Sargassum Muticum, Wireweed

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Diagnostic information

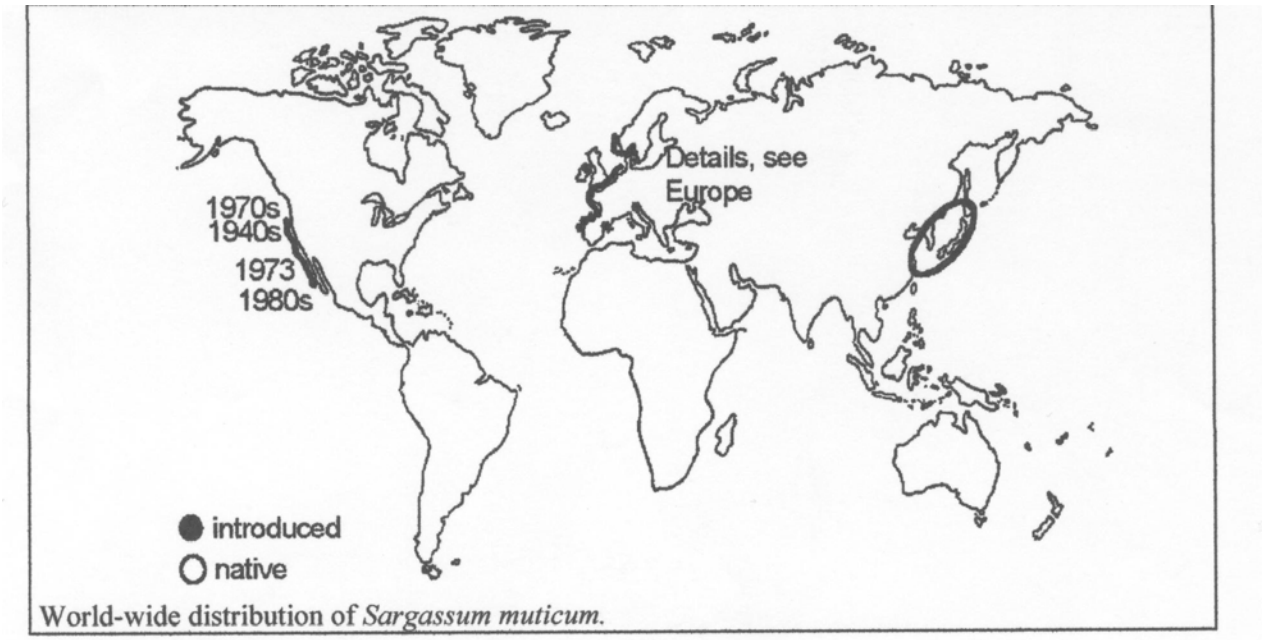
Scientific Name:
Order: Fucales
Family: Sargassaceae
Genus: Sargassum
Species: muticum
Common Names: Wireweed, Japweed

Basic Identification

Sargassum muticum varies in color from a golden brown to a very dark bronze brown. It has a tough, smooth texture to the stem of the plant with elongated lanceolate blades possessing toothed margins. It is found ranging in the low intertidal and upper subtidal, but it is usually found at 2 to 3 meters deep in the subtidal zone. It has a discoidal holdfast from which the main axes arise. Also each main axis branches alternately and the branches posses small blades. Located between the blades of the blanches are small floats, called vesicles, which are about 2mm in diameter and are rounded with no point at the tip. These vesicles allow the fronds of Sargassum muticum to remain upright in the water column and allow the fronds that break off to float free at the surface of the water. Finally the plant can reach heights of about 2m from holdfast to the tip of the longest stem (O'Clair & Lindstrom, 2000).

