GLOBAL INVASIVE SPECIES DATABASE

FULL ACCOUNT FOR: ***Caulerpa taxifolia***

Caulerpa taxifolia 简体中文 正體中文

System: Marine

Kingdom	Phylum	Class	Order	Family
Plantae	Chlorophyta	Chlorophyceae	Caulerpales	Caulerpaceae

Common name Schlauchalge (German), lukay-lukay (English, Philippines), sea weed (English), killer alga (English), caulerpa (English)

Synonym *Fucus taxifolius* , Vahl, 1802

Similar species *Caulerpa mexicana, Caulerpa prolifera, Caulerpa racemosa, Caulerpa veravalensis*

Summary Caulerpa taxifolia is an invasive marine alga that is widely used as a decorative plant in aquaria. A cold-tolerant strain was inadvertently introduced into the Mediterranean Sea in wastewater from the Oceanographic Museum at Monaco, where it has now spread over more than 13,000 hectares of seabed. Caulerpa taxifolia forms dense monocultures that prevent the establishment of native seaweeds and excludes almost all marine life, affecting the livelihoods of local fishermen.

view this species on IUCN Red List

Species Description

Caulerpa taxifolia is a light green macroalga with upright leaf-like fronds arising from creeping stolons. The fronds are flattened laterally and the small side branchlets are constricted at the base (where they attach to the midrib of each frond), are opposite in their attachment to the midrib (as opposed to alternating) and curve upwards and narrow towards the tip. The invasive aquarium clone is morphologically identical to native populations of the species. Frond diameter is 6-8mm and frond length is usually 3-15cm in the shallows, 40-60cm in deeper situations but can grow up to 2.8m in height (NIMPIS, 2002). *C. taxifolia* is distinguished from other Australian *Caulerpa* species by the branchlets that are constricted at the base (where they attach to the midrib of each frond) and they are opposite in their attachment to the midrib (as opposed to alternating). Also, the branchlets curve upwards and taper at the apex (NIMPIS, 2002\r\n).

Notes
The cold-tolerant aquarium (Mediterranean) clone is the invasive strain of this species, and is therefore referred to as *Caulerpa taxifolia* in this profile. It was introduced to the Mediterranean in wastewater from the Oceanographic Museum at Monaco where it now covers over 13,000 hectares of seabed along 190km of coast. An invasive tropical strain has also been discovered near Sydney, Australia (Nova, 2003) and invasions were also detected in southern California (Williams & Grosholz, 2002). Genetic analysis has revealed that the *C. taxifolia* strains found in California are identical to those found in the Mediterranean and in many aquaria. They are also very similar to plants found in southern Australia, leading to the hypothesis that the invasive strain originated from Australia and was distributed *via* the aquarium trade to many parts of the world (Meinesz *et. al*, 2001b).
In the Mediterranean Sea, the molluscs *Oxynoe olivacea* and *Lobiger serradifalci* are found on *C. taxifolia* and feed on it. The grazing rate of these two ascoglossans is low and significantly effected by temperature. *Elysia subornata* is an opisthobranch that feeds only on species of *Caulerpa* and is a potential for biological control of *C. taxifolia* in the Mediterranean. During summer and autumn, the toxic substance produced by *C. taxifolia*, caulerpenyne, may be the reason there are few consumers (NIMPIS, 2002).
Research on the Mediterranean and tropical strains of *C. Taxifolia* revealed some major differences between them. The Mediterranean strain has larger fronds, lacks female gametes, can withstand lower temperatures, and has increased concentrations of defensive chemical metabolites (Raffaelli *et. Al*, 1997).
C. Taxifolia appears to have been distributed around the Mediterranean as fragments attached to ship anchors, as the locations of new outbreaks are predominantly associated with port and mooring facilities (Meinesz *et. Al*, 2001b).
Observation of native populations of *C. Taxifolia* growing at temperatures of 9 to 11°C in Moreton Bay, Australia, has raised doubts over whether the Mediterranean populations are of a genetically-modified, cold-adapted strain, as has been asserted by some authors (Phillips & Price, 2002).

