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Research Article

The French benthic newcomers: new records of *Ampithoe valida* S.I. Smith, 1873 and *Polydora colonia* Moore, 1907 in Brittany, first record of *Bispira polyomma* Giangrande & Faasse, 2012 in the North-East Atlantic and northernmost record of *Prostheceraeus moseleyi* Lang, 1884 in Europe

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Abstract

As introduced species constitute a major threat to biodiversity, it is crucial to properly monitor their spread to new regions. The present study reports new records of four species: 1) the amphipod *Ampithoe valida* S.I. Smith, 1873 and 2) the polychaete *Polydora colonia* Moore, 1907, both new records for Brittany (North-West part of France); 3) the polychaete *Bispira polyomma* Giangrande & Faasse, 2012, a first finding in the North-East Atlantic; and 4) the flatworm *Prostheceraeus moseleyi* Lang, 1884 with a confirmed northernmost record in North-East Atlantic. These species were recorded within two semi-enclosed bays: the Morbihan Gulf on the southern coast of Brittany and the Bay of Brest in the North-West part of Brittany. Both localities are already known to host numerous non-indigenous species as well as benthic macrofaunal distributional range limits. Morphological variations and inconsistencies are discussed and reported for *A. valida*, revealing missing characters and errors in the literature. This work adds three non-indigenous species to Brittany and two non-indigenous species to French waters, for which we discuss potential introduction vectors.

Key words: Amphipoda, Polychaeta, Platyhelminthes, introduction, non-indigenous, non-native, distribution

Introduction

Non-indigenous species (NIS; *i.e.* species introduced successfully to new areas through human activities; Blackburn et al. 2011) are considered as one of the major threats to biodiversity (Molnar et al. 2008; Brondízio et al. 2019), leading in some cases to extinction of the threatened species (Blackburn et al. 2019). While the number of introduced species is probably underestimated

(Bailey et al. 2020), their actual impacts on native environments is still largely unknown due to 1) few studies reporting low NIS impact, 2) the difficulties encountered in detecting and studying small and low abundance species and 3) dedicated funds being focused on suspected impacts targeting the most aggressive invasive NIS (Anton et al. 2019). Nevertheless, impacts on native communities are in some cases unequivocal, such as alterations in ecosystem services, native species extinctions or changes in to their native species behaviour (Vilà et al. 2010; Catford et al. 2018; Anton et al. 2019). The majority of NIS in the marine realm are introduced through shipping (Hewitt et al. 2009; Tsiamis et al. 2018), which is expected to further increase in the near future (Sardain et al. 2019). Modelling studies focused on introduction and dispersion of NIS provide important tools to predict the spread and impacts of these species (Faulkner et al. 2020; Laeseke et al. 2020). To do so, a thorough baseline of records, species traits and environmental conditions of introduced areas are needed not only as input for these models, but ultimately for defining new management procedure to tackle NIS introductions or spread (e.g. Weerasena et al. 2022). All these steps rely on an international network of taxonomic skills able to detect newly-introduced NIS (Cottier-Cook et al. 2017; Hutchings and Lavesque 2020). Therefore, a worldwide up-to-date and accurate NIS records database represents a crucial tool.

Simultaneously, several species that are expanding their ranges in response to anthropogenic environmental changes, defined as neonative (Essl et al. 2019), are shifting poleward following climate induced changes in temperature (Poloczanska et al. 2013; Burrows et al. 2014; Lenoir et al. 2020). Consequently, range expansions or local extinctions are underway and are affecting local community structure and functioning (Sorte et al. 2010; Pinsky et al. 2020). While their effects may be considered as transient, rather than permanent (Urban 2020), their impacts may be comparable to those of NIS (Sorte et al. 2010; Wallingford et al. 2020). It is therefore important to also monitor species range shifts, to fill the knowledge gap concerning those species (Occhipinti-Ambrogi 2007).

Here, we report four new NIS records along the French Atlantic coast: 1) the amphipod *Ampithoe valida* S.I. Smith, 1873 and 2) the polychaete *Polydora colonia* Moore, 1907 that continue to spread across the French coasts; 3) the polychaete *Bispira polyomma* Giangrande & Faasse, 2012, recorded for the first time in the North-East Atlantic and 4) the flatworm *Prostheceraeus moseleyi* Lang, 1884 with a major distributional range shift poleward. For the latter, we also discuss briefly the naturalist knowledge available on non-scientific sources. For all four records, we discuss whether the species occurrences are likely due to human-mediated introduction or whether they can be attributed to natural dispersion.

Materials and methods

Sampling and analysis

This study compiles several new records and sightings around Brittany (Western France, Europe) – a biogeographical transition area between cold- and warm-temperate European ecoregions (Figure 1) (Dinter 2001).

Ampithoe valida was discovered as part of a research project monitoring the macrofauna in the Séné natural reserve (curator Guillaume Gélinaud). Started in 2003, the aims are to monitor benthic macrofauna in order to quantify the food availability for birds and to monitor the ecological status of the estuary. The monitoring is not undertaken annually. Samples were retrieved using an intertidal hand-corer (0.00817 m²).

Polydora colonia were discovered as part of the two year research project IMPECAPE (2015–2017) dedicated to the assessment of ecological impacts of clam dredging on maerl beds. Samples were retrieved seasonally between January 2016 and May 2017 using a Smith-McIntyre grab (0.1 m²).

Samples for these first two species were sieved on a 1 mm mesh before fixation with 4% formaldehyde in advance of being sorted and preserved in 70% ethanol.

Bispira polyomma were first detected during a non-affiliated project field inventory and later on an artificial seawall during the monitoring of eco-engineered structures, through a Rapid Assessment Survey, as part of the CoEcoDigue project (https://dyneco.ifremer.fr/Nos-equipes/LEBCO/Recherche/Projets/COECODIGUE), started in 2020. Specimens were removed from the substratum with a scalpel and preserved in 70% ethanol.

Prostheceraeus moseleyi was also retrieved from the substratum during a personal field inventory and preserved in 70% ethanol.

