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Lumbrineridae (Polychaeta) from the Portuguese continental shelf (NE Atlantic) with the description of four new species

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Abstract

The present study reports four new species of the Family Lumbrineridae Schmarda, 1861, three in the genus *Lumbrineris* de Blainville, 1828 and one in the genus *Gallardoneris* Carrera-Parra, 2006. The new species were found on the Portuguese continental shelf at water depths ranging from 11 to 190 m. *Gallardoneris iberica* **sp. nov.** is the first record of this genus in the Atlantic Ocean and can be distinguished from the other two known *Gallardoneris* species by the distribution of the composite and the simple multidentate hooded hooks and the shape of the parapodial lobes. *Lumbrineris luciliae* **sp. nov.** has an arcuate, unidentate MIII and MIV unidentate with well-developed plate, digitiform wide basally postchaetal lobes in anterior parapodia, composite multidentate hooded hooks with short blade. Furthermore, *L. luciliae* **sp. nov.** has simple multidentate hooded hooks of two sizes, preacicular hook twice as big as postacicular hook, and distally curved aciculae in median and posterior parapodia. Both *Lumbrineris lusitanica* **sp. nov.** and *Lumbrineris pinaster* **sp. nov.** are characterized by having MIII unidentate followed by a knob. However, *L. lusitanica* **sp. nov.** has digitiform wide basally postchaetal lobes in the anterior parapodia, composite multidentate hooded hooks with short blade and simple multidentate hooded hooks with short hood; while *L. pinaster* **sp. nov.** has auricular postchaetal lobes in the anterior parapodia, composite multidentate hooded hooks with long blade, and simple multidentate hooded hooks with short and long hood. A multivariate analysis was performed upon morphological characteristics and validates the separation of the four new species. A taxonomic key to lumbrinerid species from Iberian waters is included.

Key words: Western Iberia, Portugal, lumbrinerids, first record, taxonomic key

Introduction

Lumbrinerids are commonly found at continental shelf depths, in muddy and sandy sediments. They have a simple body shape with reduced external morphological characters and a wide variety of maxillary characters. The Family Lumbrineridae Schmarda, 1861 comprises more than 200 valid species worldwide recognized in 13 genera. For the Iberian waters, a total of 19 valid species have been recorded, belonging to the following genera: *Abyssoninoe* Orensanz, 1990, *Augeneria* Monro, 1930, *Hilbigneris* Carrera-Parra, 2006, *Lumbricalus* Frame, 1992, *Lumbrineris* de Blainville, 1828, *Lumbrinerides* Orensanz, 1973, *Ninoe* Kinberg, 1875 and *Scoletoma* de Blainville, 1828 (Ramos 1976; Campoy 1982; Núñez *et al.* 1991; Parapar *et al.* 1994; Aguirrezabalaga & Carrera-Parra 2006; Cacabelos *et al.* 2008). In Atlantic waters, the genus *Gallardoneris* was unknown until now, being only recorded from the Pacific. It includes two species, *G. shinoii* (Gallardo) and *G. thailandensis* Carrera-Parra. This genus is easily differentiated from others mainly by the presence of four pairs of maxillae, with MIV having a whitish central area, and totally fused mandibles (Carrera-Parra 2006a). In contrast, several species of the genus *Lumbrineris* are known from European waters. *Lumbrineris latreilli* Audouin & Milne Edwards, *Lumbrineris coccinea* Renier and *Lumbrineris futilis* Kinberg are the most extensively reported, from the cold waters of the North Sea and northeast Atlantic as well as from the warmer Mediterranean Sea (e.g. Fauvel 1923; George & Hartmann-Schröder 1985; Núñez *et al.* 1991; Carrera-Parra 2006b; Aguirrezabalaga & Carrera-Parra 2006; Cacabelos *et al.* 2008). Recently, the presumed cosmopolitan distribution of some lumbrinerids has been questioned since several species are closely related and

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difficult to identify. This is supported by recent worldwide taxonomic studies, which described several new lumbrinerids species in areas where only few species were known (e.g. Aguirrezabalaga & Carrera-Parra 2006, Carrera-Parra 2006a, b; Hernández-Alcántara *et al.* 2006; Carrera-Parra *et al.* 2010; Cai & Li 2011a, b).

The Portuguese continental shelf extends for approximately 900 km from the Galician shelf to the Gulf of Cadiz, with an average width of 45 km (Fig. 1). Coarser sediments are mainly present north of the Nazaré Canyon, fine and very fine sands occur at greater depths along the western shelf while mud dominates the southern shelf and the area off Tagus Estuary (Martins *et al.* 2012). The western Portuguese shelf is characterized by a very energetic regime of waves and tides and a complex current system while the southern shelf sector is characterized by a low-energy hydrodynamic regime with dominant eastward-directed currents (Ambar & Fiúza 1994). Furthermore, the Atlantic Iberian coast is a region of contact between colder waters from the North Atlantic and warmer waters from northern Africa and the Mediterranean Sea (Ambar & Fiúza 1994), which can affect the latitudinal distribution patterns of benthic species (Spalding *et al.* 2007)

Herein, we present the description of three new species belonging to the genus *Lumbrineris* and one new species of *Gallardoneris*, which is also the first record of this genus in the Atlantic Ocean. A taxonomic key to lumbrinerid species from Iberian waters is included.

Material and methods

This study is based on a total of 464 soft-bottom sediment samples, collected with a 0.1 m^2 Smith-McIntyre grab along the Portuguese continental shelf (latitude between 41°51.8′N to 36°50.1′N and longitude between 9°43.1′W to 7°24.7′W), at water depths ranging from 3 to 195 m, in five field campaigns from 2007 to 2010 (Fig. 1; Table 1). Sediment samples were washed through a 1.0 mm mesh sieve and fixed with 4% formalin neutralized with borax. All organisms collected were sorted and identified under a stereomicroscope and then transferred for long-term storage to 70% ethanol. Sediments were analyzed in terms of grain-size and total organic matter (TOM) content according to Quintino *et al.* (1989).

A total of 184 specimens were used for the detailed morphological study of the new species. Some individuals of each known species were also morphologically examined. The descriptions of the new species are based on the type materials and follow the format of Carrera-Parra (2006b). The maxillary apparatus of each individual was extracted after an anterodorsal incision and mounted dorsally and ventrally on a slide to study the details of both the maxillae (M) and the mandible under an optical microscope. For each specimen, the length through chaetiger 10 (L10) and the width at chaetiger 10 excluding parapodia (W10) were determined. The terminology of the maxillary apparatus, the blade size of composite multidentate hooded hooks (CMHH) and the size of simple multidentate hooded hooks (SMHH) followed Carrera-Parra (2006a). Photographs of relevant morphological features were taken to illustrate the descriptions.

A data matrix of morphological descriptors for *Abyssoninoe*, *Gallardoneris*, *Lumbrineris*, *Lumbrinerides*, *Lumbrineriopsis* and *Ninoe* species was constructed on the basis of the presence/absence of the several categories identified for each descriptor: hooded hooks type (composite multidentate, simple multidentate, limbated simple multidentate, simple bidentate), aciculae color (yellow, reddish, black), aciculae type (straight, curved), 4 and 5 maxillae, MI attachment lamellae, MII ligament, MIII type (edentate, unidentate, unidentate followed by a knob, bidentate, multidentate), prominent projection in the basal part of MIII, MIV pigmentation, MIV types (edentate, unidentate, unidentate with well-developed plate, unidentate with pointed tooth, broad rectangular plate with a projection), anterior postchaetal lobe shape (conical, rounded, digitiform, digitiform wide basally, auricular), postchaetal branchiae. Another data matrix was also prepared for the new species of *Lumbrineris* using the presence/absence of some relevant features for this genus (aciculae type, MIII type, MIV type, prominent projection in the basal part of MIII, anterior postchaetal lobe shape) as well as the width at chaetiger 10, the last chaetiger with composite multidentate hooded hooks, the first chaetiger where simple multidentate hooded hooks appear and the last chaetiger with ventral limbates. The data matrices were submitted to ordination analysis, using Principal Coordinates Analysis, upon the Jaccard distance matrix between samples (specimens) for the presence/absence matrix and upon the Euclidean distance matrix between samples, following the variables normalization for the *Lumbrineris* data matrix. In addition, the most correlated variables (Spearman rho > 0.8) were represented as vectors. The multivariate data analyses were performed with the software PRIMER v.6 (Clarke & Gorley 2006).

