A Field Guide to Pennsylvania's Freshwater Mussels

Prepared by:

Pennsylvania Fish & Boat Commission
Division of Environmental Services

For:

Pennsylvania Chapter
American Fisheries Society
Mussel Identification Workshop

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Table of Contents

Quick Reference – Pennsylvania's extant endangered and threatened mussels

			Regulatory Status			
	Common Name	**Scientific Name**	**Federal**	**State**	**Drainage Basin**	**Page #**
1	Dwarf Wedgemussel	*Alasmidonta heterodon*	Endangered	Endangered	Delaware	22
2	Northern Riffleshell	*Epioblasma rangiana*	Endangered	Endangered	Ohio	50
3	Snuffbox	*Epioblasma triquetra*	Endangered	Endangered	Ohio	52
4	Eastern Pearlshell	*Margaritifera margaritifera*		Endangered	Delaware	92
5	Round Hickorynut	*Obovaria subrotunda*		Endangered	Ohio	97
6	Sheepnose	*Plethobasus cyphyus*	Endangered	Threatened	Ohio	101
7	Clubshell	*Pleurobema clava*	Endangered	Endangered	Ohio	103
8	Salamander Mussel	*Simpsonaias ambigua*		Endangered	Ohio	125
9	Rabbitsfoot	*Theliderma cylindrica*	Threatened	Endangered	Ohio	132
10	Pistolgrip	*Tritogonia verrucosa*		Endangered	Ohio	136
11	Rayed Bean	*Villosa fabalis*	Endangered	Threatened	Ohio	144

This field guide is intended as a quick reference for Pennsylvania Fish and Boat Commission (PFBC) biologists, Waterways Conservation Officers, and other individuals who are either required to identify mussels or have an interest in mussel identification. The goal of this guide is to foster and promote the protection, conservation, and enhancement of Pennsylvania's mussel fauna by creating a greater awareness and appreciation of this imperiled group through correct identification.

Introduction

Pennsylvania has over 39,000 miles of perennial streams flowing through five major drainage basins: Delaware, Genesee, Lake Erie, Ohio, Potomac, and Susquehanna. Collectively, these basins at one time supported at least 67 species of native freshwater mussels, the most imperiled group of organisms in North America (Ricciardi and Rasmussen 1999). Today, 50 species (75%) are considered to be Species of Greatest Conservation Need, including 11 extant species listed as state or federally endangered or threatened (PGC-PFBC 2015). Historical and ongoing threats such as dams, dredging, sedimentation, and water pollution have contributed to the decline in Pennsylvania's mussel diversity. PFBC is charged with the protection, conservation, and enhancement of these mussel resources.

Mussel biology and natural history

Freshwater mussels are bivalve mollusks and are related to snails, limpets, squids, and octopuses. Pennsylvania's mussels come in a great variety of shapes, colors, and sizes and are found predominantly in streams and rivers with some adapted to living in lakes and ponds. Mussels are rather sedentary filter-feeders that live along the bottoms of rivers as large as the Ohio or as small as the headwater tributaries of the Delaware. Pennsylvania's mussels are found statewide representing two broad faunal regions, the Mississippian and the Atlantic. These regions reflect the drainage divide between streams that drain to the Gulf of Mexico via the Ohio River basin or those that continue on towards the Atlantic Ocean. Because of Pennsylvania's glacial history, the Mississippian region is further divided into two faunal provinces (Ohioan and St. Lawrence – Great Lakes). Pennsylvania's Atlantic region is represented by just one faunal province, the Northern Atlantic (Haag 2010).

Mussels have a unique – and distinct – life cycle. Females draw in sperm that upstream males release into the water column. The specialized larvae (called glochidia) are brooded in the female's gills and eventually released to parasitize fish. Nearly all of Pennsylvania's mussels require a host fish for the glochidia in order to complete their life cycle. Exceptions include the Salamander Mussel (*Simpsonaias ambigua*) which uses a Mudpuppy as its host and the Green Floater (*Lasmigona subviridis*) and Paper Pondshell (*Utterbackia imbecillis*) which are known to be hermaphroditic, i.e., the eggs do not require esternal fertilization in order to develop viable glochidia, or in some cases juveniles. These hosts are critical for mussel survival and dispersal and not all fish species are capable of transforming glochidia into juvenile mussels.

Mussels have evolved a fascinating range of strategies in order to parasitize suitable hosts. These strategies include mass glochidia broadcast events, a strategy used by the Eastern Pearlshell to infest salmonids. Other mussels, such as the Lampsilines (e.g., pocketbooks (*Lampsilis cardium, L. ovata*) and Wavyrayed Lampmussel (*L. fasciola*) utilize a "lure" that resembles a minnow or darter to illicit an attack by a predator host fish, usually a member of the sunfish family. Others, such as the Rainbow (*Villosa iris*) may mimic crayfish or in the case of the endangered Pistolgrip (*Tritogonia verrucosa*) mysteriously entice Flathead Catfish during the night. The endangered Sheepnose (*Plethobasus cyphyus*) and more common Kidneyshell (*Ptychobranchus fasciolaris*) use conglutinates, or packets of glochidia that resemble fish prey items such as oligochaete worms or blackfly larvae. Perhaps the most sophisticated strategies are those used by Pennsylvania's most endangered group of mussels, the Epioblasmids (Snuffbox, (*Epioblasma triquetra*) and Northern Riffleshell (*E. rangiana*). These mussels use their shell to capture or trap the head of their darter hosts and only release the fish after the fish's gills have been heavily infested with glochidia

Why should you care about mussels?

The benefits of freshwater mussels go far beyond their intrinsic and historical value as producers of pearls, buttons, or shell material for the cultured pearl industry. Freshwater mussels provide valuable services such as acting as "canaries in the coal mine" when monitored providing an early warning indicator that something may be

wrong in a watershed. Large numbers of living mussels, or mussel "beds," have the capacity to filter millions of gallons of water per day improving water quality by removing algae, bacteria, and sediments. This filtering ability generates cost savings for municipalities that use riverine water sources. These filtering activities also convert suspended particles into nutrients for other organisms and contribute to the cycling of energy and nutrients back into the environment. Additionally, mussels benefit the rest of the food web by providing habitat for benthic macroinvertebrates - such as caddisflies - and habitat for smaller fishes, which in turn contributes to a stream or river's forage base for larger sport fishes such as Smallmouth Bass and Flathead Catfish. Mussels also provide a food source for some fishes such as Freshwater Drum and serve as an important food source for fur-bearers such as muskrats, raccoons, and river otters. Large piles of mussel shells consumed by muskrats and raccoons (called "middens") can often be observed along river and stream banks or beneath fallen trees or root wads.

Historically Native Americans valued mussels as a food source and for ornamentation and tools. Later mussels were valued for the button industry, native pearl industry, and pearl nuclei for the cultured pearl industry. Pennsylvania mussels were heavily exploited for pearls during the "Pearl Rush" of the late 1800s but were not highly sought after for either the button or pearl nuclei industry.

Protection

Freshwater mussels are protected in Pennsylvania (Title 30 (Fish and Boat Code) Chapter 61.1, 61.2, and 61.3). Collection or harvest of live mussels – including invasive species - for bait or consumption is not permitted. The U.S. Endangered Species Act of 1973 prohibits possession of any part of an endangered species, including the shells of any federally-listed mussel species. Collection for scientific research is permitted only with a valid PFBC Scientific Collector's Permit. Additionally, endangered and threatened species are protected by PFBC regulations (e.g., Chapter 75.4) along with the federal Endangered Species Act. Other agencies – such as Pennsylvania Game Commission, DCNR, National Park Service, and U.S. Forest Service – regulate collecting on their lands. PFBC and the U.S. Fish and Wildlife Service review and provide comments for permits that propose to encroach upon streams and rivers that contain protected mussels. These agency comments are provided to the Pennsylvania Department of Environmental Protection and the U.S. Army Corps of Engineers in order to avoid, minimize, or mitigate the impacts projects may have on Pennsylvania's freshwater mussel resources.

Your observations are important

Depending upon water depths, live mussels can be observed by wading, using water scopes, snorkeling, or SCUBA diving. Dead shells can be observed cast along the banks or in muskrat or raccoon middens. In the case of a mussel kill – which are not always easy to detect - thin-shelled species may be observed floating on the water surface or trapped in debris jams along the banks.

The most important tools for recording observations are a good digital camera and a notebook for recording locality information. PFBC is interested in your observations particularly if you encounter rare species, an area of high mussel diversity, invasive species, or a recent die-off or mussel kill.

Information to collect:

1. Photographs of both sides of the mussel shell, and inside of the shell (if dead shell), including pictures of the umbos or "beaks; "
2. Wide-angle photographs of the sampling location;
3. Locality information - stream/river name, nearest crossing or town, GPS coordinates (decimal degrees preferred), plus any other relevant information (access location, put-in/take-out, landowner contact, etc.).

Send observation information to:

Nevin Welte (c-nwelte@pa.gov)

In the case of a mussel kill or other aquatic life kill, please contact PFBC law enforcement:

PFBC Law Enforcement: **1-855-FISH-KIL**

Table 1. Regulatory, state rank (S), and global rank (G) status of Pennsylvania's freshwater mussels. Recent name changes highlighted in yellow[3].

			Regulatory Status			
	Common Name	**Species**	**Federal**	**State**	**PABS S-Rank[1]**	**Global Rank[2]**
1	Mucket	*Actinonaias ligamentina*			S4	G5
2	Dwarf Wedgemussel	*Alasmidonta heterodon*	Endangered	Endangered	S1	G1G2
3	Elktoe	*Alasmidonta marginata*			S3S4	G4
4	Triangle Floater	*Alasmidonta undulata*			S3	G4
5	Brook Floater	*Alasmidonta varicosa*			S1S2	G3
6	Threeridge	*Amblema plicata*			S2S3	G5
7	Cylindrical Papershell	*Anodontoides ferussacianus*			S2S3	G5
8	Pimpleback	*Cyclonaias pustulosa*			S1	G5
9	Purple Wartyback	*Cyclonaias tuberculata*			SH	G5
10	Fanshell	*Cyprogenia stegaria*	Endangered		SH	G1
11	Butterfly	*Ellipsaria lineolata*			SH	G4G5
12	Eastern Elliptio	*Elliptio complanata*			S4	G5
13	Elephant Ear	*Elliptio crassidens*			SH	G5
14	Northern Lance	*Elliptio fisheriana*			S1	G4
15	Atlantic Spike	*Elliptio producta*			SNR	
16	Northern Riffleshell	*Epioblasma rangiana*	Endangered	Endangered	S2	G2
17	Snuffbox	*Epioblasma triquetra*	Endangered	Endangered	S2	G3
18	Spike	*Eurynia dilatata*			S4	G5
19	Wabash Pigtoe	*Fusconaia flava*			S2S3	G5
20	Longsolid	*Fusconaia subrotunda*			S2	G3
21	Cracking Pearlymussel	*Hemistena lata*	Endangered		SX	G1
22	Pink Mucket	*Lampsilis abrupta*	Endangered		SH	G2
23	Plain Pocketbook	*Lampsilis cardium*			S4	G5
24	Yellow Lampmussel	*Lampsilis cariosa*			S4	G3G4
25	Wavyrayed Lampmussel	*Lampsilis fasciola*			S3S4	G5
26	Pocketbook	*Lampsilis ovata*			S2S3	G5
27	Eastern Lampmussel	*Lampsilis radiata*			S1	G5
28	Fatmucket	*Lampsilis siliquoidea*			S4	G5
29	White Heelsplitter	*Lasmigona complanata*			S1S2	G5
30	Creek Heelsplitter	*Lasmigona compressa*			S2	G5
31	Flutedshell	*Lasmigona costata*			S4	G5
32	Green Floater	*Lasmigona subviridis*			S2S3	G3
33	Fragile Papershell	*Leptodea fragilis*			S2S3	G5
34	Tidewater Mucket	*Leptodea ochracea*			S1	G3G4
35	Eastern Pondmussel	*Ligumia nasuta*			S2S3	G4
36	Black Sandshell	*Ligumia recta*			S4	G4G5
37	Eastern Pearlshell	*Margaritifera margaritifera*		Endangered	S1	G4
38	Threehorn Wartyback	*Obliquaria reflexa*			S3	G5
39	Hickorynut	*Obovaria olivaria*			SH	G4
40	Ring Pink	*Obovaria retusa*	Endangered		SX	G1
41	Round Hickorynut	*Obovaria subrotunda*		Endangered	S1	G4
42	Orangefoot Pimpleback	*Plethobasus cooperianus*	Endangered		SH	G1
43	Sheepnose	*Plethobasus cyphyus*	Threatened	Threatened	S1	G3
44	Clubshell	*Pleurobema clava*	Endangered	Endangered	S2	G1G2

Table 1 (continued). Regulatory, state rank (S), and global rank (G) status of Pennsylvania's freshwater mussels. Recent name changes highlighted in yellow[3].

			Regulatory Status			
	Common Name	**Species**	**Federal**	**State**	**PABS S-Rank[1]**	**Global Rank[2]**
45	Ohio Pigtoe	*Pleurobema cordatum*			SH	G4
46	Rough Pigtoe	*Pleurobema plenum*	Endangered		SH	G1
47	Pyramid Pigtoe	*Pleurobema rubrum*			SH	G2G3
48	Round Pigtoe	*Pleurobema sintoxia*			S3S4	G4G5
49	Pink Heelsplitter	*Potamilus alatus*			S4	G5
50	Pink Papershell	*Potamilus ohiensis*			S1	G5
51	Kidneyshell	*Ptychobranchus fasciolaris*			S4	G4G5
52	Eastern Floater	*Pyganodon cataracta*			S4	G5
53	Giant Floater	*Pyganodon grandis*			S4	G5
54	Mapleleaf	*Quadrula quadrula*			S3	G5
55	Salamander Mussel	*Simpsonaias ambigua*		Endangered	S1	G3
56	Creeper	*Strophitus undulatus*			S5	G5
57	Rabbitsfoot	*Theliderma cylindrica*	Threatened	Endangered	S1S2	G3G4
58	Monkeyface	*Theliderma metanevra*			SH	G4
59	Lilliput	*Toxolasma parvum*			S1S2	G5
60	Pistolgrip	*Tritogonia verrucosa*		Endangered	S1	G4G5
61	Fawnsfoot	*Truncilla donaciformis*			S1	G5
62	Deertoe	*Truncilla truncata*			S1	G5
63	Paper Pondshell	*Utterbackia imbecillis*			S4	G5
64	Alewife Floater	*Utterbackiana implicata*			S3	G5
65	Flat Floater	*Utterbackiana suborbiculata*			S1	G5
66	Rayed Bean	*Villosa fabalis*	Endangered	Threatened	S1S2	G2
67	Rainbow	*Villosa iris*			S3	G5
		Total	**13***	**11**		

[1]S-ranks updated November 19, 2014

[2]G-ranks obtained from NatureServe Explorer June 2015

[3]Names updated per Williams et al. 2017

Table 2. Distribution of Pennsylvania's freshwater mussels by major drainage basins.

			Drainage Basin					
	Common Name	**Species**	**Ohio**	**Erie**	**Genesee**	**Susquehanna**	**Potomac**	**Delaware**
1	Mucket	*Actinonaias ligamentina*	X					
2	Dwarf Wedgemussel	*Alasmidonta heterodon*						X
3	Elktoe	*Alasmidonta marginata*	X	X°		X	X	
4	Triangle Floater	*Alasmidonta undulata*				X	X	X
5	Brook Floater	*Alasmidonta varicosa*				X	X	X
6	Threeridge	*Amblema plicata*	X	X*				
9	Cylindrical Papershell	*Anodontoides ferussacianus*	X	X		X		
10	Purple Wartyback	*Cyclonaias tuberculata*	X					
11	Fanshell	*Cyprogenia stegaria*	X					
12	Butterfly	*Ellipsaria lineolata*	X					
13	Eastern Elliptio	*Elliptio complanata*				X	X	X
14	Elephant Ear	*Elliptio crassidens*	X					
15	Spike	*Eurynia dilatata*	X	X				
16	Northern Lance	*Elliptio fisheriana*					X	
17	Northern Riffleshell	*Epioblasma rangiana*	X					
18	Snuffbox	*Epioblasma triquetra*	X					
19	Wabash Pigtoe	*Fusconaia flava*	X	X				
20	Longsolid	*Fusconaia subrotunda*	X					
21	Cracking Pearlymussel	*Hemistena lata*	X					
22	Pink Mucket	*Lampsilis abrupta*	X					
23	Plain Pocketbook	*Lampsilis cardium*	X	X°				
24	Yellow Lampmussel	*Lampsilis cariosa*				X	X	X
25	Wavyrayed Lampmussel	*Lampsilis fasciola*	X					
26	Pocketbook	*Lampsilis ovata*	X	X*				
27	Eastern Lampmussel	*Lampsilis radiata*	?			X		X
28	Fatmucket	*Lampsilis siliquoidea*	X	X				
29	White Heelsplitter	*Lasmigona complanata*	X					
30	Creek Heelsplitter	*Lasmigona compressa*	X	X	X			
31	Flutedshell	*Lasmigona costata*	X	X				
32	Green Floater	*Lasmigona subviridis*				X	X	X
33	Fragile Papershell	*Leptodea fragilis*	X	X*				
34	Tidewater Mucket	*Leptodea ochracea*						X[a]
35	Eastern Pondmussel	*Ligumia nasuta*	X	X*				X[a]
36	Black Sandshell	*Ligumia recta*	X	X*				
37	Eastern Pearlshell	*Margaritifera margaritifera*						X
38	Threehorn Wartyback	*Obliquaria reflexa*	X					
39	Hickorynut	*Obovaria olivaria*	X					
40	Ring Pink	*Obovaria retusa*	X					
41	Round Hickorynut	*Obovaria subrotunda*	X					
42	Orangefoot Pimpleback	*Plethobasus cooperianus*	X					

Table 2 (continued). Distribution of Pennsylvania's freshwater mussels by major drainage basins.

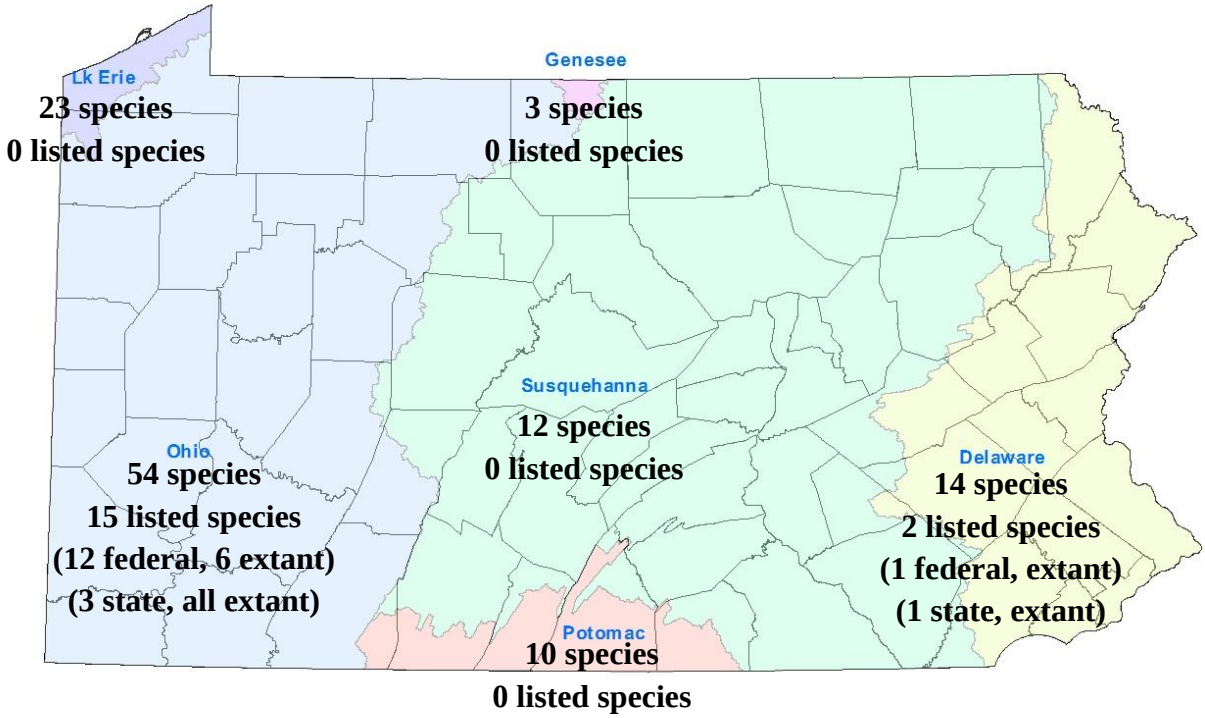
			Drainage Basin					
	Common Name	**Species**	**Ohio**	**Erie**	**Genesee**	**Susquehanna**	**Potomac**	**Delaware**
43	Sheepnose	*Plethobasus cyphyus*	X					
44	Clubshell	*Pleurobema clava*	X					
45	Ohio Pigtoe	*Pleurobema cordatum*	X					
46	Rough Pigtoe	*Pleurobema plenum*	X					
47	Pyramid Pigtoe	*Pleurobema rubrum*	X					
48	Round Pigtoe	*Pleurobema sintoxia*	X	X°				
49	Pink Heelsplitter	*Potamilus alatus*	X	X*				
50	Pink Papershell	*Potamilus ohiensis*	X					
51	Kidneyshell	*Ptychobranchus fasciolaris*	X	X				
52	Eastern Floater	*Pyganodon cataracta*				X	X	X
53	Giant Floater	*Pyganodon grandis*	X	X	X			
54	Rabbitsfoot	*Theliderma cylindrica*	X					
55	Monkeyface	*Theliderma metanevra*	X					
56	Pimpleback	*Cyclonaias pustulosa*	X	X*				
57	Mapleleaf	*Quadrula quadrula*	X	X*				
58	Pistolgrip	*Tritogonia verrucosa*	X					
59	Salamander Mussel	*Simpsonaias ambigua*	X					
60	Creeper	*Strophitus undulatus*	X	X	X	X	X	X
61	Lilliput	*Toxolasma parvum*	X					
62	Fawnsfoot	*Truncilla donaciformis*	X	X*				
63	Deertoe	*Truncilla truncata*	X	X*				
64	Paper Pondshell	*Utterbackia imbecillis*	X					
	Alewife Floater	*Utterbackiana implicata*				X		X
	Flat Floater	*Utterbackiana suborbiculata*	X					
65	Rayed Bean	*Villosa fabalis*	X					X
66	Rainbow	*Villosa iris*	X	X°		X		
`	**Total**		**54**	**23**	**3**	**12**	**9**	**14**

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919; Masteller *et al.* 1993.

Total species per basin:

1. **Ohio** **54**
2. **Erie** **23** (*Lake Erie only, °Conneaut Creek only)
3. **Genesee** **3**
4. **Susquehanna** **12**
5. **Potomac** **9**
6. **Delaware** **14** ([a] tidal)

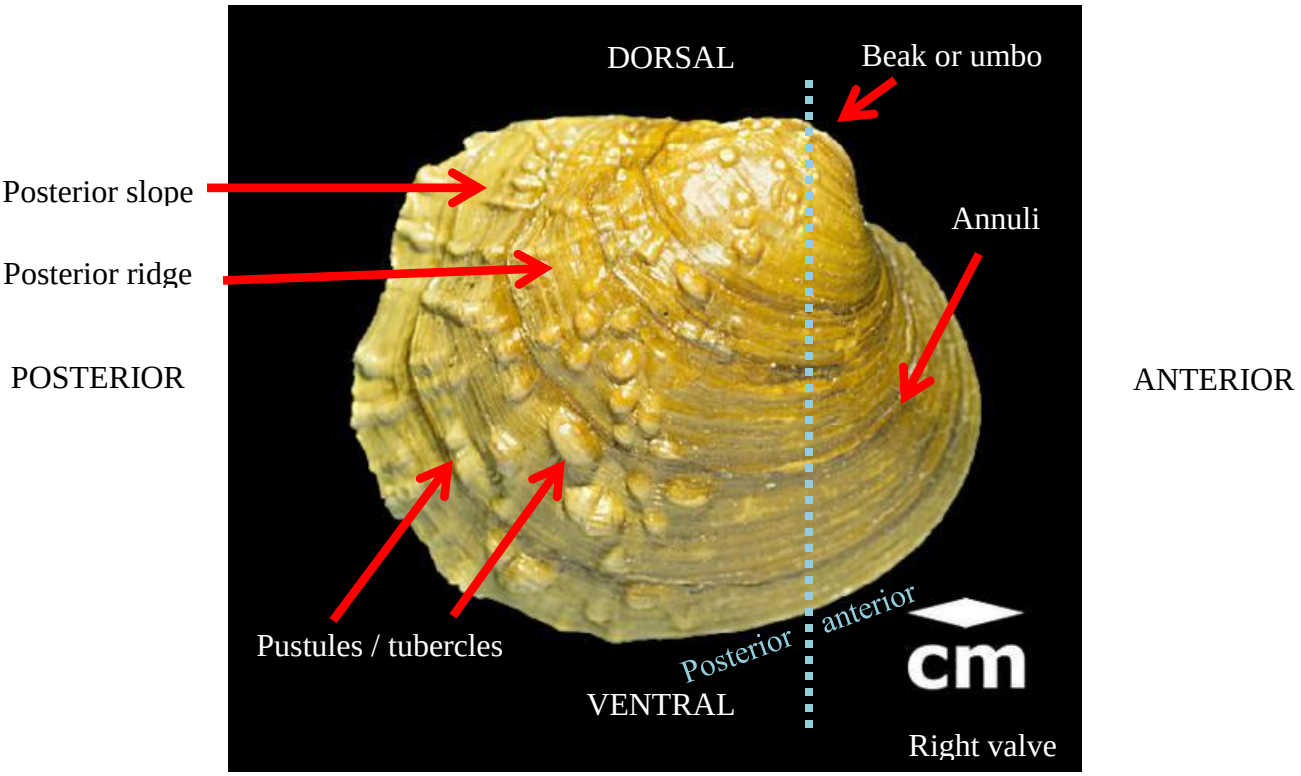
Number of species in each major drainage basin and number of species with regulatory status

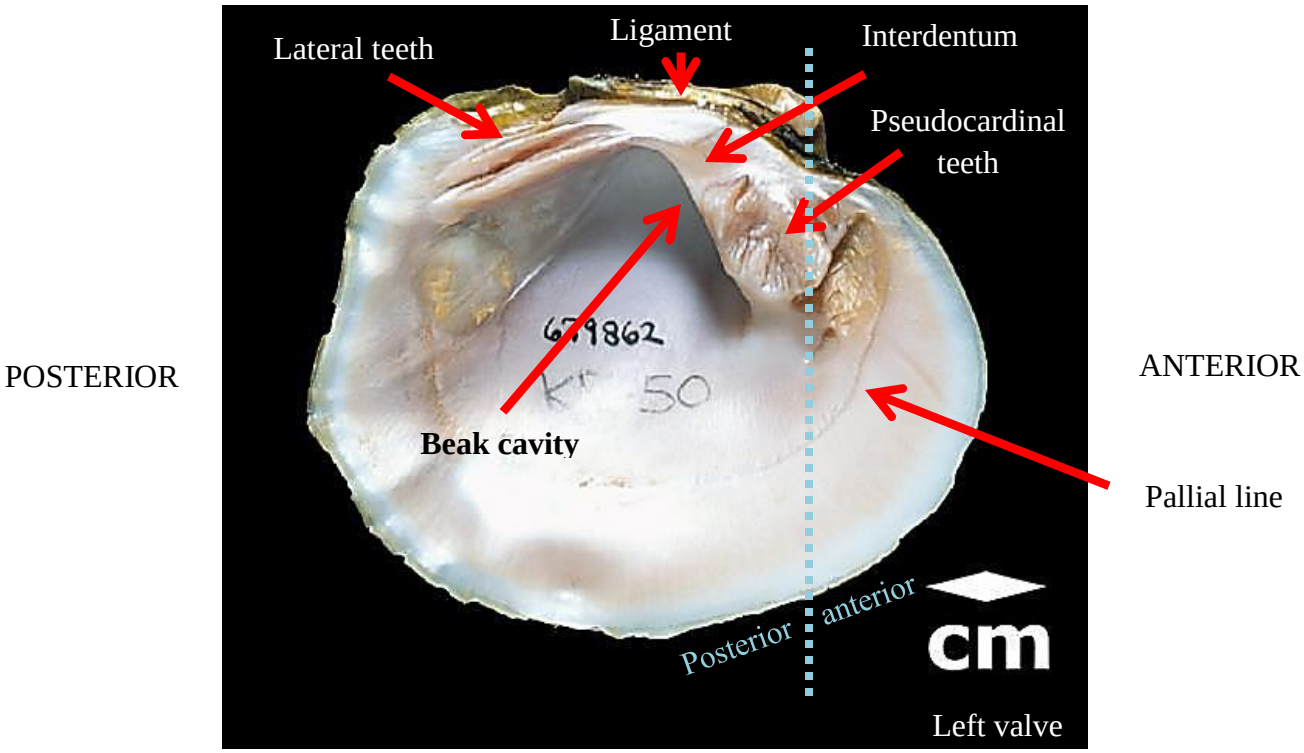


Pending and state and federal status assessments

1. **Delaware**
    1. Brook Floater (*Alasmidonta varicosa*) (state and federal status; USFWS 12 month finding due in 2018)
2. **Susquehanna**
    1. Brook Floater (*A. varicosa*, see previous)
    2. Eastern Lampmussel (*Lampsilis radiata*) (state status)
    3. Green Floater (*Lasmigona subviridis*) (state and federal status; USFWS 12 month finding due in 2020)
3. **Potomac**
    1. Brook Floater (*A. varicosa*, see previous)
    2. Northern Lance (*Elliptio fisheriana*) (state status)
    3. Atlantic Spike (*Elliptio producta*) (state status)
4. **Ohio**
    1. Longsolid (*Fusconaia subrotunda*) (federal status; USFWS 12 month finding due in 2018)
    2. Round Hickorynut (*Obovaria subrotunda*) (federal status; USFWS 12 month finding due in 2018)
    3. Salamander Mussel (*Simpsonaias ambigua*) (federal status; USFWS 12 month finding due in 2023)

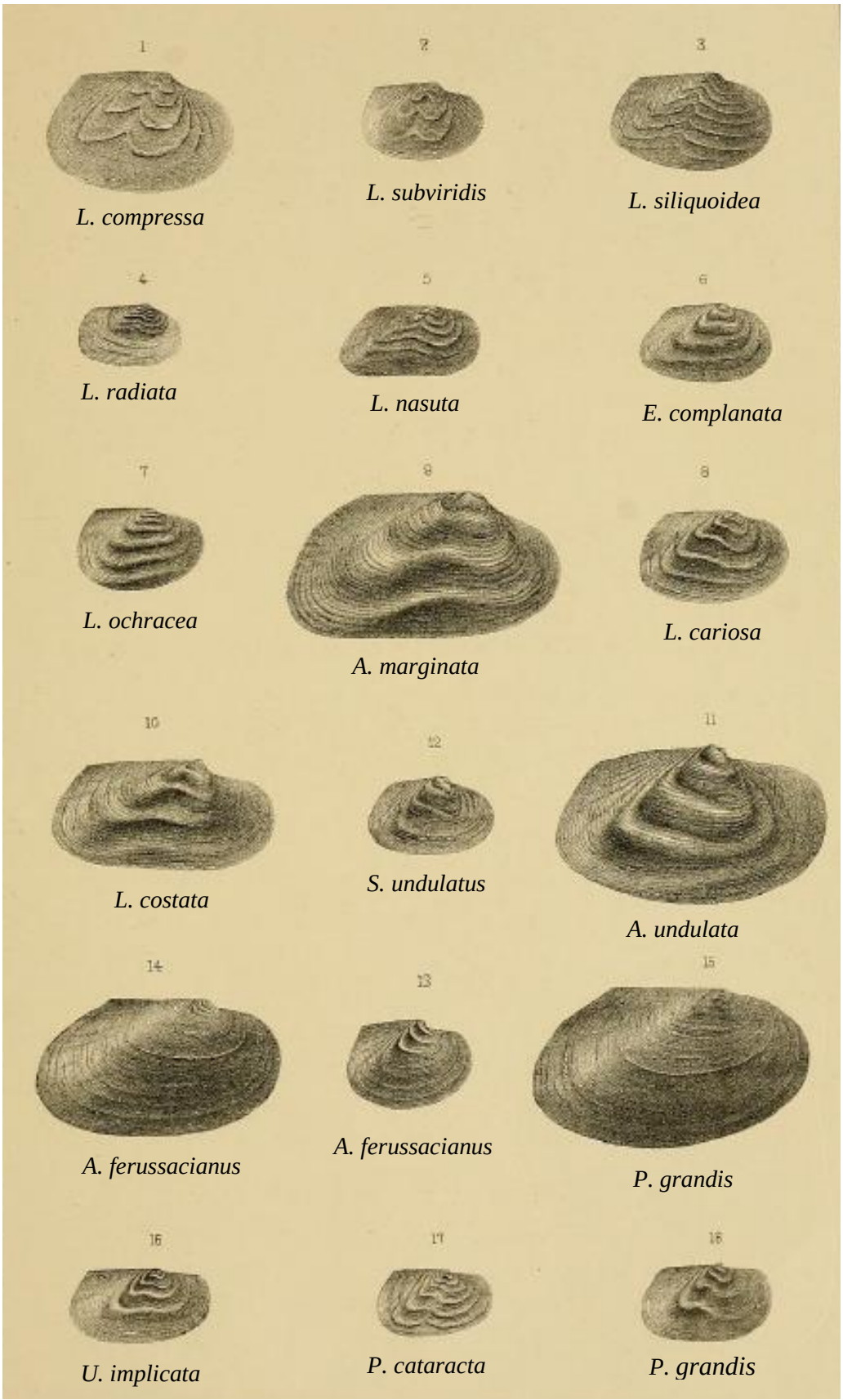
Shell features (Purple Wartyback, *Cyclonaias tuberculata*. photo credits: R. Warren)





Nacre – interior layer of the shell, often iridescent, shiny, may be white, salmon, pink, purple or shades of blue.
Periostracum – proteinaceous outer layer of shell, typically brown, yellow, black, or shades between.

Juvenile beak sculptures (from Marshall 1890)



Taxonomy

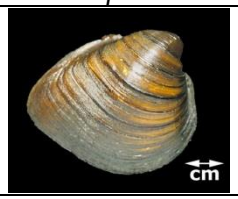
	Characteristics
Kingdom Animalia	
Phylum Mollusca	
Class Bivalvia	
Order Unionida	
Superfamily Unionoidea	
Family Margaritiferidae	Absence of water tubes; fused anal openings; minute glochidia
Margaritifera	
Family Unionidae	
Subfamily Anodontinae	
Tribe Andontini	Bradytictic (long-term brooders); water tubes; separated anal openings; middle part of water tube serve as ovisac, very large, triangular glochidia with hooks; thin-shelled; host generalists
Alasmidonta	
Anodontoides	
Lasmigona	
Pyganodon	
Simpsonaias	
Strophitus	
Utterbackia	
Utterbackiana	
Subfamily Ambleminae	
Tribe Ambleminae	Tachytictic (short-term brooders); water tubes; separated anal openings; entire water tube serves as ovisac; shells usually heavier, may have warts
Amblema	
Tribe Lampsilini	
Actinonaias	
Cyprogenia	
Ellipsaria	
Epioblasma	
Lampsilis	
Leptodea	
Ligumia	
Obliquaria	
Obovaria	
Potamilus	
Ptychobranchus	
Toxolasma	
Truncilla	
Villosa	
Tribe Pleurobemini	
Elliptio	Bradytictic (long-term brooders); water tubes; separated anal openings; entire water tube serves as ovisac; marsupium swollen at the edge of the gill; dimorphic; may be very host specific
Fusconaia	
Hemistena	
Plethobasus	
Pleurobema	
Tribe Quadrulini	
Cyclonaias	
Quadrula	
Theliderma	
Tritogonia	
Order Veneroida	
Superfamily Corbiculoidea	
Family Corbiculidae	Pennsylvania invasive species
Corbicula fluminea	
Family Dreissenidae	
Dreissena bugensis	
Dreissena polymorpha	

Shell Characteristics – Quick Reference for Genera

Warty - Bumpy	Winged
Cyclonaias (p. 36) *Cyprogenia* (p. 40) *Obliquaria* (p. 94) *Plethobasus* (p. 99) *Quadrula* (p. 123) *Theliderma* (p. 132) *Tritogonia* (p. 136)	*Lasmigona* (in part) (p. 78) *Leptodea* (p. 87) *Potamilus* (p. 114)
Thin	**Dimorphic**
Anodontoides (p. 34) *Hemistena* (p. 61) *Lasmigona* (in part) (p. 78) *Leptodea* (p. 87) *Pyganodon* (p. 118) *Simpsonaias* (p. 125) *Strophitus* (p. 127) *Toxolasma* (p. 135) *Utterbackia* (p. 140) *Utterbackiana* (p. 142)	*Epioblasma* (p. 50) *Lampsilis* (p. 62) *Ligumia* (p. 89) *Obovaria* (p. 95) *Villosa* (p. 144)

Problematic Species 1 – Quick Reference

The "Fuscobemas" (genera *Fusconaia* and *Pleurobema*) (photo credits: K. Little, R. Warren, N. Welte)

Characteristic	Wabash Pigtoe *F. flava*	Longsolid *F. subrotunda*	Ohio Pigtoe *P. cordatum*	Rough Pigtoe *P. plenum*	Pyramid Pigtoe *P. rubrum*	Round Pigtoe *P. sintoxia*
External image						
Sulcus	Broad, gentle	None	Prominent	Slight or none	Usually prominent	Rare, and if present, weak
Umbos		Distinct green blotches near umbo when young	Prominent and facing forward; near anterior margin	Prominent and facing forward; not near anterior margin	Very prominent and facing forward; at or beyond anterior margin	Facing each other, prominent in river forms, not in creek forms
Beak cavity	Shallow	Deep & compressed				Shallow & rounded
Nacre	White or salmon	White	White	White	White or pink	White, salmon or pink
Internal		Orange foot				White foot
Shell elongation		Particularly elongated as older individuals	Elongated only as older individuals	Vertically elongated, "tall"	Often quite elongated	Elongated only as older individuals
Other characters	Almost trapezoid outline; brown/chestnut/russetted-colored periostracum	Dorsal and ventral margins approaching parallel	Young individuals may have fine, indistinct, green or blackish rays or bundles of rays, NO BLOTCHES!	Periostracum shaggy or matte; anterior margin drops sharply from umbo		
Distribution	Allegheny, Ohio, Monongahela		Ohio, Allegheny, Monongahela, Shenango(?)	Ohio, Allegheny	Ohio, Allegheny	

P. sintoxia beak cavity shallow and round **(LEFT)**

F. subrotunda beak cavity deep and compressed **(RIGHT)**

Problematic Species 2 – Quick Reference

The "winged" mussels (photo credits: K. Little and R. Warren)

Characteristic	**White Heelsplitter** *Lasmigona complanata*	**Fragile Papershell** *Leptodea fragilis*	**Pink Heelsplitter** *Potamilus alatus*	**Pink Papershell** *Potamilus ohiensis*
External image				
Wing	Posterior only	Posterior and anterior	Posterior only	Posterior and anterior; anterior wing distinct, especially in smaller individuals
Wing characteristics	May have flutings or ribs	Anterior wing rarely apparent, broken off		Anterior wing usually broken off
Shell	Thin, but stout, not easily breakable	Thin	Moderately thick	Very thin
Periostracum	Blackish brown, varnished appearance	Yellow	Dark brown	Variable brown
Other	Very distinct beak sculpture, even in large specimens; shell not highly erodible	Posterior end of shell not truncated	Posterior end of shell truncated	Posterior end of shell not truncated

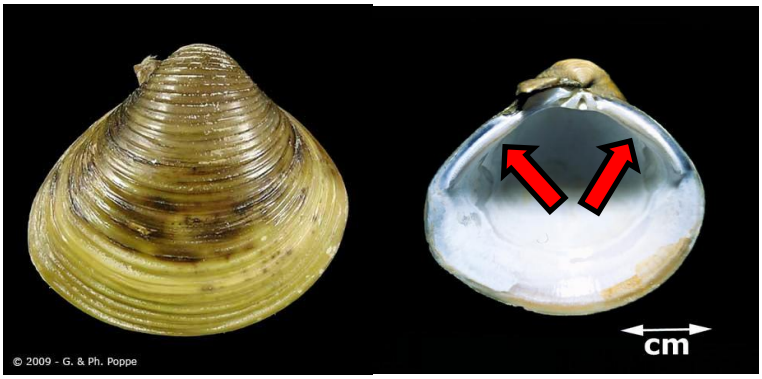
Problematic Species 3 – Quick Reference

Brown-ish, toothless, and thin-shelled (photo credits: K. Little, R.Warren, N. Welte)

Characteristic	**Alewife Floater** *U. implicata*	**Cylindrical Papershell** *A. ferussacianus*	**Giant Floater** *P. grandis*	**Eastern Floater** *P. cataracta*	**Creeper** *S. undulatus*	**Paper Pondshell** *U. imbecillis*
External image						
Distribution	Atlantic Slope	Interior Basin, Atlantic Slope	Interior Basin, Atlantic Slope	Atlantic Slope	All basins	Interior Basin, Atlantic Slope
Beak sculpture (young mussels)	Double-looped in concentric bands	Concentric single loops	Several nodulous, double-looped ridges	5-7 low, evenly raised double-looped bars	Concentric	Irregular ridges, slightly sinuous or double-looped ventrally
Umbo in relation to the hinge line	Umbos extend above hinge line	Umbos extend above hinge line	Umbos extend above hinge line	Umbos extend above hinge line	Umbos extend above hinge line	Umbos below hinge line
Habitat	Rivers (e.g., Delaware)	Smaller streams	Rivers, lakes, ponds	Lakes, ponds, back channels	Riverine	Lakes, ponds, back channels
Other	Coppery color, anterior thickening below pallial line	Nearly circular in cross-section	Species characterized by shell plasticity, see large list of synonyms (e.g., Parmalee and Bogan 1998)		S – shaped hinge line	Greenish-bluish shell (sometimes)

Invasive bivalves

1. **ASIAN CLAM** *Corbicula fluminea* (Muller, 1774),



Defining characteristics:

1. Two lateral teeth
2. Elevated ridges
3. Hermaphroditic

2. **QUAGGA MUSSEL** *Dreissena bugensis* (Andrusov, 1897)

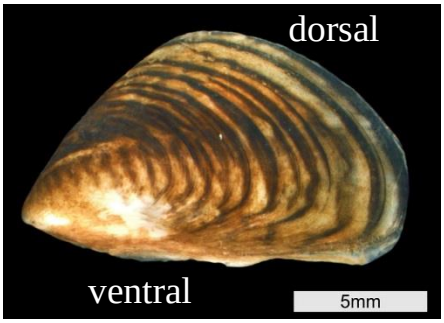


Image (credit, Motte 123)

Defining characteristics:

1. Rounded ventral side
    a. Shell will <u>roll over</u> if you try to stand it up on its ventral side
2. Pattern/coloration nearly identical to *D. polymorpha*
3. May be more common in soft sediments
4. Reproduce via free-swimming veligers

3. **ZEBRA MUSSEL** *Dreissena polymorpha* (Pallas, 1771)

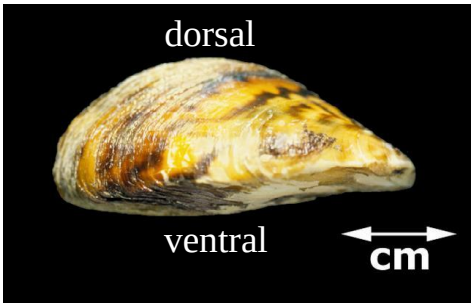


Image (credit, R. Warren)

Defining characteristics:

1. Flattened ventral side
    a. Shell will <u>stand up</u> on its ventral side
2. Pattern/coloration nearly identical to *D. bugensis*
3. May be more common on hard surfaces
4. Reproduce via free-swimming veligers

Resources

Regional guides

1. Cicerello, R.R. and G.A. Schuster. 2003. A guide to the freshwater mussels of Kentucky. Kentucky State Nature Preserves Commission, Scientific and Technical Series 7: 1-62.

2. Nedeau, E.J., McCollough, M.A., and B.I. Swartz. 2000. The freshwater mussels of Maine. Produced by Maine Department of Inland Fisheries and Wildlife. State House Station #41. Augusta, Maine.

3. Ortmann, A.E. 1919. A monograph of the naiads of Pennsylvania. Part III: Systematic account of the genera and species. Memoirs of the Carnegie Museum 8(1): xvi – 384.

4. Parmalee, P.W. and A.E. Bogan. 1998. The freshwater mussels of Tennessee. The University of Tennessee Press. Knoxville, Tennessee.

5. Strayer, D.L. and K.J. Jirka. 1997. The pearly mussels of New York State. New York State Museum. Memoir 26. The University of the State of New York. The State Education Department.

6. Watters, G.T., Hoggarth, M.A., and D.H. Stansbery. 2009. The freshwater mussels of Ohio. The Ohio State University Press, Columbus, Ohio.

7. Williams, J.D., Bogan, A.E., and J.T. Garner. 2008. Freshwater mussels of Alabama and the Mobile River Basin in Georgia, Mississippi, and Tennessee. The University of Alabama Press, Tuscaloosa, Alabama.

Online resources

1. A field guide to the freshwater mussels of Connecticut – Nedeau, E.J. and J. Victoria. http://www.ct.gov/deep/lib/deep/wildlife/pdf_files/nongame/fwmusl.pdf

2. Unio Gallery – Chris Barnhart, Missouri State University http://unionid.missouristate.edu/

3. Mussel/host database – The Ohio State University Division of Mollusks http://140.254.118.11/MusselHost/

4. PFBC (internal use) – P:\FieldOperations\Fisheries\EnvServ\Welte\Literature\Mussels

Other

1. Haag, W.R. North American freshwater mussels. Natural history, ecology, and conservation. Cambridge University Press, Cambridge, New York.

A few notes on the species descriptions

Common vs. scientific names – We encourage the use of scientific names. Common names can be quite variable or confusing, e.g., Pocketbook vs. Plain Pocketbook or Pink Papershell vs. Paper Pondshell but occasionally common names are useful shell descriptors, e.g., Rayed Bean or Deertoe. Common and scientific names in this guide follow Williams et al. (2017).

Etymology – This is to encourage appreciation (and use!) of the scientific names. Sometimes the genus/species translations may not line up as perfect descriptors of each species due to genus/species naming priority.

Defining characteristic(s): This is our attempt to facilitate rapid field identification and differentiation of species. We feel like we came close for most species and recognize that more refinement is necessary for others – we welcome your feedback.

May be confused with: We tried to address scenarios where two or more species at a single site could be easily confounded. Knowing the drainage that you're in or having a species list (see **Appendices**) will help narrow your choices in some situations. In other situations, it pays to know when you have to check foot color or when to examine the beak cavity closely.

Stream tables – The species stream tables include historical and extant occurrences from the early 1900s to present. As a rule of thumb, please consider these tables incomplete – some streams no longer harbor mussels, some streams have been under-surveyed, and some streams may have been accidentally omitted. If you have questions regarding a species and its distribution or a stream and its fauna, please ask!

Reported hosts – Mussel/host work studies continue with the goal of producing mussels for conservation efforts. Other research on basic host suitability is ongoing. The lists of reported hosts should be informative regarding the general – and in some cases specific – fish species/families/guilds that are essential for natural reproduction. Not all hosts that transform glochidia into juveniles are considered "natural hosts" because some fish and mussels may never encounter each other due to geography, habitat preference, behavior, or unique life history. Difficulty with captive care of potential host fish, the ability to collect and maintain potential host fish in a lab setting, etc. also limit our knowledge of host fish.

Rationale for excluding a dichotomous key – Strayer and Jirka (1997) eloquently summed up caveats about using their dichotomous key for the freshwater mussels of New York:

> "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** (authors' emphasis)…"

MUCKET *Actinonaias ligamentina* (Lamarck, 1819). (S4, G5).

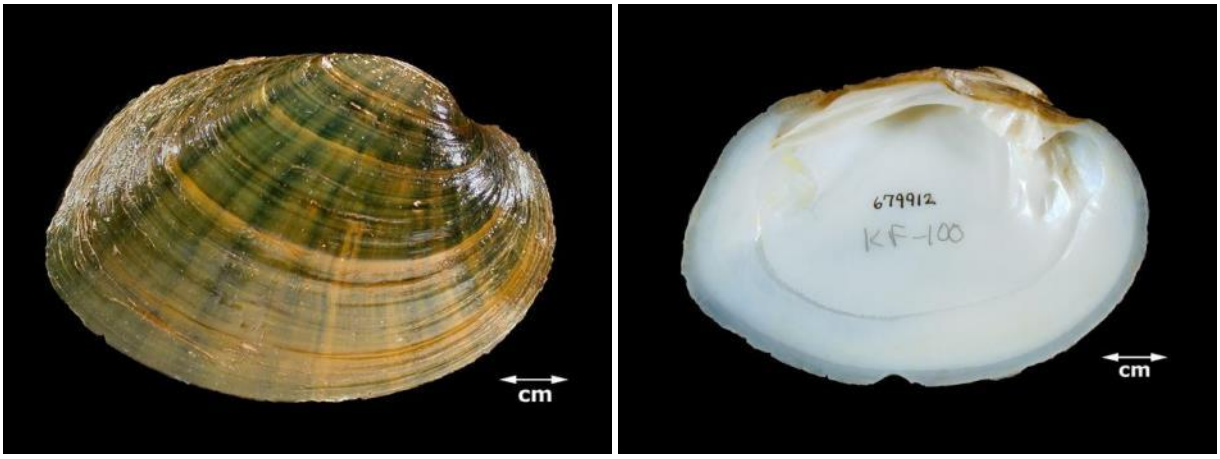


Image (credit, K. Little): Illinois State Museum, ISM# 679912 (external and internal)

Defining characteristic(s):

1. Large, heavy, thick shell;
2. Green rays, ranging from thick to thin (younger specimens).

Ortmann (1919) noted: *"…externally a form of simple appearance, without striking characteristics."*

May be confused with: Large male *Lampsilis siliquoidea* or male *L. abrupta*. *L. siliquoidea* will have sparse green rays, if visible, and *L. abrupta* will have pinkish or purplish nacre.

