TWO INVASIVE BRACKISH WATER MUSSEL SPECIES IN SWEDEN: *RANGIA CUNEATA* (G. B. SOWERBY I) AND *MYTILOPSIS LEUCOPHAEATA* (CONRAD)

The North American Mactrid clam *Rangia cuneata* (G. B. Sowerby I, 1832), 'The Atlantic Rangia' or 'The Gulf Wedge Clam', is native to estuaries in the area of the Gulf of Mexico. During the 1960's it started spreading northwards along the east coast of the USA up to the mouth of Hudson River[1,2]. The species is clearly invasive and the first European record was made in the harbour of Antwerp, Belgium in 2005[3]. The first Record from the Baltic Sea (Vistula Lagoon, Kaliningarad area, Russia) was made in 2010[4]. Since then it has been found also in the Kiel Canal[5] and along the Polish and German parts of the south Baltic coast[6,7]. In 2013 the species was also found in Lithuania (Curonian Lagoon) [8] and in 2016 in Estonia (Pärnu Bay)[9]. The localities are all brackish water, but in Lincolnshire, England *R. cuneata* has been found also in fresh water[10].

In September 2016 I received from J. Edlund, Litoralis Natur AB, Norrköping, specimens of a mussel species which he asked me to identify. They all turned out to be *Rangia cuneata* – this is the first record for Sweden and the so far northernmost in the Baltic Sea. The site is the bay Svensksundsviken, a nature reserve, which constitutes a small part of the larger bay Bråviken in the province of Östergötland. The specimens were found in the southern and eastern parts of the bay, at five localities between 58º 37'0.08'' N 16º 25'43.69'' E and 58º 35'30.09'' N 16º 23'30.65'' E on 20th August and 15th September 2016, at a depth of 1–2m, during monitoring of the submerged vegetation with a Luther rake[11]. At the western end of the bay Bråviken the city of Norrköping is situated. Its harbour is one of the largest and most important on the Swedish east coast, with intense shipping. In the light of the rapid spread and colonisation of the species in Europe (not at least in the Baltic Sea), the record was not unexpected. In addition a second Swedish record of *R. cuneata*, this time from the west coast, was made in the channel Stora Hamnkanalen between the bridges Residensbron and Kämpebron in the city of Gothenburg [Göteborg] (57º 42'22.08'' N 11º 57'41.40'' E). A single living specimen was found on September 24th 2017 during a survey of the fish fauna (leg: P. Lindberg, Enviro Planning AB, Gothenburg). The site is situated close to the opening of the channel into the River Göta Älv, which in turn is rather close to the mouth of the river into Kattegatt. There is intense shipping in the river, and its mouth is part of the harbour of Gothenburg, the largest in Sweden. The Stora Hamnkanalen is connected to a freshwater course system, but has frequent influx of brackish water.

With high probability the spread of *R. cuneata* takes place through transport of larvae in ballast water – cf[3,6,12]. According to North American literature the species needs a PSU of 6–10 and a temperature of 18–29°C for its larval development[13], but the European records seem to indicate that lower values may be sufficient – here further studies are necessary. *R. cuneata* is one of few species having the ability to pass the boundary between fresh and brackish water[14], which gives it advantages in establishing and expanding its range in waters with varying salinity. A rapid spread to estuaries along the southern parts of the Swedish Baltic and southern Bothnian coast in the coming years is to be expected. The species may also spread into the lower parts of rivers and canals. Possible mass occurrences may be a threat to the native fauna on soft bottoms. In the Kaliningrad area densities of > 4000 individuals/m^2 were observed in 2011[4]. In the west, it seems possible that *R. cuneata* will spread northwards in the river Göta älv, at least up to the lock at Lilla Edet, as this lower part of the river is frequently flooded with brackish water at high tide. With the help of the shipping activity it might even pass the locks and reach the great Lake Vänern and the waters connected to it.

A further North American clam, originating from the same area as *R. cuneata*, is *Mytilopsis leucophaeata* (Conrad, 1831) 'The dark false mussel' or 'Conrad's false mussel', has probably spread in almost the same way – firstly along the east coast of the USA[15], then to Europe, but the process took place earlier – *M. leucophaeata* reached Europe already in 1835 (the harbour of Antwerp!)[16, 17]. However, Oliver[18] suggests that it was in the UK as early as 1800. It was found in

the Kiel Canal in 1928[19] and before the onset of the second world war also in the Kaliningrad area (former East Prussia)[20], there it presumably later died out[21]. In modern times, the first record in the Baltic Sea is from 2000, when it was found near the mouth of the river Warnow in the Hanseatic town Rostock (Mecklenburg-West Pomerania in NE Germany)[22]. In 2003, when it was found in the central part of the Gulf of Finland, in an area affected by cooling water outlet from the nuclear power plant at Loviisa[21]. It has also been found in the harbours of Turku and Naantali, situated not far from the mouth of the Gulf of Finland, and also in the southern part of the Bothinian Sea, close to the nuclear power plant at Olkiluoto (so far the northernmost occurrence)[23,24]. Further records on the Finnish side of the Bothnian Sea were made in the years 2011–2015, they are situated far away from any outlet of artificially heated water, about 120km from the nearest of the above mentioned occurrencies[25].

In 2011 the species was also recorded from Sweden for the first time, under similar conditions as the first Finnish records, in several places close to the outlet of the cooling water system of the nuclear power plant at Forsmark [60º25'40.7'' N 18º11'23.05]'' E in the province of Uppland at the coast of the southern Bothnian Sea[24]. In 2012 it was also found at the small islet Borgarna about 5km NW of the outlet area[24]. A further record of *M. leucophaeata* was made at the bay Sågbofjärden [60º38'46.7'' N 17º29'13.7] in August 2016 by T. von Proschwitz. In this latter case a single empty shell was found on the shore. This second site is situated some 48km NW of Forsmark. The spread of the species both to Finland and Sweden has, with high probability, taken place by transport of larvae with ballast water[12,23,24,25]. *M. leucophaeata* occurs in fresh and brackish water up to a PSU of > 20 and needs a temperature of at least 13°C to be able to reproduce[21,26]. The cooling water outlet area hence offers an area of survival and recruitment for further spread – a spread which will possibly also be enhanced by the predicted climate warming[27], although the latest records on the Finnish side of the Bothnian Sea, clearly shows the species' ability the spread and establish also in areas far from and unaffected by outlets of artificially heated water[25]. A rapid spread of *M. leucophaeata* along the Swedish Balthic-Bothnian coast in the forthcoming years, and also into the lower parts of rivers and canals, seems highly probable. The species may cause problems by effects on the native fauna and by biofouling[24], as it may occur in high densities – 28.000 individuals/m^2 has been reported from Finland[17] and 8.000 individuals/m^2 from Sweden[28].

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