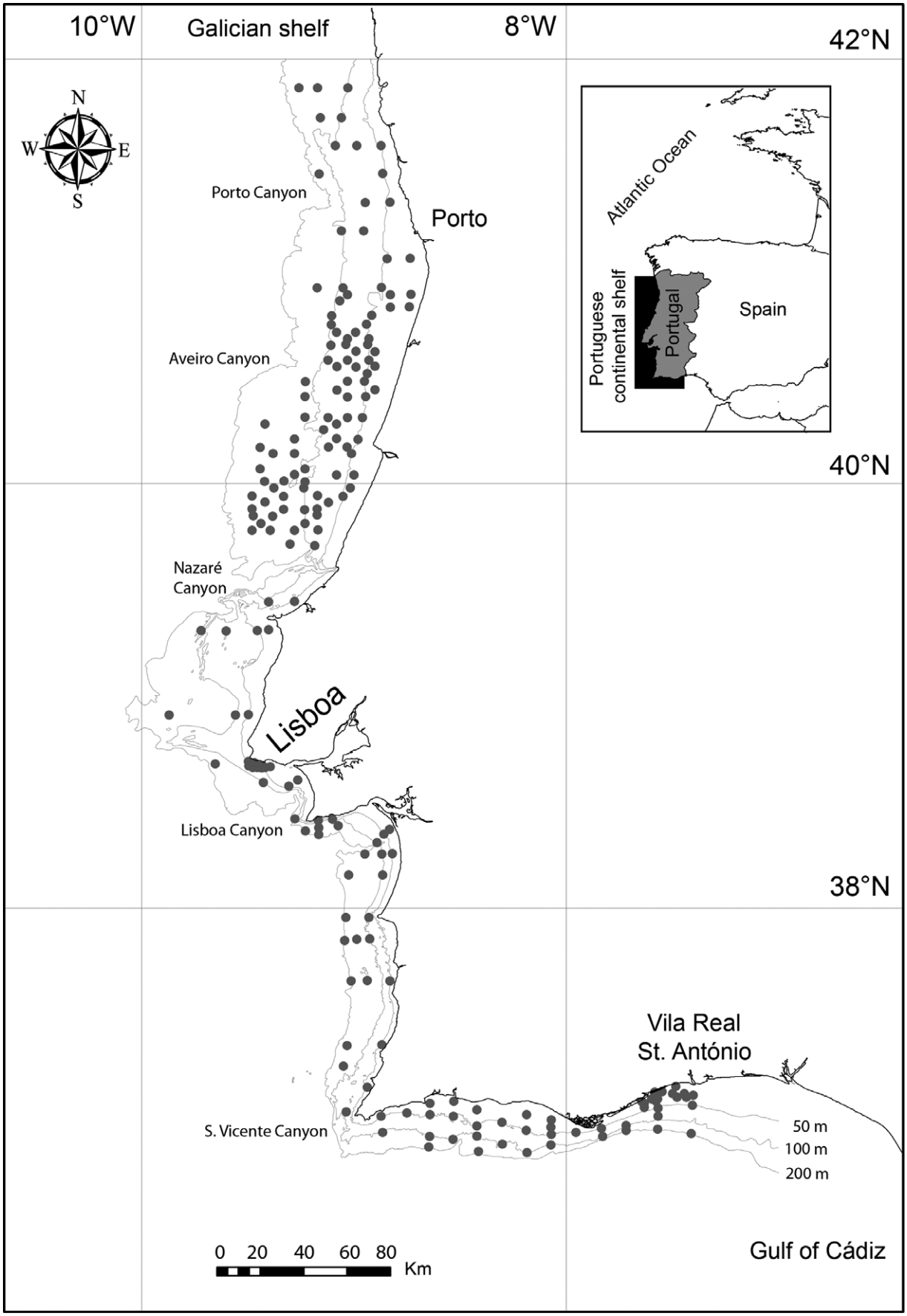

FIGURE 1. Study area: the Portuguese continental shelf. Grey dots correspond to sampling sites where Lumbrineridae specimens were found.

TABLE 1. Characterization of the sites where individuals of the new species were obtained for morphological studies.

Site	Latitude (ºN)	Longitude (ºW)		Date	Depth (m)	Sediment type	Fines (%)	TOM (%)	Biogenic fraction (%)
G18(1)	38°39.890′	9°26.239′	Shelf off Tagus Estuary (Lisbon)	Oct. 2007	36.4	Fine sand	12.43	2.03	—
G19(2)	38°39.528′	9°26.107′			47.7	Mud	77.32	5.78	—
G22(1)	38°40.030′	9°29.695′			72.5	Very fine sand	34.83	2.56	—
G25(3)	38°39.548′	9°28.576′			75.9	Mud	78.11	4.80	—
G26(1)	38°39.916′	9°27.742′			49.4	Fine sand	12.97	1.76	—
G28(1)	38°39.621′	9°27.364′			61.2	Mud	77.83	5.34	—
G28(2)	38°39.621′	9°27.364′			61.2	Mud	77.83	5.34	—
R2	41°51.780′	9°01.696′	Northwestern Portuguese continental shelf	Oct. 2007	93.9	Mud	58.31	3.33	0.37
R16	41°27.557′	8°51.866′			52.3	Fine sand	15.36	1.72	0.36
R19	41°19.354′	8°56.862′			72.0	Very fine sand	41.37	2.06	0.60
R25	41°11.358′	8°51.392′			47.3	Very coarse sand	4.10	0.85	8.34
PC85	39°26.552′	9°16.839′	Western Portuguese continental shelf	April/ May 2008	44.5	Very coarse sand	0.33	0.41	22.87
PC92	39°18.502′	9°24.120′			32.7	Gravel	1.09	0.97	12.43
PC102	38°54.444′	9°33.465′			103.4	Fine sand	24.80	6.93	0.24
PC114	38°40.121′	9°25.811′			31.2	Fine sand	5.12	1.63	0.18
PC115	38°35.368′	9°25.567′			97.7	Mud	99.12	8.96	0.03
PC118	38°34.315′	9°18.384′			34.6	Very fine sand	23.69	2.42	0.13
PC119	38°36.006′	9°15.831′			17.3	Fine sand	5.02	1.43	1.55
PC125	38°22.615′	9°09.977′	Southwestern Portuguese continental shelf		120.9	Very fine sand	34.08	3.66	1.40
PC128	38°23.199′	9°04.497′			116.7	Fine sand	23.48	2.88	0.17
PC135	38°15.177′	8°56.890′			133.5	Medium sand	17.52	2.82	0.17
PC146	37°57.242′	8°55.810′			94.2	Very fine sand	33.96	2.88	9.43
PC150	37°51.013′	8°59.208′			140.5	Fine sand	17.07	3.93	0.31
PC173	37°15.224′	9°03.009′			123.1	Fine sand	13.13	2.51	0.61
PC180	37°02.315′	9°02.129′			75.3	Very fine sand	30.79	3.35	0.35
PC186	36°56.396′	8°51.914′	Southern Portuguese continental shelf		102.7	Mud	77.01	5.51	0.06
PC187	37°01.009′	8°52.376′			53.3	Mud	53.36	4.13	0.99
PC188	37°01.953′	8°45.031′			46.5	Fine sand	32.24	5.18	9.12

continued next page

TABLE 1. (continued)

Site	Latitude (ºN)	Longitude (ºW)			Depth (m)	Sediment type	Fines (%)	TOM (%)	Biogenic fraction (%)
PC191	36°52.321′	8°38.865′	Southern Portuguese continental shelf	April/ May 2008	179.3	Medium sand	16.49	3.54	6.55
PC193	37°01.420′	8°38.572′			47.5	Fine sand	19.65	3.85	5.29
PC195	37°05.213′	8°31.834′			25.6	Medium sand	12.52	3.73	1.36
PC196	37°00.975′	8°31.844′			46.1	Fine sand	28.55	4.13	3.18
PC199	36°55.461′	8°25.269′			98.7	Mud	79.17	7.10	0.24
PC201	37°02.860′	8°25.285′			32.7	Fine sand	20.29	3.91	6.44
PC203	36°59.258′	8°18.222′			48.8	Very fine sand	49.91	5.43	4.64
PC206	36°50.706′	8°11.107′			101.8	Mud	74.57	5.53	0.60
PC208	36°57.025′	8°11.282′			45.3	Medium sand	21.45	4.50	3.00
PC209	37°01.496′	8°11.211′			31.2	Very fine sand	38.39	4.79	4.57
PC211	36°57.934′	8°04.405′			38.3	Very fine sand	39.84	4.62	1.80
PC219	36°57.057′	7°43.116′			169.2	Mud	55.80	6.21	14.52
PC220	36°58.416′	7°43.173′			94.1	Mud	62.54	5.57	18.84
PC223	37°03.307′	7°34.136′			55.1	Mud	98.75	8.24	0.03
PC229	37°06.909′	7°24.120′			13.8	Coarse sand	2.77	1.75	14.91
ALG86	37°07.344′	7°26.717′		July 2008	18.0	Mud	51.51	—	2.91
MESH 2D	39°46.622′	9°23.663′	Northwestern Portuguese continental shelf	June 2010	130.8	Very fine sand	40.87	—	0.43
MESH 2E	39°46.680′	9°28.770′			139.7	Very fine sand	21.03	—	0.04
MESH 3B	39°48.584′	9°13.773′			100.5	Fine sand	16.12	—	0.13
MESH 3D	39°48.583′	9°26.277′			133.3	Mud	61.46	—	16.31
MESH 5D	39°54.610′	9°23.168′			130.6	Very fine sand	49.74	—	15.67
MESH 6E	39°56.250′	9°19.898′			122.3	Mud	65.85	—	0.15
MESH 6F	39°56.347′	9°28.804′			139.4	Very fine sand	47.95	—	18.40
MESH 7D	40°00.405′	9°13.807′			100.2	Very coarse sand	3.20	—	65.91
MESH 7E	40°00.542′	9°19.765′			125.6	Fine sand	24.14	—	2.02
MESH 12D	40°12.431′	9°16.800′			120.1	Fine sand	12.27	—	0.04
MESH 14D	40°18.608′	9°13.848′			113.8	Very fine sand	44.59	—	0.22
MESH 23D	40°42.602′	9°04.916′			91.9	Fine sand	1.98	—	0.05
MESH 24D	40°44857′	9°06.451′			105.5	Fine sand	2.70	—	0.45

Legend: "—" = no available data; TOM = total organic matter; Fines =grain-size fraction <0.063µm; Biogenic fraction = faunal skeletal remains bigger than 2.0 mm

The type specimens were deposited in the Muséum National d'Histoire Naturelle, Paris (MNHN), Museu Nacional de História Natural e da Ciência, Lisbon (MB), the Reference Collection of ECOSUR-Chetumal, Mexico (ECOSUR), and in the Collection of the Departamento de Biologia, Universidade de Aveiro (DBUA).

Results

A total of 1943 lumbrinerids were recorded from 222 sampling sites along the Portuguese continental shelf. These individuals belong to *Abyssoninoe hibernica* (McIntosh), *Gallardoneris iberica* **sp. nov.**, *Lumbrinerides amoureuxi* Miura, *Lumbrineriopsis paradoxa* (de Saint-Joseph), *Lumbrineris futilis*, *Lumbrineris latreilli*, *Lumbrineris luciliae* **sp. nov.**, *Lumbrineris lusitanica* **sp. nov.**, *Lumbrineris pinaster* **sp. nov.**, *Ninoe armoricana* Glémarec and *Scoletoma fragilis* (Müller). Table 1 shows the sedimentary characterization, depth and geographical coordinates of the sites where the specimens of the new species were collected. A comparison of morphological descriptors and intraspecific variability of the most important morphological features measured in all species recorded in the studied area is reported in Table 2. A systematization of the environmental characteristics of the sampling sites where Lumbrineridae species were sampled is presented in Table 3.

