



ON THE LOOKOUT FOR  
INVASIVE TUNICATES

*Identification Guide for Early Detection and Response*



# ON THE LOOKOUT FOR INVASIVE TUNICATES

## *Identification Guide for Early Detection and Response*



Developed by  
**Lorne Curran**  
lornecurran@gmail.com

Introduction by  
**Samuel Chan**  
Oregon Sea Grant, samuel.chan@oregonstate.edu

Original layout by  
**Jennifer Lam**  
Oregon Sea Grant

Edited by **Rick Cooper**, graphic design by **Jared Corcoran**.

Guide revised February 2015 by **Samuel Chan, Jennifer Lam, Kayla-Maria Martin, and Tania Siemens**.

## ACKNOWLEDGMENTS

We thank **Amy Benson** (U.S. Geological Survey) for her thorough review and maps specifying current distribution of species, **Amanda Slade** for her carefully crafted species illustrations, and **Rick Cooper** (Oregon Sea Grant) for his editing expertise. Special thanks to all who contributed materials, feedback, and advice on this project. Appreciation is also extended to the many photographers and artists who contributed their images for the benefit of this project.

Published by Oregon Sea Grant,  
© 2015 by Oregon State University  
To order copies, call 541-737-4849 or e-mail  
sea.grant.communications@oregonstate.edu

## PARTNERS IN THIS EFFORT



# CONTENTS

## LET'S WORK TOGETHER

- 1 Introduction
- 27 Controlling Invasive Species
- 29 References

## SOLITARY TUNICATES

- 7 *Styela clava*
- 9 *Ciona savignyi*
- 11 *Ciona intestinalis*
- 13 *Molgula manhattensis*

## COLONIAL TUNICATES

- 17 *Didemnum vexillum*
- 19 *Botrylloides violaceus*
- 21 *Botryllus schlosseri*
- 23 *Diplosoma listerianum*
- 24 *Distaplia occidentalis*

## SOCIAL ASCIDIAN

- 25 *Perophora japonica*



Tunicate colonies of *Didemnum vexillum* encrusting mussel cages. Okeover Inlet, Malaspina Peninsula, BC (Gordon King, Taylor Shellfish Farms, Inc.)

Cover photo: *D. vexillum* overgrowing N Feather Duster Worm on mooring line, Winchester Bay, Oregon (Lorne Curran).

# WHY SHOULD WE BE CONCERNED ABOUT INVASIVE TUNICATES?

**TUNICATES, OR SEA SQUIRTS**, are ancient, attaching marine animals that have evolved over 500 million years in association with cyanobacteria, which gives tunicates different colors. They filter-feed voraciously through an inhalant siphon, and expel the filtered water through an exhalant siphon (see illustrations on pages 4 and 6). Tunicates have two life stages that enable them to spread: a swimming juvenile tadpole stage with a primitive “backbone,” and an adult “sessile” stage. The name “tunicate” comes from its unique exoskeleton, or “tunic,” comprised of cellulose formed from proteins and carbohydrates. Tunicates are believed to have first evolved as solitary organisms. Some species of tunicates have evolved to form highly efficient, interconnected colonies (colonial tunicates), allowing them to foul substrates and overgrow other marine organisms.

The nonindigenous tunicates listed in this guide are invasive on the west coast of North America. They spread rapidly and are easily transported by boating gear and aquaculture. They foul surfaces of boats, fishing nets, water intakes, docks, and buoys, making them costly to control, and their ability to smother shellfish beds and sensitive marine environments is a significant threat to other marine life. The fouling potential from tunicate invasions can be severe, given tunicates’ ability to reproduce asexually by budding, or breaking off as fragments, and through sexual reproduction where tadpoles emerge and attach themselves to surfaces to form new colonies. Under cooler and shaded conditions, the majority

of tunicates can survive for 48 hours out of water. Their ability to survive this long out of water indicates that they may be transported inadvertently by normal boating activities (Darbyson et al. 2009).

Tunicates colonize primarily hard surfaces, as epibionts (organisms that live on the surface of other organisms), and increasingly on human-made infrastructure such as docks, pilings, jetties, aquaculture facilities, nets, lines, boats, and water intakes. Though individual tunicates (zooids) are small, they are efficient suspension filter-feeders of plankton, bacteria, and other fine particulate organic materials, often filtering hundreds of liters of seawater per day through their gill sacs. Unlike bivalves (mussels and clams), tunicates efficiently capture the suspended food on the mucous layer lining the branchial basket. Since tunicates are often epibenthic (growing over other organisms), they may have an additional competitive advantage over the aquaculture bivalves they foul.

Not all nonindigenous tunicates become invasive. Environmental factors such as water conditions, substrate, food web dynamics, climate, radiation, benthic diversity, and pressure from human introductions via maritime activities can contribute to the spread, establishment, and growth of an infestation. Until we gain a better understanding of these interactions, prevention and early detection and rapid response (EDRR) will continue to be emphasized as the principal forms of management.

## ARE TUNICATES HITCHING A RIDE ON YOUR HULL?

Although colonial tunicate mats (such as *Didemnum*) can break apart and spread via currents or storms, the primary way tunicates spread is either through the ballast water of ships or by attaching themselves to boats that are moved from one body of water to another.

### WHAT YOU CAN DO TO HELP:

1. Clean your boat hull before you move from one harbor to another.
2. Educate yourself and others.

If your boat has been in dock for more than a week, inspect its hull for fouling tunicates. Clean the hull before moving the boat from one harbor to another. Dispose of the tunicates in a dumpster, leave them to dry out on the dock, or soak them in a bucket of fresh water for several days. Also, check any gear that spends long periods of time in the water.

And here's how you can keep these invaders from becoming a serious threat:

**INSPECT** your boat before you leave the dock.

**REMOVE** single tunicates by snipping them off at the base of the stalk.

**DISPOSE** of tunicates in the garbage.

**CLEAN** your hull regularly.

**REPORT** anything that may be an invasive tunicate:

**OregonInvasivesHotline.org, 1-866-INVADER (1-866-468-2337),**  
or **<http://nas.er.usgs.gov/SightingReport.aspx>**



**IF YOU SUSPECT YOU'VE FOUND an invasive tunicate, take good-quality photos at both close and wider scales, record its location, and report it to [OregonInvasivesHotline.org](http://OregonInvasivesHotline.org), 1-866-INVADER (1-866-468-2337), or <http://nas.er.usgs.gov/SightingReport.aspx> so experts can work with you on identification (which may include gathering samples for microscopic and genetic analysis) and rapid response.**



**THIS GUIDE IS INTENDED** to enhance the early detection and rapid response (EDRR) of invasive tunicates by providing basic identification of nine of the most invasive tunicates posing a threat to the marine infrastructure, ecology, and economy of the Pacific Northwest coast. Sections on identification, similar species (those that may look similar, including natives), and ecology describe each of the nine invasive tunicates, and current distribution maps indicate areas where they've been found.

Colonial tunicates may exhibit a wide variety of morphological variants, including vast differences in coloration. For example, the colonial tunicate *Didemnum vexillum* forms long, ropey or beard-like colonies that commonly hang from hard substrates such as docks, lines, and ship hulls where water current moves slowly. Where the current is faster, the tunicate forms low, undulating mats with short appendages that encrust and drape rocky seabeds of pebbles, cobbles, boulders, and rock outcrops (Valentine 2012).

