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Squirt Alert

A tiny marine alien is emerging as a coastal grinch

Janet Raloff

As scientific adviser to a group of Maine watermen, ecologist Larry Harris had heard his share of stories. But one tale, told to him 2 years ago, proved unforgettable. A fisherman related how he had been hauling up a dredge used to scout for scallops in nearby Cobscook Bay when he snagged something novel: a life form resembling blobs of pancake batter.



MAKE WAY. The peachy-beige amorphous sheets—highly acidic mats of the invasive sea squirt *Didemnum*—spread like pancake batter over rocks and any living thing in their path. For scale, white disk at bottom is 2 millimeters in diameter.

Whitlatch

In all his decades at sea, the man said, he'd never encountered anything like it. His girlfriend, riding along at the time, told the man not to touch the pearly-white, gelatinous glob draping over rocks and shells that the dredge had brought up. The stuff looked like it might have come from outer space, she said.

It was an alien, all right, but one of Earthly origins.

From the waterman's description, Harris recognized the globs as parts of a mat of sea squirts—soft-bodied animals that scientists refer to as tunicates, for the tunic-resembling sheath covering each individual. This was a colonial tunicate consisting of thousands of 2-millimeter-tall individuals fused side to side.

Harris was also fairly certain that the Cobscook encounter signaled bad news:


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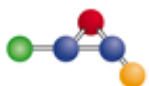
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arrival of what he calls "the tunicate from hell." This devilish species' behavior is a biologist's "worst nightmare," says Harris, who's based at the University of New Hampshire in Durham. This sea squirt reproduces rapidly by several means, has no known predator, and grows over and smothers any plant or animal that doesn't make way.

Last August, Harris was among scientists looking for alien species in Cobscook Bay, one of Maine's important fishing grounds. At his prompting, the team's search included the area from which the fisherman had hauled up the sea squirt mats. Sure enough, the bottom there was riddled with patches of this animal that researchers are confident isn't a native.

Over the past few years, the smothering mats have turned up in coastal waters as distant as those off western Canada, New Zealand, and Holland. In most of these newfound invasions, patchy mats occur within only small areas, perhaps a tidal pool or a few hectares of a bay.

No one knows where the organisms came from, but biologists agree that they belong to the genus *Didemnum* and are spreading quickly in nontropical northern and southern latitudes.

This is a new breed of alien. It's moving into offshore ocean waters previously thought immune from such invasions. The presumption before *Didemnum* was that anything that could live in harsh, open-ocean conditions had established itself there so long ago that it could now be considered a native.

Biologists haven't determined the squirt's species or environmental requirements, but they're rushing to identify some vulnerability that might be exploited to check its explosive spread.

It's already too late to think of eradicating this ocean invader, says James T. Carlton, director of maritime studies at Williams College & Mystic Seaport in Connecticut. "When a species like this sea squirt becomes so abundant, it's no longer retrievable," he says. At this point, the goal can only be to cope with existing populations and slow their takeover of neighboring territories.

Designed to survive

Some 3,000 species of squirts inhabit waters from the equator to the poles. For most of Gretchen Lambert's 40 years spent studying these animals, "I was kind of like the Maytag repairman," she says. "Nobody ever called."

Squirts were a little-valued detail in the seas' vast diversity of inhabitants, explains the taxonomist, who is affiliated with the University of Washington's Friday Harbor Laboratories in Seattle. Demand for her expertise rose precipitously a dozen or so years ago, she says, when an unremitting tide of nonnative marine species began upsetting the balance of established ecosystems in near-coast waters around the world. Some of the more unusual pests were foreign squirts.



SPAWN. To seed distant colonies, *Didemnum* mats periodically release these 1-millimeter-long, tadpolelike larvae all summer.

S. Bullard, Univ. of Hartford

"Now, I spend virtually all of my time on invasive species," she says—particularly on that "very interesting scourge" known as *Didemnum* sp.

Like other sea squirts, this one begins life as a tadpolelike larva with eyes, a gut, a heart, and a primitive, backbonelike notochord. Once a sea squirt larva finds a suitable surface, it bonds to it. At that point, the larva metamorphoses into a barrel-shaped animal with a cover—its tunic—that's strengthened by hard clumps of cellulose. Squirts are the only animals to make cellulose, a primary structural component of plants.

The animals take their name from their two siphons at or near the top of the barrel. One draws in water laden with food—bacteria, algae, and other goodies—and squirts it into a filter basket lined with a sticky mucus. The critter then squirts out the water via the other siphon.

Most squirts are solitary animals, and some can grow several inches high and a few inches in diameter. Among the *Didemnums*, each individual, or zooid, is tiny, but it's usually part of a larger population. These colonies expand by budding new zooid clones from their edges.

