Biofouling Control Strategies

A Field Guide for Maryland Oyster Growers

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Unless otherwise noted, photos were taken by Shannon Hood.

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INTRODUCTION TO THIS HANDBOOK

The Chesapeake Bay is populated by many commercially and ecologically important species. This diversity is valuable to the Bay's ecology. In oyster aquaculture, colonization by some of these species can cause problems. Biofouling, or plants and animals which colonize oysters and/or cages, can affect profitability. Conservative estimates indicate that 5-10% of total costs to the aquaculture industry are attributed to biofouling control[1]. These organisms can affect shellfish growth and condition[2], shell strength[3] and valve movement[4]. They can also colonize cage materials, which increases weight for handling and reduces critical water flow by clogging meshes in the cage[5,6].

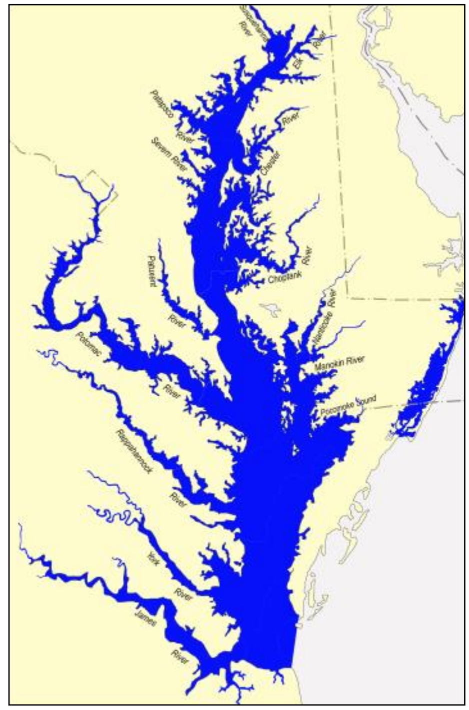
This field guide is meant to be carried on board the vessel for quick use in identifying common biofouling organisms in the Chesapeake Bay. For each species, "Description" gives an overview of how the organism looks and functions; "Habitat" indicates areas of the Bay where they may be found; "Operational Effects" tells how the species influences oysters, gear or both; and "Control Strategies" provides information on documented treatments that have proven effective in controlling the species on adult oysters. Images of each species will assist with identification.

Detailed recordkeeping is recommended, noting water temperature and salinity, if possible, and dates when biofouling organisms were first observed. This information can be used in future years to judge when species may affect the operation. Early identification and control of fouling organisms allows the grower to put controls into effect as quickly as possible.

Each location in the Bay is unique. Testing a control strategy on a small sample of oysters and/or cages is recommended before moving to large scale application. For additional assistance in identifying species or developing applied research for a control strategy, please contact your University of Maryland Extension Aquaculture Team.

Macroalgae

Ulva lactuca, Ulva intestinalis
Gracilaria sp., *Ectocarpus* sp.



Macroalgae habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

Description

U. lactuca is a vibrant green macroalgae with a broad, sheet-like shape and slightly curled edges that often float freely in the water column. *U. intestinalis* is a vibrant green, filamentous algae which often attaches to substrate[7]. *Gracilaria* sp. are reddish brown to purple branching macroalgae[7] and *Ectocarpus* sp. are tan to brown delicate filamentous algae[7].

Habitat

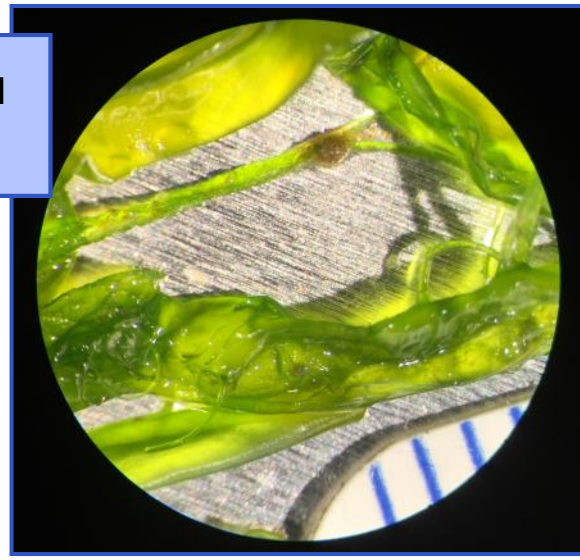
U. lactuca and *U. intestinalis* are common in shallow intertidal regions of the Chesapeake Bay in salinities of 11-30[7]. *Gracilaria* sp. are common in higher salinity regions of the mid and lower Chesapeake Bay in salinities of 18-30[7]. *Ectocarpus* sp. are common in salinities of 11 - 30, but associated with winter months when water temperatures have declined[7].

Operational Effects

Macroalgae can colonize oysters and cages. This can detract from appearance of market products. In sufficient quantities, macroalgae can contribute to meshes being blocked and flow to oysters restricted. Large volumes of macroalgae can cause odor problems when decomposing.

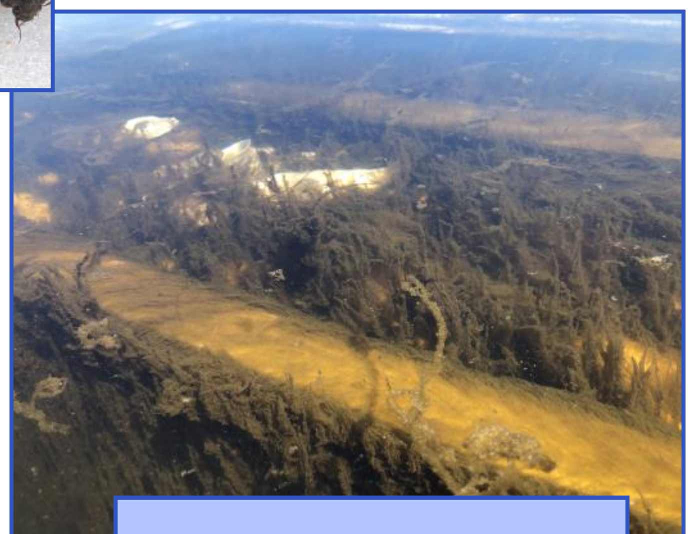
Control Strategies

- **Desiccate:** Weekly desiccation for 4, 8 or 24 hours may reduce macroalgae presence, but desiccation for 8 or 24 hours weekly may lead to reduced growth and longer time to market[8]. The effectiveness of desiccation may depend on the ability of cages and algae to fully dry, as inconsistencies have been seen in the effectiveness of desiccation to control macroalgae.
- **Physical:** Manual removal by tumbling, scraping or pressure washing may eradicate macroalgae.



Ulva intestinalis viewed under magnification.

Red algae fouling on an oyster cage. Red algaes are common in higher salinity waters and can be found deeper than green algaes.



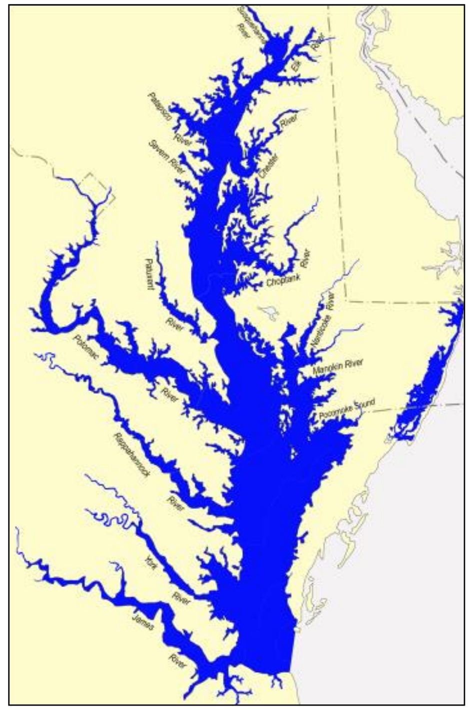
Ectocarpus fouling on an oyster cage in water. The algae is thin, light brown and filamentous.

