

**Report on the First Tsunami Vessel,
the *Sou-you* (壮 洋), Washed Ashore in
North America with Living Japanese Species**

Biofouling Community on Japanese Vessel 20-210-42909
Washed Ashore June 15, 2012 on Benson Beach at
Cape Disappointment State Park, Ilwaco, Washington

NSF RAPID Japanese Tsunami Marine Debris Biofouling Register # **JTMD-BF-2**

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Four hundred and sixty-three days after the Tōhoku Earthquake and Tsunami of March 11, 2011, a 21-foot (6.4 meter) skiff washed ashore on June 15, 2012 at Benson Beach on the outer coast of Cape Disappointment State Park, just north of the mouth of the Columbia River, near the town of Ilwaco, Washington. The vessel bore a Japanese vessel registration number (20-210-42909) permitting its identification by the Japanese Consulate as originating from the Tōhoku region of northern Honshu, and confirmed as being lost in the tsunami. In addition, the vessel bore the name of the prefecture, Miyagi (宮城), in smaller black writing, above the registration number. The vessel was named the *Sou-you* (壮 洋).

This boat is the first Japanese vessel, associated with the tsunami, recorded to have landed in North America with living Japanese species. It may also be the *first Japanese vessel with living Japanese species to ever be washed ashore in North America*, as no previous records of a comparable incident are, at this time, known.

As part of a National Science Foundation RAPID response grant (Lead Principal Investigator, Dr. James Carlton) to document the marine biofouling arriving on North American shores on Japanese tsunami marine debris, this vessel was given the NSF RAPID Japanese Tsunami Marine Debris Biofouling Registration number **JTMD-BF-2**.

Sampling and the Biofouling Community

Allen Pleus, Aquatic Invasive Species Coordinator with the Washington State Department of Fish and Wildlife (WDFW), and other WDFW staff, collected samples from the vessel on June 16. The vessel appears to have floated upside down across the ocean, such that the bottom of the hull, the strake-bottom break, and a portion of the transom, were not fully submerged. This prevented heavy colonization and monopolization of these areas by the native oceanic (pelagic) gooseneck barnacle *Lepas anatifera*, a non-invasive species, which otherwise formed a heavy fouling biomass on the deck, sides, and inside of the vessel. Where *Lepas* did not form a dense cover, patches of acorn barnacles, mussels, seaweed, and other species were present.

Species Identification and Sample Handling

Samples were submitted to the Carlton Laboratory and to the laboratories of co-operating systematists and biologists for identification. Algae (seaweed) were provided to **Gayle Hansen** (EPA and Oregon State University), copepods and small invertebrates in water derived from bulk fouling samples (largely being the water drained out of *Lepas* samples) were sent to **Jeffery Cordell** (University of Washington) and general invertebrate samples were sent to **James Carlton** (Williams College - Mystic Seaport Maritime Studies Program). Additional samples were retained in WDFW offices, Olympia WA. All samples are the property of the State of Washington, and will eventually be deposited in one or more designated museums.

Algae (seaweed) identification was carried out in Newport, Oregon by Gayle Hansen, and in Kobe, Japan. Fragments of pressings were sectioned and photographed by G. Hansen and sent to Japan for genetic sequencing by T. Hanyuda and H. Kawai. Final identifications were made from morphology and sequence data. Brown algae were identified using morphology and, for one species (*Saccharina*), sequencing the nuclear ITS2 gene. Red and green algae were identified via morphology and sequencing *rbcl* (for red algae and *Ulva*), and 18S rRNA, 3' terminal (for *Cladophora*).

RESULTS and DISCUSSION

The General Fouling Community

A list of species from the *Sou-you* is shown in Table 1. Species-level identifications of the sponges, roundworms, polychaetes, mites, and bryozoans are being pursued by specialized taxonomists, coordinated by Dr. Carlton.

