Styela plicata **System:** Marine

Kingdom	Phylum	Class	Order	Family
Animalia	Chordata	Ascidiacea	Pleurogona	Styelidae

Common name solitary ascidian (English), sea squirt (English), leathery tunicate (English), pleated sea squirt (English)

Synonym
Ascidia plicata , Lesueur, 1823
Styela barnhart , Ritter & Forsyth, 1917
Styela gyrosa , Heller, 1877
Styela pinguis , Herdman, 1899
Tethyum plicatum , Hartmeyer, 1909
Ascidea plicata

Similar species *Styela clava*

Summary Styela plicata (sea squirt) is a pandemic, temperate to subtropical tunicate. As a pest species, Styela plicata outcompete native encrusters and excludes them from hard substrates. It is a known fouler of sea vessels and other hard substrates, travelling the oceans in this fashion. Few places classify Styela plicata as an invasive species, but some effective management options are available to control this tunicate.

view this species on IUCN Red List

Species Description
Styela plicata (sea squirt) is an ovular, greyish to tannish white benthic tunicate. This solitary sessile invertebrate is cloaked in an unstalked tunic that is large, tough, (Fuller, 2007), warty and ridged (Howey, 1998). Perry & Larson (2004) report that the lumpy surface of the tunic gives it the appearance of cobblestone pavement. Internal structures are protected by this tunic, which is composed largely of cellulose compounds and contains a circulatory system of \"blood\" transport vesicles. Dividing the tunic is a membrane which allows fluid to flow up one side and down the other. *S. plicata* has an incurrent siphon that intakes water into the pharyngeal basket where food particles are filtered out; the waste is then excreted through the excurrent siphon (Howey, 1998). The two short siphons have red or purple stripes on the inside of the siphons and four lobes (Fuller, 2007). When physically disturbed, *S. plicata* expels water, which explains why it is called a sea squirt. *S. plicata* is a very eurythermal tunicate; able to tolerate changes in seawater between 10°-30°C and salinites between 22%-34% (Thiyagarajan & Qian, 2003). NIMPIS (2002) reports that *S. plicata* can tolerate some pollution and brackish waters. Adults can reach sizes between 40-70mm, even up to 90mm in some cases (NIMPIS, 2002). As a protandric hermaphrodite, *S. plicata* has \"testes - small and attached along most of the length of each ovary,\" with two gonads on the left side of the body and five on the right (Lambert*et al*. 2005).

Notes
As a defence mechanism, *Styela plicata* (sea squirt) concentrates deterrant chemical compounds in its gonads so that they may be passed on to larvae, thus protecting them from predation (Pisut & Pawlik, 2002). Alcohol from the body of *S. plicata* exhibits anti-Hepatitis B properties (STRI, undated). *S. plicata* harbours the amphiped *Leucothoe spinicarpa* and an ascidicolous copepod (Thiel, 1998). Cold winters kill *S. plicata*, limiting its northern distribution to Cape Hatteras, North Carolina. One way this is thought to happen is by dislodgement from substrates during cold (growth inhibiting) periods (Fisher, 1976). Populations of *S. plicata* fluctuate; they may be abundant one year and absent the next (Lambert & Lambert, 1998).

Lifecycle Stages
The eggs of *Styela plicata* (sea squirt) are surrounded by a complex ovular envelope (Mansueto*et al*. 2003) that supplies the larvae with its nutritional requirements (Pisut & Pawlik, 2002). Once hatched, the larvae attempt to find a suitable substrate. *S. plicata* can have an extended swimming period of over 2 days prior to settlement without a cost to metamorphosis (Thiyagarajan & Qian, 2003). Larval settlement is most successful in the spring and fall (Fisher, 1977). *S. plicata* has a life span of less than one year that is characterised by rapid growth. Some sea squirts can live between 2-3 years (Lambert & Lambert, 1998). Yamaguchi (1975) reported that *S. plicata* reached sexual maturity in 2 months during the summer and 5 months during the winter. *S. plicata* has an extended breeding season, reproducing all year except during winter (NIMPIS, 2002).

