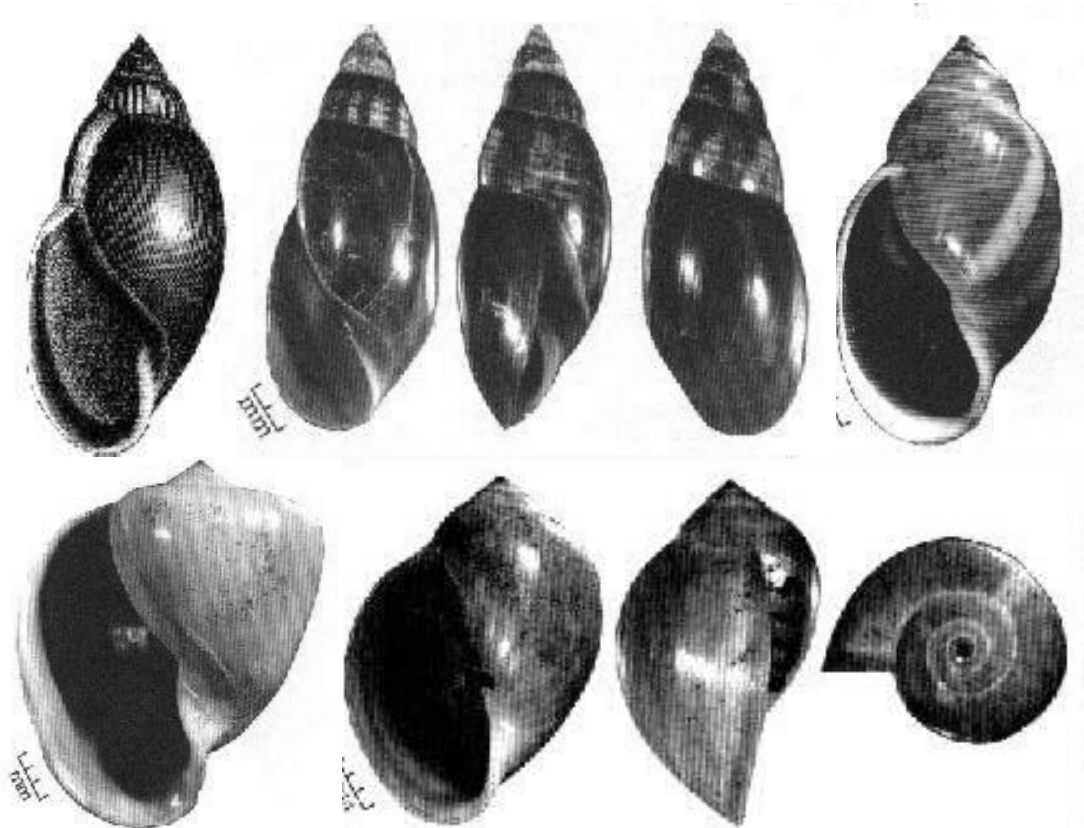


Family Physidae

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(Shell pictures taken from Burch and Tottenham 1980)

Family Physidae

The family Physidae has a holarctic distribution with extensions into Central and South America. Physidae have the following features which separate them from other pulmonate families: high spired sinistral shell, radula with teeth in v-shaped rows, no lateral teeth, and no hemoglobin or pseudobranchia. They are hermaphrodites with the ability to self fertilize and can be found in a wide variety of freshwater habitats worldwide. As a group, they display a wide variety of life history parameters which are affected by: climate, type of habitat, and whether predators or parasites are present. Members of this group can have between 1 and 3 generations per year and in some cases, they can reproduce continually (e.g. warm springs). Dillon (2000) provides an excellent ecological overview of this group. This family is also generally reproduction selected and can handle harsh environments, including environments that have been polluted. This family can be divided into six groups: *Aplexa* group (*Aplexa*), *marmorata* group (*Stenophysa*), *fontinalis* group (a), *acuta* group (c), *gyrina* group (b) and *pomilia* group (bc). These six groups are phylogenetically different, have distinctive penial morphology, and to some extent have distinctive shell morphology. Shell morphology has an environmental component in addition to a genetic component so using shell alone to distinguish members of this group can lead to mistakes in identification (DeWitt *et al* 1999, DeWitt *et al* 2000, Burnside 1998, Britton in press).

