Gymnodinium catenatum

System: Marine

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Common name: naked dinoflagellate (English), estuarine dinoflagellate (English), chain-forming dinoflagellate (English)

Synonym

Similar species: Gymnodinium microreticulatum, Gymnodinium nolleri, Gymnodinium uberrium, Diplopsalis

Summary

Gymnodinium catenatum is a toxic, bloom forming species of microalgae. It is usually seen in long, swimming chains of tiny cells, with up to 32 cells in a chain (occasionally 64). It is also seen as solitary cells with a green-brown colour. The size of these cells ranges from 38 - 53 um long and 33 - 45 um wide. The cells are circular to squarish in shape, with many rounded organelles within them. Cysts of G. catenatum are brown, spherical and range in size from 45 - 50 um in diameter. G. catenatum is the only known unarmoured dinoflagellate that produces toxins responsible for PSP (Paralytic Shellfish Poisoning). This species is widely distributed, from the Mediterranean to the Caribbean, Indian Ocean and Australasian waters.

Species Description

For a detailed description of the vegetative cell, resting cyst, gametes and young planozygotes please see species description.

Notes

Once established, blooms are subject to disturbance by turbulence caused by high windstress. In winter months declining water temperatures (<10°C) and increasing windstress are responsible for the termination of seasonal dinoflagellate blooms (NIMPIS, 2002d). Shellfish, copepods, tintinnids and dinoflagellates have all been recorded as consumers of G. catenatum (NIMPIS, 2002a).
Lifecycle Stages
Soil extracts are essential for growth (NIMPIS, 2002d). One division every 3-4 days is the optimal growth rate (NIMPIS, 2002d).

Habitat Description
A nektonic species (capable of independently moving about the water column and currents) *Gymnodinium catenatum* is found in bays and estuaries throughout the world. Vegetative cells can be distributed throughout the whole water column during a bloom, with cysts being found in sediments (NIMPIS, 2002a). Minimum temperature is 4°C, maximum is 30°C. Growth poor at 4°C and 12°C (Tasmanian strains). No growth at 11°C. Growth in laboratory at 12-17°C. Blooms when water temperatures range from 12-18°C. Ambient temperature <10°C terminates blooms. Growth poor at 25°C and 30°C (Tasmanian strains). Rapid growth at 17-28°C, optimal 18-22°C. Killed at temperatures of 35°C for 30 minutes to several hours. Minimum salinity is 15 ppt, maximum is 35.5 ppt. Survives 15-34 psu (Tasmanian strains). No survival after 35 days at 15-20 psu, no growth at 20 psu. *G. catenatum* described from the Gulf of California with salinity 35.07-35.50 ppt. Survives 15-34 psu, optimum 23-34 psu (Tasmanian strains). Chain-forming at 23-26 ppt. (NIMPIS, 2002b).

Reproduction
Both sexual and asexual reproduction occurs in *G. catenatum*. Vegetative cells reproduce primarily asexually via oblique binary fission, dividing into new cells. Certain environmental conditions (primarily a deficiency in nutrients) are thought to trigger the switch to sexual reproduction. Sexual reproduction results in the formation of cysts, which lie dormant in the sediments until conditions are suitable for them to germinate and produce new cells (NIMPIS, 2002a). Reproductive temperature range is 12-18°C, while the reproductive salinity range is 23-34 ppt. Temperature and organic nutrients are the cues for reproduction. In Tasmania blooms can only develop if temperatures are >14°C at the time of bloom initiation, a rainfall event occurs as a trigger, and there is a calm, stable water column for sustained development (NIMPIS, 2002d).

Nutrition
*G. catenatum* produces its own food through the process of photosynthesis. It is able to acquire nutrients through the cell wall, and has also been noted as a grazer on other phytoplankton (NIMPIS, 2002a). The physico-chemical variables that correspond with the presence of *G. catenatum* are, in descending order of importance: temperature, phosphates, dissolved oxygen, silicate, nitrite, and nitrate (Morquecho & Lechuga-Devéze, 2004).
General Impacts
Toxins (saxitoxins and gonyautoxins) produced by Gymnodinium catenatum can cause Paralytic Shellfish Poisoning (PSP). Studies show that most outbreaks are produced at temperatures lower than 25°C (Garate-Lizarraga et al., 2004). The toxins are released when G. catenatum cells are eaten by shellfish, such as oysters, mussels and scallops, making them poisonous to consume (NZFSA, 2004). In extreme cases, PSP causes muscular paralysis, respiratory difficulties, and can lead to death. In Mexico, three separate outbreaks of PSP, in Mazatlán, Guerrero, and Oaxaca, resulted in 460 individuals being poisoned, with 32 deaths (Band-Schmidt et al., 2004). G. catenatum also poses threats to wild and aquaculture shellfish industries, due to economic losses resulting from farm closures (NIMPIS, 2002a). Commercial shellfish farming has been impacted through the denial of access to traditional sources of spat supply. This is due to the risk of introducing G. catenatum into important unaffected populations. There has also been widespread contamination of shellfish with PSP toxins in New Zealand, and 500 individuals were hospitalised and at least 20 people died due to PSP along the Pacific coasts of Mexico. Mussels, oysters and scallops from areas affected by G. catenatum blooms have been highly contaminated with paralytic shellfish toxins, resulting in human poisonings (NIMPIS, 2002c). Mass mortality has occurred at shrimp farms that have been affected by blooms of G. catenatum (Alonso-Rodríguez & Páez-Osuna, 2003).

