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# Description of *Bispira causioi* sp. nov. (Annelida, Sabellidae), an introduced taxon or another case of native invasion?

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## Abstract

The new species *Bispira causioi* sp. nov. is here described. This taxon shares several morphological features, such as the shape of both uncini and companion chaetae, with other *Bispira* species mostly of tropical origin. The first observation of this taxon, along the Apulian coast, dates back to 2012 and was never recorded before. At the present, it occurs along the whole Italian Coasts, being reported in several pictures by the SCUBA-diving photographers and tentatively identified as either *Sabella pavonina* Savigny, 1822 or *Bispira viola* (Grube, 1863).In addition, in depth comparisons were conducted with material housed at the Museo di Biologia Marina of the Salento University, especially with the similar Mediterranean species (*B. viola* described by Grube 1863 for the North Adriatic Sea, as well as *Bispira riccardi* Giangrande, Putignano, Enrichetti 2022, described for North Tyrrhenian deep muddy substrates), but also with material of tropical *Bispira* species present in this collection. An extensive discussion on the literature concerning the reports of *B. viola* in the past precede the new species description, suggesting different interpretations for our findings.

**Keywords:** Annelida; Sabellidae; Bispira; new taxon.

## Introduction

During the last 40 years the Mediterranean Sea experimented several faunistic changes as consequence of the global warming, with the introduction of several alien species (Zenetos *et al.,* 2012; 2022; Tiralongo *et al.*, 2022). This is particularly evident along the Apulian coast where in-depth faunal studies were conducted in the last years (Langeneck *et al.*, 2024; Toso *et al.*, 2024a; Giangrande *et al*., 2024). Similarly, increase in abundance and distribution of meridional species has been observed in the Mediterranean Sea (Toso *et al.,* 2022). Among the annelids belonging to the Sabellidae family, allochthonous tropical species of the genus *Branchiomma* Kölliker, 1858 showed an increase in their abundance and distribution in certain areas of the Mediterranean Sea over time (El Haddad *et al.*, 2008; Arias *et al.*, 2013; Giangrande *et al.,* 2014; Mastrototaro *et al.,* 2015; Del Pasqua *et al.*, 2018; Fernández-Romero *et al.*, 2021; Toso *et al*., 2024b). In the last 10 years another sabellid species became progressively common and, thanks to its relatively large size, colourful crown and presence on different substrates, it was often reported also by SCUBA-Diving photographers as either *Sabella pavonina* Savigny, 1822 or *Bispira viola* (Grube, 1863). Today this taxon represents the most common *Bispira* Krøyer, 1856 species along the Italian coasts (especially in the Salento peninsula), contrasting with past data that saw the historically species *Bispira mariae* Lo Bianco, 1893, being the most common species on hard substrates (A. Giangrande pers. obs.).

The genus *Bispira* is part of the sub-family Sabellinae, including the genera *Sabella* Linnaeus, 1767, *Branchiomma*, *Pseudobranchiomma* Jones, 1962, *Sabellastarte* Krøyer, 1856 and *Stylomma* Knight-Jones, 1997. Contrasting to the well-supported monophyly of the clade (Capa, 2007a; 2007b; Tilic *et al.*, 2020), relationships among these genera remain unresolved, as well as their current diagnosis results weak (Fitzhugh, 1989, 2003; Rouse & Fitzhugh, 1994; Fitzhugh & Rouse, 1999; Capa, 2007a; Nogueira *et al.,* 2010). In their taxonomic review, Knight-Jones & Perkins (1998) included 19 species in the genus *Bispira*, most of them possessing compound radiolar eyes and ventral pinnular appendages. Since then, additional species have been described, such as *Bispira paraporifera* Tovar-Hernández & Salazar-Vallejo, 2006 from the Caribbean Sea, *Bispira klautae* Costa Paiva & Paiva, 2007 for the Brazilian coast, *Bispira serrata* Capa, 2007c from Australia, *Bispira polyomma* Faasse & Giangrande, 2012 for Netherlands, *Bispira primaoculata* Cepeda & Lattig, 2017 from the Alboran Sea, *Bispira marmarensis* (Çinar & Giangrande, 2018) from the Marmara and the Mediterranean Sea (Putignano *et al.,* 2023), *Bispira riccardi* Giangrande, Putignano & Enrichetti, 2022 for the Italian coast (Enrichetti *et al.,* 2022), *Bispira beatrizae* Tovar-Hernández et al., 2025, and *Bispira nunezi* Tovar-Hernández et al., 2025, for deeper waters of the Gulf of California and Mexican Pacific coast, respectively. Up to now only *B. mariae*, *B. viola*, and *B. riccardi* are reported for the Mediterranean Sea (Giangrande, 1989; Knight-Jones & Perkins, 1998; Castelli *et al.*, 2008; Enrichetti *et al.,* 2022), with the addition of *B. polyomma*, recently found with few individuals only once in the Venice lagoons and housed in the Polychaete Collection of the Museo di Biologia Marina "Pietro Parenzan".

## Material and Methods

Sampling activities were carried out by means of SCUBA diving along the Salento coasts. Specimens housed in Museo di Biologia Marina "Pietro Parenzan" were included in the analysis for comparison (museum codes PCZL): one specimen identified as *B. viola* by Giangrande (1989) and one specimen identified as *B. mariae* by Gambi *et al.,* (2003), both housed in Museo di Biologia Marina "Pietro Parenzan" (PCZL. S. B. 3.2-3.3), were included in the analysis; specimens belonging to the species *Sabella spallanzanii* Gmelin, 1791 (PCZL S. S. 1.12), *Bispira volutacornis* (Montagu, 1804) (PCZL S. B. 2.1), *B. mariae* (PCZL S. B. 1.4), and *B. riccardi* (PCZL S. B. 8.1) were re-examined. Specimens of *Bispira brunnea* (Treadwell, 1917) and *Bispira melanostigma* (Schmarda, 1861) collected by Giangrande *et al.*, (2007) in the Caribbean Sea at Carrie Bow (PCZL S.B. 5.1 and PCZL S. B. 6.1, respectively) were re-examined; specimens of *B. melanostigma* collected from a fish tank in an Aquaria Shop located in Lecce (PCZL S. B. 6.3) were included in the analysis.

Specimens were photographed using a stereo microscope SMZ 25 equipped with DS-Ri2 video camera and a video-interactive image analysis system NIS–Elements BR 4.30.02 Nikon Instruments software (BioForIU, Laboratory of the University of Salento). Photographs were obtained whenever possible from live specimens relaxed in an 8% MgCl2 solution. For molecular analysis, a single radiole was detached from the individual and preserved in 96% molecular grade ethanol until DNA extraction. Specimens were then fixed in either formalin or 70% molecular grade ethanol. Parapodia from the fourth thoracic chaetiger, and mid-abdominal chaetigers were dissected and mounted on permanent slides (using Faure's medium). Drawings of chaetal structures were performed under camera lucida. For scanning electron microscopy (SEM), samples were dehydrated in an ascending ethanol series and in Hexamethyldisilazane (HMDS), coated with a gold-palladium (Au–Pd) alloy to enhance conductivity before imaging with a Hitachi Tabletop SEM TM4000PlusIII (Senckenberg Naturmuseum). Type material of *Bispira causioi* sp. nov., used in this work, is housed either at the Polychaete Collection of the Senckenberg Naturmuseum (Frankfurt am Main – museum codes SMZ), or at Polychaete Collection of the Museo di Biologia Marina "Pietro Parenzan" (Lecce – museum codes PCZL).

Molecular analysis. Total genomic DNA was extracted using the DNeasy® Blood and Tissue kit (Qiagen Inc., Valencia, CA). COI was amplified using the HCO2198/LCO1490 primer set (Folmer *et al.,* 1994). Amplification was carried out in 20 µL solutions using 4 µL of FIREPol® Master Mix (Solis BioDyne), 0.1 µM of each primer and 1 µL of template DNA and/or using Pure Taq™ Ready-to-Go™ PCR Beads (Cytiva, UK). The reaction protocol was as follows: HCO/LCO - 94°C/180s – (94°C/30s – 47°C/45s – 72°C/60s) * 5 cycles – (94°C/30s – 52°C/45s – 72°C/60s) * 30 cycles – 72°C/300s. A negative control was included in each reaction. Successfully amplified products were purified using 2µl of ExoSAP-IT PCR product cleaning reagent. PCR products were sent to Senckenberg BIK-F Laboratory Centre and Macrogen Europe for sequencing and assembled with Geneious v.11.0.2 (https://www.geneious.com). Molecular data were uploaded in BOLD (https://www.boldsystems.org) within the project MAPWORMS - Mimicking Adaptations and Plasticity in WORMS.

## Results

Taxonomic account
Sabellidae Latreille, 1825
**Genus *Bispira* Krøyer, 1856**
*Distylia* Quatrefages, 1866: 421
*Metalaonome* Bush, 1905: 287

**Type species.** *Amphitrite volutacornis* Montagu, 1804, accepted as *Bispira volutacornis* (Montagu, 1804).

***Bispira viola* (Grube, 1863)**
*Sabella viola* Grube, 1863: 58-60, Tav. IV, fig. 6
*Bispira viola* Giangrande, 1989: 169
*Bispira viola* Knight-Jones & Perkins, 1998: 422-424, fig. 14
*Bispira mariae* sensu Gambi *et al.,* 2003: 263

**Material examined.** Montecristo Island, Tyrrhenian Sea; 1989; 30m depth on rocky wall; 1 specimen; PCZL S.B. 3.3. Secca delle Formiche, Gulf of Naples, Tyrrhenian Sea; 2003; 15m on rubble; 1 specimen; PCZL S.B. 3.2.

