

American (*Urosalpinx cinerea*) and Japanese oyster drill (*Ocenebrellus inornatus*) (Gastropoda: Muricidae) flourish near shellfish culture plots in The Netherlands

Marco Faasse^{1*} and Marianne Ligthart²

¹National Museum of Natural History Naturalis, P.O. Box 9517, 2300 RA Leiden, The Netherlands

E-mail: mafaasse@hetnet.nl

²Stichting Anemoon, P.O. Box 29, 2120 AA Bennebroek, The Netherlands

E-mail: ahmligthart@hetnet.nl

*Corresponding author

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Abstract

Two non-native muricid gastropods are known from The Netherlands since 2007, i.e. the American oyster drill *Urosalpinx cinerea* and the Japanese oyster drill *Ocenebrellus inornatus*. Both species reproduce and slowly increase their area of distribution. Eight vacant shells of another non-native muricid, *Hexaplex trunculus*, have been collected in 2007, 2008 and March 2009. The latter species from southern Europe has recently been observed along the western coast of Europe in areas of shellfish culture. Vacant shells of *Haustellum brandaris* and *Ocenebra erinacea*, two more non-native muricids, have been collected as well.

Key words: *Ocenebrellus inornatus*, oyster drills, shellfish imports, *Urosalpinx cinerea*, *Hexaplex trunculus*

Introduction

The family Muricidae is a group of marine snails noted for their predation on bivalves, especially cultured oysters. Hence the name 'oyster drill' assigned to several related species with this behaviour. The species referred to in Faasse and Ligthart (2007) as the European oyster drill, *Ocenebra erinacea* (Linnaeus, 1758), was subsequently identified as the Japanese oyster drill, *Ocenebrellus inornatus* (Récluz, 1851). *O. inornatus* was introduced to the Pacific coast of North America in 1924 and in 1995 it was detected in the Baie de Marennes-Oléron on the Atlantic coast of France (Pigeot et al. 2000). It later extended its range in France northward to the Golfe de Morbihan, south Brittany (Gouilletquer et al. 2002). Therefore, since the discovery of the non-native American oyster drill

Urosalpinx cinerea (Say, 1822) in The Netherlands (Faasse and Ligthart 2007), selected localities have been surveyed repeatedly for the presence of non-native muricids and their egg cases. Our aim was to investigate whether these species reproduce, expand and establish themselves. *Urosalpinx cinerea* was introduced to the United Kingdom in or prior to 1920 and established itself there (Cole 1942). Although *U. cinerea* was found in south-west France (Bassin d'Arcachon) in the 1960s it did not establish itself in France (Gouilletquer et al. 2002). Surveys in The Netherlands revealed the dispersal and reproduction of both *U. cinerea* and *O. inornatus*. Developments in population numbers and prospects of the respective species in coastal waters of The Netherlands are described. The most likely introduction vector for both is import of shellfish.

Material and Methods

Five locations were surveyed in 2008 and 2009: Yerseke, Stavenisse, Gorishoek, Tuttelhoek and Bergse Diep (Figure 1). Yerseke is the centre of shellfish trade in The Netherlands. Gorishoek is the location where *Urosalpinx cinerea* was found in 2007. The other three locations are close to mussel culture plots and to Gorishoek. Stavenisse is 9 km to the west of Gorishoek, Tuttelhoek 1 km to the east of Gorishoek, Bergse Diep 7 km to the east of Gorishoek.

