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# SHIPWORMS AND THE MAKING OF THE AMERICAN COASTLINE

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SHIPWORMS AND THE MAKING OF THE AMERICAN COASTLINE

BY

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DISSERTATION

Submitted to the University of New Hampshire  
in Partial Fulfillment of  
the Requirements for the Degree of

Doctor of Philosophy

in

History

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I've shown pictures of teredo to hundreds of people over the years. So, I have a pretty good idea how most will react. First comes the eyebrow raise, followed by the looks of confusion, curiosity, and disgust—sometimes all at once. Next comes the word. “Teredo” is infectious and most people can't help but give it a whirl, mouthing it to themselves, quietly and hesitantly at first, usually as I drone on with my elevator pitch. I owe a debt to all of you who couldn't look away and who couldn't help but say the word aloud. I can't name you all, but our conversations taught me how to tell stories about shipworms in ways that resonate with people—as I imagine they would have to people a hundred years ago or more.

My deepest thanks go to Kurk Dorsey and Jeff Bolster. As a marine topic, this project fell to them by default. They shared and shouldered the burden of overseeing a peculiar topic and I'm grateful to both of them for permitting me the long leash that I required to pursue my own interests at my own pace. I've found that Jeff and Kurk work extremely well together and I've always felt that their advice complements and never competes. It's hard to imagine what this project would have looked like without both cooks in the kitchen.

Others from the University of New Hampshire have helped me along the way. Jess Lepler has been a supporter and mentor whose advice I wish I had followed more closely during my exile in Washington State. I bookended my time at UNH assisting

Ellen Fitzpatrick with her modern history surveys and I'm grateful for her vote of confidence. In retrospect, I wish I had studied more with Jan Golinski, especially after taking his 2011 historiography class, the most entertaining course I've ever taken. My friends Sarah Batterson and Mike Verney rescued me from my isolation as the sole member of my graduate cohort and made me feel welcome in New Hampshire. Sarah deserves special thanks for helping with the Ancient Greek translations. Finally, a thanks goes to Department Chair, Eliga Gould, and Department Staff, Laura Simard, Lara Demarest, and, formerly, Thea Dickerman, who've made being a graduate student that much easier.

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There are a number of other scholars outside of UNH who have helped. Far and away, marine biologist Jim Carlton has had the biggest impact on this dissertation. I met Jim shortly after I decided to go all in on shipworms and he put me on the scent for sources that I had no idea that I needed. I'm very grateful for the encouragement from Christine Keiner and John Gillis—both reviewed the blueprint for this dissertation. Dozens of others have offered valuable advice, usually between panels at conferences. Sadly, I can only name a few of you here. Chris Pastore kindly pressed me to think big. Aboard the *Sabino* in Mystic, Connecticut Matt McKenzie listened to my pitch and pushed me to embrace the coastal dimensions of the project and to play up the “weaponizing” of nature, as he likes to say. Matt Klingle generously gifted me research

on teredo that he did not include in his book. A special thanks goes to Mart Stewart who, as my thesis advisor, has listened to me ramble on about teredo perhaps longer than anyone else—though neither of us knew way back when that a distracting two-page tangent on shipworms in the middle of my master’s thesis would grow into a dissertation.

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## TABLE OF CONTENTS

ACKNOWLEDGMENTS .....	iv
LIST OF FIGURES .....	viii
ABSTRACT .....	x
CHAPTER	PAGE
INTRODUCTION .....	1
I. THE SHIPWORM DIASPORA	
Global Exchanges and Discourses in the Age of Sail .....	22
II. “TIME FOR THE RAVAGES OF THE ‘TEREDO’”	
Nineteenth Century Coastal Designers Confront Shipworms Along the Southern Atlantic Seaboard and Gulf Coast .....	64
III. THE BOOK WORM	
Knowing Nature Through Language .....	103
IV. “THE SCOURGE OF PUGET SOUND”	
How Teredo Hindered and Helped The People of the Pacific Northwest .....	136
V. AN UNNATURAL NATURAL DISASTER	
Marine Borer Invasions of San Francisco Bay .....	192
VI. “IS THE PORT OF NEW YORK IN DANGER?”	
The Northeast, Invasive Species, and the Professionalization of Marine Borer Research .....	232
CONCLUSION .....	270
BIBLIOGRAPHY .....	277

## LIST OF FIGURES

FIGURE 1:	Shells of <i>Teredo navalis</i> .....	2
FIGURE 2:	Pile attacked by three genera of woodborers .....	3
FIGURE 3:	<i>Teredo navalis</i> .....	13
FIGURE 4:	“Honeycombed” Timber .....	14
FIGURE 5:	Iconography of the Dutch Crisis .....	56
FIGURE 6:	James Buchanan Eads (1820-1887) .....	77
FIGURE 7:	Mississippi Jetties at South Pass .....	78
FIGURE 8:	Willow Mattresses .....	80
FIGURE 9:	Creosote Chamber .....	93
FIGURE 10:	Domestic Creosote Production .....	101
FIGURE 11:	Hollowed Wood .....	109
FIGURE 12:	Newspaper Graph .....	131
FIGURE 13:	Google Ngram .....	132
FIGURE 14:	<i>Bankia setacea</i> .....	141
FIGURE 15:	Seattle Harbor and the Duwamish Mudflats, 1854 .....	147
FIGURE 16:	Lake Washington Ship Canal Route .....	154
FIGURE 17:	Birdseye of Bellingham Bay’s North Shore .....	158
FIGURE 18:	Nautical Chart of Bellingham Bay .....	159
FIGURE 19:	Birdseye of Everett, Washington .....	165
FIGURE 20:	Nautical Chart Everett, Washington and Port Gardner .....	167
FIGURE 21:	Birdseye of Seattle, Washington, 1925 .....	173

FIGURE 22: Eugene Semple (1840-1908) .....	181
FIGURE 23: Blueprint for the South Canal and Duwamish Waterways .....	182
FIGURE 24: Hiram Chittenden (1858-1917) .....	189
FIGURE 25: Map of <i>Teredo navalis</i> Invasion .....	193
FIGURE 26: Yerba Buena Cove, 1847 .....	196
FIGURE 27: <i>Limnoria</i> .....	206
FIGURE 28: <i>Limnoria</i> Eating .....	207
FIGURE 29: “Hourglass” Piles .....	208
FIGURE 30: The Clark House .....	226
FIGURE 31: Trestle Collapse, Oleum, California .....	227
FIGURE 32: “Only the Teredo Dislikes the <u>Plastic Boat</u> ” .....	266

## ABSTRACT

### SHIPWORMS AND THE MAKING OF THE AMERICAN COASTLINE

by

Derek Lee Nelson

University of New Hampshire, May, 2018

This dissertation tells the forgotten history of the American teredo epidemic. During the late nineteenth and early twentieth centuries, an assortment of native and invasive wood-boring marine organisms, known collectively as “teredo,” swept through the ports and harbors of the United States. Teredo’s penchant for wood, both for shelter and sustenance, made wharves and wooden ships easy targets. Because teredo enters timber as tiny juveniles, and grows to maturity beyond view, it was often detectable only after a wharf had collapsed or a ship had sunk. Teredo’s unpredictability grated on people so much so that the borer was rarely mentioned apart from the ominous saying, “the ravages of the teredo.”

At the turn of the twentieth century, teredo frustrated coastal people immensely, and they responded to the epidemic in a variety of ways. Developing freshwater estuaries and filling tidelands were common adaptations to borers, and have given many coastal landscapes the look they have today. But the epidemic wasn’t only about people fighting borers; shipworms also drove a wedge between people. For instance, teredo-free port communities liked to criticize teredo-infested harbors. This sort of “teredo-slandering” became common along the west coast, where cities all tried to stand out. So reviled were

borers that the word “teredo” even became a widely used pejorative metaphor that captured the resentment that people felt towards society. “Teredo” could mean everything from “furtive” to “ruthless” and could be flung at people of different political leanings and even ethnicities. The epidemic, in short, was just as much about people as teredo.

By the mid-twentieth century, science and technology caught up to teredo. Steel hulled ships, improved timber treatments, and better understandings of woodborer biology and ecology all helped to lessen teredo’s ravages. After San Francisco Bay and New England were hit with costly woodborer attacks, the federal government finally stepped in and organized research, first through the National Research Council, and then by the Bureau of Docks and Yards. After WWII, professional woodborer researchers helped bring the teredo epidemic to an end. Resurrecting this forgotten epidemic underscores the need for more marine and coastal environmental histories.



## INTRODUCTION

### **The Epidemic**

In March of 1890, Bill Nye (not *that* Bill Nye) stopped over in Seattle while on a national speaking tour. Edgar William Nye, better known as “Bill,” was a syndicated writer and founding editor of the Laramie, Wyoming *Daily Boomerang*. As a humorist, journalist, and author with a national following, Nye was just as much interested in scouring the Pacific Northwest for new material as he was about recycling his older stories to packed theatre houses. During his stay in Seattle, Nye ventured over to Lake Washington, a 22-mile stretch of water along the city’s eastern border. Its placid waters stirred his imagination. Nye envisioned a ship canal running from Puget Sound, through the city, and into the lake where oceangoing vessels could moor. What intrigued him most about Lake Washington was what it lacked: teredo. Following his visit, Nye wrote a nationally circulated article explaining how the “chief advantage of a fresh water harbor for ships, of course, is that the teredo, or ship worm, the pest of all warm salt waters, and especially of Puget Sound, would be eliminated.” The idea of digging a canal through the city because of a worm was no joke; the humorist was very much serious.<sup>1</sup>

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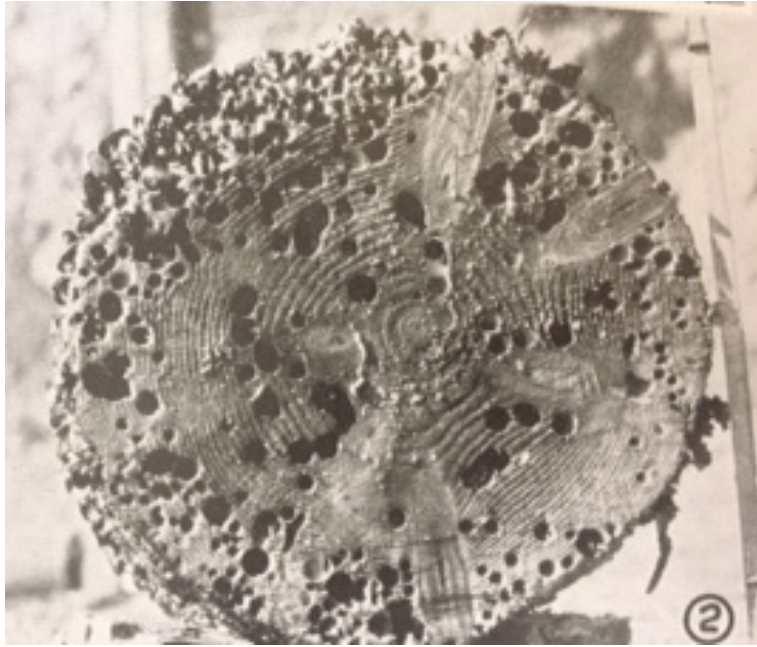
1. Edgar W. Nye, “Bill Nye In Seattle,” *Seattle Post-Intelligencer*, May 31, 1890, 9. Syndications of this article went by the alternate title, “Doings In Seattle”.



**Figure 1: Shells of *Teredo navalis*. Credit: The San Francisco Marine Piling Committee of the American Wood-Preservers' Association, Inc. [First] Report on the San Francisco Bay Marine Piling Survey, plate 29. Used with permission of the American Wood-Preservers Association.**

It's hard for modern readers to fathom how such a thing as teredo—a collection of worm-like marine wood-boring organisms—could inspire such a colossal scheme as the Lake Washington Ship Canal. But we no longer live in an era in which these so-called shipworms routinely feast on planks of ships and piles propping up wharves, endeavoring all the while, as Nye insisted, “to damage the commerce of the world.” During Nye’s lifetime, teredo reached epidemic proportions all along the American coastline. Over a period spanning roughly the 1860s through the 1940s, woodborers flared up in nearly every major harbor. They swept through ports, such as Galveston, San Francisco, Seattle, New York, and Boston at different times and to varying degrees. Since World War II, coastal dwellers have taken steps to fight borers, such as by improving wood preservation techniques and gaining a better understanding of borer biology, both of which have sapped these once virulent creatures of their power. Though they are still around, memory of how borers once shaped the shoreline has all but vanished. But at their peak,

the “ravages of the teredo,” a once common saying, resonated with Americans all across the nation, often through the medium of texts by writers like Nye.<sup>2</sup>



**Figure 2: Pile attacked by three genera of woodborers: *Teredo*, *Bankia*, and *Limnoria*. Credit: The San Francisco Marine Piling Committee of the American Wood-Preservers' Association, Inc. [First] Report on the San Francisco Bay Marine Piling Survey, plate 14. Used with permission of the American Wood-Preservers Association.**

This dissertation will examine how *people* experienced and responded to the teredo epidemic. The emphasis on people is important. Shipworms are peculiar and fascinating creatures (more details on them shortly). They have a way of arresting our attention, like a sleight of hand artist, and obscuring the real agents in this story: seamen, stevedores, scientists, politicians, investors, harbormasters, journalists, newsmen, and many others. By keeping the focus on people throughout, the following pages illuminate how Americans all along the coastline responded to environmental crises in ways that had social, economic, and cultural implications. Their responses were as remarkable as

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2. Ibid.

they were varied and deserve to be the focus, lest this work slip from environmental history into historical geography or historical ecology.<sup>3</sup>

One way to keep the spotlight on people is by paying attention to the ways in which they altered coastal landscapes in response to teredo. This dissertation explores the many instances of subtle and extreme environmental change. Throughout the epidemic, coastal designers struggled to keep shipworms out of their wharves, piers, and docks. When feasible, engineers enclosed their piles with sheets of metal and filled underneath their structures—a practice known as “bulkheading”. At other times, they manipulated estuaries to enhance the teredo-killing effects of freshwater. Extreme examples, such as the aforementioned Lake Washington Ship Canal, though rarer, highlight the lengths to which people would go to repel borers. As a result, people have reshaped the American coastline in their quest to adapt to shipworms. To look upon the coastline today is to see the legacy of a long ago contest between people and borers.

Not every story about teredo centers on a battle between people and borers. Shipworms became the pretext for several interurban rivalries across the late nineteenth and early twentieth centuries. Many commercial waterways and urban waterfronts around the country benefited from nearby river mouths, such that the constant dousing of freshwater prevented the saline-loving teredo from gaining a foothold in docks and wharves. These communities didn’t take this benefit for granted. Boosters in cities like Astoria, Oregon (at the mouth of the Columbia River) and Bellingham Bay, Washington

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3. For warnings about the challenges of remaining true to the historical discipline while relying heavily on records from the hard sciences, see Joseph E. Taylor III, “Knowing the Black Box: Methodological Challenges in Marine Environmental History,” *Environmental History* 18 (January 2013): 60–75. Taylor has been the most critical of this conundrum; see also, W. Jeffrey Bolster, “Opportunities in Marine Environmental History,” *Environmental History* 11 (July 2006): 579; and Lance Van Sittert, “The Other Seven Tenths,” *Environmental History* 10 (January 2005): 106–109.

(freshened by the Nooksack River in Puget Sound) learned how lucky they were to be free from woodborers and leveraged their advantages by criticizing rival ports, such as Seattle, Washington and Tacoma, Washington, which were saddled with teredo infestations. This practice, which we may call “teredo-slandering,” underscores how the woodborer epidemic impacted people differently and how some people even welcomed the spike in borer activity for the opportunities it might hold. The epidemic is just as much a part of social history as environmental history.

“Crisis” and “epidemic” appear often in the following chapters, so it’s important to address the utility of such words. Across the period surveyed, people spoke about borers with such direness that one might think a horde of invaders had arrived on a regular basis out of the blue. In truth, there are only a few documented cases where nonnative shipworms arrived to the United States—or moved from one part of the coastline to another. With the exception of southern California, woodborers were present along every part of the American coastline long before the start of what I dub the “teredo epidemic.” There’s a tendency, as historian Ted Steinberg has argued, to attribute disasters solely to nature that are equally the product of decisions made (or not made) by people. The teredo epidemic is no different. Specific decisions about how to develop the American coastline fostered the crisis. Wharf builders drove an ungodly number of piles into the worm-infested waters of the Gulf and West coasts after the Civil War and, if anything, this represents a human invasion of teredo’s habitat, not the other way around. At every turn, the teredo epidemic was human-induced.<sup>4</sup>

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4. Ted Steinberg, *Acts of God: The Unnatural History of Natural Disaster in America* (Oxford: Oxford University Press, 2006)

Charting the rise and fall of the teredo epidemic poses a conceptual conundrum. Some coastal regions struggled with borers for much or all of the period from the Civil War to World War II, while others, particularly in the northeast, were spared for much of this span, before witnessing a rash of attacks during the 1930s and 1940s. This lack of uniformity might seem to undercut the notion of a broader national epidemic. But there is glue that binds everything together: language. Wherever “teredo” appeared in texts—whether it was in newspaper accounts, books, or engineering reports, etc.—it almost always came as part of the ominous phrase the “ravages of the teredo.” The saying became part of the national vernacular and those who encountered it were quick to learn about teredo’s destructiveness no matter how distant they were from such attacks. Over the course of the epidemic, the word “teredo” took on a life of its own, evolving into a pejorative metaphor that people could use to vent their social and cultural anxieties and frustrations, concerning everything from politics to race and class. The rise and fall of the word “teredo” in cultural terms is just as important to this overall analysis and mirrors the ebb and flow of real borers over time. Moreover, it shows that shipworms vexed a lot of people, and not just pile drivers and wharf managers. They were something that almost everyone experienced in some way or another.

It wasn’t until the federal government took the lead in coordinating and professionalizing woodborer research at the national level that the epidemic started to wane. The government’s role in this regard grew slowly but steadily throughout the first half of the twentieth century. The sudden and destructive appearance of a particularly ravenous borer, *Teredo navalis*, first in San Francisco Bay (1910s) and then later along the northeast coastline (1930s), required a level of coordination like that of a progressive

era style commission. Led at first by the National Research Council, a handful of well organized and well funded woodborer committees sprouted up in San Francisco, New York, Boston, and Los Angeles. They would later be joined after World War II by the Bureau of Docks and Yards. Together, these organizations and institutions would coordinate research and formalize methods. In the postwar era, the navy took the reins of the woodborer research program and made some breakthroughs in borer prevention, taxonomy, and physiology. State level interventions into the environment have a history of backfiring, as James C. Scott has argued, but in the case of teredo, “seeing like a state” was the only way to fathom the magnitude of the epidemic and meet it head on. Within a few short years, these efforts would render shipworms less dangerous, and the word “teredo,” which had once been so resonant, would all but disappear. The epidemic was over.<sup>5</sup>

### **The Context**

Histories like this one are not often told, not even by environmental historians. At first glance, teredo’s history feels more than a little out of step with the wider currents of this field, which overwhelmingly favors terrestrial environments. Fortuitously, this study has benefited from the steady contributions of marine environmental historians over the past ten years, and has ridden quietly on the coattails of these scholars—perhaps undeservedly and even a little opportunistically. To be sure, a history about teredo is warranted and stands on its own, but in light of recent scholarship, it requires some further justification as to its merits as marine environmental history and should not be lumped in with this field thoughtlessly or solely by virtue of its nickname: “shipworm”.

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5. James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998).

Teredo does not always mesh with the amazing work being done on the history of commercial fisheries declines. It doesn't rely on such innovative methods as Catch Per Unit Effort, nor does it have any stakes in problematizing older models like Maximum Sustainable Yield or attaching to the Shifting Baselines Syndrome. This dissertation goes against the grain of the bulk of marine environmental scholarship.<sup>6</sup>

But the subfield is maturing, and what shipworms offer is another story in a growing body of work on non-fisheries topics. Histories about tides, sharks, and deep-sea environments have opened up new ways of thinking about the sea, particularly in terms of culture. Fisheries historians have made use of cultural attitudes towards the sea, and how its perceived inexhaustibility had real consequences in fisheries management over the centuries. Scholars such as historians Gary Kroll and Helen Rozwadowski have uncovered other cultural attitudes toward the sea. Drawing on the American frontier, they have shown how western mindsets were applied to the ocean and how biologists once

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6. W. Jeffrey Bolster, "Putting the Ocean in Atlantic History: Maritime Communities and Marine Ecology in the Northwest Atlantic, 1500–1800," *American Historical Review* 113 (February 2008): 19-47; W. Jeffrey Bolster, *The Mortal Sea: Fishing the Atlantic in the Age of Sail* (Cambridge: Belknap, 2012); Kurkpatrick Dorsey, *Whales and Nations: Environmental Diplomacy on the High Seas* (Seattle: University of Washington Press, 2013); Brian Fagan, *Fish on Friday: Feasting, Fasting, and Discovery of the New World* (New York: Basic Books, 2006); Carmel Finley, *All The Fish in the Sea: Maximum Sustainable Yield and the Failure of Fisheries Management* (Chicago: University of Chicago Press, 2011); Glenn M. Grasso, "What Appeared Limitless Plenty: The Rise and Fall of the Nineteenth-Century Atlantic Halibut Fishery," *Environmental History* 13 (2008): 66–91; Richard C. Hoffmann, "Economic Development and Aquatic Ecosystems in Medieval Europe," *American Historical Review* 101 (June 1996): 631-669; Jeremy B. C. Jackson, Karen E. Alexander, and Enric Sala, *Shifting Baselines: The Past and Future of Ocean Fisheries* (Washington, DC: Island Press, 2011); Christine Keiner, "How Scientific Does Marine Environmental History Need to Be?" *Environmental History* 18 (January 2013): 111–120; Arthur F. McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850–1980* (Cambridge: Cambridge University Press, 1986); Callum Roberts, *The Unnatural History of the Sea* (Washington DC: Island Press, 2007); Andrew A. Rosenberg, et al., "The History of Ocean Resources: Modeling Cod Biomass Using Historical Records," *Frontiers in Ecology and the Environment* 3 (March 2005): 84-90; Tim D. Smith, *Scaling Fisheries: The Science of Measuring the Effects of Fishing, 1855–1955* (New York: Cambridge University Press, 1994); Joseph E. Taylor, *Making Salmon: An Environmental History of the Northwest Fisheries Crisis* (Seattle: University of Washington Press, 1999); Lissa K. Wadewitz, *The Nature of Borders: Salmon, Boundaries, and Bandits on the Salish Sea* (Seattle: University of Washington Press, 2012).



envisioned such things as whale ranching. By contrast, historian Jennifer Martin explores how sharks have shifted in the American imagination from dangerous predators to vulnerable species, similar to wolves—thus their nickname, “wolves of the sea”. Humans have imagined and reimagined the sea and its species in many different ways, and shipworms are no different. At its peak, the teredo epidemic resonated with people all across America. Curiously, the cultural construction of teredo went both ways; people projected anthropomorphic intentions onto shipworms while at the same time drawing on the habits of teredo to make sense of a wide array of social phenomena, which will be explored more fully in Chapter Three.<sup>7</sup>

In spite of its nautical moniker, teredo’s history belongs just as much to the subfield of coastal environmental history as it does to marine. In fact, its less common English nickname, the “pile-worm,” is the colloquial term preferred in the Netherlands, e.g. *paalworm*. In recent years, a number of scholars have shared simultaneous epiphanies and discovered a middle ground—or “muddy ground,” as historian Christopher Pastore puts it—between land and sea that does not conform to either terrestrial or marine environmental histories. In these coastal landscapes, where people do not always live, but still often exert control, a variety of different stakeholders have clashed over such things as sedimentation, near shore fisheries and aquaculture,

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7. Alain Corbin, *The Lure of the Sea: Discovery of the Seaside in the Western World* (London: Penguin Press, 1995); Gary Kroll, *America’s Ocean Wilderness: A Cultural History of Twentieth-Century Exploration* (Lawrence: University Press of Kansas, 2008); Jennifer A. Martin, “Seeing Jaws: The Role of Shark Science in Ocean Conservation,” *Historical Studies in the Natural Sciences* 46 (February 2016): 67-100; Jennifer A. Martin, “When Sharks (Don’t) Attack: Wild Animal Agency in Historical Narratives,” *Environmental History* 16 (July 2011): 451-455; Michael S. Reidy, *Tides of History: Ocean Science and Her Majesty’s Navy* (Chicago: University of Chicago Press, 2008); Helen M. Rozwadowski, “Arthur C. Clarke and the Limitations of the Ocean as a Frontier,” *Environmental History* 17 (July 2012): 578-602; Helen M. Rozwadowski, *Fathoming the Ocean: The Discovery and Exploration of the Deep Sea* (Cambridge: Harvard University of Press, 2005); Philip E. Steinberg, *The Social Construction of the Ocean* (Cambridge: Cambridge University Press, 2001).

navigable channels, and polluted runoff, among other things. The majority of this dissertation emphasizes these sorts of coastal conflicts and rarely strays out to sea again after the opening chapter.<sup>8</sup>

Coastal environmental history is not without its drawbacks. Out of necessity, researchers have focused narrowly on specific estuaries or bays. While such a slender scope has illuminated the changing nature and shifting understandings of these environments, it can also be limiting. As it stands, the subfield is made up of a series of case studies that sacrifice breadth for depth. There are merits to such an approach. But there is also the need (to avoid clichés) for stepping back and taking in a broader geographical framework. Teredo liberates coastal environmental history from such parochialism and seeks comparisons over a broad geographic range. The wide distribution of shipworms begs for a greater comparative coastal history that is sorely needed. In the case of teredo, going big has illuminated the aforementioned interregional tensions that would otherwise remain unexplored. More of this is welcome.

The history of teredo also serves as an open invitation to urban environmental historians to incorporate marine environments into their analyses. Cities have long been an opportunity for the field, as demonstrated by the gentle prodding of historians such as Joel Tarr and Martin Melosi. Ari Kelman’s impressive study of the Mississippi River and

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8. Matthew Morse Booker, *Down By the Bay: San Francisco’s History Between the Tides* (Berkeley: University of California Press, 2013); Connie Y. Chiang, *Shaping the Shoreline: Fisheries and Tourism on the Monterey Coast* (Seattle: University of Washington Press, 2008); John R. Gillis, *The Human Shore: Seacoasts in History* (Chicago: University of Chicago Press, 2012); Matthew G. McKenzie, *Clearing the Coastline: The Nineteenth-Century Ecological and Cultural Transformation of Cape Cod* (Hanover: University Press of New England, 2010); Christine Keiner, *The Oyster Question: Scientists, Watermen, and the Maryland Chesapeake Bay Since 1880* (Athens: The University of Georgia Press, 2010); Derek Lee Nelson, “‘Let’s Make a Harbor Into a Harbor’: An Environmental History of Bellingham Bay” (master’s thesis, Western Washington University, 2010); Christopher L. Pastore, *Between Land and Sea: The Atlantic Coast and the Transformation of New England* (Cambridge: Harvard University Press, 2014), 4.

City of New Orleans is a lauded exception, but there's an opportunity to explore the saltwater-urban nexus too. Environmental historians writing about Seattle have dabbled with waterfronts in encouraging ways (and have even tripped over teredo a handful of times). In particular, Michael Rawson's work on Boston Harbor—which explores landfilling and its effects on underwater shipping channels—offers an excellent model to emulate. This dissertation explores many urban waterfronts around the country—hopefully it inspires other scholars to keep their eyes peeled for borers or other marine organisms that are also historically causal.<sup>9</sup>

There are encouraging signs that teredo might finally be emerging from obscurity and reaching historians. In a matter of months, three different studies on woodborers, emphasizing three different corners of the planet, became available in the latter half of 2015. One of them, by historian Adam Sundberg, has made use of eighteenth century studies on the so-called Dutch Crisis and reinterpreted them effectively from an environmental-religious framework (see Chapter One). On the other side of the world, scientists in New Zealand have admirably descended various rabbit holes in their exhaustive recounting of the repeated missteps by marine builders during the late nineteenth and early twentieth centuries. For my part, I offered some initial thoughts on the social and cultural responses to the American teredo epidemic—ideas that will be

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9. Ari Kelman, *A River and Its City: The Nature of Landscape in New Orleans* (Berkeley: University of California Press, 2006); Matthew W. Klinge, *Emerald City: An Environmental History of Seattle* (New Haven: Yale University Press, 2007); Martin V. Melosi, "The Place of the City in Environmental History," *Environmental History Review* 17 (Spring 1993): 1-23; Martin V. Melosi, *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present* (Baltimore: Johns Hopkins University Press, 2000); Michael Rawson, "What Lies Beneath: Science, Nature, and the Making of Boston Harbor," *Journal of Urban History* 35 (July 2009): 675-697; Michael Rawson, *Eden on the Charles: The Making of Boston* (Cambridge: Harvard University Press, 2010); Joel A. Tarr, *The Search for the Ultimate Sink: Urban Pollution in Historical Perspective* (Akron: University of Akron Press, 1996); Joel A. Tarr and Clay McShane, *The Horse in the City: Living Machines in the Nineteenth Century* (Baltimore: Johns Hopkins University Press, 2007); David B. Williams, *Too High, Too Steep: Reshaping Seattle's Topography* (Seattle: University of Washington Press, 2015).

expanded in this dissertation. In the long run, the history of teredo will require a comprehensive global narrative, so it's encouraging that the foundation for such a work is being laid in such disparate parts of the world.<sup>10</sup>

## The Worm

Before going too much further, it's time to give teredo a more proper introduction. Teredo's peculiar-sounding name is befitting of one of the most puzzling organisms in the sea. In taxonomic jargon, *Teredo* is not actually a species, but a genus of marine wood-boring bivalve mollusks—which means that shipworms are not worms at all, but close cousins to clams. There are several different genera of shipworms in the larger family known as the Teredinidae, such as *Lyrodus* and *Bankia*. But *Teredo* is the oldest, and is a word drawn from the ancient Greek language. When eighteenth century taxonomists described the first shipworm for Carl von Linnaeus' *Systema Naturae*, they settled on *Teredo*, which had not been used regularly for at least a millennium. As it happened, *Teredo navalis*, the first shipworm identified in this genus, is also one of the most widespread and destructive borers in the world. Subsequently, “teredo” became shorthand for roughly seventy similar looking and acting mollusks, even though few are *Teredo navalis* or share its genus.<sup>11</sup>

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10. Adam D. Sundberg, “Floods, Worms, and Cattle Plague: Nature-induced Disaster at the Closing of the Dutch Golden Age, 1672-1764,” (PhD diss., University of Kansas, 2015); Courtney A. Rayes, James Beattie, and Ian C. Duggan, “Boring Through History: An Environmental History of the Extent, Impact and Management of Marine Woodborers in a Global and Local Context, 500 BCE to 1930s CE,” *Environment and History* 21 (November 2015): 477-512; Derek Lee Nelson, “The Ravages of Teredo: The Rise and Fall of Shipworm in US History, 1860–1940,” *Environmental History* 21 (January 2016): 100-124. The advanced online access of this article was in October of 2015.

11. For the sweeping and still relevant reorganization of the systematics of the family Teredinidae, see Ruth Dixon Turner, *A Survey and Illustrated Catalogue of the Teredinidae (Mollusca: Bivalvia)* (Cambridge: Museum of Comparative Zoology, Harvard University, 1966). Turner estimates that there are about seventy teredinids; Godfrey Sellius, *Historia Naturalis Teredinis Seu Xylophagi Marini* (1733). Sellius is credited with discovering that shipworms were mollusks ad not worms; Carl von Linnaeus, *Systema Naturae* 10th ed. (1758). It wasn't until the tenth edition of the Linnaean taxonomy that the genus *Teredo* was adopted. 12



**Figure 3: *Teredo navalis*.** The shells sit atop the anterior ends (bottom of image), and their siphons and pallets jut out from the posterior (top). Credit: The San Francisco Marine Piling Committee of the American Wood-Preservers' Association, Inc. [*First Report on the San Francisco Bay Marine Piling Survey*, plate 28. Used with permission of the American Wood-Preservers Association.

While shipworms vary in size and shape, they share enough in common with each other that a brief sketch of *Teredo navalis* can stand-in as a general description for the rest. Unlike its clammy cousins, *Teredo navalis* has forsaken its protective shells, allowing its organs to spill out and elongate into a worm-like form, stretching to almost a

foot in length when fully grown. Not that its shells would have offered much protection anyways; they grow from between  $\frac{1}{4}$  and  $\frac{3}{8}$  of an inch in diameter, the same width as the worm's body. *Teredo navalis* swaps out the security of its shells by boring into wood and excavating long wooden tubes that it then lines with a protective calcareous secretion. Its shells still serve a purpose, but as rasping tools that help the mollusk dig a deeper cavern that widens from the size of a pinhead at the surface of the wood to its full girth. Since *Teredo navalis* bores parallel to the grain of the wood, and never crisscrosses tubes drilled by other borers, a heavily infested piece of wood looks like a honeycomb when cut into cross sections. Other species of shipworms don't always stay in their lanes, so to speak, meaning that *Teredo navalis* is uniquely efficient and very destructive, from a human standpoint.<sup>12</sup>



**Figure 4: “Honeycombed” Timber: Credit: The San Francisco Marine Piling Committee of the American Wood-Preservers’ Association, Inc. [First] Report on the San Francisco Bay Marine Piling Survey, plate 2. Used with permission of the American Wood-Preservers Association.**

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12. For a general overview of the biology of shipworms, see N. Balakrishnan Nair and M. Saraswathy, “The Biology of Wood-Boring Teredinid Molluscs,” *Advances in Marine Biology* 9 (1971): 336-482; This paragraph draws specific data from Charles A. Kofoed, “Biological Phrase—The Marine Borers,” in [First] Report on the San Francisco Bay Marine Piling Survey (San Francisco: Committee, 1921), 36.

To survive deep inside timber, *Teredo navalis* controls and regulates its sequestered environment with a set of posterior plugs, called pallets, which block its tiny opening to the outside world from intruders. The pallets also seal in seawater when the tube is not submerged. Its pallets enable borers to survive for weeks out of water. When the pallets are not performing this function, two small siphons extend out into the water column and snare plankton, which the borer supplements with food derived from the wood it tunnels through. To digest wood, *Teredo navalis* is aided by symbiotic bacteria that live inside its gills—all but one other teredinid has this trait. *Teredo navalis* never ventures from its tube (not that a full sized borer could squeeze through its minute borehole even if it wanted to). It prefers to live out its days in what is tantamount to a well-stocked bomb shelter.<sup>13</sup>

Shipworms have mystified biologist for centuries, and still do. Teredinids are extremely hard to distinguish from one another, which has led to misidentifications over the centuries. Unlike other bivalves, shipworm shells have a lot of intraspecific morphological variations, meaning that two sets of shells from the same species can appear quite different. This makes them useless as means of parsing one species from another. On the other hand, pallets show much more intraspecific consistency, something that was discovered in the 1960s, and are usually what biologists rely on to make identifications. But even pallets can warp or wear down, fooling taxonomists. What's more, borers with identical pallets are not always of the same species. For instance, *Lyrodus pedicellatus* and *Lyrodus floridanus* look like identical twins. But they are

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13. For digestion of wood, see Daniel L. Distel et al., "Molecular Phylogeny of Pholadoidea Lamarck, 1809 Supports a Single Origin for Xylotrophy (Wood Feeding) and Xylotrophic Bacterial Endosymbiosis in Bivalvia," *Molecular Phylogenetics and Evolution* 61 (June 2011): 245-254; For siphons, see Nair and Saraswathy, "The Biology of Wood-Boring Teredinid Molluscs": 348-349.

physiologically distinct species. The former is a long-term brooder (carrying its eggs to an advanced developmental stage) while the latter is closer to a broadcast spawner (sending out hundreds of small and immature larvae into the water). With so many physiological and morphological subtleties, shipworms have confused taxonomists, leading them to describe and re-describe single species dozens of times over. Calls for greater “taxonomic resolution” have been repeated like music from a broken record for centuries and remain a regular refrain in modern woodborer research.<sup>14</sup>

Shipworms have also surprised and baffled marine builders for centuries. The reproductive habits of shipworms are largely to blame for their surreptitious behavior. Once the litter of borers is released, the larvae from broadcast spawning borers float in the water column for as long as a month while they search for wood to make their new homes. By contrast, long-term brooders, known as veliger, are slightly larger and more mature at birth, and seek out wood in two weeks or less. Either way, both types of juvenile borers are tiny, and when they attach to timber and begin excavating, they leave behind a pinhead-sized hole, which is almost impossible for wharf inspectors to detect under water. Before anyone on top of the wharf is the wiser, teredo has colonized and begun to hollow out the piles below their feet. Just as quickly, the juveniles mature and undergo a sex change (typically from male to female) and in a month or more they are sending out their own larvae and veliger into the sea. These might attach to a ship moored at the wharf (or get sucked up into its ballast tank). As the ship embarks from the

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14. J. Reuben Shipway et al., “The Broadcast Spawning Caribbean Shipworm, *Teredothyra dominicensis* (Bivalvia, Teredinidae), Has Invaded and Become Established in the Eastern Mediterranean Sea,” *Biological Invasions* 16 (February 2014): 2037–2048; Luisa M. S. Borges et al., “Investigating the Taxonomy and Systematics of Marine Wood Borers (Bivalvia: Teredinidae) Combining Evidence from Morphology, DNA Barcodes and Nuclear Locus Sequences,” *Invertebrate Systematics* 26 (December 2012): 572–582. There’s hope that genetic analyses might finally clear up the taxa.



honeycombed structure, its captain has unwittingly become a transmitter of borers to distant shores.<sup>15</sup>

Shipworms have spread to every corner of the globe. Salinity, temperature, and breeding habits are the only things restricting their distributions, with some being more ecologically selective than others. The temperate *Teredo navalis* is one of the most widely distributed borers and can be found in all oceans, save the Arctic, and shows a high resistance to brackish water and colder temperatures. By contrast, *Bankia setacea* is partial to even colder and saltier waters, often preferring to bore into piles deep down at the mud-line—its aversion to surface water temperatures might explain why it doesn't readily attach to ships and, thus, hasn't spread out of the North Pacific Ocean. One of the most spectacular shipworms is *Teredora princesae*, which is an entirely pelagic species, living out its whole life floating inside wood in the open ocean—and since it avoids coastal waters, it requires timber to fall into the ocean and float deep out to sea for it to colonize! Likewise, there are borers that live hundreds of feet below the surface, thriving on waterlogged timber that falls to the ocean floor. For organisms that have evolved to eat wood, some seem as though they are going out of their way to avoid the trees that give them sustenance.<sup>16</sup>

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15. Nair and Saraswathy, “The Biology of Wood-Boring Teredinid Molluscs”; Shipway, “The Broadcast Spawning Caribbean Shipworm, *Teredothyra dominicensis* (Bivalvia, Teredinidae), Has Invaded and Become Established in the Eastern Mediterranean Sea”: 2038.

16. For recent research on temperature-salinity envelopes for *T. navalis* and other European borers, see Luisa M. S. Borges et al., “Diversity, Environmental Requirements, and Biogeography of Bivalve Wood-Borers (Teredinidae) in European Coastal Waters,” *Frontiers in Zoology* 11 (December 2014); for a description of *Bankia setacea*'s habits, see James Theodore Carlton, “History, Biogeography, and Ecology of the Introduced Marine and Estuarine Invertebrates of the Pacific Coast of North America” (PhD diss., University of California, Davis, 1979), 549-550; For pelagic borers, see Charles Howard Edmondson, “Teredinidae, Ocean Travelers,” *Occasional Papers of Bernice P. Bishop Museum* 23 (July 1962): 45-59; for deep marine borers, see Distel, “Molecular Phylogeny of Pholadoidea Lamarck, 1809 Supports a Single Origin for Xylotrophy (Wood Feeding) and Xylotrophic Bacterial Endosymbiosis in Bivalvia”: 246.

## The Source

Detecting shipworms in the heart of a pile is bewildering enough, but tracking them down in historical records is equally challenging. Still, there is plenty of low hanging fruit there for the taking. Travel narratives from the Age of Discovery are easily accessible and contain fascinating tidbits about shipworms. During the early modern period, borers were still novel enough that explorers gave thoughtful descriptions and interpretations about shipworms. Chapter One draws on many of these sources to show how early modern seamen reimagined marine environments and their place in them through a never-ending negotiation with marine woodborers.

Besides travel narratives, there are plenty of other sources easy to find. In the wake of the *Teredo navalis* invasion of San Francisco Bay, for instance, the National Research Council, in conjunction with the American Wood-Preservers' Association, conducted a wide-ranging survey of borers all around the nation. This study produced dozens of reports, both large and small, that have proved crucial at every juncture of the dissertation. A few years later, two separate northeastern consortiums—made up of business leaders and government agencies (from the local, state, and national levels)—investigated the spike in borer activity in New England and New York City during the 1930s and early 1940s. While the reports that the New England and New York committees produced are not as dense as the San Francisco Bay Marine Piling Survey, they are still valuable, covering an important period towards the end of the epidemic. All of these sources provide a crucial backbone to Chapters Five and Six, but they are also interspersed throughout other chapters.

Immediately following World War II, the Navy Bureau of Docks and Yards built

on the research taking place in the northeast and began coordinating and funding an even wider array of studies on marine borers, some of which took more than a decade to complete. This research offers what is perhaps the clearest picture of marine borers ever created (though there has been a renaissance in attention to borers over the last decade that may in time surpass the work done in the fifties and sixties—see Conclusion). They examine taxonomy, physiology, prevention, and timber-resistance, among other things. The studies conducted by the navy helped bring about the end of the teredo epidemic, and close out the final chapters of the dissertation.

Extraordinary events like the invasion of San Francisco Bay have generated a more robust cache of records than the earlier years of the teredo epidemic. Getting at these earlier years has been difficult, but by no means impossible. The US Army Corps of Engineers kept tabs on shipworms, especially after it began improving coastal waters through dredging and diking after roughly the 1870s. From these sources, we can see the efforts that engineers took to counteract borers. By their nature, these sources are terse and technical, but it is rare to find a report that does not convey feelings of frustration since nearly all of them repeat the ominous phrase “the ravages of the teredo.” Corps reports are most useful in Chapters Two and Four, which cover navigational and coastal improvements along the Gulf Coast and Puget Sound.

Speaking of emotions, this dissertation tries to account for the ways in which everyday people felt about the vexing teredo epidemic. In particular, Chapter Three explores how Americans refashioned the word “teredo” to express their feelings not just about the constantly falling wharves, but also the broader changes in society. Capturing these feelings and sentiments might have been impossible were it not for digitized

sources, namely newspaper archives. At this present juncture, the number of digitized sources that contain references to teredo (and its various synonyms) is still manageable. But they are growing all the time, and may soon be too difficult for one scholar to explore on his or her own. In any case, the quality of these sources will hopefully trump any concerns about the quantity of references to teredo now currently available. Without them, a crucial element of this dissertation—the cultural element—would have been nigh impossible to recover.

Finally, this dissertation draws on a number of scholarly studies produced over a couple hundred years. Ever since the eighteenth century, researchers have tried to make sense of shipworms in terms of physiology and taxonomy. Many of these studies are notable more for their shortcomings than their accuracy, so they must be taken with a grain of salt (it wasn't until the twentieth century when studies became more accurate). What they provide are stories and anecdotes. Moreover, errors and flawed methodologies (of which there are many) shed just as much light on the teredo epidemic as the more reliable data that emerged during the twentieth century.

### **The Rundown**

There was such a thing as a teredo epidemic, and it has shaped the way that American waterfronts look decades after it passed. This is perhaps the most radical and overarching takeaway from this dissertation—and the easiest to lose sight of or take for granted. Everything that follows flows from this observation. It is also a point that this dissertation will not overuse, preferring instead to let it remain more or less implicit as the work unfolds. Instead each chapter will focus on specific implications of the teredo epidemic. They trace the environmental changes, social clashes, cultural apprehensions,

and scientific developments that stem from the crisis. This is a story about a largely maritime problem that for a brief time became a coastal conundrum before disappearing into history.

CHAPTER ONE  
THE SHIPWORM DIASPORA:  
GLOBAL EXCHANGES AND DISCOURSES IN THE AGE OF SAIL

**Introduction**

When the *Golden Hind* sailed into London in 1580, Queen Elizabeth greeted it with reservations. Although it had carried the English flag around the world, the queen, wary of provoking Spain, forbade Captain Francis Drake from speaking about its journey. Still, the *Golden Hind* was a national treasure in her eyes, symbolizing the nation's growing naval might. England would go on to command the seas for most of the next three centuries, while the *Golden Hind* would suffer a shorter fate. During its voyage the galleon had been riddled by “*Teredo*” and “grown rotten and spongy.” It never sailed again. Details of the *Golden Hind*'s run-in with shipworms are spotty. The ship's logbook was suppressed by the queen and later lost. It is from the writings of Thomas Muffet, a naturalist specializing on insects, that we know anything concrete about the ship's encounter with borers. Muffet knew Drake and may have personally examined the *Golden Hind*. Years later, Muffet recounted how Drake brought borers “home with him, in his Ship that had gone over the world.”<sup>1</sup>

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1. Thomas Muffet, “The Theatre of Insects,” in *The History of Four-Footed Beasts and Serpents*, ed. Edward Topsel (London: E. Cotes, 1658), 1083; For the Queen Elizabeth's tepidness to Drake see, John H. Parry, “Drake and the World Encompassed,” in *Sir Francis Drake and the Famous Voyage, 1577-1580: Essays Commemorating the Quadricentennial of Drake's Circumnavigation of the Earth*, ed. Norman J. W. Thrower (Berkeley: University of California Press, 1984), 8-9; Existing firsthand accounts of the voyage are vague on shipworms. A deposition by one of Drake's Spanish prisoners mentions how the *Golden Hind* “has two sheathings, one as perfectly as the other,” which may have been protection against shipworms, see Zelia Nuttall, trans. and ed., *New Light on Drake: A Collection of Documents Relating to His Voyage of Circumnavigation, 1577-1580* (London: The Hakluyt Society, 1914), 302-303; The notes (now lost) from Drake's chaplain, Francis Fletcher, which were the basis for *The World Encompassed*, indicates that the *Golden Hind* had “received a leake at sea, was brought to anchor neer the shoar, that her goods being

Just as Drake and other early modern seamen changed the world, they also changed the sea. European explorers and traders unintentionally redistributed marine organisms all over the globe. Stowaway shipworms rode inside the planks of vessels piloted by Christopher Columbus, William Dampier, James Cook, and many others. The specific details of this shipworm diaspora, unfortunately, are hazy. A clearer understanding of teredinid taxonomy didn't come into focus until the twentieth century. By then, some of the most ravenous species had attained global distributions such that their places of origin are unknown, and may forever remain a mystery. Therefore, it's unclear if shipworms arrived "home with" Drake or the other way around—or some combination of both. The shipworm diaspora is not at all transparent, except in the most general of terms.<sup>2</sup>

Early modern seafarers weren't oblivious to shipworms. Far from it. They paid careful attention to the borers they encountered—and sometimes shuttled—around the globe. Their lives depended on it. Logbooks and travel narratives contain stories about teredo that range from mundane to harrowing. Modern biologists have tried to mine these

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landed, she might be repaired." This happened off the coast of California, though it's unclear if teredo was the culprit as many have assumed. See, Sir Francis Drake and Francis Fletcher, *The World Encompassed By Sir Francis Drake* (London, 1628), 68, and Sir Simon Cassels, "Where Did Drake Careen the Golden Hind in June/July 1579? A Mariner's Assessment," *The International Quarterly Journal of the Society for Nautical Research* 89 (August 2003): 260-271; On Drake's lost logbooks see, David B. Quinn, "Early Accounts of the Famous Voyage," in *Sir Francis Drake and the Famous Voyage, 1577-1580: Essays Commemorating the Quadricentennial of Drake's Circumnavigation of the Earth*, ed. Norman J. W. Thrower (Berkeley: University of California Press, 1984), 38-39; for the connection between Drake and Muffet see, W. T. Calman, *Marine Boring Animals Injurious to Submerged Structures* (London: British Museum of Natural History, 1919), 5 n. 1.

2. For arguments about the early modern redistribution of shipworms, see James T. Carlton, "Molluscan Invasions in Marine and Estuarine Communities," *Malacologia* 41 (1999): 439-54; and Carlton, "Blue Immigrants: The Marine Biology of Maritime History," *The Log of Mystic Seaport* (May 1992): 31-36; For an analysis of the difficulties of establishing the origins of teredinids, see Luisa M. S. Borges et al., "Diversity, Environmental Requirements, and Biogeography of Bivalve Wood-Borers (Teredinidae) in European Coastal Waters," *Frontiers in Zoology* 11 (December 2014), 6; For an evolution in taxonomy, see Ruth Dixon Turner, *A Survey and Illustrated Catalogue of the Teredinidae (Mollusca: Bivalvia)* (Cambridge: Museum of Comparative Zoology, Harvard University, 1966).

sources for data on the spread of borers, but have found them too scant to be of much use. From a historical perspective they are worth examining for the human stories that they tell. They reveal how seamen struggled to fathom the sea; how they developed and revised theories about teredo; and how they adapted technologically and logistically to borers. The story of the spread of shipworms that is told here is from the view of merchants and explorers, for the shipworm diaspora is just as much about people as it is about teredo.<sup>3</sup>

This chapter explores how early modern seafarers constructed and used knowledge about shipworms in the Age of Sail. Europeans knew next to nothing about teredo when they embarked in search of distant lands five centuries ago, but they quickly discovered that shipworms were among the most dangerous organisms in the sea. Seamen crafted theories about borers and developed strategies for negotiating marine environments teeming with teredo. To accomplish this, they exchanged stories and evaluated one another's practices. Seafarers jotted down their encounters with borers around the world and observed how foreign cultures dealt with them in distant seas. Every honeycombed ship, and every anecdote etched in a logbook, helped to paint a picture of teredo throughout the world. Journals, travel narratives, and scholarly works all open a window onto this multi-century, multi-cultural, and multi-environmental

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3. For the difficulty of reconstructing the spread of shipworms, see Carlton, "Molluscan Invasions in Marine and Estuarine Communities"; Other fields have tried to use written sources to reconstruct historical ecologies. For proponents of using written records to reconstruct historical fish populations and distributions, see Jeremy B. C. Jackson, "Reefs Since Columbus," *Coral Reefs* 6 (Supplemental, 1997): 23-32; and Jackson, "Historical Overfishing and the Recent Collapse of Coastal Ecosystems," *Science* 293 (July, 2001): 629-637; Some scholars have warned about the field of marine environmental history caving to the demands of historical ecology. See W. Jeffrey Bolster, "Opportunities in Marine Environmental History," *Environmental History* 11 (July 2006): 567-597; See the January 2013 forum in *Environmental History*, especially Christine Keiner, "How Scientific Does Marine Environmental History Need to Be?" *Environmental History* 18 (January 2013): 111-120; and Joseph E. Taylor III, "Knowing the Black Box: Methodological Challenges in Marine Environmental History," *Environmental History* 18 (January 2013): 60-75; However, it is possible to do both, W. Jeffrey Bolster, *The Mortal Sea: Fishing the Atlantic in the Age of Sail* (Cambridge: Belknap, 2012).



discourse. After more than two centuries of contending with shipworms, Europeans constructed a paradigm that guided their preparations for journeys throughout the world's oceans as well as their defenses against shipworms back in Europe.

### **The Rise and Fall of *τερηδών***

Muffet's use of "*Teredo*" is peculiar; Europeans hadn't used it for a thousand years, and wouldn't regularly use it again for two more centuries. It was the ancient word for shipworm. The ancients were well versed with shipworms. Beginning in the fourth century BCE, Greeks and Romans studied teredo and adapted to it throughout the Mediterranean. By the 1500s, Europeans were mostly unaware of this ancient discourse. A quick review of what the ancients knew about shipworms can help establish a baseline from which we can interpret early modern experiences with shipworms.

For centuries, the ancient Greek language did not have a word for shipworms. Then around the fourth century BCE it got one. *Teredo* has its origins in the word *τερηδών*—spelled "teredon" in English. The playwright Aristophanes first used the word *τερηδόνων* (a declension of *τερηδών*) in his play *The Knights* (424 BCE). In this story, Hyperbolus, a corrupt and inept warmonger, inspired a great deal of contempt throughout Athens. He was so reviled that a flotilla of triremes came to life to complain about him. The sentient ships feared that the next battle would end in their destruction, so they blocked Hyperbolus' army from boarding their decks. One of the hotheaded younger ships captured how other triremes felt about Hyperbolus when she said, "God save us! Never shall he be my master! Rather, if need be, I'll let myself grow old here and be eaten away by woodworm [or, *τερηδόνων* in the original]."4

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4. Aristophanes, *Knights*, trans. and ed. Alan H. Sommerstein (Warminster: Aris & Phillips LTD, 1981), 130-131.

It *seems* like Aristophanes intended *τερηδόνων* to refer to shipworms. But this might not have been so. According to some translators, *τερηδόνων* means “rust” or “rot.” It might have been that modern translators were simply unfamiliar with shipworms. But it doesn’t help that Aristophanes and other ancients use the word inconsistently before the fourth century BCE. In another of his plays, *τερηδών* is the name of a piper boy who plays a Persian dance—this might have been an allusion to the name of an older Persian maritime city at the mouth of the Euphrates that also went by the name *Τερηδών*. The meaning of *τερηδών* is further clouded by its usage by other famous Greeks. Hippocrates defined it as a horrific malady whereby a “teredo forms in the skull” and “the skin over the teredo becomes thin and puffed up, and a break develops in it.” By contrast, Aristotle explains that *τερηδόνας* (another declension of *τερηδών*) is a parasite that destroys beehives (given that shipworm-infested wood looks like a honeycomb, it’s possible that this was the inspiration for the word for shipworm). While these competing definitions certainly conjure the imagery of teredinids, they might have been coincidental homonyms. What’s more likely is that the competing definitions independently drew from the Ancient Greek root “ter” (which means “to bore.”). Regardless, it is far from certain whether any of these terms stood for shipworm, as we know them.<sup>5</sup>

It wasn’t until the mid-fourth century BCE that *τερηδών* clearly came to signify

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5. *The Complete Plays of Aristophanes*, ed. Moses Hadas (New York: Bantam Books, 1962), 97; *Aristophanes: The Birds and Other Plays*, trans. David Barrett and Alan H. Sommerstein (London: Penguin Books, 2003), 84; *Aristophanes: Birds, Lysistrata, Women at the Thesmophoria*, trans. Jeffrey Henderson (Cambridge: Harvard University Press, 2000), 607; *Strabo: Geography, Books 1-2*, trans. Horace Leonard Jones and John Robert Sitlington Sterrett (Cambridge: Harvard University Press, 1917), 302, 303; *Hippocrates: Vol. 5*, trans. Paul Potter (Cambridge: Harvard University Press, 1988), 233; Aristotle, *History of Animals: Books VII-X*, trans. and ed. D. M. Balme (Cambridge: Harvard University Press, 1991), 194-195; Edwin W. Fay, “The Latin Confixes -Edon, -Edno-, ‘Eating,’” *Classical Philology* 6 (July 1911): 318.

shipworms. Theophrastus, a pupil of Aristotle, clarified the meaning in his book the *Enquiry Into Plants*, which made it abundantly clear that *τερηδών* referred to marine woodborers and nothing else. He writes, “woods which decay in sea-water are eaten by the teredon” and “those which decay on land by the skolex and thrips; for the teredons not occur except in the sea.” It’s fair to wonder what triggered Theophrastus to develop a stricter definition. Were shipworms new to the Mediterranean? Or had they always been there and only escaped the notice (or interest) of Greeks up until then? While there is no way to know for certain, there is some evidence that around the same time Alexander the Great (or his commanders) showed interest in trees from Arabia that purportedly resisted decay when submerged, making them ideal for ships. Thus, shipworms may have become a strategic concern, necessitating an unambiguous signifier. Whatever the reason, the Greek language lacked a distinct word for shipworms before the fourth century BCE. Then, for reasons that will likely remain a mystery, it got one.<sup>6</sup>

Thereafter, *τερηδών* remained a stable Greek referent. Evidence comes from Polybius, who mentioned *τερηδόνες* (yet another declension of *τερηδών*) in *The Histories*, written in the second century BCE. Polybius was a historian, not naturalist; so, teredinids interested him only so far as they shed light on the history of politics of the Mediterranean. Polybius used shipworms as a metaphor in his analysis of the inherent faults of government. He argued that all kingships, aristocracies, and democracies, even when they appeared stable on the surface, carried the seeds for their own downfall. Government was like a piece of wood; while it might escape all external injuries, it has a

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6. Theophrastus, *Enquiry Into Plants, Books I-V*, trans. Arthur Hort (Cambridge: Harvard University Press, 1916), 443; Pliny the Elder, *Natural History, Books 12-16*, trans. H. Rackham (Cambridge: Harvard University Press, 1945), 531.

“vice engendered in it” and will “fall prey to the evils” of shipworms (τερηδόνες) that are “inseparable from it.”<sup>7</sup>

When the Romans gained hegemony over the Mediterranean, they inherited the problem of shipworms as they constructed their vast empire. They seem to have known even less about shipworms than their Greek neighbors. Not only did Romans lack a word of their own for shipworms, they didn’t bother to make one. They simply borrowed τερηδών from the Greeks. Given the cross-cultural nature of the Hellenistic period, it is not surprising that Greek words transferred to Latin more or less intact. Romans transcribed τερηδών variously as teredine, teredini and teredinem. Pliny the Elder parsed out their meanings in his book *Natural History* where he writes that “it is held that [shipworms] are the only ones to which the name [teredinem] properly applies.”<sup>8</sup>

Shipworms had an impact on Roman coastal infrastructure. The architect Vitruvius, author of the first century BCE book titled *On Architecture*, had shipworms in mind when he recommended that Mediterranean shipyards “be built and with a northern aspect, as a rule. For southern aspects because of their warmth generate dry rot, wood worms and ship worms [spelled “teredines” in Latin] with other noxious creatures, and feed and maintain them.”<sup>9</sup>

Romans also tangled with woodborers in one corner of their empire. In faraway Britannia, archeologists have discovered shipworm borings in the so-called Blackfriars

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7. Polybius, *The Histories: Books 1-2*, trans. W. R. Paton, revised by Frank W. Walbank and Christian Habicht (Cambridge: Harvard University Press, 2010), 316-317.

8. Pliny the Elder, *Natural History, Books 1-2*, trans. Harris Rackham (Cambridge: Harvard University Press, 1949), 530-531.

9. Marcus Vitruvius Pollio, *On Architecture, Books 1-5*, trans. and ed. Frank Granger (Cambridge: Harvard University Press, 1998), 316-317.

ship. Unearthed along the banks of London, the ship contains rare evidence of millennia-old teredinid attacks. Named after the Blackfriars Bridge where it was found, the ship sank in the second century CE. Judging by its flat-bottomed, keel-less hull, and cargo of Kentish ragstone, the Blackfriars was a barge that floated from Londinium down the Thames to the estuary near the River Medway, where the barge probably became infected, since borers can't survive upstream of Gravesend, thirty miles from London. The find suggests that Britannia was home to shipworms long before Drake returned from his famous voyage.<sup>10</sup>

Shipworms found a prominent place in Roman culture, just as they had in Greek. Much like Polybius, the famed poet Ovid found the behaviors of borers very useful as a metaphor. While exiled from Rome, Ovid writes, “[d]eath at least by his coming will put an end to my exile, my sin even death will not remove. ’Tis then no marvel if my heart has softened and melts as water runs from snow. It is gnawed as a ship is injured by the hidden borer [spelled ‘teredine navis’].” While it is fair to wonder how versed most Romans were with the habits of teredinids, Ovid’s poetry reached a broad audience, indicating that literate Romans throughout the empire had some familiarity with woodborers through his texts, if not through direct experience.<sup>11</sup>

As early as the second century CE, the meaning of the Greek word *τερηδών* fragmented again. Plutarch, for instance, explained in his work *Moralia* that *τερηδόνων*

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10. P. R. V. Marsden, *A Ship of the Roman Period, from Blackfriars, in the City of London* (London: Society for Nautical Research, 1966); J. H. Williams, “Roman Building-Materials in South-East England,” *Britannia* 2 (1971): 172; For the geography of woodborers in the Thames River, see J. J. Wilkinson, “An Historical Account of Coppering Sheathing for Vessels,” *Minutes of Proceedings of the Institution of Civil Engineers* 2 (February 1842): 67.

11. Publius Ovidius Naso, *Tristia. Ex Ponto*, 2nd ed., trans. A. L. Wheeler, revised by G. L. Goold (Cambridge: Harvard University Press, 1996), 268-269.

“are generated in trees when the moisture in them putrefies,” which indicates that he was referring to a terrestrial woodborer, not a teredinid. Later, the physician Galen used *τερηδών* to refer to “caries of the bone,” a definition that harkens back to the writings of Hippocrates. And, finally, Aelian, a Roman writer who preferred Greek to Latin, used *Τερηδόνη* to signify the Babylonian City of Teredon. It is not clear from surviving records if *τερηδών* stopped meaning “shipworm”, but by the start of the Middle Ages woodborers no longer had a monopoly it.<sup>12</sup>

Shipworms resurfaced a couple of times in written records in the intervening years before the Age of Discovery, though the word “teredo” and derivatives of *τερηδών* would not. One such instance occurred in *The Saga of Erik the Red*. In the tale, voyagers from Vinland to Iceland “came into a sea, which was filled with worms, and their ship began to sink beneath them.” According to the saga, the crew had been unaware of the infestation until it was too late. Bjarni, the leader of the voyage, ordered all of his men into the ship’s boat, “which had been coated with seal-tar; this the sea-worm does not penetrate.” Unfortunately, the boat could not hold them all so they randomly selected who would board and who would remain on the ship, ultimately to perish.<sup>13</sup>

The remaining sagas make no more mention of teredinids. In fact, had it not been for a selfless act by Bjarni, shipworms probably wouldn’t have made it into *The Saga of Erik the Red* either. Bjarni’s story became ensconced in Viking lore, not because of shipworms, but because he chose to go down with his ship. Bjarni refused to make “the

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12. Plutarch, *Moralia*, trans. F. H. Sandbach (Cambridge: Harvard University Press, 1969), 15: 154-155; Galen, *On the Constitution of the Art of Medicine*, ed. and trans. Ian Johnston (Cambridge: Harvard University Press, 2016), 36-37; Aelian, *On the Characteristics of Animals*, trans. A. F. Scholfield (Cambridge: Harvard University Press, 1959), 3:345.