**Remarks.** *Bispira viola* was described as *Sabella viola* by Grube (1863) for the North Adriatic Sea (Croatia, Mali Lošinj, Krivica). Specimens reported by Grube are 2.9-7.8 cm long, reaching 212 chaetigers, 13-16 of them belonging to the thorax and with 12-17 pairs of radioles; the body/crown length ratio ranges from 1.63 (for the smallest specimen) to 5.08 (for the larger). The palmate membrane is ¼ of crown length, with one continuous band occurring below the palmate membrane edge all around the crown, made by violet spots; occasionally few sparse and irregular spots are present medially or subdistally on the radioles. The radiolar appendages are ⅙ of crown length and white basally, while both radiolar dorsal appendages (probably referring to the dorsal pinnular appendages) and radiolar eyes are reported by the author as absent. The posterior peristomial collar is violet internally and white externally, and the tori don't reach the ventral shields (Grube, 1863: 58-59). Grube repeatedly underlines, as peculiarities of this species, the length of the thorax, the presence of only 2 violet bands, often irregular, on the white crown, the color of the peristomial collar and the softness of the body (Grube, 1863: 59-60). Grube (1864: 30-31) illustrates his staying in Krivica, reporting that he sampled *B. viola* by trawling ("Netzzüge") offshore in the Krivica Bay at "[...] *27-30 Faden* [...]" depth (Grube, 1863: 30), which corresponds to 51-57 m (1 Faden = 1.8965 m). Knight-Jones *et al.,* (1991) report *B. viola* from the Aegean coasts of Turkey, collected among rocks, sponges and calcareous nodules at 3-13 m depth. The specimens described by the authors are quite small (1.8 cm the largest) and characterized by 4-5 brown spots along each radiole which occasionally bears compound radiolar eyes, at least on the basal spots. Lastly, Knight-Jones & Perkins (1998), transferred *S. viola* to the genus *Bispira*, based on material from the Solomon Islands (South Pacific Ocean, Papua Nuova Guinea) collected by Gibbs (1971), material from the Indonesia reported in Fossa & Nilsen (1996) and material later collected by Grube in Lesina Island (Croatia). Following Knight-Jones & Perkins (1998), the analysed specimens have up 185 chaetigers (11-17 of which are from the thorax) for up to 5.6 cm and 3.5 cm length of body and crown, respectively, and with up to 25 pairs of radioles. These are characterized by 2-3 liver patches along radioles which may have radiolar eyes in the basal spots. The radiolar appendages are ⅙ of crown length and radiolar skeleton is composed of 6 cells in quadrangular arrangement, while radiolar tips are short and filiform. The specimens of *Sabella melanostigma* Schmarda, 1861 collected in the Solomon Islands at 22-33 m depth by Gibbs (1971) and included in the material identified as *B. viola* by Knight-Jones & Perkins (1998) are rather small, 1.2 cm long (body + crown) and with 7 radioles, each characterized by 2-3 pairs of radiolar eyes (Gibbs, 1971: 201-202). Unfortunately, no additional *B. viola* specimens have been collected in the Adriatic Sea since the work of Knight-Jones & Perkins (1998).

Two specimens of *B. viola* are housed in the Polychaete Collection of the Museo di Biologia Marina "Pietro Parenzan" (PCZL S. B. 3.2-3.3), the first one was collected by Dr. Maria Cristina Gambi at Secca delle Formiche of Ischia Island (15 m depth, on rubble), and mistakenly identified as *B. mariae* (Gambi *et al*., 2003); the second one was collected by one of the authors (AG) in

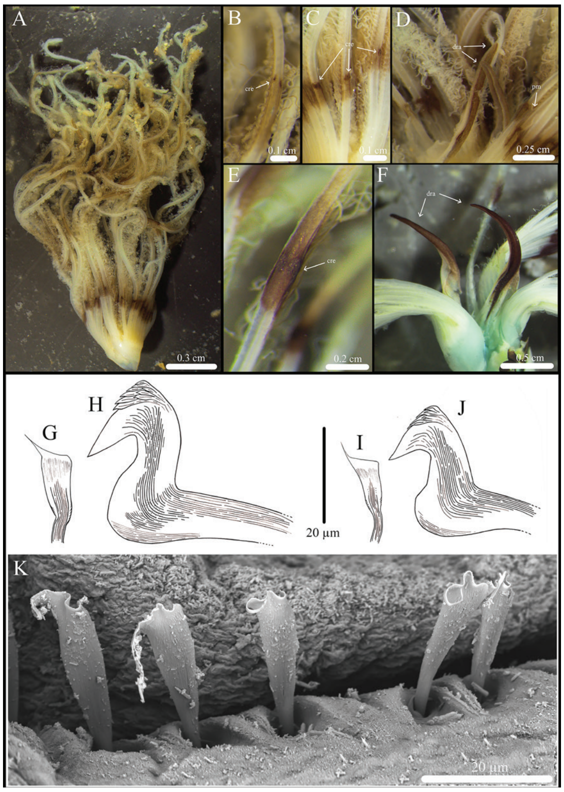

***Fig. 1:*** *Bispira viola* specimens from Secca della Formiche (PCZL S.B. 3.2) and Montecristo Island (PCZL. S.B. 3.3). A-D. PCZL S.B. 3.3: A. Crown; B, C. Compound radiolar eyes; D. Dorsal radiolar appendages. E, F. PCZL S.B. 3.2: E. Compound radiolar eyes; F. Dorsal radiolar appendages. G-J. Line drawings: G, H. PCZL S.B. 3.2 (G. Companion chaetae; H. Thoracic uncini); I, J. PCZL S.B. 3.3 (I. Companion chaetae; J. Thoracic uncini). K. Companion chaetae, SEM scans (PCZL S.B. 3.2) (**cre.** compound radiolar eyes, **dra.** dorsal radiolar appendages, **pm.** palmate membrane).

the Western Mediterranean Sea (Tyrrhenian Sea, Montecristo Island) on hard bottom at 30 m depth (Giangrande, 1989) (Fig. 1). The specimen from Montecristo (PCZL S.B. 3.3) shows 2 distinct dark bands on the crown made by elongated spots of similar length in all the crown (Fig. 1A), with the basal band occurring at ¼ of crown length, below palmate membrane edge (Fig. 1D); both basal and medial bands maintain the same height around the crown; occasionally, a third spot is present sub-distally on dorsal radioles, but never forming a pigmented band around the crown. The spots of the basal band host a pair of elongated compound radiolar eyes, medially in the spots (Fig. 1B-C). The dorsal radiolar appendages are dark and rounded, ⅕ of crown length (Fig. 1D); the dorsal pinnular appendages are present, short, filiform, with purple tips. The specimen from Ischia (PCZL S.B. 3.2) is identical with respect to the material collected in Montecristo, showing only minor differences (i.e., specimen from Ischia is larger than specimen from Montecristo, with basal band occurring at ⅓ of crown length instead of ¼). Both specimens show thin radiolar flanges, slightly enlarging at the dark spots (Fig. 1B-C, E), thoracic uncini with a distinctly long handle (Fig. 1H, J) and asymmetrical, elongated companion chaetae with thin mucro (Fig. 1G, I, K).

### ***Bispira causioi*** **sp. nov.**

ZooBank: urn:lsid:zoobank.org:act:501501A2-CC7E-4175-8328-34718E7F8A17

? *Bispira viola* sensu Knight-Jones *et al.*, 1991: 846-847

**Holotype.** Santa Caterina di Nardò, Ionian Sea (40.140614°N; 17.979802°E); 1 November 2023; 12 m depth, gravel to coarse sand with small patch of *Halophila stipulacea* (Forsskål) meadows; SMF 33433.

**Paratypes.** Same locality and date; 4 specimens; SMF 33434-33437. Same locality; 26 June 2023; 13 m depth, gravel to coarse sand; 2 specimens; PCZL S.B. 10.1-2. Santa Maria al Bagno, Ionian Sea (40.125159°N; 17.995368°E); 19 March 2023; 13 m depth, sand; 1 specimen; PCZL S.B. 10.4. Torre Guaceto, Adriatic Sea (40.751067°N; 17.743967°E); 15 October 2023; 17 m depth, *Posidonia oceanica* (L.) Delile, 1813 meadow; 1 specimen; SMF 33438. Porto Cesareo, Ionian Sea (40.252179°N; 17.907219°E); 13 May 2022; 0.5 m depth, mud covering stones; 9 specimens; SMF 33439-33447. Otranto, Adriatic Sea (40.147720°N; 18.500246°E); year 2012; 10 m depth, *Posidonia oceanica* (L.) Delile, 1813 meadow; 5 specimens; PCZL S.B. 3.4. Same locality; year 2014; 3 specimens; PCZL S.B. 3.5. Miseno Lake, Tyrrhenian Sea (40.792993°N; 14.072992°E); 21 July 2021; 1 m depth, mud; 4 specimens; SMF 33448-33451. Leuca, Ionian Sea (39.78355°N; 18.35548°E); 18 July 2025; 40 m depth, gravel to coarse sand; 1 specimen; SMF 33432.

