

EXTENSION OF THE RANGE OF THE BRYOZOANS *TRICELLARIA*
INOPINATA AND *BUGULA SIMPLEX* IN THE NORTH-EAST ATLANTIC
OCEAN (BRYOZOA: CHEILOSTOMATIDA)

Hans De Blauwe & Marco Faasse

A survey of the bryozoan fauna of harbours and marinas in the Netherlands, Belgium and France revealed two interesting bryozoans. The invasive *Tricellaria inopinata* originates from the North Pacific Ocean. It has probably been introduced by man in southern Australia, New Zealand, the western part of the Pacific and in Venice. In recent years it has expanded its range in the lagoon of Venice and colonized the Atlantic coast of Europe. It has now been found for the first time in France, Belgium and the Netherlands. *Bugula simplex* was first described in 1886 from the Adriatic Sea. Its occurrence mainly in ports and harbours in the North-East Atlantic suggests introduction by man. At the end of the twentieth century the species was introduced to Australia and New Zealand and it is also known from the Atlantic coast of North America. It has now been found for the first time in the Netherlands and Belgium. Expected future developments in the distribution of both species in Belgium and the Netherlands are discussed.

INTRODUCTION

During an investigation of the bryozoan fauna of the delta area in the south-western part of the Netherlands *Tricellaria inopinata* d'Hondt & Occhipinti Ambrogi, 1985 was collected at two sheltered inland localities near Goes. During an extensive investigation of tidal waters this bryozoan was never encountered. After the discovery the distribution of *T. inopinata* was further investigated. One harbour and nine marinas in the delta area in the southwestern part of the Netherlands, four along the coast of Belgium and seven along the Atlantic coast of France were visited. In each, samples of fruticose bryozoans were taken from floats and, if present, buoys and ropes. Substrates of colonies were noted, as well as presence of ovicells with embryos. Before the present investigation the littoral zone near Goesse Sas was carefully studied by inspecting both sides of a huge amount of boulders on April 24, 2000. In almost every harbour visited in the south-west of the Netherlands *T. inopinata* was collected.

Furthermore the bryozoan *Bugula simplex* Hincks, 1886 was collected. These are the first records of this species for Belgium and the Netherlands. In this paper the results of this research are presented and characteristics of the species are given.

Tricellaria inopinata (fig. 1-5)

Range

The description of *Tricellaria inopinata* is based on specimens collected in the lagoon of Venice, in 1985. It probably originates from the Pacific coast of North-America and has invaded the north of Japan to Taiwan, Australia, New Zealand, the Mediterranean (Occhipinti Ambrogi & d'Hondt 1994) and is now also present in the North-East Atlantic Ocean (fig. 1).

North-East Atlantic Ocean

In 1996 *T. inopinata* was observed in the Atlantic for the first time, in Galicia, the north-west of Spain (Fernández Pulpeiro et al. in press). In 1998



Figure 1
Sites where *Tricellaria inopinata* has been found in Europe.
Figuur 1
Vindplaatsen van *Tricellaria inopinata* in Europa.

it was observed in central southern England (Dyrynda et al. 2000).

In table 1 and figure 2 the sites which we investigated in 2000 are summarized. The survey provided the first records for the Netherlands, Belgium and France. Hendaye is a town in the French Basque Country (southwest of France), close to the Spanish border. The other marinas investigated in France are on the east Channel and North Sea coast. *Tricellaria inopinata* is widespread and abundant in the south-western part of the Netherlands. It was found growing on ship's hulls, floats, buoys, ropes, stones, the algae *Sargassum muticum* (Yendo) Fensholt, *Codium fragile* (Sur.) Hariot and *Ulva* sp., on an unidentified campanulariid hydrozoan, on mussels, *Mytilus edulis* Linnaeus, 1758 and the ascidians *Styela clava* Herdman, 1882 and *Ascidiella aspersa* (Müller, 1776). In Hendaye it was found on the bryozoan *Bugula neritina* (Linnaeus, 1758) and the polychaete worm *Ficopomatus enigmaticus* (Fauvel, 1923). Ancestrulas settle on colonies of their own species as well. At all localities ovicells with embryos were observed.