Uses
Styela plicata (sea squirt) is a host to several different kinds of organisms, including brittle stars, mussels, chitons, sponges, polychaete worms, diatoms, eggs, etc., that live on its tunic (Howey, 1998).

Habitat Description
The different life cycle stages of *Styela plicata* (sea squirt) have different habitat requirements for survival. The larval and juvenile stages of *S. plicata* live on marinas and docks, oyster reefs, rocks and coarse woody debris, while the adults prefer marinas, docks and hard rocky substrates (NEMESIS, 2006). *S. plicata* also live in coral reef habitats (STIR, undated). *S. plicata* is found from the low intertidal zone to depths of 30m (NIMPIS, 2002).

Reproduction
Styela plicata (sea squirt) is a protandric hermaphrodite. Initially, *S. plicata* is a male, then later it changes to a female. Fertilisation is external; eggs and sperm are released into the water column in the late afternoon and the larvae, 1.3mm in total length (Yamaguchi, 1975), hatch the next morning and settle that day (NIMPIS, 2002). *S. plicata* undergoes reproductive cycles yearly in conjunction with annual temperature changes. According to West & Lambert (1975), *S. plicata* must experience a period of darkness; approximately 8.5 hours long, prior to the release of gametes. Spawning can occur between 11°-28° C (West & Lambert, 1975), with 20°C being optimal (Yamaguchi, 1975). Water filtration is not optimal during the release of gametes (Fiala-Medlioni, 1978).

Nutrition
Styela plicata (sea squirt) is a suspension filter feeds that preys primarily on phytoplankton, zooplankton and organic materials. Snails, crustaceans, sea stars and fish have been known to prey on *S. plicata* (NIMPIS, 2002). Specifically, the species *Linatella caudata* preys upon *S. plicata* (Morton, 1989).

General Impacts
Styela plicata (sea squirt) competes with other organisms, excluding them from the space it occupies. Its larvae are capable of invading occupied space and growing to a large size in a relatively short period of time, attached to other organisms. *S. plicata* then sloughs off because of its large size, often taking other marine organisms with it. This sloughing destabilises the marine community. The presence of this tunicate also inhibits the recruitment or growth of other larval species (Sutherland, 1978). *S. plicata* has also replaced native solitary tunicates *Pyura haustor* and *Ascidia ceratodes* (Fuller, 2007). *S. plicata* is a fouler of ships, boats, docks, power plants and shellfish ponds, attaching to hard substrates and remaining there until removed (NEMESIS, 2006). *S. plicata* is usually covered with non-ascidian epibionts, which can travel on the tunicate and add non-indigenous species to aquatic ecosystems (Lambert & Lambert, 1998). Wyatt *et al* (2005) claims that *S. plicata* acts as a vector for the invasive *Bugula neritina* in Australia.

Management Info
Chemical: Tributylin (TBT) is used in anti-fouling paints, wood preservation, slime control in paper mills and other industrial processes. It affects *Styela plicata* by blocking the sperm-egg interaction, thus preventing fertilisation (Mansueto *et al*, 2003). PAN (2006) reports that Butyltrichlorostannane, Cyhexatin, Dibutyltin dichloride, Fenton hydroxide, Tributylin chloride, Triphenyltin acetate and Triphenyltin chloride cause mortality in *S. plicata* cells aquired post-fertilisation (PAN, 2006). Copper sulphate was proposed as a broadcast spray control method, but scientists deemed it too expensive and non-specific, lethal to non-target species. It is also absorbed by the soil and ineffective at high pH levels.
Physical: Plastic wraps have been applied to timber pylons in intertidal to subtidal zones, which prevent oxygenated water from touching *S. plicata*, thus suffocating it (NIMPIS, 2002).