**Description.** Holotype complete, missing one radiole for DNA analysis (Fig. 2A). Live material whitish with a tinge of green due to hemocyanin and with magenta to dark-purple spots on the crown, peristomium, thorax and anterior abdomen (Figs. 3A, D-F; 4A-C). Fixed material yellowish with magenta to black/purple spots on crown and body (Fig. 2A). Body sub-cylindrical, 3 cm long; 10 thoracic and 76 abdominal chaetigers. Thorax longer than wide; maximum width 2.17 mm. Crown 2.1 cm long, holding 15 pairs of radioles; crown not spiralized. Ratio body/crown length 1.43. Palmate membrane 1/10 of crown length (Fig. 3E), persisting as distinct smooth radiolar flanges all along the radiole (Fig. 3D-F). Radiolar tips pointy to round, depending on the presence of pigmented spots, up to 1/63 of radiole length (Fig. 3F). Pinnules thin, blunt, following radiole pigmentation, alternating along radioles, up to 1/10 of radiole length; longest pinnules medial to subdistal. Radiolar skeleton as eight rows of squared vacuolated cells basally, six rows of squared vacuolated cells medially (two larger); radiolar skeleton not supporting radiolar flanges (Fig. 3G, H).

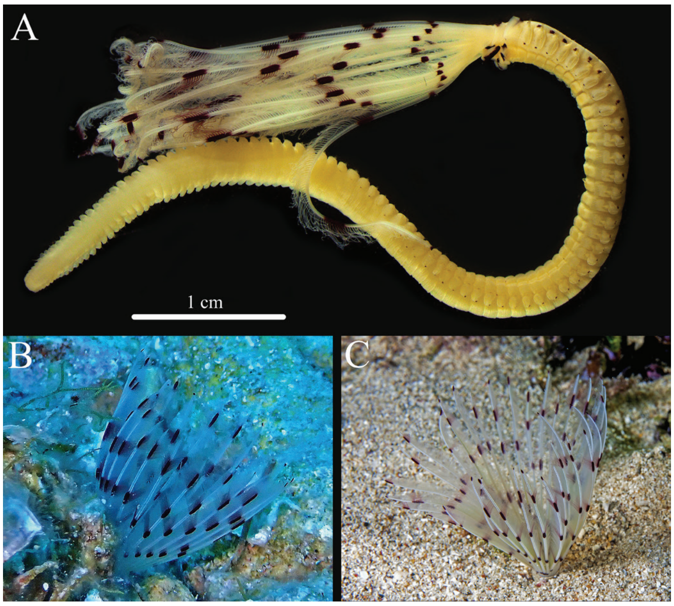

***Fig. 2:*** *Bispira causioi* sp. nov. A. Holotype (SMF 33433); B, C. Field photographs of specimens from natural environment (B, photo credit: A.T.; C, photo credit: Salvatore Causio).

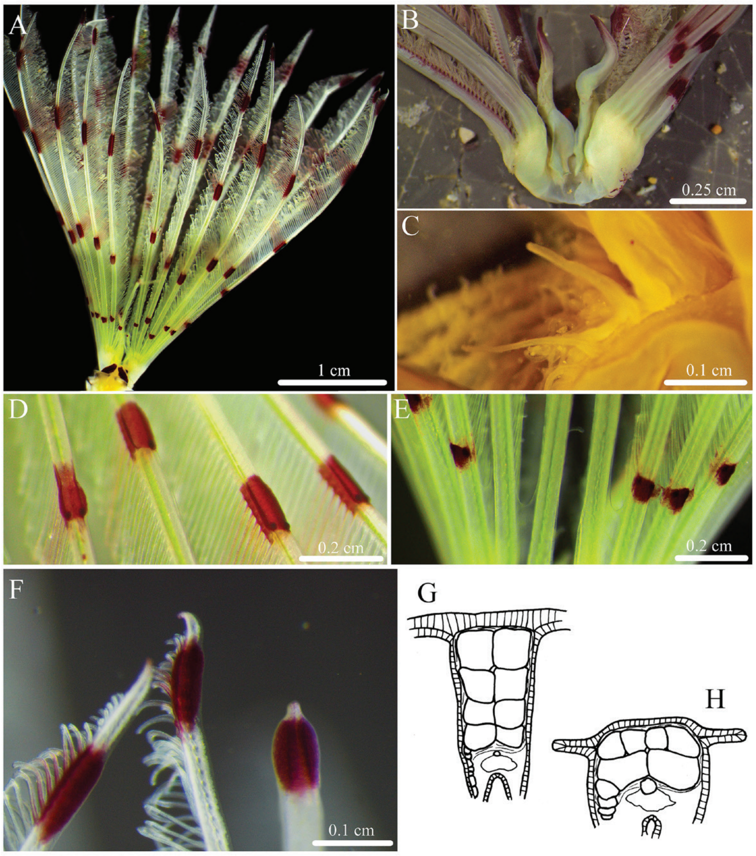

***Fig. 3:*** *Bispira causioi* sp. nov., crown details. A-F. Photographs. A. Crown ventral view, holotype (SMF 33433 - alive); B, C. Lips and related structures, paratypes (SMF 33440 - fixed): B. Dorsal radiolar appendages, C. Dorsal pinnular appendages; D, E. Radiolar spots and radiolar eyes, holotype (SMF 33433 - alive): D. Dorsal basal band, E. Medial ventral band; F. Radiolar tips holotype (SMF 33433 - alive). G, H. Line drawings of radiolar skeleton sections: G. Basal section, H. Medial section.

Radioles with well-defined, dorsal, rounded to oblong spots; radiolar flanges distinctly enlarging at the spots; spots elongating distally (Fig. 3A, D-F). Ventral radioles with four spots (basal, medial and sub-distal); basal spots at palmate membrane edge (Fig. 3E). Spots arranged in bands on the crown (basal, medial and sub-distal): basal and medial bands tidy; sub-distal band irregular (Figs. 2A-C; 3A). Dorsal radioles with up to five spots. Spots arranged in irregular and indistinct bands. Dorsal radiolar appendages rounded, grooved, distally pigmented, 1/7-1/8 of crown length (one radiolar appendage in regeneration) (Fig. 3B). A pair of dorsal pinnular appendages each radiolar lobe (Fig. 3C). A single pigmented spot on each radiolar lobes ventrally (Fig. 4A-B). Parallel lamellae unpigmented, connecting ventral lips to ventral peristomium (Fig. 4A-B, D-E). Ventral sacs pigmented, rounded, elongated, external to the crown (Fig. 4A-B, D-E). Ventral lappets short, rounded, sub-distally widening, pigmented inside, partially overlapping (Fig. 4A-B, D-E). Posterior peristomial collar smooth, latero-ventrally with a round, pigmented notch each side, dorsally fused to peristomial notopodia; posterior peristomial collar edge pigmented inside and outside (Fig. 4A-F). Sub-distal clear girdle all around posterior peristomial collar (Fig. 4C, E, F). Anterior peristomial ring dorsally bilobed, with a pair of rounded pigmented spots (Fig. 4C, F). Posterior peristomial collar not covering anterior peristomial ring. First ventral shield W-shaped + 2 mid anterior rounded elements; a mid-rounded depression present (Fig. 4A, D). Thoracic shields squared, undivided (Fig. 4G-H). Abdominal shields squared, divided by faecal groove. Thoracic tori antero-ventrally pigmented, not reaching ventral shields (Fig. 4G-H); pigmentation decreasing posteriorly, disappearing at abdominal chaetiger 5. Thoracic notopodia dorsally pigmented (Fig. 4I); pigmentation decreasing posteriorly, disappearing at abdominal chaetiger 35. One pair of rounded to ovoidal compound radiolar eyes in spots from basal to subdistal bands (Fig. 3D-E); radiolar eyes distally in the spots, just dorsal to radiolar flanges; radiolar eyes diameter less than half radiolar rachis. Cerebral eyespots not visible. Segmental eyespots single, occasionally double, small, rounded, purple; segmental eyespots ventral on both thoracic neuropodial and abdominal notopodial tori (Fig. 4J). Pygidium bilobed (Fig. 4K); pygidial eyespots indistinct. Few narrowly hooded superior thoracic notochaetae arranged in a dorsal row (Fig. 5A1-2); numerous hooded inferior thoracic notochaetae arranged in one-two ventral rows (Fig. 5B1-4). Thoracic neuropodial uncini avicular with long main fang and four-five rows of teeth, covering half of it; teeth progressively increasing in number and getting smaller toward uncini vertex; handle thick, long as neck; uncini long as high (Fig. 5F1-3); SEM. scans consistent with optical microscopy (Fig. 5I). Companion chaetae sub-rectangular, flattened, wider subdistally, with a short thin mucro (Fig. 5C); SEM. scans consistent with

