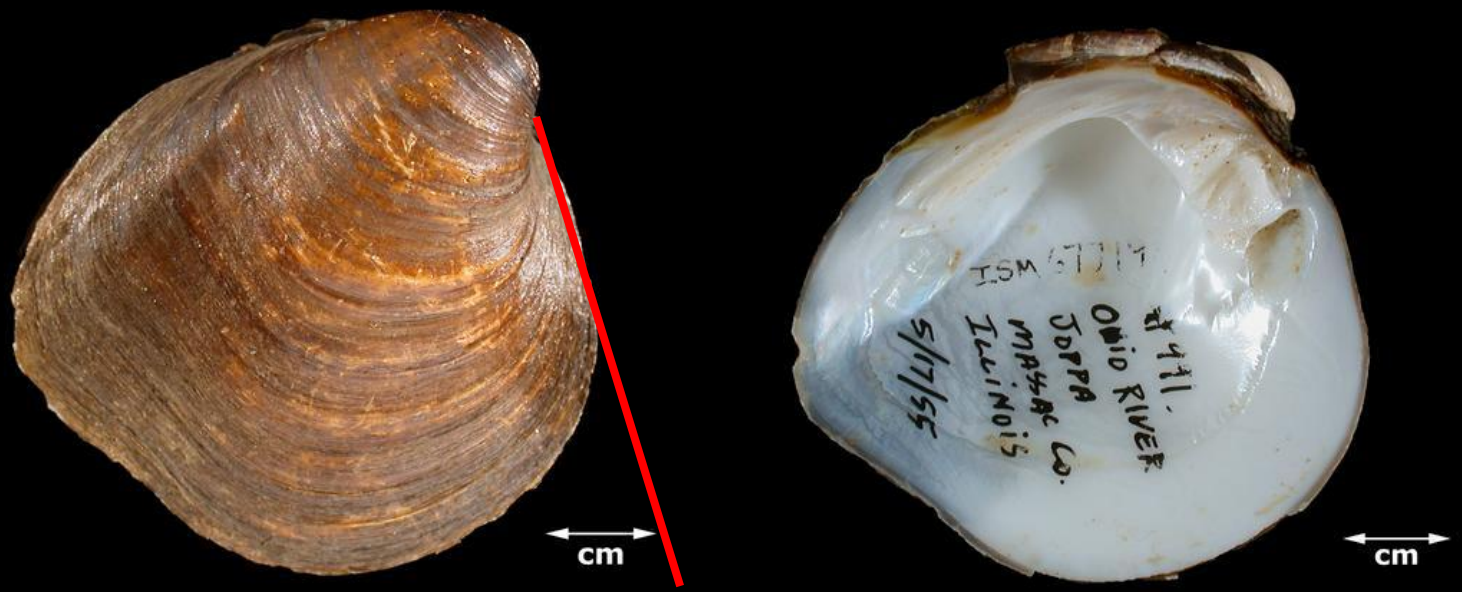
- Orange-foot Pimpleback

orange foot key character that separates *P. cooperianus* from *Q. pustulosa*

Photo credits: *Karen Little*

Pleurobema plenum *"plump"*

- Rough Pigtoe



Anterior margin drops sharply from umbo

Photo credits: *Karen Little*

Thanks!

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