Ulva lactuca covering a rock in the shallow intertidal zone.

COLONIAL ORGANISMS

Cushion Moss

Victorella pavida



Cushion Moss habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

Description

V. pavida is a soft bodied bryozoan that forms dense mats on shellfish, debris, pilings, jetties, boats, and other surfaces that can be up to ¼ inch (6mm) in height[9].

Habitat

This bryozoan is common in fresh to brackish waters and found in coastal regions of North and South America, Europe, Africa and Asia[9]. It has been documented in salinities from 0 through 36[9].

Operational Effects

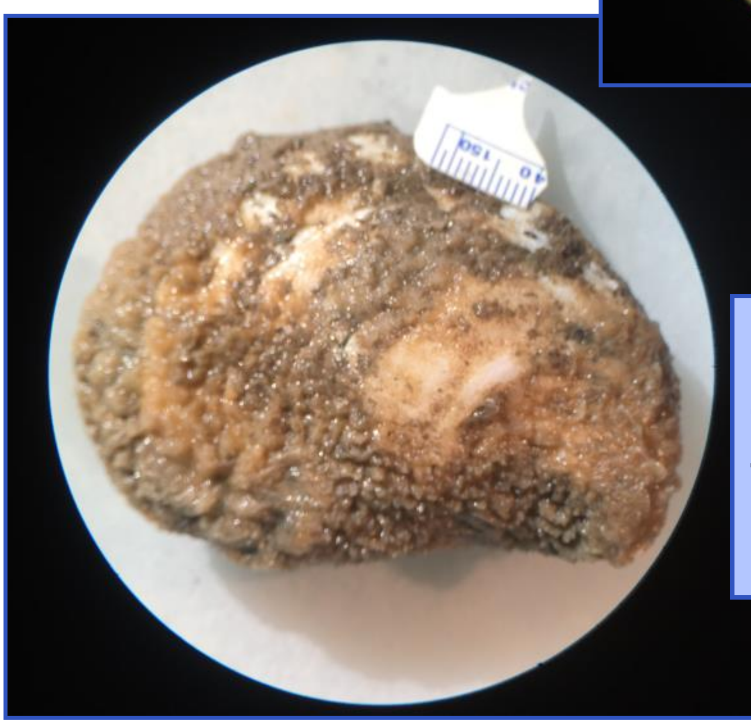
This bryozoan can quickly establish on oysters and cages, which adds weight to gear and blocks cage mesh. As a phytoplankton consuming filter feeder, *V. pavida* may compete with oysters for food, and it can detract from the appearance of the shell.

Control Strategies

- **Desiccate:** Weekly desiccation for 4, 8 or 24 hours has been shown to significantly reduce *V. pavida* presence on oysters and cages, although 4 hour desiccation was less effective in mid-summer during intense colonization and desiccation for 8 or 24 hours weekly can result in slower oyster growth[8].
- **Physical:** Manual removal by scraping or pressure washing may remove *V. pavida* .

Dense population of cushion moss on a growout basket. Notice that the openings in cage mesh have been reduced due to severe cushion moss presence.

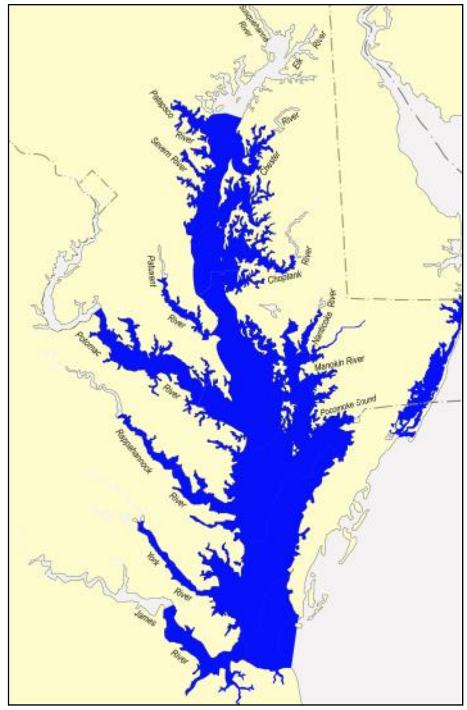
Closeup view of cushion moss. Individual animals make up this colony of bryozoa.



Cushion moss on an oyster. The bryozoa can become so thick on an oyster that the oyster is not visible.

Encrusting Bryozoans

Conopeum tenuissimum, Membranipora tenuis



Encrusting Bryozoan habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

Description

C. tenuissimum and *M. tenuis* are delicate in appearance, with colonies typically whitish to gray and growing radially along substrates. They tend to furl upward when horizontal space has been exhausted[7].

Habitat

C. tenuissimum is native to the US Atlantic and Gulf Coasts, but has been introduced to other locations. They have been found in salinities as low as 6[10] and as high as 37[11]. *C. tenuissimum* is the most abundant species in the Chesapeake Bay, but *M. tenuis* is common and can overgrow *C. tenuissimum*[7].

Operational Effects

Encrusting bryozoans colonize oysters and gear and may detract from visual shell appearance.

Control Strategies

- **Desiccate:** Weekly desiccation for 4, 8 or 24 hours significantly reduced encrusting bryozoa presence on oysters, but treating for 8 or 24 hours weekly can result in slower growth and longer time to market[8].

Encrusting bryozoan that has grown upward in 3 dimensional space after horizontal space was used up.

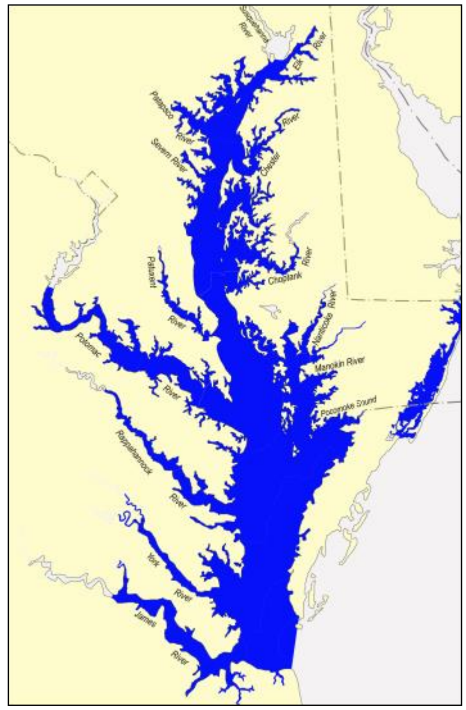
Encrusting bryozoan on an oyster cage. They typically begin in an area and radiate outward, covering all horizontal space before growing three dimensionally.

Encrusting bryozoan on an oyster. Individual animals make up this colony of bryozoa and are recognizable as a faint sheen growing on top of the oyster shell.

Barnacle

(Bay Barnacle, White Barnacle, Little Gray Barnacle, Ivory Barnacle)

Balanus improvisus, Balanus subalbidus, Chthamalus fragilis, Semibalanus eburneus



Barnacle habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

Description

Barnacles are white to gray crustaceans reaching up to 1 inch (25 mm) in size. Overlapping shell plates come together at an opening at the top from which plates open and a feeding appendage protrudes. Barnacles can close their plates to insulate themselves from environmental conditions.

