

## Noxious Seaweed Found in Southern California Coastal Waters

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Dubbed "killer algae," the alien seaweed *Caulerpa taxifolia* was discovered in June 2000 in a coastal lagoon in Carlsbad, California, within San Diego County. An aggressive clone of this species has already proven to be highly invasive in the Mediterranean Sea, where the governments of France, Spain, Monaco, and Italy have been unable to control its spread. The first confirmed American occurrence of this invasive species in California has caused considerable alarm. The resulting press coverage of the issue led to discovery of a second infestation of *Caulerpa taxifolia* in Huntington Harbour in Orange County (about 75 miles north of the Carlsbad occurrence). Genetic studies have determined these two infestations to be of the same clone threatening the Mediterranean Sea. Efforts are underway to eradicate *Caulerpa taxifolia* from California and control its spread before the infestation reaches the magnitude seen in the Mediterranean.

*Caulerpa taxifolia* is a green alga native to tropical waters that typically grows to small size and in limited patches. In the late 1970s this species attracted attention as a fast-growing and decorative aquarium species that became popular in the saltwater aquarium trade. A clone of the species was cultured for display at the Stuttgart Aquarium in Germany and provided to aquariums in France and Monaco. Around 1984 this species apparently escaped or was released from an aquarium into Mediterranean waters, and rapidly spread from an initial patch of about one square yard to over two acres by 1989. Meinesz reports that by 1997 it blanketed more than 11,000 acres of the northern Mediterranean coastline and has recently been reported off northern Africa. Genetic analysis suggests that all *Caulerpa taxifolia* plants in the Mediterranean are clones of the original, inadvertently released saltwater aquarium plant.



Photo: R. Woodfield

In areas where the species has become well established, it has caused ecological and economic devastation by overgrowing and eliminating native seaweeds, seagrasses, reefs, and other communities. In the Mediterranean, it is reported to have harmed tourism and pleasure boating, devastated recreational diving, and had a costly impact on commercial fishing both by altering the distribution of fish as well as creating a considerable impediment to net fisheries. The dense carpet that this species can form on the bottom could inhibit the establishment of juveniles of many reef species, and its establishment offshore could seriously impact commercial fisheries and navigation through quarantine restrictions to prevent the spread of this species.

This alga poses a substantial threat to marine ecosystems Southern California, particularly to the extensive eelgrass meadows and other benthic environments that make coastal waters such a rich and productive environment for fish and birds. The eelgrass beds and other coastal resources that could be directly impacted by an invasion of *Caulerpa* are part of a food web that is critical to the survival of numerous native marine species including the commercially and recreationally important spiny lobster,



Photo: A. Meinesz

California halibut, and sand basses. However, this threat is not exclusive to California. Aside from the likelihood that this invasive strain could thrive in other warm locales, such as the Gulf of California, the Gulf of Mexico, and the Pacific coast of Florida, cooler waters should not be ruled out as at risk also. This seaweed has been observed to survive many months in 50° F water. Given this tolerance to cold and the remarkable adaptability that this species has displayed, it would be wise for even more northern regions to be aware of the damage that introduction of this species could cause to their native ecosystems.

According to French biologist and *Caulerpa* expert Alexandre Meinesz, this clone can grow larger, at deeper depths (in excess of 300 feet), and in colder waters than the tropical populations of the species and therefore threatens not only tropical areas, but temperate regions as well. It grows on almost any substrate and in many different energy regimes, ranging from protected bays to exposed headlands. Great monotypic stands can develop, giving the appearance of a carpet of "astroturf." *Caulerpa* spreads readily via fragmentation, making prevention of spread and mechanical removal nearly impossible.

Fishing nets and boat anchors are believed to be primarily responsible for the dispersal of the species throughout the Mediterranean.

This species has recently been reported near Sydney, Australia, smothering seagrass beds in a manner reminiscent of the invasion in the Mediterranean. Despite bans on its possession in France, Spain, and Australia, this organism continues to be transported and sold by the aquarium trade; fearing its eventual introduction into US waters, over 100 prominent scientists petitioned the federal government in 1998 to ban the use of *Caulerpa taxifolia* in American aquaria, leading to its designation in 1999 as a prohibited species under the Federal Noxious Weed Act. The discovery of this species in southern California, recently reported in the journal *Nature* to be genetically identical to the strain in the Mediterranean, confirms that it nevertheless continues to invade marine ecosystems, such as the ecologically rich eelgrass beds that thrive in many of our coastal lagoons. It is likely that the alga was released from an aquarium at the locations in California where it has been discovered, a practice banned under California law.