Considerable care should go into correctly identifying *A. ligamentina* specimens from the navigable pools of Allegheny and Ohio River, the last known locations of the federally endangered *L. abrupta*.

Etymology - "rayed water nymph of the river"
(from Watters *et al.* 2009)**:** Greek *aktis*, *aktinos*, ray, beam + Greek *naias*, *naiados*, a water nymph of rivers and springs. Latin *ligamentun*, a band, tie, bandage.

Table 1. Pennsylvania's known *Actinonaias ligamentina* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	- Little Beaver Creek	
3	• North Fork Little Beaver Creek	
4	Beaver River	
5	- Connoquenessing Creek	
6	• Slippery Rock Creek	
7	- Mahoning River	
8	- Shenango River	
9	Allegheny River	
	- (Kiskiminetas River)	No specimens reported.
10	• Conemaugh River	
	- (Black Lick Creek)	No specimens reported.

Table 1. *A. ligamentina* streams (continued)		
11	○ Yellow Creek	
12	• Loyalhanna River	
	(mainstem)	
13	- Crooked Creek	
14	- Mahoning Creek	
15	- Clarion River	Williams (2015, relic shell); live *A. ligamentina* reintroduced by PFBC/WPC/USFS in 2015.
16	- Sandy Creek	
17	- French Creek	
18	• Conneaut Outlet	
19	• Cussewago Creek	
20	• Woodcock Creek	
21	• Conneauttee Creek	
22	• Muddy Creek	
23	• LeBoeuf Creek	
24	• South Branch French Creek	
25	• West Branch French Creek	
26	- Oil Creek	
27	- Hemlock Creek*	*PFBC considers this population to be part of the Allegheny River because the creek is not hospitable much further than its confluence with the Allegheny.
28	- Brokenstraw Creek	
29	- Conewango Creek	
30	- Oswayo Creek	
31	- Potato Creek	
32	Monongahela River	
33	- Tenmile Creek	
34	- Youghiogheny River	
35	- Cheat River	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *A. ligamentina* hosts (from Watters *et al.* 2009; Gibson *et al.* 2015): Rock Bass (*Ambloplites rupestris*), American Eel (*Anguilla rostrata*), Central Stoneroller (*Campostoma anomalum*), Common Carp (*Cyprinus carpio*), Silverjaw Minnow (*Ericymba buccatta*), Tippecanoe Darter (*Etheostoma tippecanoe*), Banded Killifish (*Fundulus diaphanus*), Green Sunfish (*Lepomis cyanellus*), Orangespotted Sunfish (*Lepomis humilis*), Bluegill (*Lepomis macrochirus*), Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), White Bass (*Morone chrysops*), Tadpole Madtom (*Noturus gyrinus*), Yellow Perch (*Perca flavescens*), White Crappie (*Pomoxis annularis*), Black Crappie (*Pomoxis nigromaculatus*), Blacknose Dace (*Rhinichthys atratulus*), Sauger (*Sander canadensis*), and Creek Chub (*Semotilus atromaculatus*).

DWARF WEDGEMUSSEL *Alasmidonta heterodon* (Lea, 1830). **State Endangered, Federally Endangered.** (S1, G1G2).

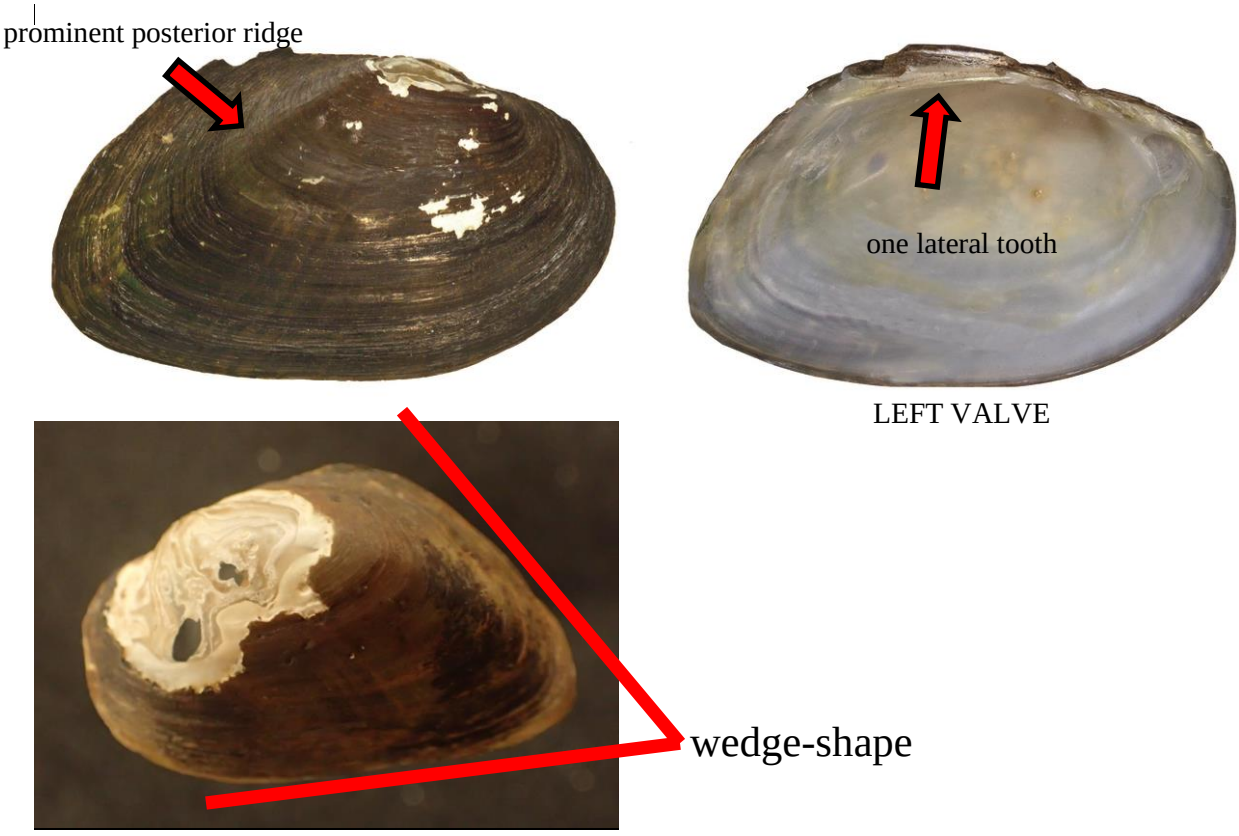


Image (credit, A. Bogan, www.discoverlife.com): North Carolina State Museum, NCSM# 16255 (external and internal); **image (credit, N. Welte):** Carnegie Museum of Natural History, CMNH# 61.11849 (external).

Defining characteristic(s):

1. Small, thin shell (typically < 38 mm);
2. Sexually dimorphic;
3. Distinct 'wedge' shape;
4. Some specimens have heavy erosion migrating from the umbo and across the shell;
5. Two lateral teeth in the right valve, one in the left (atypical; opposite of other mussels);
6. Delicate pseudocardinal teeth.

May be confused with: Small, oddly-shaped *Elliptio complanata*. Heft (*A. heterodon* is very light) and shell inflation (*A. heterodon* more swollen laterally vs. *E. complanata* of the same length) separates the two species.

Etymology – "the one with lateral teeth"
(from Watters *et al.* 2009)**:** Greek "*a, an*," not, without + Greek "*elasmos*," a thin plate + Greek

"*odontos*," tooth. Translation: "without lateral teeth."
Welte: *heterodont*, means "different teeth" or having more than a single tooth morphology.

Table 2. Pennsylvania's known *Alasmidonta heterodon* streams.

	Stream	Notes
	Delaware River Basin	
1	Delaware River	Galbraith et al. (2016)
2	- Darby Creek	Ortmann (1919)
3	Schuylkill River	Ortmann (1919)
4	- Schuylkill Canal	Ortmann (1919)
	(mainstem)	
5	- Neshaminy Creek	Ortmann (1919)
	(Lehigh River)	No specimens reported
	- (Valley Creek)	No specimens reported
6	• Princess Run	Ortmann noted this as "Princess Creek, Kunkletown"

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *A. heterodon* hosts: White (2007): Mottled Sculpin (*Cottus bairdi*), Slimy Sculpin (*Cottus cognatus*), Tessallated darter (*Etheostoma olmstedi*), Banded Killifish (*Fundulus diaphanus*), Striped Bass (*Morone saxatilis*), Shield Darter (*Percina peltata*), Atlantic Salmon (*Salmo salar*), and Brown Trout (*Salmo trutta*).

Galbraith et al. (2016) noted that field-collected *A. heterodon* glochidia were only observed on Tessellated Darters.

ELKTOE *Alasmidonta marginata* (Say, 1818). Other vernacular name(s): Northern Elktoe. (S3S4, G4).

Image (credit, K. Little): Illinois State Museum, ISM# 673223 (external), ISM 673282 (internal).

Defining characteristic(s):

1. Thin, elongated shell;
2. Very prominent, sharp posterior ridge;
3. Posterior slope flattened and usually contains fine ridges or flutings;
4. Bright orange foot.

May be confused with: *Alasmidonta varicosa*. The two species can be differentiated by examining the steepness of the slope of the posterior ridge. *A. marginata* approaches a nearly 90° slope whereas *A. varicosa* has a gentle, rounding slope.

Etymology – "without lateral teeth, with border"
(from Watters *et al.* 2009)**:** Greek *a, an*, not, without + Greek *elasmos*, a thin plate + Greek *odontos*, tooth. Translation: "without lateral teeth." Latin *margo, marginis*, edge, border.

Table 3. Pennsylvania's known *Alasmidonta marginata* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	- Little Beaver Creek	
3	• North Fork Little Beaver Creek	
4	Beaver River	
5	- Connoquenessing Creek	
6	• Slippery Rock Creek	
7	- Wolf Creek	
8	- Mahoning River	
9	- Shenango River	
10	• Neshannock Creek	
11	• Pymatuning Creek	
12	• Little Shenango River	
13	Allegheny River	
14	- Buffalo Creek	
	- (Kiskiminetas River)	No specimens reported.
15	• Loyalhanna River	

Table 3. *A. marginata* streams (continued).

	• (Stony River)	No specimens reported.
16	- Quemahoning Creek	
17	- Crooked Creek	
	- (Mahoning Creek)	No specimens reported.
18	• Little Mahoning Creek	
19	- Sandy Creek	
20	- French Creek	
21	• Cussewago Creek	
22	• Woodcock Creek	
23	• Conneauttee Creek	
24	• Muddy Creek	
25	• LeBoeuf Creek	
26	• West Branch French Creek	
27	- Hemlock Creek*	*PFBC considers this population to be part of the Allegheny River because the creek is not hospitable much further than its confluence with the Allegheny.
28	- Oil Creek	
29	- Tionesta Creek	
30	- Conewango Creek	
31	- Oswayo Creek	
32	- Potato Creek	
	(Monongahela River)	No specimens reported.
33	Cheat River	
	Lake Erie Basin	
34	Conneaut Creek	
	Susquehanna River Basin	
35	Susquehanna River	
36	- Conodoguinet Creek	
37	- Swatara Creek	
38	• Little Swatara Creek	
39	- Juniata River	
40	• Aughwick Creek	
41	• Raystown Branch Juniata River	
42	• Frankstown Branch Juniata River	
	(mainstem)	
43	- Penns Creek	
	(West Branch Susquehanna River)	No specimens reported.
44	- Pine Creek	
45	North Branch Susquehanna River	
46	- Chemung River	
	Potomac River Basin	
47	Sideling Hill Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *A. marginata* hosts (from Watters *et al.* 2009): Rock Bass (*Ambloplites rupestris*), White Sucker (*Catostomus commersoni*), Northern Hogsucker (*Hypentelium nigricans*), Warmouth (*Lepomis gulosus*), and Shorthead Redhorse (*Moxostoma macrolepidotum*).

TRIANGLE FLOATER *Alasmidonta undulata* (Say, 1817). (S3, G4).

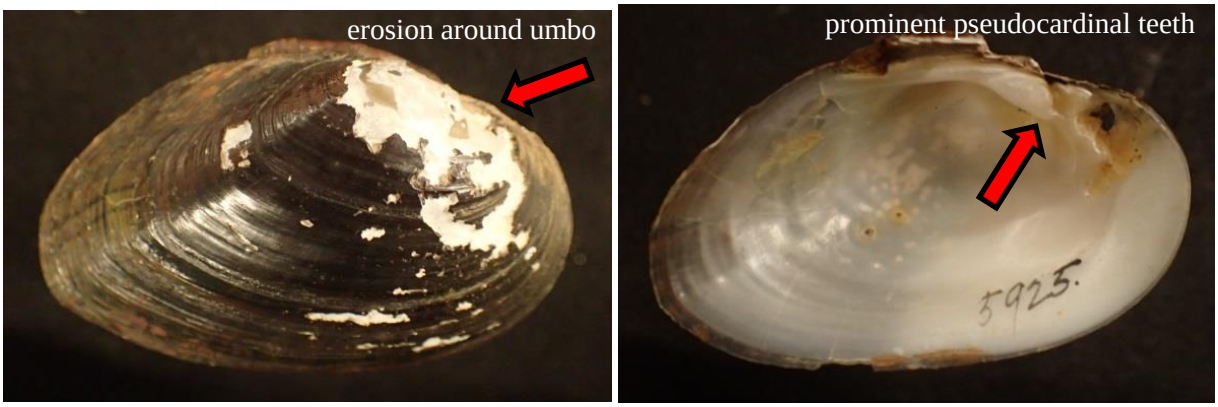


Image (credit, N. Welte): Carnegie Museum Natural History, CMNH# 61.5925 (external and internal)

Defining characteristic(s):

1. Short, inflated, and heavy shell with tear-drop shape;
2. Large pseudocardinal and vestigial teeth makes this mussel heavy anteriorly;
3. Usually heavy erosion around the anterior part of the umbo (e.g., Delaware River specimens);
4. Prominent umbo;
5. Younger specimens may have rays, these disappear with age;
6. Live specimens typically have a white foot although it can infrequently be cantaloupe-colored (Nedeau *et al.* 2000).

May be confused with: Oddly-shaped *Elliptio complanata*. The tear-drop shape, inflation, and heavy anterior of *A. undulata's* shell will differentiate between the two species. Deep erosion around the umbo may also be a key character. Young individuals of *A. undulata* may be confused with *A. varicosa* on rare occasions because both species (*A. undulata* very rarely) may have corrugations on their posterior slope.

Etymology - "without lateral teeth, having nature of a wave"
(Watters *et al.* 2009)**:** Greek *a*, *an*, not, without + Greek *elasmos*, a thin plate + Greek *odontos*, tooth.
Translation: "without lateral teeth."
Welte: *undulate*, having a wavy surface or edge

Table 4. Pennsylvania's known *Alasmidonta undulata* streams.

	Stream	Notes
	Delaware River Basin	
1	Delaware River	
2	- White Clay Creek	
3	- Ridley Creek	
4	Schuylkill River	
5	- Perkiomen Creek	
6	- Manatawny Creek	
	- (Maiden Creek)	No specimens reported.
7	• Sacony Creek	
	(Lehigh River)	No specimens reported.

Table 4. *A. undulata* streams (continued).

8	- Valley Creek	
9	• Princess Run	Ortmann noted this as "Princess Creek, Kunkletown"
	(mainstem)	
10	- Schuylkill Canal	
11	- Neshaminy Creek	
12	• Little Neshaminy Creek	
13	- Cherry Creek	
	Susquehanna River Basin	
14	Big Elk Creek (Chester Co.)	Tributary to the Elk River (MD) and the Chesapeake Bay
15	Susquehanna River	
16	- Muddy Creek (Lancaster Co.)	
17	- Pequea Creek (Lancaster Co.)	
18	- Conestoga River	
19	- Conewago Creek	
20	• Middle Creek	
21	- Swatara Creek	
22	• Little Swatara Creek	
23	- Conodoguinet Creek	
24	Juniata River	
25	- Kishacoquillas Creek	
26	- Raystown Branch Juniata River	
	• (Dunning Creek)	No specimens reported.
27	- Shobers Run	
28	- Frankstown Branch Juniata River	
29	• Canoe Creek	
	- (Mahantango Creek)	No specimens reported.
30	• West Branch Mahantango Creek	
	- (Penns Creek)	No specimens reported.
31	• Sinking Creek	
32	West Branch Susquehanna River	
33	- Pine Creek	
34	• Little Pine Creek	
35	- Bald Eagle Creek	
	- (Clearfield Creek)	No specimens reported.
36	• Beaver Dam Creek (Cambria)	
37	• Swartz Run (Cambria)	
	(mainstem)	
38	- Chest Creek	
39	North Branch Susquehanna River	
40	- Chemung River	
	• (Tioga River)	No specimens reported.
	o (Cowanesque River)	No specimens reported.
41	o Crooked Creek	Ortmann (1919) reported specimens from a millrace to Crooked Creek.
	Potomac River Basin	
	- (Antietam Creek)	No specimens reported
41	• East Branch Little Antietam Creek	
42	- Conococheague Creek	
43	• West Branch Conochocheague Creek	

Table 4. (continued).

44	• Back Creek	
45	- Great Tonoloway Creek	
46	Sideling Hill Creek	
47	• Oregon Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *A. undulata* hosts (Nedeau *et al.* 2000; NatureServe 2015): Central Stoneroller (*Campostoma anomalum*), White Sucker (*Catostomus commersoni*), Slimy sculpin (*Cottus cognatus*), Spotfin shiner (*Cyprinella spiloptera*), Fantail Darter (*Etheostoma flabellare*), Northern Hogsucker (*Hypentelium nigricans*), Common Shiner (*Luxilus cornutus*), Pumpkinseed (*Lepomis gibbosus*), Largemouth Bass (*Micropterus salmoides*), Rosyface Shiner (*Notropis rubellus*), Blackside Darter (*Percina maculata*), Blacknose Dace (*Rhinichthys atratulus*), Longnose Dace (*Rhinichthys cataractae*), and Fallfish (*Semotilus corporalis*).

BROOK FLOATER *Alasmidonta varicosa* (Say, 1819). (S1S2, G3).

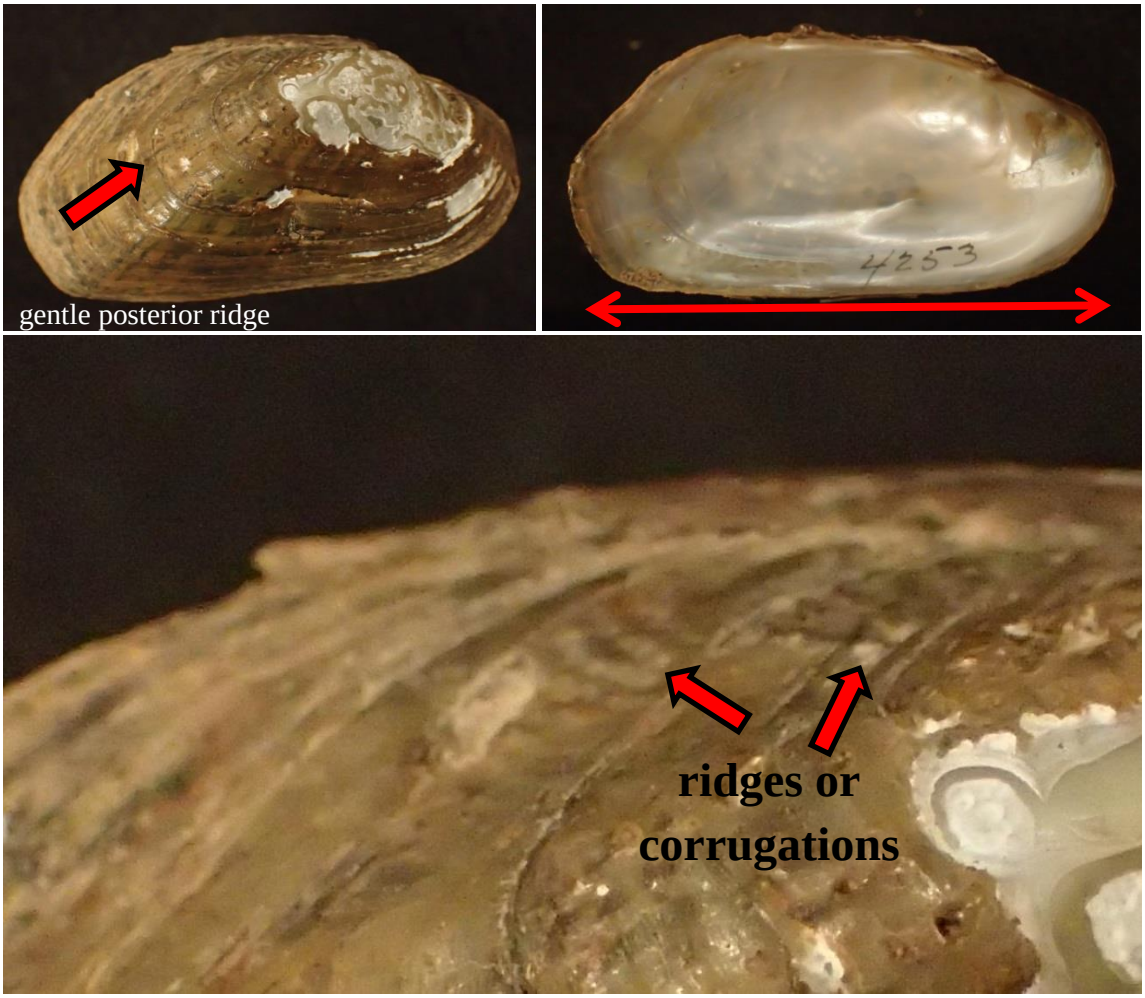


Image (credit, N. Welte): Carnegie Museum of Natural History, CMNH 61.4253 (external and internal)

Defining characteristic(s):

1. Small size (~<70 mm), swollen or inflated thin shell;
2. Lateral teeth absent, knob-like pseudocardinal teeth;
3. Flattened ventral margin;
4. Prominent but gentle, rounding posterior ridge;
5. Posterior slope contains fine ridges or subtle corrugations;
6. Live specimens have a unique habit of gaping and exposing a cantaloupe-colored foot (per Nedeau *et al.* 2000).

May be confused with: *A. marginata*. The two species can be differentiated by examining the steepness of the slope of the posterior ridge. *A. marginata* approaches a nearly 90° slope whereas *A. varicosa* has a gentle, rounding slope. Young individuals of *A. undulata* may be confused with *A. varicosa* on rare occasions because both species (*A. undulata* very rarely) may have corrugations on their posterior slope. Otherwise the other characteristics of *A. undulata* (heavy shell, tear-drop shape, etc.) separate the two species.

Etymology - "without lateral teeth, having ridges"
(from Watters *et al.* 2009)**:** Greek *a, an,* not, without + Greek *elasmos,* a thin plate + Greek *odontos,* tooth. Translation: "without lateral teeth."

Table 5. Pennsylvania's known *Alasmidonta varicosa* streams.

	Stream	Notes
	Susquehanna River Basin	
1	Susquehanna River	
	- (West Conewago Creek)	No specimens reported.
2	• Bermudian Creek	
3	- Conewago Creek	
4	- Conodoguinet Creek	
5	- Swatara Creek	
6	• Quittapahilla Creek	
7	Juniata River	
8	- Raystown Branch Juniata River	
	(mainstem)	
9	- Penns Creek	
	(West Branch Susquehanna River)	No specimens reported.
10	- Pine Creek	
11	• Little Pine Creek	
12	- Sinnemahoning Creek	
	• Driftwood Branch	
13	- Cush Cushion Creek	
	Delaware River Basin	
14	Delaware River	
15	- White Clay Creek	
16	- Ridley Creek	
17	- Crum Creek	
18	Schuylkill River	
	- (Perkiomen Creek)	No specimens reported.
19	• Swamp Creek	
20	- Manatawny Creek	
21	- Maiden Creek	M. Walsh report of findings in 2015, other prior records exist.
22	• Sacony Creek	
23	Lehigh River	
24	- (Valley Creek)	No specimens reported.
25	• Princess Run	
	- Jordan Creek	
26	- Lizard Creek	
27	- Mahoning Creek (Carbon Co.)	
	(mainstem)	
28	- Pennypack Creek	
29	- Neshaminy Creek	
	Potomac River Basin	
30	- Conococheague Creek	
31	• West Branch Conococheague Creek	
32	- Great Tonoloway Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *A. varicosa* hosts (Nedeau *et al.* 2000; NatureServe 2015): Slimy sculpin (*Cottus cognatus*), Pumpkinseed (*Lepomis gibbosus*), Golden Shiner (*Notemigonus chrysoleucas*), Margined Madtom (*Noturus insignis*), Yellow Perch (*Perca flavescens*), Blacknose Dace (*Rhinichthys atratulus*), and Longnose Dace (*Rhinichthys cataractae*).

THREERIDGE *Amblema plicata* (Say, 1817). Other vernacular name(s): Bluepoint. (S2S3, G5).

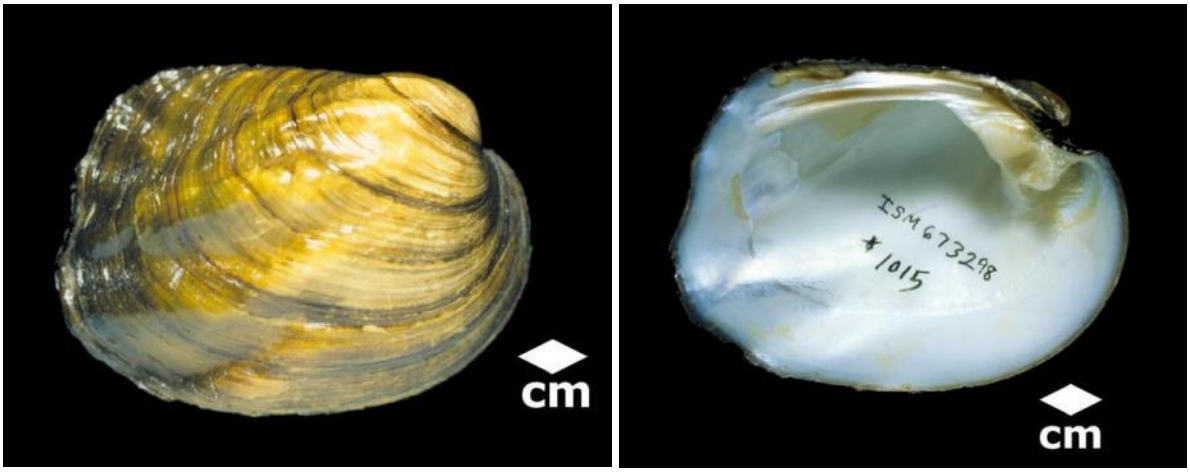


Image (credit, R.Warren): Illinois State Museum, ISM# 673298 (external and internal)

Defining characteristic(s):

1. Plications (usually) on side of shell – there are ridgeless Threeridges (e.g., Conewango Creek)!
2. Large (~160 mm), heavy, often compressed shell;
3. Distinct rhomboidal shape.

May be confused with: *Megalonaias nervosa*, which occurs in Ohio, resembles *A. plicata* but is differentiated by having a blackish shell color and nodules/etchings on the anterior end of the shell.

Etymology - "blunt and folded"
(from Watters *et al.* 2009)**:** Greek *amblys*, blunt, dulled, obtuse. The name, unfortunately, describes Rafinesque's given figures better than it does most specimens of this species. Latin *plicatus*, folded, braided, or doubled up; from Latin *plico*, to fold or braid.

Table 6. Pennsylvania's known *Amblema plicata* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	Beaver River	
3	- Connoquenessing Creek	
4	- Mahoning River	
5	- Shenango River	
6	• Pymatuning Creek	
7	• Little Shenango River	
8	• Padan Creek (Linesville)	
9	Allegheny River	
10	- Crooked Creek	
11	- Oil Creek	
12	- French Creek	
13	• Conneaut Outlet	
14	• Cussewago Creek	

Table 6. *A. plicata* streams (continued).

15	• Woodcock Creek	
16	• Conneauttee Creek	
17	• Muddy Creek	
18	• LeBoeuf Creek	
19	- Hemlock Creek*	*PFBC considers this population to be part of the Allegheny River because the creek is not hospitable much further than its confluence with the Allegheny.
20	- Conewango Creek	
	(Monongahela River)	No specimens reported.
21	- Tenmile Creek	
22	• South Fork Tenmile Creek	
23	- Dunkard Creek	
24	- Cheat River	
	Lake Erie Basin	
25	Lake Erie (Presque Isle Bay)	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *A. plicata* hosts (from Watters *et al.* 2009): Rock Bass (*Ambloplites rupestris*), Freshwater Drum (*Aplodinotus grunniens*), Spotfin Shiner (*Cyprinella spiloptera*), Steelcolor Shiner (*Cyprinella whipplei*), Streamline Chub (*Erimystax dissimilis*), Northern Pike (*Esox lucius*), Mooneye (*Hiodon tergisus*), Northern Hogsucker (*Hypentelium nigricans*), Channel Catfish (*Ictalurus punctatus*), Shortnose Gar (*Lepisosteus platostomus*), Green Sunfish (*Lepomis cyanellus*), Pumpkinseed (*Lepomis gibbosus*), Warmouth (*Lepomis gulosus*), Bluegill (*Lepomis macrochirus*), Largemouth Bass (*Micropterus salmoides*), White Bass (*Morone chrysops*), Black Redhorse (*Moxostoma duquesnei*), Golden Redhorse (*Moxostoma erythrurum*), Emerald Shiner (*Notropis atherinoides*), Yellow Perch (*Perca flavescens*), Logperch (*Percina caprodes*), White Crappie (*Pomoxis annularis*), Black Crappie (*Pomoxis nigromaculatus*), Flathead Catfish (*Pylodictis olivaris*), and Sauger (*Sander canadensis*).

CYLINDRICAL PAPERSHELL *Anodontoides ferussacianus* (Lea, 1834). Other vernacular name(s): Cylinder Shell, Creek Papershell. (S2S3, G5).

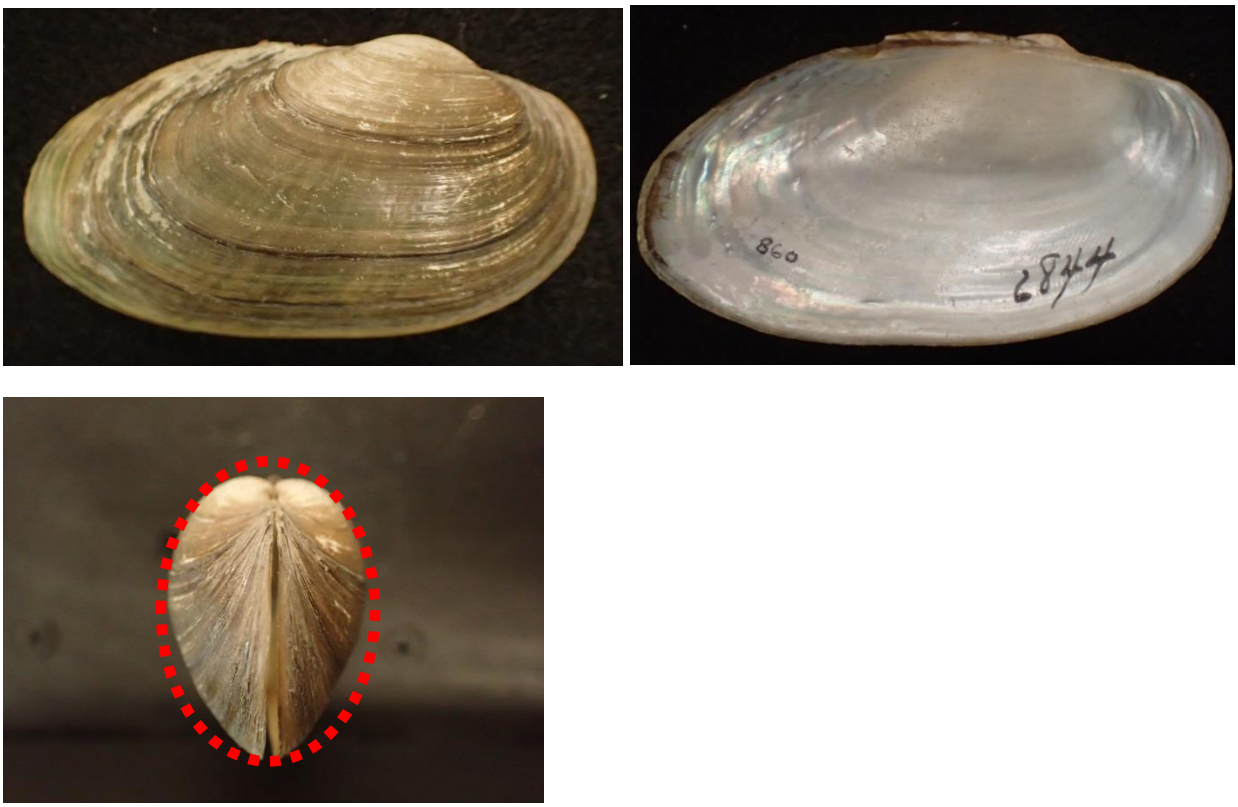


Image (credit, N. Welte): Carnegie Museum of Natural History, CMNH# 61.6844 (external and internal)

Defining characteristic(s):

1. Small/medium (<80 mm), elongated cylinder;
2. Subcylindrical cross-section;
3. Umbo extends above hinge line;
4. Concentric (single loop) beak sculpture.

May be confused with: *Pyganodon grandis*, *P. cataracta*, *Strophitus undulatus* and *U. implicata*. This species is difficult to identify; generally, *A. ferrussacianus* shell will be shorter and more uniformly cylindrical than *P. grandis*.

Etymology - "resembles *Anodonta*, patronym for Baron de Ferussac"
(from Watters *et al.* 2009)**:** Greek *an*, not, without + Greek *odontos*, tooth + Greek *–oides*, like, resembling. Translation: "resembles *Anodonta*." From Baron de Ferussac. This is a patronym in honor of the French malacologist. Translation: "in honor of Ferussac."

Table 7. Pennsylvania's known *Anodontoides ferussacianus* streams.

	Stream	Notes
	Ohio River Basin	
	(Beaver River)	No specimens reported.
1	- Shenango River	
2	• Pymatuning Creek	
3	• Little Shenango River	
4	• Randolph Run (Linesville)	
	(Allegheny River)	No specimens reported.
5	- French Creek	
6	• Conneaut Outlet	
7	- Conneaut Lake	
8	• Cussewago Creek	
9	• Muddy Creek	
10	- Oil Creek	(K.R. Anderson, 2015)
	- (Brokenstraw Creek)	
11	• Little Brokenstraw Creek	(J.R. Allison, 2015)
12	- Conewango Creek	
	(Monongahela River)	No specimens reported.
13	- Dunkard Creek	
	Lake Erie Basin	
14	Lake Erie	
15	- Conneaut Creek	
	Susquehanna River Basin	
	(Susquehanna River)	No specimens reported.
16	- Conestoga River	*Specimen or presence needs to be confirmed.
	- (Swatara Creek)	No specimens reported.
17	• Quittapahilla Creek	Specimen needs to be confirmed (NTW).

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *A. ferussacianus* hosts (from Watters *et al.* 2009; NatureServe 2015): White Sucker (*Catostomus commersoni*), Mottled Sculpin (*Cottus bairdi*), Brook Stickleback (*Culaea inconstans*), Spotfin Shiner (*Cyprinella spiloptera*), Iowa Darter (*Etheostoma exile*), Tippecanoe Darter (*Etheostoma tippecanoe*), Bluegill (*Lepomis macrochirus*), Common Shiner (*Luxilus cornutus*), Largemouth Bass (*Micropterus salmoides*), Blacknose Shiner (*Notropis heterolepis*), Sea Lamprey (*Petromyzon marinus*), Bluntnose Minnow (*Pimephales notatus*), Fathead Minnow (*Pimephales promelas*), and Black Crappie (*Pomoxis nigromaculatus*).

PIMPLEBACK *Cyclonaias pustulosa* (Lea, 1831). Other vernacular name(s): White Pimpleback, Round Pimpleback, Warty Pigtoe, Wartyback, specimens without pustules have been referred to as Smooth Pimpleback. (S1, G5).

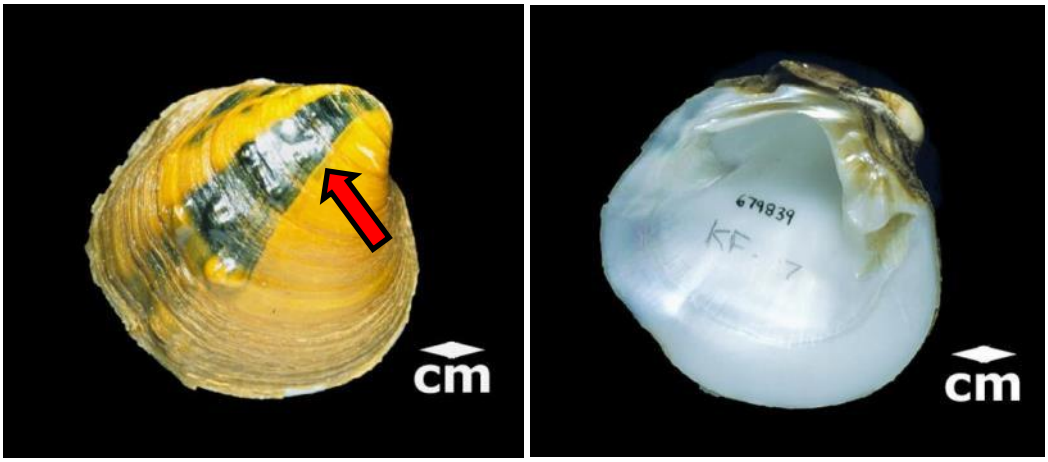


Image (credit, R. Warren): Illinois State Museum, ISM# 679839 (external and internal)

Defining characteristic(s):

1. Broad green ray that begins on umbo and extends either intact or broken;
2. Pustules, although some shells may be smooth;
3. No posterior wing.

May be confused with: *Plethobasus cooperianus.* Shells of both species are nearly identical, absent the green blotch typically present on most young specimens of *C. pustulosa* and occasionally pink/salmon nacre of *P. cooperianus*. Live *P. cooperianus* distinguished by the presence of an orange foot.

Etymology - "round, pimply, water nymph of the rivers"
(from Watters *et al.* 2009)**:** Greek *kyklos*, ring, circle, wheel, sphere + Greek *naias, naiados,* a water nymph of rivers and springs. The genus name literally means "round unionid," an apt description, although not that distinctive. Latin *pustula*, a pimple or blister + *-osa*, full of. Individuals of this species very frequently develop pustules, a few or many, on the surface of the disc.

Ortmann (1919) notes: "*This is one of the rarer species in Pennsylvania. It occurs in the Ohio and Monongahela, in the latter as far up as the lower Cheat River, but it is missing in the headwaters of this system in West Virginia. In the Allegheny River, it has been traced up into Armstrong Co., and, in addition, it is found in the Beaver and Mahoning Rivers, but has not been found in the Shenango*."

Table 8. Pennsylvania's known historical *Cyclonaias pustulosa* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Historical distribution – per Ortmann (1919): Shippingport, Cooks Ferry (across from Shippingport), Industry, Coraopolis, Neville Island Tentative current distribution – Unvouchered specimen reported from the backchannel of Neville Island, Dashields pool (Ecological Specialists 2013).
2	Beaver River	Ortmann (1919): Wampum
3	- Mahoning River	Ortmann (1919): Mahoningtown, Edinburg
4	Allegheny River	Ortmann (1919): Natrona (pool 3), Godfrey and Kelly (present-day pool 5). Bob Ventorini collected a shell specimen in Pool 6 (RM 45.5) just below L&D #7 in 2009.
5	Monongahela River	Ortmann (1919): Westmoreland Co., Charleroi
6	- Cheat River	Ortmann (1919): Cheat Haven
	Lake Erie Basin	
7	Lake Erie	Ortmann (1919): Presque Isle Bay

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *C. pustulosa* hosts (from Watters *et al.* 2009): Black Bullhead (*Ameiurus melas*), Brown Bullhead (*Ameiurus nebulosus*), Channel Catfish (*Ictalurus punctatus*), White Crappie (*Pomoxis annularis*), Flathead Catfish (*Pylodictis olivaris*), and Shovelnose Sturgeon (*Scaphirhynchus platorynchus*).

PURPLE WARTYBACK *Cyclonaias tuberculata* (Rafinesque, 1820). Other vernacular name(s): Purple Pimpleback. (SH, G5).

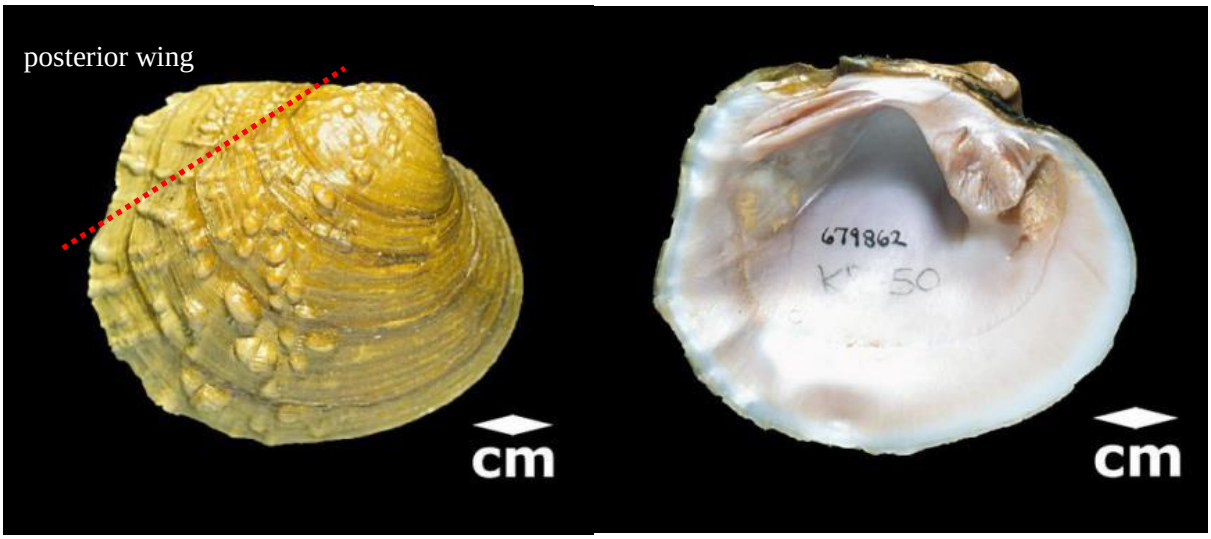


Image (credit, R. Warren): Illinois State Museum, ISM# 679862 (external and internal)

Defining characteristic(s):

1. Numerous pustules, tubercles;
2. Compressed shell and posterior wing;
3. Brilliant purple nacre.

May be confused with: *Cyclonaias pustulosa*. *C. tuberculata* is a much more compressed shell with an obvious posterior wing and deep purple nacre. *C. pustulosa* is a more swollen shell, yellowish periostracum, occasional green blotches near the umbo, and has white nacre.

Etymology - "round, warty, water nymph of the rivers"
(from Watters *et al.* 2009)**:** Greek *kyklos*, ring, circle, wheel, sphere + Greek *naias, naiados*, a water nymph of rivers and springs. The genus name literally means "round unionid," an apt description, although not that distinctive. Latin *tuberculum*, small swelling or bump; from Latin *tuber*, hump, bum, swelling, + Latin *–ata*, provided with.

Ortmann (1919) notes: "*In Pennsylvania, this species has a rather wide distribution, being found in all three river-systems. It goes rather high up (in the Allegheny as far up as Warren Co., according to Marshall, 1895). The smallest streams in which I have found it are Slippery (R)ock, French, and Dunkard Creeks. From the Monongahela proper records are missing, but it ascends to West Virginia (West Fork River). It is nowhere abundant, and is decidedly one of the rarer shells; only few individuals have been found at any one place. This also holds good for the Ohio below Pittsburgh, where this species is by no means abundant.*"

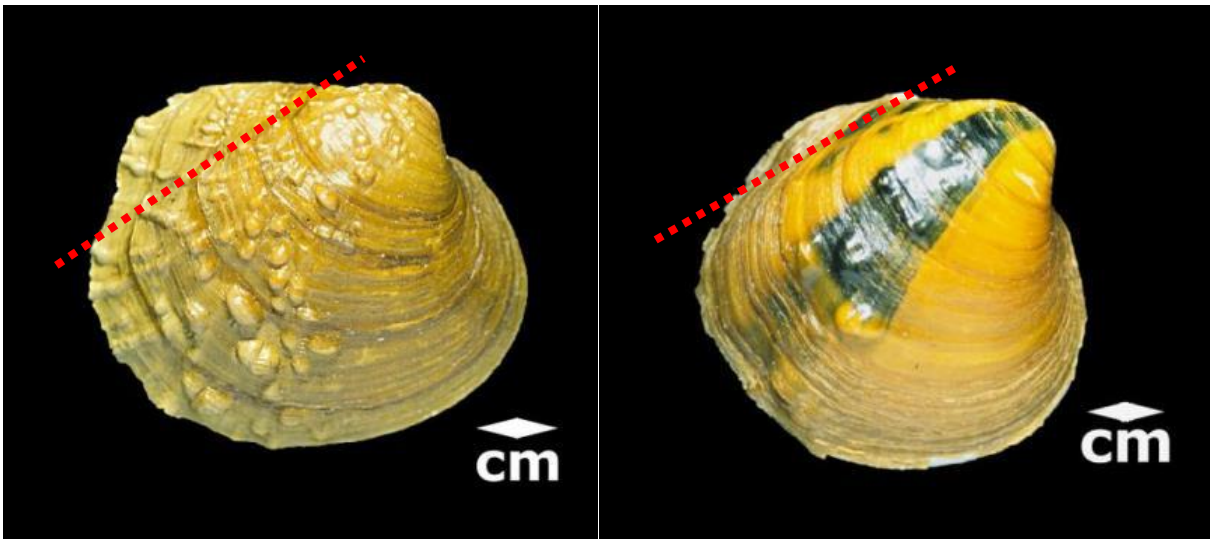
Table 9. Pennsylvania's known historical *Cyclonaias tuberculata* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919): Cooks Ferry (historical location across from Shippingport), Industry, Beaver, Coraopolis, Neville Island
2	Beaver River	Ortmann (1919): Wampum
	- (Connoquenessing Creek)	No specimens reported.
3	• Slippery Rock Creek	Ortmann (1919): Wurtemburg
4	Allegheny River	Ortmann (1919): Godfrey, Johnetta, Kelly (all located in present-day pool 5), Walnut Bend (upstream of present-day Ahrensville Venango Co.), Warren Co. (per Marshall in Ortmann 1919).
5	- French Creek	Ortmann (1919): Utica
	(Monongahela River)	No specimens reported.
6	- Dunkard Creek	Ortmann (1919): Wiley (downstream of present-day Bobtown?)
7	- Cheat River	Ortmann (1919): Cheat Haven

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *C. tuberculata* hosts (from Watters *et al.* 2009): Black Bullhead (*Ameiurus melas*), Yellow Bullhead (*Ameiurus natalis*), Channel Catfish (*Ictalurus punctatus*), and Flathead Catfish (*Pylodictis olivaris*).

C. tuberculata posterior slope vs. *C. pustulosa* posterior slope



FANSHELL *Cyprogenia stegaria* **(**Rafinesque, 1820). Other vernacular name(s): Ringed Wartyback. **Federally Endangered.** (SH, G1).

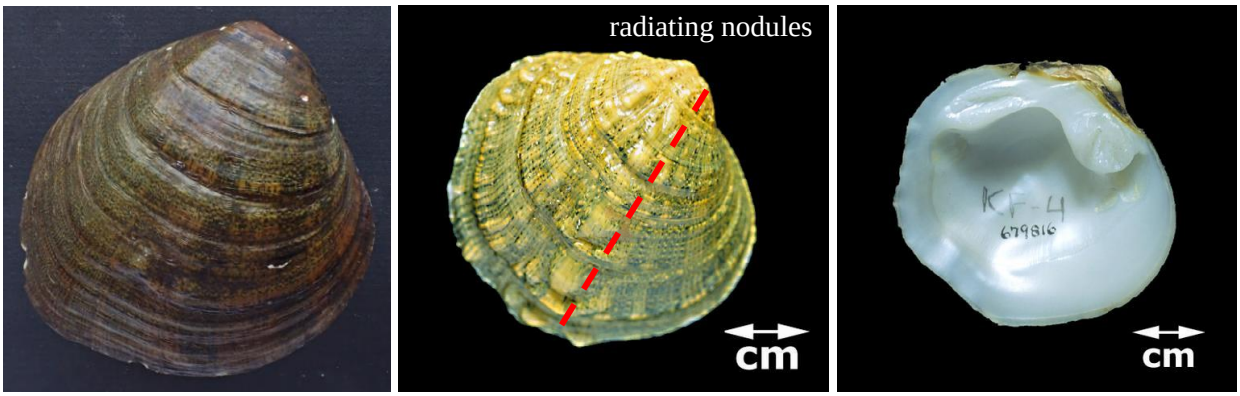


Image ((left) credit, N. Welte): CMNH 3948 (external), Ohio River, Industry, Pennsylvania. **Image (center, right) credit, R. Warren):** Illinois State Museum, ISM# 679816 (external and internal)

Defining characteristic(s):

1. Numerous fine green dots or dashes sometimes bundled into broken dark rays;
2. Slight sulcus;
3. Some nodules in sulcus or on slope may assume a radial arrangement extending vertically from the umbo.