The classification within this family has been heavily debated. The most commonly used classification for this family has been that of the Burch guides (Burch and Tottenham 1980, Burch 1982, 1988, and Burch and Jung 1992) and adopted by Turgeon *et al* (1998). The classification is based on George Te's (1978) dissertation (see also Te 1975, 1980). The letters or word above the nodes reflects the penial morphology groups that Te (1978) used in his dissertation. There are 36 species along with 43 subspecies and morphs listed in the Burch guides mentioned above.

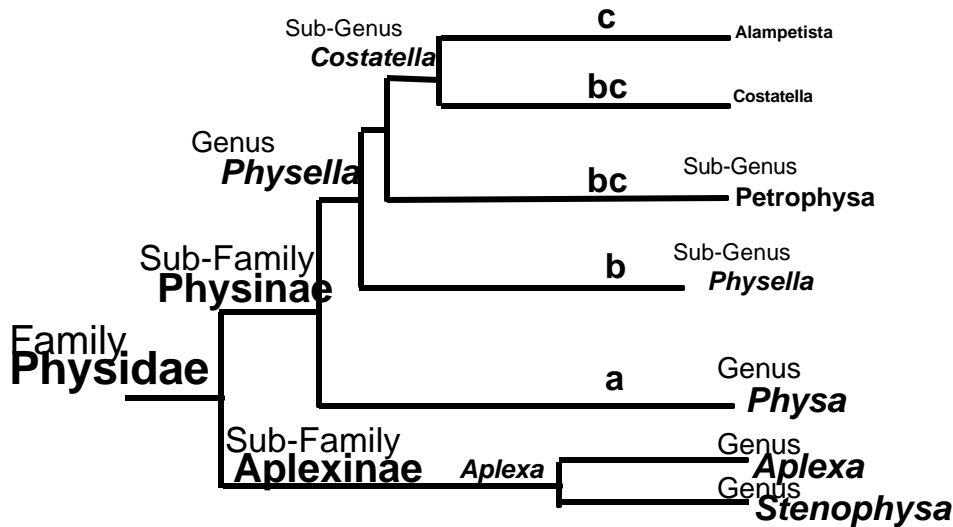


Figure 1. Te (1978) classification for Physidae.

Taylor (2003) has recently suggested an alternate classification scheme that divides each subfamily into one to seven tribes with a total number of 23-24 genera and around 80 species. The diagram below shows Taylor's genera along with the penial group Taylor assigned to each. Taylor (2003) did not separate the bc from the b penial group. Taylor (2003) feels that the area of greatest diversity for this group is Central and South America instead of North America as suggested by Te (and the Burch guides).

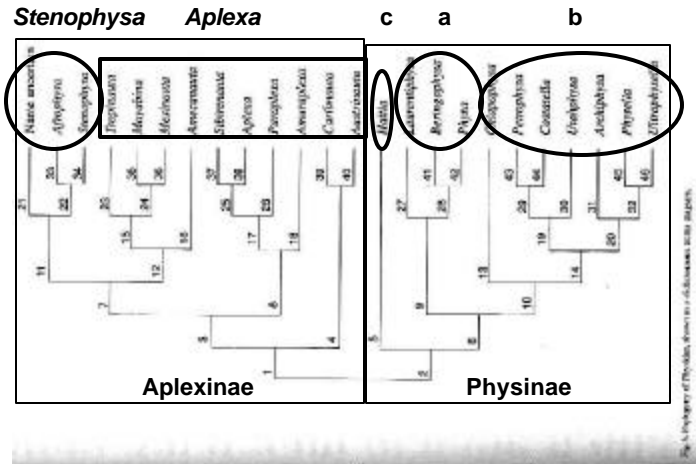


Figure 2. Taylor (2003) classification for Physidae

Burch and Jung (1992) recognized that more work is needed including molecular genetics to better resolve Physidae taxonomy. The two classification schemes above are based solely on morphology and both are weighted with regards to penial characters. Recent genetic work has been done on Physidae in both the Lydeard and Dillon laboratories. There is a strong correlation between penial morphology, reproductive isolation and a molecular phylogeny developed for the group (Dillon et al 2002, Wethington & Guralnick in press, Dillon & Wethington in press, Wethington 2004). But there are some Te and Taylor groups improperly placed or assigned, including: *Petrophysa*, bc penial group, and *Stenophysa*. Our sampling was primarily of North America and we only recognized 13 species (which includes *Physa fontinalis* and *Physa marmorata*, not of North America). We suggest that there are two genera in this family, *Physa* and *Aplexa* (Wethington 2004). The penial groups may be ranked at the subgenera level.

