

*Crepidula fornicata* 正體中文

**System:** Marine

Kingdom	Phylum	Class	Order	Family
Animalia	Mollusca	Gastropoda	Neotaenioglossa	Calyptraeidae

**Common name** Toffelsneg (English, Sweden), Pantoffelsnecke (English, Germany), American limpet (English, Great Britain), common Atlantic slippersnail (English, USA), slipper limpet (English, USA), oyster-pest (English, Great Britain), crépidule (English, France)

**Synonym** *Crepidula nautiloides*, auct. non Lesson  
*Crepidula maculata*, Rigacci  
*Crepidula mexicana*, Rigacci  
*Crepidula violacea*, Rigacci  
*Crepidula densata*, Conrad  
*Crepidula virginica*, Conrad  
*Crepidula roseae*, Petuch  
*Patella fornicata*, Linné  
*Crypta nautarum*, Mörch

**Similar species** *Crepidula convexa*, *Crepidula onyx*, *Crepidula* spp.

**Summary** *Crepidula fornicata* is a protandrous hermaphrodite mollusc, which means that the animals start their lives as males and then subsequently may change sex and develop into females. This species can tolerate a wide range of environmental conditions. Populations are particularly well developed in wave-protected areas such as bays, estuaries or sheltered sides of wave-exposed islands. *C. fornicata* competes with other filter-feeding invertebrates for food and space, and often occur in enormous numbers. Few management options are available to combat this species. Dredging operations to clear slipper limpets from oyster beds have been attempted in some areas, but it was concluded that further spread of the species could not be prevented.



[view this species on IUCN Red List](#)

## Species Description

*Crepidula fornicata*'s shell is oval, up to 5cm in length, with a much reduced spire. The large aperture has a shelf, or septum, extending half its length. The shell is smooth with irregular growth lines and white, cream, yellow or pinkish in colour with streaks or blotches of red or brown. *C. fornicata* are commonly found in curved chains of up to 12 animals. Large shells are found at the bottom of the chain, with the shells becoming progressively smaller towards the top MarLIN (2003).

## Notes

JNCC (2002) states that, "*C. fornicata* were introduced in association with imported American oysters *Crassostrea virginica*. This species may also be transported on ships' hulls, and in ballast water in the pelagic larval phase. Historic populations (now extinct) have also been introduced in association with the American hard-shelled clam *Mercenaria mercenaria*. In France, an order during a council in 1932 encouraged the destruction of *C. fornicata*. In Helford River (Essex), British authorities even set a price on *C. fornicata*, viz 5 shillings per limpet in 1949, but only 1 penny in 1953 due to the increasing proliferation (de Montaudouin *et al.*, 1999).

Other species belonging to the same family are: Europe – Mediterranean sea - *C. unguiformis*, *C. moulinsi*; Atlantic side of the U.S.A. - *C. convexa*, *C. onyx*, *C. plana*, *C. maculosa*, *C. acta*, *C. janacus*; Pacific side of the USA - *C. grandis*, *C. adunata*, *C. nummaria* ; Central America - *C. onyx*, *C. arenata*, *C. excavata*, *C. incurva*, *C. lessoni*, *C. striolata*, *C. uncata* ; Southern America - *C. philippiana*, *C. fecunda*, *C. dilatata*, *C. arenata*, *C. onyx*, *C. protea*; Southern Africa - *C. porcellana*, *C. rugosa*, *C. aculeata*; Asia - *C. onyx*, *C. walshi*, *C. grandis*; New Zealand - *C. costata*, *C. monoxyla*; Australia - *C. immersa*, *C. aculeata*. (Blanchard, M., pers. comm., 2005)