May be confused with: *Cyclonaias pustulosa*. Differentiate by numerous fine rays (versus large green blotches on *C. pustulosa*). Nodules on *C. stegaria* tend to be finer and more systematically arranged. *C. stegaria* individuals generally have a smaller shell than *C. pustulosa*.

Etymology - "Aphrodites + shingles"
(from Watters *et al.* 2009)**:** Greek *Kypris*, a name of Aphrodite or *kypros*, henna (an Old-World tropical shrub, the leaves of which yield a reddish dye) + Greek *genea*, race, generation, offspring. The Greek word *Kypris* (or Latin *Cypris*) has been used to denote beauty, elegance, or grace, qualities possessed by Aphrodite and Venus. Greek *stege, stega, stegos*, roof, shelter. Rafinesque noted that the shell was "…slightly imbricated by the large separate wrinkles" [in Rafinesque's French terminology a "wrinkle" is a growth line or annular ring on the shell]. These apparently reminded Rafinesque of overlapping shingles on a roof.

Ortmann (1919) notes: "*In Pennsylvania this species has been found in the Ohio and lower Allegheny. All specimens collected by myself (only seven) were dead shells, but some of them were quite fresh. However, this species must once have also existed in the Monongahela, at least as far up as the mouth of the Cheat River, for I have found specimens in an old Indian garbage heap, opposite Point Marion…*"

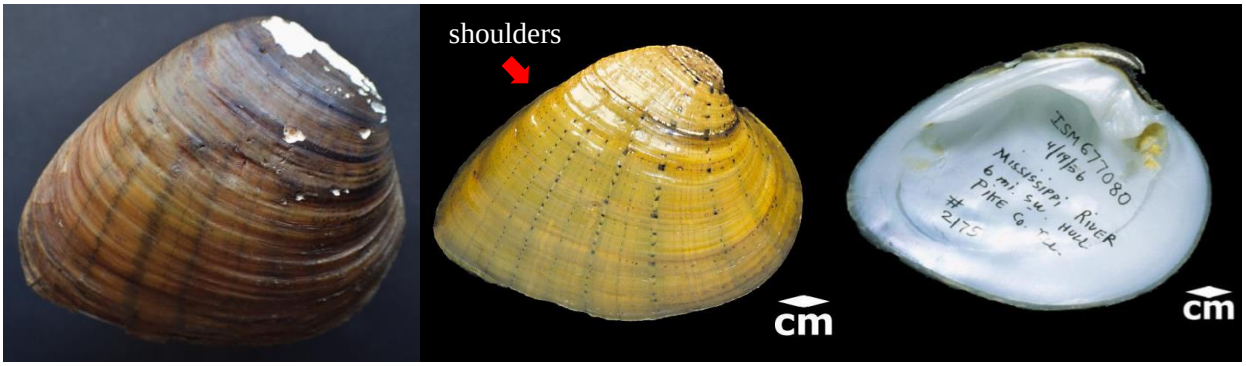
Table 10. Pennsylvania's known historical *Cyprogenia stegaria* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919): Industry, Beaver
2	Allegheny River	Ortmann (1919):Natrona (pool 3), Aladdin and Godfrey (present-day pool 5)

Data source(s): Ortmann 1919.

Reported *C. stegaria* hosts (from Watters *et al.* 2009): Mottled Sculpin (*Cottus bairdi*), Banded Sculpin (*Cottus carolinae*), Tangerine Darter (*Etheostoma aurantiaca*), Greenside Darter (*Etheostoma blennioides*), Snubnose Darter (*Etheostoma simoterum*), Banded Darter (*Etheostoma zonale*), Blotchside Logperch (*Percina burtoni*), Logperch (*Percina caprodes*), and Roanoke Darter (*Percina roanoka*).

BUTTERFLY *Ellipsaria lineolata* (Rafinesque, 1820). (SH, G4G5).



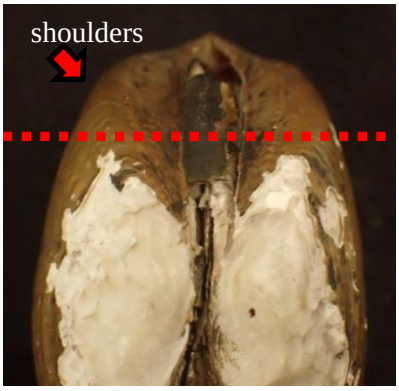


Image ((left) credit, N. Welte): CMNH 3656 (external), Ohio River, Industry, Pennsylvania; **image (center, right) credit, R. Warren):** Illinois State Museum, ISM#677080 (external and internal).

Defining characteristic(s):

1. Easily recognized species;
2. Compressed;
3. Sharp posterior ridge, no posterior slope, narrow "shoulders";
4. Distinct color pattern.

May be confused with: A distinct species that should not be confused with anything else in Pennsylvania.

Etymology - "falls short of an ellipse"
(from Watters *et al.* 2009)**:** Greek "*elleipsis,*" a defect, a falling short. The geometric figure was so named because the angle between a conic section (ellipse) and its base "falls short of" (is less than) the inclination of the side of the cone. Rafinesque (1820: 303) described the genus *Ellipsaria* as having a "forme elliptique." Although this was probably an apt description of the species Rafinesque originally included in his new subgenus, it is less appropriate for *E. Lineolata*, the only species we include in *Ellipsaria* today. Latin *lineola*, a little line + Latin *–ata*, provided with.

Ortmann (1919) notes: "*In Pennsylvania this species is found only in the Ohio, Allegheny, and Monongahela. In the Allegheny it goes to southern Armstrong County, where it is quite rare. In the*

Monongahela it is known only from Charleroi in Washington County, and on the opposite site in Westmoreland County. Below Pittsburgh it is not a rare shell, and has been found in considerable numbers in the riffles and shell-banks in coarser or finer gravel and in strong currents."

Table 11. Pennsylvania's known historical *Ellipsaria lineolata* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919): Smiths Ferry (historically across from present-day Georgetown), Shippingport, Industry, Coraopolis, Neville Island
2	Allegheny River	Ortmann (1919): Godfrey and Kelly (present-day pool 5) *****This species **rediscovered in 2016** by Chad Lewis in the Allegheny River downstream of L&D #2, which is in the Pittsburgh pool.
3	Monongahela River	Ortmann (1919): Charleroi

Data source(s): Ortmann 1919.

Reported *E. lineolata* hosts (from Watters *et al.* 2009): Freshwater Drum (*Aplodinotus grunniens*), Green Sunfish (*Lepomis cyanellus*), and Sauger (*Sander canadensis*).

EASTERN ELLIPTIO *Elliptio complanata* (Lightfoot, 1786). Other vernacular name(s): Eastern Spike, Flat Ladyfinger, Eastern Ladyfinger, Flat Spike. (S4, G5).

Image (credit, N. Welte): PFBC reference collection.

Defining characteristic(s):

1. Extremely variable shell;
2. Shell typically compressed;
3. Nacre color varies, but never deep purple like some *Eurynia dilatata*.

May be confused with: A sometimes polymorphic species, may occasionally resemble other Atlantic Slope species (e.g., *A. heterodon*, *A. undulata*. *E. fisheriana*, and *E. producta*) depending upon shell size.

Etymology - "flattened ellipse"
(from Watters *et al.* 2009)**:** Greek *elleiptikos*, elliptic, having the shape of an ellipse. Nearly all species of *Elliptio* are elongated in lateral view, some scarcely and some extremely so, but this ellipsoidal outline can be considered to justify the name *Elliptio*. Latin *com-*, from *cum*, with, together + Latin *plana*, to level, to make plain, flat, even. So the construction *complanatus* means "flattened together," or compressed. A number of the forms of this complex are very much compressed laterally as are other species in other genera.

Table 12. Pennsylvania's known *Elliptio complanata* streams.

	Stream	Notes
	Delaware River Basin	
1	Delaware River	
2	- White Clay Creek	
3	- Brandywine Creek	
4	• East Branch Brandywine Creek	
5	- Ridley Creek	
6	- Schuylkill Canal	
	(Schuylkill River)	No specimens reported
7	- Wissahickon Creek	
8	- Perkiomen Creek	
9	- French Creek	
10	- Manatawny Creek	
11	- Tulpehocken Creek	
	- (Maiden Creek)	No specimens reported

Table 12. *E.complanata* streams (continued).

12	• Sacony Creek	
	(mainstem)	
13	- Neshaminy Creek	
14	• Little Neshaminy Creek	
15	- Tohickon Creek	
16	(Lehigh River)	No specimens reported
17	- Common Creek	= Aquashicola? Stream reported in Ortmann 1919
18	- Sacony Creek	
19	- Princess Creek	
20	- Meniolagomeka Creek (?)	Ortmann reference, probably near Kunkletown
21	- Lizard Creek	
22	- Mahoning Creek (Carbon Co.)	
	(mainstem)	
23	- Cherry Creek	
24	- Marshalls Creek	
25	- Bushkill Creek	
26	- Van Campens Brook	New Jersey
27	- Flat Brook	New Jersey
28	- Lackawaxen River	
	Susquehanna River Basin	
29	Susquehanna River	
30	- Conestoga River	
31	• Mill Creek	
32	• Cocalico Creek	
33	- Chiques Creek	
	- (West Conewago Creek)	No specimens reported
34	• Bermudian Creek	
35	- Codorus Creek	
36	- Conewago Creek	*greatest abundance in Lower Susquehanna Subbasin
37	• Middle Creek	
38	- Yellow Breeches Creek	
39	- Swatara Creek	
40	• Little Swatara Creek	
41	- Conodoguinet Creek	
42	• Big Sandy Creek	Bogan attributes this as a trib to Conodoguinet Ck.
43	- Clarks Creek	
44	- Shermans Creek	
45	Juniata River	
46	- Buffalo Creek (Perry Co.)	
47	- Cocolamus Creek	
48	- Lost Creek	
49	- Tuscarora Creek	
50	• East Licking Creek	
51	- Kishacoquillas Creek	
52	- Aughwick Creek	
53	• Little Aughwich Creek	
54	- Raystown Branch Juniata River	
55	• Dunning Creek	
56	• Yellow Creek	
57	- Standing Stone Creek	
58	- Frankstown Branch Juniata River	

Table 12. *E.complanata* streams (continued).

	(mainstem)	
	- (Mahantango Creek)	No specimens reported.
59	• West Branch Mahantango Creek	
60	- Penns Creek	
61	• Sinking Creek	
62	West Branch Susquehanna River	
63	- Chilisquaque Creek	
64	- Pine Creek	
65	• Marsh Creek	
66	- Bald Eagle Creek	
	- (Sinnemahoning Creek)	No specimens reported.
67	• Driftwood Branch	
	- (Clearfield Creek)	No specimens reported.
68	• Beaver Dam Creek (Cambria)	
69	- Cush Cushion Creek	
70	- Chest Creek	
71	North Branch Susquehanna River	
72	- Chemung River	
	• (Tioga River)	No specimens reported.
	○ (Cowanesque River)	No specimens reported.
73	○ Crooked Creek	Ortmann (1919) reported specimens from a millrace to Crooked Creek.
	Potomac River Basin	
74	- Rock Creek	
	- (Antietam Creek)	No specimens reported.
75	• East Branch Antietam Creek	
76	- Conococheague Creek	
77	• West Branch Conochocheague Creek	
78	• Back Creek	
79	- Licking Creek	
80	- Great Tonoloway Creek	
81	- Sideling Hill Creek	
82	- Town Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *E. complanata* hosts (Lellis *et al.* 2013): American Eel (*Anguilla rostrata*), Brook Trout (*Salvelinus fontinalis*), Lake Trout (*Salvelinus namaycush*), Mottled Sculpin (*Cottus bairdi*), and Slimy Sculpin (*Cottus cognatus*).

ELEPHANTEAR *Elliptio crassidens* (Lamark, 1819). Other vernacular name(s): Pink Elephantear. (SH, G5).

Image (credit, K. Little): Illinois State Museum, ISM# 674876 (external and internal)

Defining characteristic(s):

1. Very large, heavy shell;
2. Reddish brown, blackish periostracum;
3. Distinct pink or purple nacre.

May be confused with: Younger specimens may resemble *E. dilatata*, *E. crassidens* has a much heavier shell, even at similar sizes as *E. dilatata*.

Etymology - "ellipse with solid, thick tooth"
(from Watters *et al.* 2009)**:** Greek *elleiptikos*, elliptic, having the shape of an ellipse. Latin *crassus*, solid, thick + Latin *dens, dentis*, tooth. This species may well have the thickest shell of any in the genus. Thick shells are typically accompanied by heavy hinge teeth.

Ortmann (1919) notes: "*This is a species restricted to the large rivers, Ohio, Allegheny, and Monongahela, but extremely abundant in them. I have never seen it in the Allegheny above Templeton in Armstrong Co. In the Monongahela it once must have gone up above Charleroi at least as far as the West Virginia state-line, since I have found it in an Indian garbage-heap at Point Marion…*"

Table 13. Pennsylvania's known historical *Elliptio crassidens* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919): Smiths Ferry (across the river from present-day Georgetown), Shippingport, Cooks Ferry (across the river from present-day Shippingport), Industry, Beaver, Shoustown (present-day Cresent), Coraopolis, and Neville Island.
2	Allegheny River	Ortmann (1919): Warren Co.
3	Monongahela River	Ortmann (1919):

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *E. crassidens* hosts (from Watters *et al.* 2009): Skipjack Herring (*Alosa chrysochloris*).

NORTHERN LANCE *Elliptio fisheriana* (Lea, 1838). (S1, G4).

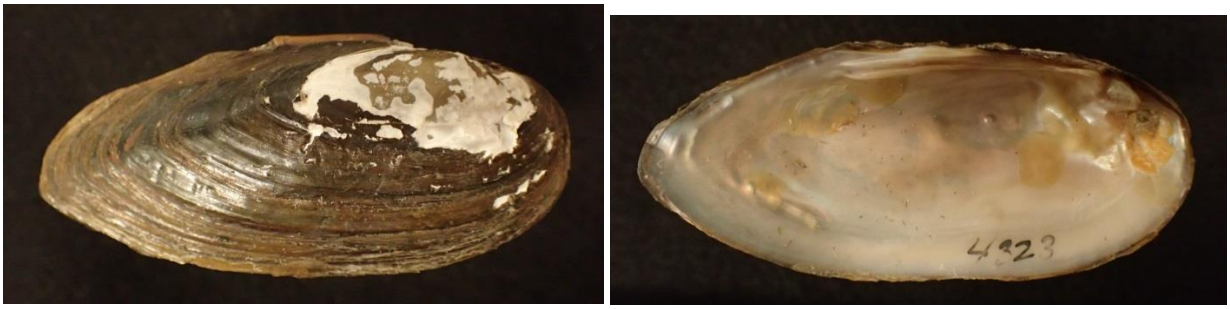


Image (credit, N. Welte): Carnegie Museum of Natural History, CMNH# ???.

Defining characteristic(s):

1. Elongated, lance shape;
2. Only one specimen reported from the Delaware River basin (Ortmann 1919).
3. Much taxonomic uncertainty associated with the lanceolate Elliptios.

May be confused with: *E. complanata*, *E. producta* and *Ligumia nasuta*. The narrow, lance shape distinguishes *E. producta* from *E. fisheriana*. The lance shape also separates *E. fisheriana* from *E. complanata*. *Ligumia nasuta* is more inflated, has a heavier shell and can be separated by distribution (*L. nasuta* in some Ohio River basin tributaries as well as the lower Delaware River tidal zone).

Etymology - "patronym for Fisher"
(from Watters *et al.* 2009)**:** Greek *elleiptikos*, elliptic, having the shape of an ellipse.

Table 14. Pennsylvania's known *Elliptio fisheriana* streams.

	Stream	Notes
	Delaware River Basin	
1	- Schuylkill River	(Ortmann 1919)

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *E. fisheriana* hosts: No known hosts.

ATLANTIC SPIKE *Elliptio producta* (Conrad, 1836). (SNR, G3).

Image (credit, N. Welte): Specimen courtesy of Rick Spear and the Pennsylvania Department of Environmental Protection reference collection.

Defining characteristic(s):

4. Narrow, elongated lance shape;
5. Pennsylvania's Potomac River drainage
6. Much taxonomic uncertainty associated with the lanceolate Elliptios.

May be confused with: *E. complanata* and *Ligumia nasuta*. The lance shape distinguishes between the two. *Ligumia nasuta* is more inflated, has a heavier shell and can be separated by distribution (*L. nasuta* in some Ohio River basin tributaries as well as the lower Delaware River tidal zone).

Etymology:
(from Watters *et al.* 2009)**:** Greek *elleiptikos*, elliptic, having the shape of an ellipse.

Table 15. Pennsylvania's known *Elliptio producta* streams.

	Stream	Notes
	Potomac River Basin	
1	- Licking Creek	
2	- Tonoloway Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *E. producta* hosts: No known hosts.

NORTHERN RIFFLESHELL *Epioblasma rangiana* (Lea, 1838). Other vernacular name(s): Tan Riffleshell. **State Endangered, Federally Endangered.** (S2, G2).

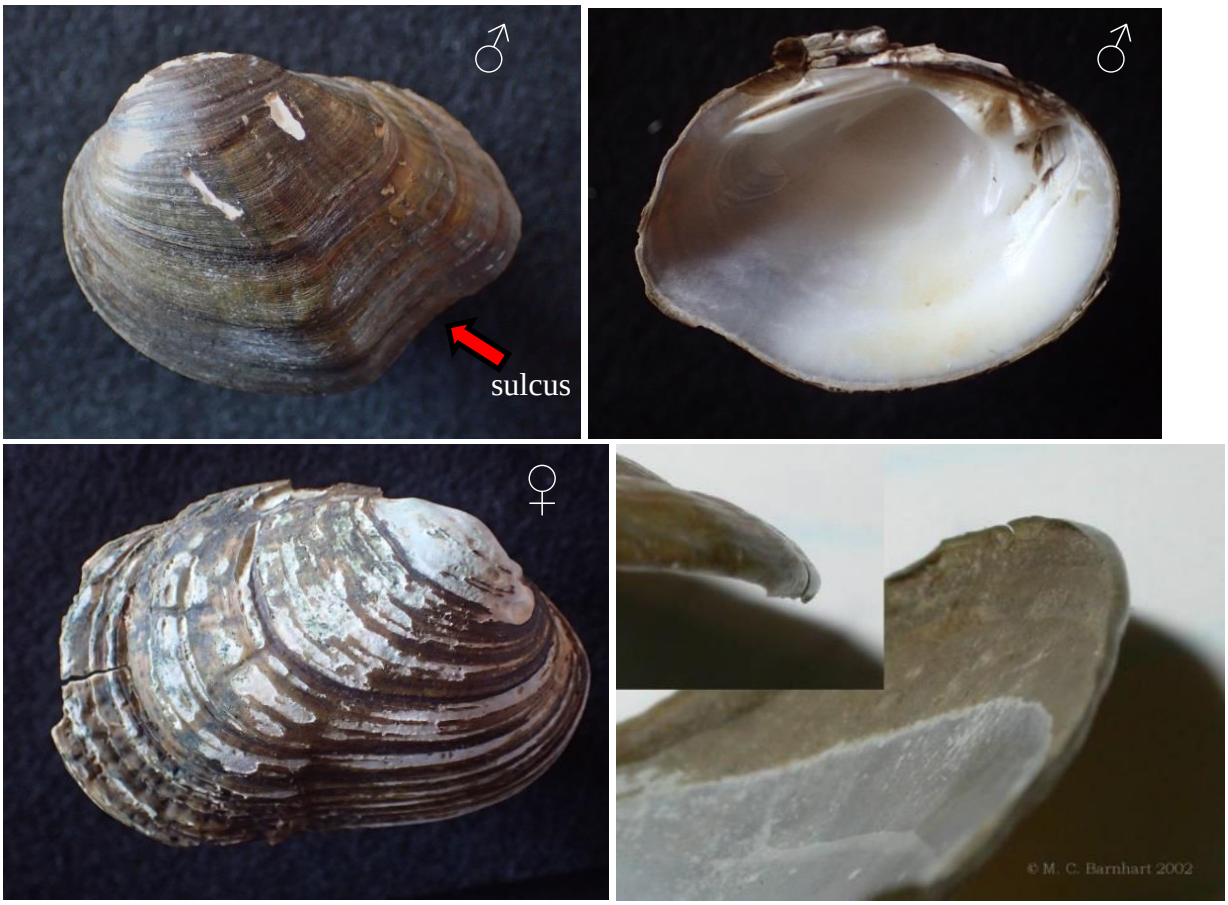


Image (credit, N. Welte): PFBC reference collection**, image (credit, C. Barnhart):**

Defining characteristic(s):

1. Small, moderately thick shell, progressively thinner towards the posterior ventral margin, especially in females;
2. Females with a distinct lobed posterior/ventral margin;
3. Males with a distinct sulcus;
4. Numerous fine green rays.

May be confused with: Male *E. rangiana* may superficially resemble *Plethobasus cyphyus*. *E. rangiana* never has a brilliant yellow shell like young *P. cyphyus* which would be similar in size to mature male *E. rangiana*. Greenish coloration and numerous green rays always present on *E. rangiana*. Young female *E. rangiana* may resemble young *Lampsilis fasciola*. Shell thickness and shape will usually distinguish the two pretty easily, the young female *E. rangiana* is a heavier shell than a similar sized *L. fasciola*.

Etymology (from Watters *et al.* 2009)**:** Greek *epi-*, upon, over, above + Greek *ob-*, toward, to + Greek *elasma*, metal beaten out, metal plate. Rafinesque's description of the genus is generally based upon the space between the lateral teeth, which are slightly further apart anteriorly than posteriorly. Rang + Latin

iana, adjectival ending. Lea (1838: 96) explained the coining of the patronym: "I name it after an ardent student of the Mollusca, Mons. Sander Rang." Rang was an early malacologist known to unionoid researchers for his 1835 paper, "Quelques Acephales d'eau douce du Senegal."

Table 16. Pennsylvania's known *Epioblasma rangiana* streams.

	Stream	Notes
	Ohio River Basin	
	(Beaver River)	No specimens reported.
1	- Shenango River	
2	Allegheny River	
3	- Sandy Creek	
4	- French Creek	
5	• Cussewago Creek	
6	• Muddy Creek	
7	• LeBoeuf Creek	
8	- Oil Creek	
9	- Hemlock Creek*	*PFBC considers this population to be part of the Allegheny River because the creek is not hospitable much further than its confluence with the Allegheny.
10	- Conewango Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *E. rangiana* hosts (Watters 1996; O'Dee and Watters 2000; McNichols *et al.* 2007; Zanatta and Murphy 2007; Watters *et al.* 2009): Mottled Sculpin (*Cottus bairdi*), Banded Sculpin (*Cottus carolinae*), Rainbow Darter (*Etheostoma caeruleum*), Bluebreast Darter (*Etheostoma camurum*), Iowa Darter (*Etheostoma exile*), Johnny Darter (*Etheostoma nigrum*), Banded darter (*Etheostoma zonale*), and Brown Trout (*Salmo trutta*).

SNUFFBOX *Epioblasma triquetra* (Rafinesque, 1820). Other vernacular name(s): Northern Arc Shell. **State Endangered, Federally Endangered.** (S2, G3).

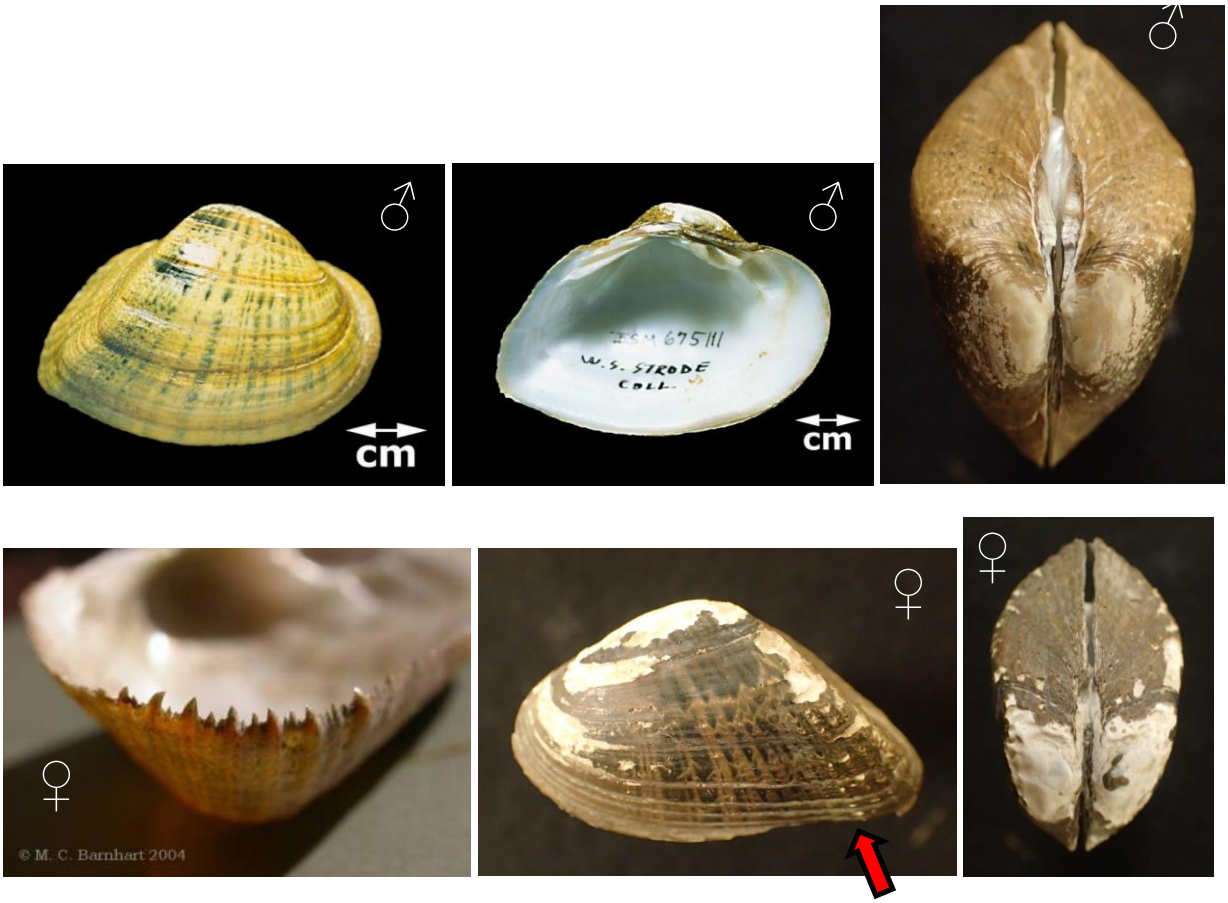


Image (credit, R. Warren): Illinois State Museum, ISM# 675111 (external and internal), **image (credit, C. Barnhart):** http://unionid.missouristate.edu, **image (credit, N. Welte)**: female (external), vertical profile (male and female).

Defining characteristic(s):

1. Moderately thick shell;
2. Very sharp posterior slope, allowing shell to sit flush with the stream bottom;
3. Females distinctly swollen posterior for brooding glochidia;
4. Females with distinct "teeth" on posterior margin for trapping host fish (darters).

May be confused with: *A. marginata*. *A. marginata* is a much thinner, lighter shell and could be confused with male *E. triquetra*. The heft of the *E. triquetra* shell is distinct and clearly separates the two species.

Etymology (from Watters *et al.* 2009)**:** Greek *epi-*, upon, over, above + Greek *ob-*, toward, to + Greek *elasma*, metal beaten out, metal plate. Rafinesque's description of the genus is generally based upon the space between the lateral teeth, which are slightly further apart anteriorly than posteriorly. Latin

triquetrus, having three corners, triangular. Rafinesque (1820: 300) noted that the shape of this shell is "radiate triedre," or almost tetrahedral. Together, the posterior slopes of the two valves of an individual *E. triquetra* (especially a female) more nearly form a plane than in any other species.

Table 17. Pennsylvania's known *E. triquetra* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	Beaver River	
3	- Mahoning River	
4	- Shenango River	
5	• Pymatuning Creek	
6	• Little Shenango River	
7	Allegheny River	
8	- Crooked Creek	
9	- French Creek	
10	• Conneaut Outlet	
11	• Woodcock Creek	
12	• Muddy Creek	
13	• LeBoeuf Creek	
14	• West Branch French Creek	EnviroScience 2008
	(Monongahela River)	No specimens reported.
15	- Tenmile Creek	Bogan (1993) collected 4 pairs of dead *E. triquetra* shells
16	- Dunkard Creek	
	Lake Erie Basin	
17	Lake Erie (Presque Isle Bay)	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *E. triquetra* hosts (from Watters *et al.* 2009): Black Sculpin (*Cottus baileyi*), Mottled Sculpin (*Cottus bairdi*), Banded Sculpin (*Cottus carolinae*), Ozark Sculpin (*Cottus hypselurus*), Blackspotted Topminnow (*Fundulus olivaceous*), Logperch (*Percina caprodes*), Blackside Darter (*Percina maculata*), and Roanoke Darter (*Percina roanoka*).

SPIKE *Eurynia dilatata* (Rafinesque, 1820). Other vernacular name(s): Little Spike, Ladyfinger, Bluefinger Spike. (S4, G5).

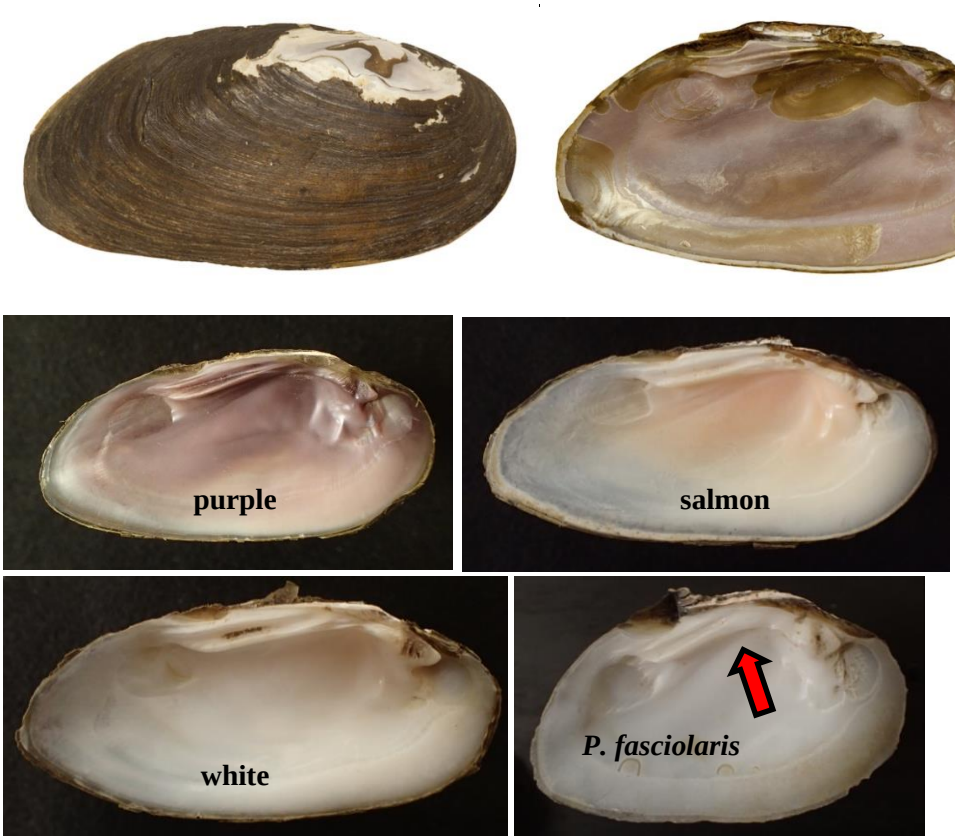


Image (credit, A. Bogan, www.discoverlife.com): North Carolina State Museum, NCSM# 16236 (external and internal), **image (credit, N. Welte)**: varying nacre coloration; hinge teeth comparison with *Ptychobranchus fasciolaris*.

Defining characteristic(s):

1. Shell shape variable, but usually "spike-like;"
2. Brownish, blackish periostracum;
3. Slender, nearly straight lateral teeth;
4. Nacre color ranges from white, salmon, to a deep, vibrant purple.

May be confused with: *Ptychobranchus fasciolaris*. Older, darker *P. fasciolaris* individuals may resemble *E. dilatata*. Species distinguished by posterior slope and shell heft when alive (*P. fasciolaris* is more humped and heavier). Dead shell easily distinguished by *P. fasciolaris*' heavy, curved, and club-shaped lateral teeth. *E. dilatata* will have slender, nearly straight lateral teeth and may also be distinguished by salmon/pink/purple nacre, if present.

Etymology - "dilated ellipse"
(from Watters *et al.* 2009)**:** Greek *elleiptikos*, elliptic, having the shape of an ellipse. Latin *dilato*, spread out, dilate, enlarge, amplify. Rafinesque's concept of width corresponds to the current concept of length.

An elongate specimen in today's terminology would be described as wide or dilated by Rafinesque in his time.

Table 18. Pennsylvania's known *Eurynia dilatata* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	- Little Beaver Creek	
3	• North Fork Little Beaver Creek	
4	Beaver River	
5	- Connoquenessing Creek	
6	• Slippery Rock Creek	
7	- Wolf Creek	
8	- Mahoning River	
9	- Shenango River	
10	• Neshannock Creek	
11	• Pymatuning Creek	
12	• Little Shenango River	
13	Allegheny River	
	- (Kiskiminetas River)	No specimens reported.
14	• Loyalhanna River	
	• (Conemaugh River)	No specimens reported.
15	- Black Lick Creek	
	o Yellow Creek	
	• (Stony River)	No specimens reported.
16	- Quemahoning Creek	
17	- Crooked Creek	
	- (Mahoning Creek)	No specimens reported.
18	• Little Mahoning Creek	
19	- Clarion River	Live *E. dilatata* introduced by PFBC/WPC/USFS in 2015
20	- Sandy Creek	
21	- French Creek	
22	• Conneaut Outlet	
23	- Conneaut Lake	
24	• Cussewago Creek	
25	• Woodcock Creek	
26	• Muddy Creek	
27	• LeBoeuf Creek	
28	• South Branch French Creek	
29	• West Branch French Creek	
30	- Oil Creek	
31	- Hemlock Creek*	*PFBC considers this population to be part of the Allegheny River because the creek is not hospitable much further than its confluence with the Allegheny.
32	- Tionesta Creek	
33	- Brokenstraw Creek	
34	- Conewango Creek	
35	- Oswayo Creek	
36	- Potato Creek	
37	Monongahela River	
38	- Tenmile Creek	Ortmann 1919 – found as dead shell only

Table 18. *E.dilatata* streams (continued).

39	- Dunkard Creek	
40	- Cheat River	
	Lake Erie Basin	
41	Lake Erie (Presque Isle Bay)	
42	- Conneaut Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *E. dilatata* hosts (from Watters *et al.* 2009): Rock Bass (*Ambloplites rupestris*), Banded Sculpin (*Cottus carolinae*), Gizzard Shad (*Dorosoma cepedianum*), Rainbow Darter (*Etheostoma caeruleum*), Yellow Perch (*Perca flavescens*), White Crappie (*Pomoxis annularis*), Black Crappie (*Pomoxis nigromaculatus*), Flathead Catfish (*Pylodictis olivaris*), and Sauger (*Sander canadensis*).

WABASH PIGTOE *Fusconaia flava* (Rafinesque, 1820). Other vernacular name(s): Pigtoe. (S2S3, G5).

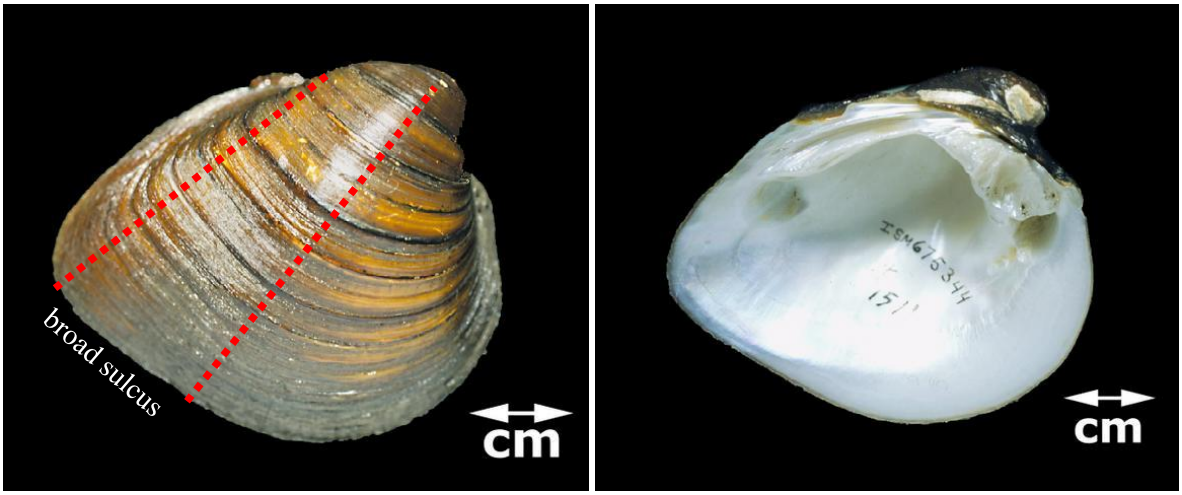


Image (credit, R. Warren): Illinois State Museum, ISM# 675344 (external and internal)

Defining characteristic(s):

1. Subtrapezoidal outline;
2. Shallow beak cavity;
3. Brown, chestnut, or russet-colored periostracum;
4. Gentle, broad sulcus.

May be confused with: Primarily *Pleurobema cordatum* because of *F. flava*'s weak sulcus. See "Fuscobema" worksheet for differentiating characteristics.

Etymology - "tawny water nymph of the river"
(from Watters *et al.* 2009)**:** Latin *fuscus*, dark, dusky, tawny + Latin *naias* (from Greek *naias*, *naiados*), a water nymph of rivers and springs. Latin *flavus*, yellow. Poulson (1832: 38-39) in his translation of Rafinesque's original description noted that the shell is "yellowish brown" and the soft parts "…of a deep or orange yellow colour," and further that the "*shell* almost yellow when young." While true, the colors "tan to dark brown" for the adult shell would better fit the species.

Table 19. Pennsylvania's known *Fusconaia flava* streams.

	Stream	Notes
	Ohio River Basin	
	- (Wheeling Creek (tributary to mainstem Ohio River, West Virginia))	No specimens reported.
	• (Dunkard Fork)	No specimens reported.
1	- North Fork Dunkard Fork	
2	Ohio River	
3	- Raccoon Creek	
4	- Chartiers Creek	
5	Allegheny River	
6	- Crooked Creek	
7	• South Branch Plum Creek	

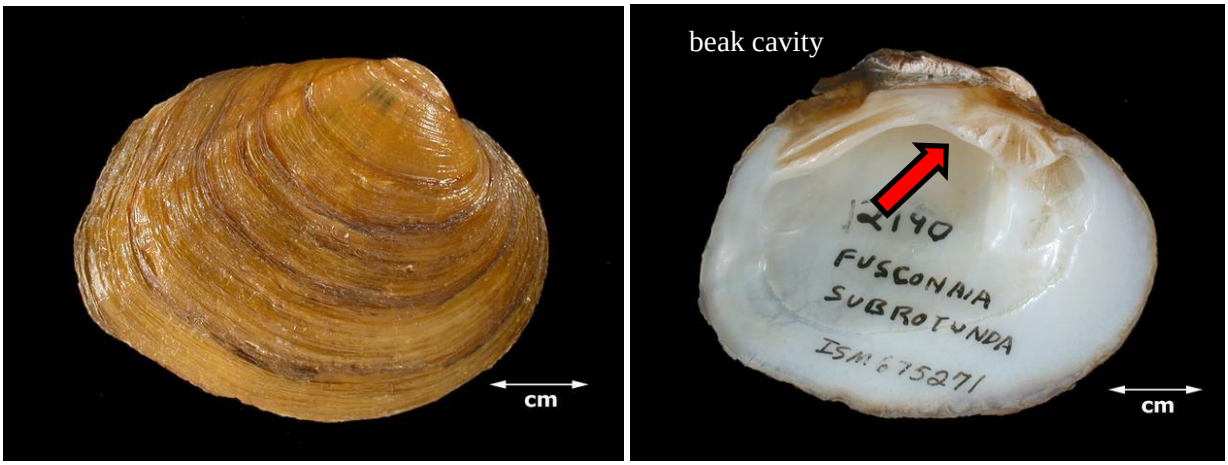
Table 19. *F. flava* streams (continued).

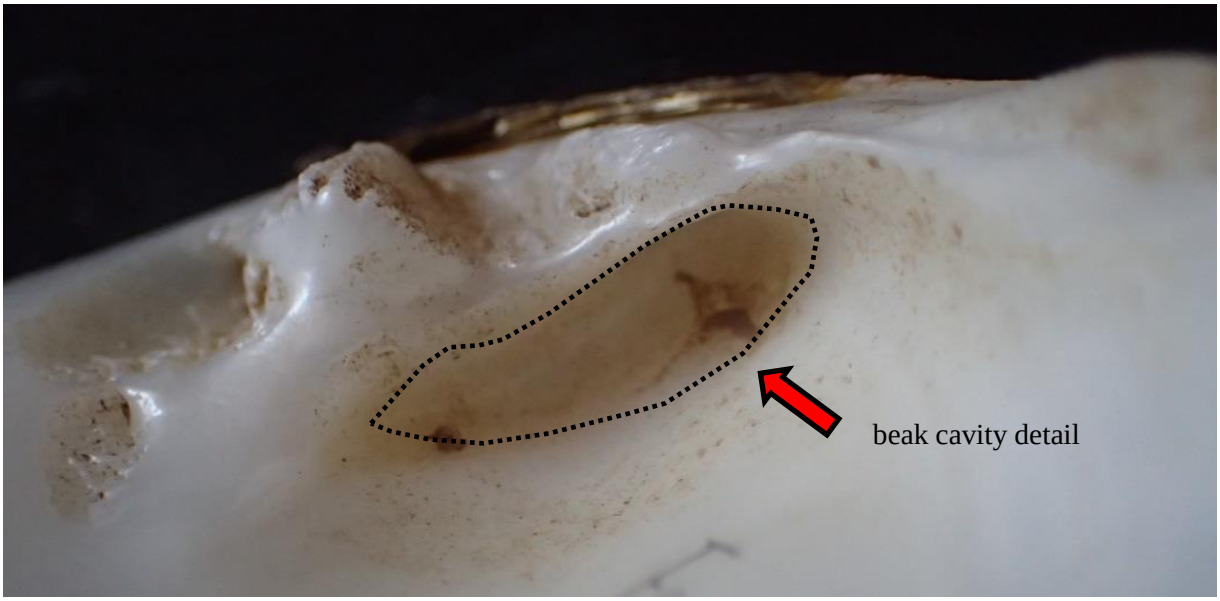
8	- Mahoning Creek	
9	Monongahela River	
10	- (Tenmile Creek)	No specimens reported.
11	• North Fork Tenmile Creek	
12	• South Fork Tenmile Creek	
13	- Dunkard Creek	
	Lake Erie Basin	
14	Lake Erie (Presque Isle Bay)	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *F. flava* hosts (from Watters *et al.* 2009): Bluegill (*Lepomis macrochirus*), Silver Shiner (*Notropis photogenis*), White Crappie (*Pomoxis annularis*), Black Crappie (*Pomoxis nigromaculatus*), and Creek Chub (*Semotilus atromaculatus*).

LONGSOLID *Fusconaia subrotunda* (Lea, 1831). Other vernacular name(s): Spotted Pigtoe. (S2, G3).





dorsal and ventral margins approaching or nearly parallel

Image (credit, K. Little): Illinois State Museum, ISM# 675271 (external and internal), **image (credit, N. Welte):** PFBC reference collection, deep, compressed, beak cavity detail

Defining characteristic(s):

1. No sulcus;
2. Deep, compressed beak cavity;
3. Dorsal and ventral margin approaching parallel;

4. Distinct green blotches near umbo when young;
5. Orange-ish foot when alive.

May be confused with: *Pleurobema sintoxia.* When alive, the distinguishing character *is F. subrotunda'*s orange foot. *F. subrotunda* nacre always white, never pinkish or salmon-colored. *P. sintoxia* has a rather shallow, non-compressed beak cavity – *F. subrotunda* has a deep, compressed beak cavity.

Etymology - "nearly round"
(from Watters *et al.* 2009)**:** Latin *fuscus*, dark, dusky, tawny + Latin *naias* (from Greek *naias, naiados*), a water nymph of rivers and springs. Latin *sub-*, somewhat, less than + Latin *rotundus*, circular, round.

Ortmann (1919) notes: "*Its external characteristics are rather indifferent, and it resembles several other species, with which it is easily confounded."*

Table 20. Pennsylvania's known *Fusconaia subrotunda* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	Beaver River	
	- (Connoquenessing Creek)	No specimens reported.
3	• Slippery Rock Creek	
4	- Mahoning River	
5	- Shenango River	
6	• Pymatuning Creek	
7	Allegheny River	
8	- French Creek	
9	• Muddy Creek	
10	- Tionesta Creek	
11	Monongahela River	
12	- Cheat River	
	Lake Erie Basin	
13	Conneaut Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *F. subrotunda* hosts (from Watters *et al.* 2009): No hosts known.

CRACKING PEARLYMUSSEL *Hemistena lata* (Rafinesque, 1820). Other vernacular name(s): Painted Papershell, Fragile Painted Shell. **Federally Endangered.** (SX, G1).

Image (credit, K. Little): Illinois State Museum, ISM# 679815 (external and internal)

Defining characteristic(s):

1. Very, very thin, compressed, and elongated shell;
2. Very fragile shell;
3. Numerous rays.

Etymology (from Watters *et al.* 2009)**:** Greek *hemi-*, half + Greek *stenos*, narrow. We are uncertain as to what Rafinesque intended to communicate with the name *Hemistena*. Latin *latus*, broad, wide, wide-spread, extended. The term *lata* was used to describe the "width" from the anterior to posterior extremes.

Table 21. Pennsylvania's known historical *Hemistena lata* streams.

	Stream	Notes
	Ohio River Basin	
1	Allegheny River	Only reported Pennsylvania specimens were collected from an archaeological (crevice) site at Murphy's Bottom, Allegheny River, pool 5 (CM 79729). Specimen collected by a P. Doyle and identified by Bob Winters. B. Winters identification confirmed by A.E. Bogan (2015).

Data source(s): Carnegie Museum of Natural History (CM 79729).

Reported *H. lata* hosts (from NatureServe 2015): No hosts known.

PINK MUCKET *Lampsilis abrupta* (Say, 1831). Other vernacular name(s): Ohio Mucket, Square Mucket. **Federally Endangered.** (SH, G2).

Image (credit, K. Little): Illinois State Museum, ISM# 675668 (external and internal)

Defining characteristic(s):

1. When shell is well-developed, easily recognized by the extremely heavy shell, may be the heaviest shell in the Ohio drainage (per Ortmann);
2. Females distinctly truncated;
3. Shell is distinct to subtly more round than *A. ligamentina*, even males;
4. Salmon, pink nacre, although this is not always apparent;
5. Brown, yellowish periostracum.

May be confused with: *Actinonaias ligamentina*. Large male *L. abrupta* may resemble *A. ligamentina* – differentiate by the nacre (salmon/pink in *L. abrupta* vs. white in *A. ligamentina*). *L. abrupta* lateral tooth is broader/deeper than *A. ligamentina*.

Etymology - "broken off"
(from Watters *et al.* 2009)**:** Greek *elasma*, metal beaten out, metal plate + Greek *kampsis*, a bending, a curving, from Greek *kampto*, to bend. Latin *abruptus*, broken off from, separated, inaccessible, precipitous, and steep; from Latin *abrumpo*, to break off.

Ortmann (1919) notes: "*This is a rare shell in Pennsylvania, and is only found in the larger rivers. The largest number of specimens has been secured in the Ohio in Beaver County, but here also it is by no means abundant. It used to be in the Ohio in Allegheny County, and in the Monongahela as far up as Charleroi, Washington Co. (only one individual is at hand from this locality). It also ascends up the Allegheny to Armstrong County, but here it is extremely rare, and only a few specimens were taken.*"

Table 22. Pennsylvania's known historical *Lampsilis abrupta* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919): Shippingport, Cooks Ferry (historical location across from Shippingport), Industry, Neville Island
2	Allegheny River	Ortmann (1919): Godfrey, Kelly (both present-day pool 5)
3	Monongahela River	Ortmann (1919): Charleroi

Data source(s): Ortmann 1919.

Reported *L. abrupta* hosts (from Watters *et al.* 2009): Smallmouth Bass (*Micropterus dolomieu*), Spotted Bass (*Micropterus punctulatus*), Largemouth Bass (*Micropterus salmoides*), and Walleye (*Sander vitreus*).

PLAIN POCKETBOOK *Lampsilis cardium* (Rafinesque, 1820). (S4, G5).