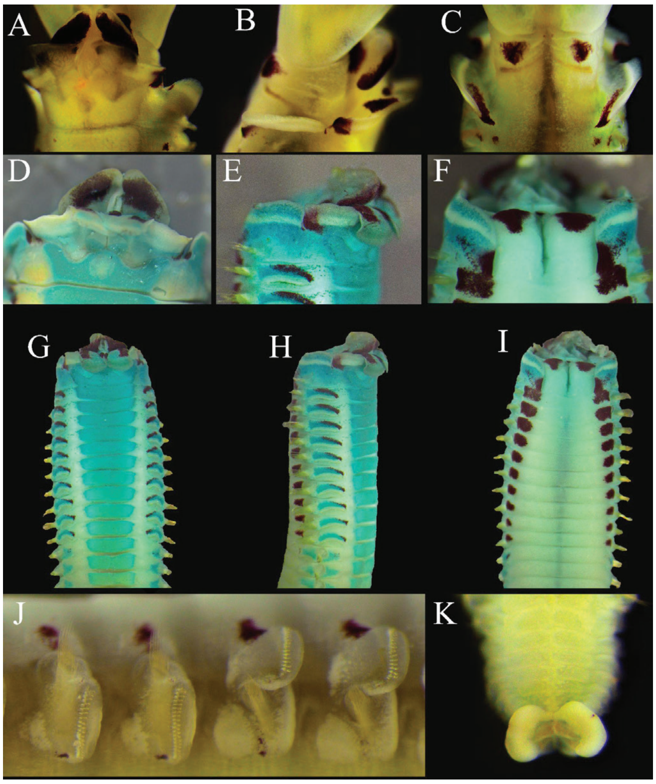

***Fig. 4:*** *Bispira causioi* sp. nov., body details. A-C. Peristomium, holotype (SMF 33433 - alive): A. Ventral view, B. Lateral view, C. Dorsal view; D-F. Peristomium, paratype (SMF 33440 - fixed, stained with green methyl): D. Ventral view, E. Lateral view, F. Dorsal view; G-I. Thorax and anterior abdomen, paratype (SMF 33440 - fixed, stained with green methyl): G. Ventral view, H. Lateral view, I. Dorsal view; J. Thoracic and abdominal parapodia, holotype (SMF 33433 - alive); K. Pygidium, holotype (SMF 33433 - alive).

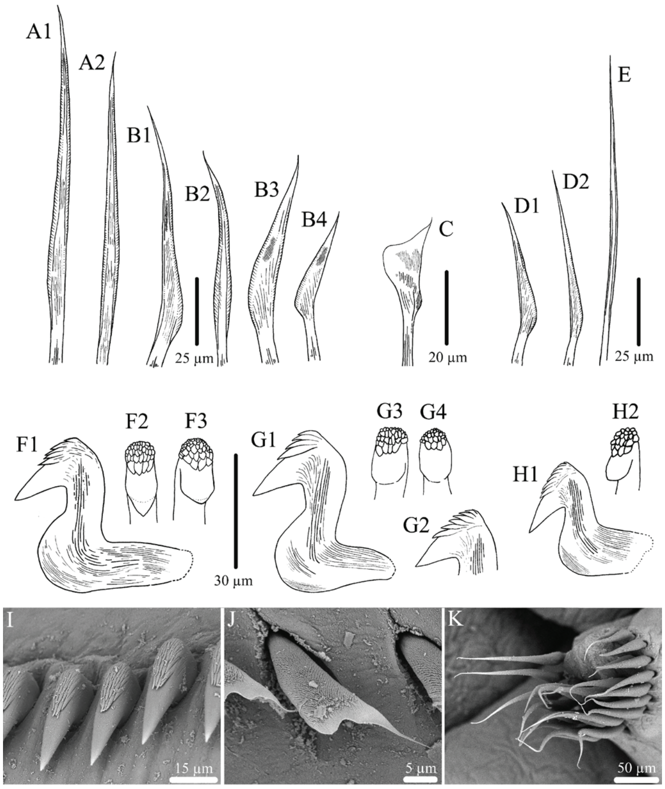

***Fig. 5:*** *Bispira causioi* sp. nov., chaetal structures. A1-H2. Line drawings. A1, A2. Thoracic superior narrowly-hooded notochaetae; B1-B4. Thoracic inferior hooded notochaetae; C. Companion chaeta; D1, D2. Abdominal inferior hooded neurochaetae; E. Abdominal superior narrowly-hooded neurochaeta; F1-F3. Thoracic avicular neuropodial uncini: F1. Lateral view, F2, F3. Rostral view; G1-H2. Abdominal avicular notopodial uncini: G1, G2. Mid abdomen, lateral view, G3, G4. Mid abdomen, rostral view, H1. Posterior abdomen, lateral view, H2. Posterior abdomen, rostral view. I-K. SEM. photographs: I. Thoracic avicular neuropodial uncini, J. Companion chaeta, K. Abdominal neurochaetal tuft arrangement.

optical microscopy (Fig. 5J). One-two extremely narrowly hooded superior abdominal neurochaetae from abdominal chaetiger 45 (Fig. 5E); few narrowly hooded superior abdominal neurochaetae arranged in circular tufts (Fig. 5D1-2, K). Abdominal notopodial uncini avicular; main fang longer with four-six rows of teeth, covering half of it; teeth progressively increasing in number and getting smaller toward uncini vertex; handle thick, shorter than neck; uncini long as high (Fig. 5G1-4). Posterior abdomen uncini with progressively increasing number of rows of teeth over the main fang (Fig. 5H1-2).

**Morphological variability.** Different morphotypes of *Bispira causioi* sp. nov. were found from different localities and environmental contexts: a first one collected on coarse sediments from open sea, a second one characteristic of more confined environments. Differences among them mainly concern crown and body pigmentation (Fig. 8).

Morphotype 1 (Adriatic and Ionian Sea; 10-40 m depth, on gravel to coarse sand and *P. oceanica* (L.) Delile, 1813 meadows; marine) (Fig. 6A1-10). Crown visible only during field observations, tubes opening not visible (Figs. 2B, C; 7A); crown white punctuated with dark irregular spots (Figs. 2B, C; 7A). Body 1.68 to 3.29 cm long; 9 to 12 thoracic and 68 to 100 abdominal chaetigers. Maximum width 2.96 to 5.45 mm. Crown 1.15 to 3.72 cm long, holding 11 to 19 pairs of radioles (often unpaired radioles: min 12; max 18). Ratio body/crown length 1.36 to 1.68. Posterior peristomial collar covering or not covering anterior peristomial ring depending on specimens. Crown with distinct, rounded to oblong pigmented spots elongating distally, ventral radioles spots

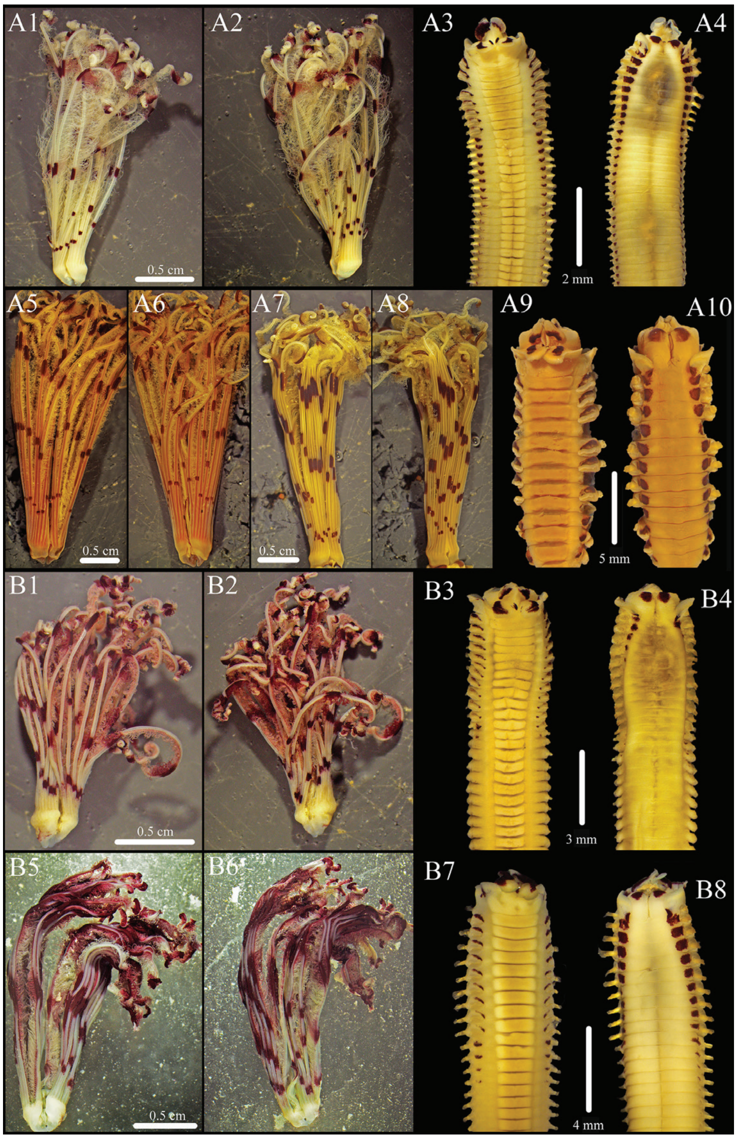

***Fig. 6:*** *Bispira causioi* sp. nov., morphological variation. A1-A10. Morphotype 1. A1-A4. Paratype (SMF 33435 - fixed), Santa Caterina di Nardò - marine: A1. Crown, ventral view, A2. Crown, dorsal view, A3. Anterior body, ventral view, A4. Anterior body, dorsal view; A5-A10. Paratype (fixed), Otranto - marine: A5. Crown, ventral view (PCZL S.B. 3.4 ), A6. Crown, dorsal view (PCZL S.B. 3.4), A7. Crown, ventral view (PCZL S.B. 3.5), A8. Crown, dorsal view (PCZL S.B. 3.5) A9. Anterior body, ventral view (PCZL S.B. 3.4), A10. Anterior body, dorsal view (PCZL S.B. 3.4); B1-B8. Morphotype 2. B1.B4 Paratype (SMF 33450 - fixed), Miseno Lake - coastal lake:  B1. Crown, ventral view, B2. Crown, dorsal view, B3. Anterior body, ventral view, B4. Anterior body, dorsal view; B5-B8. Paratype (SMF 33440 - fixed), Porto Cesareo - confined environment: B5. Crown, ventral view, B6. Crown, dorsal view, B7. Anterior body, ventral view, B8. Anterior body, dorsal view.

starting basally; interspots unpigmented (Figs. 2A-C; 3A; 6A1-2). Occasionally larger specimens with elongated and contrasted spots on the crown (Fig. 6A5-8). Number of spots increasing with size: ventral radioles with 2 to 5 spots; dorsal radioles with 3 to 7 spots. Radiolar compound eyes diameter occasionally large as half radiolar rachis. Pigmentation on ventral sacs, ventral lappets, posterior peristomial collar notches and dorsal anterior peristomium variable in extension; larger specimens' pigmentation generally wider and contrasted. Neuropodial pigmentation ending at last thoracic chaetiger to abdominal chaetiger 37 (Fig. 8A3, 9); notopodial pigmentation ending at abdominal chaetigers 3 to 55 (Figs. 6A4, 10). Abdominal superior neurochaetae at chaetigers 24 to 53. The holotype belongs to this morphotype.

