

Research Article

New invader in the Polish Baltic Sea Proper: phylogeny and global distribution of *Calyptospadix cerulea* Clarke, 1882 (Cnidaria, Hydrozoa)

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Abstract

Calyptospadix cerulea Clarke, 1882 is a colonial athecate hydrozoan known for forming dense biofouling communities, having broad environmental tolerance and global yet taxonomically obscured distribution. Here, we confirm for the first time its presence in the Polish part of the Baltic Sea (Gulf of Gdańsk), marking a significant range expansion into the Baltic Proper. We support our morphology-based identification, with the first molecular data for *C. cerulea*, allowing its phylogenetic placement within a clade alongside *Bimeria vestita* Wright, 1859 and *Cordylophora caspia* (Pallas, 1771), therefore suggesting reassignment to the family Cordylophoridae. We also reviewed historical occurrence data of *C. cerulea*, spanning nearly 150 years of research, to provide up-to-date description of its distribution range. In addition, our *in situ* observations suggest that *C. cerulea* plays an important role in providing secondary substrate for number of species in benthic environments of the southern Baltic Sea. As *C. cerulea* is likely well-suited to the Baltic's variable brackish conditions, its presence raises concerns about potential ecological impacts on native fouling communities and industrial infrastructure. Given its ecological plasticity and expanding range, we emphasize the need for continued monitoring and further research into its population dynamics, ecological interactions, and potential impacts.

Key words: Biofouling, hard-bottom, hydrozoan tufts, non-indigenous species, hydroid habitat former

Introduction

The Baltic Sea is a shallow, semi-enclosed postglacial sea, with limited water exchange with the Atlantic Ocean through the Danish Straits. Such unique setting has shaped its salinity patterns with pronounced vertical and horizontal gradients, the latter spanning nearly marine conditions (30 g kg⁻¹) at the entrance on the west to near freshwater in

the north (Reusch et al. 2018). This in turn has shaped the biodiversity patterns therein, with overall low species richness; higher towards the west, where marine and brackish fauna coexist, and lower in the northernmost and easternmost sectors, where only freshwater taxa can survive (Ojaveer et al. 2010). Like many other continental seas, the Baltic has been subjected to significant anthropogenic pressures, including rapid coastal urbanization and intensified maritime traffic which has facilitated the introduction of approximately 117 non-indigenous species, around 70% of which have established reproducing populations (Ojaveer et al. 2010). This phenomenon has earned the Baltic the ironic nickname “the sea of invaders” (Leppäkoski et al. 2002).

This notable biodiversity pattern is also seen in hydrozoans. To date, only ten species of Hydrozoa have been recorded in the Polish sector of the Baltic Sea (Ronowicz 2022). Among them, two exclusively benthic species are particularly common: the native *Gonothyraea loveni* (Allman, 1859) and the invasive Ponto-Caspian *Cordylophora caspia* (Pallas, 1771) (Dziubińska and Janas 2007; Brzana and Janas 2016). Three species appear occasionally in plankton samples, following strong water inflows from the North Sea: *Halitholus cirratus* Hartlaub, 1914, *Melicertum octocostatum* (M. Sars, 1835) and *Clytia hemisphaerica* (Linnaeus, 1767) (Margoński and Dembek 2024). Medusae of *Ectopleura dumortieri* (Van Beneden, 1844), *Corymorpha nutans* M. Sars, 1835 and a siphonophore *Rosacea plicata* Bigelow, 1911 have been recorded once by Radziejewska (1973). *Protohydra leuckarti* Greeff, 1870 inhabits sandy-muddy bottoms (Żmudziński 1990), while one benthic species, *Clava multicornis* (Forsskål, 1775), is rarely observed in shallow bays (Dziubińska and Janas 2007). Żmudziński (1990) suggested even greater diversity of Hydrozoa in the Polish sea areas, but some of these records (e.g., *Hybocodon prolifer* Agassiz, 1869, *Sarsia tubulosa* (M. Sars, 1835)) are unverifiable due to the lack of proper reference to original sources. Most of the mentioned species appear only temporarily with sporadic Atlantic inflows, and are unable to establish permanent populations due to the unfavorable low-salinity conditions.

The non-native hydrozoan, *Calyptospadix cerulea* Clarke, 1882 has been identified in the westernmost Baltic Sea, almost a century ago (Stechow 1927, as *Bimeria baltica* Stechow, 1927) but had seemingly not spread into the Baltic Proper. This species, commonly referred to as the “rope-grass hydroid”, is an athecate hydrozoan belonging to family Bougainvilliidae. Currently, the species is considered native to the western Atlantic (Calder 2019). Due to its wide tolerance range for salinity and temperature (Crowell and Darnell 1955), it is found in environments spanning from temperate to tropical regions, and from fully marine to brackish waters and is commonly recognized as a widespread invasive species (Calder 2019). The absence of *C. cerulea* is rather surprising and may indicate that it has been overlooked by biodiversity surveys.

In this study, we document the first records of the colonial hydroid *C. cerulea* in the southern Baltic Sea (Gulf of Gdańsk), showcasing a significant range expansion into the Baltic Proper. We supplement our observation with in-depth analysis of *C. cerulea* distribution and morphology, and provide first molecular data, allowing us to uncover its phylogenetic position and facilitating subsequent monitoring.