Lifecycle Stages
Monoecious. In the Mediterranean reproduction is vegetative by fragmentation. In native populations, male and females gametes fuse forming a zygote which grows through two little known stages prior to becoming the adult (NIMPIS, 2002). Sexual reproduction has been observed in central Queensland. Gametes released in June - September in Adriatic Sea (NIMPIS, 2002).

Uses
Widely used as a decorative plant in private and public saltwater aquaria (Meinesz *et. al*, 2001b).

Habitat Description
Found on a wide variety of substrates from rock, sand and mud to seagrasses. It is usually found in depths of 3-35m, but has been recorded at depths down to 100m in the Mediterranean. The invasive aquarium strain is able to occupy up to 100% of the available substratum. Native populations in tropical waters are found on rocky reefs and seagrass meadows in sheltered or moderately wave-exposed areas in both polluted and pristine waters (NIMPIS, 2002).
The temperature range for the Mediterranean strain is 7°C - 32.5°C, while the maximum salinity is 38 ppt (NIMPIS, 2002).

Reproduction
Native populations of *C. taxifolia* are known to reproduce sexually, however the aquarium strain is apparently an all-male clone (only producing male gametes). In the Mediterranean the aquarium strain spreads vegetatively by growth of the stolons or by regeneration from broken off fragments as small as 1 square centimetre in size (NIMPIS, 2002). The minimum reproductive temperature has been recorded as 25°C for all-male clones in the Adriatic Sea (NIMPIS, 2002).

Nutrition
Caulerpa taxifolia gains nutrition through photosynthesis.

General Impacts
The *Caulerpa taxifolia* aquarium strain in the Mediterranean Sea is extremely invasive and smothers other algal species, seagrasses and sessile invertebrate communities. It does this by either out-competing species for food and light or due to the toxic effects of its caulerpenyne compounds. Its large monospecific meadows have vastly reduced native species diversity and fish habitat (NIMPIS, 2002). Effects on humans are mostly related to the reduction of catches for commercial fishermen due to the elimination of fish habitat by *C. Taxifolia*, although the entangling of nets and boat propellers with this weed also affect efficiency (NIMPIS, 2002). Fish which are able to eat *C. Taxifolia*, such as the Mediterranena bream (*Sarpa salpa*), accumulate toxins in their flesh that make them unsuitable for human consumption (Meinesz & Hesse, 1991).
C. Taxifolia outcompetes the seagrasses *Posidonia oceanica* and *Cymodocea nodosa* in Mediterranean ecosystems (NIMPIS, 2002).
Economic impacts resulting from the cost of eradication included approx $US6 million spent in Southern California up to 2004 (Anderson, 2004) and $AUS6-8 million in South Australia.

Management Info
Preventative measures: Nyberg and Wallentinus (2005) state that *Caulerpa taxifolia* is one of five top risk species in Europe. The authors study quantitatively ranked species traits which facilitate introduction and predominance using interval arithmetic to search for common patterns among 113 marine macroalgae introduced in Europe. From the abstract Nyberg and Wallentinus (2005) “Three main categories were used: dispersal, establishment and ecological impact. These were further subdivided into more specific categories, a total of 13. Introduced species were compared with the same number of native species randomised from the same families as the introduced. Invasive species (i.e. species having a negative ecological or economical impact) were also compared with non-invasive introductions, separately for the three algal groups. In many categories, as well as when adding all species, the introduced species ranked more hazardous than the native species and the invasive species ranked higher than the non-invasive ones. The ranking within the three main categories differed, reflecting different strategies between the species within the three algal groups. When all categories (excluding salinity and temperature) were summed, the top five risk species, all invasive, were, in descending order, *C. fragile* spp. *tomentosoides*, *Caulerpa taxifolia*, *Undaria pinnatifida*, *Asparagopsis armata* and *Grateloupia doryphora*, while *Sargassum muticum* ranked eight and *Caulerpa racemosa* ten. Fifteen of the twenty-six species listed as invasive were among the twenty highest ranked”.
Chemical: Colonies of *C. taxifolia* that were discovered in Southern California were eradicated by covering and sealing them with PVC tarpaulins and injecting liquid chlorine underneath. Subsequent treatments at another location used solid chlorine formulations (Anderson & Keppner, 2001). Costs of the Southern Californian eradication were $US2.33 million from 2000-01 for control and monitoring (Carlton, 2001), with an ongoing annual surveillance cost of $US1.2 million until 2004 (Anderson, 2004).
Application of coarse sea salt at a concentration of ~50kg/m² has been used with moderate success in Australia, eradicating *C. taxifolia* from an area almost 5200 m² in one case, although in another case an area of 3000 m² showed a reduction in algal density but eradication was not achieved. The use of this method in the cooler months, when *C. taxifolia* naturally dies back, was recommended. Salting has so far only been succesfully used on soft sediments in water <6m in depth (Glasby *et. Al*, 2004).
Physical: Simply covering *C. Taxifolia* colonies with black PVC plastic was found to be reasonably successful in Croatia. A total area of 512 m² was treated, with either no or sporadic regrowth occurring after treatment (McEnnulty *et. Al*, 2001).
Manual removal by scuba divers was successful in eradicating a small patch of *C. Taxifolia*, around 3.4 m², in the French Mediterranean. The use of a suction pump to remove all fragments has also met with moderate success in other areas. Clearance rates for manual removal are from <1 m² to ~3 m² per diver per hour (McEnnulty *et.al*, 2001).