Except for the localities near Goes and Ostend, all sites where *T. inopinata* was collected have direct access to open water. However, until now (October 2000) this bryozoan was not observed in open tidal waters in France, Belgium and the Netherlands. Particularly careful investigation of the littoral zone near Goesse Sas did not yield a single colony of *T. inopinata*. All collecting localities are marinas, harbours or inland waters. At all sites where *T. inopinata* was collected, including Goes and Ostend, freshwater influence is negligible. At three sites, viz. Zierikzee, Nieuwpoort and Calais, huge amounts of freshwater were seen to flow into the harbour. At none of these localities *T. inopinata* was collected.

Diagnosis

The genus *Tricellaria* (excluding *Bugulopsis*) can be distinguished from other genera of North East Atlantic anascan Bryozoa by the combination of the following characters: colonies erect, branched, biserial, conspicuously jointed. Zooids with scutum and lateral avicularia, vibracula absent (fig. 3).

- surveyed but *T. inopinata* was not found /
onderzocht, maar *T. inopinata* werd niet gevonden
- *T. inopinata* found / *T. inopinata* aangetroffen

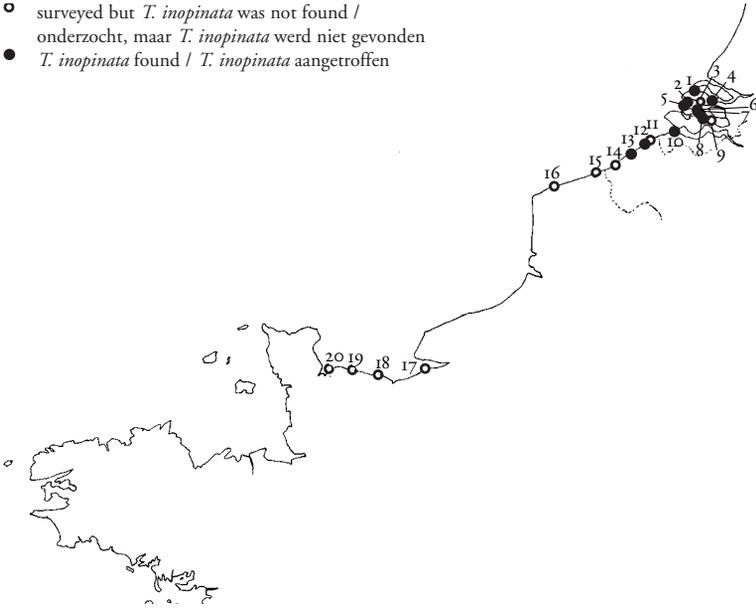


Figure 2
Investigated sites and records of *Tricellaria inopinata* in the Netherlands (NL), Belgium (B) and France (F). Sitenumber 21 is not shown on the map.

Figuur 2
Onderzochte locaties en waarnemingen van *Tricellaria inopinata* in Nederland (NL), België (B) en Frankrijk (F). Locatienummer 21 is niet weergegeven op de kaart.

nr	locality	date	abundance
1	Scharendijke (NL)	28.X.2000	1
2	Burghsluis (NL)	28.X.2000	> 100
3	Zierikzee (NL)	04.XI.2000	-
4	Bruinisse (NL)	04.XI.2000	>1
5	Neeltje Jans Binnenhaven (NL)	11.XI.2000	> 100
6	Colijnsplaat (NL)	06.X.2000	> 1
7	Kats (NL)	06.X.2000	> 100
8a	Goesse Meer (NL)	29.VIII.2000	> 100
8b	Goesse Sas (NL)	21.IX.2000	> 10
9	Yerseke (NL)	16.XII.2000	-
10	Breskens (NL)	21.IX.2000	> 100
11	Zeebrugge (B)	15.XI.2000	-
12	Blankenberge (B)	17.X.2000	1
13	Ostend (B)	21.X.2000	1
14	Nieuwpoort (B)	18.IX.2000	-
15	Dunkerque (F)	18.XI.2000	-
16	Calais (F)	18.XI.2000	-
17	Honfleur (F)	02.XI.2000	-
18	Courseulles (F)	02.XI.2000	-
19	Port-en-Bessin (F)	31.X.2000	-
20	Grandcamp-Maisy (F)	01.XI.2000	-
21	Hendaye (F)	23.IX.2000	> 10

Table 1
Investigated sites and records of *Tricellaria inopinata* in the Netherlands (NL), Belgium (B) and France (F).

