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Short communication

Market potential for *Styela clava*, a non-indigenous pest invading New England coastal waters

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Abstract

Styela clava is a solitary tunicate that has spread rapidly from its native waters in the Philippines and is now a dominant resident in marine habitats of much of the world. It was first reported on the east coast of the U.S. at Beverly, Massachusetts in 1970 and is now commonly found in marine environments throughout the state. The alien sea squirt is a pest to the shellfish aquaculture industry that causes nuisance fouling on aquaculture gear. In southern Korea, *Styela clava* is considered to be a seafood delicacy and has acquired a cultural distinction as an aphrodisiac. A consumer market already exists for the fouling tunicate in Korean markets in the U.S. that sell imported frozen *Styela clava* at a retail price of at least $8 per pound ($3.63/kg). It is suspected that local fresh tunicate product, if available, could sell for an even higher price. A market study to turn this alien pest into a profitable seafood product is proposed.

Key words: *Styela clava*, invasive species, tunicates, Korean, market

Styela clava, Herdman 1881, (Phylum Chordata/ Subphylum Urochordata/Class Ascidiacea/Order Pleurogona/Suborder Stolidobranchia/ Family Styelidae) is a solitary tunicate that has spread rapidly from its native waters in the Philippines, and now is a dominant resident in marine habitats in much of the world (Whitlatch et al. 1995). Where established, the sessile ascidian is commonly found in dense stands (5-15 animals/100 cm^2) attached by a tunic holdfast to any available hard substrate (Whitlatch et al. 1995). The adult form has a distinctive club shape, narrow stalk and tough, warty outer covering. The adult sea squirt ranges from 5-15 centimeters in length and lives 12-18 months (Whitlatch et al. 1995). Settlement is reported to occur from mid-July to late September in Connecticut (Whitlatch et al. 1995). Growth rates observed in California are 1-1.5 cm / month (Whitlatch et al. 1995).

Styela clava is widely distributed. It occurs along most of the Asian coast, including Japan, and in Australia, Northwestern Europe, and the west and east coasts of the United States (Whitlatch et al. 1995). The first reported appearance in Europe was in Plymouth, England in 1953 (Whitlatch et al. 1995). By 1970, it had invaded habitats in southern England and northern France (Whitlatch et al. 1995). It is believed to have been introduced to California waters in the 1920's via the hulls and ballast waters of ships once docked in Asian ports (Stout 1982). It is thought to have arrived on the Atlantic coast of North America in the late 1960's from Japan via Europe (Berman et al. 1992). *Styela clava* was first collected on the east coast of the U.S. at Beverly, Massachusetts in the spring of 1970 (Berman et al. 1992), and was reported from the east end of Long Island in 1973 (Whitlatch et al. 1995). Researchers at the University of Rhode Island have documented explosive population growth in Rhode Island waters since 1976 (Stout 1982). By 1988, it ranged from Connecticut to Maine (Berman et al. 1992).

Styela clava, a Pest for Shellfish Growers

Biofouling organisms in general and *Styela* in particular have proven to be a nemesis for

shellfish growers. Biofouling of cultured oysters results in competition between the oysters and the fouling organisms for both living space and food (Arakawa 1980). Under the influence of heavy fouling, oysters suffer crowding and smothering that reduces the flow of water and food over the oysters with negative results, including slow oyster growth, poor shell quality, reduced meat yields and mortality (Arakawa 1980). Arakawa included *Styela clava* in his "Blacklist of the major fouling organisms on cultured oysters in the Hiroshima area." (Arakawa 1980, p.2). *Styela clava* has been indicated as the cause of asthma in Japanese oyster shuckers. The ascidians were reported atomized during shucking operations, and extracts from the tunicates were reported to be highly allergenic in medical studies (Morris et al. 1980). Ascidians, including *Styela* sp., were reported to be the predominant biofoulers on aquaculture cages in China (Zheng 1990).

In the United States, fouling by *Styela* poses an economic hardship for the developing aquaculture industry by diverting labor from production to the removal of this alien nuisance organism. Dr. Robert Rheault of Moonstone Oysters in Rhode Island reported that ascidians were the foremost cause of fouling to his scallop culture gear. He complained that *S. clava* could be found attached to every available surface of his culture equipment. It was particularly costly to remove as it was more strongly attached than other tunicates that could be removed with power washers, and needed to be hand picked. Rheault observed that *S. clava* attached to nearly every individual *Ostrea edulis* he was culturing (R. Rheault, pers. comm.).

Arakawa has offered a multitude of suggestions for oyster farmers to control, prevent, and remove fouling on culture gear (Arakawa 1980). These included burning, air drying, immersions in hot water, fresh water and brine, scrubbing and brushing, high pressure spraying, towing, chemical pesticides, biological control agents and the experimental use of low frequency electric shocks and ultrasonics to impede attachment of setting larvae. Finally, with some enthusiasm, Arakawa recommended taking advantage of any useful qualities that the fouling pests may possess, an approach he called "a real countermeasure!" (Arakawa 1980, p. 26). As an example, he recommended that the oyster farmers investigate the marketing of *Mytilus edulis,* a pest fouling their oyster culture nets, to Europe, where mussels are widely used as food.