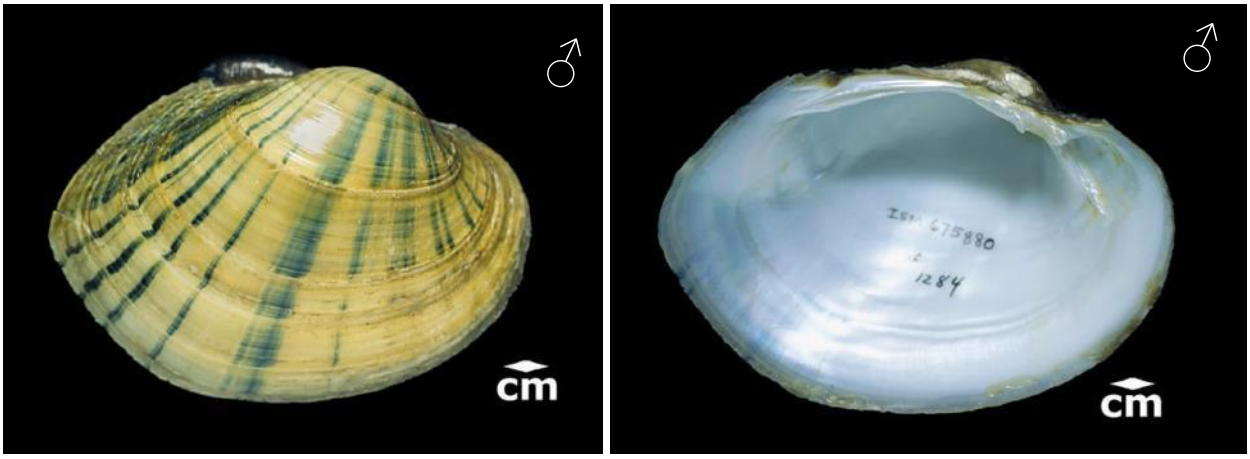


Image (credit, R. Warren): Illinois State Museum, ISM#? (external), ISM# 675880 (internal)

Defining characteristic(s):

1. Large, moderately heavy shell;
2. Rounded posterior slope;
3. Females distinctly truncated;
4. Females have a distinct minnow/darter lure;
5. Yellowish periostracum, with sparse to heavy green rays throughout shell;
6. Shell roundish, particularly along the ventral margin.

May be confused with: *L. ovata*. *L. ovata* has a very sharp, concave posterior ridge (approaching 90°); *L. ovata* posterior slope is darkened, and generally has no rays on the anterior end of shell. Intergrades between the two species do exist and the taxonomic validity of the separation of the two species is a source of debate.

Etymology - "heart-shaped"
(from Watters *et al.* 2009)**:** Greek *elasma*, metal beaten out, metal plate + Greek *kampsis*, a bending, a curving, from Greek *kampto*, to bend. Latin *cardio*, heart, from Greek *kardia*, heart. Rafinesque apparently was referring to the heart-shaped cross-section through both valves.

Table 23. Pennsylvania's known *Lampsilis cardium* streams.

	Stream	Notes
	Ohio River Basin	
	- (Wheeling Creek (tributary to mainstem Ohio River, West Virginia))	No specimens reported.
	• (Dunkard Fork)	No specimens reported.
1	- North Fork Dunkard Fork	
2	Ohio River	
3	- Little Beaver Creek	
4	• North Fork Little Beaver Creek	
5	- Raccoon Creek	
6	Beaver River	

Table 23. *L. cardium* streams (continued).

7	- Connoquenessing Creek	
8	• Slippery Rock Creek	
9	- Mahoning River	
10	- Shenango River	
11	• Neshannock Creek	
12	• Pymatuning Creek	
13	• Little Shenango River	
14	- Chartiers Creek	
15	Allegheny River	
16	- Buffalo Creek	
	- (Kiskiminetas River)	No specimens reported.
17	• Conemaugh River	
18	• Loyalhanna River	
	• (Stony River)	No specimens reported.
19	- Quemahoning Creek	
20	- Crooked Creek	
21	- Redbank Creek	
22	- Mahoning Creek	
23	• Little Mahoning Creek	
24	- Clarion River	*L. cardium* introduced by PFBC/WPC/USFS in 2015.
25	- French Creek	
26	• Cussewago Creek	
27	• Woodcock Creek	
28	• Conneauttee Creek	
29	• Muddy Creek	
30	• LeBoeuf Creek	
31	• South Branch French Creek	
32	- Oil Creek	
33	- Hemlock Creek*	*PFBC considers this population to be part of the Allegheny River because the creek is not hospitable much further than its confluence with the Allegheny.
34	- Tionesta Creek	
35	- Brokenstraw Creek	
36	- Conewango Creek	
37	- Oswayo Creek	
38	- Potato Creek	
39	• Marvin Creek	
40	Monongahela River	
41	- Tenmile Creek	
42	• South Fork Tenmile Creek	
43	- Dunkard Creek	
44	- Cheat River	
	Lake Erie Basin	
45	Lake Erie (Presque Isle Bay)	
46	- Conneaut Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. cardium* hosts (from Watters *et al.* 2009): Tiger Salamander (*Ambystoma tigrinum ssp.*), Green Sunfish (*Lepomis cyanellus*), Pumpkinseed (*Lepomis gibbosus*), Bluegill (*Lepomis macrochirus*), Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), Yellow Perch

(*Perca flavescens*), White Crappie (*Pomoxis annularis*), Black Crappie (*Pomoxis nigromaculatus*), Sauger (*Sander canadensis*), and Walleye (*Sander vitreus*).

YELLOW LAMPMUSSEL *Lampsilis cariosa* (Say, 1817). (S4, G3G4).

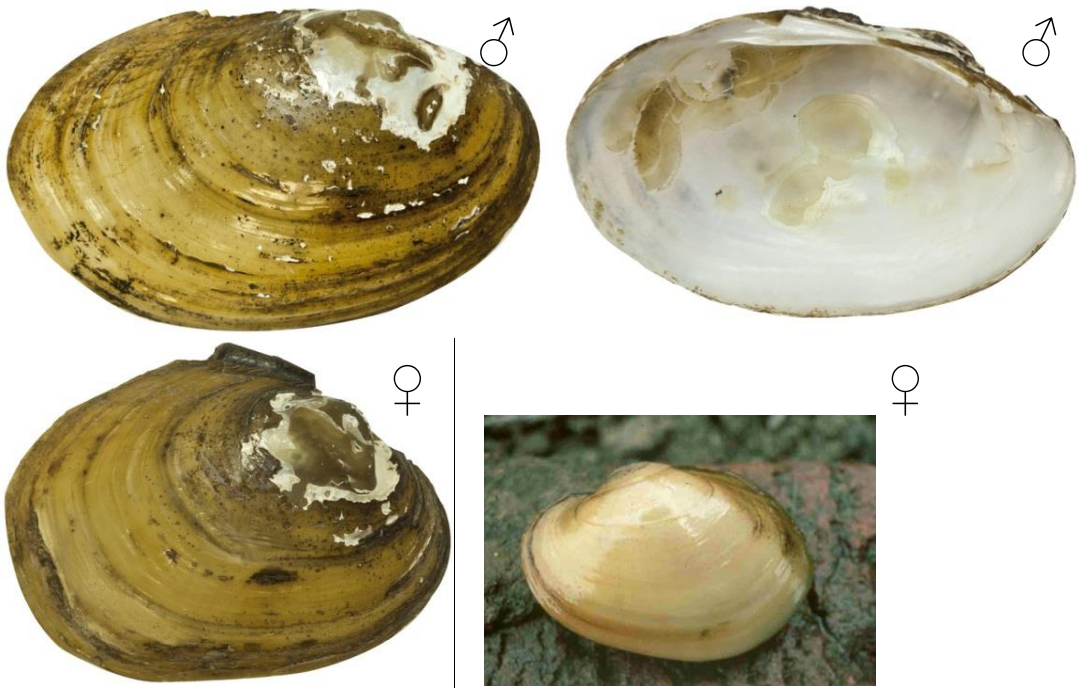


Image (credit, A. Bogan, www.discoverlife.com): North Carolina State Museum, NCSM# 133406 (external and internal, male), NCSM# 133405 (external, female). Photo with rock in background, author unknown.

Defining characteristic(s):

1. Glossy, yellow shell;
2. Females distinctly truncated;
3. No rays.

May be confused with: *L. cardium*. There appears to be both species in the Potomac River basin and intergrades appear between the two species. Hybridization has been suggested. May also be confused with *L. ochracea*. *L. ochracea* has thinner shell and thinner teeth vs. *L. cariosa*. *L. ochracea* also has rays and a duller shell than *L. cariosa*. Per Nedeau *et al.* (2000), *L. ochracea* is smaller, with a thinner shell and more delicate hinge teeth, *L. ochracea* nacre is usually pinkish or salmon-colored, and *L. ochracea*'s pseudocardinal teeth are thin and elongated versus thick and blunt in *L. cariosa*.

Etymology - "rotten, decayed"
(from Watters *et al.* 2009)**:** Greek *elasma*, metal beaten out, metal plate + Greek *kampsis*, a bending, a curving, from Greek *kampto*, to bend.
Welte: Latin *caries*, rot, rottenness. In English *caries*, the progressive destruction of bone or tooth by decay. Perhaps the type specimen(s) appeared particularly weathered or eroded.

Table 24. Pennsylvania's known *Lampsilis cariosa* streams.

	Stream	Notes
	Delaware River Basin	
1	Delaware River	
	Susquehanna River Basin	
2	Susquehanna River	
3	- Conewago Creek	
4	• Little Conewago Creek	
5	• Middle Creek	
	- (West Conewago Creek)	No specimens reported.
6	• Bermudian Creek	
7	- Swatara Creek	
8	- Conodoguinet Creek	
9	Juniata River	
10	- Tuscarora Creek	
11	• East Licking Creek	
12	- Aughwick Creek	
13	- Raystown Branch Juniata River	
14	• Yellow Creek	
15	- Frankstown Branch Juniata River	
	(mainstem)	
16	- Mahantango Creek	
17	- Penns Creek	
18	West Branch Susquehanna River	
19	- Chillisquaque Creek	
20	- Pine Creek	
21	• Marsh Creek	
22	North Branch Susquehanna River	
23	- Mehoopany Creek	
24	- Tunkhannock Creek	
25	- Chemung River	
	Potomac River Basin	
26	- Rock Creek	
27	- Conococheague Creek	
28	- Back Creek	
29	- Town Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. cariosa* hosts (from NatureServe 2015): White Perch (*Morone americana*) and Yellow Perch (*Perca flavescens*) – from coastal areas. More host work needs to be done for this species.

WAVYRAYED LAMPMUSSEL *Lampsilis fasciola* (Rafinesque, 1820). Other vernacular name(s): Wavyrayed Pocketbook, Fine-rayed Pocketbook, Wavyrayed Lamp Mussel. (S3S4, G5).

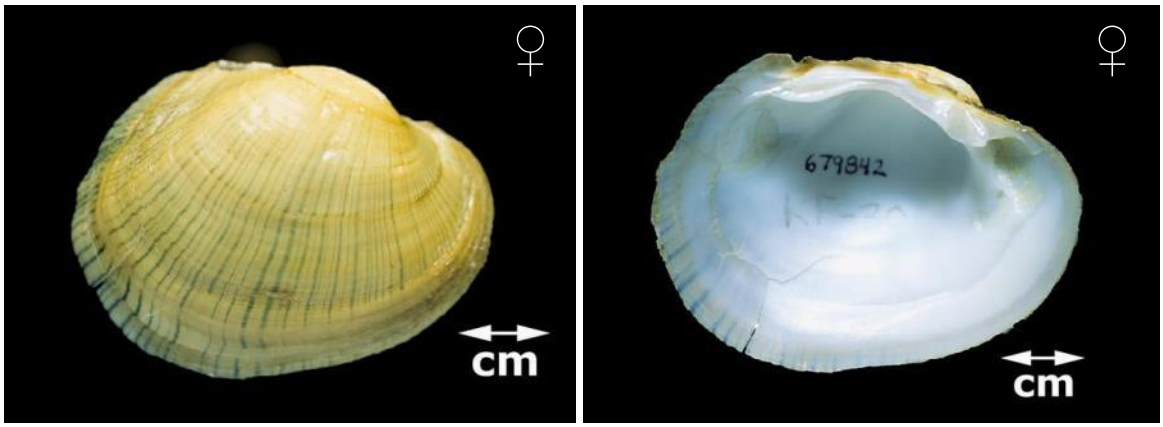


Image (credit, R. Warren): Illinois State Museum, ISM# 679842 (external and internal)

Defining characteristic(s):

1. Smaller shell (~<75 mm) with numerous green, fine, wavy rays;
2. Shell typically thin, particularly in comparison to other *Lampsilis* spp. of similar size;
3. Females distinctly truncated;
4. Females may have a range of mantle displays.

May be confused with: *L. cardium.* Thin shell and fine, wavy rays distinguish *L. fasciola* from *L. cardium* of similar size. Young *E.t. rangiana* may resemble *L. fasciola* but *E.t. rangiana* is distinguished by its much thicker shell and more compressed shell.

Etymology - "with bands of rays"
(from Watters *et al.* 2009)**:** Greek *elasma*, metal beaten out, metal plate + Greek *kampsis*, a bending, a curving, from Greek *kampto*, to bend. Latin *fascia*, a band, bandage, zone + Latin *–ola* (diminutive). Rafinesque often used the word "bands" when referring to rays on the periostracum of a unionoid shell.

Table 25. Pennsylvania's known *Lampsilis fasciola* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	- Little Beaver Creek	
3	• North Fork Little Beaver Creek	
4	Beaver River	
5	- Connoquenessing Creek	
6	• Slippery Rock Creek	
7	- Mahoning River	
8	- Shenango River	
9	• Neshannock Creek	
10	• Pymatuning Creek	
11	• Little Shenango River	
12	Allegheny River	

Table 25. *L. fasciola* streams (continued).

13	- Buffalo Creek	
	- (Kiskiminetas River)	No specimens reported.
14	• Conemaugh River	
15	• Loyalhanna River	
	• (Stony Creek)	
16	- Quemahoning Creek	
17	- Crooked Creek	
18	- Mahoning Creek	
19	• Little Mahoning Creek	
20	- Clarion River	Discovered by WPC/USFS in 2014. Augmented by PFBC/WPC/USFS in 2015.
21	- Sandy Creek	
22	- French Creek	
23	• Woodcock Creek	
24	• Conneauttee Creek	
25	• Muddy Creek	
26	• LeBoeuf Creek	
27	- Oil Creek	
28	- Tionesta Creek	
29	• Salmon Creek	
30	- Brokenstraw Creek	
31	- Conewango Creek	
32	- Oswayo Creek	
	(Monongahela River)	No specimens reported.
33	- Cheat River	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. fasciola* hosts (from Watters *et al.* 2009; Gibson *et al.* 2015): Longear Sunfish (*Lepomis megalotis*), Smallmouth Bass (*Micropterus dolomieu*), and Largemouth Bass (*Micropterus salmoides*) and Bluntnose Minnow (*Pimephales notatus*).

POCKETBOOK *Lampsilis ovata* (Say, 1817). Other vernacular name(s): Ridged Pocketbook. (S2S3, G5).

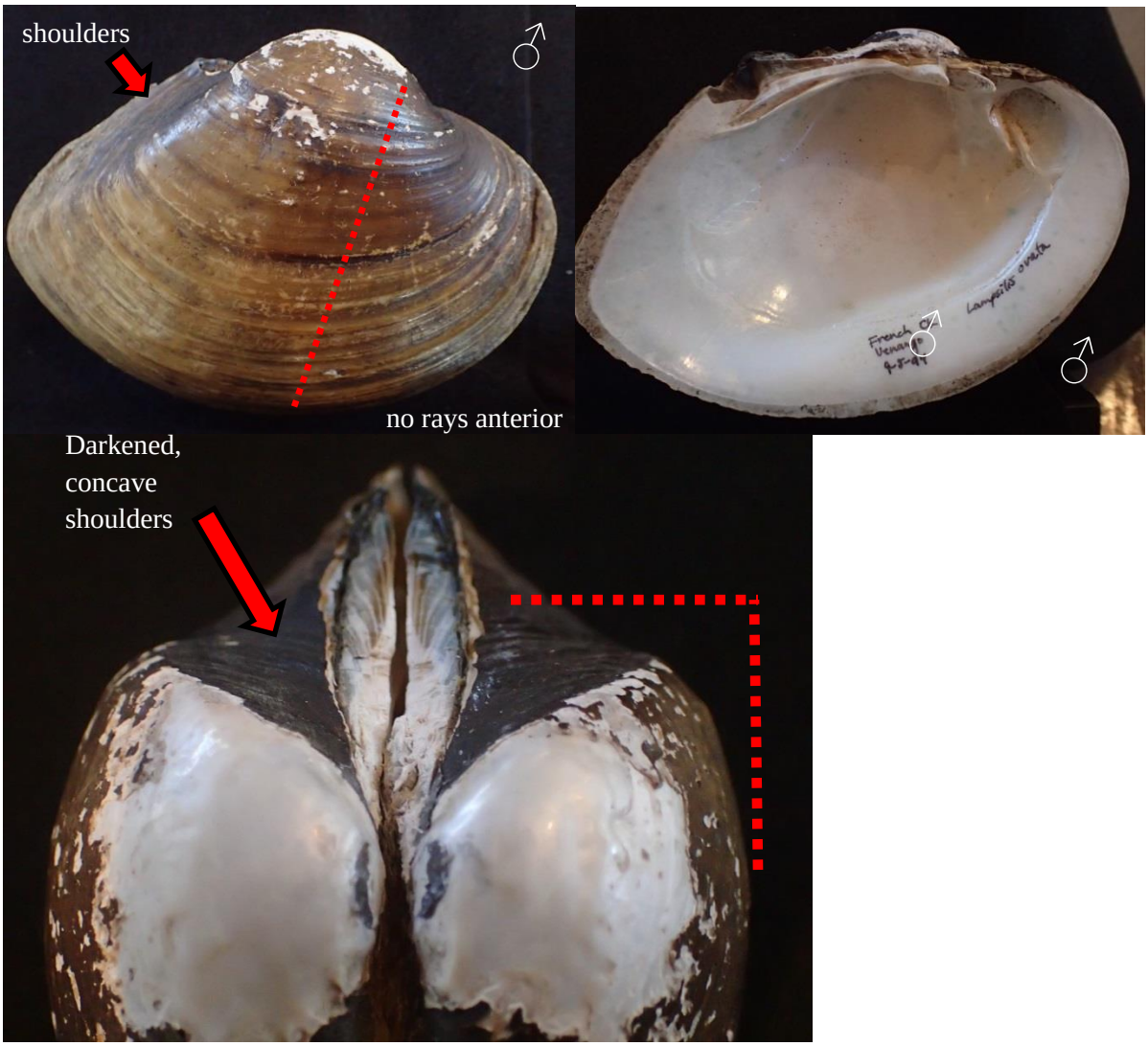


Image (credit, N. Welte): PFBC reference collection

Defining characteristic(s):

1. Very sharp, nearly 90°, concave posterior slope;
2. Darkened posterior slope;
3. No rays on the anterior of the shell (vs. *L. cardium*).

May be confused with: *L. cardium*. *L. ovata* has a very sharp posterior ridge (approaching 90°); posterior slope is darkened, and generally has no rays on the anterior end of shell. Intergrades between the two species do exist and the taxonomic validity of the separation of the two species is a source of debate.

Etymology - "egg-shaped"
(from Watters *et al.* 2009)**:** Greek *elasma*, metal beaten out, metal plate + Greek *kampsis*, a bending, a

curving, from Greek *kampto*, to bend. Latin *ovatus*, egg-shaped, ovate; from Latin *ovum*, egg. Say (1817) noted "Shell subovate," and subovate outline is very typical of this species – especially the males and juvenile females.

Table 26. Pennsylvania's known *Lampsilis ovata* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
	(Beaver River)	No specimens reported.
2	- Shenango River	
3	• Pymatuning Creek	
4	Allegheny River	
5	- Mahoning Creek	
6	• Little Mahoning Creek	
7	- Clarion River	*L. ovata* introduced by PFBC/WPC/USFS in 2015.
8	- French Creek	
9	• Conneaut Outlet	
10	• Conneauttee Creek	
11	• Muddy Creek	
12	• LeBoeuf Creek	
13	• South Branch French Creek	
14	• West Branch French Creek	
15	- Oil Creek	
16	- Hemlock Creek*	*PFBC considers this population to be part of the Allegheny River because the creek is not hospitable much further than its confluence with the Allegheny.
17	- Conewango Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. ovata* hosts (from Watters *et al.* 2009): May be confused with *L. cardium* hosts.

EASTERN LAMPMUSSEL *Lampsilis radiata* (Gmelin, 1791). (S1, G5).

Image (credit, N. Welte): Carnegie Museum of Natural History, CMNH# 61685 (external and internal)

Defining characteristic(s):

1. Numerous fine, dark green-colored rays;
2. Females distinctly truncated.

May be confused with: *L. siliquoidea*. *L. siliquoidea* tend to have a few, widely spaced rays versus a concentration of green rays like *L. radiata*. Intergrades between the two species do exist and the taxonomic validity of the separation of the two species is a source of debate.

Etymology - "furnished with rays"
(from Watters *et al.* 2009)**:** Greek *elasma*, metal beaten out, metal plate + Greek *kampsis*, a bending, a curving, from Greek *kampto*, to bend. Latin *radiates*, furnished with rays; from Latin *radio*, furnish with beams, spokes, make beaming, irradiate.

Table 27. Pennsylvania's known *Lampsilis radiata* streams.

	Stream	Notes
	Susquehanna River Basin	
1	Susquehanna River	
2	- Octoraro Creek	
3	West Branch Susquehanna River	
4	North Branch Susquehanna River	
5	- Chemung River	
	Delaware River Basin	
6	Delaware River	
7	- Schuylkill Canal	
	Ohio River Basin	
8	Pymatuning Creek (?)	Confusion with *L. siliquoidea*?
9	Shenango River (?)	Confusion with *L. siliquoidea*?

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. radiata* hosts (from NatureServe 2015): Rock Bass (Ambloplites rupestris), Pumpkinseed (*Lepomis gibbosus*), Bluegill (*Lepomis macrochirus*), Longear Sunfish (*Lepomis megalotis*), Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), White Perch (*Morone*

americana), Sand Shiner (*Notropis ludibundus*), Yellow Perch (*Perca flavescens*), Bluntnose Minnow (*Pimephales notatus*), and Black Crappie (*Pomoxis nigromaculatus*).

FATMUCKET *Lampsilis siliquoidea* (Barnes, 1823). (S4, G5).

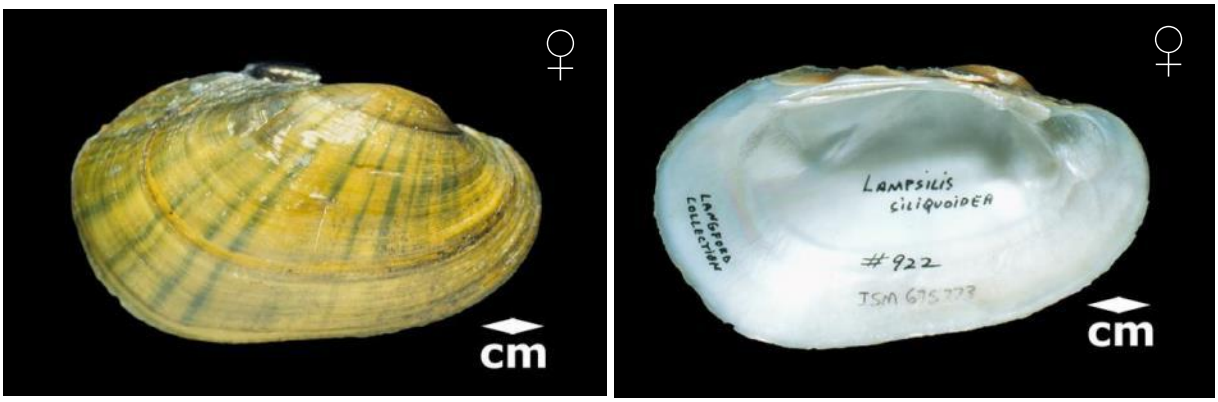


Image (credit, R. Warren): Illinois State Museum, ISM# 675773 (external and internal)

Defining characteristic(s):

1. Sparse, thin, green rays;
2. Females distinctly truncated;
3. Yellowish shell.

May be confused with: *L. radiata*. *L. siliquoidea* tend to have a few, widely spaced rays versus a concentration of green rays like *L. radiata*. Intergrades between the two species do exist and the taxonomic validity of the separation of the two species is a source of debate.

Etymology - "pod-like"
(from Watters *et al.* 2009)**:** Greek *elasma*, metal beaten out, metal plate + Greek *kampsis*, a bending, a curving, from Greek *kampto*, to bend.
Welte: Latin *silique*, the long two-valved seed vessel or pod of plants belonging to the mustard family.

Table 28. Pennsylvania's known *Lampsilis siliquoidea* streams.

	Stream	Notes
	Ohio River Basin	
1	- Buffalo Creek (tributary to mainstem Ohio River, West Virginia)	
2	• Dutch Fork	
	- (Wheeling Creek (tributary to mainstem Ohio River, West Virginia))	No specimens reported.
3	• Enlow Fork	
4	Ohio River	
5	- Little Beaver Creek	
6	• North Fork Little Beaver Creek	
7	- Raccoon Creek	
8	Beaver River	
9	- Connoquenessing Creek	
10	• Slippery Rock Creek	
11	- Wolf Creek	
12	• Brush Creek	

Table 28. *L. siliquoidea* streams (continued).

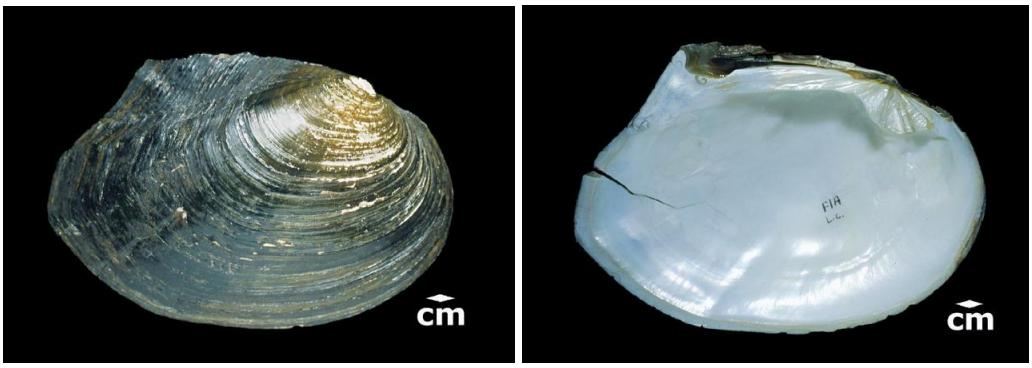
13	• Little Connoquenessing Creek	
14	• Glade Run	
15	• Thorn Creek	
16	• Bonnie Brook	
17	- Mahoning River	
18	- Shenango River	
19	• Neshannock Creek	
20	- Otter Creek	
21	• Pymatuning Creek	
22	• Little Shenango River	
23	• Randolph Run (Linesville)	
24	• Padan Creek (Linesville)	
25	- Chartiers Creek	
26	• Little Chartiers Creek	
27	Allegheny River	
28	- Buffalo Creek	
29	- Kiskiminetas River	
30	- Crooked Creek	
31	- Cowanshannock Creek	
	- (Mahoning Creek)	No specimens reported.
32	• Little Mahoning Creek	
33	- French Creek	
34	• Conneaut Outlet	
35	• Cussewago Creek	
36	• Conneauttee Creek	
37	• Muddy Creek	
38	• LeBoeuf Creek	
39	• South Branch French Creek	
40	• West Branch French Creek	
41	- Oil Creek	
42	- Brokenstraw Creek	
43	- Conewango Creek	
44	- Potato Creek	
45	Monongahela River	
46	- Whiteley Creek	
47	- Tenmile Creek	
48	• South Fork Tenmile Creek	
49	- Dunkard Creek	
50	• Toms Run	
51	• Pennsylvania Fork Dunkard Creek	
52	• West Virginia Fork Dunkard Creek	
	Lake Erie Basin	
53	Lake Erie (Presque Isle Bay)	
54	- Conneaut Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. siliquoidea* hosts (from Watters *et al.* 2009): Rock Bass (*Ambloplites rupestris*), White Sucker (*Catostomus commersoni*), Florida Gar (*Lepisosteus platyrhincus*), Green Sunfish (*Lepomis cyanellus*), Pumpkinseed (*Lepomis gibbosus*), Warmouth (*Lepomis gulosus*), Bluegill (*Lepomis macrochirus*), Longear Sunfish (*Lepomis megalotis*), Common Shiner (*Luxilus cornutus*), Smallmouth

Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), White Bass (*Morone chrysops*), Sand Shiner (*Notropis ludibundus*), Tadpole Madtom (*Noturus gyrinus*), Yellow Perch (*Perca flavescens*), Bluntnose Minnow (*Pimpephales notatus*), White Crappie (*Pomoxis annularis*), Black Crappie (*Pomoxis nigromaculatus*), Sauger (*Sander canadensis*), and Walleye (*Sander vitreus*).

WHITE HEELSPLITTER *Lasmigona complanata* (Barnes, 1823). Other vernacular name(s): Elephant Ear. (S1S2, G5).



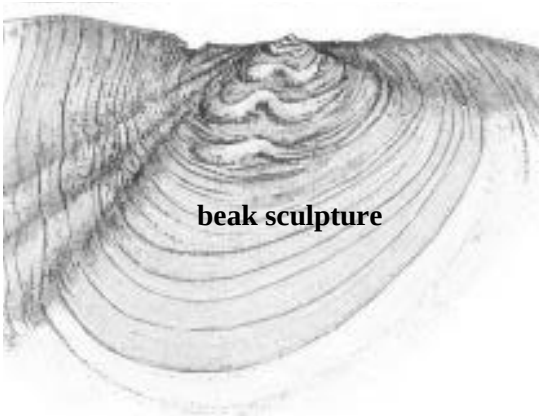


Image (credit, R. Warren): Illinois State Museum, ISM# ISM-FIA (external and internal); **Figure (credit, A. Clarke)**: from Clarke (1985), beak sculpture.

Defining characteristic(s):

1. Shell large, stout, but rather thin when young;
2. Very distinct posterior wing;
3. Wing may be ornamented with irregular ridges running towards the posterior margin;
4. Shell may appear to be varnished; stout despite thinness;
5. Well-formed, narrow umbo, obvious even in larger specimens (see figure).

May be confused with: *Potamilus alatus*. *L. complanata* always has white nacre; *P. alatus* will have pink/purplish nacre. See the "winged" mussel worksheet for additional differentiating characteristics.

Etymology – "plate-like lateral teeth, flattened"
(from Watters *et al.* 2009)**:** Greek *elasma*, metal beaten out, metal plate + Greek *gonia*, corner, angle. Rafinesque used the word *elasma* to refer to a unionoid lateral tooth, which is often thin and plate-like. Latin *complantus*, flattened. Most individuals of this species are flattened or compressed.

Table 29. Pennsylvania's known *Lasmigona complanata* streams.

	Stream	Notes
	Ohio River Basin	
	- (Buffalo Creek (tributary to mainstem Ohio River, West Virginia))	No specimens reported
1	• Dutch Fork	
2	Ohio River	
3	Allegheny River	
4	- French Creek	
5	• Conneaut Outlet	
6	• LeBoeuf Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. complanata* hosts (from Watters *et al.* 2009): Common Carp (*Cyprinus carpio*), Gizzard Shad (*Dorosoma cepedianum*), Banded Sunfish (*Fundulus diaphanus*), Longnose Gar (*Lepisosteus osseus*), Green Sunfish (*Lepomis cyanellus*), Orangespotted Sunfish (*Lepomis humilus*), Longear Sunfish (*Lepomis megalotis*), Largemouth Bass (*Micropterus salmoides*), River Redhorse (*Moxostoma carinatum*), Yellow Perch (*Perca flavescens*), White Crappie (*Pomoxis annularis*), Black Crappie (*Pomoxis nigromaculatus*), and Sauger (*Sander canadensis*).

CREEK HEELSPLITTER *Lasmigona compressa* (Lea, 1829). Other vernacular name(s): Flat Creek Shell. (S2, G5).

Image (credit, K. Little): Illinois State Museum, ISM# 680575

Defining characteristic(s):

1. Shell moderately large, typically greenish, and compressed;
2. Varnished appearance when dry;
3. Largely recognized by the shape and color of its shell;
4. Found in headwater streams.

May be confused with:

Etymology (from Watters *et al.* 2009)**:** Greek *elasma*, metal beaten out, metal plate + Greek *gonia*, corner, angle. Rafinesque used the word *elasma* to refer to a unionoid lateral tooth, which is often thin and plate-like. Latin *com-* from *cum*, with, together + Latin *pressus*, crowd, bear down upon. Individuals of this species are typically compressed (laterally flattened) individuals.

Table 30. Pennsylvania's known *Lasmigona compressa* streams.

	Stream	Notes
	Ohio River Basin	
	(Ohio River)	No specimens reported.
1	- Little Beaver Creek	
2	• North Fork Little Beaver Creek	
3	- Raccoon Creek	(R.E. Miller, 2015. Upstream of Moffats Mill)
4	Beaver River	
	- (Connoquenessing Creek)	No specimens reported.
5	• Brush Creek	
6	- Mahoning River	
7	- Shenango River	
8	• Neshannock Creek	
9	• Pymatuning Creek	
10	• Little Shenango River	
11	• Randolph Run (Linesville)	
12	- Cowanshannock Creek	
13	- Sandy Creek	
14	- French Creek	

Table 30. *L. compressa* streams (continued).

15	• Conneaut Outlet	
16	• Cussewago Creek	
17	• Conneauttee Creek	
18	• Muddy Creek	
19	• LeBoeuf Creek	
20	• Brokenstraw Creek)	
21	- Little Brokenstraw Creek	Jordan Allison (2015)
22	• West Branch French Creek	
	- (Tionesta Creek)	No specimens reported.
23	• West Branch Tionesta Creek	
24	- Conewango Creek	
25	- Potato Creek	
26	• Marvin Creek	
	(Monongahela River)	No specimens reported.
27	- Tenmile Creek	
	Lake Erie Basin	
28	Lake Erie	
29	- Conneaut Creek	
	Genesee River Basin	
30	Genesee River	
31	- Cryder Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. compressa* hosts (from NatureServe 2015): Black Bullhead (*Ameiurus melas*), Yellow Bullhead (*Ameiurus natalis*), Slimy Sculpin (*Cottus cognatus*), Brook Stickleback (*Culaea inconstans*), Spotfin Shiner (*Cyprinella spiloptera*), Gizzard Shad (*Dorosoma cepedianum*), Brassy Minnow (*Hybognathus hankinsoni*), Shortnose Gar (*Lepisosteus platostomus*), Green Sunfish (*Lepomis cyanellus*), Orange-spotted Sunfish (*Lepomis humilus*), Bluegill (*Lepomis macrochirus*), Smallmouth Bass (*Micropterus dolomieu*), Emerald Shiner (*Notropis atherinoides*), Mimic Shiner (*Notropis volucellus*), Yellow Perch (*Perca flavescens*), Black Crappie (*Pomoxis nigromaculatus*), Flathead Catfish (*Pylodictis olivaris*), Longnose Dace (*Rhinichthys cataractae*), and Creek Chub (*Semotilus atromaculatus*).

FLUTEDSHELL *Lasmigona costata* (Rafinesque, 1820). Other vernacular name(s): Sandshell, Fluted Riffleshell, Hackle-back, Ribbed Creek Shell, Ribbed Riffleshell. (S4, G5).

Image (credit, K. Little): Illinois State Museum, ISM# 676150 (external and internal)

Defining characteristic(s):

1. Easily recognizable by shape and sculpture on the posterior wing;
2. Sculpture is rib-like, or flutings – always present;
3. Brown, sometimes varnished appearance on periostracum.

May be confused with: A very distinct species, no other Ohio River basin species attains the same large, compressed size with posterior flutings.

Etymology - "rib-like ridges"
(from Watters *et al.* 2009)**:** Greek *elasma*, metal beaten out, metal plate + Greek *gonia*, corner, angle. Rafinesque used the word *elasma* to refer to a unionoid lateral tooth, which is often thin and plate-like. Latin *costatus*, having rib-like lines or ridges; from Latin *costa*, rib. The posterior slope has a series of prominent costae.

Table 31. Pennsylvania's known *Lasmigona costata* streams.

	Stream	Notes
	Ohio River Basin	
1	- Buffalo Creek (tributary to mainstem Ohio River, West Virginia)	
2	• Dutch Fork	
	- (Wheeling Creek (tributary to mainstem Ohio River, West Virginia))	No specimens reported.
3	• Enlow Fork	
	• (Dunkard Fork)	No specimens reported.
4	- North Fork Dunkard Fork	
5	Ohio River	
6	- Little Beaver Creek	
7	• North Fork Little Beaver Creek	
8	- Raccoon Creek	
9	Beaver River	
10	- Connoquenessing Creek	
11	• Slippery Rock Creek	
12	- Wolf Creek	

Table 31. *L. costata* streams (continued).

	• (Connoquenessing Creek)	No specimens reported.
13	• Little Connoquenessing Creek	
14	- Mahoning River	
15	- Shenango River	
16	• Neshannock Creek	
17	○ Otter Creek	
18	• Pymatuning Creek	
19	• Little Shenango River	
20	- Chartiers Creek	
21	Allegheny River	
22	- Buffalo Creek	
	- (Kiskiminetas River)	No specimens reported.
23	• Loyalhanna River	
	• (Conemaugh River)	No specimens reported.
	○ (Black Lick Creek)	No specimens reported.
24	○ Two Lick Creek	
25	○ Yellow Creek	
	• (Stony River)	No specimens reported.
26	○ Quemahoning Creek	
27	- Crooked Creek	
28	- Cowanshannock Creek	
	- (Mahoning Creek)	No specimens reported.
29	• Little Mahoning Creek	
30	- Clarion River	*L. costata* introduced by PFBC/WPC/USFS in 2015.
31	- Sandy Creek	
32	- French Creek	
33	• Sugar Creek	
34	• Cussewago Creek	
35	• Conneauttee Creek	
36	• Muddy Creek	
37	• LeBoeuf Creek	
38	• Woodcock Creek	
39	• South Branch French Creek	
40	• West Branch French Creek	
41	- Oil Creek	
42	- Hemlock Creek*	*PFBC considers this population to be part of the Allegheny River because the creek is not hospitable much further than its confluence with the Allegheny.
43	- Tionesta Creek	
44	- Brokenstraw Creek	
45	- Conewango Creek	
46	- Oswayo Creek	
47	- Potato Creek	
48	Monongahela River	
49	- Whiteley Creek	
50	- Tenmile Creek	
51	• South Fork Tenmile Creek	
52	- Dunkard Creek	
53	• Pennsylvania Fork Dunkard Creek	
54	• West Virginia Fork Dunkard Creek	
55	- Cheat River	

Table 31. (continued).

	Lake Erie Basin	
56	Lake Erie (Presque Isle Bay)	
57	- Conneaut Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. costata* hosts (from Watters *et al.* 2009): Rock Bass (*Ambloplites rupestris*), Brown Bullhead (*Ameiurus nebulosus*), Bowfin (*Amia calva*), Central Stoneroller (*Campostoma anomalum*), Goldfish (*Carrasius auratus*), Banded Sculpin (*Cottus carolinae*), Common Carp (*Cyprinus carpio*), Gizzard Shad (*Dorosoma cepedianum*), Northern Pike (*Esox lucius*), Rainbow Darter (*Etheostoma caeruleum*), Fantail Darter (*Etheostoma flabellare*), Variegate Darter (*Etheostoma variatum*), Banded Darter (*Etheostoma zonale*), Northern Studfish (*Fundulus catenatus*), Northern Hogsucker (*Hypentelium nigricans*), Green Sunfish (*Lepomis cyanellus*), Pumpkinseed (*Lepomis gibbosus*), Bluegill (*Lepomis macrochirus*), Longear Sunfish (*Lepomis megalotis*), Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), River redhorse (*Moxostoma carinatum*), Yellow Perch (*Perca flavescens*), Longnose Dace (*Rhinichthys cataractae*), Walleye (*Sander vitreus*), and Creek Chub (*Semotilus atromaculatus*).

GREEN FLOATER *Lasmigona subviridis* (Conrad, 1835). (S2S3, G3).

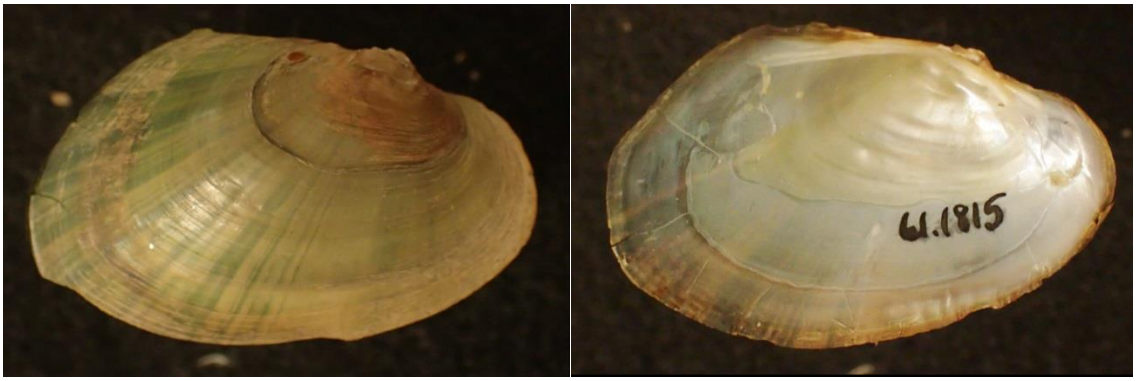


Image (credit, N. Welte): Carnegie Museum of Natural History, CMNH# 61.1815 (external and internal)

Defining characteristic(s):

1. Small, very thin, but somewhat inflated shell;
2. Yellowish green periostracum;
3. Hermaphroditic.

May be confused with: Young *L. cariosa* that co-occur with this species in the Atlantic Slope are also inflated and may have a thin shell. *L. cariosa* will not have green rays.

Etymology – "less green"
(from Watters *et al.* 2009)**:** Greek *elasma*, metal beaten out, metal plate + Greek *gonia*, corner, angle. Rafinesque used the word *elasma* to refer to a unionoid lateral tooth, which is often thin and plate-like. Welte: Latin *viridis*, green. "Sub-" connotes "less", thus *L. subviridis* is "less green."

Table 32. Pennsylvania's known *Lasmigona subviridis* streams.

	Stream	Notes
	Delaware River Basin	
1	Delaware River	
2	- Schuylkill Canal	
	(Lehigh River)	No specimens reported.
3	- Valley Creek	
	Susquehanna River Basin	
4	Susquehanna River	
5	- Conodoguinet Creek	
	(Juniata River)	No specimens reported.
	- (Tuscarora Creek)	No specimens reported.
6	• East Licking Creek	
7	- Aughwick Creek	
	- (Raystown Branch Juniata River)	
8	• Dunning Creek	
	(West Branch Susquehanna River)	No specimens reported.
9	- Bald Eagle Creek	
10	- Sinnemahoning Creek	
11	- Cush Cushion Creek	

Table 32. *L, subviridis* streams (continued).		
12	- Chest Creek	
13	North Branch Susquehanna River	
14	- Chemung River	
	Potomac River Basin	
15	- Conococheague Creek	
16	- Great Tonoloway Creek	
17	- Sideling Hill Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. subviridis* hosts (from Watters *et al.* 2009): No hosts known, hermaphroditic.

FRAGILE PAPERSHELL *Leptodea fragilis* (Rafinesque, 1820). (S2S3, G5).

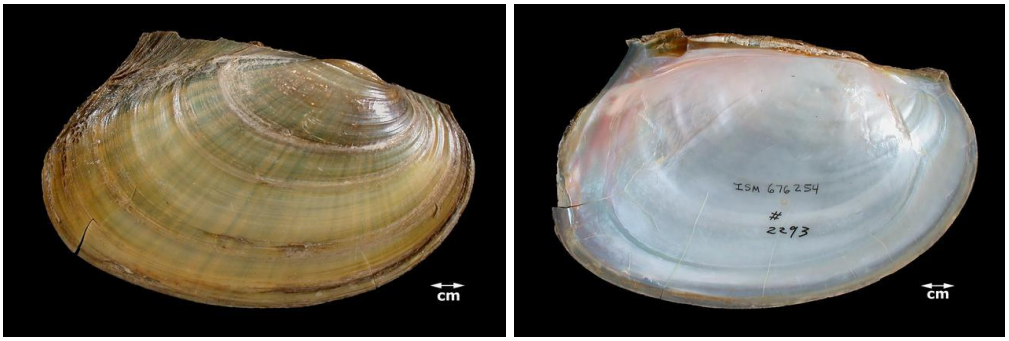


Image (credit, K. Little): Illinois State Museum, ISM# 676254 (external and internal)

Defining characteristic(s):

1. Shell large, but thin;
2. Distinct posterior wing, which may be obliterated. Small anterior wing, usually obliterated;
3. Smooth, light-colored (pale yellowish) shell
4. Pinkish nacre.

May be confused with: *Potamilus ohiensis, P. ohiensis, Lasmigona complanata*. See the "winged" mussel worksheet for differentiating characteristics.

Etymology – "fine, delicate teeth"
(from Watters *et al.* 2009)**:** Greek *leptos*, fine, thin, delicate + Greek *odous (odon), odontos*, tooth. In his original description, Rafinesque (1820: 295) writes of the cardinal teeth of *Leptodea*: "Bilobed tooth entire and smooth; that of the right valve simple. Contour not thickened." Latin *fragilis*, easily broken, brittle, fragile, weak. Rafinesque (1820: 295) described the shell of *U. fragilis* as "very thin and fragile," which is typical of this species.

Table 33. Pennsylvania's known *Leptodea fragilis* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	- Raccoon Creek	(NTW, R. Miller)
3	Allegheny River	
	- (French Creek)	No specimens reported.
4	• LeBoeuf Creek	
5	Monongahela River	
6	- South Fork Tenmile Creek	NTW, 2015.
	Lake Erie Basin	
7	Lake Erie (Presque Isle Bay)	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. fragilis* hosts (from Watters *et al.* 2009): Freshwater Drum (*Aplodinotus grunniens*).

TIDEWATER MUCKET *Leptodea ochracea* (Say, 1817). (S1, G3G4).

Image (credit, A. Bogan, www.discoverlife.com): North Carolina State Museum, NCSM# 148634 (external and internal)

Defining characteristic(s):

1. Fine rays across a satiny, thin shell;
2. Often has pink nacre;
3. Lives in coastal ponds and tidal waters of the lower Delaware River.

May be confused with: *L. cariosa*. *L. ochracea* has thinner shell and thinner teeth vs. *L. cariosa*. *L. cariosa* does not have rays and *L. cariosa* has a much glossier (shinier) shell than *L. ochracea*. Per Nedeau *et al.* (2000), L. ochracea is smaller, with a thinner shell and more delicate hinge teeth, *L. ochracea* nacre is usually pinkish or salmon-colored, and *L. ochracea*'s pseudocardinal teeth are thin and elongated versus thick and blunt in *L. cariosa*.

Etymology – "fine, delicate teeth, pale yellow"
(from Watters *et al.* 2009)**:** Greek *leptos*, fine, thin, delicate + Greek *odous (odon), odontos*, tooth. In his original description, Rafinesque (1820: 295) writes of the cardinal teeth of *Leptodea*: "Bilobed tooth entire and smooth; that of the right valve simple. Contour not thickened."
Welte: *ocher*, an earthy usually read or yellow and often impure iron ore used as a pigment

Ortmann (1919) notes: "*This species has been often misunderstood and confounded with L. cariosa. In general terms it may be defined as a rather small and thin shell, with dull-colored epidermis, and fine, indistinct, or missing rays, which, when present, cover a larger part of the shell than is the case in L. cariosa*."

Nedeau *et al.* (2000) notes: "…*often difficult to distinguish this species from the Yellow Lampmussel*."

Table 34. Pennsylvania's known *Leptodea ochracea* streams.

	Stream	Notes
	Delaware River Basin	
1	Delaware River	
2	Schuylkill River	
3	- Wissahickon Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. ochracea* hosts (from NatureServe 2015): White Perch (*Morone americana*).

EASTERN PONDMUSSEL *Ligumia nasuta* (Say, 1817). (S2S3, G4).

Image (credit, A. Bogan, www.discoverlife.com): North Carolina State Museum, NCSM# 135087 (external and internal)

Defining characteristic(s):

1. Very distinct posterior end, resembling a nose.

May be confused with: *Elliptio fisheriana*. Fortunately the range of Pennsylvania range of these two species does not overlap. *L. nasuta*'s heavy, often inflated shell with a hooked, posterior "nose" distinguishes this species.

Etymology – "bean pod resembling a nose"
(from Watters *et al.* 2009)**:** Latin *legume, leguminis,* bean, leguminous plant, seed or pod of a legume. Latin *nasutus,* having a large nose, large-nosed… The pointed posterior of this species apparently reminded Say of a rostrum or nose.

Table 35. Pennsylvania's known *Ligumia nasuta* streams.

	Stream	Notes
	Ohio River Basin	
	(Beaver River)	No specimens reported
1	- Shenango River	
2	Allegheny River	
3	- French Creek	
4	• Conneaut Outlet	
5	- Conewango Creek	
	Lake Erie Basin	
6	Lake Erie	
	Delaware River Basin	
7	Delaware River	
8	- Schuylkill Canal	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. nasuta* hosts (per NatureServe 2015): No hosts known.

BLACK SANDSHELL *Ligumia recta* (Lamarck, 1819). (S4, G4G5).