Tabel 1
Onderzochte locaties en waarnemingen van *Tricellaria inopinata* in Nederland (NL), België (B) en Frankrijk (F).

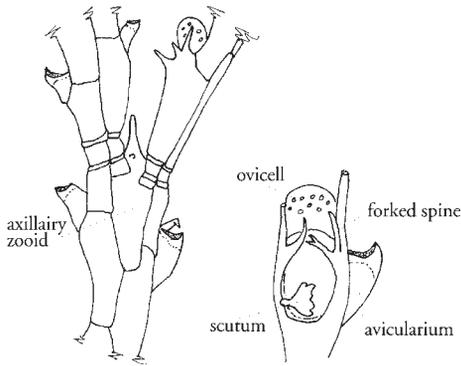


Figure 3
Tricellaria inopinata. a. arrangement of zooids at bifurcation in basal view, b. ovicellate zooid with forked proximal spine. After d'Hondt & Occhipinti Ambrogi (1985).

Figuur 3
Tricellaria inopinata. a. rangschikking van zoïden bij vertakking in basaal aanzicht, b. zoïde met oviceel en gevorkte proximale stekel. Naar d'Hondt & Occhipinti Ambrogi (1985).

Ryland & Hayward (1998) mention two species of the genus *Tricellaria* (including *Bugulopsis*) from British waters, viz. *T. ternata* (Ellis & Solander, 1786) and *T. peachii* (Busk, 1851). According to d'Hondt & Occhipinti Ambrogi (1985) the latter species belongs to the genus *Bugulopsis*. These authors recognize *Bugulopsis* as a valid genus. They observed two characters which clearly separate *Bugulopsis* from *Tricellaria*: the two series of zooids of the internodes are orientated perpendicularly to each other and the oviceles have a mosaic-like ornamentation (d'Hondt & Occhipinti Ambrogi 1985). *Tricellaria ternata* differs from *T. inopinata* principally in the rounded or triangular scutum, the presence of frontal avicularia and the oviceel with at most a few pores. *Tricellaria ternata* is a northern species, known from the Arctic to Norfolk on the east coast of the U.K.

According to d'Hondt & Occhipinti Ambrogi (1985), apart from *T. inopinata*, only two *Tricellaria*-species exist with multiporous oviceles, viz., *T. occidentalis* (Trask, 1873) and *T. praescuta* Osburn, 1950. The only character which clearly

separates *T. inopinata* without overlap from the other two species is the shape of the oviceles. Length and breadth of the oviceles are more or less equal. In *T. praescuta* the oviceles are 1.5-2 times as long as wide. In *T. occidentalis* the breadth of the oviceles is 1.5-2 times the length. The other discriminating characters in fact show an overlap (d'Hondt & Occhipinti Ambrogi 1985).

Dyrynda et al. (2000) compare *T. inopinata* with *T. occidentalis* and *T. porteri* (MacGillivray, 1889). They do not mention *T. praescuta*, which has been collected only once (d'Hondt & Occhipinti Ambrogi 1985). According to Dyrynda et al. (2000) the form and variation of the scutum can be regarded as the key diagnostic feature. The scutum of *T. inopinata* is extremely variable within a single colony, from a slender projection, perhaps forked, to an extensive structure with an irregular margin, often cervicorn-like. The scutum of *T. occidentalis* is slender or slightly spatulate and the scutum of *T. porteri* is consistently large and reniform (Dyrynda et al. 2000). The ancestrula of *T. inopinata* is anchored to the substrate with a pair of rootlets at the basal side. The proximal end of the ancestrula is rounded. The distal part is usually slightly bent upright. It typically has ten long spines around the frontal membrane, the proximal pairs of which may be slightly bent inwards.

We were able to observe some characters not described by d'Hondt & Occhipinti Ambrogi 1985. The number of tentacles of the polypide is thirteen, occasionally twelve in zooids at the end of the branches. The colour of the embryos is pinkish or yellowish, probably depending on the state of development. Oviceles usually have two rows of pores. However, some of them have three or more rows of pores. Morphological variability in *T. inopinata* is remarkable. In colonies from the Netherlands the proximal spine on the outer margin of the zooids is often forked, in the colonies collected in Belgium it is never forked. In the colony from Ostend, the scutum is very reduced. Distally, it is only twice as broad as proximally.