Considerable resources have been invested in surveying, monitoring, and managing *Didemnum vexillum* since its discovery in estuaries of California, Washington, and British Columbia in 2004 and in Oregon and Alaska in 2010. Managing and eradicating infestations of invasive tunicates after they are established is extremely costly and has resulted in very limited success.



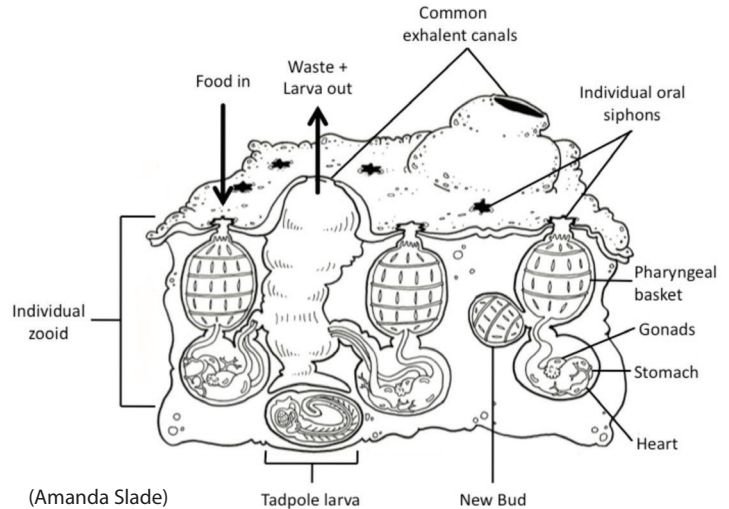
**PREVENTION, EARLY DETECTION,** and rapid response are the most cost-effective approaches to preventing the spread of invasive tunicates and associated invasive species. Knowledge of invasive tunicates led volunteer divers to the discovery and, ultimately, the decontamination of construction barge hulls heavily infested with nonindigenous species (including some of the invasive tunicates described in this guide). These barges (see white arrow in photo below) were used in the construction of the new NOAA Pacific Fleet Operations docks in Newport, Oregon; thus decontamination helped minimize the risk of a potentially costly infestation.



NOAA's Pacific Fleet Headquarters in Newport, Oregon (Port of Newport)

Since 1970, a new invading tunicate species has been reported about every five to six years in Atlantic or Gulf waters and every three to four years on the Pacific Coast (National Exotic Marine and Estuarine Species Information System [NEMESIS]). This guide will be updated as new species of concern emerge. It is intended for initial identification and reporting for verification by experts.

## ANATOMY OF COLONIAL TUNICATES



(Amanda Slade)

SCIENTIFIC NAME	PNW SITES FOUND	REGIONAL ORG'S TRACKING
<i>Styela clava</i>	COOS BAY, 3+ SITES WA	OISC/ODFW, WDFW (PRIORITY), REEF
<i>Ciona savignyi</i>	19+ SITES WA	OISC/ODFW, WDFW (PRIORITY), REEF
<i>Ciona intestinalis</i>	3+ SITES WA	WDFW (SECONDARY)
<i>Molgula manhattensis</i>	COOS BAY, 6+ SITES WA; 2010 OCCURRENCE IN YAQUINA BAY, OR, BUT NOT ESTABLISHED	WDFW (SECONDARY)

(OISC = Oregon Invasive Species Council; ODFW = Oregon Department of Fish and Wildlife; REEF = Reef Environmental Education Foundation; WDFW = Washington Department of Fish and Wildlife)

**WE BEGIN WITH THE SOLITARY TUNICATES**, which anchor to the substrate at their base or tether themselves with a stalk. They have an outer skin, called a tunic, and two apertures—most often at the end of tube-shaped siphons—at the distal, or free end, of the body. Beating cilia move water through the oral siphon and into the pharyngeal basket, filtering out oxygen and feeding on plankton and other suspended organics, then pump the water as waste out through the atrial siphon. The siphons retract when the animal is disturbed. Though we call them “solitary” tunicates, by virtue of each discrete body being an individual organism, they can form dense aggregations that aggressively compete with many other organisms. We consider *Styela clava* and *Ciona savignyi* particularly threatening to our local ecosystems.



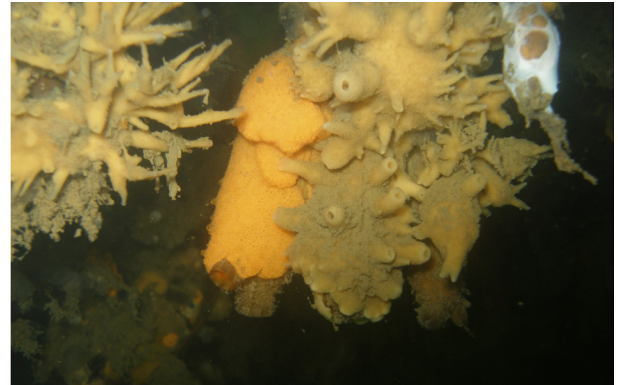
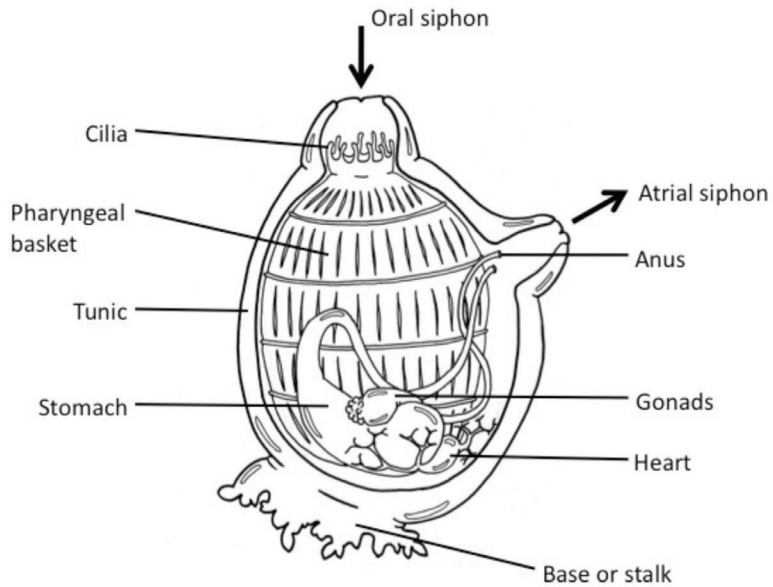
*Ciona savignyi* (California Academy of Sciences: SFBay:2K)



*C. intestinalis* (Keith Hiscock)



# ANATOMY OF A TUNICATE



*Styela clava* overgrown (Lorne Curran)



*Molgula manhattensis* (Lorne Curran)

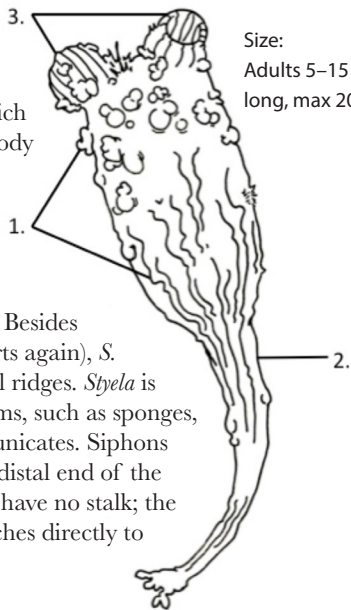
## CLUB TUNICATE (*Styela clava*)

### IDENTIFICATION

1. Tunic shows conspicuous bumps (think warty), often wrinkled swellings at the siphon end of body, and irregular longitudinal ridges on the bottom portion.

