Ciona intestinalis **System:** Marine

Kingdom	Phylum	Class	Order	Family
Animalia	Chordata	Ascidiacea	Enterogona	Cionidae

Common name cione (French), doorschijnende zakpijp (Dutch), gelbe seescheide (German), vase tunicate (English), sea vase (English), yellow sea squirt (English), ascidie jaune (French)

Synonym
Ascidia viridiscens , (Brugiere, 1792)
Ciona canina , (Mueller, 1776)
Ciona diaphanea , (Quoy & Gaimard, 1834)
Ciona ocellata , (Agassiz, 1850)
Ciona pulchella , (Alder, 1863)
Ciona robusta , (Hoshino & Tokioka, 1967)
Ciona sociabilis , (Gunnerus, 1765)
Ciona tenella , (Stimpson, 1852)
Phallusia intestinalis , (Linnaeus, 1767)
Tethyum sociabile , (Gunnerus, 1765)

Similar species

Summary The sea vase, *Ciona intestinalis*, is a tunicate that has such widespread distribution that its natural range continues to be a source of constant debate. A major pest on shellfish aquaculture production, *C. intestinalis* is a highly competitive species. There is evidence of *C. intestinalis* displacing native species, reducing biodiversity, and altering community properties in some invaded habitats. Control of *C. intestinalis* is difficult due to its rapid recolonisation, difficulty of containment and proximity to valuable aquaculture production that limits the control options able to be used.

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Species Description
Like all *Ciona* spp. *Ciona intestinalis* has a sessile adult stage which lives attached to submerged hard substrates (Holland, 2002). *C. intestinalis* usually adheres vertically to these substrates, with its siphons pointing downward (Marins *et al*, 2009). The body of *C. intestinalis* is cylindrical, reaching to 100 - 150 mm in length, with its two siphons at the anterior end (Marins *et al*, 2009). All *Ciona* spp. are encased in a soft leathery tunic, which in the case of *C. intestinalis*, it is thin, soft, gelatinous, translucent, and clear to greenish coloured, making the internal organs visible (McDonald, 2004; Jackson, 2008; in Marins *et al*, 2009).
The inhalant anterior opening into the gut is larger and terminal with eight lobes while the atrial siphon is smaller and shorter with six lobes (McDonald, 2004). Larvae are free swimming and tadpole-like in appearance, with a dorsal nerve cord, a rudimentary brain and a notochord (Holland, 2002). After dispersal, larvae attach to a surface with their head after which the tail is reabsorbed and metamorphosis into a sessile filter-feeding adult occurs (Holland, 2002).
Once settled, *C. intestinalis* provide a poor substrate for other settlers, producing strong anti-microbial compounds that may restrict epibiosis and therefore limit recruitment of other species (Finslay & Smith, 1995; in Blum *et al*, 2007). The maximum reported lifespan of individuals is 2 years, but a more typical lifespan is 1 year (Jackson, 2000; in Blum *et al*, 2007).

Notes
The origin of *Ciona intestinalis* populations in Canada is a source of debate. Locke (2009) describes populations in sourthern Nova Scotia as cryptogenic while populations in Atlantic Canadian waters are non-indigenous. In contrast, Therriault & Herborg (2008a) describe populations in Atlantic Canadian waters as cryptogenic and populations in Pacific Canadian waters as non-indigenous.

Lifecycle Stages
Larvae are free swimming and tadpole-like in appearance, with a dorsal nerve cord, a rudimentary brain and a notochord (Holland, 2002). After dispersal over a period of 1 - 5 days (Dybern, 1965; in Howes *et al*, 2007), larvae attach to a surface with their head after which the tail is reabsorbed and metamorphosis into a sessile filter-feeding adult occurs (Holland, 2002).

