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A new species of the genus *Lightiella*: the first record of Cephalocarida (Crustacea) in Europe

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A new species of Cephalocarida belonging to the genus *Lightiella* is described. Like all known species of *Lightiella*, the new species is characterized by reduction of trunk segment 8, which also lacks both pleura and thoracopods. The diagnostic characters of the species are: (1) one seta on the inner distal corner of the penultimate endopodal segment of second maxilla and thoracopods 1–5; (2) only one claw on the distal segment of the endopod of thoracopod 6. A cladistic analysis of 27 morphological characters was used to estimate the phylogeny of all species of *Lightiella*, with all other cephalocarid species used as outgroups. The discovery of this species in the Mediterranean fills a gap in the distribution of the genus and of the entire class. © 2006 The Linnean Society of London, *Zoological Journal of the Linnean Society*, 2006, **148**, 209–220.

ADDITIONAL KEYWORDS: cladistic analysis – Mediterranean – thoracopod morphology – systematics.

INTRODUCTION

Since their first description (Sanders, 1955), Cephalocarida have been considered the most primitive living crustaceans (Sanders, 1963; Hessler, 1964, 1984, 1992; Hessler & Newman, 1975; Hessler & Elofsson, 1992). Together with a specialization in their reproductive biology (they are simultaneous hermaphrodites with probable self-fertilization), Cephalocarida seem to preserve several features of their external morphology and development which are similar to those of the hypothetical ancestral crustacean. These features are: (1) postantennal cephalic limbs and trunk segments all bearing series of very similar limbs; (2) very gradual development to the adult stage, not differing greatly from the larva. Despite their phylogenetic importance, Cephalocarida remain a poorly known group, with most of the morphological and molecular data regarding only one species, *Hutchinsoniella macracantha* Sanders, 1955 (Sanders, 1957, 1963; Hessler, 1964, 1992; Brown & Metz, 1967; Hessler, Hessler & Sanders, 1970; Hessler & Newman, 1975; Elofsson & Hessler, 1990, 1991, 1992; Elofsson, Hessler & Hessler, 1992; Hessler & Elofsson, 1992; Read, Hessler & Govind, 1994; Hessler, Elofsson & Hessler, 1995; Spears & Abele, 1999; Regier & Shultz, 2001; Richter, 2002; Lavrov, Brown & Boore, 2004).

At present, Cephalocarida is one of the least speciose of the crustacean classes. Only ten species, belonging to five genera, have hitherto been reported from North and South America (Sanders, 1955; Jones, 1961; Gooding, 1963; Sanders & Hessler, 1964; Wakabara, 1970; Hessler & Sanders, 1973; McLaughlin, 1976; Saloman, 1978; Stoner, 1981; Heard & Goeke, 1982; De Troch, Fiers & Vincx, 2000; Hessler & Wakabara, 2000; Schiemer & Ott, 2001; Martin, Cadien & Zimmerman, 2002), Africa (Hessler & Sanders, 1973), Japan (Shiino, 1965), New Zealand (Knox & Fenwick, 1977) and New Caledonia (Cals & Delamare Deboutteville, 1970), occurring from the intertidal to a depth of about 1550 m. No species have been reported thus far from Europe.

All the described genera are so similar in general morphology that only one family seems to be justified. However, the genus *Lightiella* Jones, 1961 differs from the others in the reduction of trunk segment 8, which

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also lacks thoracopods. Most records of *Lightiella* are known for the Gulf of Mexico and Caribbean (Gooding, 1963; Sanders & Hessler, 1964; McLaughlin, 1976; Saloman, 1978; Stoner, 1981; Heard & Goeke, 1982; De Troch *et al*., 2000; Schiemer & Ott, 2001; Martin *et al*., 2002). Only three additional records of this genus are known for San Francisco Bay, California (Jones, 1961), Biscayne Bay, Florida (Hessler & Sanders, 1973) and Saint Vincent Bay, New Caledonia (Cals & Delamare Deboutteville, 1970). Moreover, it is the most speciose of the cephalocarid genera, with four species: *L. serendipita* Jones, 1961, *L. incisa* Gooding, 1963, *L. floridana* McLaughlin, 1976 and *L. monniotae* Cals & Delamare Deboutteville, 1970.

In the present paper, we describe a new species of the genus *Lightiella*, which represents the eleventh cephalocarid species to be recognized and the first species known from Europe. In addition, to estimate the phylogeny of all species of *Lightiella*, including the new one described here, we use a cladistic analysis of 27 morphological characters, with all other cephalocarid species used as outgroups.

MATERIAL AND METHODS

Samples

Specimens were collected at 15–20 m depth from a muddy sand bottom, rich in organic material mostly consisting of leaf fragments of *Posidonia oceanica*, on the southern shore of the isle of S. Stefano, part of the La Maddalena Archipelago. Three samplings were carried out by hand using SCUBA in October 1999, July 2004, and October 2004, respectively. Twenty-eight specimens (13 adults and 15 larvae) were found.

Four adults were prepared and mounted for light and scanning electron microscopic (SEM) analyses.

Light microscopy

Two specimens were dissected to isolate the cephalic and trunk appendages. Each appendage was mounted on a separate slide using Aquamount medium.

Scanning electron microscope (SEM)

Two samples were fixed in formalin 4%, dehydrated in a graded ethanol series, dried in a Polaron Jumbo critical-point drier, sputter-coated with gold in an Edwards SI5A unit and observed with a ZEISS DMS 962 scanning electron microscope of the Electron Microscopy Center, Sassari University.

Cladistic analysis

The analysis was based on 11 taxa and 27 morphological characters with 70 character states. As ingroup, we used the five *Lightiella* species known at present (including the new species): *L. serendipita*, *L. incisa*, *L. floridana*, *L. monniotae*, and *L. magdalenina* sp. nov. All other cephalocarid species were used as outgroups: *Hutchinsoniella macracantha*, *Chiltoniella elongata*, three species of the genus *Sandersiella*, *S. acuminata*, *S. calmani*, and *S. bathyalis*, and *Hampsonellus brasiliensis*.

Character coding was based on the original descriptions and figures reported in: Sanders (1957) for *Hutchinsoniella macracantha*; Jones (1961) for *L. serendipita*; Gooding (1963) for *L. incisa*; Shiino (1965) for *S. acuminata*; Hessler & Sanders (1973) for *S. calmani* and *S. bathyalis*; McLaughlin (1976) for *L. floridana*; Knox & Fenwick (1977) for *C. elongata*; Cals & Delamare Deboutteville (1970) for *L. monniotae*; Hessler & Wakabara (2000) for *Hampsonellus brasiliensis*.