The specimens were examined under a Zeiss Stemi 2000-C stereomicroscope and an Olympus BX-40 microscope. Photographs were taken either with a Canon Eos 600D or with the software Zen core V2.7 connected to either 1) a Zeiss Axioscope 5 equipped with an Axiocam 208 color or 2) a Zeiss Discovery.V20 equipped with an Axiocam 305 color. Scanning electron microscopy (SEM) images were produced with dehydrated specimens in ascending ethanol, dried to critical-point, coated with gold and photographed using the Quanta200 FEI (Ifremer).

The materials examined in this work were deposited in the Muséum National d'Histoire Naturelle de Paris (MNHN) reference collection. Accession numbers are given in each species sub-section.

For each species, a "short diagnosis" lists the main morphological diagnostics criteria. It should be noted that the diagnosis is insufficient for species identification; the authors highly recommend comparing specimens to the descriptions found in the literature used and cited in each species sub-section to avoid any confusions with morphologically close species.

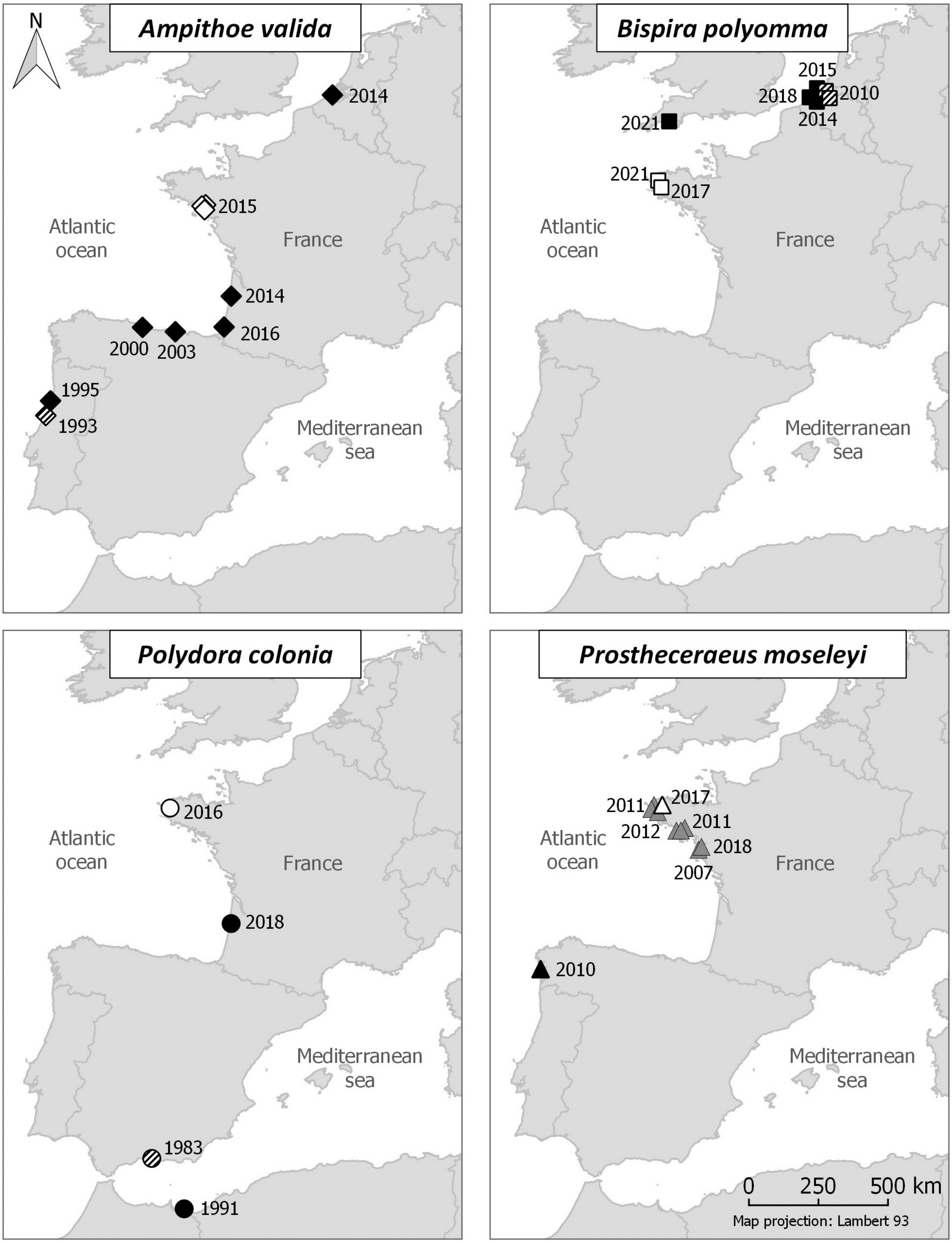

Figure 1. Map of Western Europe where all the newly recorded species have been observed and/or collected. Each symbol represent a species: (◊) *Ampithoe valida* Smith, 1873, (o) *Polydora colonia* Moore, 1907, (□) *Bispira polyomma* Giangrande & Faasse, 2012, (∆) *Prostheceraeus moseleyi* Lang, 1884. Black symbols display records from literature; grey symbols records from internet data; white symbols records from this study; black streaked symbols refer to the first mention in Europe.

Occurrence of Prostheceraeus moseleyi

To further complete the scientific literature and our field data, we compiled all records of *Prostheceraeus moseleyi* along the Atlantic coast of France reported through several media used by amateur biologists, such as websites (Doris; mer-littoral.org; Flickr; 500px), social networks (ResearchGate; Facebook) and the Bretagne vivante-SEPNB database. The search consisted of the following queries: *Prostheceraeus moseleyi; Prostheceraeus* AND *moseleyi* AND Atlanti*; depending on the media used (results in Supplementary material Table S3).

Measurements

All measures were made with an Axiocam MRc 5 mounted on a Zeiss stereo Lumar.V12. For the amphipod species, the length was measured from the rostrum to the distal end of the telson. For the two polychaetes, length was measured from the prostomium to the pygidium or, if damaged, to the last segment.