Uses
Species of sea squirt, including *Ciona* spp., were popular models for embryological research in the early part of the twentieth century. *Ciona* spp. were instrumental in the discovery of cytoplasmic determinants, and were one of the first animals to have a cell lineage mapped (Holland, 2002). More recently, numerous developmentally expressed genes have been cloned from *Ciona* spp., hundreds of gene expression patterns are published, and there are powerful methods for introducing gene constructs into *Ciona* spp. embryos using electroporation (Holland, 2002).

Habitat Description
Ciona intestinalis lives attached to submerged rocks or other hard surfaces, such as ropes, chains and boat hulls (Holland, 2002). *C. intestinalis* has a cosmopolitan distribution, tolerates organic pollution and a wide range of enviornmental conditions. It is abundant in ports and marinas all over the world (Meliane, 2003; in Marins *et al*, 2009; Therriault & Herborg, 2008a).

Reproduction
As with all Ascidians, *Ciona intestinalis* is hermaphroditic and potentially capable of self-fertilisation (Silva & Smith, 2008). It is also a solitary (opposed to colonial) Ascidian which undergoes broadcast spawning (Silva & Smith, 2008). Each mature individual can potentially spawn once per day over the spawning period, releasing appproximately 500 eggs per day (Carver *et al*, 2003). Eggs are negatively buoyant and released in mucus strings that tangle and attach to nearby adults, contributing to the dense aggregations of adults (MarLIN, 2004; in McDonald, 2004).

Nutrition
Ciona intestinalis is a filter feeding organism, feeding on particles in the water column (Daigle & Herbinger, 2009). Clearance rates increase in an approximately linear relationship with increasing temperature with rates ranging from 4.6 ml per min per individual at 4 °C to about 29 ml per min per individual at 19 °C (Daigle & Herbinger, 2009).

General Impacts
The most severe impacts of *Ciona intestinalis* worldwide have been on aquaculture production, causing substantial economic losses to the shellfish industry in particular (Robinson *et al*, 2005). Higher *C. intestinalis* densities are generally linked to lower mussel size and condition, with heavy fouling resulting in up to 50 % mussel mortality (Daigle & Herbinger, 2009). This is due mainly to inhibited growth and yield through food and space competition (Daigle & Herbinger, 2009; Rocha *et al* 2009) as well as increasing weight of gear, leading to difficulties in handling and processing (Locke *et al*., 2009b).
Additionally, as a highly competitive species within subtidal, epibenthic communities, *C. intestinalis* has also displaced native species, lowered biodiversity, and altered community properties in some invaded habitats (Blum *et al* 2007; Therriault & Herborg, 2008b).

Management Info
Please follow this link for detailed information on the management of *Ciona intestinalis*. A brief summary can by found below.
Preventative measures: A risk assessment carried out by Hayes *et al* (2005) in Australia determined that *C. intestinalis* was one of top ten species in both its likelihood to be spread to uninfected bioregions by shipping and its damage potential. Preventative requirements on Prince Edward Island, Canada failed to stop the spread of *C. intestinalis* (Locke *et al*., 2009b). The only regulated vector in Canada is ballast water coming in from commercial shipping (Locke *et al*., 2009a)
Monitoring: Tunicate collectors were created and used to detect the presence and distribution of exotic tunicate species in the Bay of Fundy, including *Ciona intestinalis* (LeGresley *et al*, 2008).
Physical control: Aquaculture farmers surveyed by Clancey & Hinton (2003) revealed that physical removal methods such as hand scrubbing, scraping or high pressure spraying were the most common treatments used to remove tunicates that had become established on gear, however *C. intestinalis* quickly re-established populations within short periods.
Chemical control: A number of chemical treatments to control *C. intestinalis* have been trialed (Carver *et al*, 2003). While some like acetic acid and calcium hydroxide have shown promising results, chemicals have the potential to alter estuarine pH are and have been shown to be biocidal to a variety of non-target organisms such as species of bacteria, shrimp and fish (Locke *et al*, (2009b).
Biological control: Potential biological control agents include the rock crab, *Cancer irroratus* and green crab, *Carcinus maenas*. The use of crab predators for the control of *C. intestinalis* in aquaculture is limited for a number of reasons (Carver *et al*, 2003). Grazing species such as *Littorina littorea* and the shrimp *Rhynchocinetes typus* have also been trialled, with the shrimp in particular showing promising results (Dumont *et al*., 2009).
Cultural control: These refer to aquaculture management practices and generally include avoiding times of high *C. intestinalis* recruitment, changing or rotating the gear used or air drying depending on the species being farmed and the gear being used. More information on *C. intestinalis* recruitment patterns and population development is necessary to develop more effective management procedures (Ramsay, *et al*, 2009).