Systematics

Class Polychaeta Grube, 1850

Order Eunicida, Dales, 1962

Family Lumbrineridae Schmarda, 1861

Genus *Gallardoneris* Carrera-Parra, 2006

Gallardoneris iberica sp. nov.
Figure 2

Material examined. *Type material*: Holotype (MNHN TYPE 1538) northwestern Portuguese continental shelf, site MESH 3B, 39º48.584′ N 9º13.773′ W, June 2010, in fine sand, 100.5 m. *Paratypes*: MB29-000226, 1 specimen, same data as holotype. DBUA 01315.01, 1 specimen, same data as holotype. ECOSUR0128, 1 specimen, site PC128. MB29-000227, 1 specimen, site MESH 2E. MB29-000228, 2 specimens, site MESH 7E. DBUA 01315.02, 1 specimen, site MESH 7E. *Additional material*: site MESH 2D, 1 specimen; site MESH 2E, 1 specimen; site MESH 3B, 1 specimen; site MESH 5D, 1 specimen; site MESH 6E, 1 specimen; site MESH 6F, 7 specimens; site MESH 7D, 1 specimen; site MESH 7E, 7 specimens; site MESH 12D, 3 specimens; site MESH 14D, 2 specimens; site MESH 23D, 2 specimens; site R2, 3 specimens; site R16, 2 specimens; site R19, 1 specimen; site PC102, 2 specimens; site PC125, 2 specimens; site PC135, 1 specimen; site PC150, 1 specimen; site PC186, 1 specimen; site PC191, 1 specimen; site PC196, 2 specimens; site PC199, 1 specimen; site PC206, 1 specimen; site PC208, 1 specimen; site PC209, 1 specimen; site PC211, 1 specimen; site PC219, 3 specimens; site PC220, 2 specimens; site PC223, 1 specimen; site G28(2), 1 specimen.

Description. Holotype complete, with 101 chaetigers, LT=16.0 mm, W10=0.3 mm, L10=1.7 mm. Prostomium conical, slightly longer than wide, with a pair of nuchal organs, ventrally with short buccal lips. Peristomium about 2/3 of the prostomium length, with two rings of similar size (Fig. 2A).

All parapodia well developed, first six smaller than following ones. Prechaetal lobe in parapodia 1–5 inconspicuous, in parapodia 6–14 ovoid, from parapodium 15 digitiform; smaller than postchaetal lobe in anterior parapodia, of similar size in median parapodia (15–81), longer than postchaetal from parapodium 82. Postchaetal lobe in parapodia 1–18 auricular, from parapodium 19 digitiform (Fig. 2B–D). Short rounded dorsal cirri in all parapodia.

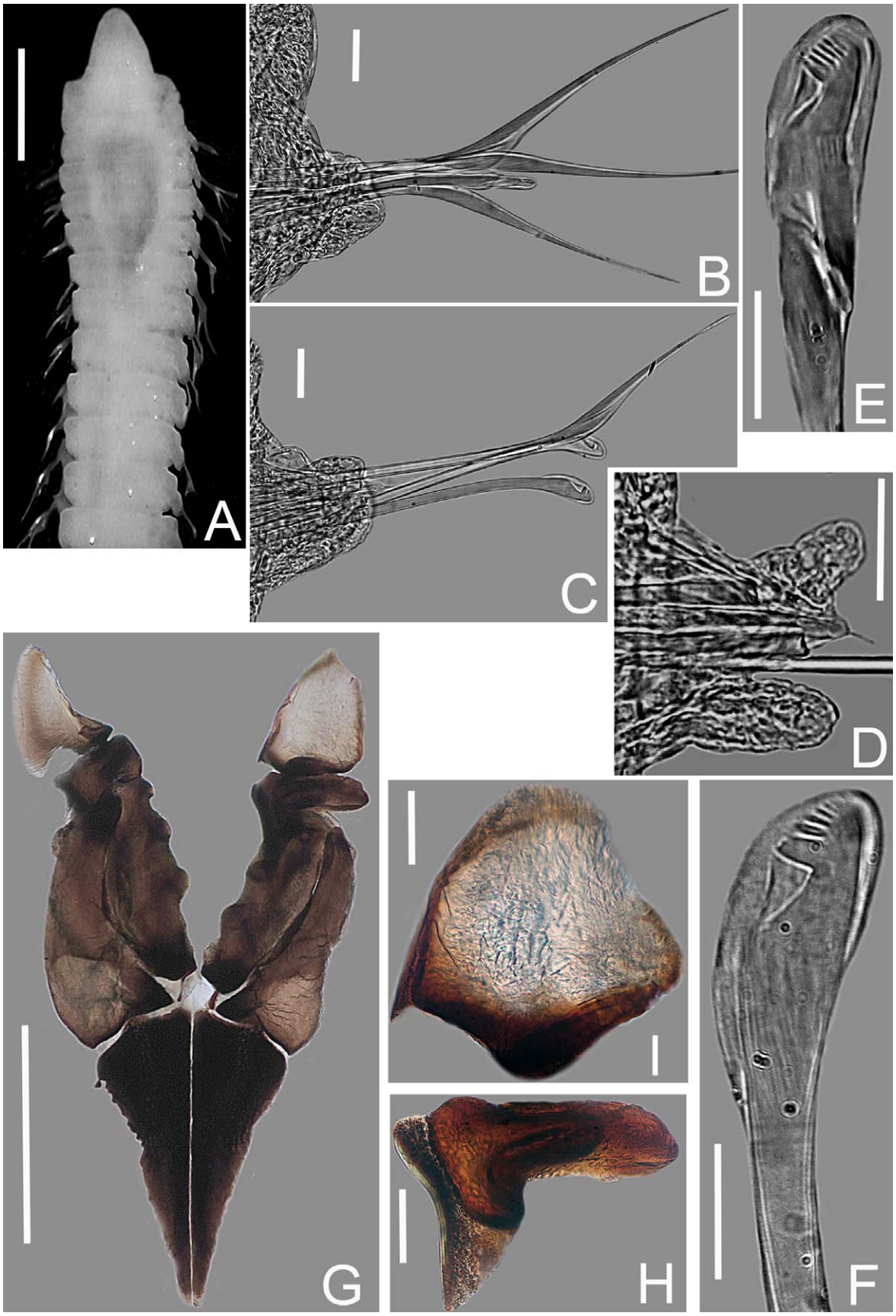

FIGURE 2. *Gallardoneris iberica* **sp. nov.** Paratype (ECOSUR0128) A, anterior end, dorsal view; B, parapodium 4, frontal view; C, parapodium 16, frontal view; D, parapodium 88, frontal view; E, composite multidetate hooded hook, from parapodium 4; F, simple multidentate hooded hooks, from parapodium 16; G, maxillary apparatus, dorsal view; H, maxillae III; I, maxillae IV. Scale bars: A, 0.3 mm; B, C, D, 0.025 mm; E, F, 0.012 mm; G, 2.5 mm; H, I, 0.5 mm.

TABLE 2. Comparison of morphological descriptors and intraspecific variability of the morphological characters assessed on species found in the Portuguese continental shelf.

	Gallardoneris iberica **sp. nov.**	*Lumbrineris luciliae* **sp. nov.**	*Lumbrineris lusitanica* **sp. nov.**	*Lumbrineris pinaster* **sp. nov.**	*Lumbrineris latreilli*	*Lumbrineris futilis*
Width 10th ch. (mm)	0.2–0.5	0.6–1.8	0.3–0.9	0.4–0.7	1.0	0.6–4.0
Length through 10th ch. (mm)	1.2–2.3	2.2–6.3	1.4–3.2	1.3–2.5	2.5	2.2–7.4
Anterior postchaetal lobe (shape)	Auricular	Digitiform wide basally	Digitiform wide basally	Auricular	Digitiform wide basally	Digitiform wide basally
Hooded hook (type)	CMHH; SMHH	CMHH; SMHH	CMHH; SMHH	CMHH; SMHH	CMHH; SMHH	CMHH; SMHH
Blade CMHH (type)	short	short	short	long	long	long
Teeth CMHH (nr.)	7	9	7	7	7	7
Last CMHH (ch.)	6–9	14–21	7–15	7–12	19	10–19
Teeth simple HH (nr.)	7	7	7	7/5	10	8
1st SMHH long hood (ch.)	n.a.	n.a.	n.a.	8–13	n.a.	12–20
1st SMHH short hood (ch.)	7–10	14–21	8–16	19–35	20	21–42
1st SBHH (ch.)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Last ventral limbates (ch.)	7–13	14–21	8–17	10–15	25	10–38
Last dorsal limbates (ch.)	25–35	33?–82	25–59	36–45	36	35–74
Aciculae (colour)	Yellow	Yellow curved	Yellow	Yellow	Yellow	Black
Maxillae (nr.)	4	5	5	5	5	5
MI attachment lamellae	Absent	Present	Present	Present	Present	Present
MII ligament	Present	Present	Present	Present	Present	Present
MIII	Edentate	Unidentate arcuate	Unidentate followed by a knob	Unidentate followed by a knob	Bidentate	Unidentate followed by a knob
MIV	Edentate with whitish central area	Unidentate with a well-developed plate	Unidentate with pointed tooth	Unidentate with a well-developed plate	Unidentate with pointed tooth	Unidentate with pointed tooth
Postchaetal branchiae	Absent	Absent	Absent	Absent	Absent	Absent
Eggs size (µm)	129–188	—	181–192	98–147	—	—
Sperm size (µm)	—	2.0–3.0	2.8–3.2	2.5–3.0	—	—

continued.

	Lumbrineriopsis paradoxa	*Lumbrinerides amoureuxi*	*Ninoe armoricana*	*Abyssoninoe hibernica*	*Scoletoma* cf. *fragilis*
Width 10th ch. (mm)	0.4–0.8	0.3–0.6	0.5–1.1	0.4–1.1	1.2–2.1
Length through 10th ch. (mm)	2.4–3.4	2.1–3.0	1.4–3.1	1.4–3.8	3.1–5.1
Anterior postchaetal lobe (shape)	Digitiform	First 6 rounded, then digitiform	Digitiform	Conical	Auricular
Hooded hook (type)	SBHH	SBHH	SMHH	LSMHH SMHH	SMHH
Blade CMHH (type)	n.a.	n.a.	n.a.	n.a.	n.a.
Teeth CMHH (nr.)	n.a.	n.a.	n.a.	n.a.	n.a.
Last CMHH (ch.)	n.a.	n.a.	n.a.	n.a.	n.a.
Teeth simple HH (nr.)	2	2	7–8	7–9	7
1st SMHH long hood (ch.)	n.a.	n.a.	8–18	6–18	13-16
1st SMHH short hood (ch.)	n.a.	n.a.	23–36	30–71	—*
1st SBHH (ch.)	1	5	n.a.	n.a.	n.a.
Last ventral limbates (ch.)	All ch.	All ch.	All ch.	37–78	48
Last dorsal limbates (ch.)	All ch.	All ch.	All ch.	All ch.	33
Aciculae (colour)	Yellow	Yellow	Reddish	Yellow	Black
Maxillae (nr.)	4	4	5	4	5
MI attachment lamellae	Present	Present	Present	Present	Present
MII ligament	Present	Absent	Present	Present	Present
MIII	Unidentate	Unidentate arcuate	With up to 4 teeth	Unidentate	Unidentate
MIV	Multidentate	Unidentate	Multidentate	Broad rectangular plate with a projection from middle of its inferior border	Unidentate
Postchaetal branchiae	Absent	Absent	Present (ch.3–35)	Absent	Absent
Eggs size (µm)	—	—	—	—	—
Sperm size (µm)	—	—	—	—	—

Legend: nr. = number; ch. = chaetiger; all ch. = feature present in all chaetigers; CMHH = composite multidentate hooded hooks; SMHH = simple multidentate hooded hooks; SBHH = simple bidentate hooded hooks; LSMHH = limbated simple multidentate hooded hooks; * — incomplete specimens. n.a. = not applicable; — = no available data.