2. Commonly called club tunicate, *S. clava* may gradually taper but more often makes an abrupt transition to the stalk, which comprises up to one-half of its body length. 3. Siphons are smooth, with alternating dark and light bands around the edges.

Its tough, leathery tunic may be yellowish-gray to reddish-brown. Besides the signature tubercles (think warts again), *S. clava* will exhibit fine, longitudinal ridges. *Styela* is often covered with other organisms, such as sponges, hydroids, bryozoans, and other tunicates. Siphons project with a slight curve at the distal end of the body. Young specimens, 1–3 cm, have no stalk; the base of the cylindrical body attaches directly to the substrate.



Size:  
Adults 5–15 cm  
long, max 20 cm.



*Styela clava* (Janna Nichols)

## ECOLOGY

*Styela* will attach to rock, wood, and shells but prefers artificial structures in protected waters such as pilings, floats, docks, mooring lines, aquaculture gear, and boat hulls. It occurs in the low intertidal to shallow subtidal, rarely to 25 m depth. On our coast, it has been collected in water temperatures of 11–27°C and salinities of 22–36. Adults die in salinities of less than 10. It arrived here from Japan via Europe. It is eaten in Korea.



**Club tunicate**  
*Styela clava*

## SIMILAR SPECIES

Four natives, two exotics. Only the native *Styela montereyensis* presents any real confusion with adult *S. clava*. *S. montereyensis* most often occurs on rocky outer shores and other environments with strong water flow.

Resembling *S. clava* in that it attaches to the substrate by a stalk, it grows longer and more slender, merging gradually with its stalk. The oral siphon has a more pronounced curve than *S. clava*'s. Regular and coarse ridges and furrows run along the tunic's length. Small specimens of *S. montereyensis* may be found in protected waters and may be difficult to distinguish from *S. clava*. Approach slowly to avoid startling the animal, and observe the curve of the siphon.

*S. gibbsii* reaches a length of 4 cm, attaches to the substrate without a stalk, and is also primarily found on outer rocky shores. It has a uniform trunk width and no banding around siphons. *Boltenia villosa* also attaches with a stalk and has bands alternating around the siphons, but it has hairs and is shaped like a heart. *S. truncata* can be common on floats and protected coastal rocks, but the orange to brown body is squat and oval, usually less than 3 cm high.

Exotic *S. plicata* grows to 9 cm and is ovoid and stalkless, with a whitish to light-brown tunic covered in lumps. *S. canopus* runs to 3 cm long and is ovoid to glandular, stalkless, smooth-skinned, and reddish-brown. To date, investigators have found these two invasives only in southern California.

TOP RIGHT: *Styela montereyensis*

BOTTOM LEFT: *Styela gibbsii*

BOTTOM RIGHT: *Boltenia villosa*

(all photos on this page by Janna Nichols)

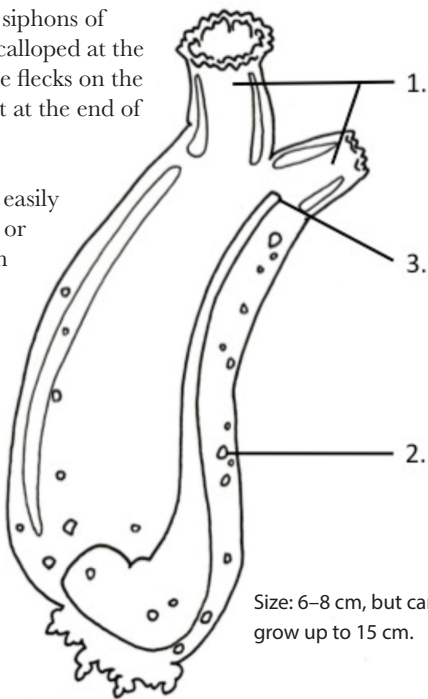


## PACIFIC TRANSPARENT SEA SQUIRT (*Ciona savignyi*)

### IDENTIFICATION

1. *Ciona* is tube-shaped, with two siphons of unequal length that are slightly scalloped at the openings. 2. It has yellow or white flecks on the body wall. 3. There is no red spot at the end of the sperm duct.

*Ciona's* tunic is smooth, thin, and easily damaged. Its color may be white or yellowish-green, but the tunic can be so translucent that internal organs can be seen. Its siphons are well separated at the distal end of the body. It has light, longitudinal lines of pigment at the siphon openings, often with orange dots on the rim.



Size: 6–8 cm, but can grow up to 15 cm.



*Ciona savignyi* (Janna Nichols)



*Ciona savignyi* (California Academy of Sciences: SFBay: 2K)



**Pacific transparent sea squirt**  
*Ciona savignyi*

## ECOLOGY

It is usually found in depths 12 to 25 m, but it can also grow under docks and on pilings and boat hulls. It can survive in water temperatures of 11 to 27°C. It is tolerant of salinities 22 to 36 and may be found in estuaries. It is native to Japan.

## SIMILAR SPECIES

See in particular *Ciona intestinalis*. Several native tunicates have translucent bodies. Almost completely transparent, *Corella willmeriana* grows to only 7.5 cm with stubby siphons, the atrial siphon pointing to one side. It typically grows at subtidal depths of up to 75 m. *Corella inflata*, native to Washington but an introduced species in Oregon, has a still-more cubic shape and a maximum height of 5 cm. Apertures may appear to be emanating directly from the body if the short siphons are retracted. Common on floats and under docks, it likely will be found to only 20 m. *Ascidia paratropha*'s tunic bears numerous fleshy protuberances.



*Corella inflata* (Lorne Curran)



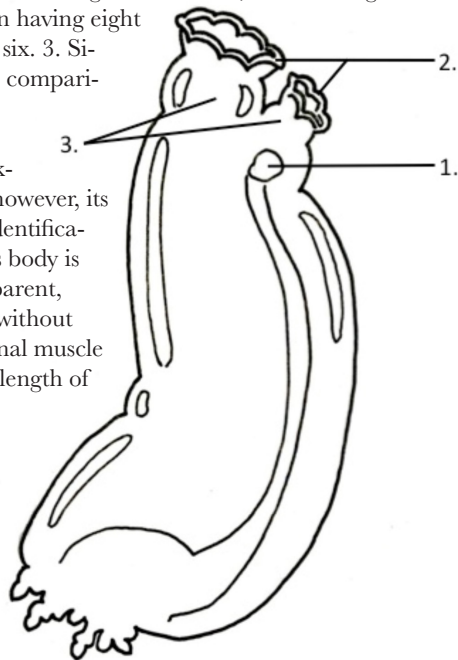
*Corella willmeriana* (Janna Nichols)

## SEA VASE (*Ciona intestinalis*)

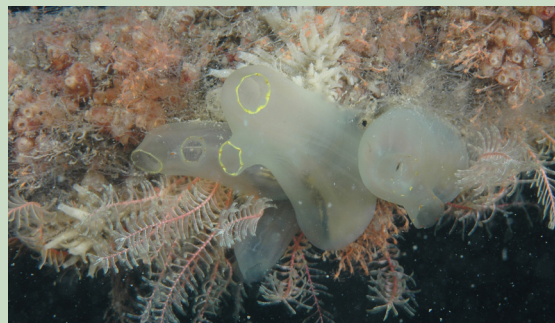
### IDENTIFICATION

1. Sexually mature specimens have a red spot at the end of the sperm duct, visible through the tunic or atrial siphon. 2. Two siphons may bear bright-yellow margins with small, red to orange spots, the longer oral siphon having eight lobes and the shorter atrial six. 3. Siphons are close together, in comparison to *C. savignyi*.