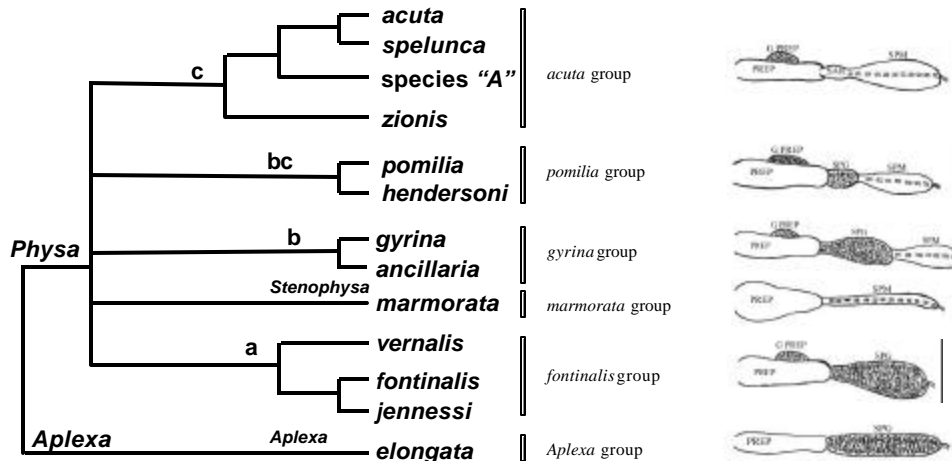


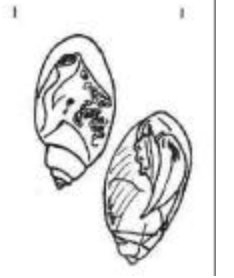

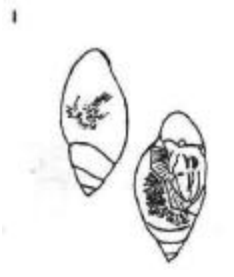

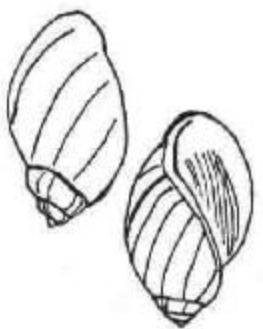



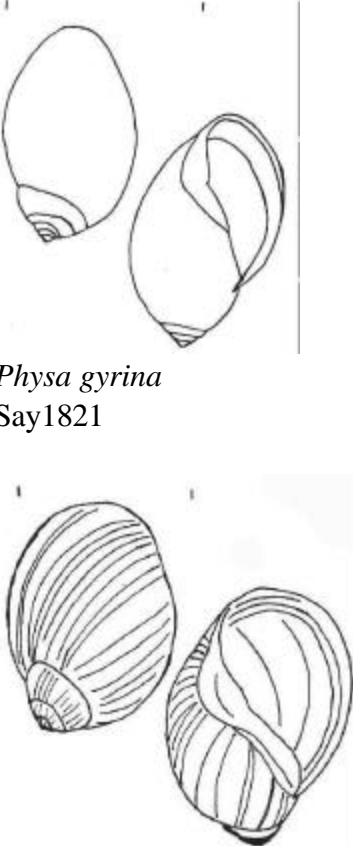

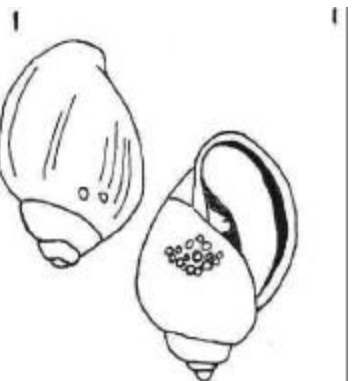



Figure 3. Wethington (2004) classification for Physidae based on mtDNA.