Results

Observations

Phylum Arthropoda von Siebold, 1848
Order Amphipoda Latreille, 1816
Family Ampithoidae Boeck, 1871
Genus *Ampithoe* Leach, 1814

Ampithoe valida Smith, 1873

Fourteen specimens were collected in 2015 and 2016, as part of a benthic monitoring project, directed by the Réserve Naturelle des Marais de Séné, France (curator Guillaume Gélinaud) in the Morbihan Gulf. Male specimens were firstly identified to the family and genus level (Chevreux and Fage 1925; Lincoln 1979; Bellan-Santini et al. 1982). Species level were attained through comparison of several works carried out in Europe reporting NIS (Faasse 2015; Gouillieux 2017), and through the use of guides and scientific publications dealing with amphipod fauna from other continents (Mills 1964; Bousfield 1973; Lecroy 2002; Shin et al. 2005; Kim 2011).

Materials examined: 2 males: MNHN-IU-2022-387, 11.3 mm, 47°36′5.526″N; 2°41′49.721″W, 21/12/2016; MNHN-IU-2022-388, 13 mm, 47°36′5.526″N; 2°41′49.721″W, 22/10/2016; 12 females: MNHN-IU-2022-389, ovigerous female, 10.8 mm, 47°35′31.499″N; 2°41′44.415″W, 09/10/2015; MNHN-IU-2022-390, 13.8 mm, 47°35′31.499″N; 2°41′44.415″W, 09/10/2015; MNHN-IU-2022-391, 9 mm, 47°35′31.499″N; 2°41′44.415″W, 09/10/2015; MNHN-IU-2022-392, ovigerous female, 9 mm, 47°35′31.499″N; 2°41′44.415″W, 09/10/2015; MNHN-IU-2022-393, female with juveniles emerging from the brood, 13.1 mm, 47°35′31.499″N; 2°41′44.415″W, 09/10/2015; MNHN-

IU-2022-394, 5.6 mm, 47°36′5.526″N; 2°41′49.721″W, 22/10/2016; MNHN-IU-2022-395, ovigerous female, 7.1 mm, 47°36′5.526″N; 2°41′49.721″W, 21/10/2016; MNHN-IU-2022-396, 11.8 mm, 47°35′31.499″N; 2°41′44.415″W, 09/10/2015; MNHN-IU-2022-397, 6.7 mm, 47°35′31.499″N; 2°41′44.415″W, 09/10/2015; MNHN-IU-2022-398, 7.8 mm, 47°35′31.499″N; 2°41′44.415″W, 09/10/2015; MNHN-IU-2022-399, 11.7 mm, 47°36′5.526″N; 2°41′49.721″W, 21/10/2016; MNHN-IU-2022-400, 6.7 mm, 47°36′5.526″N; 2°41′49.721″W, 21/10/2016.

Additional materials examined: MNHN-IU-2014-12860, dissected specimen (17 slides), 7.8 mm, 44°40′30.651″N; 1°05′55.540″W, 22/10/2014; MNHN-IU-2014-12861, 11.6 mm, 44°39.639′N; 1°9.099′W, 27/04/2016.

Short diagnosis: Males share: 1) first gnathopod with large carpal lobe (Figure 2A); 2) second gnathopod with subquadrate middle tooth on palmar margin (Figure 2C); 3) coxa 1 to 4 with long setae on postero-distal margin (Figure 2B).

Morphological variations: Several morphological variations were observed on males from this study compared to recent descriptions (Mills 1964; Barnard 1965; Bousfield 1973; Conlan and Bousfield 1982; Lecroy 2002; Gouillieux 2017). Uropods and coxae 1–4 display the main variations (Table S1, excluding the study based on female descriptions (Shin et al. 2005; Kim 2011)).

Left propodus on pereopods 5–7 on male MNHN-IU-2022-388 reach 7 clusters of 1 spine and setae, instead of 5 as reported by Gouillieux (2017) at Arcachon. Alike Gouillieux's (2017) specimens, *A. valida* males studied here have propodus on pereopods 5–7 distally enlarged and not straight, as mentioned by Faasse (2015).

Gouillieux's (2017) specimens display some morphological variations compared to other descriptions (Table S1). After careful examination of the materials deposited at the MNHN by Gouillieux (2017), we noticed several characters that do not fit his recent description (Table S2 and Figure S1 B–F).

Ecology: All stations sampled in this area were muddy sediments with brackish water conditions (Perez-Belmonte 2008).

Grandidierella japonica Stephensen, 1938 also a recently discovered NIS (Droual et al. 2017), co-occurred with *Ampithoe valida*, in all but two stations. Furthermore, in at least one station *A. valida* co-occurred with two other introduced species, *Tritia neritea* (Linnaeus, 1758) and *Ruditapes philippinarum* (A. Adams & Reeve, 1850).

Phylum Annelida Lamarck, 1802
Order Spionida sensu Rouse & Fauchald, 1997
Family Spionidae Grube, 1850
Genus *Polydora* Bosc, 1802

Polydora colonia Moore, 1907

Nine specimens were sampled in the Bay of Brest on maerl beds as part of the IMPECAPE project (directed by Dr. Jacques Grall) in 2016. Identification