Characters and character states (shown in bold) were (Table 1):

1. Thoracic segment 8, pleura: present (**0**); reduced to a spinose process (**1**); absent (**2**).
2. Thoracic segment 8, limbs: present (**0**); absent (**1**).
3. Abdominal segments, pleura: prominent but smaller than those of segments 1–7 (**0**); small but distinct (**1**); reduced to a spinose process (**2**).
4. First antenna, knoblike structure on the second segment: present and jointed (**0**); present and unjointed (**1**); absent (**2**); unknown (**?**).
5. Second antenna, knoblike structure on the second protopod segment: present and setose (**0**); present and naked (**1**); absent (**2**).
6. First antenna, length ratio formula of 4th- 5th segments: 1 : 1 (**0**); 1 : 2 (**1**); 2 : 3 (**2**); unknown (**?**).
7. First antenna, length ratio formula of 3rd- 6th segments: 5 : 10 (**0**); 5 : 4 (**1**); 1 : 1 (**2**); 2 : 3 (**3**); unknown (**?**).
8. Labrum, shape: anteriorly and posteriorly pointed (**0**); pointed only posteriorly (**1**); both anteriorly and posteriorly rounded (**2**); unknown (**?**).
9. Mandible, incisor process: one tooth (**0**); two teeth (**1**); unknown (**?**).
10. First maxilla, endopod: 3-segmented (**0**); 4-segmented (**1**); unknown (**?**).
11. First maxilla, setae on the endopod distal segment: 4 (**0**); 3 (**1**); unknown (**?**).
12. First maxilla, gnathobase: jointed (**0**); unjointed (**1**).
13. First maxilla, setae on the gnathobase: 5 (**0**); 4 (**1**); 3 (**2**); 2 (**3**).
14. First maxilla, setae on the exopod: 14 (**0**); 11 (**1**); 9 (**2**); 8 (**3**); 7 (**4**).
15. Second maxilla, endopodal segments: 6 (**0**); 5 (**1**).
16. Second maxilla, number of claws on the endopod distal segment: 4 (**0**); 3 (**1**).

17. Second maxilla, setae on the epipod: 6–10 (**0**); 5 (**1**); 4 (**2**).
18. Thoracopods 1–4, number of claws on the endopod distal segment: 4 (**0**); 3 (**1**).
19. Thoracopod 5, number of claws on the endopod distal segment: 4 (**0**); 3 (**1**).
20. Thoracopod 6, number of claws on the endopod distal segment: 3 (**0**); 2 (**1**); 1 (**2**).
21. Thoracopod 7, number of claws on the endopod distal segment: 1 (**0**); 2 (**1**).
22. Thoracopods 1–5, setae on the epipod: 6–10 (**0**); 5 (**1**); 4 (**2**).
23. Thoracopod 6, exopod: unmodified (**0**); strongly modified (**1**).
24. Second maxilla and thoracopods 1–5, small seta on the inner distal corner of the penultimate endopodal segment: present (**0**); absent (**1**).
25. Second maxilla and thoracopods 1–7, number of spines or short setae between the long setae on the last segment of exopod: one (**0**); more than one (**1**).
26. Penultimate abdominal segment, ventral comb: present (**0**); absent (**1**).
27. Telson, spinose processes on the dorsal caudal margin: present (**0**); absent (**1**).

The data matrix was edited in MacClade (Maddison & Maddison, 1992) and the parsimony analysis was performed in PAUP (Swofford, 1993). An exhaustive search (with collapse option in effect) was applied and all minimal trees were retained. Clade support was assessed by bootstrap and jack-knife (1000 replicates).

RESULTS

FAMILY HUTCHINSONIELLIDAE SANDERS, 1955
GENUS *LIGHTIELLA* JONES, 1961
***LIGHTIELLA MAGDALENINA* SP. NOV.** (FIGS 1–5)

Holotype: One adult kept in ethanol, October 1999, S. Stefano isle, La Maddalena Archipelago, deposited in the Swedish Natural History Museum, Stockholm (SNMH) (accession number: SMNH Type 6141).

Type locality: Italy, Sardinia, S. Stefano isle, La Maddalena Archipelago, water depth 14 m, very fine muddy sand with shells and organic material (mostly leaves of *Posidonia oceanica*).

Paratypes: Serial slides of cephalic appendages, trunk appendages and telson of 1 adult, October, 1999, from the type locality, deposited in the Swedish Natural History Museum, Stockholm (SMNH) (accession numbers: SMNH Type 6142).

Serial slides of cephalic appendages, trunk appendages and telson of 1 adult, October, 1999 (accession numbers DIZABceph1.1); 1 whole gold-coated adult, mounted on a stub for SEM observation and 1 dissected gold-coated adult mounted on two stubs, July, 2004 (accession numbers DIZABceph1.2); 9 adults (accession numbers DIZABceph1.3) and 15 larvae (accession numbers DIZABceph1.4) kept in an aqueous solution of 4% formalin, July and October, 2004. All these specimens are deposited in the zoological collection of the Department of Zoology and Biological Anthropology (DIZAB), Sassari University.

Etymology: The species is named after the locality where it was collected: La Maddalena Archipelago (from lat. 'Magdalena').

Diagnosis: This species is distinguished from congenerics on the basis of the following characters: (1) one small seta on the inner distal corner of the penultimate endopodal segment of second maxilla and thoracopods 1–5; (2) only one claw on the distal segment of the endopod of thoracopod 6.

Description

Adult (body length up to 2.6 mm) (Fig. 1A–D). Holotype. Trunk 20-segmented (including telson) and 5 times as long as cephalon. Trunk segments 1–7 with terga produced latero-ventrally forming well developed and overlapping pleura with rounded free edges (Fig. 1A). Trunk segment 8 reduced and without pleura and legs (Fig. 1B). Trunk segment 9 with highly modified legs (see detailed description below) and tergum with lateral spines (Fig. 1B). Trunk segments 10–19 without legs, and with pleura developed into strong spinose processes (Fig. 1A). Telson bearing two caudal rami, and characterized by a ventral comb of strong teeth and with two well developed dorsal spines with rounded edges (Figs 1A, C, D). Caudal rami equalling the width of telson and bearing one or two short, and two long, terminal setae (Fig. 1A).