Materials and methods

The sampling site was the torpedo testing facility from the World War II located over 300 m offshore in Gdynia (“Torpedownia”, 54.587639 N, 18.545711 E) in the Gulf of Gdańsk (southern Baltic Sea) (Fig. 1). Samples were collected by divers during three sampling events between November and December 2024 from the submerged concrete construction and biotic surfaces overgrowing it, at

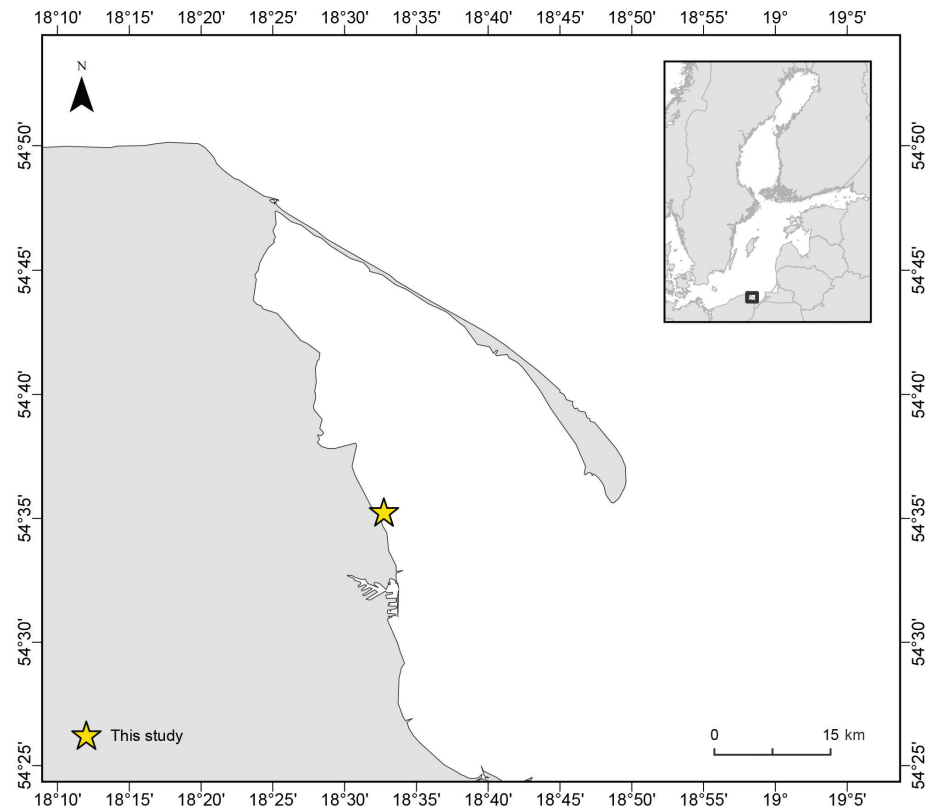


Figure 1. Location of sampling site at Torpedo Launch Station (“Torpedownia”) in Gdynia in the Gulf of Gdańsk.

depths between 6 and 8.8 m. The seawater temperature at the study site was 8 °C in November and 6 °C in December. The colonies were transported in containers with seawater to the laboratory, where they were identified and measured. Part of the material was preserved in 96% ethanol for molecular analysis, while the remaining material is kept alive in the laboratory culture facility for further research.

Morphological analyses

Morphological analyses were conducted under stereomicroscope Leica M205C with the use of Leica Application Suite v. 4.13. The following traits were measured: colony size, branch length, hydranth length, hydranth width, pedicel width, and number of tentacles.

Squash preparations for light microscopy were made using fresh nematocysts obtained from a living colony of *C. cerulea*. The nematocysts were examined and photographed using interference-contrast optics on a Nikon Eclipse Ti-S microscope. Morphometric measurements of hydranths were performed *in vivo*.

Molecular analyses

Genomic DNA was extracted from two colonies using DNeasy Blood and Tissue Kit (QIAGEN) following manufacturer’s instructions. Two mitochondrial markers, 16S rRNA and COI, and nuclear 18S rRNA were amplified using standard primers: SHA/SHB for 16S rRNA (Cunningham and Buss 1993), LCO-1490/HCO-Med-2414 for COI (Folmer et al. 1994; Ortman et al. 2010) and MitchA/MitchB for 18S rRNA (Medlin et al. 1988). The following PCR profiles were used: for 16S rRNA, 30 cycles of 20 s at 94 °C, 45 s at 50 °C, 120 s at 68 °C

(Schuchert 2018); for COI, 40 cycles of 60 s at 94 °C, 120 s at 45 °C, 180 s at 72 °C (Ortman et al. 2010); for 18S rRNA, 30 cycles of 30 s at 94 °C, 60 s at 40 °C, 60 s at 72 °C, 300 s at 72 °C (Dunn et al. 2005). Amplified DNA was sent to Eurofins Genomics for Sanger sequencing. Consensus sequences were assembled in Geneious Prime (v. 2025.0.2) and deposited in GenBank (see Suppl. material 1).