Habitat

Barnacles of interest in the Chesapeake Bay include bay barnacles *(Balanus improvisus)* and white barnacles (*Balanus subalbidus)* which dominate brackish waters of the upper Bay in salinities of 0.8 - 17.9[12] and the little gray barnacle (*Chthamalus fragilis)* and ivory barnacle (*Semibalanus eburneus)* which dominate areas of the lower Bay in salinities of 20 through full seawater[9].

Operational Effects

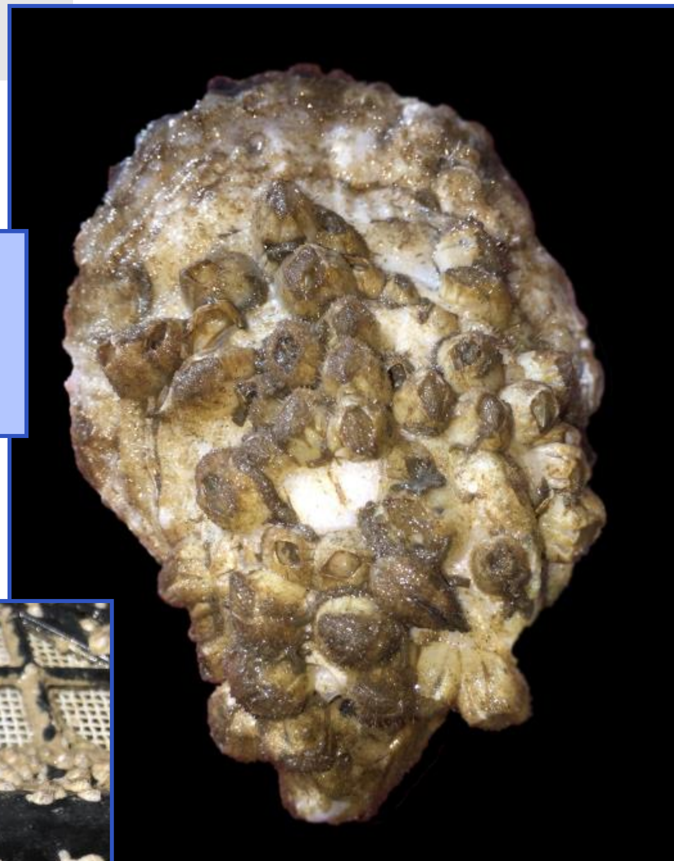
Barnacles set on oysters and cages. They may detract from shell appearance and, in large numbers, can add weight to equipment and may block cage mesh, reducing flow through cages.

Control Strategies

- **Desiccate:** Weekly desiccation for 4, 8 or 24 hours significantly reduced bay barnacle presence on oysters, but desiccation for 8 or 24 hours weekly may be cause slower growth of oysters[8] and longer time to market. Desiccation must be timed to control barnacles as juveniles, since adult barnacles can tolerate lengthy desiccation intervals. Quick identification and treatment are recommended for effective control.
- **Physical:** Manual removal by tumbling, scraping or pressure washing may remove barnacles.

Barnacle with its feeding appendage extended. Note the overlapping plates and the opening along the top of the barnacle.

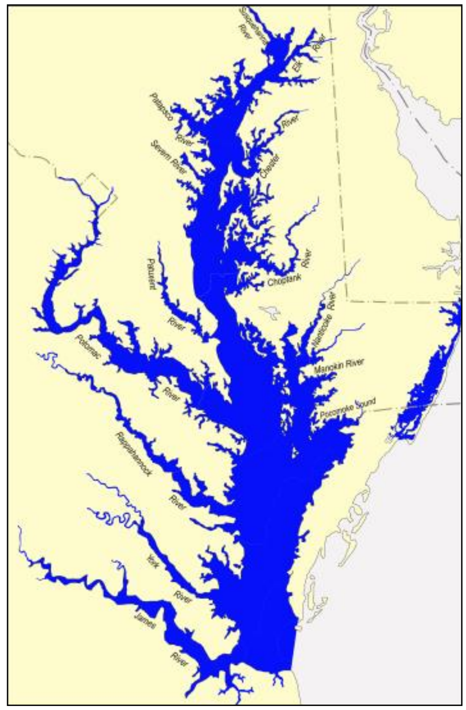
Photo credit: "*Amphibalanus improvisus*_(I1553)_0892" by SERC Photos from Flickr licensed under CC by 2.0.



Barnacles (5 months old) attached to an adult oyster.

Newly set juvenile barnacles. Barnacle sets tend to be episodic, with many barnacles setting over a short period of time.

False Mussel
Dark False Mussel
Mytilopsis leucophaeata



False Mussel habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

SOLITARY ORGANISMS

Description

A bivalve mollusc with a thin, oval shaped shell. Ridges radiate conically from hinge to bill. Coloration is often brown/tan[7]. Mussels attach to substrate using byssal threads and can reach 1 inch (25mm) in length[9].

Habitat

The false mussel is native to US south Atlantic and Gulf of Mexico regions, but has been documented in many coastal areas of the United States, South America and Europe. It is common in fresh to brackish waters (salinity 0.5 - 5) but has been documented in salinity up to 30[9].

Operational Effects

Mussels can detract from the visual shell quality of oysters and, as phytoplankton feeders[9], may compete with oysters for food.

Control Strategies

- **Desiccate:** Weekly desiccation for 4, 8 or 24 hours significantly reduced false mussel presence on oysters, but desiccation for 8 or 24 hours weekly can lead to reduced growth and longer time to market[8]. Desiccation must be timed to control mussels when they are juveniles, as adult mussels can tolerate lengthy desiccation intervals. Quick identification and treatment are recommended for effective control.
- **Physical:** Manual removal by tumbling, scraping or pressure washing may remove mussels.

This juvenile false mussel is brownish gray in color with ridges radiating conically from the hinge. Some of the byssal thread is visible along the right side of the mussel.

False mussel, showing darker coloration. Ridges radiate conically from hinge to bill.

Photo credit: "Mytilopsis_leucophaeata_(I0840)" by SERC Photos from Flickr licensed under CC by 2.0.

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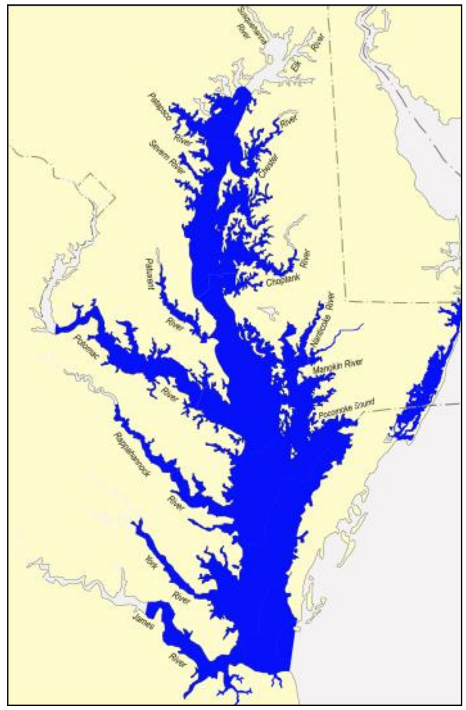
Hooked Mussel

Ischadium recurvum



Hooked Mussel habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

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Description

A bivalve mollusc with a thin, oval shaped shell. The shell surface is marked with longitudinal lines, or ridges extending from hinge to bill with colors ranging from greyish blue/brown to greenish yellow[9]. Mussels attach to substrate using byssal threads and can reach 1-2 inches (25-50mm) in length[9].

Habitat

These mussels are native to the Gulf of Mexico and North American Atlantic Coast and have also been found in Europe[9]. They have been found in salinities as low as 4.5[13] through full seawater[9].

Operational Effects

Mussels can detract from visual shell quality of oysters. As phytoplankton feeding bivalves[9], they may compete with oysters for food.

