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# Taxonomy, ecology and geographic distribution of *Gallardoneris iberica* (Polychaeta, Lumbrineridae) in southern Europe

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*The polychaete* Gallardoneris iberica *was described in soft-bottom benthic habitats from the Atlantic Iberian Peninsula coasts in 2012. Since then, successive studies have found this species in Spain, Italy and Croatia. The present study is the first to report* G. iberica *for Greece and Cyprus (42 new records) confirming its wide geographic distribution on southern European coasts. Taxonomic accounts and ecological preferences based on a large survey and review of available literature are being presented. The species was frequently found in habitats characterized by infralittoral muddy sands with variable organic matter and 'Moderate' ecological quality status; nevertheless it was also recorded in coarser and finer sediments, circalittoral mixed sediments, phytal substrates and undisturbed sites. Its relative abundance per sample was always lower than 2%. A review of the available ecological and geographic data of the other* Gallardoneris *species and a worldwide taxonomic key to* Gallardoneris *species are provided.*

**Keywords:** macrofauna, Cyprus, Greece, East Mediterranean, WFD, *Lumbrineris nonatoi*

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## INTRODUCTION

The Lumbrineridae Schmarda, 1861 are polychaetes with simple body shape and reduced number of external morphological characters (Carrera-Parra, 2001; Martins *et al*., 2012). The emphasis in the systematics of this family has shifted considerably in the last 25 years (Orensanz, 1990; Carrera-Parra & Orensanz, 2002; Carrera-Parra, 2006a). In the past, the identification was based on readily accessible, but confusing external characters (e.g. shape of the prostomium and the parapodial lobes; type, size, shape and body arrangement of the hooded hooks). Now, the identification of lumbrinerids is mostly based on a combination of unique, reliable and size independent characters, focused in the maxillary apparatus and some key external features (Orensanz, 1990; Carrera-Parra & Orensanz, 2002; Carrera-Parra, 2006a, b). This approach has led to the description of several new taxa (both species and genera) and to taxonomic rearrangements (e.g. resurrecting genera, synonymizing or re-assigning species). Thus, more than 200 species belonging to 19 genera are currently recognized worldwide (Carrera-Parra, 2006a, b). In the Mediterranean Sea, a total of 10 genera are recorded so far (D'Alessandro *et al*., 2016), of which eight are reported for the Eastern Mediterranean (Kurt-Sahin *et al*., 2016). These are *Augeneria* Monro, 1930; *Lumbrineris* de Blainville, 1828; *Lumbricalus* Frame, 1992; *Lumbrinerides* Orensanz, 1973; *Lumbrineriopsis* Orensanz, 1973; *Scoletoma* de Blainville, 1828; *Ninoe* Kinberg, 1865 and *Hilbigneris* Carrera-Parra, 2006a.

Highlighting the importance of several maxillary features, Carrera-Parra (2006a) erected four new genera that together with *Augeneria*, have in common four pairs of maxillae and Maxillae IV with whitish central area. Among them, *Gallardoneris* is mainly distinguished by the absence of prostomial antennae and attachment lamellae in Maxillae I and Maxillae II (present in *Augeneria*), presence of composite and simple multidentate hooded hooks (*Helmutneris* and *Gesaneris* only have simple multidentate hooks), mandibles totally fused and maxillary carriers joined to the entire base

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of Maxillae I (mandibles partially fused and carriers joined to half of base of Maxillae I in *Loboneris*).

*Gallardoneris* originally consisted of two species, *G. shinoii* (Gallardo, 1968) and *G. thailandensis* Carrera-Parra, 2006a, both of which occur in the Western Pacific. Recently, Martins *et al.* (2012) described *Gallardoneris iberica* from specimens collected in the Portuguese continental shelf. The composite multidentate hooded hooks of *G. iberica* have short hoods and they are present up to chaetiger 9, whereas the hoods are long in *G. shinoii* and present up to chaetiger 16 in *G. thailandensis*. In anterior body, after 6–7 first chaetigers and until chaetigers 14–17, prechaetal lobes are ovoid, in comparison to *G. thailandensis* where they are rounded with digitiform extension. In posterior body, prechaetal lobes are longer than postchaetal lobes, instead of similar size in *G. shinoii*. Since then, *G. iberica* has been recorded from a number of sites along the Adriatic Sea (Bertasi *et al.*, 2014; Mikac, 2015), in the west-central Mediterranean Sea (D'Alessandro *et al.*, 2016; García Gómez *et al.*, 2016) and on the south-western Spanish Atlantic coast (García Gómez *et al.*, 2016), on the basis of the detailed description of jaw morphology and external characteristics. In addition, one specimen of the genus *Gallardoneris* (identified as *Gallardoneris* sp.) has been recently recorded in Malta, although further study is required to determine whether this could be an undescribed species or not (Langeneck *et al.*, 2017).

Up-to-date taxonomic keys, species lists and geographic occurrences are highly interesting for taxonomists and ecologists, but they are also very important for environmental conservation policies, where identification of benthic macrofauna is required (e.g. EU Water Framework Directive; EU Marine Strategy Framework Directive; EU Habitats Directive; EU Biodiversity Strategy). In fact, there is an evident need for easy-to-use keys (and descriptions), which are addressed to end-users with less experience than expert taxonomists and must be freely available in a collective worldwide database. The present study contributes to the above needs, by showing the results of an extensive survey conducted throughout the Greek and Cypriot coasts which include the taxonomy, geographic distribution and ecological preferences of *G. iberica*. Additionally, a comparison with other species of the same genus and a worldwide key is provided, as well as the species widespread distribution is discussed.

