Living scaphopods from the Valencian coast (E Spain) and description of *Antalis caprottii* n. sp. (Dentaliidae)

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Abstract

Living scaphopods from the Valencian coast (E Spain) and description of Antalis caprottii *n. sp. (Dentaliidae)*.— This paper reports on eight scaphopod species found at 128 sampling stations near the coast of Valencia (Spain) during the campaigns of the Water Framework Directive (2000/60/CE) 2005, 2006 and 2008. Samples deposited in several Valencian institutions and private collections are also described. The identified species belong to four families: Dentaliidae (*Antalis dentalis, A. inaequicostata, A. novemcostata, A. vulgaris*, and *A. caprottii* n. sp., a new species described from material found on the coasts of the province of Castellón), Fustiariidae (*Fustiaria rubescens*), Entalinidae (*Entalina tetragona*) and Gadilidae (*Dischides politus*). We describe the characteristics and conchiological variations for each species and give geographic distribution maps on the Valencian coast for each species.

Key words: Scaphopods, Dentalida, Gadilida, *Antalis caprottii*, New species, Mediterranean Sea.

Resumen

Escafópodos de la costa valenciana (E España) y descripción de Antalis caprotti *sp. n. (Dentalidae)*.— Se citan y describen en profundidad ocho especies de escafópodos halladas en 128 puntos de muestreo próximos a la costa de la Comunidad Valenciana (España), durante las campañas de la Directiva Marco del Agua (2000/60/CE) de 2005, 2006 y 2008, en las muestras depositadas en diversas instituciones valencianas y colecciones privadas. Las especies identificadas pertenecen a cuatro familias: Dentaliidae (*Antalis inaequicostata, A. vulgaris, A. dentalis, A. novemcostata* y *A. caprottii* sp. n., especie nueva que se describe a partir de material encontrado en las costas de la provincia de Castellón), Fustiariidae (*Fustiaria rubescens*), Entalinidae (*Entalina tetragona)* y Gadilidae (*Dischides politus*). Todas las especies halladas han sido estudiadas y caracterizadas conquiológicamente y se muestran los mapas de distribución geográfica para cada una de ellas en la costa valenciana.

Palabras clave: Escafópodos, Dentalida, Gadilida, *Antalis caprottii*, Nueva especie, Mar Mediterráneo.

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Introduction

Many species of scaphopod molluscs have been reported from the Mediterranean Sea since the late 19th century. Bucquoy et al. (1882–89) first cited three species of scaphopods in Roussillon (France): *A. dentalis* (Linnaeus, 1758), *A. novemcostata* (Lamarck, 1818) and *A. vulgaris* (Da Costa, 1778). Perrier (1930) cited *A. novemcostata* and *A. vulgaris* on the French Mediterranean coast, Caprotti (1966a, 1966b, 1966c, 1966d, 1966e, 1966f, 1967, 1979, 2009) cited nine species of the order Dentalida and 16 of the order Gadilida on the Italian coast,, and Ozturk (2011) reported 10 species in the Levantine and Aegean seas. Very recently, Gruppo Malacologico Romagnolo (GMR) (2010) recorded 13 species in the Mediterranean Sea, and Cossignani & Ardovini (2011) recorded 14 species, including a possible fossil species *C. ovulum*.

Scaphopod fauna from the coasts of the Iberian Peninsula and the Balearic islands are poorly known, and only 28 species have been recorded to date. Of these, 12 correspond to the order Dentaliida (families Fustiariidae, Dentaliidae and Gadilinidae) and 16 to the order Gadilida (families Entalinidae, Gadilidae and Pulsellidae) (table 1).

Respect to our study area, there are several historical antecedents. Boscá (1916) cited a scaphopod for the first time here, concretely *A. dentalis* (as *Dentalium dentalis*), and Pardo (1920) cited *Fustiaria rubescens* (as *Dentalium rubescens*) from the Gulf of Valencia. Roselló (1934) cited several species from the Valencia and Alicante coasts: *A. dentalis* (as *Dentalium dentalis*), *A. inaequicosta* (as *D. inaequicostata*, *D. novemcostatum* v. *inaequicostatum* and *D. fasciatum), A. vulgaris* (as *A. vulgare*) from the Valencia coast only, *F. rubescens* (as *Dentalium rubescens)* and *D. politus* (as *Siphonodentalium bifissus*), and *Dentalium elephantinum* from the Pliocene of the Alicante coast. The author reported the presence of *Pulsellum lofotense* but it was later found to correspond to the polychaete *Ditrupa arietina* (Müller, 1776). We also found a specimen of *A. novemcostata* (as *Dentalium novemcostatum*) from the Cantabrian Sea in this collection. Later, Giner (1989) also cited the species *A. inaequicostata* and *F. rubescens* from the coast of Valencia, and Rubio & Rodríguez (1996) cited three unidentified scaphopods from the coast of Dénia (Alicante). And more recently, Plá (2006) cited *A. inaequicostata* and *F. rubescens* from the coast of La Marina Alta (Alicante), Ibiza and Formentera (Balearic Islands), confusing *F. rubescens* with the polychaete *D. arietina*.

Some of these recent species have been recorded as fossils from several Spanish deposits and published in several papers. For example, the species *A. dentalis, A. inaequicostata, A. sexangulum* (Gmelin, 1789), *A. vulgaris, E. tetragona, F. emersoni* (Caprotti, 1979), *F. rubescens* and *P. lofotense* were cited by Vera–Peláez & Lozano (1993) and Jordá et al. (2010) from various Pliocene–Lower Holocene cave deposits located in the province of Málaga. Moreno (1995) cited *A. dentalis, A. novemcostata, A. vulgaris* and *Antalis* sp. from deposits ranging from the Lower Palaeolithic until medieval times. In recent months, Cádiz & Martínez–Ortí (2011) reported *A. novemcostata* from the Valencian coast.

This study presents the seven scaphopod species collected between 2005 and 2008 along 454 km of coastline covering 60 municipalities of the Valencian coast. We also include data from samples we studied from various institutions and private collections in Valencia, recording one additional species. The total eight species have been conchiologically characterized, highlighting the discovery and description of a new species, the dentalid *Antalis caprottii* n. sp. The geographic distribution maps for each species in the study area are provided, except for *E. tetragona* due to its imprecise locations.

Material and methods

The study area includes the coast of Valencia from Vinaroz (Castellón), in the north, to Orihuela (Alicante), in the south (fig. 1, table 2). The coastal morphology is very varied and irregular, from coastal lowlands with long beaches to cliffs with varying topography. South of Dénia (Alicante), there are fewer long beaches; small coves predominate and then the beaches become longer again at the southern most end of the province.

Scaphopod samples studied here were obtained in the Water Framework Directive (2000/60/CE) campaigns in July and August in 2005, 2006 and 2008, coordinated by the Universitat Politécnica of Valencia and the 'Universidad Católica de Valencia–San Vicente Mártir'. Topographic features were defined and the water depth was monitored by continuous–recording echo–sounder. Samples were taken from a boat with a bilateral anchor dredge, covering a total of 172 sampling stations, but scaphopod specimens were found in only 63 (fig. 1, table 2: 1–63). The stations were mapped using a global positioning system (GPS) Garmin and coordinates were expressed in UTM units (table 2). These sampling stations vary between 5 and 20 m in depth; they are located on substrates of medium to fine sand, and many of them are dominated by the endemic Mediterranean seagrass *Posidonia oceanica* ((L.) Delile, 1813). All samples obtained from the dredging were fixed in 5% formaldehyde and screened using 0.5 mm mesh sieves. We then proceeded to the screening of the diverse biological groups obtaining the scaphopod assemblages, which were preserved in 70% ethanol.

We also revised 69 samples from several institutions: 7 from the Siro de Fez collection deposited in the 'Museu Valencià d'Història Natural' (MVHN), 16 from the Roselló collection deposited in the 'Museo de Ciencias Naturales' of Valencia (MCNV), 38 from the 'Instituto de Ecologia Litoral' of Alicante (IEL), and 8 from two private collections (table 2: 64–92).

The species were determined using the taxonomic criteria of Bucquoy et al. (1882–89), Hidalgo (1917), Caprotti (1966a, 1966b, 1966c, 1966d,

Table 1. Scaphopods recorded from the coasts of the Iberian peninsula and Balearic Islands: A. Jeffreys (1877, 1882); B. Locard (1898); C. Hidalgo (1917); D. Alzuria (1984, 1985a, 1985b, 1986); E. Steiner (1997); F. Giribet & Peñas (1997); G. Tarruella Ruestes & Fontanet Giner (2001); H. Salas et al. (1985); I. Templado et al. (2006); J. Salas & Gofas (2011).

Tabla 1. Escafópodos citados en las costas de la península Ibérica e Islas Baleares. (Para las abreviaturas, ver arriba.)

	A	B	C	D	E	F	G	H	I	J
Dentaliidae										
A. agilis		X	X		X	X				
A. dentalis	X		X		X					
A. entalis			X		X	X				
A. inaequicostata			X	X	X	X	X	X		
A. panorma		X	X		X					X
A. novemcostata			X		X					X
A. rossati				X	X					
A. vulgaris			X	X	X	X	X		X	X
F capillosum	X				X					
F. camdidum	X				X					
Fustiiaridae										
F. rubescens		X	X		X	X	X	X		X
Gadilinidae										
E. filum	X		X		X					
Entalinidae										
E. tetragona	X				X					
B. ensiculus	X				X					
H. subterfissus		X			X					
Gadilidae										
C. amphora		X			X					
C. artatus		X			X					
C. jeffreysi		X			X					X
C. subfusiformis		X			X					
C. gracilis		X			X					
C. propinquus		X			X					
C. cylindratus		X			X					
C. monterosatoi		X			X					
C. gibbus		X			X					
C. ovulum		X			X					
C. tumidosus					X					
D. politus	X		X		X		X			X
Pulsellidae										
P. lofotense					X					

Table 2. List of species found in the sampling stations together with those from private and public collections: S. Station; D. Depth (in m); MHNV. Museu Valencià d´Història Natural of Valencia; FD. Framework Directive; MCNV. Museo de Ciencias Naturales of Valencia; IEL. Instituto de Ecología Litoral of Alicante.

Tabla 2. Listado de especies encontradas en los muestreos junto a las muestras procedentes de colecciones privadas y museísticas: S. Estación; D. Profunidad (en m); MHNV. Museu Valencià d'Història Natural de Valencia; FD. Directiva Marco; MCNV. Museo de Ciencias Naturales de Valencia; IEL. Instituto de Ecología Litoral de Alicante.