Phylogenetic reconstruction was based on data previously reported in Mendoza-Becerril et al. (2018). We retrieved complete matrix (16S, COI and 18S) for all species reported in their study belonging to: Filifera, Filifera III (excluding *Janaria mirabilis*; renaming *Lepidopora microstylus* to *Leptohelia microstylus*, due to species status), Pandeidae (except *Pandea* sp.), Pseudothecata (renaming a likely mis-identified *Podocorynoides minima* as *Cytaeis uchidae*, Peter Schuchert personal communication), and additionally of *Dicoryne conybeari* (Suppl. material 1), totaling to 29 species. Sequences of each gene were then aligned in Geneious Prime with MAFFT using FFT-NS-i algorithm with 1000 iterations and 1PAM/k=2 scoring matrix and concatenated into a single matrix. Maximum likelihood phylogenetic analysis was run in W-IQ-TREE (Trifinopoulos et al. 2016) on concatenated multi-gene dataset with ModelFinder for model selection, FreeRate heterogeneity, edge-linked partition, and subsequent testing with ultrafast bootstrap analysis with 1000 iterations. Consensus tree was visualized in FigTree v.1.4.4 with additional formatting done in CorelDraw 2021.

Distribution map

Occurrence records of *C. cerulea* were downloaded from GBIF.org (2025) and OBIS (taxonid: 292221; accessed on 04-Feb-2025). Additional records were sourced from earlier taxonomic works (Suppl. material 2), most notably from species distribution reviews by: Vervoort (1964; European waters), Calder (2019; west Atlantic) and Zaitsev and Öztürk (2001; Aegan, Marmara, Black, Azov and Caspian Seas). We also included references listed in the NEMESIS database (Fofonoff et al. 2018), excluding certain records due to misidentifications, inability to verify original sources or original location being not specific enough (Suppl. material 2). As literature-based records often lacked geographic coordinates, their position was approximated based on the descriptions given in the text (Suppl. material 2). All occurrence records were processed in R with *tidyverse* (v.2.0.0), to combine them into a single database and to remove duplicates. Then, maps were plotted in ArcGIS Pro (v.3.4.1).

Results and discussion

Taxonomic analysis

***Calyptospadix cerulea* Clarke, 1882**

Fig. 2A–D, G, H, Table 1

Calyptospadix cerulea Clarke, 1882: 136, pl. 7, figs 1–9. – Wedler 1973: 32, fig. 1.
– Calder (2019): 22–23, fig. 2e.

Garveia cerulea (Clarke, 1882). – Bandel and Wedler 1987: 39. – Calder 1971: 39, pl. 2, fig. E. – Dean and Bellis 1975: 6. – Palacios 1979: 114.

Bougainvillia ramosa (Van Beneden, 1844). – Funke 1922: 192, fig. 3.

Bimeria franciscana Torrey, 1902: 28, pl. 1, fig. 4. – Leloup 1932: 139, figs 12, 13, pl. 17, figs I, Ia. – Weill 1934: 77, 386, fig. 71a, b. – Fraser 1937: 31, pl. 3, fig. 14. – Deevey 1950: 335. – Crowell and Darnell 1955: 516–518. –

Buchanan 1956: 276. – Cory 1967: 79. – Nauman and Cory 1969: 218–226. – Gomez 1970: 1–56, figs 6–10, 12–15. – McLean 1972: 229. – Defenbaugh 1972: 387. – Defenbaugh and Hopkins 1973: 49.

not *Bimeria franciscana*. – Joyce, 1961: 36, pl. 5, figs 3, 4 [= *Bimeria humilis* Allman, 1877].

Bimeria Monidi Billard, 1927: 467, figs 1, 2a.

Bimeria baltica Stechow, 1927: 306–308, figs 1, 2.

Cordylophora caspia. – Hummelinck, 1936: 42, fig. 1a, b.

Bimeria tunicata Fraser, 1943: 76, 86, pl. 15, fig. 2. – Fraser 1944: 50, pl. 5., fig. 18. – Fraser 1945: 21.

Perigonimus megas Kinne, 1956a: 257–268, figs 1–7. – Penzlin 1957: 229–231, figs 1, 2. – Simkina 1963: 216–224. – Zevina et al. 1962: 8. – Vervoort 1964: 125. – Zaitsev and Öztürk 2001: 119–120, 156–158, 197–199.

in part *Cordylophora lacustris* Allman, 1844 – Pennycuik 1959: 165, pl. 2, figs 4, 5.

Garveia franciscana (Torrey, 1902) – Vervoort 1964: 127, figs 1–4. – Thiel 1970: 484. – Calder 1971: 40, pl. 2, figs. F, G. – Andrews 1973: 223–234. – Poirrier and Mulino 1977: 15. – Calder and Hester 1978: 89. – Morri 1982: 381: figs 1–5, pl. 1. – Fox and Ruppert 1985: 162, 167, 219. – Larsen 1985: 800. – Schönborn et al. 1993: 220, pl. 4, fig. 2. – de Rincón and Morris 2003: 17–24, pl. 1, 7. – Schuchert 2007: 253–255, fig. 22. – Garman et al. 2011: 71. – Wedler 2017: 23, figs 7–8.