First antenna: (Fig. 2A). 6-segmented. Length ratio formula of 3rd–6th segments: 3-1-2-3. Setal formula (from base to tip); 0; 2; 4; 0; 0; 7 + 1 aesthete.

Second antenna: (Fig. 2B). Protopod 2-segmented. Endopod 2-segmented with 2 setae on the distal margin of the first segment and three setae and two spines on the second segment. Exopod 19-segmented with setal formula: 2; 2; ?; ?; 0; 1; 1; 2; 0; 1; 1; 1; 1; 2; 1; 1; 1; 1; 4.

Labrum: (Fig. 2C–E). Large, broadly rounded anteriorly, acutely triangular posteriorly. Postero-ventral surface with thin setae randomly distributed.

Mandible: (Figs 3A, B). Without palp. Incisor processes bearing two teeth with one small seta in between. The molar processes with numerous small teeth.

First Maxilla: (Figs 2C, 3C–F). Biramous. Protopod with an elongate and unsegmented gnathobase bear-

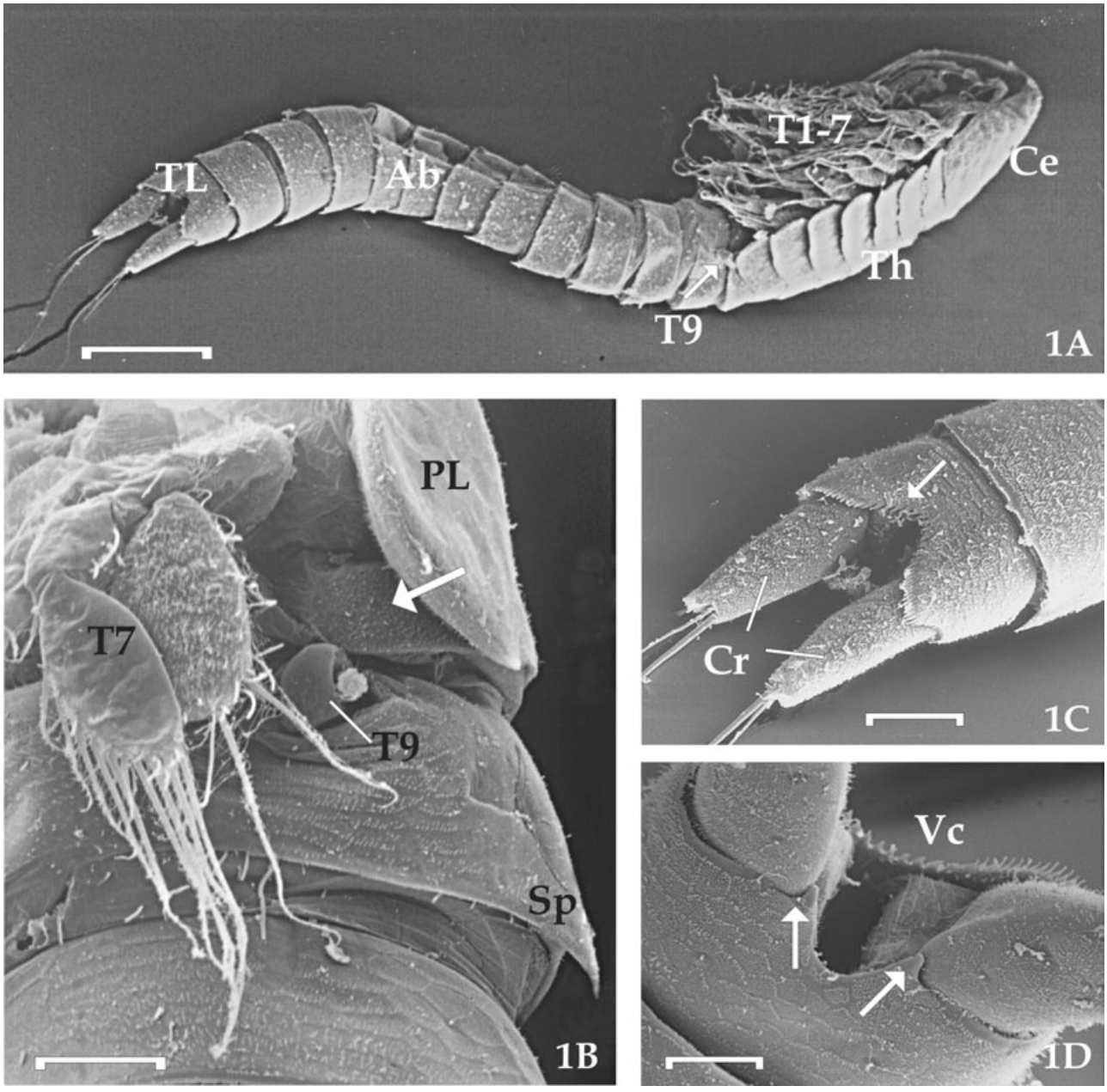

Figure 1. Scanning electron micrographs of ***Lightiella magdalenina* sp. nov.** A, ventral view of an adult showing the horseshoe shaped cephalon (Ce), 9-segmented thorax (Th) with thoracopods 1–7 (T1-7) and reduced thoracopod 9 (T9), 11-segmented abdomen (Ab), including telson (TL). Scale bar = 300 μm. B, high magnification of segments 7–9 showing: segment 7 with pleura (PL) and limb (T7); segment 8 reduced and lacking pleura and limb (arrow); segment 9 with tergum reduced to a spine (Sp) and limb highly modified (T9). Scale bar = 14 μm. C, ventral view of the last portion of the abdomen showing the ventral comb on the telson (arrow) and caudal rami (Cr). Scale bar = 90 μm. D, dorsal view of telson characterized by two spinose processes with rounded edges (arrows); ventral comb (Vc). Scale bar = 10 μm.

ing three indented spines and two plumose setae (Fig. 3E–F). Endopod 3-segmented. Each segment bears a small seta on its inner corner. In addition to this small seta, the last segment bears two other setae which are long and plumose (Fig. 3C, D) (for setal formula see Table 2). Exopod with 7/8 marginal plumose setae (Fig. 3C).