Table 1: Representative taxa of Physidae

General Description	Illustration (shell) (10 mm between lines)	Penial Morphology
<p><i>Aplexa</i> group</p> <p>Shell is glossy, shiny and smooth. Long and skinny shells that are generally spindle shaped and narrowly sub-ovately conic. Between 6.75 to 7.5 whorls. Aperture is relatively broad and narrows to a point. Maximum adult shell height is ~20 mm. Body of the animal is highly pigmented, foot is long and rounded which tapers to a point behind. Mantle does not protrude over the shell and has no lobes or digitations.</p> <p>The penial morphology is <i>Aplexa</i> type with no preputial gland and a one-part glandular sheath.</p> <p>The habitat is generally temporary wood pools or ditches, sometimes <i>Aplexa</i> can be found in extremely shallow streams. The animals can be found mostly floating at the surface in pairs when their habitat is inundated with water during Spring to early summer. Their distribution is circumboreal and they are mostly found at high latitudes.</p>	 <p><i>Aplexa elongata</i> (Say 1821)</p>	
<p><i>marmorata</i> group</p> <p>Shell is shiny, somewhat narrow, and ovoid-fusiform. Shell length can be as long as 16 mm. Aperture is large and is about 0.75 that of the shell length. Mantle reflects broadly on both sides. Foot generally has a median stripe in the last section that narrows to a triangular tip.</p> <p>The penial morphology consists of no preputial gland and a one-part muscular penial sheath.</p> <p>Generally found in ponds and ditches in the Greater Antilles, Central America, and parts of South America. They have been reported in Texas, but none have been collected there recently.</p>	 <p><i>Physa marmorata</i> Guilding 1828</p>	
<p><i>fontinalis</i> group</p> <p>Shell is glossy, apertures are large, and the apex of the shell is rounded. Mantle is reflected on both sides for some species; this is most pronounced in the European species, <i>Physa fontinalis</i>. The mantle is not reflected over the outer lip of the shell in <i>P. vernalis</i>. Overall, members of this group are generally small.</p> <p>Penial morphology is of the type “a” which consists of a penial gland and a one-part glandular penial sheath.</p> <p>The most commonly found species of this group in the United States is probably <i>Physa vernalis</i> which superficially resembles a juvenile <i>Aplexa</i> and can be found in ponds and ditches in the Northeastern United States.</p>	 <p><i>Physa vernalis</i> Taylor and Jokinen 1984</p>	