13. Julius E. Olson, ed., *The Northmen, Columbus, and Cabot: 985-1503* (New York: Charles Scribner’s Sons, 1906), 42-43.

rank of the men” a factor in the lottery that decided the crew’s fate. As luck would have it, Bjarni won a seat in the survivor’s boat, but willingly gave it up to another crewmember. While Bjarni perished in the so-called “Worm-sea,” his self-sacrifice immortalized him in Norse culture. If it were not for his altruism the presence of teredinids in the North Atlantic might have gone undocumented altogether.<sup>14</sup>

The last reliable shipworm sighting of the middle ages came during the Third Crusade in 1190. During his lengthy stay in Sicily, Richard I ordered “all the ships of his fleet to be hauled ashore and repaired, as many of them had become damaged in consequence of being eaten away by worms,” writes Richard’s clerk. It would seem that the crusaders had no prior experience with the borers. They didn’t have a word for them, instead relying on the local term “beom.” Richard’s clerk associated the worms with Sicily. “For in the river Del Faro,” he writes, “there are certain thin worms...whose food is every kind of wood.” Since Richard lingered in Sicily for roughly half a year, it’s possible that his fleet contracted shipworms on arrival—though it’s not out of the question that he unknowingly brought them from northern Europe.<sup>15</sup>

Shipworms existed in the waters of Europe before the early modern era. They survived in the chilly seas of the Norsemen to the sunny ports of Alexandria, though the exact species and their distributions are unknown. When Christopher Columbus set sail for the New World, much of this traditional knowledge about borers had vanished. For all practical purposes, teredo was a new and novel species.

### **Shipworm Ecology in the Age of Discovery**

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14. Ibid.

15. *The Annals of Roger de Hoveden, Comprising the History of England and of Other Countries of Europe*, trans. Henry T. Riley (London: H. G. Bohn, 1853), 2:173-174.

Stories from the New World reignited a long dormant interest in shipworms. The near fatal voyages of Christopher Columbus and Gonzalo Fernández de Oviedo captivated European readers. In 1503, Columbus nearly succumbed to teredo, or *broma* (as the Spanish called borers) on his final voyage. While exploring Panama, he had to abandon two of his four ships when they had become “riddled with holes as a honeycomb.” With his remaining ships in peril, Columbus set a course for Cuba. The journey was dreadful. “With three pumps, pots and cauldrons and all hands at work,” he writes, “I still could not keep down the water that entered the ship, and there was nothing we could do to meet the damage done by the shipworm.” Columbus spent the year marooned on Jamaica.<sup>16</sup>

Similarly, Oviedo, a Spanish New World chronicler, recounts in his famous history of the Indies how in 1523 he had “traveled in a small caravel...so eaten up by shipworms that to keep afloat we were using our shirts to try to plug the holes through which the water was flooding the ship.” Oviedo might have been guilty of dramatizing this frightful episode, but for good reason. He was concerned that naïve Europeans might come to the New World with high expectations and little understanding of the risks. Scaring European readers with tales of shipwrecks might dissuade the foolish and unprepared from coming. In these ways, dramatic stories about shipworms spread to Europe.<sup>17</sup>

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16. J. M. Cohen, ed., *The Four Voyages of Christopher Columbus: Being His Own Log-Book, Letters and Dispatches with Connecting Narrative Drawn from the Life of the Admiral by His Son Hernando Colon and Other Contemporary Historians* (London: Harmondsworth, 1969), 293-295.

17. Gonzalo Fernandez de Oviedo, *Misfortunes and Shipwrecks in the Seas of the Indies, Islands, and Mainland of the Ocean Sea (1513–1548): Book Fifty of the General and Natural History of the Indies*, trans. Glen F. Dille (Gainesville: University Press of Florida, 2011), 2.



Throughout the sixteenth century, Europeans tried to get to the root of these shocking tales. Peter Martyr d'Anghiera, an Italian employed as Spain's royal historian, offered one theory. The reason teredo was so destructive in the West Indies was due to the warmer weather. Martyr had never encountered shipworms in the New World (he never went there) but he was familiar with borers from his homeland. Venetians called them *bissa* and complained about borers attacking their trading ships at Alexandria. Martyr inferred from reading Columbus' logbook and speaking with returnees from the New World that shipworms were more prolific in the West Indies because the "suns from the waters of these regions situated near the equator."<sup>18</sup>

There's some truth to Martyr's deduction. In general, shipworms are more prolific in warmer waters. Shipworms breed until temperatures drop below a certain level. This varies from borer to borer. To give an example, *Bankia gouldi*, a borer common in the Caribbean, spawns as long as temperatures remain above 27-28 degrees Celsius. In the tropics, there is little stopping this borer from breeding most of the year. *Bankia gouldi* also ranges as far north as Chesapeake Bay. But owing to fluctuations in water temperature, it breeds there less frequently. While there are certainly exceptions to Martyr's rule of thumb (*Bankia setacea*, a Northeastern Pacific borer, breeds in the chilly waters of Alaska), he hit upon a theory that was accurate enough for the purposes of early modern sailors.<sup>19</sup>

Within a few decades, Martyr's climate theory spread northward to England, but in fits and starts. By 1553, Richard Chancellor, the discoverer of the Northeast Passage to

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18. *De Orbe Novo: The Eight Decades of Peter Martyr d'Anghiera*, trans. Francis Augustus MacNutt (New York: G. P. Putnam's and Sons, 1912), 1:43, 325-327.

19. Turner, *A Survey and Illustrated Catalogue of the Teredinidae (Mollusca: Bivalvia)*, 52, 261.

Russia, had heard “that in certaine parts of the Ocean, a kinde of wormes is bredde, which many times pearceth and eateth through the strongest oake.” But he clearly didn’t associate borers with the tropics since he prepared as though he might run into shipworms in the Artic Sea. Shortly after his return, in 1555, a translation of Martyr’s writings clarified the relationship between teredo and the tropics for English readers.<sup>20</sup>

The English caught a glimpse of the dangerous combination of teredo and warmer climates during the Anglo-Spanish War. In 1590, when King Philip learned of a squadron of English ships sent to harry the West Indian trade, he ordered his fleet to wait in the Caribbean until it was safe to return. But by “Wintering in the *Indies*,” writes William Monson, a veteran and historian of the war, “the Worm which that Country is subject to, weaken[ed] and consume[d] their Ships.” When the treasure filled ships finally returned in 1591 they had become so riddled with teredo that nearly one hundred ships sank.<sup>21</sup>

After the war, the English started to evaluate the climate theory through their own experiences. The English explorer Richard Hawkins noted during his voyage to the Pacific in 1593 how a “certaine worm” inhabited the “coast of Brasill.” Hawkins warned his fellow seamen to beware of places like Brazil where these worms “breed in the great seas in all hot clymates, especially neere the equinoctiall lyne” and “enter into the planks of shippes.”<sup>22</sup>

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20. Richard Hakluyt, *Hakluyt’s Collection of the Early Voyages, Travels, and Discoveries, of the English Nation* (London: 1809), 270-271; Edward Barber, *The First Three English Books on America [? 1511]-1855 A.D., Being Chiefly Translations, Compilations, &c., by Richard Eden* (Westminster: Archibald Constable and Co., 1895), 153, 396.

21. William Monson, *A True and Exact Account of the Wars with Spain, in the Reign of Q. Elizabeth (of Famous Memory) Being the Particulars of What Happened Between the English and Spanish Fleets, from the Years 1585 to 1602* (London: 1682), 25.

22. *The Observations of Sir Richard Hawkins, Knt, in His Voyage Into the South Sea in the Year 1593*, ed. C. R. Drinkwater Bethune (London: Hakluyt Society, 1847), 118-121.

The Portuguese also associated shipworms with warmer climates, and went so far as to quarantine parts of the tropics because of borers. Ships coming back from the East Indies were prohibited from going near Brazil “because of the wormes that there do spoil the ship,” explained Jan Huygen van Linschoten, a Dutchman who sailed under Portugal’s flag. This rule was not to be broken, even for ships that missed the way station at Saint Helena in the South Atlantic. In 1590, this very thing happened, prompting Linschoten to note that the “King had expressly under a great penalty forbidden” anyone from sailing to Brazil “because of the wormes.”<sup>23</sup>

In spite of the dangers, the tropics were too valuable to avoid. Seamen headed for Panama, Hispaniola, Brazil, and India knew they were walking into prime shipworm country. Still, they wondered if every corner of the tropics was equally dangerous. If sailors could determine the teredo hotspots, they might be able to mitigate the risks. This led some to ask whether New World shipworms were saltwater or freshwater species, so they could understand which types of water to avoid.

Columbus might have inadvertently fueled this line of inquiry. Columbus arrived in the New World in October of 1492, but he does not mention shipworms until January of 1493 when a river on Hispanola caught his eye. According to his *Diario*, Columbus approved of the mouth of the Rio de Gracia, as he named it, because of its anchorage and safe shelter. Its biggest drawback, however, was that “it has a lot of shipworms,” or *broma*, as he called them. Columbus complained that “the caravel Pinta...was badly damaged [by *broma*], because...he stayed there trading for 16 days.” It’s unclear from the

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23. *John Huyghen van Linschoten: His Discours of Voyages into ye Easte & West Indies. Divided Into Four Books*, trans. William Philip (London: John Wolfe, 1598), 191.

passage if Columbus thought *broma* was a freshwater species or not; he did not indicate whether he anchored in the fresh, brackish, or saltwater parts of the Rio de Gracia. But readers of the *Diario* probably left with the impression that shipworms might be freshwater species.<sup>24</sup>

Europeans following in Columbus' path debated the relationship between teredo and salinity more explicitly. In 1535, Oviedo sketched out two positions. "Some say that this worm enters the ships through the water," while "others believe that it grows in the wood itself." Oviedo had his own views: "I believe that the moisture of the water and the readiness of the sun and the power of the sun are the materials, from which such animals naturally form in these parts over time." The "moisture" he was referring to was freshwater. Oviedo writes, "on those shores of Tierra-Firme, as there are many great rivers, so there is much shipworm in them, and soon the ships are lost." This became the accepted view for much of the century.<sup>25</sup>

In 1593, Richard Hawkins cast some doubt on this notion. He acknowledged that the "common opinion is that [shipworms] are bred in fresh water, and with the current of the rivers are brought into the sea." But his experiences didn't mesh with the conventional view. On his way to the Pacific Hawkins stopped over in Brazil where he noticed that his shallop in tow had become infested "with these wormes, as bigge as the

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24. Bartolomé de las Casas, ed., *The Diario of Christopher Columbus's First Voyage to America, 1492-1493*, trans. O. C. Dunn and J. E. Kelley (Norman: University of Oklahoma Press, 1989), 321-323. There is a lot about this episode that is problematic. Shipworms can certainly destroy timber in one season, and cause noticeable damage in driftwood in as short as two months, but no source has ever suggested that shipworms have caused the degree of damage done to the *Pinta* in as little as sixteen days. What is more likely to have occurred is that the *Pinta* contracted shipworms upon landfall in the Bahamas two months earlier—or, perhaps, Columbus brought them across the Atlantic. When Columbus noticed the damage, he mistakenly assumed that the borers that attacked the *Pinta* were from the Rio de Gracia. This is not to say that there were no shipworms in the Rio de Gracia, just that they weren't the borers that attacked the *Pinta*.

25. Gonzalo Fernandez de Oviedo y Valdes, *Historia General y Natural de las Indias* (Madrid: Real Academia de la Historia, 1851), 1:79.

little finger of a man.” Contrary to what he had heard, his “experience teacheth that [shipworms] breed in the great seas in all hott clymates.” Hawkins had a hard time believing shipworms were an exception to the rule that species “bred and nourished in the sea, comming into fresh water die, as those actually bred in ponds or fresh rivers, die presently, if they come into salt water.”<sup>26</sup>

Just when Hawkins thought he understood borers they surprised him after he departed Brazil for the Pacific. After stocking up on freshwater, Hawkins discovered some time later that his water barrels had started leaking on account of teredo. Befuddled, Hawkins was left with the feeling that shipworms “eyther are part terrestryall, and part aquatile, as the maremaide...or have their breeding in the fresh, and growth...in the salt water, as the salmond.” His frustration with being unable to diagnose shipworms was palpable.<sup>27</sup>

There’s a good explanation for these competing theories. Oviedo and Hawkins could not have known that they were encountering multiple species of shipworms. Virtually every teredinid is a saltwater species. But along the coast of Brazil up to Panama there exists a rare freshwater shipworm: *Psiloteredo healdi*. This species likely caused so much confusion on the part of Oviedo, Hawkins, and others. It also might have been the reason why early modern seamen failed to realize that most shipworms perish in freshwater. It would be another century before captains, especially Englishmen, would

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26. *The Observations of Sir Richard Hawkins*, 119.

27. *The Observations of Sir Richard Hawkins*, 119.

learn to take advantage of this knowledge and head for the “freshes” during their voyages.<sup>28</sup>

When the first century of the Age of Discovery came to a close, Europeans had gained a greater appreciation of teredo’s habitat and distribution. The biggest lesson they learned was that temperature determines the destructiveness of shipworms. But some things still remained a mystery, such as teredo’s relationship with salinity and the fact that there was more than one species of shipworm. But knowledge was cycling throughout Europe, and seamen would start to draw on this knowledge as they developed and shared technologies for preventing shipworm attacks.

### **The Ecology of the Ship**

While shipworms forced seamen to think in global terms, more often than not the exigencies of surviving at sea left them reacting to hyper-localized threats in pitched vertical battles with borers at the waterline. No one understood this better than James Cook. In June of 1770, Cook feared that a scratch to the wood sheaths lining the ship’s hull, caused by a run-in with a coral reef, would “be sufficient to let the worm into her bottom, which may prove of bad consequence.” He was right. It almost cost him and his crew their lives. By November, with no means to repair the hull’s damage, Cook discovered that “the worms had made their way quite into the timbers so that it was a matter of surprise to every one who saw her bottom how we had kept her above water.”

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28. Turner, *A Survey and Illustrated Catalogue of the Teredinidae (Mollusca: Bivalvia)*, 52; for distributions of these freshwater species, see N. Balakrishnan Nair, “The Biology of Wood-Boring Teredinid Molluscs,” *Advances in Marine Biology* 9 (1971): 456-457.

To meet these kinds of threats, Cook and others waged a biological and chemical war with their stealthy shipworm adversaries. The frontline was the waterline.<sup>29</sup>

Cook's account underscores an overlooked truth about the environmental history of seafaring: ships are at their most basic level ecosystems. There is nothing "unnatural" about them. They are composed of botanicals floating in seawater; mammals carrying microbes; barnacles siphoning plankton; and bivalves housing cellulose-digesting bacteria in their intestines. What's more, the ship is an ecosystem in constant flux. When coral scratched off the *Endeavor's* sheathing (temporary planks attached to a ship that slow borers from reaching the hull) it created a niche in the ecosystem exploitable by teredo, which reacted to the ship as if it were no different than countless other pieces of driftwood floating in the sea.<sup>30</sup>

For sailors of the early modern period, the ship was a potentially hostile environment. To survive, they had to render ships uninhabitable to borers. This was easier said than done. European seamen lacked shipworm deterrents when they set to sea in the fifteenth century, and wouldn't come across a reliable method until late in the eighteenth century, when copper sheathing became standard. In the meantime, they discussed and debated a whole host of (mostly ineffective) new preventative measures that appeared in the sixteenth and seventeenth centuries. Interestingly, many of these new methods were gleaned from listening to or watching indigenous maritime cultures—preventing ship decay was something that people all around the world could get behind.

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29. *Captain Cook's Journal: During His First Voyage Round the World Made In H. M. Bark "Endeavor" 1768-71*, ed. W. J. L. Wharton (London: Elliot Stock, 1893), 359-340.

30. *Ibid.*

Poisoning borers by building ships with wood they could not eat was one popular theory. The New World chronicler, Martyr, might have been the first to popularize this notion among westerners. While researching his history of the Indies, Martyr learned of a visit that a colonial administrator named Pedro Arias Davila once paid to the Coiba people of Panama. The Coiba leader, a man named Careta, was so taken with the Spaniard's musical instruments and horses that he decided to give Davila a gift in the form of information about an allegedly teredo-proof tree. According to Martyr, "there grew in [Careta's] province a tree, of which the wood was suitable for the construction of ships, since it was never attacked by marine worms." This (unspecified) tree was "so bitter that the worms do not even attempt to gnaw it."<sup>31</sup>

Oviedo tried to nip this theory in the bud. When he learned of Martyr's claim, he responded that such a discovery "would be very helpful, if it were true." In general, Oviedo was not fond of people writing "about things of the Indies without seeing them." When it came to teredo-proof trees, Oviedo writes, "I have been in that land" and "there are no such trees...that is exempt, or can be said free of worms." He went on to say, "if such a tree were to be, it would be well known." The debate that Martyr and Oviedo touched off is fascinating because it would recur in changing attires for the next four centuries. Just about every tree on the planet would be dubbed "teredo-proof" at one time or another. In the end, science would prove Oviedo right. But he couldn't get ahead of this enticing narrative.<sup>32</sup>

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31. Martyr, *De Orbe Novo*, 355.

32. Oviedo, *Historia General y Natural de las Indies*, 1:457-458; For a survey of immunity claims, see Nair, "The Biology of Wood-Boring Teredinid Molluscs": 478-482.



The allure of an impervious tree was just too tempting to ignore, and many people would spread rumors about purportedly resistant trees. In 1596, for instance, Jan Huygen van Linschoten, who had never been to the Americas, saw no problem publishing hearsay that there is wood in South America “good to make ships, for that it neuer consumeth in the water, by wormes, or any other meanes.” Likewise, the Frenchman Francois Pyrard, after a visit to Goa, recommended an (unspecified) Indian tree in his 1611 travel narrative because it is less likely to be attacked than French timber. By the mid-seventeenth century, rumors of a wild Indian pear-tree, too bitter for shipworms to eat, had spread to Europe. This came as welcome news since “very many ways have been used” to prevent teredo, “but without success,” as another Frenchmen complained. While some felt that the best solution “would be to find out a Wood having that quality,” a least one skeptic was willing to admit that there might be no such “Timber, fit for Ships, that is not known.”<sup>33</sup>

Had a resistant tree ever been discovered, it is doubtful that it would have supplanted oak in shipbuilding. Oak, especially English Oak, was the preferred timber for shipbuilding in the early modern era. Oak was strong and durable, and less liable to rotting from the alternating exposure to wet and dry. Woodborers were important considerations, but they would never steer shipbuilders from oak. While oak is not immune to borers, there is some evidence that English shipbuilders distinguished between different varieties of oak because of their perceived resistance to borers. In 1696, English shipwrights criticized American white oak in one instance because they thought it was

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33. *Iohn Hvighen van Linschoten*, 239; *Voyage de François Pyrard de Laval; Contenant sa Navigation aux Indes-Orientales, aux Maldives, Moluques, au Brésil* (Paris: 1679), 2:114; Anonymous, “An Extract Of a Letter, Written from Holland, about Preserving of Ships from being Worm-eaten,” *Philosophical Transactions* 1 (1665-1666): 190-191.

“subject to many worm holes.” These comments probably stem from the staunch (and erroneous) belief among English shipbuilders that their oak trees were superior to oaks from other regions.<sup>34</sup>

While on the lookout for teredo-proof trees, Europeans paid attention to the ways that indigenous people coated and covered the hulls of their ships. Some of these coatings and coverings were even adopted by Europeans, such as scupper nailing, a practice that probably originated in India. Scupper nailing is a tedious process. It involves hammering hundreds of (usually) iron nails into the hull of a ship (the practice was later used on piles). Nails oxidized in the presence of saltwater and formed a shield of rust that prevented shipworms from ever getting a taste of the wood underneath. Europeans probably learned about scuppering from the travel narrative of Ludovico di Varthema, an Italian who made his way to India sometime between 1503-1508. While in Calicut, Varthema observed how shipbuilders “put in an immense quantity of iron nails” into the hull. His travel narrative was published in 1510 and spread throughout Europe. Scupper nailing was practiced sporadically into the twentieth century, but gave inconsistent results since the protective shield often became brittle and cracked, allowing teredo easy access.<sup>35</sup>

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34. Robert Greenhalgh Albion, *Forests and Sea Power: The Timber Problem of the Royal Navy, 1652-1862* (Cambridge: Harvard University Press, 1926), 11, 16, 24. Albion’s excellent book on shipbuilding is surprisingly quiet and confused about shipworms (though he provides an excellent account of fungal dry rot). Albion claims that shipworms find oak’s tannic acid “distasteful,” but in the very next breath admits, “marine borers made leaky sieves” of ships; For a recent analysis of the oak tree *Quercus petraea* see, H. Sivrikaya, “Evaluation of Wooden Materials Deteriorated by Marine-Wood Boring Organisms in the Black Sea,” *Maderas, Ciencia y Tecnologia* 14 (2012): 79-90.

35. *The Travels of Ludovico di Varthema in Egypt, Syria, Arabia Deserta and Arabia Felix, in Persia, India, and Ethopia, A. D. 503 to 1508*, trans. John Winter Jones and ed. George Percy Badger (London: Hakluyt Society, 1863), 152-153; Scupper nailing is discussed more in chapter two. Record of scuppering in England dates back to 1666, but probably arrived much early. See J. J. Wilkinson, “On Iron Sheathing, Broad-Headed Nails, and Inner Sheathing for Ships,” *Minutes of Proceedings of the Institution of Civil Engineers* 2 (June 1842): 168-170; For descriptions of the process and its effectiveness, see William G.

Other East and West Indian methods attracted the attention of Europeans, but were not widely adopted. In Asia, Joao de Barros explained how Chinese junks were coated with a mixture of limestone and oil that forms “in short time almost stone,” which “the worm does not enter.” Hawkins had heard that this process was so durable that “neither worme nor water peirceth it.” Europeans also read about how people in the West Indies protected their vessels, but there is no evidence that they tried to recreate these lost practices. For instance, Jan Huygen van Linschoten wrote that the Taino people used a “certaine gumme...unholosome and fatty like tallow, wherewith and with oyle they dresse their shippes, and because it is bitter, it preserueth the ships from wormes.”<sup>36</sup>

By the seventeenth century, Europeans had developed some of their own teredo-repellants. The British adventurer John Hawkins (father of Richard) is credited with developing one of the more intriguing shipworm deterrents. At some point in the mid-1500s, Hawkins improved upon two other practices common by then: pitching and double-planking. Applying pitch, tar, or other oily substances to a hull was thought to poison borers. Double-planking, on the other hand, did not kill borers, but prevented them from consuming the inner hull. Sheathing hulls with layers of light, pliable timber (sometimes called “yacht planks”) gave borers something to chew on, but once the

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Atwood and A. A. Johnson, “Protections Against Borers,” in *Marine Structures, Their Deterioration and Preservation* (Washington DC: National Research Council, 1924), 98-99; see also, C. L. Hill and C. A. Kofoid, *Marine Borers and Their Relation to Marine Construction on the Pacific Coast: Final Report of the San Francisco Bay Marine Piling Committee* (San Francisco: Committee, 1927), 95.

36. *Da Asia de Joao de Barros: Dos Fietos, Que os Portuguezes Fizeram No Descobrimento, e Conquista Dos Mares, E Terras Do Oriente. Decada Terceira, Parte Primeira* (Lisboa: Na Regia Officina Typographia, 1777), 5:219-220; Variations on the lime treatment involve crushed lime or sea shells and hair held in place by sheaths, called *chunam* in the East Indies. See, John Knowles, *An Inquiry into the Means Which Have Been Take to Preserve the British Navy, from the Earliest Period to the Present Time, Particularly from that Species of Decay, Now Denominated Dry-Rot* (London: Winchester and Varnham, 1821), 136-137; *The Observations of Sir Richard Hawkins*, 120-121; *John Hvighen van Linschoten*, 225. 43

double-planks were riddled, they were removed and replaced, leaving the hull unharmed. Both methods were effective in the short run, but not as permanent protections.<sup>37</sup>

John Hawkins combined these practices and added animal hair to the concoction. Before nailing on the yacht planks, Hawkins smeared the hull with tar and applied a generous layer of animal hair. His son, Richard, wasn't sure how his father's method was supposed to prevent borers. He thought that the tar poisoned the worms, or that the worms struggled to maneuver through the hair and tar, like a fly caught in a spider's web, and therefore "choked" before they could reach the inner hull. In any case, the hair, pitch, sheath method offered temporary protections against teredo and became the preferred method in England for two centuries.<sup>38</sup>

In the long run, metal sheathing proved to be the most effective shipworm deterrent. It was also the costliest and hardest to perfect. Europeans didn't invent it as much as they discovered it. In the fifteenth century, archeologists raised a ship of Emperor Trajan's from the bottom of a lake. Leone Battista Alberti, a scholar of architecture, took time away from his study of Italian buildings to write about the find. According to Alberti, Trajan's ship "was plated over with sheets of lead fastened on with brass nails." It's unclear why the ship was sheathed at all since it was found in a freshwater lake (there are no freshwater shipworms in the Mediterranean). This ship has

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37. For a more detailed history of John Hawkins' invention see, Tom Glasgow Jr., "Sixteenth-Century English Seamen Meet a New Enemy—The Shipworm," *American Neptune* 27 (1967): 177-184.

38. *The Observations of Sir Richard Hawkins*, 121.

been cited (incorrectly) for centuries as evidence that Romans sheathed their ships to ward off shipworms.<sup>39</sup>

During the sixteenth century, knowledge about lead sheathing spread throughout Europe. Spain and Portugal had the edge in developing and implementing this technology. In 1506, the Spanish House of Trade of the Indies began to experiment with lead sheathing as a deterrent to shipworms. In 1514, when Pedro Arias Dávila (the same who heard about teredo-proof timber from the Coiba) departed for the New World, he took with him what may have been the first modern lead sheathed vessel, the *Santa Ana*. Lead sheathing finally reached England in 1553 when Sebastian Cabot reunited with London after a hiatus serving Madrid. He instructed Richard Chancellor to sheath his ships with lead before heading on his voyage in search of a northern route to Russia.<sup>40</sup>

Over the next century, some English sailors complained about metal sheathing. In 1622, Richard Hawkins grumbled of its exorbitant cost, lack of durability, and weight, which slowed down ships. The objections might have stemmed from the inability of the English to produce lead as well as the Spanish and Portuguese, who used the “thinnest sheet-lead I have seene in any place,” noted Hawkins. The English gave lead another look in the 1670s. Charles II took interest and in 1673 ordered the *Phoenix* to be sheathed and sent to sea. Upon its return, Charles personally inspected it. Satisfied with the results, Parliament ordered that all of his Majesty’s ships ought to be sheathed in lead. Not long after, unfortunately, captains began complaining that their ships had been attacked by

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39. *The Architecture of Leon Battista Alberti in Ten Books*, trans. James Leoni (London: T. Edlin, 1739), book 5, chap. 12; For freshwater shipworms, see Nair, “The Biology of Wood-Boring Teredinid Molluscs”: 456-457

40. Gervasio de Artinano y de Galdacano, *La Arquitectura Naval Espanola (El Madera): Bosquejo de sus Condiciones y Rasgos de su Evolucion* (Madrid: Artinano, 1920), 130-131; J. J. Wilkinson, “On Lead Sheathing for Ships,” *Minutes of Proceedings of the Institution of Civil Engineers* 1 (May 1841): 133-134.

worms even with the sheathing. Oxidation, caused by the copper nails that fastened the lead sheaths to the hull reacting in seawater, corroded and weakened the sheathing. By the 1690s lead was mostly abandoned.<sup>41</sup>

In light of these failures, John Hawkin's hair, pitch, and yacht board sheathing method remained standard until the 1760s. This is when West Indian captains, fed up with shipworms, complained to the Admiralty in 1761 and asked that ships be sheathed with copper and that tests be conducted on this metal. The Navy Board responded by testing copper sheathing on the *Alarm* that year. The results were positive, so a couple of other ships were sheathed. So promising were the result that, by the 1780s, the British Navy mandated that the entire fleet be coppered. For the next century, copper sheathing became the only sure protection against shipworms and would remain the standard for the remainder of the wooden ship era.<sup>42</sup>

Early modern ships often take a back seat to the famous explorers who piloted them. They are backdrops for the larger than life narratives. Consequently, it is easy to lose sight of them, or think of them only in the abstract. One scholar has urged us to think of them as "floating biological islands" that spread organisms around the world. Such a metaphor, while apt in some regards, misses the mark in others. Ships were more like gardens or landscapes (albeit mobile ones) that sailors tended carefully, but could not always control. They were complex ecosystems. If ever sailors lost sight of this fact,

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41. *The Observations of Sir Richard Hawkins*, 120; Wilkinson, "On Lead Sheathing for Ships," 134-135.

42. John Fincham, *A History of Naval Architecture* (London: Whitaker and Co., 1851), 95-96; For other histories of the rise of copper sheathing, also see W. J. Hay, "On Coppering and Other Sheathing for the Navy," *Transactions of the Institution of Naval Architects* 4 (1863): 79-96; Knowles, *An Inquiry into the Means Which Have Been Take to Preserve the British Navy*, 136-137; Wilkinson, "An Historical Account of Coppering Sheathing for Vessels": 65-69; J. R. Harris, "Copper and Shipping in the Eighteenth Century," *Economic History Review* 19 (1966): 550-568.

teredo was quick to remind them by forcing sailors to feverishly bail water from leaky holds.<sup>43</sup>

### **Seasons and Shipworms in the British Atlantic**

To survive in the sea, explorers and traders constructed knowledge about shipworms. They did so by sharing stories. The evolving discourse put shipworms into broadly horizontal and narrowly vertical perspectives. To this we can add another layer of knowledge: seasonal. Nowhere is this clearer than in the British Atlantic World where sailors heading out of port cities like London and Bristol found the populations of shipworms in the waters from Maryland to Jamaica to be ever changing. It was along this stretch of the periphery that seamen went to great pains to coordinate the Atlantic economy around the seasonal life cycle of teredo.

The British Atlantic World has loomed large across the historiographical spectrum. For the most part, however, marine landscapes and the organisms inhabiting them have been treated more as historical backdrops rather than active forces shaping broader economic and cultural developments. While it would be far too ambitious to reinsert shipworms into every corner of the Atlantic, a closer look at colonial British America may suffice to show how teredo—far from being a backdrop—was viewed by colonial administrators, merchants, and naval officers as unavoidable threats during the late seventeenth and early eighteenth centuries. During this period, a robust dialogue between the periphery and the metropole ensued on how to best negotiate the teredo season.<sup>44</sup>

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43. Carlton, "Molluscan Invasions in Marine and Estuarine Communities": 440.

44. W. Jeffrey Bolster, "Putting the Ocean in Atlantic History: Maritime Communities and Marine Ecology in the Northwest Atlantic, 1500-1800," *American Historical Review* 113 (February 2008): 19-47; Brian M<sub>47</sub>

By the end of the seventeenth century a chorus of complaints about shipworms could be heard emanating from the colonies. In Barbados, for instance, seamen had to kill shipworms by laying ships on their sides, or “careen” them, in order to dry borers out: “[i]f ships in these seas are not careened every five or six months,” warned Barbados Governor Francis Russell in 1695, “they are in danger of having their bottoms eaten out by worms.” Merchants heading to Virginia and Maryland were more fortunate than their island neighbors since a number of freshwater rivers were at their disposal to kill shipworms. But this wasn’t a perfect solution by any means, however. In 1696, the Lords of Trade and Plantations, the overseers of all colonial commerce and laws, received a complaint from merchants that running into freshwater was prohibitive. The petition noted how merchants were “obliged for six weeks to run up into the fresh water to preserve themselves” whenever they arrived “at a time when the worm in that country eats the ships”—a burdensome amount of time. It was evident that borers had become a chronic problem in the colonial trade at the dawn of the 1700s.<sup>45</sup>

Traders, unnerved by teredo, pestered colonial administrators for unscheduled convoys and un-chaperoned voyages across the Atlantic. Virginia Governor Edmund Andros bent to their demands in 1693 and allowed a “small fleet of ships to Bristol.” The “masters” of the vessels persuaded Andros that the unscheduled departure was necessary to “prevent the ships from being eaten up by the expense if not by the worm.” Something

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Fagan, *Fish on Friday: Feasting, Fasting, and the Discovery of the New World* (New York: Basic Books, 2006).

45. “America and West Indies [hereafter, “A&WI”]: May 1695, 1-15,” in *Calendar of State Papers Colonial, America and West Indies* [hereafter, “CSPCAWI”]: *Volume 14, 1693-1696*, ed. J. W. Fortescue (London: His Majesty’s Stationery Office, 1903), 466-482; “A&WI: September 1696, 11-15,” in *CSPCAWI: Volume 15, 1696-1697*, ed. J. W. Fortescue (London: His Majesty’s Stationery Office, 1904), 99-112.



similar occurred in 1704 when Bristol merchants beseeched the Lords of Trade to grant the *Expectation* permission to return from Virginia unaccompanied because the “worm may occasion loss of the ship by her remaining so long in those waters.” Likewise, in 1712, several merchants petitioned the governor of Barbados, Robert Lowther, “praying leave to sail for Great Britain.” “Should they be detained till the London Fleet is ready to sail,” warned the petitioners, “their ships would be prejudiced by the wormes.” Whether or not merchants were able to get their wishes, it was evident that they considered shipworms of such importance that they feared them as much if not more than pirates.<sup>46</sup>

Not only did traders have to wrestle with shipworms, at times they had to contend with colonial laws that inadvertently left them more exposed to teredo. Such a thing happened in 1702 when a trader named Michael Cole carped to the Lords of Trade about a South Carolina duty levied on non-Carolinian ships. Cole had traded with Carolina for eight years, but because he was based out of London, his ships were subject to the tax. The law forced him to remain docked longer than accustomed because it was harder to buy furs from sellers willing to bear the higher cost of shipment imposed by the tax. He hoped that the Lords of Trade would overrule the law because he thought it unfair that “the ships belonging to England must lay there till the wormes shall eat their bottoms out.”<sup>47</sup>

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46. “A&WI: July 1693,” in *CSPCAWI: Volume 14, 1693-1696*, ed. J. W. Fortescue (London: His Majesty's Stationery Office, 1903), 123-136; “A&WI: November 1704, 1-15,” in *CSPCAWI: Volume 22, 1704-1705*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1916), 303-317; “A&WI: May 1712,” in *CSPCAWI: Volume 26, 1711-1712*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1925), 272-293.

47. “A&WI: February 1702, 16-20,” in *CSPCAWI: Volume 20, 1702*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1912), 79-98.

Colonial governors had their own gripes with teredo, which made it hard for them to adhere to orders from London. For instance, when the Lords of Trade requested quarterly statistics on imports and exports from Maryland in 1700, Governor Nathaniel Blakiston resisted, explaining that such a request “is not practicable, for there are few or no ships goes out of this Province but from Feb. to June.” After that date, “the worm begins to molest them, and no ship comes in but by great chance from the middle of March till October or November.”<sup>48</sup>

Gradually, merchants and administrators alike grew tired of constantly reacting to shipworms and tried to institute proactive policies. Francis Nicholson led the charge. In 1697, while serving as the Governor of Maryland, Nicholson requested that the Lords of Trade be conscious of borers the next time they sent a convoy to the Chesapeake. Specifically, he hoped that the fleet would arrive before April “lest they should not get out of the country before the hottest weather and the worme come, the one being very prejudicial to the men’s health, and the other to the ship’s bottoms.”<sup>49</sup>

Nicholson and others would hit upon this point several times over the next few years—shipworms were a seasonal phenomenon. As long as traders left before the waters warmed, they suffered no harm. The trouble was that Chesapeake officials had only a vague sense of when the waters became too dangerous. “I most humbly propose,” Nicholson explained vaguely to the Lords of Trade, “that for the future (if possible) all Fleets, which shall go hence may doe it at the beginning of June or rather the latter end of

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48. “A&WI: February 1700, 1-5,” in *CSPCAWI: Volume 18, 1700*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1910), 46-59.

49. “A&WI: July 1697, 12-20,” in *CSPCAWI: Volume 15, 1696-1697*, ed. J. W. Fortescue (London: His Majesty's Stationery Office, 1904), 545-560.

April or beginning of May, for I'm afraid a great many ships in this Fleet doe suffer by the worm with staying so long." Customs officer Robert Quarry was only slightly more exact when he recommended that ships "be ready to sail in April or May, by which damage to their ships by the wormes and sickness and the enemy will be prevented." Since shipworms fluctuated with water temperatures, variations in the warming and cooling of the Chesapeake made it hard to predict the onset of teredo season as precisely as the rising tides.<sup>50</sup>

Arrival dates were just as important as departure dates. Before filling their holds with tobacco, traders first had to unload merchandise they brought to the Chesapeake. Dispensing of cargo was much more of a process than simply unloading it all at once. Ships became markets and warehouses, and merchants had to negotiate prices for clothing and other stores. After emptying their holds, merchants had to repeat the process again, this time by haggling with tobacco sellers. All this took time, which customs officer Quarry understood. "By being here in Nov.," writes Quarry to the Lords of Trade, "there will be time enough all the winter for merchants to sell their goods and purchase tobacco." Moreover, traders "may then be ready to go hence in April or May, and will prevent the ships being damaged by the worm."<sup>51</sup>

Governor John Seymour of Maryland saw a way to shorten the time it took to unload and refill ships, all while limiting their exposure to borers. This occurred to him after the Lords of Trade advised him to invest in "ware-houses, wharfs, and keys, for the

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50. "A&WI: July 1702, 21-31," in *CSPCAWI: Volume 20, 1702*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1912), 488-497; "A&WI: February 1706, 16-28," in *CSPCAWI: Volume 23, 1706-1708*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1916), 53-62.

51. "A&WI: May 1704, 26-31," in *CSPCAWI: Volume 22, 1704-1705*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1916), 137-157.

better advantage of trade in this Province.” Improving commercial infrastructure would have the effect of “shortning the time of the convoys and merchant ships tarrying here, and prevent both men and ships seasoning and being destroy’d in the country by the hott weather and worme.”<sup>52</sup>

Shipworms were an important aspect of the British Atlantic economy. Everyone from colonial governors down to ship owners knew that trade required carefully dancing between saltwater, freshwater, and seasonal changes. Any misstep could lead to tragedy.

### **Adapting Colonial Defenses to Teredo**

Shipworms kept the British navy on its heels while it protected the Caribbean during the 1690s. In March of 1693, for instance, Sir Francis Wheler was forced to order several ships from Barbados back to London or risk losing them. “[I]f they did not go hence,” explained Wheler to the Earl of Nottingham, “their bottoms would be spoiled by the worms.” Sending ships away due to shipworms made the Caribbean vulnerable to privateers, as Jamaica’s Governor William Beeston learned in 1696. With six or seven hostile ships circling Jamaica like vultures, Beeston complained that his only available ship, the *Swan*, “is eaten with the worm” and “must go home or be lost,” leaving the traders defenseless.<sup>53</sup>

Ironically, defending against privateers could result in teredo destroying the very trading ships that the navy aimed to protect. Jamaican merchants made this argument in an effort to halt impressment. All men-of-war, they argued, “should carry with them

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52. “A&WI: March 1706, 1-9,” in *CSPCAWI: Volume 23, 1706-1708*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1916), 62-68.

53. “A&WI: March 1693, 1-15,” in *CSPCAWI: Volume 14, 1693-1696*, ed. J. W. Fortescue (London: His Majesty's Stationery Office, 1903), 36-53; “A&WI: April 1696,” in *CSPCAWI: Volume 14, 1693-1696*, ed. J. W. Fortescue (London: His Majesty's Stationery Office, 1903), 657-675.

supernumerary men, and be strictly ordered to press no men at or near the Island, for by pressing seamen they disable the ships, which has been the ruin of many of them, some being eaten by the worm from long lying.” While it is fair to question whether the traders exaggerated their claims in order to avoid conscription, it is telling that teredo was the first reason they gave, even over the danger of sailing with undermanned crews.<sup>54</sup>

Combating smugglers along the mid-Atlantic seaboard also required careful attention to shipworms. In 1698, Robert Quarry, the colonial Judge of the Admiralty, lamented that “[a]ny vessel that is sent hither must expect to have her bottom eaten out by the worm every summer.” To prevent this from happening colonial administrators advised the Council of Trade and Plantations to send its patrol ship, the *Messenger*, into the “Freshes to avoid the worm.”<sup>55</sup>

Laying the *Messenger* up in the “Freshes” did not mean it was wholly out of commission. At the same time that the *Messenger* basked in the freshwater of the Potomac River, it also performed gunboat diplomacy. The *Messenger* acted as a “terror and dread to the Indians,” while reassuring colonists of their safety. All the while, the *Messenger* was a “safety to herself from the worms” by bobbing in the river. The ship pulled this sort of double duty on other occasions. For instance, the *Messenger* rooted out “illegal traders” in the fresher portions of Delaware Bay “in ye time of ye worm” since these parts of the bay “be free from the worm.” In this way the *Messenger* was “more capable to serve his majesty.” As a rule, the *Messenger* served only where it could avoid

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54. “A&WI: September 1696, 16-19,” in *CSPCAWI: Volume 15, 1696-1697*, ed. J. W. Fortescue (London: His Majesty's Stationery Office, 1904), 112-125.

55. “A&WI: July 1 1698, 1-5,” in *CSPCAWI: Volume 16, 1697-1698*, ed. J. W. Fortescue (London: His Majesty's Stationery Office, 1905), 301-322; “A&WI: July 1700, 1-5,” in *CSPCAWI: Volume 18, 1700*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1910), 388-398.

shipworms—on a few occasions it avoided Point Comfort at the opening of the James River and instead patrolled from Point Turkey in Maryland because of the “worm biting much more there than in Maryland.”<sup>56</sup>

Bigger didn't always equal better for warships combating illegal trade. Smaller ships fared better against shipworms than larger men-of-war. Maryland Governor Nathaniel Blakiston had this in mind when he asked the Lord High Admiral to send a sloop to patrol the upper Chesapeake because they “can run into any of those creeks and coves where skulking traders have frequented.” Just as importantly, sloops were easier to maintain from borers than larger men-of-war. Blakiston explained that a “man-of-war must be laid up in the Fretches from the beginning of June till the latter end of Sept., by reason of severe biting of the worm.” Sloops, on the other hand, could be cheaply careened once or twice a season to suffocate teredo, thus allowing them to patrol nearly year round. Above all, Blakiston's biggest objection with men-of-war was their “greater value to H. M.”; there was no reason to risk a ship “if the worm should enter the bottom of a man-of-war.”<sup>57</sup>

Nearly everyone associated with British America was beholden to the nature of the sea. Winds, tides, and seasons influenced the day-to-day operations of the Atlantic economy. So did shipworms. Protecting trade required everyone from merchants on up to

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56. “A&WI: July 1700, 8-10,” in *CSPCAWI: Volume 18, 1700*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1910), 398-410; “A&WI: April 1701, 22-25,” in *CSPCAWI: Volume 19, 1701*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1910), 170-176; “A&WI: May 1700, 1-4,” in *CSPCAWI: Volume 18, 1700*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1910), 217-229; “A&WI: May 1700, 21-25,” in *CSPCAWI: Volume 18, 1700*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1910), 263-284.

57. “A&WI: November 1702, 16-20,” in *CSPCAWI: Volume 20, 1702*, ed. Cecil Headlam (London: His Majesty's Stationery Office, 1912), 729-738.

the Lords of Trade to be mindful of teredo and configure the Atlantic trade and its defense to teredo's life cycle and habitat.

### **The Dutch Crisis and Invasive Theory**

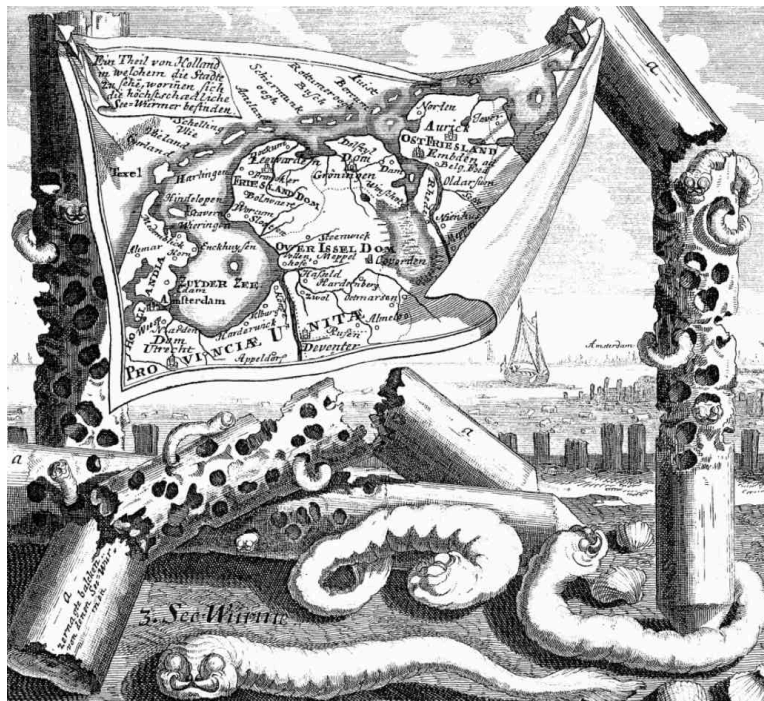
In 1730, something unexpected happened along the coast of Holland. The Dutch dikes along the Zuiderzee and Rhine-Meuse Delta started to collapse, threatening to flood the polders. The dikes had been designed to handle several hazards: strong waves, storms, and seepage. Many of them were tailored specifically to their waterways. Some consisted of clay and sand, while others were made from bundles of reeds; some sloped gradually to absorb crashing waves, and still others stood upright because they faced gentler tidal changes. But most contained timber. The dikes were built and maintained over decades to withstand almost everything—except shipworms.<sup>58</sup>

The Dutch shipworm crisis of 1730-1733 caught many by surprise. Shipworms had long been a maritime problem, but never a coastal issue, and never so far north. Reactions to the phenomenon varied. Some saw the collapsing dikes as a heavenly admonition. Job Baster, who researched the crisis, noted that “[t]he superstitious Populace immediately persuaded themselves” that the crisis “was created by the divine Wrath for punishing the Sins of Mankind.” “Sins” could refer to any number of forbidden practices, but in this instance they probably referred to one act in particular: sodomy. According to historian Adam Sundberg, a spate of sodomy trials had recently taken place and some people believed that God was punishing the Dutch for these ecclesiastic

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58. Audrey M. Lambert, *The Making of the Dutch Landscape: An Historical Geography of the Netherlands*, 2nd ed. (London: Academic Press, 1985), 223-231.

violations by bringing the plague of shipworms. The Dutch desperately needed “Divine Clemency,” or so Baster and others thought.<sup>59</sup>



**Figure 5: Iconography of the Dutch Crisis. By Elias Back, 1732. The nation threatens to collapse in the face of the woodborer epidemic: <http://sammlungen.ub.uni-frankfurt.de/4360341>**

Since the crisis struck at the doorstep of the European Enlightenment, it prompted a secular response as well. A number of scientists entered the fray and sought rational explanations to the collapsing dikes. The crisis forced them to rethink much of what they had assumed to be true about teredo. The knowledge about shipworms that seamen and scholars had debated, refined, and utilized over the previous two centuries couldn't explain this particular crisis. With this in mind, scientists studied everything about shipworms from their biology to distributions in their quest for an explanation. In the end,

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59. Job Baster, “A Dissertation on the Worms Which Destroy the Piles on the Coasts of Holland and Zealand,” *Philosophical Transactions of the Royal Society* 41 (January 1739): 276-288; For an analysis of the religious dimensions of the Dutch crisis see, Adam D. Sundberg, “Floods, Worms, and Cattle Plague: Nature-Induced Disaster at the Closing of the Dutch Golden Age, 1672-1764,” (University of Kansas, PhD. Dissertation, 2015), 190-194.



the scientific community arrived at an answer, albeit a controversial one: shipworms had invaded the European coastline from the tropics via ship.

More than anyone, zoologist Godfrey Sellius (1704-1767) reoriented how people would think—and even talk—about shipworms. Sellius resurrected the ancient word “teredo” and turned it into the chief signifier for shipworms henceforth (something that Muffet failed to do). More importantly, he discovered that shipworms were not worms at all, or even a single species of worm. Shipworms were bivalve mollusks—a cousin to clams. Sellius identified three such species, which he named *Teredo marina*, *Teredo navium*, and *Teredo oceani*. None of these particular names stuck, but Carl von Linnaeus used “*Teredo*” as a genus for the species and renamed *Teredo marina* as the fearsome *Teredo navalis* of today. Of the dozens of shipworms that would be described over the next two centuries, many would contain the word *Teredo*.<sup>60</sup>

Sellius gave a very precise breakdown of shipworm anatomy, but he was more equivocal on the cause of the crisis. Plenty of others would chime in. There was no shortage of opinions floating about Europe. Pierre Massuet, a physician who wrote a book on the crisis, shared several of them. There were some who thought that the worms were produced by mosses in the sea and activated during hot days. When moss floats towards the coast and rubs against piles, it spreads the worms. Others believed that shipworms ordinarily grew on the surface of piles during the summer time, and not inside the wood, as others have observed. Under a microscope, they appear like sheep’s lice. Still others argued that the heavy winds out of the north over the previous two years had brought the shipworms down to the Netherlands from the North Sea, where they had been

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60. Sellius, *Historia Naturalis Teredinis Seu Xylophagi Marini, Tubullo-Conchoidis Speciatim*, 264-303.

residing for forty or fifty years (where they were before that is unclear). Of all these explanations, this latter invasive theory won the day.<sup>61</sup>

European seafarers knew full well that they were carrying shipworms around the world in the hulls of their ships—William Dampier might have been the most explicit when he marveled that a “Ship will bring them lodg’d in its Plank for a great way.” But for nearly two centuries no one ever expressed any concern that stowaway shipworms could invade and thrive in the colder waters of northern Europe. The climate theory proposed by Martyr held that this was impossible. The shipworms that ravaged the Dutch dikes, however, demonstrated that the existing paradigm (or parts of it at least) no longer represented nature accurately. New ideas were in order.<sup>62</sup>

The invasive theory filled in some (but not all) of the gaping conceptual holes that shipworms had dug. It gained many adherents, though not all of them agreed on the specifics. For instance, Sellius supposed that shipworms had arrived from France, not the North Sea, while the French Huguenot and historian, Jean Rousset de Missy, was convinced that borers had arrived from Iceland where “they are found in mighty Number.” Other scholars still associated shipworms with the tropics and saw the source of the invasion as emanating from there. The French philosopher Andre Francois Deslandes argued that shipworms had arrived from the French Antilles. Carl von Linnaeus thought they came from India. By 1749, the invasion theory caught hold across the Atlantic too. In Boston, a historian of British America argued that shipworms were

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61. Pierre Massuet, *Recherches Interessantes Sur l'origine, La Formation, Le Developement, La Structure, &c. Des Diverses Especies De Vers à Tuyau* (Amsterdam: F. Changuion, 1733), 221-222. The use of “sheep’s lice” is intriguing, since it suggests that a non-teredinid marine borer known as the gribble, or limnoria was also present along the coast in addition to shipworms. For more on limnoria, see Chapter Five.

62. William Dampier, *A New Voyage Round the World* (London: 1697), 362-363.

“at first only in the *West-Indies*, but have from thence been carried with Ships, and do propagate in *Carolina, Virginia, [and] Maryland.*” No one could agree on the origin of the supposed invasions, but it was clear to many that shipworms were on the move.<sup>63</sup>

Just as suddenly as it began, the crisis came to an end. In 1733, the shipworm invasion had finally been repelled. Baster rejoiced: “Divine Clemency has already so far destroyed these pernicious Insects.” For some, this was all the explanation they needed. The scientific community needed more. And they thought they had it in the form of a shiny new theory based on reason, not on faith. But there were problems with the explanation that no one was willing to admit at the time. The invasion theory explained the coming of borers, but not their going. For the remainder of the eighteenth century, shipworm scholars would overlook this glaring flaw as they clung to the explanation.<sup>64</sup>

It’s a little ironic that European naturalists picked this particular moment to appreciate the role of seamen in spreading woodborers around the globe since it’s unlikely that shipworms had invaded northern Europe in this instance. Instead, climate change may have been responsible, giving the appearance of an invasion. The Little Ice

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63. Jean Rousset de Missy, *Observations of the Sea- or Pile-Worms* (London: J. Roberts, 1733), 18; Andre Francois Deslandes, “Diverses Observations Anatomiques,” *Histoire De L’Academie Royale, 1720* (1722): 26; For Sellius and Linnaeus, see John Gwyn Jeffreys, *British Conchology; Or an Account of the Mollusca Which Now Inhabit the British Isles and the Surrounding Seas* (London: John Van Voorst, 1862), 1:49; William Douglass, *A Summary, Historical and Political, of the First Planting, Progressive Improvements, and Present State of the British Settlements in North-America* (Boston: Rogers and Fowls, 1749), 1:125

64. The invasion theory recurs in the following ways: In 1751, a Dutch naturalist, for instance, parroted earlier explanations that shipworms were introduced to Holland. Decades later a French scholar explained similarly how “Taret ordinaire” was transported from the tropics in the hulls of ships. In 1778, a mollusk scholar attributed the rise of shipworms in Britain to introductions from the tropics, while another zeroed in on the East Indies. According to still another, shipworms could be seen arriving in ships coming from warm climates, but they are “happily not of English production”; For later evidence of the invasion theory, see William F. Clapp and Roman Kenk, *Marine Borers: An Annotated Bibliography* (Washington DC: GPO, 1963), 276, 953; Emanuel Mendes da Costa, *Historia Naturalis Testaceorum Britanniae, or the British Conchology* (1778), 21-22; Richard Pulteney, *Catalogues of the Birds, Shells, and Some of the More Rare Plants, or Dorestshire* (London: 1799), 53.

Age (c. 1300-1850) was marked by lower precipitation in Western Europe, allowing saltwater to creep up into the Dutch lowlands. Timberwork that had long been protected from shipworms by freshwater runoff was vulnerable during drier periods, especially in the summer. Shipworms that had been content to nibble on driftwood off the coast for decades, if not centuries or millennia, were sucked into estuaries devoid of freshwater. A nineteenth century Dutch shipworm commission discovered that subsequent spikes in shipworm activity in the years 1770, 1827, 1858, and 1859 all occurred during periods of lower rainfall.<sup>65</sup>

This is an idea that the Dutch entertained during the crisis, but eventually abandoned. According to Pierre Massuet, “In the Province of Holland... we have believed, among other things, that the sea became more salty in the year 1731, because we were short of rains & of snow.” Lower precipitation restricted the flow of the rivers, such that they “did not abound so much” and “refresh and temper the salt water.” This is what “produced these worms more abundantly than the other years.” Hollanders hoped that greater rainfall in 1732 would kill the shipworms. They even tried to divert more of the river water to the locks “so that the locks provided with fresh water, could more easily communicate it to the sea and refresh it as much as it would be necessary.” The experiment failed, but not because the logic was wrong. Massuet overestimated the volume of precipitation that the winter had brought, and underestimated the resilience of shipworms.<sup>66</sup>

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65. For an English summary of the Dutch commission’s findings, see Adolph Ott, “On the Ship-Worm and the Means of Preventing Its Ravages,” *Van Nostrand's Eclectic Engineering Magazine* 4 (Jan.-Jun. 1871): 466-471; Jean M. Grove, *The Little Ice Age* (London: Routledge, 2012).

66. Massuet, *Recherches Interessantes Sur l'origine, La Formation, Le Developement, La Structure, &c. Des Diverses Especies De Vers à Tuyau*, 222-224.

Other evidence undercuts the invasion theory. The aforementioned Vikings saga mentions shipworms in the North Atlantic long before the Dutch dikes had become riddled with borers. Combine this with the fuzzy timeline of the invasion and it appears likelier that climate change caused the crisis during the 1730s. Writing twelve years before the dikes began to collapse, Deslandes argued that French seamen had brought borers back from the West Indies as many as fifty years before. Rousset agreed and noted, “These worms are no new Things on our Coast.” Fifty years earlier they had been observed boring into the dikes—they just didn’t grow so large. Similarly, Job Baster explains that a “sort of Worms, before that time very scarce, but [had] now increased to an incredible Number.” Something triggered the disaster in the 1730s, but it’s far from clear that a new species of teredo had arrived in Europe. It’s possible that native shipworms might have taken advantage of changing climatic conditions. It’s also possible that borers that were brought back to Europe as far back as the fifteenth century waited for the right conditions to strike.<sup>67</sup>

Regardless, the Dutch believed that the evidence indicated an invasion, and they went to great lengths to ensure that such a thing would never happen again. The damaged dikes had to be rebuilt, and much thought was given to how to protect them. A number of overnight experts all claimed that they had cheaper solutions and swamped the dike inspectors with proposals for chemical and mechanical timber treatments. Job Baster considered most of these ineffective, but described what he thought was the best:

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67. Deslandes, “Diverses Observations Anatomiques”: 26; Rousset de Missy, *Observations of the Sea- or Pile-Worms*, 7; Baster, “A Dissertation on the Worms Which Destroy the Piles on the Coasts of Holland and Zealand”: 277; For a review of the doubters of the invasion theory who emerged in the nineteenth century, see Clapp and Kenk, *Marine Borers*, 377, 593, 594; and Edward Forbes and Sylvanus Hanley, *A History of British Mollusca, And Their Shell* (London, 1853): 1:62-64; and Ott, “On the Ship-Worm and the Means of Preventing Its Ravages,” 467.

perforate the pile with nail holes, cover it with a hot “*Varnish*,” and blanket it with “*Brick-dust*”. In the end, most of the dikes were rebuilt with stone instead of wood, thus mitigating the threat of shipworms in the future, no matter their origin.<sup>68</sup>

## Conclusion

In many ways, the Dutch crisis is the culmination of more than two centuries of battling shipworms around the world. In the wake of Columbus’ famous and infamous voyage, teredo went from a maritime threat localized in the tropics to a global phenomenon capable of affecting terrestrial populations. Holland’s collapsing dikes would be a reminder that no place in the sea, or adjoining it, was entirely safe from teredo.

The crisis also underscores the limitations of what we can know about shipworms. While borers spread around the world during the early modern period, it’s unclear from whence they came and where they went. The kinds of questions that Europeans discussed and debated regarding the native or invasive status of teredo during the crisis of the 1730s have largely remained unanswered all the way to the present. To be sure, a clearer picture of teredinid taxonomy, geography, and ecology has come into focus, especially in the last century. But the larger question of when shipworms spread around the world has not progressed much since the first Dutch dikes came crashing down.

But by focusing solely on the limitations of historical ecology, we miss the fascinating lengths that early modern people went to meet an environmental threat that constantly kept them guessing. For more than two centuries a vibrant discourse brought

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68. For the rebuilding of the dikes with stone, see Lambert, *The Making of the Dutch Landscape*, 223-231; Baster, “A Dissertation on the Worms Which Destroy the Piles on the Coasts of Holland and Zealand”: 285-286; Massuet, *Recherches Interessantes Sur l’origine, La Formation, Le Developement, La Structure, &c. Des Diverses Especies De Vers à Tuyau*, 218-233. Massuet surveys the numerous teredo deterrents.

people all around the world together. They exchanged information, adapted technologies, and developed paradigms about shipworms. Spanish, Indian, Dutch, English, Native American, and Portuguese speakers overcame language barriers in their pursuit of knowledge about borers. Learning about marine environments did not happen overnight; it was a process.

CHAPTER TWO  
“TIME FOR THE RAVAGES OF THE ‘TEREDO’”:  
NINETEENTH CENTURY COASTAL DESIGNERS  
CONFRONT SHIPWORMS ALONG THE SOUTHERN  
ATLANTIC SEABOARD AND GULF COAST

**Introduction**

In the spring of 1855, James Jarvis of Portsmouth, Virginia received a request from *Monthly Nautical Magazine* for information on shipworms. He was the perfect person to ask. Not only did Jarvis run a shipbuilding yard, he also conducted a navy test board program designed to find a cheap and effective anti-borer paint. Jarvis knew more about shipworms than probably any other American at the time and obliged the magazine’s editors with a copy of a report he had made to the Chief of the Bureau of Docks and Yards. With one dash of the pen he cited European studies on the history of borers, and with another he described ships taking cover from shipworms during the War of 1812 (in which he fought). In a few short pages, Jarvis effortlessly summarized the natural history of teredo for the magazine’s readers.<sup>1</sup>

Just as he surveyed the past and present, Jarvis also had one eye on the future. He anticipated a new relationship with borers on the horizon. He even had an ominous saying for it: “the time for the ravages of the ‘Teredo,’” he warned, “begins to usher in.” Jarvis couldn’t have been more prophetic. Before the Civil War, few outside of shipping and naval circles had probably ever heard of the word “teredo,” but by century’s end, it

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1. James Jarvis, “The Teredo, or Salt Water Worm,” *Monthly Nautical Magazine and Quarterly Review* 2, no. 2 (May 1855): 97-104, the remainder of the article concluding in no. 3, 193-202; For some additional biographical information on Jarvis see, Stuart L. Butler, *Defending the Old Dominion: Virginia and its Militia in the War of 1812* (Lanham: University Press of America, 2013), n. 37-40.



would have been hard to miss. Even those who had never spent any considerable time at sea learned about shipworms from songs, poems, word-puzzles, and even political speeches. In a way, Jarvis marked a turning point. While the human history of teredo in North America predates his magazine article by centuries (if not millennia), the “time for the ravages of the ‘Teredo’” in United States history was just starting. Over the next few decades, shipworms would become big concerns from Chesapeake Bay all the way down to Corpus Christi and beyond.<sup>2</sup>

Like most prophets, Jarvis left the particulars of his prediction vague. He never spelled out the root causes of the coming “time for the ravages.” Nor did he forecast the consequences with any specificity. And since he died in 1862, we are left to piece together the story. But he was right. After the Civil War, the relationship with teredo changed. Long a maritime problem, shipworms transformed into a dangerous and costly coastal phenomenon. The turning point arrived when the federal government descended upon the southeastern seaboard and gulf coast with new ideas about how to manage and improve riparian and underwater landscapes. Engineers and politicians set to work taming unwieldy waterways by initiating hundreds of navigational improvements. Instead of constantly fighting against such things as tides, sediment, and runoff, engineers tried to guide nature in ways beneficial to commerce. Unfortunately, shipworms took to the untold number of brush mattresses, piles, and jetties as they did driftwood. As a rule, shipworms were more destructive in the south. Jarvis noted how wharf builders in Boston

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2. Jarvis, “The Teredo, or Salt Water Worm”: 97; For an example of a song, see “The Teredo Knocked Out,” *Daily Morning Astorian* (OR), September 18, 1895, 3; For an example of a poem, see Dr. Riley, “On the Death of General Stonewall Jackson,” *Macon Telegraph*, May 25, 1863, 1; For an example of word-puzzle, see *National Tribune* (DC), May 2, 1895, 7; an example of teredo used in a speech can be in, “Hill’s Path: Marked Out by the New York Platform,” *Sun* (NY), December 5, 1891, 5. For a cultural analysis of the impact of teredo, see Chapter Three.

could expect their structures built of untreated timber to last twenty-five years, whereas in Virginia they didn't last a season. Along the gulf coast, borers destroyed piles in as short a time as three or four months in some places. Remaking the southern coastline, in short, brought people and teredo onto a collision course, magnifying and exacerbating a threat that had long remained latent. This is what Jarvis probably saw coming.

