Microporella hastingsae Harmelin, Ostrovsky, Cáceres-Chamizo and Sanner, 2011 (Bryozoa, Cheilostomatida): a possible new Lessepsian species in the Mediterranean Sea?

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Research Article

Microporella hastingsae Harmelin, Ostrovsky, Cáceres-Chamizo and Sanner, 2011 (Bryozoa, Cheilostomatida): a possible new Lessepsian species in the Mediterranean Sea?

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Contributing Editor: Vasilis GEROVASILEIOU

Abstract

The introduction of Non-Indigenous Species (NIS) in the Mediterranean Sea is one of the main threats to biodiversity and its increasing frequency could bring a significant ecological impact on native species. However, knowledge of marine bioinvasions, the spreading patterns of NIS and their possible pathways of dispersion is still limited, especially for particular taxonomic groups. In this paper, we report the first Mediterranean record of a colony of a non-indigenous bryozoan, *Microporella hastingsae* Harmelin, Ostrovsky, Cáceres-Chamizo and Sanner, 2011, found on plastic litter stranded south of Catania (Sicily, western Ionian Sea) during spring 2023. Based on this colony, a formal taxonomic description of *M. hastingsae* is provided for this species, which was recently erected for old, misidentified material collected in the early twentieth century in the Suez Canal and the north Red Sea. We suggest that the species could be considered a Lessepsian migrant assuming it entered the Mediterranean Sea at any time, through larval dispersal and/or the possible facilitation by human activities, presumably shipping. Further surveys in coastal localities of Sicily and the eastern Mediterranean are needed to confirm the establishment of *M. hastingsae* or if the present colony only represents an occasional record of the species in the basin.

Keywords: Bryozoans; taxonomy; Non-Indigenous Species; Ionian Sea.

Introduction

The establishment of Non-Indigenous Species (NIS) in the Mediterranean Sea is ongoing, leading to an increase of *ca* 28% of NIS between October 2012 and December 2021 (from data in Zenetos *et al*., 2022, cf Zenetos *et al*., 2012) and 40% of NIS that became established since 2010 (Zenetos *et al*., 2022).

Owing to different frameworks and terminology used for the attribution of a specific status to each individual species (e.g., Blackburn *et al*., 2011; Marchini *et al*., 2015; Zenetos *et al*., 2022), the number of species and the composition of inventories of NIS at local and regional scale is highly dynamic and subject to refinements, and even to significant changes through time (e.g., for the Mediterranean: Zenetos & Galanidi, 2020; Zenetos *et al*., 2022, and therein references to the numerous updates since 2005), occasionally leading to inconsistencies (see Rosso & Di Martino, 2023, for bryozoans). Owing to continuous changes in the distribution ranges and status of each species, reviews and updates of records are frequent for providing policymakers and stakeholders with refined validated inventories for the management of NIS at local and basinal scale, also in the frame of the EU's Marine Strategy Framework Directive (e.g., Marchini *et al*., 2015; Tsiamis *et al*., 2019).

Some major problems in inventory compilations concern the criteria applied to the definition of the status of each species (Marchini *et al*., 2015; Zenetos *et al*., 2022), following its detection and correct identification. Therefore, the number of species in the inventories (especially the number of records) can show a disproportion between large-sized, motile, conspicuous, relevant species and small-sized, less "notable" ones (e.g., sessile, not edible, not exploited and/or not particularly harmful to humans) among which are bryozoans (e.g., Katsanevakis *et al*., 2020; Ragkousis *et al*., 2023). In fact, most bryozoans often grow as small colonies in cryptic microhabitats and can be overlooked (e.g., Rosso *et al*., 2013), if targeted investigation is not carried out. Furthermore, bryozoan identification is based on fine morphological characters requiring the routine use of Scanning Electron Microscopy (SEM) by skilled taxonomists (e.g., Harmelin & Rosso, 2023, and references therein), especially when NIS

are part of species complexes (e.g., Harmelin *et al*., 2012) which include both native species and NIS which differ by only few non conspicuous features (e.g., Harmelin *et al*., 2011). Hence, the correct identification is crucial for detecting NIS introduction and for monitoring their possible establishment.

For sessile species, introduction is driven by different possible pathways, including transport on floating items, regardless of their natural or artificial origin (see Barnes & Sanderson, 2000; Belmonte, 2019; Garcia-Gómes *et al*., 2021) besides voluntary and involuntary human-mediated transfer, including shipping (e.g., Zenetos *et al*., 2012). Owing to the massive use and waste of plastics, such drift material – usually hosting a plethora of encrusting species – could represent a relevant vector in facilitating the spread of species (e.g., Barnes, 2002; Garcia-Gómes *et al*., 2021; Subías-Baratau *et al*., 2022; Kannan *et al*., 2023), often doubling the chances of species dispersal in the tropics (Barnes & Milner, 2004). Winston *et al*. (1997) and Winston (2012) have considered rafting among the possible dispersal modes for encrusting and pseudo-planktonic organisms that can be transported for long distances over relatively short time-scales, as demonstrated through simulated scenarios by Soares *et al*. (2023). Bryozoans, known for having short-lived larvae (e.g., Winston, 1988) with reduced range spreading ability, benefit from the availability of drift plastic, on which they form species-rich communities (Winston *et al.,* 1997).