## MATERIALS AND METHODS

Specimens of *Gallardoneris iberica* were collected from seven coastal sites in Greece (Ionian Sea and Aegean Sea) as part of the Water Framework Directive National Monitoring and from 35 sites off Vasilikos Bay and an inshore area in southern Cyprus, as part of two research projects (Figure 1). In total, four sampling surveys were carried out: in May 2012 and March 2013 in Greece, and in late June/early July and August 2013 in Cyprus. The water depth of the sampling sites ranged from 6 to 59 m. All sites were sampled with a 0.1 $m^2$ grab, for sedimentary and macrofauna analysis. Macrofauna samples were sieved using a mesh size of 0.5 mm (Cyprus; samples with prefix VAS) or 1 mm (Greece; samples with prefix WFD), fixed with 10% solution of formalin with seawater and coloured with Rose Bengal.

At the HCMR laboratory in Greece, sediment samples for grain-size analysis were divided between sand and mud fractions by wet sieving through a 63 μm mesh. Size distribution of the fine-grained subsamples were determined by X-ray attenuation analyser (Sedigraph Micrometrics 5000 ET). Results were used to classify the substrates according to Folk (1954). At the laboratory of MER in Cyprus, grain-size analysis was carried out in dried sediment by using the Endecotts Octagon Digital sieve shaker and sieves. Sediment types were automatically determined by GRADISTAT™ v8 (Blott & Pye, 2001). Organic matter (OM) was determined by loss on ignition in the MER laboratory, following the procedure outlined in CEN/TC 292 (2007). Total organic carbon

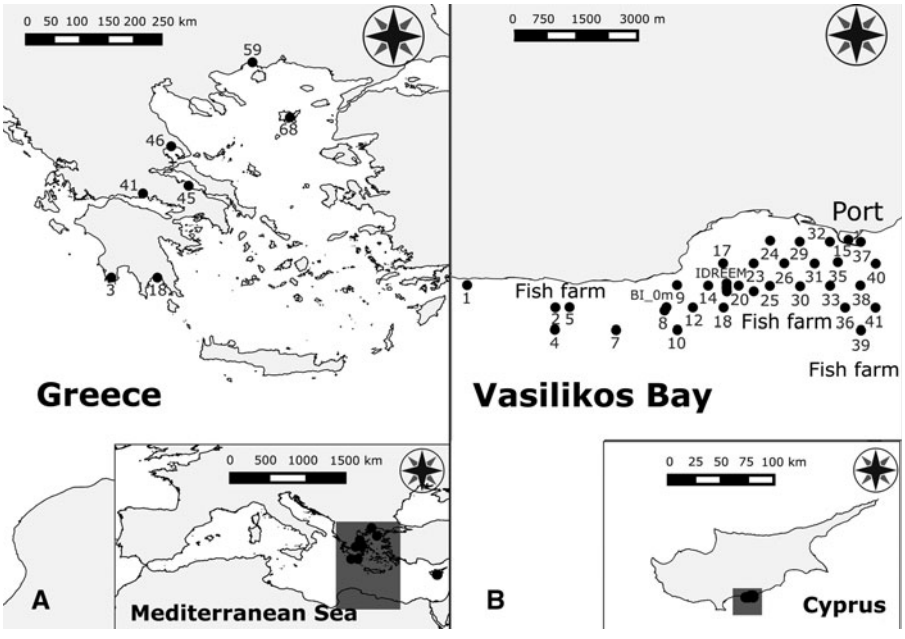


**Fig. 1.** Sampling stations where *G. iberica* has been found in the East Mediterranean. (A) Samples from Greece; (B) Samples from Vasilikos Bay and southern Cyprus. Sites under human pressures are labelled as 'fish farm' or 'port'.

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(TOC) was determined with CHN elemental analyser (EA-1108, Fisons Instruments) according to Verardo *et al.* (1990) in HCMR laboratory. Biological samples were rinsed with fresh water, sorted, identified up to species level, wherever possible and preserved in 70% ethanol.

Herein, we are following the terminology and abbreviations proposed by Carrera-Parra (2006a). These abbreviations stand for the simple multidentate hooded hooks (SMHH), the composite multidentate hooded hooks (CMHH), ventral limbate (VL), dorsal limbate setae (DL) and maxillae (M). For a total of 22 individuals of *G. iberica* (10 from Cyprus, 10 from Greece, 2 from Spain) the following morphometric characters were measured: $L_T$, total length; Nb, number of chaetigers (ch.); $L_{10}$, length from prostomium tip to the 10th ch.; $W_{10}$, width of ch. 10, excluding parapodia; $P_L$: prostomium length; $P_W$: prostomium width; CMHH (blade size, number of teeth, last ch. presence); SMHH (size, number of teeth, first ch. presence); aciculae number (anterior, middle, posterior body); VL (last ch.); DL (last ch.); number of teeth in maxillae. For analysing relevant morphological features, the following equipment was used: stereoscopes (OLYMPUS SZE and SZX7), microscopes (OLYMPUS BZ43 and CX41), digital cameras (Luminera and Q-Imaging Micropublisher 5.0RTV) and Image Analysis Pro Plus™ software for biometric measurements.

Sensitivity of *G. iberica* to disturbance was estimated according to the methodology of Rosenberg *et al.* (2004), modified later by Leonardsson *et al.* (2009). Habitat type of the stations was also described. Finally, the Ecological Quality Status for each station was determined using the Bentix index (Simboura & Zenetos, 2002) and the anthropogenic activities associated directly with the investigated stations were noted. Table 1 lists the environmental characteristics of each station and the human activities taking place.

The two individuals collected from Spain were loaned from DBUA – Department of Biology, University of Aveiro (Biological Research Collection). A set of well-preserved *G. iberica* specimens was deposited in the Natural History Museum of Crete, Irakleio (NHMC). The remaining specimens were deposited in the formal collection of Hellenic Centre for Marine Research (Athens, Greece); Museum of Zoology of the Department of Biology, University of Thessaloniki (Greece); Polychaeta collection of the Department of Biology, University of Pisa (Italy) and in the reference collection of Marine & Environmental Research Ltd (Limassol, Cyprus).