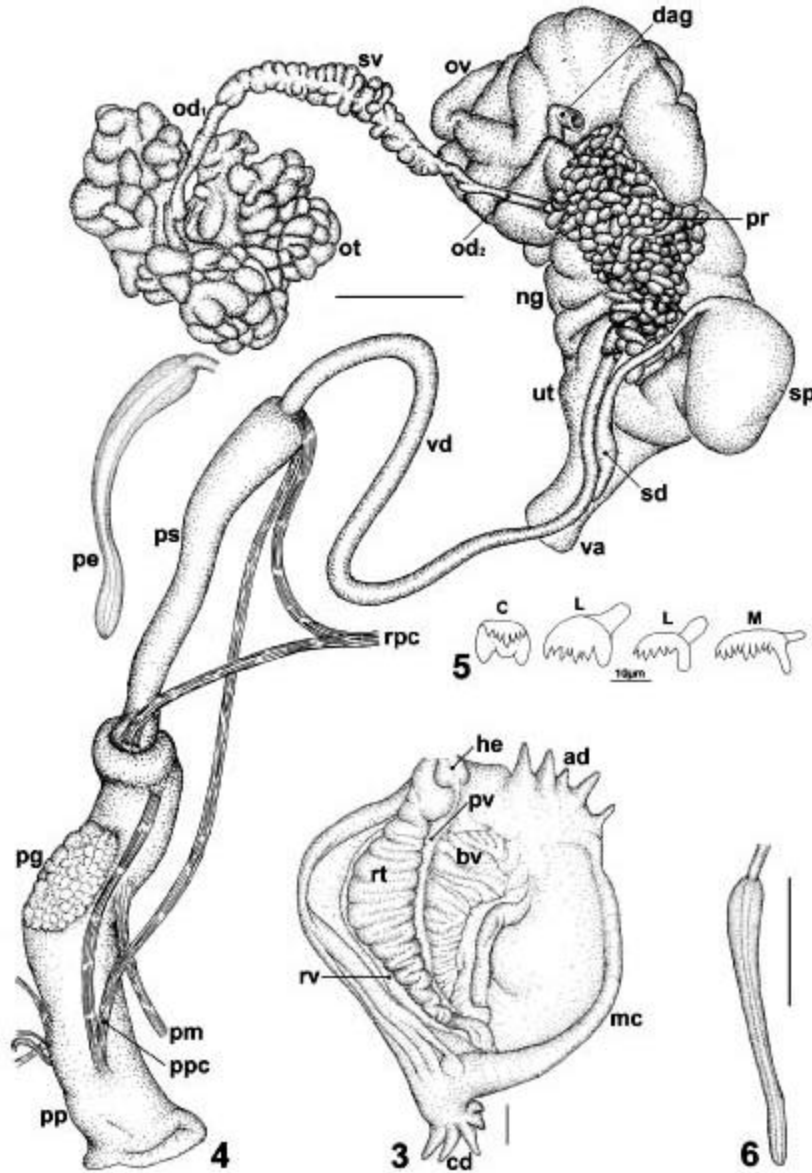
General Description	Illustration (shell) (10 mm between lines)	Penial Morphology
<p><i>acuta</i> group</p> <p>Shell shape is oval and spire is pointed (acute). Aperture is large and narrow at the top. Shell is dull and striated longitudinally. Whorls are convex with deep sutures. A good bit of color variation exists in the shell and mantle from very pale to dark, from striped to mottled to plain. An individual reaches maturity between 5-7 mm and can get as large as 15 mm or so.</p> <p>Penial morphology is of the type “c”: preputial gland present along with a one-part muscular penial sheath.</p> <p><i>Physa acuta</i> is easily the most successful physid, having been dispersed world wide and found in a variety of fw habitats. It is a generalist and reproduction selected. It can survive well under harsh conditions, as long as they are short-lived.</p> <p>This group has a huge amount of genetic variation both within species and within populations. This variation along with a lack of reproductive isolation between nominal species has lead to many species within this group becoming synonymized under the name <i>Physa acuta</i>, including <i>P. heterostropha</i>, <i>P. integra</i>, <i>P. cubensis</i>, and <i>P. virgata</i> (Dillon et al, 2002; Wethington 2004). Basal populations of this group uncovered in mitochondrial based phylogenies have also been found to be at least partially reproductively isolated from geographically nearby populations in the one case that has been closely studied (Dillon, personal communication).</p>	 <p><i>Physa acuta</i> Draparnaud 1805</p>	
<p><i>acuta</i> group: <i>Physa zionis</i></p> <p>Shell is a rounded oval shape. Spire is very short and rounded. Aperture is almost as long as the shell itself and very broad. The animal is highly pigmented, practically a solid black. The foot of the animal is very large and broad apparently adapted to provide a sufficient suction for the animal to climb the vertical cliffs where it is primarily found (where the rock seeps). Their foot is also helpful in keeping the animal from being swept off the canyon wall when the Virgin River floods.</p> <p>Penial morphology is of the type “c”: preputial gland present along with a one-part muscular penial sheath.</p> <p><i>Physa zionis</i> is probably the most misunderstood physid. Highly endemic to its type locale: along the Narrows trail in Zion National Park. It can be found proximately close to <i>P. gyrina</i>, but the latter is restricted to horizontal, stream-based habitat. Not much is known of living specimens, just that they are quite prolific, are extremely small as adults (5 mm is a whopper), egg masses range in size from 1 to about 4 embryos, they are definitely not <i>P. gyrina</i>, and they are a basal member of the <i>acuta</i> group.</p>	 <p><i>Physa zionis</i> Pilsbry 1926</p>	