## Lifecycle Stages

*Crepidula fornicata* spats settle in isolation or on top of an established chain. If the individual settles alone, it becomes male briefly, passing rapidly on to a female, especially if another animal settles on it to initiate chain formation. Sex change can only occur to the bottom-most male in a stack and takes approximately 60 days, during which the penis regresses and the pouches and glands of the female duct develop. If a juvenile settles on an established stack it develops and may remain as a male for an extended period (up to 6 years), apparently maintained by pheromones released by females lower in the stack (Fretter & Graham, 1981 in MarLIN, 2003). "*C. fornicata* has an obligate planktonic larval stage (Pechenik *et al.* 2002) that may facilitate natural dispersal. After swimming and feeding in the plankton for at least several weeks (2 to 4), the veliger larvae become competent to metamorphose (Pechenik, 1990, in Pechenik *et al.* 2002); that is, they become capable of metamorphosing in response to specific external cues such as adult pheromone and microbial films (Pechenik, 1980; Pechenik and Heyman, 1987; McGee and Targett, 1989; Pechenik and Gee, 1993, in Pechenik *et al.* 2002). In laboratory experiments the authors concluded that, "\"In the absence of such external cues, the larval form can be maintained for at least an additional 10 days (Pechenik and Lima, 1984; Zimmerman and Pechenik, 1991, in Pechenik *et al.* 2002). Eventually the larvae metamorphose \"spontaneously\" in frequently cleaned glassware, in the apparent absence of external cues (Pechenik, 1984; Pechenik and Lima, 1984; Pechenik *et al.* 1996a, in Pechenik *et al.* 2002). Collin (2001) states that, \"*C. fornicata* can usually be found attached to rocks or oyster shells, which do not facilitate adult dispersal\". However, these species are also known to occur on the carapaces of horseshoe crabs (Botton & Ropes 1988), which could result in occasional long distance dispersal. Dispersal may also be facilitated by human activities such as fouling on the hull of ships, within ballast water (JNCC, 2002) and by accidental transfer linked to aquaculture (Blanchard, 1997).

## Uses

Vallet *et al.* 2001 states that, "In the Bay of Saint-Brieuc, the presence of *C. fornicata* could have a major effect on the suprabenthic community by increasing species number and diversity. This suggests that, for slow swimmers such as decapods, dead and live individual shells of *C. fornicata* provide new habitats where they can hide." Grady *et al.* (2001) believe that, "*C. fornicata* could indicate age of host horseshoe crabs if horseshoe crabs have a terminal molt or do not molt often as adults, if *C. fornicata* remain on the same horseshoe crab, and if *C. fornicata* age can be determined with some degree of accuracy."

## Habitat Description

*Crepidula* are often abundant in habitats such as shallow bays and the intertidal regions, where they may be exposed to rapid fluctuations in temperature and salinity, *C. fornicata* are common in the intertidal and shallow subtidal regions in New England and Canada, while they are exclusively subtidal in Florida (Collin 2001). Populations are particularly well developed in wave protected areas such as bays, estuaries or sheltered sides of wave exposed islands. The species is found on a variety of substrata but is most abundant in muddy or mixed muddy areas. *C. fornicata* may also, exist on sand or gravel bottoms in low energy environments, in which the accumulation of shells may lead to the formation of a biogenic hard substrate (CIESM, 2000). *C. fornicata* are found on a variety of substrata (rocks, gravel, sand, mud...) and also on metal, plastic, shelves...For metamorphosis, the larvae need a hard substrate, so the original substrat is sandy or gravelly. But, when densities rise, the sediment becomes increasingly muddy and anoxic, because of their own bio-deposits and because stacks form traps for suspended matter. This would explain why maximal densities are found in mud (Blanchard, M., pers. comm., 2005). Populations in Europe are mainly found in subtidal regions, between 0 and 20m (Blanchard, 1997, Thielteges)

## Reproduction

*Crepidula fornicata* that is typically found in stacks in which younger males are attached to the shells of larger females, exhibit a peculiar mating system as it is a long - lived protandrous hermaphrodite . This means that the animals start their lives as males and then subsequently may change sex and develop into females. Copulation is internal and larvae are grouped into an egg capsule before their release. Stacks can be viewed as independent mating group with copulation occuring between individuals occupying any position in a chain. Most females spawn twice in a year, apparently after neap tides. The variation of fecondity is very important with concentration between 5000 and 30000 eggs per female depending on the site. Laboratory experiments have revealed that following incubation, approximately 4000 larvae were released per female (MarLIN 2003).