Second maxilla and thoracopods 1–5: (Fig. 4A–D). Biramous, with about the same length and morphol-

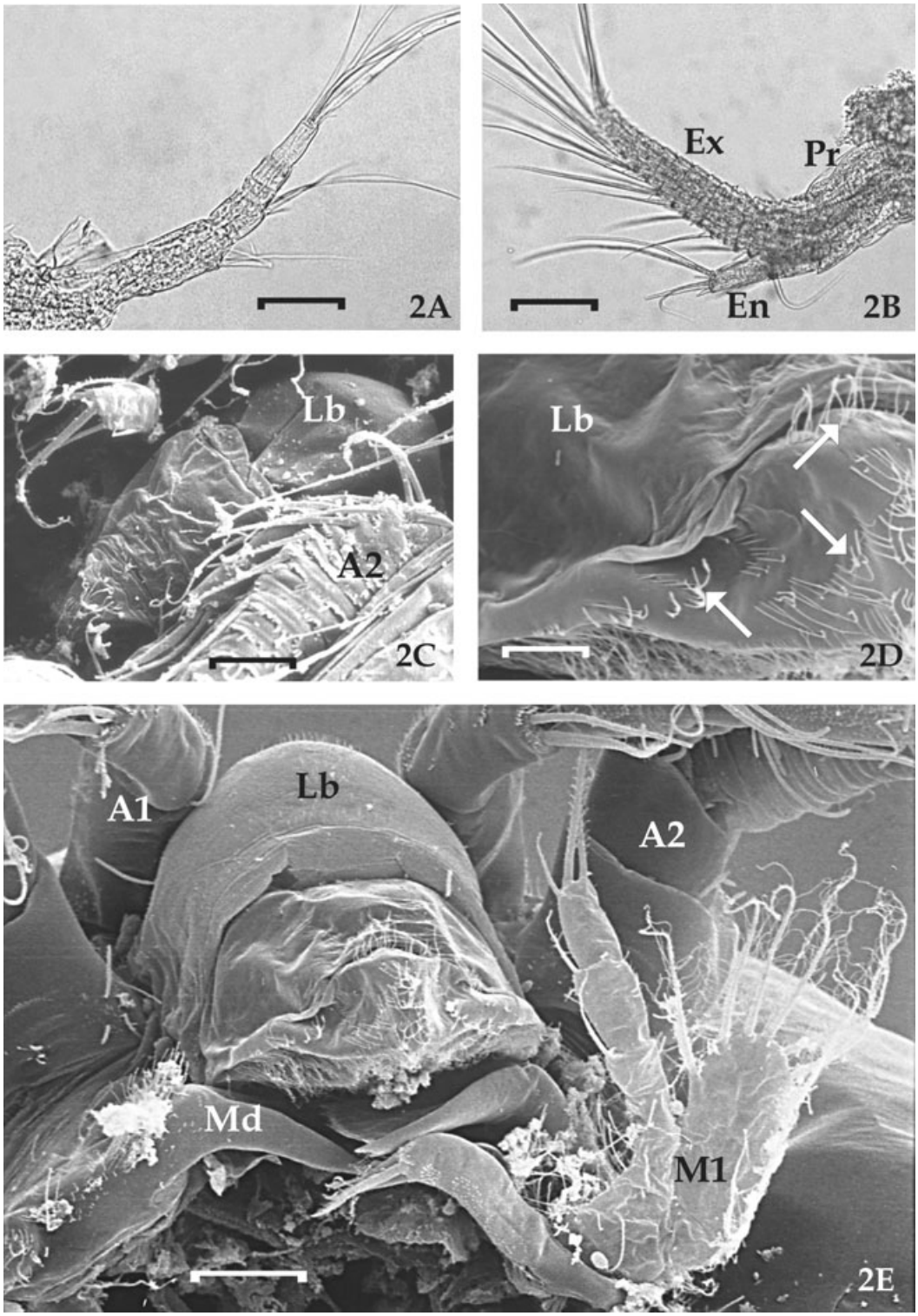

Figure 2. Light and scanning electron micrographs of first and second antennae and labrum of ***Lightiella magdalenina* sp. nov.** A, 6-segmented first antenna. Scale bar = 70 μm. B, second antenna with 2-segmented protopod (Pr), 2-segmented endopod (En) and 19-segmented exopod (Ex). Scale bar = 80 μm. C, ventral view of labrum (Lb), which appears rounded anteriorly and acutely triangular posteriorly; second antenna (A2). Scale bar = 45 μm. D, detail of the postero-ventral surface of labrum (Lb) covered by thin setae randomly distributed (arrows). Scale bar = 3 μm. E, posterior view of cephalon separated by the remaining part of the body at the level of the second maxilla. First antenna (A1), second antenna (A2), labrum (Lb), unsegmented mandible (Md), first maxilla (M1). Scale bar = 10 μm.