By far the predominant marine organism, comprising an estimated 95% of the total fouling biomass on the boat, was the native oceanic (pelagic) gooseneck barnacle *Lepas anatifera*. However, a surprising diversity of Japanese coastal species have been identified in the other approximately 5% of the biomass. At least 30 species originating from Japan were on the vessel when it came ashore at Cape Disappointment. An additional two species (the pelagic barnacle *Lepas*, and pelagic snails) were acquired by the boat as it drifted across the North Pacific. The pelagic snails are not strictly part of the fouling community, but were entrained by the boat as it drifted through the water.

The blue mussels, with 81 specimens collected and ranging in size from 6 to 70 mm, comprised the next (to the *Lepas*) largest apparent biomass of species. The mussels are preliminarily identified as *Mytilus galloprovincialis*, pending genetic confirmation by the Geller Laboratory (Moss Landing Marine Laboratories), work also under the aegis of the NSF RAPID grant. If all of the mussels are *Mytilus galloprovincialis*, the smaller mussels of the cohort (less than 10 mm in length) would be interpreted as having settled in Japan, and then either subsequently growing slowly or not at all as the vessel crossed the Pacific through relatively oligotrophic open ocean waters. In this regard, note that the smallest individuals of another mussel, the Japanese black (or purple) mussel *Septifer virgatus* (3 specimens collected), were also less than 10 mm, and these undoubtedly settled in Japan. Adults of this mussel grow to 28 mm. The third mussel species, *Musculus cupreus*, with 2 specimens collected measuring 11 mm, grows to 23 mm as adults.

Seaweeds

Seven algal species were found on the transom (a 0.25 m² area). Of these, one species is already known to occur in Washington and six species are not known from Washington (of which three are also not known from western North America). Although only three of the collected species were reproductive, uncollected samples of any of the species may have been fertile. Therefore, all of the species show some potential for recruiting in Washington. If these species were to recruit, two Asian species stand out as the most likely to become invasive:

- *Grateloupia turuturu*. This red seaweed is known to be highly invasive in New England, western Europe, and New Zealand and is on a “100 worst invasives in the Mediterranean” list. This thin red blade could easily be confused with the native *Grateloupia* and *Halymenia* species and go unnoticed on our shores, unless it were to bloom in large populations in, for example, harbors and estuaries.
- *Ulva pertusa*. This green seaweed resembles the common species *Ulva lactuca* and is identifiable only through DNA sequencing. This species, a common boat fouler, could already be widespread along the North American west coast. In Europe it is sometimes the main component of green tides.

Invertebrates

The mussel *Mytilus galloprovincialis* (native to the Mediterranean Sea) and the amphipod crustacean *Jassa marmorata* (native to the North Atlantic), both present on this vessel, are already present in the State of Washington, having been introduced decades ago, although these (and future arrivals on tsunami-generated debris) may represent new and different genetic stocks not now present in the Pacific Northwest.

While the conspicuous and well-known invasive species (such as the Japanese kelp *Undaria pinnatifida*, the crab *Hemigrapsus sanguineus*, and the seastar *Asterias amurensis*) that were present on the JTMD dock that came ashore on Agate Beach, Oregon in June 2012 were not found on the *Sou-you*, other non-native species, in addition to *Mytilus* and *Jassa*, were present (Table 1). In particular, two Japanese fouling mussel species (*Musculus cupreus* and *Septifer virgatus*, as noted above) were aboard the vessel. Neither are known to be invasive species yet, but both have the potential to be introduced to the American Pacific coast. *Musculus cupreus* was also present on the Agate Beach dock.

As a fuller picture develops of the diversity of Japanese species arriving on marine debris, algae such as *Grateloupia turuturu* and *Ulva pertusa*, and mussels such as *Musculus cupreus* and *Septifer virgatus*, are examples of the types of species to be watched for as potential invaders in marine invasive species surveys along the Pacific Northwest coast.

ACKNOWLEDGMENTS

We thank Oregon Sea Grant for support for G. Hansen for making time available for algal identifications, Hiroshi Kawai and Takeaki Hanyuda (Kobe University) for taxonomic assistance with the algae, and Miho Sakuma (Williams College) for translation of the Japanese.