## Nutrition

*Crepidula fornicata* is a suspension-feeder, which is rare for a marine gastropod and is the reason for its spread in eutrophised bays and estuaries (eutrophication may be described as pollution resulting from an excess of nitrates and phosphates discharge that leads to disturbances of the ecosystem such as a shift in the natural species composition or oxygen deficiency near the bottom). We observe that its diet is not only composed mainly of pelagic algae of all size and forms, but also of benthic ones, and detritic and bacterial material. A number of experiments to measure and model trophic fluxes for oyster-farm ponds and shellfish bed management are being conducted in France (Blanchard, M., pers. comm., 2005). MarLIN (2003) states that, \"for optimum growth and reproduction, an individual *C. fornicata* being fed with the alga *Phaeodactylum tricornutum* requires  $5 \times 10^8$  algal cells per gram of flesh wet weight per day.\"

## General Impacts

*C. fornicata* has been reported to alter sediment characteristics (by removing a huge volume of suspended organic material from the water column, and depositing that filtered material on the bottom as pseudofeces). It is also reported to decrease the abundance of certain suprabenthic species (such as mysids) (Vallet *et al.* 2003). Other studies (de Montaudouin *et al.* 1999), show that the presence of *C. fornicata* does not affect the benthic community and spatial competition with other macrozoobenthic species didn't occur, but that the habitat became more heterogeneous.

JNCC (2002) states that, "*C. fornicata* competes with other filter-feeding invertebrates for food and space. It is considered a pest on commercial oyster beds, competing for space and food, while depositing mud on them and the mud rendering the substratum unsuitable for the settlement of spat." Some experimental studies de Montaudouin *et al.* (1999) conclude that the potential competition of *C. fornicata* with oysters (*Ostrea edulis*), populations did not show much overlap, and that *C. fornicata* provided the required niches for further hard-substrata species and that a rich association could be built on the initial basis of *Crepidula* alone that the competition of *C. fornicata* on oyster growth was negligible compared with the effect of competition by oysters themselves (intraspecific competition).

Grall and Hall-Spencer (2003) state that *C. fornicata* is one of many reasons for the decline in local maerl bed habitats in Britain. Live maerl thalli become covered in *Crepidula* and the interstices of the deposit become clogged with silt; this kills the maerl thalli and dramatically alters associated maerl communities.

The other major reason for the decline in local maerl bed habitats in Britain being industrial exploitation, first by sucking and dredging tons of living material and secondly by depositing overboard tons of suspension matter on or near the beds (Blanchard, M., pers. comm., 2005).

Le Pape *et al.* 2004 showed the negative effect of this invasive species on the density of young-of-the-year sole *Solea solea* in coastal nursery areas of the Bay of Biscay (France).

Other impacts include increase in the levels of sediments; and, when limpet densities raise, the volume of shell-attached fauna raises and endogean (domain immediately beneath the ground surface) fauna disappear regularly (Blanchard, M., pers. comm., 2005).

## Management Info

Preventative measures: "Identifying potential marine pests – a deductive approach applied to Australia" (Hayes, K.R., *et al.*, 2002) presents an inductive hazard assessment protocol that is simple, does not require large amounts of data, and is capable of grouping hazardous species in to high, medium and low priority. Hazard priority is determined by the invasion potential and impact potential of the species. Invasion potential is expressed as the weighted sum of all vessel movements between Australia and 'infected' bioregions around the world. Impact potential is expressed in terms of human health, economic and ecological impacts. These were estimated using a web-based questionnaire sent to world-wide experts on each species investigated.

The results of this analysis suggest the following hazard groups for *Crepidula fornicata*:

Relative to human impacts: Low priority – low impact potential and low invasion potential

Relative to ecological and economic impacts: Medium priority – low to medium impact potential and medium invasion potential.

Mechanical: Management experiments have been attempted in response to the invasion of shell fisheries by *C. fornicata*. Dredging operations to clear slipper limpets from oyster beds have been attempted, but it was concluded that further spread of the species could not be prevented. Dredging involves removal of the surface layer of sediment. Studies suggest that this operation may impact maerl habitats more severely than proliferation of the gastropod itself since removal of live maerl cover results in long-term habitat damage (Grall and Hall-Spencer, 2000).