In this context, we report the occurrence of a colony of *Microporella hastingsae* on a piece of plastic debris, stranded in the south of Catania (Sicily, western Ionian Sea). This species has only been recently introduced by Harmelin *et al*. (2011) for colonies reported by Hastings (1927) as *M. ciliata* var. *coronata* from the Suez Canal, at Km. 157, near its connection to the Red Sea. The meaning of the new record within the distribution of the species and the spreading of NIS in the Mediterranean Sea, is discussed.

Materials and Methods

Stranded material, including shells and other skeletal remains, wood and plant remains and plastic items were collected during a periodic walking survey along selected pathways at the Plaia, a *ca* 20 km long beach located in the south of Catania (Ionian coast of Sicily: Fig. 1). The survey was performed on the 4th of April 2023, also in the framework of the PhD sampling activities of one of us (C.S.), and included a trail of 30 minutes walking in the area of the Simeto river-mouth, in the central sector of the Plaia (coordinates: between 37.390916° N, 15.090242° E and 37.385563° N, 15.090070° E).

Collected items were visually inspected to identify the hosted fouling communities and one particular plastic fragment including bryozoans was selected for the present study. Bryozoans were examined under stereomicroscope and colonies of *M. hastingsae* were first documented through a photo camera using the software imaging program ZEN 3.1. After detachment, the colony was photographed, untreated and uncoated under a Tescan Vega 2 LMU, Low Vacuum Scanning Electron Microscope (SEM) at the Microscopical Laboratory of the Department of Biological, Geological and Environmental Sciences of the University of Catania (DipBioGeo). Images were generated using back-scattered electrons.

The material is housed at the Palaeontological Museum (PMC) of the DipBioGeo, in the Rosso collection, under the catalogue number PMC Rosso-Collection I. H. B.111a.

Results

Collected items included an irregularly shaped plastic fragment (possibly the edge of a fruit box), partly burned and solidified after melting, around 20 x 8 x 5 cm in size (Fig. 1). Plant remains, serpulid tubes, encrusting ostreid valves and *Anomia* adhesion thickenings, byssate (arcid) molluscs, barnacles and encrusting foraminifera fouled this item together with few bryozoan colonies. The latter

Fig. 1: *Microporella hastingsae* Harmelin, Ostrovsky, Cáceres-Chamizo and Sanner, 2011 on its plastic substratum collected at the Simeto river-mouth (Sicily, Ionian Sea). The sole colony is indicated within the red circle. Known distribution of the species in the inset. Asterisk: present colony; solid circle: previous records in northern Red Sea and the southern entrance of the Suez Canal.

included *Cryptosula pallasiana* (Moll, 1803), *Hagiosynodos latus* (Busk, 1856) and the basal worn parts of undetermined representatives of *Entalophoroecia* sp., *Aetea* sp. and a possible species of Candidae detected only by its rhizoids. A single colony of *Microporella hastingsae* was also present (Fig. 1) showing evidence of partial breakage and detachment at least of the ancestrula and some periancestrular autozooids, seemingly after stranding. The colony was presumably recently dead because some autozooids still showed opercula and avicularian mandibles and only a few ones displayed some evidence of the iridescent cuticle.

Systematics

Phylum Bryozoa Ehrenberg, 1831
Class Gymnolaemata Allman, 1856
Order Cheilostomatida Busk, 1852
Family Microporellidae Hincks, 1879
Genus *Microporella* Hincks, 1877
Type species: *Eschara ciliata* Pallas, 1766
Microporella hastingsae Harmelin, Ostrovsky, Cáceres-Chamizo and Sanner, 2011
figs 1–3; tables 1–2
Microporella ciliata var. *coronata*: Hastings 1927, p. 340, figs 83–84
Microporella coronata: Waters 1909, p. 142, pl. 12, figs 6–9; Balavoine 1959, p.274, pl. 3, figs 7, 8.

Examined material

One colony encrusting a plastic item stranded close to the Simeto river-mouth, South Catania (Sicily, Ionian Sea), collected on the 4.4.2023.

Photographs of the holotype of *M. hastingsae*, colony n. 1926.9.6.238 housed at the Natural History Museum, London and illustrated by Harmelin *et al.* (2011) in their fig. 6a, b.

Description

The examined colony is encrusting, unilaminar, multiserial, forming a sub-elliptical patch (Fig. 2A); zooids communicating via two proximolateral, two distolateral and two, rarely three distal pore-chamber windows, situated along the lateral walls (Fig. 2F, 3B, C).

Autozooids rhomboidal, usually elongated (mean size 489 x 392 μm, and Table 1), distinct, the boundaries marked by narrow grooves between the slightly raised vertical walls (Figs 2 E, F, 3D). Frontal shield slightly convex, evenly covered with low, moderately coarse granules, interspersed with 17–45 subcircular pseudopores (15–20 μm in diameter, occasionally larger). Pseudopores usually evenly distributed but missing in the central, proximal and distal portions of some autozooids, seemingly irrespective of their position in periancestrular or peripheral growing areas (Figs 2E, F, 3A); the area between orifice and ascopore always imperforate (Fig. 3B, C). Marginal areolae numbering 6–8 (Fig. 2F), barely distinguishable, especially in late ontogeny.