The following pages explore how coastal design evolved and adapted to shipworms along the coastline of the American south during the final third of the nineteenth century. While borers might have seemed foreign to most Americans before the war, it wasn't because they were recent arrivals to the coast. Teredo's rise to prominence is fairly traceable. The annexation of vast swaths of infested shoreline brought borers onto engineer's radars. Also, key events, such as jetty controversies at the mouths of the Mississippi River and Galveston Bay, vaulted borers into national discourses. But the ultimate, or underlying, causes of the "time for the ravages of 'Teredo'" are difficult to discern without a greater appreciation of evolving tools of harbor management, such as hydraulic theory, jetty design, and timber preservation. A byproduct of these approaches to development was the greater risk of shipworms. Coastal design had matured in part through a dialectic tension with teredo.

### **Going Mainland**

Teredo's rise to prominence was a long time in the making. During the early years of the republic, federal administrators showed little interest in shipworms along the eastern seaboard. This is not to say they totally ignored them. Damages were recorded from Kennebunk, Maine down to Cape Fear, North Carolina. In New England, a navy surveyor in 1802 thought poorly of New London, Connecticut and Pawtuxet, Rhode

Island on the account of “worms.” In 1825, a Charleston, South Carolina man told federal surveyors that teredo was an “annoyance,” but no worse than in other “Southern ports.” Besides these few examples, the government exhibited little curiosity or urgency over borers. This should come as no surprise since Congress had yet to invest much into developing the coastline, and wouldn’t for decades to come. A wharf collapse here, or a jetty breach there, did not amount to a crisis worthy of mustering over. Not many people uttered the menacing catchphrase “the ravages of the teredo” before midcentury.<sup>3</sup>

In the meantime, teredo remained part of the maritime world and only raised the government’s hackles in these settings. Nothing goaded American leaders perhaps more than the seizure and impressment of ships and sailors. Teredo added to these frustrations. In 1796, for instance, Secretary of State Timothy Pickering griped to Minister Rufus King that British impressment in the West Indies left merchant vessels undermanned since they “carry no more hands than their safety renders necessary.” Impressment was tantamount to “detention of the vessel,” which led to it being “injured or destroyed by the worms.” An actual detention, of course, had the same effect. This scenario played out in 1805 after French privateers captured the brig *Susannah* and its cargo on its way to Cuba. When the owner tried to reclaim the brig he discovered that it had been “much injured by worms” while in custody.<sup>4</sup>

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3. Senate, *Report of the Secretary of War, in Compliance to a Resolution of the Senate, Relative to the Erection of the Pier at Kennebunk*, 21st Cong., 1st sess., 1829, S. Doc. 7, 3; House, *Cape Fear River*, 21st Cong., 1st sess., 1830, H. Doc. 44, 1; “Navy Yards—Communicated to the House of Representatives, March 10, 1802,” *American State Papers: Naval Affairs*, 1, No. 27, 89-91, 94; Senate, *Report of the Secretary of the Navy, with the Report of the Officer Appointed to Examine the Harbors of Charleston and St. Mary’s, on the Expediency of Establishing a Navy Yard at Either of Those Places*, 19th Cong., 1st sess., 1826, S. Doc. 27, 28-29.

4. “Great Britain—Impressments. Communicated to the Senate, July 6, 1812,” *American State Papers: Foreign Relations* 3, No. 249, 574; House, *Spoliations on the Commerce of the United States*, 19th Cong., 2d sess., 1827, H. Doc. 68, 183.

Similarly, Americans complained when their ships were detained in foreign ports on the suspicion of illegal trading because of the risk shipworms posed. In 1825, for instance, a ship called the *Spermo* was seized by Brazilian officials for supposedly running a blockade. Condy Raguet, the chargé d'affaires to Brazil, thought that the accusations were specious and reminded Rio de Janeiro that the *Spermo* had arrived the day *before* the blockade took effect. Raguet feared that the ship “would become prey to the climate and the worms” long before Brazilian judges would ever come around to the truth and release it. “Justice, too long delayed,” he protested, “ceases to be justice.” Likewise, in 1833, the schooner *Augustus*, on route to Honduras, stopped unexpectedly in Mexico when its captain came down with cholera. Once there, it was detained for ten months on the suspicion of illegal trading, during which time it “became unseaworthy by the worms.”<sup>5</sup>

Eventually, teredo came knocking on the door of the United States mainland. Or, rather, the opposite is closer to the truth. If we were to pinpoint a leading cause of Jarvis’ premonitions, it would have to be territorial expansion. The acquisitions of Florida and Texas added hundreds of miles of shipworm-infested coastline to the nation’s southern border. Any ignorance and/or ambivalence towards shipworms began to wither away, especially with respect to the armed forces, which were tasked with pacifying and defending huge swaths of coastline along the Florida panhandle, eastern Florida, and Texas.

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5. House, *Correspondence with the Government of Brazil in Relation to an Alleged Blockade by the Naval Force of Brazil, the Imprisonment of American Citizens, and the Demand Made By the Charge d’Affaires of the U.S. of his Passports, and the Cause Thereof*, 20th Cong., 1st sess., 1828, Doc. No. 281, 16-18; House, *Message from the President of the United States to the Two Houses of Congress at the Commencement of the Second Session of the Twenty-fifth Congress*, 25th Cong., 2d sess., 1837, Doc. No. 3, 83.

In Florida, for example, the navy learned some hard truths about teredo after the United States acquired lands through the Adams-Onís Treaty in 1819. During the 1830s, when surveyors got down to charting the panhandle they dusted off surveys produced years earlier by Andrew Ellicott. Ellicott had warned that the harbor of Pensacola “as well as all the others east of Mississippi, is rendered much less valuable on account of the worms.” He goes on to say, “[t]hey are so numerous in this bay, that a vessel’s bottom has been known to be ruined in two months.” Ellicott was right. The navy found this out after borers ate through piles at the new Pensacola navy yard. “Such is the destructive operation of worms upon wood in the Pensacola Bay,” lamented an official to the Navy Board.<sup>6</sup>

On the eastern side of the state the army learned similar lessons. Lieutenant Joseph Hooker, fresh out of West Point, made the mistake of ignoring shipworms during the Second Seminole War. In 1838, Hooker oversaw the steamboat *James Boatwright* as it ran supplies up and down the Indian River, a largely saltwater body of water that runs parallel to the coast and is hemmed in by barrier islands. After three or four weeks of service, Captain B. W. Donnell asked Hooker for permission to return to Charleston, South Carolina to repair damages caused by shipworms. Hooker refused; no other ship was available to replace the *James Boatwright*. Donnell repeated the request, but was rebuffed several times. Two months into its service, the steamboat sprung a leak and sank. Hooker denied that shipworms had caused the wreck, believing instead that a collision with a sand bar was to blame. But after ten years of legal wrangling the Senate

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6. House, *Florida Boundary*, 21st Cong., 1st sess., 1830, Doc. No. 80, 10; House, *Marine Rail-way, &c. ... In Relation to the Erection of a Marine Rail-way at the Navy Yard at Pensacola*, 21st Cong., 1st sess., 1830, Doc. No. 101, 4.

Committee of Claims sided with the owners of the *James Boatwright*. Testimonies from several captains and shipbuilders helped the claimants by establishing the fact that shipworms were dangerously active in southeast Florida.<sup>7</sup>

During the Mexican-American War, General Zachary Taylor learned firsthand how troublesome teredo was in Texas. In May 1846, after winning the first round of battles at the mouth of the Rio Grande, Taylor tried to press his advantage and push upstream to prepare for the Battle of Monterrey, but was unable to because shipworms had destroyed his troop transports. “The boats on which I depend,” he complained, “were found to be nearly destroyed by worms,” leaving his army “completely paralyzed.” Taylor’s assistants scrambled to resolve the problem, and not knowing anything about teredo, asked some “experienced captains” for advice. The advice they received was either bad or (more likely) misunderstood, since they reported that shipworms “become more active” when introduced to freshwater. By the end of 1846, they finally learned how to maintain wooden transports by sending them into freshwater on occasion to kill borers. In the future, Taylor’s assistants sent specific instructions on how to prepare troop transports for work in infested waters.<sup>8</sup>

With the annexation of so much coastline came greater consideration of shipworm distributions, with some even going so far as to consider them in light of the north-south ideological divide. City leaders in New London, Connecticut are a case in point. In July 1861, the city’s Court of Common Council made a rather sweeping claim: “No place

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7. House, *Stalker & Hill*, 13th Cong., 1st sess., 1848, Report No. 118, 1-22.

8. House, *Correspondence With General Taylor*, 29th Cong., 2d sess., 1847, Doc. No. 119, 252, 348, 387-389; House, *Messages of the President of the United States, with the Correspondence, Therewith Communicated, Between the Secretary of War and other Officers of the Government on the Subject of the Mexican War*, 30th Cong., 1st sess., 1848, H. Exec. Doc. 60, 653, 696-698.

south of 35° is believed to be suitable for the permanent establishment of a [naval depot or naval school] on account of the destruction to timber by worms.” The councilmen desperately wanted a naval presence of some sort, so branding the south as ecologically inferior to New London, “where worms never injure,” was one path to getting what they wanted (a tad ironic, if not disingenuous, since a navy surveyor had criticized New London *because* of worms decades before; and also strange given that rebellion had broken out three months earlier). In another example, Edward Everett made an even more explicit distinction between north and south. The former Massachusetts politician and secretary of state wed shipworms to the south in an 1861 speech denouncing secession. Everett predicted that the south would never become a naval power. The reasons? While the confederacy had plenty of “live-oak, naval stores, and gallant officers,” Everett listed “the teredo” in the harbors of the south as one of a handful of factors holding southern states back from collectively becoming a sea power.<sup>9</sup>

In sum, throughout the first two-thirds of the nineteenth century, shipworms made their impression on many influential generals and statesmen, some of who were learning about borers in the field, such as Taylor and Hooker. Still, “teredo” wasn’t yet a household word. Up to that point, borers registered only so far as they nibbled at the fringes of the nation’s growing sphere of influence. The turning point would come after the war when the federal government sought to integrate land and sea, particularly in the south. Economic growth depended on the free movement of commerce through coastal environments. Major Samuel M. Mansfield summed this up best when he said simply,

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9. Senate, *Report of a Committee Appointed by the Court of Common Council of the City of New London, Connecticut, In Favor of the Location of the Naval School at that Place*, 37 Cong., 1st sess., 1861, Mis. Doc. No. 6, 2-3; “Navy Yards—Communicated to the House of Representatives, March 10, 1802,” 89-91, 94; Edward Everett, *The Great Issues Now Before the Country* (New York: James G. Gregory, 1861), 29.

“prosperity is deep water.” Getting to deep water, building in deep water, or making deep water preoccupied coastal improvers during the last third of the century. Unfortunately, mastery over coastal environments would not come easily so long as shipworms played the antagonist. Henceforth, teredo rarely went mentioned separate from the saying “the ravages of the teredo.”<sup>10</sup>

### **Unlocking the Interior**

Taming the southern coastline was never going to be easy, regardless of shipworms. The shallow-bottomed harbors dotting the coast from Chesapeake Bay down to Corpus Christi suffered from another foe to commerce: mud. The silt-laden waters that spewed from the mouths of southern rivers created swamplands, lagoons, bars, and barrier islands that made navigating and developing the coast more challenging than in the northeast, where the deep water harbors of New York and Boston made navigation comparatively easy. To make matters worse, the mud-spawned landforms and impediments fluctuated unpredictably: rivers changed courses; storms moved sand bars; and swashes kept pilots guessing where the safest deep-water channels were located. More than anything silt made controlling nature along the coast a tall task.

Compared with sedimentation, shipworms seemed the lesser evil. In fact, a couple people welcomed teredo in southern ports for much of the nineteenth century because of how they cleared dangerous drift and obstructions. The Briton William Bollaert thought well of teredo during his tour of the Republic of Texas in the 1840s. “The *Teredo navalis* is actively at work amongst the drift-wood,” he remarked, “reducing speedily into very

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10. House, *Report of the Secretary of War*, 48th Cong., 1st sess., 1883, Ex. Doc. 1, Vol. 2, Pt. 2, 1063. Mansfield was referring specifically to Galveston Harbor, but his remarks could have been cut and pasted onto any number of harbors.



friable stuff immense trees, breaking by the mere impression of the foot.” Jarvis also admitted that borers were “useful to commerce” because they destroyed “sunken obstructions of wood in harbors, &c.” Bollaert and Jarvis weren’t alone; many throughout Europe and, to a lesser extent, America could appreciate teredo, even as they griped about its costs. At first glance, this ambivalence is perplexing; it doesn’t jive with how rigidly people would speak about the “ravages of teredo” during the last third of the nineteenth century. To understand how teredo polarized public opinion it is necessary to look at the evolution of coastal design and how corps engineers learned to manage mud.<sup>11</sup>

During the mid-nineteenth century, dredging was the corps’ favorite tool for improving waterways. “Dredging” was a loose term. It could refer to any number of machines or practices, such as dipper-, bucket-, suction-, and clamshell dredging, etc. Most dredgers mechanically moved mud from one place to another (often with the aid of a scow), but others didn’t. Scraping and stirring riverbeds so that suspended sediment whisked away with the currents—a practice sometimes called “harrowing”—also fell under the umbrella of dredging. In 1852, the corps dredged the Mississippi River in this fashion when sandbars prevented ships from passing through the mouth for days and weeks at a time. Between 1868 and 1873, the corps built two boats, each costing \$350,000, fitted with propellers that (unsuccessfully) stirred mud up into the current. Whatever form they took, dredgers were everywhere at work sculpting the coastline at midcentury.<sup>12</sup>

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11. William Bollaert, “Notes of the Coast Region of the Texan Territory: Taken During a Visit in 1842,” *Journal of the Royal Geographical Society of London* 13 (1843): 226-244; Jarvis, “The Teredo, or Salt Water Worm”: 199.

12. William F. Switzler, Chief of Bureau of Statistics, *Report on the Internal Commerce of the United States, Part 2 of Commerce and Navigation; Special Report on the Commerce of the Mississippi, Ohio, and other Rivers, and of the Bridges that Cross Them* (Washington DC: GPO, 1888), 254.

Dredgers didn't face much resistance from shipworms, which is a reason why federal engineers didn't bother with borers for so long. The corps used simple strategies to avoid teredo. Time and again, engineers planned dredges around what they called the "teredo season." Dredgers worked during the winter, but as soon as spring and summer arrived, they stopped and took cover in fresher waters. Improvements of this kind could be stopped and started without consequences. In the meantime, teredo spawned and thrived. In the fall, when temperatures dropped and borers died or slowed their activity, dredgers were towed back into place and resumed work.<sup>13</sup>

The corps avoided teredo in this manner around Norfolk, Virginia. In 1878, engineers suspended a dredging until "after another warm season, the water being infested with the teredo." The corps even crafted language like the "teredo season" into its contract with a private dredging company. In 1878, the corps paid Mr. F. B. Colton to dredge 350,000 cubic yards of mud; however, "[o]wing to the prevalence of the teredo the commencement of the work was fixed for October 1st." Working around the "teredo season" wasn't unique to Norfolk either. As far away as Sabine Pass, Texas, engineers suspended a dredging in February of 1879 because it was "dangerous to leave the *Essayons* [a government dredger] in the pass after the commencement of the season in which the teredo becomes most active. This season begins in February or March."<sup>14</sup>

So long as dredge boats tiptoed around shipworms, the corps treated borers as nuisances at worst. But things wouldn't remain so simple. By the end of the 1870s, the

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13. An explicit reference to the "teredo season" comes from, House, *Report of the Secretary of War, Vol. II, Pt. I*, 46th Cong., 3d sess., 1880, Ex. Doc. 1, Pt. 2, 820.

14. House, *Report of the Secretary of War, Vol. II, Pt. I*, 46th Cong., 2d sess., 1879, Ex. Doc. 1, Pt. 2, 89, 677, 902.

corps had begun to expand its repertoire, adding jetties, revetments, and other permanent structures to its arsenal. Fixed in place, and often made of wood or brush, these schemes had to withstand shipworms year round. One engineer recognized how troublesome this would be. In a foreshadowing of things to come, when Lieutenant H. M. Adams disapproved of a twenty-mile dredging across Galveston Bay in 1872, he cited teredo. It would only be a matter of time, he argued, before the bay's light and moveable sand would refill the freshly dredged channel, requiring endless excavating. The only way to maintain depths would be through a permanent revetment to keep out the powdery sand. Unfortunately, such a work "would only stand a few years on account of the rapid destruction of timber in this latitude by the ship-worm *teredo navalis*."<sup>15</sup>

The farther that engineers pressed into teredo infested waters, the more problems they encountered. The troubles on the part of the New Orleans & Mobile Railroad proved a big wakeup call in this regard. Completed in early 1870, the New Orleans & Mobile was an ambitious engineering feat that fell to pieces before its first birthday. The most direct route between its termini was across fifty miles of marshlands, bayous, and rivers—much of which was habitable to teredo. The road's builders made no effort to combat borers, and the railway paid the price; by November, both bridges crossing Bay St. Louis and Biloxi Bay had failed and a railroad engine had crashed into the water.<sup>16</sup>

In 1871, the railroad's engineers addressed teredo by trying to adapt maritime tactics to pile construction. This decision was born of urgency. Railroad engineer John Putnam recalled "[r]ealizing that something must be done to protect the piles, and

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15. House, *Report of the Secretary of War*, 42d Cong., 2d sess., 1872, H. Exec. Doc. 1, Pt. 2, Vol. 2, 536.

16. For an overview of the early woes of this railroad, see John W. Putnam, "The Preservation of Timber," *Transactions of the American Society of Civil Engineers* 9 (May 1880): 206-216.

knowing of no method of reliably treating them, it was decided to sheath them with metal.” There are a handful of cases of wharf owners sheathing their piles before the war, but it does not appear to have been widely practiced up to then. In 1871, the New Orleans & Mobile hoped that copper, zinc, and “yellow” metal (a blend of zinc and copper) would protect its refurbished line. The results were poor. Engineers made the mistake of not sheathing piles below the surface of the mud (ostensibly to save money). What they had not anticipated was scour. Driving hundreds of piles into both bays had the effect of restricting the channels and increasing velocities in the spaces between the structures. Very quickly, the river scoured mud from their bases, exposing them to shipworms.<sup>17</sup>

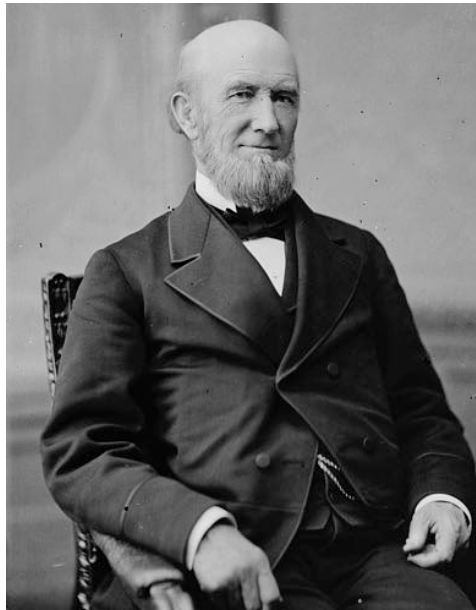
By 1874, the railway was foundering and its “expenditures were very largely in excess of the road’s receipts,” the company explained to the New Orleans Chamber of Commerce, in large part to pay for the “renewal of Teredo destroyed bridges.” After successive failures, the New Orleans & Mobile hired engineer George W. R. Bayley to find a solution. Bayley went straight to the library where he studied every text on teredo that he could find (which he admitted were few). Bayley learned that even the biggest shipworms in the deepest of burrows still needed access to seawater to survive. So he proposed dumping sand and clay around the bases of the piles, covering the boreholes and suffocating the shipworms inside. This was not a long-term solution; the river would eventually scour away the mud. But in the short run it allowed the railway to limp along

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17. G. W. R. Bayley, “The Teredo Navalis, Or Ship-Worm,” *Transactions of the American Society of Civil Engineers* 3 (1874): 159, 160; “Yellow” metal, or “Muntz” metal, was a blend of copper and zinc sheathing popular in the late nineteenth century; Octave Chanute, “The Preservation of Timber: Report of the Committee on the Preservation of Timber,” *Transactions of the American Society of Civil Engineers* 14 (July 1885): 333.

as it settled on a long-term solution. Meanwhile, Bayley published his experiences in the *Transactions of the American Society of Civil Engineers* for all his peers to read.<sup>18</sup>

News of the New Orleans & Mobile made waves and forced engineers everywhere to think more deeply about teredo. But this begged a crucial question: how *does* one properly develop the coastline in a way mindful of teredo? This was not a question that coastal designers had wrestled with—there was no definitive manual to turn to for answers. To make matters worse, the need for a slow and methodical investigation ran counter to demands for urgent coastal improvements. There was no choice but to learn about teredo on the go, a conundrum that played out on the national level when a confident engineer named James Eads promised to unclog the mouth of the Mississippi River.

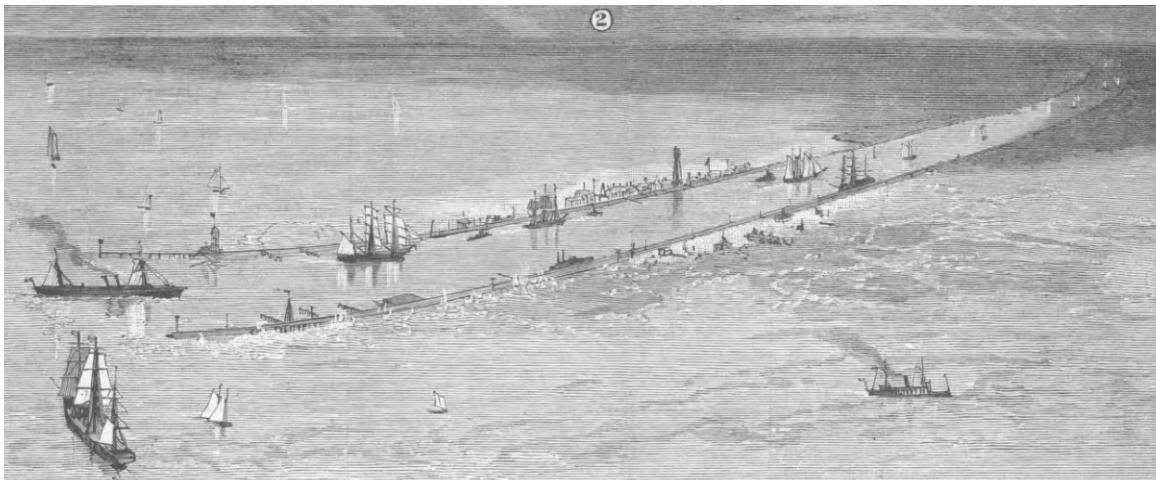


**Figure 6: James Buchanan Eads (1820-1887). Library of Congress Prints and Photographs Division. Reproduction Number: LC-DIG-cwpbh-05219.**

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18. The New Orleans and Mobile changed names and hands several times. Initially called the New Orleans, Mobile & Chattanooga Railroad, it was sold renamed the Louisville & Nashville; Bayley, “The Tereido Navalis, Or Ship-Worm”: 155-170; The New Orleans Chamber of Commerce Committee on Railroads, “New Orleans, Mobile, & Texas Railroad,” *New Orleans Republican*, June 7, 1874, 2.

James Buchanan Eads had a knack for beating the odds. Born into poverty, Eads got his start working days as a clerk while spending his evenings at the library pursuing his real passion, engineering. His first practical experience came while descending inside diving bells in search of shipwrecks. In 1873, after a career that had him building everything from ironclad warships to bridges spanning the Mississippi River, Eads accompanied a board of army officers on a survey of the Mississippi River Delta. Whereas his peers saw an untamable sand bar, Eads imagined two parallel jetties projecting outwards from the banks of the lazy Mississippi, turning it into a water cannon capable of blasting mud over the bar and clearing the way for ships to enter the river under all conditions.<sup>19</sup>



**Figure 7: Mississippi Jetties at South Pass. J. O. Davidson, “The South Pass Jetties of the Mississippi River,” *Harper’s Weekly* 27 (December 1883): 788, 790.**

Eads’ jetty proposal met with a lot of resistance—some of it was petty, some of it substantive. Because of the company he kept, Eads got caught up in long festering rivalries amongst corps engineers over who should run the agency. When he proposed his

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19. See, Elmer Lawrence Corthell, *A History of the Jetties at the Mouth of the Mississippi River* (New York: John Wiley & Sons, 1880), 23-24, for a biographical sketch of Eads.

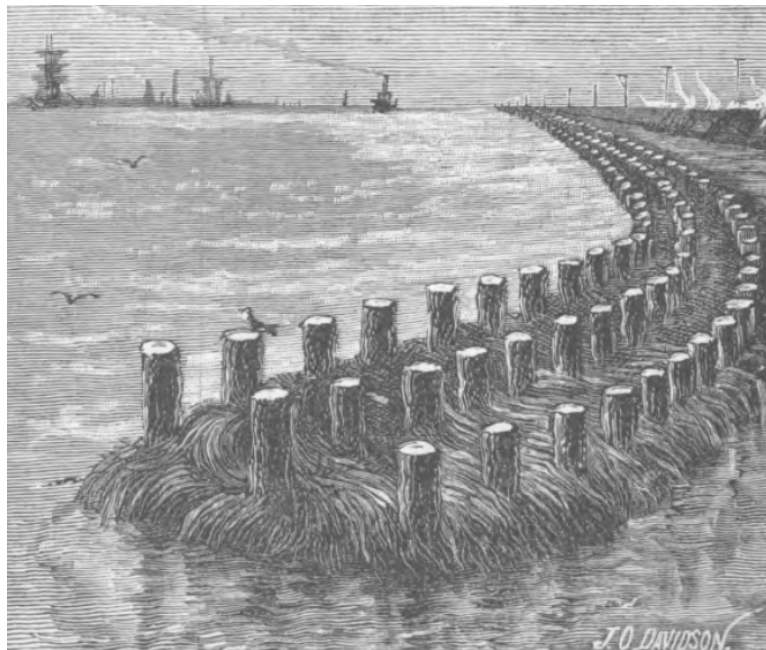
jetties, these enmities dogged him since his rivals preferred a canal opposed to his jetties. But the jetty fight was also theoretical. Nationally, ideas guiding silt removal were in flux. No consensus had emerged. Bostonians, for instance, clung to the so-called “scour theory”, which held that insufficient tidal *volume* caused siltation, while a faction in the corps argued that *vertical eddies* (the tendency of freshwater to slope upwards when it meets saltwater) forced ascending silt-laden river water to drop its load, thus forming sandbars. Eads got behind a new theory. It was *velocity* that determined whether silt suspended in the water column or sank to form shoals and sandbars. His jetties were designed to restrict the width of the river at its mouth, increase its velocity, and push silt out into the currents of the gulf. Since Eads’ theories lacked unanimous consensus from the corps, Eads offered Congress a deal that it couldn’t refuse: he would take no payment unless the jetties worked.<sup>20</sup>

If there was one thing about which Eads spoke overconfidently it was teredo. From the get go, his proposed jetties came under scrutiny for their alleged weakness to borers. In 1874, New Orleans’ business elite begged Eads to withdraw his proposal from consideration, citing shipworms as its number one flaw. In a curt letter, they wrote, “[o]ur objections to your jetties are: First, they will not stand against worms.” Eads would not stand down. He shot back, explaining that his jetties could not be attacked by teredo because they “will not be composed of wood.” This was only partly true. The jetties were

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20. Michael Rawon, “What Lies Beneath: Science, Nature, and the Making of Boston Harbor,” *Journal of Urban History* 35 (July 2009): 675-697. The “scour theory,” which may have been unique to Boston Harbor, was used throughout the nineteenth century by city leaders in their efforts to restrict and regulate landfilling; For a description of the “vertical eddies” (also called “dead angles”) as well as the factionalism of the corps, see Martin Reuss, “Andrew A. Humphreys and the Development of Hydraulic Engineering: Politics and Technology in the Army Corps of Engineers, 1850-1950,” *Technology and Culture* 26 (January 1985): 15-23; For Eads’ thoughts on hydrology and sedimentation, see a letter he wrote to Senator William Windom dated March, 15, 1874, reprinted in Corthell, *A History of the Jetties at the Mouth of the Mississippi River*, 28-36.

built with layers of “mattresses”—thin willow twigs and branches woven together and then sunk with a layer of small stone, called riprap. Eads didn’t think shipworms would bore into such thin branches. At any rate, he expected mud to seep into the mattresses, shielding them from teredo. This was the same premise that guided Bayley’s hand when he took charge of the New Orleans & Mobile (Eads hired Bayley as an assistant, but its unclear how much influence Bayley had on his boss since he died in 1876).<sup>21</sup>



**Figure 8: Willow Mattresses. Davidson, “The South Pass Jetties of the Mississippi River”: 788.**

When Congress finally authorized the improvement there were still engineers in the corps who believed that borers would attack the mattresses. Between 1876 and 1879, Captain M. R. Brown kept detailed notes on the “ravages of the worms.” Contrary to what Eads had promised, teredo had begun to eat away at the willow mattresses. Brown found a willow branch one and a half inches in diameter “honey-combed” by teredo. Captain Brown, however, wasn’t one to jump to conclusions, warning instead that the

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21. Estill McHenry, ed., *Addresses and Papers of James B. Eads, Together with a Biographical Sketch* (St. Louis: Slawson & Co., 1884), 146, 153.



situation needed further monitoring. Mud might still blanket and protect the jetties, but any claims about the resistance of willows from borers were clearly untrue.<sup>22</sup>

The press pounced on the corps' findings. Newsmen throughout the Mississippi Valley had been skeptical of Eads' jetties from the moment they were announced. Most of the ire flowed down from Chicago, Cincinnati, and Memphis, probably because people there felt threatened by the economic potential of improved transportation throughout the lower Mississippi basin at the expense of the transportation networks evolving in the north. The *Chicago Tribune* had no problem putting words into the mouths of corps engineers, arguing how their "reports show conclusively that the 'teredo'—a very destructive worm—has badly eaten" the jetties."<sup>23</sup>

Eads got the last laugh. In 1879, the Senate Committee on Transportation Routes to the Seaboard deemed the South Pass jetties "to be of substantial and permanent character, free from the danger or injury by wave action or destruction by the teredo." The jetties filled in with sediment enough to prevent the worst fears from coming true. Shipworms might bore into exposed willows, but they couldn't undermine the structures. The *Times-Democrat* of New Orleans celebrated the news (the local press gradually came around to the scheme as the depths increased) and rubbed it in the faces of northern newsmen, equating them with borers, writing "Capt. Eads proves himself an overmatch alike from the teredoes of the press and the sea." Eads couldn't refrain from tearing into his doubters either. In April, he wrote an editorial for the *New York Tribune* poking fun at the "distress which worms have caused" his critics. In the end, Eads got paid. The jetties

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22. House, *Jetties South Pass, Mississippi River*, 45th Cong., 2d sess., 1878, Ex. Doc. No. 37, 7; House, *South Pass of the Mississippi River*, 45th Cong., 2d sess., 1878, Ex. Doc. 52, 35-37.

23. "Eads' Jetties Failure," *Chicago Tribune*, March 13, 1879, 4.

cleared the sand bars and made navigation into the valley much easier and much safer.

Eads was right about jetties, wrong about the resistance of willow, and lucky that the silt had filled in the mattresses before teredo could do its worst.<sup>24</sup>

## **Two Steps Back**

Thanks to Eads, jetties became trendy. But the new wave of builders had trouble replicating his success. To the east, the fates of many jetties went the way of Cumberland Sound, Georgia. In 1880, a corps surveyor recommended brush mattresses for the jetties because “sediment will doubtless fill the brush and prevent the action of the ‘teredo.’” By 1882 this had not happened, leaving the jetties exposed “more or less to the attacks of the teredo.” This was no trifling matter, as Captain J. C. Post made clear. “[P]rotection against this ship worm,” he explained, “is regarded of especial importance, as without it the entire wood-work of the foundation course may be destroyed in a single year.”<sup>25</sup>

Hastily, Post recommended a layer of rock be placed atop the jetties to protect them from borers. Unfortunately, no work could be done until logrollers in Congress passed another rivers and harbors appropriation. During the suspension of work, teredo did more damage. By 1888, navy surveyors visited the sound during their search for a new navy yard location and noted how much damage that borers had caused to the jetties over the years. They wisely deemed “further consideration of this harbor for a navy-yard site...unnecessary.” What happened at Cumberland Sound (insufficient blanketing of silt

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24. Senate, *In the Senate of the United States*, 45th Cong., 3d sess., 1879, Report No. 781, 1; “Captain Eads and the Teredoes,” reprinted in the *Daily Cairo Bulletin* (Il), April 13, 1879, 1; “The Mississippi Jetties; A Letter from Captain Eads,” *New-York Daily Tribune*, April 3, 1879, 2.

25. House, *Report of the Secretary of War*, 47th Cong., 2d sess., 1882, Ex. Doc. 1, Vol. 2, Pt. 2, 1186-1189; Senate, *Letter from the Secretary of War, Transmitting, in Response to Senate Resolution of the 11th Instant, a Report from the Chief of Engineers and an Extract from Report of Capt. James C. Post, Corps of Engineers, Respecting the Condition of the Work at the Entrance to Cumberland Sound*, 47th Cong., 2d sess., 1883, Ex. Doc. 47, 3.

combined with piecemeal funding) occurred to varying degrees to many other southeastern Atlantic jetties, like those at Cape Fear, Charleston, and Jacksonville.<sup>26</sup>

West of the Mississippi River, jetty builders encountered similar problems, especially along the Texas coastline where sandbars rippled out for miles into the gulf. At Galveston, the state's largest and most important commercial hub by the 1880s, a massive bar blocked the entrance into Galveston Bay, a 490 square-mile, semi-enclosed waterway. The only practical exit into the gulf was through Bolivar Channel, which bisects Bolivar Peninsula and Galveston Island (to the north and south, respectively), and offered depths of 24-feet. After passing through the channel, the seafloor gradually rose into a semi-circular berm that bulged out four miles into the gulf. To the north and to the south, the bar curved back towards land. At its crest, the shield-like mound afforded a scant 10 to 13 feet of clearance. For a city that handled the bulk of the Texas cotton trade, the Galveston bar was a glaring impediment.<sup>27</sup>

Beginning in 1880, the US Army Corps of Engineers commenced work on a jetty. It stretched eastward from the tip of Galveston Island and aimed to scour a channel through the bar in excess of 30 feet. Following in the footsteps of Eads, the jetty was constructed of mattresses. Mattresses of the sort were adopted all along the Texas coast because they were "supposed to be proof against the teredo." Over the next three years, construction proceeded smoothly. Then Congress failed to pass a river and harbor bill. Construction halted. In 1883, Galveston's mayor-elect R. L. Fulton grew concerned about

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26. House, *Report of the Secretary of War*, 51st Cong., 1st sess., 1889, Ex. Doc. 1. Vol. 1, Pt. 3, 183; House, *Altamaha and Canoochee Rivers, Romerly Marshes and Mouth of Jekyl Creek, Georgia, and Wappoo Cut, and Ship Channel Across Charleston Neck, South Carolina*, 46th Cong., 3d sess., 1881, Ex. Doc. 19, 23.

27. House, *Improvement of Galveston Harbor, Texas*, 49th Cong., 1st sess., 1886, Ex. Doc. No. 85, 5-6.

the fate of the scheme and asked Major Samuel Mansfield about what to expect.

Mansfield saw nothing to fear and reassured Fulton that “no injury can possibly happen to my work by reason of it being left in an unfinished state; on the contrary, it should improve with age, by reason of the accretion of sand and shell.” Anyhow, inspections had shown that the “worm had done no injury.”<sup>28</sup>

In 1885, Mansfield returned to Galveston astonished to discover that shipworms and storms had caused the jetty to lose 61 percent of its height. This resulted in a measly two feet increase in depth over the bar—hardly the world-changing depths that the people of Texas had hoped for. Mansfield was stunned by the revelation and his reactions ran the gamut. Initially, he cast doubt on whether teredo had even caused the settlement, surmising instead that the mattresses had filled with mud (as he had hoped for) and settled under their own weight. When this proved false, he stooped to excuses. In a fit of revisionism, Mansfield claimed all along that he had meant for the jetty to be protected with a layer of stone to prevent the inroads of teredo—it was not his fault that Congress interrupted funding. Reluctantly, he admitted that the “bulk of our loss must be attributed to the teredo.”<sup>29</sup>

Predictably, Texans expressed frustration as they debated how to proceed. One newspaper wrote that there was nothing to show for the improvement but “a few broken-down, dilapidated and teredo-eaten sea-walls.” Mansfield’s successor made no excuses for the failure, citing the corps’ flawed assumptions. Galveston Bay’s tributaries were not the muddy Mississippi River. “At the mouth of the Mississippi,” explained General John

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28. House, *Report of the Secretary of War*, “Appendix P.: Improvement of Rivers and Harbors in the State of Texas,” 48th Cong., 1st sess., 1883, Ex. Doc. 1, Vol. 2, Pt. 2, 1061-1063.

29. House, *Improvement of Galveston Harbor, Texas*, 13, 20, 24.

Newton, “where the bottom is mainly of mud, the condition of the water will be a protection against the rapid ravages of the teredo.” Expecting the lazy rivers that fed Galveston Bay to scour through the bar *and* deposit mud over the mattresses was a foolish expectation. The light, friable pebbles and sand of the gulf had no such binding qualities. After expending nearly two million dollars (and 100,000 dollars raised independently by the people of Galveston), the corps was forced back to the drawing board with a greater respect for the capabilities of teredo. Future jetties would need to take better account of borers. When the corps returned to Galveston in the 1890s to fulfill its promise of deepening the water, it spared no expense. Gone were the mattresses. The jetties were built from heavy stone brought in from the interior of the state. So sturdy was the improvement that a train ran over the top of it, carrying the stone miles out into the gulf. There was no way that shipworms were going to attack this jetty.<sup>30</sup>

### **Resistance**

Along the southern coastline, wharf and trestle owners watched as the corps stumbled in ways all too familiar to them. Building in southern waters was risky business and timberwork rarely lasted more than one or two years. Galveston’s very first wharf may have set the record for shortest lifespan since it comically succumbed to teredo *before* it was even finished in 1838. Later in the century, an engineer named Alex Mitchell painted a particularly bleak picture of the conditions along the gulf coast. “Staggered” at Texas’ high wharfage rates, Mitchell gradually (and begrudgingly) accepted that “over 70 per cent. of the charges were for renewals [of piles] and went into nobody’s pocket: simply eaten up by the teredo.” While his comments were doubtlessly

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30. “Deep Water: What the Texas Newspapers are Saying of the Long-Felt Want,” *Fort Worth Daily Gazette*, April 18, 1886, 13; House, *Improvement of Galveston Harbor, Texas*, 3.

exaggerated (Mitchell lobbied for a renewal of the Galveston jetties) they captured the sentiments that many felt about teredo throughout the south.<sup>31</sup>

Marine builders like Mitchell desperately needed ways of protecting coastal infrastructure. But their hands were tied. There was one large obstacle preventing the development and distribution of reliable and cost effective timber preservatives: abundant timber supplies. In the 1880s, the American Society of Civil Engineers (ASCE) lamented that “[t]imber has hitherto been so abundant and cheap in the United States that there has been but little inducement or economy in preserving it.” Indeed, “it was generally more economical to let the wood rot than to go to the expense” of preserving it. Replacing piles so often may have been frustrating, but it remained feasible as long as forestry supplies appeared endless and moderate in cost.<sup>32</sup>

After the war, the scales began to tip slowly in favor of preservation when doubts about the sustainability of logging practices surfaced. In the 1880s, the ASCE determined that “supplies were being rapidly exhausted” and that the “advancing price of timber...about doubled within the last twenty years.” Rising prices finally made “it practicable, and in many cases necessary, to preserve wood against decay.” A fortune awaited the person who could develop and patent anti-borer products. Predictably, a wave of inventors flooded the market with every concoction or method imaginable—and a few unimaginable. Timber preservation hit perhaps its lowest point when a New Yorker mixed tar and tobacco and slathered it on a scow—“[b]eing a hater of tobacco, he

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31. “Tells How It Can Be Done,” *Dallas Morning News*, July 24, 1888, 4; Chanute, “The Preservation of Timber”: 273, 277, 293. The ASCE’s special committee on timber preservation gave conflicting info on how long timber lasted in the gulf coast, ranging from eight months to 1-2 years.

32 Chanute, “The Preservation of Timber”: 247, 249.

believed this would be about the most disagreeable thing he could do to the *teredo*.”

Sorting out the scrupulous inventors and legitimate products from the hucksters and snake oils became a new hurdle in the fight against teredo.<sup>33</sup>

Initially, southern marine builders clutched at the lowest hanging fruit—which in this case meant the trunk of the tree, not its fruit. Over the centuries, many North American trees have been rumored to be immune to teredo (spoiler: none are immune). Rumors thrived on the scantest of evidence. When someone plucked a piece of unharmed driftwood from infested waters, he or she might find this sufficient to advertise the timber as resistant (or reveal the name of the tree for a price). Likewise, shipwrecks became accidental lab experiments—when they seemed to resist borers, people claimed that the trees from which the planks were hewn resisted teredo. These types of single-causal observations regularly made their way into newspapers, government reports, and scholarly publications. When they did, hearsay acquired ostensive validity. Reputations might persist for years or decades before ultimately fading once the results were not sufficiently replicable.<sup>34</sup>

More than any other tree, the palm illustrates the power of teredo-resistant rumors. Native to Florida, Georgia, and South Carolina, the *Sabal palmetto*, or cabbage tree, had a reputation that persisted for well over a century. Adoration for the palmetto

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33. Chanute, “The Preservation of Timber”: 291; This wasn’t the first time that tobacco had been tried as a deterrent. During the 1830s, French shipbuilders experimented with pitch and “essence of tobacco”. See, “Preservation of Ships from Worms,” *Mechanics’ Magazine* (London), 18 (December 1832): 192.

34. For an example of a rumor started by a shipwreck, see *Report of the Superintendent of the United States Coast Survey, Showing the Progress of the Survey During the Year 1867* (Washington DC: GPO, 1869), 213; For an example of anecdotal tests based on floating driftwood, see “Exempt From the Teredo: Timber In Alaska Which It Is Said the Borer Will Not Molest,” *San Francisco Call*, March 22, 1895, 8; For an analysis of potentially resistant trees, see William G. Atwood and A. A. Johnson, “Timber For Which Immunity is Claimed,” in *Marine Structures, Their Deterioration and Preservation* (Washington DC: National Research Council, 1924).

dates back at least to the 1820s when botanist Stephen Elliot lauded the palm as “the only tree produced in our forests which is not attacked by the *teredo navalis* or ship-worm.” Because of this the “palm possesses a great, and to this country an increasing value.” Not much later, a Charleston pilot named Michael Dulaney touted the palm to navy surveyors searching for a site for a new navy yard. Dulaney admitted that “worms cut from April to November,” but was quick to tell them how “Palmetto logs resist worms, and are in general use in building wharves, and may be had in abundance,” implying that the navy should have no reservations with choosing Charleston. Even Jarvis thought that the palmetto resisted borers.<sup>35</sup>

As time passed, the palmetto’s reputation spread to the press. In 1850, for instance, a southern newspaper urged the State of South Carolina to send boards of palmetto for the Washington Monument instead of stone (in a symbolic gesture, stone from every state constituted the monument). The paper cited palmetto’s resistance to teredo as its national value (both in real and symbolic terms). In another example from 1871, *Harper’s* ran a story on the Florida Reef that explained how the palmetto “is a notable and striking example of Providential care for man’s well-being” because it “alone is invulnerable” to the “irresistible encroachments of the teredo.” By 1884, faith in the palmetto had grown to such heights that a southern newspaper called itself the *Palmetto Post*. Its motto: “Worms Can’t Affect It.” The palmetto knew no bounds.<sup>36</sup>

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35. Stephen Elliot, *A Sketch of the Botany of South Carolina and Georgia* (Charleston: J. R. Schenck, 1821), 482; Senate, *Report of the Secretary of the Navy, with the Report of the Officer Appointed to Examine the Harbors of Charleston and St. Mary’s, on the Expediency of Establishing a Navy Yard at Either of Those Places*, 22; Jarvis, “The Teredo, or Salt Water Worm”: 199.

36. “The Forest Trees of America,” *Daily Crescent* (LA), May 21, 1850, 2; “Along the Florida Reef,” *Harper’s New Monthly Magazine* 42 (March, 1871): 520; N. W. Ayer’s & Sons, *American Newspaper Annual* (Philadelphia: N. W. Ayer & Son, 1886), 2: 824.



The showering of praise, however, was not completely earned. In 1885, John Putnam, an engineer working for the New Orleans and Mobile, recognized that his peers “generally...considered that palmetto or cabbage wood was safe from the attacks of marine animals.” But his investigations contradicted these claims. In Pensacola, Putnam found palmetto “more or less eaten.” In Charleston, he found also “numerous pieces badly eaten.” What troubled Putnam was that shipworms seemed to favor the bark of the palmetto over its sapwood and heartwood. This surprised him because many people had assumed (rightly) that tree bark slowed the work of borers. Despite his findings, shipworms failed to tarnish the palmetto’s reputation. Palm trees continued to receive praise well into the twentieth century, and long after the search for other trees fabled to be immune from teredo had diminished.<sup>37</sup>

Charring was another easy anti-teredo method practiced in the south for a time. Charring is very old. European explorers probably witnessed charring in the Pacific Ocean and brought knowledge of it back with them. The practice then spread to the United States. Unfortunately, there is no evidence that charred wood prevents borers. In 1855, Jarvis warned that “[c]harring the surface of wood is not found to be of any use.” Regardless, marine builders charred away. In 1879, the Chesapeake and Ohio Railroad Co. built a pier at the mouth of the James River with charred piles, only to discover that borers had rendered it unsafe in a year’s time. Thereafter, reports would surface of the effectiveness of charring, but nearly always in the conjunction of other preservatives. By

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37. Jarvis, “The Teredo, or Salt Water Worm”: 201. Jarvis, for instance, argued that the “bark of all trees, as long as it can be kept on, is positively one of the best securities for piles”; Chanute, “The Preservation of Timber”: 287, 339. Navy researchers came to the same conclusion as Jarvis. After testing various pile preservatives, they concluded that the “only favorable results have been that oak piles cut in the month [of] January and driven with the bark on”—these piles resisted teredo for “four or five years, or till the bark chafed or rubbed off”; For another analysis that casts some doubt on the palmetto tree, see Atwood and Johnson, *Marine Structures, Their Deterioration and Preservation*, 78.

the end of the century, trade journals such as *Engineering News* recommended the practice, but with the caveat that it be used in conjunction with other methods. Later studies dismissed even this benefit, arguing that “[w]hen timber is charred and some additional protective method is used, the quality of protection seems to depend largely on the efficiency of this second method.” Charring was freely available to all, but useful for none.<sup>38</sup>

There was no shortage of alternatives to palmettos, un-barked timber, and charring. Some southern builders spared no expense, favoring metal sheathing, casing, scupper nailing, and other heavy-duty pile armors in an attempt to limit any risk from teredo. Builders employed sheaths made from steel, copper, iron, and zinc at various times. Also, precast concrete casings as well as vitrified pipes lowered over piles and filled with sand have also been tried. Scupper nailing was also tried on occasion.<sup>39</sup>

While pile armors held a lot of promise, so much had to bend right for them to work properly. Special care had to be taken to ensure that the armors reached below the mud line in case of scour. Also, armored piles weren’t any less immune than un-armored piles to the usual wear and tear customary in port settings. Cracks caused by floating debris or roughly docked ships could easily damage armors. Corrosion also made some kinds of armor brittle and liable to break. If any of these things occurred, the expense of armoring piles was for naught. As such, most gulf coast builders shied away from pile

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38. A. K. Armstrong, “Protecting the Bottoms of Wooden Ship,” *American Lumberman* 2220 (December 1917): 52-53; Jarvis, “The Teredo, or Salt Water Worm”: 99; E. S. Christian, “Destruction of Timber by Marine Borers,” *Proceedings of the American Wood-Preservers Association* 11 (January 1915): 296-297; William Kennish, “Charring Piles Before Creosoting,” *Engineering News* 24 (September 1890): 280. Another article by the same title and author, with slightly different content, ran in *Engineering News* 28 (September 1892): 201; Atwood and Johnson, *Marine Structures, Their Deterioration and Preservation*, 88-90.

39. Atwood and Johnson, *Marine Structures, Their Deterioration and Preservation*, 92-95, 98.

armors for much of the nineteenth century, with the exception of railway companies, which could afford to bear the expense.<sup>40</sup>

Perhaps it is best to think about timber preservation as if it were a spectrum. Armoring piles and driving untreated timber are the two extremes on this continuum. In between is a vast array of pile coatings, too numerous to list in all, such as tar, verdigris paint, resin, sulfate of copper, lime, and arsenic, to name a few. Pile coatings have been around a long time (Vikings slathered seal-tar onto their hulls, while Elizabethan shipwrights preferred tar mixed with animal hair) and varied widely in color, origin, viscosity, and price. Before the nineteenth century, all shared one thing in common: none worked well. Coating the surface of a pile was easy to do, but impregnating its inner sapwood was the challenge. If the chemical coating did not achieve proper penetration, leaching quickly left the timber vulnerable to teredo. Piles submerged in seawater began bleeding their chemicals the moment they were driven into place. For the longest time, no one had an answer for leaching. All the while, the list of ineffectual coatings grew, and the ravages of teredo went unchecked.<sup>41</sup>

In 1838, a Briton named John Bethell solved the mystery. Bethell patented a process for injecting creosote, or “dead oil,” a liquid distilled from coal tar, much deeper into the sapwood than any previous technique. He listed a bunch of caveats—if his

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40. Ibid.

41. For a review of pre-nineteenth century pile coatings, see William Chapman, *A Treatise Containing the Results of Numerous Experiments on the Preservation of Timber from Premature Decay, and on the Prevention of the Progress of Rotteness, When Already Commenced, in Ships and Buildings, and their Protection from the Ravages of the Termite, or White Ant; With Remarks on the Means of Preserving Wooden Jetties and Bridges from Destruction by Worms* (London: T. Davison, Whitefriars, 1817); Refer to Chapter 1 for references to Viking and English coatings; For an analysis of the effects of rainfall and moisture on various nineteenth century coatings, see Chanute, “The Preservation of Timber”: 256, 265, 272, 349.

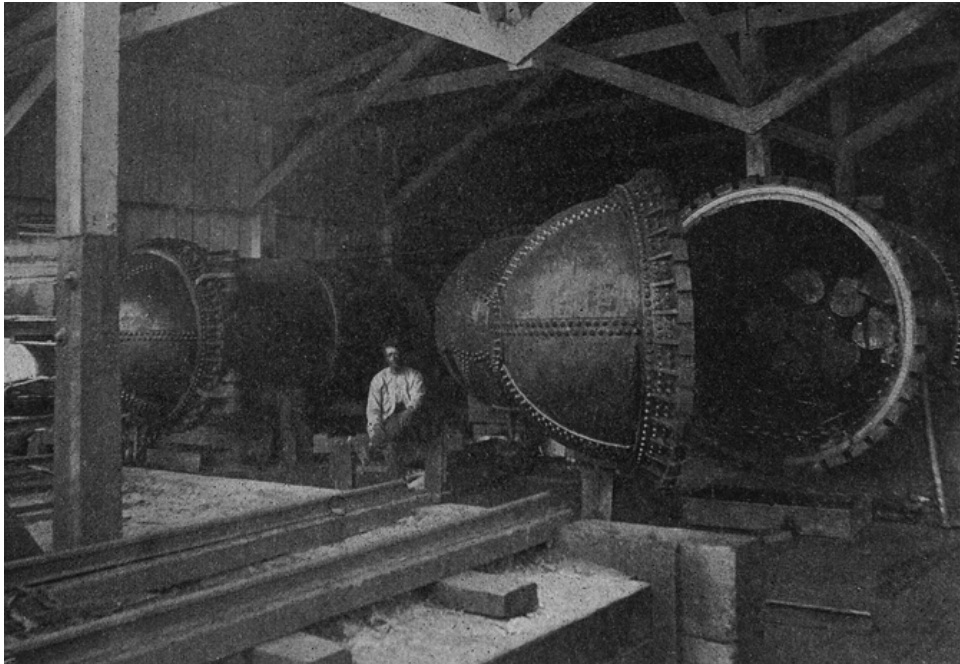
process wasn't followed meticulously, the treatment would fail. Seasoning was the first step. As a rule, British timber dried for six months or more before treatment. Less moisture meant less resistance to creosote's saturation. After seasoning, Bethell placed the timber into cylinders and filled them with hot creosote. The secret to Bethell's success was pressure. Under intense pressure, creosote absorbed more deeply. Bethell recommended treating timber to refusal (when timber can't absorb any more creosote). Absorption of anything less than 10 lbs. per cubic foot was deemed inadequate for marine uses (In the United States, the amount of creosote needed varied from north to south—piles in the north needed 10-12 lbs. per cubic foot, while southern piles required as much as they could hold, but no less than 14-20 lbs. per cubic foot). Finally, Bethell cautioned anyone from cutting or trimming treated timber. Doing so nullified all the benefits and allowed borers to circumvent the ring of penetrated creosote. European engineers wasted little time anointing the Bethell Process as the best and only protection against borers and it quickly became the European standard.<sup>42</sup>

American timber preservers tried their hands at creosoting after the war. But the results were mixed at best. The divergent experiences of two gulf coast railroads offer a telling contrast. In 1874, Galveston became home to one of the country's first creosote factories and the following year it delivered an order of 4,000 piles for a train trestle spanning Galveston Bay. After a few years, half of the trestle's piles succumbed to teredo, probably due to improper treatment. The railroad charged that the failure was

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42. For a description of the Bethell Process, see Henry Potter Burt, "On the Nature and Properties of Timber, With Descriptive Particulars of Several Methods, Now in Use, For its Preservation and Decay," *Minutes of Proceedings of the Institution of Civil Engineers* 12 (1853): 206-243. In the discussion, pg. 228, Bethell claims that no less than 10 lbs. per cubic foot was needed for "marine work." Several British engineers attested to the success of creosote in resisting teredo, most notably Isambard Brunel, pg. 234; Chanute, "The Preservation of Timber": 265-267, 289.

“caused evidently by dishonest creosoting.” Farther up the coast, the New Orleans and Mobile Railroad had a different experience. In 1875, this railway purchased 10,000 gallons of creosote and constructed a creosoting plant at Pascagoula, Louisiana. The plant produced piles for the railroad’s bridges spanning Biloxi Bay and Bay St. Louis—the same trestles that Bayley had struggled to keep upright. Ten years later, neither bridge showed any sign of attack.<sup>43</sup>



**Figure 9: Creosote Chamber.** Credit: “The West Pascagoula Creosoting Works,” *Railway and Engineering Review* 43 (1903): 186-189.

Discrepancies like these troubled Octave Chanute, of the American Society of Civil Engineers (ASCE), who remarked how the “same processes seemed to give different results, and these again differed from the European experience.” In 1880, Chanute headed an ASCE committee to investigate why American timber preservers had trouble executing Bethell’s blueprint. Chanute quickly realized that his question would

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43. F. A. Kummer, “A Proposed Method for the Preservation of Timber,” *Proceedings of the American Society of Civil Engineers* 26 (1900): 198-212; Chanute, “The Preservation of Timber”: 275; “Checkmating the Tereido,” *New Orleans Republic*, July 16, 1875, 1; Putnam, “The Preservation of Timber”: 206-216

require a multi-year investigation to answer. Over the course of five years, Chanute obtained information from timber preservers all around the country via a questionnaire he mailed to some 2,000 individuals. Hundreds responded. After reviewing dozens of different attempts to creosote timber, Chanute's committee came to the root of the problem: timber preservers *couldn't* or *wouldn't* follow the Bethell Process.<sup>44</sup>

One of the problems that Chanute identified was seasoning. Poorly dried timber prevented timber saturation. American preservers largely treated fresh timber because the humid summers prevented timber from air-drying on its own. Green piles, such as those driven underneath the Galveston Bay trestle, failed to absorb more than 8 lbs. per cubic foot of creosote. Ironically, some good came from stubbornly treating fresh timber—after some tinkering with Bethell's Process, American preservers learned that steaming before creosoting helped rid piles of some of their excess moisture. Steaming involved heating a pile to such a temperature that the internal moisture vaporized—under a vacuum, these vapors were drawn out, leaving the timber free to soak up creosote. Steaming eventually proved “a valuable improvement upon the original process of Mr. Bethell,” according to Chanute.<sup>45</sup>

The high price of creosote also led to improper creosoting. “Creosote is cheap and abundant in England,” noted Chanute, “while it is comparatively scarce and dear in this country.” The price of creosote fluctuated, but it was consistently and prohibitively expensive throughout the nineteenth century, ranging in 1885, for example, from 14 to 24

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44. Chanute, “The Preservation of Timber”: 248.

45. Chanute, “The Preservation of Timber”: 266-267; Putnam, “The Preservation of Timber”: 214-215; Descriptions of the steaming process can be found in C. M. Davis, “Notes on Creosoting,” *Military Engineer* 3 (April-June 1911): 190-196; and George S. Page, *Transactions of the American Fish Cultural Association, Eighth Annual Meeting* (New York: Johnson Reprint Corporation, 1879), 31.

cents per cubic foot. In a bid to protect their profit margins, timber preservers cut corners. Either by skimping on creosote (i.e. not treating to refusal), or “modifying” the Bethell Process altogether (a euphemism for disregarding his blueprint) preservers tried “to make a little creosote perform as much as a great deal.” They could get away with this because few comprehended the difference between “creosote” and “creosoting.” One is a chemical, the other a method. Dozens of inventors pushed products with words such as “creosote” and “Bethell” plastered in their advertisements, even though they were “not true creosoting.”<sup>46</sup>

The Robbins Process is illustrative of so many pseudo-creosoting methods. Introduced in 1865, its inventor, Louis Robbins, marketed the multi-purpose preservative as a protection against “Mould, Decay and Destruction by Worms,” as the title of its 1868 marketing brochure proclaimed. Like so many other timber preservers, Robbins blurred the lines between his treatment and the Bethell Process, characterizing his method as an improvement over the latter. The differences were subtle, but significant. Robbins flooded his pressurized chambers with creosote vapors instead of liquid creosote. Smoking piles in this way, instead of bathing them in dead oil, required less creosote. Consequently, vapor treatment lowered the saturation rate significantly—less than two lbs. per cubic foot of creosote vapor penetrated the timber, a fraction of the amount that Bethell had recommended to protect against teredo.<sup>47</sup>

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46. Chanute, “The Preservation of Timber”: 267, 277.

47. For a description of the Robbins Process, see the company’s promotional brochure, National Patent Wood Preserving Company, *The Robbins Process for Preserving Wood and Lumber from Mould, Decay and Destruction by Worms* (New York: National Patent Wood Preserving Company, 1868), 81-84; More details are offered by Chanute, “The Preservation of Timber”: 270.

Robbins ignored the ominously low saturation rate and proceeded to advertise his product around the country. In fact, he proved to be a better marketer than a timber preserver. Whenever Robbins came across praise of his process in newspapers, trade magazines, and correspondences, he clipped them and inserted them into his promotional literature. For example, he transcribed a lengthy passage from an 1866 edition of the *American Artizan* that claimed his process “affords a complete protection against marine worms.” Accolades such as this were meaningless since untreated wood often withstood teredo for a year or two under the right conditions—since the Robbins Process wasn’t yet that old, there was no way empirically to confirm such a claim. Yet, Robbins leveraged these hollow and ill-informed compliments into new sales pitches. Within a couple years Robbins was selling his treatment from New York to California.<sup>48</sup>

The moment of truth for the Robbins Process came in 1871 when the corps ordered piles for its breakwater in Wilmington, California. Major G. H. Mendell had no choice but to rely on Robbins piles; no other treatment existed on the west coast. Still, he was cautiously optimistic that the Robbins Process would “afford some protection against the teredo navalis.” If it didn’t “the reputation of the company will be at stake.” The jinx was on. It didn’t take long for his worst fears to come true. In 1873, Mendell’s subordinate, C. B. Sears, lamented that the process had “utterly failed to protect the timber from the worms, which were not more than two months longer in attacking it than

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48. For testimonials regarding the Robbins Process’ immunity to teredo, see National Patent Wood Preserving Company, *The Robbins Process for Preserving Wood and Lumber from Mould, Decay and Destruction by Worms*, 67, 68, 72, 92, 95.



in attacking the untreated piles.” The Robbins Co. had been exposed and soon after went out of business.<sup>49</sup>

When Octave Chanute submitted his report to the ASCE in 1885, he had harsh words for snake oil makers like the Robbins Co. These companies, he writes, “patented sundry preparations and methods, took such jobs as they could obtain, sold whatever State and county rights they could, and retired from the field when the insufficiency or danger of their process became apparent.” Chanute identified only six creosote plants that faithfully followed the Bethell Process. Notably, four of the six were located in the south: Texas, South Carolina, and two in Louisiana. It was his earnest hope that more timber preservers would see their errors and adopt standardized creosoting methods, but he feared his report might have the opposite effect. When timber preservers discovered how tedious and costly creosoting was, they might give up the pretense and veer in the direction of developing “a new crop of inventions based on the method of ‘how not to do it’”—which is to say abandoning the Bethell Process in favor of reinventing the wheel, but much cheaper. This is more or less what happened. Until timber prices rose high enough that it made creosoting worthwhile, inventors muddied the market with miracle cures for teredo that promised much but delivered little.<sup>50</sup>

### **Retreating**

By the turn of the century, many southerners had grown understandably weary of teredo. Nearly everything they tried—from willow mattresses, to inconsistent and expensive creosoting, to bargain bin preservatives—seemed to fail. Instead of fighting borers, some started calling for a tactical retreat. A few harbors along the coast contained

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49. House, *Report of the Secretary of War*, 42d Cong., 2d sess., 1871, Ex. Doc. 1, Vol. 2, Pt. 2, 942; The quote from Sears can be found in, Chanute, “The Preservation of Timber”: 270.

50. Chanute, “The Preservation of Timber”: 249, 250, 277.

water too fresh to support shipworms. Boosters in these places urged their fellow southerners to abandon infested waterways and invest their money and energy in places like Houston, Port Arthur, and Savannah.