In shape and color it is strikingly similar to *C. savignyi*; however, its differences make positive identification possible in the field. Its body is translucent to nearly transparent, greenish to yellow, with or without orange bars. Five longitudinal muscle bands are visible along the length of the tunic.



Size 6 to 10 cm, up to 15 cm.



*C. intestinalis* has siphons with yellow margins versus *C. savignyi*'s yellow speckles (Keith Hiscock)



Sea vase  
*Ciona intestinalis*

## ECOLOGY

Like *C. savignyi*, it grows on bedrock and boulders but also fouls artificial substrates such as pilings, floats, and ship hulls and over other organisms. It prefers low wave exposure and some water flow. It is common in both marine and brackish water, at the low tide line to 550 m. It is native to the North Atlantic.

## SIMILAR SPECIES

As with *C. savignyi*, it has ghostly white, elongated cylinders; squid eggs can be mistaken for the *Ciona intestinalis* but are tightly clustered with no siphons. *Ascidian paratropa* has a cactus-like look similar to that of *Ciona intestinalis*.



*Ascidian paratropa* has that cactus look  
(Janna Nichols)



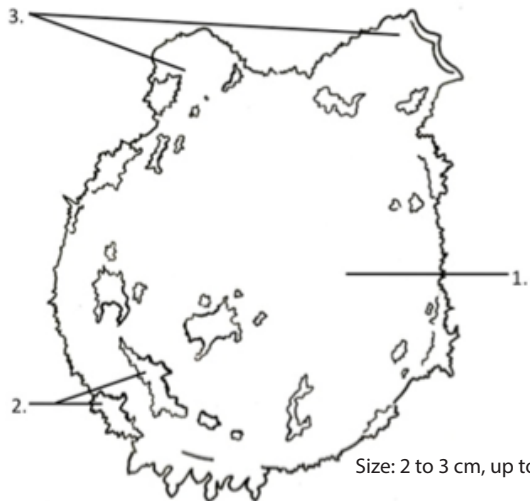
Squid eggs are tightly clustered, no siphons  
(Janna Nichols)

## COMMON SEA GRAPE (*Molgula manhattensis*)

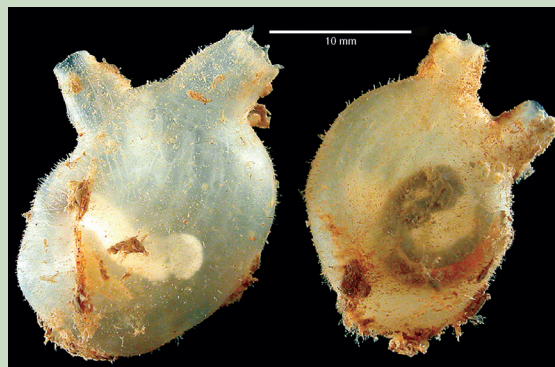
### IDENTIFICATION

1. *Molgula* is more or less spherical (common name: sea grapes). 2. Its body is covered in fibrils that collect debris, giving the tunic a muddy look. 3. It has distinct siphons, even when retracted.

*Molgula*'s tunic is soft but tough, yellow-gray to gray-green, even translucent in clean specimens. It is stemless; it has a broad-based attachment to substrate.



*M. manhattensis* on bottom of barge (Lorne Curran)



*M. manhattensis* (California Academy of Science: SFBay: 2K)



## ECOLOGY

*Molgula* thrives on softer substrates than other invasives and can be found attached to bedrock, boulders, shells, seaweeds, and sandy or soft bottoms. It can be found in the low intertidal, to 90 m. It is tolerant of a wide range of temperatures, salinities, and pollution. It is native to the northeastern Atlantic and the Gulf of Mexico.



**Common sea grape**  
*Molgula manhattensis*

## SIMILAR SPECIES

Several tunicates have a globular body form. *Corella inflata*, already discussed in comparison to the *Cionas*, can be common on floats and under docks, but its lesser siphons and enlarged atrial chamber give it an altogether different look. *Chelyosoma productum* is more barrel-shaped, with top flattened and covered in horny plates. The apertures are simple holes in the top, distinctly different from *Molgula*'s prominent siphons. *Pyura mirabilis* has siphons but they are well separated and facing in opposite directions. As its name indicates, the shiny orange sea squirt, *Cnemidocarpa finmarkiensis*, is smooth, orange, and shiny.

Native *M. pacifica* has orange siphons. Expert help may be necessary to differentiate other *Molgula*. It is native to the Atlantic; only two recorded sightings of *M. citrina* have been made in the Pacific Ocean—in Alaska, and in the Triangle at the mouth of the Umpqua River, Oregon.



*C. productum* (Richard Zade)



*M. pacifica* (Marine Life of the Pacific Northwest)

## THE COLONIAL TUNICATES



*Botryllus schlosseri* (Lorne Curran)



*Botrylloides violaceus* (Lorne Curran)



*Diplosoma listerianum* (Steve Trehwella)



*Didemnum vexillum* (foreground) with *D. listerianum* (Dann Blackwood)

SCIENTIFIC NAME	PNW SITES FOUND	REGIONAL ORGANIZATIONS TRACKING
<i>Didemnum vexillum</i>	COOS AND WINCHESTER BAYS, OR; 12+ SITES WA	OISC/ODFW, WDFW (PRIORITY), REEF
<i>Botrylloides violaceus</i>	COOS, WINCHESTER, NETARTS, AND YAQUINA BAYS, OR, AND PRESUMED ELSEWHERE; 26+ SITES WA	WDFW (SECONDARY)
<i>Botryllus schlosseri</i>	COOS AND WINCHESTER BAYS, OR; 11+ SITES WA	WDFW (SECONDARY)
<i>Diplosoma listerianum</i>	WA	OFFSHORE OCCURRENCES AS WELL, ON NATURAL REEF

(OISC = Oregon Invasive Species Council; ODFW = Oregon Department of Fish and Wildlife; REEF = Reef Environmental Education Foundation; WDFW = Washington Department of Fish and Wildlife)

### APPEARING AS AN ENCRUSTING ORGANISM,

colonial tunicate colonies consist of many small individuals, called zooids, encased within a common tunic. Each zooid pumps water in through its own oral siphon, filtering oxygen and plankton. The zooid's atrial siphon discharges the waste water into a space shared within a system of other zooids, where the waste exits through the larger, readily apparent openings. Unlike the invasive solitary tunicates described above, colonials brood their larvae within the colony's matrix before releasing them. Larvae may survive in the planktonic stage for only a day before attaching to substrate, but colonials also reproduce asexually from fragments of the colony, spreading after a colony is disturbed—drifting in ocean currents for months or traveling in ships' ballast water.

Most often discovered in bays and harbors, *D. vexillum* has also been found covering much of 230 square kilometers of the Georges Bank,

prime fishing grounds in the Gulf of Maine. The *botrylloides* (*B. violaceus* and *B. schlosseri*) form smaller colonies but have greatly increased their distribution on the west coast over the past 40 years. *D. listerianum* has also been documented as an aggressive invader.