Management Info
A two year study was undertaken for the Department of Environment and Heritage (Australia) by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to identify and rank introduced marine species found within Australian waters and those not found within Australian waters.

All of the non-native potential target species identified in this report are ranked as high, medium and low priority, based on their invasion potential and impact potential. Gymnodinium catenatum is identified as one of ten potential domestic target species most likely to be spread to uninfected bioregions by shipping. G. catenatum is also identified as one of ten most damaging potential domestic target species, based on overall impact potential (economic and environmental). A hazard ranking of potential domestic target species based on invasion potential from infected to uninfected bioregions identifies G. catenatum as a 'high priority species' - these species have a reasonably high invasion potential and their impact potential is the highest of all the potential domestic target species.

For more details, please see Hayes et al. 2005. The rankings determined in Hayes et al. 2005 will be used by the National Introduced Marine Pest Coordinating Group in Australia to assist in the development of national control plans which could include options for control, eradication and/or long term management.

For details on management of this species, please see management information.

Pathway
Ballast water can transport this organism long distances to new environments. Cysts of G. catenatum can be accidentally translocated through aquaculture and fisheries activities, such as in oyster cages or on mussel ropes.

Compiler: IUCN/SSC Invasive Species Specialist Group (ISSG)

Review: M.C. Ismael Garate Lizarraga, Departamento de Plancton y. Ecología Marina, CICIMAR-IPN. Mexico

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ALIEN RANGE
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[1] MEDITERRANEAN & BLACK SEA
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[1] PHILIPPINES
[1] SINGAPORE
[1] URUGUAY

BIBLIOGRAPHY
36 references found for Gymnodinium catenatum

Management information


Summary: Contains management information.


General information

Summary: Outlines the effects of Gymnodinium catenatum blooms on commercial shrimp farms.


Summary: Has information on salinity and temperature preferences.


Summary: Has distribution information for Venezuela.


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.


Spanish:
La lista de especies del Sistema de informaci?n sobre especies invasoras de M?xico cuenta actualmente con informaci?n acerca 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 lo que es aconsejable consultar la portada (http://www.conabio.gob.mx/invasoras/index.php/Portada), en la secci?n Novedades, para conocer los cambios.


Summary: This paper records the first known occurrence of Gymnodinium catenatum in Brazilian waters. PSP toxins were detected in mussels (Perna perna), which are cultured in this area.


Summary: The original paper describing Gymnodinium catenatum for the first time.


ITIS (Integrated Taxonomic Information System). 2005. Online Database Gymnodinium catenatum

Summary: An online database that provides taxonomic information, common names, synonyms and geographical jurisdiction of a species. In addition links are provided to retrieve biological records and collection information from the Global Biodiversity Information Facility (GBIF) Data Portal and bioscience articles from BioOne journals.


Summary: Note: paper is in Spanish. This paper records the first known occurrence of G. catenatum in Cuban waters. Lu, S. and Hodgkiss, I.J. 2004. Harmful algal bloom causative collected from Hong Kong waters. Hydrobiologia. 512 (1-3): 231-238.


Summary: Reports on the algal bloom of G. catenatum that resulted in the closure of many commercial shellfish-growing areas in New Zealand.


Summary: Has some information on the effects of G. catenatum in Mexico.


Summary: States some of the environmental variables that correlate with the presence of G. catenatum.


Summary: Contains a species summary.


Summary: Contains information on life-cycle and reproduction.


Summary: Contains information on life-cycle and reproduction.


Summary: Contains information on life-cycle and reproduction.


Summary: Contains identification information.


New Zealand Food Safety Authority (NZFSA). Frequently asked questions about Gymnodinium catenatum and PSP toxins webpage.

Summary: Contains informations on PSP toxins and human-health related effects.


Summary: Report into a molecular detection method.


Summary: Contains the results of a survey to determine the locations in which G. catenatum occurs in New Zealand.


Summary: Has information on G. catenatum in Costa Rica. Written in Spanish.