The *Didemnum* in U.S. waters is like a squirt on steroids, notes Robert B. Whitlatch of the University of Connecticut in Groton. This "beast," as he refers to it, grows several times faster than any other sea squirt known. Within a few seasons, a single zooid can clone itself into a mat that's a meter in diameter. The zooids can also reproduce sexually, and each summer spew larvae into the water to establish distant colonies.

In colors ranging from white to peach, *Didemnum* mats have the slick feel and compressibility of cured silicone caulking, Whitlatch says. A colony's surface is acidic as is that of others of its genus—presumably, to make it unappetizing to potential predators. However, Whitlatch notes, "with a pH of 2, equivalent to stomach acid," the invasive species' coating is more acidic than that of its cousins.

How long can each animal live? "We don't know," Lambert says, "but theoretically, it could be immortal" because it can continue to clone.

Orphans no more

No one knows precisely when *Didemnum* sp. moved into North American waters. But as many as 25 years ago, people around the Damariscotta River estuary in Maine described something resembling the rubbery mats. Lambert recently examined a preserved, 11-year-old specimen from the estuary. She concluded that Maine's invader is the same sea squirt now spreading in Massachusetts waters.

Lambert has spent most of the past 5 years trying to assign the invasive squirt in U.S. waters to some previously known species, but neither she nor other researchers have found a match. "I finally ended up calling it 'sp' for species to indicate I don't know what it is," Lambert concedes.

What she can say is that it looks exactly like the invasive squirt that emerged in waters off New Zealand in late 2000, near British Columbia 2 years ago, and off Washington State last year.

Page Valentine of the U.S. Geological Survey in Woods Hole, Mass., maintains a Web site devoted to mapping suspected *Didemnum* sp. colonies.

He says that the mats emerged in coastal waters of the Netherlands and California in the early 1990s and at French coastal sites this past summer.

The animals in all those colonies appear to be the same as a *Didemnum* reported by Japanese scientists. If confirmed, Valentine says, this may point to an Asian origin. Texts from the 1920s describe such a colonial squirt in waters near Japan. Lambert is seeking samples of Japan's *Didemnum* for DNA fingerprinting and comparison with the U.S. invader and colonies elsewhere.

Asian origins for this species would be consistent with the leading theory of the squirt's introduction to U.S. coastal waters: that the tunicate hitchhiked on oysters imported from Japan into New England, 30 years ago, to serve as seed stock for aquaculture operations.

Whatever its source, the squirt certainly made itself at home. Three years ago, Valentine spotted *Didemnum* mats on the floor of Georges Bank, 240 kilometers east of Cape Cod. Perplexed as to what it was, he sought the help of Lambert and Mary R. Carman of the Woods Hole Oceanographic Institution. From them, he learned that what appeared to be the same squirt was overtaking tidal pools in his own backyard, Woods Hole.

In 2004, Valentine went back to Georges Bank, one of the Northeast's primary finfish and shellfish grounds. He found that *Didemnum* sp. was by that time blanketing 100 square kilometers of seafloor. By last summer, Valentine reports, that patch had grown to 175 km². He also found *Didemnum* spreading over another, 70-km² patch of seafloor.

These sightings are troubling, Carlton says, because Georges Bank's 40-to-60-meter-deep water is open ocean. He told *Science News*, "Prior to this *Didemnum* showing up there, I would have said there was no clear example of nonnative species in our offshore waters, despite nearly 500 years of steady shipping from Europe and more than 200 years of shipping from elsewhere."

Novel behavior

Connecticut researchers have been studying *Didemnum*'s invasion of Long Island Sound, where the squirt almost completely covers 2.5 km² of the seafloor at a depth of 30 m. That alone is unusual, Whitlatch notes, "because sea squirts that we regularly have in this area rarely grow along the bottom." They prefer instead to live on pilings, floating docks, buoys, and the bottoms of boats.

Didemnum sp. grows on such marina features, too, and on any hard surface—from plastic to gravel—at apparently any depth. Whitlatch has seen it overgrow sponges, sedentary shellfish, and even sea grasses. The only surfaces it avoids are mud and sand; the only neighbors it respectfully sidesteps are stinging corals and anemones.

The Connecticut scientists worry about the squirt's ecological repercussions. Besides smothering sponges and shellfish, it can bury the small worms, shrimp, and other seafloor animals that nourish fish. There is even concern that *Didemnum* may make U.S. waters inhospitable to prized, young lobsters.

To better understand the invader, Whitlatch's team has begun rearing it in the lab. These studies have revealed still more novelties.