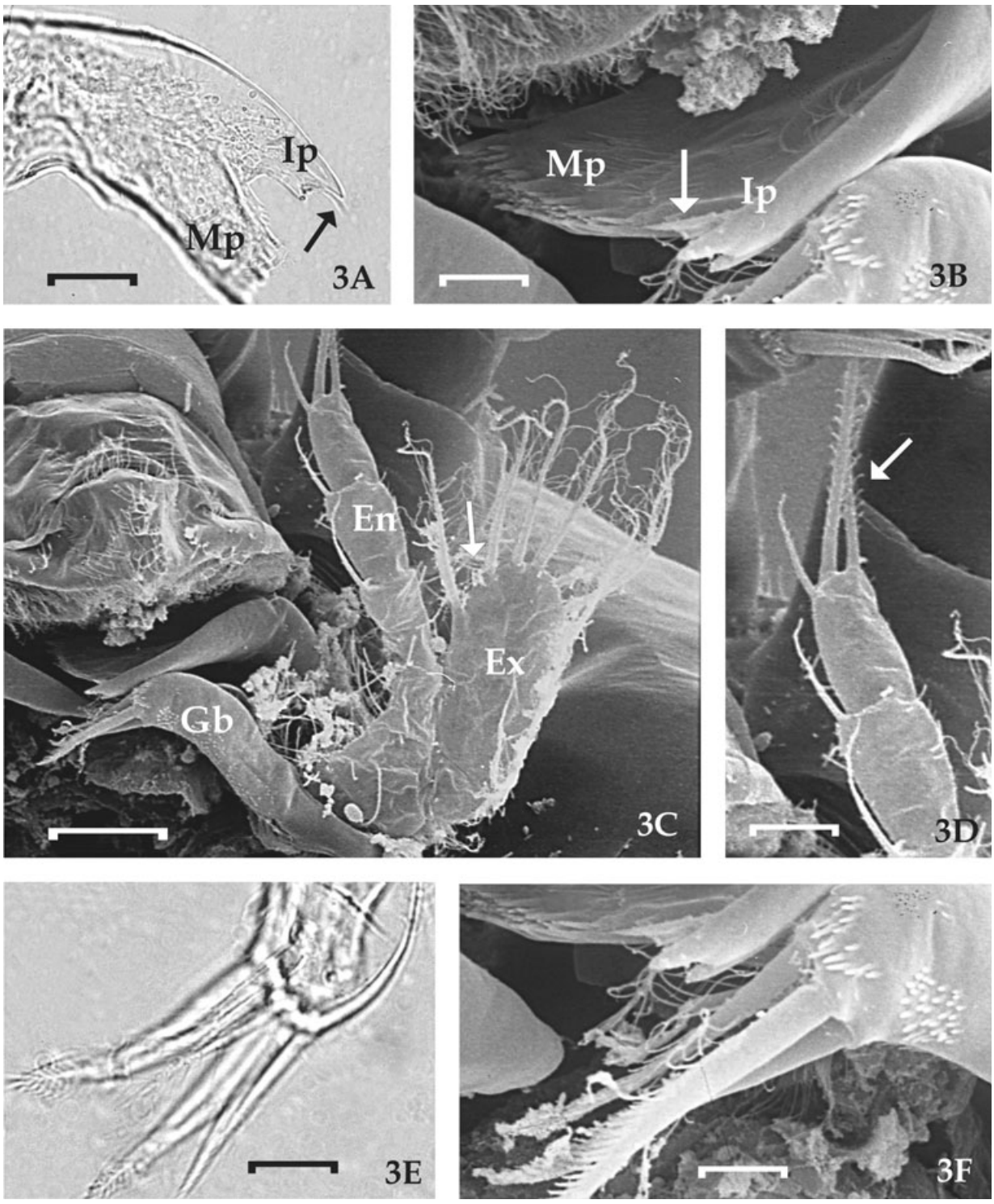

Figure 3. Light and scanning electron micrographs of mandible and first maxilla of ***Lightiella magdalenina* sp. nov.** A, B, mandible with incisor process (Ip) bearing two teeth with one small seta in between (arrow) and molar process (Mp) with numerous small teeth. Scale bars: A, 35 μm; B, 2 μm. C, first maxilla with unsegmented protopodal gnathobase (Gb), 3-segmented endopod (En) and unsegmented exopod (Ex). Exopod bears 8 long plumose setae, one of which is broken (arrow). Scale bar = 10 μm. D, detail of the endopod showing the small seta on the inner corner of each segment and the two longer plumose setae of the last segment (arrow). Scale bar = 5 μm. E, F, detail of gnathobase bearing three indented spines and two plumose seta. Scale bars: E, 10 μm; F, 2 μm.

Table 1. Character matrix for all described cephalocarid species. Question mark denotes unknown character state

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Hutchinsoniella macracantha	0	0	1	0	0	2	0	0	0	1	0	0	1	2	0	1	1	1	1	0	1	1	0	0	1	0	1
Sandersiella acuminata	0	0	0	1	2	?	?	2	0	1	0	1	1	2	0	1	1	1	1	1	1	1	1	0	1	0	1
Sandersiella calmani	0	0	0	?	2	?	?	2	?	1	0	1	1	2	0	1	0	1	1	1	1	0	1	0	1	0	1
Sandersiella bathyalis	0	0	0	?	2	?	?	2	?	1	0	1	1	0	0	1	0	1	1	1	1	0	1	0	1	0	1
Hampsonellus brasiliensis	0	0	0	2	2	?	?	2	0	0	0	1	2	1	1	1	0	1	1	1	0	0	1	0	1	0	1
Chiltoniella elongata	0	0	0	0	1	0	3	?	?	1	1	1	3	2	1	1	1	0	1	1	1	1	0	0	1	0	1
Lightiella serendipita	2	1	2	2	2	1	2	2	0	?	?	0	2	4	1	1	2	0	1	0	0	2	0	1	0	1	1
Lightiella incisa	2	1	2	2	2	2	1	1	0	0	0	1	1	3	1	0	1	0	1	1	0	1	0	1	0	1	0
Lightiella monniotae	1	1	2	2	2	1/2	1	1	1	0	1	1	0	4	1	0	1	0	1	1	0	1	0	1	0	1	0
Lightiella floridana	1	1	2	2	2	0	2	1	1	0	1	1	1	3	1	0	1	0	1	1	0	1	0	1	0	1	0
***Lightiella magdalenina* sp. nov.**	2	1	2	2	2	1	2	1	1	0	1	1	0	3	1	0	2	0	0	2	0	2	0	0	0	1	0

Table 2. Setae, claws and number of protopodal endites on adult limbs. Claws (roman numbers); number of protopodal endites (NPe); endopodal segments (En1–5); exopodal segments (Ex1–2); epipod (Ep)

	NPe	En1	En2	En3	En4	En5	Ex1	Ex2	Ep
1° maxilla		1	1	1 + 2			7/8		
2° maxilla	6	2	3	2	3 + 1	IV	2 + 1	14	4
1° thoracopod	6	2/3	3/4	3	3 + 1	IV	2 + 1	15	4
2° thoracopod	6	3	4/3	3	3 + 1	IV	2 + 1	12/15	4
3° thoracopod	6	2/2	4/3	3	3 + 1	IV	2 + 1	13/15	4
4° thoracopod	6	3	3	3	4 + 1	IV	3 + 1	14	4
5° thoracopod	6	3/4	3/4	3	3 + 1	IV	2 + 1	13/14	4
6° thoracopod	6	2/3	3/4	2	2 + 1	I	1 + 1	11/12	4
7° thoracopod	3	1	1	1	0	I	0 + 1	10/11	4

ogy. Protopod 1-segmented, bearing 6 enditic processes on the latero-internal margin (Fig. 4C), and with 1-segmented epipod on its outer distal corner (Fig. 4A, B). Endites are armed with spines and setae. Epipod with four long-terminal setae (Fig. 4A, B). Endopod 5-segmented. Segments 1–3 bearing from 1 to 5 setae on the inner corner (see Table 2 for setal formula). Segment 4 with one seta on the inner corner and a group of three or four setae on the outer corner (Fig. 4A, B, D). Distal segment with four claws. Three of these are large, indented and decreasing in size medially. The last one is small, smooth and located on the medial side of the base of the outermost claw (Fig. 4D). Exopod 2-segmented; for setal formula, see Table 2. Segment 2 bears from 12 to 15 long setae and one spine. The latter divides the setae into two groups, with the distal group always consisting of four setae (Fig. 4A, B).