Physical : In France, stocks of *C. fornicata* limpets are huge : 150, 000 metric tons in the Bay of Mount Saint-Michel, 250, 000 metric tons in the Bay of Saint-Brieuc, 50, 000 Metric tons in the Bay of Brest...A five year programme of industrial collection and treatment of *Crepidula* has been set by the fishermen and oyster-farmers of Brittany, in the more colonized areas, where biomasses overset 10kg m<sup>-2</sup>. The survey was conducted by IFREMER (French Research Institute for Exploitation of the Sea). About 30, 000 metric tons were collected in a year, and treated for agricultural use, and for calcareous and organic ground enrichment (Blanchard, M., pers. comm., 2005).

**Principal source:** [MarLIN, 2003., \*Crepidula fornicata\*](#)

de Montaudouin *et al.* 1999., Does the slipper limpet (*Crepidula fornicata*, L.) impair oyster growth and zoobenthos biodiversity? A revisited hypothesis.

Blanchard, 1997., Spread of the slipper limpet *Crepidula fornicata* in Europe. Current state and consequences

Collin, 1995., Sex, size, and position: a test of models predicting size at sex change in the protandrous gastropod *Crepidula fornicata*

Pechenik *et al.* 2002., Relationships between larval nutritional experience, larval growth rates, juvenile growth rates, and juvenile feeding rates in the prosobranch gastropod *Crepidula fornicata*

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

**Review:** Frederique Viard and Lise Dupont \Evolution et Genetique des Populations Marines\ Station Biologique de Roscoff France

Michel Blanchard IFREMER France.

**Publication date:** 2005-06-07

## ALIEN RANGE

[2] ATLANTIC - NORTHEAST

[10] FRANCE

[1] JERSEY

[2] NETHERLANDS

[2] SPAIN

[4] UNITED KINGDOM

[1] WEST MEDITERRANEAN COAST

[2] DENMARK

[2] ITALY

[1] MEDITERRANEAN & BLACK SEA

[1] NORWAY

[1] SWEDEN

[1] UNITED STATES

## BIBLIOGRAPHY

47 references found for *Crepidula fornicata*

### Management 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](http://www.cefas.co.uk/media/118009/fisk_guide_v2.pdf) is available from [http://www.cefas.co.uk/media/118009/fisk\\_guide\\_v2.pdf](http://www.cefas.co.uk/media/118009/fisk_guide_v2.pdf) [Accessed 13 January 2009].

[Conchological Society of Great Britain & Ireland. UNDATED. The current distribution of the slipper limpet, \*Crepidula fornicata\* \(L. 1758\).](#)

[Conchological Society of Great Britain & Ireland: Registered Charity Number 208205.](#)

**Summary:** Information on description, economic importance, distribution, habitat, history, growth, and impacts and management of species.

Available From: <http://www.conchsoc.org/projects/crepidula-forn.php> [Accessed 9 June 2008]

Dyrynda, P. 2003. *Slipper limpet beds*. School of Biological Sciences, University of Wales Swansea server.

**Summary:** Information on description, economic importance, distribution, habitat, history, growth, and impacts and management of species.

[Hayes, K., Sliwa, C., Migus, S., McEnulty, 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]

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**Summary:** Information on description, economic importance, distribution, habitat, history, growth, and impacts and management of species.

Available from: <http://www.ciesm.org/atlas/CrepidulForni.html> [Accessed 29 January 2004]

[JNCC \(Joint Nature Conservation Committee\), 2002. \*Crepidula fornicata\*. Advisors of UK Government.](#)

**Summary:** Information on description, economic importance, distribution, habitat, history, growth, and impacts and management of species.

Available from: <http://www.jncc.gov.uk/default.aspx?page=1711> [Accessed 29 January 2004]

[MarLIN 2003. \*Crepidula fornicata\*. Slipper limpet. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme \[on-line\]. Plymouth: Marine Biological Association of the United Kingdom.](#)

**Summary:** Information on description, economic importance, distribution, habitat, history, growth, and impacts and management of species.