General Description	Illustration (shell) (10 mm between lines)	Penial Morphology
<p><i>gyrina</i> group</p> <p>Shell shape is oval to round. Spire is raised with rounded or somewhat flattened sutures to being short with a prominent shoulder. Mature sizes can range from being extremely small (around 4 to 5 mm) to extremely large (as large as 24 mm). Shell color is variable from pale yellow, to dark with red stripes, to black. The shell shape for <i>Physa gyrina</i> is skinny with a prominent spire. <i>Physa ancillaria</i> has a globose shell with a more flat spire, generally thicker, and sometimes with prominent shoulder.</p> <p>Penial morphology is of the type “b”: preputial gland present along with a two-part penial sheath (one part glandular, one part muscular). The two sheaths are roughly equal in size.</p> <p><i>Physa gyrina</i> is a specialist. It can survive under harsh conditions as long as the overall environment is stable and rich. <i>Physa gyrina</i> is found in rivers, streams, intermittent ponds, and large lakes all over North America and has been introduced at least in Europe. <i>Physa ancillaria</i> is more restricted to the more Northern latitudes of North America and can be found in large rivers and large lakes. There may be an underlying physiological difference between these two species which affects how well the animals get oxygen and thermo-regulate based on the difference in culture ability (Dillon & Wethington in press, Wethington 2004).</p> <p><i>Physa gyrina</i> and <i>P. ancillaria</i> are genetically very similar. Mitochondrial DNA can separate them into the two groups, but allozymes cannot. The two species can interbreed at least to some extent and a recent allozyme study showed that geography is more important than shell shape with regards to genetic distance between populations of both forms. It is possible that this may be one amazingly diverse and phenotypically plastic species, <i>P. gyrina</i>.</p>	 <p><i>Physa gyrina</i> Say 1821</p> <p><i>Physa ancillaria</i> Say 1825</p>	
<p><i>pomilia</i> group</p> <p>Shell is oval shaped with a pointed, but rounded spire. Sutures are prominent and whorls are convex as in <i>P. acuta</i>. It has been commonly referred to as a subspecies of <i>P. heterostropha</i> (now synonymized with <i>P. acuta</i>), but it is genetically and biologically distinct.</p> <p>Penial morphology is of the type “bc”: preputial gland present along with a two-part penial sheath (as in <i>P. gyrina</i>), but unlike <i>P. gyrina</i>, the muscular sheath is much larger than the glandular sheath.</p> <p>This species is found more often in large rivers, but can also be found in ponds. Individuals can reproduce at an unusually</p>	 <p><i>Physa pomilia</i></p>	

<p>small size, around 4 mm or less. It is less common than members of the <i>acuta</i> or <i>gyrina</i> group. It has a rather disjunct and patchy distribution in the United States (Alabama, South Carolina, Kansas, Connecticut, and California (<i>Physa costata</i>) populations are known).</p>	<p>Conrad 1834</p>	
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-Notes-

Figure 4. This figure is taken from Paraense and Pointier 2003. It depicts the internal reproductive anatomy of *Physa acuta* in detail.



Physa acuta. Fig. 3: roof of pulmonary cavity (ad = apical digitations of mantle collar; bv = blood vessels; cd = columellar digitations of mantle collar; he = heart; mc = mantle collar; pv = pulmonary vein; rt = renal tube; rv = renal vein). Fig. 4: reproductive system (dag = duct of albumen gland – gland removed; ng = nidamental gland; od₁ = proximal segment of ovispermiduct; od₂ = distal segment of ovispermiduct; ot = ootestis; ov = oviduct; pe = penis; pg = preputial gland; pm = protractor muscle of prepuce; pp = prepuce; ppc = protractor muscle of penial complex; pr = prostate; ps = penis sheath; rpe = retractor muscles of penial complex; sd = spermathecal duct; sp = spermatheca; sv = seminal vesicles; ut = uterus; va = vagina; vd = vas deferens). Fig. 5: radular teeth (C = central; L = lateral; M = marginal). Fig. 6: penis of *Physa cubensis* from Batabanó, Cuba. Bar (unless otherwise stated) = 1 mm

Dissection Instructions for use in identifying physids.

You will need a dissecting microscope, a petri dish, a pair of iris scissors, two forceps, and either pond water or ethanol (or favorite preservative solution).

Step one: Separate the shell from the snail. You can do this by carefully crushing the shell with the two pair of forceps and then pulling the shell fragments off to one side.

Step two: Cut away the mantle and pull off to either side.