For instance, most squirts grow faster in the warmest waters in their temperature range. However, within the range that *Didemnum* sp. prefers, it grows faster in cooler water. Therefore, New Jersey may be the farthest south that this squirt will invade along the East Coast, says Whitlatch, but Canada's so-far-untouched Maritime Provinces are at grave risk. They're just north of Cobscook Bay and have a similar environment.

Although the lack of any apparent predator suggests that mats of *Didemnum* sp. are well defended, Whitlatch wondered whether young, solo zooids of the species might be vulnerable. So, in the lab, he induced mats of the *Didemnum* to spawn and then introduced crabs and certain fish renowned for dining on squirts. He now reports, "We have yet to find anything that will eat even these small *Didemnum*."

Another troubling lab observation: When it ran out of real estate, *Didemnum* sp. didn't stop growing, as other squirts do.

In a glass tank fed by running water, the *Didemnum* mat covered the bottom, then grew up a wall. When that, too, was covered, the mat extended onto the underside of the water surface, suspended from a thin layer of bubbles. The colony apparently "used those bubbles as a flotation mechanism. How bizarre," Whitlatch says.

On docks and pilings, he and others have observed *Didemnum* sp. developing pendulous tendrils of clones—another feature unique to this squirt. Whitlatch surmises that these lobes expand the mat's surface area to permit further growth.

What's more, the tendrils can break off under intense wave action. "We've seen these [broken pieces] roll on the seafloor, like a tumbleweed," he says. Once they settle, they can attach to something hard and resume growth.

"We now feel this fragmentation may be more important than larvae for long-range dispersal," Whitlatch says.

Looking for controls

At Woods Hole, Carman and Valentine have been testing strategies for controlling the *Didemnum*'s growth, especially where it threatens shellfish aquaculture. Growers of clams, mussels, and oysters, for example, typically raise their broods in bags, cages, or nets. *Didemnum* mats can encrust the bags and even get into the cages and nets to coat individual bivalves.

Carman reasoned that since shellfish can survive exposure to air for up to a day, but *Didemnums* can't, "it might be possible to just lift the shellfish out of the water periodically to kill the squirts." She and Valentine have just begun field tests to determine how long it takes to dry out the *Didemnum* and to identify the extent to which the timing is affected by air temperature, sunlight



intensity, and humidity.

ANY WHICH WAY. Squirts typically anchor themselves to a rock, pier, or boat hull. However, in the lab, this invader has grown across the floor of an aquarium, up its walls, and then onto the underside of bubbles on the water's surface.
Whitlatch

Ultimately, Carlton says, that's just palliative. It doesn't block the infection

of new sites. Although most imports of seed stock for shellfish aquaculture today come from farms certified to be free of pest organisms, people have been known to illegally obtain adult oysters and clams from uncertified beds, he says. If the shellfish were to come from an area infected with *Didemnum* sp., it could spread the colonies, says Carlton.

"There's almost no way to regulate something being transported in the tarp-covered back of a pickup truck," he notes.

At least some *Didemnum* immigrants could have arrived in the ballast water of a ship or in a hull compartment storing an anchor and its chain. "Below the waterline, [that compartment] is always full of water and poses a fantastic refuge" for alien plants and animals, Lambert notes. One study under way in New Zealand, she says, has already found sea squirts, fish, crabs and many other creatures hitchhiking in this largely ignored closet aboard oceangoing vessels.

Finally, ships trawling seafloors that host the invasive squirt or berthed in infected ports might pick *Didemnum* up on their gear or hulls and carry it to new sites. Indeed, trawling might prove a major boon to the species' dispersal, Lambert notes, since any fragment broken from a mat can establish a new colony.

This scenario reinforces the need for early action to prevent the spread of alien species. Carlton says that the *Didemnum* invasion is proving that "once out, there's no putting the toothpaste back in the tube."

Letters:

This fine piece about invasive sea squirts states that the critters maintain an unappetizing surface pH of 2. Does this make these mats harmful to touch?

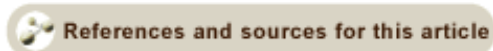
Andrew J. Dolson
Richmond, Va.

Robert Whitlatch of the University of Connecticut, who grows Didemnum in the lab, says it's fine to handle for short periods of time, "though I wouldn't attempt to taste/eat them, lick your fingers, or rub your eyes after you've been handling them."—J. Raloff

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Information about the international invasive sea squirt conference, held April 21-22, 2005, is available at <http://www.whoi.edu/institutes/oli/activities/seasquirt-program.html>.

Information about the sea squirt can be found at http://www.exoticsguide.org/species_pages/didemnum.html and <http://woodshole.er.usgs.gov/project-pages/stellwagen/didemnum/>.

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