*Didemnum vexillum* (Lorne Curran)

## DIDEMNUM (*Didemnum vexillum*)

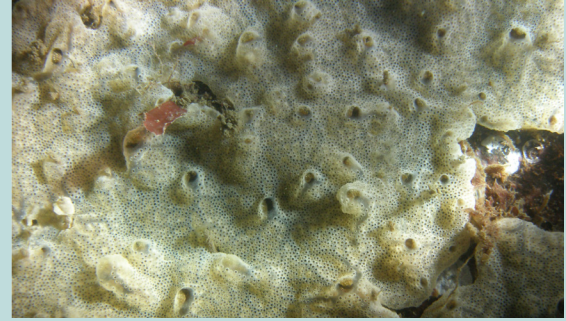
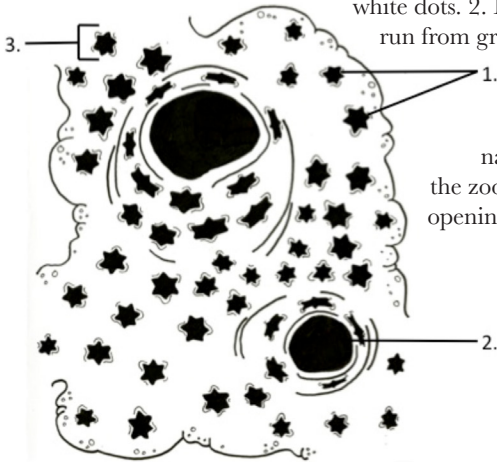
### IDENTIFICATION

The appearance of *D. vexillum* can vary widely. In calmer waters, it develops thick masses that hang from hard substrates in irregular lobes. In high current, colonies encrust substrates with only small, finger-like lobes projecting.

1. Zooids are less well-defined than those of *B. violaceus* and are randomly distributed in a tan, cream, or yellow to orange matrix. Some appear as open holes; other zooids with closed openings appear as

white dots. 2. Dark channels

run from groups of zooids to common excurrent openings. 3. Close examination reveals that the zooids have six-sided openings.



*Didemnum vexillum* in Winchester Bay (Lorne Curran)



*Didemnum vexillum* in Shilshole Bay, Seattle (Janna Nichols)



a colonial tunicate  
***Didemnum vexillum***

## ECOLOGY

Found on many hard, artificial substrates, rock, and gravel seabeds, *D. vexillum* will overgrow other organisms such as seaweed and shellfish. It occurs in the low intertidal to 80 m. When salinity falls below 20, infestations may die back, only to later recolonize from colonies deeper in the water column. Its origin is most likely Japan.

## SIMILAR SPECIES

See *B. violaceus*, *D. occidentalis*, and *D. listerianum*. Sponges and bryozoans lack the dark channels of *D. vexillum*. Like other native didemnids found on the open coast, *Didemnum carnulentum* encrusts substrate and will overgrow other organisms, but it never achieves the lobate form of *D. vexillum*. Colors are limited to a uniform white to gray with tinges of pink.



*Halichondria sp. sponge* (Lorne Curran)



*Didemnum carnulentum* (Lorne Curran)

## ORANGE TUNICATE (*Botrylloides violaceus*)

### IDENTIFICATION

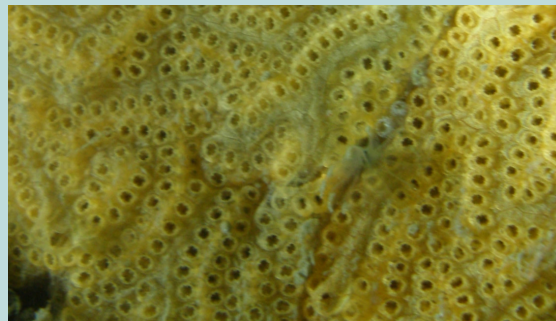
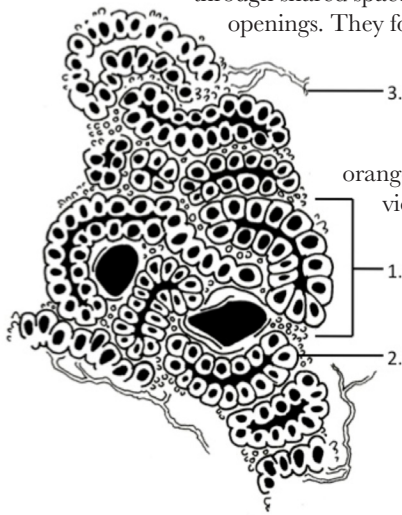
1. Colonies consist of zooids 1–2 mm long, arranged in elongated clusters (called “systems”) within a clear, firm matrix. 2. In mature systems, zooids appear rounded and well-defined. 3. Stringy, white bodies at the edges of the colonies may be apparent; they serve as part of the *botrylloide*’s vascular system.

Commonly called chain tunicate, these systems take the shape of long ovals, meandering double rows, or chains, discharging their wastes through shared spaces and out the larger excurrent openings. They form flat sheets on hard substrates

up to a third of a meter in diameter. They can develop into lobate forms. All the zooids of a colony are the same color, usually

orange, yellow, red, purple (also called violet tunicate), or tan, and occasionally brown or lavender. Networks of blood vessels running through the matrix have numerous dead ends, visible as small pigmented blobs the same color as the zooids showing up in the clear matrix.

In older colonies, the matrix may be dark.



*Botrylloides violaceus* (all photos on this page by Lorne Curran)



**Orange tunicate**  
***Botrylloides violaceus***

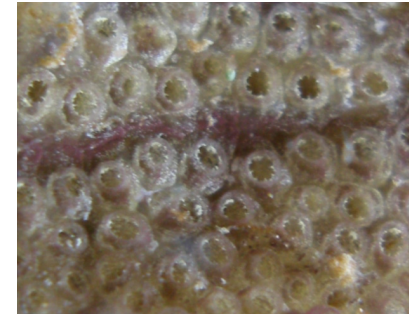
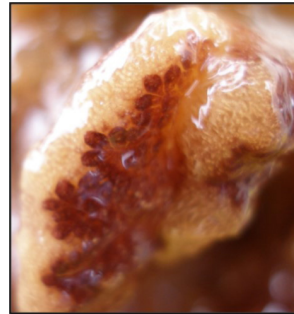
## ECOLOGY

*Botrylloides* grow on docks, boat hulls, buoys, ropes, pilings, the undersides of rocks, eelgrass, seaweeds, aquaculture gear, and shellfish. They occur in the intertidal to 50 m and can be on structures several feet in the air at low tide. They can survive in temperatures ranging from 8 to 25°C and salinity of 26 to 34, but can still flourish in an estuary's variable salinity. Originally from Japan.

## SIMILAR SPECIES

In contrast to *D. vexillum*'s small, randomly located zooids and dark channels, *B. violaceus* has well-defined zooids organized in linear fashion, often forming circles or half-loops, and the matrix between zooid systems does not connect zooids to any excurrent openings.

In *B. diegensis*, reported as far north as San Francisco Bay, each zooid has two colors with a white, yellow, orange, or greenish ring around the oral aperture, contrasting with the zooids' overall darker color. Farther south, *B. perspicum* has a thicker matrix, with ridges that separate the systems of zooids.