Step three: Use the scissors to make a cut between the eyes and posteriorly. Try to cut the mesentery only. You should be able to see the heart and the penial organ will be on the snail's left side. The penial organ will be folded up and wrapped onto itself. I usually take the penial apparatus out and stretch it to better see the different parts. Be careful to include as much of the preputium as possible in order to diagnose the presence or absence of a preputial gland.

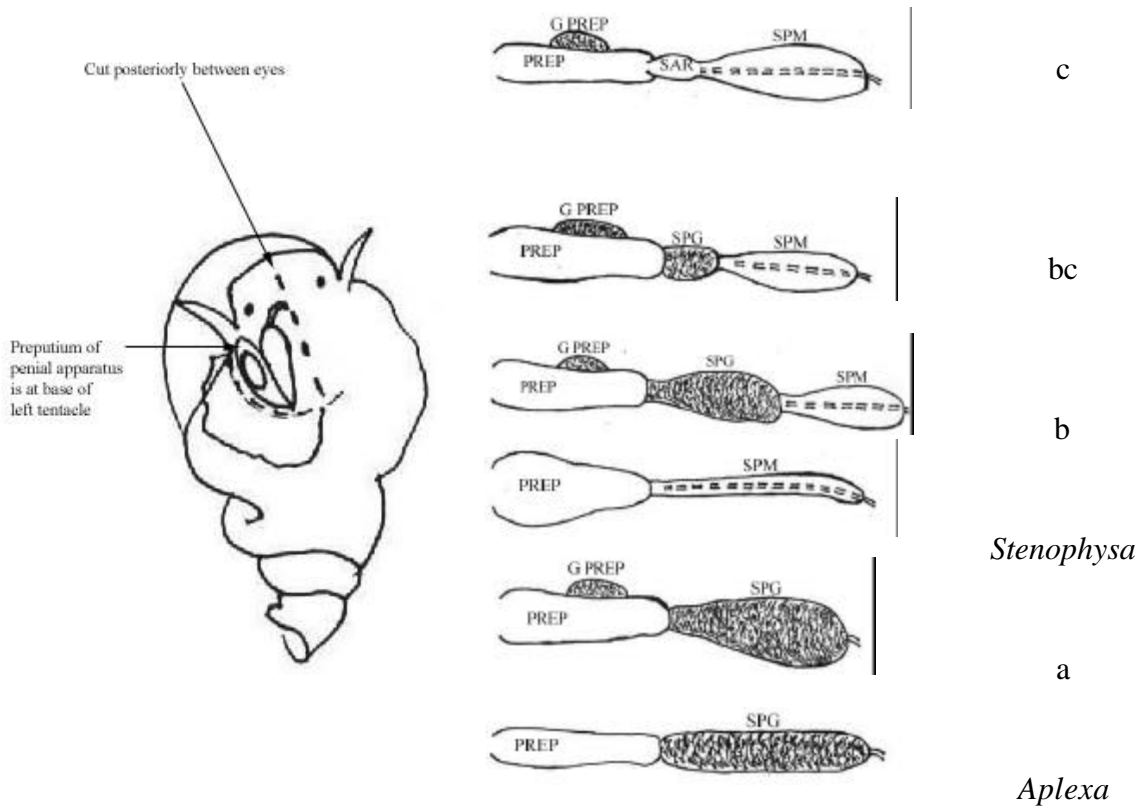


Figure 5: Diagram for dissecting the penial organ from a physid along with a diagram showing the penial organ for the six categories of physids. PREP = Preputium. G PREP = Preputial gland. SAR = Sarcobelum. SPM = Muscular penial sheath. SPG = Glandular penial sheath.

Table 2. Currently recognized species (names as in Burch guides + some species described since then), G-rank, and tentative distribution of the North American Physidae:

