A sea squirt (*Ciona intestinalis*)

MarLIN – Marine Life Information Network
Biology and Sensitivity Key Information Review

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A report from:
The Marine Life Information Network, Marine Biological Association of the United Kingdom.

Please note. This MarESA report is a dated version of the online review. Please refer to the website for the most up-to-date version [https://www.marlin.ac.uk/species/detail/1369]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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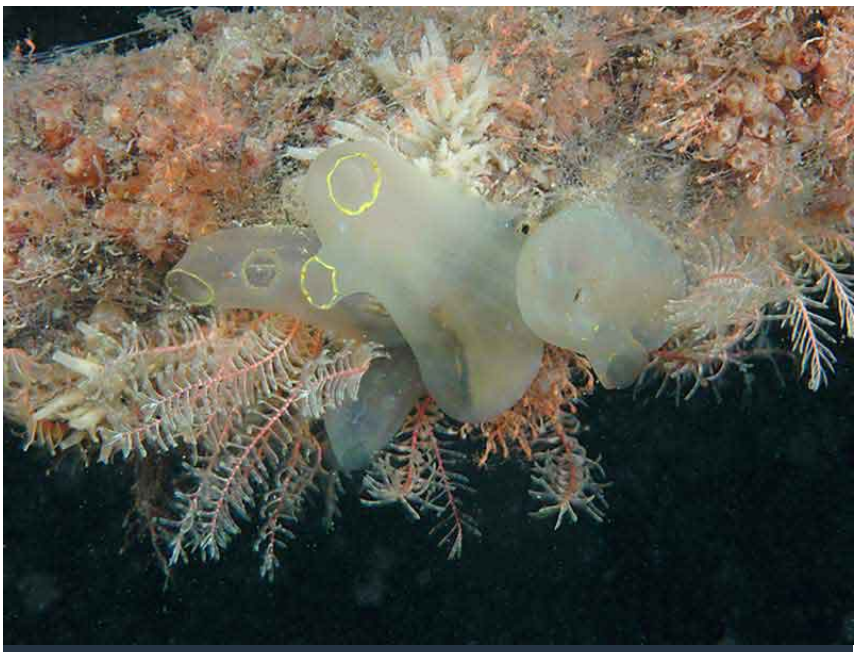

The solitary sea squirt *Ciona intestinalis*.
Photographer: Keith Hiscock
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See online review for distribution map

Distribution data supplied by the Ocean Biogeographic Information System (OBIS). To interrogate UK data visit the NBN Atlas.

Researched by	Angus Jackson	**Refereed by**	Dr John Bishop
Authority	(Linnaeus, 1767)		
Other common names	-	**Synonyms**	-

Summary

Description

Ciona intestinalis is a large solitary sea squirt which grows up to 15 cm in length. The body is soft, retractile and a pale translucent greenish/yellow, through which the internal organs are visible. Sometimes there are orange bars on the body. There are two openings or siphons which may have yellow margins with orange/red pigment spots.

Recorded distribution in Britain and Ireland

Widely distributed round British and Irish coasts.

Global distribution

Widely distributed throughout temperate regions of the world.

Habitat

Found from the lower shore down to at least 500 m. Often common in man-made environments such as harbours and marinas. Grows on bedrock and boulders but also artificial surfaces such as metal and concrete. Other species such as algae are also used as substrata. *Ciona intestinalis* prefers habitats with low wave exposure and some water flow.

Depth range
0-500

Identifying features

- A large solitary ascidian commonly found in dense, unfused aggregations.
- Body is a translucent pale greenish yellow with or without orange bars.
- Oral (inhalant) siphon is terminal and has 8 lobes.
- Atrial (exhalant) siphon is subterminal and has 6 lobes.
- Siphon lobes may have red-orange pigment spots.

Additional information

Also sometimes known as a sea vase.