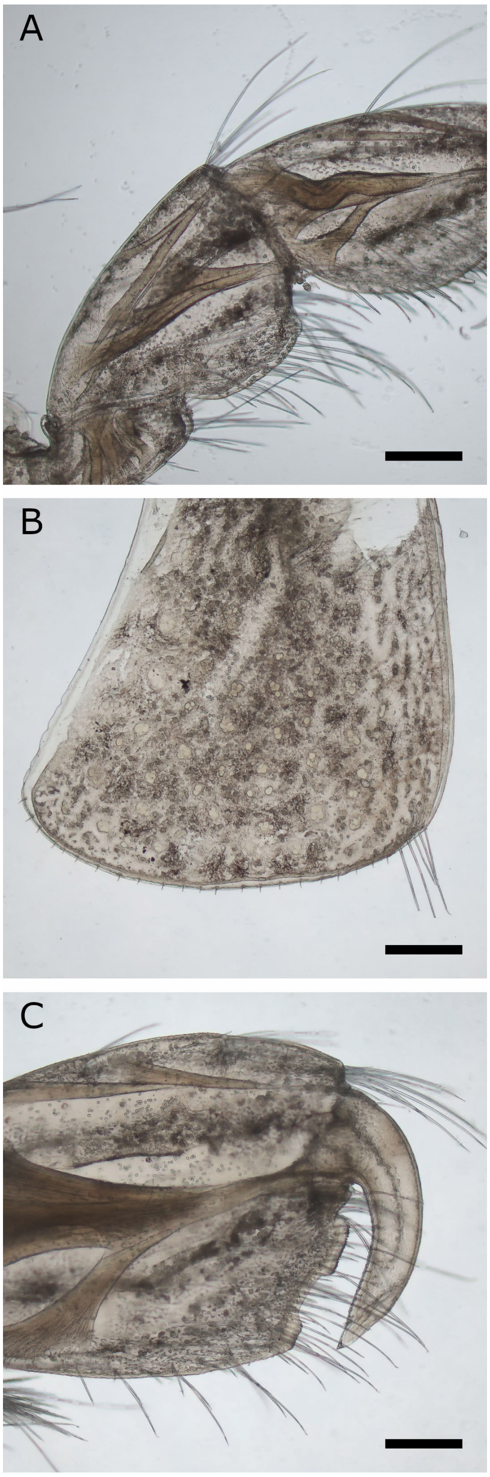

Figure 2. *Ampithoe valida* Smith, 1873, male from Morbihan Gulf, Brittany, France, MNHN-IU-2022-388, 13 mm, 22/10/2016. (A) Male first gnathopod, left side, inside view. (B) Long setae on postero-distal margin on left coxa 1. (C) Subquadrate middle tooth on propodus of second gnathopod, right side. Scale bars: 200 µm.

to the species level was achieved with several descriptions and records (Blake 1971; Aguirre et al. 1986; Gil 2011; David and Williams 2012).

Materials examined: MNHN-IA-PNT-139, 7.81 mm, 48°18′58.71″N; 4°23′27.99″W, 10/2016; VC1, 5.88 and 3.68 mm, 48°18′58.71″N; 4°23′27.99″W, 10/2016 and 01/2016; MD3, 2.97, 4.59, 5.17 and 7.23 mm, 48°19′10″N;

4°23′06.1″W, 01/2016; ZG4, 6.06 mm, 48°17′10.20″N; 4°21′19.90″W, 06/2016; ZC2, 3.64 mm, 48°18′55.35″N; 4°21′53.77″W.

Additional materials examined: 10 specimens, 44°34′N; 1°14′16.74”W, 13/04/2011, sampled by scuba-diving by Benoit Gouillieux.

Diagnosis: 1) collar on major spines of chaetiger 5 (Figure 3A); 2) major spines of chaetiger 5 bifid, with two unequal teeth (Figure 3A); 3) boat hooks on last few chaetigers before pygidium (Figure 3B).

Morphological variations: Compared to the re-description made by David and Williams (2012) the length of chaetiger 5 is smaller than twice the length of chaetigers 4 and 6; boat hooks appear between 7–10 last chaetigers with sometimes the last and/or penultimate chaetiger(s) without boat hooks, instead of starting from 2–7 last chaetigers; two boat hooks only observed on one specimen instead of generally two; boat hooks accompanied by 2–5 setae instead of two capillary setae; 4–7 hooded hooks per neuropodia size-dependent instead of 3–5 hooded hooks per neuropodia, and two pairs of eyes on a 47 chaetigers specimen.

Ecology: All specimens were sampled on maerl beds in the Bay of Brest in shallow waters with depth inferior to 10 m.

Order Sabellida Levinsen, 1883
Family Sabellidae Latreille, 1825
Genus *Bispira* Kröyer, 1856

Bispira polyomma **Giangrande & Faasse, 2012**

During an intertidal assessment of biodiversity, in 2017, one specimen attached to a dead oyster fixed to an oyster culture table frame was sampled in the Bay of Brest, in Penfoul cove at Plougastel-Daoulas. Later, in September 2021, a high density of *Bispira polyomma* was discovered during a survey monitoring artificial seawall biodiversity. To identify the specimens, Giangrande et al. (2015) and Faasse and Giangrande (2012) were used.

Materials examined: MNHN-IA-PNT-140, 11.5 mm, 48°20′48.20″N; 4°20′27.96″W, 16/11/2017; MHNH-IA-PNT-141, 2 broken specimens (8 and 20 chaetigers), 48°22′47.82″N; 4°26′31.33″W, 02/02/2022.

Diagnosis: 1) Thoracic tori reaching ventral shields (Figure 4C); 2) blackish pigment on thoracic tori (Figure 4C); 3) numerous eyes on the radioles (Figure 4B); 4) wide dorsal gap in the collar (Figure 4A); 5) few radioles (maximum = 20) (Figure 5A); 6) 6–8 coloured bands on radioles (Figure 5).

Remarks: The specimens observed fit completely to the original description (Faasse and Giangrande 2012). Specimen MNHN-IA-PNT-140, two body regions due to a posterior regeneration.

Ecology: One specimen identified in this study comes from an intertidal area in an oyster farm where *Steromphala albida* (Gmelin, 1791), another potentially abundant NIS (8 to 10/m², Gabin Droual and Vincent Le Garrec *pers. obs.*) is present. The second location where *Bispira polyomma*