Primary orifice (Fig. 3B, C) transversely D-shaped (mean size 87 × 112 μm, Table 1) with a mean OL/OW = 0.8; occupying *ca* 1/5–1/6 of autozooidal length (mean ZL/OL = 5.7); distal rim smooth, the lateral sides slightly converging proximally; hinge-line straight, smooth, without condyles and denticles. Four articulated oral spines, detached in the available colony, rare remnants pointing to their possible shortness (*ca* 70 μm; see Fig. 2 C, E); spine bases situated along the distal half of the orifice

Table 1. *Microporella hastingsae* Harmelin, Ostrovsky, Cáceres-Chamizo and Sanner, 2011. Measurements of diagnostic features in microns.

|	
Autozooid length	415–570; 489.2±39.6 (n=15)
Autozooid width	310–540; 391.6±73.5 (n=15)
Autozooid length/autozooid width	1.27
Orifice length	80–98; 86.9±4.6 (n=15)
Orifice width	105–120; 112.3±4.7 (n=15)
Orifice length/orifice width	0.8
Autozooid length/orifice length	5.7
Ovicellate autozooid length	580–700; 635.4±36.4 (n=16)
Ovicellate autozooid width	280–420; 341.1±40.0 (n=16)
Ovicellate orifice width	101–120; 109.1±5.3 (n=16)
Ooecium length	178–230; 206.2±16.7 (n=16)
Ooecium width	200–278; 238.6±20.7 (n=16)
Avicularium cystid length	104–130; 115.4±8.5 (n=14)
Avicularium cystid width	70–100; 83.7±9.4 (n=14)
Avicularian mandible	220–320; 287.5±35.4 (n=10)
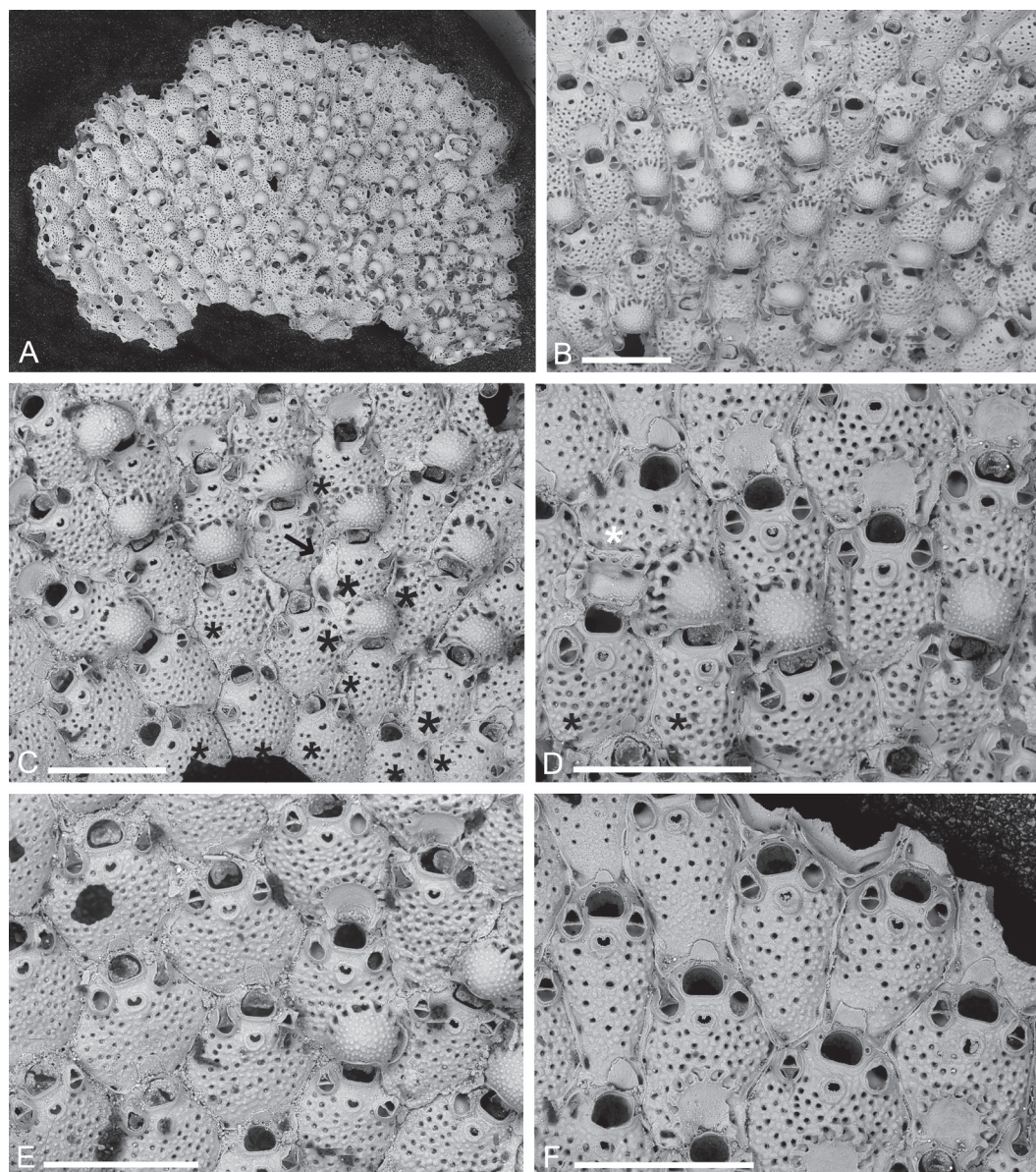
Fig. 2: *Microporella hastingsae* Harmelin, Ostrovsky, Cáceres-Chamizo and Sanner, 2011: colony and autozooidal appearance. (A) General view of the examined colony (PMC Rosso-Collection I. H. B.111a) collected at the Simeto mouth (Sicily, Ionian Sea). (B) Colony portion showing ovicellate and non-ovicellate autozooids. (C) The possible periancestrular area with several autozooids showing single avicularia (black asterisks), some (large asterisks) in connection with kenozooidal production from marginal areolae. (D) Subsequent autozooid rows with complete and incomplete ovicells. Black asterisks: autozooids with a single avicularium, that on the left showing internal budding; white asterisk: an autozooid missing both avicularia. (E) Wide rhomboidal autozooids. (F) Autozooids at the colony margin. Scale bars: 2 mm: (A); 500 µm (B-F).