When Congress mulled over a plan to excavate a massive ship canal connecting Houston with Galveston Bay, state officials passed a resolution in favor of the scheme and forwarded it to Congress. Out of all the “important results” that “will thus be secured” by the ship canal, the first benefit that the resolution listed was “[a]n interior harborage, in tidal waters, free from barnacles and the teredo.” One Texan bragged that the ship canal would put Houston ahead of its nearest rival, Galveston, but he “refrained from saying the ship yards would be free from storms, and the teredo not known” when in the presence of “my Galveston friends.”<sup>51</sup>

Something similar occurred in Sabine Pass, Texas. In 1898, the corps considered digging a ship canal through the pass and into the gulf. It justified the scheme by citing the anti-shipworm benefits of Port Arthur. Washed by the freshwaters of Taylors Bayou, Port Arthur could boast of piles driven before the war that still stood tall. This fact “is alone worth the entire cost of the canal,” explained the corps. Congress authorized the scheme, and within less than a year, the dredging neared completion. Boosters in Port Arthur were more than pleased. The Port Arthur Land and Townsite Co. ordered a full-page advertisement in the *Kansas City Star* touting how the “[f]reshwater from Taylors

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51. House, *Examination and Survey for a Water Route from the Jetties at Galveston, Tex., Through and Up Buffalo Bayou to Houston*, 55th Cong., 2d sess., 1897, Doc. No. 99, 8; “Building of the Naomi,” *Dallas Morning News*, February 6, 1898, 7.

river (or bayou) protects piling and timbers from the teredo and barnacle,” making Sabine Pass the ideal outlet for Kansan goods as well as those produced in the greater Midwest.<sup>52</sup>

Savannah, Georgia also tried to leverage the anti-teredo effects of its harbor to improve the city’s prospects. In 1905, the leaders of the city’s chamber of commerce, cotton exchange, and board of trade, all got together and authored a letter calling on the corps to dredge its harbor so that deeper draft vessels could approach. Teredo was among the six “Points In Favor of Savannah Harbor.” They write: “Savannah has the great advantage of affording a port where vessels can lie in fresh water while loading and unloading, thus affording them a chance to destroy all teredo and marine growth on their bottoms at no cost whatever.”<sup>53</sup>

It’s difficult to say how much these freshwater boosters were able to corral regional commerce. It’s also fair to question the degree to which teredo factored into the long-term plans of places like Houston, Port Arthur, and Savannah for the reasons listed above. All three, after all, had asked for federal money. It’s possible that shipworms were merely rationales that padded their respective proposals. But even if this were to turn out to be true, the arguments must have been persuasive to someone, for if they weren’t there would be no reason to make them, either honestly or disingenuously.

## **Conclusion**

The southern coastline is far from pristine. Much of it has been designed, often in ways that are hard to see. Mud has always been the principal obstacle to commercial development, and throughout the nineteenth century, engineers managed mud through

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52. House, *Ship Canal as Sabine Pass*, 55th Cong., 2d sess., 1898, Doc. No. 549, 32; “Port Arthur Ship Canal Celebration,” *Kansas City Star*, March 12, 1899, 4.

53. House, *Savannah Harbor, Georgia*, 59th Cong., 1st sess., 1905, Doc. No. 181, 11.

subtle and gradual manipulations of river mouths and sandbars. There were few grandiose schemes, and most are invisible to the human eye. Coastal designers didn't govern nature with an iron fist. They were more like symphony conductors who gently guided their orchestras. There was an art to moving mud around.

Shipworms regularly turned the best efforts of coastal designers into a cacophony. The precipitous settling of jetties or the crashing down of wharves toyed with their visions of an idealized coast. Marine builders loathed teredo throughout the south and struggled to combat its ravages during the final third of the nineteenth century. Most innovations led to dead ends: no tree proved to be immune; no pile armor guaranteed protection; and virtually every chemical preservative failed miserably. Shipworms inspired a lot of innovation in coastal design, but few proven results.

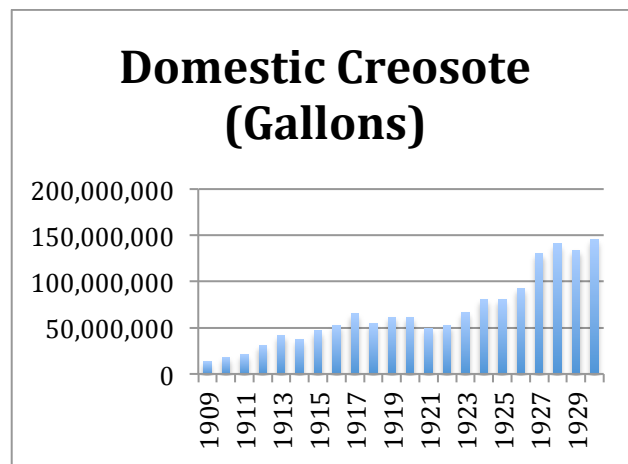
The dawn of the twentieth century brought new hope. In a very short period of time, creosoting became more cost effective. Creosoting alone protected timber from shipworms, something that the American Society of Civil Engineers had determined by 1885, and which later researchers would confirm over and over again. As late as 1900, however, Octave Chanute still complained that the high cost of creosote and low cost of timber held back the budding preservation industry. He noted that the United States had just eight creosoting plants—up from six in 1885. Until circumstances changed, teredo had free rein.<sup>54</sup>

The turning point came shortly thereafter. For the year 1904, the United States Forest Service estimated that American preservers had treated approximately 500,000,000 board feet of timber. Three years later, as the price of timber soared,

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54. Octave Chanute, "Preservative Treatment of Timber," *Journal of the Western Society of Engineers* 5 (1900): 100-103.

preservation rose swiftly until sixty factories cranked out 1,250,000,000 board feet by 1907. Creosoting expanded steadily over the next two decades. Domestically produced creosote grew by a factor of ten between 1909 and 1930 (Figure 3). Imported creosote doubled during that same time, but accounted for a decreasingly smaller share, as domestic producers tried to corner this market. In 1909, foreign creosote made for 73 percent of all dead oil used in American creosoting works. By 1930, this figure had dropped to just 32 percent. The coast was flush with toxins and their effectiveness started to take shipworms out of the news. Teredo seemed more beatable and far less imposing than it had once been.<sup>55</sup>



**Figure 10: Domestic Creosote Production. The slight dip after the war resulted from European resumption of exports to the United States. Senate, *Dead Or Creosote Oil: Letter from the Chairman of the United States Tariff Commission*, 72d Cong., 1st sess., 1932, Doc. No. 73, 29.**

For much of the nineteenth century, the southern American coastline had seemed anomalous. Compared with the northeast (see Chapter Six) the shipworm-infested harbors of Texas, Florida, and North Carolina proved a peculiar and onerous impediment

55. W. F. Sherfese and H. F. Weiss, “Wood Preservation,” in *Report of the National Conservation Commission* (Washington DC: GPO, 1909), 658-667. The Forest Service maintains that creosote was the “most common preservative used” by these facilities, but it is unclear how many of the sixty plants treated wood with zinc chloride, which was more in central and western railroads

to commerce. But by the end of the century the south started to look more like the norm, rather than the outlier. Along the coasts of California, Washington, and Alaska, woodborers had begun to ravage wharves and piers as rapaciously as borers along the Gulf Coast and southeastern seaboard. In time, the fight with borers would even extend to the northeast. The ravages of teredo would become a national epidemic. In the long run, the south would influence how this epidemic would play out. Southern marine builders had a head start on the rest of the country, and their early trials and errors would shape how people around the country would think about borers and respond to them for decades to come.

CHAPTER THREE  
THE BOOK WORM:  
KNOWING NATURE THROUGH LANGUAGE

**Introduction**

In March of 1895, John L. Davie, a Populist, ran for mayor of Oakland, California on an anti-teredo platform. He made the city's teredo-infested waterfront central to his campaign strategy. Davie railed against the so-called "Octopus"—better known as the Southern Pacific Railroad—for allowing its train trestle linking Alameda Island with Oakland to become worm-infested. Between seven and ten thousand commuters crossed the bridge twice daily on their way to and from ferry terminals servicing San Francisco. Davie once owned a wharf in Oakland, so he knew the condition of the waterfront well. He had warned people not to ride across the trestle, but to no avail. Without the ability to broadcast his message, Davie's mayoral bid appeared doubtful on the eve of the election. He needed a political miracle—or better yet, a megaphone and a speechwriter.<sup>1</sup>

Davie's saving grace came exactly one day before the polls opened. On that date, the *San Francisco Chronicle* published the first of a series of exposés on the rickety train trestle. The headlines screamed disaster: "Teredo-Eaten Piles Are Not Safe"; "Passenger Trains on Wormy Crutches"; and, "A Menace To Life." The *Chronicle* amplified Davie's message and whipped Oakland into frenzy, leading to a fifty percent drop in ridership across the trestle. On election day, "[p]olitics and teredo worms gave the people of

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1. "The Teredo-Eaten Piles Are Not Safe," *San Francisco Chronicle* [hereafter shortened as "SFC"], March 10, 1895, 19; "Passenger Trains On Wormy Crutches," *SFC*, March 11, 1895, 10; "Octopus Gets A Harpoon In Its Hard Back," *SFC*, March 13, 1895, 8.

Oakland something to talk about,” explained the paper, and voters rewarded Davie for his prescience. The editors made no buts about it: Davie was elected to office by this “wily worm,” and their reporting “made his election possible over all other candidates in the field.” Davie agreed. “The work of the CHRONICLE in exposing the unsafety of the Southern Pacific’s bridges,” he explained, “made my election possible.” Davie would go on to be Oakland’s longest serving mayor.<sup>2</sup>

The Oakland mayoral race highlights an important aspect of the broader American teredo epidemic. Nature was mediated by language at nearly every step. Unlike floods, fires, droughts, and plagues—disasters which people felt in their lungs, stomachs, and skin—few had the fortune (or misfortune) of seeing and experiencing the nature of shipworms firsthand. The commuters who lifted Davie into office fit this mold. They never witnessed collapsed wharves or injuries to fellow commuters. They were moved to act, not from Davie’s rational explanations of the dangers of the trestles, but from the *Chronicle*’s lurid descriptions of teredo “death traps”. Newsmen described the “deadly work” of the “mischief-maker,” and how “one of the greatest accidents in the history of the State would occur,” if nothing were done. When Oaklanders laid down their newspapers, they decided against “testing the powers of the teredo by riding over the bridge.” The people of Oakland knew the nature of teredo intimately, but primarily through the intensity of the language used to describe it.<sup>3</sup>

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2. “The Teredo-Eaten Piles Are Not Safe,” *SFC*, March 10, 1895, 19; “Passenger Trains On Wormy Crutches,” *SFC*, March 11, 1895, 10; “A Menace To Life,” *SFC*, March 12, 1895, 6; “Victory After A Forty Years’ Fight,” *SFC*, March 15, 1895, 8; “Cut Away The Stilts,” *SFC*, March 12, 1895, 14; “Octopus Gets A Harpoon In Its Hard Back,” *SFC*, March 13, 1895, 8.

3. “A Menace To Life,” *SFC*, March 12, 1895, 6; “The Teredo-Eaten Piles Are Not Safe,” *SFC*, March 10, 1895, 19; “Passenger Trains On Wormy Crutches,” *SFC*, March 11, 1895, 10; “Victory After A Forty Years’ Fight,” *SFC*, March 15, 1895, 8.



Dissecting language has proven illuminating for environmental historians in recent years. Ever since Roderick Nash's pioneering 1967 work, *Wilderness and the American Mind*, scholars have contemplated how language mediates the relationship between people and nature. Not until the cultural turn in the 1980s and 1990s, however, did the weight of mainstream historiographical trends come to bear on scholars more preoccupied with soil samples and ecological principles than with French linguists and post-structural literary criticism. More than anyone, William Cronon pivoted the field away from its emphasis on historical ecology and towards a greater appreciation of the cultural dimensions of the natural world. For his part, Cronon demonstrated that "wilderness" did not exist in a timeless vacuum separate from human influence; it was a repository for cultural values—some of which were contradictory and changing. How people interacted with "wilderness" (i.e. "taming" or "preserving") was inseparable from the values they instilled in the word. The cultural construction of nature can be just as historically causal as any drought, microbe, or introduced species.<sup>4</sup>

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4. The title of this chapter is a play on two essays by Richard White, "'Are You an Environmentalist or Do You Work for a Living?': Work and Nature," in *Uncommon Ground: Rethinking the Human Place in Nature* (New York: W. W. Norton & Co., 1996), 171-185; and White, "Knowing Nature Through Labor," in *The Organic Machine: The Remaking of the Columbia River* (New York: Hill & Wang, 1995); Roderick Nash, *Wilderness and the American Mind* (New Haven: Yale University Press, 1967); William Cronon, "The Trouble With Wilderness; Or, Getting Back to the Wrong Nature," *Environmental History* 1 (Jan., 1996): 7-28; Once historians opened themselves up to the slippery nature of "nature" (and other related words) they found that the meanings imbued in animals and landscapes could have significant and unintended consequences. For instance, Cronon argues that by defining "wilderness" as places without people, Native Americans are recast as intruders in lands that had once been their hunting grounds. Similarly, Susan Flader, *Thinking Like a Mountain: Aldo Leopold and the Evolution of an Ecological Attitude Toward Deer, Wolves, and Forests* (Columbia: University of Missouri Press, 1974), has shown that demonizing wolves as "vermin" has made them vulnerable to exterminating policies. Such practices have backfired, leading to deer overpopulation; W. Jeffrey Bolster, *The Mortal Sea: Fishing the Atlantic in the Age of Sail* (Cambridge: Belknap, 2012). Likewise, the sea has not been immune to cultural constructions. Casting it as "timeless" and "immutable" has inhibited conservation. Laura Alice Watt, *The Paradox of Preservation: Wilderness and Working Landscapes at Point Reyes National Seashore* (Berkeley: University of California Press, 2017). Ironically, efforts to protect coastal waters by treating

Language opens a revealing window onto the teredo epidemic. Shipworms triggered deeply emotional responses that are not often captured by rote engineering reports and passionless news blurbs. Seemingly everyone knew about the ravages of teredo, and not just those who lived close to shore. People knew the nature of teredo, not through leisure or work, but most often through language. Stories about shipworms traveled to the center of the nation, connecting people to the environments and disasters that they could only imagine. Over the course of the shipworm epidemic, the word “teredo” absorbed so much negative meaning that it evolved into a complex and broadly applicable metaphor. “Teredo” came to embody all that was surreptitious, devious, and destructive about human nature. Disreputable people acted like shipworms when they undermined important institutions through corrupt, fraudulent, or inept behaviors. In these ways, the anthropomorphizing of teredo captured the raw sentiments of an environmental crisis, transmogrified them, and exposed them to people far from the coastline through words and stories. The nature of the teredo epidemic flourished in texts just as much as in piles.

“Teredo’s” transmutation had as much to do with broader social changes as it did with the increasing frequency of borer attacks. Nineteenth century Americans watched in amazement as the world around them became increasingly impersonal and volatile. Many looked to nature for explanations. Some lauded and justified social change by drawing on evolutionary biology as their rationale: society was by its nature a competition of the survival of the fittest individuals, so some argued. Cynics, too, tried to explain upheavals in business, politics, and demographics in terms of nature. Every unforeseen calamity had

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them as wilderness have not worked well. For instance, all human interactions with Point Reyes are cast as deleterious, when in fact oyster culture has a beneficial impact on the ecosystem.

some cause lurking in the shadows to blame, some ill-defined “teredo” working away secretly to undermine financial markets and government agencies, etc. In short, “teredo” became a prism or framework through which to fathom increasingly complex or mysterious social phenomena.

The following pages are organized more or less thematically. They explore how Americans channeled their apprehension with coastal environments into words used to express a range of different topics—everything from economics and politics to race and gender—across a period from roughly the 1860s to the 1910s, with the bulk of sources dealing with the 1880s and 1890s. While the word “teredo” evolved rapidly, maturing in all its meanings in a short period of time, and obviating the need for a strictly chronological analysis, it’s important to note that “teredo” followed a historical arc—a rise and fall over time. It’s no coincidence that the word “teredo” came into vogue around the same time that coastal builders in the south were struggling to keep shipworms out of their wharves and jetties during the 1870s. “Teredo” was at its most potent during the 1880s and 1890s when much of the west coast struggled with borers. Its decline, unsurprisingly, corresponds with the explosion in the use of creosote at the start of the twentieth century. Over time, as shipworms no longer seemed so dangerous, “teredo” lost much of its force as a metaphor and went into disuse. But at its peak, “teredo” captured and conveyed the raw feelings of both environmental and social crises.

### **Anthropomorphic Worms and Animalistic Humans**

The initial cultural construction of the word “teredo” is an example of what ethnologists refer to as “folk biology.” This line of inquiry describes how individuals and societies experience, interpret, and order the natural world. The objectivity that scientists

put between themselves and their subjects (or strive to) often goes missing in folk biology, where cultural values are projected onto nature, sometimes consciously. This is especially the case for wild animals that exhibit types of behaviors that could be construed as anthropomorphic.<sup>5</sup>

Wherever they crossed shipworms, coastal dwellers exhibited folk biologist tendencies. Rarely could they detach themselves emotionally from the infrastructure that borers consumed. Teredo was doing them wrong, making their lives harder, if not dangerous. Their feelings were reflected in the adjectives they attached to teredo. To them, shipworms were “ominous,” “deadly,” and “fierce.” They described borers as “pestilential” and “pernicious.” Above all, they characterized borers as vermin, or “pile-pests.” Shipworms had no place in their idealized coastline.<sup>6</sup>

The hidden nature of teredo only intensified people’s loathing, which was reflected in the language they used to describe it. Teredo worked beyond view, entering piles as far down as the mud line. Even in these darkest of depths a teredo larva left little evidence of its point of entry, where it bored entrances the size of pinpricks and usually

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5. Douglas L. Medin and Scott Atran, *Introduction to Folkbiology* (Cambridge: MIT Press, 1999); Tina Loo, *States of Nature: Conserving Canada’s Wildlife in the Twentieth Century* (Vancouver: University of British Columbia Press, 2006), 74-82. My analysis builds on the work of Historian Tina Loo who has captured the porous boundaries between nature and culture in her analysis of “Uncle” Jack Miner, Canada’s first celebrity hunter-turned-conservationist. When Miner embraced conservationism in the early twentieth century, he drew distinctions between good and bad animals based on his religious and familial ideals. In ducks, for example, Miner saw nurturing mothers, doting fathers, and non-incestuous siblings. Since ducks practiced his sense of moral probity they were worthy of conserving. On the other hand, crows were “nest robbers” that “murdered babies.” Miner saw no place for these types of immoral animals in the wild and would have just as soon seen them eradicated. Suffice it to say that Miner’s views about nature blinded him to the benefits of predators in the wild, even those that he did not like. Miner’s folk biology, in short, influenced how he acted towards Canadian wildlife.

6. “All Along the Line,” *Los Angeles Times*, March 18, 1895, 7; “Sea Unbends, Pier Bents,” *Los Angeles Times*, June 14, 1908, I10; “The Teredo Navalis,” *Times-Picayune*, May 29, 1893, 6; “The Collapse of a Barn,” *Evening Times* (DC), August 23, 1899, 4; “Editorial Notes,” *Daily Alta California*, February 24, 1868, 2; “Seawall Extension,” *SFC*, March 30, 1888, 8.

no more than 1-2 millimeters. Because of this, people had no idea that a structure was liable to fail until it did—even those who were most familiar with the ravages of teredo, such as harbor commissioners and wharf owners, were regularly taken aback by collapses. It is no wonder that coastal people used words like “stealthy” and “burglarious” to describe shipworms.<sup>7</sup>



**Figure 10: Hollowed Wood.** From the outside, infested piles and planks appeared unharmed. But when opened, they could be completely perforated. Credit: The San Francisco Marine Piling Committee of the American Wood-Preservers' Association, Inc. [*First*] *Report on the San Francisco Bay Marine Piling Survey*, plate 13. Used with permission of the American Wood-Preservers Association.

“Burglarious” is a word worth analyzing in greater detail because it is a prime example of the literary metamorphosis of teredo. By casting shipworms as surreptitious thieves, not only does “burglarious” paint borers in a negative light, it gives them willful intention. Teredo was both “ruthless” and “remorseless.” “He, or she,” was “insidious” and “evil.” Of course, nobody truly entertained the notion that shipworms were actually

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7. “Burglarious Insects,” *Boston Evening Transcript*, May 3, 1905.

volitive agents. But anthropomorphic words like “burglarious” captured how strongly many felt. People took teredo attacks as personally as if they had been “assailed” by another human being<sup>8</sup>

Not every verb or adjective that humanized teredo came across so vehemently. “Industrious” was one of the more common anthropomorphisms. In this context, teredo behaved with remarkable diligence and assiduousness—ostensible marks of praise. Shipworms were the “perfect paragon of industry and patience,” writes the *Los Angeles Herald*. Such high measures of respect shouldn’t be confused with genuine admiration. “Industrious” allowed people to complain about teredo without completely losing their cool and writing about borers as if they were using all caps all of the time. In the process, purposeful understatement transformed the word “teredo” into a flexible figure of speech that could be used (in addition to its more forceful meanings) as an ironic form of tongue in cheek.<sup>9</sup>

Folk biology is not science. Its practitioners lean whichever way the winds of culture happen to blow. This is evident with the word “teredo,” which could take on wholly different meanings when the context changed. While most people viewed teredo as a villainous roadblock to coastal development, others struck a softer tone, stressing its more beneficial nature. Seamen praised shipworms for filtering the ocean of dangerous flotsam. “If nature made no provision for the removal of floating wreck from the surface of the ocean,” explained one paper, “dangers of navigation would increase in a fearful

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8. “Burglarious Insects,” *Boston Evening Transcript*, May 3, 1905; “General Notes,” *New York Tribune*, February 25, 1884, 4; “Drying Slabs,” *Daily Post-Intelligencer* (WA), December 3, 1877, 3; “Dropped Out Of Office,” *Seattle Post-Intelligencer*, July 22, 1891, 4; “Shipworms’ Evil Ways Shown in Engineer’s War to End Them,” *Evening Star* (DC), September 4, 1922, 9; *Los Angeles Times*, November 22, 1887, 4.

9. *Los Angeles Times*, November 22, 1887, 4.

ratio.” When exposed to oxygen, drift rots. Logs that bob just below the surface can remain in a perfect state of preservation. Fortunately, nature had an answer for wood that refused to surface and rot: teredo. A retired sea captain claimed that drift would make “navigation of the high seas...tenfold more dangerous were it not for the teredo.” Moreover, shipworms “will take the contract without pay of clearing up all this wreckage.” Specifically, the aged skipper was trying to allay fears about a large log raft loose in the Atlantic. His portrayal was shared by others who agreed that teredo was more than just “mischievous.” Shipworms were going to make “mincemeat of the great derelict floating raft,” writes another editor, and “[e]very log will be attacked by millions of these destructive workers.”<sup>10</sup>

Closer to shore, teredo was welcomed as a “serviceable creature” that cleared harbors of debris. This was how a Smithsonian naturalist described shipworms that ate “wrecks and other submerged wood, which might otherwise block up harbors and impede navigation.” Similarly, when a Seattle newspaper described the salvage of a sunken bark, it commended shipworms for having “done their work faithfully well” for breaking apart the hulk. Likewise, Army Corps engineers viewed teredo as a tool in their toolbox. In Virginia, engineers dynamited or weighted down wrecks and floating debris, leaving the rest of the work to teredo, which made short work of the mess. More often than not, shipworms were described with scorn. But every so often they were spoken of as an ally, just like the enemy of my enemy is my friend.<sup>11</sup>

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10. “The Fate of Floating Wrecks,” *Centre Reporter (PA)*, April 11, 1878, 1; “A Good Word for the Teredo,” *San Francisco Bulletin*, January 6, 1888, 2; “In General,” *Vermont Phœnix*, January 27, 1888, 1.

11. Senate, *Annual Report of the Board of Regents of the Smithsonian Institution, Showing the Operations, Expenditures, and Condition of the Institution for the Year 1860*, 36th Cong., 2d sess., 1861, S. Misc. Doc. 21, 248-250; “Fading From View,” *Daily Post-Intelligencer (WA)*, December 18, 1887, 7; House, *Annual Reports of the War Department for the Fiscal Year Ended June 30, 1905*, 59th Cong., 1st sess., 1905, H. 111

## **Institutional Pillars and Planks**

Tides ebb, and then they flow. So it goes with “teredo”. The links between nature and culture flowed both ways. Just as shipworms were imbued with human intentions and emotions, so too were people likened to shipworms, thus completing “teredo’s” metamorphosis into a human caricature.

“Teredo’s” transition to a human metaphor owes at least some to mere coincidence. Shipworms *bore*. So can people. The humorous double entendre proved irresistible. In the 1870s, for instance, clever writers drew on the double meaning to describe dull speeches. In Detroit, a reporter at a research conference complained when a presenter committed a cardinal sin and spoke past his allotted time. The speaker, a “Teredo-Michigander,” exhausted his audience with statistic after statistic and “bored away persistently.” Similarly, a magazine critic tore apart an article written by former statesmen Gideon Welles, explaining that “old ‘Teredo’ Gid. Welles, has bored...the public with an abusive personal article.” Puns of this sort only worked if people knew what teredo meant. Personifications of teredo in playful and caustic ways would become more frequent.<sup>12</sup>

Shipworms made for countless punch lines, but they were no laughing matter when used to portray society. If shipworms represented people, pillars and planks signified the building blocks of social relations and abstract institutions. Late nineteenth century analysts liked to describe the economy as if it were resting on a strong

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Doc. 2, 1181; House, *Annual Reports, War Department. Fiscal Year Ended June 30, 1913. Report of the Chief of Engineers, U.S. Army, 1913. In Three Parts. Part 2*, 63d Cong., 2d sess., 1913, H. Doc. 402, 1877.

12. “Social Science,” *New York Times*, May 15, 1875, 3; “Magazines For May,” *Times-Picayune*, May 4, 1873, 8.



“foundation” and the nation as if it were the “ship of state.” Such clichés, however, oftentimes rang hollow. In an era of cornered markets and backroom political dealings, Americans had a hard time trusting their eyes, ever wary of the “teredo” that they couldn’t see operating just under the surface.

Nowhere is this clearer than in analyses of the economy. In 1876, for instance, the *Pacific Rural Press* grew frustrated by “[h]ow often great banks and commercial houses come down with a mighty crash in calm weather.” Institutions that seemed so sturdy must have some common defect. The editors weren’t certain where the cracks in the foundation lay. But they surmised that “honest-looking” bankers were to blame. The editors suspected that bankers were “perforated and honeycombed” by “hush-money” and bribes. “Could we have looked into the private papers, correspondences and secret habits of the managers,” griped the editors, “we would have seen that the teredo had long been at work, silently, almost unconsciously, eating away the fiber of conscience and honor.”<sup>13</sup>

While some blamed the avaricious amongst them for imperiling the foundations of the economy, others thought to the contrary. In 1887, the *Arizona Citizen* urged its readers to “meet avarice on its own ground” in order to prevent the enervating influences of economic shipworms. Specifically, the paper urged its readers to get behind a proposed new smelter that had the potential to bring wealth to the City of Tucson. “Let’s be wicked just a little,” prodded the *Citizen* as it allayed concerns of unfettered growth, and “become grossly speculative and engage in this worldly enterprise ere the terrible teredo of poverty honeycombs the pillars that elevate our moral structure.”<sup>14</sup>

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13. “Defaulters of the Day,” *Pacific Rural Press* (CA), January 10, 1885, 28.

14. “Smelting the Tucson Populace,” *Los Angeles Times*, March 21, 1887, 4. *Arizona Citizen* is quoted in the *Times*.

Oscar Lewis, a San Francisco businessman, tried to frame the economy in a slightly different light. He too saw “teredo” undermining the economy. But it wasn’t necessarily the result of individual acquisitiveness or the lack thereof. The “human teredo” was a macroeconomic phenomenon (not his words) that manifested itself in an unequal balance of trade. In 1895, Lewis tried to articulate his views at the Manufacturers’ Convention by leaning on the metaphor of teredo. When Lewis took the podium, he warned of the “Eastern drummer, or human teredo...boring around” California. The “human teredo” marketed eastern made goods at prices that California producers could not match. Rather than bash the “human teredo,” Lewis wanted to understand it. The “human teredo” was not so much a person as it was a blending of cheap eastern labor and abundant capital that took the form of cheap goods. Like so many of his contemporaries, Lewis struggled to reconcile laissez-faire theory and practice. It is telling that “teredo” helped him work through these larger questions and convey his findings to others.<sup>15</sup>

Disciples of laissez-faire looked outside their ranks for a different sort of teredo undermining the economy: politicians. When the government minded its own business; and when people pursued their own self-interests; the economy was as solid as an oak tree. Ignoring these truisms could worsen the economy, so the argument went. In the wake of the Panic of 1873, for instance, politicians in New York came under fire for levying high taxes during a bear market. Such “mal-administration” led the *San*

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15. “For The Benefit Of Our State,” *San Francisco Call*, March 21, 1895, 5.

*Francisco Bulletin* to conclude that these “political *teredo* in time will undermine and bring down the most substantial structure.”<sup>16</sup>

This use of “teredo” is not at all unique. Of all the personifications of teredo, the “political teredo” was the most common and gravest. More so than the economy, the “political teredo” posed its biggest threat to the federal government, or “ship of state,” as it often went by. After the Civil War, as the administrative state grew in size, so too did opportunities to take advantage of its large, unregulated hull. Americans feared that logrolling, corruption, and downright ineptitude might destroy their mighty nation just as easily as an invasion by a foreign power. But just exactly who posed the threat and what harm they might do was often hard to pinpoint. Thus, the metaphor of the “political teredo” attacking the “ship of state” became an analytical crutch that some used to describe the shadowy and ill-defined threats to the nation.

“Political teredo” popped up for the first time around the Civil War, and it might have been introduced to American readers by the Irishman William Howard Russell. Russell has been dubbed one of the first modern war correspondents. He first got his boots dirty in Crimea before covering the American Civil War. Russell witnessed teredo at work in both conflicts—real borers in the first, and figurative borers in the second. While in America, Russell watched while the members of President Lincoln’s cabinet constantly involved “themselves with the affairs of departments which do not belong to them.” Such conduct, which Russell described as the “teredos of every plank in the ship

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16. “A Municipal Warning,” *San Francisco Bulletin*, September 21, 1874, 2. Emphasis in original.

of state,” did not bode well for winning the war. Russell’s words were infectious as his *London Times* piece resurfaced in several northern newspapers.<sup>17</sup>

The “political teredo” proved a flexible figure of speech later in the war. In 1863, the *Weekly National Intelligencer* saw the ravages of teredo in the cantankerous partisan press. Republican editors characterized all Northern Democrats as “traitors at heart,” while their counterparts in the Democratic press saw everything that Lincoln did as a blundering misstep. Such political hacking was having a terrible effect on morale. The *Intelligencer* warned that “the noxious *teredo* of party” was spreading like “distemper” and its “unrelenting fang, gnaws into the very heart of her strong timbers.” If the press wouldn’t tamp down its extremist rhetoric, then it was up to every man, woman, and child to guard against “intemperate discussion, which is discouraging our armies, weakening the hands of the Government, and thereby strengthening the enemy.”<sup>18</sup>

After the war, Republicans watched in awe as the southern political teredo bucked federal authority. Southern obstructionism took the form of innumerable small acts, which when viewed together represented so many shipworms quietly and secretly threatening the republic. This is how a San Francisco paper interpreted the actions of southern lawmen when in 1880 they prosecuted federal tax collectors on trumped up charges. “It is an operation similar to that of the teredo,” writes the *San Francisco Bulletin*, “[t]he honeycombing is covered over at a point difficult to reach and beyond

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17. The Crimean port at Sebastopol had a bad reputation for borers, which Russell undoubtedly knew. During the Crimean War, the Russian navy, outgunned, chose tactically to sink its entire fleet in the harbor of Sebastopol to prevent enemy ships from entering. After the war, salvagers discovered that the ships were too riddled by teredo to be recovered. For information on William Howard Russell see, James M. Perry, *A Bohemian Brigade: The Civil War Correspondents, Mostly Rough, Sometimes Ready* (New York: Wiley, 2000); Russell’s metaphor was probably a riff on a line from Henry Wadsworth Longfellow’s poem “Building of the Ship,” which reads “...Sail on, O Ship of State!”

18. “Party Spirit,” *Weekly National Intelligencer* (DC), May 21, 1863, 1.

general observation.” Furthermore, “[t]he institutions which war could not shake or overthrow may be permanently undermined by these obscure borings.” Massachusetts Senator George Frisbie Hoar made a similar argument in an 1880 speech at Faneuil Hall. “My friends,” he remarked, “the republic would be in no danger if all the powers of earth should combine to make an assault upon her doors.” On the other hand, election fraud, voter intimidation, and disenfranchisement rampant throughout the South “constitutes a crisis.” “It is not the gale or the rock,” exhorted Frisbie, “it is the teredo and the dry-rot which our ship of state alone has to fear,” to which his audience applauded.<sup>19</sup>

Over time, teredo shed its narrower associations with southern redeemers and came to embody corruption at all levels of government. This is how Reverend John Hemphill of San Francisco adapted the phrase. In an 1879 sermon, Hemphill warned his congregation that the nation was “being swept onward toward an ocean of corruption, where a single plank of our ship, being pierced by the teredo of fraud, she will go down to destruction.” Corruption also troubled editors in Indiana, which, in 1889, claimed that the “vote-seller is the teredo that is gnawing at the heart of the government timber.” In 1890, an Oregonian paper went so far as to say “we have got pretty nearly to a government by purchase” thanks to the “political teredo.” And in 1892, a southern California editorialist questioned whether voters even cared if their elected officials were of “pure and lofty character,” which was too bad since “[v]ice of any kind eats out the life of a people or a man, even as the teredo eats the timbers of a ship.” Rarely was the

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19. “Where the Real Breakers Are,” *San Francisco Bulletin*, September 27, 1880, 2; “The Case In a Nutshell,” *New York Times*, July 2, 1880, 2.

“political teredo” specifically pointed out; it was akin to a political boogeyman that spared no level of the government.<sup>20</sup>

### **Race, Gender, Class**

More often than not, “teredo” had no identifying features. They were faceless and nameless threats to institutions. But even shipworms couldn’t escape identity politics. Otherness abounded in America, and white middle-class males applied the metaphoric teredo to people that threatened their sense of racial, gender, and class norms.

White Americans often drew on the imagery of teredo to express their resentment with non-whites. Nowhere was this more obvious than with Chinese exclusion. Not long after the completion of the first transcontinental railroad in 1869, whites all along the west coast lobbied vociferously to block any more Chinese people from emigrating. Teredo proved a useful image to capture and simplify their rationale. In the Pacific Northwest, for example, a Seattle newspaper drew an analogy between Chinese-Americans and teredo in 1877. “It has been shown already too plainly,” wrote the *Daily Intelligencer*, “that the Chinamen is to the land what the teredo is to the water.” Racially dehumanizing Chinese-Americans was only one part of the analogy. The editors argued that Chinese-Americans were, like teredo, “a destroyer of what others create, consuming the vitality of every structure with which he comes in contact.” Evidence to back up this threatening analogy, however, was limited only to complaints that immigrants would send “abroad his earnings” rather than investing in their new communities.<sup>21</sup>

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20. “A Discourse on Johahs,” *Daily Alta California*, March 31, 1879, 1; “The State Press,” *Indianapolis Journal*, May 9, 1889, 4; “New Struggle For Liberty,” *The Dalles Times-Mountaineer* (OR), May 17, 1890, 2; “The Important Question,” *Santa Cruz Sentinel*, February 21, 1892, 2.

21. “The Chinese Problem,” *Daily Intelligencer* (WA), December 1, 1877, 2.

Down the coast, San Franciscans echoed this sentiment during a rally in support of the Chinese Exclusion Act of 1882. Two months before Congress passed the fateful legislation, hundreds of disgruntled whites filled Platt Hall to express their support for the bill, while many more showed their support outside in the streets. On the stage, dozens gave speeches to a floor “full of intelligent men” and to the galleries above where “many ladies” listened. A man named D. J. Toohey took the podium midway through and delivered a brief statement. “In no manner have [Chinese immigrants] contributed to the support or advancement of our institutions,” he remarked; “but, like the teredo, [they] are sapping the very foundation of our social structure.” Since no specifics were given, the figure of speech must have been evidence enough.<sup>22</sup>

Following the passage of the exclusion act, white Californians continued to liken Chinese-Americans to teredo in an effort to reinforce an order of white supremacy. To maintain this order, whites placed responsibility for “labor strikes, mobs, murders and arsons” on Chinese-Americans, condemning their acts as the “teredo boring into the morals of the State and destroying them.” Order, however, proved difficult to maintain when white employers broke ranks and hired Chinese laborers, as a white Fresno raisin producer did in 1889. Dismayed, the editors of the *San Francisco Bulletin* feared that Chinese-Americans would soon learn the business of raisin making and come to dominate it, as they allegedly had done with the fruit-packing industry. “When these and other facts are considered, the wonder grows how...a weak treble should be heard favoring in any manner the continuance of the Coolie *teredo* which is honeycombing so many of our industries.” Maintaining racial solidarity required that all California whites

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22. “Of One Mind,” *SFC*, March 5, 1882, 8-9.

resist even the smallest accommodations, lest they fall down a slippery slope. Portentous metaphors, such as teredo, were meant to remind whites that the smallest things could have larger ramifications, so they best keep in line.<sup>23</sup>

As with Chinese Americans, whites dehumanized Native Americans by invoking teredo. In 1890, the *Seattle Post-Intelligencer* mocked the “useless siwash” (a derogatory term for Pacific Northwest Indians) for trying to organize and earn higher wages. A reporter in attendance described, “[t]he siwash crowd [staring] in stolid stupidity at the orator.” Every once in a while they cheered, but the reporter characterized their yells, not as signs of comprehension, but as evidence of their intrinsic wildness and primitiveness. So savage were the siwash in these moments that their ferocious shouts were powerful enough to “scare the teredo out of his lair.” While teredo had nothing to fear from humans, it did have something to fear from Indians, who were considered wild animals by the reporter. (The “intelligent” Native labor organizer, it must be noted, was a “half-breed,” unlike his full-blooded, and “stolid” compatriots).<sup>24</sup>

While American xenophobia peaked and plateaued over the years, one of its more fervent spikes came after World War I—during the nationwide debates over immigration reform. Unsurprisingly, proponents of exclusion dusted off the word “teredo” and put it to work. In 1920, the *San Francisco Bulletin* took aim at the *New York World* for suggesting that Japanese immigrants were beneficial to California. The *World* characterized Japanese-Americans as “law-abiding” and “industrious,” to which the *Bulletin* scoffed and scolded. “Industrious,” in the latter’s view, was not synonymous

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23. “Is It Settled?” *Daily Alta California*, October 24, 1887, 4; “Once More to the Breach,” *San Francisco Bulletin*, June 27, 1889. Emphasis in original.

24. “The Useless Siwash,” *Seattle Post-Intelligencer*, September 5, 1890, 8.



with “beneficial.” “The teredoes that chew up the piers and piling are even more industrious,” writes the *Bulletin*, “but that doesn’t make them any more desirable.” Through the use of wordplay, white Californians could dodge a meaningful debate and denigrate Japanese-Americans simultaneously.<sup>25</sup>

Of all the categories that historians explore, gender might be the most lopsided to analyze in terms of teredo. In some ways, it’s fairly straightforward. The adjectives most often used to anthropomorphize teredo, for instance, are masculine, and the metaphors are typically applied to men or male-dominated professions. Likewise, when the word was used to depict illicit activity, such as corruption, theft, and fraud, men were usually the targets. To give an example, when the author of a short story needed a name for his villainous ruffian, “Teredo Mike” seemed perfect. All this is a touch ironic since teredinids are protandrous—they begin their lives as males and change to females. Thus, most of the smaller borers are males, while the largest and most destructive shipworms are typically females.<sup>26</sup>

While feminine inflections of teredo were far less common, they were not entirely absent. For instance, in recounting the fate of an infested sailboat, a Texas newspaper described the activity of teredo on the ship’s hull with gender norms. Copper sheathing protected the bottom, but, as so often happened, a damaged nail offered a point of entry for borers. Thereafter, “Mrs. Teredo lit upon the broken nail, found the little hole, and

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25. “The ‘Industrious’ Japanese,” *Seattle Star*, August 9, 1920, 6. The newspaper debate is tracked by the *Seattle Star*; For more on immigration and xenophobia see Mae M. Ngai, *Impossible Subjects: Illegal Aliens and the Making of Modern America* (Princeton: Princeton University Press, 2004).

26. James Stevens, “Ferry Trip,” *Washington Post*, July 14, 1935, SM8; For more detailed explanations of teredinid sexual phases see Wesley R. Coe, “Sexual Phases in Wood-Boring Mollusks,” *Biological Bulletin* 81 (October 1941): 168-176; Benjamin H. Grave, “The Sexual Cycle of the Shipworm, *Teredo Navalis*,” *Biological Bulletin* 82 (June 1942): 438-445; N. Balakrishnan Nair, “The Biology of Wood-Boring Teredinid Molluscs,” *Advances in Marine Biology* 9 (1971): 390-396.

squeezed herself in.” Once inside, “she began to eat the timber and lay her eggs in it.” The imagery of a nesting mother contrasts with most descriptions of ship infestations, which typically leaned on violent or surreptitious language.<sup>27</sup>

When it comes to feminine-shaded metaphors, few crop up. However, there is one fascinating example involving a group of Mormon neophytes that stands out. In 1883, a proselytizer recruited seventy-six female converts, ranging from fifteen to twenty-five years in age. A Seattle newspaper bemoaned the loss of the girls to “concubinage.” By joining the faith, they became part of a “pool of pollution” filled with “teredo boring its way into the social and moral foundations which support a professedly enlightened government.” By transforming into metaphorical teredo, these girls abandoned their socially constructed roles as “wives of honorable men” and “mothers of legitimate offspring.”<sup>28</sup>

Teredo also proved a useful ideological descriptor for class. For instance, in 1880, when Senator James Bayard Jr. argued that capital and labor were “natural allies and not enemies,” a Missourian struck back in a letter to the *Iron County Register*, writing that this “conclusion is just as erroneous to-day as when, in the days of African slavery, capital made a master on one side and servant on the other.” Jeffersonian agrarianism, he argued, was the best solution to inequality. A tax on land (and no other form of taxation) would force the class of large landholders to improve their properties or give them up. Such a tax “strikes directly at the very root of every form of aristocracy,” explained the Missourian, “and frees the Ship of State from ten thousand barnacles and teredoes.” A

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27. “Faithful in Little Things,” *San Saba News* (TX), November 15, 1889, 1.

28. “Missionary Work,” *Daily Post-Intelligencer* (WA), October 14, 1883, 2.

teredo-less society, in short, discouraged the class of land barons instead of aiding them further.<sup>29</sup>

In San Francisco, teredo meant something entirely different. During the summer of 1893, a theatre critic invoked teredo to explain why “the fashionable class” had stopped attending shows. While others thought this was due to the hot weather, the critic for the *Call* knew otherwise, arguing that the “real reason is the increase of that theatrical teredo, low prices.” Reduced ticket prices explain why “those who are in the theaters are not in society.” Associating the cost of admission with borers was, of course, a thinly veiled dig at laboring classes, which were the teredo trying to worm their way into high society only to find that they were degrading the very venues they entered—or so the critic thought.<sup>30</sup>

Downtrodden Americans could draw on the imagery of teredo to describe their plight and protest such things as regressive tax codes. For instance, a Deming, Washington man, incensed with high taxes that burdened poorer Americans, did not mince his words in a newspaper editorial. “Practically everything Americans need, but the air, sunlight and rain, is taxed,” fulminated Alfred J. Clode. The first sentence of his polemic speaks volumes: “Taxes are eating holes in the pockets of the poorer class of people like the teredo eats holes in the bottoms of wooden ships.”<sup>31</sup>

### **Breaking Down Europe**

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29. W. P., “Capital and Labor,” *Iron County Register* (MO), April 8, 1880, 4.

30. “Our Theatres,” *Morning Call* (CA), April 23, 1893, 11.

31. Alfred J. Clode, “Communications: Taxes,” *Bellingham Herald* (WA), July 13, 1921, 6.

During the late nineteenth century, Americans marveled with awe and apprehension at the enormous changes happening all around them. But they took some solace in distinguishing themselves from the nations of Europe. America was free and open thanks to its frontier, as Frederick Jackson Turner had argued. While the distinctions between the Old World and the United States would disappear in the twentieth century, journalists found comfort in pointing fingers at metaphorical shipworms (corruption, vice, and radicalism) that infested European institutions far worse than they had in the United States.<sup>32</sup>

“Europe today, generally, is eaten into like an old log exposed to the boring process of the teredo.” These gloomy words graced the *Daily Alta California* in 1879. Teredo signified radicalism. The editors were perturbed by Europe’s “secret societies and associations” that went by “the name of Communism, Nihilism, Socialism, or some other term which indicates an opposition to the existing condition of things, political and social.” These “associations,” in the paper’s view, peddled ideas that were pure “insanity” and because of them the “nations [of Europe] are perforated by the boring, destroying attacks of secret societies.”<sup>33</sup>

Besides radicalism, other types of teredo had undermined Europe: “drunkenness and debauchery.” The *Santa Cruz Sentinel* labeled these evils the “Historic Teredo” and warned of their dire consequences. “Many a gallant ship of State,” explain the editors,

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32. Frederick Jackson Turner, “The Significance of the Frontier in American History,” in *The Frontier in American History* (New York: Henry Holt and Co., 1921).

33. “The Spirit of Destruction,” *Daily Alta California*, May 22, 1879, 2; similarly, a British writer also saw the ravages of teredo in radical politics. After the Paris Commune, Philip Gilbert Hamerton feared that communards would destroy France’s art and architecture, writing “We know that every beautiful building, every precious manuscript and picture, has to be protected against the noxious swarm of Communards as a sea-jetty against Pholas and the Teredo” (Pholas are rock borers). Philip Gilbert Hamerton, *The Intellectual Life* (London: Macmillan and Co., 1873), 368-369.

“has had its timbers destroyed by the teredo of enervating vices.” Nation-states had just as much to fear from vice as the individual—just as an “addicted” person becomes “dull in mind, and low and obtuse in moral perceptions, so does the nation which is given up to intemperance and immorality inevitably become diseased in the social life.” Not all was lost. The paper had high hopes that Kaiser Wilhelm II would curb intemperance and immorality since the “young Emperor of Germany has sagacity enough to perceive, and courage enough to attack this enemy of nations.” But he had a tall task ahead of him, for the “dreaded teredo has been known to disintegrate sound timbers” and it “destroys ships of State...with equal rapidity.”<sup>34</sup>

Corruption was another metaphorical teredo eating away at the foundations of European states. This was particularly the case in Russia, Europe’s last bastion of conservative absolutism. According to the *Sioux City Journal*, the “fatal teredo,” otherwise known as “official corruption,” had taken such a toll on Nicolas I’s regime that it “sometimes weakens even the army.” The trouble with corruption in a bureaucratic autocracy, explained the paper, is that it’s not often apparent, thus making the comparison with teredo so instructive. A ruler was not aware until too late. In the “hour of danger,” when a leader finally confronts the corruption in his ranks, the “whole apparent strength of his empire has been hollowed out.”<sup>35</sup>

Typically, teredo symbolized Europe’s immoral if not illicit behavior (i.e. corruption, immorality, and anti-monarchism). But at least in one instance it represented the challenges of pluralism in an age of rising ethno-nationalism. Perhaps no other part of

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34. “The Historic Teredo,” *Santa Cruz Sentinel*, November 8, 1891, 2.

35. “Russia and Its Rulers,” *Sioux City Journal*, December 30, 1894, 4.

Europe felt the pressure of nationalism so intensely as the Austro-Hungarian Empire. Ethnically and linguistically heterogeneous, the empire proved difficult to govern when its subjects, which included Germans, Czechs, Magyars, and others, who spoke different languages and practiced different religions, pressed for their group interests. In particular, ethnic Germans grew restless as they watched Germany unify under Bismarck. The *San Francisco Call* feared that the increasingly detached German minority would commit “parliamentary warfare” while defending their interests and, consequently, “shatter without scruple the teredo-eaten piles on which the empire of the Hapsburgs is supported.”<sup>36</sup>

For decades, the European continent looked like a honeycomb to Americans. It was everything they feared would befall America. Frederick Jackson Turner captured this best when he cautioned the closing of the frontier might lead to “the extension of the Old World's system of arbitrary rule, its class wars and rivalries and interventions to the destruction of the free States and democratic institutions which they were building in the forests of America.” The prospect of turning into Europe, or being gobbled up by it, left Americans with a number of complex feelings. Teredo captured and conveyed these emotions quite well, at least until the aftermath of World War I, when the United States emerged as a world power and Europe no longer looked so intimidating by comparison. The metaphoric teredo changed in turn. When the *Oakland Tribune* wrote about the unseated German Kaiser, it likened him to a teredo—but not in a menacing way. “Silence is the best safety for Wilhelm Hohenzollern,” explained the paper, for it would be best for him “[i]f he could be metamorphosed into a teredo, now, and disappear into a submerged

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36. E. D. Cowen, “Decadence of Austria: Empire Falling to Pieces of Its Own Weight,” *San Francisco Call*, December 12, 1897, 14.

pile.” In sum, teredo was no laughing matter, so long as Americans had something to fear with Europe. When the worst fears about Europe were not realized, Americans could breathe a sigh and crack a boring joke or two.<sup>37</sup>

### **A Popular Polemic**

Peak Teredo coincided with one of the more contentious stretches in American political history. In the wake of the Great Railroad Strike of 1877, political allegiances were thrown in flux, leading to a massive political realignment that finally coalesced after the defeat of the People’s Party in 1896. All the while, teredo became a handy figure of speech that Republicans, Democrats, and Populists all wielded in their ideological battles over their political identities. Ironically, in this war of words, “teredo” proved very flexible, if not utterly hollow. It could mean any number of things depending on who slung it. Teredo was in eye of the beholder—a rhetorical Rorschach.

With political identities constantly shifting, the essence of what it meant to be a Republican or Democrat was up for grabs. In this context, “teredo” proved a useful intraparty slur aimed at shaming dissenters and demarcating core party tenets. Republicans exemplify this, both in the present and the past. In the twenty-first century, some on the far Right endeavor to weed out so-called RINOs (Republicans in name only) in an effort to redefine the party. Teredo was the RINO of the late nineteenth century. In 1889, the *Washington Standard* (WA) ran a story titled “The Republican ‘Teredo,’” which criticized fellow Republicans who supported paying out pensions to widows of servicemen who did not die on the battlefield. The editors of the paper were appalled at this affront to the party’s commitment to *laissez-faire*, calling it a clear attempt “to

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37. Frederick Jackson Turner, “Middle Western Pioneer Democracy,” in *The Frontier in American History* (New York: Henry Holt and Co., 1921); *Oakland Tribune*, January 22, 1919, 8.

introduce communism into our Federal system.” Consequently, the paper condemned these “Republican teredo” in their ranks. In short, Republicans who didn’t walk the talk were the teredo eating away at the party’s soul.<sup>38</sup>

Teredo-inspired ridicule didn’t force every Republican into lockstep with the party’s core principles. On the contrary, some saw the establishment as the true teredo weakening Republicanism. William Patrick Hackney, a longtime Kansas state legislator and chairman of the Republican state convention, argued as much when he defied his party’s stance on the free coinage of silver. In an 1894 op-ed, Hackney urged his fellow Republicans to undo the “monstrous wrong” committed by the demonization of silver, as well as bending to the “money oligarchy” that had hurt Kansan farmers. “How long, oh Lord, how long, must republicanism continue to be cursed with these official political teredos.” Party insiders, contrary to the previous example, were the “true” teredo after all.<sup>39</sup>

On the eve of the election of 1896 Republicans desperately wanted to show a united front against the insurgent left. Judge Robert Bell Tappan of Alameda criticized Republicans who didn’t back William McKinley by dubbing them the “teredo” that threatened the party. In particular, he took aim at the American Protective Association, or APA, an anti-Catholic organization. When the APA labeled McKinley as pro-Catholic, Tappan went after the group. “This institution is to the Republican party what the teredo is to the pile,” Tappan explained in an open letter, “and unless we soak our party in creosote its heart will soon disappear into the stomach of the teredo.” Tappan was so

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38. “The Republican ‘Teredo,’” *Washington Standard* (WA), October 11, 1889, 1.

39. “Hackney’s Alarm,” *Advocate* (KS), March 7, 1894, 9.



infuriated with the APA that he even withdrew his membership from the Republican Party.<sup>40</sup>

More often than not, politicians and the press hunted for political teredo in rival parties. When Republicans, for instance, took aim at Democrats for opposing the McKinley tariff of 1890, they compared them with borers. The *Kansas City Journal* had choice words for Missouri Democrats who voted against the tariff. “If there has been a state in the Union affected with the teredo in politics it is Missouri,” read the first line of the story. There were a few reasons for the comparison. For one, Missouri had a budding tin industry—so, opposing the tariff was tantamount to “fighting the industries of their own state.” The paper also insinuated that Missouri Democrats acted treasonously by abetting English tin manufacturers, claiming that Britain “never had a more efficient helper than the Democratic party of the United States.” The crass appeal to patriotism shaded the metaphor with both economic and national security meanings.<sup>41</sup>

On the Left, Populists and Democrats similarly cast their Republican opponents as teredo. In an effort to unite the two left-leaning parties, the *Los Angeles Herald* painted Republicans as a common enemy in 1892. In general, the paper had no strong distaste for the policies of the right, but loathed the carpetbagger-like politicians arriving from the east who are nothing more than “taxeaters who masquerade as Republicans.” These sinecure politicians were the “official teredos who are honeycombing the timbers of our edifice.” Drastic times called for equally drastic measures. “It is only through a fusion of

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40. “Against the A.P.A.,” *Oakland Tribune*, May 26, 1896, 6; Donald L. Kinzer, *An Episode in Anti-Catholicism: The American Protective Association* (Seattle: University of Washington Press, 1964).

41. “A Fact—Not a Theory,” *Globe-Republican* (KS), May 20, 1891, 1. This article is a reprint from the *Kansas City Journal*.

the Democratic forces with the People's party," urged the *Herald*, "that we can look for a dethronement of the teredos that are devouring the fabric of our county government."<sup>42</sup>

On the other side of the country, Governor David Hill also saw his Republican foes acting like teredo. In a speech at an upstate rally in 1891, Hill accused Republicans of an elaborate scheme to throw a wrench in the Democratic agenda. In the upcoming election, he argued, Republicans were doomed to lose western states since their fiscal policies fell on deaf ears, even among their fellow Republicans. But in New York, they stood the chance of luring away Democratic voters. If successful, Hill reasoned, Republicans could win New York and thereby retain the executive branch. Even if they lost both houses of Congress, Republicans could veto any and all Democratic legislation aimed at repealing tariffs and advancing monetary reforms. All of this infuriated Hill. Obstructionism, he believed, kept "the Republican teredo ever honeycombing and rotting the timbers of the Democratic Constitution of these United States."<sup>43</sup>

## **Conclusion**

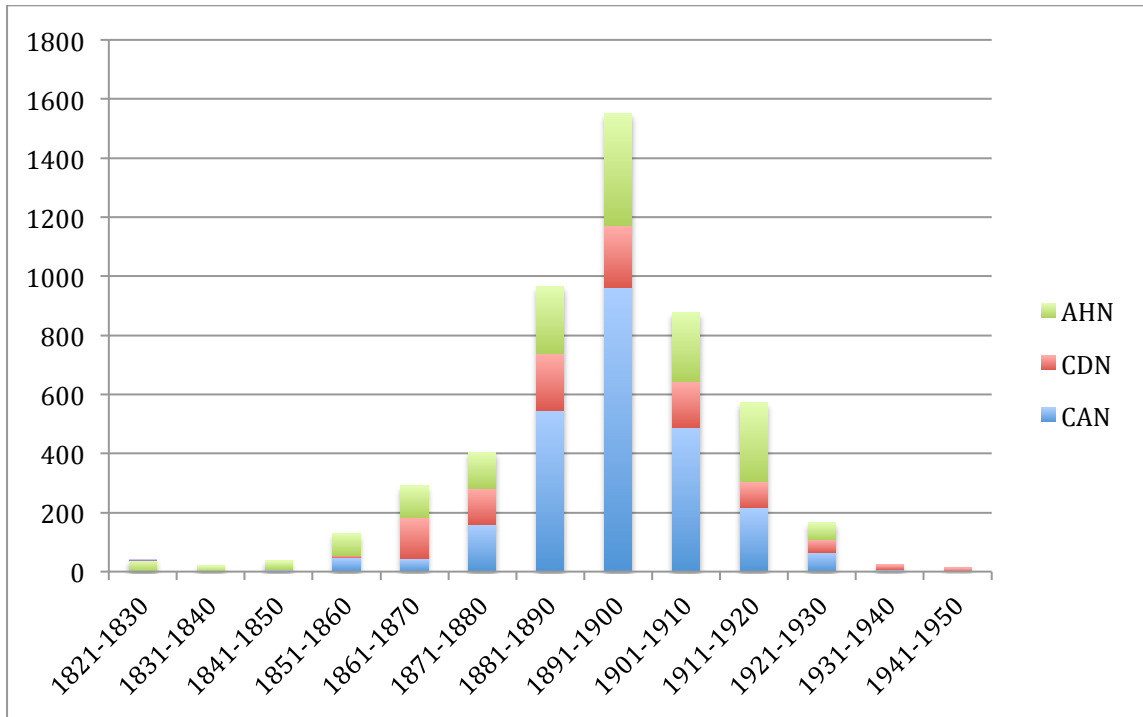
During the first two decades of the twentieth century, the word "teredo" gradually lost much of its potency. In fact, all references to shipworms declined (Figures 1 & 2). Shipworms no longer appeared as frequently in stories about wharf collapses or announcements of the latest anti-teredo method. Over the course of a couple decades, "teredo" more or less disappeared from newspapers and books. In turn, metaphors based on borers also became less frequent. Riffing on shipworms made sense if borers were

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42. "Fusion or Bankruptcy?" *Los Angeles Herald*, July 17, 1892, 4; "What The Harvest Has Been," *Los Angeles Herald*, July 27, 1892, 1.

43. "Hill's Path: Marked Out by the New York Platform," *Sun* (NY), December 5, 1891, 5.

regularly in the news; when they weren't in the headlines, metaphors about them no longer had a point of reference.



**Figure 12: Newspaper Graph. Digitized newspapers are a convenient way to visualize rise and fall of teredo in texts. This graph draws from three databases: Chronicling America: Historic American Newspapers (CAN), the California Digital Newspaper Collection (CDN), and America’s Historical Newspapers (AHN). This search is limited to “teredo”. Common synonyms, such as “shipworms,” and “toredo” (a common misspelling) are excluded. They y-axis represents the number of search results. Digitized newspapers have drawbacks. While CDN continues to the present, AHN stops in the 1920s and CAN ends in the 1940s, which makes the decline appear more precipitous than it probably was.**

The simplest explanation for why teredo faded from written records has to do with the greater effectiveness and greater availability of creosote. The secret to combating secretive organisms was no longer out of reach, or even mysterious. Teredo had once been feared like a disease, but now creosote acted like a vaccine. Cultural uses of “teredo,” consequently, softened and diminished on the whole as the twentieth century progressed.

The effect that creosote had on this once popular metaphor is perfectly captured in a *Bellingham Herald* analysis of the 1912 Democratic Party Platform. During the convention William Jennings Bryan convinced his party to insert a single-term presidential limit into its platform. He was so confident about this plank in the platform eventually becoming law that it was, according to the *Herald*, as if it could “withstand the most vigorous assaults of the elements and to be proof against teredo attack without the use of creosote.” Teredo no longer had power, unless in the absence of creosote, which was becoming rarer.<sup>44</sup>



**Figure 13: Google Ngram. This shows a similar pattern as historical newspapers. Ngram parameters: books written in “American English” and has a smoothing of 20.**

There is another reason why “teredo” probably lost its cultural relevance. Metaphors based on shipworms stopped sounding so scary and portentous. The gloomy predictions that “teredo” foreshadowed did not come to pass. The economy stumbled here and there, but it recovered. The major parties squabbled amongst themselves, but they evolved and endured. Corruption was met head on by reformers. The nation did not collapse under the weight of its supposedly inherent flaws and divisions. Thus, “teredo” lost some of its flair when the sky never fell.

44. “Walking the Plank,” *Bellingham Herald* (WA), February 15, 1916, 4.

Additionally, “teredo” suffered the fate of so many other metaphors: it became worn-out. In his 1946 article “Politics and the English Language,” George Orwell described how fresh and evocative metaphors, when overused, can warp into unrecognizable or meaningless words. It happens when lazy writers embellish their prose with trendy words or phrases without a full comprehension of the language they are wielding. The results are mixed metaphors and unintended meanings. “Teredo” is a textbook example of a worn-out word. Its overuse spawned several Frankenstein-like species of “teredo” that hardly resemble the ominous and pointed metaphor that captured and crystallized so much of the world that people feared around them.<sup>45</sup>

This tiresome “teredo” shines through best in a news article about the battleship *Nebraska*. In 1906, a reporter for the *Oregonian* went to see its construction and marveled at the shipbuilders installing miles upon miles of piping throughout the hull. “The men are now mostly working far down in the depths of the hold, 10 to 15 feet under water, or below the waterline,” explained the reporter. They seemed like teredo because of the way “[t]hey crawl about through dark passages, through manholes and worm their way around like teredo in a pile.” This is a perfect example of a metaphor in the early stages of wear. Parts of it are used correctly—countless men, invisible to the eye, laboring below the waterline certainly share the characteristics of shipworms. Fine. But what originally made the metaphor so fresh in the nineteenth century was how “teredo” destroyed, not built. In this instance, the lazy use of “teredo” turned shipworms into builders, not breakers.<sup>46</sup>

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45. George Orwell, “Politics and the English Language,” *Horizon* 13 (April 1946): 252-265.

46. “War’s Costly Work,” *East Oregonian*, April 4, 1906, 6.

There are numerous other examples of wearing that we could point to. But one of the worst comes from a 1908 editorial praising Theodore Roosevelt. Roosevelt was part of a special class of “civilized peoples” who “labor untiringly and unconsciously, like teredos in the heart of a pile, to fortify their most valued institutions.” This example might be the laziest of all. Metaphorically, the “political teredo” had always eroded institutions. Never did they fortify them. This example runs counter to how “teredo” was used in the nineteenth century.<sup>47</sup>

By the start of World War I, shipworms had been rendered more or less safe, or so it must have felt at the time. No one could have anticipated the *Teredo navalis* invasion of San Francisco Bay (1917-1920) or the spike in borer attacks in the northeast (1930s) to come—there was still more work to do. But for the moment, shipworms lacked the bite they once had. With the danger seemingly gone, people could even make light of teredo, as a Tacoma, Washington clerk named John Bradley did in the fall of 1917. Bradley had lugged a teredo eaten plank from the harbor just when he saw a reporter approaching. Bradley thought fast and told the reporter as she approached that the plank had been manufactured by a new company that was marketing “wooden sponges”. When the reporter appeared perplexed, Bradley told her that the “sponges” would be popular among amputated soldiers with wooden legs, to which the “fair reporter almost swooned.”<sup>48</sup>

“Teredo” was a very paradoxical word. For all its supposed shadowy meanings, “teredo” was intended to clarify. “Teredo” was a word that most Americans probably had never encountered before the Civil War. The more that “teredo” circulated, the more it

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47. “Mr. Roosevelt as an Honorary Bencher,” *Sun* (NY), August 23, 1908, 6.