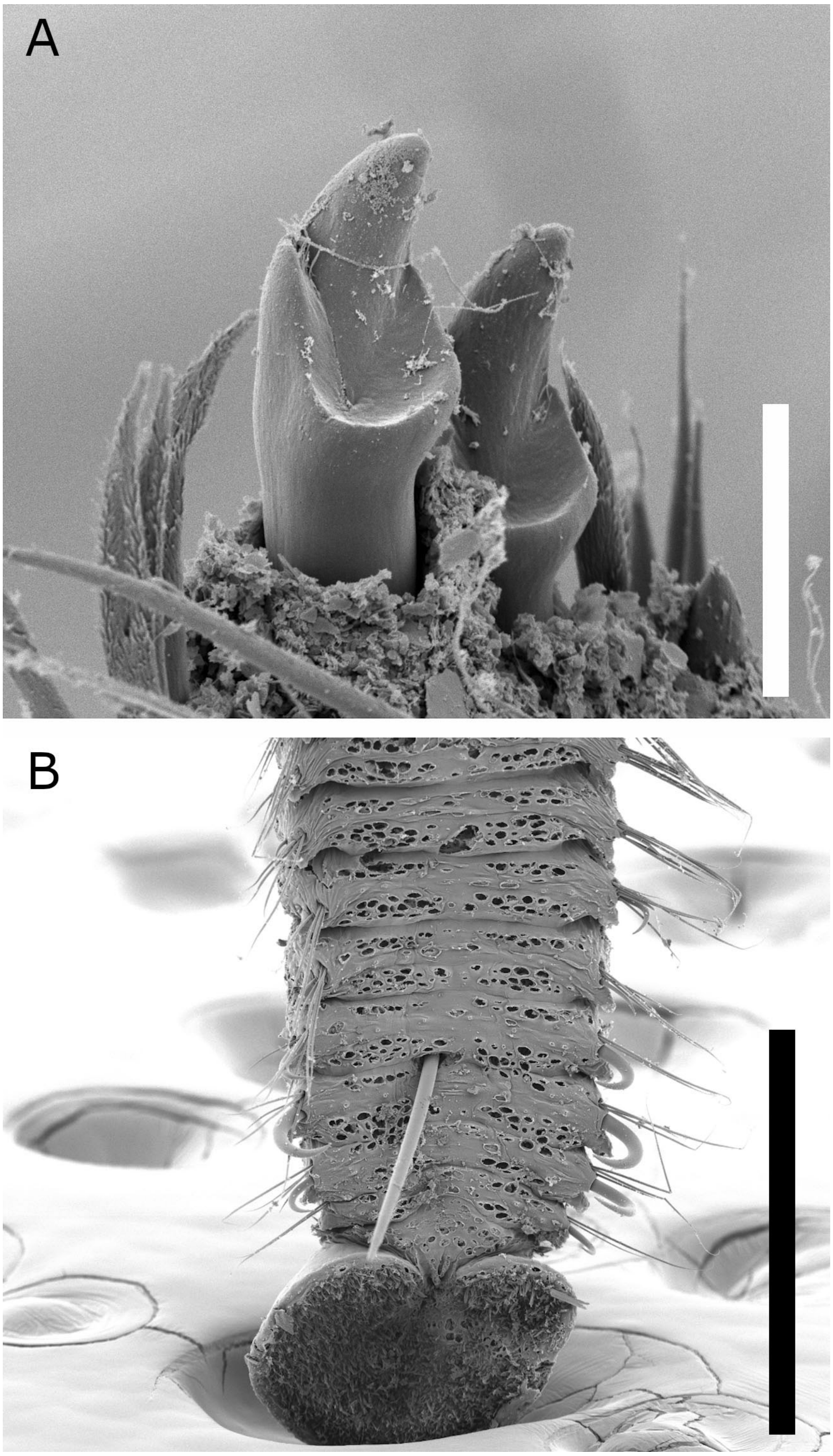

Figure 3. *Polydora colonia* Moore, 1907 from Brest, MD3 01/2016. (A) Major spines of chaetiger 5, scale bar: 20 µm. (B) Boat hooks and pygidium with a sponge spicule embedded through the posterior part, scale bar: 300 µm.

was found is an artificial seawall in which large concrete tidepools have been incorporated. Specimens from this locality were easily observed due to the bright blue colour of their branchial crown (Figure 5A, B) and their high abundance (Figure 5B). As noted by Faasse and Giangrande (2012), this

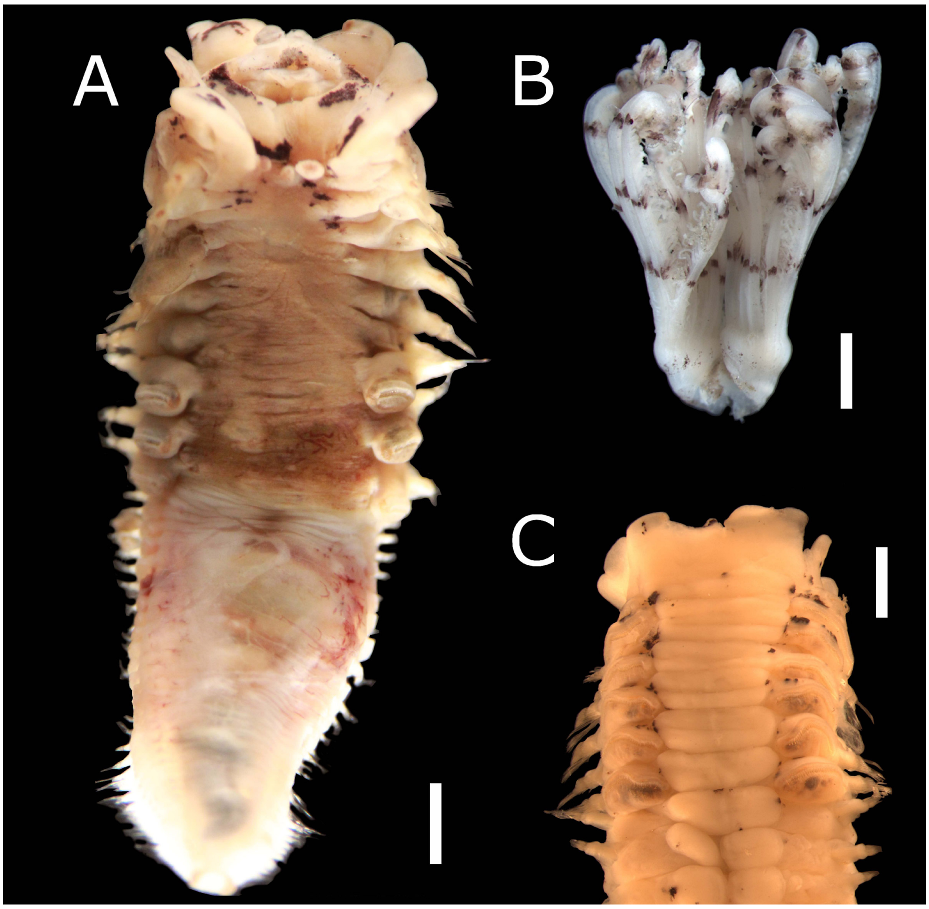

Figure 4. *Bispira polyomma* Giangrande & Faasse, 2012, MNHN-IA-PNT-140, collected in the Bay of Brest the 16/11/2017. (A) Dorsal view. (B) Crown. (C) Collar margin. Scale bars: 1 mm.

species occurs just below the water line of tidepools. At the bottom (approximatively 110 cm depth) of these concrete tidepools temperature is ranging from 8 to 23 °C annually.