## SYSTEMATICS

Class POLYCHAETA Grube, 1850
Order EUNICIDA Dales, 1962
Family LUMBRINERIDAE Schmarda, 1861
Genus *Gallardoneris* Carrera-Parra, 2006a

*Gallardoneris iberica* Martins, Carrera-Parra, Quintino & Rodrigues, 2012
(Figures 1–4, Tables 1 and 2)

*Gallardoneris iberica* Martins *et al.*, 2012, p. 6, Figure 2 – Bertasi *et al.*, 2014, p. 2, Figures 2–4; Mikac, 2015, p. 46. García Gómez *et al.*, 2016, p. 4, Figure 3A; D'Alessandro *et al.*, 2016, p. 4, Figure 4.

### MATERIAL EXAMINED

NHMC 61.5, 2 specimens, VAS.37; NHMC 61.6, 1 specimen, VAS.32; NHMC 61.7, 4 specimens, VAS.17; Collection of Hellenic Centre for Marine Research: VAS.24, 1 specimen complete, LT = 6.6 mm, L10: 1.05 mm, W10: 0.30 mm, 59 chaetigers; WFD3 2012, 4 specimens; WFD18 2012, 1 specimen; WFD59 2012, 3 specimen; WFD68 2012, 1 specimen; WFD41 2013, 2 specimens; WFD45 2013, 2 specimens; WFD46 2013, 2 specimens. Collection of the University of the Thessaloniki: VAS.5, 14 specimens; VAS.14, 16 specimens; VAS.31, 9 specimens; Collection of the University of Pisa: VAS.20, 9 specimens; VAS.41, 3 specimens; Reference collection of Marine & Environmental Research Lab Ltd: VAS.1, 1 specimen; VAS.2, 16 specimens; VAS.4, 9 specimens; VAS.5, 3 specimens; VAS.7, 9 specimens; VAS.8, 1 specimen; VAS.9, 1 specimen; VAS.10, 2 specimens; VAS.12, 3 specimens; VAS.14, 7 specimens; VAS.15, 1 specimen; VAS.17, 3 specimens, VAS.18, 4 specimens; VAS.20, 3 specimens; VAS.23, 4 specimens; VAS.24, 4 specimen; VAS.25 3 specimens; VAS.26, 3 specimens; VAS.29, 4 specimens; VAS.30, 27 specimens; VAS.31, 9 specimens; VAS.32, 4 specimens; VAS.33, 36 specimens; VAS.35, 1 specimen complete, LT = 11.75 mm, L10: 1.75 mm, W10: 0.44 mm, 82 chaetigers; VAS.35, 6 specimens; VAS.36, 15 specimens; VAS.37, 14 specimens; VAS.38, 14 specimens; VAS.39, 5 specimens; VAS.40, 9 specimens; VAS.41, 11 specimens; IDR SW Cages, 1 specimen; IDR SW 50 m, 8 specimens; IDR SW 100 m, 14 specimens; IDR SW 200 m, 8 specimens; BI_0 m, 1 specimen.

### COMPARATIVE MATERIAL EXAMINED

DBUA001457.02, 2 specimens, site: Barcelona, NE Spain, coordinates: 41°23′27.14″N 02°12′56.48″E, water depth: 21 m, sediment type: muddy sand.

### DESCRIPTION

Longest complete specimen had a total length of 11.75 mm with 82 chaetigers. Material examined varied in L10 from 0.27 to 2.05 mm and in W10 from 0.16 to 0.54 mm.

Prostomium conical (Figure 2A), with variable size, in terms of length and width. Prechaetal lobe smaller than acicular lobe in anterior parapodia; ovoid, as long as acicular lobe or slightly shorter after about ch. 7; and then digitiform, longer than postchaetal lobe in posterior parapodia. Postchaetal lobe auricular, longer than acicular and prechaetal lobes in anterior parapodia, as long as acicular and prechaetal lobes or slightly longer after ch. 7–10 (until at least ch. 66; only two complete individuals), then shorter than prechaetal lobe in posterior parapodia. CMHH present from ch. 1 up to 6–9, with up to 7 teeth, proximal tooth larger (Figure 3A). SMHH from ch. 7–10, with up to 7 teeth, proximal tooth larger, preacicular hook larger than postacicular hook, present from ch. 19 (Figure 3B). Dorsal limbates present from ch. 1 up to 17–22, ventral limbates from ch. 1 up to 7–9 (Figure 3A). Aciculae yellow, 3–4 in most anterior parapodia, 2 after ch. 4–7. Maxillary apparatus with four pairs of maxillae (Figure 2A), MI forceps-like, MII with 3 smooth teeth, MIII edentate (Figure 2C), MIV edentate, with white central area (Figure 2A, B). Pygidium without anal cirri (Figure 2D).

### REPRODUCTION

A mature female specimen was found in June, as seen in the Atlantic specimens (Martins *et al.*, 2012). The gametes are globular with diameter ranging from 130 μm to 144 μm. These were located on parapodium 10, the last segment of the incomplete individual (material VAS.38).