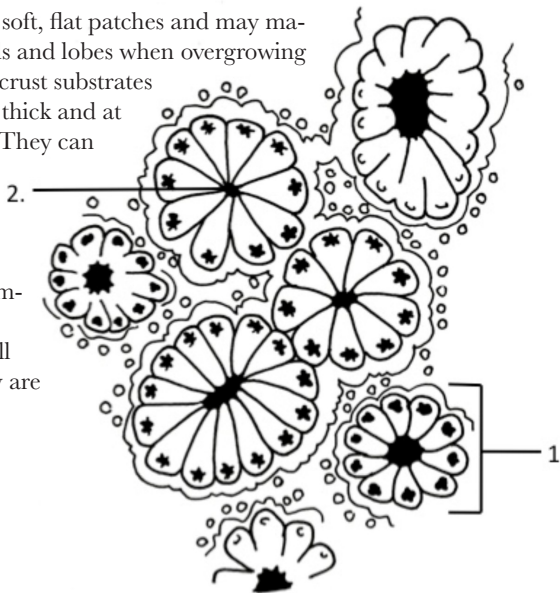
*Botrylloides violaceus* (Lorne Curran)

## GOLDEN STAR TUNICATE (*Botryllus schlosseri*)

### IDENTIFICATION

1. Individual zooids are organized into flower-shaped clusters (commonly called golden star tunicate). 2. The narrow ends of the teardrop-shaped zooids point to the excurrent opening at the center of the cluster.

Colonies begin as soft, flat patches and may mature into loose rolls and lobes when overgrowing seaweed. They encrust substrates in sheets 3–4 mm thick and at least 10 cm wide. They can be orange, yellow, red, white, gray-green, purple, dark gray, black, or some combination of these colors, although all zooids of a colony are the same color.







**Golden star tunicate**  
***Botryllus schlosseri***

## ECOLOGY

*B. schlosseri* can be found on docks, piers, boat hulls, ropes, aquaculture gear, rocks, gravel sea floor, and shells; and on seaweed, eelgrass, solitary tunicates, and mussels. It is subtidal to 200 m and survives in temperatures of 3+°C and salinity of 16 to 44. It is possibly an east coast native, or it may have been introduced there from Europe.

## SIMILAR SPECIES

*Botrylloides* systems grow in elongated shapes, most commonly in meandering double rows. Sometimes the matrix between *Botrylloides* systems have an oval appearance reminiscent of *Botryllus* clusters, but in *Botryllus* the zooids clearly point toward the center. Young systems of *Botrylloides* at the edge of a colony may begin in an oval pattern, with the teardrop shape of the young zooid still evident. At times, the ends of blood vessels show up as pigmented blobs in the oval spaces of *Botrylloides* specimens, further indicating that the oval is matrix and not cluster.

The rarely seen *B. tuberatus* has 1 mm zooids, versus *B. schlosseri*'s 2 mm zooids; and waste exits through a spout-like excurrent opening rather than a simple large hole, as with *B. schlosseri*.



*Botryllus schlosseri* on oyster (Lorne Curran)

## COMPOUND SEA SQUIRT (*Diplosoma listerianum*)

### IDENTIFICATION

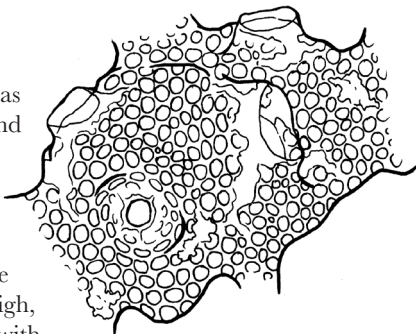
1. *Diplosoma listerianum* grows in thin, flat, soft, gelatinous sheets up to 20 cm across. 2. It has a milky, translucent appearance, often with granules of bluish-white or yellow pigment. Brown spots appearing on it are fecal matter. 3. Zooids are colorless and grouped around large, exhalant openings.

### ECOLOGY

*Diplosoma* grows on seaweed, eelgrass, and most hard substrates, including docks. It thrives in mostly shallow water, to 80 m. It has been found in Puget Sound, Washington.

### SIMILAR SPECIES

*Diplosoma* forms smooth colonies and has an appearance similar to that of fish and invertebrate eggs, but can be mistaken for *D. vexillum* when growing in slow-moving currents. *D. vexillum* forms long, ropey, or beard-like colonies that hang from marine structures and sessile organisms. Where current velocity is high, *D. vexillum* forms low, undulating mats with short, surficial appendages that encrust and drape rocky seabeds and marine organisms.



Close-up of *Diplosoma listerianum* (Dann Blackwood)

# MUSHROOM ASCIDIAN

*(Distaplia occidentalis)*

(NATIVE to the west coast)

## IDENTIFICATION

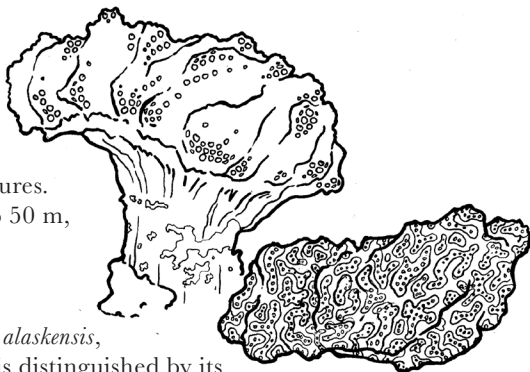
*Distaplia occidentalis*, commonly called the mushroom ascidian, resembles a mushroom-like globe that varies in color from pale orange, yellow, pink, dark purplish-red, to brown. Colonies range in size from less than 2 cm in diameter to 10 cm. It can be globular or sometimes flat with a short, narrow stalk. Zooids have their own incurrent siphon and pharynx, but share a raised excurrent siphon and atrial cavity.

## ECOLOGY

*Distaplia occidentalis* ranges from Alaska to southern California. It grows on rocky shores and human-made structures. It thrives in mostly intertidal to 50 m, high-saline, cold waters.

## SIMILAR SPECIES

It can be mistaken for *Distaplia alaskensis*, found only in Alaska, where it is distinguished by its more columnar lobes. Another contrasting species is *Didemnum vexillum*, which has more lobate growths. *D. occidentalis* has a much shorter lobate form and is more mushroom-like.



*Distaplia occidentalis* growing on an anchor in Charleston, Oregon

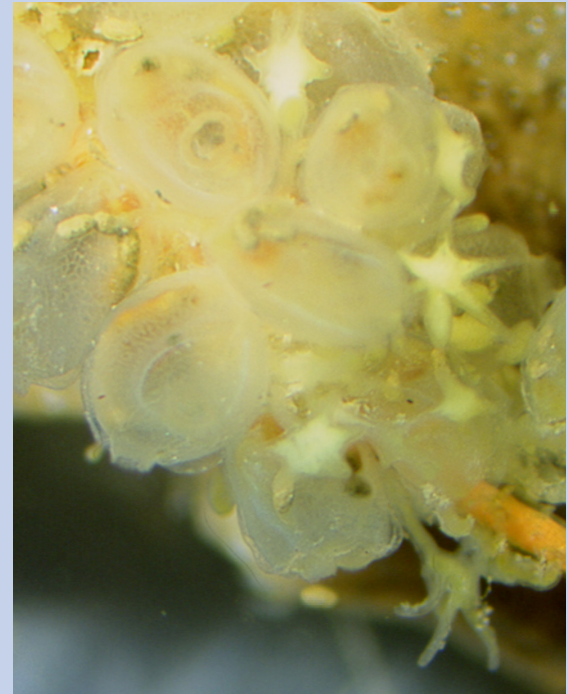
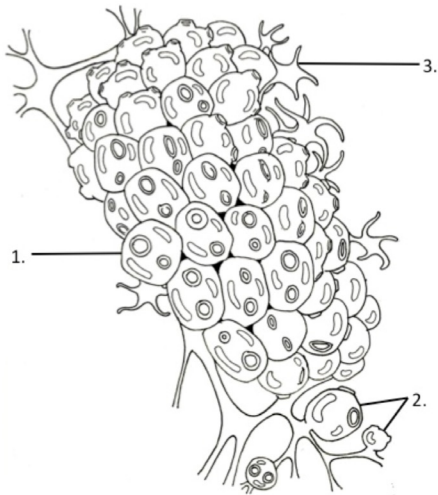