Thoracopods 6–7: (Fig. 5A–E). Slightly smaller than the previous legs. Thoracopod 6 is very similar to the others with the exception of the distal endopodal segment, which bears only one claw (Fig. 5A), and the protopod, with a genital pore on the posterior surface. The genital pore is oval, with the major axis parallel to the protopodal endites. Its opening is covered by a convex plug-like membrane and its lateral margin is covered by short thin setae (Fig. 5B, C). Thoracopod 7 similar to the previous one except for the reduced protopod, bearing only 3 endites (Fig. 5D, E).

Thoracopod 8: Absent.

Thoracopod 9: (Figs 1B, 5F). Highly modified. Inserted on the ventro-lateral surface of segment 9 and comprised of two parts: an apical part, consisting of a short cylindrical process, emerging from the lateral concave surface of a subspherical basal part.

Cladistic analysis

The analysis yielded 8 most parsimonious trees (tree length 59, consistency index 0.7288, retention index

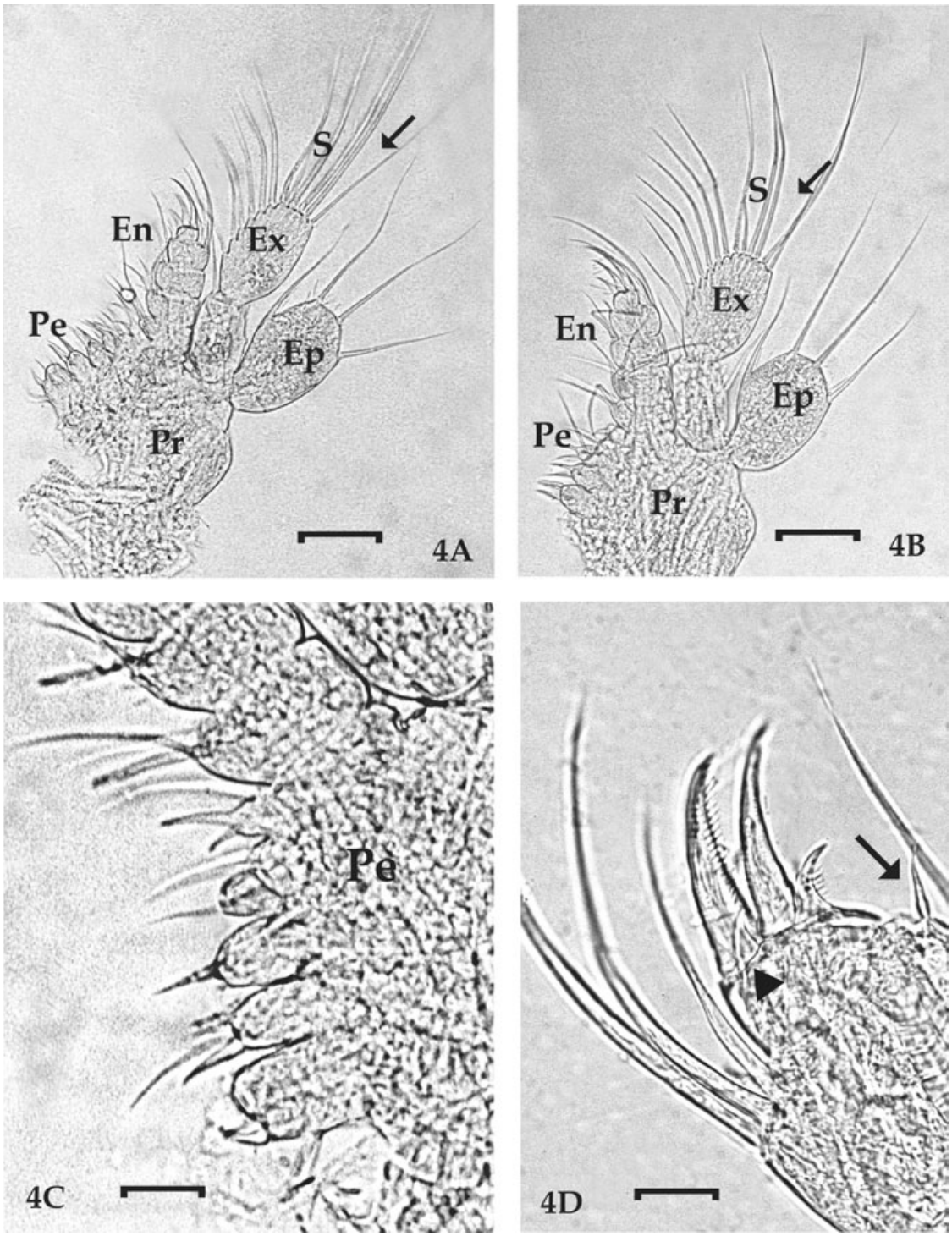

Figure 4. A, B, light micrographs of second maxilla (A) and thoracopod 5 (B) of ***Lightiella magdalenina* sp. nov.** showing the same morphological organization. Protopod (Pr) characterized by 6 enditic processes (Pe) and 1-segmented epipod (Ep) with 4 long plumose setae. 5-segmented endopod (En) and 2-segmented exopod (Ex) with a spine (S) that distinguishes the distal group of 4 long setae (arrow). Scale bars: A, 56 μm; B, 60 μm. C, high magnification of protopodal endites (Pe) armed with spines and setae. Scale bar = 25 μm. D, detail of the last two segments of endopod. Segment 4 characterized by the small seta on the inner corner (arrow) and 3 long setae on the outer corner. The last segment bears 4 claws, three of which are large and indented; the last one is small, smooth and located on the medial side of the base of the outermost claw (arrowhead). Scale bar = 15 μm.