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**Table 1.** Environmental characteristics of the sampling sites.

| Country | Station code | Latitude (°N) | Longitude (°E) | Date | Depth (m) | OM (%) | TOC (%) | Substrate | EQS | Human activity |
|---|---|---|---|---|---|---|---|---|---|---|
| Greece | WFD3 | 36°48′05.47″ | 21°48′51.65″ | May 2012 | 20 | n/a | 0.43 | Sandy silt with *P. oceanica* | Good | – |
| | WFD18 | 36°48′0″ | 22°42′0″ | | 7 | n/a | 0.11 | Silty sand | Good | – |
| | WFD59 | 40°57′13.32″ | 24°31′48.72″ | | 12 | n/a | 0.82 | Sandy silt | Moderate | Industrial sewage |
| | WFD68 | 39°53′29.04″ | 25°15′3.24″ | | 12 | n/a | n/a | Muddy sand | Moderate | Agriculture drain |
| Cyprus | BI_0m | 34°41′43.20″ | 33°16′13.20″ | June 2012 | 40 | 6.41 | n/a | Sand | Moderate | Fish farm |
| Greece | WFD41 | 38°25′25.68″ | 22°25′20.64″ | March 2013 | 25 | n/a | 0.5 | Muddy sand | Moderate | Industrial sewage |
| | WFD45 | 38°34′18.84″ | 23°18′2.88″ | | 17 | n/a | 0.92 | Muddy sand | Moderate | Wastespoil disposal |
| | WFD46 | 39°19′59.88″ | 22°58′0.12″ | | 42 | n/a | 0.52 | Silty sand | Good | – |
| Cyprus | VAS.1 | 34°42′16.08′ | 33°12′51.54″ | June–July 2013 | 6 | 1.93 | n/a | Sand | High | – |
| | VAS.2 | 34°41′54.48″ | 33°14′16.8″ | | 31 | 8.42 | n/a | Muddy sand with *Caulerpa* spp. | Moderate | Fish farm |
| | VAS.4 | 34°41′33.40″ | 33°14′16.36″ | | 55 | 6.93 | n/a | Muddy sand | Good | – |
| | VAS.5 | 34°41′54.72 | 33°14′30.48″ | | 31 | 4.62 | n/a | Muddy sand with *Caulerpa* spp. | Good | – |
| | VAS.7 | 34°41′32.95″ | 33°15′15.52″ | | 58 | 5.94 | n/a | Muddy sand with *Caulerpa* spp. | Good | – |
| | VAS.8 | 34°41′51.48 | 33°16′2.34″ | | 44 | 6.43 | n/a | Muddy sand | Moderate | Fish farm |
| | VAS.9 | 34°42′16.08′ | 33°16′14.40″ | | 10 | 2.76 | n/a | Sand | Good | – |
| | VAS.10 | 34°41′33.06 | 33°16′14.73″ | | 59 | 6.25 | n/a | Muddy sand with *Caulerpa* spp. | Good | – |
| | VAS.12 | 34°41′54.48″ | 33°16′29.69″ | | 45 | 4.65 | n/a | Muddy sand with *Caulerpa* spp. | Moderate | – |
| | VAS.14 | 34°42′15.60″ | 33°16′44.50″ | | 25 | 8.18 | n/a | Muddy sand with *Caulerpa* spp. | Good | – |
| | VAS.15 | 34°43′00.00″ | 33°19′00.00″ | | 11 | 10.31 | n/a | Muddy sand | Good | Port |
| | VAS.17 | 34°42′37.18 | 33°16′58.96″ | | 12 | 2.20 | n/a | Sand | Good | – |
| | VAS.18 | 34°41′54.35″ | 33°16′59.38″ | | 51 | 5.62 | n/a | Muddy sand with *Caulerpa* spp. | Good | – |
| | VAS.20 | 34°42′15.58″ | 33°17′14.00″ | | 35 | 6.65 | n/a | Muddy sand with *Caulerpa* spp. | Moderate | – |
| | VAS.23 | 34°42′37.09″ | 33°17′28.43″ | | 19 | 5.19 | n/a | Muddy sand with *Caulerpa* spp. | Good | – |
| | VAS.24 | 34°42′59.16″ | 33°17′44.40″ | | 13 | 3.18 | n/a | Sand with *C. nodosa* | High | – |
| | VAS.25 | 34°42′59.16″ | 33°17′44.10″ | | 37 | 6.13 | n/a | Muddy sand with *Caulerpa* spp. | Moderate | – |
| | VAS.26 | 34°42′37.20″ | 33°17′58.02″ | | 23 | 6.79 | n/a | Muddy sand with *Caulerpa* spp. | Good | – |
| | VAS.29 | 34°42′58.15″ | 33°18′12.96″ | | 12 | 2.78 | n/a | Sand | Good | – |
| | VAS.30 | 34°42′14.98″ | 33°18′13.36″ | | 35 | 6.26 | n/a | Muddy sand with *Caulerpa* spp. | Moderate | – |
| | VAS.31 | 34°42′37.03″ | 33°18′27.35″ | | 22 | 7.28 | n/a | Muddy Sand | Moderate | – |
| | VAS.32 | 34°42′58.12″ | 33°18′42.12″ | | 11 | 3.06 | n/a | Sand with *C. nodosa* | High | – |
| | VAS.33 | 34°42′15.42″ | 33°18′42.30″ | | 32 | 8.85 | n/a | Muddy sand with *Caulerpa* spp. | Moderate | – |
| | VAS.35 | 34°42′38.34″ | 33°18′49.80″ | | 20 | 7.70 | n/a | Muddy sand with *P. oceanica* | Moderate | – |
| | VAS.36 | 34°41′54.27″ | 33°18′56.83″ | | 40 | 9.41 | n/a | Sand with *Caulerpa* spp. | Moderate | – |
| | VAS.37 | 34°42′57.98″ | 33°19′11.92″ | | 10 | 4.20 | n/a | Muddy sand | Moderate | Port entrance |
| | VAS.38 | 34°42′15.73″ | 33°19′11.58″ | | 28 | 8.32 | n/a | Muddy sand with *Caulerpa* spp. | Moderate | – |
| | VAS.39 | 34°41′32.70″ | 33°19′12.12″ | | 48 | 6.02 | n/a | Sand | Moderate | Fish farm |
| | VAS.40 | 34°42′36.87″ | 33°19′26.41″ | | 17 | 6.46 | n/a | Muddy sand | High | – |
| | VAS.41 | 34°41′54.24″ | 33°19′26.22″ | | 39 | 11.12 | n/a | Muddy sand with *Caulerpa* spp. | Moderate | – |
| Cyprus | IDR_SW Cages | 34°42′9.96″ | 33°17′2.52″ | August 2013 | 38 | 5.70 | n/a | Sandy mud | Poor | Fish farm |
| | IDR_SW 50 m | 34°42′12.90″ | 33°17′2.28″ | | 36 | 6.61 | n/a | Sandy mud with *Caulerpa* spp. | Moderate | – |
| | IDR_SW 100 m | 34°42′14.52″ | 33°17′2.28″ | | 34 | 7.25 | n/a | Muddy sand with *Caulerpa* spp. | Moderate | – |
| | IDR_SW 200 m | 34°42′17.87″ | 33°17′2.28″ | | 30 | 9.10 | n/a | Muddy sand with *Caulerpa* spp. | Moderate | – |