Material examined. Gulf of Gdansk, at Torpedo Station, 8–10 m, 23.11.2024, 8 °C, infertile colonies, on the Torpedo Station wall, 17–48 mm high, coll. B. Moreno. Gulf of Gdansk, at Torpedo Station, 0–5 m, 22.12.2024, 6 °C, infertile colonies, on *Mytilus trossulus* (A. A. Gould, 1850), *Halichondria panicea* (Pallas, 1766) and *Amphibalanus improvisus* (Darwin, 1854), 10–42 mm high, coll. B. Moreno. Gulf of Gdansk, Torpedo Station, 31.12.2024, 6 °C, large infertile colony, 90 mm high, coll. B. Moreno.

Description. Colonies erect, reaching up to 9 cm in height, branched, bushy, covered by thick, brown perisarc (Fig. 2A, B). Hydrorhiza composed of a dense network of anastomosing and intertwining fibers, forming a mat-like structure covering the substrate. Main stem monosiphonic, smooth, lacking nodes, sometimes covered by secondary tubes at the base. Branches positioned around the stem, originating with a ringed stretch of varying length. Secondary branches not common. Hydranths raise from short pedicels annulated basally, with conical hypostome and a single distal whorl of 8 to 11, filiform tentacles. Pseudohydrotheca covering polyp base but not reaching the base of tentacles (Fig. 2H). In fully relaxed polyps, the pseudohydrotheca difficult to observe (Fig. 2C). All examined colonies were sterile. Two types of nematocysts; larger oval microbasic euryteles with an average length of 8.1 µm and width of 4.9 µm, and smaller, round desmonemes with an average length of 3.7 µm and width of 3.3 µm. In the examined material, only eurytele capsules with a discharged cnidocil were observed (Fig. 2G).

Measurements of selected morphological characteristics are presented in Table 1.

Remarks. The presence of pseudohydrotheca and filiform tentacles clustered in a single whorl around the hypostome permit reliable distinction from another common athecate hydroid in the Baltic Sea, *Cordylophora caspia* (Vervoort 1964).

The colonies of *C. cerulea* were numerous and occasionally reached high biomass and size at the sampling site (Fig. 2A, B). They created bushy meadows both on the concrete walls and on biotic substrates such as bivalve shells of *Mytilus trossulus*, demosponge *Halichondria panicea* and cirriped *Amphibalanus improvisus*. The surface of colonies was covered with sediments and epibiota e.g., diatoms,