Morphotype 2 (Tyrrhenian Sea; 1 m depth on mud; coastal lake; Ionian Sea; 0.5 m depth on mud covering stones; enclosed basin) (Fig. 6B1-8). Only crown visible during field observations, tubes opening occasionally visible (distal 1-2 cm) (Fig. 7B); crown dark and dark spots indistinct (Fig. 7B). Body to 2.43 to 4.06 cm long; 9 to 13 thoracic and 61 to 114 abdominal chaetigers. Maximum width 2.8 to 3.98 mm. Posterior peristomial collar covering or not covering anterior peristomia ring depending on specimens. Crown 1.47 to 1.84 cm long, holding 13 to 15 pairs of radioles. Ratio body/crown length 1.6 to 2.57. Crown with distinct, rounded to oblong pigmented spots elongating distally, ventral radioles spots starting basally to medially; interspots pinkish to dark purple on radiolar rachis and pinnules (Fig. 6B1-2, 5-6). Number of spots increasing with size: ventral radioles with 3 to 5 spots; dorsal radioles with 4 to 7 spots. Pigmentation on ventral sacs, ventral lappets, posterior peristomial collar notches and dorsal anterior peristomium variable in extension; larger specimens' pigmentation generally wider and contrasted. Neuropodial pigmentation ending at chaetigers (abdominal) 1 to 5 (Fig. 6B3, 7); notopodial pigmentation ending at chaetigers (abdominal) 1 to 35 (Fig. 6B4, 8). Abdominal superior neurochaetae at chaetigers 41 to 72.

**Molecular data.** Two COI sequences were obtained for *B. causioi* sp. nov., one from the holotype (morphotype 1, SMF 33433, accession number PX794753) and one from a paratype (morphotype 2, SMF 33440, accession number PX794752). The comparison between these two sequences gave a 100.00% identity, supporting the identity between the two morphotypes. The COI sequence from the holotype was then compared with all the sequences deposited on GenBank: the best match is a sequence assigned to *B. riccardi* from the Mediterranean Sea (accession number: OL853450; Enrichetti *et al.*, 2022), with 90.22% identity; the second best match is a sequence assigned to *Bispira tricyclia* (Schmarda, 1861) (accession number: OP536416), with 84.09% identity; lastly, the third best match is a sequence assigned to *Bispira manicata* (Grube, 1878) from Australia (accession number: KX894904 and HQ015124; Capa *et al.,* 2010; Capa & Murray, 2016), with 83.12% and 82.99% identity. A comparison with COI sequence from a specimen of *B. melanostigma* (unpublished data) revealed a 82.06% identity.

**Etymology.** This species was named after Dr. Salvatore Causio, who first observed and collected it in the years 2012 and 2014 from the Adriatic coasts of the Salento peninsula.

**Ecology and distribution.** Infralittoral, from <1 to 10 m depth, occasionally at 40 m depth. Morphotype 1 typically marine, on mixed substrates from gravel to coarse sandy bottom and *P. oceanica* meadows; Morphotype 2 in enclosed basins (i.e., coastal lakes and lagoons) on mud and stones covered by mud. Known for the South Adriatic Sea, Ionian Sea and South Tyrrhenian Sea. Figure 7 shows the abundance of individuals in two sites along the Apulian coast.

**Remarks.** *Bispira causioi* sp. nov. shows a remarkable phenotypic variability, with the occurrence of two distinct morphotypes: one found in marine environments

***Fig. 7:*** *Bispira causioi* sp. nov. habitus in marine (A) and confined brackish water environment (B) contexts (A. Santa Caterina di Nardò, 10 m depth, morphotype 1 - photo by AT; B. Porto Cesareo, 0.5 m depth, morphotype 3 - image from an underwater video realized with a GoPro7 White by MP); arrows point to radiolar crowns.

with light coloration on the crown (Figs. 2B, C; 6A1-10; 7A), the other in enclosed systems, such as coastal lakes or lagoon, with a dark crown (Figs. 6B1-8; 7B). Still, despite these differences, molecular data indicate that they belong to the same species.

*Bispira causioi* sp. nov. can be easily distinguished from most of the other *Bispira* species based on the morphology of both companion chaetae and uncini (such as *B. mariae, Bispira elegans* (Bush, 1905), *Bispira oatesiana* (Benham, 1927)*, B. primaoculata*, *B. polyomma*, *Bispira turneri* Hartman, 1969, and *B. volutacornis*), the shape of radiolar flanges (serrated in *B. serrata* and *B. nunezi,* enlarged distally in *Bispira pacifica* (Berkeley & Berkeley, 1954), *Bispira wireni* (Johansson, 1922) and *Bispira fabricii* (Krøyer, 1856)) and on the morphology of the peristomium (cushion-like in *Bispira porifera* (Grube, 1878), *B. paraporifera* and *B. klautae* (Knight-Jones and Perkins, 1998).

By contrast, *B. causioi* sp. nov. shares several similarities with some other congenerics such as *Bispira guinensis* (Augener, 1918), *B. manicata, B. melanostigma, Bispira monroi* (Hartman, 1961), *B. riccardi, B. tricyclia,* and *B. viola,* having sub-rectangular and flattened companion chaetae, thoracic and abdominal uncini with few rows of teeth decreasing in size over the main fang, and thoracic tori not reaching ventral shields. Also, most of them have compound radiolar eyes and a violet/purple coloration on both the crown and the body (Knight-Jones & Perkins, 1998; Capa, 2007c; Yáñez-Rivera *et al.,* 2020; Enrichetti *et al.,* 2022).

Among these species, *B. viola* and *B. riccardi* are the only ones occurring in the Mediterranean Sea. They both are characterized by 2-3 regular purple bands all around the crown, distinctly wider and darker in *B. riccardi* than in *B. viola* (Grube, 1863; Knight-Jones & Perkins, 1998; Enrichetti *et al.,* 2022). On the opposite*, B. causioi* sp. nov. shows well defined and irregular spots on the crown (Fig. 8A). Furthermore, *B. riccardi* lacks radiolar eyes, present in both *B. causioi* sp. nov. (on most of the spots) and *B. viola*. In particular, the literature shows that *B. viola* possesses radiolar compound eyes in the first two pigmented bands (basal and medial), even if in the examined specimens from the Western Mediterranean Sea the radiolar eyes are found only in the basal band. In all the morphotypes of *B. causioi* sp. nov. the radiolar eyes occur basally to sub-distally in well-defined spots. On the contrary, in *B. viola* the radiolar eyes occur basally to medially in the elongated spots (the pigment of which often fades distally) that form a regular band, resulting in completely different appearance (closer to what is observed in *B. riccardi* - Fig. 8B-C).

Resuming, both *B. viola* and *B. riccardi* share the presence of elongated dark spots on the crown, without enlarged radiolar flanges, which form 2-3 bands around the crown, the third one being always incomplete and messy, never bringing radiolar eyes (Grube, 1863; Knight-Jones & Perkins, 1998; Enrichetti *et al.,* 2022; present data). *Bispira causioi* sp. nov. shows a high number of rounded to oblong, well-defined spots on the radioles (up to 7), with radiolar flanges distinctly enlarging and radiolar compound eyes present in most of them. Different to what can be observed in both *B. viola* and *B. riccardi,* only the basal and medial spots on the ventral radioles form appreciable bands in *B. causioi* sp. nov., while both ventral sub-distal spots and dorsal spots are irregularly arranged. Additionally, the companion chaetae of both *B. viola* and *B. riccardi* are more elongated than those of *B. causioi* sp. nov., as well as handle of thoracic uncini, which are distinctly elongated in *B. viola*. Lastly, the radiolar skeleton in *B. riccardi* is composed only by 4 cells in squared arrangement, whilst in *B. causioi* sp. nov. is composed by 6 cells basally, with two clearly bigger cells composing a ventral row and the remaining four smaller, all included in the dorsal row. In *B. viola* the radiolar skeleton is also composed by 6 cells basally in the radioles, but their arrangement is completely different, being all of similar size and forming three equal rows (Knight-Jones & Perkins, 1998).