Listed by

Further information sources

Search on:

G G NBN WoRMS

Biology review

Taxonomy

Phylum	Chordata	Sea squirts, fish, reptiles, birds and mammals
Class	Ascidiacea	Sea squirts
Order	Phlebobranchia	
Family	Cionidae	
Genus	Ciona	
Authority	(Linnaeus, 1767)	
Recent Synonyms	-	

Biology

Typical abundance	Moderate density
Male size range	
Male size at maturity	
Female size range	Medium(11-20 cm)
Female size at maturity	
Growth form	Cylindrical
Growth rate	10-20mm/month
Body flexibility	High (greater than 45 degrees)
Mobility	
Characteristic feeding method	Active suspension feeder, Non-feeding
Diet/food source	
Typically feeds on	Seston
Sociability	
Environmental position	Epifaunal
Dependency	Independent.
Supports	Host Various parasitic or inquilistic copepods, e.g. the family Doropygidae (Millar, 1953).
Is the species harmful?	No

Biology information

Although not strictly gregarious, *Ciona intestinalis* occurs mainly in dense aggregations such that it dominates the substratum. These aggregations are believed to be caused by hydrodynamic conditions rather than some preferential selection mechanism by the larvae (Havenhand & Svane, 1991) but see Adult distribution. In Swedish shallow waters there are two distinct growth phases: in summer/autumn after settling and in spring/early summer before spawning. Growth rates have also been recorded as up to 0.7 percent of body length per day. Growth rate is dependent on temperature and body size. The species is permanently hermaphroditic so the sexes are not separate. Filter feeders including ascidians are known to be able to accumulate trace elements such as heavy metals. A detailed account of the anatomy of *Ciona* sp. is provided by Millar (1953).

Habitat preferences

Physiographic preferences	Open coast, Offshore seabed, Strait / sound, Sea loch / Sea lough, Ria / Voe, Estuary, Enclosed coast / Embayment
Biological zone preferences	Lower circalittoral, Lower infralittoral, Upper circalittoral, Upper infralittoral
Substratum / habitat preferences	Macroalgae, Artificial (man-made), Bedrock, Large to very large boulders, Other species, Small boulders
Tidal strength preferences	Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.), Very Weak (negligible), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Extremely sheltered, Moderately exposed, Sheltered, Ultra sheltered, Very sheltered
Salinity preferences	Full (30-40 psu), Reduced (18-30 psu), Variable (18-40 psu)
Depth range	0-500
Other preferences	No text entered
Migration Pattern	Non-migratory / resident

Habitat Information

Growths of the hydroid *Tubularia larynx* may greatly enhance the settlement and may be a causative factor for ascidian blooms (Schmidt, 1983). *Ciona intestinalis* is believed to have originated as a North Atlantic species but has spread widely through shipping to all temperate regions.

Life history

Adult characteristics

Reproductive type	Permanent (synchronous) hermaphrodite
Reproductive frequency	Annual protracted
Fecundity (number of eggs)	1,000-10,000
Generation time	<1 year
Age at maturity	Insufficient information
Season	January - December
Life span	1-2 years

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Oviparous
Duration of larval stage	2-10 days
Larval dispersal potential	100 -1000 m
Larval settlement period	

Life history information

Reproductive frequency: The Plymouth Marine Fauna (Marine Biological Association, 1957)

recorded *Ciona intestinalis* reproduction throughout the year. In more northerly populations (Sweden), gamete release peaks in May / June. In Sweden, a variety of reproductive frequencies occur. In shallower waters (0-8m) and reduced salinity (20 psu) the species tends to be semelparous whereas in deeper (15-30m), more stable waters with full salinity (30-32 psu) the species reaches larger sizes, lives longer and is more iteroparous. Adults may reach 2-3 years of age although more typically live for just one year.

Spawning: Reproductive capability is size rather than age dependent. In the laboratory, settlement and spawning can be controlled by manipulation of light levels (Whittington, 1967; Woollacott, 74). Light intensity may have some role in the field but spawning and settlement may occur at any time. Whittington (1967) noted that *Ciona intestinalis* spawned within 4min (±2.6) of exposure to light. Therefore, light exposure may synchronize spawning in some instances, and *Ciona intestinalis* has been reported to spawn around dawn (Whittingham, 1967).

The species is not self fertile and fertilization is external. Sperm remain viable for up to 16 hours after release in the absence of egg substances. However, in the presence of egg substances the sperms viability is reduced to 1.5 hours (Bolton & Havenhand, 1996).

After release, the eggs remain viable for fertilisation for up to 30 hours. The eggs are negatively buoyant and sink in still water. They are adhesive and stick to the substratum. The eggs are about 160 microns in diameter, yolky and red or green in colour. Long tapering outer follicle cells radiate from the surface of the eggs. Eggs may be released individually or in mucus strings. The mucus strings tangle with and readily adhere to nearby adults.