Control Strategies

- **Desiccate:** Weekly desiccation for 4, 8 or 24 hours significantly reduced hooked mussel presence on oysters, but desiccation for 8 or 24 hours weekly may lead to reduced growth and longer time to market[8]. Desiccation must be timed to control mussels when they are juveniles, since adult mussels tolerate long desiccation periods.
- **Physical:** Manual removal by tumbling, scraping or pressure washing may remove mussels.

Juvenile hooked mussel viewed under magnification. Notice the longitudinal lines that radiate outward from the hinge.

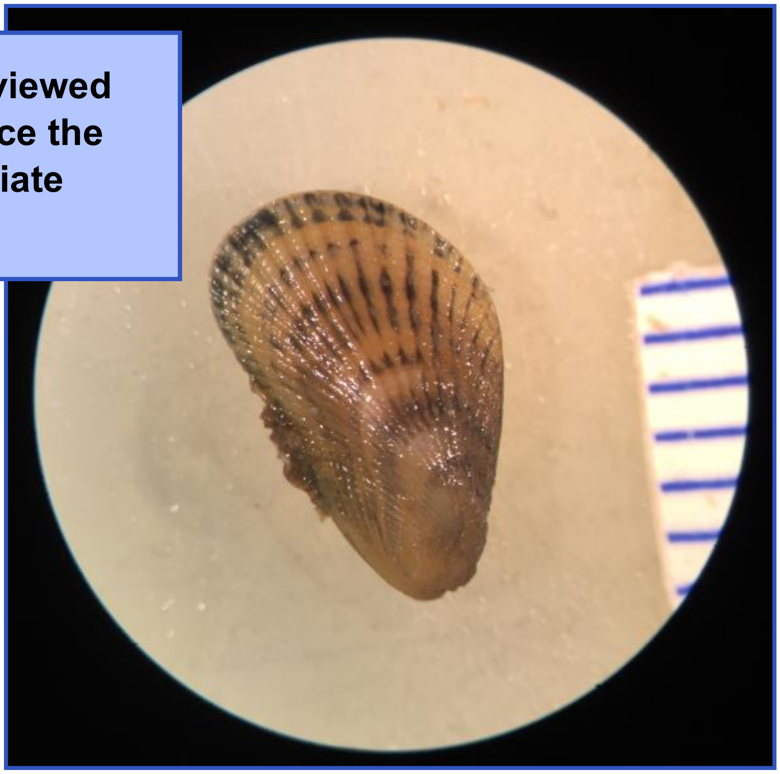


Photo credit: “File: Ischadium recurvum SERC 7-29-14 (14607619819).jpg” by Smithsonian Environmental Research Center from Wikimedia Commons licensed under CC by 2.0.

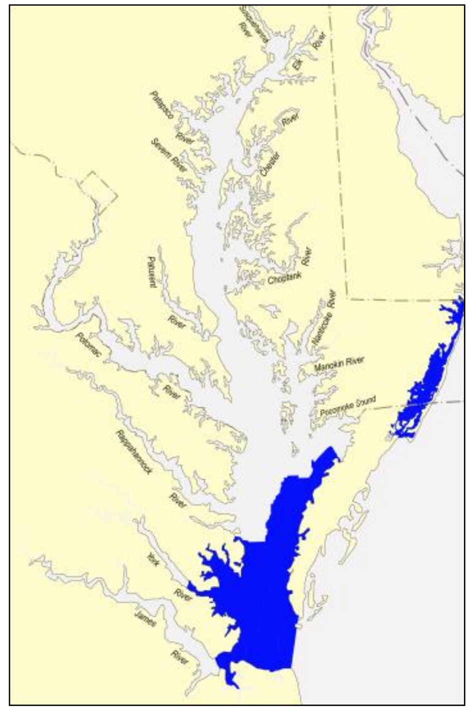
Adult hooked mussel, which is fouled by an encrusting bryozoan. Notice the longitudinal lines that radiate outward from the hinge, in the non-fouled parts of the mussel.

Slipper Limpet

Crepidula sp.

Description

The Atlantic slipper limpet is a mollusc with an arched, dome shaped shell[7]. Limpets may stack on top of one another and form dense populations[14]. Limpets can reach ¾ inch (20mm) in 2 years.



Slipper Limpet habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

Habitat

The Atlantic slipper limpet is found in high salinity waters of the lower Chesapeake Bay and Atlantic Coastal Bays[7] in salinities from 20 through full seawater[14].

Operational Effects

Slipper limpets colonize on top of oysters, forming chains or clusters on top of one another[14]. This can reduce space available for oysters and, as phytoplankton consumers[15], slipper limpets may compete with oysters for food.

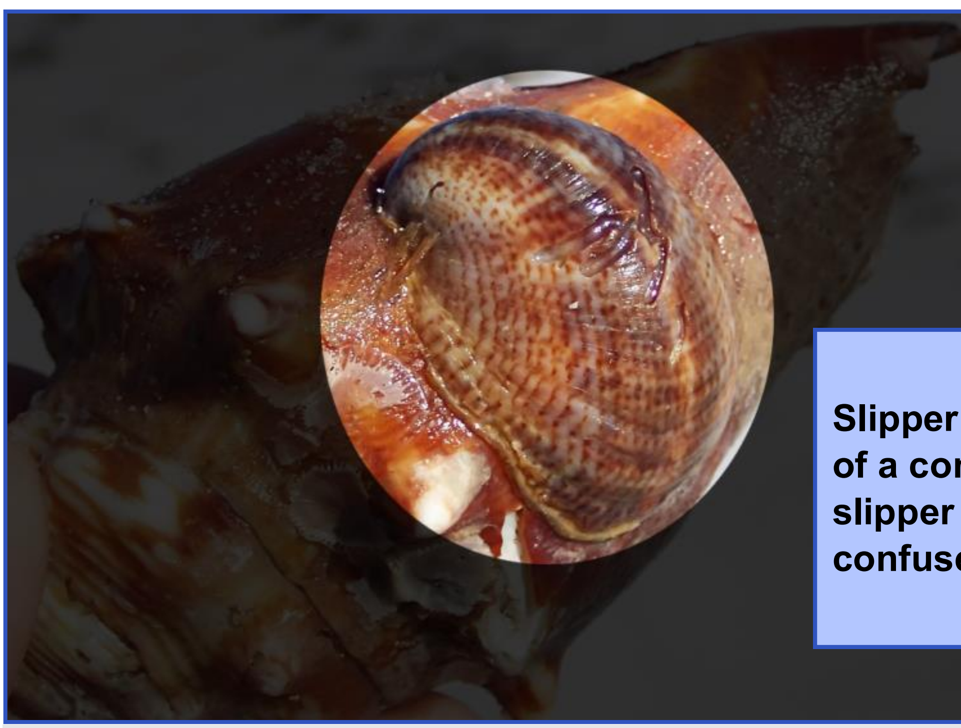
Control Strategies

- **Brine:** A three to five (3-5) minute dip in saturated salt solution followed by 30-60 minutes of air drying may kill slipper limpets[16].
- **Physical:** Manual removal by tumbling, scraping or pressure washing may remove slipper limpets.

Slipper limpets stacked on the shell of a horseshoe crab. Notice that the limpets stack on top of one another very closely.

Photo credit: “Horseshoe crab, right side up” by brownpau from Creative Commons licensed under CC by 2.0.