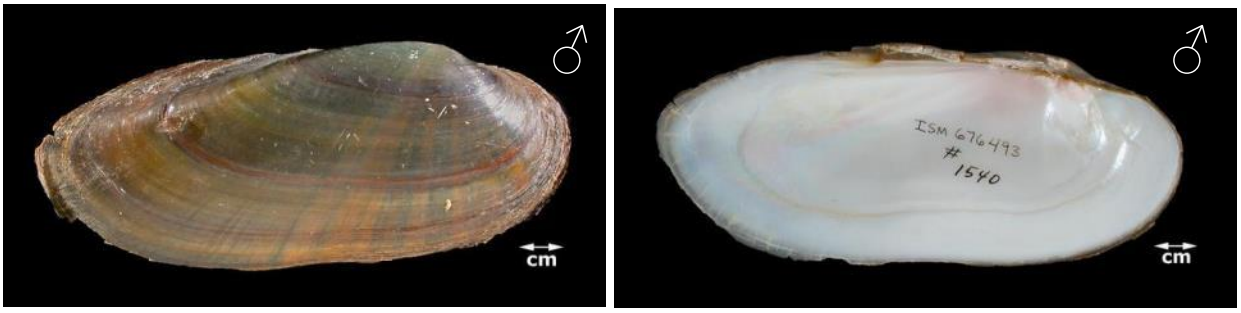


Image (credit, K. Little): Illinois State Museum, ISM# 676493 (external and internal)

Defining characteristic(s):

1. Very distinct, large, thick, rather swollen, elongated, black mussel;
2. Fresh dead specimens may have salmon or pink-purplish nacre in vicinity of the beak cavity.

May be confused with: *Eurynia dilatata*. *L. recta* is more elongated with nearly parallel dorsal and ventral margins. *E. dilatata* maintains a "spike" shape and is not sexually dimorphic.

Etymology – "bean pod that keeps straight"
(from Watters *et al.* 2009)**:** Latin *legume, leguminis*, bean, leguminous plant, seed or pod of a legume. Latin *rectus*, straight, upright; from Latin *rego*, to keep straight, to lead straight, guide, direct, rule. Lamarck chose an appropriate name for this species, since it is one of only a few elongate species that have the dorsal and ventral margins parallel and nearly straight.

Table 36. Pennsylvania's known *Ligumia recta* streams.

	Stream	Notes
	Ohio River Basin	
1	- Raccoon Creek	(R.E. Miller, 2015. Upstream of Moffats Mill)
2	Ohio River	
3	Allegheny River	
	- (Kiskimenetas River)	No specimens reported.
4	• Conemaugh River	
5	- Crooked Creek	
6	- Clarion River	1 live individual (male) introduced by PFBC/WPC/USFS in 2015
7	- French Creek	
8	• Muddy Creek	
9	- Conewango Creek	
10	Monongahela River	
11	- Dunkard Creek	
12	- Cheat River	
	Lake Erie Basin	
13	Lake Erie (Presque Isle Bay)	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *L. recta* hosts (from Watters *et al.* 2009): Rock Bass (*Ambloplites rupestris*), American Eel (*Anguilla rostrata*), Central Stoneroller (*Campostoma anomalum*), Common Carp (*Cyprinus carpio*), Banded Killifish (*Fundulus diaphanus*), Redbreast Sunfish (*Lepomis auritus*), Green Sunfish (*Lepomis cyanellus*), Pumpkinseed (*Lepomis gibbosus*), Orangespotted Sunfish (*Lepomis humilis*), Bluegill (*Lepomis macrochirus*), Longear Sunfish (*Lepomis megalotis*), Largemouth Bass (*Micropterus salmoides*), White Perch (*Morone americana*), Rosyface Shiner (*Notropis rubellus*), Yellow Perch (*Perca flavescens*), White Crappie (*Pomoxis annularis*), Black Crappie (*Pomoxis nigromaculatus*), Sauger (*Sander canadensis*), and Walleye (*Sander vitreus*).

EASTERN PEARLSHELL *Margaritifera margaritifera* (Linnaeus, 1758). Other vernacular name(s): Pearlshell. **State Endangered.** (S1, G4).

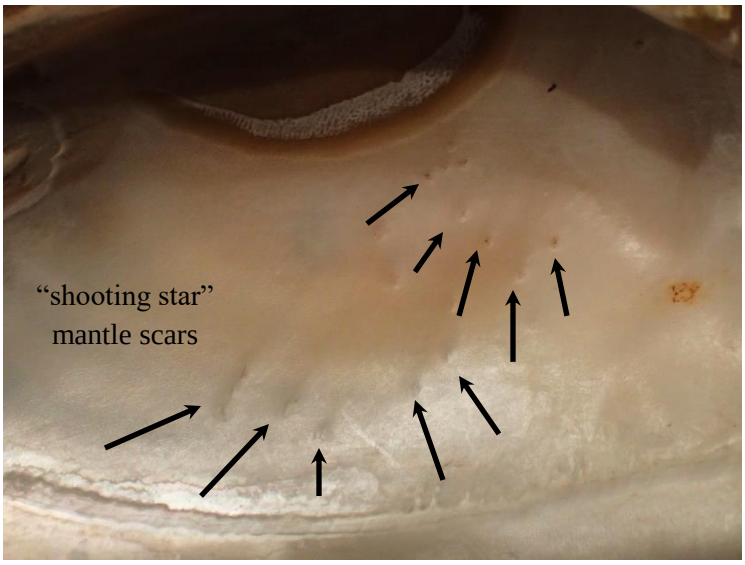


Image (credit, David Fenwick): (external), **image (credit, N. Welte)**, internal and mantle scar detail.

Defining characteristic(s):

1. Distinct blackish shell, often arcuate when older;
2. Nacre has distinct mantle tissue scars that resemble shooting stars;
3. When alive, easily distinguished by gills which are irregular compared to Unionidae.

May be confused with: Live *Elliptio complanata*. *E. complanata* has a brown shell that's more rhomboidal, and less arcuate than *M. margaritifera*. *M. margaritifera*'s muddy-colored foot and connected incurrent and excurrent apertures and black shell separate it from *E. complanata*.

Etymology – "pearl-bearer"
Latin *margarita*, pearl, "to bear pearls," "pearl-bearer."

Table 37. Pennsylvania's known *Margaritifera margaritifera* streams.

	Stream	Notes
	Delaware River Basin	
1	Delaware River	
2	- White Clay Creek (?)	
	(Schuylkill River)	No specimens reported.
3	- Bear Creek	2015 finds by M. Walsh and B. Leppo.
	- (Maiden Creek)	No specimens reported.
4	• Pine Creek (Berks Co.)	
	- (Little Schuylkill River)	No specimens reported.
5	• Indian Run	
6	• Cold Run	
7	• Panther Creek	
8	• Locust Creek	
9	• Hosensock Creek	
10	• Pine Creek (Schuylkill Co.)	
11	• Neifert Creek	
12	• Still Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported M. *margaritifera* hosts (Harms 1907; Davis 1934; Zhadin 1952; Clarke and Berg 1959; Smith 1976; Meyers and Milleman 1977; Karna and Milleman 1978; Bauer 1979; Young and Williams 1984; Bauer 1987; Bauer and Vogel 1987; Bruno *et al.* 1988; Cunjak and McGladdery 1991; Silkenat *et al.* 1991; Hruska 1992; Jungbluth 1993; Nezlin *et al.* 1994; Buddensiek 1995; Young *et al.* 1997): Huchen (*Hucho hucho*), Cutthroat Trout (*Oncoryhnchus clarki*), Coho Salmon (*Oncoryhnchus kisutch*), Rainbow Trout (*Oncoryhnchus mykiss*), Chinook Salmon (*Oncoryhnchus tshawytscha*), Eurasion Minnow (*Phoxinus 93bama93ia*), Bitterling (*Rhodeus sericeus*), Atlantic Salmon (*Salmo salar*), Brown Trout (*Salmo trutta*), Brook Trout (*Salvelinus fontinalis*).

THREEHORN WARTYBACK *Obliquaria reflexa* (Rafinesque, 1820). Other vernacular name(s): Horny-Back, Three Knot, Three Dot. (S3, G5).

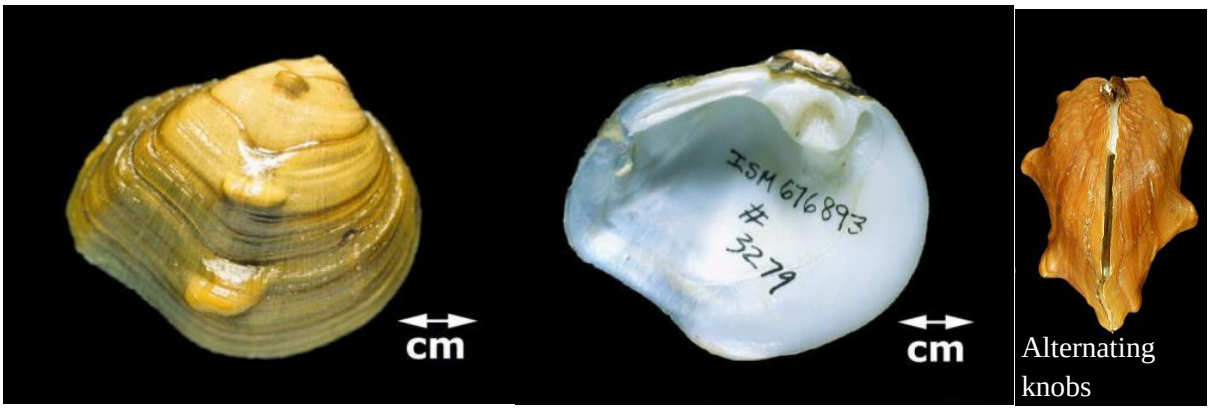


Image (credit, R. Warren): Illinois State Museum, ISM# 676893 (external and internal)

Defining characteristic(s):

1. Prominent/obvious knobs which alternate with each other on opposite valves;
2. Max number of knobs ~ 4-5/valve;
3. Small, thick, solid shell.

May be confused with: A distinct species, nothing else in Pennsylvania resembles *O. reflexa*.

Etymology – "sideways and reflected"
(from Watters *et al.* 2009)**:** Latin *obliquus*, sidelong, slanting, oblique, side-ways. Latin *reflexus*, bent back, turned back, reflected, from Latin *reflecto*, to bend or turn back.

Table 38. Pennsylvania's known *Obliquaria reflexa* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	Allegheny River	
3	Monongahela River	(Ortmann 1919)

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *O. reflexa* hosts (from Watters *et al.* 2009): Silverjaw Minnow (*Ericymba 94bama94ia*), Common Shiner (*Luxilus chrysocephalus*), and Longnose Dace (*Rhinichthys cataractae*).

HICKORYNUT *Obovaria olivaria* (Rafinesque, 1820). Other vernacular name(s): Eggshell, Glassyback. (SH, G4).

Image (credit, K. Little): Illinois State Museum, ISM# 676952 (internal and external)

Defining characteristic(s):

1. Short elliptical or ovate outline, margins rounded;
2. Very anterior beaks;
3. Greenish-olive color.

May be confused with: *Obovaria subrotunda* and *O. retusa*. The egg shape and a distinctly anterior umbo separate *O. olivaria* from its cogeners.

Etymology – "a nearly egg-shaped olive"
(from Watters *et al.* 2009)**:** Latin *ob*, toward, to + Latin *ovatus*, egg-shaped. An apt description of many of the shells in this genus, particularly *Obovaria subrotunda* (Rafinesque, 1820), the type of the genus. Latin *olivaria*, of or belonging to olives, from Latin olive, an olive. Rafinesque (1820: 314) described the periostracum of this species as "olivaceous," referring to its typical olive-green-tan color.

Ortmann (1919) notes: "*One of the rarest species in Pennsylvania. It reaches the state only in the Ohio River in Beaver and Allegheny Counties, and does not extend upstream beyond Pittsburgh.*"

Table 39. Pennsylvania's known historical *Obovaria olivaria* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919): Industry, Cooks Ferry (across from present-day Shippingport)
2	Allegheny River	RM 45.5, Pool 6, just downstream of L&D #7. Shell specimen collected in 2009 by Bob Ventorini.

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *O. olivaria* hosts (from Watters *et al.* 2009): Lake Sturgeon (*Acipenser fulvescens*) and Shovelnose Sturgeon (*Scaphirhyncous platorynchus*).

RING PINK *Obovaria retusa* (Lamarck, 1819). Other vernacular name(s): Golf Stick. **Federally Endangered.** (SX, G1).

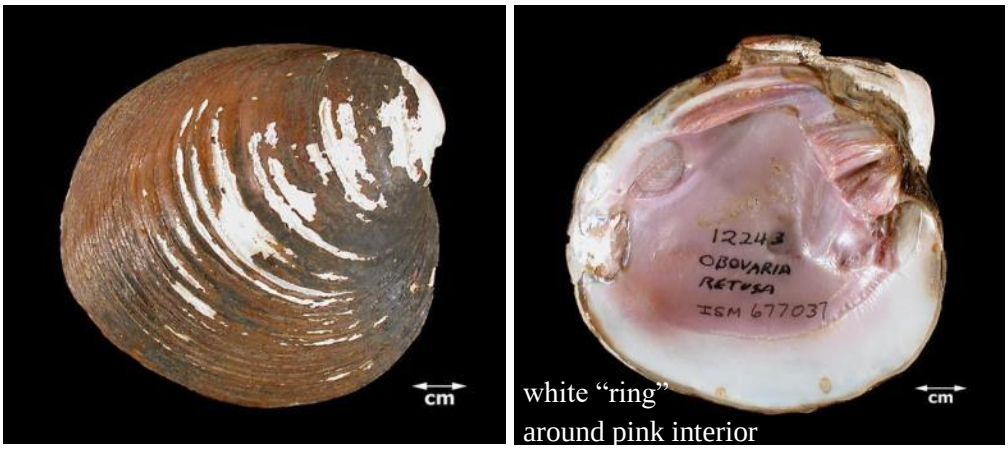


Image (credit, K. Little): Illinois State Museum, ISM# 677037 (external and internal)

Defining characteristic(s):

1. Shell high, if not higher, than it is long;
2. Beaks elevated and incurved;
3. Nacre deep purple with white margin.

May be confused with: *Obovaria olivaria* and *O. subrotunda*. The coiled shape and purple nacre separates *O. retusa* from its cogeners.

Etymology – "blunted, nearly egg-shaped"
(from Watters *et al.* 2009)**:** Latin *ob*, toward, to + Latin *ovatus*, egg-shaped. An apt description of many of the shells in this genus, particularly *Obovaria subrotunda* (Rafinesque, 1820), the type of the genus. Latin *retusa*, dulled, made blunt, from Latin *re-* back, again + Latin *tundo*, beat, strike. In his original description, Lamarck (1819: 72) wrote "with blunt, eroded umbos." The umbos of *O. retusa* are in fact rounded and, in that manner, blunted, but Lamarck may have been using *retusa* in the more strictly literal sense of "beat back," referring to the strong anterior rotation of the umbos, a striking feature of this species.

*The shape and nacre color what make this species unique.

Ortmann (1919) notes: "*Only two specimens have ever been found in Pennsylvania, both at the same place in Beaver County* [Industry]. *This marks the furthest point upstream in the Ohio of the range of this species*."

Table 40. Pennsylvania's known *Obovaria retusa* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	(Ortmann 1919): Industry

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *O. retusa* hosts (from Watters *et al.* 2009): No hosts known.

ROUND HICKORYNUT *Obovaria subrotunda* (Rafinesque, 1820). **State Endangered.** (S1, G4).

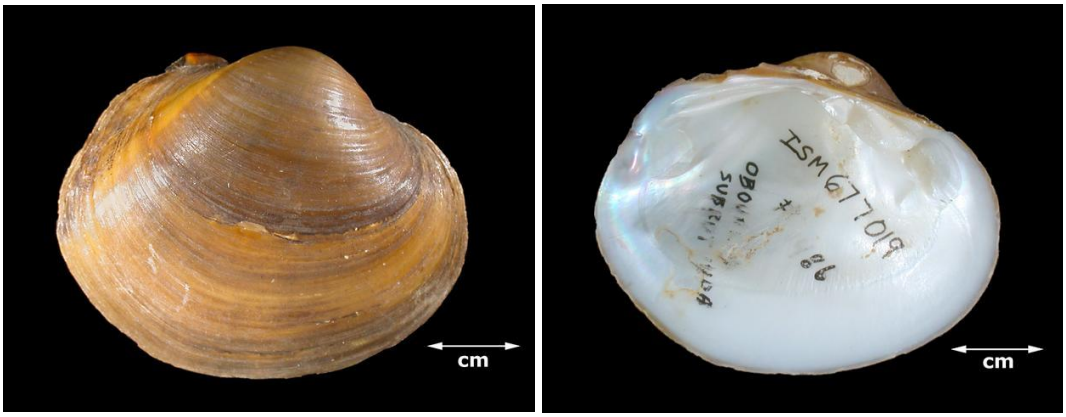


Image (credit, R. Warren): Illinois State Museum, ISM# 677019 (external and internal)

Defining characteristic(s):

1. Circular outline, subglobular (globe-like) shape;
2. Nearly central umbo;
3. Light color of the posterior slope;
4. Nacre can sometimes be pink with a white margin.

May be confused with: *Obovaria olivaria* and *O. retusa*. The egg shape and centralized umbo distinguishes *O. subrotunda* from its cogeners. *O. subrotunda* is presently only known from the Shenango River.

Etymology – "egg-shaped, almost perfectly round"
(from Watters *et al.* 2009)**:** Latin *ob*, toward, to + Latin *ovatus*, egg-shaped. An apt description of many of the shells in this genus, particularly *Obovaria subrotunda* (Rafinesque, 1820), the type of the genus. Latin *sub*, under, rather, somewhat + Latin *rotundus*, wheel-shaped, round, circular, spherical, from Latin *rota*, a wheel. Rafinesque (1820: 308) described this species as "perfectly rounded," it is uncertain why he used the modifier *sub*- except that in reality few individuals are perfectly round.

Table 41. Pennsylvania's known *Obovaria subrotunda* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	Beaver River	
3	- Mahoning River	
4	- Shenango River	
5	• Pymatuning Creek	
6	Allegheny River	
7	- Crooked Creek	
8	Monongahela River	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *O. subrotunda* hosts (Ehlo and Layzer 2014; Watters *et al.* 2009; Shepard and Mair, *personal communication*): Banded Sculpin (*Cottus carolinae*), Emerald Darter (*Etheostoma baileyi*), Greenside Darter (*Etheostoma blennioides*), Fantail Darter (*Etheostoma flabellare*), Speckled Darter (*Etheostoma stigmaeum*), Longhunt Darter (*Etheostoma* sp. Cf. *stigmaeum*), Spangled Darter (*Etheostoma 98bama*), Variegate Darter (*Etheostoma variatum*), Frecklebelly Darter (*Percina strictogaster*).

ORANGEFOOT PIMPLEBACK *Plethobasus cooperianus* (Lea, 1834).**Federally Endangered.** (SH, G1).

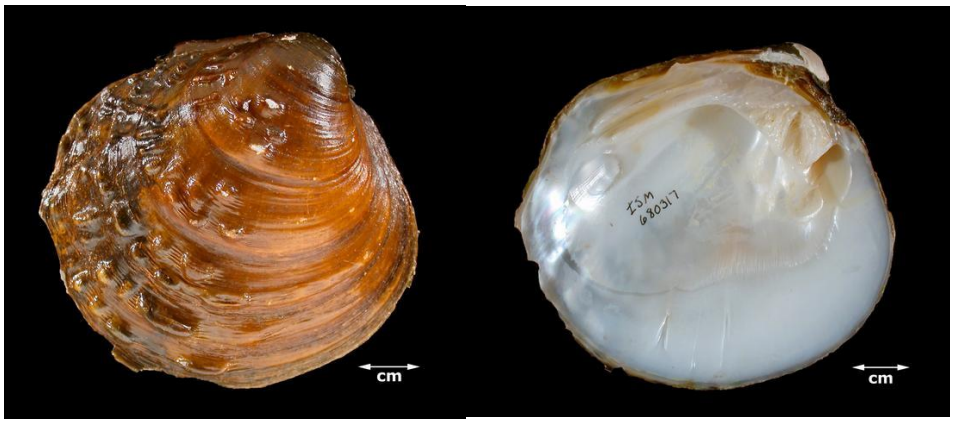


Image (credit, K. Little): Illinois State Museum, ISM# 680317 (external and internal)

Defining characteristic(s):

1. Distinctly bright orange foot when alive;
2. Nacre white, sometimes pink/salmon;
3. Scattered, irregularly placed nodules, absent upon the posterior slope (per Ortmann 1919);
4. Umbo appears to be more anterior than *C. pustulosa*.

May be confused with: *C. pustulosa.* Shells of both species are nearly identical, absent the green blotch typically present on most young specimens of *C. pustulosa*. Live specimens distinguished by orange foot.

Etymology – "swollen, or full in the middle, patronym for Cooper"
(from Watters *et al.* 2009)**:** Greek *plethos*, multitude, magnitude, mass, main body, largest part, OR Greek *plethora,* fullness + Greek *basis*, step, base, pedestal, foundation. Simpson (1900a: 764) described the genus *Plethobasus* as"…somewhat suddenly swollen at the posterior base…" This ventral fullness is especially apparent in the two species he included in this genus, P. *cyphyus* and *P. cicatricosus*. The name honors "William Cooper, Esq." who had lent Lea the first specimens.

Ortmann (1919) notes: "*Externally in shape and sculpture this species greatly resembles C. pustulosa and C. tuberculata*."

"*This is one of the rarest species in Pennsylvania, and exists only in the Ohio River in Beaver and Allegheny Cos., and is even there very scarce. I was able to secure only four specimens, one of which was alive. The latter was found upon a shell-bank, in a steady current, associated with the usual bank-forming species*."

Table 42. Pennsylvania's known historical *Plethobasus cooperianus* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919):Shippingport, Cooks Ferry (across from present-day Shippingport), Industry, Beaver, Coraopolis

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *P. cooperianus* hosts (from Watters *et al.* 2009): No hosts known.

SHEEPNOSE *Plethobasus cyphyus* (Rafinesque, 1820). Other vernacular name(s): Bullhead, Yellow Knob Shell. **State Threatened, Federally Threatened.** (S1, G1).

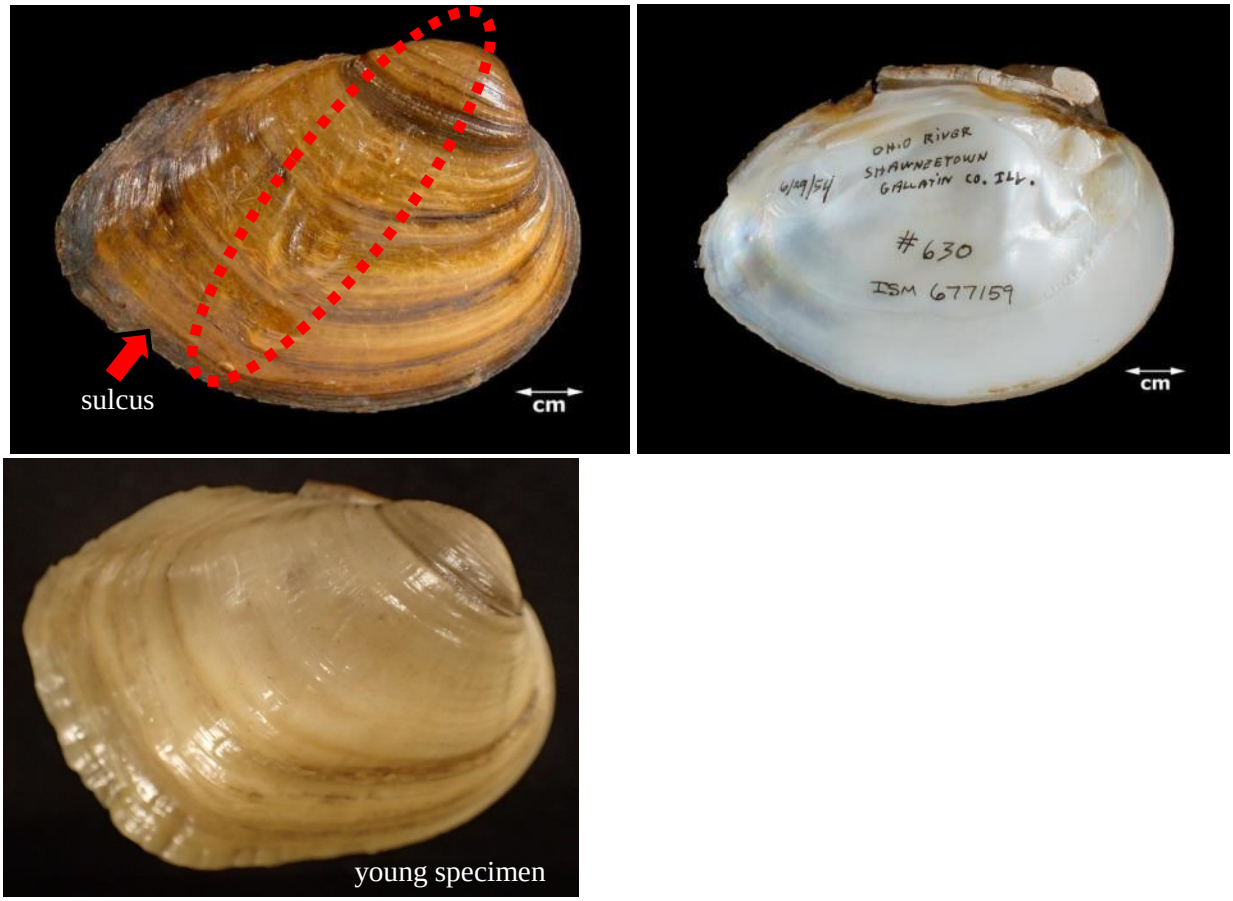


Image (credit, K. Little): Illinois State Museum, ISM# 677156 (external), ISM# 677159 (internal)**; image (credit, N. Welte):** Carnegie Museum of Natural History, CMNH# ??? (young *P. cyphyus*)

Defining characteristic(s):

1. Broad, shallow sulcus;
2. Anterior to sulcus is row of low, broad, tubercles radiating from the umbo towards the ventral margin;
3. Brilliant yellow, varnished, high-gloss young mussel shell.

May be confused with: A distinct shell.

Etymology – "swollen, or full in the middle" "hump-backed"
(from Watters *et al.* 2009)**:** Greek *plethos*, multitude, magnitude, mass, main body, largest part, OR Greek *plethora*, fullness + Greek *basis*, step, base, pedestal, foundation. Simpson (1900a: 764) described the genus *Plethobasus* as"…somewhat suddenly swollen at the posterior base…" This ventral fullness is especially apparent in the two species he included in this genus, P. *cyphyus* and *P. cicatricosus*. Greek *kyphos*, humped, sloped, humpbacked, curved. The central ridge of this species is typically sculptured with a radial row of humps or swellings.

Table 43. Pennsylvania's known *Plethobasus cyphyus* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919): Shippingport, Industry, Coraopolis,
2	Beaver River	Ortmann (1919): Wampum
3	Allegheny River	Ortmann (1919): Aladdin, Godfrey, Kelly (present-day pool 5), Templeton (pool 8). Known, present-day occurrences extend from Franklin, PA to Tionesta, PA.
4	- Hemlock Creek*	*PFBC considers this population to be part of the Allegheny River because the creek is not hospitable much further than its confluence with the Allegheny.
5	Monongahela River	Ortmann (1919): Westmoreland Co.

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *P. cyphyus* hosts (from Watters *et al.* 2009): Central Stoneroller (*Campostoma anomalum*) and Sauger (*Sander canadensis*).

CLUBSHELL *Pleurobema clava* (Lamarck, 1819). Other vernacular name(s): Northern Club Shell, Ohio Club Shell, Ohio River Club Shell, Common Club Shell**. State Endangered, Federally Endangered.** (S2, G1G2).

Image (credit, K. Little): Illinois State Museum, ISM# 679769 (external and internal)

Defining characteristic(s):

1. A very distinct, club-shaped shell;
2. Shell thickened anteriorly;
3. Umbos located very anterior of the shell;
4. Periostracum yellowish, with green blotches or rays;
5. Nacre always white.

May be confused with: Maybe *Ptychobranchus fasciolaris*? *P. clava* is a distinctly swollen shell near the umbos and becoming tapered at the posterior. *P. fasciolaris* is a more evenly compressed shell.

Etymology – "club-shaped"
(from Watters *et al.* 2009)**:** Greek *pleura*, the side, or Greek *pleuron*, a rib + Greek *bema*, step, pace, raised place, base, pedestal. In his original description Rafinesque (1820: 313) gave us no clue as to his choices of root words to form the name *Pleurobema*… Latin *clava*, staff club, cudgel. The shell of P. clava typically has its greatest height and width very near the anterior end and gradually becomes lower and narrower moving posteriorly. The resulting form is that of a tapered wedge or club.

Table 44. Pennsylvania's known *Pleurobema clava* streams.

	Stream	Notes
	Ohio River Basin	
	(Ohio River)	No specimens reported.
1	- Little Beaver Creek	
2	• North Fork Little Beaver Creek	
3	- Raccoon Creek	
4	Beaver River	
5	- Connoquenessing Creek	
6	- Mahoning River	
7	- Shenango River	
8	• Neshannock Creek	At Eastbrook was supposedly best site in the entire state

Table 44. *P. clava* streams (continued).

9	• Pymatuning Creek	
10	Allegheny River	
11	- Buffalo Creek	
	- (Kiskiminetas River)	No specimens reported.
12	• Conemaugh River	
13	• Loyalhanna River	
14	- Sandy Creek	
15	- French Creek	
16	• Conneaut Outlet	
17	• Conneauttee Creek	
18	• Muddy Creek	
19	• LeBoeuf Creek	
20	- Hemlock Creek*	*PFBC considers this population to be part of the Allegheny River because the creek is not hospitable for mussels far upstream from its confluence with the Allegheny.
21	- Conewango Creek	Augmented two sites in 2014 (JRA, NTW)
	(Monongahela River)	No specimens reported.
22	- Dunkard Creek	
23	- Cheat River	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *P. clava* hosts (from NatureServe 2015): Central Stoneroller (*Campostoma anomalum*), Striped Shiner (*Luxilus chrysocephalus*), Logperch (*Percina caprodes*), and Blackside Darter (*Percina maculata*).

OHIO PIGTOE *Pleurobema cordatum* (Rafinesque, 1820). Other vernacular name(s): Ohio River Pigtoe, River Pigtoe, Common Pigtoe, Big River Pigtoe. (SH, G4).

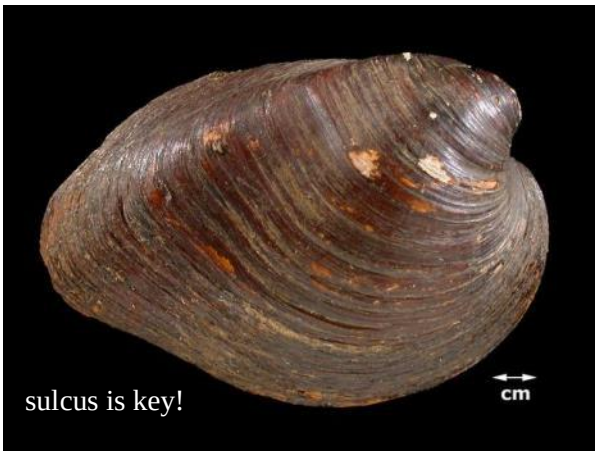


Image (credit, K. Little): Illinois State Museum, ISM# 677237 (external and internal), **image (credit, N. Welte)**: heart-shaped ("cordate") profile.

Defining characteristic(s) (modified from Watters *et al.* 2009)**:**

1. Prominent sulcus;
2. Umbos prominent and facing forward;
3. Umbos near anterior margin;
4. Elongated only as old individuals;
5. Nacre always white.

May be confused with: *Pleurobema plenum*, *Fusconaia flava*. See "Fuscobema" worksheet for differentiating characteristics.

Etymology - "heart-shaped"
(from Watters *et al.* 2009)**:** Greek *pleura*, the side, or Greek *pleuron*, a rib + Greek *bema*, step, pace, raised place, base, pedestal. In his original description Rafinesque (1820: 313) gave us no clue as to his choices of root words to form the name *Pleurobema*… Latin *cor*, *cordis*, heart + Latin *–atus*, provided

with; i.e., heart-shaped. Most *Pleurobema* species, when viewed from the anterior, are cordate or heart-shaped, and the well-developed adult *P. cordatum* is especially so.

Ortmann (1919) notes: "*The typical form of P. (cordatum) is restricted in Pennsylvania to the three large rivers, the Ohio, Allegheny, and Monongahela. In the Allegheny it is found as high up as Armstrong Co., but is not very abundant there. In the Monongahela, judging from the large number of specimens collected by G.A. Ehrmann, it must have been at one time abundant in the vicinity of Charleroi, but we do not know how far it ascended the river. In the Ohio below Pittsburgh it is a common shell. Farther down it is extremely abundant, and is the prevailing species, at least locally. It is the shell, which largely contributes in forming the shell-banks, in rather deep, steadily flowing water, and, next to the "mucket" (Actinonaias ligamentina), it is the shell most highly valued by the clam-diggers. In Pennsylvania, it is present also in riffles, and immediately above them, in strong current, and among coarse gravel.*"

Table 45. Pennsylvania's known historical *Pleurobema cordatum* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919): Smiths Ferry (historical town across from present-day Georgetown), Shippingport, Cooks Ferry (historical town across from present-day Shippingport), Industry, Coraopolis, and Neville Island
2	Beaver River	
3	- Shenango River*	*Bursey (1987) – Bursey notes that he collected a relic shell at Sharon. Identification of this specimen is uncertain/questionable because he references Ortmann's collection of the form *P. sintoxia* from the Shenango as the basis for this species occurrence in the Shenango River.
4	• Pymatuning Creek	
5	Monongahela River	Ortmann (1919): Westmoreland Co., and Charleroi
6	Allegheny River	Ortmann (1919): Godfrey and Kelly (present-day pool 5)

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *P. cordatum* hosts (from Watters *et al.* 2009): Brook Stickleback (*Culaea inconstans*), Rosefin Shiner (*Lythrurus ardens*), Bluegill (*Lepomis macrochirus*), and Creek Chub (*Semotilus atromaculatus*).

ROUGH PIGTOE *Pleurobema plenum* (Lea, 1840). Other vernacular name(s): Ridged Pigtoe, Full Pigtoe. **Federally Endangered.** (SH, G1).

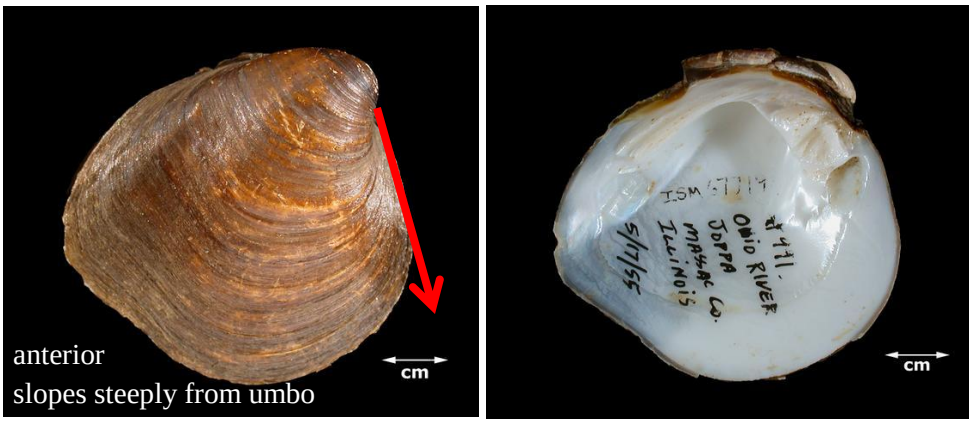


Image (credit, K. Little): Illinois State Museum, ISM# 677194 (external and internal)

Defining characteristic(s) (modified from Watters *et al.* 2009)**:**

1. Slight or no sulcus;
2. Umbos prominent and facing each other;
3. Umbos not near anterior margin;
4. Not elongated;
5. Nacre always white;
6. Periostracum rather shaggy or matte.

May be confused with: *Pleurobema cordatum*. See "Fuscobema" worksheet for differentiating characteristics.

Etymology - "plump"
(from Watters *et al.* 2009)**:** Greek *pleura*, the side, or Greek *pleuron*, a rib + Greek *bema*, step, pace, raised place, base, pedestal. In his original description Rafinesque (1820: 313) gave us no clue as to his choices of root words to form the name *Pleurobema*… Latin *plenus*, full, stout, plump. Lea (1840: 286), in his original description of the species, that it is "*inflata*" or wide, and later (Lea 1842: 211) compared it with *P. cordatum* and *F. flava* in other regards. Specimens of this species typically appear "full, stout, or plump."

Ortmann (1919) notes: "*Wherever found, in Pennsylvania, as well as in the Tennessee-drainage, this form is associated with the main form* (NTW - Ortmann is referencing *P. cordatum*), *and does not show any remarkable facts in its distribution.*"

Table 46. Pennsylvania's known *Pleurobema plenum* streams.

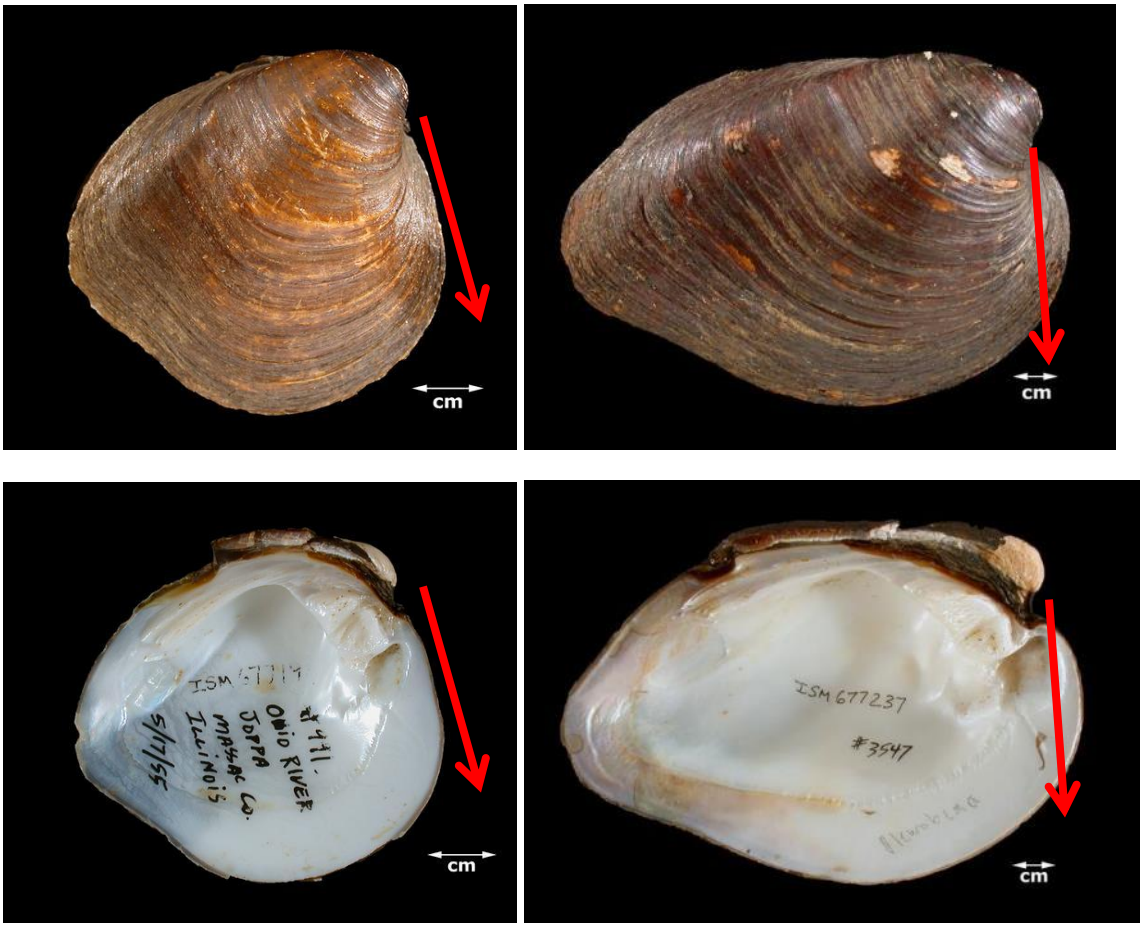
	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919): Cooks Ferry (historical town across from present-day Shippingport)
2	Allegheny River	Ortmann (1919): Godfrey (present-day pool 5)

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *P. plenum* hosts (from Watters *et al.* 2009): No hosts known.

Difference between *P. plenum* and *P. cordatum. P. cordatum* anterior end protrudes beyond the umbo.

P. plenum vs. *P. cordatum*



PYRAMID PIGTOE *Pleurobema rubrum* (Rafinesque, 1820. Other vernacular name(s): Pink Pigtoe. (SH, G2G3).

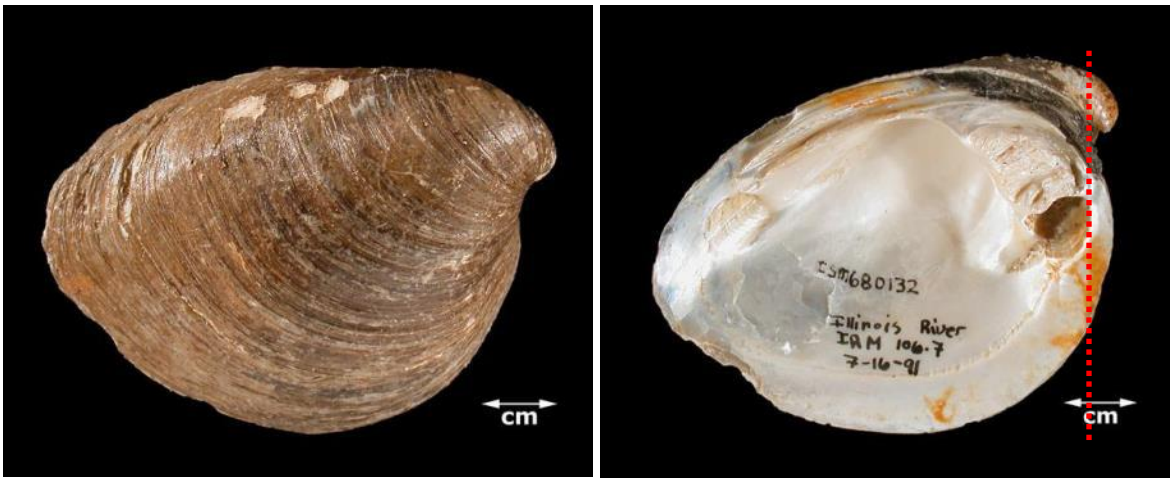


Image (credit, K. Little): Illinois State Museum, ISM# 680132 (external and internal)

Defining characteristic(s) (modified from Watters *et al.* 2009)**:**

1. Usually a prominent sulcus;
2. Umbos very prominent and facing forward;
3. Umbos at or beyond anterior margin;
4. Often quite elongated;
5. Nacre pink or white.

May be confused with: *Pleurobema sintoxia*. See "Fuscobema" worksheet (page 14) for differentiating characteristics.

Etymology - "red nacre periostracum"
(from Watters *et al.* 2009)**:** Greek *pleura*, the side, or Greek *pleuron*, a rib + Greek *bema*, step, pace, raised place, base, pedestal. In his original description Rafinesque (1820: 313) gave us no clue as to his choices of root words to form the name *Pleurobema*… Latin *ruber*, red, ruddy. Rafinesque may have used the term "ruber" to refer to the pink nacre frequently found in the species or to the reddish brown periostracum that typically accompanies it. The nacre, however, is white-iridescent in many individuals.

Ortmann (1919) notes: "*The range of this form in Pennsylvania, is coextensive with that of P. (cordatum), but it is rather rare. The same is true farther down the Ohio, and wherever I collected it myself between Pittsburgh and Cincinnati I found only a few specimens of it among large numbers of (cordatum) and its intergrades.*"

Table 47. Pennsylvania's known historical *Pleurobema rubrum* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919):
2	Allegheny River	Ortmann (1919):

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *P. rubrum* hosts (from Watters *et al.* 2009): Spotfin Shiner (*Cyprinella spiloptera*), Streamline Chub (*Erimystax dissimilis*), Scarlet Shiner (*Lythrurus fasciolaris*), and Silver Shiner (*Notropis photogenis*).

ROUND PIGTOE *Pleurobema sintoxia* (Rafinesque, 1820). Other vernacular name(s): Flats Pigtoe, Solid Pigtoe. (S3S4, G4G5).

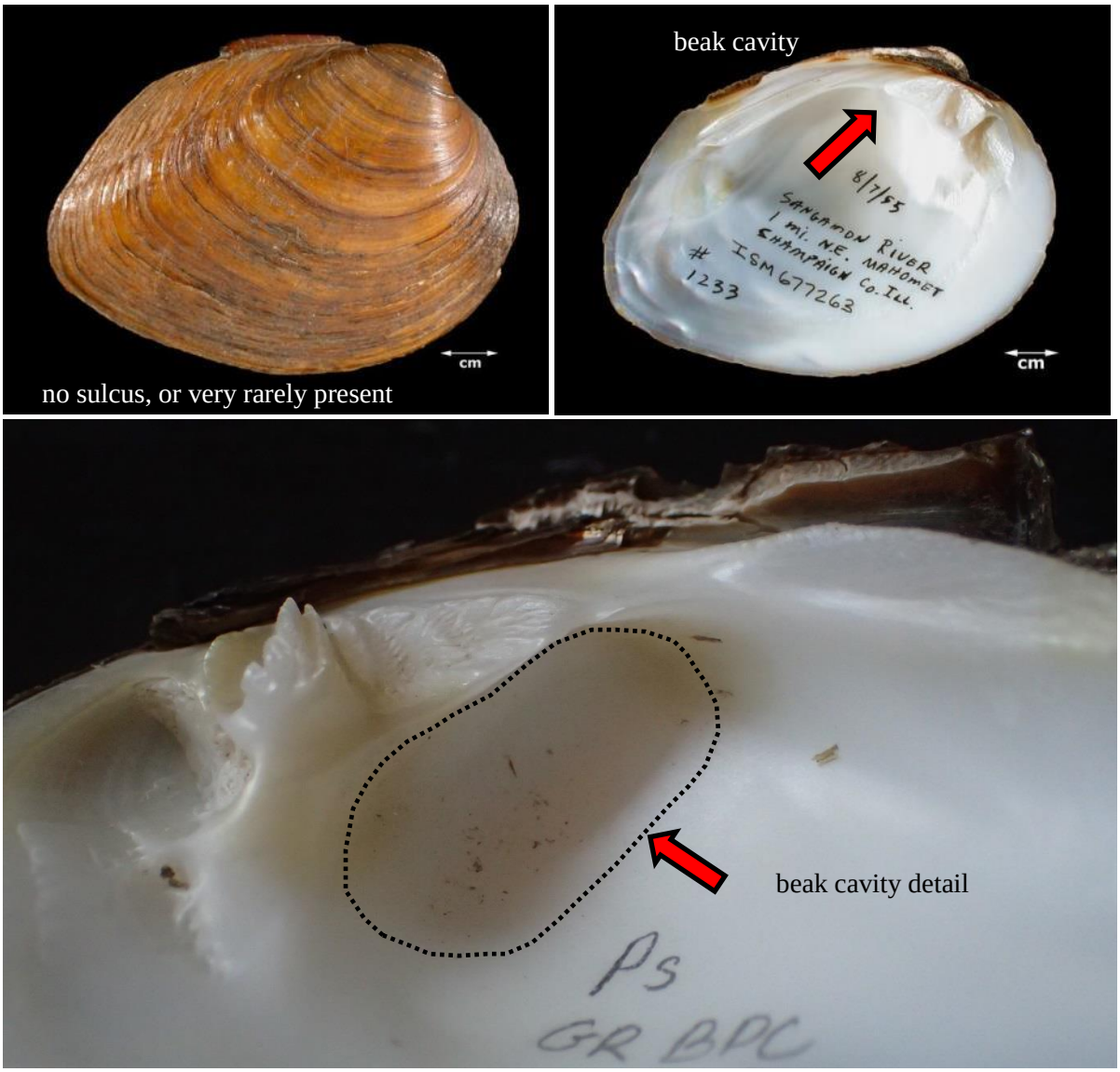


Image (credit, K. Little): Illinois State Museum, ISM# 677263 (external and internal), **image (credit, N. Welte):** PFBC reference collection, round, shallow, beak cavity detail.

Defining characteristic(s) (modified from Watters *et al.* 2009)**:**

1. Sulcus absent, or in rare cases, weak;
2. Umbos prominent in river forms, not in creek forms; facing each other;
3. Umbos not before anterior margin;
4. Elongated only as old individuals;
5. Beak cavity shallow and round;
6. Nacre pink, salmon, or white.

May be confused with: *Fusconaia subrotunda, P. rubrum*. See "Fuscobema" worksheet for differentiating characteristics. When alive, the distinguishing character *is F. subrotunda'*s orange foot. *F. subrotunda* nacre always white, never pinkish or salmon-colored. *P. sintoxia* has a rather shallow, non-compressed beak cavity – *F. subrotunda* has a deep, compressed beak cavity. *P. rubrum* umbos extend beyond the shell's anterior margin.

Etymology - "half-arched lateral tooth"
(from Watters *et al.* 2009)**:** Greek *pleura*, the side, or Greek *pleuron*, a rib + Greek *bema*, step, pace, raised place, base, pedestal. In his original description Rafinesque (1820: 313) gave us no clue as to his choices of root words to form the name *Pleurobema*… Latin *semi-*, half; small, light + Greek *toxon*, bow, arch. Rafinesque (1820: 310), in characterizing his subgenus Sintoxia, noted that both the lateral tooth and ligament are curved. Although true, the widespread occurrence of this character in many unionid species makes it of little value as a species character.