Dispersal: The embryonic period of development occurs over around 24 hours but is temperature dependent. The newly hatched 'tadpole' larvae may escape from the mucus strings to disperse in the plankton (40-60% of larvae) or may be retained until settlement. Retention in the mucus string may explain the dense aggregations of adults found. In the laboratory, settlement of the swimming larva may take up to six days but in the field this is usually much less (minutes or hours). Some dispersal is possible at the egg stage but most occurs during the short swimming larval stage and is, therefore, limited.

Sensitivity review

This MarLIN sensitivity assessment has been superseded by the MarESA approach to sensitivity assessment. MarLIN assessments used an approach that has now been modified to reflect the most recent conservation imperatives and terminology and are due to be updated by 2016/17.

Physical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Substratum Loss	High	High	Moderate	High

The species is permanently attached to the substratum so substratum loss will result in loss of the population. The species is widespread. Adults are sessile and so cannot contribute to recovery through active immigration. Rafting by adults attached to floating objects or shipping may form an important mechanism for recolonization. Dispersal through attachment to ships is believed to be the main reason behind the widespread global distribution Otherwise, dispersal is mediated by the larval stage. Larval recruitment from other populations may be restricted by the larvae being retained near the adults in mucus threads. Settling time of the larva is quite short - usually a few hours so dispersal may be limited. No information is available regarding the fecundity of this species. Reproductive frequency and longevity varies from semelparous and annual to iteroparous and living 2-3 years depending on depth and salinity (in Sweden at least). Reproduction (in Plymouth) is recorded as occurring all year round.

Smothering	Intermediate	Very high	Low	Moderate

The species is permanently attached to the substratum and is an active suspension feeder. Because the adults reach up to 15 cm in length and frequently inhabit vertical surfaces, smothering with 5 cm of sediment will probably only affect a proportion of the population. The species frequently occurs in habitats with highly transformed substrata. The species is widespread. Adults are sessile and so cannot contribute to recovery through active immigration. Local recovery may be facilitated by the retention of larvae in mucus string close to the parent adults. Settling time of the larva is quite short - usually a few hours so dispersal may be limited. No information is available regarding the fecundity of this species. Reproductive frequency and longevity varies from semelparous and annual to iteroparous and living 2-3 years depending on depth and salinity (in Sweden at least). Reproduction (in Plymouth) is recorded as occurring all year round.

Increase in suspended sediment	Low	Immediate	Not sensitive	Moderate

The species frequently occurs in habitats with highly transformed substrata and high levels of silting and suspended matter. *Ciona intestinalis* is quite large bodied and the siphons have wide apertures which helps prevent blocking. Increased siltation may potentially have some detrimental effects in clogging up feeding filtration mechanisms, however, there are possible benefits from increased siltation (Naranjo *et al.* 1996). On resumption of normal energy expenditure and feeding, condition should be restored rapidly.

Decrease in suspended sediment

Dessication	Intermediate	Very high	Low	Low

The species only occurs subtidally but is generally quite hardy. Exposure to desiccating influences for one hour will probably kill a proportion of the population. The species is

widespread. Adults are sessile and so cannot contribute to recovery through active immigration. Local recovery may be facilitated by the retention of larvae in mucus string close to the parent adults. Settling time of the larva is quite short - usually a few hours so dispersal may be limited. No information is available regarding the fecundity of this species. Reproductive frequency and longevity varies from semelparous and annual to iteroparous and living 2-3 years depending on depth and salinity (In Sweden at least). Reproduction (in Plymouth) is recorded as occurring all year round.

Increase in emergence regime High High Moderate Low

Ciona intestinalis is a subtidal species. Exposure to an emergence regime is likely to cause the population to die. The species is widespread. Adults are sessile and so cannot contribute to recovery through active immigration. Rafting by adults attached to floating objects or shipping may form an important mechanism for recolonization. Dispersal through attachment to ships is believed to be the main reason behind the widespread global distribution Otherwise, dispersal is mediated by the larval stage. Larval recruitment from other populations may be restricted by the larvae being retained near the adults in mucus threads. Settling time of the larva is quite short - usually a few hours so dispersal may be limited. No information is available regarding the fecundity of this species. Reproductive frequency and longevity varies from semelparous and annual to iteroparous and living 2-3 years depending on depth and salinity (in Sweden at least). Reproduction (in Plymouth) is recorded as occurring all year round.