SOLITARY ORGANISMS

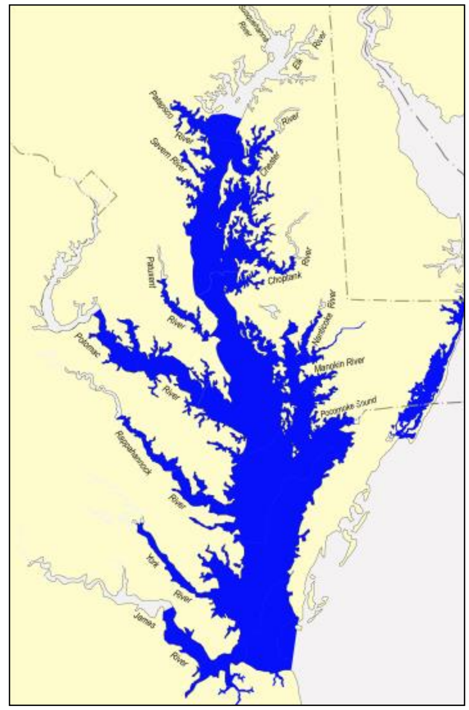


Slipper limpet on the shell of a conch. As juveniles, slipper limpets can be confused with oyster spat.

Photo credit “Crepidula fornicata (common Atlantic slipper snail) attached to a Strombus alatus shell (Cayo Costa Island, USA) 1” by James St. John from Creative Commons licensed under CC by 2.0.

Ghost Anemone

Diadumene leucolena



Ghost Anemone habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

Description

This anemone is characterized by a tubular column and tentacles along their top. They can reach 1½ inches (38mm) in height and ½ inch (12mm) in width[9] and range in color from translucent pink/yellow/orange to green[7].

SOLITARY ORGANISMS

Habitat

Ghost anemones are native to the US Atlantic coast, but have been introduced to other coastal areas[9]. They are widespread in the Chesapeake Bay[7] and found in salinities ranging from 7 through full seawater[9].

Operational Effects

Anemones colonize oysters and may detract from shell appearance.

Control Strategies

- **Desiccate:** Weekly desiccation for 4, 8 or 24 hours significantly reduced reduced anemone presence on oysters, but desiccation for 8 or 24 hours weekly may lead to reduced growth and longer time to market[8] .
- **Physical:** Manual removal by scraping or pressure washing may remove anemones.

Ghost anemone in water. Notice the tentacles along the top of the anemone and the tan tubular column.

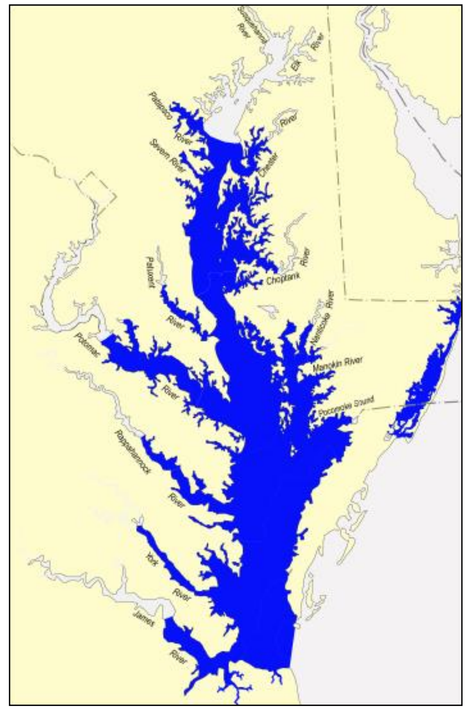
Photo credit: "Diadumene_leucolena_(I0977)" by SERC Photos from Flickr licensed under CC by 2.0.

Ghost anemone in water. Notice the tentacles along the top of the anemone and the pink/orange column.

Photo credit: "Diadumene leucolena_Manokin_08-28-17_0593" by SERC Photos from Flickr licensed under CC by 2.0.

Sea Squirt

Molgula manhattensis



Sea Squirt habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

Description

M. manhattensis is a solitary tunicate with two siphons along its front. Sea squirts can reach 2 inches (50mm) and are typically tan/yellow/greenish in color[9].

Habitat

M. manhattensis is native to the US Atlantic and Gulf Coasts, but has been introduced around the world. They are found in salinities as low as 10[17] and as high as 35[9].

Operational Effects

M. manhattensis attaches to oysters and cages, which increases weight on culture equipment and can block openings in the mesh. Since they are also phytoplankton feeders, *M. manhattensis* may compete with oysters for food[16].

Control Strategies

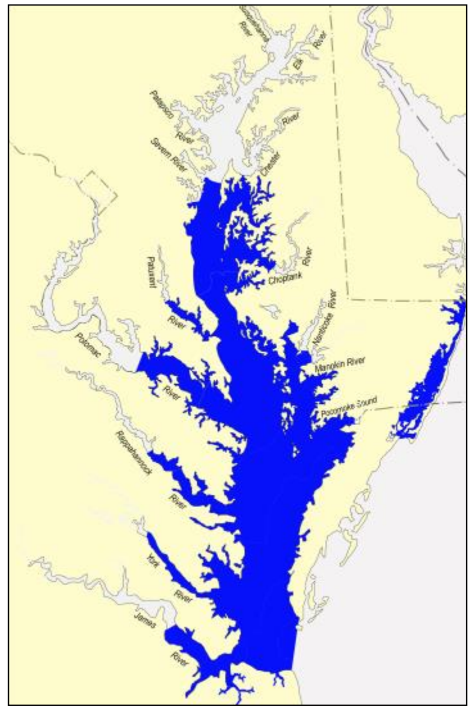
- **Brine:** Dip for one to three (1-3) minutes in saturated salt solution, followed by one hour of air drying can lead to *M. manhattensis* mortality[16].
- **Physical:** Manual removal by scraping or pressure washing may remove sea squirts.

Closeup image of a sea squirt. Notice the two siphons along the top. One siphon draws water in, and the other pushes water out.

Oyster bag with heavy sea squirt fouling. Sea squirts set heavily on the upper portion of the inside of the bag.

Boring Sponge

Cliona truitti
Cliona celata



Boring Sponge habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat. ***There are areas known to have Boring Sponge problems that may need special vigilance.***

Description

Yellow to orange sponge which bores into the shell (*C. celata*: orange, *C. truitti*: yellow to orange[18]). Sponge tissue may be noted by many small holes in the shell and a sulfuric (rotten egg) smell may accompany infestation by *C. celata*.

Habitat

Cliona truitti: Documented in waters with salinities ranging from 14-36[19]. Most abundant in brackish and lower salinity areas[18,19].
Cliona celata: Documented in waters with salinities ranging from 3-36, with greater prevalence in salinities above 14[19]. Most abundant in high salinity areas[19].

Operational Effects

General: Bores into oyster shells, resulting in brittle shell, susceptibility to predation and reduced condition.

Control Strategies

- **Brine:** Place in saturated salt solution for 3 minutes, followed by one hour of air drying[16].
- **Brine:** Place in saturated salt solution for 6 minutes, followed by 18 hours of air drying every 2 years[21].
- **Desiccate:** Regular desiccation[24], which must be maintained consistently. Sponge tissue may be degraded from a single treatment but will recover in several weeks[21], so repeated procedures will be needed.

Live *Cliona* sp. growing on an oyster shell. Note the small circular areas of sponge flesh visibly protruding from the shell (left).