Principal source:

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ALIEN RANGE

[1] ATLANTIC - NORTHWEST
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[1] CHILE
[1] KOREA, DEMOCRATIC PEOPLE'S REPUBLIC OF
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[1] AUSTRALIA
[6] CANADA
[1] HONG KONG
[4] NEW ZEALAND
[3] UNITED STATES

BIBLIOGRAPHY
45 references found for **Ciona intestinalis**

Managment information
Bellas, Juan, 2005. Toxicity assessment of the antifouling compound zinc pyrithione using early developmental stages of the ascidian *Ciona intestinalis*. Biofouling, 2005; 21(5/6): 289 - 296
Bernier, Y. Ren&#65533;e; Andrea Locke and John Mark Hanson, 2009. Lobsters and crabs as potential vectors for tunicate dispersal in the southern Gulf of St. Lawrence, Canada. Aquatic Invasions (2009) Volume 4, Issue 1: 105-110
Summary: Available from: http://www.aquaticinvasions.ru/2009/AI_2009_4_1_Bernier_etal.pdf [Accessed May 20 2010]

Carver, C. E.; Chisholm, A.; Mallet, A. L., 2003. Strategies to mitigate the impact of *Ciona intestinalis* (L.) biofouling on shellfish production. Journal of Shellfish Research. 22(3). December 2003. 621-631

Clancey, Lewis & Richard Hinton, 2003. Distribution of the Tunicate, *Ciona intestinalis*, in Nova Scotia. Nova Scotia Department of Fisheries and Agriculture

Summary: Available from: http://www.gov.ns.ca/fish/aquaculture/surveysquirts.pdf [Accessed May 20 2010]

Darbyson, Emily; Andrea Locke; John Mark Hanson and J. H. Martin Willison, 2009. Marine boating habits and the potential for spread of invasive species in the Gulf of St. Lawrence. Aquatic Invasions (2009) Volume 4, Issue 1: 87-94

Summary: Available from: http://www.aquaticinvasions.net/2009/AI_2009_4_1_Darbyson_etal.pdf [Accessed May 20 2010]

Dumont, C. P.; Urriago, J. D.; Abarca, A.; Gaymer, C. F.; Thiel, M., 2009. The native rock shrimp *Rhynchocinetes typus* as a biological control of fouling in suspended scallop cultures. Aquaculture. 292(1-2). JUL 1 2009. 74-79.

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]

Inglis G., Gust N., Fitridge I., Floerl O., Woods C., Hayden B., & Fenwick G. 2006a. Port of Nelson. Baseline survey for non-indigenous marine species. Biosecurity New Zealand Technical Paper No: 2005/02

Summary: Available from: http://www.biosecurity.govt.nz/files/pests/salt-freshwater/2005-02-port-of-nelson.pdf [Accessed June 15 2010]

Inglis G., Gust N., Fitridge I., Floerl O., Woods C., Hayden B., & Fenwick G. 2006b. Port of Napier. Baseline survey for non-indigenous marine species. Biosecurity New Zealand Technical Paper No: 2005/13

Summary: Available from: http://www.biosecurity.govt.nz/files/pests/salt-freshwater/2005-13-port-of-napier.pdf [Accessed June 15 2010]

Inglis G., Gust N., Fitridge I., Floerl O., Woods C., Hayden B., & Fenwick G. 2006c. Port of Timaru. Baseline survey for non-indigenous marine species. Biosecurity New Zealand Technical Paper No: 2005/06

Summary: Available from: http://www.biosecurity.govt.nz/files/pests/salt-freshwater/2005-06-port-of-timaru.pdf [Accessed June 15 2010]

IUCN/SSC Invasive Species Specialist Group (ISSG)., 2010. A Compilation of Information Sources for Conservation Managers.