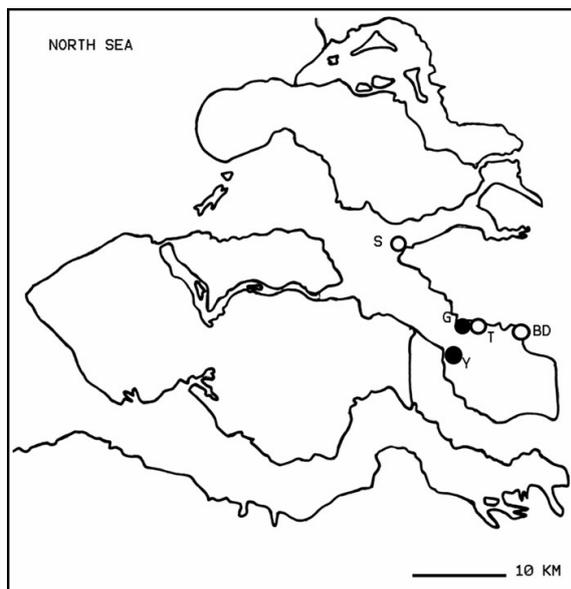


Figure 1. South-west Netherlands with locations surveyed for muricids in 2007, 2008 and March 2009. S = Stavenisse, G = Gorishoek, T = Tuttelhoek, BD = Bergse Diep, Y = Yerseke. Closed dots = *Ocinebrellus inornatus* found. Open circles = no alien muricids found

Localities less than 1 km away from these have been mentioned as Gorishoek east, Tuttelhoek east, etc. For dates of the surveys at the respective sites refer to the Annex section at the end of this paper. During low tide, the undersides and lateral sides of boulders and oyster clumps were inspected for gastropod molluscs and egg cases. On each survey date at least two hours were spent searching for gastropods.

Results

Urosalpinx cinerea has become more numerous near Gorishoek. Up to 61 specimens were counted during a two hour-survey in 2008

(Annex 1) at this location, whereas a maximum of nine were found in 2007. Egg cases were abundant in summer 2008 (Figure 2). On 12.05.2008 three clusters of egg cases were found. From 29.07.2008 onwards clusters of egg cases were not counted any more; on that date numbers of clusters were higher than numbers of oyster drills seen. Dispersal of *U. cinerea* from previous areas of occurrence is less than 200m.



Figure 2. *Urosalpinx cinerea*, egg cases with juvenile snails, Gorishoek, 29.07.2008. Photo by A.H.M. Ligthart



Figure 3. *Hexaplex trunculus*, vacant shell, Gorishoek, 04.12.2007. Shell height 53 mm. Photo by A.H.M. Ligthart

Numbers of *O. inornatus* near Yerseke have increased since 2007 from a maximum of four live individuals per two hour-survey in 2007 to twenty-one individuals in September 2008 and to thirty individuals in March 2009. Several clusters of egg cases were found, but not counted. Gorishoek is a new location for *O. inornatus* and two individuals were found

here for the first time on 12 May 2008. This species was not observed at Stavenisse, Tuttelhoek and Bergse Diep.

A vacant shell of *Hexaplex trunculus* (Linnaeus, 1758) with a shell height of 53 mm was collected near Gorishoek on 04.12.2007 (Figure 3) and another on 21.03.2009. Two other vacant shells of this species were collected at the same location by Mr R. Rijken in October 2008 (Faasse et al. 2009) and four vacant shells on 17.03.2009 (Rijken, pers. comm. and photo).

The native muricid *Nucella lapillus* (Linnaeus, 1758) was observed in 2008 and in March 2009 near Gorishoek and Yerseke. It was particularly abundant in 2008 at Tuttelhoek-east, where several hundreds were found during a two hour-survey.

For details of survey results see the Annex section at the end of this paper.

Discussion

Living muricid snails

In our earlier paper on muricids in The Netherlands (Faasse and Ligthart 2007) we considered a muricid species new to The Netherlands (Figure 4) as a northern form of the European oyster drill, *Ocenebra erinacea*, as depicted by Berrou et al. (2004) from Ireland. Goud et al. (2008) subsequently demonstrated that the species concerned was the Japanese oyster drill *Ocenebrellus inornatus*. They cite part of the description by Amano and Vermeij (1998) and the latter author identified their specimens. Apparently we relied too heavily on Pigeot et al. (2000) for identification. According to Pigeot et al. (2000) the shell of *O. inornatus* has only three or four varices or axial ribs on the otherwise smooth aperture whorl, whereas Amano and Vermeij (1998) mention 4-12 axial ribs. Pigeot et al. (2000) state that the shoulders of the varices are more prominent in *O. inornatus*; however in some specimens there is almost no shoulder (Goud et al. 2008, figure 7). Pigeot et al. (2000) clearly underappreciated this phenotypic variation in *O. inornatus*. Amano and Vermeij (1998) state: "Phenotypic variation is so great that the genus- and species-level taxonomy of *Ocenebrellus* has remained confused".