Composite multidentate hooded hooks (CMHH) in chaetigers 1–7, with 2–3 per parapodium, with short blade, with up to 7 teeth, proximal tooth largest (Fig. 2E). Simple multidentate hooded hooks from chaetiger 8, with short hood, with up to 7 teeth, proximal tooth largest, preacicular hook as large as postacicular hook (Fig. 2F). Dorsal limbate chaetae in chaetigers 1–26, ventral limbates in chaetigers 1–7. Aciculae yellow, aristate, one in anterior parapodia and up to two in posterior parapodia.

Pygidium with terminal anus, without anal cirri.

Mandible completely fused. Maxillary apparatus with four pairs of maxillae; maxillary carriers as long as MI, almost triangular, joined along base of MI (Fig. 2G). MI forceps-like with wide recurved base, without attachment lamella. MII stout, as long as MI, with ligament, with three teeth, without attachment lamella. MIII edentate (Fig. 2H). MIV edentate plate, with whitish central area (Fig. 2I).

Variations. Material examined varied in L10 from 1.2 to 2.3 mm, in W10 from 0.2 to 0.5 mm and also varied in the following features: the last composite multidentate hooded hooks were found from chaetigers 6 to 9; the first simple multidentate hooded hooks appeared from chaetigers 7 to 10; the end of dorsal and ventral limbate ranged from chaetigers 25 to 35 and from 7 to 13, respectively (cf. Table 2).

Reproduction. Mature specimens were found in June and October. The female gametes are globular with a diameter ranging from 129 µm to 188 µm. The gametes were located from parapodia 23 until last segment in incomplete specimens examined (Paratypes DBUA 01315.01, MB29-000226). The male gametes of *Gallardoneris iberica* **sp. nov.** are located posteriorly to chaetiger 18 in an incomplete specimen (Paratype MB29-000227). The male gametes have a long tail and a subspherical nucleus with diameter between 2.3 and 3.0 µm.

Type locality. Portuguese continental shelf.

Etymology. The name of the species refers to the type locality, the Iberian Peninsula.

Distribution and habitat. *Gallardoneris iberica* **sp. nov.** was found in the Portuguese continental shelf at depths ranging from 18 to 180 m (cf. Table 3). The specimens inhabit mainly finer sediments with high content of fines, biogenic fraction and TOM (Table 3). The Galician shelf and the Gulf of Cádiz shelf (northwestern and southern Iberia) present extensive mud patches being a continuity of the muddy areas recorded in the shelf off the rivers Minho and Guadiana (Dias *et al.* 2002; Gonzalez *et al.* 2004; Martins *et al.* 2012). These sediments seem to be preferred by this species and therefore it is expected to be found in those shelf areas.

Discussion. *Gallardoneris iberica* **sp. nov.** is the third species described in the genus, together with *G. shinoii* and *G. thailandensis*. *Gallardoneris iberica* **sp. nov.** and *G. thailandensis* differ from *G. shinoii* in the shape of composite multidentate hooded hooks (CMHH). The former species have CMHH with a short hood, while those of *G. shinoii* have a long hood (chaetiger 1 up to 18). *Gallardoneris iberica* **sp. nov.** and *G. thailandensis* have larger prechaetal than the postchaetal lobes in the posterior parapodia, whereas in *G. shinoii* the two lobes are of similar length. *Gallardoneris iberica* **sp. nov.** differs from *G. thailandensis* in the shape of the prechaetal lobe of the anterior parapodia: ovoid in *Gallardoneris iberica* **sp. nov.** and rounded with digitiform extension at the dorsal end in *G. thailandensis*. Another difference is related to the distribution of CMHH: in *Gallardoneris iberica* **sp. nov.** CMHH are present up to chaetiger 9, while in *G. thailandensis* they occur up to chaetiger 16.

Genus *Lumbrineris* de Blainville, 1828

Lumbrineris luciliae sp. nov.

Figure 3

Material examined. *Type material*: Holotype (MNHN TYPE 1539) southern Portuguese continental shelf, site PC201, 37º02.860′ N 8º25.285′ W, April 2008, in fine sand, 32.7 m. *Paratypes:* MB29-000229, 1 specimen, site PC125. ECOSUR0129, 1 specimen, site PC191. DBUA 01317.01, 1 specimen, site MESH 3D. *Additional material*: site MESH24D, 1 specimen; site PC85, 1 specimen; site PC92, 2 specimens; site PC187, 3 specimens; site PC188, 1 specimen; site PC191, 2 specimens; site PC193, 2 specimens; site PC196, 2 specimens; site PC203, 1 specimen; site PC219, 1 specimen.

Description. Holotype mature male complete with 121 chaetigers (last 17 chaetigers regenerating), LT=52.0 mm, L10=4.7 mm , W10=1.8 mm. Prostomium subconical, as long as wide, with a pair of nuchal organs, ventrally with short buccal lips. Peristomium with two rings, anterior ring twice as long as second one (Fig. 3A).

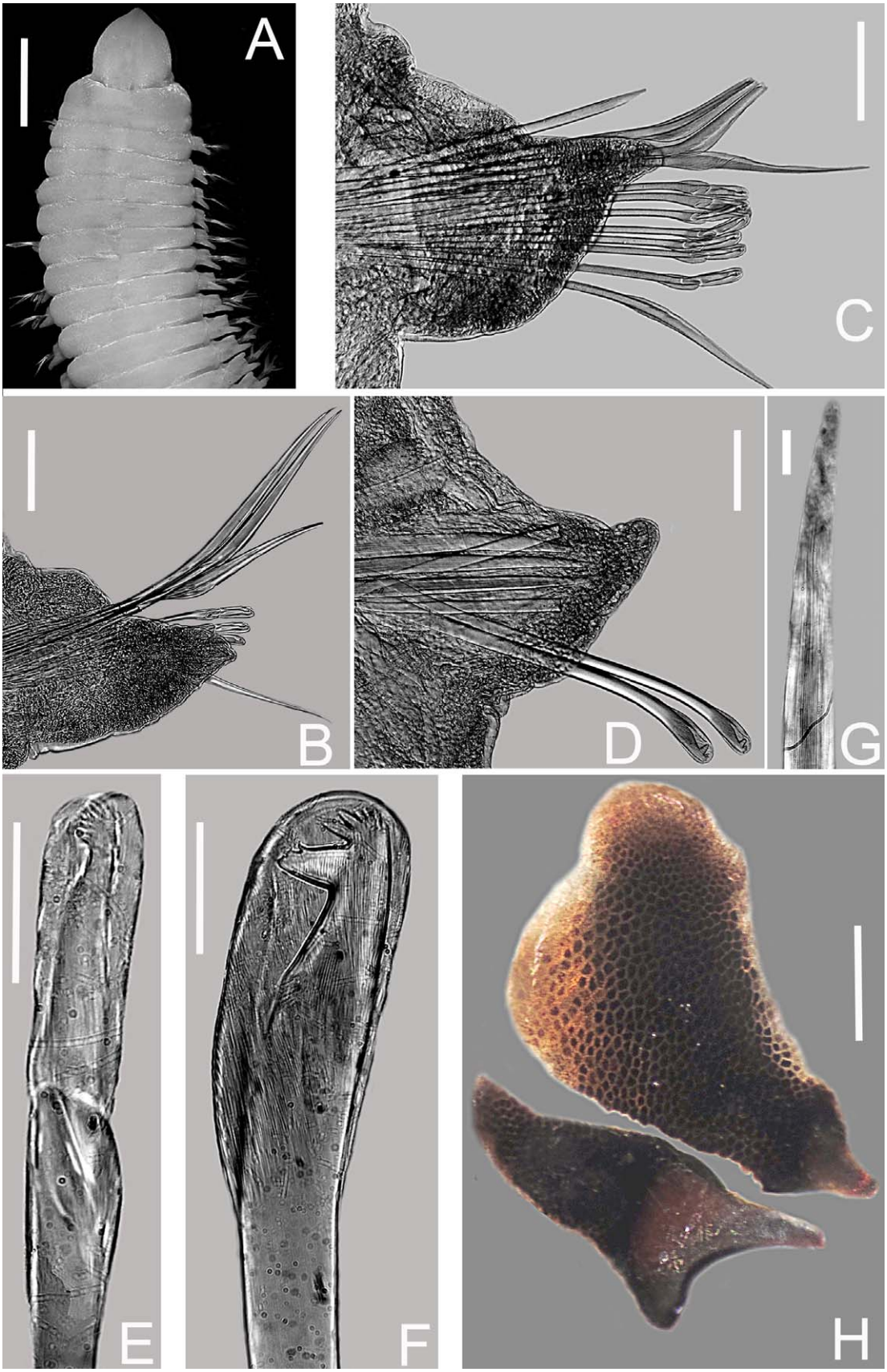

FIGURE 3. *Lumbrineris luciliae* **sp. nov.** Paratype (ECOSUR0129) A, anterior end, dorsal view; B, parapodium 3, frontal view; C, parapodium 13, frontal view; D, parapodium 77, frontal view; E, composite multidentate hooded hook, from parapodium 3; F, simple multidentate hooded hook from parapodium 77; G, acicula from parapodium 86; H, maxillae III and IV, dorsal view. Scale bars: A, 1.0 mm; B, C, D, H 0.1 mm; E, F, 0.025 mm; G, 0.01 mm.

All parapodia well developed, first six smaller than following ones. Prechaetal lobe in first parapodia inconspicuous, in chaetigers 2–10 as a small globular protuberance, conical in posterior chaetigers; always smaller than postchaetal lobe. Postchaetal lobe digitiform in parapodia 1, digitiform wide basally from parapodia 2 to 28; in posterior chaetigers digitiform; larger in anterior and posterior parapodia; always longer than prechaetal lobe (Fig. 3B–D). Short rounded dorsal cirri in all parapodia.