Origin and Distribution

Sargassum muticum is native the southeastern portion of Asia and the island of Japan, were it grows in sheltered areas and is one of the smaller, less dispersed and ecologically unimportant of the native Sargassum species (Yendo, 1907). It is believed that Sargassum muticum was transported to the west coast of the United States and in British Columbia in the 1940s as an accidental tag along with the intentional introduction of the Japanese pacific oyster for aquaculture (Druehl, 1973; Critchley, 1983). After its initial introduction Sargassum muticum invaded over 3000 km of coastline alone the west coast of North America; stretching up into the southeastern portion of Alaska and down to the Mexican San Ignacio Lagoon (Scagel, 1956; Setzer & Link 1971; Critchley, 1983; Critchley, Farnham, Yoshida & Norton, 1990). In the 1970 a population of attached Sargassum muticum was discovered along the south coast of the British Isles; this was the first discover of an attached plant in Europe in the, there had been previous sighting of drift specimens before that (Farnham et al. 1973). After it established in the British Isles the algae began to invade the coast line of western and southwestern Europe from Portugal to Scandinavia; reaching Scandinavia and Spain around the mid 1980s (Critchley, 1983; Rueness, 1989; Karlsson & Loo, 1999; Buschbaum & Chapman 2006).



World-wide distribution of *Sargassum muticum*.

The map above is a global representation of the distribution of Sargassum muticum. The area within the circle represents the native range of the species, whereas the areas with the solid lines represent the areas along both coasts where it has invaded. As the map above also shows Sargassum as invaded coast on both oceans, a feat that has been accomplished by only one other alga and that is the species Codium fragile subspecies tomentosoides (Silva, 1955; Wood, 1962; Malinowski & Ramus, 1973; Dromgoole, 1975; Critchley, 1983).

The map to the right is a closer look at the native range of Sargassum muticum and some of the other Sargassum species native to Japan. As the map shows Sargassum muticum is limited to the southern and east Pacific coast of Honshu which is bathed in the warm waters of the Kuroshio current; this might indicate that in its native Sargassum muticum itself is either limited by the warmer water or that the other species are limited by the cooler water and they are able to out compete Sargassum muticum (Critchley, 1983).

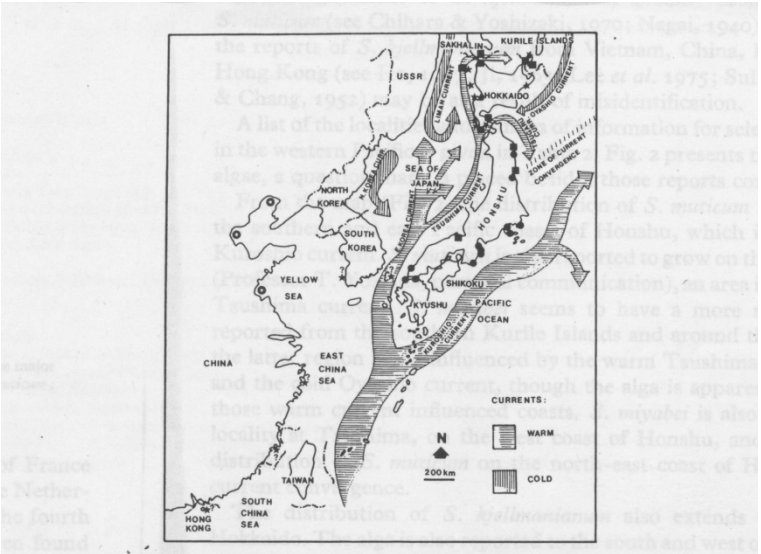
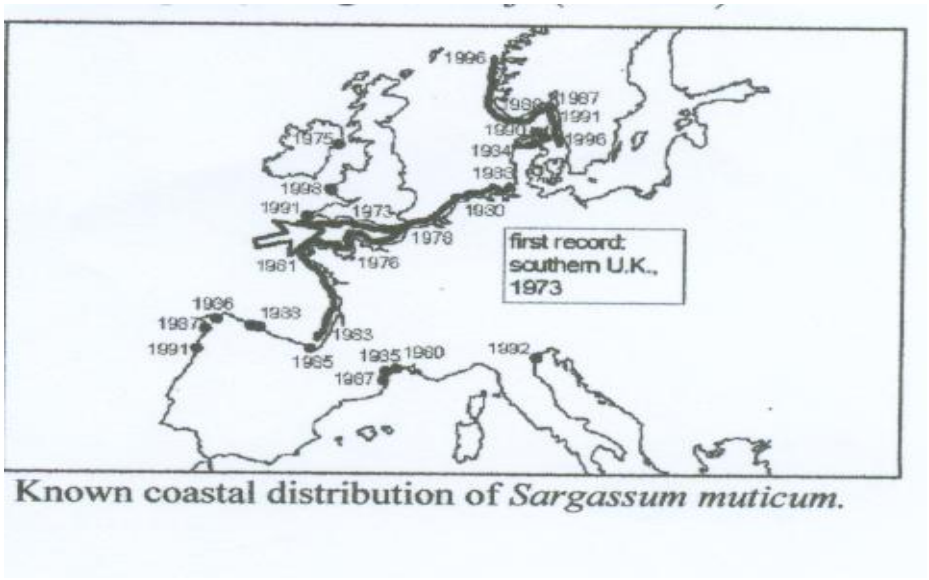