Phylum Platyhelminthes Minot, 1876
Order Polycladida Lang, 1884
Family Euryleptidae Stimpson, 1857
Genus *Prostheceraeus* Schmarda, 1859

***Prostheceraeus moseleyi* Lang, 1884**

One unknown Polycladida was collected on the mid-shore oyster reef (*Magallana gigas* (Thunberg, 1793)) in Penfoul cove, Plougastel-Daoulas, inside the Bay of Brest in November 2017 (Figure 6A). The species was identified thanks to Noreña et al. (2014) study.

Materials examined: MNHN-IA-PNT-142, about 7 mm long and 4 mm wide (alive), 48°20′53.66″N; 4°20′18.01″W, 06/11/2017.

Diagnosis (external morphology): 1) dark round or oval spots on dorsal margin (Figure 6A–F); 2) yellow band coloration along body margin (Figure 6A–F); 3) marginal tentacles dark erected (Figure 6A); 4) rounded

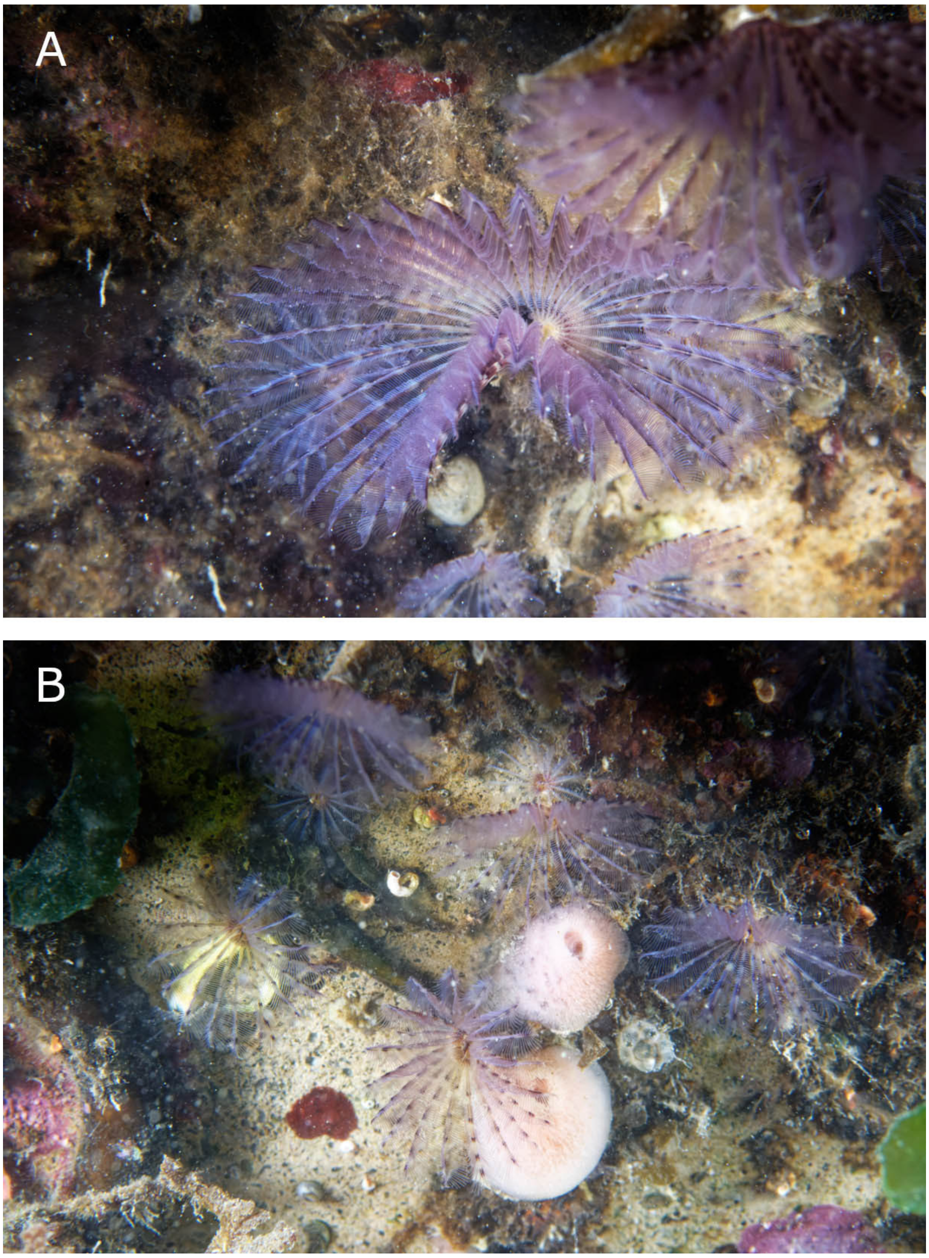

Figure 5. *Bispira polyomma* Giangrande & Faasse, 2012, live specimens from the Renewable Marine Energy polder seawall (ecoblock H32), photographed on 03/03/2022. (A) Close-up of one specimen. (B) Specimens from an "ecoblock" pool showing individual density (photographed by Olivier Dugornay).

anterior and posterior ends (Figure 6A–F); 5) undulating margins (Figure 6A–F); 6) ventral surface white.

Ecology: *Prostheceraeus moseleyi* occurs from the intertidal to 20 m depth in France (see Table S3 for all French records).