Composite multidentate hooded hooks in chaetigers 1–21, 3–8 per parapodium, with short blade, with up to 9 teeth, all of similar size (Fig. 3E). Simple multidentate hooded hooks from chaetiger 21, with short hood, with up to 7 teeth, proximal tooth largest ; preacicular hook with a section that is twice as large as the postacicular hook (Fig. 3F). Dorsal limbate chaetae in chaetigers 1–82, ventral limbate chaetae in chaetigers 1–21. Aciculae yellow, aristate, distally curved in median and posterior parapodia (Fig. 3G), up to five in anterior parapodia and two in posterior parapodia.

Pygidium with terminal anus, with two pairs of anal cirri of similar size.

Mandible divided for about half its length. Maxillary apparatus with five pairs of maxillae; maxillary carriers as long as MI. MI forceps-like with attachment lamella well developed. MII as long as MI, with wide connecting plates slightly developed; with four teeth of similar size. MIII arcuate, unidentate. MIV unidentate, with well-developed plate. MV free, prominent, lateral to MIV and MIII (Fig. 3H).

Variations. The specimens examined ranged in L10 from 2.2 to 6.3 mm, in W10 from 0.6 to 1.8 mm and varied in the following features: the last appearance of the composite multidentate hooded hooks and ventral limbates and the first simple multidentate hooded hooks (from chaetigers 14 to 21; cf. Table 2).

Reproduction. One mature male was found (Holotype MNHN TYPE 1539) in April; the sperm cells have a long tail and a head with a subspherical nucleus, which diameter ranging from 2 to 3 µm.

Type locality. Southern Portuguese continental shelf.

Etymology. This species is named in honor of Lucília Gonçalves, mother of the first author.

Distribution and habitat. *Lumbrineris luciliae* **sp. nov.** occurred in several sediment types from gravel to mud, characterized by high sand and biogenic contents, on average, 65% and 8% respectively (cf. Table 3). The species is distributed on the whole Portuguese continental shelf, but mainly in the southern part, at water depths ranging from 33 to 179 m (cf. Table 3). The species seems to occur mainly in biogenically enriched sediments. The biogenic fraction of the sediment is mainly composed of skeletal remains of molluscs, echinoderms or other fauna. Those mixed sediments may play some role in the creation of a favorable predator habitat and/or a protective habitat to these specimens, which are bigger than the other new species (based on the W10 and L10 values).

Discussion. *Lumbrineris luciliae* **sp. nov.** belongs to a group of species characterized by having an arcuate unidentate MIII, including *L. kerguelensis* Grube (from Kerguelen Islands), *L. cingulata* Ehlers (from Magellanic biogeographic province), *L. vanhoeffeni* Michaelsen (from Greenland), *L. paucidentata* Treadwell (from Florida, USA), *L. californiensis* Hartman (from California, USA), *L. cruzensis* Hartman (from California, USA), *L. pallida* Hartman (from California, USA), *L. inhacea* Hartman (from Mozambique channel), *L. aniara* Fauchald (from Western Norway), *L. nonatoi* Ramos (from Mediterranean Sea), *L. imajimai* Carrera-Parra (from Shimoda, Japan), *L. indica* Carrera-Parra (from Saint Paul Island), *L. higuchiae* Carrera-Parra (from Shimoda, Japan), *L. mustaquimi* Carrera-Parra (from Pakistan), *L. nishii* Carrera-Parra (from Shimoda, Japan), *L. geldiayi* Carrera-Parra, Çinar & Dagli (from Turkey) and *L. sinensis* Cai & Li (from China).

Lumbrineris luciliae **sp. nov.** has yellow aciculae, whereas *L. pallida*, *L. geldiayi* and *L. nishii* have reddish or dark aciculae. *Lumbrineris luciliae* **sp. nov.** has postchaetal lobe digitiform wide basally in anterior parapodia; while *L. nonatoi*, *L. vanhoeffeni*, *L. mustaquimi, L. indica, L. paucidentata, L. higuchiae* have a digitiform postchaetal lobe, and *L. aniara, L. cingulata, L. californiensis, L. imajimai, L. inhacea, L. cruzensis* and *Lumbrineris pinaster* **sp. nov** have an auricular postchaetal lobe.

Additionally, the postchaetal lobes of *Lumbrineris luciliae* **sp. nov.** are always longer than the prechaetal lobes, while in *L. californiensis*, *L. imajimai, L. inhacea, L. cruzensis*, *L. nonatoi* and *L. sinensis*, the prechaetal lobe is as long as or longer than the postchaetal lobes in the posterior parapodia. *Lumbrineris luciliae* **sp. nov.** resembles *L. cingulata* by having preacicular simple multidentate hooded hooks with a section that are twice as large as the postacicular hooks. However, *Lumbrineris luciliae* **sp. nov.** differs having aciculae distally curved in median posterior parapodia rather than straight. Furthermore, *Lumbrineris luciliae* **sp. nov**. differs from *L. cingulata* by having MIV unidentate with a well-developed plate, whereas *L. cingulata* has MIV unidentate with a long prominent tooth, without a well-developed plate.

***Lumbrineris lusitanica* sp. nov.**
Figure 4

Material examined. *Type material*: Holotype (MNHN TYPE 1540) northwestern Portuguese continental shelf, site R16, 41º27.557′ N 8º51.866′ W, October 2007, in fine sand, 52.3 m. *Paratypes*: MB29-000230, 2 specimens, same data as holotype. MB29-000231, 2 specimens, site PC114. MB29-000232, 6 specimens, site PC118. MB29-000233, 1 specimen, site PC119. ECOSUR0130, 2 specimens, site R25. DBUA 01316.01, 2 specimens, site PC118. DBUA 01316.02, 1 specimen, site PC119. *Additional material*: site G18(1), 27 specimens; site G26(1), 6 specimens; site R16, 18 specimens; site R19, 5 specimens; site R25, 4 specimens; site PC114, 4 specimens; site PC118, 29 specimens; site PC146, 1 specimen; site PC173, 1 specimen; site PC180, 21 specimens; site PC187, 32 specimens; site PC195, 26 specimens.

Description. Holotype complete with 174 chaetigers, LT=33.5 mm, L10=2.5 mm, W10=0.7 mm. Prostomium conical, slightly longer than wide, with a pair of nuchal organs, short buccal lips ventrally. Peristomium shorter than prostomium, about half its length, with two rings of similar size (Fig. 4A).

All parapodia well developed, first six smaller than following ones. Prechaetal lobe in parapodia 1–4 inconspicuous; from parapodia 5 very short, as a globular projection, gradually increasing in length between parapodia 6–15; from parapodia 16 as a digitiform lobe, always smaller than postchaetal lobe. Postchaetal lobe in parapodia 1 small and conical; in parapodia 2–48 digitiform wide basally; becoming longer in posterior parapodia (Fig. 4B–D). Short rounded dorsal cirri in all parapodia.

Composite multidentate hooded hooks in chaetigers 1–11, 2–3 per chaetiger, with short blade, with up to 7 teeth, proximal tooth largest (Fig. 4E). Simple multidentate hooded hooks from chaetiger 11, with short hood, with up to 7 teeth, preacicular hook twice as big as postacicular hook, proximal tooth largest (Fig. 4F). Dorsal limbate chaetae in chaetigers 1–38, ventral limbate chaetae in chaetigers 1-11. Aciculae yellow, aristate, one in anterior parapodia and up to two in the posterior parapodia.

Pygidium with terminal anus, with two pairs of anal cirri, dorsal longer than ventral pair.

Mandible divided for about half its length. Maxillary apparatus with five pairs of maxillae; maxillary carriers as long as MI, anterior end constricted. MI forceps-like with attachment lamella well developed. MII as long as MI, with wide connecting plates slightly developed; with four teeth of similar size. MIII unidentate, followed by a knob, with a very prominent projection in the basal part of the maxilla. MIV unidentate, with a pointed tooth. MV free, prominent, lateral to MIV and MIII (Fig. 4G).

Variations. The material examined ranged in L10 from 1.4 to 3.2 mm, in W10 from 0.3 to 0.9 mm and varied in the following features: the last composite multidentate hooded hook was found from chaetigers 7 to 15; the first simple multidentate hooded hook was found from chaetigers 8 to 16; the last ventral limbate ranged from chaetiger 8 to 17 and the last dorsal limbate from 25 to 59 (cf. Table 2).

Reproduction. Mature specimens were found only in October. Male gametes of *Lumbrineris lusitanica* **sp. nov.** (Paratypes MB29-000231, DBUA 01316.02) were located from chaetiger 35 to 139, and had a long tail and head with a subspherical form, with diameters ranging from 2.8 to 3.2 µm. Female gametes (Paratypes MB29-000232, DBUA 01316.01) were located from parapodia 34 though the last segment of an incomplete specimen. The gametes were globular with a size diameter ranging between 181 and 192 µm.

Distribution and habitat. *Lumbrineris lusitanica* **sp. nov.** is widely distributed on the whole Portuguese continental shelf, at water depths ranging from 14 to 190 m, but mostly below 100 m (cf. Table 3). The species is recorded in mud as well as in fine gravel however, it is usually found in fine and very fine sands with low to moderate fines content. Overall, the sediments are characterized by very high sand content and low to moderate content in fines, gravel, biogenic fraction and TOM (averages of 77.5%, 15.4%, 7.1%, 3.8% and 2.6%, respectively) (cf. Table 3).

Type locality. Northwestern and western Portuguese continental shelf.

Etymology. The specific name *lusitanica* refers to the western Iberian Roman province, where this species is very dominant.