Decrease in emergence regime

Increase in water flow rate Low Immediate Not sensitive Moderate

As a general rule, ascidians require a reasonable water flow rate in order to ensure sufficient food availability. However, *Ciona intestinalis* is remarkably tolerant of low flow rates. It is frequently found in areas with minimal water exchange and renewal such as harbours, marinas and docks. Feeding may be reduced in comparison with areas with higher flow rates. Extremely high water flow rates may also be detrimental to feeding ability and posture. Changes in hydrodynamics may not have lethal effects. On resumption of normal energy expenditure and feeding, condition should be restored rapidly.

Decrease in water flow rate

Increase in temperature Intermediate Very high Low Moderate

intolerance to changes in temperature varies with geographical distribution. In the Mediterranean, growth is optimal at between 15-20°C and most of the adult population dies below 10 °C. During cold spells the population is maintained through survival of young individuals which are more cold tolerant. More northerly populations in Sweden do not begin to reproduce until temperatures rise above 8 °C. The distribution range of the species extends north and south from the British Isles into water temperatures above and below those experienced locally. Long term chronic changes in temperature can probably be accommodated. Short term acute changes in temperature, particularly decreases may cause some of the population to die. Growth rates are temperature dependent. The species is widespread. Adults are sessile and so cannot contribute to recovery through active immigration. Local recovery may be facilitated by the retention of larvae in mucus string close to the parent adults. Settling time of the larva is quite short - usually a few hours so dispersal may be limited. No information is available regarding the fecundity of this species. Reproductive frequency and longevity varies from semelparous and annual to iteroparous and living 2-3 years depending on depth and salinity (in Sweden at least). Reproduction (in

Plymouth) is recorded as occurring all year round.

Decrease in temperature

Increase in turbidity Tolerant Not relevant Not sensitive Moderate

The species is frequently dominant in areas such as harbours with high levels of suspended matter and low light penetration. *Ciona intestinalis* probably has little or no requirement for light and may be found down to 500 m depth where light available is very limited.

Decrease in turbidity

Increase in wave exposure Intermediate Very high Low Moderate

High energy wave action can be detrimental to ascidian populations. This is mainly through physical damage to the sea squirts and through the abrasive action of suspended sediment. The species is often dominant in highly sheltered areas such as harbours. Decreases in wave exposure are unlikely to have any effect. Increases in wave exposure above moderately exposed are likely to cause a proportion of the population to die. Changes in hydrodynamics do not always have lethal effects. The species is widespread. Adults are sessile and so cannot contribute to recovery through active immigration. Local recovery may be facilitated by the retention of larvae in mucus string close to the parent adults. Settling time of the larva is quite short - usually a few hours so dispersal may be limited. No information is available regarding the fecundity of this species. Reproductive frequency and longevity varies from semelparous and annual to iteroparous and living 2-3 years depending on depth and salinity (in Sweden at least). Reproduction (in Plymouth) is recorded as occurring all year round.

Decrease in wave exposure

Noise Tolerant Not relevant Not sensitive Low

The adult stage of the species probably has very limited facility for noise vibration detection and is unlikely to be sensitive to noise.

Visual Presence Tolerant Not relevant Not sensitive Low

The adult stage of the species probably has very limited facility for visual perception and is unlikely to be sensitive to visual disturbance. Although spawning is exposure to light, periodic shading during daylight hours is unlikely to affect spawning.

Abrasion & physical disturbance High High Moderate High

Emergent epifauna are thought to be particularly vulnerable to damage from passing fishing gear (Jennings & Kaiser, 1998). Damage to emergent epifauna was the first sign of damage from scallop dredging on horse mussel beds (see *Modiolus modiolus*) (Service & Magorrian, 1997; Magorrian & Service, 1998; Service 1998). However, while several species of upright hydroids and bryozoans were adversely affected by bottom fishing, some species increased in abundance after fishing disturbance either due to their ability to rapidly colonize space (e.g. *Nemertesia* sp.) and/or their ability to recover from fragments or budding (e.g. small ascidians, especially *Ascidiella* spp. and *Alcyonium digitatum*) (Bradshaw *et al.*, 2000; 2002). *Ciona intestinalis* is a large ascidian, with a soft, retractile body. Physical disturbance by a passing scallop dredge is likely to cause physical damage and death. Therefore, an intolerance of high has been recorded.