(Fig. 3B, C), the proximal pair often larger (diameter of *ca* 15 µm) than the distal ones (diameter of *ca* 10 µm). Only two spines have been observed on regenerated autozooids (Fig. 3D).

Ascopore field, an area of smooth gymnocystal calcification is placed 40–60 µm below the orifice, subcircular, ca 50 µm in diameter, encircled by a thick and smooth rim, often more raised proximally. Ascopore widely and transversely C-shaped, with tiny radial denticles and a small, median tongue projecting from the distal edge, often consisting of 1–3 more prominent denticles (Fig. 3B, C).

Avicularia paired (mean size 115 × 84 µm; Table 1), located just proximolaterally to the orifice (Figs 2B, D, 3A); crossbar complete, usually level with the space be-

tween the ascopore and orifice; rostrum short, truncated distally and open-ended, distally directed. Mandible brown, 220–320 µm long, setiform and straight, lying on the distal autozooid (Fig. 3A) or on the frontal shield when open (Fig. 2D). Avicularia single, located more proximally than the paired ones and directed distolaterally on presumed periancestrular autozooids (Fig. 2A, C), or placed and directed more irregularly on regenerated autozooids (Figs 2B; 3D, E).

Ovicell subglobular prominent (mean size 206 × 238 µm; Table 1), non-personate, not obscuring the proximal part of the orifice, leaving visible the proximal-most pair of spines; produced by and continuous with the frontal shield of the distal autozooid but with the distal boundary
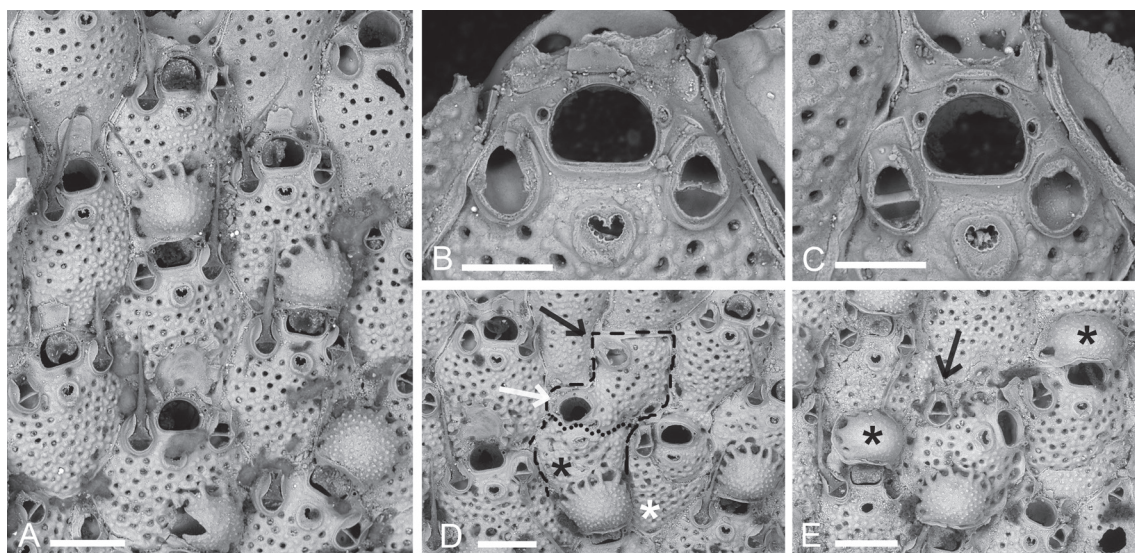
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Fig. 3: *Microporella hastingsae* Harmelin, Ostrovsky, Cáceres-Chamizo and Sanner, 2011: details of diagnostic features and reparative regeneration. (A) Close-up of ovicellate and non-ovicellate autozooids with avicularia, some setiform mandibles still present. (B) Distal part of an autozooid: note the complete ascopore, the smooth-rimmed D-shaped orifice and the orificial spine bases, the distal-most smaller. (C) As (B), but with four equally sized spine bases. (D) Regeneration and fusion of two neighbouring autozooids forming an hourglass new module (marked with a dashed line). The regenerated autozooid (regeneration line marked by dots) develops an inclined, irregular, proximally placed orifice (white arrow), an incomplete ascopore, and a unique distally placed avicularium (black arrow) unrelated with the orifice. Another autozooid (white asterisk), regenerated as a miniature autozooid without avicularia and only two distal spines. (E) A damaged area of the colony showing an irregularly oriented regenerated autozooid with only one irregularly placed avicularium (black arrow) inherited from the preceding broken autozooid, and two ovicells, possibly regenerated from marginal areolae (black asterisks). Scale bars: 200 µm: (A) (D), (E); 100 µm: (B), (C).