48. “Peter’s Piffle,” *Tacoma Times*, September 6, 1917, 7.

connected people all across the country to the shoreline and showed them the environmental challenges that accompanied those who lived there. “Teredo” was also a mirror. When people peered at a riddled pile or imagined that a comb of honey was a hollowed out ship plank, they saw a microcosm for human society staring back at them. Teredo was like an animal in one of Aesop’s Fables offering wisdom through parable. For a species that few people ever witnessed firsthand, teredo transcended its form and took a life of its own through language.

CHAPTER FOUR  
“THE SCOURGE OF PUGET SOUND”:  
HOW TEREDO HINDERED AND HELPED  
THE PEOPLE OF THE PACIFIC NORTHWEST

**Introduction**

On the afternoon of January 12, 1891, panicked riders packed the streetcars of Victoria, British Columbia and raced towards the scene of a deadly accident. Down at the waterfront, the Ocean Dock had lurched and then given way, leaving stevedores handling crates of salmon with no time to react. In the aftermath, a worker named James Kelly was pulled from the wreckage, but it was obvious that the “spark of life had fled.” Six longshoremen were missing when the crowd emptied from the streetcars onto the docks. The worried bystanders looked on as rescuers pulled debris in feverish silence, all the while wondering what had gone wrong. By all accounts, the wharf had been “substantially built” and there was “not the slightest reason to believe that the floor was being overloaded or that there was such a thing as a weak spot in the foundation.” Hours later, after the death toll reached four, an examination revealed that the wharf’s “most important supports” had been “absolutely perforated” by the “terrible teredo.”<sup>1</sup>

Sympathy swept across the Pacific Northwest. The *Oregonian* described in heart-wrenching detail how Victorians elbowed their way to the front of the crowd to identify bodies, while the *Seattle Post-Intelligencer* dubbed the calamity the “Victoria Teredo Disaster”. Then there’s the curious case of the *Aberdeen Herald*. It too offered its condolences, writing that the affair “was a sad illustration of these borers.” But the

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1. “Down With a Crash,” *Seattle Post-Intelligencer*, (Hereafter, *Seattle Post-Intelligencer* will be *P-I*), January 13, 1891, 1.



accident was just as much an opportunity. It gave the *Herald* a chance to boast about Aberdeen vis-à-vis neighboring ports. Aberdeen, which sits at the easternmost end of Grays Harbor in southwest Washington State, is quenched by the Chehalis River, leaving the waterfront free from teredo. “We are scarcely thankful enough that the freshness of the waters of Grays harbor keeps us entirely free from these pests,” writes the *Herald*. Puget Sound could claim no such distinction. The “[p]iling on the sound is never secure,” but “[o]n Grays harbor it practically lasts forever.” The *Herald* saw the collapse as evidence of Aberdeen’s superiority in this regard and had no qualms spinning tragedy into opportunity.<sup>2</sup>

“Opportunity” might seem like a strange way to frame a discussion about teredo, but the *Aberdeen Herald*’s behavior is indicative of a broader relationship between the people of the Pacific Northwest and shipworms. To be sure, Pacific Northwesters didn’t *like* teredo. It’s just that they weren’t above using shipworms as a means to an end. When the *Herald* besmirched the ports of Puget Sound, it was trying to do just this—by sending a message to anyone who would listen (i.e. eastern investors and trade journals) that there was money to be made by investing in Grays Harbor (and not Puget Sound) on the merits of teredo. While we may doubt the efficacy of this strategy (e.g. no matter how much Aberdeen clamored about teredo, it never did grow to regional prominence) we can’t deny that it was practiced all across the Pacific Northwest at the end of the nineteenth century. From the teredo-*free* harbor of Astoria, Oregon to the teredo-*filled*

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2. “The Dock Gave Way: Accident at Victoria and Three Lives Lost,” *Oregonian*, January 13, 1891, 2; “The Victoria Disaster,” *P-I*, January 14, 1891, 1; “Down With a Crash,” 1; *Aberdeen Herald* (WA), January 15, 1891, 4. Technically, Victoria is in the Strait of Juan de Fuca, not Puget Sound, but the historical geography of the sound was once murkier back than it is presently.

waterfront of Seattle, Washington, people everywhere tried to spin teredo in the best possible light.

This chapter takes its cues from urban environmental history. Cities, long considered the anti-theses of nature, have become prime terrain for environmental analysis. Discarding the maxim, “as the pavement spreads, nature is pushed away,” many scholars have peeled back the layers of urban development only to find nature coursing throughout cities such as Chicago and New Orleans. One theme unites much of the literature: the amenities and costs of urban environments are rarely shared equitably across class, ethnic, or racial lines (lessons that have informed three recent environmental histories of Seattle). The present study adds to these works through a comparative and integrative urban environmental approach. The tale of teredo in the Pacific Northwest can’t be understood through a case study of any one city in particular; it’s part of a multi-city and multi-environmental discourse over how to corral the benefits and avoid the costs of this most vexing marine organism.<sup>3</sup>

Throughout the Pacific Northwest, opportunism took four general forms: adaptation, weaponization, alteration, and justification. A quick glimpse at each of these concepts might prove helpful before jumping into the heart of the chapter. Out of the four, adaptation was the most common. Businesses that touched the sea had to adapt or pay the price. This goes for wharf owners, railroad operators, and lumber millers.

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3. William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W. W. Norton & Co., 1991); The quote from Lewis Mumford can be found in Ari Kelman, *A River and Its City: The Nature of Landscape in New Orleans* (Berkeley: University of California Press, 2006), 10; Andrew Hurley, *Environmental Inequalities: Class, Race, and Industrial Pollution in Gary, Indiana* (Chapel Hill: University of North Carolina Press, 1995); Michael Rawson, *Eden on the Charles: The Making of Boston* (Cambridge: Harvard University Press, 2010); 179-222; Cole Thrush, *Native Seattle: Histories from the Crossing-Over Place* (Seattle: University of Washington Press, 2008); Matthew Klingle, *Emerald City: An Environmental History of Seattle* (New Haven: Yale University Press, 2007); David B. Williams, *Too High, Too Steep: Reshaping Seattle's Topography* (Seattle: University of Washington Press, 2015).

Adaptations ranged from avoiding shipworm-infested waters or at least the seasons when borers were most active. When the playing field was more or less level (as it was around Puget Sound) businesses gained a competitive advantage over their rivals through successful adaptations.

Some Pacific Northwesterners had no reason to adapt because they had nothing to fear from shipworms (something that the *Aberdeen Herald* was quick to remind its readers). But they kept close tabs on teredo as well. What's more, they weaponized borers through libel and slander. Newsmen in Aberdeen, Astoria, and Bellingham criticized their beleaguered neighbors on Puget Sound seemingly every time a wharf collapsed. Such behavior was not motivated out of schadenfreude. There were real gains to be had. As late as the 1880s, no city could claim to be the region's undisputed economic leader, though a few, like Seattle, had a clear step on the rest. All it would take was a new railroad terminus or a naval base to upset the regional balance of power. Upstarts like Aberdeen used every tool at their disposal to attract these sorts of investments, even teredo.

Puget Sounders didn't take these repeated jabs sitting down. Instead, they dreamed big. Seattle and Everett, for instance, drew up blueprints for ambitious environmental schemes designed to circumvent teredo, which took the form of river diversions, artificial harbors, and canals excavations. Moreover, Puget Sounders pitched the anti-teredo benefits of these schemes to corps engineers in their efforts to gain federal appropriations. In the long run, not every one of these improvements fulfilled their original purposes, but all left their stamps on the landscape as they tried to derive the benefits of a teredo-free harbor through artificial means.

Pacific Northwesterners cited teredo with such frequency that one might be fooled into thinking that it was public enemy number one. But there's reason to be suspicious of some of the rhetoric. Rarely were shipworms the only goal of any stated improvement. While it's hard to know for certain, urban boosters probably padded their proposals by citing the threat of shipworms in order to give their schemes the appearance of working for the greatest good possible. Unsurprisingly, schemers, such as Seattle's Eugene Semple, grew wise to the importance of shipworms in the regional discourse and used them as justifications for blatantly disingenuous proposals, such as Seattle's South Canal. Teredo was just as much a boogeyman that some people exploited as it was a legitimate reason to act.

### **Adapting to *Bankia setacea***

In 1918, prospectors made a chance discovery underneath the City of Bellingham, Washington, which put to rest a question that had puzzled many for decades: is teredo an invasive species, or has it always lurked in the salty waters of the Pacific Northwest? The discovery centered on a log found 110 feet below a city street by coalers searching for a new seam. The wood had all the markings of teredo. "That teredos existed hundreds if not thousands of years ago," writes the *Bellingham Herald*, "is proved by the discovery." Scientists had come to a similar conclusion. The waters of the Pacific Coast, they found, were home to a native species of shipworm that goes by several different names: the "Giant Shipworm," the "Plumed Pileworm," the "Feathery Shipworm," and the "Northwest Shipworm." Taxonomically, the borer is referred to as *Bankia setacea*, even though everyone simply knew it as "teredo".<sup>4</sup>

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4. "Teredo Eaten Log is Found at Depth of 110 Feet," *Bellingham Herald*, May 29, 1918, 5.



**Figure 14: *Bankia setacea*.** Credit: The San Francisco Marine Piling Committee of the American Wood-Preservers' Association, Inc. [*First*] Report on the San Francisco Bay Marine Piling Survey, plate 16. Used with permission of the American Wood-Preservers Association.

Of all the shipworms that fall under the umbrella term “teredo,” *Bankia setacea* has one of the simpler distribution histories to trace. It is native to the North Pacific—thus, the thorny questions that beset so much of teredinid research (i.e. the origins of species and their dispersal timeline) do not hamper attempts to reconstruct *B. setacea*'s history in the Pacific Northwest. Also, *B. setacea* is, practically speaking, the only borer that lives north of San Francisco Bay, so virtually every attack on piles and vessels is attributable to it. In contrast to the nebulous histories of so many other shipworms, *B. setacea* is rather transparent.<sup>5</sup>

*Bankia setacea* lives up to its many nicknames, especially the “Giant Shipworm,” since it grows much larger than some of its notorious compatriots. Legend has it that a log drifted into the mouth of the Columbia River in 1892 containing a dead shipworm ten feet in length. In reality, the average *B. setacea* reaches anywhere between two to three

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5. D. B. Quayle, *Marine Wood Borers in British Columbia* (Ottawa: Department of Fisheries and Oceans, Canadian Special Publication of Fisheries and Aquatic Species 115, 1992), 1, 2.

feet in length, while the more widespread *Teredo navalis* stretches a mere eight to twelve inches.<sup>6</sup>

*Bankia setacea* prefers colder and saltier waters than other shipworms. In the Salish Sea, *B. setacea* grows to thirty inches on average, with the longest verifiable worm measuring forty-eight inches. In San Francisco Bay, by comparison, *B. setacea* is much smaller, averaging twenty inches in length with the largest known specimen reaching thirty inches. In terms of diameter, *B. setacea* expands in girth to between  $\frac{5}{8}$  -  $\frac{3}{4}$ -inches. The other defining feature that differentiates *B. setacea* from other shipworms is its unique and stunning pallets that plug up its borehole. For such a functional appendage, the ornate pallets look like a cross between a feather and the head of a wheat plant; thus the nicknames “plumed” and “feathery.” Since the pallets retracted when disturbed, *B. setacea* rarely allowed people to gaze at its plumes when alive.<sup>7</sup>

For several millennia *Bankia setacea* shared the shores of the Pacific Northwest with Native Americans. Their respective histories, however, diverged quite dramatically as soon as explorers and settlers arrived by sailboat and by wagon train. Native populations plummeted in the wake of deadly diseases, and their territory shrank to just a handful of federally managed reservations. *B. setacea*, on the other hand, thrived in the presence of its new neighbors. The woody ships that entered through the Strait of Juan de Fuca on their way to the salty waters of Puget Sound and the Strait of Georgia were the equivalent to backhoes and construction crews building vast new tract housing for the

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6. San Francisco Bay Marine Piling Committee, *[First] Report on the San Francisco Bay Marine Piling Survey* (San Francisco: The Committee, 1921), 23-51.

7. *Ibid.*

borer. Once limited to driftwood, *B. setacea* larvae found new sources of food and shelter in the form of ships, docks, and wharves.<sup>8</sup>

Circumstances continued to improve for the shipworm once the new arrivals laid their eyes on the vast expanses of forest. Logging quickly became one of the region's fastest growing industries. Lumbermen dragged freshly hewn trees down the so-called "skid roads" that connected upland timber camps with the hastily built waterfront sawmills. Borers feasted on the floating log booms that held together thousands of unprocessed trees waiting to be sawed and planed into boards and shingles. Timber men grew wise to this and weren't about to hand out free lunches to teredo indefinitely. It is no coincidence that some of the first mills were sited next to sources of freshwater where log booms could float safely. One mill man received praise for setting up shop where teredo struggled to survive. Port Ludlow, a waterway along the northwestern shore of Puget Sound, "was selected with great sagacity by the late Arthur Phinney," writes the *Seattle Post-Intelligencer*. The paper goes on to describe how "[a]t the upper end of the bay is a stream of fresh water which so freshens the water of the bay that saw logs remain in the boom for an indefinite length of time without injury from the teredo or borer that attacks logs and piles in salt water."<sup>9</sup>

As the region rose on the backs of loggers, some in the Pacific Northwest hoped shipworms would shape the geography of the timber industry. On the banks of the Columbia River, editors for the *Daily Morning Astorian* predicted in 1890 how lumbermen would (or should) gravitate towards fresher waters where shipworms couldn't

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8. For a history of smallpox and Pacific Northwest Indians see, Cole Harris, *The Resettlement of British Columbia: Essays on Colonialism and Geographic Change* (Vancouver: University of British Columbia Press, 1997); Thrush, *Native Seattle*.

9. "Two Puget Sound Sawmills," *P-I*, January 3, 1884, 1.

survive. Astoria could boast how “the water is fresh and logs may lie almost any length of time without deterioration.” By contrast, “[o]n Puget Sound, where the water is salt, the teredo is an enemy to logs in the water, and they cannot long lie in the water without being damaged.” With timber anchoring the regional economy, it just made ecological sense, in the editors’ view, to work within natural constraints set by shipworms rather than fight against them.<sup>10</sup>

It’s tempting to view shipworms through the lens of environmental determinism. But borers alone did not define the historical geography of the Pacific Northwest. If they had, the freshwater harbors like Port Ludlow and Astoria would have long ago outstripped Seattle, Tacoma, and Vancouver B.C. as the region’s economic focal points. In truth, the opposite occurred. The environments where borers thrived also became the places with the greatest commercial activity and highest urban populations. Puget Sounders thrived in part because of how they adapted to the threat of shipworm.

Lumbermen adapted to teredo, for instance, by timing their timber deliveries to waterfront sawmills in order to limit exposure to borers. Ironically, an example of when this practice unexpectedly backfired sheds light on this adaptation. In 1891, an unanticipated January freshet upset an ecological balancing act that separated shipworms and loggers. After three weeks of heavy rains, the Snohomish, Stillaguamish, and Skagit Rivers, which empty into northern Puget Sound, swelled and flooded. Timber men watched in anguish as the floodwaters prematurely flushed millions of feet of their logs down into the sound—logs that were not supposed to reach the sea until the spring

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10. “Lumber Advantages: Why Astoria is the Best Place to Manufacture Lumber,” *Daily Morning Astorian* (OR), January 1, 1890, 8.



freshets. To make matters worse, sawmills were already running at full capacity with the previous season's cut. With the market now glutted, the unfortunate loggers had to take next to nothing for their cut or risk losing it all to the shipworms. One desperate logger sold two million feet at a loss of two thousand dollars instead of chancing it and losing more. This unexpected freshet, while an annoyance, shows how lumbermen adapted to teredo under normal circumstances.<sup>11</sup>

Loggers adapted in other ways too. The Pacific Northwest had its fair share of rumors about supposedly immune trees. When stories about the resistance of Alaskan yellow cedar spread down the coast, many kept their eyes peeled for this magical tree in the forests of the Pacific Northwest. In the 1880s, stands were reportedly found in two parts of western Washington Territory, leading Territorial Governor Eugene Semple to list them as the region's "undeveloped resources" since they were "said to be proof against the depredations of the teredo." Yellow cedar never lived up to its reputation. But this didn't discourage timber men from marketing other semi-resistant timber products. In 1902, F. W. D. Holbrook, a civil engineer who moonlighted for the navy, commented how the teredo "does not attack readily piles on which the bark has been retained." Tests later confirmed that bark slows borers; however, it is not immune. Once chipped it becomes useless. Moreover, bark prevents the penetration of chemical treatments. However, none of this stopped the *Practical Lumbermen* handbook from exaggerating the benefits of bark, instructing loggers that the "bark on piles is considered an absolute

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11. "The Logs Are Out: High Water in Rivers Bring Logs to the Sound," *P-I*, January 3, 1891, 5.

protection against the Teredo.” Therefore, loggers ought to market so-called “winter cut” timber, when the bark firmly attaches to the outer sapwood.<sup>12</sup>

Just as loggers up in the hills adjusted to teredo, so too did mill men down along saltwater shores. When erecting sawmills, lumbermen had the unenviable task of choosing between shallower (but fresher) estuaries or the deeper (but saltier) shipping channels rife with borers. In the south sound, a Tacoma, Washington mill tried to strike a balance between both. To prevent the “ravages of the teredo,” Gibbs & Co. stored its bolts (semi-processed logs waiting to be finished into shingles) in a boom in the nearby Puyallup River, which emptied into the depths of Commencement Bay. The river offered the benefit of being close to the sawmill, but still out of range of teredo. While clever, this arrangement was far from perfect. Even though the boom of bolts benefited from the river, it remained close enough to the bay that the tides rocked it twice daily. In 1895, heavy rains in conjunction with a high tide raised the boom too high, letting the bolts loose down the river. The accident, while a minor one, illuminates another subtle way that millers tried to adapt to borers.<sup>13</sup>

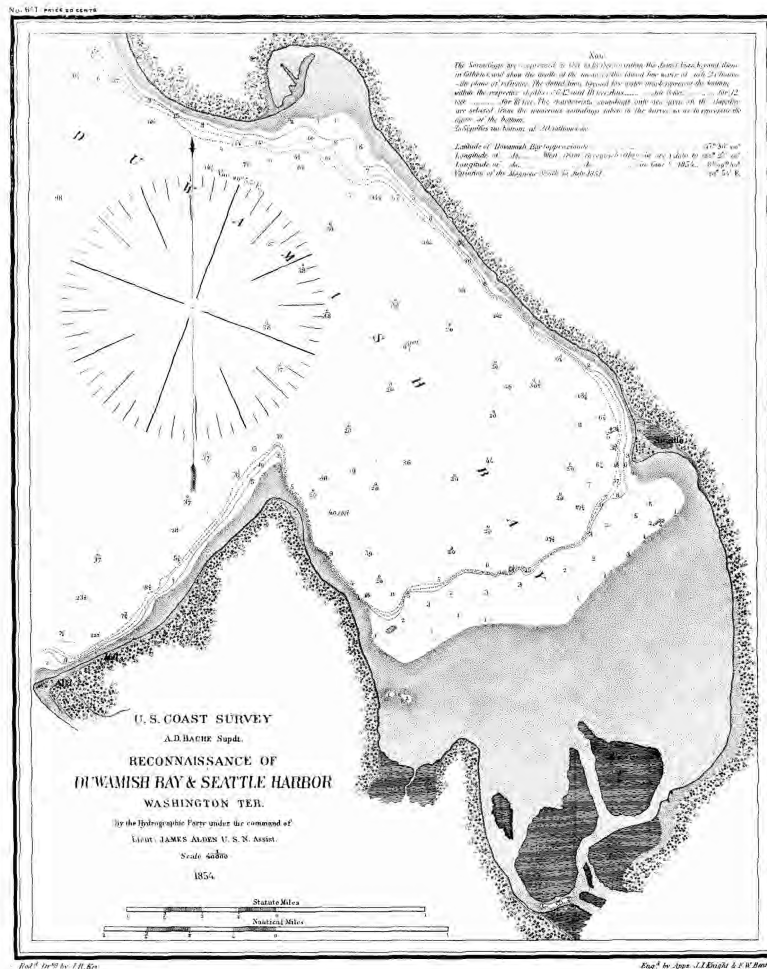
A more aggressive tactic that millers practiced involved landfilling. Henry Yesler, one of Seattle’s earliest settlers and entrepreneurs, knew all too well that building permanent structures in saltwater invited teredo. Yesler, a local icon, was born in Ohio before coming to Seattle in 1852. He promptly married a Duwamish Indian woman

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12. Eugene Semple, *Report of the Governor of Washington Territory* (Washington DC: GPO, 1884), 35; F. W. D. Holbrook, “The Teredo and the Limitations of its Actions,” *Proceedings of the Pacific Northwest Society of Engineers* 1 (September 1902): 1-6; William G. Atwood and A. A. Johnson, “Timber For Which Immunity is Claimed,” in *Marine Structures, Their Deterioration and Preservation* (Washington DC: National Research Council, 1924), 77-78; Bernard Brereton, *The Practical Lumberman: Short Methods of Figuring Lumber, Octagon Spars, Logs Specifications and Lumber Carrying Capacity of Vessels* (Tacoma: 1908), 104.

13. “High Water in the Puyallup River,” *Tacoma Daily News* (WA), December 10, 1895, 1.

named Susan (a marriage that his other wife Sarah approved). Shortly thereafter he built a steam-powered sawmill that employed dozens of Duwamish men who lived in nearby bunkhouses. The mill quickly generated revenue and became the center of the growing city.<sup>14</sup>



From the Image Archives of the Historical Map & Chart Collection  
Office of Coast Survey/National Ocean Service/NOAA

**Figure 15: Seattle Harbor and the Duwamish Mudflats, 1854. Yesler’s Mill is located in the center-right of the image, far from the mouth of the Duwamish River (bottom of image). Image from NOAA’s Office of Coast Survey Historical Map & Chart Collection. <http://historicalcharts.noaa.gov>.**

At the same time that Yesler sawmill thrived, so too did the shipworms that ate away at its piling. The Duwamish River, which spewed northward and brushed the

14. For a general history of Henry Yesler and the Duwamish tide flats, see Klinge, *Emerald City*, chap. 1 & 2. Klinge discusses his polygamous marital arrangement and employing of Duwamish men on pages 29-30.

eastern shore of Elliot Bay, deposited silt onto a massive tideland mudflat right in front of the sawmill, requiring the wharf to traverse hundreds of feet of shipworm-infested tidewater to reach deeper waters where oceangoing vessels anchored. Unfortunately, the river did not bring enough freshwater to fend off shipworms, setting the stage for a troublesome situation.<sup>15</sup>

Tired of replacing piles under his wharf roughly every six months to a year, Yesler finally experimented with dumping mill refuse beneath his wharf to cover the piling. To secure the debris under his mill, Yesler spread buckets of rock ballast on top. The test worked and Yesler earned praise for his work: “[t]he teredos are content to work on the outer piles, which are easily replaced,” writes the *Daily Intelligencer*; and “[w]e congratulate Mr. Yesler on having the best built and best paying piece of wharf property on Puget Sound.” Landfilling gave Yesler a significant edge over his competition. Clarence Bagley, a historian and longtime Seattle resident, reflected on the importance of shipworms. According to Bagley, the Yesler wharf had two major competitors during the 1860s: the Butler and Plummer wharves. Neither, however, followed Yesler’s lead and, subsequently, both were destroyed by shipworms after a few years.<sup>16</sup>

While Yesler’s mill proved a success, others found shipworms so vexing that they considered shifting their operations away from Elliot Bay. In 1888, for example, prominent Seattle lumbermen joined forces to build a sawmill in landlocked Lake Union,

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15. Klinge, *Emerald City*, 61, makes a passing reference to “teredo” (misidentifying it as a “marine snail”) and how it ate away at the waterfront, but offers no specific details.

16. “Nearly Complete,” *Daily Intelligencer* (WA), September 14, 1877, 3; “Drying Slabs,” *Daily Intelligencer* (WA), December 3, 1877, 3. No precise descriptions of Yesler’s landfilling practices have survived from the 1850s and 1860s, but these detailed explanations of his methods from 1877 are probably consistent with his earlier practices. (Hereafter *Daily Intelligencer* is *D-I*). Clarence Bagley, “Pioneer Seattle and the Homes of its Pioneers,” *P-I*, December 16, 1900, 27.

just northeast of Seattle's downtown. George Foster, a partner in the venture, explained that they chose Lake Union "to escape the teredo." Soon after, Foster's idea gained the attention of other lumbermen when a ranking member of the Puget Sound Loggers Association proposed converting the lake into an immense freshwater storehouse for logs. This seemed necessary because the supply of logs had exceeded demand, and without ample flat land in hilly Seattle to stack them, the surplus timber would soon be honeycombed if left in booms on the sound.<sup>17</sup>

The timber industry adapted to borers as well as it could. But there were undeniable benefits to be gained by leaving Puget Sound for fresher waters, such as the Columbia River. In 1904, for instance, Weyerhaeuser Timber Company found itself in a bind after the lumber market crashed. Instead of dumping more timber on already depressed markets, the company chose to store a hundred million feet of logs in the Columbia River until prices rebounded in the future. Such a practice, according to one newspaper reporter, "would be unsuccessful on Puget Sound because of teredoes." The Columbia provided Weyerhaeuser with economic flexibility to weather such a storm—not to mention it gave it an edge over Puget Sound loggers who had to sell their logs at cut rates whenever they sat idly in shipworm-infested waters.<sup>18</sup>

Loggers elsewhere in the Pacific Northwest fared worse than those operating along the Columbia River. British Columbian loggers found the twin evils of shipworms and glutted timber markets particularly vexing, which resulted in a change to provincial trade policy in 1908. That year left lumbermen in a bind. Timber sales dipped well below

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17. "A Notable Project," *P-I*, May 2, 1888, 3; "Local Miscellany," *P-I*, May 27, 1888, 5.

18. "Timber Company Plans to Hold Prices High," *San Francisco Call*, July 12, 1904, 14.

1907 levels. Low prices came at a bad time since the mills across British Columbia and Vancouver Island had stockpiles of logs waiting to be processed. Most shut their doors for want of buyers—by December, nine out of every ten mills closed. Shipworms took advantage of these circumstances. As markets slumped, with no end in sight, teredo stood ready to lay waste to millions of feet of timber floating in booms everywhere in the Strait of Georgia. Provincial authorities responded to the problem by briefly permitting British Columbian loggers to sell to foreign mills—chiefly to Puget Sound sawmills.<sup>19</sup>

The following year, Puget Sound lumbermen worried that cheap surplus timber from British Columbia might spill over the border and cause a similar predicament. If cheap foreign timber hit Puget Sound mills, booms of American owned lumber might float idly on the sound and succumb to shipworms. To make matters worse, Congress considered lifting a tariff on Canadian lumber imports. Anxieties swirled. Once the tariff fell, “heavy losses will be encountered by the destructive action of the Puget Sound toredo [*sic*].” L. L. Doud of Defiance Lumber tried to throw water on all this “teredo talk,” as he called it, by discrediting the rumormongers as nothing more than “calamity howlers.” Regardless, lumbermen had to be prepared for changing trade policies and how they might increase the risk of shipworms.<sup>20</sup>

### **Weaponizing Teredo**

The battle with borers did not go unnoticed in other parts of the Pacific Northwest. Places free from the ravages of teredo, such as Astoria, Bellingham, Portland,

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19. House, *Commercial Relations of the United States with Foreign Countries, During the Year 1908, Volume Two*, 60th Cong., 2d sess., 1909, H. Doc. 1567, 26.

20. “Log Prices Are Holding Firm,” *Olympia Daily Recorder* (WA), April 5, 1909, 1.

and Aberdeen, watched keenly, for they had financial incentive to learn as much as they could about shipworms. With the regional economy exploding around them, no other city, bay, or harbor had yet claimed political and economic hegemony over the rest. This vacuum left the door slightly ajar for other communities to ascend to the top, if only they could distinguish themselves from the frontrunners like Seattle and Tacoma. One way to accomplish this was through teredo slander and libel. Ports without shipworms publicly criticized their infested neighbors with the hope of eclipsing them. This response to shipworms, though occasionally practiced elsewhere around the country, was unique to the Pacific Northwest in terms of frequency and frankness.

The opening salvos in the region's shipworm debate made little noise, belying the ruckus yet to come. In 1877, Astoria's newsmen mused about Puget Sound's "Great Bore." The piece centered on the curious nature of shipworm biology, something that locals seemed to know little about, judging from the content and the fact "*teredo nevalis*" had been misspelled. There was neither a hint of an ulterior motive nor any apparent effort to disparage Puget Sound, even though the paper stumbled upon the very argument it would relentlessly wield later to discourage investment in Seattle, Tacoma, and elsewhere. The editors remarked that "[w]hen a wharf is built at Astoria it is a great satisfaction to the builder to know that his property will stand as long as time lasts, at least so far as the ravages of the *teredo nevalis* [*sic*] are concerned," thanks to the Columbia River.<sup>21</sup>

It didn't take long for teredo to become a bludgeon used for attacking rival ports. Vancouver, Washington residents may have been the first to do so. Upstream from

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21. "The Great Bore," *Daily Astorian* (OR), November 15, 1877, 1.

Astoria, and right across the state line from Portland, Vancouver also benefited from the anti-shipworm effects of the Columbia River. In 1878, boosters played up this advantage by attaching a stigma onto Seattle and Tacoma. “Piles driven in the bay at Seattle only last year,” railed Washington’s *Vancouver Independent*, “are already completely destroyed by the teredo.” Likewise, in 1881, the paper sneered at the fact that Tacoma had been forced to rebuild a railroad wharf for a third time, which “illustrates the loss of Puget Sound wharf owners by reason of the teredo.” Soon after, neighboring cities, especially Astoria, followed suit. Astorians liked to collect pieces of honeycombed piles from Puget Sound and show them to visitors and potential investors for shock value.<sup>22</sup>

Throughout the 1880s, criticism of infested ports grew from petty squabbles to more robust indictments. In 1888, Congress raised the stakes of the shipworm debate substantially. To bolster defenses on the Pacific Coast, Congress ordered the Navy to find a location in the Pacific Northwest suitable for a naval dry dock. Captain Alfred Thayer Mahan, head of the commission, led the crucial survey. Shipworms were on his radar. Before heading to the region, Mahan sent out questionnaires to cities that might be good candidates. In twenty questions, Mahan requested everything from shipping statistics to industrial output, the availability of natural resources, and so forth. Question number two dealt with shipworms: “Can lumber be obtained for wharves, etc., that is not subject to the attacks of the teredo?”<sup>23</sup>

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22. “Territorial,” *Vancouver Independent* (WA), May 2, 1878, 1; “Territorial Items,” *Vancouver Independent* (WA), January 27, 1881, 4; *Daily Astorian* (OR), March 4, 1882, 3; *Daily Morning Astorian* (OR), May 19, 1887, 3; *Daily Morning Astorian* (OR), March 23, 1888, 3; “Just Wanted To Know,” *Daily Morning Astorian* (OR), June 6, 1889, 3; *Daily Morning Astorian* (OR), January 25, 1894, 3.

23. House, *Report of the Secretary of the Navy*, “No. 5.—Report of the Commission to Select a Site for a Navy-Yard on the Pacific Coast North of the Forty-Second Parallel of North Latitude,” 51st Cong., 1st sess., 1889, Ex. Doc. 1, Pt. 3, 150.



Mahan's interest in shipworms took the issue to a whole new level. With government contracts now on the table, positioning one's community as shipworm-free held the potential of bringing in allocations—contracts that might beget future government investments. Moreover, landing the big dry dock contract might even reorient the economic map of the region and anoint the winner as the Pacific Northwest's metropolis. People across the Pacific Northwest understood all this and went to great pains to lobby Mahan and his traveling commission, while also responding to his shipworm query.

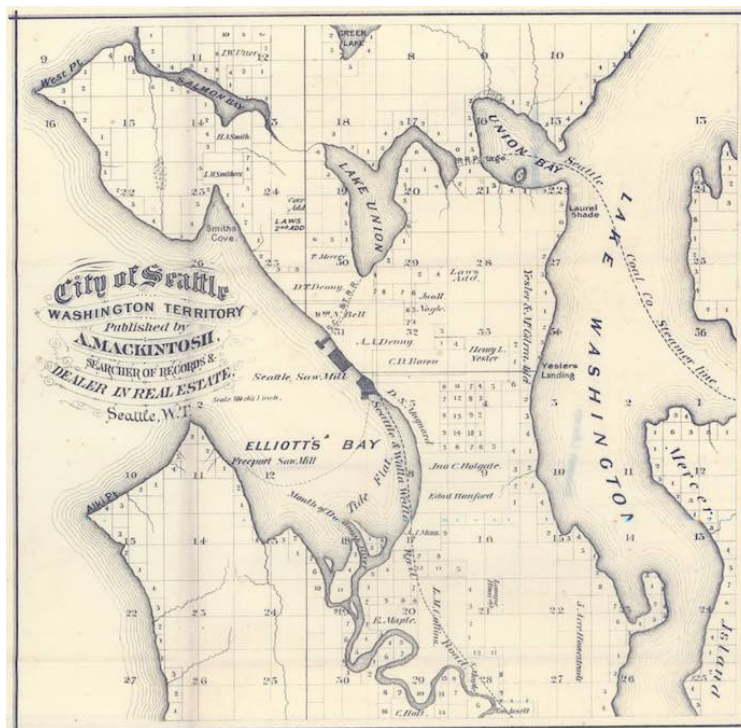
Some addressed Mahan's question more easily than others. All that Astorians had to do was riff on a well-worn argument: that the Columbia River makes it impossible for teredo to survive. The Astoria Chamber of Commerce took the lead in replying to Mahan and echoed this common refrain in its response to the questionnaire. Furnishing lumber resistant to teredo was no problem at all, for "teredo is not known in our waters," according to the Chamber, and piling thus "not subject to its ravages." The absence of shipworms meant "piles now standing that were driven thirty years ago...are still in a sound condition to the water's edge." The chamber men clearly tiptoed around the question; they failed to offer up any resistant trees, per se. But they did address the spirit of Mahan's request—or its unstated assumptions—by explaining how shipworms would never be a problem for the dry dock itself if sited along the Columbia River.<sup>24</sup>

The City of Seattle also took the questionnaire seriously, but chose a slightly different tack than Astoria. Upon receipt of Mahan's questionnaire, Seattle Mayor Robert Moran appointed a confidant named Alexander Begg to prepare answers. Before

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24. "Questions and Answers Regarding a Site for the Navy Yard," *Daily Morning Astorian* (OR), February 12, 1889, 2.

returning the questionnaire, Begg was called before a joint committee made up of Seattle's Chamber of Commerce, Board of Trade, and City Council and asked about his analysis. Begg was rather forthright to the committee about shipworms. "It is impossible to obtain any lumber or timber for wharves anywhere throughout the entire coast," explained Begg, "that is not subject to the ravages of the teredo." However, Seattle had something even better than teredo-resistant wood to offer Mahan: it had Lake Washington.<sup>25</sup>



**Figure 16: Lake Washington Ship Canal Route. Seattle in 1874. From its founding, Seattle's residents dreamed of digging a canal from Salmon Bay (top left of image) into Lake Union, and from thence, another canal into Union Bay and Lake Washington. Courtesy of Washington State University Libraries' MASC.**

Lake Washington, a twenty-two square mile body of freshwater just east of the city, had all the benefits that Seattle's waterfront lacked: no teredo and no tides. Begg pitched the lake as the perfect location for the naval dry dock. But there was one—

25. "The Proposed Navy Yard: Reasons Why It Should Be Located at Seattle," *P-I*, January 12, 1889, 3.

enormous—catch. The lake had no navigable connection with Puget Sound. If Mahan chose Lake Washington, he would have had the additional tall task of convincing Congress to pay for a massive lock and canal excavation. In this light, Begg’s suggestion seems totally absurd. But Seattleites had long wanted a canal through their city. So, asking the federal government to fund it in connection with the dry dock seems like a sneaky way of getting it free of charge.

Mahan’s recommendations came as a bit of a stunner. None of the major cities on the sound or along the Columbia River earned the prized dry dock. Instead, Port Orchard, a sparse community on the western side of Puget Sound, got the nod. Port Orchard had no natural defenses against teredo, which required engineers to build costly stone abutments to rest the wharves upon. But it did offer strategic defense of Admiralty Inlet, the gateway to Puget Sound.<sup>26</sup>

On the face of it, shipworms didn’t appear to factor in Mahan’s recommendations. But upon closer examination the commission had shipworms very much in mind. Mahan reasoned that ships arriving at Port Orchard would sit in saltwater for a short time as they waited to be pulled into the dry dock. Before then, vessels were free to moor in fresher waters where shipworms couldn’t attack them. Mahan predicted Lake Washington would someday be one of these places; he thought highly of the lake, listing its number one benefit as the “absence of the teredo.” Unfortunately, Mahan worried that an enemy fleet could too easily damage the proposed canal, leaving American warships stranded in the

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26. House, “No. 5.—Report of the Commission to Select a Site for a Navy-Yard on the Pacific Coast North of the Forty-Second Parallel of North Latitude,” 146; “The Nation’s Navy Growing Rapidly,” *Los Angeles Herald*, December 6, 1896, 1, 2.

lake. Port Orchard allowed the navy to get all the anti-shipworm benefits without having to build and defend the ship canal.<sup>27</sup>

The dry dock verdict roused the entire Pacific Northwest. Everyone chimed in. The biggest winner was Seattle. Mahan confirmed what Seattleites had long hoped: that the federal government had serious interest in helping excavate the Lake Washington Ship Canal in the future. Reactions down along the Columbia, however, were not rosy. “Whatever good points the naval commissioners may have found for locations on the Sound suitable for a dry dock,” carped the *Daily Morning Astorian*, “they are respectfully reminded that the Columbia river can offer one which is of almost paramount importance as a location for a navy yard, and that is, the fresh water here contains no teredos to destroy piles.”<sup>28</sup>

Further up the Columbia River, the *Dalles Daily Chronicle* seconded criticisms of Mahan. Had a specimen of honeycombed timber been displayed in the halls of Congress, the editors asserted, then the dry dock would never have been sited on Puget Sound. While no actual piece of timber was ever entered as evidence, Oregon Congressman Joseph Dolph did reference shipworms in a tussle he had with Washington senator John Allen. During a congressional debate Dolph reminded lawmakers that a dry dock on the Columbia would be safe from shipworms. While the outcome might not have been what people throughout the Columbia Basin had hoped for, at least they could be encouraged that their arguments about teredo were being heard where it mattered most.<sup>29</sup>

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27. Ibid.

28. *Daily Morning Astorian* (OR), October 14, 1890, 2.

29. *Daily Morning Astorian* (WA), October 14, 1890, 2; “Local Brevities,” *Dalles Daily Chronicle* (OR), May 17, 1892, 3; “Fighting For Dry Dock,” *P-I*, February 11, 1891, 3; “The Port Orchard Dry Dock,” *P-I*, February 24, 1891, 3.

In the wake of the dry dock decision, teredo-slandering ramped up all across the Pacific Northwest. Shipworms became selling points for some communities and obstacles for others to downplay. Aberdeen newsmen, for instance, took aim at Puget Sounders: “[o]ne of the strongest arguments in favor of Grays harbor,” explained the paper, “is the absence of these pests from its waters,” citing a huge loss of timber there at the mouths of teredo. Seattleites took umbrage and responded to “certain newspapers on Gray’s harbor [*sic*]” with a piece titled, “Teredo and Saw Logs: False Statements About the Ravages of the Worms.” Sounders had plenty of incentive to refute the portrayal since national publications such as *Scientific American* picked up the story, writing “one of the large sawmill companies of Puget Sound lost 50,000,000 feet of logs that were allowed to lie in the water until the teredo had ruined them.” In this instance, Grays Harbor landed a blow and shaped national perceptions of the sound.<sup>30</sup>

Ports free of borers had ulterior motives for keeping shipworms in the headlines. Oftentimes their libel came from a place of insecurity. Vessels approaching the mouths of the Columbia River and Grays Harbor had to contend with dangerous sandbars. These shallow and shifting masses could delay ships reaching Aberdeen, Astoria, and Portland for weeks. For this reason, Puget Sounders routinely portrayed these ports as incapable of handling increased commerce. One Astoria man didn’t take these characterizations lightly and responded to criticisms about the Columbia bar by explaining how “Astoria can build immense warehouses on piling which will not be eaten with teredo,” adding, rhetorically, “Can Puget Sound do that?” In another example, Oregon’s *Daily Morning*

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30. “Bound to Lead,” *Aberdeen Herald* (WA), May 21, 1891, 4; “Teredo and Saw Logs: False Statements About the Ravages of the Worms,” *P-I*, June 26, 1891, 2; “The Teredo,” *Scientific American*, April 25, 1891, 266.

*Astorian* responded to criticism of the bar by remarking how the sound, “minus its soup kitchens, breakneck city sites and teredoes, would be a habitable place.” In short, shipworms became a shield to hide from criticism.<sup>31</sup>

### **Waterfronts By Design: Bellingham, Everett, and Seattle**

While Puget Sounders dodged and downplayed criticism emanating from elsewhere in the Pacific Northwest, there was no getting around the fact that teredo “forms a severe tax upon commerce,” a common refrain. To remain competitive, some communities moved beyond the war of words and proceeded to enhance the anti-borer qualities of their waterfronts and harbors. The legacy of shipworms in the Pacific Northwest is perhaps best viewed through efforts to regulate and reshape entire estuaries. The Puget Sound coastal cities of Bellingham, Everett, and Seattle are perfect examples.<sup>32</sup>



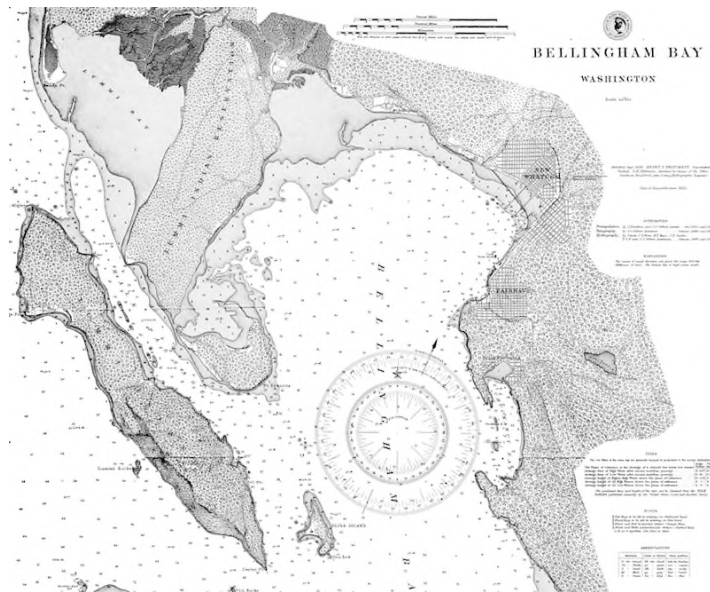
**Figure 17: Birdseye of Bellingham Bay’s North Shore. Lake Whatcom (pictured in the bottom left) is just east of the City of Bellingham (known as New Whatcom prior to 1904). Courtesy of Washington State University Libraries’ MASC.**

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31. “Not a Dream—Truths: Astoria, the State of Oregon, and Washington Territory,” *Daily Astorian*, December 20, 1881, 1; “A Difficult Task,” *Daily Morning Astorian* (OR), March 4, 1894, 4.

32. House, *Ship Canal Connecting Lakes Union and Washington with Puget Sound*, 52d Cong., 2d sess., 1893, H. Rpt. 2395, 2.

Bellingham Bay's relationship with shipworms differed markedly from those of neighboring Puget Sound waterways. Located just a few miles south of the Canadian border, the bay looks like an upside-down fishhook, a layout that attracted settlers since its western shore (the hook end) shielded the shoreline from the rougher waters of the Strait of Juan de Fuca. The capacious bay stretches ten miles in length and five miles in width. Its depths vary. At its deepest, the bay affords 26 fathoms of clearance at its southerly entrance, while its average depth is 10 fathoms. The safe and excellent anchorage of the bay was one of its initial selling points. Not to mention the bay was fed by Whatcom Creek and the Nooksack River, which prevented borers from gaining a foothold.<sup>33</sup>



**Figure 18: Nautical Chart of Bellingham Bay. The commercial district is found in the upper right-hand corner. The Nooksack River Delta emanates from the top-center. Lummi Bay, which is not part of Bellingham Bay, is located in the upper left-hand corner. The bay empties south into Puget Sound. Image from NOAA's *Office of Coast Survey Historical Map & Chart Collection*. <http://historicalcharts.noaa.gov>.**

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33. For a general knowledge about Bellingham Bay, see Nelson, "Let's Make a Harbor into a Harbor"; The figures for the size and depth of the bay represent how it appeared in the late nineteenth century a can be found in the following report, House, *Report of the Secretary of War*, 54th Cong., 1st sess., 1895, Doc. No. 2, Vol. 2, Pt. 5, 3473.

Initially, Bellingham residents showed little interest in shipworms. In the wake of the Mahan report, however, they quickly engaged in the budding regional discourse. But they did so in an unexpected way. Their first foray occurred in 1890 when a booster advertisement mentioned shipworms. Curiously, it didn't acknowledge the bay's natural resistance to borers. Instead, it called for the construction of a canal to allow ships to pass back and forth between the bay and nearby Lake Whatcom to hinder the "tenacious teredo." The wildly impractical plan underscores just how little the people of Bellingham understood the advantages that their bay bestowed. It took a crisis of a different nature before Bellingham residents appreciated the anti-borer qualities of their harbor—and that crisis was sedimentation.<sup>34</sup>

Throughout Puget Sound, as more and more people settled in the region, fears mounted that loggers and farmers were causing potentially irreversible environmental damage. Layers of muddy runoff—silt emanating from denuded forests and farms—made Puget Sound's many tributaries appear as cloudy as the Mississippi River. Some predicted that the increased load of sediments would fill up the entire sound. While most did not fall prey to such ominous forecasts, they did fear that sedimentation was making it increasingly difficult for ships to reach port and stay there at all tides. The prospect of clogged shipping lanes was no trifling matter, especially in Bellingham Bay.<sup>35</sup>

The sediments rushing out from the Nooksack River stoked fears throughout Bellingham Bay. In 1892, Edward Eldridge, a politician, businessman, and longtime Bellingham resident, jumped to action. He called on the federal government to intervene

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34. J. Martin Miller, "Wealth's Gate," *Sun* (NY), March 2, 1890, 23.

35. "Interesting Figures," *Washington Standard*, December 20, 1889, 2.



and save the harbor from the blanket of sediment. In a letter to the Army Corps of Engineers, Eldridge commended the bay as “a great space where vessels can safely ride at anchor.” Unfortunately, he noted, ships could safely load and unload only along the eastern shore of the harbor. For forty years, Eldridge watched as the Nooksack mudflats emanating from northwest of the bay crept eastward, inching towards the shipping centers. Desperate times called for desperate measures, so Eldridge urged the corps to do away with the sediments. To preserve depths, Eldridge insisted on dredging the harbor and prohibiting mills from dumping sawdust under the waves. But his most ambitious plan was to divert the source of the sediment, the Nooksack River, away from Bellingham Bay entirely. He counseled the corps to divert the river to the northwest so that it emptied all of its sediments north into Lummi Bay, so sparing Bellingham Bay.<sup>36</sup>

The diversion scheme generated a lot of debate. Eldridge anticipated that “[t]he closing of this river will discommode a few of our settlers and will, naturally, be objected to by them.” While he didn’t specify whom exactly, a corps survey hints at the key objection. Captain Thomas Symons of the Army Corps conducted the survey of the bay and generally agreed with Eldridge that the filling of Bellingham Bay ought to “receive the attention of the General Government.” But Congress shouldn’t act too hastily; another round of surveys were needed to establish the rate of sedimentation before Congress could fund the diversion. In particular, Symons mused that “[t]he influences of the fresh waters of the Nooksack in limiting or preventing the ravages of the teredo should also be considered, as there are persons who think this an advantage paramount to the disadvantage of the sediment brought down by the river.”<sup>37</sup>

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36. House, *Nooksack River, Washington*, 52d Cong., 2d sess., 1892, Ex. Doc. No. 32, 4, 5.

Over the next three years, the Nooksack debates boiled down to the lesser of two evils: mud or shipworms. Eldridge passed away in 1892, but his cause was taken up by Senator Watson Squire of Washington. In 1894, Squire called for government appropriations “to prevent Bellingham bay from shoaling by reason of deposits from river water.” Support for the Nooksack diversion, however, was far from unanimous, and diversionists acknowledged contrary opinions. For instance, the *Daily Reveille*, a Bellingham newspaper, acknowledged that some were concerned about teredo, but downplayed the arguments that a diversion would put the harbor’s piling and ships at greater risk of shipworms if the fresh waters of the Nooksack flowed into Lummi Bay. “The piles can be replaced,” write the editors; “but when once the harbor is ruined we become an inland city forever.” In short, silt was worse than worms, in the paper’s view.<sup>38</sup>

In 1894, Bellingham Bay’s anti-shipworm advocates found a leader in J. J. Donovan. Donovan, an engineer, local businessman, and member of the Bellingham Bay Improvement Company, did not buy into Eldridge’s Chicken Little argument. While the engineer conceded that sedimentation was real, he did not think that it posed an existential threat to commercial activities. Most of the alluvial debris, he believed, washed out to sea and not in front of the harbor’s commercial centers. On the other hand, the Nooksack River, owing to its unique tidal action, which washes freshwater for several

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37. House, *Nooksack River, Washington*, 4, 5.

38. “The Bellingham Bay Survey,” *P-I*, February 21, 1894, 1; *Daily Reveille* (WA), September 24, 1892, 1, Center for Pacific Northwest Studies (CPNWS).

miles along the eastern harbor, all but prevented shipworms from eating away at piles and wharves.<sup>39</sup>

Momentum shifted in favor of the opposition once the potential benefits of the Nooksack River became clear. Boosters started to market the river's anti-teredo qualities as a potential boon to the region. In 1894, an advertisement ran repeatedly in the *Daily Reveille* touting "the fact that the great volume of the Nooksack river and Whatcom creek empties into this harbor." Consequently, "piles are never destroyed by the teredo."<sup>40</sup>

In 1895, the corps published its all-important follow-up survey of Bellingham Bay. After taking all factors into account, Captain Symons chose not to endorse the Nooksack diversion. Sedimentation was certainly a problem, but not as severe as Eldridge and Squire had foretold. Moreover, "[w]hile the Nooksack River must be considered detrimental to the bay," explained Symons, "it is esteemed to be of great value, in that its fresh waters...prevent the ravages of the teredo among the pile wharves, etc., with which the shores are lined." Judging by Symons' report, Bellingham Bay's anti-shipworm contingent had won over many bay residents. "So important is this fresh water considered," Symons admitted, "that a very strong protest would go up against the project of deflecting [the Nooksack] from the harbor." The terminus of the Nooksack remained in Bellingham Bay thanks to shipworms.<sup>41</sup>

The Nooksack's anti-shipworm qualities eventually won over previous diversionists at the *Daily Reveille*. Owing to the bay's natural resistance to shipworms,

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39. "The Nooksack River: Its Waters of Great Benefit to Bellingham Bay," *P-I*, October 26, 1894, 2.

40. *Daily Reveille* (WA), October 10, 1894, CPNWS.

41. House, *Preliminary Examination of Bellingham Bay*, Washington, 53d Cong., 3d sess., 1895, Ex. Doc. 228, 3.

the editors changed their tune and proclaimed their newfound appreciation that “the harbor was perfected by the Almighty, and the government will not try to improve on the work.” The *Daily Reveille*’s sentiments are only partially true. Over the next decade the corps went to great lengths to reshape Bellingham Bay with the aim of overcoming its perceived deficiencies—especially, its shallowness. But on this day, people surrounding the bay could only feel blessed, as if God had created a perfect bay that would endow them with fortunes. What’s astonishing is how fast the Nooksack turned from a burden into an asset. In the future, boosters took pride in their bay’s resistance to borers and marketed it as such. In 1904, for instance, they described “the icy, fresh water of the Nooksack river and numerous small creeks pouring into it” as benefits that make it “impossible for the destructive teredo to live in its mingled waters.”<sup>42</sup>

### **Everett Harbor**

Bellingham Bay wasn’t the only marine landscape on Puget Sound shaped by shipworms. Fifty miles to the south lay another shipworm-infested waterway: Everett Harbor. From a bird’s eye view, Everett looks like an inverted Manhattan Island. To the city’s west is Puget Sound—Everett’s equivalent of the Hudson River. To its east is the Snohomish River, which wraps around the peninsula, much like New York’s East River wraps around the southern end of Manhattan. Unlike New York, Everett will never have to worry about flooded subways (not that it has any) since the peninsula lies high upon a bluff. The elevated plan made it hard to develop the city’s northern and eastern shores. Only Port Gardner, to the southwest, was suitable for wharves and factories that deep draft vessels could access.

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42. *Daily Reveille* (WA), February 7, 1895, CPNWS; “Bellingham, ‘The Imperial City,’” *Bellingham Herald* (WA), January 25, 1904.



**Figure 19: Birdseye of Everett, Washington. This pre-bulkhead map looks east. The northern facing peninsula is to the left of the image and the Snohomish River wraps around the city southward. Courtesy of Washington State University Libraries' MASC.**

Undaunted, Everett's founders saw promise in these motley environments.

Between 1855 and 1890, only a handful of people resettled in Everett—perhaps three dozen in all. Railroad speculation changed everything. In 1890, a lumberman named Henry Hewitt Jr. came to the peninsula with dreams of enticing J. J. Hill to build his Great Northern Railway terminus in Everett. As president of the Everett Land Company, Hewitt quickly bought up and platted as much land as he could, leading the way to the eventual incorporation of Everett in 1893. By decade's end, Everett could boast 8,000 lumber and industrial workers.<sup>43</sup>

From the get-go Hewitt and his associates viewed teredo as an obstacle to progress. And the solution seemed obvious: the fresh waters of the Snohomish River could snuff out shipworms. The corps was the first to draw attention to the value of the river. In 1889, the corps ordered its shallow draft snag boat, *Skagit*, to round the

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43. For a social history of the Everett waterfront, see Lawrence E. O'Donnell and Jack C. O'Donnell, *The Evolution of a Vibrant Everett Waterfront: A Story of Sawdust, Salmon & Speedboats* (Everett: Port of Everett, 2010).

peninsula and moor along the river. According to the ship's captain, "the water is fresh, thus avoiding the ravages of the destructive teredo." The example of the *Skagit* is both instructive and deceptive all at once. If every ship could round the peninsula then a network of wharves and factories could be erected southeast of the city. Unfortunately, deep draft vessels could not pass the massive mudflat that formed at the tip of the peninsula—only shallow draft vessels (like the *Skagit*) could pass, and only when conditions were right.<sup>44</sup>

Such formidable circumstances might have scared off others, but Hewitt and his associates believed they could harness the river and make it do work for them. In fact, the river's anti-shipworm properties were a reason why the Everett Land Company grew interested in the city in the first place. Board members even pitched the merits of the river to well-funded capitalists such as John D. Rockefeller, who invested in Hewitt's company. The river held vast potential to deter shipworms, but until the stream was actually improved, it would remain just that: potential.<sup>45</sup>

Hewitt's plan was bold and sweeping. He envisioned nothing less than an entire remaking of the harbor. He hoped to bring the freshwater river to bear on the waterfront through the construction of an artificial strip of land out in the harbor called a bulkhead, or seawall. This bulkhead would parallel the city some two thousand feet from the shoreline and stretch the entire western length of the city before wrapping around the peninsula and connecting with the northern bank of the Snohomish River. Instead of a harbor that was fully open to Puget Sound, Hewitt wanted to enclose it and redirect the

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44. House, *Report of the Secretary of War*, 51st Cong., 1st sess., 1889, H. Ex. Doc. 1, Vol. 2, Pt. 4, 2563.

45. "Puget Sound Ship Yards," *Washington Standard* (WA), June 19, 1891, 2.

river's terminus southward towards the working waterfront. To trap the freshwater along the waterfront, Hewitt envisioned building two locks—one to the north and the other at the southerly tip of the bulkhead. Once in place, Everett would never want of freshwater to protect its waterfront wharves. For these reasons, the improvement was often called the “freshwater basin.”<sup>46</sup>



**Figure 20: Nautical Chart Everett, Washington and Port Gardner. In this image, the bulkhead has burst and a new bulkhead line is proposed. North of the bulkhead are Ebey, Steamboat, and Union Sloughs, which carry much of the commerce into the Snohomish Valley. Image from NOAA's Office of Coast Survey Historical Map & Chart Collection. <http://historicalcharts.noaa.gov>.**

46. The freshwater basin improvement is explained in House, *Everett Harbor, Washington*, 52d Cong., 2d sess., 1892, Ex. Doc. No. 47, 1-4; and, House, *Letter from the Secretary of War*, 53d Cong., 2d sess., 1894, Ex. Doc. No. 53, 1-15.

To ensure that this artificial harbor would remain fresh, Hewitt recognized that he would have to do more than just redirect the river. At the same time that the mudflat prevented ships from entering the river, it also inhibited drainage and forced the river's valuable freshwater back upstream, forming a massive slough. What little water passed through the mudflat quickly dissipated northwest of the peninsula, having little anti-shipworm impact on the harbor to the southwest. What's worse, the blockage forced the river to find alternate outlets to the sea. East of Everett, the river splintered off into several channels (Union Slough, Ebey's Slough, and Steamboat Slough), two of which emptied outside of the planned bulkhead. Hewitt's solution was to close the sloughs and dredge the mudflats. In sum, as Hewitt and his associates strolled along the bluff, they viewed the waters surrounding the peninsula as imperfect. Only through these radical changes could Everett enjoy the anti-shipworm deterrents that so many of its neighbors on Puget Sound could only dream about.<sup>47</sup>

To see his vision through, Hewitt had one last hurdle to overcome: the Army Corps of Engineers. By the power of the 1890 Rivers and Harbor Act, Congress had ceded authority over navigable bodies of water to the corps. Nobody had permission to alter rivers or harbors without first gaining its consent. In 1892, Hewitt contacted Captain Thomas Symons (the same Symons who surveyed Bellingham Bay) and lobbied for the project. Symons surveyed the peninsula and quickly learned that "[t]he projectors of the town," as he writes, "lay great stress upon the fact that it so largely fronts on the Snohomish River, from the fresh waters of which they expect to derive great benefit due to their well-known anti-teredo effects." Symons saw value but did not see fit to allow

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47. Ibid.



Hewitt to complete the massive improvement alone. On the merits of his report the corps recommended that Congress fund the scheme. Over the next few years, Congress allocated funds for the bulkhead while ceding responsibility to the land company for dredging out the artificial basin and building the dams and locks to trap the freshwater. This arrangement seemed to please everyone, and Everett was on the verge of building a shipworm-free harbor.<sup>48</sup>

Then 1893 happened. The fallout from the Panic of 1893 hit Everett particularly hard, especially once Rockefeller pulled his investments in the Everett Land Company. Shortly thereafter, Hewitt was dismissed as the land company's president and the City of Everett fell into dire financial straits (at one point the city couldn't even afford to turn on the streetlights). In turn, progress on the freshwater harbor slowed. The land company made no effort to live up to its side of the bargain. But the freshwater harbor scheme was far from dead. Congress continued to build the bulkhead and took over responsibility for dredging the Snohomish River. What had once been a local initiative gradually became a federal improvement by default. The corps continued to execute the blueprint drafted by Hewitt and Symons, but there was no longer a leader with a clear vision about the goals of the improvement.<sup>49</sup>

In 1899, the scheme got a boost when J. J. Hill acquired the Everett Land Company's holdings and took keen interest in the corps' doings. Hill has been described as a capitalist who thought like an engineer. It's perhaps because of this mindset that he grew concerned about the bulkhead and the Snohomish dredging. In 1900, he penned a

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48. The freshwater basin improvement is explained in House, *Everett Harbor, Washington*, 3, 4.

49. Lawrence E. O'Donnell, *Everett: Past and Present* (Everett: 1993), 21-23.

letter to Secretary of War Elihu Root explaining how “Everett is the first point at which our Railway reaches Puget Sound.” The railroad titan urged that the improvement “be indefinitely postponed” because he feared that the project might “forever destroy the harbor.” His overriding fear: shipworms. Any alteration to the harbor had to take into account how it would alter the hydrology. “Without any improvement of any kind on the part of the General Government,” Hill explained, “the harbor is susceptible of being made a good one, and is quite free from the ravages of the teredo owing to the large volume of fresh water from the Snohomish River.”<sup>50</sup>

When someone like Hill speaks, others listen, including the Secretary of War. Secretary Root ordered corps engineers to pore over their notes and review every facet of the improvement. After evaluating every report, survey, and blueprint, the corps found Hill’s fears to be unfounded. Regarding shipworms, the report states that the improvement “will be a benefit so far as causing more fresh water to flow along the wharves and thus protect them to a certain extent from the ravages of the teredo.” The corps concluded that “Mr. Hill’s letter is based on misinformation,” and the improvement continued with no more opposition from Hill.<sup>51</sup>

By the end of 1901, Everett was on the verge of getting its long-awaited freshwater harbor. Then a series of events brought the improvement to an abrupt halt. For one, farmers along the Snohomish River vigorously objected to the diking of the river. Closing the sloughs would reduce drainage and undermine their own dikes designed for

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50. O’Donnell, *The Evolution of a Vibrant Everett Waterfront*, 29, 30; Klinge, *Emerald City*, 58; Correspondence between J. J. Hill and Elihu Root, National Archives Records and Administration, Pacific-Alaska Branch, Record Group 77, Office of Chief of Engineers, Seattle District Office, Letters and Reports Recd. Relating to Specific River & Harbor Imps, 1892–1906, Box 42, Everett Harbor, 1898–1901.