Invasive *Didemnum vexillum* (top) contrasts with smaller *Distaplia occidentalis* (bottom)

## A SOCIAL ASCIDIAN

The tunicates covered by this guide are members of the class Ascidiacea. They may be more precisely called sessile tunicates, ascidians, or sea squirts. Social ascidians fall between the solitary and colonial ascidians in appearance and form. Like the solitaires, individuals grow in aggregation, each ensconced in its own tunic and with projecting incurrent and excurrent siphons. More like the colonials, socials bud from and are interconnected with stolons, or a thin, vascularized sheet of tunic, at their bases.

## *Perophora japonica*



*Perophora japonica* (Dorothea Sommerfeldt/Marine Biological Association of the United Kingdom)



a social ascidian  
*Perophora japonica*

## *Perophora japonica*

### IDENTIFICATION

1. *P. japonica*'s 4–6 mm translucent zooids bud from stolons, densely packed. 2. The zooids attach to the stolon by a broad part of the tunic. 3. Stolons may have bright yellow terminal buds, angular in form, even star-shaped.

Colonies range from yellow in the younger parts to greenish-yellow. Documenting the terminal buds is key to confirming identification.

### ECOLOGY

*P. japonica* overgrows macro-algae; other benthic organisms such as tunicates, sponge, and oysters; and human-made structures. The only North American record thus far comes from Humboldt Bay, California, in 2003. It is native to Japan and Korea.

### SIMILAR SPECIES

The Pacific coast native *Perophora annectens* lacks terminal buds. Its zooids run 2.5–3.5 mm in length and attach to the stolon by a narrow stalk.

## CONTROLLING INVASIVE SPECIES: LET'S WORK TOGETHER

The Pacific Northwest is renowned for its natural environment. Diverse plant and animal communities thrive in our ecosystems. Unfortunately, these natural communities and systems are increasingly threatened by aquatic invasive species, a form of biological water pollution. Harmful nonnative plants and animals are moving into our coasts, waterways, and wetlands, degrading habitats, displacing desirable species, damaging infrastructure, contaminating water resources, and necessitating expensive control treatments.

Once established, invasive species spread relentlessly, each generation taking over more territory. Unlike other forms of water pollution such as oil spills, invasive species don't dissipate with time and they will permanently alter the environment. Awareness and early detection help us contain these threats and keep them from spreading and causing further damage to the environment and our quality of life.

This guide is an introduction to some of the more prominent and harmful tunicates in our region. It is not too late to stop the spread and establishment of these species.

You can make a difference in your community and watershed by

- staying informed and “connected.” Learn about the species listed in this guide. Visit **[OregonInvasivesHotline.org](http://OregonInvasivesHotline.org)**, **[oregoninvasivespecies.com](http://oregoninvasivespecies.com)**, or **[anstaskforce.gov/campaigns.php](http://anstaskforce.gov/campaigns.php)** for more information on invasive species and access to other resources available on the Web. Contact experts listed on the back of this publication.
- detecting and reporting these invasive species. Be vigilant, and report sightings by calling **1-866-INVADER** or by visiting **[OregonInvasivesHotline.org](http://OregonInvasivesHotline.org)**.



## BOATERS AND ANGLERS

Aquatic invasive species can very easily spread between waterways by hitching a ride on boats and trailers. Some species can even cause expensive damage to your boat. Protect Oregon's waterways and never launch a dirty boat!

- Inspect hard-to-reach spots, damp areas, and other protected places on your boat. Harmful species can survive in such places for days. Feel for small bumps, which could be attached organisms. Remove any plants and animals you find before leaving the water.
- Clean your boat and equipment with high-pressure hot water, or allow equipment and your boat to dry in sunny conditions for at least five days before entering new waters.
- For more information about clean boating activities, visit [anastaskforce.gov/campaigns.php](https://anastaskforce.gov/campaigns.php) or contact the Oregon State Marine Board at 503-378-8587.
- Drain and empty water entirely from the motor, wet well, and bilge on land, before leaving the water body.
- Remove any plants, dirt, and water from your gear and clothing.
- Dispose of bait properly. Empty your bait bucket on land in a trash container before leaving the water body. Never release live bait into the water or release aquatic animals from one water body to another.

## GARDENERS, HIKERS, AND WATERSHED STEWARDS

- Learn about the prominent aquatic invasive species. Do not buy or share aquatic invasives.
- Inspect and clean your equipment, tools, and clothing of seeds, soil, and plant fragments before entering and after leaving natural areas and waterways.
- Do not dump pond plants or animals into natural areas.
- Inspect, decontaminate, rinse, and remove “hitchhiking” invasive plants and animals from purchased aquatic plants before setting them in your garden.
- Remove and properly dispose of aquatic invasive plants by drying them, away from natural areas. When possible, place them in a plastic bag for disposal in the trash.

## PETS AND AQUARIUMS

- Don't dump your pets. If you have a pet that you can no longer care for, contact your local pet store, humane society, veterinarian, or other expert, for guidance on appropriate and human options.
- Don't dump your aquarium water into natural habitats. Seal aquarium plants in plastic bags and place them in the trash.
- Make responsible pet and aquarium purchases. Check to see whether they are listed as invasive species by local agencies. Many pets may live longer, grow bigger, and take more care than you realize. Before choosing a pet, do some research and be sure you're ready to care for it long-term.