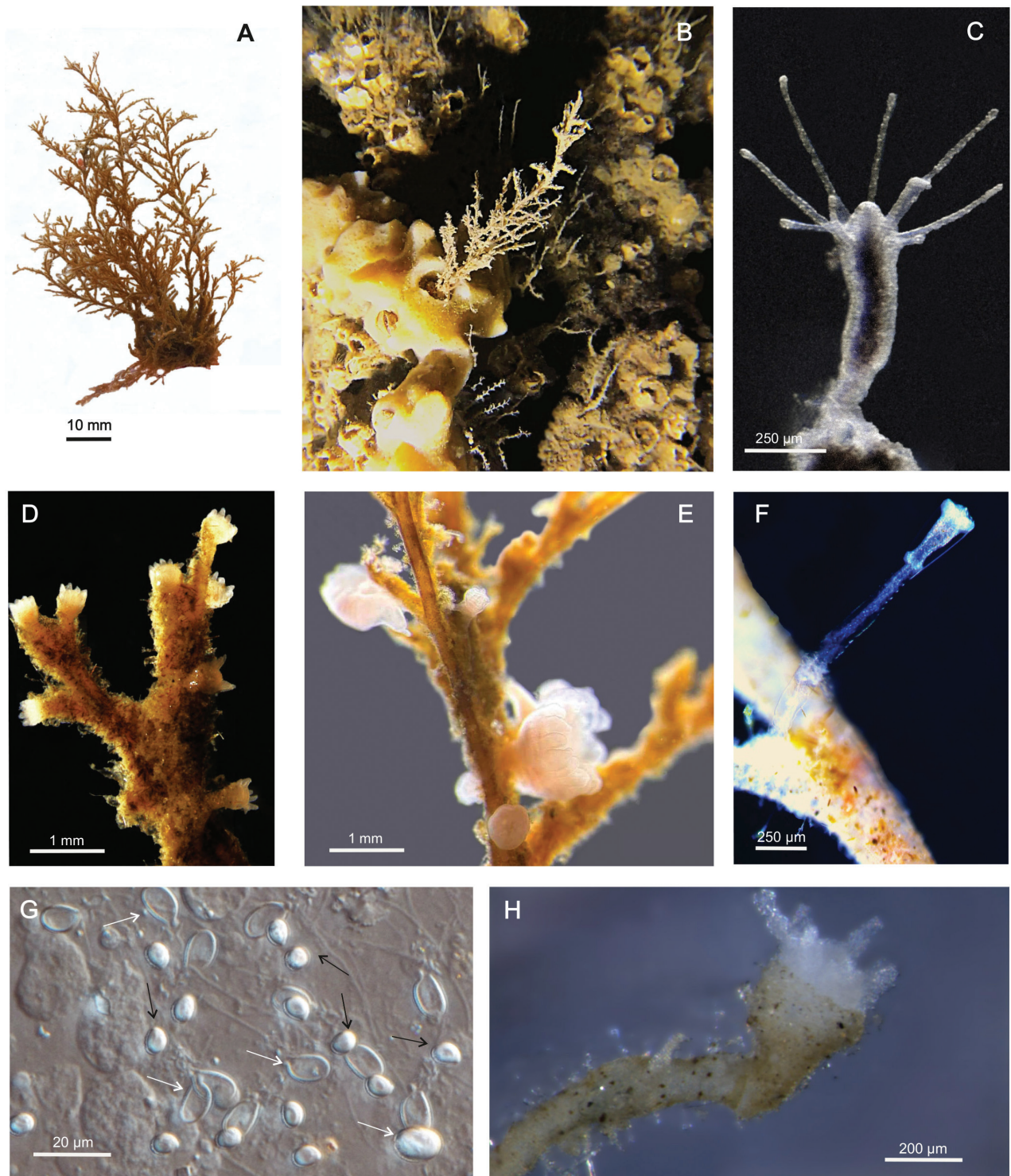


Figure 2. *Calyptospadix cerulea* Clarke, 1882: colony silhouette (A), underwater image of a colony colonizing a demosponge *Halichondria panicea* (Pallas, 1766) (B), relaxed polyp with characteristic single distal whorl of tentacles (C), close up of branch with polyps with contracted tentacles (D), epizootic *Aurelia aurita* (Linnaeus, 1758) polyps (E) and *Gonothyrea loveni* (Allman, 1859) (F) growing on colonies of *C. cerulea*, nematocysts of living *C. cerulea* colony, white arrows – euryteles, black arrows – desmonemes (G), pseudohydrotheca covering polyp base (H).

protozoans, polyps of *Aurelia aurita* (Linnaeus, 1758) (Fig. 2E) and *M. trossulus* juveniles. Direct spatial competition with the native hydroid *Gonothyrea loveni* was not observed; instead they grew on the substrate side by side, with occasional cases of *G. loveni* using *C. cerulea* as a substrate (Fig. 2F).

Table 1. Morphological analysis of *C. cerulea* Clarke, 1882 colonies with number of measurements (N), range, mean and standard deviation.

Morphological trait	N	Range	Mean	SD
Colony size [cm]	12	1.2-9	3.02	5.56
Branch size [cm]	18	1.65-15.05	6.29	3.21
Hydranth length [mm]	16	0.40-0.82	0.56	0.12
Hydranth greatest width [mm]	16	0.20-0.39	0.29	0.08
Pediceal width [mm]	16	0.09-0.18	0.15	0.08
Number of tentacles	14	8-11	9	1
Euryteles length [μm]	11	7.13-8.90	8.09	0.54
Euryteles width [μm]	11	4.30-5.29	4.87	0.35
Desmonemes length [μm]	10	3.53-4.08	3.73	0.22
Desmonemes width [μm]	10	3.28-3.43	3.31	0.07

Hydranths were present in November despite the seawater temperature was 8 °C, while regressed hydranths were observed in colonies collected in December, when temperature dropped to 6 °C. However, when the latter were transferred to the laboratory and kept at 10 °C, they had regrown actively functioning feeding polyps after few days.

Phylogenetic position

To facilitate subsequent phylogeographic analyses, as well as to provide reference data for biological invasion monitoring, we present the first set of molecular data for *C. cerulea* that was used to reconstruct its phylogenetic position (Fig. 3, Suppl. material 1). The recovered topology of the majority of athecate hydrozoans (order Anthoathecata) was consistent with recent molecular works (e.g., Prudkovsky et al. 2017; Mendoza-Becerril et al. 2018). We documented paraphyletic relationships within Cytaeidae, Pandeidae, Oceanidae, indicating a non-monophyletic Bougainvilliidae with multiple divergent lineages scattered across the phylogeny (Fig. 3). We also found that sequences of *C. cerulea* clustered together with *B. vestita* and *C. caspia*. Although the branch support for this grouping was relatively low (79), this result suggests that they all should be united under the same family Cordylophoridae. This, however, will require a more thorough examination of their morphological and molecular diversity.

Distribution and invasion history

The original description of *C. cerulea* dates back to 1882 and was based on material from the western Atlantic, off the coast of Virginia, United States (Clarke 1882). In 1902, a similar species, *Garveia franciscana*, was described from the eastern Pacific, in San Francisco Bay, USA (Torrey 1902, as *Bimeria franciscana*). The distinction between these two species was based on the number of eggs produced by a gonophore, with a single egg developing in *G. franciscana*, and multiple eggs in *C. cerulea*. It was only recently, that Calder (2019), observed different developmental stages of gonophores, containing both a single egg cell, as well as multiple egg cells within the same colony. This led him to consider both species as conspecific, and to propose that they represent a single species under the priority name *Calyptospadix cerulea* (Calder 2019).