Pathway
Hayes *et al* (2005) report that *Styela plicata* was introduced to Australia accidently with the translocation of fish or shellfish.*Styela plicata* can be introduced to new locations in ship ballast water (Fuller 2007).*Styela plicata* can be introduced to new locations by hull/ship fouling (Fuller 2007).

Principal source:

Compiler: National Biological Information Infrastructure (NBII) & IUCN/SSC Invasive Species Specialist Group (ISSG)

Review: Expert review underway: Dr. Richard Osman, Senior Scientist Smithsonian Environmental Research Center., Edgewater, Maryland, USA

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ALIEN RANGE

[1] ARGENTINA
[1] BERMUDA
[1] HONG KONG
[1] ITALY
[1] MEDITERRANEAN & BLACK SEA
[1] URUGUAY
[8] AUSTRALIA
[1] BRAZIL
[1] INDIAN - OCEAN EASTERN
[1] JAPAN
[15] UNITED STATES

BIBLIOGRAPHY
28 references found for **Styela plicata**

Managment information

Centre for Environment, Fisheries & Aquaculture Science (CEFAS)., 2008. Decision support tools-Identifying potentially invasive non-native marine and freshwater species: fish, invertebrates, amphibians.
Summary: The electronic tool kits made available on the Cefas page for free download are Crown Copyright (2007-2008). As such, these are freeware and may be freely distributed provided this notice is retained. No warranty, expressed or implied, is made and users should satisfy themselves as to the applicability of the results in any given circumstance. Toolkits available include 1) FISK- Freshwater Fish Invasiveness Scoring Kit (English and Spanish language version); 2) MFISK- Marine Fish Invasiveness Scoring Kit; 3) MI-ISK- Marine invertebrate Invasiveness Scoring Kit; 4) FI-ISK- Freshwater Invertebrate Invasiveness Scoring Kit and AmphISK- Amphibian Invasiveness Scoring Kit. These tool kits were developed by Cefas, with new VisualBasic and computational programming by Lorenzo Vilizzi, David Cooper, Andy South and Gordon H. Copp, based on VisualBasic code in the original Weed Risk Assessment (WRA) tool kit of P.C. Pheloung, P.A. Williams & S.R. Halloy (1999).
The decision support tools are available from:
http://cefas.defra.gov.uk/our-science/ecosystems-and-biodiversity/non-native-species/decision-support-tools.aspx [Accessed 13 October 2011]
The guidance document is available from http://www.cefas.co.uk/media/118009/fisk_guide_v2.pdf [Accessed 13 January 2009].
Hayes, K., Sliwa, C., Migus, S., McEnnulty, F., Dunstan, P. 2005. National priority pests: Part II Ranking of Australian marine pests. An independent report undertaken for the Department of Environment and Heritage by CSIRO Marine Research.
Summary: This report is the final report of a two year study designed to identify and rank introduced marine species found within Australian waters (potential domestic target species) and those that are not found within Australian waters (potential international target species).
Available from: http://www.marine.csiro.au/crimp/reports/PrioritypestsFinalreport.pdf [Accessed 25 May 2005]
Mansueto, C., Villa, L., D'Agati, P. Marcian`, V., Pellerito, C., Fiore, T., Scopelliti, M., Nagy, L., and L. Pellerito. 2003. Effects of tributyltin (IV) chloride on fertilization of *Styela plicata* (Ascidiacea: Tunicata): II. Scanning and transmission electron microscopy studies. Appl. Organometal. Chem. 17: 553-560
Summary: This report discusses the use of TBT in industrial systems. It also explains the affect of this chemical on *S. plicata* and gives some management information.
National Introduced Marine Pest Information System (NIMPIS), 2002. *Styela plicata* species summary. National Introduced Marine Pest Information System (Eds: Hewitt C.L., Martin R.B., Sliwa C., McEnnulty, F.R., Murphy, N.E., Jones T. & Cooper, S.).
Summary: This Autralian based website provides a wealth of information about *S. plicata*. Gives information concerning management, similar species, reproduction and growth, general biology.
Available from: http://www.marine.csiro.au/crimp/nimpis/spSummary.asp?txa=6837 [Accessed 16 January 2007]
Orme, S. and S. Kegley, 2006. PAN Pesticide Database, Pesticide Action Network, North America (San Francisco, CA. 2006).
Summary: Information on toxicity studies with *Styela plicata*. Tells exactly what each chemical will do and in what life cycle phase they are effective.
Varnham, K. 2006. Non-native species in UK Overseas Territories: a review. JNCC Report 372. Peterborough: United Kingdom.
Summary: This database compiles information on alien species from British Overseas Territories.
Available from: http://www.jncc.gov.uk/page-3660 [Accessed 10 November 2009]