The shape of the oviceles of specimens from the

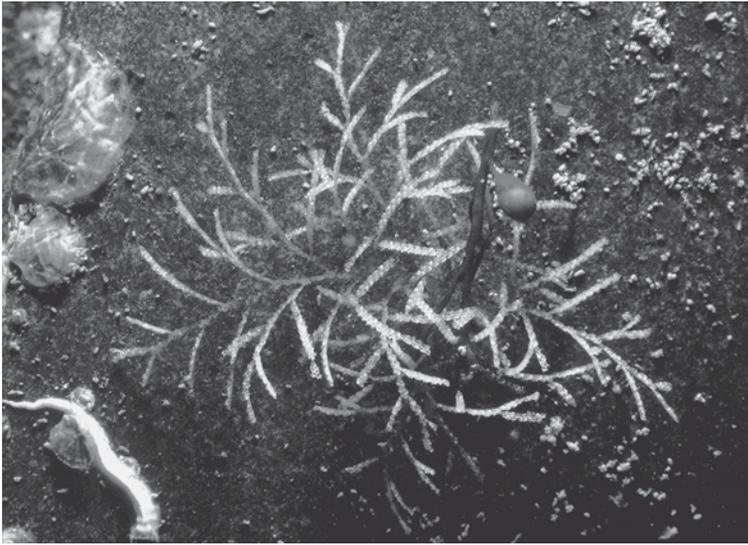


Figure 4
Tricellaria inopinata,
 colony from the Goesse
 Meer.
 Photo Marco Faasse.
 Figuur 4
Tricellaria inopinata,
 kolonie van het Goesse
 Meer.
 Foto Marco Faasse.

Netherlands, Belgium and France shows relatively little variability. They are subglobular, length being approximately equal to breadth. However, we studied material from just a few localities, collected within a period of only about two months.

Discussion

The introduction of *T. inopinata* is a case where the vector of introduction can be indicated with a relatively high degree of certainty. The only locality where d'Hondt & Occhipinti Ambrogi 1985 collected *Tricellaria inopinata* was the Canal de Giudecca in Venice, which is a busy shipping route. Before their description of *T. inopinata* the genus *Tricellaria* was not known from the Mediterranean. These facts led d'Hondt & Occhipinti Ambrogi (1985) to the conclusion that *T. inopinata* has been introduced by shipping. It is unlikely that *T. inopinata* was directly introduced to the Netherlands, Belgium and France from the lagoon of Venice or even from its region of origin, i.e. the North Pacific. Breskens is situated at the mouth of the Western Scheldt, a busy international shipping route. However, large vessels do not visit the harbour of Breskens. Release of bryozoan larvae from colonies on large

vessels in the mouth of the Western Scheldt, subsequent transport by water currents to Breskens and settlement can not be ruled out. However, as bryozoan larvae typically live just a few hours (Ryland 1965) and larvae of *T. inopinata* are released in still water (Occhipinti Ambrogi & d'Hondt 1994) other routes of introduction are more likely.

All collecting localities in the Netherlands are visited by small commercial vessels, fishing boats and yachts only. Yachts from the U.K. regularly visit marinas in Belgium (pers. obs.) and the south-western part of the Netherlands (Critchley & Thorp 1985, pers. obs.). Shipping between Belgium and the Netherlands is intensive. Introduction of *T. inopinata* to Belgium and/or the Netherlands by yachts from elsewhere on the Atlantic coast of Europe seems the most likely route. Larvae released by colonies on floats in marinas are likely to settle on suitable surfaces on yacht's hulls and vice versa. In fact we observed a number of yachts with abundant fouling of *T. inopinata*. However, the possibility that *T. inopinata* was introduced on drifting fragments of the alga *Sargassum muticum* in the first place can not be ruled out. The same vector of introduction was suggested as an alternative way of



Figure 5
Tricellaria inopinata, detail of colony. In the zooid in the centre the scutum is vaguely discernible.
Photo Hans De Blauwe.

