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Rapana venosa (Gastropoda: Muricidae): a new invasive species in the North Sea

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In July 2005 a living veined whelk *Rapana venosa* was caught by a fishing vessel off Scheveningen, The Netherlands. This record is the first for the North Sea and The Netherlands. In September, a second veined whelk ended up in the nets of an Eurokotter in the central southern North Sea (the wider Thames estuary) and in November a third one was caught off Scheveningen again. These records - together with reports of more specimens occasionally being fished - indicate that this ferocious invasive East Asian gastropod has established a (small) population in the North Sea. This paper describes the three records, discusses the ways *Rapana* may have reached the North Sea and the possible impact on the marine ecosystem and local aquacultures of bivalve shells.

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INTRODUCTION

In the early morning of 23 July 2005 Klaas Post was aboard the fishing vessel OD-9 in the harbour of Stellendam, Zuid-Holland, The Netherlands. On deck he found a shell he was unfamiliar with. The gastropod-shell, with the size of a men's fist, smelled badly and the mollusc inside was barely alive. As an experienced fisherman, Klaas Post judged that it must have been trawled two or three days earlier. He collected the specimen and donated it to the Natuurhistorisch Museum Rotterdam (NMR).

Identification as veined whelk *Rapana venosa* (VALENCIENNES, 1846) was straightforward. The specimen was given catalogue number NMR 9930-0020210, with the shell kept dry, and the partly decomposed mollusc preserved in 70% alcohol. Soon after, we were informed that the OD-9 had been fishing on flatfish in the Dutch part of the North Sea in an area off Scheveningen, northeast of the Eurogeul, the 'channel' leading to the harbour of Rotterdam (Fig. 1). This makes this find the first for The Netherlands and the North Sea. According to the crew members of the OD-9, more Rapana specimens were fished, but they all ended up on the fish market together with native whelks *Buccinum undatum*. Apparently, the *Rapana* mr Post collected was overlooked by the crew and remained on deck.

After the first report on this *Rapana* (Vink & Post 2005), the Dutch media reported widely about this 'ferocious invader' (e.g. Anonymus 2005a, b), and a request to report other finds to the Natural History Museum Rotterdam was posted on the web (http://www.nmr.nl/actueeR5.html). This alerted the Dutch fishery community and till now two more finds of *Rapana* in the North Sea became known to us. Vink & Post (2005) reported on the first find, and Vink *et al.* (2005) and Kerckhof *et al.* (in press) published the first and second

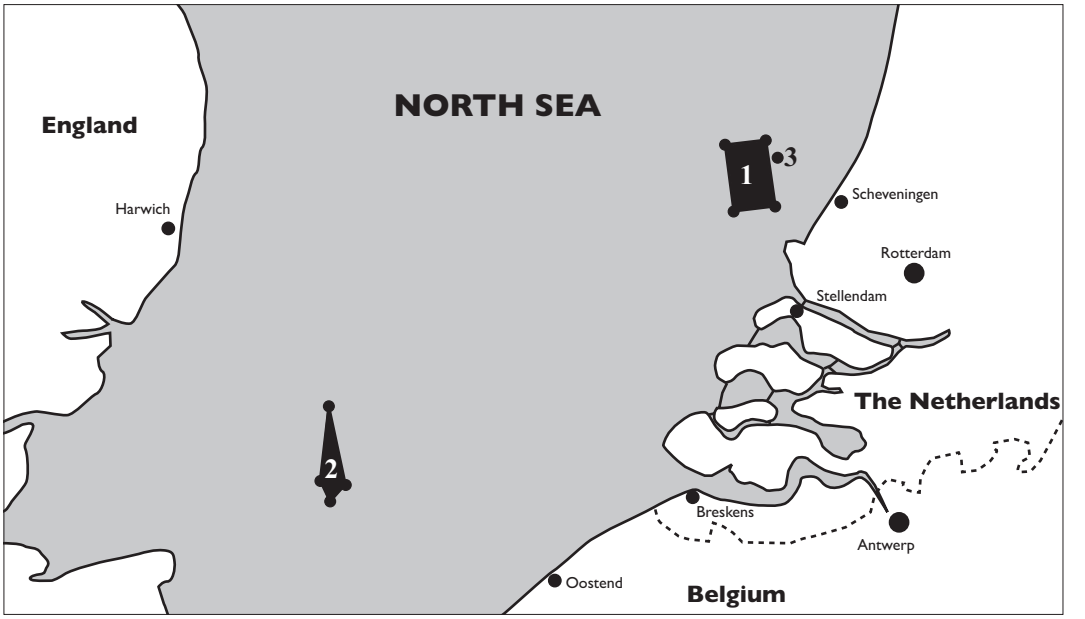

Figure 1 Map of the North Sea, showing the locations where *Rapana venosa* has been found. **1** the first specimen (NMR 9930-0020210); **2** the second specimen (Visserijmuseum Breskens); **3** the third specimen (NMR 9930-0020215). Locations where specimen 1 and 2 were fished are not exact, but bordered by the black dots; for coordinates see text. [mapgraphics: Jaap van Leeuwen]

find. In this paper we present a third find and summarise all known cases up till the end of November 2005.