OM, organic matter (in % sediment); TOC, total organic carbon (in % sediment); EQS, ecological quality status; n/a, not available data; –, No relevant activity recorded.

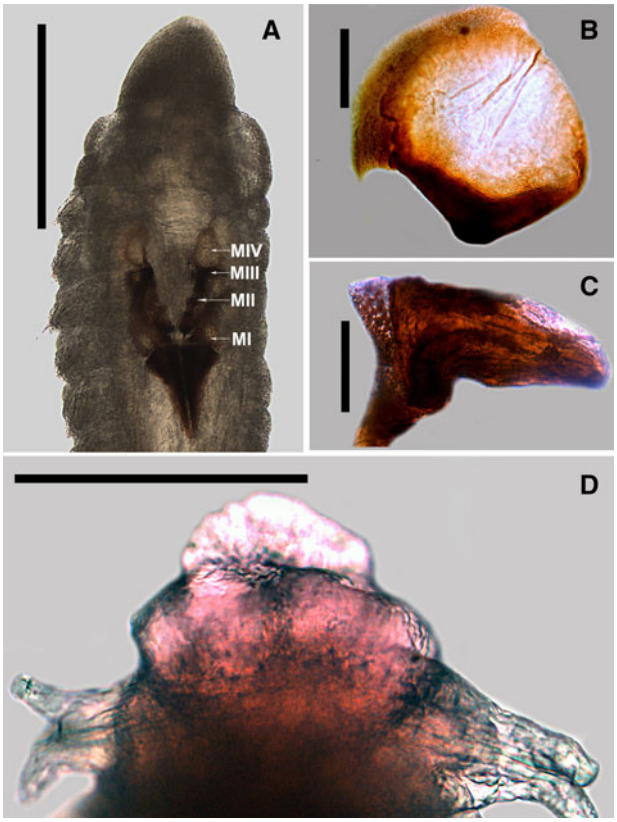


**Fig. 2.** *Gallardoneris iberica* Martins, Carrera-Parra, Quintino & Rodrigues, 2012: (A) Maxillary apparatus view without dissection (WFD3 2012); (B) MIV (BI_om 2012); (C) MIII (BI_om 2012); (D) Pygidium (VAS.32 2013). M: Maxillae. Scale bars: A, 400 μm; B–C, 50 μm; D: 300 μm.

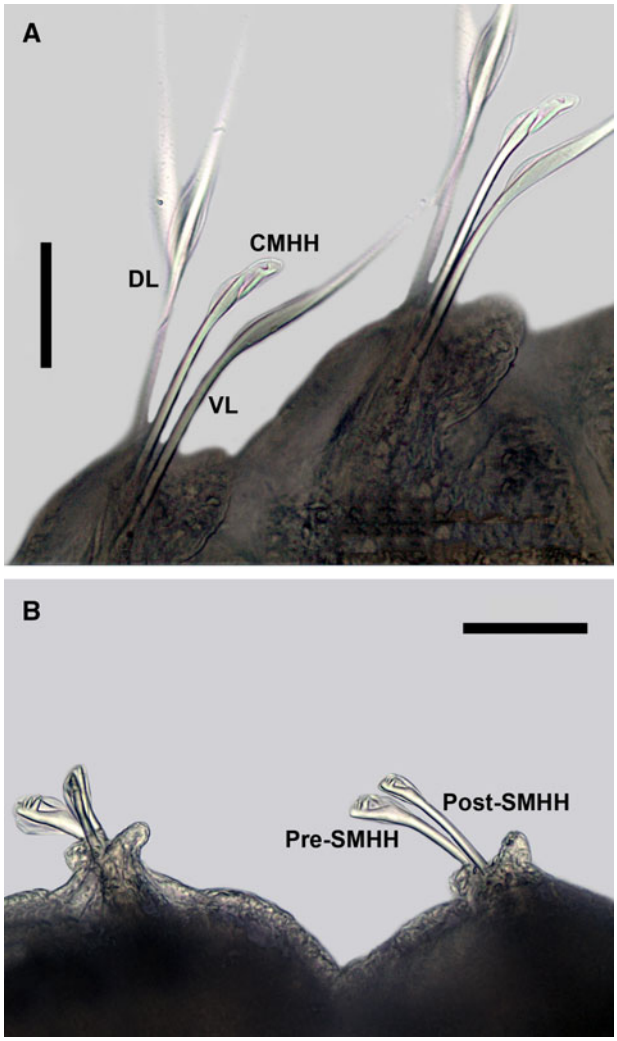


**Fig. 3.** *Gallardoneris iberica* Martins, Carrera-Parra, Quintino & Rodrigues, 2012 (WFD3 2012): (A) Dorsal limbates (DL), post-acicular composite multidentate hooded hooks (CMHH) and ventral limbates (VL) from chaetigers 3–4; (B) Pre-acicular (Pre-SMHH) and post-acicular simple multidentate hooded hooks (Post-SMHH) from chaetigers 47–48. Scale bars: A–B, 50 μm.