51. *Ibid*

flood prevention. The farmers had leverage too. Since they owned the land on which the corps wanted to dump river dregs they collectively brought the dredging of the mudflat to a standstill. With no legal recourse and no means of transferring the sediment over longer distances, this component of the improvement ended abruptly.<sup>52</sup>

Late in 1902 the project suffered another setback. The bulkhead breached at a point just northwest of the peninsula, allowing the freshwater to escape before it could be deflected southward to the waterfront. To add insult to injury, the corps discovered that the dike had deflected an enormous amount of sediment down along the waterfront in the short time it had been in operation. Engineers had always known that this might be a possibility. But as recently as one year earlier the corps downplayed the threat of sedimentation. How quickly things had changed. The degree of sedimentation, coupled with the protest from farmers, forced the corps' Major John Millis to recommend a halt to the improvement. "It is proposed," Millis wrote, "to indefinitely abandon the dredging and improvement of [the Snohomish River] and the original scheme of a 'fresh water harbor.'" This signaled the end of Henry Hewitt's original vision for a shipworm-free harbor.<sup>53</sup>

While the teredo-inspired freshwater basin was never finished, shipworms continued to shape the waterfront. Borers encouraged wharf owners to remake the waterfront through landfilling. In 1904, E. J. McNeely, an Everett mill owner, was the

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52. Ibid

53. Ibid.

first to sluice waste underneath his mill for the “purpose to decrease damage by Teredos.” In subsequent years, new land would encroach into the harbor.<sup>54</sup>

The remnant of the bulkhead was another legacy of shipworms. Sediment soon escaped through the breach and out to sea. But some of the mud collected just outside of the seawall, forming an island. Jetty Island, as it’s now called, was later converted into a nature preserve—a prime destination for nature seekers, sunbathers, and windsurfers. In hindsight, it is fair to characterize the freshwater basin scheme as a failure. But this failure should not distract from the consequences. Everett Harbor has been remade because of a long ago battle with shipworms.

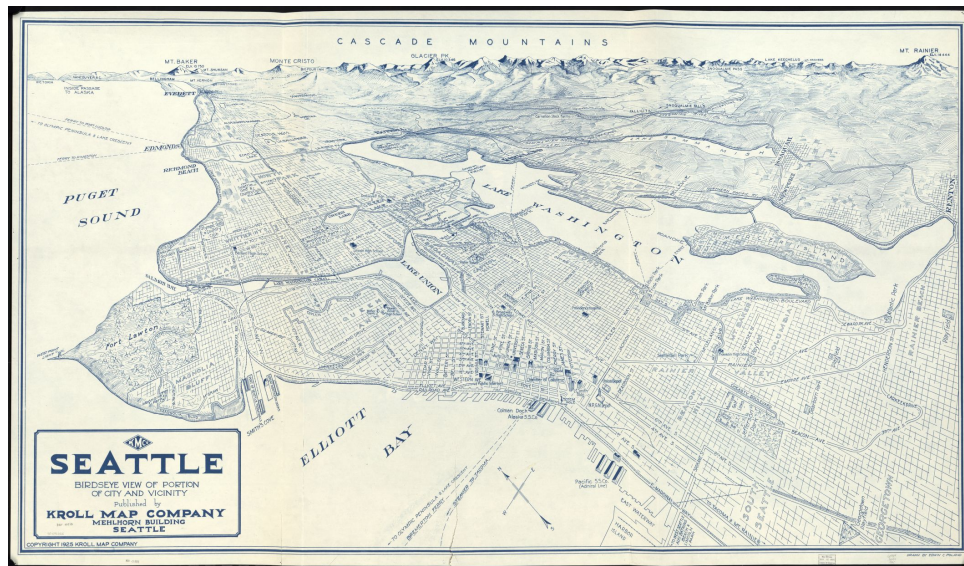
### **Seattle and the Scheming of Semple**

The people of Seattle were a spirited bunch. They even coined their own mantra, the “Seattle Spirit,” which became their rallying cry at the turn of the century. God knows they needed one. Seattleites powered through several obstacles on their way to regional hegemony. For instance, on July 17, 1873, just three days after learning that the terminus of the Northern Pacific would not reach their city, Seattleites organized a makeshift army of volunteers to attempt their own railroad over the Cascade Mountains to link up with transcontinental lines—the stunt, which was more of public relations effort, predictably failed, but was a moral victory nonetheless. Later, after the Great Seattle Fire of 1889 leveled the city (prompting Rudyard Kipling to describe downtown as a “black smudge”), residents rebuilt at an astonishing pace. Seattleites even carried their spirit into the halls of Congress, where, upon learning of the fateful Mahan Commission, they lobbied to build the ship canal to Lake Washington. The canal project was just the start. With an

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54. Ibid.

uncanny zeal, the people of Seattle radically transformed the topography, bathymetry, and hydrology of their city and its waterfront.<sup>55</sup>



**Figure 21: Birdseye of Seattle, Washington, 1925. In this image the Lake Washington Ship Canal has been finished. The filled Duwamish tideflats, bottom right, are not fully visible. The Newcastle coalmines are also not marked, but would appear in the upper right. Edwin C Poland and Kroll Map Company Inc. *Seattle Birdseye View of Portion of City and Vicinity*. Seattle, Kroll Map Company, 1925. Map. Retrieved from the Library of Congress, <https://www.loc.gov/item/75696666/>. (Accessed March 21, 2018.)**

City chroniclers rarely mention shipworms when recounting Seattle’s spirited transformation (recent environmental histories by Matthew Klinge and David Williams only mention teredo in passing). Their stories do pay close attention to the environment, but typically center on how Seattleites dug massive canals, reversed the flows of rivers, filled the world’s largest manmade island, and even tried to blast through a hill three hundred feet high. Local lore emphasizes how earlier generations did big things, how they fought one Goliath after another in their quest to tame the landscape and finish what they believed Nature hadn’t. Casting huge hills and torrential rivers as antagonists came

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55. Sharon Boswell and Lorraine McConaghy, *Raise Hell and Sell Newspapers: Alden J. Blethen and the Seattle Times* (Pullman: Washington State University Press, 1996); Rudyard Kipling, *From Sea to Sea: Letters of Travel* (New York: Doubleday & McClure, 1899), 47; See, Klinge, *Emerald City*, Williams, *Too High, Too Steep*, and Thrush, *Native Seattle*, for the environmental and social histories of Seattle.

easy for writers looking back on the city's formative years. Shipworms, on the other hand, make for poor Goliaths and don't easily fit into such grand narratives. But Goliaths they were. Seattle's design owes much to teredo.<sup>56</sup>

Canalization is where shipworms had their biggest impact on the city. Seattle's quest for a canal connecting Puget Sound to Lake Washington dates back to the 1850s. But it wasn't until later in the century, after Seattle's population and economy exploded, that it seemed within reach. By 1880, the city had grown to a mere 3,000 people. Ten years later that number would jump tenfold. The city's growth has a lot to do with the coal in the Newcastle seams just east of Lake Washington, which became the region's most important export during these early days.<sup>57</sup>

Retracing the path that carloads of coal took to get from mine to sea partly explains why the city became so intent on building a canal. Upon receiving coal from the mineshafts, the cars rode trams down some 900 feet to the eastern shore of Lake Washington. Afterwards, the cars were moved onto barges and floated across Lake Washington until they reached an isthmus near present-day University of Washington that blocked the path to Lake Union. After another short tram ride, the coal cars came to rest on another barge that took them two more miles to the south end of Lake Union. From there they were transferred to another tram that carried the cars through downtown and to the waterfront where they were finally relieved of their sooty contents in enormous coalbunkers.<sup>58</sup>

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56. The two best environmental histories of Seattle—Klingbe, *Emerald City* and Williams, *Too High, Too Steep*—mention shipworms, but only in passing and in nothing more than a general way.

57. Williams, *Too High, Too Steep*, 60.

58. This description of coal drayage is paraphrased from, Williams, *Too High, Too Steep* 71.

Coal operators no doubt found this process tortuous and costly, but they worried just as much about their coal once it reached the waterfront. The coalbunkers they built hovered over the tidelands of Elliot Bay in order to meet approaching ships, making them prime targets for shipworms. Bunker collapses became a regular occurrence. In 1877, for instance, a bunker owned by the Seattle Coal and Transportation Company spilled about 1,000 tons of coal into the bay after borers attacked its piling. In 1882, a man miraculously escaped a collapse after a steamer knocked over a riddled coal wharf.<sup>59</sup>

Coal distributors became vocal supporters of canalization. Wesley Wilson, manager of the Seattle Coal and Iron Company, complained to the U. S. Board of Engineers that his business was “very much handicapped by the enormous expenses of maintaining bunkers for the loading of coal into sea-going vessels in the salt water of Puget Sound, by reason of the ravages of the teredo.” Likewise, C. J. Smith, General Manager of the Columbia and Puget Sound Railroad (CPSR), moaned of the “difficulty of teredo at Seattle.” The canal was the answer. Coalmen viewed the canal not as a conduit for getting coal to the waterfront, but as a means of moving their coalbunkers away from teredo. According to the CPSR, coalbunkers on Elliot Bay cost \$168,000 to build, a figure that didn’t account for maintenance (re-sheathing and re-piling, etc.). On Lake Washington, the CPSR estimated that bunkers would cost a mere \$50,000 and survive almost indefinitely in fresher waters. These figures were bandied about in support of the canal for several years to come.<sup>60</sup>

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59. “Great Loss of Property,” *P-I*, June 11, 1877, 3; “Fell Down,” *P-I*, May 11, 1882, 4; “Watching the Teredo’s Work,” *P-I*, August 22, 1890, 12; “A Big Undertaking,” *P-I*, July 3, 1888.

60. House, *Canal Connecting Lakes Union, Sammamish, and Washington with Puget Sound, Washington*, 52d Cong., 1st sess., 1892, Ex. Doc. No. 40, 26, 33; Senate, *Report of Committee on Commerce*, 52d Cong., 1st sess., 1892, Rep. No. 666, 164.

Beyond its value to coalers, canalization offered other advantages, potentially to the navy. Territorial Governor and future Senator Watson Squire made this abundantly clear when he made one of the first detailed pitches for the canal to the Secretary of the Interior in 1884. Watson smartly tailored his message to his audience. He avoided discussing the local economic benefits of the canal and emphasized its value to national defense. “If this ship canal can be completed,” he explained, “it will, among other advantages, afford the finest known facilities for building and repairing sea-going ships of the greatest capacity in deep, accessible fresh water, where the teredo can do no damage, and will enable the United States Government to establish a great navy-yard on the Pacific coast under the most favorable circumstances.” Missing from his pitch are the advantages of opening up new lands to development, or access to coal, etc. The one variable that remains constant, however, is teredo.<sup>61</sup>

By 1889, Seattleites sharpened their arguments in favor of the ship canal (not coincidentally) at the same time Mahan sought a place to build the dry dock. Captain H. K. Hall, a well-known area shipbuilder, offered the usual arguments in favor of Lake Washington, which had become more widespread. After returning from a business trip to San Francisco, he reported how the “universal opinion” amongst Bay Area shippers “is that Lake Washington is the most eligible location for the navy yard.” He continues: “The important factor in bringing about this general conclusion is the fact that Lake Washington is fresh water, and that the teredo does not ply his destructive vocation therein.”<sup>62</sup>

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61. House, *Report of the Secretary of the Interior*, 48th Cong., 2d Sess., 1884, H. Exec. Doc. 1, 579.

62. “No Chance For The Teredo,” *P-I*, February 7, 1889, 3.



But Hall went further. Unlike his contemporaries, he didn't tiptoe around the inconvenient fact that the navy would first have to dig an expensive canal before constructing a dry dock. He explained: "It is my judgment that the cost of the channel would be entirely paid for in a few years by the saving made in the preserving of the yard plant from the action of the teredo—a consideration that cannot be ignored." While Seattleites ultimately missed out on the navy yard, they refined an important premise in their larger case for the ship canal—it made economic sense when the costs of replacing wharves throughout the city were factored into the balance sheet.<sup>63</sup>

Though disappointed by Mahan's recommendation, Seattleites didn't miss a beat in their pursuit for the canal. The next year they rejoiced after Congress authorized a survey of the proposed canal route through Shilshole Bay, Salmon Bay, Lake Union, and Lake Washington. The *Seattle Post-Intelligencer* salivated at the prospect of "eighty miles of wharves" sprouting around the lakes. Moreover, maintaining these structures would be but a "trifle compared to the cost of repairing the ravages of that salt-water pest, the teredo." And the savings would be "many times greater than the cost of the proposed canal."<sup>64</sup>

The Seattle Chamber of Commerce stressed the importance of borers to the canal surveyors. The chamber submitted three letters to the U.S. Board of Engineers endorsing the canal that were published in the final report to Congress. In one letter, the chamber explains that the "maintenance of wharves and docks in the salt water of the sound is now very expensive by reason of the ravages of the teredo." In another letter the chamber

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63. Ibid.

64. "From Lake To Sound," *P-I*, February 27, 1891, 8.

explained how it was “a well-known fact that the ravages of the teredo in the waters of Puget Sound, and, in fact, in all the waters of the Pacific Ocean, are so great as to be a tremendous tax on commerce.” The last phrase—“tax on commerce”—was a catchy refrain, and variations of it would reappear in reports and articles for years to come.<sup>65</sup>

When the full report came out in early 1892, Seattleites were yet again disappointed. The corps would not endorse the canal at that time. But this did not stop Watson Squire, now a U. S. Senator, from lobbying his fellow congressmen to fund the canal. Squire exhibited specimens of riddled timber pulled from the Seattle waterfront in Washington D. C. His samples are notable because they were driven *after* the Great Seattle Fire of 1889—in less than three years they had been perfectly devoured. The *Seattle P-I* thought that Squire’s display was the “best argument why there should be a fresh water harbor.” The editors saw no reason to doubt “that when the sensible congressmen come to examine the destructiveness of the teredo...they will vote to have a great fresh water harbor.” This clipping exudes the sort of confidence that many across the city shared. Seattleites were convinced, in spite of the setbacks, that they would get their freshwater harbor in no time at all. Unfortunately, their hubris was about to be shaken yet again since the ship canal saga had only just entered its second act.<sup>66</sup>

By the summer of 1892, proponents of the ship canal realized that they needed to rebrand the scheme. Prior to then they had pitched the canal primarily as a benefit to national security—any commercial advantages were ancillary to the benefits bestowed on the navy. When Congress refrained from building naval infrastructure in Lake

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65. Senate, *Report of Committee on Commerce*, 29, 32.

66. “Argument For The Ship Canal,” *P-I*, May 17, 1892, 2.

Washington, the canal's secondary features became the primary justifications for the project. Without the cover of the navy, promoters of the canal opened themselves up to attacks from people in neighboring cities who accused Seattle of lobbying Congress to fund an improvement that benefited only one city. The canal's future depended on its supporters showing otherwise.

One of the most vicious attacks came from the other side of the state where the *Spokane Review* beseeched Congress to “remain firm in their opposition” to the ship canal. With a heavy dose of sarcasm, the paper accused the people of Seattle of downplaying the destructiveness of shipworms, only to cry wolf when it was conveniently in their interest to do so. “For years,” the editors seethed, “we have heard the contention that the harbor in front of Seattle is the finest in the world; that it has anchorage and scope enough for the combined navies of the universe, and that the ravages of teredo were too trifling to be considered. And so it is with surprise that we read...that all this has been error.”<sup>67</sup>

Similarly, Tacoma—Seattle's biggest rival—went on the offensive. The *Tacoma Daily Ledger* whipped up fears that half the city might leave if the canal were built. In this anxious climate, an inventor named Lucian Cook tried to ease fears. “Why, I can do away with the necessity of a Lake Washington ship canal,” he told reporters, “by simply building a floating dam or cofferdam, which will retain the fresh water flowing into the harbor.” The proposed dam would stretch across Tacoma's harbor, blocking only the water on the surface. Freshwater, which is lighter, would apparently force the heavier saltwater out underneath the dam once pressure built, preserving the freshness of the

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67. The *Review*'s article was republished as, “That Canal Scheme,” *Dalles Daily Chronicle* (OR), June 23, 1892, 3.

water upstream. “At the patent office,” Cook bragged, “they said my scheme was the simplest and best method yet heard of in dealing with the teredo.” Tacomans like Cook saw Seattle’s potential victory over shipworms as their defeat.<sup>68</sup>

Canal backers expected criticism and went to work convincing others of the canal’s benefits. The Chamber of Commerce, in a memorial titled, “Key to the State,” argued that shipworms were a “tremendous tax upon commerce” and that the reduction in “wear and tear of wharves” would have the effect of “lessening the cost of transportation and terminal charges upon the handling of the grains and other products of the country.” In other words, the entire region saved by protecting wharves. This idea was shared by a Seattle grain trader C. G. Austin, who often mingled with eastern Washingtonian and Idahoan farmers. “I talked nothing but canal to the farmers,” the trader explained, “and they saw the advantage of it.” Two factors raised the cost of trade, in his mind. In Seattle, Austin moaned, “[w]e have seventeen feet of tide to contend with very often and it cost us \$40,000 to fill in under the building to keep out the teredo.” The canal would solve these problems and the savings would reach faraway farmers.<sup>69</sup>

Some eastern Washingtonians found Austin’s argument persuasive. For instance, the *Palouse City News* grew convinced that the canal would help rural farmers. “It will give her the finest harbor in the world, where the ships of all nations will congregate to free their bottoms from the destructive teredo,” remarked the editors. Moreover, the canal “will reduce the cost of handling the grain of the Palouse country and thereby benefit

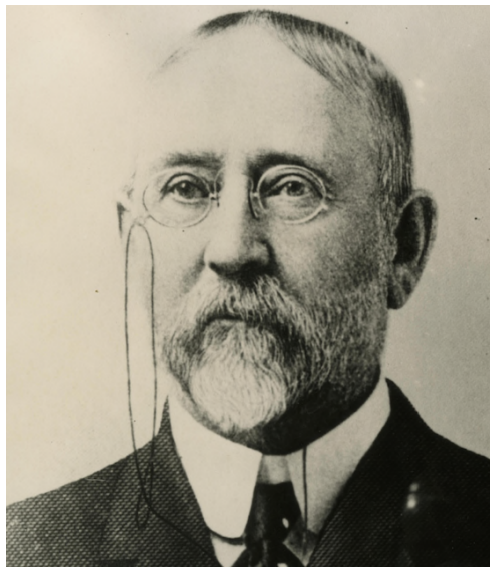
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68. “A Tacoma Man’s Patent,” *P-I*, June 16, 1892, 2; There’s no record of Cook’s application for the freshwater dam, but he was granted a patent a few years later for a freshwater pile jacket designed to prevent teredo. See, Lucian F. Cook, “Appliance for the Protection of Piles,” US Patent 789,207, filed June 30, 1902, and issued May 9, 1905.

69. “Key of the State,” *P-I*, March 26, 1891, 8; “The Passing Throng,” *P-I*, December 10, 1892, 4.

every farmer.” The paper closed with a rousing call to action, explaining that the ship canal “is an improvement in which the whole state is interested, which the people of the whole state should heartily support and work for.”<sup>70</sup>

By the close of 1893, ship canal boosters had persisted in spite of several roadblocks. Support for the canal grew and even came from one of the most unlikely of places: the editors of the *Skamokawa Eagle*, a Columbia River paper. “We went to Olympia biased against the Lake Washington ship canal,” write the editors, “but after seeing the work of the teredo in Olympia harbor we returned home in favor of the canal.” In short, borers proved effective marketing tools for the canal, an insight that didn’t go unnoticed by Eugene Semple, one of Seattle’s most notorious connivers.<sup>71</sup>



**Figure 22: Eugene Semple (1840-1908). Undated, Portraits of Territorial Governors, 1853-1889, Washington State Archives, Digital Archives, <http://www.digitalarchives.wa.gov>, (March 20, 2018).**

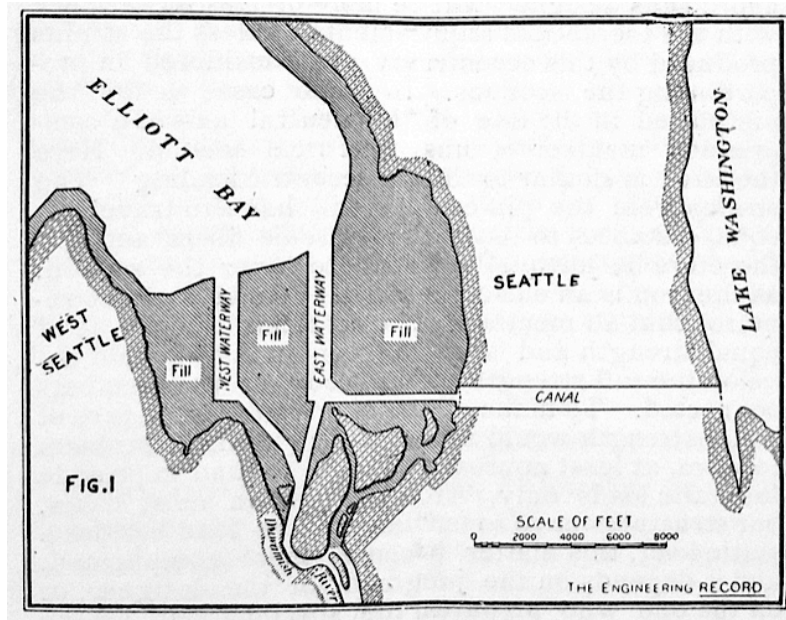
Historians largely deride Semple as a big talker and master of misdirection. Trained as a lawyer, Semple moved from the Midwest to Portland in the 1860s and

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70. The *Palouse City News* was reprinted in “State Press Opinion,” *P-I*, October 20, 1893, 4.

71. “A Convert to the Canal,” *P-I*, August 23, 1892, 5.

worked as a newspaper editor. Thanks to the influence of his father, a judge and senator, Semple was appointed to a term as Washington’s territorial governor. After Washington attained statehood in 1889, Semple ran unsuccessfully for governor before landing on the State Harbor Line Commission in 1890 where he studied tideland issues. While on the commission, Semple discovered a way to make himself rich by proposing an alternative canal: the so-called “south canal”.<sup>72</sup>



**Figure 23: Blueprint for the South Canal and Duwamish Waterways. Source: “The Seattle Canal and Land Reclamation Enterprise,” *Engineering Record* 32 (October 1895): 363-364.**

On paper, the south canal addressed some of the drawbacks of the older canal blueprint (known henceforth as the “north canal”). Ships entering through the proposed north canal, for instance, inconveniently circumvented downtown on their way to Lake Washington. The south canal, on the other hand, cut right through the commercial center of the city. Also, the north canal relied on endorsement by the corps and congressional

72. Alan A. Hynding, “Eugene Semple’s Seattle Canal Scheme,” *Pacific Northwest Quarterly* 59 (April, 1968): 77-87; Hynding, *The Public Life of Eugene Semple: Promoter and Politician of the Pacific Northwest* (Seattle: University of Washington Press, 1973); Klinge, *Emerald City*, 19-42; Williams, *Too High, Too Steep*, 91-112.

appropriations. The south canal did not; it was a private venture under the jurisdiction of state law. To pay for the south canal Semple exploited a new state law that permitted the filling and claiming of public tidelands so long as reclamation occurred in conjunction with the creation of public waterways—the North Canal had no tidelands to commandeer and sell to fund the scheme.<sup>73</sup>

Critics complained that the south canal was merely a ruse to justify the seizing of publicly owned tidelands for private profit. As further evidence of chicanery, opponents drew attention to the near impossibility of blasting through Beacon Hill, a three hundred foot tall peak that blocks Elliot Bay from Lake Washington, which even the corps had dismissed as impractical. This fact alone revealed Semple’s true intention: to make a quick buck by selling tidelands under the guise of a public improvement that would never come to be. As mightily as critics complained, their protests were rebuffed by the State Commission of Public Lands and muted by the enthusiasm across the city. With the north canal stalled, Seattleites willingly ignored the south canal’s flaws just to see some progress.<sup>74</sup>

Semple capitalized on this groundswell of support, and a year after submitting his south canal proposal, he notified the commissioner of public lands that he wanted to expand the canal project and completely transform the tidelands in front of the city by reengineering the mouth of the Duwamish River. In addition to the South Canal across Beacon Hill, Semple devised a plan to excavate two navigable large north-south channels through the tidelands until they reached the mouth of the Duwamish. The dregs were to

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73. Hynding, “Eugene Semple’s Seattle Canal Scheme.”

74. Klinge, *Emerald City*, 64-65.

be sluiced onto the tidelands directly between the two commercial waterways (confusingly named the “eastward” and “westward” waterways, even though they ran north and south) creating what would become for a time the world’s largest manmade island, Harbor Island. To help justify the continuously sprawling scheme Semple played up its anti-shipworm qualities.<sup>75</sup>

Shipworms had interested Semple for some time. In 1891, he listed combating shipworms as one of the advantages of the south canal. In a series of bullet points, Semple distinguished between “economical advantages” and “speculative advantages”. At this stage, shipworms fell into the latter category. Semple merely regurgitated what north canal boosters had long argued. He writes, “the canal would make available all the frontage of the Lake, where wharves would be free from the depredations of the teredo.” There was little new or inspired in this; everyone agreed on this point.<sup>76</sup>

Over the next three years Semple grew more preoccupied with shipworms and made fighting them central to the Harbor Island scheme. He argued as much to the Commission on Public Lands. Semple proposed that the eastward channel would emit a “large volume of fresh water with a current along the present wharf front [and] would act as a teredo destroyer and extend the life of a wharf from ten to twenty years.” To justify his scheme, Semple reminded the commission that Bellingham had done the same thing. He writes: “At Bellingham Bay the Nooksack River renders this service and it is considered of such importance that the silting up of the harbor by the river is a secondary

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75. Hynding, “Eugene Semple’s Seattle Canal Scheme,” 79, 80.

76. Eugene Semple, “Proposition for a Ship and Water Power Canal Between Elliott Bay and Lake Washington, near Seattle, Wash.,” January 3, 1891, University of Washington Special Collections, Eugene Semple Papers, Box 17, Folder 3, Acc. 174, 532.



question.” Semple concluded, “[i]t would pay to excavate this waterway if no other result than this was accomplished.”<sup>77</sup>

Semple received a lot of fanfare throughout Seattle. The Seattle Chamber of Commerce passed a resolution praising the scheme and explained that its object “would be to drain the river and protect the wharves along the waterways from the ravages of the teredo.” Later, in January of 1895, John E. Risedorph, a Civil War veteran-turned-Seattle booster, captured the excitement many felt when he explained to the editors of the *D. C. National Tribune* how the project “solves the great teredo question.” A few months later, the *P-I* lauded the canal and channels in an article titled “The Pestilent Worm: How Harbor Works Will Stop His Work.”<sup>78</sup>

July 29, 1895 was a big day. Hundreds came down to the tidelands to watch as Semple’s daughter Zoe flicked the start switch on the dredger *Anaconda*. Eugene had promised a canal and much more. New land would soon be the home of thriving businesses. And someday soon ships would ply through Beacon Hill and dock at even more factory wharves along Lake Washington. Shipworms helped make this big day happen, for without the threat they posed it’s hard to say whether Semple would have been able to muster the support for his schemes. Shipworms weren’t the only reason to dig, but they were one important leg that kept his scheme from falling apart. This would be Eugene Semple’s finest hour.<sup>79</sup>

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77. Eugene Semple, “Address, to the Board of State Land Commissioners, Olympia,” 1894, University of Washington Special Collections, Eugene Semple Papers, Box 17, Folder 4, Acc. 174, 532.

78. “Plan of Waterways,” *P-I*, June 20, 1894, 8; “Rival Designs,” *P-I*, June 22, 1894, 8; John Risedorph, “There Are Now Fine Prospects Ahead For Seattle,” *National Tribune* (DC), January 31, 1895, 12; “The Pestilent Worm,” *P-I*, April 7, 1895, 7.

79. Williams, *Too High, Too Steep*, 94-96.

Semple's star quickly faded, revealing him to be the "typical frontier speculator" some thought him to be. The sale of new land did not offset the costs, and dredging and blasting through Beacon Hill proved impossible. Semple scrambled to attract investors, but few came running. Excavation halted in 1897 for lack of capital, before resuming again in 1900. Fed up with Semple's unfulfilled promises, many in Seattle turned their backs on the south canal in favor of the north canal.<sup>80</sup>

Proponents of the north canal had simmered during Semple's heyday. As long as he continued digging there was no way they could convince the corps or congress to fund their canal. So north canal backers tried to undermine Semple by calling on the corps to choose officially the better route. The corps acquiesced and found Beacon Hill too formidable to blast through. This was a blow to Semple who already faced criticism due to the lengthy work stoppages. Even though he succeeded in finishing the eastward waterway, north canal backers cleverly lobbied to end Semple's water contract—no water meant no water cannons to excavate the south canal. Semple resigned in 1905, effectively ending the south canal.<sup>81</sup>

Meanwhile, as the south canal died its protracted death, north canal boosters tried to regain the momentum they'd lost to Semple. Seattle businessmen still believed that their future was tied to the fate of the canal. A man named Donald Fletcher captured these sentiments in a speech he gave to the Chamber of Commerce in 1900. Fletcher, the ex-president of the Denver Chamber of Commerce and a Seattle transplant, predicted that

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80. Hynding, *The Public Life of Eugene Semple*, xi; Hynding, "Eugene Semple's Seattle Canal Scheme," 82, 83.

81. Hynding, "Eugene Semple's Seattle Canal Scheme," 86.

the trade of the Pacific would rival that of the Atlantic just as soon as the detriments of dry-docking expenses and shipworms could be eliminated. Seattle was primed to overcome both of these with the ship canal. Chamberman James Meikle echoed these sentiments in a 1901 pamphlet that argued, in part, how the canal would mitigate the effects on shipworms. The consensus was that the north canal—and not the south canal—was where Seattleites ought to invest their energy. All that was left was convincing the corps.<sup>82</sup>

In 1902, the chamber men succeeded in having their voices heard by the corps, which reviewed the project yet again. Meikle, in particular, hammered away at the anti-shipworm benefits of the canal. He explained (in a now predictable refrain) that the savings from teredo would “repay the cost of construction of the canal within a few years.” Curiously, once the chamber men finally had the ear of the corps, they grew a little panicked, as if they feared asking for too much. So the chamber men committed a classic business faux pas by negotiating with themselves at the last minute. If the corps was unwilling to excavate to Lake Washington, the chamber men wrote, they would happily accept a compromise: dig the canal to Lake Union. “Such a modification,” they argued, would still create a “sheltered fresh-water harbor, free from storms, tidal disturbances, and the ravages of teredo.”<sup>83</sup>

The chamber men had reason to be worried. After reviewing the canal proposal, the corps, in an uncharacteristic reversal, came out strongly against the canal proposal in

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82. “Seven More Railroads,” *P-I*, September 20, 1900, 10; James B. Meikle, Seattle Chamber of Commerce, *The Lake Washington Canal, Seattle, Washington* (Seattle: Seattle Chamber of Commerce, 1901), 13-15.

83. Senate, *Canal Connecting Puget Sound With Lakes Washington and Union*, 57th Cong., 2d sess., 1903, Doc. No. 127, 23, 29.

1903. The next couple years proved to be the nadir of the scheme. As usual, shipworms factored into this decision, but not in the normal way. While engineers had long been sympathetic to complaints about shipworms, they no longer found arguments of this nature compelling, at least for this particular report. To be sure, engineers didn't negate the complaint. "It is not to be denied," they explained, that "the construction of wharves is unusually expensive" owing to "marine insects." But digging a canal for this reason was not warranted owing to the "abundance and cheapness of lumber in that region."<sup>84</sup>

It wasn't until 1906 that Seattle found its champion for the canal, and somebody who also respected shipworms: Hiram Chittenden. After designing the Yellowstone Park roadway and consulting on river improvements in Ohio and California, Chittenden took over as head of the corps' Seattle District Office. He quickly became a booster for the north canal and conducted another review of the canal proposal, during which he was awestruck to learn that sixteen million feet of logs floating in the bay were "entirely ruined" before they could be processed by local mills. This had an impression on Chittenden who saw the canal as a tool to shield the timber industry from shipworms.<sup>85</sup>

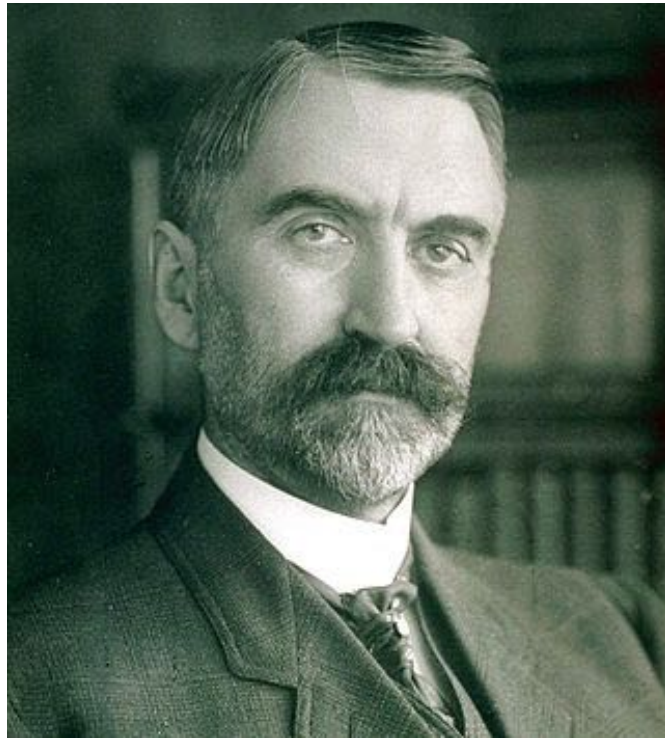
In his report, Chittenden listed four "specific benefits" that the ship canal would have over the present conditions of Elliot Bay, the first two of which involved shipworms. The ship canal would offer "unlimited amount of anchorage room" where vessels could be "free from the attacks of marine insects." Also, building wharves would be cheaper on the lakes thanks to the "more favorable depths and the absence of tide and

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84. Senate, *Canal Connecting Puget Sound With Lakes Washington and Union*, 11.

85. Gordon Barlow Dodds, *Hiram Martin Chittenden: His Public Career* (Lexington: University of Kentucky Press, 1973); House, *Puget Sound-Lake Washington Waterway*, Washington, 60th Cong., 1st sess., 1908, Doc. No. 953, 18.

marine life” (a euphemism for teredo). All in all, Chittenden became a quick convert to the cause of fighting shipworms and his commitment to the canal landed him in Seattle’s good graces. After resigning from the corps in 1908, Chittenden became one of Seattle’s first three Port Commissioners and continued to advocate for the canal. In 1910, he published a pamphlet on behalf of the Chamber of Commerce that advocated, among other things, how the “[f]reedom from the teredo is an immense advantage of a fresh water harbor.”<sup>86</sup>



**Figure 24: Hiram Chittenden (1858-1917). Source: U.S. Army Corps of Engineers**

While Chittenden supported the existing blueprint, he understood that the three pillars of the improvement—1) Freedom from shipworms 2) Freedom from tidal action and 3) the opportunity to develop around the lakes—would not be enough to convince Congress. So he added a fourth pillar: flood control. Chittenden had become an advocate

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86. House, *Puget Sound-Lake Washington Waterway, Washington*, 17-19.

of adding flood control to the corps' mission and carried that zeal to Seattle. Chittenden explained how forcing Lake Washington to empty east through Salmon Bay, instead of its historic southerly channel via the Duwamish River, would lower the lake by nine feet, thus ending the deluges that swamped farmers south of Seattle. The flood control mandate was the tipping point that convinced Congress to pay for the canal.<sup>87</sup>

## **Conclusion**

In 1916, the Government Locks, located at the head of the ship canal, opened to great fanfare. Unfortunately, the man who helped make them possible could not attend due to failing health. But Chittenden would not be forgotten. The locks were later renamed the Hiram M. Chittenden Locks in his honor. Shipworms, which also made the canal possible, were forgotten. The opening of the ship canal symbolically closed the book on teredo in the Pacific Northwest. In the future, borers would no longer remain fodder for a regional discourse. The interurban battles that had been waged for decades had come to an end. The region had taken shape. Short of a new transcontinental railroad, nothing was going to radically upset the economic and political centers that had evolved. Flinging teredo barbs certainly wasn't going to change anything. Such rhetoric might have made sense in the ill-defined frontier era, but not moving forward.

But none of this should diminish the importance that teredo had up to this point. Shipworms were just as much an opportunity as they were a burden. Whole industries adapted to teredo; many cities advertised their lack of teredo; several waterfronts took shape because of teredo; and newsmen and hucksters made careers preying on the fear of teredo. The significance of teredo was in the eye of the beholder. There's a joke that

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87. Klinge, *Emerald City*, 68-79.

circulated around the region in the 1890s that captures these sentiments to a certain degree. Victorians had discovered an unusually large shipworm, and instead of discarding it, they dropped it into a jar of alcohol to preserve it. On the front of the jar reads “The Scourge of Puget Sound.” Some jokingly questioned what the labeled referred to. “As there is about four quarts of alcohol to one teredo it is a little doubtful as to whether it is the alcohol or teredo referred to by the above title. Some people might think both.” Whether or not someone found this funny probably said a lot about how successful they had been at making the best from the ravages of teredo.

CHAPTER FIVE  
AN UNNATURAL NATURAL DISASTER:  
MARINE BORER INVASIONS OF SAN FRANCISCO BAY

**Introduction**

In the summer of 1921, the editors of the *Sacramento Union* reached deep into their archives, dusted off an old story, and reprinted it alongside the fresh news of the day, as they often did. Their regular column, “Stories From the Files,” juxtaposed life in the nineteenth century with the present in amusing ways. The past appeared quaint, strange, and curious—an entertaining reminder of how much had changed. If its purpose was to amuse, the most recent installment missed its mark. It didn’t offer a break from the headlines. In fact, it could have easily been mistaken for one. The column featured a story from all the way back in 1855 describing “a method of preserving timber from the ravages of the Tereido” that had been tested in San Francisco Bay. The preservative, which had been subjected to “prolonged experiments,” unfortunately did not meet with “satisfactory results.” Avid readers of the paper must have gulped in irony since the Bay Area was presently in the throes of a severe woodborer epidemic. The past was not something distant and amusing. Instead the column reminded readers that decades of bad luck and lackluster attempts to control borers had set the stage for an even larger crisis—the *Tereido navalis* invasion of San Francisco Bay.<sup>1</sup>

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1. “California Curiosities,” Stories From the Vault, *Sacramento Union*, July 8, 1921, 4; “California Curiosities,” *Sacramento Daily Union*, April 7, 1855, 2; For details of the study on which the report is based, see W. O. Ayres and J. B. Trask, *Proceedings of the California Academy of Natural Sciences* 1 (1854-1857): 39.



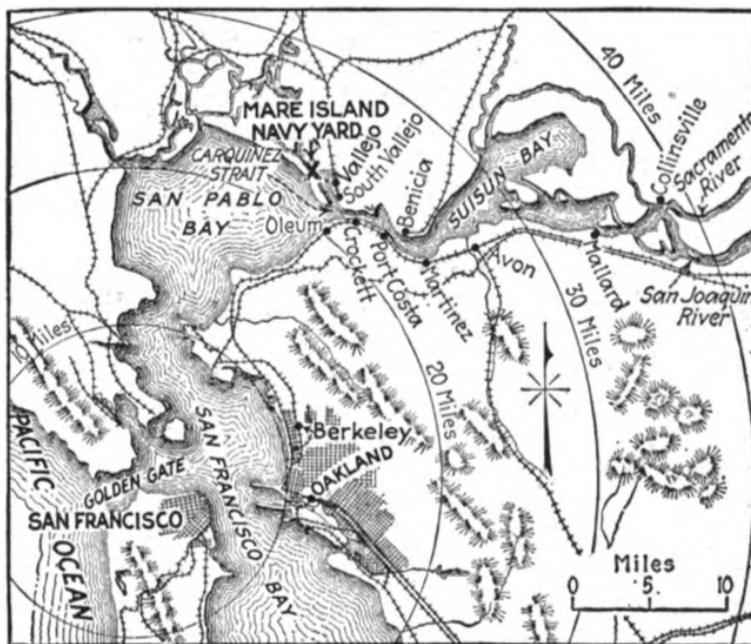


Figure 25: “Map of San Francisco Bay, Showing Remote Points Where *Teredo* Activities Have Only Recently Been Noted.” Credit: “*Teredos* Destroy Piles In Water Not Previously Infested,” *Engineering News-Record* 84 (May 1920): 1001.

The basic chronology of the *Teredo navalis* invasion is more or less clear: the first borers were spotted in 1914, though evidence of their tunneling can be traced back to 1913, and possibly a little earlier. Between 1914 and 1917, *Teredo navalis* quietly blended into the crowd of existing woodborers in the southern portion of San Francisco Bay before invading San Pablo Bay, Carquinez Strait, and Suisun Bay between 1917 and 1921 when drought conditions salinized the normally fresher waters of these northern waterways. In the fall of 1919, the worst destruction commenced. Wharves collapsed almost like dominos, often requiring little more than a nudge by docking vessels to topple them. In one instance, an engineer watched as a pier collapsed merely from the pressure of the outgoing tide. The disaster made headlines nationwide after some twenty-five million dollars worth of infrastructure failed.<sup>2</sup>

2. For an overview of the invasion, see C. L. Hill, “Origin and Development of the San Francisco Bay Marine Piling Survey Project,” in *Marine Borers and Their Relation to Marine Construction on the Pacific* 193

While the *Teredo navalis* invasion hit with a swiftness and voraciousness unlike anything anyone had ever experienced before, it was not altogether inconsistent with California's broader coastal environmental history. Each and every major port in the state has been subjected to invasive borers since the Gold Rush. All of the borers now established in Los Angeles and San Diego, for instance, came from other parts of the world long ago—none are native. If San Francisco Bay is distinguishable at all from the rest of the state's coastline, it is because it had the misfortune of being situated in an ecological Venn diagram—all of the west coast's most destructive woodborers, both native and nonnative (save one), thrive in the Bay Area, creating the potential for an ecological perfect storm.<sup>3</sup>

It would be a mistake, however, to attribute the bay's troubles solely to poor geographic luck and climatic fluctuations. People also shoulder some of the blame for the woodborer epidemic. Since before the Gold Rush, people have been creating the conditions in which woodborers flourished. For starters, without the aid of transoceanic ships, borers such as *Teredo navalis*, *Lyrodus pedicellatus*, and *Limnoria quadripunctata* might never have reached California in the first place. Upon arrival, borers were greeted by Bay Area marine builders who effectively laid down the welcome mat by doing such things as driving poorly treated structures or recycling infected piles around the bay.

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*Coast: Final Report of the San Francisco Bay Marine Piling Committee* [hereafter, "*Marine Borers and Their Relation to Marine Piling on the Pacific Coast*"] (San Francisco: Committee, 1927), 1-12; For the wharf collapsing from tidal action, see "Teredos Destroy Piles in Waters Not Previously Infested," *Engineering News-Record* 84 (May 1920): 1000-1002.

3. For a thorough review of the west coast's introduced borers, see James Theodore Carlton, "History, Biogeography, and Ecology of the Introduced Marine and Estuarine Invertebrates of the Pacific Coast of North America" (PhD diss., University of California, Davis, 1979), 547-568, 611-639. The only major borer not present in San Francisco Bay is the cold-water boreal *Limnoria lignorum*; Matthew Morse Booker, *Down By the Bay: San Francisco's History Between the Tides* (Berkeley: University of California Press, 2013). Booker's recent impressive history of the bay only mentions borers in passing.

Additionally, in the northern reaches of the bay, decades of modifications to the riparian and estuarine environments helped *Teredo navalis* spread to waterfronts it previously wouldn't have been able to survive in. In these ways and others, the woodborer epidemic that culminated with the *Teredo navalis* invasion was not totally out of people's hands. The crisis was a long time in the making.

### **The Other Miners of 1849**

The California Gold Rush caused an explosion of biological activity in San Francisco Bay. Ships barreling through the Golden Gate transported more than prospectors, they also brought nonindigenous aquatic stowaways, such as fouling organisms like the Atlantic barnacle, among dozens of other invertebrates. Meanwhile, native shipworms called *Bankia setacea*—which Californians knew simply as “teredo”—feasted on the wharves sprouting like lily pads along the waterfront. For dessert, they chomped away at the 800 or so ships abandoned at Yerba Buena Cove by sailors-turned-miners.<sup>4</sup>

The teredo attacks surprised San Franciscans, leading them to conclude (wrongly) that *Bankia setacea* was an invasive borer. A seasoned skipper articulated this common view in the 1850s. After reflecting on his thirty years of sailing, never had he encountered a woodborer anywhere north of Acapulco before 1845, and never one in San Francisco Bay up until roughly “1848 or 1849.” The sailor surmised that the borers invaded San Francisco Bay “by the ships of the Golden Fleet,” a belief that would become common among San Franciscans for years to come. The truth is that *B. setacea*, a native of the

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4. For a fuller accounting of San Francisco Bay's many introduced species (and not just woodborers), see Andrew N. Cohen and James T. Carlton, *Nonindigenous Aquatic Species in a United States Estuary: A Case Study of the Biological Invasions of the San Francisco Bay and Delta* (Washington DC: U.S. Fish and Wildlife Service, 1995). *Bankia setacea* is not one of the species that Cohen and Carlton consider invasive.

west coast from San Francisco Bay all the way up to Alaska, had quietly subsisted on driftwood long before the prospectors had arrived. The borers flourished in the presence of urban developments, giving the impression that they were an introduced species.<sup>5</sup>



**Figure 26: Yerba Buena Cove, 1847. The San Francisco Marine Piling Committee of the American Wood-Preservers' Association, Inc. *Final Report of the San Francisco Bay Marine Piling Committee*, 14. Used with permission of the American Wood-Preservers Association**

In San Francisco, shipworms might have gone unnoticed at first, but they became very well known within a few short years. The degree to which borers were on everyone's minds is encapsulated in the words of the newly created Harbor Commission. In 1863, the commissioners admitted that “[f]rom time to time we have chronicled the caving in of portions, large or small, of nearly every wharf along our city front.” Casual readers of the news couldn't fail to miss these reports, some of which made front-page headlines. Even the routine replacing of borer-infested piles graced the pages of the news.

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5. “Marine Borers In Our Harbors,” *San Francisco Bulletin* [hereafter, *SFB*], May 15, 1856, 1; R. M. Neily, “Historical Development of Marine Structures in San Francisco Bay,” in *Marine Borers and Their Relation to Marine Construction on the Pacific Coast*, 13. Neily, writes that “tradition says that the shipworm was not known there in Spanish days and did not become a menace until after the large shipping increase in the port which followed the gold rush of 1849”; “Shipworms Come to North of Bay,” *Oakland Tribune*, December 30, 1917, 26. The *Tribune* is an example of how long this mistaken belief perpetuated. It writes “The destructive shipworm was unknown in San Francisco Bay for three-quarters of a century after ships began to sail through the Golden Gate. With the vast increase in shipping which followed the discovery of gold in California, ships entered the bay which were infested with wood-boring molluscs.”

By the mid-1860s the *San Francisco Bulletin* remarked offhand how “[e]very Californian knows how the teredo bores into timber.” Californians could not avoid shipworms even if they had never set foot in the city or on the waterfront.<sup>6</sup>

After little more than a decade, the borer-infested waterfront desperately needed some attention. The harbor commissioners’ first attempt to deal with the problem was an ill-informed blunder. While overseeing the rebuilding of the Vallejo Street Wharf in 1864, the commissioners ordered the piles be stripped of their bark before driven. This was the worst possible decision, and they would have known better had they bothered to reach out to the California Academy of Science (founded 1853), which had finished a study on shipworms the year before. The academy concluded (correctly) that tree bark slowed borers to some degree. During the 1870s, the commission would learn from its mistake and use wood with its bark attached.<sup>7</sup>

The harbor commissioners made a habit of making imprudent or kneejerk decisions that benefited teredo. Their less than thorough testing of the Robbins Process is a perfect example. In 1869, the commissioners “deemed it of great importance to make some experiments” on a number of new anti-borer products, such as the Robbins Process (see chapter two), which had recently hit the market. The commissioners (smartly) didn’t take Robbins at his word and prudently conducted a test. Their mistake was cutting the test early. In November of 1870, after only eighteen months, and before the test was slated to end, the commissioners pulled the piles, saw that they were unharmed, and then

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6. “Ravages of the Teredo—A Remedy Proposed,” *Daily Alta California*, December 19, 1863, 1; “Rock-Boring Mollusks,” *SFB*, August 8, 1866, 1.

7. *Proceedings of the California Academy of Natural Sciences* 3 (1863-1867): 11; “Re-building Vallejo-Street Wharf,” *Daily Alta California*, April 4, 1864, 1; G. M. Hunt and C. L. Hill, “Engineering Phase,” in *[First] Report on the San Francisco Bay Marine Piling Survey* (San Francisco: Committee, 1921), 64. Hunt and Hill refer to a Harbor Commission report from 1871 that recommends untreated wood with bark on.

ordered all piles driven along the waterfront be treated by the Robbins Process. After a couple years, these piles fared so poorly that one observer remarked bitinglly that “[t]he worms actually appear to have attacked these preserved piles in preference to the non-preserved.”<sup>8</sup>

By the start of the 1870s, the San Francisco waterfront was in a precarious state. It looked like jagged series of gnarled saw-teeth made up of uneven wharves that conformed to a harbor line that was more theoretical than actual. The city needed a massive waterfront improvement, and everyone knew it. But talk was cheap, and until a concrete plan was in place, no one had incentive to improve their properties out of risk that their investments might go to waste if and when the harbor lines were redrawn. All the while, shipworms feasted on the inertia, and made fools of anyone who dabbled in anti-borer methods. What’s worse, the worm-infested waterfront would become an easy target for up-and-comers trying to supplant San Francisco—namely, Oakland.

### **The Oakland Conundrum**

With frustrations over shipworms mounting in San Francisco, boosters in Oakland saw an opening to distinguish themselves from their neighbors to the west. No doubt, this had a lot to do with the transcontinental railroad inching ever closer to its completion in 1869. Questions started to fly regarding the precise terminus in the bay: would it be San Francisco or Oakland? In this context, some in the Bay Area started to talk up Oakland’s absence of teredo as a would-be benefit to the railroad—a dubious claim that later

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8. Neily, “Historical Development of Marine Structures in San Francisco Bay,” 18; “Editorial Notes,” *Daily Alta California*, July 6, 1870, 2; “The Work of the Harbor Commissioners,” *Daily Alta California*, November 5, 1870, 2; John Blackbourn, “The Action of Marine Worms and the Remedies Applied in the Harbor of San Francisco, California,” *Engineer* (London) 38 (October 1874): 111-118.

became a point of contention between Oaklanders and the Central Pacific when the railway company tried to move its terminus away from the east bay in the early 1870s.

The notion that Oakland lacked teredo first surfaced in 1868 in response to a plan by San Franciscans to bypass the east bay and bring the transcontinental railroad over to San Francisco via a trestle stretching across the bay. One Bay Area newspaper criticized this scheme because it was “questionable whether a pile bridge would not be destroyed by the teredo in two or three years.” A few days later, the *Alta* went further and lobbied for Oakland to be the Central Pacific’s terminus due in part to its “immunity” from the “attack of the teredo.”<sup>9</sup>

For the next couple years, Oakland’s alleged lack of teredo became one of its calling cards. In 1871, the *Alta* again lauded the city after the unveiling of the Central Pacific Long Wharf, which carried the transcontinental railroad to deep water. An engineering marvel for its time, the wharf jutted out more than 11,000 feet across Oakland’s mudflats. According to the *Alta*, the wharf succeeded in part because “the destructive marine wood-eating worm, the teredo, is not found there at all.”<sup>10</sup>

In the same year, an Oakland booster published a lengthy pamphlet extoling his city’s many environmental amenities, especially its lack of teredo. “An important consideration in connection with the vast amount of piling already done and the vaster amount in contemplation,” explains John Scott, the author of the piece and an editor for Oakland’s *Daily Transcript*, “is the absence of the *teredo*, or ‘pile worm.’” Scott couldn’t

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9. “The Terminus of the Central Pacific Railroad,” *Daily Alta California*, January 24, 1868, 2; “The Central Pacific Railroad; Or, Science vs. the Teredo,” *Daily Alta California*, January 26, 1868, 3; “The Terminus of the Central Pacific Railroad,” *Daily Alta California*, January 28, 1868, 2.

10. “What the Pacific Railroad Has Been Doing,” *Daily Alta California*, January 17, 1871, 1.

say definitively why teredo avoided Oakland, but he did note that (unidentified) “[s]cientific men attribute this to the fact that the flood tide...throws the fresh water from the ‘Sacramento’ and ‘San Joaquin’ far over to the east side of the Bay.” While the “absence of the *teredo* from the [Oakland] Estuary has never been accounted for satisfactorily,” Scott admitted, “the fact of its non-existence is established.” Scott’s assumptions about teredo were shared by his fellow Oaklanders; dozens of them read and endorsed the veracity of the pamphlet’s contentions before it went to print (there was only room allowed for fifty-seven signatures, though Scott alleges that many more read it before its release). Moreover, the supporters of the pamphlet promised to “assist in its circulation.” Towards the end of the pamphlet, Scott unleashed his abilities as a writer and produced an elegy titled “What Nature Has Done.” Scott was grateful to nature, for “She has given us...one of the finest harbors in the world; and she has banished the *teredo* from our shores.”<sup>11</sup>

Oaklanders were proud of this distinction and criticized people who said otherwise. In October 1871, for instance, an editor for the *San Francisco Call* caused a stir after reporting that Long Wharf was under attack by borers. An Oaklander (going under the pseudonym “a prominent citizen”) responded angrily to the suggestion. “Where, in the name of common sense, did you get such an idea?” he demanded. “Why, sir,” responded the *Call*’s editor, “haven’t I been fishing from the Oakland Wharf often and often? And haven’t I bought the *teredo* for fish bait, time and time again? And don’t everybody buy the *teredo* for fish bait on the Oakland Wharf?” To this, the Oaklander

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11. John Scott, *Information Concerning the Terminus of the Railroad System of the Pacific Coast* (Oakland: Daily Transcript, 1871), ii, 8, 12, 13, 32.



retorted admonishingly, “don’t you know the difference between the *muscle worm* and the *teredo*?”<sup>12</sup>

In 1872, Oakland’s reputation as a wormless harbor came under intense scrutiny yet again. But this time the doubts could not be dismissed so easily, for they came from none other than Leland Stanford. As California’s former governor and a board member of the Central Pacific, Stanford held a lot of influence in the state. Stanford surprised the people of Oakland when he labeled Long Wharf as nothing more than a temporary structure so soon after it was built. “The wharves [of Oakland],” Stanford explained, “are wooden structures, and through decay, and the destruction of the ‘teredo,’ they, of course, must be short lived.”<sup>13</sup>

Stanford’s remarks set off a firestorm, largely because they are difficult to disentangle from the Central Pacific’s desire to secure Goat Island, also called Yerba Buena Island, which sits smack dab between Oakland and San Francisco. Goat Island is a convenient marker distinguishing the east from the west bay. Along the eastern side of the island, mudflats emanating from Oakland restrict deep draft shipping. To the west, these mudflats give way to a deep strait, making the island prime real estate for a centralized rail-to-ship terminal. For these reasons, Stanford and the Central Pacific held Goat Island in high regard. Unfortunately, the railway titans couldn’t simply buy up the island since the federal government retained rights to it for strategic purposes. This didn’t stop the Central Pacific from trying to obtain Goat Island, however, and the company openly lobbied for it in 1872, playing up the problem of teredo.

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12. “A Good Joke,” *Daily Alta California*, October 17, 1871, 1. Teredo was used as baitfish in the bay.

13. “The Goat Island Business Before An Assembly Committee,” *Daily Alta California*, March 19, 1872, 2.

Stanford had plenty of explaining to do when he arrived at the capital in Sacramento to make his case to state legislators. Stanford voiced his concerns about woodborers in Oakland and why Goat Island was so crucial to the success of the railroad. He readily admitted that woodborers would require an endless replacement of piling underneath the trestle that extended from Oakland to the island—the company accepted this as a cost of conducting business. But Stanford at least wanted a stable depot at the end of the tracks where trains and freight could rest without fear of tumbling into the bay after honeycombed piles gave way. Extending Long Wharf to Goat Island offered protection for trains and freight at rest.<sup>14</sup>

Not everyone took Stanford at his word. The *Alta* dismissed the notion that woodborers were a problem in Oakland. In fact, the *Alta* called Stanford an outright liar. “[I]t is a notorious fact, attested by [Stanford’s] own employees [*sic*] in charge of the Oakland Wharf,” writes the editors, “that no signs of the *teredo* have, thus far, been discovered in said wharf.” The paper insinuated that Stanford’s true intent was monopoly. The *Alta* went so far as to compare Goat Island to Devil’s Gate, Wyoming, a narrow and unavoidable pass that was so named because “it is presumed the Devil made it expressly for a toll-gate,” making a “bridge to Goat Island...a terrible improvement on the ‘Devil’s Gate.’” *Teredo*, in short, was an excuse to achieve a larger aim.<sup>15</sup>

The matter ultimately fell to the Senate Committee on Military Affairs, which invited the Central Pacific to Washington to make its case. Stanford wasted no time implicating woodborers as one of the core reasons why the railway needed the island.

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14. *Ibid.*

15. “Governor Stanford’s Remarks,” *Daily Alta California*, March 20, 1872, 1.

Minutes into the meeting Stanford called attention to the “little insect called the teredo, that causes great destruction by boring the piles.” Specifically, Stanford complained that insurance companies wouldn’t underwrite goods that accumulated at the end of Long Wharf because they were only “safe until the *teredo* and the elements shall cause decay.”<sup>16</sup>

Stanford’s composed testimony contrasted with that from his impassioned partner, Collis Huntington. The hotheaded Huntington made some fiery remarks during the meeting that highlights his concern over woodborers. “I hope the Government will allow us,” he remarked, “to get the nose of our road on something more permanent than forty-foot piles among the *teredo*.” Later, when the committee suggested that the matter was important enough to schedule another session to hear more testimony, Huntington pleaded for haste. “We feel very anxious about this matter,” he pressed, for “[w]e have a great deal of property on those wharves which the *teredo* is eating.”<sup>17</sup>

Huntington’s hyperbole did not persuade California Senator Cornelius Cole, who came to Washington to defend Oakland’s reputation. According to Cole, “the only reason [Central Pacific board men] fall back upon...is the damage caused by the teredo.” His colleague, Senator Eugene Casserly, further tried to knock the legs out from underneath the teredo argument. While listening to a defender of the Central Pacific talk of the prohibitive costs of woodborers, Casserly interjected: “There is nothing in support of the statement about the *teredo*,” he remarked. “I owned a good deal of property in Oakland

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16. Senate, *Arguments Before the Committee on Military Affairs of the State for and Against the Bill (H. R. 1553) to Lease Goat Island for a Railway Terminus*, 42d Cong., 3d sess., 1873, Mis. Doc. No. 75, 3, 8, 12.

17. Senate, *Arguments Before the Committee on Military Affairs of the State for and Against the Bill (H. R. 1553) to Lease Goat Island for a Railway Terminus*, 68, 84.

once,” he continued, “and one of the advantages of Oakland was always understood to be that the *teredo* did not exist there.” When cutoff, Casserly again interjected, this time more forcefully: “I think I have more interest there than any individual here, and should know something about that matter.”<sup>18</sup>

In truth, both sides were partly right and partly wrong. The debate hinged on absolute claims about the ecology of the Oakland waterfront. The bay did not conform to such black or white analyses. When biologists investigated Oakland during the *Teredo navalis* invasion they discovered that borers were more prone to attack piles further from the shore, such as the end of Long Wharf—the very spots that Huntington and Stanford fretted over. At the same time, waterfront structures closer to shore, like Casserly’s, might stand tall for decades, especially if they were kept at a distance from infected wharves. Oakland’s relationship with borers was complicated.<sup>19</sup>

In the end, everyone lost in the Goat Island debate. To begin with, the committee chair, who preferred the “positive testimony of a gentleman of the character of Mr. Stanford,” asked rhetorically, “will any gentleman tell me why, if the *teredo* is in the salt water on the San Francisco side, it would not be in the salt water upon the Oakland side?” He concluded, then, that “[t]he fact would seem to be that [woodborers] must be wherever the salt water is, thereby sustaining Governor Stanford’s position upon the matter.” As far as the government was concerned, Oakland was no different than San

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18. Senate, *Arguments Before the Committee on Military Affairs of the State for and Against the Bill (H. R. 1553) to Lease Goat Island for a Railway Terminus*, 55, 63.

19. San Francisco Bay Marine Piling Committee [hereafter, “SFBMPC”], *The San Francisco Bay Marine Piling Survey: Second Annual Progress Report* [hereafter “*Second Annual Progress Report*”] (San Francisco: The Committee, 1922), 25, 52.

Francisco in term of borers. For the Central Pacific, this win was short-lived; Congress failed to pass the Goat Island bill, leaving the tip of Long Wharf exposed to teredo.<sup>20</sup>

There was a silver lining to the kerfuffle; Oakland and Central Pacific arrived at an ecological synthesis. While Oaklanders could no longer hang their hats on claims of complete immunity from teredo, they were at least able to get the Central Pacific to scrutinize the waterfront more closely. And contrary to what the Committee on Military Affairs surmised, there were some anti-teredo benefits in Oakland after all. Later in 1873, Chief Engineer S. S. Montague remarked that while Long Wharf “cannot be regarded as permanent, its life will greatly exceed that of the San Francisco wharves, where the ravages of the teredo have been so destructive.” He credited the “fresh water from the Strait of Carquinez, which at certain states of the tide, flows along the shore.” As long as marine builders were mindful of teredo, they could take advantage of the east bay after all. Oakland had found its niche.<sup>21</sup>

Then, just as quickly, Oakland lost it, for the bay was fickle and ever changing.

### **A New Foe: Limnoria, or the Gribble**

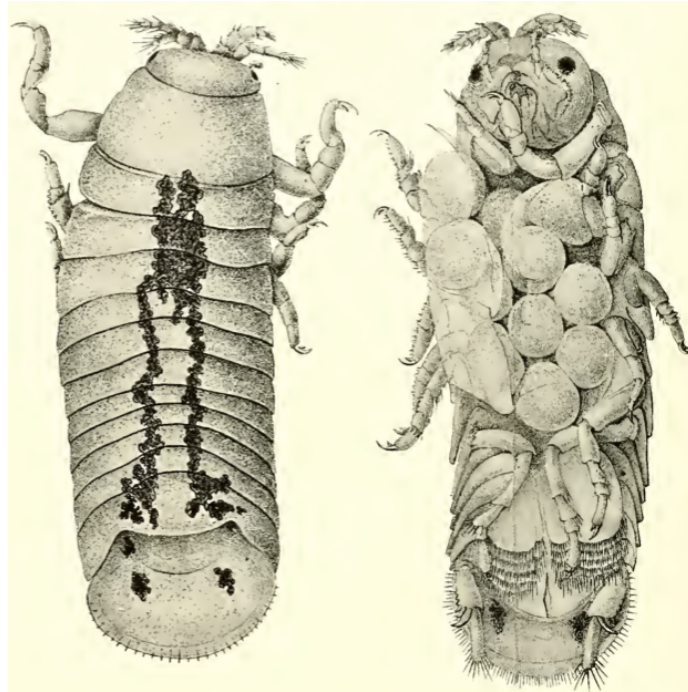
In December of 1873, Governor Newton Booth complained about the “ravages of the *teredo*” in his annual address and how these “destructive marine worms” were “preying constantly upon wooden piles” throughout the bay. Booth was itching to improve harbor facilities, especially in San Francisco (a dream that wouldn’t be fully realized until the twentieth century with the building of the seawall and Embarcadero) and teredo was the first of several reasons why he thought that the state ought to fund

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20. Senate, *Arguments Before the Committee on Military Affairs of the State for and Against the Bill (H. R. 1553) to Lease Goat Island for a Railway Terminus*, 133.

