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 Britian), 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. aduncta*, *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 gravely. 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 x 108 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).\r\n
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 volumn 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-2. The survey was conducted by IFREMER (French Research Institute\r\nfor 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.

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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

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Managment information
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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).
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