Discussion

Ampithoe valida

Comparisons of male descriptions available in the literature point out several morphological variations worldwide (Table S1). *Ampithoe valida* as a cryptic species (low phenotypic disparity relatively to their genetic differentiation and

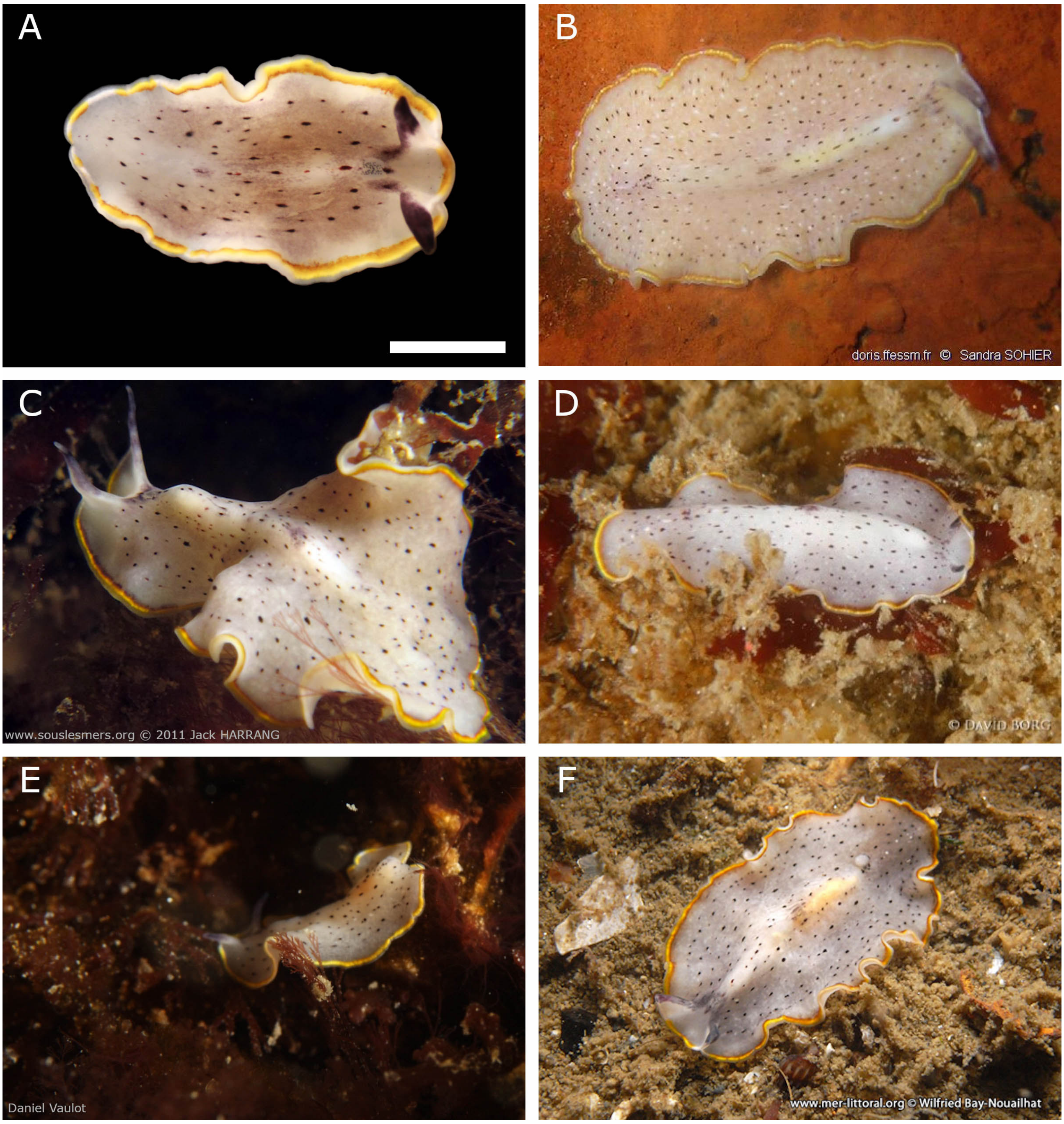

Figure 6. *Prostheceraeus moseleyi* Lang, 1884. (A) Sampled from Penfoul cove in the Bay of Brest on the 6th of November 2017, MNHN-IA-PNT-142. (B) First Atlantic French record from Noirmoutier, June 2007 (photograph by Sandra Sohier). (C) First record in Brittany (Plouhinec, Morbihan) the 23rd of August 2011 (photograph by Jack Harrang). (D) Ria d'Etel record, the 31st of May 2015 (photograph by David Borg). (E) First northernmost occurrence from the Bay of Brest the 3rd of April 2011 (photograph by Daniel Vaulot). (F) Second northernmost occurrence near Brest, the 4th of April 2011 (photograph by Wilfried Bay-Nouailhat). All data associated are available in the Table S3.

divergence times (Struck et al. 2018)) is composed of three distinct lineages in the Western Atlantic and in the Pacific (Pilgrim and Darling 2010; Sotka et al. 2017; Harper et al. 2022). We suspect that morphological dissimilarities highlighted here might reflect this complex diversity. Harper et al. (2022) did not have any genetic data from Europe but one or several lineages might occur in the European waters. This hypothesis will require further samplings, focus on the European *A. valida* lineages coupled with a morphological study. The different degrees of accuracy of the descriptions in the literature may partially explain the observed morphological variability. For instance, we observe an accessory flagellum (Figure S1A, B) on the peduncle of the first antenna which was only previously noted by Lecroy (2002) while it was overlooked by Gouillieux (2017) (Table S2). After examination of specimens used by Gouillieux's (2017) to re-describe the species, we discovered some inconsistencies on uropods microscopic characters that we updated (Figure S1 C–F; Table S2).

This species is continuing its expansion in Europe and we expect to find it in many other areas, especially where anthropogenic activities occur, particularly shellfish farming and shipping (Faasse 2015; Gouillieux 2017). Shellfish farming is an important economic activity in the Morbihan Gulf, with 4000 t of oysters produced each year (Allenou et al. 2002). This activity as mentioned by Le Roux (2018) is suspected to be one of the major entryways of NIS introduction in the Morbihan Gulf. With no international harbour within the Gulf, *Ampithoe valida* might have also been introduced by sailing boats, an activity acting as a secondary vector spreading NIS more locally (Afonso et al. 2020; Ashton et al. 2022). Since even a small number of ovigerous females may found a new population (Harper et al. 2022), the occurrence of ovigerous females and juveniles in the brood chamber of one female suggests that the species can have established a population in the south of Brittany. Further studies or the natural reserve benthic monitoring will allow to evaluate the long-term establishment of this species and its potential impacts on local benthic communities.