Table 48. Pennsylvania's known *Pleurobema sintoxia* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	Beaver River	
3	- Connoquenessing Creek	
4	• Slippery Rock Creek	
5	- Mahoning River	
6	- Shenango River	
7	• Neshannock Creek	
9	• Pymatuning Creek	
10	Allegheny River	
11	- Buffalo Creek	
	- (Kiskiminetas River)	No specimens reported.
12	• Conemaugh River	
13	• Loyalhanna River	
14	- Crooked Creek	
15	- Mahoning Creek	
16	• Little Mahoning Creek	
17	- Clarion River	Live *P. sintoxia* introduced by PFBC/WPC/USFS in 2015
18	- Sandy Creek	
19	- French Creek	
20	• Conneaut Outlet	
21	• Conneauttee Creek	
22	• Muddy Creek	
23	• LeBoeuf Creek	
24	- Hemlock Creek*	*PFBC considers this population to be part of the Allegheny River because the creek is not hospitable much further than its confluence with the Allegheny.
25	- Tionesta Creek	
26	• Salmon Creek	
27	- Brokenstraw Creek	
28	- Conewango Creek	
29	- Potato Creek	
30	- Oswayo Creek	
	(Monongahela River)	No specimens reported.

Table 48. *P. sintoxia* streams (continued).		
	- (Tenmile Creek)	No specimens reported.
31	• South Fork Tenmile Creek	
32	- Dunkard Creek	
32	- Cheat River	
	Lake Erie Basin	
33	Lake Erie (Presque Isle Bay)	
34	- Conneaut Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *P. sintoxia* hosts (from Watters *et al.* 2009): Central Stoneroller (*Campostoma anomalum*), Spotfin Shiner (*Cyprinella spiloptera*), Bluegill (*Lepomis macrochirus*), Northern Redbelly Dace (*Phoxinus eos*), Southern Redbelly Dace (*Phoxinus erythrogaster*), and Bluntnose Minnow (*Pimephales notatus*).

PINK HEELSPLITTER *Potamilus alatus* (Say, 1817). (S5, G5).

Image (credit, K. Little): Illinois State Museum, ISM# 677337 (external and internal)

Defining characteristic(s):

1. Large, winged shell (alate wing), <u>posterior wing only</u>;
2. Blackish periostracum;
3. Pinkish purplish nacre;
4. Truncated posterior.

May be confused with: *Potamilus ohiensis, Leptodea fragilis,* and *Lasmigona complanata*. See the "winged" mussel worksheet for differentiating characteristics.

Etymology - "winged mussel of the river"
(from Watters *et al.* 2009)**:** Greek *potamos*, a river or stream. Rafinesque could not have chosen a more appropriate name for his first described unionoid genus. Latin *alatus*, winged; from Latin *ala*, wing. Say was obviously impressed with the large postdorsal wing so typical of this species and so well-developed in most Lake Erie specimens.

Table 49. Pennsylvania's known *Potamilus alatus* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	- Little Beaver Creek	
3	• North Fork Little Beaver Creek	
4	- Raccoon Creek	
5	Allegheny River	
6	Monongahela River	
7	- Dunkard Creek	
	Lake Erie Basin	
8	Lake Erie	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *P. alatus* hosts (from Watters *et al.* 2009): Freshwater Drum (*Aplodinotus grunniens*).

PINK PAPERSHELL *Potamilus ohiensis* (Rafinesque, 1820). Other vernacular name(s): Fragile Heelsplitter. (S1, G5).

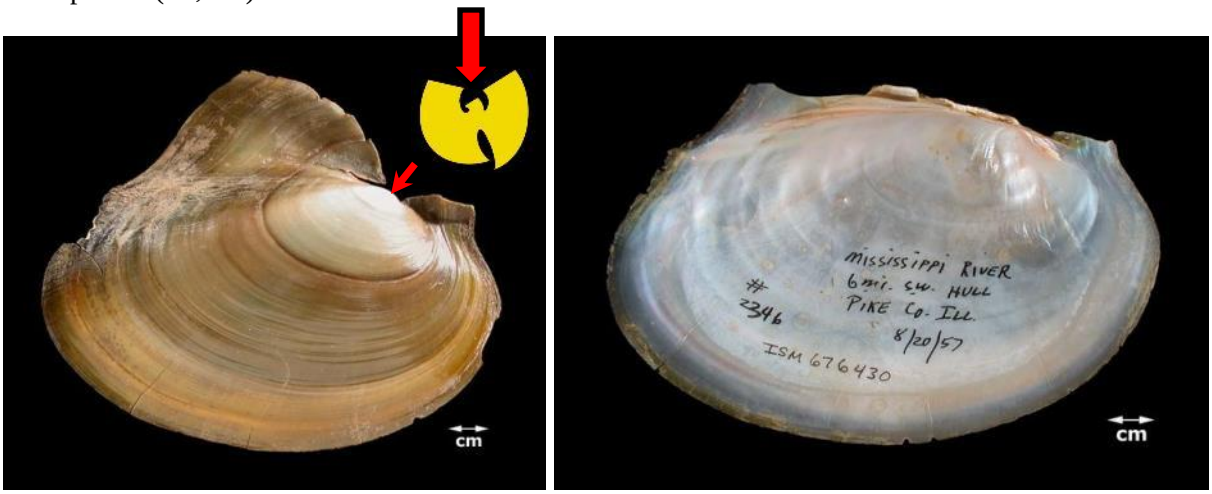


Image (credit, K. Little): Illinois State Museum, ISM# 676430 (external and internal)

Defining characteristic(s):

1. Anterior wing present, typically broken off;
2. Brownish periostracum;
3. White to pink nacre;
4. Thin, fragile shell (shell noticeably thinner than *P. alatus*)

May be confused with: *Potamilus alatus, Leptodea fragilis,* and *Lasmigona complanata*. See the "winged" mussel worksheet for differentiating characteristics.

Etymology - "Ohio River mussel"
(from Watters *et al.* 2009)**:** Greek *potamos*, a river or stream. Rafinesque could not have chosen a more appropriate name for his first described unionoid genus. Ohio [River] + Latin *–ensis*, of that place.

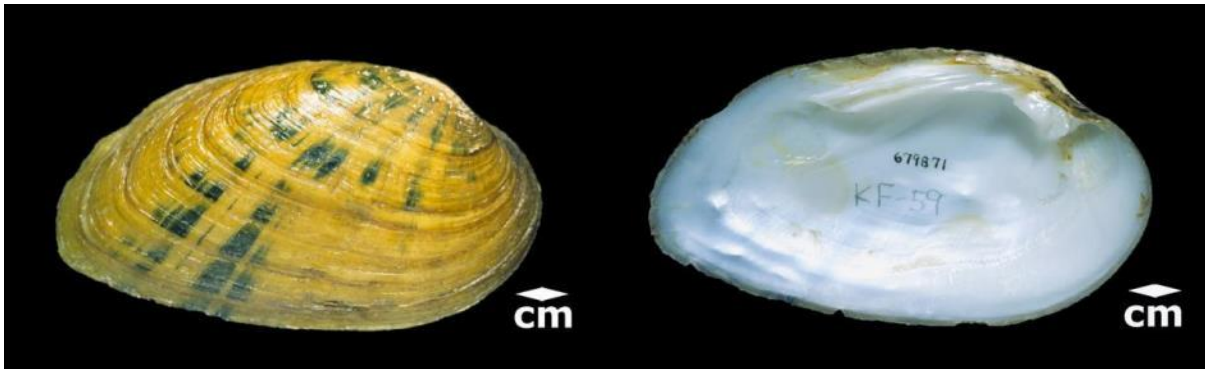
Table 50. Pennsylvania's known *Potamilus ohiensis* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	Allegheny River	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *P. ohiensis* hosts (from Watters *et al.* 2009): Freshwater Drum (*Aplodinotus grunniens*) and White Crappie (*Pomoxis annularis*).

KIDNEYSHELL *Ptychobranchus fasciolaris* (Rafinesque, 1820). (S4, G4G5).



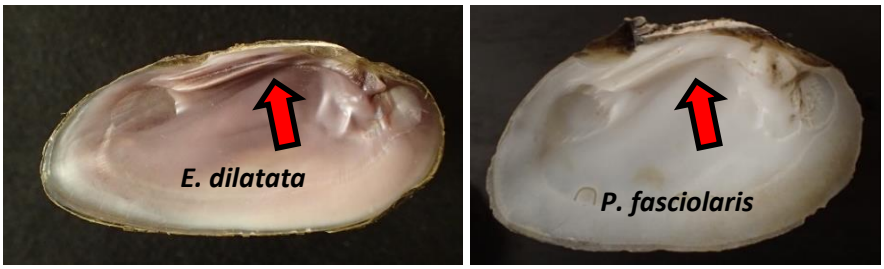


Image (credit, R. Warren): Illinois State Museum, ISM# 679871 (external and internal), **image (credit, N. Welte)**: hinge teeth comparison with *E. dilatata*.

Defining characteristic(s):

1. Distinct shell, when young(er);
2. Yellowish periostracum with green rays, fading to brown when older;
3. Heavy shell, with large club-shaped lateral teeth and heavy pseudocardinal teeth;
4. Nacre always white;
5. Sharp posterior ridge lending a 'humped' appearance, particularly for older shells.

May be confused with: *E. dilatata*. Older *P. fasciolaris* individuals may resemble *E. dilatata*. Species distinguished by posterior slope and shell heft when alive (*P. fasciolaris* is more humped and heavier). Dead shell easily distinguished by *P. fasciolaris*'s heavy club-shaped lateral teeth. *E. dilatata* will have slender, nearly straight lateral teeth and may also be distinguished by salmon/pink/purple nacre, if present.

Etymology (from Watters *et al.* 2009)**:** Greek *ptychodes,* in folds or layers + Greek *branchion,* gill. Simpson (1900a: 612) noted that "embryos are contained in distinct ovisacs with rounded bases, occupying the entire outer gills, which, when gravid, consists of a series of folds." Latin *fascia*, a band, bandage, zone + Latin *–ola* (diminutive) + Latin *–aris*, pertaining to.

Table 51. Pennsylvania's known *Ptychobranchus fasciolaris* streams.

	Stream	Notes
	Ohio River Basin	
	(Ohio River)	
1	- Little Beaver Creek	
2	• North Fork Little Beaver Creek	
3	- Raccoon Creek	
4	Beaver River	
5	- Connoquenessing Creek	
6	• Slippery Rock Creek	
7	- Mahoning River	
8	- Shenango River	
9	• Neshannock Creek	
10	○ Otter Creek	
11	• Pymatuning Creek	
12	• Little Shenango River	
13	Allegheny River	
14	- Buffalo Creek	
	- (Kiskimenetas River)	No specimens reported.
15	• Loyalhanna River	
16	○ Quemahoning Creek	
17	- Mahoning Creek	
18	• Little Mahoning Creek	
19	- Clarion River	Live *P. fasciolaris* introduced by PFBC/WPC/USFW in 2015
20	- Sandy Creek	
21	- French Creek	
22	• Cussewago Creek	
23	• Woodcock Creek	
24	• Muddy Creek	
25	• LeBoeuf Creek	
26	• South Branch French Creek	
27	• West Branch French Creek	
28	- Hemlock Creek*	*PFBC considers this population to be part of the Allegheny River because the creek is not hospitable much further than its confluence with the Allegheny.
29	- Conewango Creek	
30	Monongahela River	
31	- Dunkard Creek	
32	- Cheat River	
	Lake Erie Basin	
33	Lake Erie (Presque Isle Bay)	
34	- Conneaut Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *P. fasciolaris* hosts (from NatureServe 2015): Brook Stickleback (*Culaea inconstans*), Rainbow Darter (*Etheostoma caeruleum*), and Fantail Darter (*Etheostoma flabellare*).

EASTERN FLOATER *Pyganodon cataracta* (Say, 1817). (S4, G5).

Image (credit, A. Bogan, www.discoverlife.com): North Carolina State Museum, NCSM# 133617 (external and internal)

Defining characteristic(s):

1. Beak sculpture consists of 5-7 low, evenly raised double-looped bars;
2. Bluish-white nacre;
3. Greenish periostracum;
4. Thin shell, lacking teeth.

May be confused with: *Pyganodon grandis. P. grandis* has beak sculpture that is more nodulous. Identification difficult if beak sculpture has been obliterated.

Etymology – "buttocks without teeth"
(from Watters *et al.* 2009)**:** From Greek *pyge*, *pyganos*, rump, buttocks, nates + *an*, not, without + Greek *odontos*, tooth. Shells of this genus commonly have swollen umbos, resembling nates or buttocks, while lacking hinge teeth in the same (dorsal) region of the shell. Literally, "buttocks without teeth."

Table 52. Pennsylvania's known *Pyganodon cataracta* streams.

	Stream	Notes
	Delaware River Basin	
1	Delaware River	
2	- White Clay Creek	
3	- Crum Creek	
4	- Schuylkill Canal	
5	Schuylkill River	
6	- Wissahickon Creek	
7	- Perkiomen Creek	
8	- Tulpehocken Creek	
9	- Maiden Creek	
	(mainstem)	
	- (Neshaminy Creek)	No specimens reported.
10	• Little Neshaminy Creek	
11	- Marshalls Creek	
12	- Beaver Lake	
13	- Lackawaxen River	
14	• Wallenpaupack Creek	
15	- Porters Lake (Pike Co.)	

Table 52. *P. cataracta* streams (continued).

16	Echo Lake (Monroe Co.)	
	Susquehanna River Basin	
17	Susquehanna River	
18	- Octoraro Creek	
19	- Conewago Creek	
20	• Little Conewago Creek	
21	- Swatara Creek	
22	Juniata River	
	- (Frankstown Branch Juniata River)	No specimens reported.
23	• Canoe Creek	
24	○ Canoe Creek Lake	
	(mainstem)	
25	- Mahantango Creek	
26	West Branch Susquehanna River	
27	- Chillisquaque Creek	
	- (Bald Eagle Creek)	No specimens reported.
28	• Fishing Creek	
29	- Pine Creek	
30	- Kettle Creek	
	- (Sinnemahoning Creek)	No specimens reported.
31	• First Fork Sinnemahoning Creek	
32	- Black Moshannon Creek	
	- (Clearfield Creek)	No specimens reported.
33	• Beaver Dam Creek (Cambria)	
34	North Branch Susquehanna River	
35	- Neals Run	
36	- (Harvey Creek)	No specimens reported.
37	• Harvey Lake (Luzerne Co.)	
38	- Mehoopany Creek	
39	- Meshoppen Creek	
40	- Chemung River	
	- (Tioga River)	
41	• Cowanesque River	
42	○ Hills Creek	
43	○ Crooked Creek	Ortmann (1919) reported specimens from a millrace to Crooked Creek.
	Potomac River Basin	
44	- Conococheague Creek	
45	- Great Tonoloway Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported P. *cataracta* hosts (from NatureServe 2015): White Sucker (*Catostomus commersoni*), Common Carp (*Cyprinus carpio*), Threespine Stickleback (*Gasterosteus aculeatus*), Pumpkinseed (*Lepomis gibbosus*), Bluegill (*Lepomis macrochirus*), and Yellow Perch (*Perca flavescens*).

GIANT FLOATER *Pyganodon grandis* (Say, 1829). Other vernacular name(s): Big Floater, Large Floater, Stout Floater, Fat Floater. (S4, G5).

Image (credit, R. Warren): Illinois State Museum, ISM# 673857 (external and internal), **image (credit, N. Welte)**: "buttocks" perspective.

Defining characteristic(s):

1. Thin shell, no teeth;
2. Brownish periostracum;
3. Beak sculpture consists of several nodulous double-looped ridges;
4. Nacre can be discolored, often white but can be coppery.

May be confused with: *Pyganodon cataracta*. *P. cataract* has beak sculpture that is "low and evenly raised above the shell surface" (Strayer and Jirka 1997). Identification difficult if beak sculpture has been obliterated. Additional uncertainty is likely if there is range overlap with *P. cataracta* – the two species are thought to hybridize (see citations in Strayer and Jirka 1997).

Etymology – "giant buttocks without teeth"
(from Watters *et al.* 2009)**:** From Greek *pyge, pyganos*, rump, buttocks, nates + *an*, not, without + Greek *odontos*, tooth. Shells of this genus commonly have swollen umbos, resembling nates or buttocks, while

lacking hinge teeth in the same (dorsal) region of the shell. Literally, “buttocks without teeth.” From Latin *grandis*, grand, large, imposing. This species has individuals with dimensions that rank it among the largest unionoids known.

Table 53. Pennsylvania’s known *Pyganodon grandis* streams.

	Stream	Notes
	Ohio River Basin	
	- (Wheeling Creek (tributary to mainstem Ohio River, West Virginia))	No specimens reported.
1	• Enlow Fork	
	• (Dunkard Fork)	No specimens reported.
2	- North Fork Dunkard Fork	
3	Ohio River	
	- (Little Beaver Creek)	No specimens reported
4	• North Fork Little Beaver Creek	
5	- Raccoon Creek	
6	Beaver River	
	- (Connoquenessing Creek)	No specimens reported.
7	• Slippery Rock Creek	
8	o Wolf Creek	
9	• Brush Creek	
10	• Glade Run	
11	• Bonnie Brook	
12	- Mahoning River	
13	- Shenango River	
14	• Neshannock Creek	
15	o Yellow Creek	
16	o Little Yellow Creek	
17	• Pymatuning Creek	
18	• Little Shenango River	
19	- Little Chartiers Creek	
20	Allegheny River	
	- (Kiskiminetas River)	No specimens reported.
21	• Beaver Run (Westmoreland Co.)	
	• (Loyalhanna River)	No specimens reported
22	o Keystone Lake	
	• (Stoney River)	No specimens reported
23	- Quemahoning Creek	
24	o Clear Run	
25	- Crooked Creek	
26	• South Branch Plum Creek	
27	• North Branch Plum Creek	
28	- Cowanshannock Creek	
29	- Sandy Creek	
30	- French Creek	
31	• Sugar Creek	
32	• Conneaut Outlet	
33	o Conneaut Lake	
34	• Cussewago Creek	
35	• Conneauttee Creek	
36	• Little Conneauttee Creek	

Table 53. *P. grandis* streams (continued).

37	• Conneauttee Lake	
38	• Woodcock Creek	
39	• Muddy Creek	
40	• LeBoeuf Creek	
41	• South Branch French Creek	
42	• West Branch French Creek	
43	- Oil Creek	
44	- Brokenstraw Creek	
45	- Conewango Creek	
46	Monongahela River	
47	- Whiteley Creek	
48	- Tenmile Creek	
49	• South Fork Tenmile Creek	
	- (Youghiogheny River)	No specimens reported.
50	• Laurel Hill Creek	
51	- Dunkard Creek	
52	• Pennsylvania Fork Dunkard Creek	
53	• West Virginia Fork Dunkard Creek	
	Lake Erie Basin	
54	Lake Erie	
55	- Conneaut Creek	
	Genesee River Basin	
	(Genesee River)	No specimens reported.
56	- Cryder Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *P. grandis* hosts (from Watters *et al.* 2009): Skipjack Herring (*Alosa chrysochloris*), Rock Bass (*Ambloplites rupestris*), Yellow Bullhead (*Ameiurus natalis*), Freshwater Drum (*Aplodinotus grunniens*), Central Stoneroller (*Campostoma anomalum*), River Carpsucker (*Carpiodes carpio*), Goldfish (*Carrasius auratus*), White Sucker (*Catostomus commersoni*), Brook Stickleback (*Culaea inconstans*), Common Carp (*Cyprinus carpio*), Gizzard Shad (*Dorosoma cepedianum*), Rainbow Darter (*Etheostoma caeruleum*), Iowa Darter (*Etheostoma exile*), Johnny Darter (*Etheostoma nigrum*), Golden Topminnow (*Fundulus chrysotus*), Banded Killifish (*Fundulus diaphanus*), Brook Stickleback (*Labidesthes sicculus*), Longnose Gar (*Lepisosteus osseus*), Green Sunfish (*Lepomis cyanellus*), Pumpkinseed (*Lepomis gibbosus*), Orangespotted Sunfish (*Lepomis humilis*), Bluegill (*Lepomis macrochirus*), Longear Sunfish (*Lepomis megalotis*), Striped Shiner (*Luxilus chrysocephalus*), Common Shiner (*Luxilus cornutus*), Redfin Shiner (*Lythrurus umbratilis*), Pearl Dace (*Margariscus margarita*), Largemouth Bass (*Micropterus salmoides*), White Bass (*Morone chrysops*), Round Goby (*Neogobius melanostomus*), Golden Shiner (*Notemigonus crysoleucas*), Blackchin Shiner (*Notropis heterodon*), Blacknose Shiner (*Notropis heterolepis*),Yellow Perch (*Perca flavescens*), Bluntnose Minnow (*Pimephales notatus*), White Crappie (*Pomoxis annularis*), Black Crappie (*Pomoxis nigromaculatus*), Blacknose Dace (*Rhinichthys atratulus*), and Creek Chub (*Semotilus atromaculatus*).

MAPLELEAF *Quadrula quadrula* (Rafinesque, 1820). Other vernacular name(s): Tear Shell. (S3, G5).

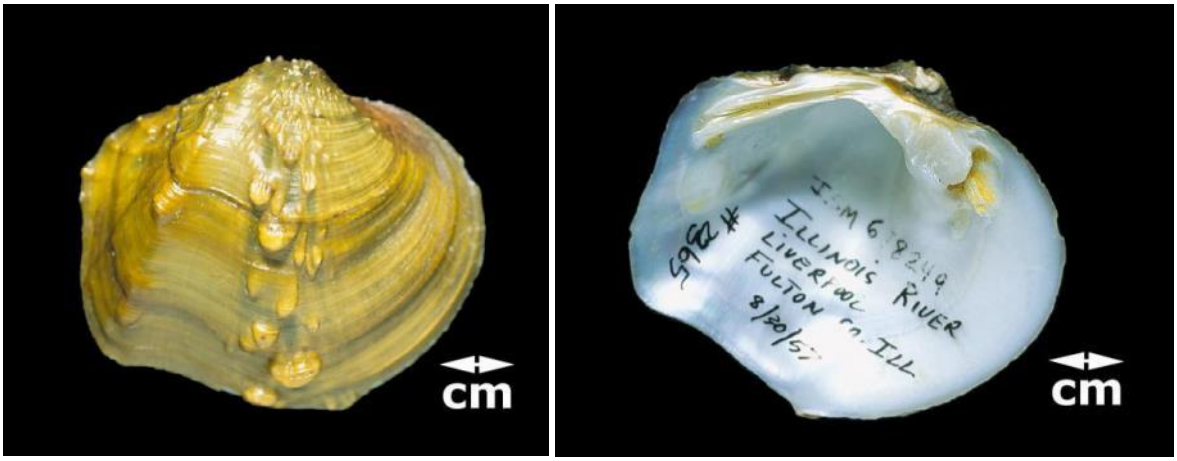


Image (credit, R. Warren): Illinois State Museum, ISM# 678249 (external and internal)

Defining characteristic(s):

1. Smooth, pustule-free, sulcus in between rows of pustules;
2. Quadrate shape.

May be confused with: *Q. nodulata*. There are no records of *Q. nodulata* from Pennsylvania. The nearest known records are from the Ohio River near Portland, Ohio (Watters *et al.* 2009). *Q. nodulata* lacks a sulcus, unlike *Q. quadrula*. *Q. nodulata* appears to have fewer and more sparse nodules than *Q. quadrula*.

Etymology - "a little square"
(from Watters *et al.* 2009)**:** Latin *quadrula*, a little square; from Latin *quadra*, a square, + Latin *–ula* (diminutive). Not all *Quadrula* species are quadrate. Many are rectangular, and many are round or nearly so. The roundish species do approach being equilateral and, in so doing, also approach, in the broadest sense, being quadrate. This species appears square in lateral outline as much as or more so than any of our other native species.

Ortmann (1919): "*Two specimens only have been found in Pennsylvania; one in the Ohio River [Cooks Ferry], just above the Ohio state line, the other in Lake Erie*."

Table 57. Pennsylvania's known *Quadrula quadrula* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Historical distribution – per Ortmann (1919): Cooks Ferry (across the river from Shippingport) Current distribution – all pools.
2	- Little Beaver Creek	Walsh, PNHP survey
3	- Raccoon Creek	Downstream of I-376 bridge in Hopewell Twp.
4	Allegheny River	
	Lake Erie Basin	
5	Lake Erie (Presque Isle Bay)	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *Q. quadrula* hosts (from Watters *et al.* 2009): Channel Catfish (*Ictalurus punctatus*) and Flathead Catfish (*Pylodictis olivaris*).

SALAMANDER MUSSEL *Simpsonaias ambigua* (Say, 1825). Other vernacular name(s): Salamander Shell, Simpson's Shell. **State Endangered.** (S1, G3).

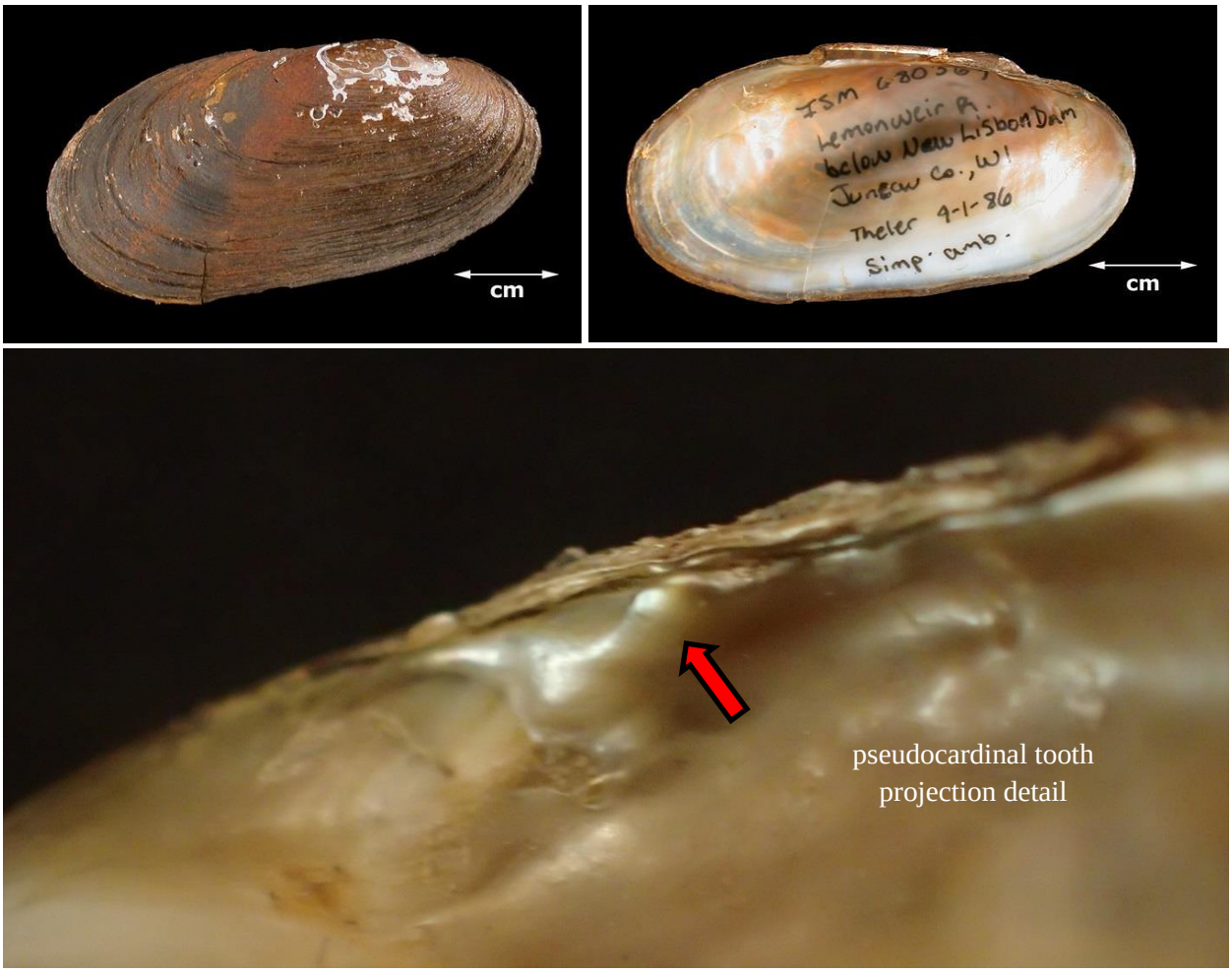


Image (credit, K. Little): Illinois State Museum, ISM# 680369 (external and internal); image (credit, N. Welte): Carnegie Museum of Natural History, CMNH# ??? (pseudocardinal tooth detail)

Defining characteristic(s):

1. Elongated, nearly elliptical mussel;
2. No lateral teeth, nub of a pseudocardinal teeth;
3. Typically found under flat, shelter rocks;
4. Only North American mussel that utilizes an amphibian host (Mudpuppy, *Necturus maculosus*).

May be confused with: Older, darker (or stained) *Villosa iris*. *S. ambigua* distinctly elliptical, lacks lateral teeth, and has a thicker shell, particularly below the pallial line.

Etymology - "Simpson's naiad"
(from Watters *et al.* 2009)**:** This name was a patronym in honor of Charles Torrey Simpson (1846-1932), one of America's most productive students of unionoid mollusks. Also from Greek *naias, naiados*, an aquatic nymph of freshwaters, especially of rivers, springs, brooks and fountains. The translation is

"Simpson's Naiad." Latin *ambiguous*, uncertain, doubtful; from Latin *ambigo*, wander about, be undecided; from Latin *ambi-*, around + Latin *ago*, go. Say (1825: 13) noted in the original description that this species occupied a doubtful position as "a link between the genera *Alasmodonta* [*sic*] and *Anodonta*. When young primary teeth are obvious, but when they shell arrives at the full growth the teeth are obsolete and in some instances, not at all visible." It was therefore "ambiguous" as to which of these two genera should receive this species.

Table 59. Pennsylvania's known *Simpsonaias ambigua* streams.

	Stream	Notes
	Ohio River Basin	
1	Allegheny River	Found in pools 5 – 8.
2	- French Creek	Freshdead shells only found at town of Venango in 1985, 1995.
3	Dunkard Creek	Presumed extirpated by 2009 toxic event.

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *S. ambigua* hosts (from Watters *et al.* 2009): Mudpuppy (*Necturus maculosus*).

CREEPER *Strophitus undulatus* (Say, 1817).Other vernacular name(s): Squawfoot, Sloughfoot, Common Creeper, Strange Floater. (S5, G5).

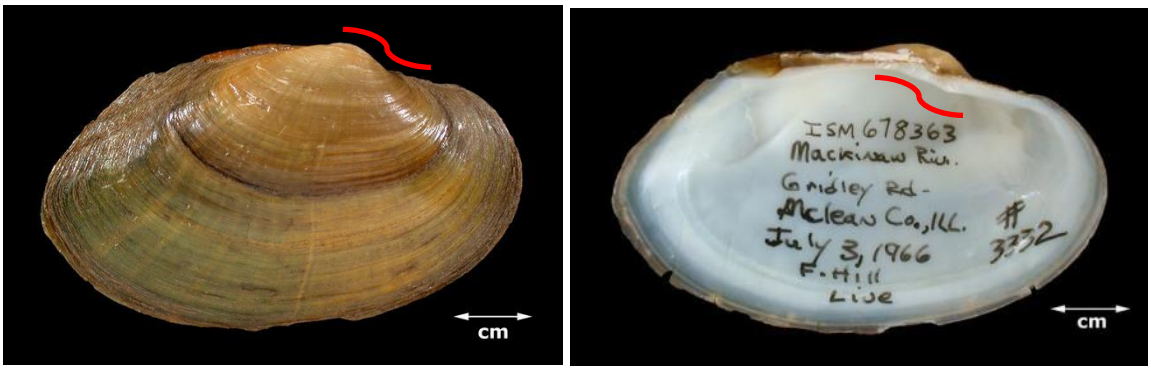


Image (credit, K. Little): Illinois State Museum, ISM# 678363 (external and internal)

Defining characteristic(s):

1. Concentric beak sculpture;
2. Orange foot, when alive;
3. Narrow, anterior/more central umbo.

May be confused with:

Etymology - "having an undulating hinge line"
(from Watters *et al.* 2009)**:** Greek *strophos*, twisted + Latin *–it is*, having the nature of, pertaining to. The root "twisted" may refer to the peculiar swelling of the hinge line near umbos in species of this genus. Translation is "having a twisted hinge line." Latin *unda*, wave + Latin *atus*, having the nature of. Translation is "having an undulating hinge line."

Table 60. Pennsylvania's known *Strophitus undulatus* streams.

	Stream	Notes
	Ohio River Basin	
1	- Cross Creek (tributary to mainstem Ohio River, West Virginia)	
2	- Buffalo Creek (tributary to mainstem Ohio River, West Virginia)	
3	• Dutch Fork	
	(Ohio River)	No specimens reported.
4	- Little Beaver Creek	
5	• North Fork Little Beaver Creek	
6	- Raccoon Creek	
7	Beaver River	
8	- Connoquenessing Creek	
9	• Slippery Rock Creek	
10	○ Wolf Creek	
11	• Brush Creek	
12	• Little Connoquenessing Creek	
13	• Thorn Creek	

Table 60. *S. undulatus* streams (continued).

14	• Bonnie Brook	
15	- Mahoning River	
16	- Shenango River	
17	• Neshannock Creek	
18	○ Otter Creek	
19	• Little Shenango River	
20	• Pymatuning Creek	
21	- Chartiers Creek	
22	• Little Chartiers Creek	
23	Allegheny River	
24	- Buffalo Creek	
	- (Kiskiminetas River)	No specimens reported.
25	• Beaver Run	
26	• Loyalhanna River	
27	○ Loyalhanna Creek	
	• (Conemaugh River)	No specimens reported.
	○ (Black Lick Creek)	No specimens reported.
28	○ Yellow Creek	
	• (Stony River)	No specimens reported.
29	○ Quemahoning Creek	
30	- Crooked Creek	
31	- Mahoning Creek	
32	• Little Mahoning Creek	
33	- Clarion River	
34	- Sandy Creek	
35	• Little Sandy Creek	
36	- French Creek	
37	• Sugar Creek	
38	• Conneaut Outlet	
39	○ Conneaut Lake	
40	• Cussewago Creek	
41	• Woodcock Creek	
42	• Conneauttee Creek	
43	• Muddy Creek	
44	• South Branch French Creek	
45	• West Branch French Creek	
46	- Oil Creek	
47	- Tionesta Creek	
48	- Brokenstraw Creek	
49	- Conewango Creek	
50	- Oswayo Creek	
51	- Potato Creek	
52	• Marvin Creek	
53	Monongahela River	
54	- Youghiogheny River	
55	• Laurel Hill Creek	
56	- Whiteley Creek	
57	- Tenmile Creek	
58	• South Fork Tenmile Creek	
59	- Dunkard Creek	
60	• Toms Run	

Table 60. *S, undulatus* streams (continued).

61	• Pennsylvania Fork Dunkard Creek	
62	• West Virginia Fork Dunkard Creek	
63	- Cheat River	
	Lake Erie Basin	
64	Lake Erie	
65	- Conneaut Creek	
	Genesee River Basin	
66	Genesee River	
67	- Cryder Creek	
	Delaware River Basin	
68	Delaware River	
69	- Chester Creek	
70	Schuylkill River	
71	- Schuylkill Canal	
72	- Wissahickon Creek	
73	- Tulpehocken Creek	
74	- Maiden Creek	
	(mainstem)	
75	- Neshaminy Creek	
76	• Little Neshaminy Creek	
	(Lehigh River)	No specimens reported.
	- (Valley Creek)	No specimens reported.
77	• Princess Run	
78	- Lizard Creek	
79	- Mahoning Creek (Carbon Co.)	
	(mainstem)	
80	- Cherry Creek	
81	- Marshalls Creek	
	Susquehanna River Basin	
82	Big Elk Creek (Chester Co.)	Tributary to the Elk River (MD) and the Chesapeake Bay
83	Susquehanna River	
	- (West Conewago Creek)	No specimens reported.
84	• Bermudian Creek	
	- (Swatara Creek)	No specimens reported.
85	• Little Swatara Creek	
86	- Conewago Creek	
87	• Little Conewago Creek	
88	• Middle Creek	
89	- Conodoguinet Creek	
90	Juniata River	
91	- Cocolamus Creek	
	- (Tuscarora Creek)	No specimens reported.
92	• East Licking Creek	
93	- Lost Creek	
94	- Aughwich Creek	
95	• Little Aughwick Creek	
96	- Raystown Branch Juniata River	
97	• Dunning Creek	
98	• Yellow Creek	
	- (Frankstown Branch Juniata River)	No specimens reported.
99	• Canoe Creek	

Table 60. *S. undulatus* streams (continued).

	(mainstem)	
100	- Mahantango Creek	
101	• West Branch Mahantango Creek	
102	- Penns Creek	
	(West Brach Susquehanna River)	No specimens reported.
103	- Chillisquaque Creek	
104	- Pine Creek	
105	• Little Pine Creek	
106	• Marsh Creek	
107	- Bald Eagle Creek	
108	• Spring Creek	
109	- Cush Cushion Creek	
	- (Clearfield Creek)	No specimens reported.
110	• Beaver Dam Creek (Cambria)	
111	• Swartz Run (Cambria)	
112	- Chest Creek	
113	North Branch Susquehanna River	
114	- Chemung River	
	• (Tioga River)	
	○ (Cowanesque River)	
115	○ Crooked Creek	Ortmann (1919) reported specimens from a millrace to Crooked Creek.
	Potomac River Basin	
116	- Rock Creek	
	- (Antietam Creek)	No specimens reported from PA
117	• East Branch Little Antietam Creek	
118	• West Branch Antietam Creek	
119	- Conococheague Creek	
120	• West Branch Conochocheague Creek	
121	• Back Creek	
122	- Licking Creek	
123	- Sideling Hill Creek	
124	- Town Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *S. undulatus* hosts (from Watters *et al.* 2009): Rock Bass (*Ambloplites rupestris*), Black Bullhead (*Ameiurus melas*), Yellow Bullhead (*Ameiurus natalis*), Central Stoneroller (*Campostoma anomalum*), Brook Stickleback (*Culaea inconstans*), Spotfin Shiner (*Cyprinella spiloptera*), Rainbow Darter (*Etheostoma caeruleum*), Iowa Darter (*Etheostoma exile*), Fantail Darter (*Etheostoma flabellare*), Johnny Darter (*Etheostoma nigrum*), Slenderhead Darter (*Etheostoma phoxocephala*), Banded Darter (*Etheostoma zonale*), Plains Killifish (*Fundulus zebrinus*), Channel Catfish (*Ictalurus punctatus*), Green Sunfish (*Lepomis cyanellus*), Pumpkinseed (*Lepomis gibbosus*), Bluegill (*Lepomis macrochirus*), Longear Sunfish (*Lepomis megalotis*), Burbot (*Lota lota*), Common Shiner (*Luxilus cornutus*), Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), River Chub (*Nocomis micropogon*), Sand Shiner (*Notropis ludibundus*), Yellow Perch (*Perca flavescens*), Logperch (*Percina caprodes*), Blackside Darter (*Percina maculata*), Northern Redbelly Dace (*Phoxinus eos*), Bluntnose Minnow (*Pimephales notatus*), Fathead Minnow (*Pimephales promelas*), White Crappie (*Pomoxis annularis*), Black Crappie (*Pomoxis nigromaculatus*), Blacknose Dace (*Rhinichthys atratulus*),

Longnose Dace (*Rhinichthys cataractae*), Creek Chub (*Semotilus atromaculatus*), Walleye (*Sander vitreus*), and Central Mudminnow (*Umbra limi*).

RABBITSFOOT *Theliderma cylindrica* (Say, 1817). Other vernacular name(s): Cob Shell. **State Endangered, Federally Threatened.** (S1S2, G3G4).

Image (credit, K. Little): Illinois State Museum, ISM# 677551 (external and internal)

Defining characteristic(s):

1. Distinctly shaped, elongated shell

May be confused with: Nothing in Pennsylvania. A subspecies, *Q. c. strigillata*, occurs in the Cumberland River drainage.

Etymology (from Watters *et al.* 2009)**:** Latin *quadrula*, a little square; from Latin *quadra*, a square, + Latin *–ula* (diminutive). Not all *Quadrula* species are quadrate. Many are rectangular, and many are round or nearly so. The roundish species do approach being equilateral and, in so doing, also approach, in the broadest sense, being quadrate. Latin *cylindrus*, cylinder, roller, from Greek *kylindros*. It would appear that the type specimen, given to Say by Professor Barton, and now lost, was the cylindrical downstream form rather than the relatively compressed form found upstream.

Table 54. Pennsylvania's known *Theliderma cylindrica* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	Beaver River	
3	- Mahoning River	
4	- Shenango River	
5	• Pymatuning Creek	
6	Allegheny River	
7	- French Creek	
8	• Conneauttee Creek	
9	• Muddy Creek	See Mohler *et al.*and USFWS critical habitat designation
10	• LeBoeuf Creek	
11	Monongahela River	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *T. cylindrica* hosts (from Watters *et al.* 2009): Rainbow Darter (*Etheostoma caeruleum*) and Striped Shiner (*Luxilus chrysocephalus*).

MONKEYFACE *Theliderma metanevra* (Rafinesque, 1820). Other vernacular name(s): Knobbed Rock Shell. (SH, G4).

Image (credit, K. Little): Illinois State Museum, ISM# 678328 (external and internal)

Defining characteristic(s):

1. Single distinct row of raised nodules on posterior slope;
2. Creased posterior wing.

May be confused with: *Q. quadrula*? *T. metanevra*, however, has no sulcus and a distinct row of raised nodules running down the posterior slope.

Etymology - "ribbed in the middle"
(from Watters *et al.* 2009)**:** Latin *quadrula*, a little square; from Latin *quadra*, a square, + Latin *–ula* (diminutive). Not all *Quadrula* species are quadrate. Many are rectangular, and many are round or nearly so. The roundish species do approach being equilateral and, in so doing, also approach, in the broadest sense, being quadrate. Greek *meta-*, in the midst of, between, after, behind + Greek *neura*, string or cord of sinew… The name *metanevra* literally means "ribbed behind."

Ortmann (1919) notes: "*In Pennsylvaniathis species is restricted to the three large rivers, the Ohio, Allegheny, and Monongahela. In the Allegheny it goes up a little beyond the middle of Armstrong County. From the Monongahela it is known only from one locality, but it must have at one time ascended into West Virginia, for it occurs in the West Fork River.*"

Table 55. Pennsylvania's known historical *Theliderma metanevra* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919): Shippingport, Cooks Ferry (across the river from Shippingport), Industry, Beaver, Coraopolis, Neville Island.
2	Allegheny River	Ortmann (1919): Aladdin, Godfrey, Johnetta, Kelly (present-day pool 5), Templeton (pool 8)
3	Monongahela River	Ortmann (1919): Charleroi

Data source(s): Ortmann 1919.

Reported *T. metanevra* hosts (from Watters *et al.* 2009): Spotfin Shiner (*Cyprinella spiloptera*), Green Sunfish (*Lepomis cyanellus*), Bluegill (*Lepomis macrochirus*), Bluntnose Minnow (*Pimephales notatus*), Blacknose Dace (*Rhinichthys atratulus*), Sauger (*Sander canadensis*), and Creek Chub (*Semotilus atromaculatus*).

LILLIPUT *Toxolasma parvum* (Barnes, 1823). (S1S2, G5).

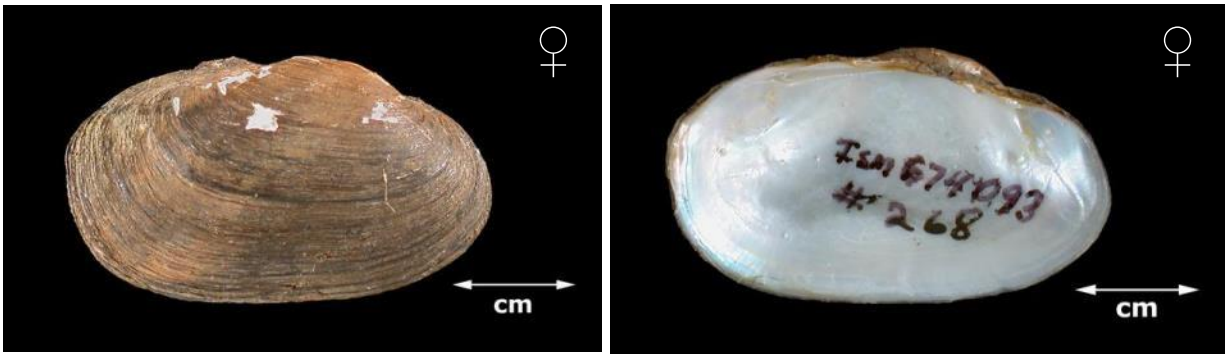


Image (credit, K. Little): Illinois State Museum, ISM# 674093 (external and internal)

Defining characteristic(s):

1. Pennsylvania's smallest mussel (~ 30 mm);
2. Oval shape;
3. Inflated shell;
4. Rayless.

May be confused with:

Etymology - "little shell with arched lateral teeth"
(from Watters *et al.* 2009)**:** Greek *toxon*, bow, arch + Greek *elasma*, metal beaten out, metal plate. As in several other of his generic names, Rafinesque used the word *elasma* to refer to lateral teeth, which are thin and plate-like. Latin *parvum*, little, small.

Table 61. Pennsylvania's known *Toxolasma parvum* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	
2	Beaver River	
3	Allegheny River	
	- (French Creek)	No specimens reported.
4	• Conneaut Outlet	
5	Monongahela River	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *T. parvum* hosts (from NatureServe 2015): Johnny Darter (*Etheostoma nigrum*), Green Sunfish (*Lepomis cyanellus*), Warmouth (*Lepomis gulosus*), Orange-spotted Sunfish (*Lepomis humilus*), Bluegill (*Lepomis macrochirus*), and White Crappie (*Pomoxis annularis*).

PISTOLGRIP *Tritogonia verrucosa* (Agassiz, 1852). Other vernacular name(s): Deer Horn, Buck Horn, Turkey Wing. **State Endangered.** (S1, G4G5).

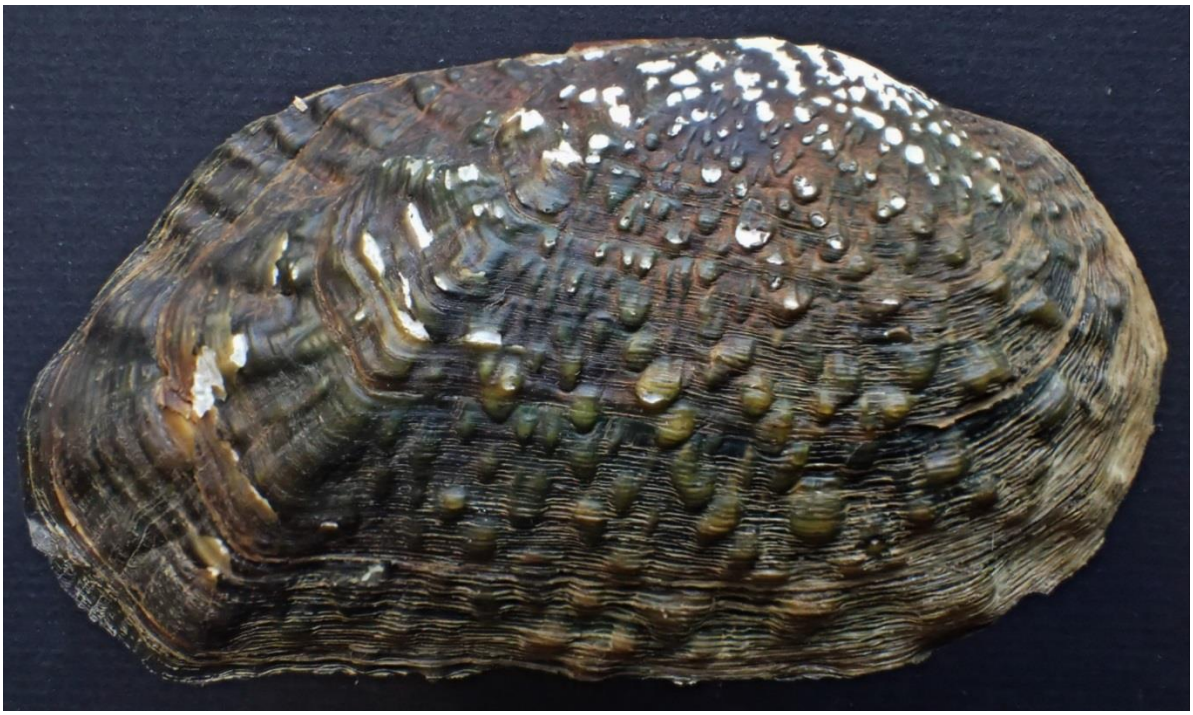


Image ((top) credit, N.T. Welte): CMNH 61.4545, Allegheny River, Kelly (Armstrong Co.), Pennsylvania; **image ((bottom) credit, R. Warren):** Illinois State Museum, ISM# 678942 (external and internal).

Defining characteristic(s):

1. Pistolgrip shape, heavily tubercled;
2. Elongated shell.

May be confused with: A very distinct species, *T, verrucosa* should not be confused with any other species in Pennsylvania.

Etymology - "full of warts"
(from Watters *et al.* 2009)**:** Greek *tritos*, third + Greek *gonia*, corner, angle. Agassiz did not give his

reason(s) for selecting the name *Tritogonia*. The roots seem clear, but their reference to features of this genus remain obscure. It may perhaps refer to the posterior third fo the shell which may be deflected or "hooked." Latin *verrucosus*, full of warts; from Latin *verruca*, a wart. The shell of this species is typically covered with pustules.