## REMARKS

*Gallardoneris iberica* can be mostly distinguished from other lumbrinerids in the Mediterranean Sea by the presence of MIV with whitish central area and longer pre-chaetal lobes than post-chaetal lobes in posterior segments. In addition, the absence of small antennae and the absence of limbate SMHH distinguish it from other species in the area having MIV with whitish central area or peculiar shape. Our material was similar to Adriatic material (Bertasi *et al.*, 2014) by (i) having pre-acicular SMHH larger than post-acicular SMHH after ch. 19, and (ii) having 3–4 aciculae present in anterior body and 2 in mid-body. The above characters diverged from the original description since the pre-acicular and post-acicular hooks were reported as having similar size and just 1 and 2 aciculae were found in anterior and posterior body, respectively (Martins *et al.*, 2012). However, examination of Portuguese material by Bertasi *et al.* (2014) revealed the same aciculae distribution with the Mediterranean material and the use of methyl green staining was suggested for a more accurate counting of all aciculae. Our material was different to the material from Sicily (D'Alessandro *et al.*, 2016) in having CMHH up to chaetiger 9, instead of chaetiger 11. Specimens from this study were different from *G. shinoii* in the shape and distribution of the CMHH (long hood and up to ch. 18 in the latter) and in size of pre-chaetal lobes compared with post-chaetal in posterior chaetigers (shorter in *G. shinoii*).

## DISTRIBUTION

*North-eastern Atlantic Ocean*: Portuguese continental shelf (Martins *et al.*, 2012), Huelva (Gulf of Cadiz; García Gómez *et al.*, 2016), *Mediterranean Sea*: Ebro Estuary (Gulf of Valencia; García Gómez *et al.*, 2016), Gulf of Milazzo (Southern Tyrrhenian Sea; D'Alessandro *et al.*, 2016) Gulf of Venice (Bertasi *et al.*, 2014; Mikac, 2015), Rovinj (several locations), Lim Channel, off Istrian Peninsula, Pula Harbour, Krka Estuary, Split Harbour, Jadro Estuary, Bracko-Splitski Canal, Ploce Harbour (Adriatic Sea; Mikac, 2015), Methoni (South Ionian Sea; this study), Lakonikos Gulf (this study), Itea (Korinthiakos Gulf; this study), Larymna (Evoikos Gulf; this study), Volos (Pagasitikos Gulf; this study), Kavala, Moudros (North Aegean Sea; this study), Vasilikos Bay (this study) and southern near-shore coastal area (Cyprus Basin; this study).

## ECOLOGY

A total of 338 *G. iberica* individuals were found in samples from Cyprus (323 individuals) and Greece (15 individuals). Water depth ranged from 6 to 59 m, which sets a shallower limit to the known bathymetric distribution (18 to 180 m) from the Portuguese continental shelf and the central and

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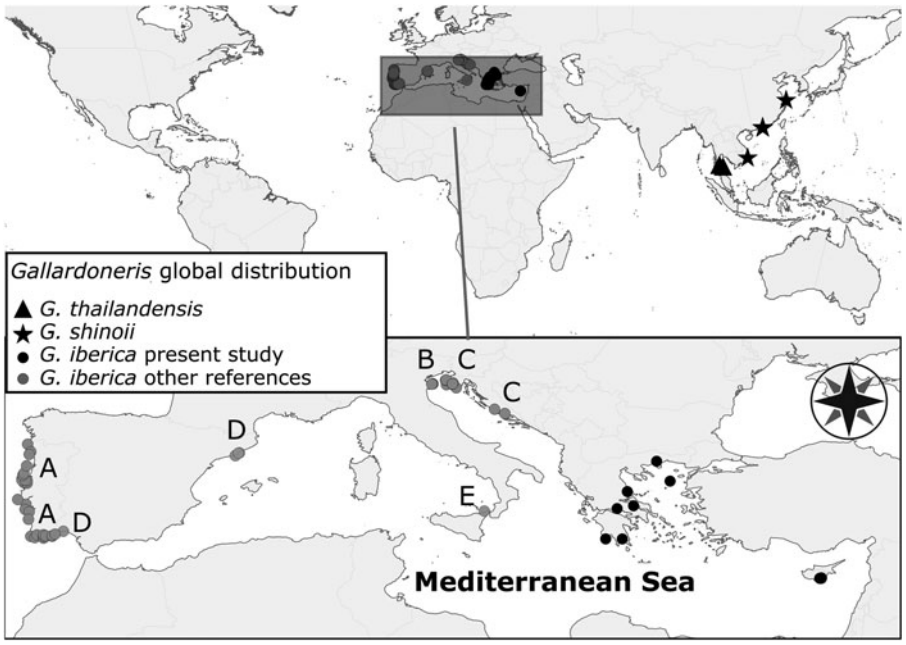


**Fig. 4.** Worldwide distribution of *Gallardoneris* species. Black dots represent the geographic distribution of *G. iberica* according to present findings, while grey dots represent previous records in European waters, according to Martins *et al.* (2012) (A), Bertasi *et al.* (2014) (B), Mikac (2015) (C), García-Gómez *et al.* (2016) (D) and D'Alessandro *et al.* (2016) (E).

western Mediterranean records. The species was mostly found in infralittoral muddy sands (62% of sites), but also finer sediments (9%) and coarser sands (12%). The above substrates were either bare, or in association with *Caulerpa* spp. (*C. prolifera* (Forsskal) Lamouroux, 1809 and *C. cylindracea* Sonder, 1845). Other recorded habitats were beds of *Cymodocea nodosa* (Ucria) Ascherson, 1870, or *Posidonia oceanica* (Linnaeus) Delile, 1813 (10%) and circalittoral detritic bottoms (7%). Sites showed a variable amount of organic matter, namely 0.11–0.92% TOC in Greece and from 1.93–11.12% OM in Cyprus.