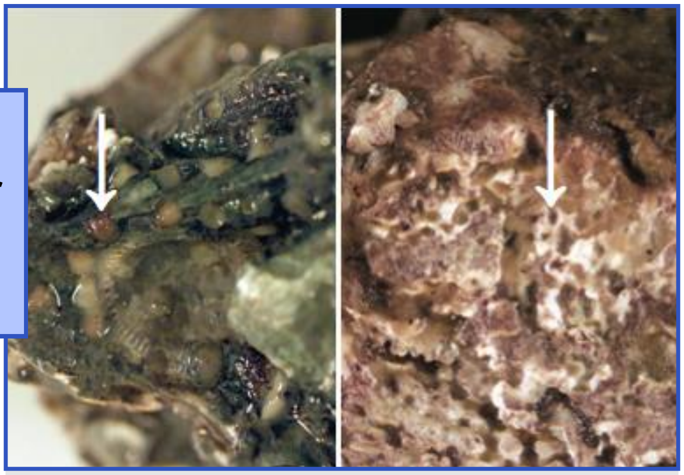


Photo credit: Howard et al., 2004.[40]

Boring sponge and shell damage to the outside of an oyster shell. The sponge is the yellow/ orange visible within the crevices. The many holes and crevices have resulted from extensive boring by the boring sponge.

Photo credit: "Cliona truitti_Chop_06-19-19_0805" by SERC Photos from Flickr licensed under CC by 2.0.

Boring sponge and shell damage to the interior of an oyster shell. Boring has been so significant that the sponge has penetrated the shell entirely and reached the interior surface.

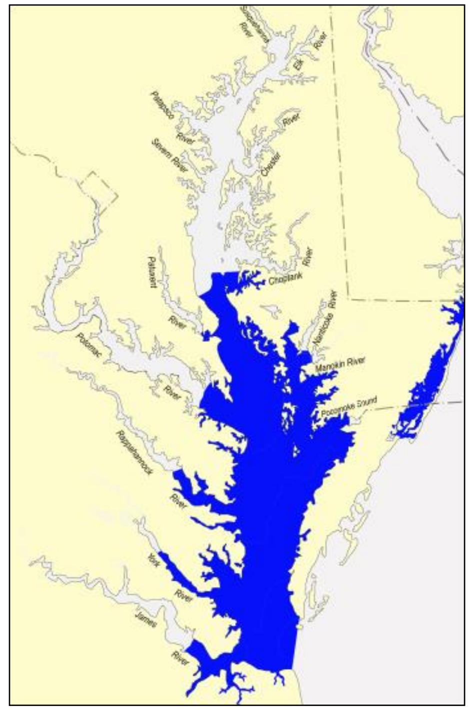
Photo credit: "Cliona truitti_Chop_06-12-19_0810" by SERC Photos from Flickr licensed under CC by 2.0.

SPONGES

Red Beard Sponge

Clathria prolifera

(formerly *Microciona prolifera*)



Red Beard Sponge habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

Description

This sponge is vibrant red to orange in color and has a fleshy texture. It can grow to 8 inches (20 cm) tall and 12 inches (30 cm) wide and can form thick clusters[25].

Habitat

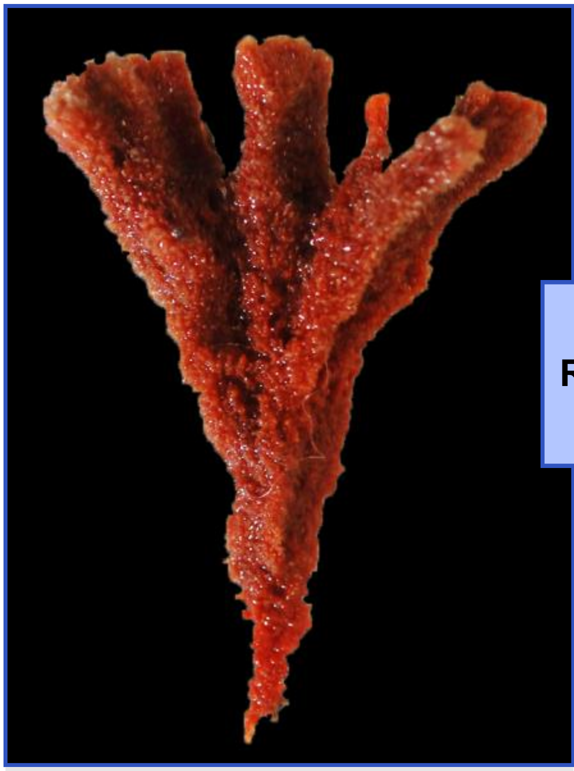
Red beard sponge is native to the Northwestern Atlantic Ocean, but is also found in the eastern Pacific. It inhabits mid and lower areas of the Chesapeake Bay, in salinities from 15 through full seawater[25].

Operational Effects

Red beard sponge grows on external surfaces of oysters and does not penetrate the shell. However, it may obstruct the oyster's ability to open and close properly[4].

Control Strategies

- **Physical:** Manual removal by tumbling, scraping or pressure washing may remove red beard sponge.



Red beard sponge.

Photo credit: "Clathria_prolifera_(I0151)" by SERC Photos from Flickr licensed under CC by 2.0.

Red beard sponge on an adult oyster. Notice that the sponge covers the entire right side of the oyster, both front and back.

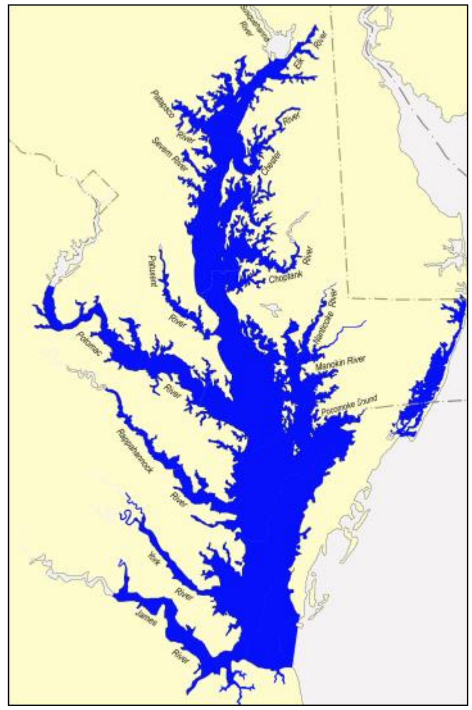
Clam Worm

Alitta succinea

(formerly *Nereis succinea*)

Description

A polychaete worm that can grow up to 7½ inches (190mm) long and ¼ inch (7mm) wide[26]. It has a segmented body with a thin bloodline visible along the top of the worm. In summer they undergo a dramatic transformation, changing body shape and size to become shorter and stout, with females taking on a yellow to green coloration[26].



Clam Worm habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

Habitat

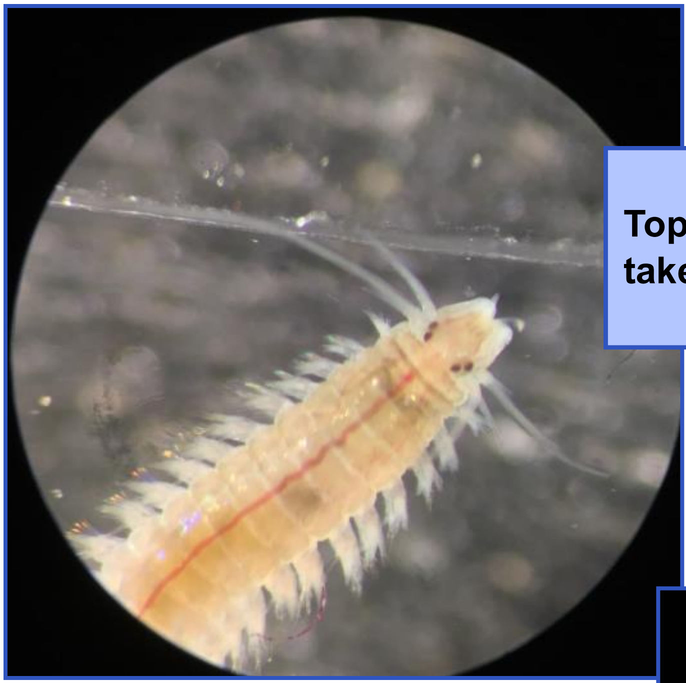
While its origins are uncertain, the clam worm is thought to be native to the western North Atlantic, but has been documented across throughout coastal areas of North America, South America, Europe, Africa and Asia[9]. The clam worm is found in marine to brackish waters (salinity of 2.5 through full seawater[9]), and can withstand freshwater inundation[26]. They are common in soft substrate, and often found with oyster reefs, mussel beds and other benthic habitats. The worm burrows quickly into soft sediments and is found in crevices within oyster shells[26].