Pathway
Cuttings can be distributed over long distances by boat anchors or fishing nets.Used as an ornamental species in home and public aquaria.*Caulerpa taxifolia* has established in a number of locations as the result of improperly disposed waste from aquaria.Cuttings can be distributed over long distances by boat anchors or fishing nets.

Principal source: National Introduced Marine Pest Information System (NIMPIS). 2002. CSIRO, Australia.

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ALIEN RANGE

[6] AUSTRALIA
[1] FRANCE
[5] ITALY
[1] MONACO
[1] SPAIN
[4] UNITED STATES
[3] CROATIA
[1] GERMANY
[1] MEDITERRANEAN & BLACK SEA
[1] NEW ZEALAND
[1] TUNISIA

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Summary: Links are provided from the species summary page to more information on Common Names, Synonyms, Identification Notes, Similar Species, Morphology, Reproduction, Life Cycle, Habitat, Survival, Food, Competitors, Predators, Impact information, Vectors, Dispersal, Control options and additional information.
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General information

Bienvenue sur le portail *Caulerpes*
Summary: Up-to-date information on the distribution of *C. taxifolia* in the Mediterranean and worldwide. Contains a dynamic distribution map of the Mediterranean and is available in both French and English.
Available from: http://www.caulerpa.org
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Summary: English:
The species list sheet for the Mexican information system on invasive species currently provides information related to Scientific names, family, group and common names, as well as habitat, status of invasion in Mexico, pathways of introduction and links to other specialised websites. Some of the higher risk species already have a direct link to the alert page. It is important to notice that these lists are constantly being updated, please refer to the main page (http://www.conabio.gob.mx/invasoras/index.php/Portada), under the section Novedades for information on updates.
Invasive species - Algae is available from: http://www.conabio.gob.mx/invasoras/index.php/Especies_invasoras_-_Algas [Accessed 30 July 2008]
Spanish:
La lista de especies del Sistema de informaci□n sobre especies invasoras de m□xico cuenta actualmente con informaci□n aceca de nombre cient□fico, familia, grupo y nombre com□n, as□ como h□bitat, estado de la invasi□n en M□xico, rutas de introducci□n y ligas a otros sitios especializados. Algunas de las especies de mayor riesgo ya tienen una liga directa a la p□gina de alertas. Es importante resaltar que estas listas se encuentran en constante proceso de actualizaci□n, por favor consulte la portada (http://www.conabio.gob.mx/invasoras/index.php/Portada), en la secci□n novedades, para conocer los cambios.
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Summary: The first record of *Caulerpa taxifolia* in the Mediterranean coasts is reported and the authors point out that the development characteristics of this population are different from those in its native tropical areas.
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Summary: A paper looking at the distribution and spread of *C. taxifolia* in the Mediterranean Sea.
Meinesz, A., Hesse, B. 1991. Introduction of the tropical alga *Caulerpa taxifolia* and its invasion of the northwestern Mediterranean. *Oceanologica Acta* 14(4): 415-426.
Summary: A review of the invasion of the Mediterranean by *C. taxifolia*.
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