21. Neily, “Historical Development of Marine Structures in San Francisco Bay,” 19.

waterfront schemes. While the listeners and readers of his speech needed no introduction to teredo, they might not have been so familiar with another word that the governor also griped about: “*limnoria*”<sup>22</sup>



**Figure 27: *Limnoria*.** The San Francisco Marine Piling Committee of the American Wood-Preservers’ Association, Inc. *Final Report of the San Francisco Bay Marine Piling Committee*, 310. Used with permission of the American Wood-Preservers Association.

The borer known as limnoria, or the gribble, also ravaged San Francisco and, especially, Oakland during the late nineteenth and twentieth centuries. Curiously, “limnoria” doesn’t refer to a specific borer at all. Like “*Teredo*,” the word “*Limnoria*” is the name of a genus—in this case of crustacean woodborers. And just like “teredo,” the word “limnoria” became shorthand for a number of species of limnorids, such as *Limnoria lignorum*, *Limnoria quadripunctata*, and *Limnoria tripunctata*, among many

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22. “Message of Governor Booth,” *Sacramento Daily Union*, December 6, 1873, 2.

others. Wood-boring crustaceans from other genera, such as *Cherula* and *Sphaeroma*, often went by the shorthand “limnoria,” and still do.<sup>23</sup>



**Figure 28: *Limnoria* Eating.** The San Francisco Marine Piling Committee of the American Wood-Preservers’ Association, Inc. *Final Report of the San Francisco Bay Marine Piling Committee*, 319. Used with permission of the American Wood-Preservers Association.

All of the borers informally called “limnoria” share common traits. Compared with the elongated shipworms, most gribbles are very small and compact, resembling a pill bug in appearance. The world’s most cosmopolitan and destructive gribble, *Limnoria lignorum*, grows to 1/8-1/4 inches, thus earning it the nickname “wood lice”. Several hundred gribbles can tightly occupy one-square inch. Unlike teredo, which hollows out timber from the inside, limnoria attacks from the outside. The majority of gribbles rasp between high and low tide, thus giving piles an unmistakable hourglass appearance when looked upon at low tide—heavily infested piles are completely severed, turning them from load bearing struts into spears that look like they are poking the surface of the water.<sup>24</sup>

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23. Limnoria didn’t come to the attention of scientists until the nineteenth century when European biologists first described them. For a general description of various wood-boring crustaceans, see William G. Atwood and A. A. Johnson, *Marine Structures, Their Deterioration and Preservation: Report of the Committee on Marine Piling Investigations of the Division of Engineering and Industrial Research of the National Research Council* (Washington DC: National Research Council, 1924), 21-26.

24. Ibid.



**Figure 29: “Hourglass” Piles. The San Francisco Marine Piling Committee of the American Wood-Preservers’ Association, Inc. *Final Report of the San Francisco Bay Marine Piling Committee*, 27. Used with permission of the American Wood-Preservers Association.**

Gribbles are not native to San Francisco Bay. They arrived sometime in the early 1870s. Harbor Commissioner T. J. Arnold first took notice of the borers in 1873 when he found a specimen and donated it to a California museum. Soon after, limnoria caught the attention of many others, such as George Hewston, a physician and one-time mayor of San Francisco, who gave a paper on the recently arrived gribbles. The *San Francisco Bulletin* also looked into the newly arrived borers and tried to date their appearance, which the editors put at February 1873. The uniformity of these accounts around the year 1873 is striking, but not unanimous. A British engineer named John Blackburn thought limnoria arrived as early as 1870, which is hardly an outlier.<sup>25</sup>

The sudden arrival of limnoria bound California more tightly into the Pacific World, at least in narrative terms. While all but one of the gribbles in San Francisco Bay is cryptic (and all are nonnative), people along the west coast were pretty certain that

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25. *Proceedings of the California Academy of Sciences* 5 (1873-1875): 19, 24; Blackburn, “The Action of Marine Worms and the Remedies Applied in the Harbor of San Francisco, California,” 111-118.



limnoria had been introduced, and they implicated the western Pacific. This theory took some time to develop. In 1874, the *San Francisco Bulletin* asserted, rather vaguely, that gribbles had arrived from somewhere in the “tropics.” This was followed by Seattle’s *Puget Sound Dispatch*, which narrowed “tropics” down to the Indian Ocean. Later, Olympia’s *Washington Standard* pinpointed Australia. But the most specific account of the limnoria invasion came from the *Los Angeles Herald* when, in 1889, the paper went further, arguing that “the limnoria was wholly unknown in Californian waters till the iron ships began to bring in Sydney coal into San Francisco as part of their cargo on their voyage to Europe.” Whether or not Australia was the source of the invasion (biologists have traced just one of the gribbles to there) west coasters started to appreciate their place in a wider environmental framework.<sup>26</sup>

In a few short years, limnoria quickly spread throughout lower San Francisco Bay, and especially Oakland (thus rendering any debate about the immunity of the east bay moot). The two most destructive gribbles, *Limnoria quadripunctata* and *Limnoria tripunctata*, each found their respective niches. The more temperate species of the two, *L. quadripunctata*, which is known in northern Europe, preferred the colder, more ocean-like conditions of San Francisco, while the sub-tropical *L. tripunctata* took to the warmer waters around Oakland. Of the two, *L. tripunctata* proved the more destructive because it had less competition from *Bankia setacea* in the east bay.<sup>27</sup>

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26. “How The Wharves Are Destroyed,” *SFB*, February 13, 1873, 3; “Local News,” *Puget Sound Dispatch*, January 13, 1877, 7; “The Tereido,” *Washington Standard* (WA), June 13, 1879, 4; “Timber Culture,” *Los Angeles Herald*, February 13, 1889, 1; Cohen and Carlton, *Nonindigenous Aquatic Species in a United States Estuary*, 84. *Sphaeroma quoyanum* is native to New Zealand, Australia, and Tasmania.

27. Up until the 1950s, all gribbles in the bay were thought to be *Limnoria lignorum*. This turned out to be false—in fact, none of the gribbles in the bay are this species. Carlton, “History, Biogeography, and Ecology of the Introduced Marine and Estuarine Invertebrates of the Pacific Coast of North America,” 611-630.

## Sticks In the Mud

Conditions worsened in the wake of the limnoria invasion. While there is no hard data to measure the growing epidemic, there are telling anecdotes that capture the state of the bay. One appeared in an 1876 edition of the *Alta*. The paper's editors, after analyzing the state's harbor tolls, encouraged lawmakers in Sacramento to adopt a variable system of rates that mirrored the destructiveness of woodborers. Wharf owners ought to be permitted to charge annual rates in excess of twenty-five percent if their wharves are "exposed to destruction by storms and certain to be ruined...by the teredo," argued the editors. On the other hand, rates for structures built "in small creeks, where the water is always sweet and quiet and where no damage is to be feared from either waves, floods or ship-worms, should be restricted to 15 percent."<sup>28</sup>

By 1877, woodborers had become such an economic burden that the State Harbor Commissioners decided to act—again. Ever since their Robbins debacle, the commissioners had kept a low profile when it came to borers. They were more cautious this time around, maybe to a fault. In February, the commissioners made a modest order of twenty-five piles treated with a secretive tar-like substance called Henry's Siliceous Coating—a concoction marketed since the 1860s—and drove them into the bay for an extended test. The next year, the commissioners ordered piles treated with the Thilmany Process (a variant on zinc chloride that preserved railroad ties, but not marine structures), and followed this up the next year with an order of Culver Process piles (a recipe lost to

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28. "Harbor Commissioners: Destructive Ravages of the Limnoria and Teredo," *SFB*, September 30, 1886, 3.

history). Then in 1882, the commissioners upped the ante and procured seven different types of allegedly teredo-proof pile coatings for a five-year test.<sup>29</sup>

The commissioners might not have realized it at the time, but they had slowly opened a Pandora's box. Throughout the 1880s, Bay Area inventors flooded the harbor commission with anti-teredo methods to test. Most were unsolicited. An endorsement from the commissioners might bestow riches onto its inventor in the form of massive sales. The *San Francisco Bulletin* captured the frenzy when it explained how “[a] fortune...is awaiting the man who will find some satisfactory plan of fighting the teredo.” The commissioners accepted proposal after proposal without as much of a thought on how to scrutinize each method. They never spelled out their methodology or criteria other than to stick piles into the bay and hope that one of the many innovators would stumble onto a vein of gold.<sup>30</sup>

The first big reveal came in October of 1887 when the harbor commissioners pulled the test piles stuck in the mud since 1882. The highly anticipated test came during a stretch of greater attack. The *San Francisco Bulletin* reported that over the “past two or three years the ravages of the destructive mollusks have increased to an alarming extent”—in nineteen months, borers had destroyed piles under Fisherman's Wharf even though they had their bark on when driven. In this context, much was riding on the 1882 test piles. They disappointed miserably. All of the coated piles failed to repel borers.

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29. “Protecting and Preserving Piles,” *Daily Alta California*, January 30, 1864, 1; “Harbor Commissioners,” *SFB*, February 20, 1877, 2; “Protecting Wood from the Ravages of the Teredo,” *SFB*, July 15, 1878, 3; For a description of the Thilmany Process, see Octave Chanute, “The Preservation of Timber,” *Transactions of the American Society of Civil Engineers* 14 (July, 1885): 325-327; “Board of Harbor Commissioners,” *SFB*, March 3, 1882, 2.

30. “The Water Front,” *SFB*, May 6, 1887, 2.

Ironically, untreated pine piles with their bark on fared better than the debarked and coated piles.<sup>31</sup>

Hopes faded further in December when the commissioners examined piles from another test. This time the timber was protected by a peculiar method called the “freshwater cure”. By pouring freshwater continuously over the top of the pile, the inventor hoped that the rungs inside would become saturated and uninhabitable to borers. When the commissioners arrived at San Francisco’s Green Street wharf for the unveiling, a crowd of people gathered round. According to the *Alta* the test piles “appeared fine and white, but at one blow from the axe it caved in, and the bystanders were liberally bespattered with noisome, colorless blood, or rather the juice of the teredo worms.” The harbor commission had grasped at straws and floundered.<sup>32</sup>

Over the years, the harbor commissioners tried some unsophisticated tactics while trying to understand and fight borers (such as weighing down a wharf with tons of pig iron to test whether it had been honeycombed). But perhaps their most unforgivable misstep was to ignore creosoting for so long after the failed test of the pseudo-creosoting Robbins Process. In 1886, the commission’s chief engineer, Marsden Manson, remarked how he “regretted that no thorough attempts have been made to saturate timber with creosote, a method so successful and beneficially applied in Europe and some of the Eastern States.” Manson grew frustrated with the incessant testing of odd inventions and called for a new direction. The board of commissioners yielded to his demands and

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31. “Harbor Commissioners: Destructive Ravages of the Limnoria and Teredo,” 3; “The Destructive Teredo,” *SFB*, October 22, 1887, 4; Marsden Manson, “The Protection of Piles from Limnoria and Teredo,” *Engineering and Building Record* 17 (December 1887): 68.

32. “The Teredo: Its Ravages on the Water-Front—The Results of an Experiment,” *SFB*, December 8, 1887; “The Terrible Teredo’s Tricks,” *Daily Alta California*, December 8, 1887, 2.

allowed him to tour creosote factories in San Diego and Virginia. Convinced of the superiority of creosoting, Manson lobbied for the construction of a state-owned plant, and the harbor commission almost did so, but stopped short once companies such as the Southern Pacific Railroad filled the void and built plants to service the bay. Creosoting was going to be the path forward and offer decades of protection to marine structures.<sup>33</sup>

Except that it didn't. During the 1890s, the first crop of creosoted piling fared poorly. There were a lot of factors that played into this, some of which were beyond the control of timber preservers. First and foremost, good quality creosote was scarce along the west coast. The factors that distinguished good creosote from bad creosote were far from clear at this time, but most considered darker oils with greater tar content as crucial. Unfortunately, according to James McKeon, of the Oakland Millowners' Association, "creosote of any value must be imported from Europe." Obtaining oil outside of Europe was a crapshoot. Even the inferior creosote oils produced on the east coast were hard to come by out west. San Francisco's distance from creosote producers thus contributed to its inability to develop adequately creosoted piling.<sup>34</sup>

The kinds of trees that timber producers used also contributed to the short lives of creosoted piles. Douglas fir trees shipped down from Washington and Oregon constituted virtually every pile driven in the bay, aside from experimental timber, such as imported

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33. "A Ferry Slip Examined," *SFB*, March 12, 1886, 3; Chief Engineer Marsden Manson is quoted in "The Destruction of Wharves," *SFB*, August 16, 1886, 1; Manson shows his frustration with test boards in "The Seawall," *SFB*, May 9, 1888, 3; "Too Late," *SFB*, April 21, 1890, 2; "Harbor Commissioners," *SFB*, August 15, 1888, 1; For the Southern Pacific's construction of a creosote factory in 1890, see Neily, "Historical Development of Marine Structures in San Francisco Bay," 21.

34. James McKeon, "Wood Preserving," *Proceedings of the Pacific Coast Railway Club* 6 (1905): 187; W. F. Sherfese and H. F. Weiss, "Wood Preservation," in *Report of the National Conservation Commission* (Washington DC: GPO, 1909), 658. Sherfese and Weiss of the United States Forest Service commented that creosote production remained an eastern industry that "prevented a more rapid expansion of wood preservation in the West." In the absence of creosote, central and western railroads relied on zinc chloride, which was sufficient for ties but useless of marine structures.

and domestically grown eucalypti. However, its affordability and availability came with a significant drawback. Douglas fir is a hard and refractory tree. It cracks when exposed to excess heat and fails to absorb much creosote through its tough fibers. During the 1890s, timber preservers were lucky to force ten lbs. per cubic foot of oil into such piles. While this was a sufficient amount to keep out teredo, it was not enough to thwart limnoria (gribble attacks opened the way for teredo, anyhow). Wharf owners were working with poor oils and poor trees.<sup>35</sup>

Rough handling of treated timber also resulted in the poor performance of creosoted piling. Chief Engineer Manson had warned as early as 1888 that any abrasion caused to the ring of creosote saturation could allow woodborers entry. This advice was not heeded. The harbor commission attributed many failed piles to post-treatment cutting, nailing, and piking. Cutting creosoted areas opened pathways for borers to attack. But even smallest penetrations by nails or pikes used to maneuver floating timber into a boom or raft gave borers all the room they needed to bypass the protective layer of creosote. All this could have been avoided. Such carelessness persisted for three decades—during the 1920s, a survey of the San Francisco waterfront revealed that eighty percent of the abrasions that led to piles being attacked by limnoria were created by pile dogs—large metal spikes with clasps used to fasten logs into larger rafts.<sup>36</sup>

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35. The San Francisco Marine Piling Survey catalogued all the piles in the bay. For the prevalence of Douglas fir in piling use, see Hunt and Hill, “Engineering Phase,” 63. Hunt and Hill explain that Douglas fir “has been used for many years almost to the total exclusion of other species, whose use has been almost entirely experimental”; For the problems with treating Douglas fir, see SFBMPC, *Second Annual Progress Report*, 60; and McKeon, “Wood Preserving”: 188; For the limitations of creosote on limnoria, see C. M. Wakeman and Harold Schiller, “The Marine-Borer Problem In Los Angeles Harbor,” in *Proceedings, Wrightsville Beach Marine Conference, Wrightsville Beach, North Carolina, 5,6 June 1950* (Washington DC: National Academy of Science, National Research Council, 1951), 19, 20, 24.

36. “Harbor Commissioners,” 1; SFBMPC, *Second Annual Progress Report*, 13; Neily, “Historical Development of Marine Structures in San Francisco Bay,” 30.

After the turn-of-the-century, Bay Area marine builders grew frustrated with creosote and sought out alternatives. But everything that they tried seemed to fail. Even the most promising substitutes had flaws. Copper sheathing, for instance, worked so long as it wasn't cracked by floating debris, which was common (copper was also subject to theft by "bay pirates," making it useful only in places where theft was hard). Timber piles covered with concrete also came into vogue during the 1910s; unfortunately, they were liable to cracking and crumbling, especially if seawater seeped into the molds that surrounded the piles. The harbor commission even caved to rumors about the resistance of eucalyptus trees and purchased 1,200 blue gums (*Eucalyptus globulus*) for a ferry slip—most of them were riddled within the year and all had to be replaced at the end of four years. By the mid-1910s, with most of the alternatives failing, marine builders returned once again to creosote.<sup>37</sup>

In 1919, the Bay Area finally got some good news. The Oakland Long Wharf was coming down, but not because of borers. It was being removed to make way for port improvements. In a sentimental way, the wharf offered a connection to the Central Pacific and its role in constructing the transcontinental railway—it had been up that long. In reality, the structure had been refurbished so many times that it was more a replica than an authentic relic of the past. One of these renovations stood out. In 1890, the wharf's new owner, the Southern Pacific, drove the first creosoted piles into the structure. In 1919, to the surprise of many, these piles were in great condition, so good in fact that

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37. For a narrative of the ebbs and flows of timber preservation at the turn-of-the-century, see SFBMPC, *Second Annual Progress Report*, 12-20; Hunt and Hill, "Engineering Phase," 65. The SFBMPC remarked in all of its reports that theft of copper was a problem. This particular report cites a Richmond company that complained about the "bay pirates"; "Sea Wall and Wharf Construction at San Francisco," *Marine Review* 41 (February 1911): 57.

they were reused in new structures (recycling undamaged or slightly bored piles was common). News of the finding delighted engineers and quickly spread across trade journals. Creosote worked after all. In the future, marine builders hoped to gradually phase out older piling. Unfortunately, there would be nothing gradual about this transition. The good news was quickly drowned out by the bad.<sup>38</sup>

### **Northern Bay on the Eve of Invasion**

In July of 1920, the American Wood-Preservers' Association (AWPA) called a special meeting to discuss a new crisis. A mysterious borer had begun to ravage portions of the Bay Area previously unaffected by shipworms. Starting with the dikes jutting out from Mare Island in San Pablo Bay, the borers quickly spread eastward through the Carquinez Strait and into Suisun Bay, and before long targeted wharves and docks, causing massive destruction. By the time that the AWPA met again for its annual meeting in January 1921, the disaster had gained national attention, later prompting President Warren G. Harding to ask Congress for an emergency bill of two and a half million dollars to repair damages to the Mare Island Naval Shipyard. All told, the disaster cost twenty-five million dollars in damages. After an exhaustive survey, the AWPA learned that the new foe was none other than *Teredo navalis*.<sup>39</sup>

The precise timing of the *Teredo navalis* invasion of San Francisco Bay is hard to pin down. Mare Island dike inspectors first noticed the borers as early as 1914. But the inspectors did not pay them any mind since small numbers of borers had ventured up

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38. A number of trade journals spread news about the Long Wharf's successful piles. The following source is representative of these. "Creosote Piles Still Sound After 29-Year Service," *Engineering News-Record* 83 (August 1919): 378.

39. For the early institutional involvement of the AWPA, see San Francisco Bay Marine Piling Committee, *[First] Report on the San Francisco Bay Marine Piling Survey* (San Francisco: Committee, 1921), 3-4; "\$2,500,000 Asked to Fight Teredo," *Engineering News-Record*, 88 (March 1922): 461.



north from time to time (so few that they were not documented). Coincidentally, while the Panama Canal opened in the same year, the two were probably unrelated. Most likely, *Teredo navalis* arrived in the hull of some unknown ship and spread to the northern waters of the bay in late 1912 or 1913. There's no evidence that it arrived any earlier than that since a joint U.S. Bureau of Fisheries and University of California biological survey of the bay did not turn up any exotic borers. Between 1914 and 1916, no borers were detected. When they resurfaced again in 1917, this time they stayed. *Teredo navalis* kept a low profile during relatively wetter year of 1918 before exploding during the dry season in 1919.<sup>40</sup>

For a region long accustomed to woodborers, it may come as a shock that the *Teredo navalis* invasion caught so many off guard. Unlike in the lower bay, no anti-borer precautions were taken north of San Pablo Strait. None of the wharves lining San Pablo and Suisun Bays were treated with creosote or protected in any way whatsoever. This was by design, not negligence. The northern bays had no prior history with borers, thanks to the Sacramento and San Joaquin Rivers, which made the bays too fresh to support shipworms and gribbles. On rare occasions, low river runoff allowed the hardiest borers a foothold to climb up north, but there is no evidence that they survived long enough to cause any trouble before the 1910s.<sup>41</sup>

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40. *Teredo navalis*' arrival into San Francisco Bay is a little cloudy, but it most certainly preceded the opening of the Panama Canal. Albert L. Barrows, "An Unusual Extension of the Distribution of the Shipworm in San Francisco Bay, California," *University of California Publications in Zoology* 18 (December 1917): 27-43; For a very detailed analysis of the timeline of the invasion, see Carlton, "History, Biogeography, and Ecology of the Introduced Marine and Estuarine Invertebrates of the Pacific Coast of North America," 560-565. Carlton has published extensively on the teredinids elsewhere, but his dissertation contains perhaps the most exhaustive analysis of the invasion timeline.

41. For the absence of woodborers in the northern bays prior to the invasion, see E. M. Blake, "Introductory," in *[First] Report on the San Francisco Bay Marine Piling Survey* (San Francisco:

Very early on, the anti-borer qualities of the northern bays attracted the attention of the navy. In 1852, as Commodore John Sloat sought a locale for a new naval shipyard, he did so with the following instructions: “You will ascertain, as far as practicable, from observation and inquiry, what is the effect, if the evil exists to any extent, of the marine worm in those waters.” With this in mind, he chose Mare Island, on the north shore of San Pablo Bay. Years later, the Commission on Navy Yards praised Sloat’s selection because of how “at every ebb tide an amount of fresh water . . . proves fatal to the teredo.”<sup>42</sup>

Like the navy, commercial shippers recognized the benefits of the upper bays during the nineteenth century. Whenever a captain feared that his ship had been attacked, he might sail north and bask in fresher waters until the borers had died. The earliest known record of this practice was preserved in a most peculiar way: a murder trial. In January 1878, the captain of the schooner *A. P. Jordan* arrived in the City of Antioch, at the mouth of the San Joaquin River in Suisun Bay. After he went ashore, he got into a fight and killed a local man. During the investigation, reporters mentioned in passing the reason why the *A. P. Jordan* had come to Antioch in the first place. The *Contra Costa Gazette* explained that it “had been lying a week or two in the river, two miles below

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Committee, 1921), 3; and R. M. Neily, “Historical Development of Marine Structures in San Francisco Bay,” in *Marine Borers and Their Relation to Marine Construction on the Pacific Coast*, 26.

42. Major Edwin A. Sherman, *Life of the Late Rear-Admiral John Drake Sloat* (Oakland: Carruth & Carruth, 1902), 253; Senate, *Letter from the Secretary of the Navy, Transmitting, in Compliance with Law, the Report of the Commission on Navy Yards, December 1, 1884*, 48th Cong., 1st sess., 1884, Ex. Doc. No. 55, 8, 9.

Antioch, to let the fresh water kill the teredos in her bottom.” This practice continued into the twentieth century.<sup>43</sup>

Boosters in the press also recognized the potential of the fresher waters and began advertising the anti-teredo qualities of the northern bays. In 1880, the *Vallejo Chronicle* explained how in the vicinity of Mare Island the “teredo, which is very destructive to wharves and piling in San Francisco harbor, cannot live in our locality, and wharves built thirty years ago are as sound to-day, as far as this worm is concerned, as when first built.” In 1885, the *Alta* extended these benefits further upstream, where “[t]he teredo, so destructive on San Francisco bay, is almost unknown at Vallejo and on Carquinez straits.” In the same year, the *Pacific Rural Press* predicted that marshland reclamation in Suisun Bay could succeed since “teredo does not affect the timbers in the upper part of the bay.”<sup>44</sup>

Around the turn-of-the-century, the business community began to appreciate the anti-teredo benefits of the northern bays. In 1895, entrepreneurs in the City of Antioch predicted that a railroad would soon descend on their waterfront bordering Suisun Bay because it had better anti-teredo qualities than at any other point along San Francisco Bay. “Our advantages,” they explained, “are superior” since “the water is fresh, no teredo.” Similarly, to the west, in neighboring San Pablo Bay, a businessman named John

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43. For details of the murder, see “Murder at Suisun,” *San Francisco Chronicle*, January 28, 1878, 2; For reference to teredo during the murder trial, see “From Marriage to Murder,” *Contra Costa Gazette* (CA), April 27, 1878, 3; For a twentieth century example of mooring in Suisun Bay, see “Teredoes Bore Holes In Hull,” *San Francisco Call*, July 3, 1902, 8. After a San Francisco dry-dock inspector discovered a bad infestation in the hull of the *Oliver J. Olsen*, he ordered the ship to sail north where, according to the *San Francisco Call*, “[t]he fresh water will kill the teredoes and upon her return to this port she will be sheathed with copper.”

44. The *Vallejo Chronicle* article was reprinted in the “Pacific Coast Items,” *Sacramento Daily Union*, May 13, 1880, 2; “Coast News,” *Daily Alta California*, November 25, 1885, 6; “Reclamation of Marsh Lands in California,” *Pacific Rural Press* (CA), July 18, 1885, 45.

McNear tried to sell his property to the navy in 1898 for a new dry dock. The *San Francisco Call* concurred, lauding his property for its “entire absence of teredoes.” When this plan fell through, McNear sought to entice an electric rail line to develop his land, which, as the *Sausalito News* reported, “serves to prevent the teredo pest.” In 1904, the City of Benicia’s Board of Trade joined the milieu, issuing a boosterish statement of its own regarding the advantages of Carquinez Strait. “Private wharves for large factories can be economically constructed,” writes the board; “[t]heir cost of maintenance is very slight, as the teredo worm is unable to live in the harbor of Benicia and destroy the piling, on account of the fact that the water is largely fresh from the rivers.”<sup>45</sup>

With nothing to fear from teredo, the industries that flocked to the upper bays made no effort to protect their structures from borers. The California and Hawaiian Sugar Refining Company warehouse, built in 1912, provides a telling example. On any given day, the warehouse on the pier supported 30,000 tons of raw sugar, worth upwards of two and a half million dollars. As such, “no chances have been taken in the construction of these foundations,” explained an architectural journal. Precautions for the warehouse’s piling, however, weren’t made since the “water in Carquinez Straits being fresh part of the year and brackish for the balance of the time, no difficulty has ever been experienced with the teredo, or other marine borers” This warehouse would later collapse during the *Teredo navalis* invasion.<sup>46</sup>

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45. “Local News In Brief,” *San Francisco Call*, March 28, 1895, 7; “It Is Well Guarded and the Fresh Water Prevents Invasions By Teredoes,” *San Francisco Call*, March 24, 1898, 4; “Will Boom San Pedro,” *Sausalito News*, September 9, 1899, 3; “Host of Attractions,” *San Francisco Call*, July 10, 1904, 47.

46. “A Concrete Warehouse With Pleasing Architectural Lines,” *Architect and Engineer of California and the Pacific Coast* 31 (January 1913): 81-82; Neily, “Historical Development of Marine Structures in San Francisco Bay,” 29.

Irony notwithstanding, naval, shipping, and industrial interests *were* wise to value San Pablo Bay, Carquinez Strait, and Suisun Bay. These waterways had demonstrated a long history of being free from borers. For decades, the Sacramento and San Joaquin Rivers delivered a relatively consistent amount of water to the bay. The rivers dispensed roughly 35 million acre-feet per year. The only catch was that the water did not arrive uniformly throughout the year. Most of it (eighty-five percent) reached the bay during the wet season, between January and June. For the remainder of the year the upper bays grew brackish—so brackish, in fact, that people along Suisun Bay filled cisterns with river water during the wet season since they couldn't rely on the rivers remaining fresh between July and December. Despite the fluctuating salinity, the upper bays remained just fresh enough to repel *Bankia setacea*, *Limnoria quadripunctata*, and *Limnoria tripunctata*.<sup>47</sup>

But there were indications that the freshwater runoff that had protected infrastructure would not remain so consistent going forward. While the annual seesaw between wet and dry seasons usually favored dike builders, wharf owners, and ship owners, conditions began to shift in the 1910s. Between the fall of 1911 and the spring of 1925, the annual discharge fell below the mean more often than not—and sometimes significantly below average. Over that span, the annual freshwater discharge reached or exceeded seventy-five percent of its average just five times and remained fifty percent or

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47. C. E. Grunsky and C. S. Jarvis, "Hydrographic Phase—The Hydrography of San Francisco Bay," in *[First] Report on the San Francisco Bay Marine Piling Survey*, 13-14.

below six times. Consequently, the bay was saltier more often and for longer periods than it had been in the past.<sup>48</sup>

The initial invasion of *Teredo navalis* came on the heels of two years of below average runoff. A discharge of approximately fifteen million acre-feet flowed into San Francisco Bay between October 1911 and September 1912. This amounted to less than half the annual flow. The following year witnessed yet another extended period of low discharge. From October 1912 to September 1913 just sixteen million acre-feet entered the bay. The combined discharge from these two years was below the single year mean. The discovery of *Teredo navalis* in the beginning of 1914 coincided with this extended period of high salinity. Runoff increased over the next three years, which prevented the borer from doing more than gaining a foothold. But *Teredo navalis* never went away. Then, in 1918, salinities rose again, allowing the borers to flourish.<sup>49</sup>

From the start, many (wrongly) attributed the emergence of borers solely to forces beyond their control, namely an anomalous period of low precipitation. The *Berkeley Daily Gazette* held this view. “Because the snows lay light on the Sierra Nevada for two successive winters,” explained the paper, “the destructive wood-boring shipworm invaded the upper regions of San Francisco bay, and for the first time in history did damage.” Similarly, the *San Francisco Chronicle* explained how the “lack of rainfall” had “caused the ocean tide to ascend much higher than it did before,” causing damage to

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48. C. E. Grunsky, “Geography and Hydrography of San Francisco Bay,” in *Marine Borers and Their Relation to Marine Construction on the Pacific Coast*, 36-39.

49. Barrows, “An Unusual Extension of the Distribution of the Shipworm in San Francisco Bay, California”: 32; Grunsky, “Geography and Hydrography of San Francisco Bay,” 38.

structures “which were never before affected by teredo.” In other words, the present conditions were anomalous and outside anyone’s control.<sup>50</sup>

These assessments, however, ignore the ways that people living in the watershed had altered natural patterns of runoff. For instance, the rise of commercial rice growing in the watershed contributed to lower runoff. Rice farming took off during the 1910s and depended on irrigation. Irrigation was not new to the region. It had been practiced in the Sacramento-San Joaquin watershed since the mid-nineteenth century when farmers began diverting water from the San Joaquin River—the drier of the two river valleys—to water crops. Along the Sacramento River, on the other hand, farmers received sufficient rainfall to grow grains, making irrigation less prevalent. This started to change in 1910 when a fall in grain prices induced farmers to irrigate and plant rice. Rice production exploded during the war years as rising demand inflated a sack of rice from \$2.02 to \$5.93. Downstream, cities along Suisun Bay suffered from the saltier conditions. The effects of irrigation on shipping was clear to the *Pacific Marine Review*, which captured this in a 1920 article titled, “Sowing Rice—Reaping Shipworms.”<sup>51</sup>

*Teredo navalis* also benefited from an increasingly “uncorked” Sacramento-San Joaquin River Basin. Before the gold rush, the watershed drained through meandering, flood-prone streams. Mining debris exacerbated this tendency by raising riverbeds as many as eight feet in places, often forcing the rivers to jump their banks during wet seasons. Before the runoff finally spewed into Suisun Bay and through the Carquinez

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50. “Shipworms Now Invading Upper Region of Bay,” *Berkeley Daily Gazette*, January 4, 1918, 6.

51. W. Turrentine Jackson and Alan M. Paterson, *The Sacramento-San Joaquin Delta: The Evolution and Implementation of Water Policy—An Historical Perspective* (Davis: California Water Resources Center, University of California, 1977), 2, 6-7; “Sowing Rice—Reaping Shipworms,” *Pacific Marine Review* 17 (September 1920): 104-106.

Strait it first had to pass slowly through a marshy delta. This torpid basin infuriated farmers. But it did have the benefit of restricting a volume of freshwater from draining out to sea, thus preventing an influx of saltwater upstream. In these ways, the river was corked, a detriment to borers.<sup>52</sup>

Drainage improved over the decades as farming supplanted mining. With the introduction of the clamshell dredger in 1879 farmers along Suisun Bay reclaimed marshlands and turned the once meandering delta into levee-buttressed channels that flushed water more speedily than before. Additionally, upstream farmers indirectly improved drainage after they lobbied to end mining-induced floods. Drainage improved further when the California Debris Commission set to work clearing mining waste from streambeds and improving navigability at the start of the twentieth century. The combination of these efforts contributed to the erasure of the natural flood basins and marshlands that held volumes of freshwater in place and checked saline intrusion during years of low precipitation or increased irrigation. Altering the watershed in these ways, in short, helped pave the way for *Teredo navalis* by creating the conditions in which it could thrive.<sup>53</sup>

When *Teredo navalis* passed through the Golden Gate, it got some help from marine builders as it made its way to the northern bays. Captain H. L. Demeritt described how “teredo will not move from place to place of its own accord.” Instead, it was “carried by human agency.” Demeritt arrived at this conclusion after observing timberwork at Point San Quentin. He marveled at an old railroad trestle that remained unharmed by

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52. Jackson and Paterson, *The Sacramento-San Joaquin Delta*, 2.

53. Jackson and Paterson, *The Sacramento-San Joaquin Delta*, 5.



borers while a newer ferry slip nearby was ravaged. The only difference between the two structures was that the “trestle was built from new timber,” while the ferry slip was built from wood taken “from teredo-infested regions.” “Second-hand piles,” Demeritt concluded, “when transplanted to a teredo-free region are the means of distributing the devastating shipworm.” The practice of recycling piles had never carried any perceivable consequences. Now it was crystal clear that it was possible to introduce borers to new waterfronts.<sup>54</sup>

### **Experiencing the Invasion**

When the crisis, which had been brewing for at least a decade, finally busted wide open in 1919, it caught everyone by surprise. No one died during the spike in teredo activity (at least not directly), which is not all that surprising since many of structures gradually keeled over or were closely monitored prior to their falling. But there were a few close calls throughout 1920 that raised eyebrows. In February, when the Southern Pacific’s ferry slip buckled, the fishermen angling on it “barely had time to escape.” In September, two sudden collapses bookended the workday. On the sixth, “a roar like the crashing of a salvo of great guns” woke people near the Crockett waterfront, sending them “rushing to their doors.” Thankfully, the collapse happened around breakfast time, and before anyone was on the structure. On the twenty-fifth, an abrupt collapse at Port Costa spared lives because it happened in the evening. The closest call of all came in October, when a wharf collapsed in Benicia, sending the home of one Herbert Clark into

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54. “Worm Destroying Bay District Piers: Teredo’s Habits Are Told By Engineer,” *San Francisco Chronicle*, May 16, 1920, 3.

the water. He and his wife barely escaped by climbing through the house's second story window to safety.<sup>55</sup>



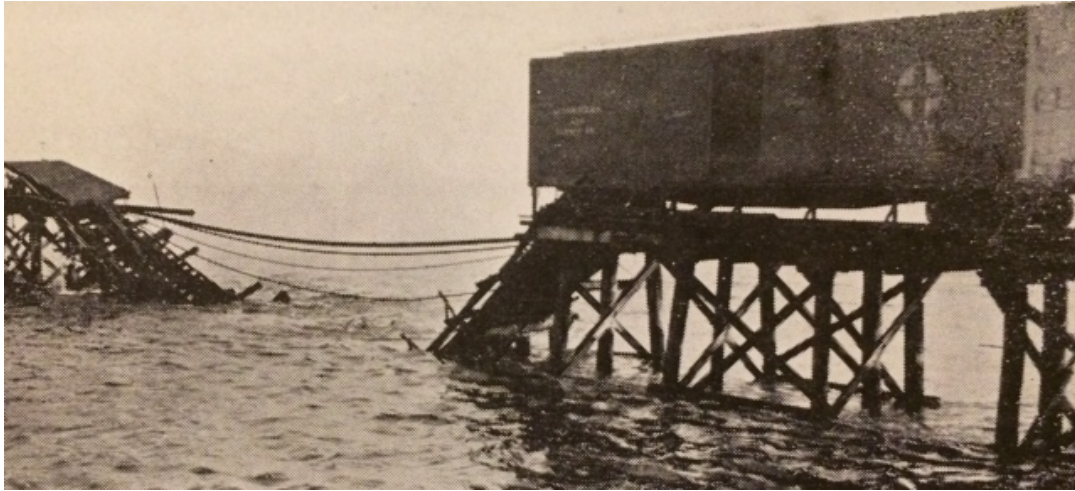
**Figure 30: The Clark House. Credit: The San Francisco Marine Piling Committee of the American Wood-Preservers' Association, Inc. [First] Report on the San Francisco Bay Marine Piling Survey, plate 1. Used with permission of the American Wood-Preservers Association.**

These sorts of scares helped awaken people in the region from their lethargy. Before the summer of 1920, many had planned to wait out the invasion. This strategy had some precedent. When borers disappeared after the initial invasion (circa, 1914), the *Oakland Tribune* credited the returning “flood of fresh water” that sent borers fleeing like “hegira for other parts” (an Islamophobic and dehumanizing comparison between shipworms and Muhammad during his flight from Mecca). When borer attacks spiked again around 1919, the *Daily Gazette* reported how people expected borers to die off similarly. It writes, the “theory has been expressed by experts that the flow of fresh water into the bay would destroy the worms.” The following year, an engineer in charge of building a trestle over Petaluma Creek justified the use of an inferior pile covering over creosoted timber because he believed “it was reasonable to assume that conditions

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55. “Teredos Destroy Piles in Waters Not Previously Infested”: 1000-1002; “Warehouse at Crockett Goes [.] Teredos Work,” *Contra Costa Gazette* (CA), September 11, 1920, 2; “\$25,000 Grain Lost; Dock Collapses,” *Martinez Daily Standard* (CA), September 25, 1920, 1; “Experts Here to Study Teredo,” *Martinez Daily Standard* (CA), October 13, 1920, 1, 3.

existing for 31 years prior to the last two years, would be restored before the temporary protection afforded by this method of treatment had deteriorated to such an extent as to permit damage by the borers.”<sup>56</sup>



**Figure 31: Trestle Collapse, Oleum, California. Credit: The San Francisco Marine Piling Committee of the American Wood-Preservers’ Association, Inc. [First] Report on the San Francisco Bay Marine Piling Survey, plate 1. Used with permission of the American Wood-Preservers Association.**

Following the summer of 1920, it became evident to everyone that borers weren’t following the script of 1914 over again. The *Teredo navalis* invasion quickly became a microcosm for the best and worst aspects of the larger national epidemic. To save the remainder of structures from crumbling, for instance, engineers tried just about every gimmick they could think of, even going so far as setting off dynamite underneath the water in order to concuss shipworms to death. Another plan was to introduce catfish into the bay. This probably started out as a joke after engineers noticed cats devouring borers that had been removed from wood and flung into the water. A few papers took the

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56. “Parasite Flees Change of Water,” *Oakland Tribune*, January 20, 1914, 7; “Some Snap Shots,” *Byron Times (CA)*, November 14, 1919, 8; “Teredos Still at Work on Wharves Here,” *Daily Gazette (CA)*, May 25, 1920, 1; Hunt and Hill, “Engineering Phase,” 68.

suggestion seriously and ran with it, which only underscores the desperation of the situation.<sup>57</sup>

As the crisis unfolded, it became clear that not everyone had the same interests in mind. Wharf owners who struggled to save their precious structures suddenly found themselves the targets of potential lawsuits. This happened to the Grangers' Business Association of Crockett. After one of its wharves collapsed in 1919, grain merchants in San Francisco sued to collect damages after thousands of dollars of their wheat spilled into the bay. The case was watched closely since it had implications for dozens of other waterfront property owners. The plaintiffs argued that the defendants should have safeguarded their structures, while the defendants contended that teredo was previously unknown in the region and that they couldn't have been expected to protect against such a random threat. In the end, Judge George Henry Cabaniss sided with the defendants. He stated the facts as follow: that teredo was a "new enemy to the wharves in that vicinity" and that "the drought in 1919 lowered the fresh water in the rivers" and "carried the teredo" up north. Because of this, Cabaniss decided that the "sudden attack of teredo was something that could not have been reasonably anticipated under the circumstances." Cabaniss' ruling ensured that shipworms were the only troublemakers wharf owners would have to defend against.<sup>58</sup>

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57. For dynamiting, see "Results Awaited With Interest By Wharf Owners," *Contra Costa Gazette* (CA), March 27, 1920, 8; Hunt and Hill, "Engineering Phase," 78. There was some merit to dynamiting. It did kill borers close to the detonation site. But for the practice to succeed constant use would be necessary; For catfish, see "Catfish May Be Used to Solve Teredo Menace," *Contra Costa Gazette* (CA), November 27, 1920, 2.

58. "Damage Suit Over Teredos In San Francisco," *Daily Gazette* (CA), March 26, 1920, 3; "Wharf Owners Are Not Responsible for Teredo Loss," *Contra Costa Gazette* (CA), April 10, 1920, 5; Garrette v. Grangers' Bus. Ass'n, 58 Cal. App. 396, 403, 208 P. 1010, 1013 (Cal. Ct. App. 1922).

At the extreme eastern end of Suisun Bay, shipworms became entangled in another legal matter, but this time they teamed up with the plaintiffs. In 1920, the City of Antioch asked the courts to enjoin upstream rice irrigators from diverting so much water that it prevented the city from obtaining fresh drinking water. While shipworms were not the catalyst for this dispute, once wharves started collapsing in Antioch, the local press added them to the list of reasons why rice irrigators ought to cease. Wharf collapses, explained the *Antioch Ledger*, “shows conclusively the taking of so much fresh water by the rice men has brought the destructive teredo.” The *Byron Times* remarked how “every wharf along the upper bay is falling into the water, due to the ravages of the teredo, never heard of in that locality UNTIL THE RICE MEN TOOK THE WHOLE RIVER UNTO THEMSELVES.” John Partridge, the city’s attorney, entered teredo damages as evidence, but his efforts went for naught as Antioch lost the case in 1922.<sup>59</sup>

Shipworms had a way of driving a wedge between people, as evidenced by the aforementioned legal wrangling. They also brought to the surface the sort of interurban rivalries that were common in the Pacific Northwest. In 1919, for instance, a Suisun Bay paper remarked “[w]e’re among the very fortunate folks in the matter of teredo” because they “won’t even look at us” (this was before shipworms became a problem there too). Similarly, people in Alameda used the extensive damages to the Mare Island Naval Shipyard as ammunition to lobby for abandoning the site and relocating it in the south

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59. “Teredo Work Is Damaging Local Piling,” *Antioch Ledger* (CA), November 27, 1920, 1; “Great Delta Interests Are Combining,” *Byron Times* (CA), November 11, 1921, 1; “Teredo Loss Is Related In Big Water Case,” *Contra Costa Gazette* (CA), November 27, 1920, 2; *Town of Antioch v. Williams Irr. Dist.*, 188 Cal. 451, 468, 205 P. 688, 696 (1922). The case went to the U.S. Supreme Court, which was forced to side with irrigators because of California’s doctrine of prior appropriation; For more background on the case, see Philip Garone, *The Fall and Rise of the Wetlands of California’s Great Central Valley* (Berkeley: University of California Press, 2011), 117.

bay. While not as prevalent as on Puget Sound, using teredo as a pawn in a regional chess match occurred to some extent in the Bay Area too.<sup>60</sup>

The most typical response to the invasion was to replace the crumbling untreated structures with teredo-resistant materials. Concrete encased piles and creosoted timber became as common in the northern bays as they had been in the south. Additionally, waterfront property owners took to landfilling where possible. To this end, several companies, such as the Southern Pacific, the California and Hawaiian Sugar Company, and Shell Oil appeared before the Board of the Federal Harbor Line Commission to request that the harbor lines be pushed slightly further out into Carquinez Strait so they could fill under the wharves. In nearly every way, the waterfronts along the northern bays were starting to resemble those in San Francisco and Oakland.<sup>61</sup>

## **Conclusion**

By early 1921, the epidemic appeared to be cresting. Fishermen at Crockett reported, “marine worms are dying because of the freshening of the water in the Straits.” But the respite was only brief. In 1924, borers returned and quickly resumed their destructiveness. At Avon, in Suisun Bay, shipworms attacked a pier owned by the Associated Oil Company. While the structure had been slated for renovation with concrete, borers got to it first. As if out of a movie, the collapsing pier tugged down wires powering electric lights, which then sparked a fire in the gasoline shed on the pier. The

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60. “No Barnacles at Bay Point Yard,” *Concord Transcript* (CA), January 23, 1919, 1; “Mare Island Is Not Alone In Teredo Grip,” *Daily Gazette* (CA), March 13, 1922, 2.

61. “Move Bulkhead Is Plea Made to U. S. by Firms,” *Contra Costa Gazette* (CA), May 7, 1921, 8.

conflagration quickly spread to the *Alden Anderson*, an oil tanker. Six men burned to death on the ship as it drifted in flames out into the middle of Suisun Bay.<sup>62</sup>

Blame for the most recent infestation was quickly attributed to the most recent drought. But it should be clear by this point that drought was more of a catalyst than a cause of the crisis. The northern bays had changed over the years and teredo infestations could no longer be blamed on extreme weather. In the coming years, people would learn to live with borers that they invited into their ports as a result of the changes that they made to estuarine environments.<sup>63</sup>

It took more than seven decades before the Bay Area got a handle on borers. Over this time, people in the region repeated several mistakes and suffered from poor luck. But the disasters that they withstood were far from entirely natural—the people throughout San Francisco Bay and its hinterland bore their share of the blame for these unnatural disasters.

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62. “Fresh Water Is Killing Tederos [*sic*] Is Statement of Bay Fisherman,” *Daily Gazette* (CA), January 21, 1921, 1; Jackson and Paterson, *The Sacramento-San Joaquin Delta*, 10.

63. “Drought Again Favors Teredo,” *Engineering News-Record* 93 (November 1924): 776; “The Teredo Again,” *Dock and Harbour Authority* 5 (1925): 66; “Teredo Destroys Piles in 2½ Months,” *Engineering News-Record* 94 (January 1925): 189.

CHAPTER SIX  
“IS THE PORT OF NEW YORK IN DANGER?”:  
THE NORTHEAST, INVASIVE SPECIES, AND THE  
PROFESSIONALIZATION OF MARINE BORER RESEARCH

**Introduction**

In March of 1922, a gathering of worried biologists, chemists, and railroad engineers convened in New York to discuss a most pressing question, “Is the Port of New York In Danger?” On everyone’s mind was the *Teredo navalis* invasion of San Francisco Bay and whether something similar could happen along the East Coast where untreated timber was still typical in harbor structures north of Chesapeake Bay. Even though the northeast had long avoided the worst effects of marine borers, the sudden and devastating introduction of *Teredo navalis* on the west coast forced the attendees to reconsider whether New York and New England were truly safe. Their fears had merit. In 1921, the New Jersey State Board of Shell Fisheries had discovered *Teredo navalis* for the first time in Barnegat Bay, New Jersey. New York or Boston might be next. “It would be foolhardy, to say the least, to await the actual infection,” insisted Charles Powell, a New York municipal engineer. He urged his fellow attendees to “take immediate action.”<sup>1</sup>

Fears over a possible invasion of the northeast were so perturbing that they would alter how the nation would respond to borers and, in the process, bring about an end to the teredo epidemic. From the 1920s to the 1950s, the battle with borers entered an institutional phase, one that was orchestrated increasingly at the national level. The

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1. The papers and discussions from this meeting were published in “Destruction By Marine Borers: Is the Port of New York In Danger?” *Municipal Engineers Journal* 8 (1922): 57, 72, 73, 80.



before-and-after picture is stark. Prior to the San Francisco Bay invasion, woodborer deterrence was coordinated at the local level by amateurs. As early as 1905, James McKeon, of the Millowners' Association of Oakland, saw the flaws with this approach. What the country needed were professional researchers who understood how to work with elaborate methodologies and who would have training in such things as water analysis, silvaculture, and marine biology. "[T]hese are sufficient reasons," he explained, "for barring private parties or poor men (of which there are many able inventors) from entering upon this field of investigation and experiment." McKeon was ahead of his time. Unfortunately, as he noted at the time, "neither governments or corporations offer adequate inducements to competent persons desirous of entering this broad field of research."<sup>2</sup>

The meeting in New York was a turning point. Over the next three decades, marine borer research underwent precisely the sort of professionalization that McKeon had urged. Instead of parochial studies conducted by local investigators, the job shifted to university scholars and government agencies with broader mandates. Professional researchers conducted massive studies and debated and formalized methodologies that made it possible to compare findings. They started publishing and meeting together at conferences and special committees. The private sector lauded these efforts and handed over the reins (and funds) to public sector professionals. Eventually, the armed forces would invest in woodborer research on the grounds that marine borers threatened the nation's military preparedness. By the 1950s, the Bureau of Docks and Yards and the Naval Research Laboratory had taken charge by coordinating research at the national

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2. James McKeon, "Wood Preserving," *Proceedings of the Pacific Coast Railway Club* 6 (1905): 184.

level. In all of these ways, the fight against woodborers had shifted from the local level to a much needed top-down and institutional approach.

Northeasters played an important role in these developments. The threat of a San Francisco-like invasion spooked people in New York, New Jersey, and New England, where untreated timber was still plentiful. During the interwar period, northeasters formed two important committees that sustained interest in borers after the San Francisco crisis: the New York Harbor Marine Borer Research Committee and the New England Marine Piling Committee. The following pages will explore the evolution and professionalization of marine borer research largely—but not exclusively—from the vantage point of northeasters as they helped lay the groundwork for a larger postwar institutional approach that brought an end to the woodborer epidemic.

### **Protected by Pollution**

Compared with the rest of the country, the northeast had a much easier time with marine borers. This advantage dates as far back as the seventeenth century. When Edward Randolph argued for the revocation of the Massachusetts Bay Colony's charter in 1677, he listed the region's lack of "worms" as one of the first reasons why the crown ought to take charge over the colony. Strategically, New England had "many harbours free from the worm, convenient towns for quartering soldiers, and plentiful accommodation for men and shipping," he explained. It's unclear from his correspondence with the Lords of Trade if Randolph thought that the entire region was free of marine borers (he qualified his statement with "many harbours" instead of "all harbours"), but compared to accounts from Virginia, Carolina, and the West Indies (see

chapter one) borers appear to have been less destructive in the northeast.<sup>3</sup>

By the eighteenth century, marine borers became more of a problem in the northeast. In 1749, the physician William Douglass described two borers in New England in his history of the British North American colonies. One of these he clearly identifies as an invasive species: the “*Worm*,” which was a “great Nuisance to Navigation.” According to Douglass, this borer was found “at first only in the *West-Indies*, but have from thence been carried with Ships, and do propagate in *Carolina, Virginia, [and] Maryland*.” At the time of his writing, worms had “got so far North as *New-England*, and lately done considerable Damage in the Port of *Newport, Colony of Rhode Island*”. Douglass thought that these “*Teredines*” were different than the shipworms that had attacked the dikes of Holland, but he hoped that a “hard frosty Winter” might rid Rhode Island of them, just as changing climate brought an end to the Dutch crisis two decades earlier.<sup>4</sup>

The “*Worm*” wasn’t the only borer that Douglass mentioned. Additionally, the northeast suffered from a “Maggot Like *Teredo*, which preys upon the Wooden Wharfs of *Boston* and elsewhere.” He calls these borers “*Ascarides*.” The ascarides had a greater distribution than the recently arrived worms. Given their likeness to maggots, he almost certainly was describing limnoria, or the gribble, the same crustacean borer that would continue to attack piling throughout the northeast in the nineteenth and twentieth centuries. Douglass makes no mention of the native or introduced status of these so-called ascarides. Unlike his stark assertion about the origins of worms (which were

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3. “America and West Indies: May 1-15, 1677,” in *Calendar of State Papers Colonial, America and West Indies: Volume 10, 1677-1680*, ed. W. Noel Sainsbury and J. W. Fortescue (London: Her Majesty's Stationery Office, 1896), 72-88.

4. William Douglass, *A Summary, Historical and Political, of the First Planting, Progressive Improvements, and Present State of the British Settlements in North-America* (Boston: Rogers and Fowls, 1749), 1:125, 2:69.

“pernicious to Ships in hot Countries”) his description of the ascarides betrays no impression that they were brought to the region from elsewhere.<sup>5</sup>

During the nineteenth century, woodborers fluctuated in intensity, particularly around New York. In 1820, shipworms were enough of a problem that a government agent ordered a Staten Island wharf be built from unseasoned hemlock with its bark on, as these piles were not “liable to the ravages of the worms.” A decade later, the New York Common Council remarked that “it is a fact of great notoriety, that piers and wharves, as now constructed of timber, are temporary, and generally endure only from fourteen to seventeen years before they are destroyed by worms” (a relative eternity compared to the short lives of marine structures in the south and west). By the end of the 1830s, shipworms seemed to have disappeared from the harbor only to return approximately 4-7 years later. In the 1850s they once again diminished, reappeared again in the 1860s, before finally withdrawing from the harbor after the 1870s. New York Harbor would remain largely free of borers for the next half-century.<sup>6</sup>

New Yorkers saw nothing mysterious behind the decline in shipworms. Pollution prevented borers from surviving in the inner harbor. So much sewage and waste had been dumped in the harbor that “no self respecting marine borer could live” in such foul

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5. Douglass, *A Summary, Historical and Political, of the First Planting, Progressive Improvements, and Present State of the British Settlements in North-America*, 2:69.

6. House, *Report of the Committee on Commerce, to which was Referred the Bill from the Senate for the Relief of Alexander Humphrey and Sylvester Humphrey*, 17th Cong., 2d sess., 1823, H. Rpt. 81, 2; Board of the Aldermen of the City of New York, “Note On Destruction of Piles by Worms in East River,” Doc. No. 85, April 15, 1833; The decline in shipworms during the 1830s was commented on at a meeting of the American Institute, “Properties, Peculiarities and Uses of Different Kinds of Wood and Timber,” *New-York Daily Tribune*, March 2, 1844, 3; For the decline in the 1850s, see Major Francis J. O’Keefe, “The Use of Treated Timber in Port Structures in New York Harbor,” in *Proceedings of the Thirty-First Annual Meeting of the American Wood-Preservers’ Association* (Washington DC: AWWA, 1935): 164; for an analysis of the decline in borers after the 1870s, see R. Montfort, “Protecting Piles Against the ‘Teredo Navalis’ on the Louisville and Nashville Railroad Company’s Lines,” *Transactions of the American Society of Civil Engineers*, 31 (February 1894): 235-237.

conditions, as an engineer for the Department of Docks later put it. In 1872, changes to the sewage system made it even more difficult for borers to survive. Prior to that, sewage was dumped along the shore, protecting piles close to the waterfront, but not the pier heads. After 1872, sewage boxes ran underneath the piers and discharged at their heads, thus polluting much of the Hudson, East, and North Rivers. In addition to raw sewage, gashouses polluted the harbor to the detriment of shipworms. In the 1890s, when an oil works stopped dumping acid sludge into the harbor, some New Yorkers reportedly grew concerned that shipworms might return once the waters cleared. Their fears wouldn't come to pass, and the harbor remained free of borers well into the twentieth century. Between the 1870s and 1920s, New Yorkers remained confident that pollution protected their harbor from shipworms.<sup>7</sup>

Outside of the polluted inner harbor, borers persisted to varying degrees. Examples range from New Jersey up to Narragansett Bay. In the 1880s, a bridge connecting Bayonne and Elizabethport in Newark Bay became riddled with teredo. Likewise, to the east, the Jamaica Bay Improvement Commission noted at the turn of the century how “[o]wing to the purity of water in the bay[,] the teredo exists in formidable quantities and must be reckoned with.” In Long Island Sound, reports of boring attacks appeared regularly. In 1902, shipworms had riddled a pier in New London until “there was nothing left but a thin shell.” At Fall River, shipworms had attacked a bridge across

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7. For the quote about pollution, see O’Keefe, “The Use of Treated Timber in Port Structures in New York Harbor”: 164; Montfort, “Protecting Piles Against the ‘Teredo Navalis’ on the Louisville and Nashville Railroad Company’s Lines”: 235; for the role of gasworks pollution, see John D. Van Buren, “The Improvement of the Water Front of the City of New York,” *Transactions of the American Society of Civil Engineers* 3 (1875): 183; “A Good Word For Sludge Acid: It Might Hurt Fish and Oysters, But It Was the Friend of Ship and Piles Owners,” *Sun* (NY), January 5, 1890, 20; For example of New Yorkers belief that sewage prevented shipworms, see the following sources: “The News of Brooklyn,” *New-York Tribune*, October 4, 1896, 28; George A. Orrok, “The Sea Wall In Connection With Buildings,” *Engineering Record* 61 (February 1910): 254; “Work of the Shipworm,” *New York Times*, March 30, 1919, 28.

the Taunton River after fill placed around its base had washed away and left the structure open to attack. Borers weren't an epidemic per se, but they were endemic to the waters surrounding New York's inner harbor.<sup>8</sup>

Experiences in and around Boston compare and contrast with New York, New Jersey, and Long Island. While shipworms were recorded south of Cape Cod, they were never abundant along the upper rim of Cape Cod. In 1843, zoologist James E. De Kay voiced the commonly held belief that teredo "scarcely extends north of the waters of this State [of New York]." This is not entirely accurate, however, since shipworms gave the Canadian Maritime Provinces fits. But for the most part shipworms were absent from northern New England. Biologists, rather than growing complacent, alertly monitored Boston Harbor for any traces of shipworms. Every once in a while, they found teredo in the hull of a ship, but never among the piling of Boston Harbor. During the 1850s, teredo damaged ships in nearby Lynn and Marblehead, but there is no evidence that it had taken root in the harbor structures along the cape, outside of a rare example from Provincetown, in 1880, where a wharf collapsed on account of teredo.<sup>9</sup>

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8. Destruction By Marine Borers: Is the Port of New York In Danger?": 73. C. M. Taylor described the conditions in Newark Bay; *Report of the Jamaica Bay Improvement Commission* (New York: Martin B. Brown Press, 1909), 137-138; "Teredo Destructive at New London, Connecticut," *Engineering News* 43 (October 1902): 349; James W. Rollins, "The Fall River Bridge," *Journal of the Boston Society of Civil Engineers* 1 (February 1914): 74, 79.

9. James E. De Kay, *Zoology of New-York, or the New-York Fauna*, in *Natural History of New York* (Albany: Carroll and Cook, 1843), 5:249; Martin Murphy, "On the Ravages of the *Teredo navalis*, and *Limnoria lignorum*, on Piles and Submerged Timber in Nova Scotia, and the Means Being Adopted in Other Countries to Prevent Their Attacks," *Proceedings and Transactions of the Nova Scotian Institute of Natural Science* 5 (1878-1879): 357-376; For early observations on teredo in ships in Boston, see Edward Hitchcock, ed., *Catalogues of the Animals and Plants of Massachusetts* (Amherst: J. S. and C. Adams, 1835), 19; and Augustus Addison Gould, *A Report on the Invertebrata of Massachusetts, Comprising the Mollusca, Crustacea, Annelida, and Radiata* (Cambridge: Folsom, Wells, and Thurston, 1841), 26; For attacks on Lynn and Marblehead vessels, see William Stimpson, *Proceedings of the Boston Society of Natural History* 4 (October 1851): 113-114; For Provincetown, see Richard Rathbun, "The Littoral Marine Fauna of Provincetown, Cape Cod, Massachusetts," *Proceedings of United States National Museum* 3 (May/July 1880): 128.

Boston and surrounding cities might have been free from teredo, but not limnoria. Throughout the nineteenth century, gribbles attacked the city's waterfront as well as piling all up and down the New England coastline. The naturalist Augustus Addison Gould observed this borer doing its work on harbor structures as early as the 1840s. Gould had mixed feelings about gribbles. On the one hand, they damaged wharves, but not all too badly. "[A] very trifling portion of their whole number interfere with the works of the possessions of man," he admitted. Gould found gribbles to be more beneficial than not because "[t]he great multitude is employed in devouring and disintegrating submerged timbers, which would otherwise remain almost imperishable." Later in the century, Boston's city engineers kept tabs on limnoria and published their findings in their annual reports. But for the most part their investigations suggest that limnoria was not worth fussing over. For all intents and purposes, Boston was free from the threat of marine borers.<sup>10</sup>

Just like their neighbors in New York, some Bostonians credited the absence of any threat from woodborers to pollution. In an 1879 article titled "Ravages of the Teredo," the *Boston Globe* declared, "[t]he wharves and shipping in Boston harbor are less subject to the ravages of teredo, that destructive little marine pest, than those in other harbors." The article goes on to explain that "[t]he reason is that they are protected by the sewerage which is now discharged among the piles and into the river." Pollution also

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10. Gould, *A Report on the Invertebrata of Massachusetts*, 355; William Jackson, *Twenty-Second Annual Report of the City Engineer, for the Year 1888*, Document 38 (City of Boston: 1889), 40. The most thorough study of limnoria by City Engineer Jackson came up "with substantially negative results," which is to say he didn't find limnoria to be a threat. The annual City Engineer's reports documented limnoria during the 1890s, but mentioned it only in passing.

purportedly protected the bay from limnoria. In 1888, Boston's City Engineer deemed the harbor too polluted for limnoria to flourish and do much damage.<sup>11</sup>

Not everyone felt confident that Boston would forever remain immune from teredo. Every now and again rumors swirled that teredo had invaded Boston, only to subside after an examination of the harbor turned up nothing. In 1888, for instance, when the Massachusetts Railroad Commissioners feared that shipworms had attacked trestles throughout the city, they hired Massachusetts Institute of Technology professor George Swain to investigate and provide a full report. After an exhaustive search, Swain found one single teredo burrow. Fears died down. But in 1893, Bostonians grew panicked once again after a couple of scows showed traces of teredo borings. The Boston Society of Civil Engineers convened a meeting to assess the threat, but no action was necessary because the shipworms disappeared over the winter. In 1899, changes to Boston's sewage and refuse disposal got residents worked up once again. The *Boston Globe* reported that shipworms had attacked the navy yard at Charlestown after the changes were instituted. Subsequent reports by the city engineer, however, do not confirm an outbreak, so the attack might have been an isolated incident. But the episode goes to show how much Bostonians credited pollution as a barrier to invasion.<sup>12</sup>

On the eve of the *Teredo navalis* invasion of San Francisco Bay, woodborers did not excite much interest in the northeast, and hadn't for decades. Bostonians for instance no longer fretted much about limnoria, and between 1915 and 1920, they drove 50-60

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11. "Ravages of the Teredo," *Boston Daily Globe*, April 21, 1879, 2; Jackson, Document 38: 40.