Table 58. Pennsylvania's known *Tritogonia verrucosa* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Presently in Dashields pool downstream of Neville Island (Aquatic Systems, 2014, unpublished data).
2	Beaver River	
3	- Mahoning River	
4	- Shenango River	Extant.
5	• Pymatuning Creek	
6	Allegheny River	
7	Monongahela River	
8	- Dunkard Creek	Extirpated as of 2009.

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *T. verrucosa* hosts (from Watters *et al.* 2009): Yellow Bullhead (*Ameiurus natalis*), Brown Bullhead (*Ameiurus nebulosus*), Channel Catfish (*Ictalurus punctatus*), and Flathead Catfish (*Pylodictis olivaris*).

FAWNSFOOT *Truncilla donaciformis* (Lea, 1828). (S1, G5).

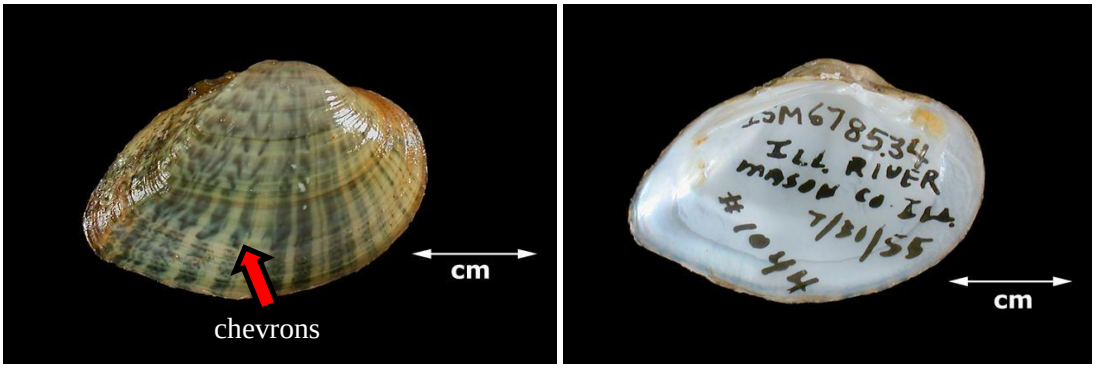


Image (credit, K. Little): Illinois State Museum, ISM# 678534 (external and internal)

Defining characteristic(s):

1. Small, elongated oval (longer than it is tall);
2. Distinct chevron markings.

May be confused with: *Truncilla truncata*. *T. donaciformis* is distinctly longer than it is tall.

Etymology - "resembling *Donax*"
(from Watters *et al.* 2009)**:** Latin *truncus*, mutilated, deprived of some of its parts, cut off + Latin *–illa* (diminutive). Rafinesque (1820: 300) explained the coining of the name *Truncilla*: "The name is derived from the remarkable oblique truncation… (Poulson translation, 1832). Members of the genus Truncilla are indeed characterized by a sharp posterior ridge and flat (or nearly so) posterior slope, giving the shell a truncated appearance. *Donax*, a genus of small marine bivalves, the coquinas (from Greek *donax*, reed or cane, shellfish) + Latin *formis*, in the form or shape of, resembling. Lea so named this species because its shape reminded him of these marine bivalves…

Table 62. Pennsylvania's known *Truncilla donaciformis* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919): Coraopolis
2	Allegheny River	Pool 2 (Hulton bridge)

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *T. donaciformis* hosts (from Watters *et al.* 2009): Freshwater Drum (*Aplodinotus grunniens*) and Sauger (*Sander canadensis*).

DEERTOE *Truncilla truncata* (Rafinesque, 1820). Other vernacular name(s): Deerfoot. (S1, G5).

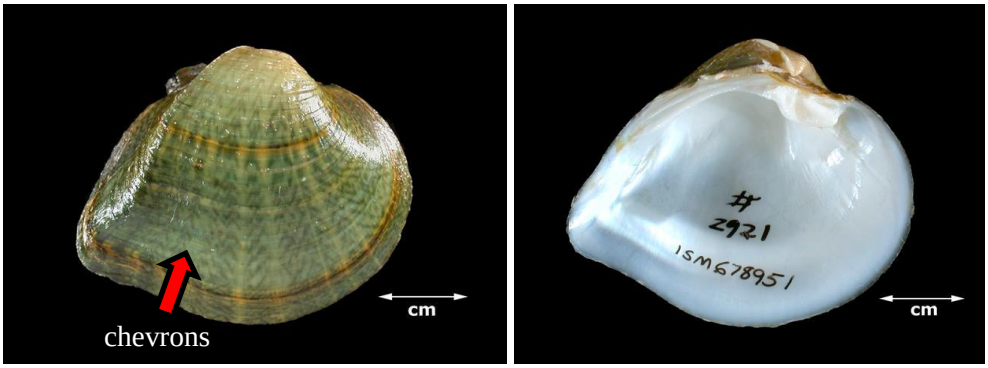


Image (credit, K. Little): Illinois State Museum, ISM# 678951 (external and internal)

Defining characteristic(s):

1. Triangular;
2. Steep posterior ridge;
3. Distinct chevron markings.

May be confused with: *Truncilla donaciformis*. *T. truncata* is distinctly triangular and not longer than it is tall.

Etymology (from Watters *et al.* 2009)**:** Latin *truncus*, mutilated, deprived of some of its parts, cut off + Latin *–illa* (diminutive). Rafinesque (1820: 300) explained the coining of the name *Truncilla*: "The name is derived from the remarkable oblique truncation… (Poulson translation, 1832). Members of the genus Truncilla are indeed characterized by a sharp posterior ridge and flat (or nearly so) posterior slope, giving the shell a truncated appearance. Latin truncates, maimed, cut off, shortened by having been cut off. Rafinesque (1820: 301) noted "posterior surface truncated" (Poulson translation, 1832), which is the typical appearance of this species.

Table 63. Pennsylvania's known *Truncilla truncata* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	Ortmann (1919): Shippingport, Industry, Coraopolis, Neville Island
	Lake Erie Basin	
2	Lake Erie	Ortmann (1919): Presque Isle Bay

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *T. truncata* hosts (from Watters *et al.* 2009): Freshwater Drum (*Aplodinotus grunniens*) and Sauger (*Sander canadensis*).

PAPER PONDSHELL *Utterbackia imbecillis* (Say, 1829). Other vernacular name(s): Papershell, Paper Floater. (S4, G5).

Image (credit, N. Welte): Carnegie Museum of Natural History, CMNH# 61.4177 (external and internal)

Defining characteristic(s):

1. Very, very thin shell, often found in lakes/reservoirs;
2. Shell periostracum often green, occasionally brilliant green, bluish;
3. Beak sculpture consists of irregular ridges, slightly sinuous or double-looped ventrally (Williams *et al.* 2008);
4. Umbo does not usually extend above the hinge line.

May be confused with: A distinct species from the other "toothless" species because the umbo is typically well below the hinge line.

Etymology - "patronym for Utterback, weak, fragile shell"
(from Watters *et al.* 2009)**:** Utterback is a patronym in honor of Professor William Irvin Utterback, author of *The Naiades of Missouri* (1915-1916) and many other studies on freshwater mussels. From Latin *imbecillis*, feeble, weak. The shell of this species is especially thin and fragile.

Table 64. Pennsylvania's known *Utterbackia imbecillis* streams.

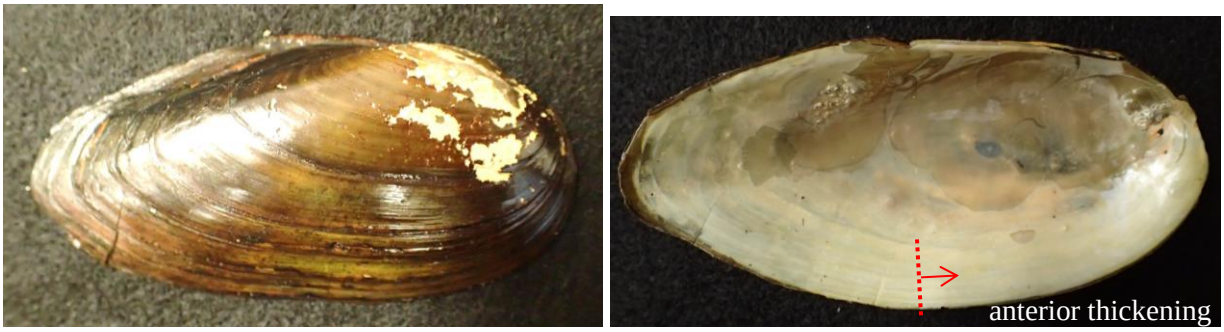
	Stream	Notes
	Ohio River Basin	
	- (Buffalo Creek (tributary to mainstem Ohio River, West Virginia))	No specimens reported.
1	• Dutch Fork	
	(Beaver River)	No specimens reported.
2	- Shenango River	
3	Allegheny River	
	- (Kiskiminetas River)	No specimens reported.
	• (Loyalhanna River)	No specimens reported.
4	○ Keystone Lake	
	• (Conemaugh River)	No specimens reported.
	○ (Blacklick Creek)	No specimens reported.
	○ (Two Lick)	No specimens reported.
5	▪ Cherry Run Lake	
	- (Crooked Creek)	No specimens reported.

Table 64. *U. imbecillis* streams (continued).		
6	• North Branch Plum Creek	
7	- French Creek	
8	• Conneaut Outlet	
9	○ Conneaut Lake	
10	• LeBoeuf Creek	
11	- Conewango Creek	
	(Monongahela River)	No specimens reported.
12	- Dunkard Creek	
	Lake Erie Basin	
13	Lake Erie	
	Delaware River Basin	
	(Neshaminy Creek)	No specimens reported.
14	- Little Neshaminy Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *U. imbecillis* hosts (from Watters *et al.* 2009): Rock Bass (*Ambloplites rupestris*), Tiger Salamander (*Ambystoma tigrinum*), Goldfish (*Carrasius auratus*), White Sucker (*Catostomus commersoni*), Brook Stickleback (*Culaea inconstans*), Common Carp (*Cyprinus carpio*), Gizzard Shad (*Dorosoma cepedianum*), Greenthroat Darter (*Etheostoma lepidum*), Banded Killifish (*Fundulus diaphanus*), Mosquitofish (*Gambusia affinis*), Channel Catfish (*Ictalurus punctatus*), Green Sunfish (*Lepomis cyanellus*), Pumpkinseed (*Lepomis gibbosus*), Warmouth (*Lepomis gulosus*), Bluegill (*Lepomis macrochirus*), Dollar Sunfish (*Lepomis marginatus*), Longear Sunfish (*Lepomis megalotis*), Largemouth Bass (*Micropterus salmoides*), Golden Shiner (*Notemigonus chrysoleucas*), Yellow Perch (*Perca flavescens*), Black Crappie (*Pomoxis nigromaculatus*), and Creek Chub (*Semotilus atromaculatus*).

ALEWIFE FLOATER *Utterbackiana implicata* (Say, 1829). (S3, G5).



I**mage (credit, N. Welte)**: specimen courtesy of Rick Spear and the Pennsylvania Department of Environmental Protection reference collection (external and internal).

Defining characteristic(s):

1. Shell thin posteriorly, but becoming thicker anteriorly, particularly below the pallial line;
2. Beak sculpture is double-looped in concentric bands;
3. Pink, purplish, or coppery nacre.

May be confused with: *Anodontoides ferussacianus, Pyganodon cataracta, P. grandis,* and *Strophitus undulatus*. Young specimens of these four species are generally separated by beak sculpture. *P. cataracta* is supposed to only be in the Atlantic Slope.

Etymology - "folded in"
(from Watters *et al.* 2009)**:** Greek *a-, an*, negative prefix expressing want or absence + Greek *odous* (*odon*), *odontos*, tooth. Hinge teeth are usually absent in the *Anodonta* shell.

Table 7. Pennsylvania's known *Utterbackiana implicata* streams.

	Stream	Notes
	Delaware River Basin	
1	Delaware River	
2	- Schuylkill River	
	(mainstem)	
3	- Marshalls Creek	
	Susquehanna River Basin	
4	Susquehanna River	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported and potential hosts for *U. implicata* (per Nedeau *et al.* 2000; Strayer and Jirka 1997; NatureServe 2015): Alewife (*Alosa pseudoharengus*), American Shad (*Alosa sapidissima*), Blueback Herring (*Alosa aestivalis*), White Sucker (*Catostomus commersoni*), Threespine Stickleback (*Gasterosteus aculeatus*), Pumpkinseed (*Lepomis gibbosus*), and White Perch (*Morone americana*).

FLAT FLOATER *Utterbackiana suborbiculata* (Say, 1831). Other vernacular name(s): Round Floater. (S1, G5).

Image (credit, K. Little): Illinois State Museum, ISM# 673903 (external and internal)

Defining characteristic(s):

1. Very round, thin shell, that can grow to the size and shape of a dinner plate;
2. Umbo typically doesn't extend above the hinge line;
3. Shell prone to cracking when dry.

May be confused with: Nothing in Pennsylvania.

Etymology - "nearly circular disc"
(from Watters *et al.* 2009)**:** Greek *a-*, *an*, negative prefix expressing want or absence + Greek *odous* (*odon*), *odontos*, tooth. Hinge teeth are usually absent in the *Anodonta* shell. Latin *sub*, under, below, somewhat + Latin *orbis*, circle, disc. Shells commonly approach being circular in outline.

Table 8. Pennsylvania's known *Utterbackiana suborbiculata* streams.

	Stream	Notes
	Ohio River Basin	
1	Ohio River	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *U. suborbiculata* hosts (from Watters *et al.* 2009): Channel Catfish (*Ictalurus punctatus*), Green Sunfish (*Lepomis cyanellus*), Warmouth (*Lepomis gulosus*), Longear Sunfish (*Lepomis megalotis*), Largemouth Bass (*Micropterus salmoides*), Golden Shiner (*Notemigonus crysoleucas*), and White Crappie (*Pomoxis annularis*).

RAYED BEAN *Villosa fabalis* (Lea, 1831). **State Threatened, Federally Threatened.** (S1S2, G2).

Image (credit, N. Welte): PFBC reference collection (external and internal, comparison of male vs. female shells)

Defining characteristic(s):

1. Very heavy shell, even for small size;
2. Large pseudocardinal and lateral teeth;
3. Dimorphic, females typically more inflated laterally than males;
4. Rays (that fade with age).

May be confused with: This species is pretty distinct despite a small size that might suggest it could be easily confused with smaller individuals of other species. The thick, heavy shell, typically with rays, is unique for the shell size.

Etymology - "shaggy, bean-like shell"
(from Watters *et al.* 2009)**:** Latin *Villosa*, hairy, shaggy, rough. The name *Villosa* was first used as a subgenus by Frierson and originally used in reference to a southern species (*Unio villosus*, Wright 1898). Frierson mentioned its "deeply striate" and "rough" periostracum. Most species of *Villosa*, including Ohio species, typically have smooth exteriors. Latin *fabalis*, of or pertaining to beans; from Latin *faba*, a bean. Although Lea didn't mention his reason for using the name fabalis, this species is small, solid, and roughly bean-shaped and bean-size.

Table 65. Pennsylvania's known *Villosa fabalis* streams.

	Stream	Notes
	Ohio River Basin	
1	Beaver River	Ortmann (1919):
2	- Mahoning River	Ortmann (1919):
3	- Shenango River	
4	• Pymatuning Creek	
5	Allegheny River	
6	- Crooked Creek	
7	- Oil Creek	K.R. Anderson (PFBC), freshdead downstream of Oil Creek State Park (2016)
8	- French Creek	
9	• Cussewago Creek	
10	• Woodcock Creek	
11	• Muddy Creek	
12	• LeBoeuf Creek	
13	- Conewango Creek	
14	- Oswayo Creek	K.R. Anderson (PFBC, 2017), recently dead shell at proposed pipeline crossing. Live individuals detected by EnviroScience at same location in 2017.

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *V. fabalis* hosts (from NatureServe 2015; Gibson *et al.* 2015): Mottled Sculpin (*Cottus bairdi*), Greenside Darter (*Etheostoma blennioides*), Rainbow Darter (*Etheostoma caeruleum*), Tippecanoe Darter (*Etheostoma tippecanoe*), Largemouth Bass (*Micropterus salmoides*), and Logperch (*Percina caprodes*).

RAINBOW *Villosa iris* (Lea, 1829). Other vernacular name(s): Rainbow Shell. (S3, G5).

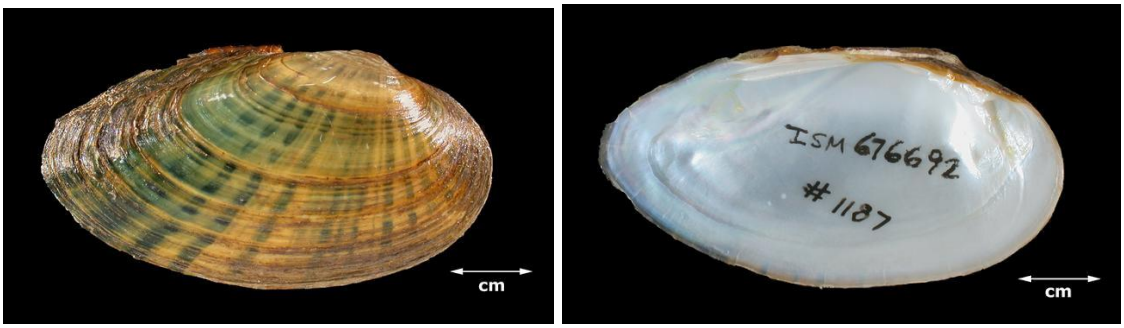


Image (credit, K. Little): Illinois State Museum, ISM# 676692 (external and internal)

Defining characteristic(s):

1. Thin shell;
2. Lateral teeth thin and delicate;
3. Rays;
4. Posteriorly iridescent nacre.

May be confused with: Other small mussels.

Etymology - "shaggy goddess of the rainbow"
(from Watters *et al.* 2009)**:** Latin *villosa*, hairy, shaggy, rough. The name *Villosa* was first used as a subgenus by Frierson and originally used in reference to a southern species (*Unio villosus*, Wright 1898). Frierson mentioned its "deeply striate" and "rough" periostracum. Most species of *Villosa*, including Ohio species, typically have smooth exteriors. Latin *iris*, goddess of the rainbow, a rainbow; from Greek *iris*, rainbow. Lea (1829: 439) noted that the nacre was "iridescent posteriorly," a characteristic especially prominent in this species.

Table 66. Pennsylvania's known *Villosa iris* streams.

	Stream	Notes
	Ohio River Basin	
	(Ohio River)	No specimens reported.
1	- Little Beaver Creek	
2	• North Fork Little Beaver Creek	
3	Beaver River	
	- (Connoquenessing Creek)	No specimens reported.
4	• Slippery Rock Creek	
5	- Mahoning River	
6	- Shenango River	
7	• Neshannock Creek	
8	- Otter Creek	
9	• Pymatuning Creek	
10	Allegheny River	
11	- Buffalo Creek	
12	- Crooked Creek	
13	- Mahoning Creek	

Table 66. *V. iris* streams (continued).

14	• Little Mahoning Creek	
15	- Sandy Creek	
16	- Oil Creek	Collected by NTW, KRA downstream of Oil Creek State Park (2016)
17	- French Creek	
18	• LeBoeuf Creek	
	(Monongahela River)	No specimens reported.
19	- Dunkard Creek	
20	- Cheat River	
	Lake Erie Basin	
21	Lake Erie (Presque Isle Bay)	
22	- Conneaut Creek	
	Susquehanna River Basin	
23	Susquehanna River	
24	- Conodoguinet Creek	
25	Juniata River	
26	- Tuscarora Creek	
27	- Aughwich Creek	
	(mainstem)	
28	- Penns Creek	

Data source(s): Western Pennsylvania Conservancy Mussel Database (Walsh); Ortmann 1919.

Reported *V. iris* hosts (from NatureServe 2015): Mottled Sculpin (*Cottus bairdi*), Streamline Chub (*Erimystax dissimilis*), Greenside Darter (*Etheostoma blennioides*), Rainbow Darter (*Etheostoma caeruleum*), Bluebreast Darter (*Etheostoma camurum*), Green Sunfish (*Lepomis cyanellus*), Striped Shiner (*Luxilus chrysocephalus*), Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), and Yellow Perch (*Perca flavescens*).

References

Barnhart, M.C., Haag, W.R., and W.N. Roston. 2008. Adaptations to host infection and larval parasitism in Unionoida. Journal of the North American Benthological Society 27(2): 370-394.

Bauer, G. 1979. Untersuchungen zur fortpflanzungsbiologie der flubperlmuschel im Fichtelgebirge. [Studies on the reproductive biology of the freshwater pearl mussel *Margaritifera margaritifera* in the Fichtelbirge]. Archiv fuer Hydrobiologie 85:152-165

Bauer, G. 1987. The parasitic stage of the freshwater pearl mussel (*Margaritifera margaritifera* L.) III. Host relationships. Archiv fuer Hydrobiologie Supplement 76(4):413-423.

Bauer, G., and C. Vogel. 1987. The parasitic stage of the freshwater pearl mussel (*Margaritifera margaritifera* L.) I. Host response to glochidiosis. Archiv fuer Hydrobiologie Suppl. 76(4):393-402.

Bruno, D.W., A.H. McVicar, and I.F. Waddell. 1988. Natural infection of farmed Atlantic salmon, *Salmo salar* L., parr by glochidia of the freshwater pearl mussel, *Margaritifera margaritifera* L. Bulletin of the European Association of Fish Pathologists 8(2):23-26.

Bogan, A.E. 1993. Freshwater bivalves (Mollusca: Unionidae) of the Monongahela River basin and direct tributaries to the Ohio River in Pennsylvania. Report submitted to the U.S. Fish and Wildlife Service, State College, Pennsylvania. 49 pages.

Buddensiek, V. 1995. The culture of juvenile freshwater pearl mussels *Margaritifera margaritifera* L. in cages: a contribution to conservation programmes and the knowledge of habitat requirements. Biological Conservation 74(?): 33-40.

Clarke, A.H., and C.O. Berg. 1959. The freshwater mussels of central New York. Memoir Cornell University Agricultural Experiment Station, N.Y. State College of Agriculture, Ithaca, N.Y. 367:1-79.

Clarke, A.H. 1985. The tribe Alasmidontini (Unionidae: Anodontinae), Part II: *Lasmigona* and *Simpsonaias*. Smithsonian Contributions to Zoology No. 399.
Ehlo, C.A. and J.B. Layzer. 2014. Population demographics and life history of the Round Hickorynut (*Obovaria subrotunda*) in the Duck River, Tennessee. American Midland Naturalist 171: 1-15.

Cunjak, R.A., and S.E. McGladdery. 1991. The parasite-host relationship of glochidia (Mollusca: Margaritiferidae) on the gills of young-of-the-year Atlantic salmon (*Salmo salar*). Canadian Journal of Zoology 69(2):353-358.

Davis, H.S. 1934. Care and diseases of trout. U.S. Bureau of Fisheries Investigational Report (22):1-69.

Galbraith, H.S., Cole, J.C., Blakeslee, B., and B. St. John White. 2016. Population demographics for the federally endangered Dwarf Wedgemussel. Journal of Fish and Wildlife Management 7(2): 377 – 387.

Gibson, T., Halmbacher, J. and G.T. Watters. 2015. New or confirmed hosts for freshwater mussels. Ellipsaria 17(4): 16-17.

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

Hruska, J. 1992. The freshwater pearl mussel in South Bohemia: evaluation of the effect of temperature on reproduction, growth and age structure of the population. Archiv für Hydrobiologie 126(2):181-191.

Karna, D.W. and R.E. Milleman. 1978. Glochidiosis of salmonid fishes. III. Comparative susceptibility to natural infection with *Margaritifera margaritifera* (L.) (Pelecypoda: Margaritanidae) and associated histopathology. The Journal of Parasitology 64(3): 528-537.

Lellis, W.A., White, B.S., Cole, J.C., Johnson, C.S., Devers, J.L., Gray, E.V.S., and H.S. Galbraith. 2013. Journal of Fish and Wildlife Management 4(1): 75-85.

Marshall, W.B. 1890. Beaks of Unionidae inhabiting the vicinity of Albany, New York. Bulletin of the New York State Museum 2: 169-189 + plate.

Masteller, E.C., Maleski, K.R., and D.W. Schloesser. 1993. Unionid bivalves (Mollusca: Unionidae) of Presque Isle Bay, Erie, Pennsylvania. Journal of the Pennsylvania Academy of Science 67(3): 120-126.

McNichols, K.M., Mackie, G.L., and J.D. Ackerman. 2007. Host fish distribution of endangered mussels in southern Ontario, Canada. (abstract). Freshwater Mollusk Conservation Society Symposium, 2007. Little Rock, Arkansas.

Meyers, T.R. and R.E. Milleman. 1977. Glochidiosis of salmonid fishes. I. Comparative susceptibility to experimental infection with *Margaritifera margaritifera* (L.) (Pelecypoda: Margaritanidae). The Journal of Parasitology 63(4): 728-733.

Nezlin, L.P., Cunjak, R.A., Zotin, A.A. and V.V. Ziuganov. 1994. Glochidium morphology of the freshwater pearl mussel (*Margaritifera margaritifera*) and glochidiosis of Atlantic salmon (*Salmo salar*): a study by scanning electron microscopy. Canadian Journal of Zoology 72: 15-21.

Nedeau, E.J., McCollough, M.A., and B.I. Swartz. 2000. The freshwater mussels of Maine. Maine Department of Inland Fisheries and Wildlife, Augusta, Maine.

O'Dee, S.H. and G.T. Watters. 2000. New or confirmed host fish identification for ten freshwater mussels. Proceedings of the Conservation, Captive Care and Propagation of Freshwater Mussels Symposium 1998, pages 78-82, Ohio Biological Survey, Columbus, Ohio.

Ortmann, A.E. 1911. A monograph of the najades of Pennsylvania. Memoirs of the Carnegie Museum. 4(6): 279-347

Ortmann, A.E. 1919. A monograph of the naiads of Pennsylvania. Part III: Systematic account of the genera and species. Memoirs of the Carnegie Museum 8(1): xvi – 384.

Ricciardi, A. and J.B. Rasmussen. 1999. Extinction rates of North American freshwater fauna. Conservation Biology 13(5): 1220-1222.

Silkenat, W., Silkenat, M., Klupp, R., Schmidt, S., Wenz, G., Eicke, L., and G. Bauer. 1991. Errichtung und Sicherung schutzwürdiger Teile von Natur und Landschaft mit gesamtstaatlich repräsentativer Bedeutung. Erfahrungen mit einem Projekt zur Rettung der Flußperlmuschel. Natur und Landschaft 66:63-67.

Smith, D.G. 1976. Notes on the biology of *Margaritifera margaritifera margaritifera* (Lin.) in central Massachusetts. American Midland Naturalist 96(1): 252-256.

Strayer, D.L. and K.J. Jirka. 1997. The pearly mussels of New York State. New York State Museum Memoir 26. The University of the State of New York. The State Education Department.

Watters, G.T. 1996. Host fish for the Northern Riffleshell (*Epioblasma torulosa rangiana*). Triennial Unionid Report, Report No. 10, September 1996. 14 pages.

Watters, G.T., Hoggarth, M.A., and D.H. Stansbery. 2009. The freshwater mussels of Ohio. The Ohio State University Press, Columbus, Ohio.

Welte, N.T. 2014. A status assessment of Pennsylvania's freshwater mussels, utilizing NatureServe ranking methodology and rank calculator for application to the 2015 State Wildlife Action Plan update. Prepared for the Pennsylvania Fish and Boat Commission. 15 pages.

Williams, J.D., Bogan, A.E., Butler, R.S., Cummings, K.S., Garner, J.T., Harris, J.L., Johnson, N.A., and G.T. Watters. 2017. A revised list of the freshwater mussels (Mollusca: Bivalvia: Unionida) of the United States and Canada. Freshwater Mollusk Biology and Conservation 20: 33-58.

White, B.S.J. 2007. Evaluation of fish host suitability for the endangered dwarf wedgemussel *Alasmidonta heterodon*. Thesis. Pennsylvania State University, State College, Pennsylvania.

Young, M. and J. Williams. 1984. The reproductive biology of the freshwater pearl mussel *Margaritifera margaritifera* (Linn.) in Scotland. I. Field Studies. Archiv fur Hydrobiologie, Bd. 99. 405-422.

Young, M., G.J. Purser, and B. Al-Mousawi. 1987. Infection and successful reinfection of brown trout [*Salmo trutta* L.] with glochidia of *Margaritifera margaritifera* (L.). American Malacological Bulletin 5(1):125-128.

Zanatta, D.T. and R.W. Murphy. 2007. Range-wide population genetic analysis of the endangered Northern Riffleshell mussel, *Epioblasma torulosa rangiana* (Bivalvia: Unionoida). Conservation Genetics 8: 1393-1404.

Zhadin, Z.D. 1952, Mollyuski presnykh i solonovatykh vod SSSR. [Keys to the fauna of the USSR]. Academy of Sciences of the U.S.S.R. Israel Program for Scientific Translation, Jerusalem. 46:1-368.

Appendix A. Pennsylvania mussel streams list

	Stream	Page #, notes
	Ohio River Basin	
1	- Cross Creek (tributary to mainstem Ohio River, West Virginia)	
2	- Buffalo Creek (tributary to mainstem Ohio River, West Virginia)	
3	• Dutch Fork	
4	- (Wheeling Creek (tributary to mainstem Ohio River, West Virginia)	The mainstem of Wheeling Creek is located entirely in West Virginia.
5	• Enlow Fork	
	• (Dunkard Fork)	No specimens reported.
6	- North Fork Dunkard Fork	
7	Ohio River	
8	- Little Beaver Creek	
9	• North Fork Little Beaver Creek	
10	- Honey Creek	
11	- Raccoon Creek	
12	Beaver River	
13	- Connoquenessing Creek	
14	• Slippery Rock Creek	
15	o Wolf Creek	
16	• Brush Creek	
17	• Little Connoquenessing Creek	
18	• Glade Run	
19	• Thorn Creek	
20	• Bonnie Brook	
21	- Mahoning River	
22	- Shenango River	
23	• Neshannock Creek	
24	o Otter Creek	
	o (Cool Spring Creek)	No specimens reported.
25	o Yellow Creek	
26	o Little Yellow Creek	
27	• Pymatuning Creek	
28	• Little Shenango River	
29	• Padan Creek (Linesville)	
30	• Randolph Run (Linesville)	
31	- Chartiers Creek	
32	• Little Chartiers Creek	
33	Allegheny River	
34	- Buffalo Creek	
35	- Kiskiminetas River	
36	• Beaver Run	
37	• Loyalhanna River	
38	o Loyalhanna Creek	
39	• Conemaugh River	
40	o Black Lick Creek	
41	o Two Lick Creek	
42	o Yellow Creek	
	• (Stony River)	No specimens reported.

Appendix A (continued). Pennsylvania mussel streams list.		
43	○ Quemahoning Creek	
44	○ Clear Run	
45	- Crooked Creek	
46	• North Branch Plum Creek	
47	• South Branch Plum Creek	
48	- Cowanshannock Creek	
49	- Mahoning Creek	
50	• Little Mahoning Creek	
51	- Redbank Creek	
52	- Clarion River	
53	- Sandy Creek	
54	• Little Sandy Creek	
55	- French Creek	
56	• Sugar Creek	
57	• Conneaut Outlet	
58	○ Conneaut Lake	
59	• Cussewago Creek	
60	• Woodcock Creek	
61	• Conneauttee Creek	
62	• Little Conneauttee Creek	
63	• Muddy Creek	
64	• LeBoeuf Creek	
65	• West Branch French Creek	
66	• South Branch French Creek	
67	- Oil Creek	
68	- Hemlock Creek	
69	- Tionesta Creek	
70	• Salmon Creek	
71	- Brokenstraw Creek	
72	• Little Brokenstraw Creek	
73	- Conewango Creek	
74	- Oswayo Creek	
75	- Potato Creek	
76	• Marvin Creek	
77	Monongahela River	
78	- Youghiogheny River	
79	• Laurel Hill Creek	
80	- Whiteley Creek	
81	- Tenmile Creek	
82	• South Fork Tenmile Creek	
83	- Dunkard Creek	
84	• Toms Run	
85	• Pennsylvania Fork Dunkard Creek	
86	• West Virginia Fork Dunkard Creek	
87	- Cheat River	
	Lake Erie Basin	
88	Lake Erie	
89	- Presque Isle Bay (including Thompson Bay)	
90	- Conneaut Creek	
	Genesee River Basin	
91	Genesee River	

Appendix A (continued). Pennsylvania mussel streams list.		
92	- Cryder Creek	
	Delaware River Basin	
93	Delaware River	
94	- White Clay Creek	
96	- Brandywine Creek	
97	• East Branch Brandywine Creek	
98	- Chester Creek	
99	- Ridley Creek	
100	- Crum Creek	
101	- Darby Creek	
102	Schuylkill River	
103	- Schuylkill Canal	
104	- Wissahickon Creek	
105	- Perkiomen Creek	
106	• Swamp Creek	
107	- French Creek	
108	- Manatawny Creek	
109	- Tulpehocken Creek	
110	- Maiden Creek	
111	• Pine Creek	
112	• Sacony Creek	
113	- Little Schuylkill River	
114	• Indian Run	
115	• Cold Run	
116	• Panther Creek	
117	• Locust Creek	
118	• Pine Creek	
119	• Hosensock Creek	
120	• Still Creek	
121	• Neifert Creek	
	(mainstem)	
122	- Pennypack Creek	
123	- Neshaminy Creek	
124	• Little Neshaminy Creek	
125	- Tohickon Creek	
126	Lehigh River	
127	- Valley Creek	
128	• Princess Run	"Princess Creek, near Kunkletown" in Ortmann (1919).
129	- Jordan Creek	
130	- Common Creek	= Aquashicola? Stream reported in Ortmann (1919)
131	- Lizard Creek	
132	- Mahoning Creek (Carbon Co.)	
	(mainstem)	
133	- Cherry Creek	
134	- Marshalls Creek	
135	- Bushkill Creek	
136	- Lackawaxen River	
137	Wallenpaupack Creek	
138	- Beaver Lake	
139	- Porters Lake (Pike Co.)	

Appendix A (continued). Pennsylvania mussel streams list.		
140	• - Echo Lake (Monroe Co.)	
	Susquehanna River Basin	
141	Big Elk Creek (Chester Co.)	
142	Susquehanna River	
143	- Octoraro Creek	
144	- Muddy Creek	Tributary to the Elk River (MD) and the Chesapeake Bay
145	- Pequea Creek	
146	- Conestoga River	
147	• Mill Creek	
148	• Cocalico Creek	
149	- Chiques Creek	
150	- Codorus Creek	
	- (West Conewago Creek)	No specimens reported.
151	• Bermudian Creek	
152	- Conewago Creek	
153	• Little Conewago Creek	
154	• Middle Creek	
155	- Yellow Breeches Creek	
156	- Swatara Creek	
157	• Quittapahilla Creek	
158	• Little Swatara Creek	
159	- Conodoguinet Creek	
160	• Big Sandy Creek	
161	- Clarks Creek	
162	- Shermans Creek	
163	Juniata River	
164	- Buffalo Creek (Perry Co.)	
165	- Cocolamus Creek	
166	- Tuscarora Creek	
167	• East Licking Creek	
168	- Lost Creek	
169	- Kishacoquillas Creek	
170	- Aughwich Creek	
171	• Little Aughwick Creek	
172	- Raystown Branch Juniata River	
173	• Dunning Creek	
174	○ Shobers Run	
175	• Yellow Creek	
176	- Standing Stone Creek	
177	- Frankstown Branch Juniata River	
178	• Canoe Creek	
	(mainstem)	
179	- Mahantango Creek	
180	• West Branch Mahantango Creek	
181	- Penns Creek	
182	• Sinking Creek	
183	West Brach Susquehanna River	
184	- Chillisquaque Creek	
185	- Pine Creek	
186	• Little Pine Creek	

Appendix A (continued). Pennsylvania mussel streams list.		
187	• Marsh Creek	
188	- Bald Eagle Creek	
189	• Spring Creek	
190	- Kettle Creek	
191	- Sinnemahoning Creek	
192	• Driftwood Branch	
	- (Moshannon Creek)	No specimens reported.
193	• Black Moshannon Creek	
194	- Cush Cushion Creek	
	- (Clearfield Creek)	No specimens reported.
195	• Beaver Dam Creek (Cambria)	
196	• Swartz Run (Cambria)	
197	- Chest Creek	
198	North Branch Susquehanna River	
199	- Neals Run	
	- (Harvey Creek)	
200	• Harvey Lake	
201	- Tunkhannock Creek	
202	- Mehoopany Creek	
203	- Meshoppen Creek	
204	- Chemung River	
	• (Tioga River)	
205	- Cowanesque River	
206	o Hills Creek	
207	o Crooked Creek	
208	**Potomac River Basin**	
209	- Rock Creek	
210	- Antietam Creek	
211	• East Branch Little Antietam Creek	
212	• West Branch Little Antietam Creek	
213	- Conococheague Creek	
214	• West Branch Conococheague Creek	
215	• Back Creek	
216	- Licking Creek	1,600’ in Pennsylvania. Mainstem formed by confluence of the East and West Branch Antietam creeks.
217	- Great Tonoloway Creek	
218	- Sideling Hill Creek	
219	- Town Creek	

Appendix B. Ohio River mainstem and minor tributaries

	Species	Common name	Ohio River	Cross Creek	Buffalo Creek	Dutch Fork	Enlow Fork	North Fork Dunkard Fork	Little Beaver Creek	North Fork Little Beaver Creek	Honey Creek	Raccoon Creek	Chartiers Creek	Little Chartiers Creek
1	*A. ligamentina*	Mucket	X						X	X				
2	*A. marginata*	Elktoe	X						X	X				
3	*A. plicata*	Threeridge	X											
4	*U. suborbiculata*	Flat Floater	X											
5	*C. tuberculata*	Purple Wartyback	X											
6	*C. stegaria*	Fanshell	X											
7	*E. lineolata*	Butterfly	X											
8	*E. crassidens*	Elephant Ear	X											
9	*E. dilatata*	Spike	X						X	X				
10	*E. triquetra*	Snuffbox	X											
11	*F. flava*	Wabash Pigtoe	X					X				X	X	
12	*F. subrotunda*	Longsolid	X											
13	*L. abrupta*	Pink Mucket	X											
14	*L. cardium*	Plain Pocketbook	X					X	X	X		X	X	
15	*L. fasciola*	Wavyrayed Lampmussel	X						X	X				
16	*L. ovata*	Pocketbook	X											
17	*L. siliquoidea*	Fatmucket	X		X	X	X		X	X		X	X	X
18	*L. complanata*	White Heelsplitter	X			X								
19	*L. compressa*	Creek Heelsplitter							X	X		X		
20	*L. costata*	Flutedshell	X		X	X	X	X	X	X		X	X	
21	*L. fragilis*	Fragile Papershell	X									X		
22	*L. recta*	Black Sandshell	X									X		
23	*O. reflexa*	Threehorn Wartyback	X											
24	*O. olivaria*	Hickorynut	X											
25	*O. retusa*	Ring Pink	X											
26	*O. subrotunda*	Round Hickorynut	X											
27	*P. cooperianus*	Orangefoot Pimpleback	X											

Appendix B (continued). Ohio River mainstem and minor tributaries

	Species	Common name	Ohio River	Cross Creek	Buffalo Creek	Dutch Fork	Enlow Fork	North Fork Dunkard Fork	Little Beaver Creek	North Fork Little Beaver Creek	Honey Creek	Raccoon Creek	Chartiers Creek	Little Chartiers Creek
28	*P. cyphyus*	Sheepnose	X											
29	*P. clava*	Clubshell							X	X		X		
30	*P. cordatum*	Ohio Pigtoe	X											
31	*P. plenum*	Rough Pigtoe	X											
32	*P. rubrum*	Pyramid Pigtoe	X											
33	*P. sintoxia*	Round Pigtoe	X											
34	*P. alatus*	Pink Heelsplitter	X						X	X		X		
35	*P. fasciolaris*	Kidneyshell							X	X		X		
36	*P. ohiensis*	Pink Papershell	X											
37	*P. grandis*	Giant Floater	X				X	X		X		X		X
38	*T. cylindrica*	Rabbitsfoot	X											
39	*T. metanevra*	Monkeyface	X											
40	*C. pustulosa*	Pimpleback	X											
41	*Q. quadrula*	Mapleleaf	X						X			X		
42	*T. verrucosa*	Pistolgrip	X											
43	*S. undulatus*	Creeper		X		X			X	X		X	X	X
44	*T. parvum*	Lilliput	X											
45	*T. donaciformis*	Fawnsfoot	X											
46	*T. truncata*	Deertoe	X											
47	*U. imbecillis*	Paper Pondshell				X								
48	*V. iris*	Rainbow	X						X	X				
	Species total		**42**	**1**	**2**	**5**	**3**	**4**	**14**	**14**	**0**	**13**	**5**	**3**

Appendix C. Beaver River and tributaries

	Species	Common name	Beaver River	Connoquenessing Creek	Slippery Rock Creek	Wolf Creek	Brush Creek	Little Connoquenessing Creek	Glade Run	Thorn Creek	Bonnie Brook	Mahoning River	Shenango River	Neshannock Creek	Otter Creek	Yellow Creek	Little Yellow Creek	Pymatuning Creek	Little Shenango River	Padan Creek	Randolph Run
1	*A. ligamentina*	Mucket	X	X	X							X	X								
2	*A. marginata*	Elktoe	X	X	X	X						X	X	X				X	X		
3	*A. plicata*	Threeridge	X	X								X	X					X	X	X	
4	*A. ferussacianus*	Cylindrical Papershell											X					X	X		X
5	*C. tuberculata*	Purple Wartyback	X		X																
6	*E. dilatata*	Spike	X	X	X	X						X	X	X				X	X		
7	*E. rangiana*	Northern Riffleshell											X								
8	*E. triquetra*	Snuffbox	X									X	X					X	X		
9	*F. subrotunda*	Longsolid	X		X							X	X					X			
10	*L. cardium*	Plain Pocketbook	X	X	X							X	X	X				X	X		
11	*L. fasciola*	Wavyrayed Lampmussel	X	X	X							X	X	X				X	X		
12	*L. ovata*	Pocketbook											X					X			
13	*L. radiata*	?											X					X			
14	*L. siliquoidea*	Fatmucket	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X
15	*L. complanata*	White Heelsplitter																			
16	*L. compressa*	Creek Heelsplitter	X				X					X	X	X				X	X		X
17	*L. costata*	Flutedshell	X	X	X	X		X				X	X	X	X			X	X		
18	*L. nasuta*	Eastern Pondmussel											X								
19	*O. subrotunda*	Round Hickorynut	X									X	X					X			
20	*P. cyphyus*	Sheepnose	X																		
21	*P. clava*	Clubshell	X	X								X	X	X				X			
22	*P. cordatum*	Ohio Pigtoe	X										X								
23	*P. sintoxia*	Round Pigtoe	X	X	X							X	X	X				X			

Appendix C (continued). Beaver River and tributaries

	Species	Common name	Beaver River	Connoquenessing Creek	Slippery Rock Creek	Wolf Creek	Brush Creek	Little Connoquenessing Creek	Glade Run	Thorn Creek	Bonnie Brook	Mahoning River	Shenango River	Neshannock Creek	Otter Creek	Yellow Creek	Little Yellow Creek	Pymatuning Creek	Little Shenango River	Padan Creek	Randolph Run
24	*P. fasciolaris*	Kidneyshell	X	X	X							X	X	X	X			X	X		
25	*P. grandis*	Giant Floater	X		X	X	X		X		X	X	X	X		X	X	X	X		
26	*T. cylindrica*	Rabbitsfoot	X									X	X					X			
27	*C. pustulosa*	Pimpleback	X									X									
28	*T. verrucosa*	Pistolgrip	X									X	X					X			
29	*S. undulatus*	Creeper	X	X	X	X	X	X		X	X	X	X	X	X			X			
30	*T.parvum*	Lilliput	X																		
31	*U. imbecillis*	Paper Pondshell											X								
32	*V. fabalis*	Rayed Bean	X									X	X					X			
33	*V. iris*	Rainbow	X		X							X	X	X	X			X			
	Species total		**26**	**12**	**14**	**6**	**4**	**3**	**2**	**2**	**3**	**22**	**28**	**13**	**5**	**1**	**1**	**24**	**12**	**2**	**3**

Appendix D. Allegheny River and tributaries

	Species	Common name	Allegheny River	Buffalo Creek	Kiskiminetas River	Beaver Run	Loyalhanna River	Loyalhanna Creek	Conemaugh River	Black Lick Creek	Two Lick Creek	Yellow Creek	Quemahoning Creek	Clear Run	Crooked Creek	N. Br. Plum Creek	S. Br. Plum Creek	Cowanshannock Creek	Mahoning Creek	Little Mahoning Creek
	A. ligamentina	Mucket	X				X		X			X			X				X	
	A. marginata	Elktoe	X	X			X						X		X					X
	A. plicata	Threeridge	X												X					
	C. tuberculata	Purple Wartyback	X																	
	C. stegaria	Fanshell	X																	
	E. lineolata	Butterfly	X																	
	E. crassidens	Elephant Ear	X																	
	E. dilatata	Spike	X				X			X		X	X		X					X
	E. rangiana	Northern Riffleshell	X																	
	E. triquetra	Snuffbox	X												X					X
	F. flava	Wabash Pigtoe	X												X		X		X	
	F. subrotunda	Longsolid	X																	
	H. lata	Cracking Pearlymussel	X																	
	L. abrupta	Pink Mucket	X																	
	L. cardium	Plain Pocketbook	X	X			X		X				X		X				X	X
	L. fasciola	Wavyrayed Lampmussel	X	X			X		X				X		X				X	X
	L. ovata	Pocketbook	X																X	X
	L. siliquoidea	Fatmucket	X	X	X										X			X		X
	L. complanata	White Heelsplitter	X																	
	L. compressa	Creek Heelsplitter																X		
	L. costata	Flutedshell	X	X			X				X	X	X		X			X		X
	L. fragilis	Fragile Papershell	X																	
	L. nasuta	Eastern Pondmussel	X																	

Appendix D (continued). Allegheny River and tributaries

	Species	Common name	Allegheny River	Buffalo Creek	Kiskiminetas River	Beaver Run	Loyalhanna River	Loyalhanna Creek	Conemaugh River	Black Lick Creek	Two Lick Creek	Yellow Creek	Quemahoning Creek	Clear Run	Crooked Creek	North Branch Plum Creek	South Branch Plum Creek	Cowanshannock Creek	Mahoning Creek	Little Mahoning Creek
	L. recta	Black Sandshell	X						X						X					
	O. reflexa	Threehorn Wartyback	X																	
	O. olivaria	Hickorynut	X																	
	O. subrotunda	Round Hickorynut	X												X					
	P. cyphyus	Sheepnose	X																	
	P. clava	Clubshell	X	X			X		X											
	P. cordatum	Ohio Pigtoe	X																	
	P. plenum	Rough Pigtoe	X																	
	P. rubrum	Pyramid Pigtoe	X																	
	P. sintoxia	Round Pigtoe	X	X			X		X						X				X	X
	P. alatus	Pink Heelsplitter	X																	
	P. ohiensis	Pink Papershell	X																	
	P. fasciolaris	Kidneyshell	X	X			X						X						X	X
	P. grandis	Giant Floater	X			X							X	X	X	X	X	X		
	T. cylindrica	Rabbitsfoot	X																	
	T. metanevra	Monkeyface	X																	
	C. pustulosa	Pimpleback	X																	
	Q. quadrula	Mapleleaf	X																	
	T. verrucosa	Pistolgrip	X																	
	S. ambigua	Salamander Mussel	X																	

Appendix D (continued). Allegheny River and tributaries

	Species	Common name	Allegheny River	Buffalo Creek	Kiskiminetas River	Beaver Run	Loyalhanna River	Loyalhanna Creek	Conemaugh River	Black Lick Creek	Two Lick Creek	Yellow Creek	Quemahoning Creek	Clear Run	Crooked Creek	North Branch Plum Creek	South Branch Plum Creek	Cowanshannock Creek	Mahoning Creek	Little Mahoning Creek
	S. undulatus	Creeper	X	X		X	X	X				X	X		X				X	X
	T. parvum	Lilliput	X																	
	T. donaciformis	Fawnsfoot	X																	
	U. imbecillis	Paper Pondshell	X													X				
	V. fabalis	Rayed Bean	X												X					
	V. iris	Rainbow	X	X											X				X	X
	Species total		**48**	**10**	**1**	**2**	**10**	**1**	**6**	**1**	**1**	**4**	**8**	**1**	**17**	**2**	**1**	**4**	**9**	**11**