S	Species	Date	UTM coordinates	Locality	D(m)
1	*A. dentalis*	15 VII 2008	31T289532/4487500	Vinaroz	14
2	*A. dentalis*	17 VII 2008	31T293764/4485082	Vinaroz	12
3	*A. dentalis*				
	F. rubescens	17 VII 2008	31T291942/4480865	Vinaroz	17
4	*A. inaequicostata*				
	A. dentalis				
	F. rubescens	15 VII 2008	31T284512/4478992	Benicarló	16
5	*A. inaequicostata*				
	A. dentalis	16 VII 2008	31T289562/4478425	Benicarló	18
6	*A. dentalis*				
	A. novemcostata	09 III 2008	31T282013/4475005	Benicarló	18
7	*A. dentalis*	16 VII 2008	31T286069/4473710	Benicarló	19
8	*A. inaequicostata*				
	F. rubescens	17 VII 2008	31T280011/470467	Peñíscola	20
9	*A. inaequicostata*	17 VII 2008	31T281498/4468312	Peñíscola	18
10	*A. inaequicostata*				
	A. dentalis				
	F. rubescens	18 VII 2008	31T 278236/468664	Peñíscola	13
11	*A. inaequicostata*				
	A. dentalis	18 VII 2008	31T276831/465776	Peñíscola	16
12	*A. inaequicostata*	18 VII 2008	31T278305/464744	Peñíscola	18
13	*A. inaequicostata*				
	A. dentalis	22 VII 2008	31T274966/464094	Peñíscola	17
14	*A. dentalis*	11VIII 2008	31T273274/459447	Alcala de Chivert	16
15	*A. inaequicostata*				
	A. dentalis	22 VII 2008	31T269000/457000	Alcala de Chivert	18
16	*A. dentalis*	12 VIII 2008	31T267000/453500	Torreblanca	12
17	*A. inaequicostata*	12 VIII 2008	31T267539/452554	Torreblanca	16
18	*A. inaequicostata*				
	A. dentalis	12 VIII 2008	31T264212/449040	Torreblanca	14
19	*A. inaequicostata*				
	F. rubescens	27 VIII 2008	31T261939/446420	Cabanes	17
20	*A. dentalis*	14 VII 2008	31T258010/443506	Oropesa	15
21	*A. inaequicostata*				
	F. rubescens	15 VII /2008	31T259306/442677	Oropesa	20
22	*A. inaequicostata*				
	F. rubescens	14 VII 2008	31T256537/440067	Oropesa	13

Table 2. (Cont.)

S	Species	Date	UTM coordinates	Locality	D(m)
23	*A. inaequicostata*				
	A. dentalis				
	A. novemcostata	27 VIII 2008	31T257121/439613	Benicassim	15
24	*A. inaequicostata*				
	A. dentalis				
	F. rubescens	27 VIII 2008	31T252102/433367	Castellón	16
25	*A. caprottii* n. sp.				
	A. vulgaris	28 VIII 2008	31S246666/424870	Burriana	18
26	*F. rubescens*	29 VIII 2008	30S755572/420716	Burriana	14
27	*A. inaequicostata*	29 VIII 2008	30S750279/409239	Nules	19
28	*A. inaequicostata*	26 VIII 2008	30S743528/403001	La Llosa	14
29	*A. dentalis*	26 VIII 2008	30S741523/399021	Sagunto	17
30	*A. inaequicostata*				
	F. rubescens	26 VIII 2008	30S743507/398010	Sagunto	19
31	*A. inaequicostata*				
	A. dentalis	22 VIII 2008	30S740551/395044	Sagunto	12
32	*A. dentalis*				
	F. rubescens	22 VIII 2008	30S737807/389923	Sagunto	19
33	*A. inaequicostata*				
	A. dentalis				
	A. novemcostata				
	F. rubescens	25 VIII 2008	30S739414/387687	Sagunto	20
34	*F. rubescens*	22 VIII 2008	30S736506/388027	Puzol	20
35	*A. inaequicostata*				
	A. dentalis				
	F. rubescens	25 VIII 2008	30S739060/386877	Puzol	13
36	*A. inaequicostata*	25 VII 2008	30S733000/379500	Pobla de Farnals	18
37	*A. inaequicostata*				
	F. rubescens	22 VIII 2008	30S735350/378672	Pobla de Farnals	16
38	*A. dentalis*				
	F. rubescens	22 VIII 2008	30S732025/376112	Albuixech	17
39	*A. inaequicostata*				
	A. dentalis				
	F. rubescens	04 IX 2008	30S733762/373908	Tavernes de Valldigna	12
40	*A .dentalis*	22 VIII 2008	30S730964/365507	Alfafar	18
41	*A. dentalis*	21 VIII 2008	30S735992/351504	Silla	19
42	*F. rubescens*	21 VIII 2008	30S738094/346733	Sueca	18
43	*A. dentalis*	19 VIII 2008	30S741904/343003	Cullera	19
44	*F. rubescens*	19 VIII 2008	30S744956/333327	Cullera	20

Table 2. (Cont.)

S	Species	Date	UTM coordinates	Locality	D(m)
45	*A. inaequicostata*				
	F. rubescens	18 VIII 2008	30S746057/329417	Gandia	19
46	*F. rubescens*	18 VIII 2008	30S747656/319524	Gandia	20
47	*A. inaequicostata*	01 IX 2008	30S759976/312059	Oliva	20
48	*A. vulgaris*	23 VII 2008	31S244289/308628	Oliva	18
49	*F. rubescens*	24 VII 2008	31S256775/296954	Jávea	19
50	*A. vulgaris*	08 VIII 2008	31S249775/284739	Jávea	21
51	*A. inaequicostata*	07 VIII 2008	30S758614/276051	Altea	17
52	*A. inaequicostata*	06 VIII 2008	30S742151/264403	Villajoyosa	21
53	*A. inaequicostata*	06 VIII 2008	30S737258/262712	Villajoyosa	20
54	*F. rubescens*	05 VIII 2008	30S727139/251339	Campello	15
55	*A. dentalis*	05 VIII 2008	30S728434/250792	Campello	20
56	*A. vulgaris*	31 VII 2008	30S721374/4240206	Santa Pola	20
57	*A. inaequicostata*				
	A. dentalis				
	A. novemcostata	30 VII 2008	30S707504/4220139	Guardamar del Segura	19
58	*A. dentalis*	30 VII 2008	30S710109/4220574	Guardamar del Segura	20
59	*F. rubescens*	28 VII 2008	30S700853/4200015	Orihuela	18
60	*A. dentalis*	29 VII 2008	30S700854/4199974	Orihuela	17
61	*F. rubescens*	28 VII 2008	30S698818/4197311	Orihuela	19
62	*A. inaequicostata*				
	A. dentalis				
	A. novemcostata				
	F. rubescens	29 VII 2008	30S698813/4197300	Orihuela	17
63	*D. politus*	29 VII 2008	31T257121/439613	Benicassim	15
64	*A. inaequicostata*	01 XII 2008	–	Gandia (MVHN–011211AB01)	–
65	*A. vulgaris*	01 XII 2008	–	Orihuela (MVHN–011211AB02)	–
66	*A. inaequicostata*				
	A. vulgaris				
	F. rubescens	01 XII /2009	–	Cullera (MVHN–011211AB03)	–
67	*A. vulgaris*				
	F. rubescens	01 XI 2008	–	Alboraya (MVHN–011211AB04)	–
68	*F. rubescens*	–	–	Valencia (MVHN–011211AB05)	–
69	*A. inaequicostata*	01 I 2011	–	Denia (MVHN–011211AB06)	–
70	*A. inaequicostata*	–	–	Sierra de Irta (MVHN–011211AB07)	–
71	*A. inaequicostata*	–	–	Piles (MVHN–011211AB08)	–
72	*A. inaequicostata*	1999	–	Sagunto (IEL)	–
73	*A. inaequicostata*	1999	–	El Pilar (IEL)	–
74	*A. inaequicostata*	2008	–	Balmar Morro Toix (IEL)	–
75	*A. dentalis*	2008	–	Balmar Morro Toix (IEL)	–
76	*A. inaequicostata*	2000		Torrevieja (IEL)	–

Table 2. (Cont.)

S	Species	Date	UTM coordinates	Locality	D(m)
77	*A. dentalis*	1999	–	Prov. Alicante (IEL)	–
78	*F. rubescens*	–	–	Valencia (MVHN–290610AU01)	–
79	*A. inaequicostata*				
	F. rubescens	–	–	Valencia (MVHN–290610AU02)	–
80	*A. vulgaris*	–	–	Valencia (MVHN–290610AU03)	–
81	*A. inaequicostata*				
	A. vulgaris	–	–	Valencia (MVHN–290610AU04)	–
82	*A. inaequicostata*	–	–	Valencia (MVHN–290610AU05)	–
83	*A. vulgaris*	–	–	Valencia (MVHN–290610AU06)	–
84	*A. inaequicostata*	–	–	Valencia (MVHN–290610AU07)	–
85	*A. dentalis*	–	–	Valencia (MCNV–3438)	–
86	*A. inaequicostata*	–	–	Valencia (MCNV–3447)	–
87	*A. vulgaris*	–	–	Valencia (MCNV–3443)	–
88	*D. politus*	–	–	Valencia MCNV–3456	–
89	*E. tetragona*	–	–	Valencia (MCNV–s/n)	–
90	*F. rubescens*	–	–	Valencia (MCNV–3452)	–
91	*A. novemcostata*	–	–	Valencia (MCNV–3446)	–
92	*A. inaequicostata*	–	–	Valencia (MCNV–3445)	–

1966e, 1966f, 1967, 1979, 2009), Alzuria (1984, 1985a, 1985b, 1986), Steiner (1997) and Ozturk (2011), classified using the supraspecific categories of Steiner & Kabat (2001, 2004), and later quantified. We considered only those shells that could be accurately identified, and we show the abundance of each species collected in sampling stations (fig. 2). For each species, measures from up to 20 adult shell specimens were obtained if available: i) total length, ii) length of the central pipe at the apex that some species have, and iii) diameter of both the apex and the base.

In addition, we propose a new procedure to measure the scaphopod mean curvature angle (α) considered as the chord that joins the apex with the midpoint of the base of scaphopod shells, applying the following formulas: $tg\alpha = b/a$ corresponding $\alpha = tag^{-1}(b/a)$, where 'a' is the angle opposite side and 'b' the adjacent side to angle. In addition, we obtained its standard deviation. All these measures were obtained from six adult specimens for each studied species, except for *A. caprottii* n. sp., for which only two type specimens were measured (fig. 3).

To achieve an accurate taxonomical identification we used a SEM HITACHI S–4100 at the Electron Microscopy Service (SCSIE), University of Valencia. Fund type was determined using a granulometric analysis and a Wudden–Wentworth scale (in Holme & McIntyre, 1971) to calculate the Shepard sedimentological triangle (fig. 4). Whole data were processed using the graphics software Grapher.

Results

We identified a total of 492 specimens; 298 from the sampling stations and 194 from the revised collections. All specimens belonged to six species of the order Dentalida (five species from the family Dentaliidae and one from the family Fustiariidae) and two species of the order Gadilida (one from the family Entalinidae and the other from the family Gadilidae). The most abundant species in our sampling stations were *A. inaequicostata* (53.5%) and *A. dentalis* (26.3%) (fig. 2). Granulometric analysis determined that the most common substrate where scaphopods occurred in our study area was fine to medium sand (fig. 4).