General information

CONABIO. 2008. Sistema de informaci□n sobre especies invasoras en M□xico. Especies invasoras - Otros invertebrados. Comisi□n Nacional para el Conocimiento y Uso de la Biodiversidad. Fecha de acceso.
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 - Aquatic invertebrates is available from:
http://www.conabio.gob.mx/invasoras/index.php/Especies_invasoras_-_Otros_invertebrados [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.
Especies invasoras - Otros invertebrados is available from:
http://www.conabio.gob.mx/invasoras/index.php/Especies_invasoras_-_Otros_invertebrados [Accessed 30 July 2008]
Fiala-Medlioni, A. 1978. Filter-Feeding Ethology of Benthic Invertebrates (Ascidians). III. Recording of Water Current *in s i t u* - Rate and Rhythm of Pumping. Marine Biology 45, 185-190
Summary: This article discusses the pumping and filtration of *S. plicata* to determine if patterns are evident. It gives information on pumping during reproduction as well.
Fisher, T. 1976. Oxygen Uptake of the Solitary Tunicate *Styela plicata*. Biol Bull 151: 297-305.
Summary: This paper discusses oyxgen uptake and metabolic coasts of *S. plicata* and hypothsizes as to why the tunicate reproduces at certain times of the year.
Available from: http://www.biolbull.org/cgi/content/abstract/151/2/297 [Accessed 16 January 2007]
Fisher, T. 1977. Metabolic Maintenance Costs of the Suspension Feeder *Styela plicata*. Marine Biology 41, 361-369
Summary: This journal article describes the different energy demands of *S. plicata*. It discusses temperature ranges and how they relate to reproduction and evergy costs.