Summary: This compilation of information sources can be sorted on keywords for example: Baits & Lures, Non Target Species, Eradication, Monitoring, Risk Assessment, Weeds, Herbicides etc. This compilation is at present in Excel format, this will be web-enabled as a searchable database shortly. This version of the database has been developed by the IUCN SSC ISSG as part of an Overseas Territories Environmental Programme funded project XOT603 in partnership with the Cayman Islands Government - Department of Environment. The compilation is a work under progress, the ISSG will manage, maintain and enhance the database with current and newly published information, reports, journal articles etc.

Locke, Andrea, 2009. A screening procedure for potential tunicate invaders of Atlantic Canada. Aquatic Invasions (2009) Volume 4, Issue 1: 71-79

Summary: Available from: http://www.aquaticinvasions.net/2009/AI_2009_4_1_Locke.pdf [Accessed May 20 2010]

Locke, Andrea and John Mark Hanson, 2009. Rapid response to non-indigenous species. 3. A proposed framework. Aquatic Invasions (2009) Volume 4, Issue 1: 259-273

Summary: Available from: http://www.aquaticinvasions.net/2009/AI_2009_4_1_Locke_Hanson2.pdf [Accessed May 20 2010]

Locke, Andrea; John Mark Hanson; Neil G. MacNair and Arthur H. Smith, 2009a. Rapid response to non-indigenous species. 2. Case studies of invasive tunicates in Prince Edward Island. Aquatic Invasions (2009) Volume 4, Issue 1: 249-258

Summary: Available from: http://www.aquaticinvasions.ru/2009/AI_2009_4_1_Locke_etal2.pdf [Accessed May 20 2010]

Locke, Andrea; Kenneth G. Doe; Wayne L. Fairchild; Paula M. Jackman and Erica J. Reese, 2009b. Preliminary evaluation of effects of invasive tunicate management with acetic acid and calcium hydroxide on non-target marine organisms in Prince Edward Island, Canada. Aquatic Invasions (2009) Volume 4, Issue 1: 221-236

Summary: Available from: http://www.aquaticinvasions.net/2009/AI_2009_4_1_Locke_etal.pdf [Accessed May 20 2010]

Therriault, Thomas W.; Herborg, Leif-Matthias, 2008a. Predicting the potential distribution of the vase tunicate *Ciona intestinalis* in Canadian waters: informing a risk assessment. ICES Journal of Marine Science. 65(5). JUL 2008. 788-794.

Therriault, Thomas W.; Herborg, Leif-Matthias, 2008b. A qualitative biological risk assessment for vase tunicate *Ciona intestinalis* in Canadian waters: using expert knowledge. ICES Journal of Marine Science. 65(5). JUL 2008. 781-787.

Willis, Kate; Nutsford, S.; Floerl, O, 2007. Ecology and management of invasive solitary ascidians in New Zealand. Woods Hole Oceanographic Institution

General information

Blum, Julia C.; Chang, Andrew L.; Liljesthrom, Marcela; Schenk, Michelle E.; Steinberg, Mia K.; Ruiz, Gregory M., 2007. The non-native solitary ascidian *Ciona intestinalis* (L.) depresses species richness. Journal of Experimental Marine Biology & Ecology. 342(1, Sp. Iss. SI). MAR 26 2007. 5-14.