## REFERENCES

- “100 Most Dangerous Invaders to Keep Out.” 11 March 2009. Oregon Invasive Species Council. [http://oregon.gov/OISC/most\\_dangerous.shtml](http://oregon.gov/OISC/most_dangerous.shtml) [last accessed 21 January 2015].
- “A sea squirt— *Perophora japonica*.” 20 August 2010. MarLIN— The Marine Life Information Network. <http://www.marlin.ac.uk/speciesinformation.php?speciesID=4074#> [last accessed 21 January 2015].
- “Aquatic Invasive Species Guidebook for the Puget Sound Area.” July 2009. Puget Sound Partnership. <http://www.psp.wa.gov/downloads/ANS/NewANSGuide.pdf> [last accessed 21 January 2015].
- Bullard, S. G., G. Lambert, M. R. Carman, J. Byrnes, R. B. Whitlatch, G. Ruiz, R. J. Miller, L. Harris, P. C. Valentine, J. S. Collic, J. Pederson, D. C. McNaught, A. N. Cohen, R. G. Asch, J. Dijkstra, and K. Heinonen. 2007. The colonial ascidian *Didemnum* sp. A: Current distribution, basic biology and potential threat to marine communities of the northeast and west coasts of North America. *Journal of Experimental Marine Biology and Ecology* 342:99–108.
- Carlton, James. 2007. *The Light and Smith Manual: Intertidal Invertebrates from Central California to Oregon*. 4th. Berkeley and Los Angeles: University of California Press.
- Cohen, Andrew N. 2005. “Guide to the Exotic Species of San Francisco Bay.” San Francisco Estuary Institute. <http://www.exoticguide.org/> [last accessed 21 January 2015].
- Darbyson, Emily A., J. M. Hanson, A. Locke, and J. H. M. Willison. 2009. Marine boating habits and the potential for spread of invasive species in the Gulf of St. Lawrence. *Aquatic Invasions* 4 (1):87–94.
- Eissinger, Ann. June 2009. “Marine Invasive Species Identification Guide.” Puget Sound Marine Invasive Species Volunteer Monitoring Program. [www.psp.wa.gov/downloads/ANS/MISM\\_Online.pdf](http://www.psp.wa.gov/downloads/ANS/MISM_Online.pdf) [last accessed 21 January 2015].
- Estabrook, John, Chris Pendergrass, and Lorne Curran. May 2010. “Sci Dive Oregon. Trip reports for Scientific Dives in Oregon.” <http://www.scidiveoregon.blogspot.com> [last accessed 21 January 2015].
- “Invasive Tunicates.” 2010. Washington Department of Fish and Wildlife. <http://wdfw.wa.gov/fish/ans/tunicates.htm> [last accessed 21 January 2015].
- Lambert, G. 2009. Adventures of a sea squirt sleuth: unraveling the identity of *Didemnum vexillum*, a global ascidian invader. *Aquatic Invasions* 4 (1):5–28.
- “Marley’s Photos 10-25-09.” 2009. Pacific Adventures. <http://www.pacadventure.com/> [last accessed 21 January 2015].





Diver Hillaire Bojonell  
collecting *D. vexillum* underwater  
(Aaron Macomber, USFS)

Morris, Robert H., Donald P. Abbot, and Eugene C. Haderlie. 1980, 1992. *Intertidal Invertebrates of California*. Palo Alto, CA: Stanford University Press.

Nichols, Janna. “Invasive Tunicates in Washington State.” PNW Scuba. <http://www.pnwscuba.com/invasives/index.htm> [last accessed 21 January 2015].

Proceedings of the 2nd International Invasive Sea Squirt Conference, October 2–4, 2007, Prince Edward Island, Canada. 2009. Locke, Andrea, and Mary Carman (guest eds.). 2009. *Aquatic Invasions* 2009 4 (1).

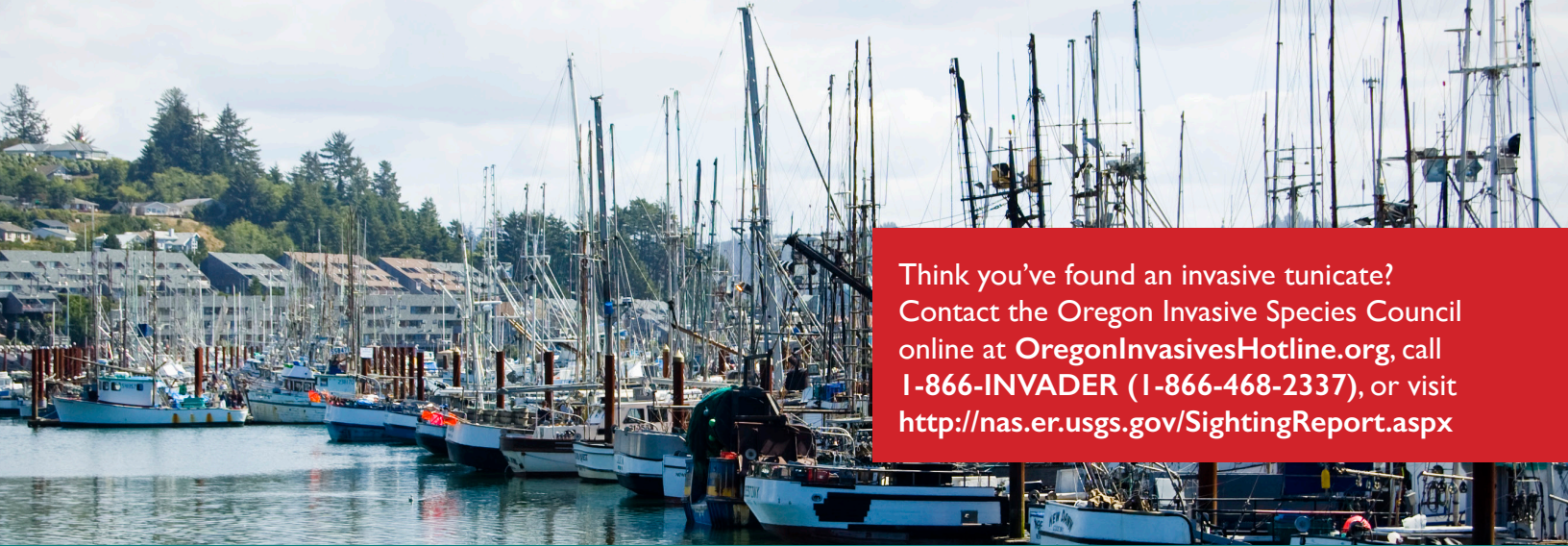
“Sea squirts (Ascidiacea).” Marine Life Information Network (MarLIN), The Marine Biological Association of the UK. <http://www.marlin.ac.uk/phylumdetails.php?phylum=2341#ascidiacea> [last accessed 21 January 2015].

“Tunicates from SF Bay.” 2010. SFBay Academy Research. California Academy of Sciences Research, 2002. 19 July 2010. <http://researcharchive.calacademy.org/research/izg/SFBay2K/aboutsfbayproject.htm> [last accessed 21 January 2015].

Valentine, Dr. Page. 13 January 2010. “Marine Nuisance Species.” U.S. Geological Survey. <http://woodshole.er.usgs.gov/project-pages/stellwagen/didemnum/> [last accessed 21 January 2015].

Yamada, Sylvia Behrens. November 2003. “Introduced Species in Oregon Estuaries.” Oregon State University. <http://www.science.oregonstate.edu/~yamadas/index.htm> [last accessed 21 January 2015].

Zade, Richard. [rzade@hotmail.com](mailto:rzade@hotmail.com)



Think you've found an invasive tunicate?  
Contact the Oregon Invasive Species Council  
online at [OregonInvasivesHotline.org](http://OregonInvasivesHotline.org), call  
1-866-INVADER (1-866-468-2337), or visit  
<http://nas.er.usgs.gov/SightingReport.aspx>

## COPYRIGHT RESTRICTIONS

Images in this publication remain the property of the photographers and are subject to their terms of use. This guide may be distributed on a limited basis to individuals for nonprofit, educational purposes; however, it may not be posted on websites or via other means of mass distribution without permission, with the exception of the Oregon Coast Aquarium's and Oregon Sea Grant's right to reprint the current version.

© 2015 Oregon State University. All images © Oregon Sea Grant unless otherwise indicated. This report was prepared by Oregon Sea Grant under award number NA10OAR4170059 (project number A/ESG-07) from the National Oceanic and Atmospheric Administration's National Sea Grant College Program, U.S. Department of Commerce, and by appropriations made by the Oregon State Legislature. The statements, findings, conclusions, and recommendations are those of the authors and do not necessarily reflect the views of these funders. ORESU-H-15-001.

