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## Brachiopods from the Barremian turbiditic formations of Serre de Bleyton, Drôme (SE France)

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(with 3 plates and 1 figure)

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### Abstract

Brachiopods from three outcrops sampled in the Barremian turbiditic formations, from Serre de Bleyton, Drôme (SE France) by G. MOOSLEITNER, reveal a great biodiversity. In the large samples obtained and dispatched to different specialists, lots of small organisms exist, among them Rhynchonelliform brachiopods. The shells observed are recognized as size-sorted and transported specimens trapped in a mud-flow. These specimens, representatives of Rhynchonellida, Thecideida, Terebratulida, are described following their morphological characteristics. The present state of the deltidial plates, among morphological characteristics, and the geological and sedimentological contexts from which they are extracted lead to the conclusion in favour of juvenile rather than micromorphic specimens.

**Keywords:** Juvenile brachiopods, Rhynchonellida, Terebratulida, Thecideida, Barremian, SE France, turbidites.

### Introduction

Many small entire or disarticulated brachiopod shells have been revealed from three outcrops in a turbiditic series at Serre de Bleyton, Drôme provençale, in the Commune of Arnayon (SE France). These Lower Cretaceous brachiopods are mainly smooth, poorly preserved, and result from size-sorted brachiopod populations, i.e. reworked assemblages. In such a context, it is difficult to be precise about a geologic age, i.e. precise zonal references, for this material redeposited from an outer shelf into an upper slope environment. The samples are juvenile specimens, in this case the evaluation must be made with caution. In the absence of adult counterparts some specimens will stay in open nomenclature because it is hazardous to recognize species characteristics with juveniles, and particularly with terebratulides and none-ornamented specimens. Nevertheless, representatives

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of several Rhynchonelliformean brachiopods have been identified (Rhynchonellida, Thecideida, Terebratulida), they are compared with a sample from a bioclastic horizon near les Tonils, a little village 25 km NW from Serre de Bleyton, though less diversified, but with somewhat larger specimens which could approach a premature stage. The main point to be highlighted here is above all the wide diversity observed in these small, poorly exposed outcrops.

Revision of the Barremian fauna from the stratotype and from SE France (cf. collection “Patrimoine géologique”, GASPARD, submitted) gives a more complete idea of the Tethyan Barremian brachiopods.

### **Studied area and geological setting**

Serre de Bleyton, though still unknown from a palaeontological point of view, is a little hill in La Drôme provençale, SE France, located east of Col de la Pertie easily reached by road D 570. From here, a small forest road leads to the three outcrops where the brachiopods have been found along with a diverse and rich fauna (ammonoids, bryozoans, asteroid ossicles, crinoids, corals, ostracods, foraminids...). Serre de Bleyton, a few hundred meters in diameter, is bordered by the torrent d’Arnayon to the North, Montagne d’Angèle to the West, headwaters of Léoux to the South, and Serre de Malivert to the East (for a full explanation and coordinates see KROH et al. 2010).

These small outcrops concern turbiditic formations in three different successive levels exposed at Serre de Bleyton (Fig. 1). The first outcrop concerned is a small visible part of the turbidite exposed at the surface (15 cm thick and some meters in length) with a large number of fossils more or less free. The second outcrop, only 15 m from the first, has some larger fossils (compared to the first exposure) in addition to the tiny ones, but not well preserved. The microfossils indicate late Lower Barremian to the Uppermost Barremian (pers. comm. P. MOJON based on the ostracods), Cretaceous stage for which zonal references are mentioned concerning SE France (among others: VERMEULEN 2005; REBOULET et al. 2009; BERT & DELANOY 2009...). The third outcrop, on the southeast side of Serre de Bleyton, about 50 m from the first outcrop, yields belemnites, small brachiopods and also broken larger specimens badly preserved in an upside down series. This last formation is a conglomeratic level present between massive marly banks of Middle/Upper Barremian boundary age dated according to JANSSEN (2010) based on the belemnites. The samples from Tonils are of Upper Barremian age (cf. Geologic map, Dieulefit 1: 50 000, BRGM).

These Lower Cretaceous formations, sampled by G. MOOSLEITNER, occur along a fault located east of Montagne d’Angèle and have overturned. Thus, the dating of the formations must be considered with caution. ARNAUD’s conclusions (in prep.) could shed some light concerning the complicated tectonic situation in this area. The turbiditic events invoked here could be compared with those presented by FERRY (2005).

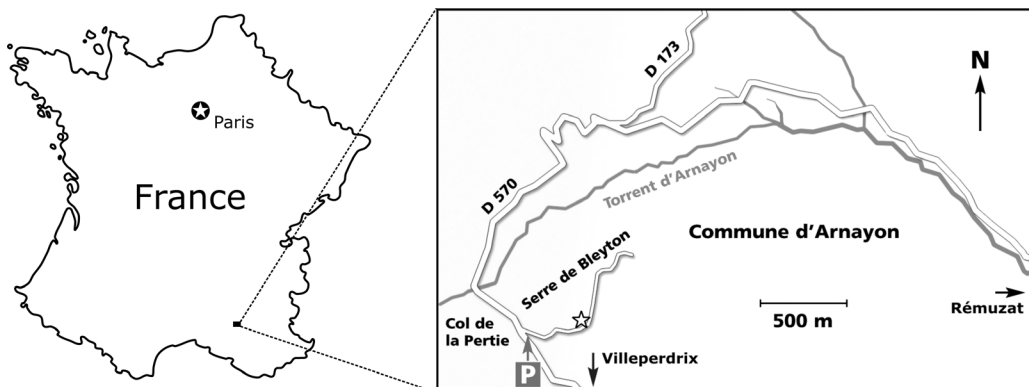


Fig. 1. Sample localities (asterisk) at Serre de Bleyton.