Brewin, I. Beryl, 1950. Ascidians of New Zealand Part IV. Transactions of the Royal Society of New Zealand Vol 78 Pts 2 and 3 pp 344-353 August 1950

Summary: Available from: http://rsnz.natlib.govt.nz/volume/rsnz_78/rsnz_78_02_004090.pdf {Accessed 20 May 2010]

Carman, R. Mary; K. Elaine Hoagland; Emma Green-Beach and David W. Grunden, 2009. Tunicate faunas of two North Atlantic-New England islands: Martha's Vineyard, Massachusetts and Block Island, Rhode Island. Aquatic Invasions (2009) Volume 4, Issue 1: 65-70

Summary: Available from: http://www.aquaticinvasions.net/2009/AI_2009_4_1_Carman_etal.pdf [Accessed May 20 2010]

Castilla, Juan C.; Uribe, Malva; Bahamonde, Nibaldo; Clarke, Marcela; Desqueyroux-Faundez, Ruth; Kong, Ismael; Moyano, Hugo; Rozbaczylo, Nicolas; Santelices, Bernabe; Valdovinos, Claudio; Zavala, Patricio, 2005. Down under the southeastern Pacific: marine non-indigenous species in Chile. Biological Invasions. 7(2). MAR 2005. 213-232.

Cohen, Andrew N. 2005. *Botrylloides violaceus* Oka, 1927. Guide to the Exotic Species of San Francisco Bay. San Francisco Estuary Institute, Oakland, CA, www.exoticsguide.org
Summary: Available from: http://www.exoticsguide.org/species_pages/b_violaceus.html [Accessed 11 September 2010]
Daigle, M. Remi and Christophe M. Herbinger, 2009. Ecological interactions between the vase tunicate (*Ciona intestinalis*) and the farmed blue mussel (*Mytilus edulis*) in Nova Scotia, Canada. Aquatic Invasions (2009) Volume 4, Issue 1: 177-187
Summary: Available from: http://www.aquaticinvasions.ru/2009/AI_2009_4_1_Daigle_Herbinger.pdf [Accessed May 20 2010]
da Rocha, Rosana M.; Bonnet, Nadia Y. K., 2009. Introduced ascidians (Tunicata, Ascidiacea) in the Arquipelago de Alcatrazes, State of Sao Paulo, Brazil. Iheringia Serie Zoologia. 99(1). MAR 2009. 27-35.
Dijkstra, Jennifer; Sherman, Hillary; Harris, Larry G., 2007. The role of colonial ascidians in altering biodiversity in marine fouling communities. Journal of Experimental Marine Biology & Ecology. 342(1, Sp. Iss. SI). MAR 26 2007. 169-171.
Getchis, Tessa S., 2006. What s Putting Some Aquaculturists in a Foul Mood? University of Connecticut Sea Grant
Summary: Available from: http://digitalcommons.uconn.edu/cgi/viewcontent.cgi?article=1017&context=wracklines [Accessed May 20 2010]
Gittenberger, Adriaan, 2007. Recent population expansions of non-native ascidians in The Netherlands. Journal of Experimental Marine Biology and Ecology 342 (2007) 122–126
Gittenberger, Adriaan, 2009. Invasive tunicates on Zeeland and Prince Edward Island mussels, and management practices in The Netherlands. Aquatic Invasions (2009) Volume 4, Issue 1: 279-281
Summary: Available from: http://www.aquaticinvasions.ru/2009/AI_2009_4_1_Gittenberger.pdf [Accessed May 20 2010]
Hayes, WK, Barry, RX, McKenzie, Z and Barry, P. 2004. "Grand Bahama's Brown-headed Nuthatch: A Distinct and Endangered Species", Bahamas Journal of Science, 12:21–28.
Summary: Available from: http://www.ecoinst.org/files/bahama_nuthatch_paper.pdf [Accessed 21 April 2010]
Holland, W.H. Peter, 2002. *Ciona*. Current Biology Volume 12, Issue 18, 17 September 2002, Page R609