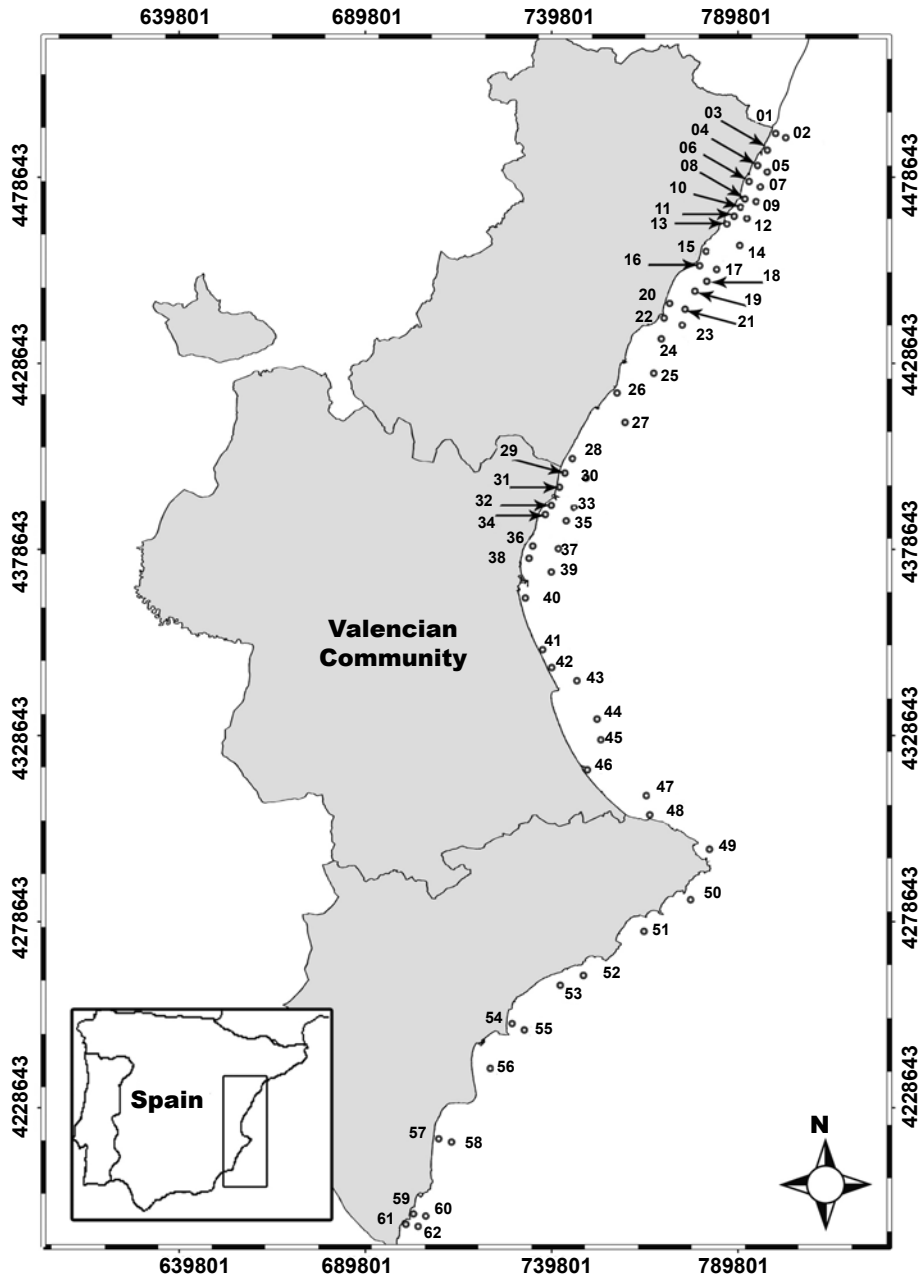

Fig. 1. Sampling stations in the Autonomous Community of Valencia (Spain).

Fig. 1. Estaciones de muestreo en la Comunidad Valenciana (España).

Systematics

Order Dentaliida Starobogatov, 1974
Family Dentaliidae Gray J. E., 1834
Genus *Antalis* Adams H. & Adams A., 1854

Antalis caprottii n. sp. (figs. 5–6).

Type locality
Coast of Burriana (Castellón) (fig. 6, table 2).

Type material
The type series consists of two specimens deposited in the MVHN (Spain). The hototype with the code MVHN–150211UB03A is preserved in alcohol 70% (fig. 5A), and the paratype, a shell, has the code MVHN–50211UB03B (figs. 5B–G).

Etymology
Dedicated to Dr. Erminio Caprotti, an eminent Italian malacologist, specialist in scaphopods.

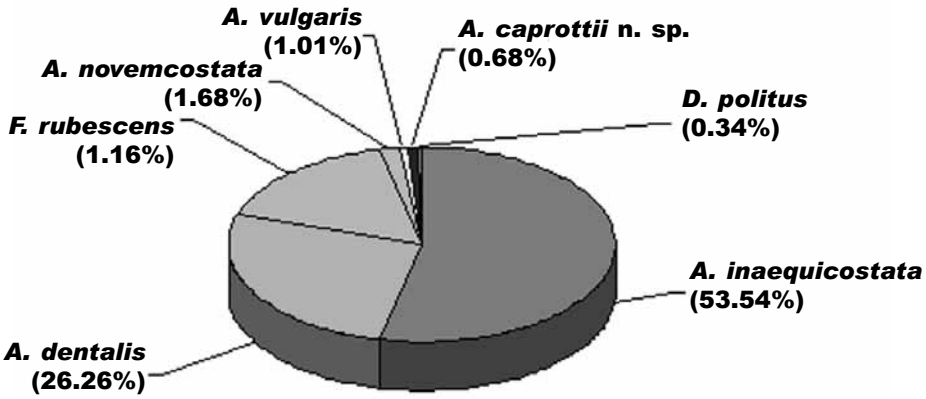

Fig. 2. Pie chart of the abundance of species obtained by dredging in the study area.

Fig. 2. Gráfico de sectores de la abundancia de especies obtenidas mediante dragado en el área de estudio.

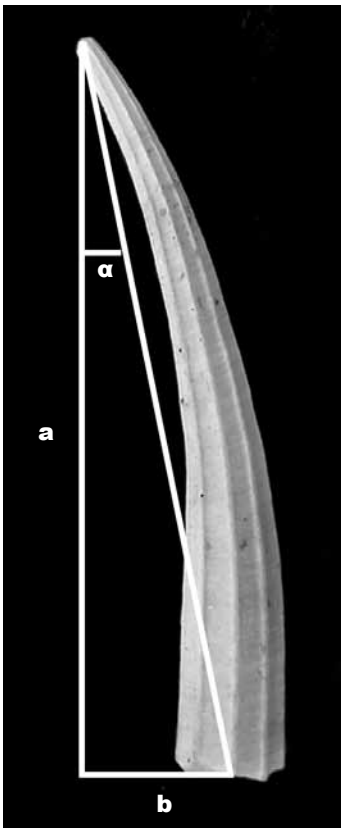

Fig. 3. Method to calculate the mean curvature angle (α) in scaphopods: a. Side opposite angle; b. Side adjacent to angle.

Fig. 3. Método de cálculo del ángulo de curvatura media (α) para escafópodos: a. Cateto opuesto al ángulo; b. Cateto contiguo al ángulo.

Common name
Valencian scaphopod

Diagnosis
Shell with a central pipe at the apex, from 14 to 16

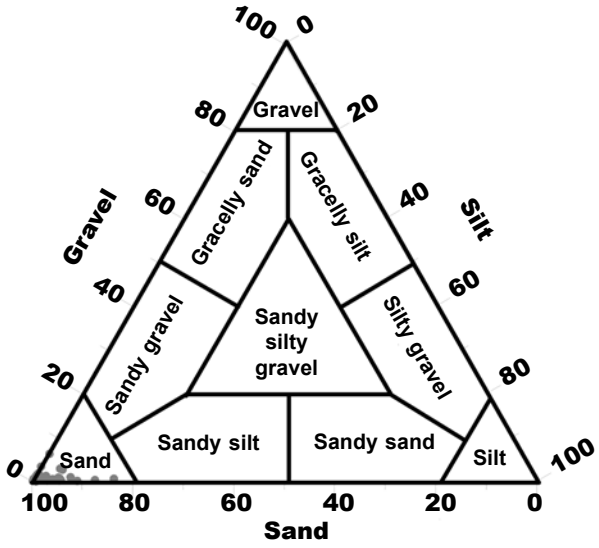

Fig. 4. Shepard triangle: sedimentological distribution of grain size (sand, silt and clay).

Fig. 4. Triángulo de Shepard: distribución sedimentológica por tamaño de grano (arenas, limos y arcillas).

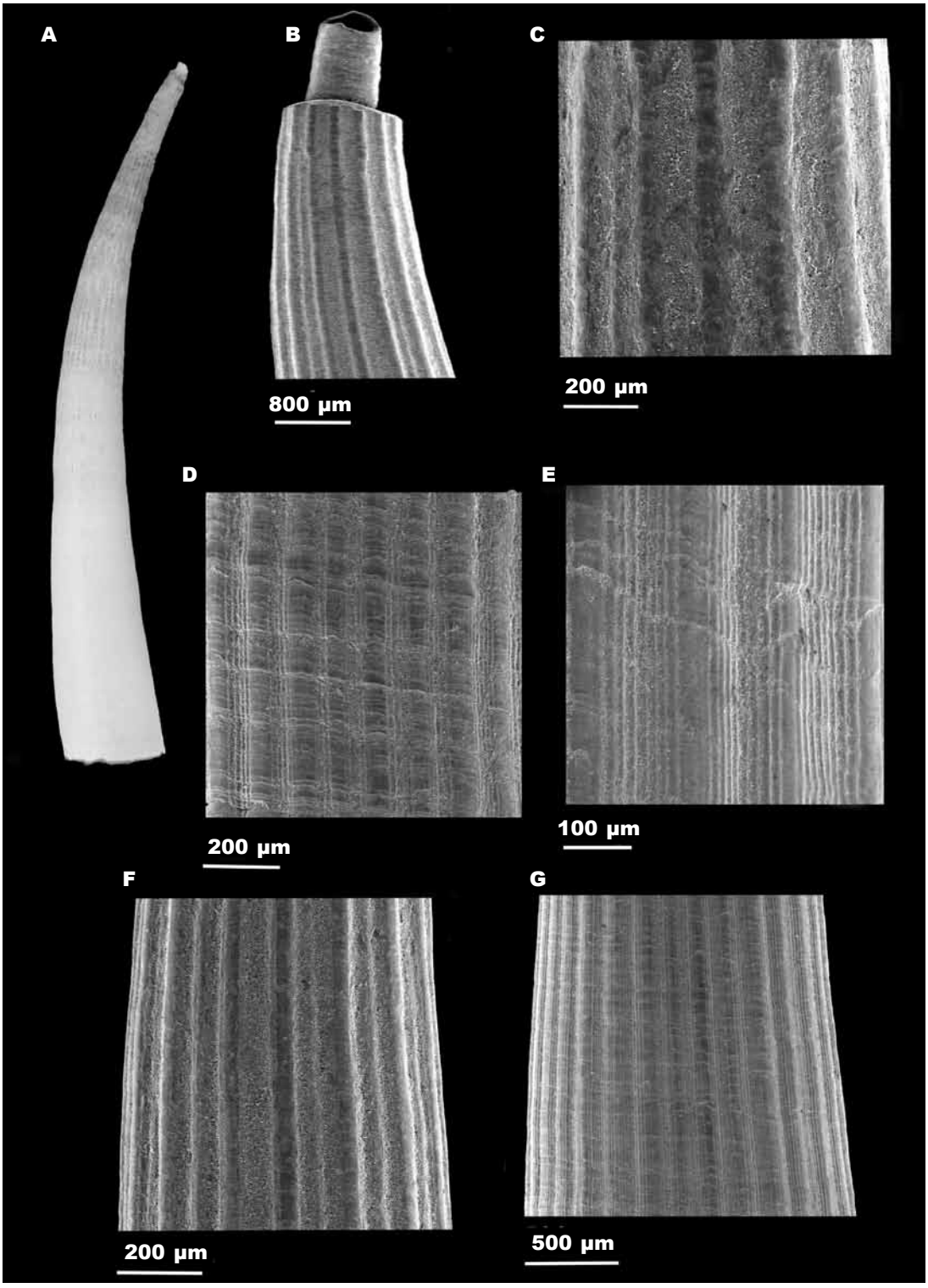

Fig. 5. *Antalis caprottii* n. sp., Burriana (Castellón): A. Holotype (MVHN–150211UB03A). B–G. Paratype (MVHN–150211UB03B): B. Apex with central pipe; C. Detail of the intercostal space in the apical zone; D. Primary ribs; E. Intercostal space detail; F. Middle zone; G. Basal zone.