Figuur 5
Tricellaria inopinata, detail van kolonie. In de zoïde in het centrum is het scutum vaag te onderscheiden.
Foto Hans De Blauwe.

transport of the introduced polychaete worm *Neodexiospira brasiliensis* (Grube, 1872) from central southern England to the Goesse Sas (Critchley & Thorp 1985). Algae originating from the Channel coasts indeed are frequently washed ashore on the coast of the south-west of the Netherlands and Belgium.

During our investigation of the bryozoan fauna of the south-west of the Netherlands neither marinas nor the Goesse Meer were sampled systematically before 2000, hence the exact year of colonization is unknown. In view of the fact that *T. inopinata* was already widespread and abundant here in 2000, colonization probably took place in or prior to 1999.

There are several reasons for the success of *T. inopinata* as an invader. Firstly, it has a wide temperature range (Dyrynda et al. 2000) and can thrive at a lowered salinity (Occhipinti Ambrogi 1991) and in silty conditions (observations in the marina of Breskens, Colijnsplaat and Kats).

Secondly, *T. inopinata* has a low substrate specificity. Especially the ability to grow on ship's hulls is important in this respect.

Future developments in the populations of *T. inopinata* can not be predicted with much certainty. The reason that presently *T. inopinata* only occurs in marinas and similar waters in the Netherlands and Belgium may be that dissemination by yachts is much more efficient than natural means. Bryozoan colonies on yachts can travel much longer distances than larvae, which live just a few hours. The occurrence of *T. inopinata* in open tidal waters in the Netherlands and Belgium may be just a question of time.

However, the preference of this species for sheltered localities suggests another scenario. In the Adriatic (Occhipinti Ambrogi & d'Hondt 1994) and in central southern England (Dyrynda et al. 2000) *T. inopinata* is found almost exclusively in very sheltered locations, Swanage Bay being the only exception. It seems unlikely that *T. inopinata* will colonize the open North Sea coasts of the Netherlands and Belgium. Other marinas more to the north, e.g. IJmuiden, will be colonized almost certainly. In the Oosterschelde, a semi-enclosed sea arm, it may extend its distribution outside marinas. However, this is not very likely. Careful investigation of the littoral zone near Goesse Sas did not yield a single colony. In the Grevelingen, an enclosed water body of high salinity, the development of a population in open water is to be expected. Developments in other enclosed water bodies will depend on salinity. Occhipinti Ambrogi (1991) did not find *T. inopinata* in stations where salinity was lower than 26 ‰.

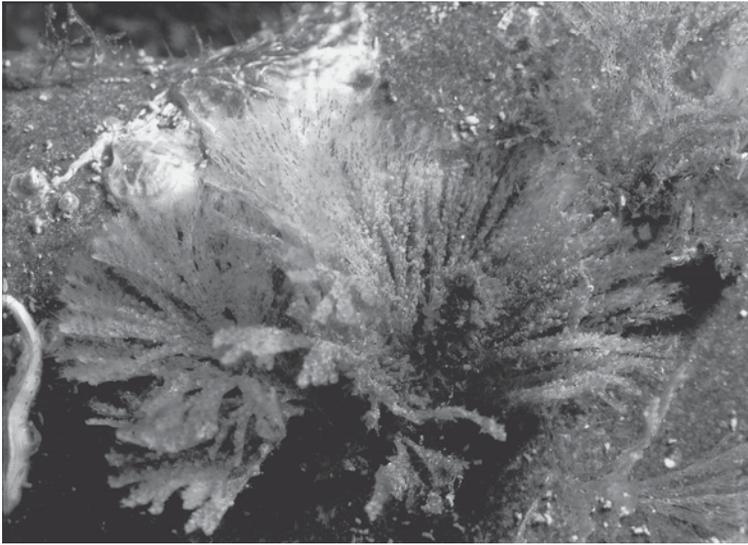


Figure 6
Bugula simplex, colony
 from the Goesse Sas.
 Photo Marco Faasse.
 Figuur 6
Bugula simplex, kolonie
 van het Goesse Sas.
 Foto Marco Faasse.