marked by a row of 11–14 (commonly 13) large marginal areolae; calcification fabric non-porous and more finely and regularly granular than the frontal shield; proximal margin of gymnocystal calcification forming a raised visor-like band.

Ancestrula missing from the partly broken observed colony.

Reparative budding frequent, leading to the formation of 1) irregularly shaped, kenozooid-like structures with extensive cryptocyst produced by frontal budding from autozooidal marginal areolae (e.g., Fig. 2C, arrowed) and 2) autozooids with extremely irregular shapes and orientations (Figs 2B, 3D-E) originating from broken autozooids, even including an hourglass shape with an apparently proximally located orifice and a very distal single avicularium (Figs 2B, 3D).

Variability

The examined colony showed a high variability, especially in relation to autozooidal appearance, largely produced by variation in width (Table 1) leading to elongated and slender autozooids (L/W = 1.76 at one end) and stouter rhomboidal autozooids (L/W = 0.83 at the other end). The paired avicularia are not constant, reducing to a single one in periancestrular autozooids (Fig. 2C: black asterisks) and occasionally elsewhere (Fig. 2D: black asterisks). Possible teratological and/or regenerated autozooids can even lack avicularia (Fig. 2D, white asterisk; 3D, E). The number and distribution of frontal pseudo-

pores is also very variable seemingly irrespective of autozooidal ontogenetic stage. In contrast, other characters, such as the number of oral spines, the morphology of the ascopore, ovicell and avicularia, appear to be constant.

The characters observed, and especially the co-occurrence of the paired distal avicularia lateral to the orifice, the smooth rimmed orifice lacking condyles and armed by four distal spines and the non-personate ovicell bounded by large marginal areolae, allowed us confidently to assign the material collected at the Simeto river-mouth to *M. hastingsae*.

Taxonomic remarks

Microporella hastingsae was introduced by Harmelin *et al*. (2011: p. 13), though with a non-formal description, mostly highlighting the differences from *Microporella coronata* (Audouin & Savigny, 1826), for the specimens studied by Hastings (1927) and deposited at the Natural History Museum London, with the colony NHM 1926.9.6.238 selected as the holotype. Harmelin *et al*. (2011) figured some ovicellate and non ovicellate autozooids (their fig. 6) and remarked that the material they examined through photos, had "four oral spines in most cases (range 3–6) in non-ovicellate zooids, two (sometimes three) remaining free at the proximal corners of the ovicells; a primary orifice with smooth edges but without step-like condyles; a frontal shield with large pseudopores; paired avicularia with truncate rostra and proximal area clearly broader than in *M. coronata*, with

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robust setoid mandibles; and ovicells with finely nodular calcified entooecium without 'pseudopores', encircled by 9–14 notches corresponding to marginal pores."

All these characters, especially the most diagnostic ones, are shared with our colony. Furthermore, our examination of this colony allowed us to add details pertaining to some morphological characters and information about species variability (see above), shown by periancestrular and young autozooids at the colony periphery. Unfortunately, the ancestrula was missing. The number of spines is constantly four in our colony, representing the prevalent feature also in the holotype material and falling in the range of 3–6 spines observed by Harmelin *et al*. (2011). The number of 11–14 marginal areolae of the ovicell observed in the available material largely overlaps with the 9–14 areolae reported by Harmelin *et al*. (2011). However, the number of pseudopores in the frontal shield counted on images provided by Harmelin *et al*. (2011) is normally higher (45–53 pores in four autozooids and 34 in only one instance) than that present in the Simeto colony (17–45, and a mean of 33 pseudopores counted in 22 autozooids). Finally, one of the paired avicularia tends to be displaced slightly proximally (i.e. proximal to the ascopore) and directed distolaterally (Fig. 2C-E) in some autozooids, and a single proximally shifted avicularium is common in diverging autozooids located at the broken proximal margin of the examined colony, presumably representing the periancestrular zone (Fig. 2C, small and large asterisked autozooids, respectively). The preferred location of autozooids with a single avicularium compared to those with paired avicularia was clearly described and sketched by Hastings (1927) in her fig. 84, which also depicts the ancestrula and the early budding pattern. Unfortunately, however, the ancestrula is not described, and the schematic drawing roughly suggests it is tatiform (as described in other species of the genus), even though the spines are not depicted. Following Hastings (1927), the first budded autozooids from the ancestrula lack any avicularium. This zone is missing in our colony, but the absence of an avicularium in some autozooids (marked with large asterisks in Fig. 2C) seems linked to regenerative budding from marginal areolae and the possible function diversion of these avicularial "budding points". Avicularia seem to be absent from a single possibly teratological autozooid (Fig. 2D, white asterisk), with a deformed orifice located in a damaged colony area with evidence of repair. Reparative budding and regeneration is common (see description, above) and involves some adventitious avicularia (Fig. 2D, left black asterisked autozooid).