Both molecular data and ecology distinguish *B. riccardi* from the new taxon (9.88% distance on COI, while *B. riccardi* is currently known for deep muddy substrates at 60 to 90 m depth where it forms dense aggregates - see Enrichetti *et al.,* 2022). No molecular data are available for *B. viola,* which shows a wider bathymetrical distribution and a different ecology with respect to *B. riccardi,* occurring on hard substrates at 15-60 m depth. *Bispira causioi* sp. nov. was observed on a wider typology of substrates with respect to both *B. viola* and *B. riccardi,* having been collected on *P. oceanica* meadows, sand, gravel, mud and mud covering stones, from very shallow

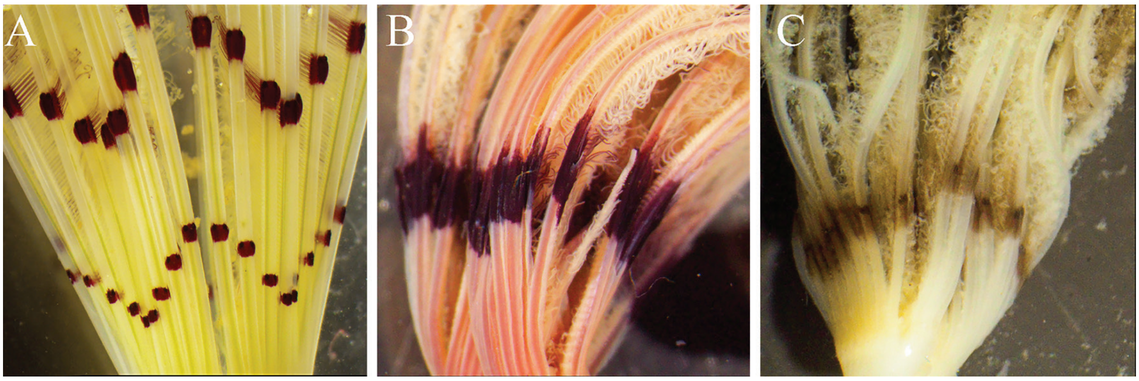

***Fig. 8:*** Comparative figure of crown colouration patterns the three different Bispira species from the Mediterranean Sea: A. Bispira causioi sp. nov.; B. Bispira riccardi; C. Bispira viola (PCZL S.B. 3.3).

(less than 1 m) to relatively deep waters (40 m for the deepest specimen collected). Furthermore, the habitus of *B. riccardi* and *B. causioi* sp. nov. are distinct, the former producing tubes that protrude from the substrates for the majority of their length (Enrichetti *et al.,* 2022), while the latter having tubes completely buried in the sediments. No data are available for *B. viola*. Lastly, specimens reported by Knight-Jones *et al.,* (1991) from Turkey show morphology and ecology consistent with *B. causioi* sp. nov. (i.e., presence of 4-5 brown spots along each radiole and being collected among rocks, sponges and calcareous nodules at 3-13 m depth, respectively), suggesting that this finding may refer to this new species.

The remaining *Bispira* taxa sharing most similarities with *B. causioi* sp. nov. (i.e., *B. guinensis, B. manicata, B. melanostigma, B. monroi*, and *B. tricyclia*) occur outside the Mediterranean Sea and have a tropical distribution.

Among them, the most similar species are *B. monroi* and *B. manicata*, especially in the arrangement of purple spots on the crown. The first one has been recently reported based on material collected in Isla Pajarera (Mexico) (Yáñez-Rivera *et al.*, 2020) and can be distinguished from *B. causioi* sp. nov. due to the distinctly spiralized crown hosting a quite high number of radioles (3 whorls with up to 29 pairs of radioles for 3.4 cm of body length *vs.* no whorls and up to 15 pairs of radioles for 4 cm of body length in *B. causioi* sp. nov.) and the presence of purple spots between thoracic tori and ventral shields, occurring only antero-ventrally on the tori in *B. causioi* sp. nov. *Bispira manicata* and *B. causioi* sp. nov. are hardly morphologically distinguishable. Following the most recent description (Capa, 2007c), these two species differentiate based on body pigmentation, with *B. manicata* having ventral sacs coloured only distally, while they are completely pigmented in *B. causioi* sp. nov. Moreover, the height of radiolar appendages is the same as the palmate membrane in *B. manicata* and higher than palmate membrane in *B. causioi* sp. nov. Lastly, *B. manicata* has a different arrangement of the radiolar skeleton, with 4-7 cells basally on the radioles. Furthermore, molecular data from one the specimen included in the re-description of *B. manicata* (Capa, 2007c) and sequenced for a next study (Capa *et al.,* 2010) (AM W30006, accession number: HQ015124) show a low percentage of identity on COI with *B. causioi* sp. nov. (82.99%), supporting the distinction between these two species. Capa (2007b), suggested that both *B. tricyclia* sensu Knight-Jones & Perkins, 1998 and *Spirographis tricyclia* sensu Augener, 1927 belong to *B. manicata.* In the original description Schmarda (1861: 37) reports a yellow-green body, with the peristomial collar edge white and the crown striped of yellow and purple. Unfortunately, this is not enough to conduct a proper comparison between the two species; however, the coloration of the crown seems to be quite similar to what is reported for some species belonging to the genus *Sabellastarte*. Therefore, collection of material from the type locality is needed to assess the identity of *B. tricyclia.*

Following Knight-Jones and Perkins (1998), *B. guinensis* differs from *B. causioi* sp. nov. for the crown pigmentation (with several brown bands), the arrangement of radiolar eyes (numerous, generally in pairs or staggered, occasionally blurring into one), the absence of radiolar flanges, the shape of peristomial ventral shield (with a tri-emarginated anterior edge rather than a proper "W-shape") and the number of radioles (50 radioles for 2.8 cm of body length). The syntypes of *B. guinensis* was re-examined by Capa (2007b) who found it partially macerated, underlining the need for the collection of new material belonging to this species.

*Bispira melanostigma* has radiolar skeleton supporting radiolar flanges (Knight-Jones & Perkins, 1998), although no data about this feature are found in Tovar-Hernández & Salazar-Vallejo (2006), which depict a radiolar skeleton composed by 8-10 cells. Both the number of skeletal cells and their arrangement clearly distinguish *B. melanostigma* and *B. causioi* sp. nov. These features are also present in specimens of *B. melanostigma* collected from the fish tank of an Aquaria Shop and housed in the Polychaete Collection of the Museo di Biologia Marina "Pietro Parenzan" (PCZL. S.B. 6.3), whose COI sequence (unpublished data) resulted in 99.27% identity with a private sequence on BOLD attributed to *B. melanostigma* (BOLD ID: BCGGI097-19), and showing 82.06% identity when blasted with COI sequence from *B. causioi* sp. nov. holotype. These specimens show both different coloration (Fig. 9A-E) and arrangement of structural characters, such as smaller radiolar eyes in less conspicuous colored spots and poorly enlarged radiolar flanges (Fig. 9B, F, G), few radioles on the crown and a radiolar skeleton composed of 8-10 cells supporting radiolar flanges both basally and dorsally in the radioles (Fig. 9I).

The comparison with the two remaining species of *Bispira* deserves a special note. *Bispira brunnea* (Treadwell, 1917) is a small and unmistakable species, known for the absence of radiolar eyes, asexual reproduction and forming colonies on both natural and artificial hard substrates (Tovar-Hernández & Pineda-Vera, 2008). Giangrande *et al.,* (2007: 44-45) collected specimens of *B. brunnea* in Carrie Bow. A recent re-examination of the same material (PCZL S.B. 5.1) unveiled the presence of both small radiolar eyes on very pale bands and asymmetrical companion chaetae with a thin but longer mucro than those found in *B. causioi* sp. nov. On the opposite, both Knight-Jones & Perkins (1998) and Tovar-Hernández & Salazar-Vallejo (2006) reported *B. brunnea* with tear-drop shaped companion chaetae, similar to those found in other *Bispira* and *Sabella* species (e.g., *B. mariae, B. polyomma* and *S. spallanzanii*. Tovar-Hernández & Pineda-Vera, (2008) described two forms of *B. brunnea* from the Caribbean region: the first one is characterized by a white crown, the second by a striped crown, this last having tear-drop shaped companion chaetae (Tovar-Hernández & Pineda-Vera, 2008: Fig. 5S), while no drawings were reported for the white form. These two forms seem to have different distribution, being the striped form present all along the Quintana Roo coast (Mexico) and the white form occurring only in the Northern part of the same state. These observations suggest that two different species may presently be identified as