The relative contribution of *G. iberica* to the total macrofauna abundance in each sampling site was always lower than 2%. The mean density of the species was higher in substrates with *Caulerpa* spp. (39.1 $m^{-2}$), co-occurring with the following dominating species: *Melinna palmata* Grube, 1870, *Aphelochaeta filiformis* (Keferstein, 1862), *Notomastus* spp. and *Cirrophorus* sp. In seagrass beds, the mean density was 19.1 $m^{-2}$ and the dominating species were *Pseudoleiocapitella fauveli* Harmelin, 1964, *Notomastus* spp., *Hilbigneris gracilis* (Ehlers, 1868) and *Abra* spp. In infralittoral bare sediments, the mean abundance was 18.9 $m^{-2}$ and dominating species were *A. filiformis*, *M. palmata*, *H. gracilis*, *P. fauveli* and *Abra* spp. In detritic bottoms the mean abundance was 18.1 $m^{-2}$ and the dominant species were *A. filiformis*, *Protodorvillea kefersteini* (McIntosh, 1869), *Aponuphis brementi* (Fauvel, 1916) and *Notomastus* spp.

The species was mostly recorded in sampling sites with 'Moderate' ecological status, although it was also found in 'Poor', 'Good' and 'High' status sites. *Gallardoneris iberica* was also found close to industrial waste disposal locations in Greece and under open-sea fish farms in Cyprus, as well as in undisturbed sites. The species sensitivity value has been estimated to be 19.54 (see discussion below).

## DISCUSSION

The present study revealed a wide distribution of *Gallardoneris iberica* in the Eastern Mediterranean (seven sites scattered around Greek coasts; 35 in Cyprus basin; Figure 1), extending its range of distribution across the Mediterranean (Figure 4). The oldest specimens of the material in the present study were collected in 2012. However, the original description was based on material collected during 2007 and 2008 (Martins *et al.*, 2012); the oldest Adriatic material, which was later re-identified, was also collected in the same period (Bertasi *et al.*, 2014; Mikac, 2015). Therefore, a recent introduction in the area is improbable and its presence so far must have been overlooked since this species was recently described and the genus was recently erected (Carrera-Parra, 2006a).

The problem of past misidentifications of Lumbrineridae in the region had already been stressed by Papadopoulou *et al.* (1994), due to difficulties in the dissection and the observation of maxillary morphology in all specimens. *Gallardoneris iberica* specimens are small (0.16–0.54 mm W10) which indeed leads to difficulties in dissection. In addition, confusing and overlapping jaw descriptions can be found in past keys. Table 2 summarizes comparisons of the external and the basic jaw features between *G. iberica* and the most common lumbrinerids in the East Mediterranean (*Lumbrineris* spp. and *Hilbigneris gracilis*). It is probable that *G. iberica* was confused in the past with one of these species, since it shares several similar external features, especially with *Lumbrinereis nonatoi* Ramos, 1976, as Bertasi *et al.* (2014) suggested. *Lumbrineris nonatoi* was not recorded in the samples of the present study. However, the latter is the only species that has the same number of teeth in MII and prechaetal lobe longer than postchaetal in posterior body, a character highlighted in the original description of the species (Ramos, 1976). *Lumbrineris nonatoi* has been previously recorded both

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**Table 2.** Comparison of characters among species possibly confused with *G. iberica* in East Mediterranean.

| | *Gallardoneris iberica*[1] | *Lumbrineris nonatoi*[2] | *Lumbrineris latreilli*[2] | *Lumbrineris coccinea*[2] | *Lumbrineris perkinsi*[2] | *Lumbrineris geldiayi*[3] | *Hilbigneris gracilis*[4] |
|---|---|---|---|---|---|---|---|
| Prostomium | Variable | As long as wide | Slightly longer than wide | Shorter than wide | As long as wide | Slightly longer than wide | Longer than wide |
| L10 (mm) | 0.27–2.05 | 1.3–2.7 | 3.7–7.7 | 3.0–6.5 | 0.8–2.8 | 1.2–1.5 | 7.3 |
| W10 (mm) | 0.16–0.54 | 0.3–0.9 | 1.3–2.7 | 1.3–1.8 | 0.3–0.9 | 0.3–0.5 | 2.6 |
| CMHH blade size* | Short | Short | Long | Short | Short | Short | Long |
| CMHH teeth (number) | Up to 7 | Up to 5 | Up to 7 | Up to 5 | Up to 6 | Up to 7 | Up to 9 |
| CMHH teeth (sizes) | Proximal bigger | Similar | Proximal bigger | Similar | Similar | Proximal bigger | Similar |
| SMHH first chaetiger | 7–10 | 7–20 | 19–25 | 17–21 | 6–17 | 9–11 | 21 |
| SMHH teeth (number) | Up to 7 | Up to 6 | Up to 10 | Up to 7 | Up to 10 | Up to 7 | Up to 9 |
| Preacicular SMHH (size)† | Twice | Same | Same | Twice | Same | Twice | Same |
| Anterior Prechaetal Lobe (shape) | Ovoid | Elongated | Rounded | Rounded | Rounded | Rounded | Rounded |
| Anterior Postchaetal Lobe (shape) | Auricular | Digitiform | Digitiform, wide basally | Digitiform | Digitiform, elongated | Digitiform, wide basally | Digitiform |
| Posterior Prechaetal Lobe (size)‡ | Longer | Longer | Shorter | Shorter | Shorter | Shorter | Shorter |
| Posterior Postchaetal Lobe (shape) | Digitiform | Digitiform | Digitiform | Digitiform | Digitiform, elongated | Digitiform | Conical |
| Aciculae (colour) | Yellow | Yellow | Yellow, red tips | Yellow | Yellow | Reddish | Yellow, reddish |
| Anterior Aciculae (number) | Up to 4 | Up to 3 | Up to 3 | Up to 3 | Up to 3 | Up to 3 | Up to 5 |
| MII (left + right) | 3 + 3 | 3 + 3 | 4 + 4 | 5 + 6 | 5 + 5 | 4 + 4 | 3 + 5 |
| MIII | Edentate | Unidentate | Bidentate | Bidentate | 4 teeth | Unidentate | Unidentate |
| MIV | Edentate, white central area | Unidentate | Unidentate, prominent tooth | Unidentate | Bidentate, distal longer | Unidentate, prominent tooth | Unidentate, prominent tooth |
| MV | Absent | Present | Present | Present | Present | Present | Present |