Fig. 2. The western Pacific, illustrating the distribution of selected *Sargassum* species and the major July current system. *Sargassum* species: (★) *S. kjellmanianum;* (■) *S. miyabei;* (●) *S. muticum;* (⊙) *S. muticum* f. *longifolium*.



Known coastal distribution of *Sargassum muticum*.

The map above is a visual example of a closer look at the spread and distribution of Sargassum muticum throughout the west coast of Europe. Below is also a list of the European areas that have been invaded Sargassum muticum; I have included this list to empathize the range of the invasion of this species, and because it has expanded in many of the areas on the map above that are only represented by a single dot:

Belgium

Denmark

France

Germany

Ireland

Italy

Norway

Portugal

Spain

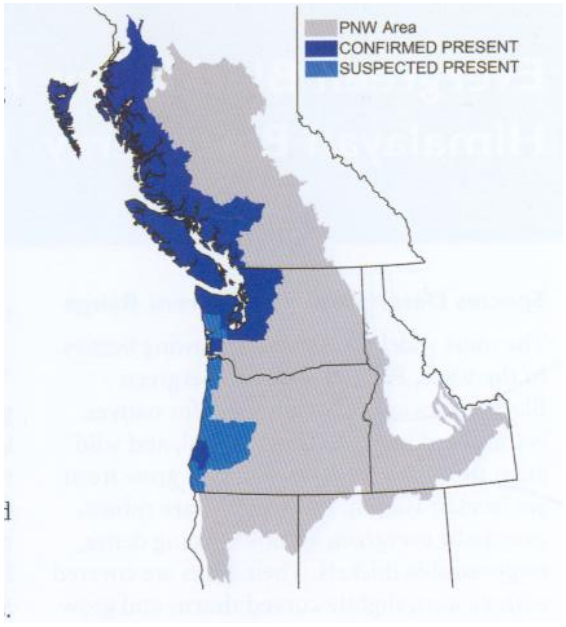
Sweden

The United Kingdom

And other areas of the Mediterranean

Within the Pacific Northwest Sargassum muticum has inhabited nearly every sheltered area along the coast of Washington and into the San Juan Islands where it has been shown to occur in densities as thick as 126 plants/m^2. It has also invaded almost the entire west coast of Oregon and British Columbia, and it has even invaded some areas as far south as Baja California. It has also invaded certain areas in the northwestern part of Mexico. It ranges from the high subtidal to very low intertidal zones, and it also occurs in tidepools as well, mostly in the California area (Nicholson et al., 1981; Norton, 1981; De Wreede, 1983; Britton-Simmons 2004).

The map below is a visual representation of the



areas in the Pacific Northwest; in this case just Washington, Oregon and British Columbia; that Sargassum muticum has invaded.