Operational Effects

Burrows made by clam worms can add weight to cages and equipment. Worms hide in oyster crevices and emerge after harvest, where they can be seen crawling along the oyster shell which creates an unsightly product for consumers.

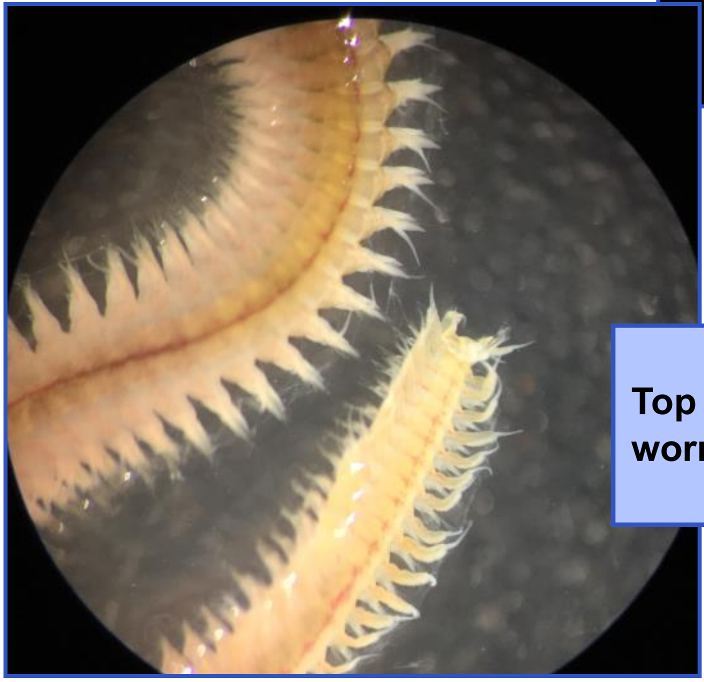
Control Strategies

- **Desiccate:** Once weekly desiccation (4, 8 or 24 hours) yielded significantly reduced worm presence, but desiccation for 8 or 24 hours weekly can result in slower growth of oysters[8] and longer time to market.



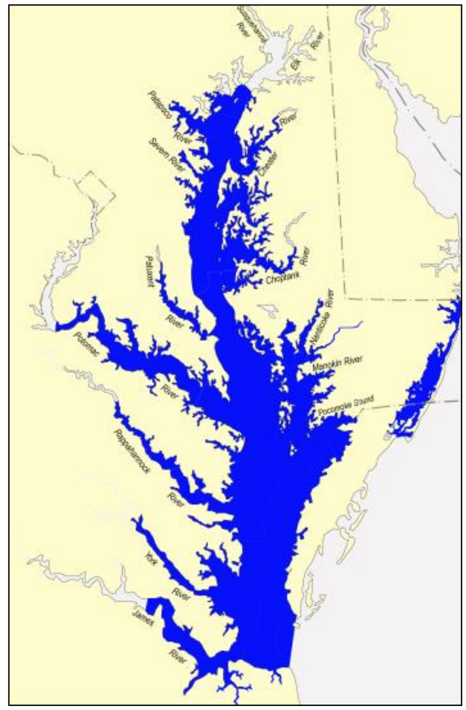
Top view of the head of a clam worm, taken under magnification.

View of the underside of a clam worm, taken under magnification.



Top view of the body of a clam worm, taken under magnification.

Mudworm
Mud Blister Worm
Polydora websteri



Mudworm habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

Description

Polychaete worms that bore into shellfish, including oyster shells, and cause a distinctive "U-shaped" burrow in the shell.

Habitat

Polydora websteri has a worldwide range and is often found living with shellfish along the US Atlantic and Gulf Coasts. In the Chesapeake Bay, mudworms are found in salinities of 5 – 30[7].

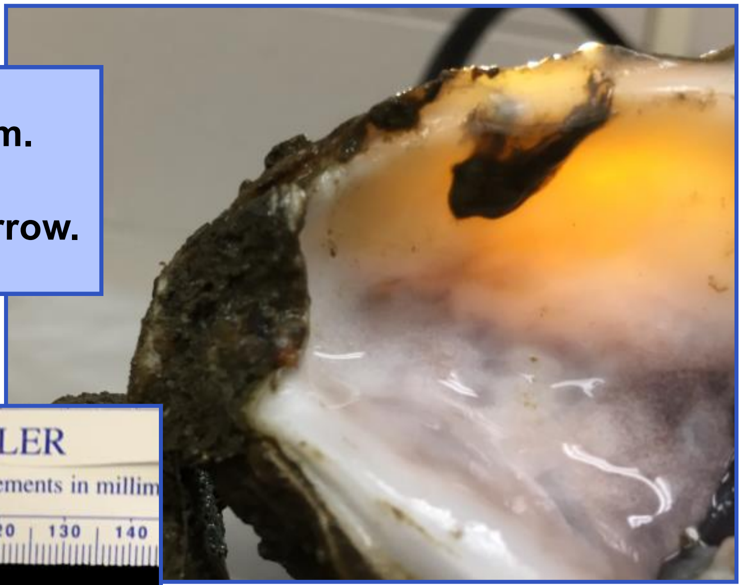
Operational Effects

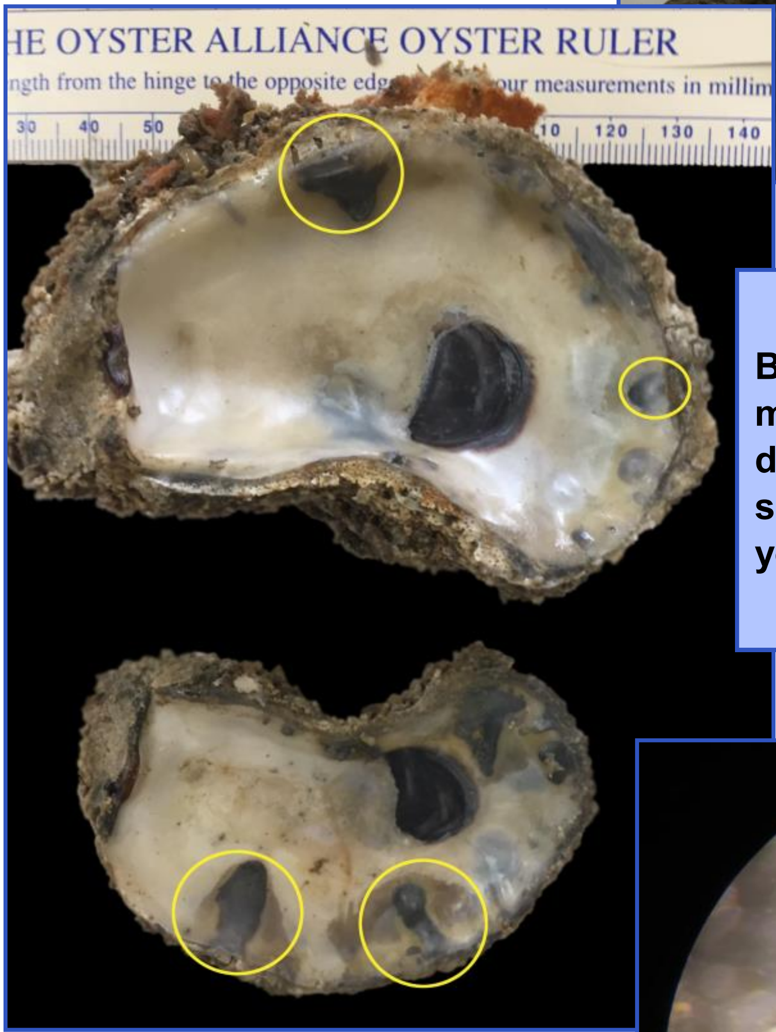
Mudworms bore into the shells of oysters, causing the oyster to deposit a layer of nacre to insulate itself from the burrow. The burrow expands and fills with detritus and worm feces underneath the thin layer of nacre deposited by the oyster. This can detract from the visual appearance of shucked oysters[27], weaken their shells[28], and lead to reduced meat quality and reduced energy available for growth[2].