Fig. 5. Antalis caprottii *sp. n., Burriana (Castellón): A. Holotipo (MVHN–150211UB03A). B–G. Paratipo (MVHN–150211UB03B): B. Ápice con túbulo; C. Detalle del espacio intercostal en la zona apical; D. Costillas primarias; E. Detalle del espacio intercostal; F. Zona media; G. Zona basal.*

primary ribs, increasing to 30 in the basal zone, and eight longitudinal microstriae in the intercostal space.

Description
Opaque, solid shell, moderately curved. Sculpture consisting of 14–16 primary ribs which increase to 30 in the basal zone. Both adults and juveniles present a small short central pipe with a circular section in the apex. In all intercostal spaces there are eight conspicuous longitudinal microstriae. Colour white and orange, more intense at the apex area.

Dimensions
The adult specimen is 22.0 mm in length and 3.0 mm in width at the basal zone. Length of the pipe is 700 µm and the diameter of the apex ranges from 300 to 1,000 µm.

Mean curvature angle
α = 11º 30' 55.99" σ ± 0º 40' 50.61"

Discussion
Because the shell is regularly close to the apex and has a conical foot (Caprotti, 1979) attribution to the family Dentaliidae is clear. It is assigned to the genus *Antalis* because it has a circular section at both the apical and basal ends and lacks an apical cleft (Caprotti, 1979). The specimens of *Antalis caprottii* n. sp. present a combination of features that clearly distinguish them from other known species of the genus. The most similar species are *A. vulgaris* and *A. inaequicostata*. It can be distinguished from these species by its 14 to 16 primary ribs which increase to 30 in the basal zone; *A. vulgaris* has 30 primary ribs which fade towards the base (figs. 13B, 13E, 13H–13I), plus five longitudinal microstriae (Alzuria, 1985a) (fig. 13F) and *A. inaequicostata* has nine primary ribs at the apex (figs. 9A, 9B, 9E increasing to 12 at the base (Steiner, 1997) (figs. 9A, 9H), and around 12 to 20 microstriae(figs. 9C–9D,10D–10E). All three species have a central pipe although in *A. vulgaris* its presence is less frequent (figs. 5A–5B, 9A–9B, 10C, 13C–13D). Besides, the pipe section is circular in *A. caprottii* n. sp. but it is oval in the other two species.

Habitat
Sandy bottoms at depths between 5 and 20 m.

Geographical distribution
Only known from the coast of Burriana (Castellón province).

Antalis dentalis (Linnaeus, 1758) (figs. 7–8)

Material examined
Seventy-eight specimens from 35 sampling stations (table 2).

Description
Species highly variable in size and colour (Caprotti, 1979; Steiner, 1997; GMR, 2010; Ozturk, 2011).

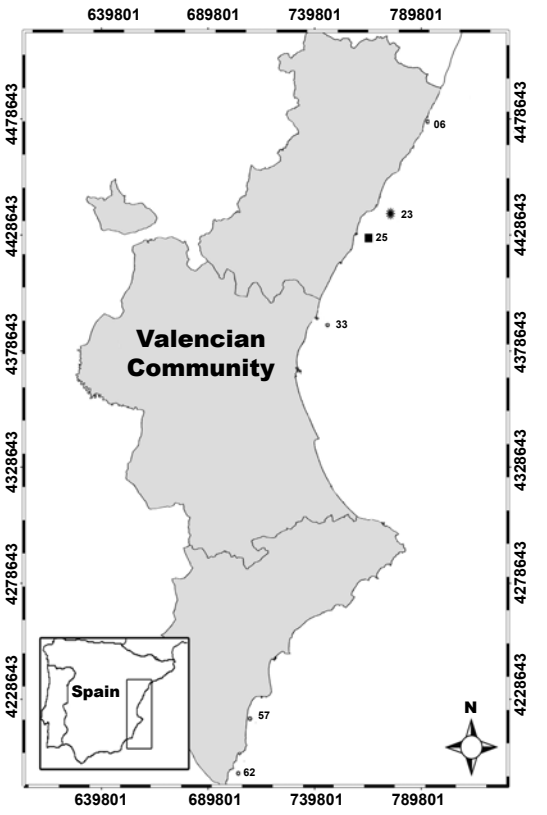

Fig. 6. Geographical distribution of *Antalis caprottii* n. sp. (square), *Antalis novemcostata* (points) and *Dischides politus* (asterisk) on the Valencian coast.

Fig. 6. Distribución geográfica de Antalis caprottii *sp. n. (cuadrado),* Antalis novemcostata *(puntos) y* Dischides politus *(asterisco) en la costa valenciana.*

The shell is slightly curved and fragile, pink, white or beige, and sometimes transparent. It presents a longitudinal sculpture in the apical zone consisting of 9 to 14 primary ribs, which increase to 20 in the basal zone. The intercostal space near the apex shows interrupted longitudinal cords which appear and disappear in the middle zone of the shell.

Dimensions
Length from 10 to 30 mm. Apex diameter from 300 to 500 µm, diameter of the basal zone from 2.0 to 2.5 mm.

Mean curvature angle
α = 9º 38' 19.45" σ ± 1º 44' 10.86"

Remarks
This species is often confused with *A. inaequicostata.*

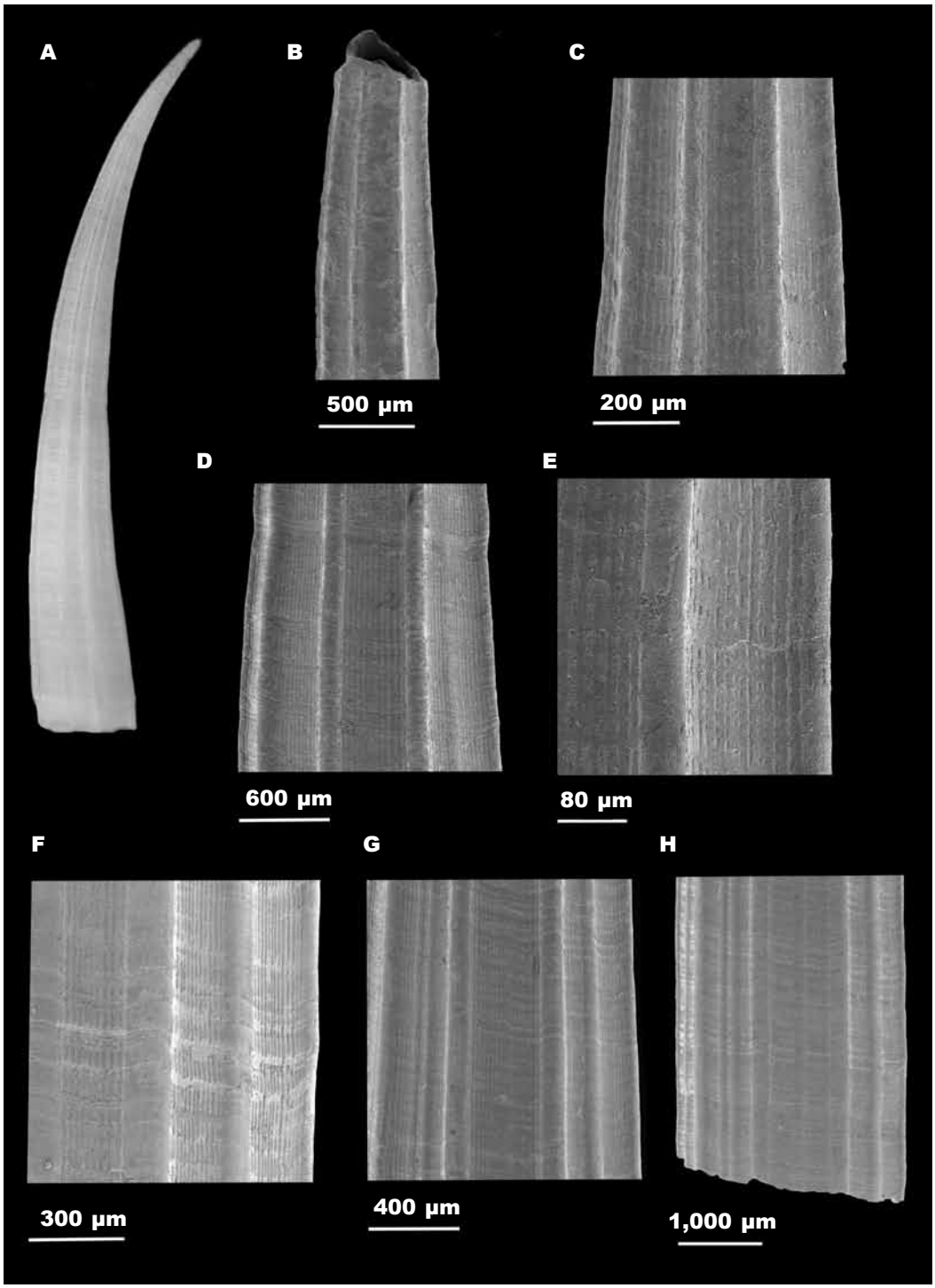

Fig. 7. A–H. *Antalis dentalis:* A. Specimen from Benicarló (Castellón) (MVHN–150211UB02); B–H. Specimen from Tavernes de la Valldigna (Valencia) (MVHN–150211UB01): B. Apex; C. Apex zone; D. Detail of the start of the first secondary rib; E. Intercostal space detail; F. Middle zone; G. Detail of the start of the secondary ribs; H. Basal zone.

Fig. 7. A–H. Antalis dentalis*. A. Ejemplar de Benicarló (Castellón) (MVHN–150211UB02); B–H. Ejemplar de Tavernes de la Valldigna (Valencia) (MVHN–150211UB01): B. Ápice; C. Zona apical; D. Detalle del inicio de la primera costilla secundaria; E. Detalle del espacio intercostal; F. Zona media; G. Detalle del inicio de las costillas secundarias; H. Zona basal.*

However, *A. dentalis* is smaller and more fragile, having a more curved shell and a greater number of ribs without interruptions (Caprotti, 1979; GMR, 2010). It is also morphologically similar to *A. entails,* a species that in contrast is completely smooth and exclusively distributed in the Atlantic (Caprotti, 1966c, 1979; Ghisotti, 1979; GMR, 2010).

Habitat
Sandy bottoms at depths up to 300 m (Steiner, 1997; Steiner & Kabat, 2004; GMR, 2010).

Geographical distribution
Located in the Mediterranean Sea and Northeast Atlantic (Steiner & Kabat, 2004; CLEMAM, 2012). In the Autonomous Community of Valencia it is common on the coasts of all three provinces (fig. 8).