Discussion. *Lumbrineris lusitanica* **sp. nov.** is characterized by having an unidentate MIII, followed by a knob. According to Carrera-Parra (2006b) the following species have this kind of MIII: *L. amboinensis* Grube (from Amboina and Kai Islands), *L. grandis* Treadwell (from Hawaii), *L. futilis* (from North Sea) and *L. reunionensis* Carrera-Parra (from La Reunion and Amsterdam Islands). *Lumbrineris lusitanica* **sp. nov.** differs from this

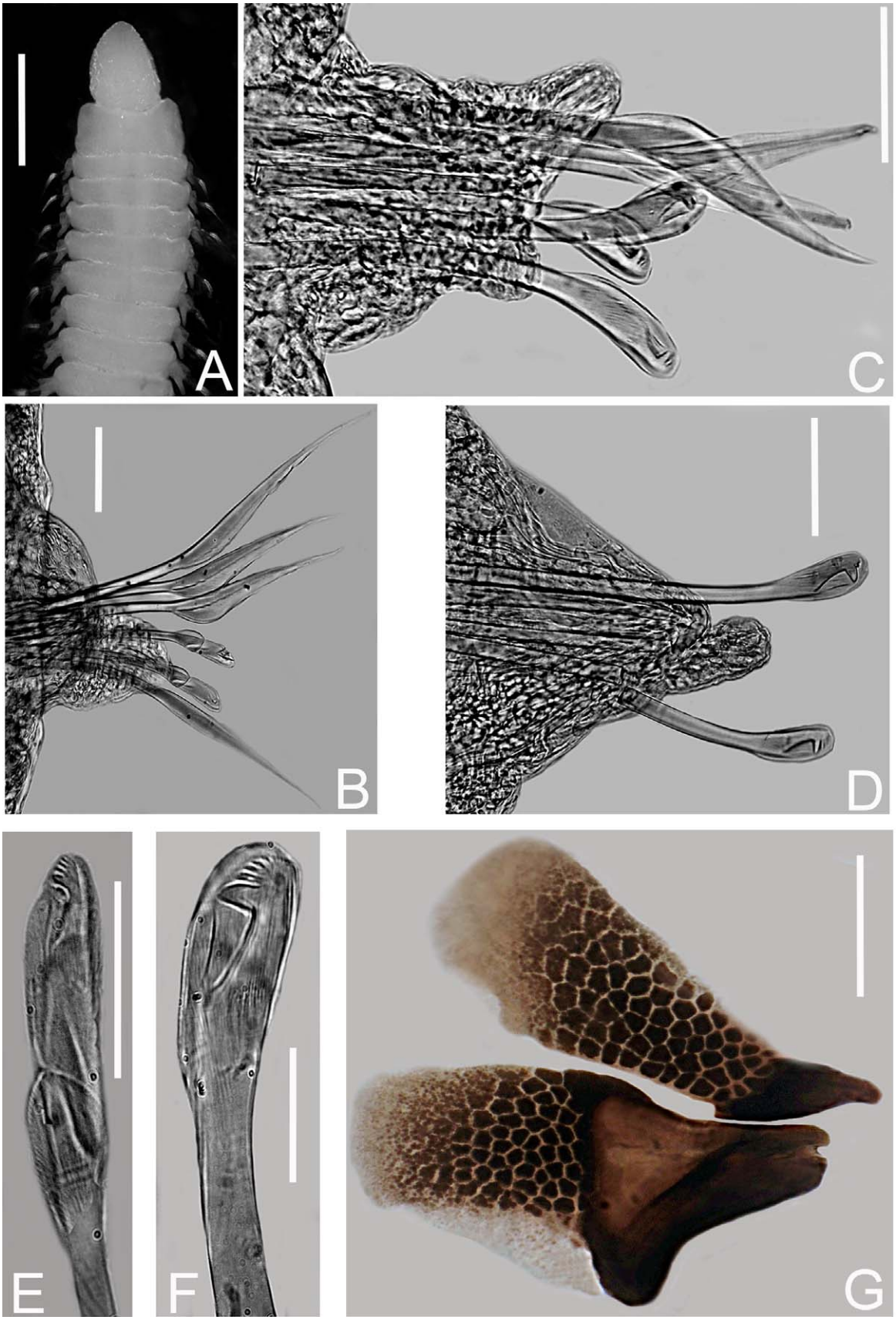

FIGURE 4. *Lumbrineris lusitanica* **sp. nov.** Paratype (ECOSUR0130) A, anterior end, dorsal view; B, parapodium 3, frontal view; C, parapodium 13, frontal view; D, parapodium 79, frontal view; E, composite multidentate hooded hook, from parapodium 3; F, simple multidentate hooded hooks, from parapodium 79; G, maxillae III and IV, dorsal view. Scale bars: A, 0.7 mm; B, C, D, G 0.05 mm; E, F, 0.025 mm.

group of species by having yellow aciculae, while they are black or dark red in all the other. *Lumbrineris lusitanica* **sp. nov.** differs from *L. reunionensis* by having the postchaetal lobe digitiform wide basally in anterior parapodia and digitiform in posterior ones, while *L. reunionensis* has a conical postchaetal lobe throughout the body; furthermore *L. lusitanica* **sp. nov.** has MIV as a pointed tooth, while *L. reunionensis* has a well-developed plate. Moreover, *L. lusitanica* **sp. nov.** differs from *L. futilis* and *L. reunionensis* by having composite multidentate hooded hooks with short rather than long blade.

***Lumbrineris pinaster* sp. nov.**
Figure 5

Material examined. *Type material*: Holotype (MNHN TYPE 1541) western Portuguese continental shelf (off Tagus Estuary, Lisbon), site PC115, 38º35.368′ N 9º25.567′ W, in mud, 97.7 m. *Paratypes*: ECOSUR0131, 1 specimen, site PC187. MB29-000234, 1 specimen, site PC203. MB29-000235, 10 specimens, site G19(2). MB29-000236, 3 specimens, site G28(1). MB29-000237, 3 specimens, site G28(2). DBUA 01318.01, 3 specimens, site G22(1). DBUA 01318.02, 10 specimens, site G19(2). *Additional material:* site G19(2), 9 specimens; site G22(1), 17 specimens; site PC114, 4 specimens; site PC118, 1 specimen; site PC187, 9 specimens; site PC188, 1 specimen; site PC195, 2 specimens; site PC201, 1 specimen; site PC208, 1 specimen; site PC229, 1 specimen; site ALG86, 6 specimens; site G25(3), 12 specimens; site G28(1), 15 specimens; site G28(2), 31 specimens.

Description. Holotype incomplete with 101 chaetigers, LT=18.1 mm, L10=1.6 mm, W10=0.4 mm. Prostomium conical, as long as wide, with a pair of nuchal organs, ventrally with short buccal lips. Peristomium half the length of prostomium, with two rings; anterior ring 0.75 of total peristomial length (Fig. 5A).

All parapodia well developed, first four smaller than following ones. Prechaetal lobe rounded with globular protuberance directed dorsally, increasing in size gradually from chaetigers 1 to 12, preserving shape and size to end; always smaller than postchaetal lobe. Postchaetal lobe auricular from parapodia 1 to 13, gradually transforming to digitiform lobe, clearly visible from parapodium 30; longer in posterior parapodia (Fig. 5B–D). Short rounded dorsal cirri in all parapodia.

Composite multidentate hooded hooks in chaetigers 1–10, 2–3 per chaetiger, with long blade, up to 7 teeth, all of similar size (Fig. 5E). Simple multidentate hooded hooks of two types; from chaetiger 11 to 22, with long hood, up to 7 teeth, proximal tooth slightly largest (Fig. 5F); from chaetiger 23 with short hood, up to 5 teeth, proximal tooth largest. Preacicular hook with a section that is twice as large as the postacicular hook (Fig. 5G-H). Dorsal limbate chaetae in chaetigers 1–41, ventral limbate chaetae in chaetigers 1–12. Aciculae yellow, aristate, up to two per chaetiger.

Pygidium with terminal anus and two pairs of anal cirri (paratype MB29-000234).

Mandible divided for about half its length. Maxillary apparatus with five pairs of maxillae; maxillary carriers as long as MI, anterior end constricted. MI forceps-like with well-developed attachment lamella. MII as long as MI, with wide connecting plates slightly developed; with four teeth of similar size. MIII unidentate, followed by a knob, .MIV unidentate with a well-developed plate. MV free, prominent, lateral to MIV and MIII (Fig. 5I).

Variations. The specimens examined ranged in L10 from 1.3 to 2.5 mm, in W10 from 0.4 to 0.7 mm, and varied in the following features: the last composite multidentate hooded hooks were observed from chaetiger 7 to 12; the first simple multidentate hooded hooks with long hood from chaetiger 8 to 13; the first simple multidentate hooded hooks with short hood from chaetiger 19 to 35; the end of ventral limbate from chaetiger 10 to 15; and the end of dorsal limbate from chaetiger 36 to 45 (cf. Table 2).

Reproduction. Mature specimens were only found in October. The male gametes of *Lumbrineris pinaster* **sp. nov.** are located posteriorly to chaetiger 37 (paratypes MB29-000235, MB29-000236, MB29-000237, DBUA 01318.01, DBUA 01318.02); they have a long tail and a subspherical nucleus with diameter between 2.5 and 3 µm. The female gametes cells are located from parapodia 38 (paratypes MB29-000235, MB29-000236, MB29-000237, DBUA 01318.01, DBUA 01318.02), the morphology is globular with diameter from 98 µm to 147 µm.

Distribution and habitat. This species occurred only on the southern Portuguese continental shelf and off the Tagus Estuary at shelf depths. It was mainly found at nearly 50 m depth (cf. Table 3). The species shows a preference for mud, very fine and fine sands. Sediments are characterized by high fines, biogenic and TOM contents (averaging, 39.7%, 6.4% and 4.7% respectively) (cf. Table 3). Although the northwestern deeper shelf is dominated