Life History and Basic Ecology

Sargassum muticum is a pseudo-perennial brown alga that has annual fronds, leaves and vesicles, but it posses a perennial discoid hold fast that remains on the substrate year round even after the rest of the plant has either broken off or died away (Norton 1976). Multiple studies have shown that the growth period of Sargassum muticum varies depending upon the prevailing water temperature around where it is living. At the colder water invasion sites Sargassum muticum will display the pseudo-perennial growth pattern that was described above. The algae will grow its lateral branches in the spring, which will then last until the summer or early autumn depending upon the temperature, and the branches will then detach and the algae will then over winter as a short perennial stipe. In areas that have a warmer climate Sargassum muticum has been shown to grow year round, but it will still lose its branches (Norton, 1976; Arenas & Fernández, 2000; and Britton-Simmons, 2004).

Sargassum muticum is a monoiceisus alga that can reproduce through both sexual and asexual reproduction; it also possesses a reproductive and sterile state both at which the plant will look the same; except for the small bumps that will appear upon the vesicles when the plant is ready to reproduce. The alga does not produce or release all of its zygotes at one time during the reproduction process; instead it will release the zygotes in phases. Also the zygotes are not released into the water column as free floating phytoplankton; instead the zygotes are released and attach themselves onto the parent plant. Once the zygotes have attached to the parent plant they will remain attached to the parent until they develop into small germlings and develop adhesive rhizoids (rootlike structures), at which point the offspring will release from the parent plant and sink to the bottom; where they will adhere to whatever substrate they land on (Fletcher, 1975; Norton, 1976; Norton, 1977; Fletcher, 1980; Norton, 1981; Britton-Simmons, 2004; Buschbaum & Chapman, 2006)

There have been several studies on the reproduction of Sargassum muticum that have shown that the length of the reproductive period of the alga varies slightly depending upon the prevailing water temperature. Despite the difference in the amount of time that Sargassum muticum is fertile the reproductive period begins at some point in spring and last until summer or early autumn. Studies have shown that Sargassum muticum is fertile from the months of April to August in Spain and California, with the exception of some areas that have year round growth; while the reproductive period in the Pacific Northwest begins at the same time as the period in Spain it ends a month earlier. The populations of Sargassum muticum in the British Isles have been shown to demonstrate a five

month fertile period between the months of May – September (Fletcher, 1975; Jephson & Gray, 1977; Norton, 1977; Nicholsen et. al., 1981; Gorham & Lewey, 1984; Norton & Deysher, 1989; Fernández, 1999; Britton-Simmons, 2006).

Sargassum muticum has invaded a wide range of habitats with varying temperatures. A lab study demonstrated that optima temperature for maximum growth in Sargassum muticum is 25 °C, and the study also showed that the temperature range of Sargassum muticum germlings are able to tolerate a temperature range between 10 °C to 30 °C; this temperature range matches those observed in the wild. Along the west coast of the United States Sargassum muticum can experience temperatures as low as 3 °C to 6 °C in Alaska and British Columbia, and it can experience temperatures exceeding 30 °C in certain areas of California and in some tidepools. Not only does this demonstrate the range of Sargassum muticum but it also shows that the alga has the ability to tolerate an annual temperature range spanning about 10 °C to 15 °C (Anon, 1970; Norton, 1977; Nicholson et al., 1981; Dring, 1982; Hales & Fletcher, 1989).

Sargassum muticum invaded areas with various ranges of salinity as well; it has been found living in the Pacific Northwest at salinities of 24 to 25.5‰, 27 to 35‰, and 21 to 30‰. In Europe Sargassum muticum has been found living in salinities of 25 to 34‰ and some brackish habitats at 27 to 30.7‰. The same study that conducted the temperature experiments also demonstrated that maximum growth of Sargassum muticum occurs at full seawater salinity of 34‰ (Widdowson, 1965; Druehl, 1967; Kjeldsen & Phinney, 1972; Norton, 1977; Hales & Fletcher, 1989).