Control Strategies

- **Brine:** Five to fifteen (5-15) minute dip in a saturated salt solution followed by air drying for a minimum of one hour reduced worm infestation[29]. It is important to note that the temperature of the solution may stress oysters and result in mortality[27].
- **Desiccate:** Once weekly desiccation (4, 8 or 24 hours) yielded significantly reduced worm presence, but desiccation for 8 or 24 hours weekly can result in slower growth of oysters and longer time to market[8,30]. Aerial exposure during low tide (40% aerial exposure or ~5 hours per low tide) reduced worm prevalence, but led to slower growth of oysters[31].
- **Freshwater:** Three to six hour dip in freshwater, followed by a minimum of one hour of air drying can reduce worm infestation[27].
- **Lime:** Ten (10) minute dip in a calcium hydroxide (0.2% lime + 99.8% freshwater) solution once per week yielded significant reduction in worms with no significant difference in oyster growth or survival[32].

Burrow resulting from a mudworm. Notice the "U shape" with two openings along the top of the burrow.





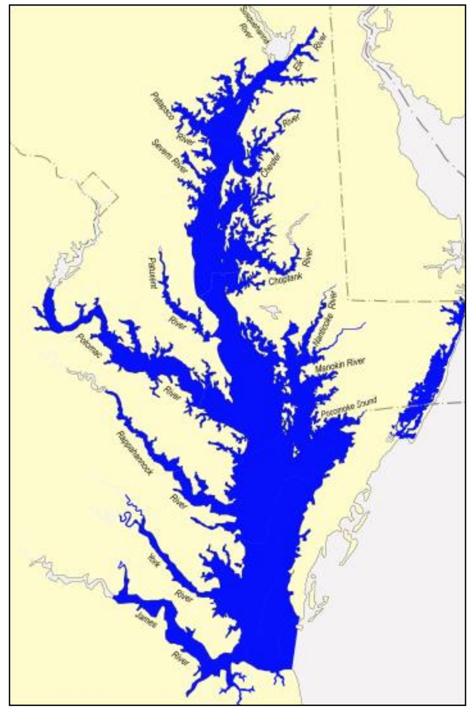
Burrows resulting from mudworms. Notice the many discolored areas around the shell margin, resulting from years of mudworm infestation.

Mudworm viewed under magnification. Palps along the head are used to sense the mudworm's environment.

Whipworm

Polydora cornuta

(formerly *Polydora ligni*)



Whipworm habitat in the Chesapeake Bay and Maryland's coastal bays. Bright blue areas indicate suitable habitat.

Description

The whipworm is a polychaete worm reaching up to 1¼ inch (32mm) in length. They are segmented with two long sensory palps extending from the head and are generally tan in color[9].

Habitat

Whipworms have been seen in coastal areas of North American East and West Coasts and many other locations. They are found in salinities from 2 - full strength seawater where they form burrows in sediment and on hard substrates[9].

Operational Effects

Thick mats of whipworm burrows can increase the weight of cages and equipment; the dry weight of mud accumulations has been estimated to be up to 98 tons per acre[33]. Severe infestations can block cage mesh and reduce flow to growing oysters.

Control Strategies

- **Physical:** Regular pressure washing can effectively remove whipworm infestations[34]. They are often confused with mudworms and some methods demonstrated for use with mudworms may prove effective in whipworm control.

Burrows made by whipworms on an adult oyster. Severe infestations can become so thick that the oyster is not recognizable.

The whipworm has long palps extending from its head that it uses to sense its environment.

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CONCLUSION

Biofouling can pose challenges to commercial growers, but control strategies have proven successful. Regularly monitoring oysters and cages will show when colonization occurs and treatment should be started. Most species are more easily controlled when they are young. Annual variability in salinity and other water quality parameters can alter the local fouling community, and some species may only be observed occasionally. Monitoring and recordkeeping of conditions of your oysters and equipment will aid you in identifying new colonization and allow you to treat it quickly, effectively and with less expense.

Some strategies have been effective on a range of species, while others target specific ones. As a farmer, you can select a treatment with broad applicability or target specific problem species. Each farm site is different and may not have all the organisms included in this handbook.

While we have focused on proven methods to control species common in the Chesapeake Bay, a great deal of research has been carried out to investigate control of biofouling broadly. Strategies including desiccation[30,31,35,36], brine dips[37] and freshwater dips[38,39] have been used across a range of species in diverse regions.

We suggest applying a control method on a small number of oysters and/or gear before starting broad scale application. Some sites may require modification to the previously identified control strategies to maximize effectiveness. It is important to assess effectiveness of control methods and compare the effort needed for application and effects on your business. For additional assistance in identifying species or developing a control strategy, please contact your University of Maryland Extension Aquaculture Team.

GLOSSARY

Appendage: A projecting part of an organism with a distinct appearance or function.

Biofouling: The accumulation of waterborne organisms on surfaces in the water, such as oysters, cages and floats.

Brackish: Water with a salt content between freshwater and seawater.

Brine: A saturated saline solution, with salinity greater than 50, made by adding salt to water until no more can be dissolved. Salt should be marine grade, such as those made for aquaria. The amount of salt needed to reach saturation will vary, but as a general rule, requires adding 2.5 pounds of salt per gallon of estuarine water or 4 pounds per gallon of fresh water. Measuring the salinity of your solution can be done quickly and accurately using a refractometer or hydrometer, which are generally available at stores selling aquarium supplies.

Bryozoan: Small aquatic animals that form colonies on substrates.

Byssal thread: Strong fibers produced by the byssus gland in many bivalve mollusks, including mussels. The fibers allow mussels to attach to substrates.

Desiccate/Desiccation: The process of exposing something to air and allowing it to dry thoroughly.

Colonial: Organisms that form colonies consisting of many physically connected discrete individuals.

Encrusting: To cover something thoroughly.

Filamentous: Having a form consisting of thin, flexible threadlike objects.

Nacre: A calcium-based material excreted by bivalve mollusks (including oysters) along the inner part of their shell.

Palp: Sensory organs, resembling antennae, along the head of segmented worms. Worms used these palps to sense food and other aspects of their environment.

Phytoplankton: Microscopic aquatic plants drifting in the water column.

Polychaete: Annelid, segmented worms, generally inhabiting marine waters.

Salinity: The amount of salt in a waterbody. Freshwater has a salinity of 0, while seawater has a salinity of ~35.

Siphon: Component of many organisms, including sea squirts, which allow the organism to draw in and expel water. One siphon brings water, oxygen and food into the sea squirt, and the other siphon expels water.

Tunicate: A group of marine invertebrates, which includes sea squirts. These organisms have a rubbery external layer and two siphons.

Valve: Another word for oyster shells.

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