Apart from an expected restriction to sheltered localities the future distribution of *T. inopinata* in Europe is difficult to predict. *Tricellaria inopinata* is able to withstand low water temperatures. Minimum water temperatures in the lagoon of Venice are 2-3°C (Occhipinti Ambrogi 1991). This means that *T. inopinata* would be able to survive temperature conditions on the Atlantic coasts of Europe up to western Norway. However, we do not have data regarding temperatures required for reproduction.

Bugula simplex (fig. 6, 7)

Range

Bugula simplex is known from the North-East Atlantic, the North-West Atlantic, the Mediterranean Sea, southern Australia and New Zealand (Ryland & Hayward 1998).

North-East Atlantic Ocean

Records of *Bugula simplex* are enumerated in table 2. Presently, *B. simplex* is known in the Netherlands from just one locality, Goesse Sas, where it occupies a very limited surface on the walls of an abandoned sluice gate and some adjoining pier piles. However, density is high, i.e.

tens of colonies per square meter. In Belgium some colonies of *B. simplex* were collected in Ostend on a pontoon float. Often the colonies of *B. simplex* were attached to colonies of the bryozoan *Cryptosula pallasiana* (Moll, 1803). However, *B. simplex* seems to settle on other substrates as well, e.g. ascidians and bare substrate such as ship's hulls, stone and wood. At both localities, ovicells with embryos were observed. Careful investigation of the littoral zone near Goesse Sas did not yield a single colony of *B. simplex*.

Diagnosis

The genus *Bugula* can be distinguished from related genera in the North-East Atlantic by the forked proximal end of the autozooids, when viewed from the basal side. As *B. simplex* has been known since long from the North-East Atlantic, we can refer to Ryland & Hayward (1998) for identification and related species.

Discussion

As colonies of *Bugula simplex* were collected only on walls and pier piles in the marina of Goesse Sas and on a pontoon float in the marina of Ostend, introduction on a yacht's hull is the most



Figure 7
Bugula simplex, detail of colony. *Bugula simplex* is the only native Dutch and Belgian *Bugula*-species with more than two rows of zooids in the branches. Photo Hans De Blauwe.

Figuur 7
Bugula simplex, detail van kolonie. *Bugula simplex* is de enige inheemse *Bugula*-soort van Nederland en België met meer dan twee rijen zoiden naast elkaar. Foto Hans De Blauwe.

likely route. As in *T. inopinata*, introduction on drifting fragments of the alga *Sargassum muticum* can not be ruled out.

Future developments of the population of this bryozoan in the Netherlands can hardly be predicted on the basis of our few observations. As it is found mainly in ports and harbours in the North-East Atlantic region (Ryland & Hayward 1998) a similar distribution in Belgium and the Netherlands is to be expected. However, *B. simplex* is unlikely to become as widespread and abundant as *T. inopinata*. Ryland & Hayward (1998) mention only a few records from the

locality	date	abundance
Ostend (B)	08.IX.2000	> 10
Goesse Sas (NL)	21.IX.2000	1
Goesse Sas (NL)	06.X.2000	> 100

Table 2
Records of *Bugula simplex* in Belgium (B) and the Netherlands (NL).

Tabel 2
Waarnemingen van *Bugula simplex* in België (B) en Nederland (NL).

British Isles, Occhipinti Ambrogi (2000) does not mention *B. simplex* among the eight most abundant bryozoan species in the lagoon of Venice and Brock (1985) describes it as a 'minor fouler' from southern Australia. Its preference for other bryozoans as a substrate may be a limiting factor. A substantial spread of *B. simplex* in the North-East Atlantic is not to be expected. In the last century chances to reach suitable localities have proven to be low.

OTHER BRYOZOAN SPECIES

Colonies of four other anascan bryozoan species were collected. *Bugula stolonifera* Ryland, 1960 was introduced much earlier than *T. inopinata* and is now widespread in sheltered localities in the Netherlands, Belgium and northern France (Faasse 1998, Kerckhof 2000). *Bugula plumosa* (Pallas, 1766) and *Scrupocellaria scruposa* (Linnaeus, 1758) are bryozoans native to the Netherlands, which were both collected in low numbers (< 10 colonies), *B. plumosa* in Kats and Breskens and *S. scruposa* only in Kats. They are widespread and locally abundant in open water, predominantly sublittoral. *Bugula neritina* was observed in high numbers (> 100 colonies) at Hendaye. This is a more southern invasive species, recently collected in Belgium (Kerckhof 2000), but not known from The Netherlands.