Korean Market for *Styela clava*

Following Arakawa's advice, does S*tyela clava* have any useful qualities to exploit?

Styela clava, under the local popular name of "mideuduck," is considered to be a seafood delicacy in southern Korea (Morris et al. 1980), and has acquired a cultural distinction as an aphrodisiac. The Korean word of "mee duh duck," for *Styela* translates as "wild tasty root." ("Mee duh duck" has also been spelled "mideu-duck" and "mideodock." English phonetics do not have equivalents for some Korean sounds. Author Rhee, a food writer and native Korean, is of the opinion that "mee duh duck" comes closest to the Korean.) *Styela clava* is a traditional accompaniment to monkfish and served as a specialty item in Korean restaurants. A consumer market for the fouling tunicate in Korean markets in the U.S. already exists. Rhee can recall finding it in Korean markets in the U.S. for at least 20 years. Presently, markets sell imported frozen *Styela clava* (in lieu of fresh, which are illegal) at a retail price of at least $8 per pound ($3.63/kg) for a 3-4 cm product. Koreans prefer fresh over frozen seafood and are willing to pay as much as 1.5 to 4 times more for the fresh product.

Koreans eat "mee duh duck" in a number of dishes. One, "Mee Duh Duck Chim," is made by steaming *Styela* with a hot pepper paste and garlic with some vegetable condiments. A similar ready-to-eat jarred product called "Salted and Seasoned Sea-squirt" is advertised on an internet site where it sells for $8.99/7 oz (198.45g) (kgrocer.com 2008). "Mee duh duck" is also used to flavor Korean miso soups called "Dwen Jahng Kuk" or "Dwen Jahng Chi Geh". Two other more popular ways of eating *Styela* are as an accompaniment to steamed monkfish (*Lophius* sp) and in monkfish soups to enhance flavor. "Ah Goo Chim," a Korean steamed monkfish dish, always calls for "mee duh duck" as part of its recipe to add flavor to the dish. Monkfish soups called "Ah Goo Tahng," also call for *Styela* for flavor. About a quarter pound (113.4 g) of "mee duh duck" is added per pound (453.6 g) of monkfish cooked. In 1994 the average consumption of monkfish in Korea was 14,000 pounds (6,350.4 kg) per day which equates to 3,500 pounds (1,587.6 kg) of *Styela* per day. The consumption of *Styela* amounted to about 1.2 million lbs (544,320 kg) per year in Korea (Commercial Attache U.S. Embassy in Korea, pers. comm.).

In Korean communities in the U.S., steamed monkfish and monkfish soup are equally as popular as in Korea and are commonly found in authentic Korean restaurants in cities coast to coast including Los Angeles, San Francisco, Portland, Seattle, Denver, Fort Worth, Houston, Chicago, Minneapolis, St. Louis, Detroit, Washington D.C., New York City, Fort Lee and Boston.

Market Development for domestic *Styela clava*

The development of a market for domestic *Styela clava* will require a market survey to determine the location and quantity of demand; an analysis of existing and potential supply, and, finally, a profitable strategy for matching supply with demand.

A survey of the tunicate market would likely require the collection of information as follows:

- Tunicate export data from Korean origin to the U.S.
- Consumption and market value of tunicates in the U.S.
- Distribution channels and networks for tunicates in the U.S.
- Areas and establishments of highest demand
- Consistent or seasonal demand
- Consumer preferences re: size; spawning condition; packaging; fresh or frozen?

Most of these tasks could be accomplished easily through interviews with Korean exporters, purveyors, distributors, market managers, restaurateurs, and end users. Determining consumer preferences could entail more involved activities such as free sample taste tests.

The supply side survey would require the identification of producers, and a determination of adequate volume (existing and potential). Considering both the prevalence and pest nature of *Styela* at aquaculture sites, a large quantity of inexpensive sea squirt product should be easily located. Best harvest/culture sites and times might be evaluated on the basis of best growth and availability, but might also include factors likely to impact consumer preference such as the quality and salinity of seawater at the site, and the size and spawning condition of the sea squirts.

If the market survey determines a substantial demand for *Styela* product in a U.S. Korean community and an adequate supply is located, connecting supply with demand will still depend on the potential to make a profit. A business plan would compare the amount that consumers would be willing to pay with the expenses entailed in harvesting/producing the product and transporting it to the market. In addition to normal expenses, a *Styela* marketer would need to address concerns particular to marketing a perishable seafood product and would likely include the need for health permits and questions of shelf life. A niche market for value priced fresh *Styela* product in a large Korean community located not too far from a supply of inexpensive "pest" *Styela* sourced from aquaculture operations seems a likely combination for successful marketing.

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