The formation of irregularly shaped autozooids possibly resulting from fusion processes has been also observed in damaged areas in *Microporella ichnusae* by Di Martino & Rosso (2021). This last species and *M. verrucosa* also showed kenozooids, but as large as autozooids or almost so, with or without avicularia and budded from lateral/distal pore windows (Di Martino & Rosso, 2021).

Microporella hastingsae was first reported as *M. ciliata* var. *coronata*, but as first suggested by Berning (2006), and later remarked by Harmelin *et al*. (2011)

when erecting the species, it sensibly differs from both *M. ciliata* and *M coronata* (see Kuklinsky & Taylor, 2008; Harmelin *et al*., 2011 and Di Martino & Rosso, 2021). In fact, the former species has a single proximally placed avicularium in almost all autozooids, a very wide D-shaped orifice with proximolateral condyles and 0–4 spines and a porous ovicell. The latter has an orifice with lateral condyles and 6–8 spines and an evenly perforate, personate ovicell lacking marginal areolae. Other species such as *Microporella appendiculata* (Heller, 1867), *M. ichnusae* Di Martino & Rosso, 2021 and *M. verrucosa* (Peach, 1868), have been reported from the Mediterranean as having paired adventitious avicularia in all or at least some autozooids (Table 2). However, *M. appendiculata*, which shares the smooth orifice and the paired avicularia, can be easily distinguished by its round ascopore and the ovicells which are imperforate but depressed and lack marginal areolae. *Microporella ichnusae* and *M. verrucosa* are more easily distinguished because they have paired avicularia on only some zooids. Furthermore, *M. ichnusae* differs by its particular tessellate autozooidal and ovicellar texture, orificial condyles, the presence of more than four orificial spines plus some pores on the ovicells that lack marginal areolae. Finally, *M. verrucosa* has a very distinctive autozooidal orifice with a corrugated distal margin and a sloping shelf in the proximal margin with two low condyles, perforate ovicells bounded by small marginal areolae leaving no visible spines and the erect, vincularian colony morphology.

Despite the high species diversity of the genus *Microporella*, with a total of 121 extant species reported on the Bryozoan Home Page by Bock (2016, accessed 28.8.2023), only 29 have paired avicularia, at least on some autozooids and only 18 have ovicells with marginal areolae or at least peripheral rows of pores with larger marginal ones. Of these, only six species, i.e., *M. lepueana* Soule, Chaney and Morris, 2004 from Samoa, *M. pectinata* Tilbrook, 2006 from the Solomon Isles, *M. planata* Soule, Soule and Chaney, 1995 and *M. sanmiguelensis* Soule, Chaney and Morris, 2004 both from California, *M. serrata* Mawatari and Suwa, 1998 from Japan and *M. stellata* (Verrill, 1879) from Panama, present both morphological characteristics. However, these six species have combinations of further characters that clearly distinguish each of them from *M. hastingsae*. These include: the denticulate orificial anter in *M. lepueana*; the co-occurrence of stout lateral condyles in the proximal border of the orifice and two stout oral spines and of a roundish stellate ascopore in *M. stellata*; and the occurrence of a denticulate anter and condyles in the orifice, associated with a cribrate ascopore and prominent umbones on both the frontal shield and the ovicell in *M. serrata*. Prominent umbones also occur in both *M. planata* and *M. sanmiguelensis*, in association with laterally directed avicularia of different shapes whereas *M. pectinata* is distinguished by the proximal location of single or paired diverging avicularia and the occurrence of six oral spines. Furthermore, none of these six species has ovicells with true areolae as large as those occurring in *M. hastingsae*. To our knowledge, and considering that several species lack modern

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Table 2. Main characters distinguishing *Microporella hastingsae* Harmelin, Ostrovsky, Cáceres-Chamizo and Sanner, 2011 from *M. coronata* with which it was originally confused, and further similar species known from the Mediterranean. Note that ranges of variability for frontal pseudopores, and number of spines in ovicellate and non-ovicellate autozooids also include observations by Harmelin *et al.* (2011) on the holotype.

Features	Species	*M. hastingsae*	*M. coronata*	*M. appendiculata*	*M. hichnusae*	*M. verrucosa*
Colony form		Encrusting	Encrusting	Encrusting	Encrusting	Erect, vincularian
Ascopore		C-shaped	C-shaped	Circular	C-shaped	C-shaped
Frontal mucro		Absent	Unknown	Present	Absent	Absent
Frontal shield	Pseudopores	17–53	50–60	30–42	10–30	19–26
Marginal areolae		ca 8	1–3	Barely visible	2–4	10, barely visible
Avicularia		2 (0–2)	2	2	1 (0–2)	1 (0–2)
Ovicell	Type	Non-personate	Personate	Non-personate	Non-personate	Non-personate
	Prominence	Prominent	Prominent	Zoarial level	Prominent	Prominent
	Pseudopores	Absent	Evenly distributed	Pits	Marginal	Evenly distributed
	Areolae	9–14, large	Absent	Absent	Absent	ca 10, moderate
	Proximal vizor	Present	Present	Present	Absent	Absent
Oral spines	Autozooids	4 (3–6)	7 (6–8)	5 (6)	4 (5–6)	4 (5)
	Ovicellate autozooids	2(3) barely visible	2	2	Hidden	Absent
	First pair bifid/ trifid	No	No	Yes	No	No
Orifice	Proximal	Smooth	Condyles at corners	Smooth	Lateral condyles	Sloping shelf; low condyles
	Distal	Smooth	Smooth	Smooth	Smooth	Corrugated
Kenozooids		Not observed	Absent	Absent	Present	Present