Records of *C. cerulea* span coastal regions in both hemispheres, extending as far north as the American subarctic (59°N) and as far south as the Australian

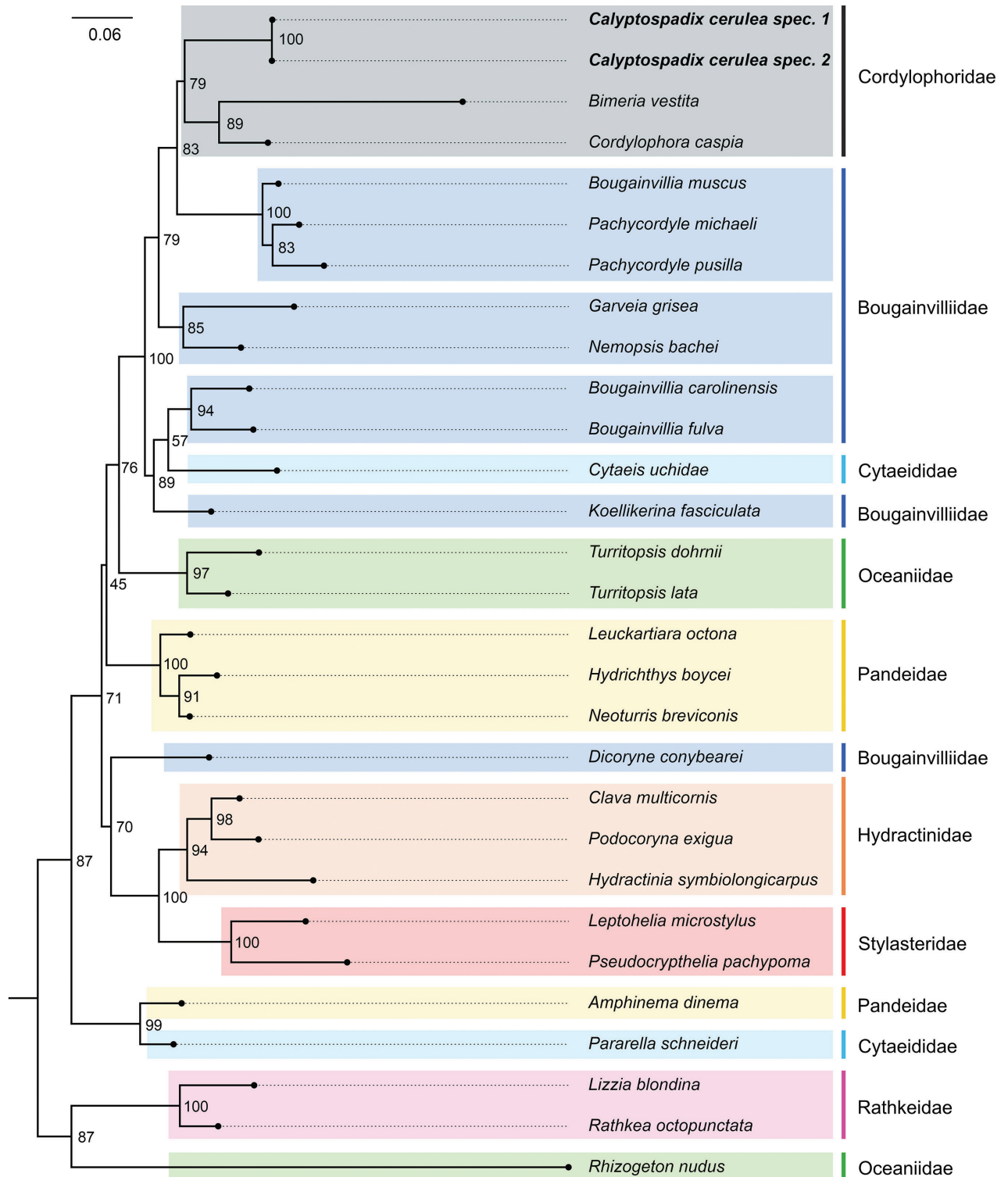


Figure 3. Maximum likelihood reconstruction of *Calyptospadix cerulea* Clarke, 1882 (in bold) phylogenetic position, based on a concatenated set of molecular markers (16S rRNA, COI, 18S rRNA), with bootstrap values showed near the nodes. Marker-specific substitution models identified with ModelFinder were: GTR+F+I+G4 (COI) and TIM2+F+I+G4 (16S rRNA and 18S rRNA). Family-level assignments are color coded. *Calyptospadix cerulea* spec. 1 and spec. 2 indicate two separate colonies sequenced in this study.

coastline (27°S, Fig. 4A). This species has been widely reported from the Atlantic Ocean, including the USA east coast (Fraser 1944, as *B. tunicata*), the Gulf Coast of Florida (Calder 2019), and Venezuela (de Rincón and Morris 2003, as *G. franciscana*). It has also been recorded in European continental seas, such as

the Mediterranean Sea (first record from Venice in 1978; Morri 1981, 1982), the Sea of Azov (Simkina 1963), the Black Sea (Paspalev 1933), the Caspian Sea (Zevina 1962), and the North Sea, especially it was very common in Zuiderzee, the no longer existing Dutch bay of the North Sea (Vervoort 1964, and references therein). Additional records come from more southern regions, including Australia (Pennycuik 1959; Davie 1990) and West Africa (Billard 1927; Buchanan 1956). Data from OBIS (2025) and GBIF (2025) also include tropical occurrences in the Indian Ocean and Caribbean Sea (Fig. 4).