The only fruticose anascan bryozoan previously occurring in any numbers in the Dutch and

Belgian localities which *T. inopinata* has colonized is *Bugula stolonifera*. In fact we were unable to find the latter species recently on Neeltje Jans, where it used to be abundant, and in Burghsluis. This is in accordance with the results of Occhipinti Ambrogi (1991), who found a reduction in the number of stations where *B. stolonifera* was present after the introduction of *T. inopinata*. We can not make a similar calculation as the number of known localities for *B. stolonifera* in the Netherlands and Belgium is rather low. However, we expect that in the coming years *B. stolonifera* will be more restricted to waters of low salinity than previously. It is able to thrive in salinities lower than 26 ‰, e.g. the 'Kanaal door Walcheren' (Faasse 1998).

Recently, Kerckhof (2000) recorded the bryozoan *Bugula neritina* from the marina of Ostend (Belgium). It seems remarkable that within a short time three fouling bryozoans colonized Dutch and Belgian waters. The mild winters of recent years may have facilitated colonization in these waters with relatively low winter temperatures. However, as the fouling fauna in these countries is not investigated on a regular basis, the recent records may merely reflect an increased interest in fouling bryozoans.

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SAMENVATTING

Uitbreiding van het areaal van de mosdiertjes *Tricellaria inopinata* en *Bugula simplex* in het noordoosten van de Atlantische Oceaan (Bryozoa: Cheilostomatida)

In 2000 werd het mosdiertje *Tricellaria inopinata* op twee plaatsen bij Goes (Zeeland) aangetroffen. De soort is in 1985 beschreven aan de hand van materiaal van Venetië, waar ze kennelijk door scheepvaart is geïntroduceerd. *Tricellaria inopinata* is afkomstig uit het noorden van de Stille Oceaan. De soort komt nu ook in Zuid-Australië, Nieuw-Zeeland, Japan en Taiwan voor, en is daar waarschijnlijk geïntroduceerd. In 1996 werd deze soort voor het eerst aan de Atlantische kust van Europa waargenomen, in Galicië (NW Spanje). Waarschijnlijk tussen 1996 en 1998 koloniseerde de soort Zuid-Engeland in de omgeving van Wight. Naar aanleiding van de vondst bij Goes werd een onderzoek ingesteld naar de struikvormige mosdiertjes van (jacht)havens in Frankrijk, België en Nederland. Vastzittende kolonies van *T. inopinata* werden aangetroffen bij Scharendijke, Burghsluis, Bruinisse, Neeltje Jans, Colijnsplaat, Kats, Goes en Breskens in Nederland, Blankenberge en Oostende in België en Hendaye in Zuidwest-Frankrijk. De soort werd aangetroffen op (begroeiing van) pontons en jachten in jachthavens en in het Goesse Meer vooral op wieren. In Zuidwest-Nederland was de soort reeds zodanig wijdverspreid en talrijk in 2000, dat de introductie waarschijnlijk al in 1999 of eerder plaatsvond. Waarschijnlijk zal de soort in België en Nederland beperkt blijven tot (jacht)havens en binnenwateren met een voldoende hoog zoutgehalte, vanaf circa 25 ‰. In de Grevelingen zal zich naar verwachting een grote populatie ontwikkelen.

Tijdens het onderzoek werden ook vastzittende kolonies van het mosdiertje *Bugula simplex* aangetroffen, en wel in Oostende (België) en bij het Goesse Sas. In beide gevallen bevonden de dieren zich op pontons, palen en een kademuur van een jachthaven. Oorspronkelijk is deze soort beschreven van de Adriatische Zee. In Groot-Brittannië wordt ze al waargenomen sinds de negentiende eeuw. Ook daar is *B. simplex* waarschijnlijk ingevoerd, want de vindplaatsen zijn steeds havens. De soort is tevens bekend van de Atlantische kust van Noord-Amerika en aan het einde van de twintigste eeuw is *B. simplex* geïntroduceerd in Zuid-Australië en Nieuw-Zeeland. De verspreiding van deze soort in België en Nederland zal waarschijnlijk beperkt blijven tot enkele (jacht)havens.

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