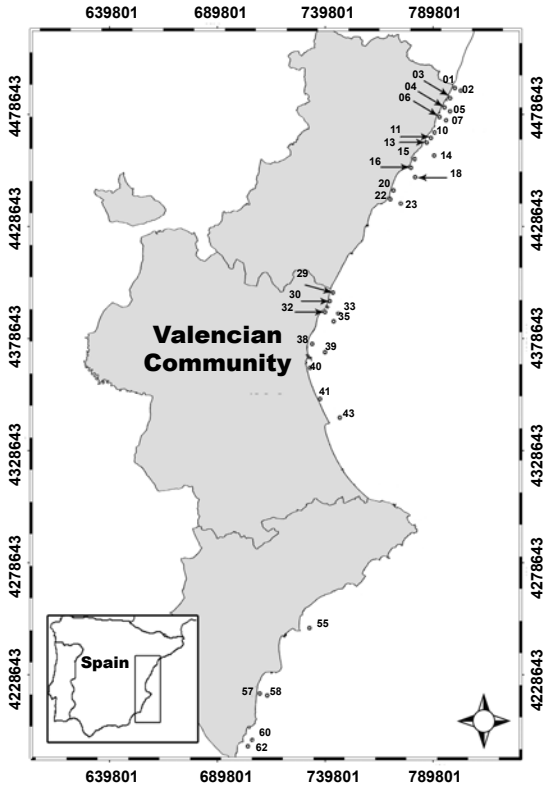

Fig. 8. Geographical distribution of *Antalis dentalis* on the Valencian coast.

Fig. 8. Distribución geográfica de Antalis dentalis *en la costa valenciana.*

Antalis inaequicostata (Dautzenberg 1891) (figs. 9–11).

Material examined
159 specimens from 50 sampling stations (table 2).

Description
Solid shell moderately curved, always opaque and white with pinkish tones. It has approximately nine primary ribs at the apex increasing to 12 at the base. The apex has an oval central pipe since juvenile phase (figs. 10A–10C), characteristic of the species. It can be up to 4 mm long in adults(figs. 9A–9B). The intercostal spaces have numerous well–marked longitudinal ridges (figs. 9C–9D). Disruptions in the shell are common (Caprotti, 1979; Steiner, 1997; GMR, 2010; Ozturk, 2011).

Dimensions
Length from 20 to 50 mm. Apical central pipe length is 700–4,000 µm. Diameter of the apex shell is 800–1,500 µm. Basal diameter is 2.5–4.0 mm.

Mean curvature angle
α = 7º 29' 11.18" σ ± 2º 31' 43.55"

Remarks
This species shows a high variability (Vera–Peláez & Lozano, 1983) so even specimens from the same region can show great morphological conchological variations, including differences in shell colour. Some specimens may even be confused with *A. dentalis* or *A. panorma*. However, *A. inaequicostata* is highly characteristic for its abundant primary and secondary ribs (Caprotti, 1979; GMR, 2010).

Habitat
Sandy bottoms at depths of 5 to 120 m (Steiner, 1997; Steiner & Kabat, 2004; GMR, 2010).

Geographical distribution
Located in the Mediterranean Sea and Northeast Atlantic (Steiner & Kabat, 2004; CLEMAM, 2012). In the Valencian Community it is common on the coasts of all three Valencian provinces (fig. 11).

Antalis novemcostata (Lamarck, 1818) (figs. 6, 12).

Material examined
Seven specimens from 4 sampling stations (table 2).

Description
Shell slightly curved, small, opaque, usually white or pinkish. Sculpture with nine longitudinal primary ribs at the apex which remain until the end of the base (figs. 12G–12H). The intercostal space is concave, with small, lightly marked, transverse striae plus longitudinal striae (figs. 12D–12E). Sometimes there is a small central pipe at the apex (figs. 12E–12F) (Steiner, 1997).

Dimensions
Shell length between 10 to 20 mm. Apex diameter 500–1,000 µm and diameter of the basal zone 2.0–2.5 mm.

Mean curvature angle
α = 11º 1' 45.35" σ ± 1º 50' 35.34"

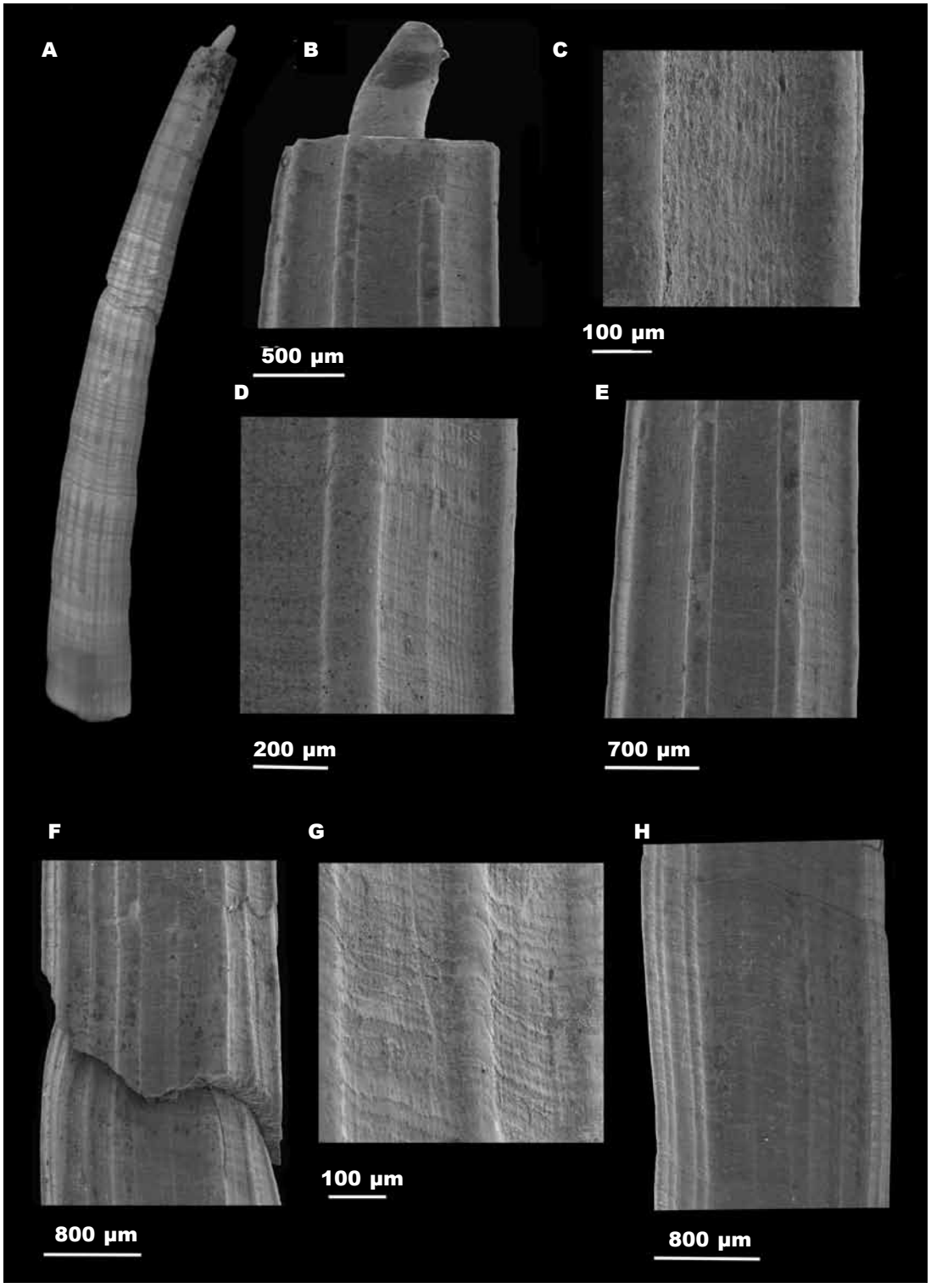

Fig. 9. *Antalis inaequicostata*, Oropesa (Castellón) (MVHN–150211UB08): A. Adult; B. Apex with pipe; C. Intercostal space detail; D. Detail of the beginning of a secondary rib; E. Middle zone; F. Disruption of the shell; G. Details of the growth striations; H. Basal zone.

Fig. 9. Antalis inaequicostata*, Oropesa (Castellón) (MVHN–150211UB08): A. Adulto; B. Ápice con túbulo; C. Detalle del espacio intercostal; D. Inicio de la formación de una costilla secundaria; E. Zona media; F. Interrupción de la concha; G. Detalle de las estrías de crecimiento; H. Zona basal.*

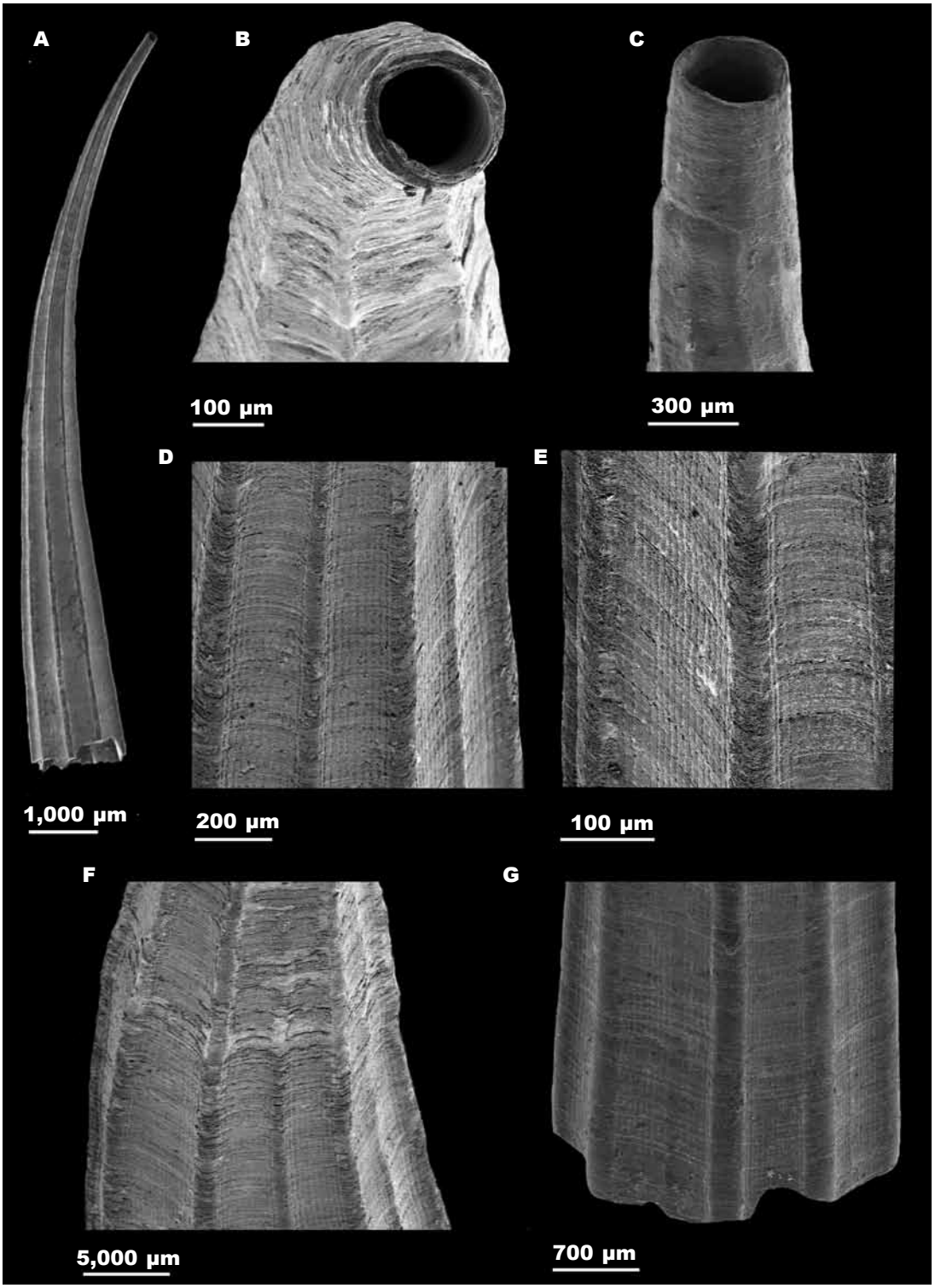

Fig. 10. *Antalis inaequicostata,* Peñíscola (Castellón) (MVHN–211011AC01): A. Juvenile; B, C. Apex with pipe; D. Detail of the beginning of a secondary rib; E. Intercostal space detail; F. Detail of a secondary rib in the middle zone; G. Basal zone.