In the Baltic Sea and adjacent waters, *C. cerulea* has been recorded only in the westernmost part of the basin (Fig. 4B), where it was previously identified under the name *G. franciscana*, including records from Kiel Bay (Thiel 1970), the Bay of Mecklenburg, and the Warnow Estuary (Penzlin 1957). We also suggest that *Bimeria baltica*, described by Stechow (1927) from the Greifswald Lagoon, may in fact be conspecific with *C. cerulea*. Although this identification was challenged by Kinne (1956b) and Penzlin (1957), Stechow's description of the hydranth morphology, the arrangement of tentacles in a single apical whorl, their number, and the position of the gonophores closely match the diagnostic features of *C. cerulea*. Since then, this species has been reported multiple times along the German Baltic coast, including Kiel Bay (2016, 2020, as *G. franciscana*), Sassnitz on the island of Rügen, and the Bay of Mecklenburg (AquaNIS 2025). Further molecular work, based on specimens from the two type localities, as well as populations from other regions of the world are needed to better resolve the complex status of species considered synonymous to *C. cerulea*.

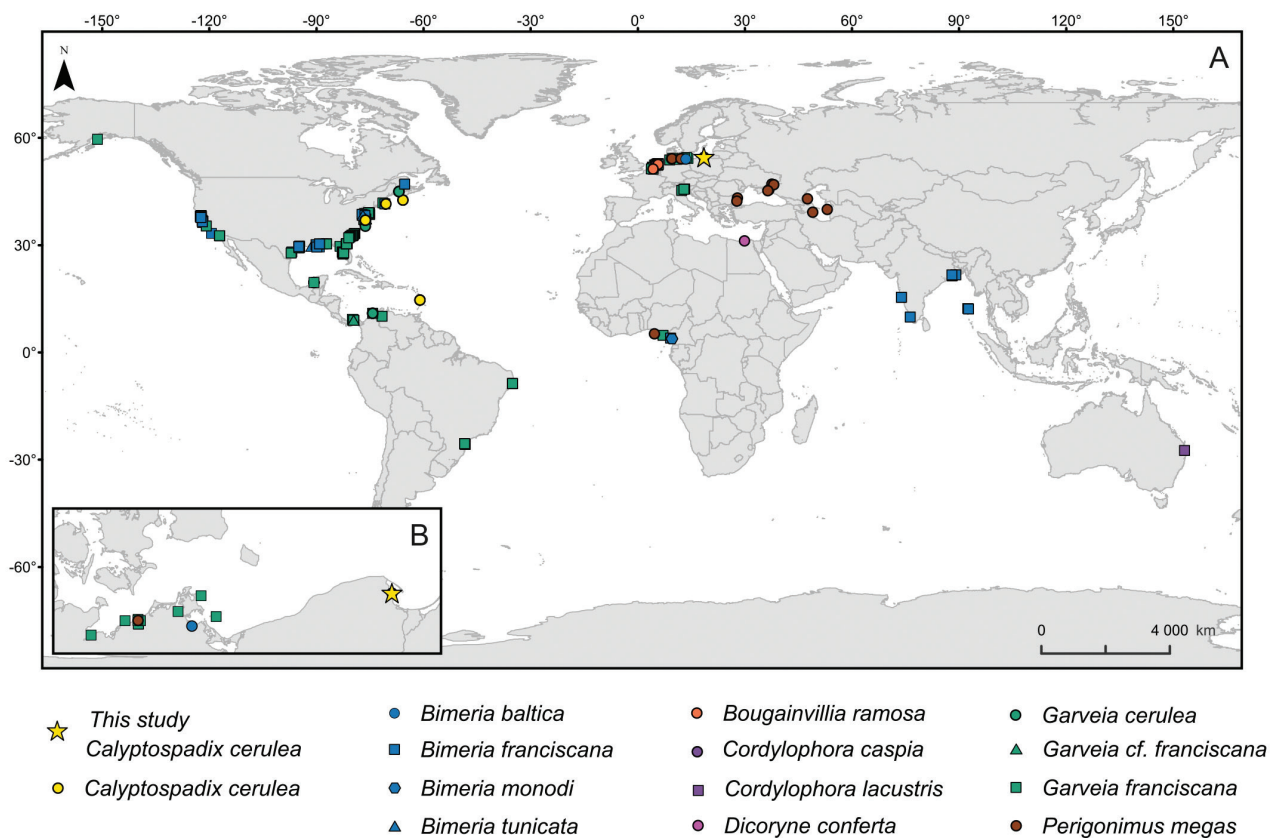


Figure 4. Global distribution of *Calyptospadix cerulea* Clarke, 1882 under various synonyms (A), with an inset showing its distribution in the Baltic Sea (B). The star symbol in the inset marks the *C. cerulea* record documented in the present study at the Torpedo Launch Station in the Gulf of Gdańsk. Occurrence records were downloaded from GBIF.org (2025), OBIS, Nemesis database and earlier taxonomic works (for detailed list see Suppl. material 2).