Appendix E. Allegheny River tributaries

	Species	Common name	Redbank Creek	Clarion River	Sandy Creek	Little Sandy Creek	Oil Creek	Hemlock Creek	Tionesta Creek	West Branch Tionesta Creek	Salmon Creek	Brokenstraw Creek	Little Brokenstraw Creek	Conewango Creek	Oswayo Creek	Potato Creek	Marvin Creek
1	*A. ligamentina*	Mucket		X	X		X	X				X		X	X	X	
2	*A. marginata*	Elktoe			X		X	X	X					X	X	X	
3	*A. plicata*	Threeridge					X	X						X			
4	*A. ferussacianus*	Cylindrical Papershell					X							X			
5	*E. dilatata*	Spike		X	X		X	X	X			X		X	X	X	
6	*E. rangiana*	Northern Riffleshell			X		X	X						X			
7	*F. subrotunda*	Longsolid							X								
8	*L. cardium*	Plain Pocketbook	X	X			X	X	X			X		X	X	X	X
9	*L. fasciola*	Wavyrayed Lampmussel		X	X		X		X		X	X		X	X		
10	*L. ovata*	Pocketbook		X			X	X						X			
11	*L. siliquoidea*	Fatmucket					X					X		X		X	
12	*L. compressa*	Creek Heelsplitter			X					X		X?	X	X		X	X
13	*L. costata*	Flutedshell		X	X		X	X	X			X		X	X	X	
14	*L. nasuta*	Eastern Pondmussel												X			
15	*L. recta*	Black Sandshell		X										X			
16	*P. cyphyus*	Sheepnose						X									
17	*P. clava*	Clubshell			X			X						X			
18	*P. sintoxia*	Round Pigtoe		X	X			X	X		X	X		X	X	X	
19	*P. fasciolaris*	Kidneyshell		X	X		X	X						X			
20	*P. grandis*	Giant Floater			X		X					X		X			
21	*S. undulatus*	Creeper		X	X	X	X		X			X		X	X	X	X
22	*U. imbecillis*	Paper Pondshell												X			
23	*V. fabalis*	Rayed Bean					X							X			
24	*V. iris*	Rainbow			X		X										
	Species total		**1**	**10**	**13**	**1**	**16**	**12**	**8**	**1**	**2**	**10**	**1**	**21**	**8**	**9**	**3**

Appendix F. French Creek (Ohio River basin) and tributaries

	Species	Common name	French Creek	Sugar Creek	Conneaut Outlet	Conneaut Lake	Cussewago Creek	Woodcock Creek	Conneauttee Creek	Little Conneauttee Creek	Muddy Creek	LeBoeuf Creek	West Branch French Creek	South Branch French Creek
1	*A. ligamentina*	Mucket	X		X		X	X	X		X	X	X	X
2	*A. marginata*	Elktoe	X				X	X	X		X	X	X	
3	*A. plicata*	Threeridge	X		X		X	X	X		X	X		
4	*A. ferussacianus*	Cylindrical Papershell	X		X	X	X				X			
5	*C. tuberculata*	Purple Wartyback	X											
6	*E. dilatata*	Spike	X		X	X	X	X			X	X	X	X
7	*E. rangiana*	Northern Riffleshell	X				X				X	X		
8	*E. triquetra*	Snuffbox	X		X		X	X			X	X	X	
9	*F. subrotunda*	Longsolid	X								X			
10	*L. cardium*	Plain Pocketbook	X				X	X	X		X	X		X
11	*L. fasciola*	Wavyrayed Lampmussel	X					X	X		X	X		
12	*L. ovata*	Pocketbook	X		X				X		X	X	X	X
13	*L. siliquoidea*	Fatmucket	X		X		X		X		X	X	X	X
14	*L. complanata*	White Heelsplitter	X		X							X		
15	*L. compressa*	Creek Heelsplitter	X		X		X		X		X	X	X	
16	*L. costata*	Flutedshell	X	X			X	X	X		X	X	X	X
17	*L. fragilis*	Fragile Papershell										X		
18	*L. nasuta*	Eastern Pondmussel	X		X									
19	*L. recta*	Black Sandshell	X								X			
20	*P. clava*	Clubshell	X		X				X		X	X		
21	*P. sintoxia*	Round Pigtoe	X		X				X		X	X		
22	*P. alatus*	Pink Heelsplitter												
23	*P. fasciolaris*	Kidneyshell	X				X	X			X	X	X	X
24	*P. grandis*	Giant Floater	X	X	X	X	X	X	X	X	X	X	X	X

Appendix F (continued). French Creek (Ohio River basin) and tributaries

	Species	Common name	French Creek	Sugar Creek	Conneaut Outlet	Conneaut Lake	Cussewago Creek	Woodcock Creek	Conneauttee Creek	Little Conneauttee Creek	Muddy Creek	LeBoeuf Creek	West Branch French Creek	South Branch French Creek
25	*T. cylindrica*	Rabbitsfoot	X						X		X	X		
26	*S. ambigua*	Salamander Mussel	X											
27	*S. undulatus*	Creeper	X	X	X	X	X	X	X		X		X	X
28	*T. parvum*	Lilliput			X									
29	*U. imbecillis*	Paper Pondshell	X		X	X						X		
30	*V. fabalis*	Rayed Bean	X				X	X			X	X		
31	*V. iris*	Rainbow	X									X		
	Species total		**28**	**3**	**16**	**5**	**15**	**12**	**14**	**1**	**22**	**22**	**11**	**9**

Appendix G. Monongahela River and tributaries

	Species	Common name	Monongahela River	Youghiogheny River	Laurel Hill Creek	Whiteley Creek	Tenmile Creek	South Fork Tenmile Creek	Dunkard Creek	Toms Run	Pennsylvania Fork Dunkard Creek	West Virginia Fork Dunkard Creek	Cheat River
1	*A. ligamentina*	Mucket	X	X			X						X
2	*A. marginata*	Elktoe											X
3	*A. plicata*	Threeridge					X	X	X		X		X
4	*A. ferussacianus*	Cylindrical Papershell							X				X
5	*C. tuberculata*	Purple Wartyback							X				X
6	*E. lineolata*	Butterfly	X										
7	*E. crassidens*	Elephant Ear	X										
8	*E. dilatata*	Spike	X				X		X				X
9	*E. triquetra*	Snuffbox					X		X				
10	*F. flava*	Wabash Pigtoe	X				X	X	X				
11	*F. subrotunda*	Longsolid	X										X
12	*L. abrupta*	Pink Mucket	X										
13	*L. cardium*	Plain Pocketbook	X				X	X	X				X
14	*L. fasciola*	Wavyrayed Lampmussel											X
15	*L. siliquoidea*	Fatmucket	X			X	X	X	X	X	X	X	
16	*L. compressa*	Creek Heelsplitter					X						
17	*L. costata*	Flutedshell	X			X	X	X	X		X	X	X
18	*L. fragilis*	Fragile Papershell	X					X	X				
19	*L. recta*	Black Sandshell	X						X				X
20	*O. reflexa*	Threehorn Wartyback	X										
21	*O. subrotunda*	Round Hickorynut	X										
22	*P. cyphyus*	Sheepnose	X										
23	*P. clava*	Clubshell							X				X
24	*P. cordatum*	Ohio Pigtoe	X										
25	*P. sintoxia*	Round Pigtoe						X	X				X

Appendix G (continued). Monongahela River and tributaries

	Species	Common name	Monongahela River	Youghiogheny River	Laurel Hill Creek	Whiteley Creek	Tenmile Creek	South Fork Tenmile Creek	Dunkard Creek	Toms Run	Pennsylvania Fork Dunkard Creek	West Virginia Fork Dunkard Creek	Cheat River
26	*P. alatus*	Pink Heelsplitter	X						X				
27	*P. fasciolaris*	Kidneyshell	X						X				X
28	*P. grandis*	Giant Floater	X		X	X	X	X	X		X	X	
29	*T. cylindrica*	Rabbitsfoot	X										
30	*T. metanevra*	Monkeyface	X										
31	*C. pustulosa*	Pimpleback	X										X
32	*T. verrucosa*	Pistolgrip	X						X				
33	*S. ambigua*	Salamander Mussel							X				
34	*S. undulatus*	Creeper	X	X	X	X	X	X	X	X	X	X	X
35	*T. parvum*	Lilliput	X										
36	*U. imbecillis*	Paper Pondshell							X				
37	*V. iris*	Rainbow							X				X
	Species total		**25**	**2**	**2**	**4**	**11**	**9**	**22**	**2**	**5**	**4**	

Appendix H. Lake Erie and tributaries

	Species	Common name	Lake Erie / Presque Isle Bay	Conneaut Creek
1	*A. marginata*	Elktoe		X
2	*A. plicata*	Threeridge	X	
3	*A. ferussacianus*	Cylindrical Papershell	X	X
4	*E. dilatata*	Spike	X	X
5	*E. triquetra*	Snuffbox	X	
6	*F, flava*	Wabash Pigtoe	X	
7	*F. subrotunda*	Longsolid		X
8	*L. cardium*	Plain Pocketbook	X	X
9	*L. siliquoidea*	Fatmucket	X	X
10	*L. compressa*	Creek Heelsplitter	X	X
11	*L. costata*	Flutedshell	X	
12	*L. fragilis*	Fragile Papershell	X	
13	*L. nasuta*	Eastern Pondmussel	X	
14	*L. recta*	Black Sandshell	X	
15	*P. sintoxia*	Round Pigtoe	X	X
16	*P. alatus*	Pink Heelsplitter	X	
17	*P. fasciolaris*	Kidneyshell	X	X
18	*P. grandis*	Giant Floater	X	X
19	*C. pustulosa*	Pimpleback	X	
20	*Q. quadrula*	Mapleleaf	X	
21	*S. undulatus*	Creeper	X	X
22	*T. truncata*	Deertoe	X	
23	*U. imbecillis*	Paper Pondshell	X	
24	*V. iris*	Rainbow	X	X
	Species total		**22**	**12**

Appendix I. Genesee River and tributaries.

	Species	Common name	Genesee River	Cryder Creek
1	*L. compressa*	Creek Heelsplitter	X	X
2	*P. grandis*	Giant Floater		X
3	*S. undulatus*	Creeper	X	X
	Species total		**2**	**3**

Appendix J. Delaware River and minor tributaries

	Species	Common name	Delaware River	White Clay Creek	Brandywine Ck + ribs	Chester Creek	Ridley Creek	Crum Creek	Darby Creek	Pennypack Creek	Neshaminy Creek	Little Neshaminy	Cherry Creek	Marshalls Creek	Bushkill Creek	Van Campens Brook	Flatbrook (NJ)	Lackawaxen River	Beaver Lake	Porters Lake	Echo Lake
1	*A. heterodon*	Dwarf Wedgemussel	X						X		X						X				
2	*A. undulatus*	Triangle Floater	X	X			X				X	X	X								
3	*A. varicosa*	Brook Floater	X	X			X	X		X	X										
4	*U. implicata*	Alewife Floater	X											X							
5	*E. complanata*	Eastern Elliptio	X	X	X		X				X	X	X	X	X	X		X			
6	*L. cariosa*	Yellow Lampmussel	X																		
7	*L. radiata*	Eastern Lampmussel	X																		
8	*L. ochracea*	Tidewater Mucket	X																		
9	*L. nasuta*	Eastern Pondmussel	X																		
10	*M. margaritifera*	Eastern Pearlshell	X	X?																	
11	*P. cataracta*	Eastern Floater	X	X				X				X		X				X	X	X	X
12	*S. undulatus*	Creeper	X			X					X	X	X	X							
13	*U. imbecillis*	Paper Pondshell										X									
	Species total		**12**	**5**	**1**	**1**	**3**	**2**	**1**	**1**	**5**	**5**	**3**	**4**	**1**	**1**	**1**	**2**	**1**	**1**	**1**

Appendix K. Schuylkill River and tributaries

	Species	Common name	Schuylkill River	Schuylkill Canal	Wissahickon Creek	Perkiomen Creek	Swamp Creek	French Creek	Manatawny Creek	Tulpehocken Creek	Maiden Creek	Pine Creek	Sacony Creek	Little Schuylkill River	Indian Run	Cold Run	Panther Creek	Locust Creek	Pine Creek	Hosensock Creek	Still Creek	Neifert Creek
1	*A. heterodon*	Dwarf Wedgemussel	X	X																		
2	*A. undulatus*	Triangle Floater	X	X		X			X				X									
3	*A. varicosa*	Brook Floater	X				X		X		X		X									
4	*U. implicata*	Alewife Floater	X																			
5	*E. complanata*	Eastern Elliptio		X	X	X		X	X	X			X									
6	*L. radiata*	Eastern Lampmussel		X																		
7	*L. ochracea*	Tidewater Mucket	X		X																	
8	*L. nasuta*	Eastern Pondmussel		X																		
9	*L. subviridis*	Green Floater		X																		
10	*M. margaritifera*	Eastern Pearlshell										X		X	X	X	X	X	X	X	X	X
11	*P. cataracta*	Eastern Floater	X	X	X	X				X	X											
12	*S. undulatus*	Creeper	X	X	X					X	X											
	Species total		**7**	**8**	**4**	**3**	**1**	**1**	**3**	**3**	**3**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Appendix L. Lehigh River and tributaries

	Species	Common name	Lehigh River	Valley Creek	Princess Creek	Jordan Creek	Common Creek	Lizard Creek	Mahoning Creek
1	*A. heterodon*	Dwarf Wedgemussel			X				
2	*A. undulatus*	Triangle Floater		X	X				
3	*A. varicosa*	Brook Floater	X		X	X		X	X
4	*U. implicata*	Alewife Floater							
5	*E. complanata*	Eastern Elliptio					X	X	X
7	*L. subviridis*	Green Floater		X					
8	*S. undulatus*	Creeper			X			X	X
9	*U. imbecillis*	Paper Pondshell							
	Species total		**1**	**2**	**4**	**1**	**1**	**3**	**3**

Appendix M. Susquehanna River and minor tributaries

	Species	Common name	Susquehanna River	Big Elk Creek	Octoraro Creek	Muddy Creek	Pequea Creek	Conestoga River	Mill Creek	Cocalico Creek	Chiques Creek	Codorus Creek	Bermudian Creek	Conewago Creek	Little Conewago	Middle Creek	Yellow Breeches	Swatara Creek	Quittapahilla Creek	Little Swatara Creek	Conodoguinet Creek	Big Sandy Creek	Clarks Creek	Shermans Creek
1	*A. marginata*	Elktoe	X															X		X	X			
2	*A. undulata*	Triangle Floater	X	X		X	X	X						X		X		X		X	X			
3	*A. varicosa*	Brook Floater	X										X					X	X		X			
4	*U. implicata*	Alewife Floater	X																					
5	*A. ferussacianus*	Cylindrical Papershell						X?											X?					
6	*E. complanata*	Eastern Elliptio	X					X	X	X	X	X	X	X		X	X	X		X	X	X	X	X
7	*L. cariosa*	Yellow Lampmussel	X										X	X	X	X		X			X			
8	*L. radiata*	Eastern Lampmussel	X		X																			
9	*L. subviridis*	Green Floater	X																		X			
10	*P. cataracta*	Eastern Floater	X		X									X	X			X						
11	*S. undulatus*	Creeper	X	X									X	X	X	X					X			
12	*V. iris*	Rainbow	X																	X	X			
	Species total		**11**	**2**	**2**	**1**	**1**	**3**	**1**	**1**	**1**	**1**	**4**	**5**	**3**	**4**	**1**	**6**	**2**	**4**	**8**	**1**	**1**	**1**

Appendix M (continued). Susquehanna River and minor tributaries

	Species	Common name	Mahantango Creek	West Branch Mahantango Creek	Penns Creek
1	*A. marginata*	Elktoe			X
2	*A. undulata*	Triangle Floater		X	
3	*A. varicosa*	Brook Floater			X
4	*E. complanata*	Eastern Elliptio		X	X
5	*L. cariosa*	Yellow Lampmussel	X		X
6	*P. cataracta*	Eastern Floater	X		
7	*S. undulatus*	Creeper	X	X	X
8	*V. iris*	Rainbow			X
	Species total		**3**	**3**	**6**

Appendix N. Juniata River and tributaries

	Species	Common name	Juniata River	Buffalo Creek	Cocolamus Creek	Tuscarora Creek	East Licking Creek	Lost Creek	Kishacoquillas Creek	Aughwick Creek	Little Aughwick Creek	Raystown Branch Juniata River	Dunning Creek	Shobers Run	Yellow Creek	Standing Stone Creek	Frankstown Branch Juniata River	Canoe Creek
1	*A. marginata*	Elktoe	X							X		X					X	
2	*A. undulata*	Triangle Floater	X						X			X		X			X	
3	*A. varicosa*	Brook Floater	X									X						
4	*U. implicata*	Alewife Floater																
5	*E. complanata*	Eastern Elliptio	X	X	X	X		X	X	X		X	X		X	X	X	
6	*L. cariosa*	Yellow Lampmussel	X			X	X			X		X			X		X	
7	*L. radiata*	Eastern Lampmussel																
8	*L. subviridis*	Green Floater					X			X			X					
9	*P. cataracta*	Eastern Floater	X															X
10	*S. undulatus*	Creeper	X		X		X	X			X	X	X		X			X
11	*V. iris*	Rainbow	X			X												
	Species total		**8**	**1**	**2**	**3**	**3**	**2**	**2**	**4**	**1**	**6**	**3**	**1**	**3**	**1**	**4**	**2**

Appendix O. West Branch Susquehanna River and tributaries

	Species	Common name	West Branch Susquehanna River	Chillisquaque Creek	Pine Creek	Little Pine Creek	Marsh Creek	Bald Eagle Creek	Spring Creek	Fishing Creek	Kettle Creek	Sinnemahoning Creek	Driftwood Branch	Black Moshannon Creek	Cush Cushion Creek	Beaver Dam Creek (Cambria)	Swartz Run (Cambria)	Chest Creek
1	*A. marginata*	Elktoe			X													
2	*A. undulata*	Triangle Floater	X		X	X		X								X	X	X
3	*A. varicosa*	Brook Floater			X	X						X	X		X			
4	*U. implicata*	Alewife Floater																
5	*E. complanata*	Eastern Elliptio	X	X	X		X	X					X		X	X		X
6	*L. cariosa*	Yellow Lampmussel	X	X	X		X											
7	*L. radiata*	Eastern Lampmussel	X															
8	*L. subviridis*	Green Floater						X				X			X			X
9	*P. cataracta*	Eastern Floater	X	X	X					X	X			X		X		
10	*S. undulatus*	Creeper		X	X	X	X	X	X						X		X	X
	Species total		**5**	**4**	**7**	**3**	**3**	**4**	**1**	**1**	**1**	**2**	**2**	**1**	**4**	**3**	**2**	**4**

Appendix P. North Branch Susquehanna River and tributaries

	Species	Common name	North Branch Susquehanna River	Neals Run	Harvey Lake	Tunkhannock Creek	Mehoopany Creek	Meshoppen Creek	Chemung River	Cowanesque River	Hills Creek	Crooked Creek
1	*A. marginata*	Elktoe	X						X			
2	*A. undulata*	Triangle Floater	X						X			
3	*E. complanata*	Eastern Elliptio	X			X?			X			
4	*L. cariosa*	Yellow Lampmussel	X			X	X		X			
5	*L. radiata*	Eastern Lampmussel	X						X			
6	*L. subviridis*	Green Floater	X						X			
7	*P. cataracta*	Eastern Floater	X	X	X		X	X	X	X	X	X
8	*S. undulatus*	Creeper	X						X			
	Species total		**8**	**1**	**1**	**1**	**2**	**1**	**8**	**1**	**1**	**1**

Appendix Q. Potomac River and tributaries

	Species	Common name	Rock Creek	East Branch Antietam Creek	West Branch Antietam Creek	Conococheague Creek	West Branch Conococheague Creek	Back Creek	Licking Creek	Great Tonoloway Creek	Sideling Hill Creek	Town Creek
1	*A. marginata*	Elktoe									X	
2	*A. undulata*	Triangle Floater		X		X		X		X	X	
3	*A. varicosa*	Brook Floater				X	X					
4	*E. complanata*	Eastern Elliptio	X	X		X		X	X	X	X	X
5	*E. fisheriana*	Northern Lance							X			
6	*L. cariosa*	Yellow Lampmussel	X			X		X				X
7	*L. subviridis*	Green Floater				X				X	X	
8	*P. cataracta*	Eastern Floater				X				X		
9	*S. undulatus*	Creeper	X	X	X	X		X	X		X	X
	Species total			**3**	**1**	**7**	**1**	**4**	**3**	**4**	**5**	**3**

MUSSEL KILL ASSESSMENT
FIELD EQUIPMENT CHECKLIST

___ Phone numbers of cooperating agencies
___ Emergency contact
___ Hospital information
___ List of available sources for analytical or diagnostic services
___ First aid kit
___ GPS unit
___ Compass
___ Area map
___ Measuring tape / rangefinders
___ Flagging
___ Rope
___ Stopwatch
___ Measuring board
___ Calipers
___ Cooler with ice
___ Plastic bags with labels and fasteners (tape)
___ Water sample containers (glass, plastic)
___ Glass vials with screw caps
___ Preservatives (i.e., formalin, alcohol, HNO_3, H_2SO_4, NaOH, zinc acetate, sodium thiosulfate) as needed
___ Bacteriological sample tubes and related items
___ Shipping boxes, packing materials, labels
___ Aluminum foil
___ Paper towels and garbage bags
___ Field notebook
___ Pencil and waterproof marking pens
___ Clipboards
___ Waterproof forms
    ___ Initial notification form
    ___ Field observation/habitat assessment forms
    ___ Specimen information forms
    ___ Chain-of-custody forms
    ___ Kill enumeration forms
    ___ Investigation report forms
___ Tape recorder and video recorder
___ Camera
___ Flashlights
___Taxonomic keys
___Mollusk kill field manual
___ Rain gear
___ Gloves, boots
___ Shovel, tubs, buckets
___ Respirators with appropriate cartridges
___ Dip nets
___ Stainless steel scoop
___ Quadrats
___ Sieves
___ Dissecting pans and tools
___ Underwater viewing scope(s)
___ Stainless steel scoop
___ Reversing pliers
___ Forceps
___ Soft bristle brush
___ Penknife
___ Compound microscope and accessories
___ Tally meters
___ Calculator
___ Collection bags
___ Water quality meter capable of measuring dissolved oxygen, temperature, pH, and conductivity
___ Sechhi disk
___ Kemmerer sampler
___ Dredge sampler
___ Core sampler
___ Rake
___ Boat, life preservers, related items
___ Driving equipment
___ Mask and snorkel
___ Two-way radios

MUSSEL KILL NOTIFICATION FORM

STATE: _____
DATE OF KILL: _____
DATE REPORTED: _____TIME REPORTED:_____
TIME SINCE INCIDENT (IF KNOWN): _____

NAME OF REPORTER: _____
ADDRESS: _____PHONE: _____
ORGANIZATION: _____
WATER(s) INVOLVED: _____COUNTY: _____

SPECIFIC LOCATION OF KILL (bridge, highway, state road, landmark, etc.):

_____
River mile: _____ Latitude: _____ Longitude: _____
Township: _____ Range: _____ Section: _____ ¼ Section: _____

SUSPECTED REASON FOR KILL (natural vs. human-induced and possible source of discharge/spill/run-off): _____
_____
_____

INITIAL REPORT OF SPECIES INVOLVED: _____
ESTIMATED NUMBER DEAD: _____ MOLLUSKS STILL DYING? Yes / No

PERSONS AND AGENCIES NOTIFIED:

NAME	TIME	PHONE #
1.		
2.		
3.		

ADDITIONAL COMMENTS:

_____
_____
_____
_____

MUSSEL KILL
FIELD OBSERVATION/HABITAT ASSESSMENT FORM

DATE OF KILL: _____
TODAY'S DATE: _____
INVESTIGATOR NAME/ORG: _____

EXTENT OF KILL:
Water(s): _____
County(s): _____
State(s): _____
Description (attach map): _____
_____

LOCATION OF THIS ASSESSMENT:
Water: _____
County: _____
State: _____
Description: _____
_____

MOLLUSK CONDITION:

1. ( ) Partial ( ) Complete kill ( ) Undetermined kill ( ) Ongoing kill
2. Status of kill :( ) Animals dead, soft parts present
( ) Animals dead, soft parts absent
( ) Many animals still dying
3. Species affected: _____
_____
_____
4. Life stages affected: ( ) < 1 year ( ) ≤ 5 years ( ) > 5 years
5. Number affected: ( ) <100 ( ) 100-1,000 ( ) 1,000-10,000 ( ) >10,000

CONDITION OF OTHER BIOTA (check all that apply):

Organism group	Proliferation	Kill	Species involved
Algae			
Macrophytes			
Zooplankton			
Insects			
Fish			
Crayfish			
Other vertebrates			
Invasive mollusks			

ENVIRONMENTAL CHARACTERISTICS:

NOTE: Investigators should specify units of measure for all parameters

WEATHER: Air temperature: _____ % cloud cover: _____
Wind speed/direction: _____ Precipitation: _____

WATER MEASUREMENTS:

Location	Time	Depth	pH	Color	Clarity	D.O.	Cond.	Temp.	Current	Other

River flow condition: ( ) low ( ) moderate ( ) flood
Identify and list nearest USGS GAGE readings _____

HABITAT/RIPARIAN CONDITION:

Bottom sediments:
Compaction: ( ) firm ( ) medium ( ) soft
Predominate substrate type(s): _____
Sedimentation/deposits present: _____

Land use (kill site):
( ) forest
( ) old field
( ) row crop
( ) pasture
( ) wetland
( ) industrial
( ) urban
( ) residential/park
( ) mining/construction
( ) other: _____

POTENTIAL IMPACT SOURCES (describe):

( ) discharge pipe _____
( ) runoff ditch _____
( ) habitat disruption _____
( ) spill occurrence _____
( ) other (e.g., predation)_____
_____

SPECIMEN INFORMATION FORM

SPECIMEN ID NO: _____ DATE: _____
PROCESSED BY: _____
Organization: _____

CHAIN OF CUSTODY: ( ) Yes ( ) No
SINGLE SPECIMEN: ( ) **OR MULTIPLE SPECIMENS:** ( )

SPECIES: _____
Length: _____ Life stage: ( ) < 1 year ( ) ≤ 5 years () > 5 years
Source: _____

GROSS EXTERNAL EXAMINATION:
SHELL: ( ) normal ( ) fresh abrasion ( ) crack ( ) puncture
( ) encrustation by: _____

GROSS INTERAL EXAMINATION:
SHELL: ( ) fresh; clean, shiny nacre
( ) weathered

SOFT PARTS: ( ) absent ( ) normal ( ) abnormal color: _____
( ) parasites ( ) reduced ( ) distended

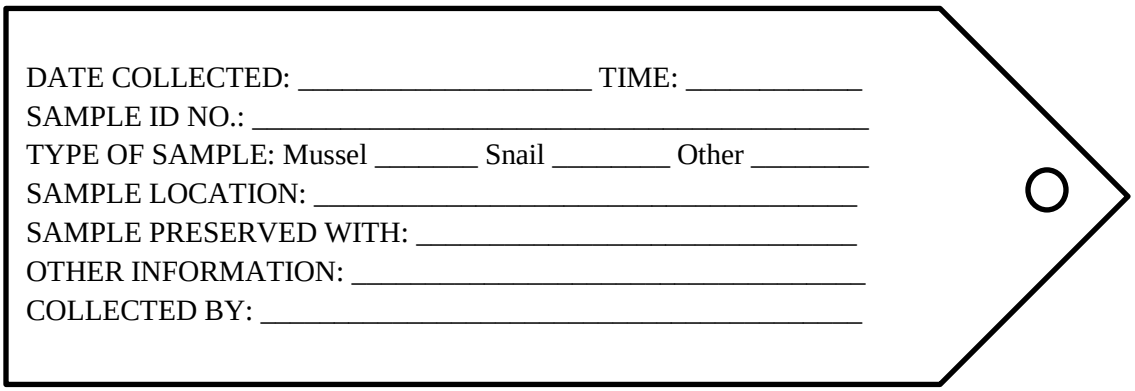
REPRODUCTIVE CONDITION: ( ) juvenile ( ) female gravid ( ) female not gravid ( ) male
( ) unknown
Other/comments: _____
_____

DISPOSITION OF SPECIMEN:
( ) Shipped for testing: ( ) shell ( ) soft parts
( ) Saved for evidence: ( ) shell ( ) soft parts
( ) Other: _____

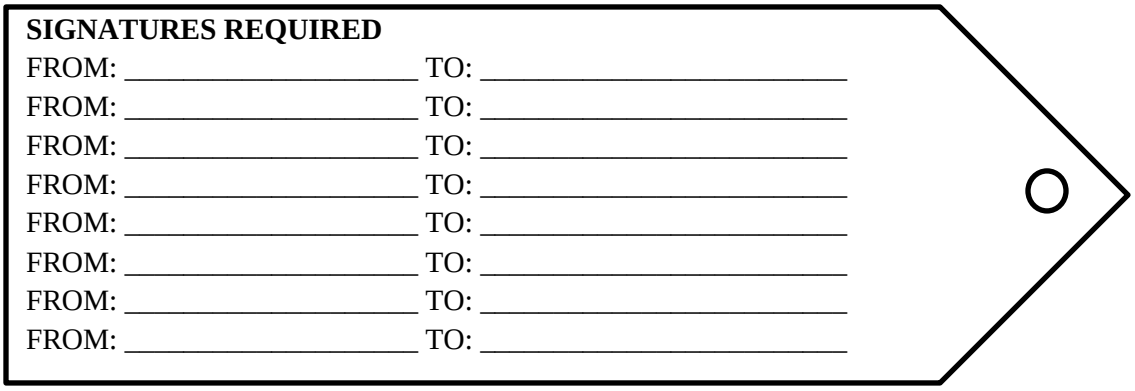
TESTS REQUIRED:
( ) Tissue residue: ( ) metals: _____ ( ) organics: _____ ( ) other: _____
( ) Biomarkers: ( ) metallothionein ( ) chlolinesterase ( ) other: _____
( ) Bacteriology ( ) Virology ( ) Histology
( ) Toxicity: ( ) water column ( ) sediment
( ) Other: _____

EVIDENCE TAG / TRANSFER RECORD

FRONT



BACK



MUSSEL KILL ENUMERATION FORM

NOTE: Investigators should specify units of measure for all parameters DATE: _____
TYPE OF SAMPLE: ( ) Transect (length: _____; width: _____)
( ) Timed Search (description of area: _____)
( ) Quadrat (size: _____)
( ) Other (describe: _____
)LOCATION: Water: _____ River mile/location ID: _____
TIME: Start: _____ Finish: _____ Coordinate system:_____
Coordinates upstream: _____ Coordinates downstream: _____
INVESTIGATORS: _____

	Count							
		Adults (> 5 years)			Juveniles (≤ 5 years old)			
	Species	Live	Fresh dead	Weathered shell	Live	Fresh dead	Weathered shell	Disposition*
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

*Returned to source; bagged as evidence; kept for further analyses, etc.

CHAIN OF CUSTODY

COLLECTOR'S NAME AND AFFILIATION:		DESCRIPTION OF SHIPMENT			
		NUMBER OF SAMPLES:			
		NUMBER OF CONTAINERS:			
SAMPLE ID NUMBER	SAMPLE DESCRIPTION	COLLECTED		ANALYSES REQUESTED FROM LABORATORY	PRESERVATIVE
		DATE:	TIME:		

Relinquished by (signature):	Date	Time	Received by (signature):	Carrier (if shipped)	Send report to:
Relinquished by (signature):	Date	Time	Received by (signature):	Carrier (if shipped)	
Relinquished by (signature):	Date	Time	Received by (signature):	Carrier (if shipped)	
Relinquished by (signature):	Date	Time	Received by (signature):	Carrier (if shipped)	

Pennsylvania Fish and Boat Commission guidelines
How and when to voucher freshwater mussels

PFBC utilizes the best available information to make decisions regarding the protection, conservation, and enhancement of Pennsylvania's freshwater mussel resources. Data quality is driven by correct identification of specimens collected from Pennsylvania waters. Careful records, including photo and specimen vouchers are an important component of maintaining data integrity. The following guidelines are intended as general reference for vouchering Pennsylvania specimens. Mussel surveyors, resource agencies, academia, or anyone that possesses a PFBC Scientific Collector's Permit authorizing the collection of freshwater mussels should carefully follow these guidelines. Following these guidelines will meet U.S. Fish and Wildlife Service reporting and vouchering requirements except when otherwise specified on an Endangered Species Act recovery permit (section 10(a)(1)(A) permit). For a more in-depth discussion on the finer points of curatorial methods and shell photography we recommend consulting Sturm et al. (2006).

The importance of vouchers cannot be overstated. Vouchers, or the lack thereof, can have significant impacts – both positive and adverse – to the aquatic resources that PFBC is charged to protect. PFBC strongly recommends, at minimum, photographic vouchering of all state rare (SX – S3S4), threatened, or endangered species encountered (Appendix 1). Photo vouchers must be submitted to PFBC annually for verification. Vouchers in the form of dry (empty shell) or wet specimens (e.g., sacrificed and preserved in 95% ethanol) must be photographed prior to being deposited and catalogued at a museum with an established and reputable history of permanently archiving freshwater mussel specimens (Table 1). Photographs should be submitted at a minimum of 300 DPI and preferably at 600 DPI and saved as a TIFF file format.

Table 1. Museums with an established and reputable history.

Institution	Preferred shipment methods	Contact person
Carnegie Museum of Natural History Section of Mollusks 4400 Forbes Avenue Pittsburgh, Pennsylvania 15213-4080	Any	Timothy A. Pearce PearceT@CarnegieMNH.org Phone: 412-622-1916 Fax: 412-622-8837
North Carolina Museum of Natural Sciences 1626 MSC Raleigh, North Carolina 27699-1626	(Shipping Address for FedEx, UPS **not** US Postal Service) 1671 Gold Star Drive Research Laboratory North Carolina Museum of Natural Sciences Raleigh, NC 27607	Arthur E. Bogan arthur.bogan@naturalsciences.org Phone: 919-707-8863 Fax: 919-715-2294 Jamie M. Smith Jamie.smith@naturalsciences.org Phone 919-707-8869 Fax: 919-715-2294

Photo vouchering

1. Before you take a picture

Clean the shell (at minimum, the outside, and if dead, the inside of one valve). A shell covered in mud, algae, or encrusted with caddisfly cases or byssal threads does not lend itself well to identification, particularly if the species can be confused with other species that may co-occur with it in the same drainage. Take a moment to gently wipe the outside of the shell with a cloth or plastic dish sponge (dry shell material may be cleaned by gentle scrubbing using a soft bristle toothbrush, water, and dish soap.

If possible, limit extensive cleaning to one valve. There is value in retaining encrustations or dirt on the shells because they can provide important clues to future researchers who are trying to reconstruct habitat.

Set-up. One of the most important elements of producing a high quality image of a mussel shell is creating a stable base that allows you to take pictures directly lateral to the shell. When taking pictures of live mussels, PFBC recommends using Styrofoam or PVC rings (see Howells 2011) to position the mussel quickly and minimize the amount of time the mussel is out of the water. As a last resort, use your hand as the stable base. When taking pictures of shells, PFBC recommends the use of a camera stand or tripod (Figure 1) using modeling clay to hold the shell in position. We also recommend the use of a scale (e.g., penny, ruler, etc.).

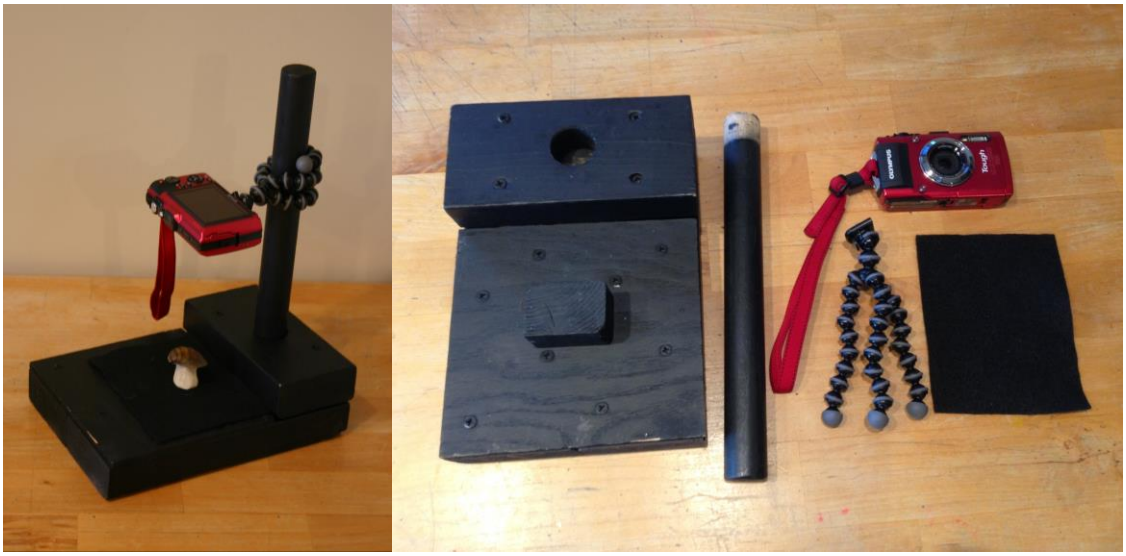


Figure 1. Homemade portable camera stand for taking pictures of mussel shells.

2. Taking pictures

External and internal views

At least three photos should be taken: 1) directly lateral to, 2) anterior to, and 3) dorsally to the shell or live mussel and should include a scale, if possible. We recommend that the outside of the right valve be shown and if a dead shell, the inside of the left valve (Figure 2). The camera lens should be as close to parallel as possible with the base to minimize image distortion. Ideally these pictures will allow examination of all the external features that could be critical to confirming the identification of the mussel (umbo, hinge, dorsal and ventral margins, beak sculpture, sulcus, shell sculpturing, bands, rays, etc.).

Figure 2. Lateral view, right valve, (a), internal view, left valve (b), anterior view (c), and dorsal view (d).

In some cases a photo of the beak cavity may be necessary (Figures 3). The photo of the beak cavity depicts the cavity's depth and compression and this view can also be helpful in examining serrations on the pseudocardinal teeth.

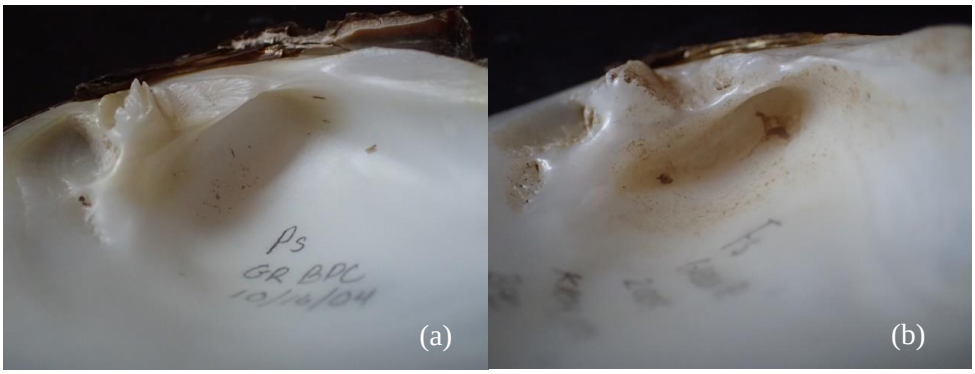


Figure 3. Examples of beak cavity photographs (*Pleurobema sintoxia*, left; *Fusconaia subrotunda*, right)

Labels

1. Photograph and specimen labels

Digital photographs should be labeled with the collection number, date, stream or lake name, species name, shell length (mm, longest distance parallel with hinge line), and the photographers initials:

Example photo voucher label:
001 07-24-15 – Allegheny River – Parker – P. clava – NTW

A detailed specimen label should accompany all dry or wet specimens. Specimen labels must be waterproof (e.g., Rite-in-the-Rain) or acid-free (dry specimens only) and labeled with a pencil or archival pen. We recommend using the Uniball Delux, this is an accepted archival permanent ink pen.

Example specimen label

Genus/species:
Collection date:
Location description (state/county/waterbody, etc.):
Coordinates:
Habitat description:
Collected by (include first, last, middle initial for all collectors):
Determined by:
Number of Specimens
State/Federal permit #:

Along with copies of state and/or federal permits, an Excel spreadsheet should accompany each specimen being deposited at a museum. Important information to include in the spreadsheet include additional data such as habitat information (e.g., depth), who determined the identity of the specimen and when the identification was made, how the specimen was collected (e.g., snorkeling, SCUBA, hand-picking), and details regarding the coordinates of the collection location (decimal degrees, source (GPS, Google Earth, etc.), precision, and datum).

Voucher disposition

The museums listed in Table 1 have indicated a willingness to accept specimen vouchers. In addition to providing the museums with an Excel spreadsheet containing appropriate collection information, each contribution of vouchers to a museum should also include a letter of conveyance (see Appendix 2 for an example) and a financial or in-kind contribution to ensure the care and curation of each specimen.

Dry specimens

After photo vouchering, dry specimens, or empty shells, must be deposited and catalogued in a museum with an established and reputable history of permanent archiving freshwater mussel specimens (Table 2).

Please contact the museum or see Table 1 for preferred shipment preferences, etc.

Except in very rare circumstances (see below), PFBC does not advocate sacrificing live mussels for deposition into a museum.

Wet specimens

The re-discovery of a live, presumed extirpated species (Table 2) should be carefully photo vouchered and single individuals of these state extirpated, potentially cryptic, but non-federally-listed species should be vouchered with the shell and soft parts preserved in ≥ 95% ethanol. The anterior and posterior adductor mussels must be cut to allow preservative to reach the tissue. Preserved specimens must be deposited at a museum (see Table 1). If ≥ 95% ethanol is limited or not available, then 70 – 80% will suffice for future anatomical analyses with consideration that a smaller piece of tissue (size of a pencil eraser) being preserved in ≥ 95% ethanol.

Table 2. List of mussel species that may be vouchered as wet specimens if encountered in Pennsylvania.

	Common Name	Scientific Name
1	Pimpleback	*Cyclonaias pustulosa*
2	Purple Wartyback	*Cyclonaias tuberculata*
3	Butterfly	*Ellipsaria lineolata*
4	Elephant Ear	*Elliptio crassidens*
5	Hickorynut	*Obovaria olivaria*
6	Ohio Pigtoe	*Pleurobema cordatum*
7	Pyramid Pigtoe	*Pleurobema rubrum*
8	Monkeyface	*Theliderma metanevra*
	Any invasive species	

There are no concerns with collection and preservation of invasive mussel species (e.g., dreissenids, cyrenidids (formerly corbiculids)) provided that these animals are placed into a preservative prior to leaving the collection locality.

Data reporting

All specimen data should be reported as per annual PFBC reporting requirements.

Conclusion

There are a few examples of state rare, historical, or extirpated mussels being reported but were not able to be confirmed due to the lack of a voucher. In one instance, the observer simply took for granted that a species occurred in Pennsylvania; however, the last reported observation was over 100 years ago. In another instance an odd-shaped shell resembled an extirpated species, but only external photo vouchers were retained. Follow-up surveys to recover that specimen were unsuccessful. PFBC recommends that anyone who works with freshwater mussels become familiar with the species lists and mussel statuses, particularly those species that are considered historical (SH) or extirpated (SX).

Appendix 1. Regulatory, state rank (S), and global rank (G) status of Pennsylvania's freshwater mussels. Recent name changes highlighted in yellow[3].

			Regulatory Status			
	Common Name	**Species**	**Federal**	**State**	**PABS S-Rank[1]**	**Global Rank[2]**
1	Mucket	*Actinonaias ligamentina*			S4	G5
2	Dwarf Wedgemussel	*Alasmidonta heterodon*	Endangered	Endangered	S1	G1G2
3	Elktoe	*Alasmidonta marginata*			S3S4	G4
4	Triangle Floater	*Alasmidonta undulata*			S3	G4
5	Brook Floater	*Alasmidonta varicosa*			S1S2	G3
6	Threeridge	*Amblema plicata*			S2S3	G5
7	Cylindrical Papershell	*Anodontoides ferussacianus*			S2S3	G5
8	Pimpleback	*Cyclonaias pustulosa*			S1	G5
9	Purple Wartyback	*Cyclonaias tuberculata*			SH	G5
10	Fanshell	*Cyprogenia stegaria*	Endangered		SH	G1
11	Butterfly	*Ellipsaria lineolata*			SH	G4G5
12	Eastern Elliptio	*Elliptio complanata*			S4	G5
13	Elephant Ear	*Elliptio crassidens*			SH	G5
14	Northern Lance	*Elliptio fisheriana*			S1	G4
15	Atlantic Spike	*Elliptio producta*			SNR	
16	Northern Riffleshell	*Epioblasma rangiana*	Endangered	Endangered	S2	G2
17	Snuffbox	*Epioblasma triquetra*	Endangered	Endangered	S2	G3
18	Spike	*Eurynia dilatata*			S4	G5
19	Wabash Pigtoe	*Fusconaia flava*			S2S3	G5
20	Longsolid	*Fusconaia subrotunda*			S2	G3
21	Cracking Pearlymussel	*Hemistena lata*	Endangered		SX	G1
22	Pink Mucket	*Lampsilis abrupta*	Endangered		SH	G2
23	Plain Pocketbook	*Lampsilis cardium*			S4	G5
24	Yellow Lampmussel	*Lampsilis cariosa*			S4	G3G4
25	Wavyrayed Lampmussel	*Lampsilis fasciola*			S3S4	G5
26	Pocketbook	*Lampsilis ovata*			S2S3	G5
27	Eastern Lampmussel	*Lampsilis radiata*			S1	G5
28	Fatmucket	*Lampsilis siliquoidea*			S4	G5
29	White Heelsplitter	*Lasmigona complanata*			S1S2	G5
30	Creek Heelsplitter	*Lasmigona compressa*			S2	G5
31	Flutedshell	*Lasmigona costata*			S4	G5
32	Green Floater	*Lasmigona subviridis*			S2S3	G3
33	Fragile Papershell	*Leptodea fragilis*			S2S3	G5
34	Tidewater Mucket	*Leptodea ochracea*			S1	G3G4
35	Eastern Pondmussel	*Ligumia nasuta*			S2S3	G4
36	Black Sandshell	*Ligumia recta*			S4	G4G5
37	Eastern Pearlshell	*Margaritifera margaritifera*		Endangered	S1	G4
38	Threehorn Wartyback	*Obliquaria reflexa*			S3	G5
39	Hickorynut	*Obovaria olivaria*			SH	G4
40	Ring Pink	*Obovaria retusa*	Endangered		SX	G1
41	Round Hickorynut	*Obovaria subrotunda*		Endangered	S1	G4
42	Orangefoot Pimpleback	*Plethobasus cooperianus*	Endangered		SH	G1
43	Sheepnose	*Plethobasus cyphyus*	Threatened	Threatened	S1	G3

Appendix 1 (continued). Regulatory, state rank (S), and global rank (G) status of Pennsylvania's freshwater mussels. Recent name changes highlighted in yellow[3].

			Regulatory Status			
	Common Name	**Species**	**Federal**	**State**	**PABS S-Rank[1]**	**Global Rank[2]**
44	Clubshell	*Pleurobema clava*	Endangered	Endangered	S2	G1G2
45	Ohio Pigtoe	*Pleurobema cordatum*			SH	G4
46	Rough Pigtoe	*Pleurobema plenum*	Endangered		SH	G1
47	Pyramid Pigtoe	*Pleurobema rubrum*			SH	G2G3
48	Round Pigtoe	*Pleurobema sintoxia*			S3S4	G4G5
49	Pink Heelsplitter	*Potamilus alatus*			S4	G5
50	Pink Papershell	*Potamilus ohiensis*			S1	G5
51	Kidneyshell	*Ptychobranchus fasciolaris*			S4	G4G5
52	Eastern Floater	*Pyganodon cataracta*			S4	G5
53	Giant Floater	*Pyganodon grandis*			S4	G5
54	Mapleleaf	*Quadrula quadrula*			S3	G5
55	Salamander Mussel	*Simpsonaias ambigua*		Endangered	S1	G3
56	Creeper	*Strophitus undulatus*			S5	G5
57	Rabbitsfoot	*Theliderma cylindrica*	Threatened	Endangered	S1S2	G3G4
58	Monkeyface	*Theliderma metanevra*			SH	G4
59	Lilliput	*Toxolasma parvum*			S1S2	G5
60	Pistolgrip	*Tritogonia verrucosa*		Endangered	S1	G4G5
61	Fawnsfoot	*Truncilla donaciformis*			S1	G5
62	Deertoe	*Truncilla truncata*			S1	G5
63	Paper Pondshell	*Utterbackia imbecillis*			S4	G5
64	Alewife Floater	*Utterbackiana implicata*			S3	G5
65	Flat Floater	*Utterbackiana suborbiculata*			S1	G5
66	Rayed Bean	*Villosa fabalis*	Endangered	Threatened	S1S2	G2
67	Rainbow	*Villosa iris*			S3	G5

[1]S-ranks updated November 19, 2014

[2]G-ranks obtained from NatureServe Explorer June 2015

[3]Names updated per Williams et al. 2017

Appendix 2. Example donor conveyance letter (courtesy of Tim Pearce, Carnegie Museum of Natural History).

DONOR CONVEYANCE LETTER

Today's date:
From: {donor}

To: Timothy A. Pearce, Assistant Curator and Section Head
Section of Mollusks
Carnegie Museum of Natural History
4400 Forbes Ave.
Pittsburgh, PA 15213-4080

Dear Tim,

Please accept this donation of {briefly describe donation}.

This donation is mine to give. I give it as an unrestricted gift to the Carnegie Museum of Natural History (and I never want it back even if it is found out later to be worth a million dollars). To the best of my knowledge it was acquired, transported, and possessed legally, and copies of all required permits (relevant collecting, export, import, endangered species, etc.), if any, are provided with the donation.

I understand that the Museum does not guarantee that objects/specimens will be exhibited, placed in the permanent collection, or maintained as a separate collection.

Sincerely,

{donor}

Literature Cited

Howells, R.G. 2011. Guide to photographing freshwater mussels. Biostudies, Kerrville, Texas. http://tpwd.texas.gov/huntwild/wild/wildlife_diversity/texas_nature_trackers/mussel-photography-howells.pdf

Sturm, C.F., Pearce, T.A., and A. Valdes. 2006. The Mollusks: A Guide to Their Study, Collection, and Preservation. American Malacological Society, Pittsburgh, Pennsylvania, U.S.A. pp. xii + 445.

Examples of poor photo vouchers