Polydora colonia

This cryptogenic species has a large distribution across the Atlantic Ocean (Ruellet 2004; David and Williams 2012). In Europe, the species was reported for the first time in Spain (Aguirre et al. 1986), then in Italy (Tena et al. 2000) and more recently in France (Gouillieux and Droual 2020; Gouillieux et al. 2022). *Polydora colonia* seems largely to occur in sponges, especially in *Clathria (Clathria) prolifera* (Ellis and Solander 1786), *Halichondria (Halichondria) bowerbanki* Burton, 1930 but also in tunicates (Moore 1907), algae such as *Padina pavonica* (L.) Thivy or calcareous algae such as *Mesophyllum lichenoides* (J.Ellis) Me.Lemoine (Aguirre et al. 1986; Tena et al. 1991; David and Williams 2012). In France, *P. colonia* has been reported in another sponge (also an introduced species), *Celtodoryx ciocalyptoides* (Burton 1935) (Gouillieux et al. 2022). In our study, the species was found on maerl beds in which *Halichondria (Halichondria) panicea* (Pallas, 1766), *H. bowerbanki* and *Halichondria* sp. are co-occurring in the Bay of Brest (López-Acosta et al. 2022). Since sorting was not carried out in the same laboratory where the identifications were made, we cannot state on which substratum (maerl or *Halichondria* spp.) the specimens were sampled. However, two specimens were observed with a spicule passing through their body (Figure 3B) which might indicate that these individuals were retrieved from sponge tissues.

Gouillieux et al. (2022) highly suspected that oyster farming in Arcachon Bay and Hossegor Lake represents the main vector of introduction of this species. In the Bay of Brest oyster farming, maritime traffic from and to the Brest international harbour, and recreational boating all constitute potential introduction pathways for *P. colonia* (David and Williams 2012). Moreover, as discussed above, maerl beds are suitable habitats for *P. colonia*. Maerl beds represent 30% of the seabed in the Bay of Brest (representing 40 km^2) and are adjacent to several anthropogenic activities cited above (Ehrhold et al. 2021). Thus, the Bay of Brest could be home to a large population of *P. colonia* and might constitute a source of dissemination through all the human activities occurring in the Bay. This species may have been present in Brittany for several years where due to its ecology (boring species) and its tendency to break easily it may have remained unnoticed until now.

Bispira polyomma

The present study provides the third published record of this species in Europe and the first in the Atlantic ocean as previous observations were made in the North Sea and English Channel (Faasse and Giangrande 2012; Gittenberger et al. 2015; ICES 2022). Because of its unknown native area, this species is also considered as cryptogenic. It has been originally described from specimens found in an outlet of an oyster storage basin and then in the marina of Yerseke (Faasse and Giangrande 2012). The specimens, in our work, were also firstly discovered on a table frame of an oyster farm. Later it has been found in large concrete artificial tidepools embedded in a seawall, located between the Brest international commercial harbour and the Moulin Blanc Marina. The fact that this species was firstly recorded in oyster farms, twice in two different countries, points to shellfish cultures as being the main pathway for introduction over long distances. The species subsequently occurs in harbours, suggesting that recreational boating could represent the secondary vector for its local spread (Gittenberger et al. 2015). This species has not yet been discovered in other areas of France, notably where oyster farming is well developed (e.g. Bay of Arcachon, Nicolas Lavesque *pers. comm.* and Morbihan gulf, Gabin Droual *pers. obs.*). Although it may have gone unnoticed until now, this record might also be indicative of a recent introduction event in the bay of Brest. Indeed, *B. polyomma* has not been observed in recent studies undertook in the Brest marinas (Kenworthy et al. 2018; Gauff et al. 2022; Rondeau et al. 2022).

Prostheceraeus moseleyi

Originally restricted to the Mediterranean Sea, *Prostheceraeus moseleyi* is first mentioned in the Atlantic by Noreña et al (2014), in Ria de Arosa, Galicia, Spain. Since no other records were reported at north of the Spanish one through the scientific literature, our study represents the northernmost record for this species. Thus, the Bay of Brest represents a poleward range extension of 750 km.

Amateur naturalists, and citizen science in general, has proven to be an effective way to collect NIS record (e.g. Lehtiniemi et al. 2020; Langeneck et al. 2022). Data generated, once validated by academic naturalists, ecologists or taxonomists, might be as good as scientific data following the ease of the protocol (Earp et al. 2022). Therefore, we looked for data on *P. moseleyi* on the internet and in Bretagne vivante-SEPNB database. Since *P. moseleyi* is a colorful species (Figure 6A–F), we expected naturalists to report their observations. Several occurrences were available and we validated all data with photographs (Figure 6B–F, Table S3). We concluded that the Bay of Brest is indeed the northernmost limit for this species since 2011 (Table S3). However, we observe that *P. moseleyi* has been present along the Atlantic coast of France since at least 2007 (Table S3, Figure 6B), three years before the Portugal discovery in 2010 (Noreña et al. 2014). We highlight here the ability and importance of citizens science in producing valuable biogeographic data (Marquina et al. 2015; OBCE 2021).

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Authors' contribution

GD and JG identified the interest to publish these records. GD designed the study with the guidance of BG, JG. GD, RG, AC, GG & JC conducted the fieldwork. All authors read, improved and approved the final manuscript.

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Supplementary material

The following supplementary material is available for this article:
Figure S1: *Ampithoe valida* Smith, 1873 missing or inconsistent morphological characters noticed throughout the literature.
Table S1: *Ampithoe valida* Smith, 1873 morphological variations, in males with a comparison between the recent redescription (Gouillieux, 2017) and the specimens from this study.
Table S2: *Ampithoe valida* Smith, 1873, morphological variations between the description from Gouillieux (2017) and the characters observed from the deposited materials MNHN-IU-2014-12860 and MNHN-IU-2014-12861.
Table S3: French records of *Prostheceraeus moseleyi* Lang, 1884.
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