Invasion Process

Nearly all of the studies have shown that the areas that Sargassum muticum has invaded was almost all originally introduced one way or another through the importation and farming of the Japanese Pacific oyster, and then after initial establishment the alga has spread through a multiple of means. Sargassum muticum can increase its short distance range through standard release of germlings; it can also increase its long distance range by detached reproductive particles with germlings still stuck to it drifting along the surface, becoming entangle on boat hulls, anchors, propellers or the continued import of Japanese Pacific oysters (Fletcher, 1975; Fletcher, 1980; Norton, 1981; Deysher & Norton, 1982; Critchley, Farnham & Morrell, 1986; Staehr, Pedersen, Thomsen, Wernberg & Krause-Jensen, 2000; Britton-Simmons, 2004; Buschbaum, Chapman & Saier, 2005).

Since the neutral buoyancy and self-fertilization abilities of Sargassum muticum allow even the broken fragments to facilitate the spread of the alga there are few factors that prevent the spread of Sargassum muticum in the areas it has

invaded. Other than being limited by its environmental range one of the only other things that has been show to reduce the establishment and spread of Sargassum muticum it the presence of native algae that prevent Sargassum muticum from settling on the substrate. There have been some studies that show that sea urchins do sometimes feed on the small germlings, but do not feed upon the larger plants. Many studies have storms and natural disturbances can facilitate the spread of Sargassum muticum; by breaking off reproductive branches and clearing patches for it to settle on. Other than these few natural factors that influence the spread of Sargassum muticum the only other factor that can influence the spread or prevention of spread is human influence.

Some studies have shown that Sargassum muticum can have many ecological impacts upon the marine ecosystems it invades. It has been shown that its ability to stand erect in the water column can affect the available light that reaches the other algae. In some areas that have invaded by Sargassum muticum the entire area has become a monospecific habitat, whereas other sites have shown no change or even an increase in species richness. In many invaded sites Sargassum muticum has been shown to increase the overall epibiotic population in the ecosystem.

Sargassum muticum not only has ecological impacts it also can have economic impacts at the sites it has invaded. Sargassum muticum has been shown to grow on top of farmed Pacific oysters; thus making it difficult and in some cases impossible to harvest all of the oysters. Since it can often times out-compete native kelp species for space Sargassum muticum can also have an economical impact of the seaweed harvesting industry. It has also been shown that floating mats of Sargassum muticum can foul commercial fishing lines, clog intake pipes and even hinder outboard motors of up to 20 h.p.

Management and Control Efforts

The only attempt at any form of control that I was able to find was an account of an attempt in south England in the 1970s. After the initial discovery of Sargassum muticum in the English Channel a working party was formed to try and deal with the invader. Initially plants were removed by hand with the help of hired workers and volunteers. However this proved to be too large a task to take on just by hand removal, so the next attempt was to use herbicides. Unfortunately the most effective herbicides where not specific enough and so the use of them was suspended until a better more specific compound could be found. The next attempt was to use biological control to remove Sargassum muticum, it was found that the plants were really on vulnerable to grazing when it was in the germling stage, and that the best candidate to use was the sea hare. However all of the tests showed that when given a choice almost all herbivores, the sea hare included, would feed on

all the other algae. The final attempt was the use of machinery to remove the alga. Initially this method was limited to areas invasion that could be reached during low tides. However after initial attempts the working party decided to look into designing some machinery that could be operate. The work party tried three different forms of machinery removal; they started with a trawl method which proved to be more destructive to the surrounding organisms and the substrate than the party was will to allow. After the trawl method the was tried the party went with a cutting method which turned out to require more expertise and cost than they were looking for. The final removal method tried was a suction method, which proved to be to problem prone to be effective. A problem that also occurred with every method of removal was what to do with the waste, since Sargassum muticum has not real economic value it came down to simply find an appropriate dumb site for the waste. Ultimately they attempts to remove the Sargassum muticum were abandoned due to cost. Since this initial attempt to control and manage the invasion of Sargassum muticum there have been no other attempts by any other country to manage the invader.