Group	Taxa	Author	G-Rank	Listed	Distribution
<i>Aplexa</i>	<i>Aplexa elongata</i>	(Say 1821)	G5		Canada, New England states, Great Lake states, WA, ID, UT, WY
a	<i>Physa jennessi</i>	Dall 1919	G5		AK, North West Territories, British Columbia
	<i>Physa skinneri</i>	Taylor 1954	G5		Canada, MA, PA, and west to MI
	<i>Physa megalochlamys</i>	Taylor 1988	G3		Saskatchewan, CO, ID, MT, OR, UT, WY
	<i>Physa vernalis</i>	Taylor & Jokinen 1984	G3		New England States and up into Eastern Canada
bc	<i>Physella (Costatella) costata</i>	(Newcomb 1861)	G1		CA
	<i>Physella (Costatella) hendersoni</i>	(Clench 1925)	G5		AL, FL, GA, NC, MO, MS, SC, TN, VA, WV
	<i>Physella (Costatella) pomilia</i>	(Conrad 1834)	G5		Eastern US to Ohio and Mississippi River drainages and IO
c	<i>Physella (Costatella) acuta</i>	(Draparnaud 1805)	G5		Practically world wide
	<i>Physella (Costatella) bottimeri</i>	(Clench 1924)	GUQ		NM, OK, TX
	<i>Physella (Costatella) conoidea</i>	(Fischer & Crosse 1886)	G3		TX
	<i>Physella (Costatella) cubensis</i>	(Pfeiffer 1839)	G5		Bahamas, Cuba, Jamaica, Puerto Rico, West Indies, Honduras and FL.
	<i>Physella (Costatella) heterostropha</i>	(Say 1817)	G5		Nova Scotia to Ontario; New England to Ohio, TN, VA, WV, Bahamas
	<i>Physella (Costatella) humerosa</i>	(Gould 1855)	G3		CA, AR, CO
	<i>Physella (Costatella) integra</i>	(Haldeman 1841)	G5		Canada, Great Lake States, KY, IO, MN, NY, OH, WI, SD, TN, WV
	<i>Physella (Costatella) natricina</i>	(Taylor 1988)	G1	LE	ID
	<i>Physella (Costatella) osculans</i>	(Haldeman 1841)	G3		CO west to CA, southeast to AR and into Mexico
	<i>Physella (Costatella) spelunca</i>	(Turner & Clench 1974)	G1		WY
	<i>Physella (Costatella) squalida</i>	(Morelet 1851)	G5		TX into Mexico, Central and South America, Costa Rica
	<i>Physella (Costatella) virgata</i>	(Gould 1855)	G5		Western US (West of TX)
	<i>Physella (Petrophysa) zionis</i>	(Pilsbry 1899)	G2		UT

Group	Taxa	Author	G-Rank	Listed	Distribution
b	<i>Physella (Physella) ancillaria</i>	(Say 1825)	G5		Eastern Canada and North Eastern US
	<i>Physella (Physella) boucardi</i>	(Crosse & Fischer 1881)	GU		NV, CA, and south into Mexico
	<i>Physella (Physella) columbiana</i>	(Hemphill 1890)	G2		WY, MT, west to WA
	<i>Physella (Physella) cooperi</i>	(Tryon 1865)	G3		WY west to CA and east to CO
	<i>Physella (Physella) globosa</i>	(Haldeman 1841)	GU		KY, OH, TN
	<i>Physella (Physella) gyrina</i>	(Say 1821)	G5		Canada, US, and introduced into Europe
	<i>Physella (Physella) hordacea</i>	(Lea 1864)	G1		British Columbia, WA, OR
	<i>Physella (Physella) johnsoni</i>	(Clench 1926)	G3		Alberta
	<i>Physella (Physella) lordi</i>	(Baird 1863)	G5		British Columbia south to MT, NV, CA
	<i>Physella (Physella) magnalacustris</i>	(Walker 1901)	G2		Ontario, south to Great Lake States & IN, east to VT and MN
	<i>Physella (Physella) microstriata</i>	(Chamberlain & E. G. Berry 1920)	GX		UT
	<i>Physella (Physella) parkeri</i>	(Currier (in DeCamp) 1881)	G2		Quebec, Ontario, MI, WI, MN
	<i>Physella (Physella) propinqua</i>	(Tryon 1865)	G5		British Columbia south to WA, MT, WY, NV and CA
	<i>Physella (Physella) traski</i>	(Lea 1864)	?		CA, OR
	<i>Physella (Physella) utahensis</i>	(Clench 1925)	G2		CO, UT, WY
	<i>Physella (Physella) vinosa</i>	(Gould 1847)	GU		Canada and Great Lake States
	<i>Physella (Physella) virginea</i>	(Gould 1847)	G2		British Columbia south to CA
	<i>Physella (Physella) wrighti</i>	(Te & Clarke 1985)	G1		Alberta

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