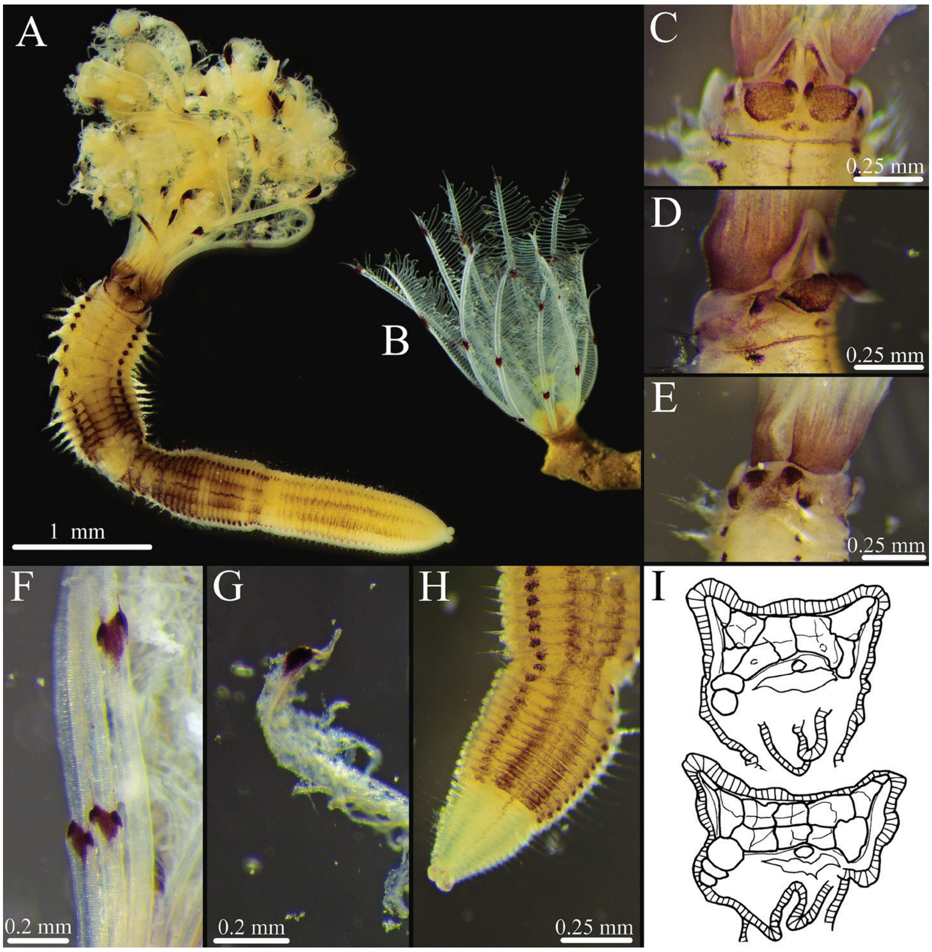

***Fig. 9:*** *Bispira melanostigma* (PCZL S.B. 6.3), body details. A-C. Peristomium (alive): A. Ventral view, B. Lateral view, C. Dorsal view; D-F. Peristomium (fixed, stained with green methyl): D. Ventral view, E. Lateral view, F. Dorsal view; G-I. Thorax and anterior abdomen (fixed, stained with green methyl): G. Ventral view, H. Lateral view, I. Dorsal view; J. Thoracic and abdominal parapodia (alive); K. Pygidium (alive).

*B. brunnea,* and that the material collected by Giangrande *et al.,* (2007) may belong to one of them. However, both taxa share important similarities which clearly differentiate them from *B. causioi* sp. nov., such as crown longer than body, asexual reproduction and colonies-formation. Lastly *Bispira crassicornis* (Sars, 1851) can be easily distinguished from *B. causioi* sp. nov. based on the radiolar skeleton composed of numerous cells and supporting distally in the radioles a well-developed radiolar flanges (Knight-Jones & Perkins, 1998). However, the drawing of companion chaetae and thoracic uncini from Knight-Jones & Perkins (1998) are difficult to interpret. These authors also underline that the reports of *B. crassicornis* from the Mediterranean Sea (Lo Bianco, 1893) most probably represent juveniles of *B. mariae* with which this species shares a general resemblance.

## Discussion

### *On the diversity within the genus* Bispira

The genus *Bispira* has been traditionally considered the sister group of *Sabella* based on the shape of the companion chaetae (Fitzhugh, 1989; Rouse & Fitzhugh, 1994), despite it successively resulted as the sister group of the clade composed by the genera *Sabella*, *Sabellastarte*, *Pseudobranchiomma* and *Branchiomma* (Fitzhugh, 2003), as an unresolved polytomy (Fitzhugh & Rouse, 1999) or paraphyletic (Capa, 2008). Still, members of the genera *Sabella* and *Bispira* share most similarities, and numerous species today included in the latter were originally described as *Sabella* (Knight-Jones & Perkins, 1998). These two genera are now distinguished based only on the arrangement of abdominal neurochaetae (spiral in *Sabella*, “C-shaped” in *Bispira* – Fig. 10C, F, I, L) and on the presence of compound eyes, presumably absent in *Sabella* (Knight-Jones & Perkins, 1998). This is most probably the reason underlying the high morphological heterogeneity present in the genus *Bispira*. In fact, its diagnosis is based on characters that do not represent any synapomorphy (Capa, 2007b) and the same diagnostic characters, such as the shape of radiolar flanges, the presence of compound radiolar eyes and the morphology of the chaetal structures, show a remarkable variability among the species of this genus (Fig. 11B1-F2). On the contrary, during our analysis we retrieved a group of *Bispira* species sharing a rather homogeneous set of characters related to general appearance (as the pigmentation of crown and body) and

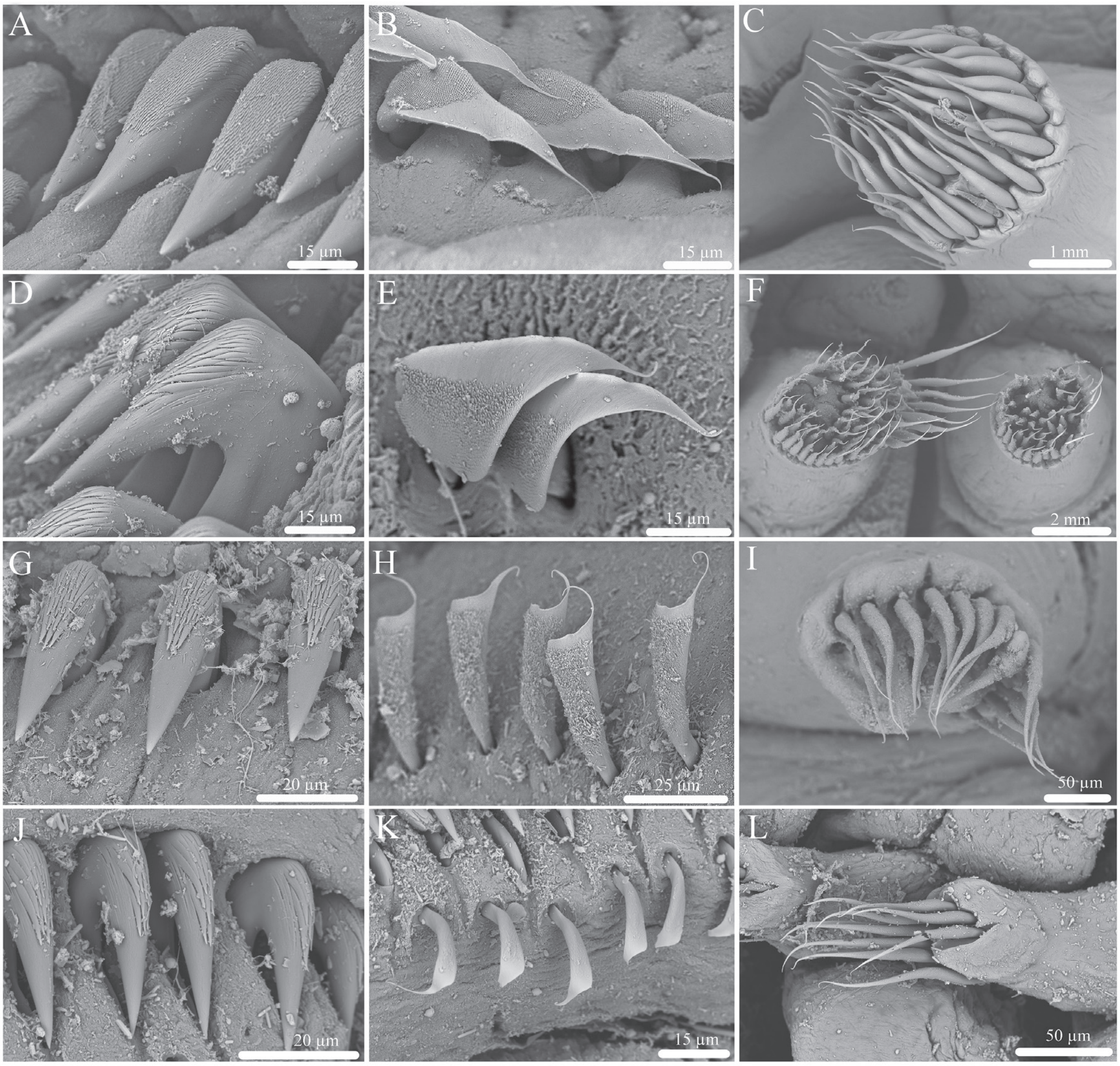

***Fig. 10:*** Comparison between different species belonging to the sub-family Sabellinae, SEM photos. A-C. *Sabella spallanzanii* (PCZL S. S. 1.12): A. Neuropodial thoracic uncini, B. Neuropodial thoracic companion chaetae, C. Abdominal neuropodial chaetal tuft; D-F. *Bispira mariae* (PCZL S. B. 1.4): D. Neuropodial thoracic uncini, E. Neuropodial thoracic companion chaetae, F. Abdominal neuropodial chaetal tufts; G-I. *Bispira riccardi* (PCZL S. B. 8.1): G. Neuropodial thoracic uncini, H. Neuropodial thoracic companion chaetae, I. Abdominal neuropodial chaetal tuft; J-L. *Bispira brunnea* fide Giangrande *et al.,* (2007) (PCZL S.B. 5.1): J. Neuropodial thoracic uncini, K. Neuropodial thoracic companion chaetae, L. Abdominal neuropodial chaetal tuft.