Fuller, Pam., 2007. *Styela plicata*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL.
Summary: A US webstite that gives information about non-indigenous aquatic species. Good information about native and introduced ranges and impacts of invasive species.
Available from: http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=1293 [Accessed 17 January 2007]
Howey, R. 1998. Tunicates with Salad on the Side. Micscape Magazine.
Summary: A good source for general infromation on tunicates. Explains their reproductive capabilities and organ functions and gives physical descriptions of tunicates.
Available from: http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artnov98/rhtunic.html [Accessed 18 January 2007]
Invasions Lab Online Databases (ILOD). 2006. *Styela plicata*. Marine Invasions Research Lab. Smithsonian Environmental Research Center.
ITIS (Integrated Taxonomic Information System), 2007. Online Database *Styela plicata*
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.
Available from: http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=159338 [Accessed 15 January 2007]
Lambert, C. & G. Lambert. 1998. Non-indigenous ascidians in southern California harbors and marinas. Marine Biology 130: 675&#65533;688
Summary: Gives geographic information about *S. plicata* in California harbors and marinas.
Lambert, G., Faulkes, Z., Scofield, Z., and C. Lambert. 2005. Ascidians of South Padre Island, Texas, with a key to species. Texas J. SCI. 57(3): 251-262.
Summary: This article gives a key to ascidians, providing very scientific information about Ascidians. It also describes the presence of *S. plicata* in different location on South Padre Island.
Morton, B. 1989. Prey Capture, Preference and Consumption by *Linatella caudata* (Gastropoda: Tonnoidea: Ranellidae) in Hong Kong. J. Moll. Stud. 56, 477-486.
Summary: A paper that discusses the prey species of *L. caudata* in Hong Kong.
National Exotic Marine and Estuarine Species Information System (NEMESIS). 2006. *Styela plicata*. Smithsonian Environmental Research Center.
Summary: A website that provides thorough information about Taxonomy, Impacts, Trophic Interactions, Invasion History, and general ecology concerning *Styela plicata*.
Available from: http://invasions.si.edu/nemesis/CH-TAX.jsp?Species_name=Styela+plicata [Accessed 19 January 2007]
Perry & Larson. 2004. *Styela plicata*. Guide to Shelf Invertebrates, Gulf of Mexico.
Summary: This page gives good range information and diagnostic characteristics.
Available from: http://www.gsmfc.org/seamap/picture_guide/Other/styela%20plicata.pdf [Accessed 18 January 2007]
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Summary: The composition of anti-predatory chemicals is the main focus on this article. It talks about what compounds in *S. plicata* are thought to be for defense and gives some information on reproduction.
Port Survey for Introduced Species [PSIS]. Undated. Sydney Harbour. Australian Museum Business Services.
Summary: This survey gives geographic information for introduced species in Australia.
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Smithsonian Tropical Research Institute (STIR). Undated. *Styela plicata*. Bocas Del Toro Species Database.
Summary: Available from: http://biogeodb.stri.si.edu/bocas_database/search/species/2493?&search_key=styela [Accessed 12 March 2010]
Sutherland, P. 1978. Functional roles of *Schizoporella* and *Styela* in the fouling community at Beaufort, North Carolina. *Ecology*, 59(2). pp. 257-264.
Summary: This report details what *S. plicata* has been doing to the marine community at Beaufort, North Carolina. It discusses impacts and alterations that the tunicate has made in the ecosystem.
Thiel, M. 1998. Host-use and population demographics of the ascidian-dwelling amphipod *Leucothoe spinicarpa*: indication for extended parental care and advanced social behaviour. Journal of Natural History, 33, 193&#65533; 206
Summary: An article that discusses the presence of the amphipod *L. spinicarpa* in *S. plicata*.
Thiyagarajan, V. & P. Qian. 2003. Effect of temperature, salinity and delayed attachment on development of the solitary ascidian *Styela plicata* (Lesueur). Journal of Experimental Marine Biology and Ecology 290; 133&#65533; 146.
Summary: A great article that discusses environmental tolerances of *S. plicata* and its ability to delay metamorphosis by swimming to a suitable substrate.
West, A. & C. Lambert. 1975. Control of Spawning in the Tunicate *Styela plicata* by Variations in a Natural Light Regime. J. Exp. Zool., 195: 263-270.
Summary: A scholarly article that tests *S. plicata* in different light regimes to determine if a dark period is needed for reproduction.
Wyatt, A., Hewitt, C., Walker, Di., & T. Ward. 2005. Marine introductions in the Shark Bay World Heritage Property, Western Australia: a preliminary assessment. *Diversity and Distributions*, (Diversity Distrib.)11, 33&#65533;44
Summary: This article discusses the presence of *S. plicata* in the protected area of the Shark Bay World Heritage Property and the mechanism of introduction. It also provides information about other marine introductions to this area.
Yamaguchi, M. 1975. Growth and Reproductive Cycles of the Marine Fouling Ascidians *Ciona intestinalis, Styela plicata, Botrylloides violaceus*, and *Leptoclinum mitsukurii* at Aburatsubo-Moroiso Inlet (Central Japan). Ymrine Biology 29, 253-259.
Summary: A journal article that gives specific reproduction information about *S. plicata*, including what temperature is optimal, how fast they reach maturity, and other life cycle events.