

THE EXOTIC JELLYFISH *BLACKFORDIA VIRGINICA* INTRODUCED INTO THE NETHERLANDS (CNIDARIA: HYDROZOA)

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In August 2014 the exotic jellyfish *Blackfordia virginica* was captured in the harbour of Amsterdam. This is the first confirmed record of this species in the Netherlands, although in October 2013 a possible specimen was filmed and released. This indicates that the species might be established in the Amsterdam area, although repeated introduction with ballast water cannot be ruled out. In September 2014 hydrozoan polyp colonies closely resembling those of *B. virginica* were collected near IJmuiden in the Noordzeekanaal, a canal connecting Amsterdam with the North Sea at IJmuiden.

INTRODUCTION

Brackish water habitats are characterised by fluctuating salinities, sometimes higher and often lower than in the sea. Survival in brackish waters requires adaptations usually not present in truly marine species. As a result brackish waters are mainly populated by a specific, often species-poor fauna restricted to this habitat. In many brackish waters the fauna contains a high proportion of introduced species. For this phenomenon several different explanations have been proposed.

One explanation is that the number of harbours in brackish areas is high, providing a continuous supply of exotic species with ships. Another explanation could be the many empty niches in these species-poor habitats (Wolff 1999).

All large brackish waters in the Netherlands are busily navigated by international shipping. This means that they are susceptible to introductions of species from all other temperate brackish harbour regions in the world, either by ballast water

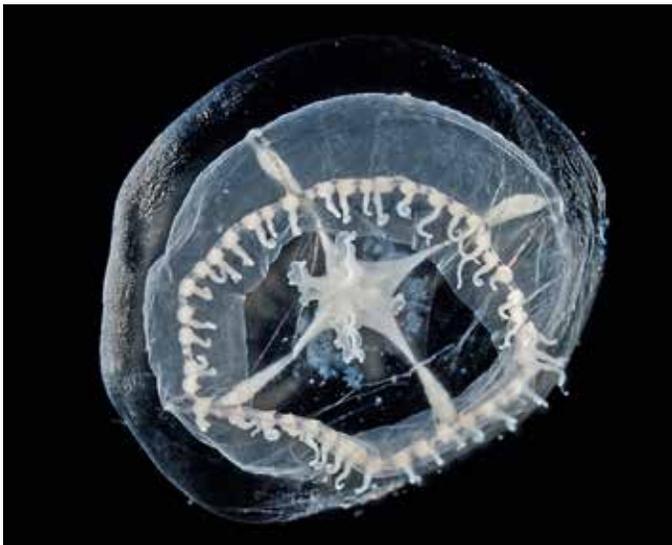


Figure 1. *Blackfordia virginica*, August 19, 2014, Amerikahaven, Amsterdam. Specimen preserved in formaldehyde. Four crenulate mouth lips are visible in the centre. Note the prominent bulbs at the base of the tentacles. Photo Marco Faasse.

Figuur 1. *Blackfordia virginica*, 19 augustus 2014 Amerikahaven, Amsterdam. In formaline geconserveerd exemplaar. Vier gekartelde mondflappen zichtbaar in het centrum. Let op de dikke tentakelbulbi (verdikkingen aan de basis van iedere tentakel). Foto Marco Faasse.



Figure 2. Harbours of Amsterdam, IJ and Noordzeekanaal. Amsterdam CS = Amsterdam central railway station at the centre of the IJ, Amerikahaven = collecting locality of *Blackfordia virginica* medusa (Amerikahaven harbour), ferry Velsen = collecting locality of presumed *B. virginica* polyps (immediately west of ferry IJmuiden-Velsen).

Figuur 2. Havens van Amsterdam, IJ en Noordzeekanaal. Amsterdam CS = Amsterdam Centraal Station aan het hart van het IJ, Amerikahaven = vindplaats van *Blackfordia virginica* meduse ferry, Velsen = vindplaats van veronderstelde *B. virginica* poliepen (direct ten westen van pontje).

release or transport in hull fouling. New species turning up here deserve particular attention as they may originate from any temperate part of the world.

In October 2013 an unusual, small jellyfish was found in a monitoring program with fyke nets in the harbor area of Amsterdam. It was filmed and released by the second author. It was unusual for its combination of a very thick mesogloea (gelatinous substance between entoderm and ectoderm) and the prominent bell margin, with big tentacle bulbs, a combination not present in native species. It was tentatively identified from the video as *Blackfordia virginica* Mayer, 1910 (fig. 1) by the first author, but definitive identification had to await the capture of additional specimens. The Dutch record is the first from the Atlantic coast of Europe north of the Loire estuary.