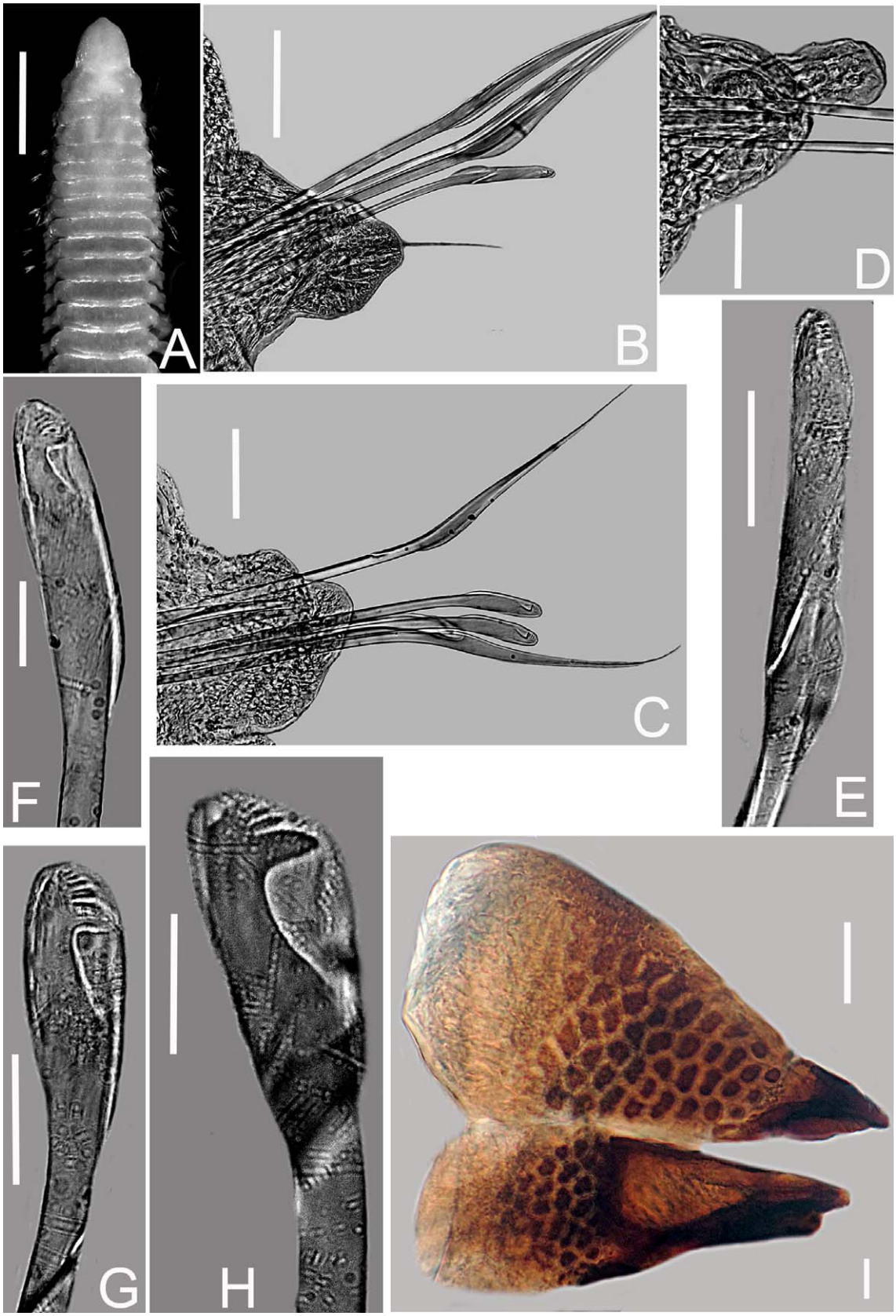

FIGURE 5. *Lumbrineris pinaster* **sp. nov.** Paratype (ECOSUR0131) A, anterior end, dorsal view; B, parapodium 3, frontal view; C, parapodium 13, frontal view; D, parapodium 153, frontal view; E, composite multidentate hooded hook, from parapodium 3; F, simple multidentate hooded hook with long hood, from parapodium 13; G, preacicular simple multidentate hooded hook with short hood, from parapodium 79; H, postacicular simple multidentate hooded hook with short hood, from parapodium 79; I, maxillae III and IV, dorsal view. Scale bars: A, 0.4 mm; B, C, 0.5 mm; D, I, 0.025 mm; E, F, 0.012 mm.

by finer sediments (Martins *et al.* 2012), the species was not recorded there. It is possible that the Lisbon/Cascais canyons, located in the western margin, could set a barrier to the distribution of this species. It is expected that *Lumbrineris pinaster* **sp. nov.** might also occur in the Gulf of Cádiz muddy area (southwestern Spain), which is a continuation of the extensive mud patch present in the southern Portuguese shelf.

Type locality: Off the Tagus Estuary (Lisbon), Portugal.

Etymology. The specific name was derived from the Maritime Pine seed (*Pinus pinaster*) which has a peculiar wing, resembling the Maxillae IV of this *Lumbrineris*.

Discussion. *Lumbrineris pinaster* **sp. nov.** belongs to the same group of species as *L. lusitanica* **sp. nov.** characterized by having an unidentate MIII, followed by a knob.*Lumbrineris pinaster* **sp. nov.** and *L. lusitanica* **sp. nov.** differ from *L. amboinensis, L. grandis, L. futilis* and *L. reunionensis* by having yellow aciculae, whereas they are black or dark red in all the other. Additionally, *L. pinaster* **sp. nov.** differs from *L. amboinensis*, *L. grandis*, and *L. lusitanica* **sp. nov.** by having composite multidentate hooded hooks with long rather than short blade. Furthermore, *L. pinaster* **sp. nov.** differs from all these species by having preacicular SMHH twice as big as postacicular SMHH, while the other species have SMHH of similar size. Among all *Lumbrineris* species with MIII unidentate followed by a knob, *L. pinaster* **sp. nov.** is unique by having postchaetal lobe auricular in anterior parapodia.

Multivariate analysis

The results of the ordination analysis based on morphological descriptors of the lumbrinerid species occurring in the studied area are shown in Fig. 6A with a detailed analysis of the data relative to the three new *Lumbrineris* species shown in Fig. 6B. Axis 1 accounts for 35.6% of the total variation and is characterized by the separation of species with five maxillae, MIV completely pigmented, MI attachment lamellae, on the positive pole, and species with four maxillae and both MIII and MIV edentate, on the negative pole. This axis thus separates *Lumbrineris* species and *Ninoe armoricana*, on the positive pole, from *Gallardoneris iberica* **sp. nov**., on the left pole. Axis 2 accounts for 27.5% of the total variation and shows the separation of species with both CMHH and SMHH (*Lumbrineris* and *Gallardoneris* species) from species with simple bidentate hooks (*Lumbrinerides amoureuxi* and *Lumbrineriopsis paradoxa*) and limbated simple multidentate (*Abyssoninoe hibernica*). *Gallardoneris iberica* **sp. nov.** is positioned on the negative pole of axis 1 and positive pole of axis 2 in the ordination analysis (Fig. 6A). The main morphological characters that allow its differentiation from the other species, are the presence of four maxillae, MII without attachment lamellae, MIII edentate, MIV edentate with a whitish central area, presence of both composite and SMHH and absence of postchaetal branchiae, bidentate and limbated multidentate hooded hooks. The *Lumbrineris* species are positioned on the positive poles of axis 1 and 2 (Fig. 6A). They are separated from the other genera mostly by the absence of postchaetal branchiae (which is only found in *Ninoe*), bidentate simple hooded hooks (*Lumbrineriopsis* and *Lumbrinerides*) and limbated simple hooded hooks (*Abyssoninoe*), and the presence of five pairs of maxillae (*Abyssoninoe, Gallardoneris, Lumbrineriopsis* and *Lumbrinerides* have four pairs of maxillae).

The detailed analysis of the morphological descriptors of the new *Lumbrineris* species are shown in Fig. 6B. Axis 1 accounts for 49.4% of the total variance and separates species with MIII unidentate, aciculae distally curved in median and posterior parapodia and the highest values of W10 (*Lumbrineris luciliae* **sp. nov.**) from the other two new species characterized by MIII unidentate followed by a knob and aciculae straitght (*L. lusitanica* **sp. nov** and *L. pinaster* **sp. nov**). Axis 2 accounts for 41% of total variance and separates the species on the positive pole, *L. pinaster* **sp. nov.**, from *L. lusitanica* **sp. nov.**, on the negative pole. The descriptors which contribute to this separation are MIV type, first SMHH and presence/absence of anterior postchaetal lobe auricular and prominent projection on MIII. The descriptor "anterior postchaetal lobe digitiform wide basally" contributes to both axes, being shared by the species *L. luciliae* **sp. nov.**, and *L. lusitanica* **sp. nov.**.

The multivariate analysis of the morphological descriptors showed a very good separation of the four new species, and between these and the other recorded species on the Portuguese continental shelf. The following key to the Lumbrineridae species of Iberian waters is based on the understanding gained from that analysis.