Adults are sessile and so cannot contribute to recovery through active immigration but the species is widespread. Rafting by adults attached to floating objects or shipping may form an important mechanism for recolonization. Dispersal through attachment to ships is believed to

be the main reason behind the widespread global distribution. Otherwise, dispersal is mediated by the larval stage. Larval recruitment from other populations may be restricted by the larvae being retained near the adults in mucus threads. Settling time of the larva is quite short - usually a few hours so dispersal may be limited. Reproductive frequency and longevity varies from semelparous and annual to iteroparous and living 2-3 years depending on depth and salinity (in Sweden at least). Reproduction (in Plymouth) is recorded as occurring all year round. Therefore, recoverability has been recorded as high

Displacement	High	High	Moderate	Moderate

Although the species is permanently attached to the substratum, there is some capability for reattachment. However, only after prolonged contact with the substratum and adults are likely to be lost from vertical substrata, or as a result of water flow. The species is widespread. Adults are sessile and so cannot contribute to recovery through active immigration. Local recovery may be facilitated by the retention of larvae in mucus string close to the parent adults. Settling time of the larva is quite short - usually a few hours so dispersal may be limited. No information is available regarding the fecundity of this species. Reproductive frequency and longevity varies from semelparous and annual to iteroparous and living 2-3 years depending on depth and salinity (In Sweden at least). Reproduction (in Plymouth) is recorded as occurring all year round.

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination				Not relevant

Although there is detailed information available on the intolerance of larvae to TBT, this does not exist for the adult stage.

Heavy metal contamination				Not relevant

Insufficient information. It is well recognised that ascidians are capable of accumulating trace elements such as heavy metals. No information is available regarding the effects of this accumulation.

Hydrocarbon contamination				Not relevant

Insufficient information

Radionuclide contamination				Not relevant

Insufficient information

Changes in nutrient levels	Tolerant*	Not relevant	Not sensitive*	Moderate

There is some suggestion that there are possible benefits to the adults from increased organic content of water (Naranjo *et al.* 1996).

Increase in salinity	Low	Immediate	Not sensitive	Low

The species inhabits a variety of salinities (down as low as 11 psu) but more typically above 20 psu. In the Mediterranean, optimal salinity for adults is 35 psu. In Sweden, reproductive frequency and longevity vary with depth and salinity. Adverse conditions may affect condition, feeding or reproductive capability. Recovery from this should be rapid.

Decrease in salinity

Changes in oxygenation	Low	Immediate	Not sensitive	Low

Cole *et al*. (1999) suggest possible adverse effects on marine species below 4 mg/l and probable adverse effects below 2mg/l. There is no information about *Ciona intestinalis* tolerance to changes in oxygenation. However, the species is frequently found in areas with restricted water renewal where oxygen concentrations may drop. Adverse conditions may affect condition, feeding or reproductive capability. Recovery from this should be rapid.

Biological Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of microbial pathogens/parasites				Not relevant

Insufficient information

Introduction of non-native species	Intermediate	Very high	Low	Very low

Styela clava was first recorded in the UK at Plymouth in 1952 (Eno *et al*., 1997). Where *Styela clava* and *Ciona intestinalis* co-occur they may compete for space and food.

Extraction of this species	Not relevant	Not relevant	Not relevant	Very low

It is extremely unlikely that *Ciona intestinalis* will be subject to extraction.

Extraction of other species	Tolerant	Not relevant	Not sensitive	Very low

Adult *Ciona intestinalis* have no known obligate relationships.

Additional information

Importance review

Policy/legislation

- no data -

Status

National (GB) importance	-	**Global red list (IUCN) category**	-

Non-native

Native	-		
Origin	-	**Date Arrived**	-

Importance information

The high densities at which the species occurs may help to reduce grazing by sea urchins. Stands of *Ciona intestinalis* provide refugia for several organisms, and some species grow on this species, albeit to a limited extent (e.g., *Diplosoma* sp.) (John Bishop pers. comm.). *Ciona intestinalis* is a significant nuisance fouling species in aquaculture, reported in mussel rope culture, oyster farms and suspended pectinid culture from Nova Scotia and North America, the Mediterranean, South Africa, Korea, and Chile (Lesser *et al.*, 1992; Cayer *et al.*, 1999; Uribe & Etchepare, 1999; Kang *et al.*, 1978; Hecht & Heasman, 1999).

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