Fig. 10. Antalis inaequicostata, *Peñíscola (Castellón) (MVHN–211011AC01): A. Juvenil; B, C. Ápice con túbulo; D. Detalle del inicio de una costilla secundaria; E. Detalle del espacio intercostal; F. Detalle de la formación de una costilla secundaria en la zona media; G. Zona basal.*

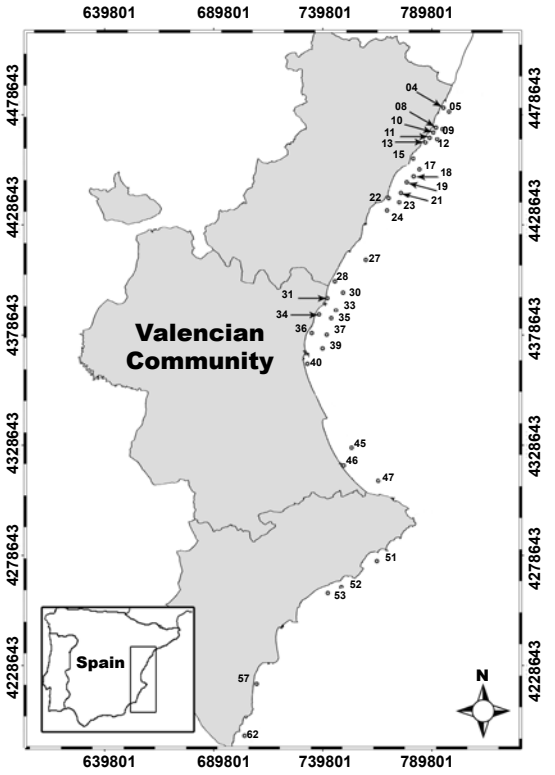

Fig. 11. Geographical distribution of *Antalis inaequicostata* on the Valencian coast.

Fig. 11. Distribución geográfica de Antalis inaequicostata *en la costa valenciana.*

Remarks
According to Caprotti (1979) and Bucquoy et al. (1882–1889) the striae of the intercostal spaces are a criterion to distinguish *A. novemcostata* from *A. inaequicostata*. Both species have a variable number of longitudinal striae (figs. 9C, 10E, 12D, 12F), but only *A. novemcostata* has transversal striae (fig. 12D). Besides, *A. novemcostata* has a more concave intercostal space. Hidalgo (1917) cited this species as recorded at the southeast of the Iberian peninsula, while Perrier (1930) cited it from the French Mediterranean coast. However, Caprotti (1966c, 1979) considered that these records were of *A. inaequicostata*, restricting the distribution of *A. novemcostata* to the Atlantic European waters. Recently, Cádiz & Martínez–Ortí (2011) and Salas & Gofas (2011) reported *A. novemcostata* from the Valencian and Andalucian coasts, respectively, confirming the taxonomical determination by Hidalgo.

Habitat
Sandy funds at depths 7 to 300 m (Steiner, 1997; Steiner & Kabat, 2004).

Geographical distribution
Northeast Atlantic (Steiner & Kabat, 2004; CLEMAM, 2012) and Mediterranean Sea (Perrier, 1930; Cádiz & Martínez–Ortí, 2011; Salas & Gofas, 2011). In the Valencian Community it is present on the coasts of the three Valencian provinces (fig. 6).

Antalis vulgaris (Da Costa, 1778) (figs. 13–14).

Material examined
Two specimens from 12 sampling stations (table 2).

Description
Slightly curved, solid shell, white or yellowish. Shell sculpture consists of numerous primary longitudinal ribs, about 30 in the apical zone, which is almost smooth towards the base (GMR, 2010; Ozturk, 2011). Intercostal space with five longitudinal microstriae (fig. 13F). The apex is thick and may have a central oval pipe (figs. 13C–13D).

Dimensions
Shell length 20–50 mm. Apex diameter 500–1,000 µm; diameter of the basal zone 2–4 mm.

Mean curvature angle
α = 10º 40' 46.88" σ ± 4º 58' 2.6"

Remarks
Easily confused with *A. entalis*, a species completely smooth and only having Atlantic distribution, while *A. vulgaris* has many ribs and also lives in the Mediterranean Sea (GMR, 2010). The shell section has four layers as in *A. inaequicostata*, a related species (Alzuria, 1985a).

Habitat
Sandy and muddy bottoms at depths of 5–1,100 m (Steiner, 1997; Steiner & Kabat, 2004; GMR, 2010).

Geographical distribution
Mediterranean Sea and Northeast Atlantic (Steiner & Kabat, 2004; Ozturk, 2011; CLEMAM, 2012). In the Autonomous Community of Valencia it is known on the coasts of both Castellón and Alicante provinces (fig. 14).

Family Fustiariidae Steiner, 1991
Genus *Fustiaria* (Stoliczka, 1868)

Fustiaria rubescens (Deshayes, 1825) (figs. 15–16)

Material examined
Forty-eight specimens from 33 sampling stations (table 2).

Description
Translucent slightly curved shell, completely smooth, without ridges, brown or beige with bright tones (figs. 15A, 15C–15E). The apex has a long

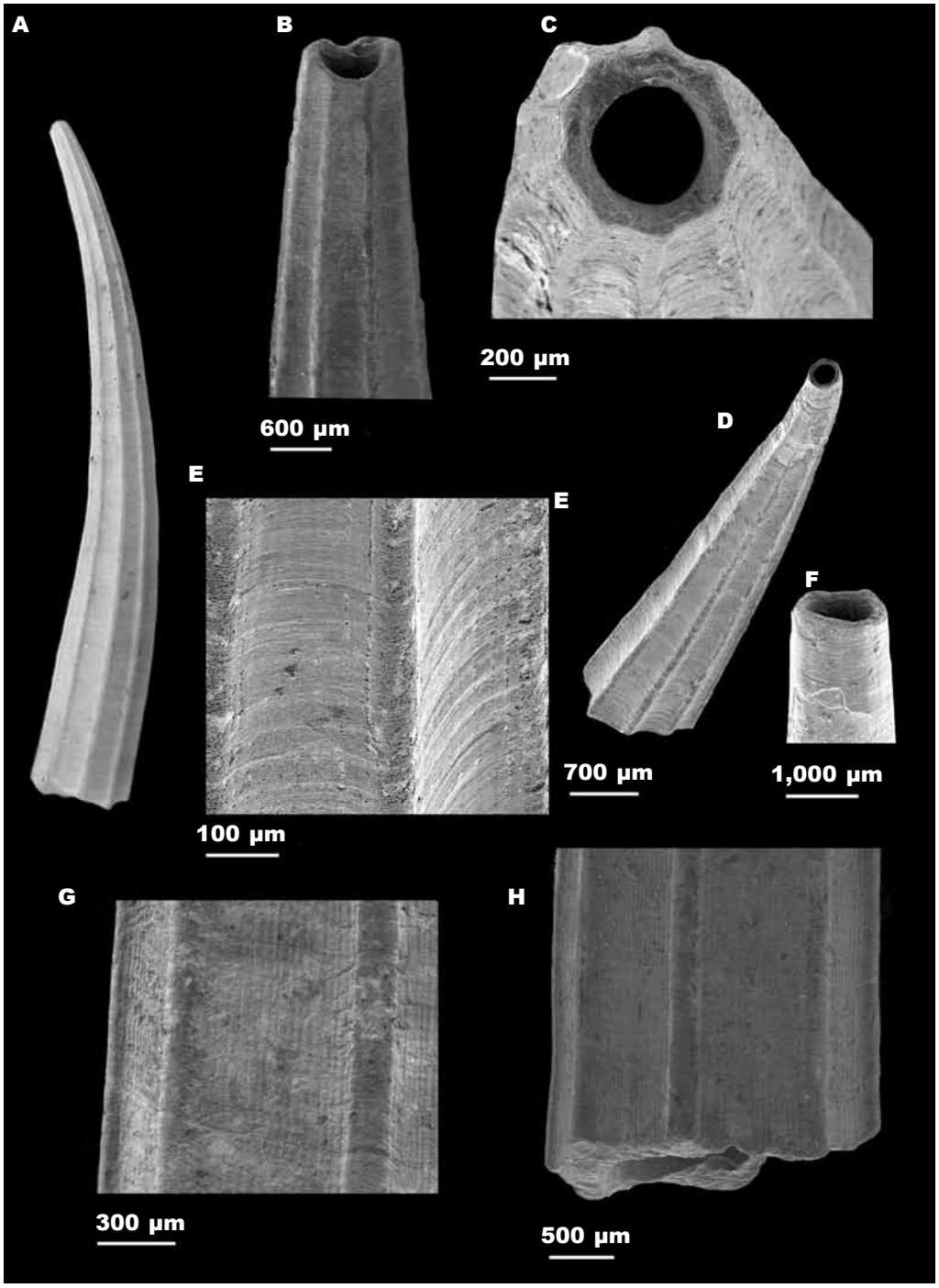

Fig. 12. *Antalis novemcostata:* A. Specimen from Guardamar del Segura (Alicante) (MVHN–150211UB05); B, C. Apex detail of a specimen from Benicassim (Castellón) (MVHN–150211UB04); D. Juvenile from Sagunto (Valencia) (MVHN–211011AC02); E. Intercostal space detail of the juvenile specimen; F. Detail of the apex pipe of the same juvenile; G. Intercostal space detail (Benicassim, Castellón); H. Basal zone (Benicassim, Castellón).