Numbers of *O. inornatus* per two hour-search in 2008 (maximum 21) and in March 2009 (30) were higher than in 2007 (maximum 4). During January and February 2009 there was a cold spell



Figure 4. *Ocenebrellus inornatus*, Yerseke, 27.10.2007. Photo by A.H.M. Ligthart

with inshore water temperatures of 0-1°C. Apparently *O. inornatus* is able to survive cold winters in The Netherlands. Furthermore, *O. inornatus* has now been found at a second location. A few live specimens of this species were found near Gorishoek. Goud et al. (2008) mention more than 50 live specimens from Yerseke and Gorishoek combined. In contrast to Pigeot et al. (2000), who found egg-laying individuals of *O. inornatus* at the end of autumn and in winter, we found egg-laying to occur during spring and summer.

Numbers of the American oyster drill, *Urosalpinx cinerea*, have increased despite of repeated collecting by us and others. Probably several shell collectors have been active, as *U. cinerea* abruptly has become easily available at Gorishoek to shell collectors in The Netherlands. Gras (2008) have collected at least 18 specimens. Egg cases have not been counted from 29.07.2008 onwards; on that date more clusters of egg cases than oyster drills were seen. Cold winters will pose no problem for *U. cinerea* (see Faasse and Ligthart 2007). After the cold spell in January and February 2009 with inshore water temperatures of 0-1°C we counted 8 specimens in two hours on 21.03.2009. It is likely that *U. cinerea* is now established in The Netherlands. Although the area colonized has slightly increased, no evidence could be found of dispersion to other localities more than a few hundred meters away.

As the population of the native muricid *Nucella lapillus* is just recovering (Faasse and Ligthart 2007) it is as yet impossible to measure the effect of competition, if there is any. It coexists with introduced oyster drills at

Gorishoek and Yerseke, where it was absent during the last decade (Gmelig Meyling et al. 2007).

Vacant shells of muricid snails

Since the first find of a vacant shell of *Hexaplex trunculus* in The Netherlands on 4 December 2007 special attention has been given to this species during our surveys. However, no live snails were found by us. The juvenile specimen of *H. trunculus* mentioned by Gras (2008) is referred to *O. inornatus* by Goud et al (2008). *H. trunculus* has a natural range that includes the Mediterranean, southern Portugal and Spain and Macaronesian islands (González-Tizón et al. 2008). It was found in the Bassin d'Arcachon (south-west France) in 1996 or 1997 by Merle and Filipozzi (2007, as *Trunculariopsis trunculus*) and first recorded from Galicia, north-west Spain, between May 1998 and March 1999 (Quintas et al. 2005). The Bassin d'Arcachon is well-known for its molluscan culture. The ability of *H. trunculus* to disperse is very low (González-Tizón et al. 2008); its northward expansion is due to imports of molluscan consignments. While this species has a southern European origin, its ability to survive the low winter temperatures in north-west Europe cannot be ruled out. *Hexaplex trunculus* occurs in the Lagoon of Venice (Pellizzato et al. 2004), where winter temperatures may be as low as 2-3°C (Occhipinti Ambrogi 2000). In coastal waters of The Netherlands minimum winter temperature was about 2°C during the years 1998-2008 (Anonymous 2007) and in the Southern Bight of the North Sea winter temperatures are even higher. Vacant shells of two more muricid species, the European oyster drill *Ocenebra erinacea* and the purple dye murex *Haustellum brandaris* (Linnaeus, 1758), were also found (Faasse et al. 2009). These species are not expected to become established on account of being unable to withstand low temperatures in The Netherlands (Orton and Lewis 1931, for *O. erinacea*).