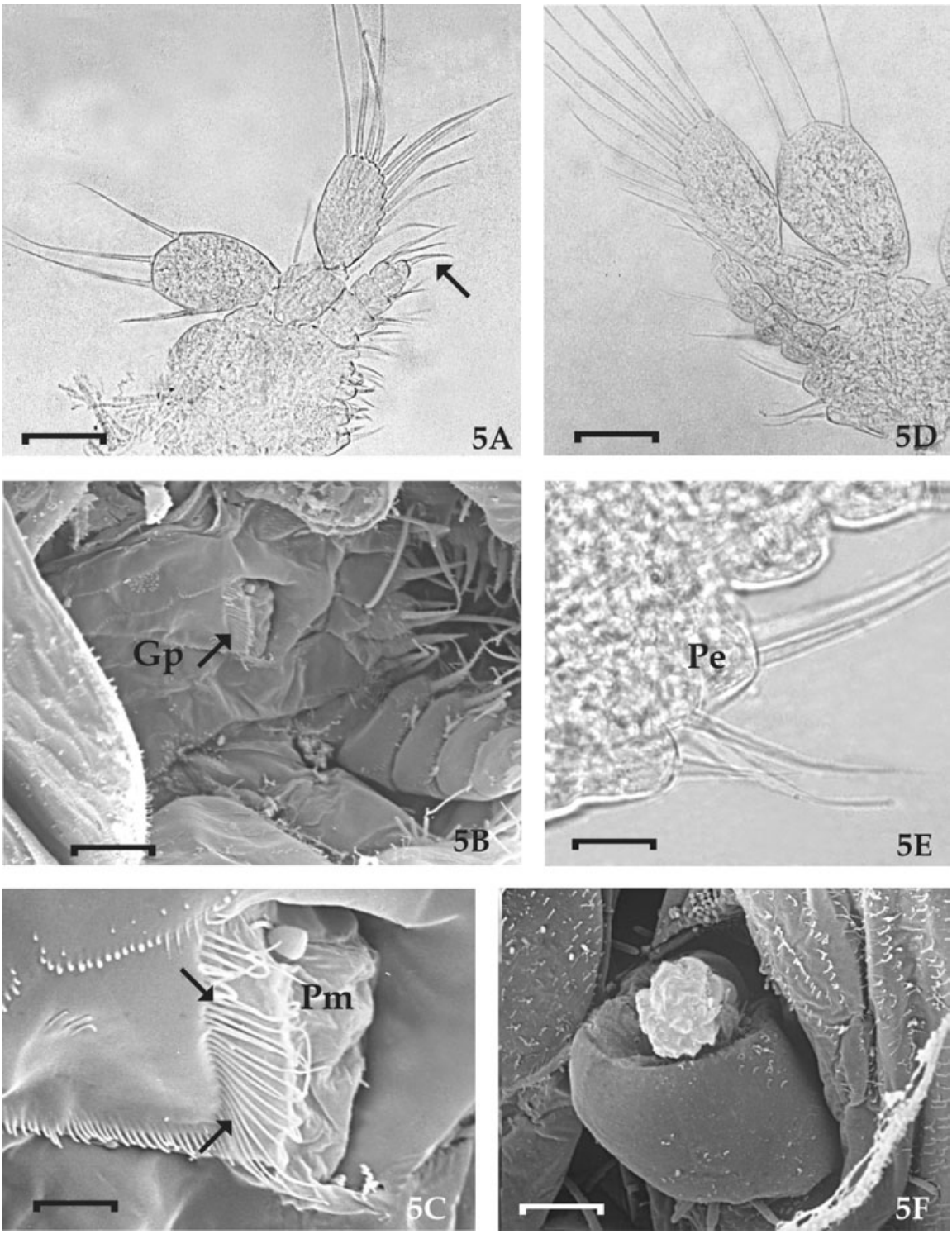

Figure 5. Light and scanning electron micrographs of thoracopods 6, 7 and 9 of ***Lightiella magdalenina* sp. nov.** A, general view of thoracopod 6 with only one claw (arrow) on the distal endopodal segment. Scale bar = 58 μm. B, posterior surface of protopod of thoracopod 6 with genital pore (Gp). Scale bar = 5 μm. C, high magnification of genital pore showing the convex plug-like membrane (Pm) and the short thin setae (arrows) covering its lateral margin. Scale bar = 2 μm. D, general view of thoracopod 7 which appears similar to the preceding one, except for the reduced protopod characterized by only three enditic processes. Scale bar = 52 μm. E, detail of protopod of thoracopod 7 showing only three enditic processes (Pe). Scale bar = 14 μm. F, high magnification of thoracopod 9. Scale bar = 3 μm.

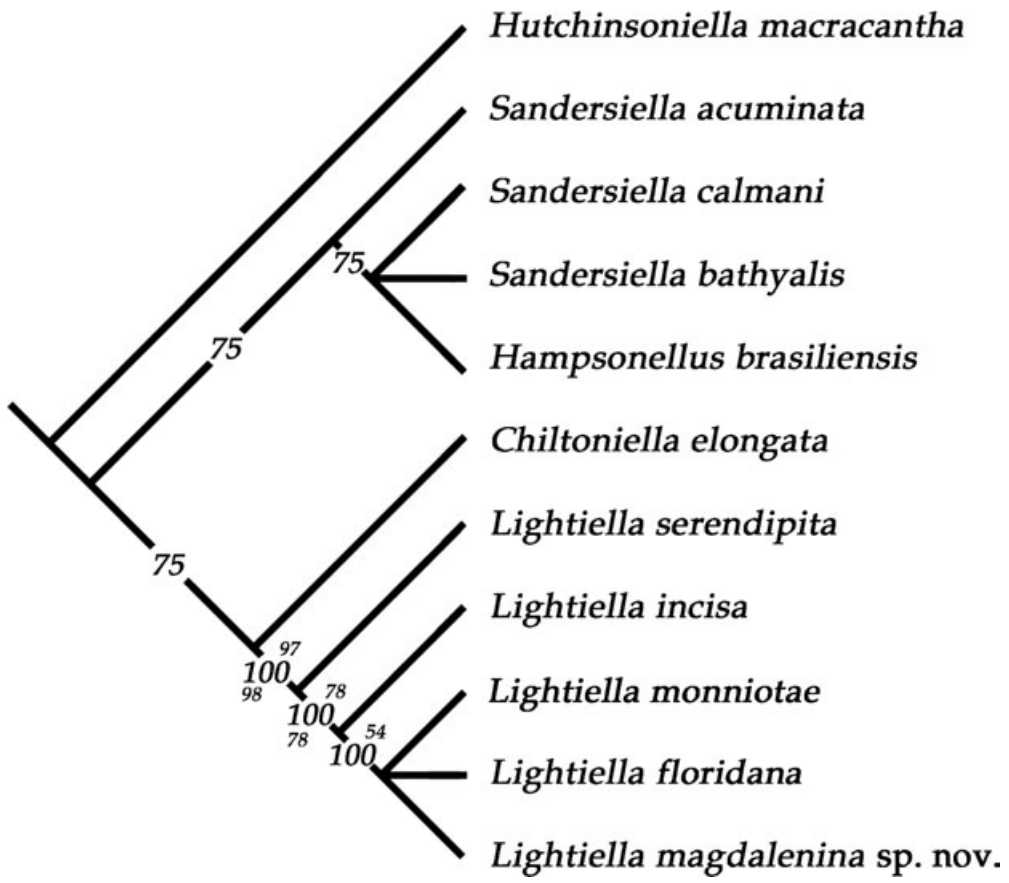

Figure 6. Majority–rule consensus tree from 8 primary trees.