MATERIAL

The first specimen

Rapana venosa - collection Natuurhistorisch Museum Rotterdam, The Netherlands, cat. nr. NMR 9930-0020210 (Fig. 2 A-C). Shell fully grown, complete (operculum missing), kept dry, mollusc preserved in 70% alcohol. Caught alive c. 20 July 2005 by the Dutch Eurokotter OD-9, North Sea, off Scheveningen, province of Zuid-Holland, The Netherlands, between 52˚ 05' - 52˚ 15' N and 03˚ 50' - 04˚ E. (Fig. 1). Depth not exactly known, but most likely not deeper that 35 m. Donated by Klaas Post, 23 August 2005. Measurements: length (A) 123 mm, width (B) 88 mm, height (C) 87 mm, width of aperture (D) 42 mm (see Figure 3 how measurements were taken).

The second specimen

Rapana venosa - collection Visserijmuseum Breskens, the Netherlands, no cat. number (Fig. 2 D-F). Shell immature. Caught alive, first week of September 2005 by the Dutch Eurokotter BR-43 in the central southern North Sea (the wider Thames estuary). The area (51˚ 43' N, 02˚ 08' E - 51˚ 31' N, 02˚ 10' E - 51˚ 29' N, 02˚ 06' E - 51˚ 32' N, 02˚ 04' E; see Figure 1) is located in British waters and known to the Dutch fishermen as 'Rug van Michiel' (Michael's ridge). Depth unknown. The live *Rapana* was transported to the harbour of Breskens, province of Zeeland, The Netherlands, and was donated by navigator mr P. de Nooijer to the local Fishery Museum (Visserijmuseum) where it is kept alive and on display in an aquarium (Fig. 4). On 1 December 2005 it was still alive. Measurements: length (A) 70 mm, width (B) 72 mm, height (C) 57 mm, width of aperture (D) 35 mm (see Figure 3).