Photo: A. Meinesz

Although delays in recognizing the true threat of the invasion in the Mediterranean make the eradication of *Caulerpa taxifolia* there unlikely, distribution of the *Caulerpa* discovered in California is restricted enough that eradication efforts have been optimistically undertaken. After exploring techniques such as dredging, hand removal, draining of the lagoon, and application of various herbicides, a biological consulting firm in San Diego developed and implemented a plan to treat the seaweed in situ to avoid further fragmentation and spread. Each patch of *Caulerpa* was covered with a heavy plastic tarp that was

sealed to the bottom at the edges and fitted with a small "port" on top that allowed for the introduction of herbicide under the tarp. The tarp allowed for the direct treatment of the target patch, while preventing the loss of herbicide to the lagoon waters. Although the algae appeared to have been effectively treated, the tarps were left in place to prevent the growth of *Caulerpa* from portions of it that grow in the mud and that may not have been fully treated by the herbicide application. All known *Caulerpa* has been treated in Carlsbad, and the site is surveyed monthly, with monitoring continuing for at least five years in order to detect regrowth. A very similar eradication is currently ongoing in Huntington Harbour.

It is critical that the initial success of the eradication efforts undertaken not lull the public and regulators into a false sense of complacency. The probability that there are infestations that so far have avoided detection, as well as the common occurrence of *Caulerpa* residing in American aquariums, nearly ensures that this seaweed will continue to pose a threat to US coastlines.

The public can help prevent and detect infestations of *Caulerpa taxifolia*. The most important task is to prevent the introduction of ANY aquarium organisms into water bodies. Extreme care must be taken when cleaning or dismantling fish tanks, because a half-inch piece of *Caulerpa taxifolia* that is inadvertently washed into the gutter while rinsing a fish tank on the lawn could quite plausibly travel through the storm drain directly to a nearby estuary or beach and establish itself there. Aside from caution, an even more responsible action would be to eliminate any risk of accidental introduction by discontinuing the use of *Caulerpa* in home aquaria. *Caulerpa* can be removed from the tank, with all the material it is attached to (rocks, gravel, etc), placed in a freezer for 24 hours, and then placed in the trash for disposal in a landfill. Under no circumstances should any unwanted aquarium plants or animals be released into the wild.

In addition to prevention of new introductions, detection of existing infestations is also critical. It is crucial that all people who spend time exploring the ocean bottom be educated and involved in detection and reporting. SCUBA and free divers as well as recreational and commercial fishermen can participate in the surveillance effort by familiarizing themselves with the appearance and habit of this seaweed. It is bright green with feathery fronds and grows in a low mat on the ocean bottom. *Caulerpa* could become entangled in fishing equipment that reaches the sea floor, but it does not float, so it is unlikely that it will be spotted on the surface of the sea. Large patches may be visible from the air due to its distinct bright green color.

If *Caulerpa taxifolia* is observed in the wild, DO NOT DISTURB IT. Note as much information as possible about the location where it was found and report it immediately to the Southern California *Caulerpa* Action Team at (858) 467-2952, visit the website <http://caulerpa.cjb.net> or E-mail: [caulerpa@rb9.swrcb.ca.gov](mailto:caulerpa@rb9.swrcb.ca.gov)

#### **Further Developments:**

On July 23, 2001 the City Council unanimously passed an ordinance to ban sale and possession of the genus *Caulerpa* in the City of San Diego. They plan to implement an outreach program to inform pet shops and the public of the new ordinance.

Under the ban, owning or selling the plant is a misdemeanor subject to a \$250 fine. The fine would be excused for those who properly dispose of the plant. One disposal method is to freeze it and throw it into a garbage.

#### **Further Reading:**

"Killer Algae", by Alexander Meinesz, translated by Daniel Simberloff. University of Chicago Press, 1999.

Websites:

- [http://www.waterboards.ca.gov/losangeles/water\\_issues/programs/water\\_quality\\_issues/killer\\_algae\\_article.shtml](http://www.waterboards.ca.gov/losangeles/water_issues/programs/water_quality_issues/killer_algae_article.shtml)
- <http://www.unice.fr/LEML/>

A websearch of *Caulerpa* returns many sites.

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