Data were based on the following references 1: Present study; 2: Carrera-Parra (2006b); 3: Carrera-Parra *et al.* (2011); 4: Carrera-Parra (2006a).
*Carrera-Parra (2006b) has defined the proportions of this subjective character: short as ~5 times longer than wide; long as ~11 times longer than wide.
†Compared to post-acicular SMHH.
‡Compared to post-chaetal lobe.

in the northern Aegean Sea and in Crete (Simboura & Nicolaidou, 2001). Additionally, both species share similar ecological preferences, namely bathymetry (10–190 m in the case of *L. nonatoi*; Karakassis, 1991; Papadopoulou *et al.*, 1994), habitat preferences (Karakassis, 1991; Dounas & Koukouras, 1992; Tselepides, 1992; Papadopoulou *et al.*, 1994; Labrune *et al.*, 2007; Mikac, 2015) and tolerance to contaminants and organic carbon (e.g. Karakassis, 1991; Ros & Cardell, 1992). *Lumbrineris nonatoi* is reported to have occasionally high and dominating abundances (e.g. Karakassis, 1991; Tselepides, 1992; Papadopoulou *et al.*, 1994), which is not the case for *G. iberica*.

Habitat preferences of *G. iberica* seem to follow a similar pattern in all Atlantic and Mediterranean records, which mainly include finer sediments with biogenic detritus and organic matter (Martins *et al.*, 2012; Bertasi *et al.*, 2014; D'Alessandro *et al.*, 2016; García Gómez *et al.*, 2016), coastal terrigenous muds (Bertasi *et al.*, 2014; García Gómez *et al.*, 2016), mixed sediments and sands (Mikac, 2015), but also coastal estuaries (during summer; Mikac, 2015; García Gómez *et al.*, 2016). Its presence in harbours (Rovinj, Pula, Split and Ploce, Mikac, 2015; nearby Milazzo, D'Alessandro *et al.*, 2016), close to wastewater outfalls (Mikac, 2015) and oil refining docking platforms was also confirmed (D'Alessandro *et al.*, 2016).

According to Leonardsson *et al.* (2009), the Hurlbert's diversity index $ES_{50}$ per site can be used to estimate the sensitivity value of a given species which is inversely proportional to disturbance. Based on this methodology, the sensitivity value of *G. iberica* was estimated to be 19.54 which may be related to the fact that the species was found in a wide variety of environmental quality levels (Poor, Moderate, Good and High ecological status). This value agrees with the sensitivity of Lumbrineridae species from the eastern Mediterranean Sea where values range between 7.22 and 31.11 (Dimitriou *et al.*, 2012; Supplementary Material). The above value for *G. iberica* is similar to the values of *Lumbrineriopsis paradoxa* (Saint-Joseph, 1888) (19.82), *Scoletoma funchalensis* (Kinberg, 1865) (19.38) and *L. nonatoi* (18.38). It is important to note that the sensitivity value is highly variable with a small number of samples and extensive datasets are required for a reliable classification of a given species to a tolerance group (Leonardsson *et al.*, 2009). Therefore, the present value is merely indicative and could be modified with increasing sampling effort.

The geographic distribution of the three valid species of genus *Gallardoneris* is depicted in Figure 4. As far as it is documented, *G. iberica* is the most widespread species of the genus. *Gallardoneris thailandensis* is only known from Thailand (Carrera-Parra, 2006a) while *Gallardoneris shinoii* is recognized in Nha Trang, Vietnam (Gallardo, 1968; Carrera-Parra, 2006a), Hong Kong (Shin, 1977; as *Lumbrineris shinoii*) and Shanghai (Shou *et al.*, 2013; from synonym); being among the most dominant species in West Hong Kong (Shin & Thompson, 1982; from synonym). While there is very little information available about the ecological characteristics of *G. thailandensis*, the tolerance to disturbance of *G. shinoii* is demonstrated from several sources. The latter was present in natural disturbance (Shin, 1989), in high sedimentation rate in the Yangtze River estuary (Shou *et al.*, 2013), in the harbour of Tolo (Shin, 1982) and intermediate sites (100 m distance) to fish farms at Kau Sai Bay (Gao *et al.*, 2008). However, *G. shinoii* was also present in undisturbed sites of muddy bottoms, relatively low in organic carbon (Shin, 1989; Gao *et al.*, 2005). It should also be highlighted that the most recent record of a single individual named as *Gallardoneris* sp. (Langeneck *et al.*, 2017) was found in a deep-sea muddy environment at 1800 m water depth (Baldrighi *et al.*, 2013).

### KEY TO SPECIES OF GALLARDONERIS

1. Posterior parapodia with prechaetal and postchaetal lobes of similar size; CMHH with long hood . . . *G. shinoii*
   - Posterior parapodia with prechaetal lobes longer than postchaetal lobes; CMHH with short hood . . . 2
2 Anterior parapodia with prechaetal lobe ovoid, no digitiform extension at the dorsal end; CMHH present up to chaetiger 9. . . *G. iberica*
   - Anterior parapodia with prechaetal lobe rounded, with digitiform extension at the dorsal end; CHMM present up to chaetiger 16 . . . *G. thailandensis*

Note: this key does not include the most recent record of *Gallardoneris* sp. due to the absence of taxonomic details of this individual.

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