Available from: <http://www.marlin.ac.uk/species/Crepidulafornicata.htm> [Accessed 15 Nov 2004]

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**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

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Blanchard M., Blanchet A., Gaffet J.D. et D. Hamon, 2000. Dynamique de population de la crepidule en baie de Saint-Brieuc (Manche-Ouest). Rapport Ifremer-del 00-08, 50 p.+ annexes

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**Summary:** A research paper that examines the impact species has on oyster growth and biodiversity.

[Diederich, S., Thieltes, D. and Reise, K. 2003. Are invasions predictable? American slipper limpets \(\*Crepidula fornicata\*\) and pacific oysters \(\*Crassostrea gigas\*\) in the Northern Wadden Sea \(North Sea, Europe\). In Abstracts: Third International Conference on Marine Bioinvasions, March 16-19, 2003. Scripps Institution of Oceanography La Jolla, California](#)

**Summary:** Report showing the unpredictability of invasions.

Dupont, L., and F. Viard. 2003. *Isolation and characterization of highly polymorphic microsatellite markers from the marine invasive species Crepidula fornicata (Gastropoda: Calyptraeidae)*. Molecular Ecology Notes 3: 498 -500.

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**Summary:** A paper that provides suggestion on how to possibly age Horseshoe crabs from *C. fornicata* attached to their bodies.

Grall, J., and J.M. Hall-Spencer. 2003. *Problems facing maerl conservation in Brittany*. *Aquatic Conservation: Marine and Freshwater Ecosystems* 13: 55-64.

**Summary:** A paper that discusses the species impact on Britain's marine ecosystems.

Hamon D., Blanchard M., Houlgatte E., Blanchet A., Gaffet J. D., Cugier P., Menesguen A., Cann P., Domalain D. et A.G. Hautbois, 2002. Programme Liteau : La crepidule identifier les mécanismes de sa prolifération et caractériser ses effets sur le milieu pour envisager sa gestion. Chantier : Baie de St Brieuc. Rapport final Liteau 1ere tranche ; Rapport Ifremer/del ec, Plouzané ; 70p.

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[ITIS \(Integrated Taxonomic Information System\), 2004. Online Database \*Crepidula fornicata\*](#)

**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.cbif.gc.ca/pls/itisca/taxastep?king=every&p\\_action=containing&taxa=Crepidula+fornicata&p\\_format=&p\\_ifx=plgt&p\\_lang=\[Accessed December 31 2004\]](http://www.cbif.gc.ca/pls/itisca/taxastep?king=every&p_action=containing&taxa=Crepidula+fornicata&p_format=&p_ifx=plgt&p_lang=[Accessed December 31 2004])

LeBlanc, A. R.; Landry, T.; Miron, G. 2003. Identification of fouling organisms covering mussel lines and impact of a common defouling method on the abundance of foulers in Tracadie Bay, Prince Edward Island. Canadian Technical Report of Fisheries & Aquatic Sciences.(2477). i-vii, 1-18.

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Vallet, C., J.C. Dauvin, D. Hamon, and C. Dupuy. 2001. *Effect of the Introduced Common slipper Shell on the Suprabenthic Biodiversity of the Subtidal Communities in the Bay of Saint-Brieuc*. *Conservation Biology* 15(6): 1686-1690.

**Summary:** A research paper that examines the impact species has on oyster growth and biodiversity.

[Viard, F., Dupont, L., Martel, C., McGlashan, D., Simon-Bouhet, B. and Garcia-Meunier, P. 2003. A comparative analysis, based on molecular ecology and population genetics, of the invasion by three gastropods in areas of oysters cultivation. In Abstracts: Third International Conference on Marine Bioinvasions, March 16-19, 2003. Scripps Institution of Oceanography La Jolla, California.](#)

**Summary:** Using genetics to investigate the origins of the invasion.

Wallentinus and Jansson, Kristina, 1999. Introduced organisms in sea areas around Sweden. *Fauna Och Flora (Stockholm)*. 94(2). July. 85-95. [Western Atlantic Gastropod Database. 2001. \*Crepidula fornicata\* \(Linné, 1758\). The Academy of Natural Sciences of Philadelphia: 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103. \[Online Database\]](#)

**Summary:** Information on taxonomy and synonyms.

Available from: <http://erato.acnatsci.org/wasp/search.php/2832> [Accessed 22 June 2004]