descriptions and SEM documentation, obvious large areolae marking the periphery of ovicells such as those in *M. hastingsae*, have only been detected in *M. speculum* Brown, 1952, a Tertiary to Recent species from New Zealand (see Di Martino & Liow, 2022), and in an undescribed *Microporella* species from the same area (see Di Martino & Liow, 2021). This latter, however, has a single avicularium, six oral spines with a stouter proximal pair, and the ascopore is rimmed by an extensive area of gymnocystal calcification. Imperforate ovicells rimmed by conspicuous marginal areolae are unique within the Mediterranean *Microporella* species and can be considered distinctive of *M. hastingsae,* especially when associated with paired avicularia.

Even though there is no formal synonymy devoted to *M. hastingsae* (whose description is introduced in the discussion of *M. coronata*), Harmelin *et al.* (2011) included synonyms for this species within those provided for *M. coronata*, listing papers and details on pagination and illustrations, but preceded by a "not" and followed by the indication (= *Microporella* **n. sp.**, see below). This synonymy is followed here, but with the exclusion of *Microporella umbracula* reported by Aristegui (1984 *fide* Harmelin *et al.*, 2011) from the Canary Isles, because Aristegui's specimens possess some pseudopores on the ovicell besides "particularly large marginal pores". In fact, pseudopores are completely absent from the ovicell

in *M. hastingsae* that is evenly and finely tuberculated as can be clearly seen in Figs 2, 3 and in fig. 6B of Harmelin *et al.* (2011). Besides this remarkable difference, the exclusion of such specimens from the synonymy is also supported by the geographical distance between the Red Sea type locality of *M. hastingsae* and the subtropical eastern Atlantic location of the provenance site of Aristegui's material.

Discussion and Conclusion

According to Harmelin *et al.* (2011), *Microporella hastingsae* only occurred in the Red Sea and the southern entrance of the Suez Canal. In fact, all known colonies were collected in that area at the beginning of the last century, in 1904 (Crossland, 1907, for material examined by Waters, 1909), in 1924 (Hastings, 1927) and between December 1928 and January 1929 (Balavoine, 1959), though they were reported later on and under different names (see above). This is the first record of the species following its erection, and the only colony from the Mediterranean Sea documented with SEM images.

Harmelin *et al.* (2011) suggested that at least some of the records of *Microporella coronata* from the Mediterranean Sea reported as *M. umbracula* Harmer, 1957 that they doubtfully synonymised with *M. coronata*, could

partially belong to *M. hastingsae*. These include the ones from Turkey (Nicoletti *et al*., 1995), the Ionian Sea (Di Geronimo *et al*., 1998); Milos Island, Aegean Sea (Morri *et al*., 1999) and Cyprus, Levantine Sea (Koçak *et al*., 2002). Some of the aforementioned records seem to correspond to *M. appendiculata* (see Di Martino & Rosso, 2021), but re-examination of these colonies is necessary, especially considering the high morphological variability previously assigned to the *Microporella ciliata-M. coronata* group of species, the absence of SEM images, and the lack of any photographic documentation for those records. However, in our opinion, the two species (*M. hastingsae* and *M. coronata*) can be distinguished based on their morphological characters (see Harmelin *et al*., 2011 and above) through careful microscopical and/or SEM examination. The differences in morphology are more obvious in fertile colonies owing to the ovicell characteristics, but differences such as the shape of the orifice and the number of oral spines, are also visible in non-ovicellate autozooids.

In this scenario, the interpretation of the occurrence of *M. hastingsae* from the Simeto river-mouth is challenging. The species has so far been identified only from *ca* one hundred-year-old material originating from the Red Sea and the Red Sea-facing portions of the Suez Canal. It has not been detected in the Levantine Sea, despite the extensive sampling performed at the beginning of this century along the coasts of Cyprus (Achilleos *et al*., 2020, on surveys of the 2011–2018 period) and Lebanon (Harmelin, 2014; Harmelin *et al*., 2016, on surveys performed between 1992 and 2003, except for one in 1968, oddly without *Microporella* species listed in the former one). We can confidently rule out the overlooking of *M. hastingsae* by Harmelin *et al.* (2016) because he coauthored the description of the species (Harmelin *et al*., 2011). Furthermore, from the examination of photos kindly provided by Katerina Achilleos (University of Otago, New Zealand), we can also exclude the conspecificity of *M. hastingsae* and the colony that Achilleos *et al.* (2020) reported as *Microporella* aff. *coronata* from a shipwreck off Cyprus. *Microporella hastingsae* has not been found either in the Aegean Sea, between the Levantine Sea and Sicily, notwithstanding some recent bryozoan investigations and checklists in the area (Koçak & Aydin Önen, 2014; Gerovasileiou & Rosso, 2016; Rosso *et al*., 2019a, b; 2022).