12. George F. Swain, *Twentieth Annual Report of the Board of Railroad Commissioners*, Public Document No. 14 (Boston: Wright & Potter Printing Co, 1889), 211-245; Henry Manley, "The Teredo Navalis in Boston Harbor In 1893," *Journal of the Association of Engineering Societies* 13 (1894): 243-248; "Worms In Harbor," *Boston Daily Globe*, May 27, 1899, 1; "Spoil Piling," *Boston Daily Globe*, June 9, 1899, 4.



thousand untreated piles into the harbor. Likewise, studies of New York Harbor supported the long held contention that pollution prevented borers from surviving in the harbor. For half a century, woodborers ravaged harbors around the country. Meanwhile, the northeast lived in a comparative bubble—one that was about to burst.<sup>13</sup>

### **Crisis and Response**

News from San Francisco shook northeasterners and called into question much of what they believed about borers. The very idea of a marine invasive species had some scratching their foreheads. Few outside of academia had ever felt the need to distinguish between various species, such as *Bankia setacea*, *Lyrodus pedicellatus*, and *Teredo navalis*. For all they knew, “teredo” was the only species of shipworm. C. M. Taylor, a railroad timber preserver, expressed how many of his peers thought when he remarked, “as engineers, we do not have to name it, we have destruction regardless of the animal that caused it.” The San Francisco crisis jolted northeasterners out of this frame of mind since *Teredo navalis* thrived in parts of the Bay Area that *Bankia setacea* had never been able to reach. Not all shipworms were the same, nor did they act the same. The prospects of an exotic borer like *Teredo navalis* thriving in the harbors of New York and Boston could not be brushed aside.<sup>14</sup>

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13. Asa H. Morrill, New England Committee on Marine Piling Investigation, *Marine Piling Investigation: Progress Report, Covering Investigation to March, 1935* (Boston, 1935), 29; Ralph H. Mann, “Marine Structures on the North Atlantic Seaboard,” *Proceedings of the Thirty-Fifth Annual Meeting of the American Wood-Preservers’ Association* 35 (1939): 292-301.

14. Taylor’s quote can be found in the discussion of “Destruction By Marine Borers: Is the Port of New York In Danger?”: 73; Taylor was speaking for other engineers since he wasn’t himself ignorant of the different species of woodborers. He distinguished between the genera in a talk he gave the year before at a railroad industry conference, C. M. Taylor, “Treated Timber,” *Proceedings of the Thirty-First Annual Convention of the American Railway, Bridge, and Building Association* 31 (October 1921): 203.

Northeasterners also found the initial reports coming out of San Francisco troubling for another reason: they had heard that *Teredo navalis* might be immune to pollution and sewage. In Oakland, shipworms had destroyed wharves used by Standard and Shell Oil Companies as well as others owned by the Shelby Smelter Company. Together, these industries dumped oil refinery waste and copper sulfate into Oakland Creek. To the surprise of biologists, the pollution seemed to have no effect on *Teredo navalis*. Hermann von Schrenk, a timber preservation expert, found these reports “disquieting” since pollution had been the chief rationale for the absence of borers in the northeast. “For years we have believed that the high sewage pollution of the waters of the New York district has rendered *Teredo* attacks more or less problematical,” writes Schrenk; “[w]e may, therefore, not be as safe in New York from an invasion of this organism as we thought.” The evidence from San Francisco was far from conclusive (as we shall see) but it was enough to rattle northeasterners who had come to depend on pollution.<sup>15</sup>

The invasion of San Francisco Bay showed that the threat of woodborers had grown beyond the resources of any one harbor, city, or region. To meet the challenge, woodborer researchers would need institutional support. They would need committees, sub-committees, and specialists from fields in chemistry and hydrology. And they would need ample financial support to conduct multi-year studies and analyses. In short, combating marine borers would require a Progressive Era-style bureaucracy.

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15. William G. Atwood, “Marine Borers,” *Proceedings of the American Society of Civil Engineers, Volume 48* (August 1922): 1416; von Schrenk had his paper on New York threat assessment printed in “Destruction By Marine Borers: Is the Port of New York In Danger?": 73

During the nineteenth century, a handful of people advocated for greater institutional support for the study of borers, but to no avail. In 1873, U.S. Fish Commissioner Spencer Fullerton Baird remarked that woodborers “are of so great importance, owing to the injuries which they do to valuable property, that it seems desirable to make a special division for the animals ordinarily found in connection with wood-work.” In 1879, George Page recommended that the American Fish Cultural Association change its name to the “American Fishery Society” so it could support research on teredo and other inedible destructive marine organisms. By the start of the twentieth century, as James McKeon noted, nothing of the level required had taken place. On the eve of the *Teredo navalis* invasion of San Francisco Bay, no organization had taken the lead in marine borer research.<sup>16</sup>

World War I finally created the mechanism for the professionalization of marine borer research. In 1916, President Woodrow Wilson formed the National Research Council to facilitate military research and preparedness. When the war closed, he saw its potential for peacetime work and issued an executive order to maintain it. During the *Teredo navalis* invasion of the Bay Area, the National Research Council responded by

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16. Spencer Fullerton Baird, *Report of the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872*, 42d Cong., 2d sess., 1873, Mis. Doc. No. 61, Pt. 1, 378; George S. Page, *Transactions of the American Fish Cultural Association, Eighth Annual Meeting* (New York: Johnson Reprint Corporation, 1879), 27-28. Page’s untitled paper focused exclusively on woodborers; McKeon, “Wood Preserving”: 184; Atwood, “Marine Borers”: 1408. Atwood describes the poor state of marine borer research prior to the San Francisco crisis. He is especially critical of the ASCE for publishing just four articles on woodborers since its inception (by including Octave Chanute’s special committee, which looked more broadly at timber preservation, the number goes to five); Charles Stowell Smith, “Preservation of Piling Against Marine Wood Borers,” U.S. Department of Agriculture, Forest Service Circular 128 (Washington DC: GPO, 1908); For test piles in California and the gulf coast, see Clyde Teesdale, “Efficiency of Various Parts of Coal-Tar Creosote Against Marine Borers,” *Engineering Record* 70 (September 1914): 301-302; For test piles of greenheart in the Panama Canal and Gulf of Mexico, see Andrew Armstrong, “Greenheart: A Timber With Exceptional Qualities,” U.S. Department of Agriculture, Forest Products Laboratory (Madison: 1915). In the public sector, the U.S. Forest Service published a short circular on borers in 1908 and laid some test piles along the west coast, gulf coast, and Panama Canal during the early 1910s. But in general no organization had taken charge of the woodborer problem.

organizing the San Francisco Bay Marine Piling Survey to study the problem. After this survey began to show its worth, the council organized a national survey called the Committee on Marine Piling Investigations, which tried to establish regional surveys based on the San Francisco model. Ultimately, it failed in this larger aim. But it did further professionalize research through an ambitious and successful national test board program—conducted between 1922-1924. During this span, more than 300 test boards were placed in harbors around the country.<sup>17</sup>

The national piling committee didn't invent test boards by any stretch of the imagination. But it did standardize them. For decades, people had tested the resistance of certain trees or anti-borer products by simply plopping piles into the water and waiting. Success or failure depended on whether borers attached to the timber or not. Little thought was put into the size or shape of the boards, or even how long they should be left in the water (not much information about the boards was ever recorded). Evaluating the piles, thus, became highly subjective. Without a systematic way of setting controls and collecting data, the information gleaned from the boards benefited very few people, if anyone at all.

The national piling committee devised a much more rigorous methodology, one that would allow researchers to compare and contrast the activity of borers in waterways as diverse as Chesapeake Bay and Boston Harbor. Instead of fixed piles, the committee suspended long boards into the water column. Onto these boards, researchers attached

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17. For general details of the NRC, see <http://www.nationalacademies.org/about/history/index.html>; The work of the San Francisco Bay Marine Piling Committee (alternatively called a "Survey," instead of "Committee"). C. L. Hill and C. A. Kofoid, *Marine Borers and Their Relation to Marine Construction on the Pacific Coast: Final Report of the San Francisco Bay Marine Piling Committee* (San Francisco: Committee, 1927), 1-12.

blocks of southern pine of following dimensions: 4" x 4" x 6". At regular intervals, the boards were pulled from the water. Some blocks were removed, while others were not. The removed blocks were sent to the committee for analysis, while the rest of the blocks were put back into the water for longer periods of exposure. In this fashion, researchers could measure the rate of infection and seasonal patterns. Additionally, the standardized test boards gave researchers valuable samples that they could compare across dozens of waterways in their effort to refine the taxonomy of American borers.<sup>18</sup>

Even though the committee was instructed to explore the nation's entire coastline, the northeast was disproportionately represented in the survey—more than half of the boards were submerged throughout New England, New York, and New Jersey. When the results were published in 1924, the test boards showed, among other things, that the fears of a northeastern invasion might have been overstated. Many sighed in collective relief and gradually lost interest in borers.<sup>19</sup>

By the late 1920s, the urgency to study borers unfortunately languished. This happened for a few reasons. The *Teredo navalis* invasion of San Francisco Bay had already done its worst and the region had rebuilt with a greater appreciation of how to prevent the inroads of borers. Also, the major research committees naturally ran their course—they published their findings to great acclaim, and then disbanded. Finally, the feared northeastern invasion did not come to pass, meaning that there was no need for a northeastern regional survey after all (or so they thought at the time). The first wave of

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18. William G. Atwood and A. A. Johnson, *Marine Structures, Their Deterioration and Preservation: Report of the Committee on Marine Piling Investigations of the Division of Engineering and Industrial Research of the National Research Council* (Washington DC: National Research Council, 1924). For descriptions and images of the standardized test boards and procedure, see 6-18.

19. Atwood and Johnson, *Marine Structures, Their Deterioration and Preservation*. For harbor reports, see 221-288.

professionalization produced many notable successes—particularly by the standardization of test boards procedures—but ultimately petered out. It would take another crisis before a sustained research program took off.<sup>20</sup>

### **Northeastern Epidemic of the 1930s**

Beginning in 1932, strange things started happening in the waters of the northeast. In Plymouth, Massachusetts, the buoys that bobbed up and down in the harbor seemed to be sinking. Designed to mark harbor channels, the buoys continued to slouch until they hardly poked above the water's surface. This wasn't the only strange occurrence. Down in Long Island Sound, the New Haven Police Department thought that they were on the hunt for a vandal who had been cutting loose several yachts under the cover of night. After a stake out, police turned up no suspects. In both instances, the culprit was not a person, but the dreaded *Teredo navalis*. Shipworms had waterlogged the buoys and bored into the mooring ropes, causing them to split (in addition to trees, teredo had an appetite for fibrous plants used for rope, and even hardened tree sap called "gutta percha," made from of a Malaysian timber and used to wrap underwater telegraph cables). The damaged buoys and yachts were just the beginning. The long-feared northeastern epidemic had finally begun.<sup>21</sup>

During the 1930s, woodborers caught the northeast by surprise. From Maine to New Jersey, mollusks and crustaceans devoured coastal structures. Trade journals capture the unexpectedness of the crisis. "Marine Borers Cause Alarm," read the title of a 1936

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20. For a bibliography of these reports, see the annual reports and final report of the San Francisco Marine Piling Survey and their appendices; see also, Atwood and Johnson, *Marine Structures, Their Deterioration and Preservation*, for a list of National Research Council funded studies.

21. William F. Clapp, "Marine Borers in the North Atlantic," *Connecticut Society of Civil Engineers* 52 (1936): 88, 92.

railroad publication. In the same year, the *Fishing Gazette* asked its readers, “Are You Prepared to Fight a New Invasion of Marine Organisms?” In 1938, a Boston business journal ran a story titled “Underwater ‘Army’ Bent On ‘Sinking’ of Coastal Wharves.” The general press also paid heed. During the mid 1930s, for example, the *Boston Globe* ran the following stories: “New England Invaded By Hungry Shipworms” and “New Pest Threatens Wharves of Boston.” The invasion of *Teredo navalis* throughout New England and Long Island Sound was becoming harder to ignore.<sup>22</sup>

Invasive borers weren’t solely to blame. Limnoria activity also spiked during the thirties. The presence of limnoria wasn’t unusual. What was strange was how destructive it had become, and seemingly overnight. Rarely had gribbles deterred marine builders in the past from driving untreated piles. In 1918, for instance, the United States Army pier in South Boston was built on untreated southern pine. During the 1920s, limnoria pecked at the 28,000 piles underneath this pier, but presented no threat when surveyed by the national piling investigation in 1924. By 1933, gribbles suddenly awoke and tore into the structure. When divers descended underneath it they discovered that thousands of piles had been reduced in diameter by a third. Two years later, they had been reduced further to just half their original diameter. The pier was in peril of collapsing and needed an urgent and costly improvement to save it. All across the northeast, limnoria stirred like never before.<sup>23</sup>

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22. “Marine Borers Cause Alarm,” *Railway Engineering and Maintenance* 32 (1936): 150; “Are You Prepared to Fight a New Invasion of Marine Organisms?” *Fishing Gazette* 52 (1936): 24; “Underwater ‘Armies’ Bent On ‘Sinking’ of Coastal Wharves,” *Boston Business* 28 (1937): 26-27; Alton Hall Blackington, “New England Invaded By Hungry Shipworms,” *Boston Globe*, August 12, 1934, A16; “New Pest Threatens Wharves of Boston,” *Boston Globe*, April 7, 1935, A43.

23. O’Keefe, “The Use of Treated Timber in Port Structures in New York Harbor”: 167-168; “Steel Bulkhead and Sand Fill Protect Piles Under the Army Base,” *New England Construction* 1 (1936): 12-13. 247

By 1934, conditions had deteriorated so rapidly that business leaders and local and state officials convened a conference to discuss the matter. In attendance were railroad engineers, public works officers, military representatives, and biologists from nearby universities. The participants tried to fathom why marine borers had come out of nowhere and caused so much damage, and when the meeting adjourned, the conference goers had decided on a course of action: a multipronged and multiyear survey. The New England Committee on Marine Piling Investigation, as it was named, followed in the spirit of the Committee on Marine Piling Investigations and the San Francisco Survey from a decade earlier. In fact, the New England Committee was fortunate to have the assistance of William F. Clapp, a veteran of these studies.<sup>24</sup>

Clapp brought a lot more than experience to the New England Committee. He was a quirky and charismatic fellow who became the informal public relations arm of the New England Committee. Born and raised in the Boston area, Clapp was a precocious lad. By the age of twelve he had amassed such a collection of rocks and animals that he earned his own desk at the Peabody Museum. Clapp taught for lengthy stints at Harvard and MIT before devoting his life to the study of marine borers. In the 1930s, he set up a private laboratory on his boat in nearby Duxbury, Massachusetts where he stored specimens of borers, as well as his pet snakes and a mouse that often rode around in his pocket. Not a big fan of Latin, Clapp liked to name new species of teredo after friends of his—e.g. *Teredo bartschi*, named after Paul Bartsch, the Curator of Mollusks at the Smithsonian. When he wasn't in Duxbury plucking borers from test boards, or playing

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24. Morrill, *Marine Piling Investigation: Progress Report, Covering Investigation to March, 1935*, 1-4.



with his pets, Clapp was traveling around the northeast giving interviews and talks warning of the dangers of teredo.<sup>25</sup>

To combat the crisis, Clapp and the New England Committee first had to determine if the attacks were isolated incidents or part of a broader rise in borers throughout the entire northeast. The only way Clapp knew how to answer this question was to ask. In 1934, he sent out several thousand questionnaires to waterfront owners from Maine all the way down to New York, and was fortunate to receive one hundred responses. Ninety-nine of the respondents stated that there was a “decided increase” in borers, with just one respondent relaying that there had been no discernable change in activity. No one reported a decline. The questionnaires confirmed what many had feared: the whole region was feeling the effects of the epidemic.<sup>26</sup>

Pinpointing the exact cause of the epidemic did not come easy for the New England Committee. There were a lot of factors at play, such as salinity changes, pollution abatement, and stabilizing levels of dissolved oxygen. But there was one particular factor that the committee could not ignore: the coastal waters of the northeast were rising in temperature. During its investigation, the New England committee compiled data on seawater temperatures from a few harbors: Gloucester, Woods Hole,

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25. For Clapp’s biographical information see, Katherine Bartlett, “Boston Naturalist Seeks Way To Stop Ravages of Tereido,” *Boston Globe*, February 15, 1929, 17; Blackington, “New England Invaded By Hungary Shipworms”: A16; Joan McPartlin, “A Duxbury Scientist K.O.’s ‘Nautical’ Termites,” *Boston Globe*, October 22, 1950, A11; “Dr. W. F. Clapp: Noted Marine Biologist, Top Authority on Borers,” *Boston Globe*, December 20, 1951, C33; “William F. Clapp,” *Nautilus* 66 (July 1952 to August 1953): 31; “William F. Clapp,” *Johnsonia* 2 (1953): ii, iii; for Clapp naming teredinids after friends, see William F. Clapp, “Marine-Borer Work at the Clapp Laboratories,” in *Proceedings, Wrightsville Beach Marine Conference, Wrightsville Beach, North Carolina, 5,6 June 1950* [hereafter, “*Proceedings, Wrightsville Beach Marine Conference*”] (Washington DC: National Academy of Science, National Research Council, 1951), 41.

26. O’Keefe, “The Use of Treated Timber in Port Structures in New York Harbor”: 167; William F. Clapp, “Increase of the Destruction of Timber Structures by Marine Borers in New England Waters,” *Proceedings of the American Wood-Preservers Association* 31 (1935): 167-169.

New York City, Portland, and Boston. In some cases the temperature readings stretched back to the nineteenth century. From the data, researchers graphed the fluctuations in average summer temperatures. In every instance, coastal seawater temperatures rose above the mean between 1929 and 1933 (the last date that the committee had data available before it published its first progress report on the crisis). The graphs are striking; the coast was heating up at just the same time that the epidemic ramped up.<sup>27</sup>

While sea temperature changes were eye opening, they didn't explain everything that Clapp was seeing, especially after he supplemented sea temperatures with data he gained after resurrecting the test board program abandoned a decade earlier. Test boards gave Clapp a way of seeing woodborer activity in as close to real time as possible, but they took a lot of work to maintain. Fortunately, he didn't have to start the program over from scratch. When the national investigation came to a close in 1924, Clapp maintained more than half of the boards used in the Northeast. He had help. Several New England railroad and steamship companies kept them up and paid Clapp for analyses of the boards so that the companies could use the data for insurance purposes. Clapp happily obliged since it gave him the opportunity to collect more specimens for his own research. He couldn't have known that these boards would one day be used to investigate another epidemic.<sup>28</sup>

Clapp regretted not maintaining more of these original test boards since they proved "of even greater value as indicators of marine borer activity," he explained. The test boards became an early warning system, of sorts; something that they were not

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27. Morrill, *Marine Piling Investigation: Progress Report, Covering Investigation to March, 1935*, 45-46.

28. Clapp, "Marine-Borer Work at the Clapp Laboratories," 40.

designed for. One place that could have used such a warning was the army pier in South Boston. Unfortunately, the boards were removed in 1924. “It is conceded by all concerned,” grumbled Clapp, “that the sudden unexpected attack would have been recorded on the blocks.” Moreover, the “[r]epairs which are now contemplated, would have been completed two or three years ago, at one tenth of the cost now estimated.” It cost one million dollars to wrap a sheet of steel around the entire pier and fill underneath it. The New England Committee learned from this experience and drove hundreds of boards from Maine to New Jersey to provide advance warning.<sup>29</sup>

The picture of the epidemic that emerged from the new test boards was far more complex than anyone could have expected. Woodborers didn’t march through the northeast in ways that neatly matched sea temperature rise. If anything, the epidemic was uneven and motley. Variations in borer populations from harbor to harbor, and even year to year, raised more questions than they answered. For instance, at the mouth of the Thames River in Connecticut, test boards showed that shipworms were abundant, while gribbles were sparse. New London was the exception. Along parts of the waterfront, limnoria dominated, while teredo barely registered. In other parts of New London, the exact opposite occurred. The intra-harbor variations in borer populations in the Thames estuary, as well as others, such as Bridgeport, Connecticut, perplexed Clapp and the New England Committee. If sea temperatures were so important, then both species of borers

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29. Morrill, *Marine Piling Investigation: Progress Report, Covering Investigation to March, 1935*, 29; “Steel Bulkhead and Sand Fill Protect Piles Under the Army Base”: 12-13; Clapp, “Marine Borers in the North Atlantic”: 88.

ought to have been on the increase. The complex picture that emerged along the Thames suggests that factors other than temperature were at play.<sup>30</sup>

In other ways, woodborers failed to follow patterns. In Old Saybrook, for instance, shipworm attacks spiked later than in other harbors. After three years of tests, no shipworms registered on the boards. Then in 1937 a heavy attack occurred, with teredo quickly reaching five inches in length. The next year they diminished. In nearby Guilford and New Haven, borers acted just as strangely. When Clapp reviewed data from the 1920s, he discovered heavy limnoria attacks in both places. He also found some teredo attacks in Guilford, but none in New Haven. To his surprise, the new test boards revealed that borer populations had flip-flopped. He couldn't find any gribbles in either of the harbors. But he did find a few shipworms attacking boards in 1934. Over the next four years, they increasingly attacked timber in both harbors until 1937, when Clapp characterized shipworms as heavily attacking the harbor. The passing of the baton from limnoria to teredo, complained Clapp, could "not be satisfactorily explained at the present time."<sup>31</sup>

The New England Committee made important advances in marine borer research and systematically compiled a wide range of data. But it failed to uncover a smoking gun. Belief in a single cause (i.e. temperature) proved to be a flawed assumption. A more holistic approach to the study of shipworms in the northeast was sorely needed. Clapp and others began to embrace this when they turned their attention to New York City.

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30. Connecticut State Water Commission and New England Marine Piling Committee, *Preliminary Report on the Investigation of Marine Borer Problems in Connecticut* (Duxbury: William F. Clapp Laboratories, 1938), 4, 5, 7.

31. *Preliminary Report on the Investigation of Marine Borer Problems in Connecticut*, 6, 7.

By 1938, New Yorkers had grown very concerned about the deteriorating conditions in Long Island Sound and Cape Cod. Fearing that they might be the next hit by the horde of borers, the city's major waterfront stakeholders, in a preemptive move, formed what they called the Marine Borer Research Committee of New York Harbor. Like the New England Committee before it, the New York Committee drew from both the private and public sectors. It included many prominent corporations, such as United Fruit, Standard Oil, and General Mills. They were joined by the New York Port Authority, Interstate Sanitation Commission, and the U.S. Navy. Nestled in between these giants of public and private life was William Clapp, probably the most important member of all.<sup>32</sup>

Clapp brought his recent experiences to bear on the new committee. Just as he had in New England, Clapp wanted to set out new test boards in New York Harbor. But he wanted them to serve a slightly different purpose. The primary goal of the test boards in New England was to “trap” borers for analysis and identification. In hindsight, Clapp realized that the boards could also function as an alarm system for detecting intruding borers. This time around, however, the primary goal of the boards suspended into the East River, Newark Bay, the Hudson River, and the Narrows would be to “warn us of approaching danger to our harbor.” In essence, Clapp saw the boards as an early detection system that allowed waterfront property owners a chance to react at the earliest opportunity.<sup>33</sup>

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32. For a full list of the agencies and companies that sponsored the survey, see W. P. Hedden and H. C. Ames, *Third Progress Report: December 1946* (New York: Marine Borer Research Committee, New York Harbor, 1946), 5.

33. Hedden and Ames, *Third Progress Report*, 7.

Additionally, the New York Committee took a more holistic view of borers than its New England counterpart, which had trouble modeling and predicting where woodborers might strike. Rising sea temperatures certainly played a pivotal role in the epidemic, but when Clapp zoomed in closer, he found that borers did not always flourish in places that also experienced similar temperature changes. Other factors must be at play. To improve the predictive abilities of the New York Committee, Clapp paid attention to other organisms that often accompanied woodborers. He referred to these as “associated organisms.” Clapp got this idea after he noticed blue crabs migrating northwards around the time that the woodborers attacked. By tracking organisms that shared the same ecological preferences as woodborers the New York Committee could better predict the likelihood of an invasion, even if no borers attached to the test boards. To this end, Clapp probed the boards for such things as fouling organisms because they were “excellent indicators” for impending borer activity.<sup>34</sup>

The impact that pollution had on borers was another topic that interested the New York Committee, especially because support for pollution abatement was gaining steam. The city established the New York Bay Pollution Committee way back in 1903, but it wasn't until 1937 that the first major sewage treatment plant was established at Ward's Island, at the mouth of the East River. How cleanup would affect borers was something that needed to be addressed.<sup>35</sup>

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34. Morrill, *Marine Piling Investigation: Progress Report, Covering Investigation to March, 1935*, 28; Hedden and Ames, *Third Progress Report*, 8.

35. Ralph H. Mann, *Pollution Abatement in New York Harbor: The Relation of Marine Borers to Changing Conditions of the Harbor Waters* (Chicago: Service Bureau, AWWA, 1940), 1.

Pollution was a variable that confounded Clapp more than any other. In some harbors, pollution abatement was followed by a spike in marine borers. But he had also seen harbors where pollution remained constant and borers varied. To muddle things even further, Clapp had trouble discerning the differences between sewage and industrial waste. His hunch was that industrial waste was the more influential of the two since borers, which had been on the rise between 1938 and 1941, diminished during World War II when wartime production resulted in greater industrial waste. Either way, he lacked a tool to measure pollution.<sup>36</sup>

The New York Committee wasn't the only organization working on the pollution question. Ralph Mann of the American Wood Preservers' Association found a new way of gauging pollution's impact on borers. Instead of parsing the difference between industrial effluent and sewage, Mann borrowed tools from sanitary science and applied them to woodborers. Dissolved oxygen levels might prove the best indicator of pollution, he argued. Mann referred to dissolved oxygen as the "sanitary engineer's yardstick" for pollution. Without dissolved oxygen, marine organisms can't survive. In addition to sustaining sea life, it also oxidizes bacteria and purifies water. But when pollution becomes excessive, all of the dissolved oxygen is used up, killing off marine animals in the process. In short, Mann argued that tracking dissolved oxygen levels might be the best way to determine how marine borers were responding to pollution. And since New York had built, and was in the process of building, several treatment plants, the city needed to monitor levels closely moving forward. Mann gave researchers a better tool to understand the relationship between pollution and borers, one that helped to explain why

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36. Hedden and Ames, *Third Progress Report*, 7, 24.

pollution worked to abate borers in some places, such as New York, and not others, such as Boston Harbor.<sup>37</sup>

New York City was more fortunate than its neighbors in Long Island Sound and Cape Cod. Borers never threatened major waterfront structures. But the New York Committee took the threat very seriously all the same. When Clapp published a progress report on behalf of the committee in 1946 he determined that the city had little to worry about in the immediate future. Pollution might dip in the postwar period, but it would be years before cleanup would create conditions suitable for borers. Still, the efforts of the committee were worth the effort. New York had created what Clapp called a “radar system” for detecting borers in the future. Test boards, associated species, and dissolved oxygen levels would give New Yorkers advance warning. Woodborer detection had come a long way thanks to the innovations of northerners. Moreover, the intricate methods and level of coordination undertaken by the committees had gained the attention of the United States Navy. In time, the federal government would build upon these efforts and coordinate borer research in lasting ways.<sup>38</sup>

### **Navy Pushes Professionalization**

Writers have long drawn upon military motifs to emphasize and dramatize teredo attacks and invasions. They’ve described woodborers as “armies” and “foreign invaders,” and characterized the relationship between people and shipworms as a “fight between man and nature” and a “war against teredo.” These literary devices, unsurprisingly, picked up around periods of actual warfare, as well as times of cold war. The New York

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37. Mann, *Pollution Abatement in New York Harbor*, 2-3.

38. Hedden and Ames, *Third Progress Report*, 7, 30.



Committee's 1946 report contains fascinating examples. After conducting most of their research during the thick of the war, the authors referred to the harbor's test boards as "our 'radar system,'" whose purpose was to "warn us of approaching danger" from "[o]ur enemy, the marine borers." The committee also likened New York's polluted inner harbor to a "fortress surrounded by enemies."<sup>39</sup>

It is hard not to pause for a moment on such overdone rhetoric, even if these metaphors are not quite so jarring in light of teredo's long history of being culturally anthropomorphized (see chapter three). But it is still a little startling to read officers in the United States armed forces using wartime language and cold war rhetoric to talk about borers. Take for instance the writings of Captain E. John Long, a compiler and publisher of naval oceanographic research. In a couple of publications in the early 1950s, he dubbed shipworms the "subversives of the sea" and described the navy as embroiled in a "battle at the tide line." Long wasn't alone. Rear Admiral A. D. Alexis once complained about the "subversive action of the Teredo" at a research conference. Remarks like these underscore a broader frustration felt by military leaders, which pushed them to act. In the end, the navy's growing interest would further professionalize woodborer research and help bring an end to the epidemic.<sup>40</sup>

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39. "Underwater 'Armies' Bent On 'Sinking' of Coastal Wharves": 26-27; John Evelyn, *Sylva, Or a Discourse of Forest Trees* (London: Doubleday & Co., 1908), 2:85; William G. Atwood, "The All-Devouring Marine Borer: A Sea-Coast Fight Between Man and Nature, That Has No End," *Scientific American* 178 (1923): 388-389; "Late Magazines," *Los Angeles Herald*, November 8, 1908, 6; "Paint and the War Against Teredos," *Western Business and Industry* 18 (1944): 38-40; Hedden and Ames, *Third Progress Report*, 7.

40. E. John Long, "Subversives of the Sea," *U. S. Naval Institute Proceedings* 77 (1951): 170-173; E. John Long, "The Battle at the Tide Line," *American Forests* 60 (1954): 8-11; Rear Admiral A. D. Alexis, "Field Problems in the General Maintenance of Marine Structures," in *Proceedings, Wrightsville Beach Marine Conference*, 6.

This was long overdue. In fact, it is surprising that the navy waited so long to tackle borers. The navy had shown little interest in shipworms since the 1850s (when it tasked James Jarvis with testing anti-borer paints) and left it up to the private sector to solve the problem. But there were warning signs that the navy might be in for some trouble. During World War I, the navy built a fleet of wooden cargo ships on the cheap to run the German blockade of Britain. They were unprotected from borers. A forester for the National Forest Service warned that the “destruction of these boats is just as certain as though hit with a torpedo.” While the brevity of the war allowed the navy to dodge this particular bullet, the ships were later suspected to be the source of the *Teredo navalis* epidemic along the east coast (a theory that was never confirmed).<sup>41</sup>

The navy finally began to feel the effects of shipworms after the war when teredinids and limnorids attacked the naval installations at Mare Island, in San Francisco Bay, and Charlestown, in Boston—not to mention the army’s pier in South Boston. Borers also destroyed structures at the Coco Solo submarine base that guarded the Panama Canal during the 1920s to the tune of two and a half million dollars. When the navy expanded into the South Pacific during World War II, shipworms hampered their efforts yet again—at Lae, New Guinea, borers took down an army wharf in less than three months. There was no more avoiding shipworms.<sup>42</sup>

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41. For the untreated wooden cargo ships used in WWI, see Howard F. Weiss, “Wooden Ships and Ship Worms,” *Scientific American* 116 (June 1917): 592, 401; For suspicions that ships returning from the war brought borers back to the United States, see “Destruction By Marine Borers: Is the Port of New York In Danger?”: 75; see also, A. A. Brown, “Marine-Borer Activity,” *Engineering News-Record* 114 (March 1935): 358.

42. For the Coco Solo submarine base, see Senate, *To Authorize the Secretary of the Navy to Proceed with the Construction of Certain Public Works, and for Other Purpose*, 74th Cong., 1st sess., 1935, Report No. 407, 12; For experiences in the South Pacific during WWII, see Richard A. Howard, “The Role of Botanists during World War II in the Pacific Theatre,” *Botanical Review* 60 (April-June 1994): 231.

During World War II, the Bureau of Docks and Yards asked William Clapp for help. The navy saw the benefits of Clapp's test board programs, which had been thriving in the northeast for several years now, and commissioned him to expand his operation around the world for strategic purposes. The navy dunked test boards in what it deemed fifty-six "important harbors" and sent them back to Clapp for analysis. In addition to locations in North America, the navy scattered test boards in the waters of the Pacific and in Australasia. Clapp relished the chance to learn about borers from beyond the North American coastline and gladly participated.<sup>43</sup>

After the war, the Bureau of Docks and Yards intensified its efforts, making the fight against marine borers a bigger part of the bureau's mission. They had good reason to do so. Over the years, the navy had grown into "one of the largest single users of timber in waterfront structures," according to a navy researcher. Moreover, as Admiral Jelley noted, its "[n]aval facilities are scattered over the globe and structures are forced to meet many different conditions." All this put a strain on the navy's readiness for future battles.<sup>44</sup>

Military preparedness became a constant theme in marine borer research over the next few years. Creosote shortages during World War II were one cause for concern. To this, Admiral Jelley argued that "[a]s a matter of our preparedness program, we have to be able to specify the best possible substitute that may be available in time of war."

George Hunt, of the U.S. Forest Service, questioned whether timber preservers were

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43. Rear Admiral Joseph F. Jelley, "An Interim Report, Navy Department Marine Borer Investigations," *Proceedings of the American Wood-Preservers' Association* 49 (April 1953): 217-218.

44. R. Horonjeff and D. A. Patrick, "Action of Marine Borers and Protective Measures Against Attack," in *Proceedings of Second Conference on Coastal Engineering, Houston, Texas, 1951* (Berkeley: Council on Wave Research, 1952), 97; Jelley, "An Interim Report, Navy Department Marine Borer Investigations": 215.

ready to meet future war-time needs. He warned, “[w]e are now in a time of planning and preparing for a so-called ‘emergency’ in which we might be obliged to build a lot of structures.” Hunt questioned whether any real advances in preparedness had been made since before the war. He and others pressed for more research in this area.<sup>45</sup>

In June of 1950, the Bureau of Docks and Yards formulated its postwar marine borer strategy at a research conference held in Wrightsville Beach, North Carolina. The bureau invited an array of experts to present on every facet pertaining to woodborers, including marine biologists, forestry specialists, and engineers from the army and navy. It even asked a liaison from the Australian Embassy to read a paper on marine borer investigations—the bureau was gearing up to leave no stone left unturned. Over roughly the next two decades, the navy funded or supported many of the research questions that came out of this meeting. The Wrightsville Beach conference was the culmination of three decades of efforts to formalize and sustain marine borer research.<sup>46</sup>

Naturally, William Clapp spoke at the conference. Now in his seventies, he gave a paper that ranged across his entire career. One of the topics that he hit upon was that of taxonomic clarity. When Clapp came into the service of the National Research Council in the 1920s, his role was to identify and describe species from the national test board program. Clapp knew of only nine species of shipworms active along the coast of the United States when he got started. But to his surprise, the test boards contained thirty

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45. Rear Admiral Joseph F. Jelley, “Current Navy Problems In Structure Failure,” in *Proceedings, Wrightsville Beach Marine Conference*, 2; George M. Hunt, “Coordination Needed In Marine-Borer Research,” in *Proceedings, Wrightsville Beach Marine Conference*, 17; For shortages of creosote during the war, see “Pulled Piles Reveal Effectiveness of Asphalt-Treated Wrapping,” *Engineering News-Record*, 130 (April 1943): 480-481.

46. Norman Tamblyn, “Marine-Borer Investigations In Australia,” in *Proceedings, Wrightsville Beach Marine Conference*, 52-54.

different species. This discovery highlighted a bigger problem: no one was really sure how many kinds of woodborers there really were in the coastal waters of the United States. To head off future crises, researchers first needed a better accounting of borers.<sup>47</sup>

Little taxonomic clarity had been achieved when Clapp spoke in Wrightsville, so the job subsequently fell to his longtime assistant Ruth Dixon Turner after the war. With the support of the Office of Naval Research, Turner began constructing a massive catalogue of all known shipworms. This was not an easy task, for, as she explained, “it is always much easier to describe a new species than to prove that one already described is a synonym.” In 1959, Turner had found an astounding 400 different names for shipworms in the existing literature. She suspected that only fifty or sixty of these were valid, the rest being synonyms (the estimated number of shipworms now sits at around 70). After two decades of painstaking research, she published a gigantic reorganization of the Teredinidae family in 1966. When she had finished, Turner humbly characterized her revised taxonomy as still in a “chaotic state.” In truth, her work made the taxa legible. The “Red Book,” as it has since been called because of its deep red cover, has been critiqued here and there, but never replaced.<sup>48</sup>

Besides general taxonomy, the navy wanted to know more about the basic physiology and life history of borers: i.e., what do they eat, when do they spawn, what environments do borers avoid, etc. Two of the Wrightsville speakers addressed these

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47. Clapp, “Marine-Borer Work at the Clapp Laboratories,” 39-42; Clapp described his revelations in, William F. Clapp, “Marine Piling Investigations of the National Research Council,” *Journal of the Boston Society of Civil Engineers* 11 (November 1924): 418.

48. Ruth Dixon Turner, “The Status of Systematic Work in the Teredinidae,” in *Boring and Fouling Organisms* (Seattle: University of Washington Press, 1959), 128; Ruth Dixon Turner, *A Survey and Illustrated Catalogue of the Teredinidae (Mollusca: Bivalvia)* (Cambridge: Museum of Comparative Zoology, Harvard University, 1966), 3.

types of questions. University of Miami professors F. G. Walton Smith and Charles Lane focused on a destructive and cosmopolitan borer called *Lyrodus pedicellatus*. Smith discovered that this borer was averse to both light and to water speeds in excess of 1.4 knots, both of which prevented larvae from entering wood. His colleague Charles E. Lane investigated whether the borer relied on wood for sustenance, or if it merely discarded the wood in the process of boring its tube. These kinds of questions had interested biologists for decades. Now the navy shared their interest. Following the conference, the Office of Naval Research established stronger ties with university biologists like Smith and Lane and funded many studies on woodborer physiology in the coming years. This emphasis on basic biology would have a big impact on timber preservation technologies after the war, as we shall see in a moment.<sup>49</sup>

The navy invited several scholars interested in creosote to the Wrightsville conference. Remarkably, creosote still remained an enigmatic substance, even after one hundred years of use. Experts trusted that it more or less worked, but weren't sure whether it interfered with borers mechanically or if it simply poisoned them. "We do not know," admitted George Hunt of the U.S. Forest Service, "what it is in creosote that makes it effective." These questions bothered C. M. Wakeman of the newly created Southern California Marine-Borer Council. "Perhaps the toxic ingredient amounts to 1 to 2 per cent, perhaps 90 per cent," mused Wakeman; "we don't know." To make matters worse, Wakeman's research on Los Angeles Harbor revealed that gribbles were not affected all that much by creosote. He discovered this after pulling piles creosoted with

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49. F. G. Walton Smith, "The Physiology of Marine Borers," in *Proceedings, Wrightsville Beach Marine Conference*, 26-36; Charles E. Lane, "The Diet of *Teredo Pedicellata*," in *Proceedings, Wrightsville Beach Marine Conference*, 37-38. *Teredo pedicellata* was later resorted into the genus *Lyrodus*.

16 lbs. per cubic foot after ten years in the harbor. Leaching reduced the saturation of the piles to around 7-11 lbs. per cubic foot. Even at this amount, creosote was sufficient to keep out teredo, but not limnoria. Wood preservers were shocked when informed that some gribbles were not deterred as much by creosote as they had long thought.<sup>50</sup>

The navy listened to these revelations and acted. In 1954, the Bureau of Docks and Yards ordered an analysis of creosote and other equally toxic substances. The Naval Research Laboratory conducted the study. By isolating chemicals from compounds such as creosote and applying them to specific borers, the laboratory could start to see how each substance ticked. After more than ten years of painstaking research, the laboratory confirmed what many had suspected for generations: that different chemicals affected borers differently. The authors of the final report concluded that “[c]hemical compounds that are toxic to animals of one borer genus frequently are nontoxic or only slightly toxic to animals of another genus.” Thanks to this sort of research, the navy could begin to take the guesswork out of timber preservation and tailor certain chemicals to specific borers.<sup>51</sup>

By the early 1970s, the navy had leveraged advances in taxonomy and creosote research to good effect. Researchers learned that “combination treatment” could ensure that treated piles would stand up to all types of borers. Ignoring the taxonomy and distributions of certain species, furthermore, was a flawed approach since some species like *Limnoria tripunctata* were resistant to creosote. Knowing which species of limnoria

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50. Hunt, “Coordination Needed In Marine-Borer Research,” 16; C. M. Wakeman and Harold Schiller, “The Marine-Borer Problem In Los Angeles Harbor,” in *Proceedings, Wrightsville Beach Marine Conference*, 19, 20, 24.

51. For post-Wrightsville interest in such a study, see Jelley, “An Interim Report, Navy Department Marine Borer Investigations”: 222-225; H. Hochman and H. P. Vind, *Screening of Chemical Toxicity to Marine Borers—Final Report, Technical Report R-426* (Port Hueneme: Naval Civil Engineering Laboratory, 1966), ii, 15.

and teredo were present in a particular harbor signaled to preservers what chemical blends were necessary to protect timber. Similarly, the AWPA also prescribed “dual treatment,” consisting of creosote and copper arsenate (or alternately copper chromate) in order to thwart multiple borers. For decades, borers had found the weak spots in various preservation technologies. But now that science and technology were teaming up together, shipworms and gribbles were finding that there were fewer ways to exploit the blind spots in between timber preservation technologies.<sup>52</sup>

For a bit of perspective, the Wrightsville conference goers got to hear a paper by the Australian Division of Forest Products on the subject of borer-resistant trees. Australians had a unique problem on their hands. For more than a century, marine builders had relied on the turpentine tree (*Syncarpia glomulifera*) for marine structures because of its reputed resistance to borers. Demand for the tree was so great that it led to its overexploitation. This was a problem that the audience in Wrightsville could only dream about. Trees like the turpentine fascinated Americans, who had nothing comparable to boast about. They had long cherished rumors about resistant foreign trees, hoping one day to find one that they could exploit. Nearby Central America purportedly had many such trees, but no one had gone to the effort to verify their resistance with scientific rigor. The navy finally determined to investigate whether any such tree existed. After the Wrightsville conference, the Naval Research Laboratory tried to sort out fact from fiction.<sup>53</sup>

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52. Albert D. Melendrez et al. *Marine Borers*. Civil Engineering Division Office of Engineering, United States Coast Guard, Report No. CG-ECV-1-77, 1977, 15-16.

53. Tamblyn, “Marine-Borer Investigations In Australia,” 53.



The inquiry was broad and thorough. The navy settled on the Panama Canal as the site for its study, which was logistically ideal, since researchers wouldn't have to travel too far to procure timber. Also, the Canal Zone was home to thirty different species of borers, including a freshwater variant in Miraflores Lake. Throughout the 1950s, researchers combed the existing literature for reports of resistant trees and solicited advice from Panamanians who had "local knowledge and experience" of native trees. In all, the navy tested 115 different trees over 7½ years during the 1960s. The results were eye-opening. After a year, around fifty percent of the boards showed heavy damage. Most of the trees repelled a few borers, but none could repel all of them. At the end of ninety months, nearly all of the trees recorded heavy damage. Only one tree proved very resistant to all borers: the cocobolo tree, a slight and crooked timber that is useless for marine structures. While the Naval Research Laboratory failed to find a tree both resistant and useful, it succeeded in invalidating dozens of rumors, which was just as helpful. Immune trees were not something that marine builders could expect to rely on in the future.<sup>54</sup>

At Wrightsville, John Kuenzel, of the Bureau of Ships, gave a talk on the advances in anti-borer (and anti-fouling) paint technology for ships. During the war, his agency grew worried over the limited availability of copper sheathing and began testing other means of protecting the fleet's wooden cargo ships from borers. These tests carried over into the postwar era and the navy discovered that copper-based paints, when regularly applied, proved highly effective. The navy wasn't alone in this pursuit. With the rise of recreational boating, the private sector produced, tested, and marketed paints to the

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54. C. R. Southwell and J. D. Bultman, "Marine Borer Resistance of Untreated Woods Over Long Periods of Immersion in Tropical Waters," *Biotropica* 3 (June 1971): 81-107.

public. Out of these investigations came one of the biggest blows to borers in the form of innovative fiberglass hull technology. Celanese, a resin and plastic company, marketed its reinforced plastic hulls specifically because of their anti-borer qualities. Combined with the emergence of iron- and steel-hulled cargo ships earlier in the century, shipworms had fewer opportunities to spread around the world (except as larvae in ballast tanks). The proliferation of paints, fiberglass, and metal-hulls all combined to make the words “ship” and “worm” increasingly mutually exclusive in the postwar era.<sup>55</sup>

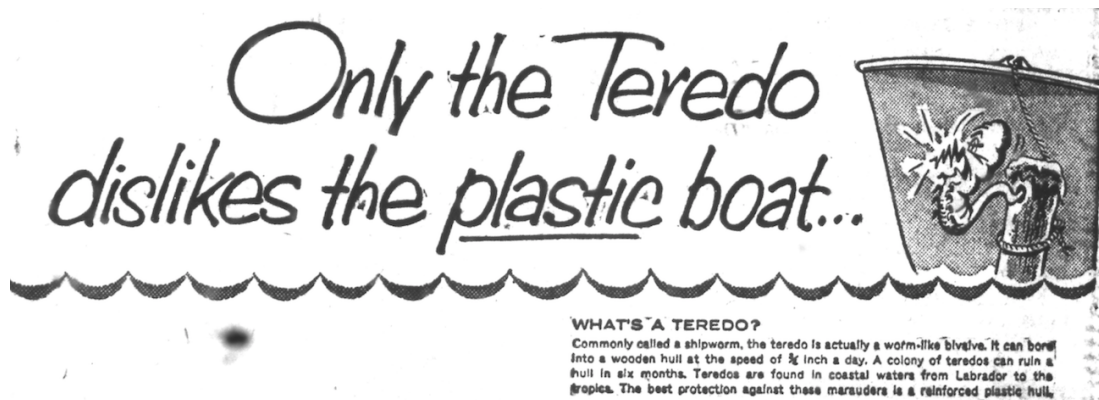


Figure 32: “Only the Teredo Dislikes the Plastic Boat,” *Boston Globe*, February 22, 1959, 74. Credit: Used with the permission of the Celanese Corporation.

Alternatives to wood piling and timber preservation also caught the attention of the Wrightsville attendees. Marine builders had been tinkering with substitutes for timber since at least 1897, when A. A. Raymond patented an economical way of casting concrete piles in place by driving pipes, draining them of seawater, and filling them with concrete. During the 1910s, an alternative called Gunitite, or Shotcrete, hit the market—a process that involved spraying semi-liquefied concrete onto piles in a way that resembled

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55. John Kuenzel, “Recent Progress in Preventing Marine-Borer Damage to Hulls of Wooden Ships,” in *Proceedings, Wrightsville Beach Marine Conference*, 49-51; For a fuller report of the navy’s wartime and postwar investigations, see Woods Hole Oceanographic Institution, *Marine Fouling and its Prevention*, Prepared for the Bureau of Ships (Annapolis: United States Naval Institute, 1952).

“shooting” them. The first generation of concrete piling, unfortunately, was far from perfect, and often eroded in the presence of seawater and because temperature changes weakened the cement. During the 1930s, corps engineers began to experiment with concrete and tried to improve on its deficiencies. The military’s interest grew further during WWII after a lack of creosote forced engineers to treat wooden piles with Gunite. At Wrightsville, Herbert Cook of the corps spoke to the advances in concrete technology and how a test pile program had revealed how high levels of tricalcium was the cause behind concrete pile deterioration in seawater. After the war, concrete pile technology proliferated, as dozens of different methods hit the market, all to the detriment of borers.<sup>56</sup>

Advances in cement and paint technologies opened the door for expanded use of steel in harbor structures. Metal piles (particularly iron) had been used as foundations for piers and wharves since the nineteenth century, but owing to their expense, few marine builders adopted them. Cost wasn’t the only knock on metal piling. Corrosion was to metal what teredo was to wood. In 1908, Bethlehem Steel lessened the impediment of cost when it unveiled the mass-produced H-beam. Over the next few decades, marine builders, particularly from the United Kingdom, tackled the corrosion problem and experimented with coatings that could protect steel in seawater. By the 1960s, dozens of methods were found useful in limiting corrosion, ranging from coal-tar to bituminous

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56. Herbert K. Cook, “Concrete Piles and their Protection in Harbor Construction,” in *Proceedings, Wrightsville Beach Marine Conference*, 8-14; For a detailed description of concrete piling technology, see Robert D. Chellis, “Concrete and Pipe Piles,” in *Pile Foundations* 2nd Edition (New York: McGraw-Hill, 1961).

paints to concrete encasing. Marine builders now had one more tool in their toolbox to circumvent woodborers.<sup>57</sup>

In the postwar era, shipworms and gribbles gradually ceased their ravages. No magic bullet brought them to heel. A combination of newer and improved older technologies reduced woodborer habitat. The convergence of so many technologies after the war was no accident. Steadily, a coordinated effort to challenge borers had ripened after *Teredo navalis* was discovered in San Francisco Bay. Military preparedness and the threat to the northeast drove these developments. The professionalization of woodborer research at the national level accomplished what local engineers and harbormasters could not. Without proper science as a rudder, innovators were steering blindly. After the war, all this had changed. Professional researchers probed every facet of the woodborer epidemic and gradually brought it to an end by the 1970s.

## **Conclusion**

It is fitting that William Clapp kicked off the final day of the Wrightsville conference. Unlike his fellow speakers, who arrived armed with detailed statistics, tables, and fresh methodologies, Clapp took to the podium and gave something of an oral history; his tone, that of a farewell speech. A lot had changed during his career. He joked about the time when he thought he had invented the first ever test board, only to discover that people had been laying out such boards since the 1870s (to his credit, he helped standardize them). He talked about the “headache” he had gotten during his pursuit of the roughly 4,000 scholarly works on woodborers—a subtle invitation for the attendees to make use of his private library. For three decades, Clapp had led the way as he tried to

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57. Chellis, “Deterioration and Preservation of Piles” and “H Piles and Other Metal Piles,” in *Pile Foundations*.

turn woodborer research from his passion project into a professional and self-sustaining field. He hadn't been alone, but he was the most visible and influential figure. He must have been encouraged to see so many people at Wrightsville taking up his life's work. Clapp died the following year, but his vision for woodborer research would thrive for the next few decades under the auspices of the Office of Naval Research and Bureau of Docks and Yards.<sup>58</sup>

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58. Clapp, "Marine-Borer Work at the Clapp Laboratories," 39-42.

## CONCLUSION

### **Vestigial Species**

Isaiah C. Woods lived a full life. Or at least that's what his obituary conveys in about two hundred words. His life's portrait, reduced down to a stick figure sketch, captures only what mattered most to Woods (or his peers) and nothing more—this is not biography; it is a caricature. We discover that Woods was a pioneer, a sailor, a veteran, and an entrepreneur. In 1849, Woods headed out west, worked as a bank manager in California, and, when that failed, he globetrotted—first to Australia, then to England, before pursuing business again in New York. He returned to California and worked as a mail contractor until the Civil War when he served as chief of staff to General John C. Fremont. And then there was teredo. Woods tried his hand at inventing an anti-teredo process. Out of all the narratives that jump from his 1880 obituary, teredo took up more than twenty percent of its total. Woods had fought the good fight, and although his process “did not answer so well as expected,” his efforts were commendable.<sup>1</sup>

Investigating teredo used to matter in way that it hasn't for a long time. People like Woods were once honored for spending time and energy fighting borers, even if their efforts ultimately were for naught. Much has changed. Most people have never heard of the word “teredo,” let alone know someone who probes borers. By the close of the twentieth century, the number of people still scrutinizing borers had dwindled down to a handful. Dan Distel, a marine biologist and an expert on shipworms, recounts a story that

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1. “Another Pioneer Dead,” *Sacramento Daily Union*, February 18, 1880, 3.

illuminates just how far woodborers had fallen out of the American imagination. In 1989, he and some colleagues crossed a street on their way to lunch when one of them remarked how “if a bus ran us over right now, it would wipe out everyone doing shipworm research in the world.” Had they actually perished, it’s doubtful that their obituaries would have mentioned anything about teredo—there would have been no one left who would have known what the word meant.<sup>2</sup>

None of this is necessarily surprising or even lamentable. What we allow ourselves to forget can be just as revealing as what we choose to remember. All this memory loss resulted from so many experts working overtime and expending a lot of brainpower on a perennial problem. Innovations have a way of being taken for granted. That no one knows anything about teredo any longer is a testament to mid-twentieth century ingenuity.

Unfortunately, historians don’t have the same luxury of forgetting. The widespread ignorance of shipworms since the late twentieth century can’t be an excuse to overlook the historical significance of these once ravenous borers. But it has, to an extraordinary degree. If anything, our lapse in memory is a reminder that we historians shouldn’t always seek to historicize only what we know, value, and miss at the moment (i.e. a warning against presentism). Even if we no longer believe in sea monsters, it does not mean that we can exclude them from the history of the sea, as some scholars have argued. The same goes for teredo. Just because it is a word that is foreign to our ears, and makes us giggle when we learn its nickname, doesn’t mean we can relegate stories about

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2. Obituaries like his were not uncommon in the late nineteenth and early twentieth centuries. For other examples of obituaries, see “Death of Herbert C. Dorr,” *San Francisco Bulletin*, December 21, 1887, 1; and “John Miller Murphy Looks Into Past and Future,” *Morning Olympian* (WA), July 6, 1913, 2; For Distel’s quote, see Sarah Gilman, “The Clam That Sank a Thousand Ships,” *Hakai Magazine* (December 2016).

it to footnote and gloss over the feelings and motivations of people in the past, especially when they spoke of the “ravages of teredo” in such grave terms and so often. Once upon a time, teredo mattered a lot, which means that it should still matter to historians as well.<sup>3</sup>

I refer to teredo as a vestigial species, a living relic of the past. While the postwar push to limit the effects of marine woodborers might have rendered them functionally extinct, it did not eradicate them by any stretch of the imagination. Shipworms are still around, and learned beachcombers have no trouble spotting bits of honeycombed driftwood or old piling that bears teredo’s mark. But teredo’s relationship to the coast and its people has grown frictionless. The admixture of people and teredo is no longer a volatile combination or catalytic spark that generates history. Shipworms have become so innocuous that it’s easy to overlook them and miss their role in coastal history. I can’t help but wonder how many other vestigial marine organisms are waiting for their lost histories to be told.

In the meantime, there are plenty of stories about shipworms to rehash. The teredo epidemic gradually, and sometimes quite suddenly, reshaped coastal landscapes and economic patterns between roughly the 1860s and 1940s. Through landfilling, river diversions, harbor improvements, and canal building, waterfronts all around the country have molded to the presence of shipworms. In Everett Harbor, Carquinez Strait, and Galveston Bay, teredo shaped and constrained how people could develop coastal waters. To look upon the coastline today is to behold landscapes that are authored by both people and shipworms.

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3. For sea monsters, see Jeremy B. C. Jackson and Enric Sala, “Unnatural Oceans,” *Scientia Marina* 65 (2001): 281; W. Jeffrey Bolster, “The Sea Serpent and the Mackerel Jig,” in *The Mortal Sea: Fishing the Atlantic in the Age of Sail* (Cambridge: Belknap, 2012), 88-120.



This story has been about much more than landscape. It has tracked how people made sense of shipworms in a variety of ways. Not everyone viewed shipworms the same way. Some even found teredo useful. For those unaffected by it, leveraging teredo as a boosterish tactic was a practice that some used—particularly in Puget Sound and San Francisco Bay—to stand out from economic rivals. Quantifying the efficacy of this sort of environmental rhetoric is not feasible, but it says a lot that people in many places thought that it was a worthwhile argument.

How people derive and employ meaning from nature has been one of the more surprising discoveries of this dissertation. “Teredo” was once a word that a lot of people knew and used. How many people exactly, we cannot say for certain. But “teredo” made the rounds through syndication, enough so that people far from the coast had encountered the phrase the “ravages of teredo”. It’s not so much that people knew the word; it’s how they used it that is so intriguing. “Teredo” became a pejorative metaphor that could be used in a variety of different contexts, ranging from politics to race relations and economics. The teredo epidemic captured the American imagination—so much so that it is hard to conceive of the rise and fall of real shipworms without a charting of the rise and fall of their metaphorical cousins.

Above all, this dissertation has tried to make the case that there was such a thing as an epidemic and that we live with the legacy. This is an enormous statement but one that I think holds up under scrutiny. This larger teredo epidemic, moreover, was by no means an entirely natural disaster. Much of the onus has been placed on people in the past and how they created the conditions for an epidemic of worms. This was certainly the case along the gulf coast, where marine builders tried to develop marine landscapes

rife with borers. In a different way, the *Teredo navalis* invasion of San Francisco Bay shows that changes to a watershed helped shipworms gain a foothold into the bay. The teredo epidemic didn't just happen: it was made.

### **Shipworm Renaissance**

There are signs that a shipworm renaissance is underway. When I first encountered the word “teredo” back in 2008, few scientists were paying it any mind. Biogeographer James T. Carlton was one of the rare exceptions, having nurtured personal relationships with some of the old guard of mid-twentieth century teredo experts. Over the last ten years, more and more marine biologists have taken interest in borers, investigating, among other things, teredo's systematics with a new emphasis on genetic analyses—this effort might finally sort out older taxonomic conundrums once and for all. Additionally, studies on physiology, distributions, and ecological requirements have demystified shipworms in a lot of ways. Researchers have also been mindful of the historical dimensions of teredo, and often preface their studies with interesting flashbacks to ancient and early modern times. Few of these studies, however, delve into the past for more than a few sentences, but the recognition that history matters may open the door to more interdisciplinary research. The collaboration between biologists and a historian on the history of teredo in New Zealand is an encouraging sign.<sup>4</sup>

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4. Introduced species are Jim Carlton's specialty, but he has an admitted affinity for shipworms in particular. Many of his publications have been cited throughout the dissertation, but for his most recent study on aquatic invasions after the Japanese Tsunami of 2011, see Nancy C. Treneman et al., “A Molecular Phylogeny of Wood-Borers (Teredinidae) from Japanese Tsunami Marine Debris,” *Aquatic Invasions* 13 (February 2018): 101-112; In lieu of an unnecessarily bulky citation, a serviceable bibliography of shipworm research over the past few years can be found in, Luisa M. S. Borges et al., “Diversity, Environmental Requirements, and Biogeography of Bivalve Wood-Borers (Teredinidae) in European Coastal Waters,” *Frontiers in Zoology* 11 (December 2014); Courtney A. Rayes, James Beattie, and Ian C. Duggan, “Boring Through History: An Environmental History of the Extent, Impact and Management of Marine Woodborers in a Global and Local Context, 500 BCE to 1930s CE,” *Environment and History* 21 (November 2015): 477-512.

The shipworm renaissance did not come entirely out of the blue. Some of this newfound interest is born out of necessity. In the 1990s, for instance, there was a spate of wharf collapses in New York's inner harbor. These were attributed to the successes of the twentieth century clean water initiatives, such as the Clean Water Act of 1971. More recently, climate change has started to invite shipworms into waters that were once too cold for them to inhabit. This is particularly a problem in the Baltic Sea where marine archeologists are racing to save centuries old wrecks from being gobbled up by borers. Farther south, in Rotterdam, eco-consultants have gone so far as to analyze potential threats of teredo in the context of warmer weather. Shipworms are on the move once again, and just as earlier in the twentieth century, experts are mobilizing and trying to play catch-up, repeating a familiar script.<sup>5</sup>

More recently, shipworms have caught the attention of the wider public. In March of 2017, researchers discovered a "giant shipworm" in the Philippines. By April, the story had gone viral, surfacing in the *Washington Post*, *New York Times*, *BBC*, *New Yorker*, and dozens of other news sources. The organism, *Kuphus polythalamia*, is not actually a "shipworm," per se, or even a woodborer for that matter. It's a giant, five-foot long worm-like mollusk that bores deep down into the mud. Biologists have known about this species from fossil remains for centuries, but had never found a live specimen until now. Notwithstanding its confusion with woodborers, the story touched a nerve with the public

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5. Lindsey Gruson, "In Cleaner Harbor, Creatures Eat the Waterfront," *New York Times*, June 27, 1993; David M. Herszenhorn, "Pest Is Eating at City's Edge; Cleaner Harbor Gives New Life to Borers," *New York Times*, July 28, 1999; James Owen, "Viking Shipwrecks Face Ruin as Odd 'Worms' Invade," *National Geographic*, January 20, 2010; Peter Paalvast and Gerard van der Velde, "New Threats of an Old Enemy: The Distribution of the Shipworm *Teredo navalis* L. (Bivalvia: Teredinidae) Related to Climate Change in the Port of Rotterdam Area, the Netherlands," *Marine Pollution Bulletin* 62 (August 2011): 1822-1829.

and gives us the taste of how people centuries ago reacted to the ravages of teredo. But barring a twenty-first century resurgence of shipworms, it's safe to say, at least for the time being, that the teredo epidemic is history.<sup>6</sup>

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6. Daniel L. Distel et al., "Discovery of Chemoautotrophic Symbiosis in the Giant Shipworm *Kuphus polythalamia* (Bivalvia: Teredinidae) Extends Wooden-Steps Theory," *Proceedings of the National Academy of Sciences of the United States of America* 114 (May 2017): E3652-E3658; Ben Guarino, "Scientists Find Giant, Elusive Clam Known as 'The Unicorn of Mollusks,'" *Washington Post*, April 17, 2017; Joanna Klein, "This Is a Giant Shipworm. You May Wish It Had Stayed In Its Tube," *New York Times*, April 18, 2017; "Live, Long and Black Giant Shipworm Found in Philippines," *BBC*, April 18, 2017; Alan Burdick, "The Loch Ness Monster of Mollusks," *New Yorker*, April 21, 2017; For another example of teredo reaching the broader public, see Gilman, "The Clam That Sank a Thousand Ships." This is a great introductory piece that draws work from multiple disciplines and periods of time.

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