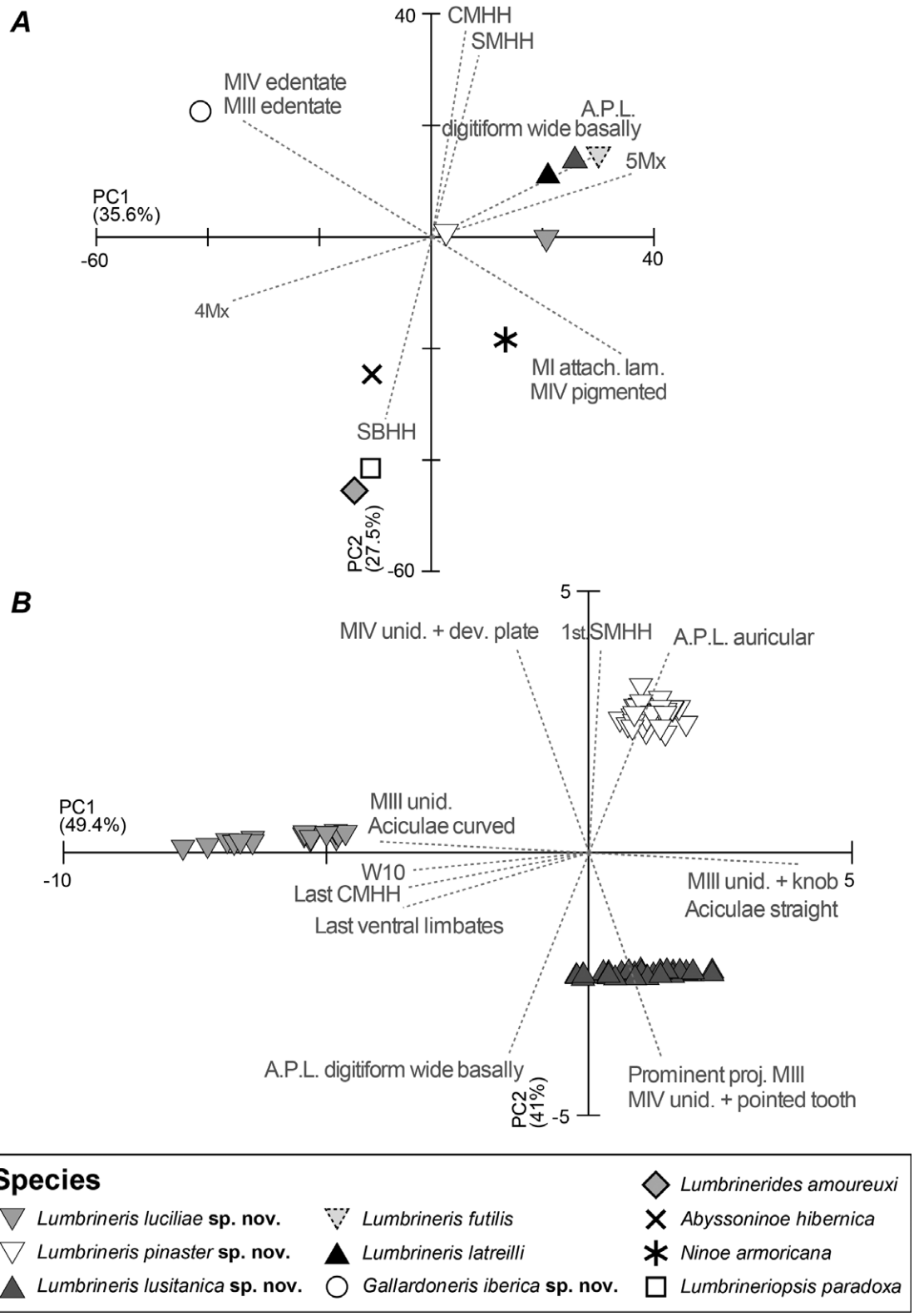

FIGURE 6. Ordination analysis based on morphological descriptors of specimens of *Abyssoninoe, Lumbrineris, Gallardoneris, Lumbrinerides, Lumbrineriopsis and Ninoe* species (A) and of *Lumbrineris luciliae* sp. nov., *L. lusitanica* sp. nov. and *L. pinaster* **sp. nov.** (B). The most correlated variables (rho>0.8) are shown as dashed vectors. Legend: A.P.L.—postchaetal lobe shape in anterior parapodia; CMHH—composite multidentate hooded hook; SMHH—simple multidentate hooded hook; SBHH—simple bidentate hooded hook; MI attach. lam.—MI attachment lamellae; MIII unid. + knob – MIII unidentate followed by a knob; prominent proj. MIII—prominent projection in the basal part of MIII; MIV unid. + dev. plate—MIV unidentate with a developed plate; MIV unid. + pointed tooth—MIV unidentate with a pointed tooth; W10—width at chaetiger 10 excluding parapodia.

Key to the Lumbrineridae species from the Iberian waters

1 Maxillary apparatus with four pairs of maxillae 2
- Maxillary apparatus with five pairs of maxillae 6
2 With both composite and simple hooded hooks 3
- With simple hooded hooks only 4
3 With antennae; MI and MII with attachment lamellae; mandible with both anterior and posterior end divergent…(*Augeneria*) 10
- Without antenna; MI and MII without attachment lamellae; mandible with wide distal end narrowing to the posterior end, totally fused … (*Gallardoneris*) … Prechaetal lobe longer than postchaetal lobe in posterior parapodia; postchaetal lobe auricular in anterior parapodia, digitiform in posterior ones; CMHH with short blade . . . . . *Gallardoneris iberica* **sp. nov.**
4 With limbate simple multidentate hooded hooks; MIV as a broad rectangular lamella with a lateral protruding expansion… (*Abyssoninoe*) 11
- Without limbate simple multidentate hooded hooks; shape of MIV different from above. 5
5 Carriers joined to 1/2 of base of MI and longer than MI; MIV multidentate; mandible fused up to 3/4 of its length … (*Lumbrineriopsis*) …MIII unidentate; simple bidentate hooded hooks from chaetiger 1 . . . . . *Lumbrineriopsis paradoxa*
- Carriers joined to entire base of MI and as long as MI; MIV with up to one tooth; mandibles completely fused … (*Lumbrinerides*) 12
6 Anterior parapodia with postchaetal branchiae, MIV multidentate … (*Ninoe*) … MIII multidentate, distal tooth largest; SMHH with long hood in branchial region, with short hood in postbranchial region . . . . . *Ninoe armoricana*
- Anterior parapodia without postchaetal branchiae, MIV with up to two teeth 7
7 MII half as long as MI 8
- MII as long as MI 9
8 With composite spinigers … (*Lumbricalus*) … Aciculae black; postchaetal lobe in anterior parapodia digitiform wide basally, digitiform in posterior ones, with up to 2-3 spinigers per chaetiger; CMHH with long blade . . . . . *Lumbricalus campoyi**
- Without composite spinigers … (*Hilbigneris*) … MIII unidentate, with prominent tooth followed by an expanded base; CMHH with long blade; aciculae yellow . . . . . *Hilbigneris gracilis**
9 With only SMHH … (*Scoletoma*) 14
- With both SMHH and CMHH … (*Lumbrineris*) 15
10 With dark aciculae; with up to eight antennae . . . . . *Augeneria riojai**
- With yellow aciculae; with up to three antennae. . . . . *Augeneria algida**
11 Prechaetal lobe inconspicuous in anterior parapodia; digitiform, and well-developed in posterior parapodia; postchaetal lobe in anterior parapodia small and conical being more developed in posterior parapodia . . . . . *Abyssoninoe hibernica*
- Prechaetal lobe inconspicuous in all parapodia; postchaetal lobe well developed in all parapodia . . . . . *Abyssoninoe scopa**
12 MI with one internal accessory tooth 13
- MI without internal accessory teeth . . . . . *Lumbrinerides acuta sensu* Ramos, 1976*[1]
13 MII with three teeth; prostomium cylindrical, very elongated . . . . . *Lumbrinerides carpinei**
- MII with four teeth; prostomium acorn-shaped . . . . . *Lumbrinerides amoureuxi*
14 MIII unidentate; aciculae black; SMHH from chaetiger 15 . . . . . *Scoletoma fragilis*
- MIII bidentate; aciculae yellow; SMHH from chaetigers 1–5 . . . . . *Scoletoma impatiens**[2]
15 MIII unidentate 16
- MIII unidentate followed by a knob 18
- MIII bidentate 20
- MIII tridentate . . . . . *Lumbrineris inflata*[3]
16 Prechaetal lobe in posterior parapodia longer than postchaetal lobe . . . . . *Lumbrineris nonatoi**
- Prechaetal lobe always shorter than postchaetal lobe 17
17 Postchaetal lobe auricular in anterior parapodia; all aciculae straight . . . . . *Lumbrineris aniara**
- Postchaetal lobe digitiform wide basally in anterior parapodia; aciculae distally curved in median and posterior parapodia . . . . . *Lumbrineris luciliae* **sp. nov.**
18 CMHH with short blade . . . . . *Lumbrineris lusitanica* **sp. nov.**
- CMHH with long blade 19
19 Aciculae yellow; postchaetal lobe auricular in anterior parapodia . . . . . *Lumbrineris pinaster* **sp. nov.**
- Aciculae black; postchaetal lobe digitiform in anterior parapodia . . . . . *Lumbrineris futilis*
20 CMHH with short blade; SMHH of two sizes, preacicular bigger; postchaetal lobe digitiform in all parapodia; prostomium rounded . . . . . *Lumbrineris coccinea**
- CMHH with long blade, SMHH of similar size; postchaetal lobe digitiform wide basally in anterior chaetigers; prostomium conical . . . . . *Lumbrineris latreilli*

* Recorded in Iberian waters, but not found in this study.

[1] Ramos (1976) recorded *L. acuta* from Spain and described MI without accessory teeth; however, *L. acuta*, a species described from Rhode Island, has MI with one accessory tooth (Perkins, 1979).

[2] *S. impatiens* (from France) has been considered synonym of *S. tetraura* (from South Africa), without a revision of both species. Therefore, we recommend that for European seas the name *S. impatiens* should be used instead *S. tetraura*. A com-

plete revision of both species is needed to clarify their status which is beyond the scope of the present study.

[3] Record questionable according to Carrera-Parra (2006b).

TABLE 3. Environmental characterization of the sites where Lumbrineridae species occurred along the Portuguese continental shelf (SD = standard deviation).

	Gallardoneris iberica **sp. nov.**	*Lumbrineris luciliae* **sp. nov.**	*Lumbrineris lusitanica* **sp. nov.**	*Lumbrineris pinaster* **sp. nov.**	*Lumbrineris latreilli*
Depth (range, m)	18.0–179.3	32.7–179.3	13.8–190.0	11.0–160.5	28.7
Depth (mean ± SD, m)	98.3±38.7	81.6±50.9	75.1±42.1	48.1±30.9	28.7
Gravel content (mean ± SD, %)	1.8±6.9	6.2±19.3	7.1±15.5	2.8 ±6.2	3.73
Sand content (mean ± SD, %)	55.3±24.8	64.9±22.2	77.5±19.3	57.6±29.7	65.85
Fines content (mean ± SD, %)	43.0±26.3	28.9±20.5	15.4±17.8	39.7±32.1	30.43
Biogenic content (mean ± SD, %)	5.3±11.8	8.0±6.5	3.8±8.3	6.4±6.9	6.02
TOM content (mean ±SD, %)	4.7±1.6	3.8±1.7	2.6±1.6	4.7±1.91	2.93
Main sediment types	Mud, very fine sand, fine sand	Several types of sediments but mostly fine sand and mud	All type of sediments but mostly finer sands	Mud, very fine sand, fine sand, coarse sand	Very fine sand
Occurrence	Portuguese shelf	Mainly southern Portuguese shelf	Portuguese shelf	Southern Portuguese shelf; off Tagus Estuary	Southern Portuguese shelf

continued.

	Lumbrineris futilis	*Lumbrineriopsis paradoxa*	*Lumbrinerides amoureuxi*	*Ninoe armoricana*	*Abyssoninoe hibernica*	*Scoletoma* cf. *fragilis*
Depth (range, m)	25.6–128.3	7.0–126.9	67.9–195.0	92.9–138.5	16.0–190.0	28.9–125.5
Depth (mean ± SD, m)	60.1±32.3	50.5±26.0	119.9±35.2	114.7±14.8	43.2±100.1	77.9±45.9
Gravel content (mean ± SD, %)	20.4±29.0	23.9±20.1	4.9±11.9	0.2±0.5	2.2±6.6	13.2±22.9
Sand content (mean ± SD, %)	68.4±25.0	72.2±19.5	73.2±11.5	48.3±24.3	58.9±25.9	66.9±20.6
Fines content (mean ± SD, %)	11.2±13.8	3.8±10.4	21.7±12.1	51.6±24.4	39.0±27.3	19.9±20.5
Biogenic content (mean ± SD, %)	5.2±7.3	5.7±11.2	5.6±2.7	2.4±4.8	2.6±4.0	3.0±4.0
TOM content (mean ±SD, %)	2.1±1.4	1.2±1.1	3.4±0.6	5.6±1.6	4.6±1.9	2.7±2.2
Main sediment types	Fine gravel, fine sand	Coarser sediments	Fine sand, medium sand, very fine sand	Mud, very fine sand, fine sand	Mud, very fine sand, fine sand	Very fine and medium sand and fine gravel
Occurrence	Portuguese shelf	Portuguese shelf	Mainly SW Portuguese shelf	Portuguese shelf	Portuguese shelf	NW Portuguese shelf

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