Indeed, no further record of *M. hastingsae* is available subsequent to those by Harmelin *et al.* (2011) from the Red Sea and Harmelin *et al.* (2016) did not report the species from the Lebanese coast where they found at least four *Microporella* NIS, i.e., *M. browni* Harmelin, Ostrovsky, Cáceres-Chamizo & Sanner, 2011, *M. coronata, M. genisii* (Audouin and Savigny 1826) and *M. harmeri* Hayward, 1988, omitting an undescribed *Microporella* cf *ciliata* (see also the updated checklist of NIS bryozoan species by Ferrario *et al*., 2018). Leaving aside the problematic records of *M. coronata*, the NIS *Microporella* species reported by Harmelin seem to be restricted to the Lebanese coast not spreading westward in the Mediterranean, and they were absent from the samples collected in the last decades around Sicily and southern Italy recently examined by Di Martino & Rosso (2021).

Consequently, we could assume that *M. hastingsae* possibly entered the Mediterranean Sea, within the last dozen years, thus becoming a Lessepsian migrant. It is reasonable to assume that it was transferred from the Red Sea to the Mediterranean through the intense shipping in the Suez Canal, as suggested for other species by Harmelin *et al.* (2016, and references therein) or even through larval dispersal (also possibly aided by relays or the stepping stones provided by local hard substrata, including working boats).

Whereas we know that a living or recently dead colony of *M. hastingsae* reached the Catania Plaia by rafting on drift plastic debris, we have no information about the origin of that material. Especially, we do not know if the studied colony derives from a population established in the very eastern sector of the Mediterranean or from localities in between, and further investigation is required to ascertain if self-sustaining populations occur in the basin. Geographically distinct records of NIS bryozoans in the Mediterranean are not uncommon, and at least one other species, *Smittina nitidissima* (Hincks, 1880), is known from Lebanon and from the shallow-water submarine Granchi Cave in the western Ionian Sea (Plemmirio Peninsula, near Siracusa, south-eastern Sicily). However, in that case living colonies were found on a plastic settlement panel deployed for six months inside the cave (Rosso *et al.* 2018) and the rapid colonization could indicate the occurrence of fertile colonies in the area and possibly a self-sustaining population of the species.

In contrast, the so far unique colony of *M. hastingsae* was not alive at the time of collection, and it was not found within the coastal benthos or attached on a natural substratum. Consequently, it cannot be considered, *tout court*, as a proof of the possible expansion of the species geographical range in the Mediterranean. Indeed, species can be absent in natural habitats although detected on drifted plastics in the same area. For example, Winston *et al.* (1997) reported that *Thalamoporella evelinae* Marcus, 1939 was not detected in coastal habitats of Florida, despite its occurrence (and with brooding colonies) on drift plastic in the same area. The occurrence of ovicellate autozooids in the *M. hastingsae* colony indicates its reproductive status. However, it is not possible to know whether the larvae were released in the Plaia coastal area or elsewhere during drifting, and if they were able to settle and survive in the local natural environment. We also lack colonies of the species collected in the area. As a matter of fact, single findings, especially from drifting items or boat hulls are not considered as NIS occurrences. Such records, although previously considered as valid, have been recently discarded in updated inventories or just considered as casual (e.g., Marchini *et al*., 2015; Zenetos *et al*., 2022).

It is worth noting that plastic items can be displaced for long distances by wind and currents, potentially transporting species in areas far beyond their original range where successful larval release and larval recruitment on the coast could produce new self-sustaining populations,

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as remarked for bryozoans and other benthic organisms (e.g., Soares *et al*., 2023). Winston (2012) cites the example of *Schizoporella pungens* Canu and Bassler, 1928, a species unknown from the Indian River area until the early 21ˢᵗ century. This species was first detected there in 2002 on drift plastic, later found on fouling panels at Fort Pierce inlet (2003) and soon after on natural and artificial substrata in the same and neighboring areas, thus clearly hinting at drift-plastic items as its transfer vector.

Soares *et al.* (2023) showed that drift-plastic debris could travel by current for hundreds kilometers from north Brazil to the Caribbean, taking about 180 days. It has also been proven by Fazey & Ryan (2016) that plastic debris can float for a considerable amount of time without sinking to the bottom by the increasing weight of the epibionts' load. Assuming comparable travel times, it is likely that drift material could serve as an effective vector for transporting encrusters from the Levantine basin to the western Ionian Sea.

To conclude, the stranded *M. hastingsae* colony could represent the vanguard of an ongoing spreading of the species from putative, still undiscovered, eastern Mediterranean populations to the Ionian Sea, through drift plastic, either as the result of a single travel event, or multiple "stepping stones" displacement. Because of the Red Sea subtropical origin of the species (Harmelin *et al.*, 2011), its expansion could be facilitated by climate change and the current warming of the Mediterranean (e.g., Wesselmann *et al.*, 2021, and references therein). Further investigation is needed to assess if self-sustaining populations of the species already exist in the Ionian Sea and the Mediterranean and to support species establishment in these areas.

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