Fig. 12. Antalis novemcostata: *A. Ejemplar de Guardamar del Segura (Alicante) (MVHN–50211UB05); B, C. Detalle del ápice de un ejemplar de Benicassim (Castellón) (MVHN–150211UB04); D. Juvenil de Sagunto (Valencia) (MVHN–211011AC02); E. Detalle del espacio intercostal del ejemplar juvenil; F. Detalle del túbulo apical de dicho ejemplar; G. Detalle del espacio intercostal (Benicassim, Castellón); H. Zona basal (Benicassim, Castellón).*

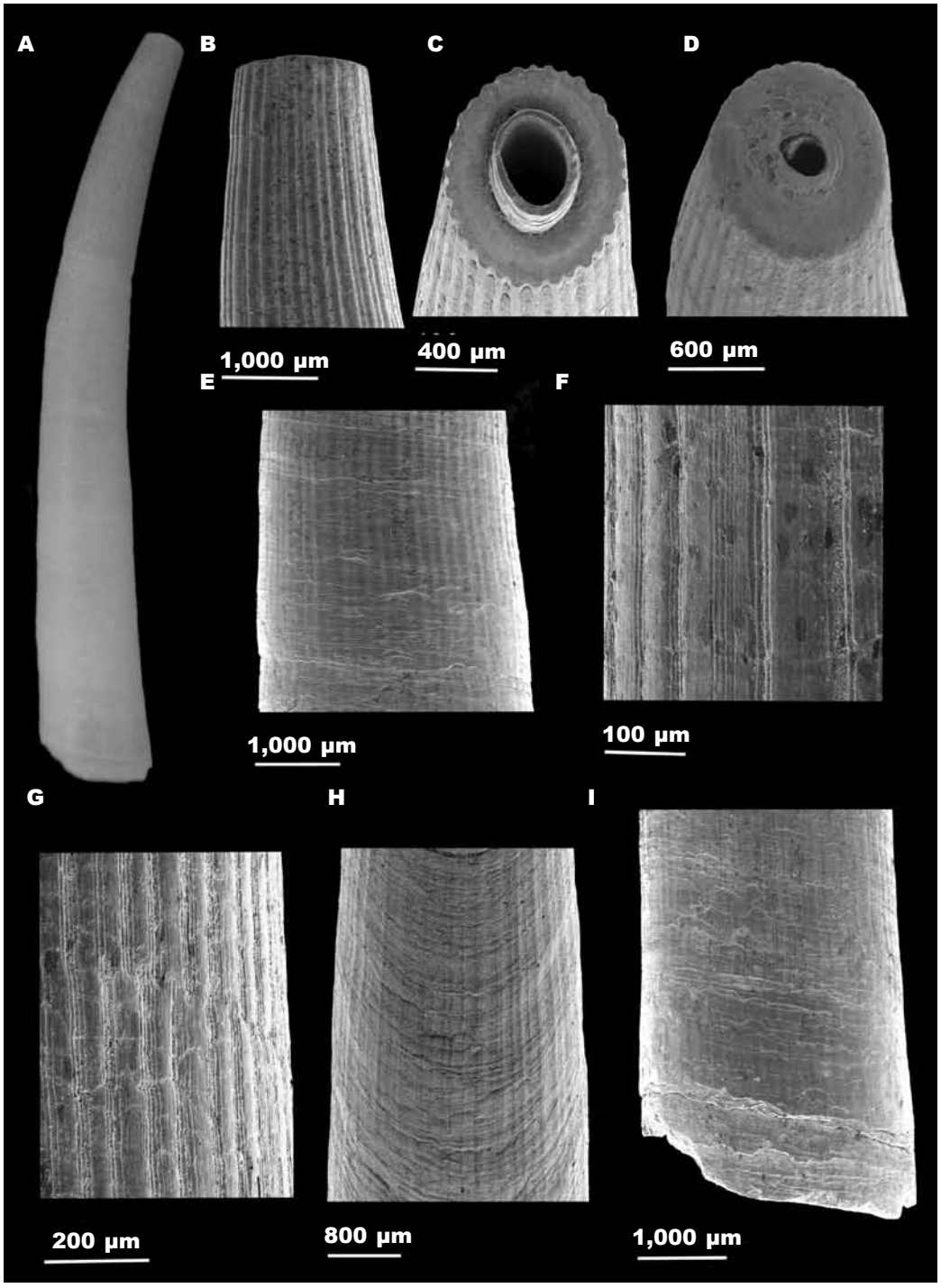

Fig. 13. *Antalis vulgaris:* A. Specimen from Oliva (Alicante) (MVHN–150211UB11). B–I. Specimen from Santa Pola (Alicante) (MVHN–150211UB09): B. Apical zone; C, D. Apex detail; E. Detail of the primary ribs; F. Intercostal space detail; G. Middle zone; I. Basal zone; C, H. Specimen from Jávea (Alicante) (MVHN–211011AC03): C. Apex with pipe; H. Detail of the secondary ribs in the basal zone.

Fig. 13. Antalis vulgaris*: A. Ejemplar de Oliva (Alicante) (MVHN–150211UB11). B–I. Ejemplar de Santa Pola (Alicante) (MVHN–150211UB09): B. Zona apical; C, D. Detalle del ápice; E. Detalle de las costillas primarias; F. Detalle del espacio intercostal; G. Zona media; I. Zona basal; C, H. Ejemplar de Jávea (Alicante) (MVHN–211011AC03): C. Ápice con túbulo; H. Detalle de las costillas secundarias en la zona basal.*

narrow deep cleft, characteristic of this species (fig. 15B) (Caprotti, 1966f, 1979; GMR, 2010; Ozturk, 2011).

Dimensions
Length 10–40 mm. Apex diameter 400–600 µm and diameter at the basal zone 2–3 mm.

Mean curvature angle
α = 9º 28' 40.95'' σ ± 1º 28' 20.11''

Habitat
Sandy sediments at depths of 4 to 618 m (Steiner & Kabat, 2004; GMR, 2010).

Geographical distribution
Mediterranean Sea and Northeast Atlantic (Steiner & Kabat, 2004; Ozturk, 2011; CLEMAM, 2012). In the Autonomous Community of Valencian it is common on the coasts of all three provinces

Order Gadilida Starobogatov, 1974
Family Entalinidae Chistikov, 1979
Genus *Entalina* Monterosato, 1872

Entalina tetragona (Brocchi, 1814) (figs. 17A–17E)

Material examined
An unpublished sample found in the Roselló collection, consisting of 12 shells (MCNV–3455b) identified as *Pulsellum quinquangulare* (Forbes, 1844) by Roselló but now considered as a junior synonym of *E. tetragona* (CLEMAM, 2012).

Description
Opaque shell, slightly curved, and white. The apical zone shows a pentagonal section and consists of five primary ribs that reach the end of the basal zone (figs. 17B–17D) (Caprotti, 1979; Steiner, 1997; GMR, 2010; Ozturk, 2011). Intercostal spaces have 28 secondary ribs (fig. 17E), considered as striae by Steiner (1997).

Dimensions
The specimens examined reach a maximum length of 9.2 mm and a maximum width of 1.3 mm.

Mean curvature angle
α = 19º 33' 20.16'' σ ± 6º 34' 42.49''

Habitat
It lives in sandy sediments at depths of 26 to 3,500 m (Steiner, 1997; Steiner & Kabat, 2004; GMR, 2010).

Geographical distribution
Mediterranean Sea and Northeast Atlantic (Steiner & Kabat, 2004; Ozturk, 2011; CLEMAM, 2012). This species is present on the Valencian coast since it was collected on the coast of the province of Valencia by Roselló on an undetermined date, but a more exact location remains unknown.

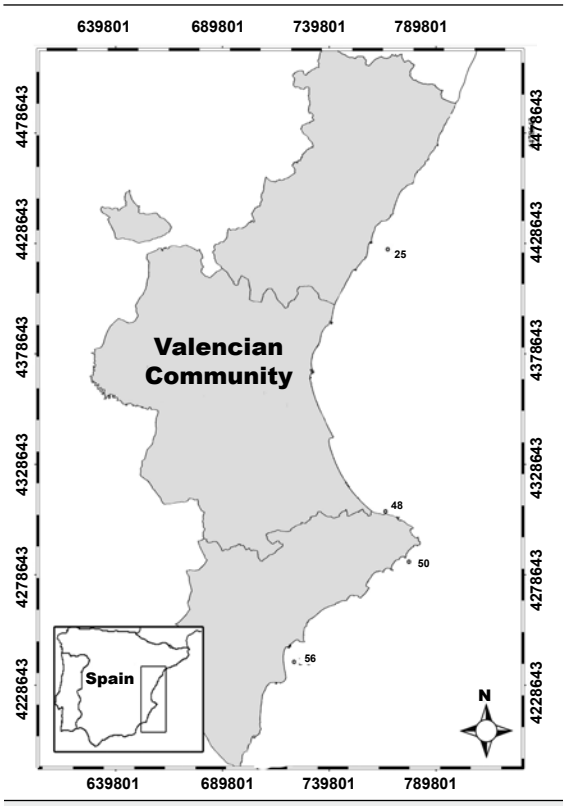

Fig. 14. Geographical distribution of *Antalis vulgaris* on the Valencian coast.

Fig. 14. Distribución geográfica de Antalis vulgaris en la costa valenciana.

Family Gadilidae Stoliczka, 1868
Genus *Dischides* Jeffreys, 1867

Dischides politus (Wood S., 1842) (figs. 6,17F–J)

Material examined
One specimen from one of the sampling stations (table 2). Besides, seven specimens were found in the Roselló collection (MCNV–nº 3456), identified as *Siphonodentalium bifissus* (Jeffreys, 1882) by Roselló (1934), but now considered as a junior synonym of *D. politus* (Steiner, 1997; CLEMAM, 2012).

Description
Translucent shell, slightly curved, subcylindrical, thin and smooth. Characteristics of the species are two short, wide clefts at the apex, dividing the shell into two parts (Caprotti, 1979; Steiner, 1997; GMR, 2010; Ozturk, 2011) (figs. 17F–17I). In adults the shell closes at the basal zone (figs. 17F–17G, 17J), having a similar morphology to the polychaete *D. arietina,* sometimes producing misidentifications.