morphology of both crown and uncinal elements. This is not new, as the recent translocation of the taxa *Pseudobranchiomma marmarensis* Çinar & Giangrande, 2018 and *Pseudobranchiomma tarantoensis* Knight-Jones & Giangrande, 2003 to the genera *Bispira* and *Sabella,* respectively, was based on the presence and shape of both companion chaetae and uncini (Putignano *et al*., 2023). The morphologically homogeneous group of *Bispira* including tropical *Bispira* species, such as *B. melanostigma, B. tricyclia, B. monroi, B. guinensis* and *B. manicata,* as well as species described from temperate regions as *B. viola* and *B. riccardi,* is characterized by asymmetrical, squared companion chaetae, more or less elongated, with a thin mucro and both thoracic and abdominal uncini with few rows of teeth (typically <10) decreasing in size over the main fang (Figs. 1G-K; 5A1-K; 10G-H, J-K; 11D1-F2). Presence of radiolar compound eyes seems to be variable (being absent in *B. riccardi*) as well as the pigmentation, which, despite always being purple-violet, is more or less extended on both the body and the crown. Specimens collected in the Caribbean Sea (Carrie Bow) by Giangrande *et al.,* (2007) and identified as *B. brunnea* (PCZL S.B. 5.1) were re-examined during this study, and show the same morphology of uncinal elements (Figs. 10J-L; 11D1-2), despite preceding reports for this taxon are clearly inconsistent with these, suggesting that it may represent an undescribed species (see before). Lastly, *B. crassicornis* shares with this group the morphology of companion chaetae, but it also shows uncinal characters similar to those found in *B. volutacornis, B. mariae* and *B. polyomma* (Figs. 10D; 11B2, C2), also occurring in members of the genus *Sabella* (Figs. 10A; 11A2). We did not fail to notice that the combination of characters "companion chaetae asymmetrical/squared with a thin mucro + uncini with few rows of teeth decreasing in size" represent a synapomorphy for the group of species above mentioned. Thus, similarly to what already proposed in previous works for different genera (Putignano *et al.*,

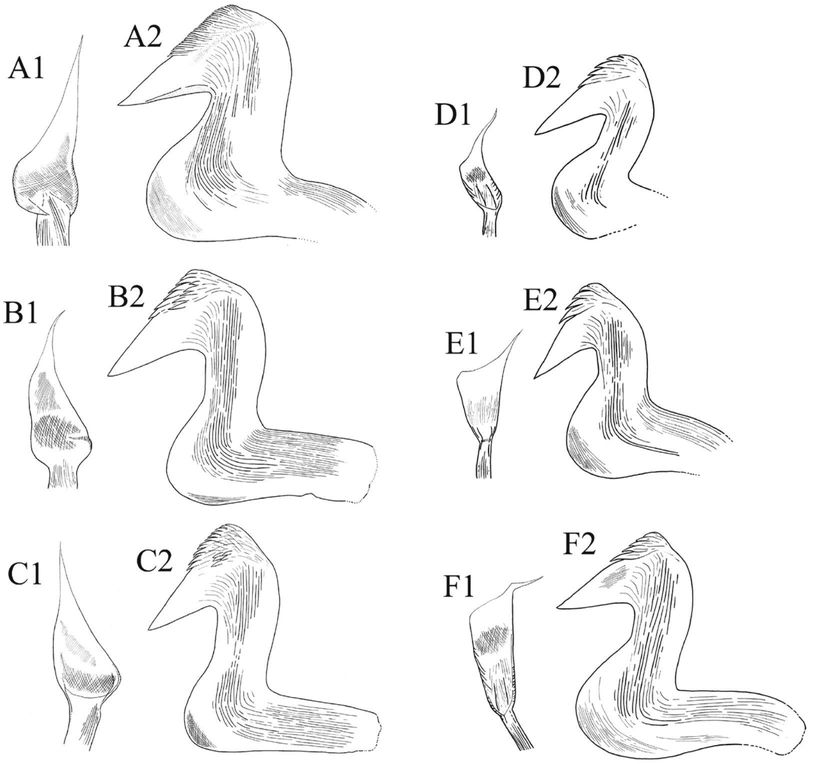

***Fig. 11:*** Comparison between different species belonging to the sub-family Sabellinae, line drawings. A1, 2. *Sabella spallanzanii* (PCZL S. S. 1.12): A1. Neuropodial thoracic uncini, A2. Neuropodial thoracic companion chaetae; B1, 2. *Bispira volutacornis* (PCZL S. B. 2.1): B1. Neuropodial thoracic uncini, B2. Neuropodial thoracic companion chaetae; C1, 2. *Bispira mariae* (PCZL S. B. 1.4): C1. Neuropodial thoracic uncini, C2. Neuropodial thoracic companion chaetae; D1, 2. *Bispira brunnea* fide Giangrande *et al.,* (2007) (PCZL S.B. 5.1): D1. Neuropodial thoracic uncini, D2. Neuropodial thoracic companion chaetae; E1, 2. *Bispira melanostigma* (PCZL S. B. 6.1): E1. Neuropodial thoracic uncini, E2. Neuropodial thoracic companion chaetae; F1, 2. *Bispira riccardi* (PCZL S. B. 8.1): F1. Neuropodial thoracic uncini, F2. Neuropodial thoracic companion chaetae.

2023; 2024), we will refer to the set of *Bispira* taxa sharing these features as the "*viola* group", being *B. viola* the oldest species belonging to this group.

### *Bispira causioi: a newly recognized species previously overlooked in proximal habitats*

*Bispira causioi* sp. nov. clearly belong to the "viola-group". Still, despite its description being based on material sampled in the Mediterranean Sea, it resembles more tropical congenerics belonging to this group than the two Mediterranean species.

However, it differs both from Mediterranean taxa belonging to the "*viola* group", as well as from all the species of the "*viola* group", up to now known in tropical areas around the world. Among them *B. manicata* is the closest taxa to *B. causioi* sp. nov., from which it can be distinguished only based on arrangement of the radiolar skeleton and height of the radiolar appendages, but confirmed as different taxa by molecular data.

The quite recent collection of *B. causioi* along the Apulian coast and its widespread presence today on different substrates (A. Giangrande & A. Toso, pers. obs.) makes one think about a possible recent introduction and/or a probably Lessepsian origin. Indeed, reports of *B. viola* from Turkey (Knight-Jones *et al.,* 1991) are more consistent with our observations on *B. causioi* sp. nov. than with proper specimens belonging to the nominal species, concerning both morphology (presence of 4-5 spots on each radiole) and ecology (found among rocks, sponges and calcareous nodules at 3-13 m depth). Similarly, Ben-Eliahu (1995) reports *Sabella bipunctata* Baird, 1865, now junior synonym of *B. melanostigma,* a species sharing several similarities with *B. causioi* sp. nov. and never reported again in the Mediterranean Sea. These may represent early findings of this species, suggesting its occurrence in the Levantine Basin in the early '90s. Furthermore, past works conducted along the Italian coasts never report the presence of an abundant sabellid species ascribable to either *B. viola* or similar *Bispira* taxa.

After its first finding along the Apulian coast, *B. causioi* sp. nov. appeared northward in the Mediterranean Sea (as can be observed on public citizen science databases, e.g., iNaturalist - https://www.inaturalist.org) and this could be due to the continue increasing temperature. However, if ocean warming favours the arrival of allochthonous species from the Suez Canal, it also can favour the spread of both allochthonous and thermophilic autochthonous species (Zenetos *et al.,* 2012; Galil *et al.,* 2014; Tsiamis *et al.,* 2020). This is the case for the thermophilic amphinomid *Hermodice carunculata* (Pallas, 1766), a species widely distributed in the subtropical Atlantic coasts, Mediterranean, and Red Sea (Fishelson, 1971; Ahrens *et al.,* 2013; Righi *et al.,* 2020), which, during the last years, increased its abundance in in the Mediterranean southern populations, expanding its distribution northward (Kržel j *et al.,* 2020; Righi *et al.,* 2020; Toso *et al.,* 2020; 2022).

The description of *B. polyomma* represent a similar case, as this taxon, suddenly occurring in harbors environment, was probably non-indigenous (Faasse & Giangrande, 2012). However, even if *B. causioi* sp. nov. could represent an introduced taxon, it shows a different invasion pattern with respect to *B. polyomma*, occurring both in enclosed basins and along the shore.

*Bispira causioi* sp. nov. is part of a morphologically homogeneous group of species with a circumtropical distribution. Furthermore, *B. causioi* sp. nov. is distinctly morphologically closer to an Indo-Pacific species (i.e., *B. manicata*) than to Mediterranean *Bispira taxa* and its findings are limited to the last 10 years, suggesting its recent introduction. On the contrary, both its absence in anthropized contexts (such as harbours and ports) and its phenotypic plasticity are incoherent with invasions patterns observed in other marine annelida species (El Haddad *et al.*, 2008; Arias *et al.*, 2013; Giangrande *et al.,* 2014; Mastrototaro *et al.,* 2015; Del Pasqua *et al.*, 2018; Fernández-Romero *et al.*, 2021; Langeneck *et al.*, 2024; Toso *et al.*, 2024b). Still, the data currently available on this species are not enough to support any hypothesis concerning its origin.

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