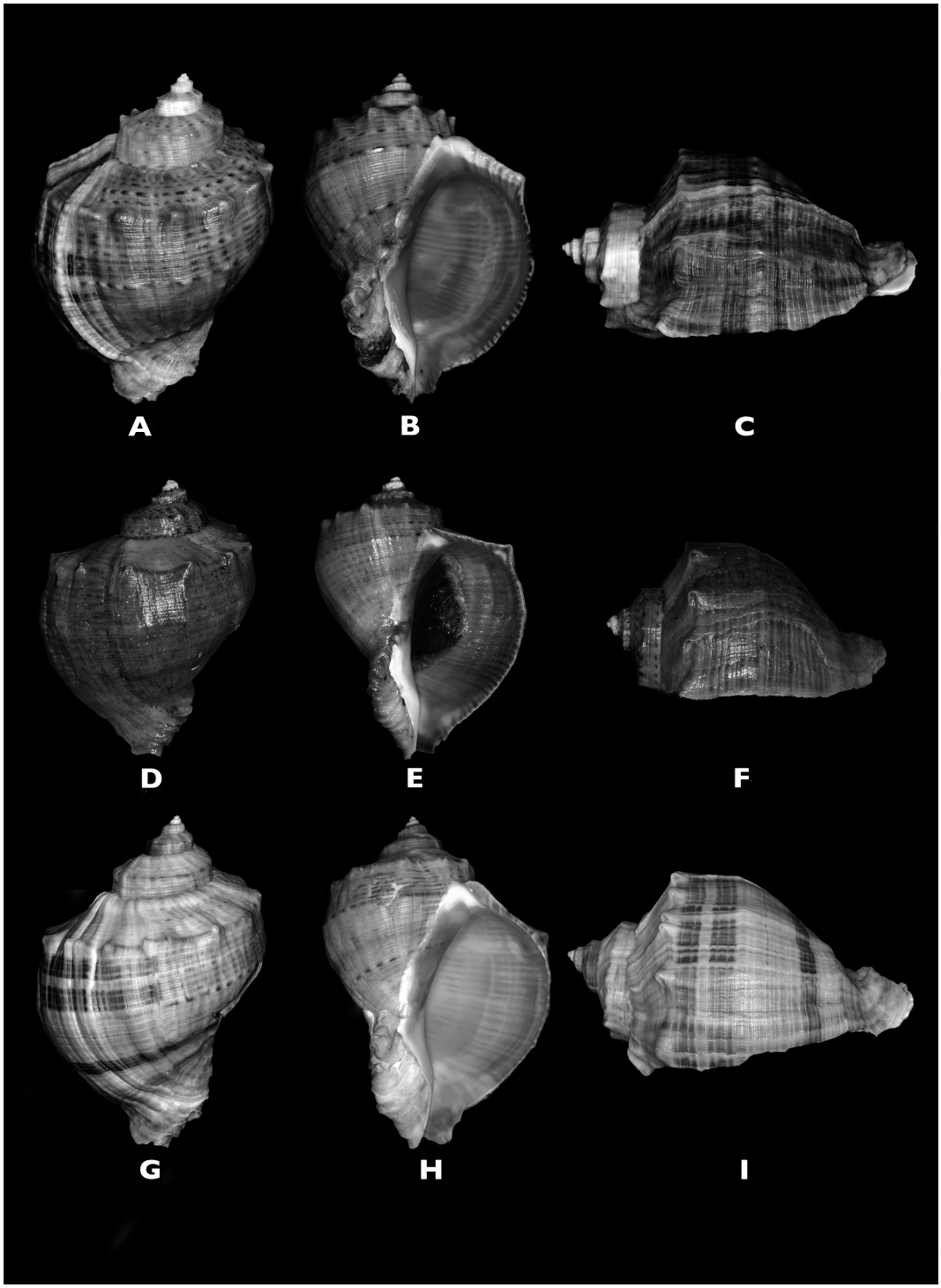

Figure 2 *Rapana venosa* from the North sea, in dorsal, ventral and lateral views. **A B C** the first specimen (NMR 9930-00202l0); **D E F** the second specimen (Visserijmuseum Breskens); **G H I** the third specimen (NMR 9930-0020215). [photo's: R.J. Vink]

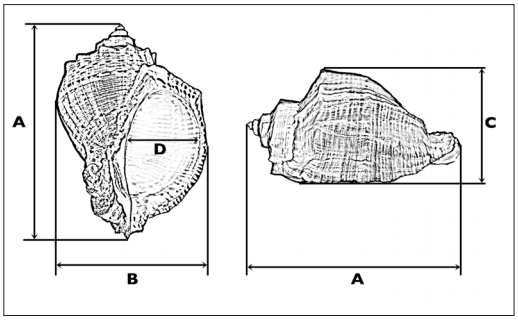

Figure 3 Measurements taken on shells of *Rapana venosa*: **A** length, **B** width, **C** height, **D** width of aperture. [illustration: R.J. Vink]

The third specimen

Rapana venosa - collection Natuurhistorisch Museum Rotterdam, The Netherlands, cat. nr. NMR 9930-0020215 (Fig. 2 G-I). Shell fully grown, partly damaged and operculum missing; kept dry, mollusc preserved in 70% alcohol. Fished alive, 23 November 2005 by the Dutch Eurokotter GO-1, North Sea, off Scheveningen, province of Zuid-Holland, The Netherlands, just West of the REM island, a (former) offshore broadcast rig, at 52˚ 12' N - 04˚ 01' E (Fig. 1). Depth 18 m. The captain of the GO-1 stated that at this location "large *Rapana*'s are occasionally fished, while they do not appear in the nets elsewhere in the North Sea". Donated by Klaas Post, 31 November 2005. Measurements: length (A) 124 mm, width (B) 80 mm, height (C) 90 mm, width of aperture (D) 53.5 mm (see Figure 3).

DISCUSSION

The veined whelk *Rapana venosa* belongs to the Muricidae, a family of predatory marine snails. The species is native to the following East Asian waters: Sea of Japan, Yellow Sea, Bohai Sea and the East China Sea (Abbot & Dance 1986; Okutani 2000; ICES 2004), and it has a history of accidentally being introduced into other regions. In the 1950s, it was discovered in the Black Sea (Drapkin 1963) and later it spread to the Aegean and Adriatic seas (Ghisotti 1974; Koutsoubas & Voultsiadou-Koukoura 1990). Nowadays, populations are also present in Chesapeake Bay on the east coast of the USA (Mann & Harding 2000) and along the northern Uruguayan coast of the estuary of the Rio de la Plata (Pastorino *et al.* 2000; ICES 2004). In Western Europe, several specimens haven been discovered by the end of the 1990s in the Bay of Quiberon, Brittany, France (Camus 2001). This population appears to be small but stable (P. Goulletquer, pers. comm. September 2005). Elsewhere in Northwest Europe, *Rapana venosa* has not yet been recorded. The report in the Times (London) of 26 August 1992 of a *Rapana* found south of the Doggersbank in the North Sea is unreliable (ICES 2004) and could not be confirmed.