Table 1.

Biofouling Species on the *Sou-you*,

Washed Ashore at Cape Disappointment State Park, Washington
June 15, 2012

* = Oceanic (pelagic) species acquired as vessel floated across the North Pacific Ocean

Bold-faced taxa are known to be invasive species.

Identifications:

General invertebrates

Copepoda, *Ianiropsis*, *Caprella*, Halacaridae, *Mesonerilla*

Algae

James T. Carlton

Jeffery R. Cordell

Gayle I. Hansen

Group	Identification	Common Name	Total number of living coastal species in group	Known Prior Presence in Washington (+)
PROTISTA	<i>Cibicides lobatulus</i>	foraminiferan	2	+
	" <i>Quinqueloculina</i> " sp.	foraminiferan		
PORIFERA	Siliceous sponge, unidentified	sponge	1	
CNIDARIA	<i>Obelia</i> sp.	hydroid	1	
NEMATODA	Unidentified species	nematode (roundworm)	1	
ANNELIDA	Syllidae, unidentified	polychaete	2	
	<i>Mesonerilla</i> sp.	polychaete		
	<i>Hydroides</i> sp.	serpulid polychaete (tube worm), empty shell fragments only		
MOLLUSCA	<i>Mytilus galloprovincialis</i> Size range: 6 - 70 mm	Mediterranean mussel	3	+ (identification pending genetic confirmation)
	<i>Musculus cupreus</i> Size range: 5 - 6 mm	mussel		
	<i>Septifer virgatus</i> Size range: 7 - 15 mm	black mussel		
	*Pteropoda	pelagic snail		
CRUSTACEA	<i>Parastenhelia spinosa</i> -	copepod	10	+ (?): A group of

	group			closely related species; these specimens appear to be different than those found in the Pacific Northwest (J. Cordell).
	<i>Tisbe</i> spp.	copepod		
	<i>Harpacticus obscurus</i> -group	copepod		+
	<i>Microsetella norvegica</i>	copepod		+
	<i>Paralaophonte congenera congenera</i>	copepod		+ (this copepod species is given a trinomial name)
	<i>Caprella</i> sp.	caprellid amphipod		
	<i>Jassa marmorata</i>	gammarid amphipod		+
	<i>Ianiropsis</i> sp.	janirid isopod		
	* <i>Lepas anatifera</i>	pelagic goose neck barnacle		+
	<i>Semibalanus cariosus</i> Size range: 10 - 16 mm (basal diameter)	barnacle		+
	<i>Balanus trigonus</i> (dead, empty shell: one, 12 mm basal diameter)	barnacle		
INSECTA	Chironomidae (larva)	marine fly	1	
ACARINA	Halacaridae, unidentified	marine mite	1	
BRYOZOA	<i>Scruparia</i> sp.	arborescent bryozoan	1	
ALGAE	<i>Feldmannia mitchelliae</i> (plurilocular)	Brown seaweed	7	
	<i>Saccharina angustata</i> (sterile)	Brown seaweed (kelp)		
	<i>Cladophora albida</i> (sterile)	Green seaweed		+
	<i>Ulva pertusa</i> (sterile)	Green seaweed (sea lettuce)		+
	<i>Chondrus giganteus</i> (sterile)	Red seaweed		
	<i>Grateloupia livida</i> (male)	Red seaweed		

	<i>Grateloupia turuturu</i> (tetrasporic)	Red seaweed		
	TOTAL ESTIMATED DIVERSITY (living Japanese species)		30	





Algae *Chondrus giganteus*



Mussels *Mytilus galloprovincialis*



Algae *Ulva pertusa* and *Chondrus giganteus*
and goose-neck barnacle *Leas anatifera*



Mussel *Musculus cupreus*



Algae *Grateloupia livida*



Barnacles *Semibalanus cariosus*