Howes, S.; Herbinger, C. M.; Darnell, P.; Vercaemer, B., 2007. Spatial and temporal patterns of recruitment of the tunicate *Ciona intestinalis* on a mussel farm in Nova Scotia, Canada. Journal of Experimental Marine Biology & Ecology. 342(1, Sp. Iss. SI). MAR 26 2007. 85-92.
LeGresley, Murielle M.; Martin, Jennifer L.; McCurdy, Paul; Thorpe, Bruce; Chang, Blythe D., 2008. Non-indigenous tunicate species in the Bay of Fundy, eastern Canada. ICES Journal of Marine Science. 65(5). JUL 2008. 770-774.
Lutz-Collins, Vanessa; Aaron Ramsay; Pedro A. Quij"n and Jeffrey Davidson, 2009. Invasive tunicates fouling mussel lines: evidence of their impact on native tunicates and other epifaunal invertebrates. Aquatic Invasions (2009) Volume 4, Issue 1: 213-220
Summary: Available from: http://www.aquaticinvasions.net/2009/AI_2009_4_1_LutzCollins_etal.pdf [Accessed May 20 2010]
Marins, Flávia de Oliveira; Camila da Silva Oliveira; Nathalia Maria Vieira Maciel and Luís Felipe Skinner, 2009. Reinclusion of *Ciona intestinalis* (Ascidiacea: Cionidae) in Brazil-a methodological view. Marine Biodiversity Records (2009), 2:e112
McDonald, J., 2004. The invasive pest species *Ciona intestinalis* (Linnaeus, 1767) reported in a harbour in southern Western Australia. Marine Pollution Bulletin. 49(9-10). November 2004. 868-870.
Monniot, C. 2010. *Ciona intestinalis* (Linnaeus, 1758). Accessed through: World Register of Marine Species
Summary: Available from: http://www.marinespecies.org/aphia.php?p=taxdetails&id=103732 [Accessed May 20 2010]
Morton, Brian, 1987. Recent Marine Introductions into Hong Kong. Bulletin of Marine Science, Volume 41, Number 2, September 1987 , pp. 503-513(11)
Rajbanshi, Rubi; Pederson, Judith, 2007. Competition among invading ascidians and a native mussel. Journal of Experimental Marine Biology & Ecology. 342(1, Sp. Iss. SI). MAR 26 2007. 163-165.
Ramsay, Aaron; Davidson, Jeff; Landry, Thomas; Arsenault, Garth, 2008. Process of invasiveness among exotic tunicates in Prince Edward Island, Canada. Biological Invasions. 10(8). DEC 2008. 1311-1316.
Ramsay, Aaron; Jeffrey Davidson; Daniel Bourque and Henrik Stryhn, 2009. Recruitment patterns and population development of the invasive ascidian *Ciona intestinalis* in Prince Edward Island, Canada. Aquatic Invasions (2009) Volume 4, Issue 1: 169-176
Summary: Available from: http://www.aquaticinvasions.ru/2009/AI_2009_4_1_Ramsay_etal.pdf [Accessed May 20 2010]
Robinson, T. B. ; Griffiths, C. L.; McQuaid, C. D.; Rius, M., 2005. Marine alien species of South Africa - status and impacts. African Journal of Marine Science. 27(1). JUN 2005. 297-306
Rocha, M. Rosana; Laura P. Kremer; Mariah S. Baptista and Rafael Metri, 2009. Bivalve cultures provide habitat for exotic tunicates in southern Brazil. Aquatic Invasions (2009) Volume 4, Issue 1: 195-205
Summary: Available from: http://content.imamu.edu.sa/Scholars/it/net/ai_2009_4_1_rocha_etal.pdf [Accessed May 20 2010]
Seo, Kyung Suk and Yoon Lee, 2009. Chapter 32 A First Assessment of Invasive Marine Species on Chinese and Korean Coasts IN G. Rilov, J.A. Crooks (eds.) Biological Invasions in Marine Ecosystems
Silva, Nathan; Smith, William C., 2008. Inverse Correlation of Population Similarity and Introduction Date for Invasive Ascidians. PLoS One. 3(6). JUN 25 2008. Article No.: e2552.