With the discovery of three living specimens in the North Sea in 2005 and reliable reports of more specimens occasionally being fished, we can conclude that *Rapana venosa* has expanded its European range northwards and established a population in the (southern) North Sea. Although the North Sea specimens have been found in the vicinity of areas with heavy shipping, we do not regard accidental or intentional discharge of live specimens from a passing ship a likely mode of introduction. The eggs hatch into pelagic larvae that have a planktonic phase which may last to a maximum of 80 days (ICES 2004). This allows accidental transfer throughout the oceans in ships' ballast water, but accidental introductions of egg cases in hull fouling or with aquaculture products is also a possible vector. Natural dispersion from the nearest population in France (Quiberon Bay, Brittany) is another possibility. Currently, the Virginia Institute of

Figure 4 The second specimen of *Rapana venosa*, alive in the aquarium of the Visserijmuseum Breskens. [photo: R.J. Vink, 22 October 2005)

Marine Science (USA) - in cooperation with the Natural History Museum Rotterdam and Ifremer (France) - is analysing *Rapana*-DNA from the Quiberon Bay population and from the North Sea finds to retrieve origin and possible affiliation of the North Sea *Rapana*'s (E. Chandler, pers. comm. November 2005).

The species has all characteristics of a successful invader. It is a fast growing snail with a high fertility that demonstrates large annual temperature tolerances (4 - 27˚C in Korea, see Chung *et al.* 1993) and a high tolerance to lower salinities, water pollution and oxygen deficiency. *Rapana* favours sandy bottoms where the snails can burrow. Thus, the seafloor of the southern North Sea is a very suitable habitat. The snails prey upon a variety of molluscs, mostly bivalves such as oysters, clams and mussels. They are very voracious predators and *Rapana* is blamed for an ecological disaster in the Black Sea by nearly wiping out the native, edible, bivalve fauna.

Due to its predatory impact *R. venosa* is considered as one of the most unwelcome invaders worldwide (ICES 2004). Hence, the discovery of this predatory gastropod in the North Sea is of great concern. The invasion history of this species elsewhere shows that it can disturb a complete ecosystem. The possible effects of *Rapana* in the North Sea remain uncertain, but if well established, *Rapana* could become a severe competitor for the native whelk *Buccinum undatum*. The industry on edible bivalves such as mussels *Mytilus edulis*, Pacific oysters *Crassostrea gigas* and cockles *Cerastoderma edule* in the region may also be at risk. But, on the other hand, *Rapana venosa* may find a copious meal in the dense population of the earlier introduced invader, the American jack knife clam *Ensis directus*.

ACKNOWLEDGEMENTS

We are greatly indebted to Klaas Post who collected the first Dutch *Rapana venosa* and donated it to the museum. The crew of the OD-9 kindly provided detailed data from their ship's log and information on other *Rapana*'s they caught. Navigator mr P. de Nooijer of the BR-43 took care of the second North Sea *Rapana* by putting it in a bucket, supplying oxygen to it and by donating it alive to the Visserijmuseum Breskens. He also reported the find and supplied us with detailed information on the area where it was caught. Francis Kerckhof (Management Unit of the North Sea Mathematical Models, Oostende, Belgium) found out that this *Rapana* was caught in British waters and pointed towards *Ensis directus* as a possible prey-species of North Sea *Rapana*'s. Willy Faas and other staff members of the Visserijmuseum Breskens kindly allowed us to study the *Rapana* in their aquarium. The third specimen reached us through Klaas Post (his connection with the Dutch fishery community proved to be of great value) and the crew of the GO-1 supplied first hand and detailed information on the occurrence of *Rapana* off Scheveningen. Dr P. Goulletquer and dr J.P. Joly (Ifremer, France) informed us about the status of the Quiberon Bay population, and dr Juliana Harding (Virginia Institute of Marine Science) supplied useful literature. We also thank dr Emily Chandler (Virginia Institute of Marine Science) for her willingness to sequence *Rapana*-DNA for further study. Jaap van Leeuwen (NMR) produced the map and Cornelis W. Moeliker (NMR) compiled the final version of this article.

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