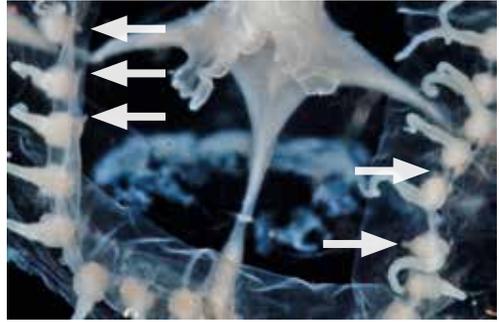


Figure 3. *Blackfordia virginica*, August 19, 2014, Amerikahaven, Amsterdam. Arrows indicate the finger-like outgrowths of tentacle entoderm. Specimen preserved in formaldehyde. Photo Marco Faasse.

Figuur 3. *Blackfordia virginica*, 19 augustus 2014, Amerikahaven, Amsterdam. De pijlen geven de vingerachtige uitgroeisels van tentakelentoderm aan.

In formaline geconserveerd exemplaar.

Photo Marco Faasse.

SURVEY AREA

The survey area consists of the IJ in the centre of Amsterdam, the harbours of Amsterdam and the Noordzeekanaal (fig. 2). The IJ is a large brackish water body in the centre of Amsterdam, connected via a canal, the Noordzeekanaal, to the North Sea. In the western part of Amsterdam several harbours constitute side-branches of this water system. Freight carriers from all over the world enter the Noordzeekanaal via the sluice docks at IJmuiden and mostly head for the harbours of Amsterdam. The water in this system is brackish, with a vertical salinity gradient and an additional gradient from IJmuiden (high) to Amsterdam (low). A wedge of water with high salinity penetrates below the water with low salinity from the IJmuiden sluice docks to the centre of Amsterdam at the central railway station. As a result marine fish are incidentally captured up to Amsterdam city. Salinity also varies, depending on fresh water influx. Fresh water from neighbouring polders is discharged by the pumping station Gemaal Halfweg into the head end of the harbour Amerikahaven. The Amerikahaven receives discharged cooling

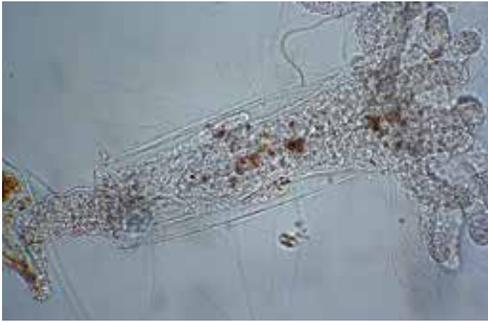


Figure 4. Presumed *Blackfordia virginica* polyp, September 9, 2014, IJmuiden.

Figuur 4. Veronderstelde *Blackfordia virginica* poliep, 9 september 2014, IJmuiden.

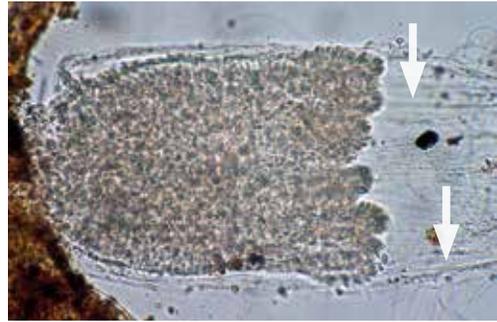


Figure 5. Presumed *Blackfordia virginica* polyp, September 9, 2014, IJmuiden. Note opercular folds distal of tentacles.

Figuur 5. Veronderstelde *Blackfordia virginica* poliep, 9 september 2014, IJmuiden. Plooiën van operculum zichtbaar voorbij tentakeluiteinden.

water of the local waste and energy company AEB via the harbour Aziëhaven. Depth of the Amerika-haven is 15 m.

METHODS

The main objective of the fyke fishery is year-round monitoring of the fish and decapod populations in the IJ and the harbours of Amsterdam (Abbing et al. 2014). Research fyke nets with a smaller mesh than usual (5×5 mm) were, weather permitting, deployed overnight at a depth of at least 2 m. The fykes have a length of 8 m and the largest diameter is 1.5 m. Contents of the fyke nets were emptied in a large bucket filled with water up to about 15 cm. On August 19, 2014, after removal of fish and decapods a cuvette was filled with water from the bucket and its contents observed. Subsequently all the contents of the bucket were observed in the same way. For medusa relaxation menthol crystals were used. Specimens were preserved using formaldehyde 4 % (volumetric), diluted in harbour water. For identification of the medusa a stereomicroscope with magnification up to 50× was used. On September 9, 2014 scrape samples from the canal wall were taken with a hand net close to the Velsen ferry near IJmuiden, in the western end of the Noordzee-

kanaal. The scrape samples were screened for hydrozoan polyps under a stereomicroscope in canal water. Hydrozoan polyps were transferred to slides and studied under a high power microscope (magnification 250× and 400×). Medusa and polyp material will be deposited in the collection of Naturalis Biodiversity Center, Leiden. Salinity has not been measured; values fluctuate with the amount of rainfall and vary in function of depth.