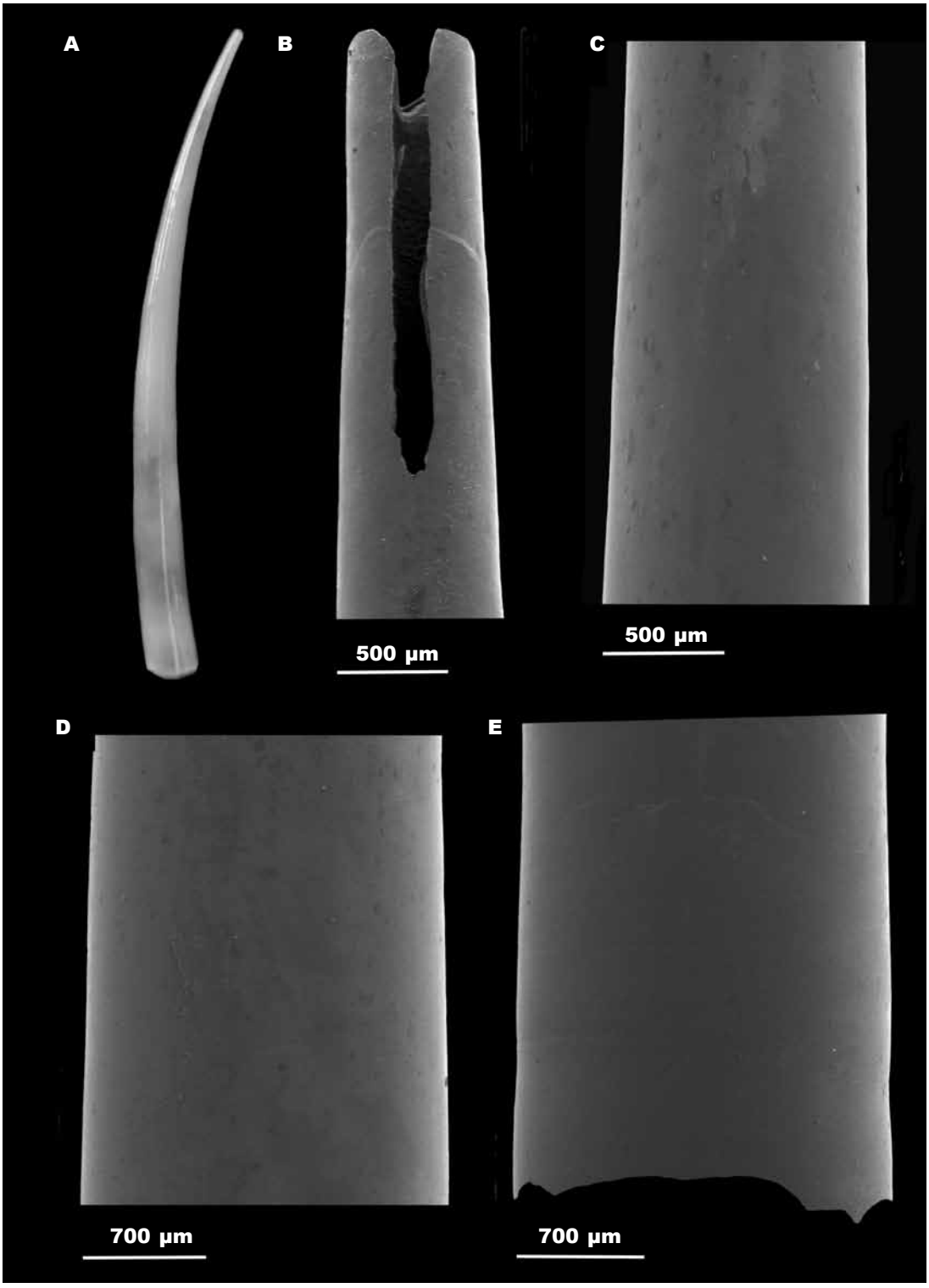

Fig. 15. A–E. *Fustiaria rubescens:* A. Specimen from Sagunto (Valencia) (MVHN–150211UB06). B–E. Specimen from Peníscola (Castellón) (MVHN–150211UB07): B. Apex detail; C. Apical zone; D. Middle zone; E. Basal zone.

Fig. 15. A–E. Fustiaria rubescens*: A. Ejemplar de Sagunto (Valencia) (MVHN–150211UB06). B–E. Ejemplar de Peñíscola (Castellón) (MVHN–150211UB07): B. Detalle del ápice; C. Zona apical; D. Zona media; E. Zona basal.*

Dimensions
Shell length from 5.7 to 8.1 mm and 1 mm in diameter.

Mean curvature angle
α = 8º 6' 52.84" σ ± 3º 24' 0.94"

Habitat
Sandy sediments at depths of 9 to 324 m (Steiner, 1997; Steiner & Kabat, 2004; GMR, 2010).

Geographical distribution
Located in the Mediterranean Sea and Northeast Atlantic (Steiner & Kabat, 2004; Ozturk, 2011; CLEMAM, 2012). On the Valencian coast it has been found at one sampling station in Benicassim (Castellón province) (fig. 6), and there is also a record on the coast of the Valencia province reported by Roselló (1934), but detailed location data are lacking.

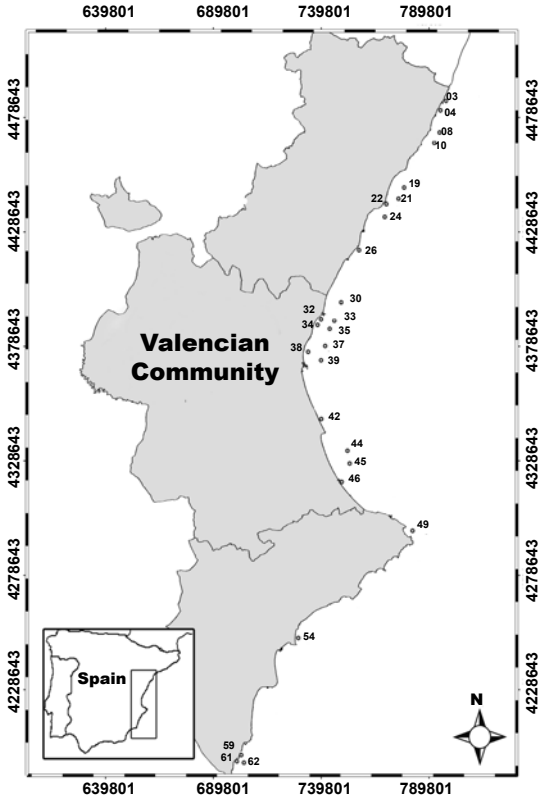

Fig. 16. Geographical distribution of *Fustiaria rubescens* on the Valencian coast.

Fig. 16. Distribución geográfica de Fustiaria rubescens *en la costa valenciana.*

Conclusions

This study shows the occurrence of eight scaphopod species on the coasts of the Autonomous Community of Valencia: *Antalis caprottii* n. sp.*, A. inaequicostata, A. dentalis, A. novemcostata, A. vulgaris, Dischides politus, Entalina tetragona* and *Fustiaria rubescens*.

The species *A. novemcostata* and *E. tetragona* are cited for the first time on these coasts. In addition, according to Hidalgo (1917), Perrier (1930), Cádiz & Martínez–Ortí (2011) and Salas & Gofas (2011) we confirm the occurrence of *A. novemcostata* for the western Mediterranean Sea. The highest abundance in the Valencian coast was recorded on the coast of Castellón province, representing 79% of the collected specimens. The most abundant collected species are *A. inaequicostata* (53.5%) and *A. dentalis* (26.3%). In addition, a new species *Antalis caprottii* n. sp. from the coast in the province of Castelló is reported.

We propose a new method to measure the scaphopod mean curvature angle (α) that we used for the eight studied species, showing that *A. inaequicosta*, *A. vulgaris*, *D. politus* and *F. rubescens* present smaller mean curvature angles than *A. caprotti* n. sp.*, A. dentalis*, *A. novemcostata* and *E. tetragona*.

This is a preliminary conclusion, however, and extensive measures of additional specimens are needed to maximize the potential of this tool to delimit and separate species.

The common species in the Mediterranean Sea, such as *A. agilis*, *A. panorma*, *C. jeffreysi*, *C. subfusiformis* and *P. lofotense*, were absent in both our sampling stations and revised collections. These species live at deeper substrates, over 100 m, than our sampling stations, which are up to 20 m deep. We expect that at least some of these species will appear in the coasts of the Autonomous Community of Valencia if future studies use suitable tools to obtain samples at deeper points. Such studies will increase the knowledge of both Valencian and Mediterranean scaphopods.

Acknowledgements

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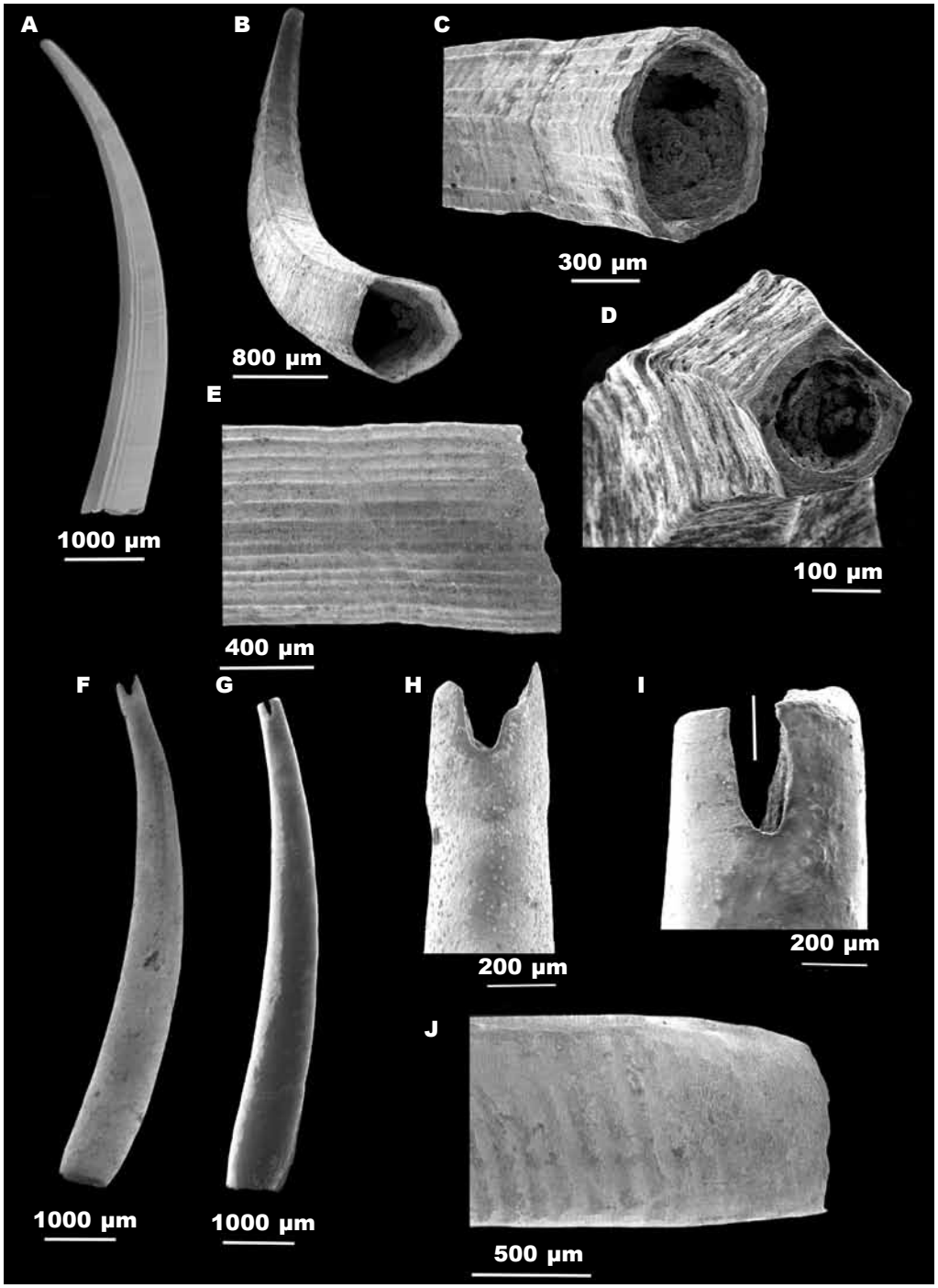

Fig. 17. A–E. *Entalina tetragona,* Valencia (MCNV–3455b): A. Adult; B. View from basal zone; C. Detail of the basal zone; D. Apex detail; E. Detail of the secondary ribs in the basal zone. F–J. *Dischides politus,* Valencia (MCNV–3456); F, G. Adults; H, I. Detail of the apical cleft; J. Detail of the shell narrowness in the basal zone. (Shells were not covered with a gold–paladium layer to avoid alteration as they are important museum specimens.)

Fig. 17. A–E. Entalina tetragona, *Valencia (MCNV–3455b): A. Adulto; B. Vista desde la zona basal; C. Detalle de la zona basal; D. Detalle del ápice; E. Detalle de las costillas secundarias en la zona basal. F–J.* Dischides politus*, Valencia (MCNV–3456); F, G. Adultos; H, I. Detalle de la fisura apical; J. Detalle del estrechamiento de la concha en la zona basal. (Los conchas no han sido cubiertas por una capa de oro–paladio para evitar su alteración por tratarse de importantes muestras museísticas.)*

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