0.7746). The analysis performed without characters 6 and 7, which are indeterminate in most of the outgroup species, yielded the same number of trees (tree length 51), same tree topography and similar values of consistency index (0.7451) and retention index (0.8088). Similarly, the use of all other cephalocarid species or *H. macracantha* alone as outgroup yielded identical results. Support values were generally low, strongly supporting only the monophyly of the genus *Lightiella* and the basal position of *L. serendipita*. The new species appears as a derived taxon within the genus *Lightiella*, nested within an unresolved and weakly supported clade including *L. monniotae* (from New Caledonia) and *L. floridana* (from Florida) (Fig. 6).

DISCUSSION

All cephalocarid species resemble each other in gross morphology, particularly the horseshoe-shaped cephalon, the 20-segmented trunk (9 thoracic and 11 abdominal segments including telson) and the similar morphology of second maxilla and thoracopods 1–7. Thoracopods 8 and 9 are the only limbs strongly reduced and/or modified. In all known species, thoracopod 9 is always strongly modified into a small subspherical appendage, whereas thoracopod 8 (which can be absent, as in the *Lightiella* species) is reduced in size and lacks an endopod. All other limbs, including the second maxilla and thoracopods 1–7, are biramous and consist of a basal protopod from which a multisegmented endopod and a bisegmented exopod emerge. The protopod is also characterized by several enditic processes on the latero-internal margin, provided with spines and setae, and one epipod on the outer distal corner, bearing several long setae. Setae of different length, spines and claws are also present on the segments of both endopod and exopod.

The most important diagnostic characters between cephalocarid genera are the peculiar morphological differences of thoracopods 6 and 7.

In the genus *Chiltoniella*, thoracopods 6 and 7 are considered to be unmodified, or at least less modified than in the other genera (Knox & Fenwick, 1977). Thoracopod 6 has an endopod with two, instead of three, terminal, claw-like setae; segment 2 of the exopod bears several rows of minute denticles on the latero-proximal quarter. The endopod of thoracopod 7 is

reduced in length and, similar to the previous one, has two terminal claw-like setae.

In *Hutchinsoniella*, the only claw of thoracopod 7 is bluntly rounded and some of the flexor muscles of the epipod of thoracopod 6 are larger than in the other thoracopods (Hessler, 1964). However, information on the latter character is not available for the other cephalocarid taxa.

In *Sandersiella* (Shiino, 1965; Hessler & Sanders, 1973) and *Hampsonellus* (Hessler & Wakabara, 2000) the distal podomer of the exopod of the thoracopod 6 is highly modified in the same way. It is divided into two lobes, each provided with its own set of setae. The three *Sandersiella* species and *Hampsonellus brasiliensis*, however, are easily discriminated on the basis of specific details. Moreover, thoracopod 7 is significantly modified only in *Hampsonellus brasiliensis*.

Finally, *Lightiella* differs from all other genera in the reduction of segment 8, which also lacks thoracopods and pleura. In this genus, thoracopods 6 and 7 are smaller than, but very similar to, the other limbs (Jones, 1961; Gooding, 1963; Cals & Delamare Deboutteville, 1970; McLaughlin, 1976).

The reduction of trunk segment 8 and the absence of both thoracopod 8 and the ventral comb of the penultimate abdominal segment support the attribution of the new species described here to the genus *Lightiella*.

Lightiella magdalenina sp. nov. differs from the other *Lightiella* species in the presence of: (1) one small seta on the inner distal corner of the penultimate endopodal segment (never reported for any other *Lightiella* species); (2) only one claw on the distal segment of the endopod of thoracopod 6 (whereas *L. incisa*, *L. floridana*, *L. monniotae* and *L. serendipita* all have two claws).

Like *Hutchinsoniella macracantha* (Hessler *et al*., 1995) and *Hampsonellus brasiliensis* (Hessler & Wakabara, 2000), *L. magdalenina* shows a genital pore on the posterior face of thoracopods 6. Only *Chiltoniella* seems to bear the genital pore on thoracopod 9 (Knox & Fenwick, 1977). All the modifications of thoracopods 6–8, as well as that of thoracopod 9, are considered to be related to reproductive function. In particular, the reduction or absence of thoracopod 8 seems to facilitate egg transfer from thoracopod 6 to thoracopod 9.

In the best known *Hutchinsoniella macracantha*, two large eggs, laid during each reproductive event, emerge from the genital pores and are then carried and cemented on thoracopods 9 (Hessler *et al*., 1995). In *Lightiella*, two eggs seems to be laid only occasionally. Two egg sacs were only found in 1 of 17 ovigerous specimens examined (Sanders & Hessler, 1964). A single egg sac was also reported in *Lightiella* by Gooding (1963), De Troch *et al*. (2000) and Martin *et al*. (2002).

Reconstruction of the phylogenetic relationships within the Cephalocarida is severely hampered by the lack of support of the resulting trees, mostly due to the number of poorly described taxa. However, monophyly of the genus *Lightiella*, as well as the basal position of *L. serendipita*, appears well supported. The close relationship between the new species and *L. monniotae* (from the Pacific Ocean) and *L. floridana* (from Florida) suggests an ancient Tethyan origin for the clade and speciation by means of allopatric divergence after the closure of the Tethys Sea.

Interestingly, the results of the phylogenetic analysis challenge the monophyly of the genus *Sandersiella*, as understood at present, and its relationships with *Hampsonellus brasiliensis* (Wakabara & Mizoguchi, 1976).

L. magdalenina sp. nov. is thus far known only for a very restricted site, about 15–20 m deep on the southern shore of the tiny island of S. Stefano. Samples of nearby benthic communities at comparable depths failed to yield specimens of the new species. It is noteworthy that the animals are not particularly inconspicuous, and the lack of previous reports from the Mediterranean may point to a very narrow distribution. This seems to be the case with Cephalocarida taxa. Indeed, most of them are only known for a single locality, and even within that locality they appear to be exceedingly rare. Therefore, it is fortunate that the only station where the new species has been found lies within the boundaries of the La Maddalena Archipelago National Park, which should ensure protection of its habitat.

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