RESULTS

In October 2013 an unknown medusa was captured in a fyke net in the harbour region of Amsterdam by the second author and released after filming it. The medusa was tentatively identified from the video as *B. virginica* by the first author. On 19 August 2014 one specimen of a *B. virginica* medusa (fig. 1, 3) was captured in a fyke net in the Amerikahaven harbour in Amsterdam (N 52°24'51.62", E 4°46'15.19") (fig. 2) and preserved. The diameter of the preserved medusa was about 6 mm. The associated gelatinous plankton captured in the fyke net consisted of about 20 specimens of the hydromedusa *Nemopsis bachei* L. Agassiz, 1849 and hundreds of the invasive ctenophore *Mnemiopsis leidyi* A. Agassiz, 1865.

On September 9, 2014 at least one hydrozoan colony that we presume to belong to *B. virginica* was collected at IJmuiden (N 52°27'47.24" E 4°37'52.65") (fig. 2). Because the substrate was heavily broken up it is impossible to say whether the about ten observed polyps all belong to the same colony. Most characters of the colony or colonies and the polyps agree with those described for *B. virginica*. The hydrotheca is stolonal, with single polyps of about 0.5 mm high on the stolon (fig. 4). Opercular folds are visible (fig. 5), without a demarcation of the operculum from the rest of the colony. The tentacular web was not visible, maybe because the polyps were mostly partly retracted. Gonophores were absent. The scrape sample largely consisted of the introduced tubeworm *Ficopomatus enigmaticus* (Fauvel, 1923). Most *B. virginica* polyps were encountered on the barnacle *Amphibalanus improvisus* (Darwin, 1854). Other species present in the sample were the bryozoan *Conopeum seurati* Canu, 1928, the entoproct *Barentsia gracilis* (M. Sars, 1835), the introduced tanaidacean *Sinelobus vanhaareni* (Bamber, 2014) and juveniles of the introduced crab *Hemigrapsus takanoi* Asakura & Watanabe, 2005.

DISTRIBUTION

Blackfordia virginica was described from the Atlantic coast of North America (Mayer 1910). It was later recorded from San Francisco Bay and Coos Bay on the Pacific coast of North America (Mills & Sommer 1995, Mills & Rees 2000) and the Atlantic coast of South America at several sites in Brasil (Nogueira & De Oliveira 2006, Bardi & Marques 2009) and in the Río de la Plata estuary on the border between Argentina and Uruguay (Genzano et al. 2006). It also occurs in coastal lagoons on the Gulf and Pacific coasts of Mexico (Álvarez Silva et al. 2003). Moore (1987) mentions observations in India and the Black and Caspian Seas in Eastern Europe. On the Atlantic coast of southern Europe *B. virginica* has been reported from the Loire estuary in southern France (Denayer 1973) and the Mira and

Guadiana estuaries in Portugal (Moore 1987, Chicaro et al. 2009). The present record from the Netherlands is the first from the Atlantic coast of Europe north of the Loire estuary.

The area of origin of *B. virginica* is not known with certainty. Harrison et al. (2013) found very low genetic diversity in *B. virginica* samples taken from all over the United States, Atlantic, Gulf and Pacific coasts. This suggests a founder effect, the low genetic diversity resulting from a limited number of introduced founder specimens. The founder effect implies a different area of origin. Harrison et al. (2013) regard this conclusion as tentative until genetic studies on *B. virginica* from other continents have been done. Thiel (1935) suggests the Black Sea is the area of origin of *B. virginica*, as particularly high densities were found there.

TAXONOMY AND IDENTIFICATION

The monotypic family Blackfordiidae belongs to the superfamily Campanulinoidea. Characters in which it differs from other families are given by Bouillon (1984). The genus *Blackfordia* currently contains three recognized species: *B. virginica*, *B. manhattensis* Mayer, 1910 and *B. polytentaculata*. *Blackfordia manhattensis* was described from the Atlantic coast of North America (Mayer 1910) and Du et al. (2010) report *B. manhattensis* from China. *Blackfordia polytentaculata* Hsu & Ching 1962 was described from China, where it was reported together with *B. virginica*. Unlike *B. virginica*, *B. manhattensis* is reported from two localities only and *B. polytentaculata* also from one locality only.

MEDUSA

The medusa of *B. virginica* is hemispherical, with a maximum diameter of 22 mm, but more typically measuring about 10 mm. The mesogloea is thick, about half of the bell height. Typically there are four radial canals, a short manubrium and four long, crenulate mouth lips. The bell margin is prominent, with closely set thick tentacle bulbs.