Introduction to The Netherlands and establishment of two species of oyster drills are recorded here together with vacant shells of other muricids unlikely to survive in coastal waters of the Netherlands. We contend that their arrival is with imports of consignments of mussels or oysters. Juvenile mussels have been imported from the United Kingdom from the region where *U. cinerea* occurs (Kent, Essex) and relaid on

culture plots in The Netherlands (Faasse and Ligthart 2007). Mussels have been imported from France from the region where *O. inornatus* occurs (Golfe de Morbihan, Ile d'Oléron region) (Wijsman and Smaal 2006, fig. 2). All shellfish imports arrive at Yerseke, the centre of shellfish trade, where they are processed or transferred to ships to be relaid. *U. cinerea* and *O. inornatus* already have a history of introduction with imported shellfish (Faasse and Ligthart 2007; Martel et al. 2004, respectively). Factors contributing to the success of these alien molluscs likely are the population development of the Pacific oyster *Crassostrea gigas* (Thunberg, 1793) and the ban on the anti-fouling agent TBT (Faasse and Ligthart 2007).

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Annex 1

Numbers of living oyster drills observed during our surveys. Possibly significant observations of vacant shells have been taken into account as well. * = specimens collected by Gras et al. (2008). ** = specimens collected by R. Rijken (Faasse et al. (2009) and pers. comm), precise date of ?? .10.2008 unknown. *** = specimen identified from photo by K. van der Wende

Location	Geographic coordinates		Survey date	<i>Ocenebrellus inornatus</i>	<i>Urosalpinx cinerea</i>	<i>Hexaplex trunculus</i>
	Latitude, N	Longitude, E				
Yerseke	51°29'36"	04°03'17"	02.06.2007	1	-	-
Yerseke	51°29'36"	04°03'17"	18.06.2007	1	-	-
Yerseke	51°29'36"	04°03'17"	17.07.2007	4	-	-
Yerseke	51°29'36"	04°03'17"	27.10.2007	3	-	-
Yerseke	51°29'36"	04°03'17"	10.04.2008	10	-	-
Yerseke	51°29'36"	04°03'17"	26.08.2008	5	-	-
Yerseke	51°29'36"	04°03'17"	30.08.2008	11	-	-
Yerseke	51°29'36"	04°03'17"	19.09.2008	21	-	-
Yerseke	51°29'36"	04°03'17"	14.03.2009	30	-	-
Gorishoek	51°31'27"	04°04'35"	16.10.2007	-	5	-
Gorishoek	51°31'27"	04°04'35"	20.10.2007	-	6	-
Gorishoek	51°31'27"	04°04'35"	03.11.2007	-	9	-
Gorishoek	51°31'27"	04°04'35"	04.12.2007	-	-	1 vacant
Gorishoek	51°31'27"	04°04'35"	07.02.2008	-	1	-
Gorishoek	51°31'27"	04°04'35"	08.03.2008	-	1	-
Gorishoek	51°31'27"	04°04'35"	11.05.2008	1*	18*	-
Gorishoek	51°31'27"	04°04'35"	12.05.2008	2	11	-
Gorishoek	51°31'27"	04°04'35"	24.05.2008	1	5	-
Gorishoek	51°31'27"	04°04'35"	29.07.2008	1	25	-
Gorishoek	51°31'27"	04°04'35"	06.09.2008	-	61	-
Gorishoek	51°31'27"	04°04'35"	?? .10.2008	-	-	2 vacant**
Gorishoek	51°31'27"	04°04'35"	20.12.2008	-	1***	-
Gorishoek	51°31'27"	04°04'35"	27.12.2008	-	1	-
Gorishoek	51°31'27"	04°04'35"	17.03.2009	-	-	4 vacant**
Gorishoek	51°31'27"	04°04'35"	21.03.2009	-	8	1 vacant
Gorishoek east	51°31'33"	04°04'49"	03.11.2007	-	3	-
Gorishoek west	51°31'32"	04°04'35"	06.09.2008	-	-	-
Stavenisse	51°35'54"	04°00'54"	22.12.2007	-	-	-
Stavenisse	51°35'54"	04°00'54"	18.10.2008	-	-	-
Stavenisse south	51°35'41"	03°59'56"	27.12.2007	-	-	-
Tuttelhoek	51°31'30"	04°05'37"	16.08.2008	-	-	-
Tuttelhoek oost	51°33'32"	04°06'04"	04.10.2008	-	-	-
Bergse Diep	51°31'00"	04°10'21"	14.06.2008	-	-	-
Bergse Diep	51°31'00"	04°10'21"	25.10.2008	-	-	-