The low number of *C. cerulea* records since it was first reported by Stechow in 1927 may be due to the limited availability of natural hard-bottom habitats in the southern Baltic Sea (Tęgowski 2005). However, future occurrences may increase because of the growing number of artificial marine structures, e.g., offshore wind farms, cables, and underwater infrastructure (Kubacka et al. 2024), which can serve as “stepping-stones” facilitating the spread of non-native species. Additionally, intensified maritime traffic and inadequate ballast water management may further contribute to the introduction and expansion of *C. cerulea* in the region.

Ecological and economic implications

The expansion of *C. cerulea* in the Baltic Sea could have both ecological and economic consequences. Its detrimental impact on industrial water systems is well-documented in several locations worldwide. For example, dense colonies of this species have been found overgrowing the intake structures of cooling water systems at the Chesapeake Bay Nuclear Power Plant, clogging filtration screens and leading to a noticeable decline in pump efficiency (Tamburri 2014). In the Sea of Azov, *C. cerulea* has been identified as a major component of biofouling communities on marine industrial water intake structures at the Azovstal metallurgical plant in Mariupol, Ukraine (Simkina 1965). The abundant growth observed on water conduits suggests that rapid water flow creates particularly favorable conditions for its development (Simkina 1963). The expanding presence of *C. cerulea* has become a growing concern for industries in Venezuela that rely on Lake Maracaibo’s water. As a primary contributor to biofouling and biological corrosion, this species creates encrustations and causes blockages in submerged equipment and infrastructure (de Rincón and Morris 2003), resulting in substantial maintenance costs and increased efforts to prevent fouling and corrosion. In Chesapeake Bay, it presents a significant challenge for crabbers, as it heavily encrusts their traps, reducing their effectiveness. As a result, fishermen are forced to frequently clean and dry their gear (Andrews 1973). Similarly, it has become problematic for oyster farms, where it extensively overgrows both oyster trays and the oysters themselves (Andrews 1973).

Nevertheless, the positive role of three-dimensional, erect, bushy colonies of *C. cerulea* as habitat providers should not be overlooked. This species frequently serves as secondary substrate for various epibionts and may be densely colonized by protozoans. Notably, despite sampling taking place in winter, juvenile bivalves and *Aurelia aurita* polyps were also observed inhabiting its colonies, indicating that *C. cerulea* can offer refuge and settlement surfaces even during less biologically active seasons. Moreover, *C. cerulea* was observed to co-occur with the native *G. loveni* without signs of competitive exclusion, suggesting a degree of ecological compatibility between the two hydrozoan species.

Similar habitat functions of bushy hydroid colonies have been documented in other studies. Numerous amphipods, mud crabs, and various microscopic protozoans were found inhabiting dense colonies on experimental panels in the Patuxent Estuary (Cory 1967). Likewise, Simkina (1965) reported mobile invertebrates such as copepods, isopods, amphipods, and polychaetes thriving among elevated hydroid colonies. In fouling communities, hydroids also supported intense predatory interactions. For example, up to 7,000 *Stiliger bellulus* (A. d’Orbigny, 1837) nudibranchs per 100 g of hydroids were recorded feeding on colonies, while approximately 1,500 juvenile *Rhithropanopeus harrisi* (Gould, 1841) crabs were found hiding and feeding within a single square meter of hydroid-covered substrate (Simkina 1965).

Although more data is needed, the particularly broad tolerance of *C. cerulea* to both salinity and temperature make it very likely that this species will continue to thrive in the Baltic Sea. Given its potential to interact with native fauna and the still insufficiently understood ecological roles it may play, further research on *C. cerulea* is needed. A better understanding of its biology and ecological impact is essential to anticipate possible long-term consequences on native assemblages and to inform effective monitoring and management strategies within the HELCOM-regulated Baltic Sea ecosystem.

Author contribution

Research conceptualization: MR, MKM. Sample design and methodology: MR, MKM. Investigation and data collection: MR, MKM, BM. Data analysis and interpretation: MR, MKM, ZS, JW, OB. Writing roles: MR, MKM, BM.

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Data availability

Species georeferenced records are available at the European Alien Species Information Network: <https://easin.jrc.ec.europa.eu/easin/RJD/Download/9729cc18-b0d6-41fb-869e-84763104099f>.

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Supplementary material 1

GenBank accession numbers for markers and species used in this study

Authors: Marta Ronowicz, Maciej Karol Mańko

Data type: docx

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Link: <https://doi.org/10.3391/ai.2026.21.2.188183.suppl1>

Supplementary material 2

Georeferenced records and complete bibliographic data on the synonymy and global distribution of *Calyptospadix cerulea* Clarke, 1882

Authors: Marta Ronowicz, Maciej Karol Mańko, Olga Broclawik

Data type: xlsx

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