One or two statocysts are present at irregular intervals between the tentacle bulbs. Cirri and permanently rudimentary tentacles are absent (Mayer 1910, Moore 1987). Characteristic for the genus *Blackfordia* are small finger-like protuberances of the tentacle entoderm extending upwards/inwards into the mesogloea (Mayer 1910, Moore 1987, Bouillon 1984) (fig. 3). Detailed drawings are provided by Mayer (1910). According to Mayer (1910) *Blackfordia virginica* differs from *B. manhattensis* in the presence of black pigment at the bases of the statocysts and entoderm protuberances being present only on some tentacles. Hsu & Ching (1962) describe *B. polytentaculata* with 200-250 marginal tentacles, whereas *B. virginica* is reported to have a maximum of 100. Hsu & Ching (1962) and Bardi & Marques (2009) both give a table with differentiating characters for the three species of *Blackfordia*. The Amsterdam specimen has 44 tentacles, but may not be fully mature. The number of statocysts between the tentacles is 0-1. Black pigment was not seen.

According to Moore (1987) *B. manhattensis* is a synonym of *B. virginica*. Moore (1987) states that the characters used for species delimitation are too variable to be reliable. Kramp (1961) indeed wrote about the characteristic pigment of *B. virginica* that 'examination of specimens from all three localities has revealed no such pigment'. Several other authors, notably Bardi & Marques (2009), state that the black pigment and the number of statocysts between the tentacles are not consistent, but differ between populations and individuals of the same species, thereby questioning the species delimitations in the genus. On the other hand Harrison (2010) suggests that *Blackfordia* from North America and Brasil differ sufficiently molecularly to regard the taxon from Brasil as a different species.

POLYP

Mills & Sommer (1995) and Mills & Rees (2000) give information on the morphology and pictures

of the polyp of *B. virginica*. The polyp colony of *B. virginica* consists of a stolon with individual polyps of about 0.5 mm high rising up from the stolon on an unbranched, ringed pedicel to a height of less than 2 mm, often less than 1 mm. The hydrotheca is provided with an operculum which folds over the retracted polyp. The operculum is not visibly delimited from the rest of the hydrotheca. The bases of the polyp tentacles are connected by a webbing. Only rearing of the medusa from the polyp or molecular analysis can give definitive certainty about the identity of the polyps (Mills & Rees 2000). Polyps from IJmuiden can be seen in figure 4 and 5. In figure 5 the operculum folds are visible.

DISCUSSION

The harbour of Amsterdam receives a large volume of ballast water from international ship traffic. This is the most likely vector of introduction of *B. virginica*. Both Dutch specimens of the medusa were collected using fyke nets with a mesh size hardly smaller than the medusa diameter, hence possibly ineffective for capturing them. The species may have established a population in the IJ-Noordzeekanaal area. The collection of presumed polyps of *B. virginica* during the first and only attempt at a randomly chosen location gives some strength to this hypothesis, although repeated introduction with ballast water cannot be ruled out completely. Surveys with more appropriate gear, collection of more hydrozoan colonies and rearing of medusae may shed light on this question. Marine ecologists all over northern Europe should be aware of the potential presence of *B. virginica* in their local estuarine habitats.

In Portugal, possible impacts of introduced *B. virginica* on the native anchovy *Engraulis encrasicolus* (Linnaeus, 1758) and zooplankton have been suggested by Chicaro et al. (2009) and in California predation on copepods, mysids and fish larvae has been found by Wintzer et al. (2013). At present it is impossible to assess the possible impact of *B. virginica* on the native

fauna of the IJ and the Noordzeekanaal. In view of the high densities of the voracious predator *Mnemiopsis leidyi* the impact of *B. virginica* may be limited. However, peak densities of both predators may occur in different periods of the year.

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SAMENVATTING

Het franjerokje *Blackfordia virginica*, een exotisch kwalletje nieuw voor Nederland (Cnidaria: Hydrozoa)

Een exemplaar van het kwalletje (hydromeduse) *Blackfordia virginica* werd op 19 augustus 2014 gevangen in een fuik in de Amerikahaven te Amsterdam. In 2013 werd op dezelfde plek waarschijnlijk een exemplaar van dezelfde soort gevangen. Hiervan is geen materiaal beschikbaar, wel een globale tekening en een filmpje. Het betreft een brakwatersoort die momenteel op diverse continenten voorkomt, waarschijnlijk geïntroduceerd. Het oorsprongsgebied is niet met zekerheid bekend. De introductie in Nederland heeft waarschijnlijk plaatsgevonden met ballastwater. Om de interesse van waarnemers te stimuleren wordt franjerokje als Nederlandse naam voorgesteld. De naam houdt verband met de opvallende rand met tentakelbulbi en de eerste indrukken van de waarnemers.

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