### Material, Preservation and Methods

The Rhynchonelliform brachiopods (a few hundreds of juvenile specimens) from the three outcrops of Serre de Bleyton reveal representatives of Rhynchonellida (Cyclothyrididae), Thecideida (Thecideidae) and Terebratulida (Sellithyrididae, Cancellothyrididae, Laqueidae, Terebrataliidae).

While brachiopods are benthic organisms living attached on firm substrates by means of the pedicle through the foramen, their bivalve shells (ventral = pedicle valve and dorsal = brachial valve) are described following their external morphology (global shape, convexity, shape of the umbo, posterior part of the ventral valve, size and shape of the foramen = pedicle aperture, ornamentation...). The internal morphology generally taken into account with the characteristics of the brachidium, median septum and muscle scars, are missing due to the size and poor preservation of the material. In the present case the small specimens do not easily permit the making of transverse serial sections to ensure these aspects. Some microstructural details have been revealed using the scanning electron microscope (SEM) after gold coating. Because of the small size of most specimens, the SEM has been also useful to study the external morphology and consequently help approach some species.

The later precisions are important to note owing to the fact that brachiopods develop their generic and specific characteristics, after the juvenile growth stage, during premature and mature stages.

**Repository:** The material described is stored in the Palaeontological collections of the Natural History Museum, Vienna (Austria); NHMW 2010/0204/0001 to 2010/0204/00046.

## Systematic palaeontology

The classification is based on the work of WILLIAMS et al. (1996) presented in the revised edition of the Treatise on Invertebrate Paleontology concerning brachiopods (in KAESLER 1997–2006).

State of art: The Tethyan Barremian brachiopods as recorded in the revision of the stratotype and SE France (GASPARD, submitted) highlight the occurrence of Pugnacoidea (*Fortunella* and *Lacunosella*), Dimerelloidea (*Peregrinella*), Norelloidea (*Monticlarella/Suiaella*), Hemithiridoidea: Cyclothyrididae (*Lamellaerhynchia* cf. *renauxiana*, “Rh”. *sayni*, “Rh”. *kiliani*) and Tetrarhynchiidae (*Belbekella rotundicostata*) for the Rhynchonellida – Thecideoidea (*Thecidiopsis* cf. *tetragona*) for the Thecidea and Terebratuloidea (*Sellithyris sella*, *S. campichei*, *Loriolithyris russillensis*, *L. valdensis* & *L. germani*, *Moutonithyris moutoniana*, *Praelongithyris salevensis*); Discolioidea: Pygopidae (*Pygope diphya*, *Pygites diphyoides*), Nucleatidae (*Nucleata* sp.); Cancellothyridioidea (*Terebratulina biauriculata*); Zeillerioidea (*Vectella*) and Laqueoidea (*Psilothyris tamarindus*, *Helvetella* sp., *Ismenia* sp.) for the Terebratulida. However the size and preservation of the material cannot easily permit the recognition of diagnostic characteristics, consequently few species are noticed and often only genera even subfamilies are highlighted, while other taxa known from SE France are missing at Serre de Bleyton.

Phylum Brachiopoda DUMÉRIL, 1806

Subphylum Rhynchonelliformea WILLIAMS et al., 1996

Order Rhynchonellida KUHN, 1949

Superfamily Hemithiridoidea RZHONSNITSKAIA, 1956

Representatives of this superfamily are among the most common specimens in the material, their shape is globally subtriangular to subpentagonal and they are strongly costate shells.

Family Cyclothyrididae MAKRIDIN, 1955

Subfamily Cyclothyridinae MAKRIDIN, 1955

### Cyclothyridinae indet.

(Pl. 1, Figs 1–12)

Material: Figured specimens: NHMW 2010/0204/0001, 0005, 0009, and NHMW 2010/0204/0036 for the remaining specimens from locality 1 (8 > 10 mm in length, 6 > 9 mm, 14 > 8 mm, 21 > 7 mm); NHMW 2010/0204/0004, 0007 (figured specimens) and NHMW 2010/0204/0037 for the 10 others (1.5–7 mm) from locality 3, and NHMW

2010/0204/0002, 0003, 0008 for figured specimens and NHMW 2010/0204/0038 for the remaining material from Tonils.

**Description & Remarks:** Specimens with fully and densely costate shells, with uniplicate anterior margin (sometimes lightly asymmetric) are considered to be representatives of the family and subfamily. The state of preservation of the material does not allow us to ascertain the morphology of the posterior area (smooth or not), but the beak is massive and erect, and the deltidial plates, produced into a short tube around the pedicle in the larger specimens is a characteristic of the subfamily. The large foramen and the conjunct deltidial plates, in some cases well exposed, as well as the numerous costellae, finer posteriorly, could indicate that the juveniles belong to *Cyclothyris* M'COY (Pl. 1, Fig. 1). However, due to the distribution of the morphological characters of most specimens a better fit is with *Lamellaerhynchia* BURRI, 1953 (Pl. 1). Nevertheless, considering the evolution of characters during morphogenesis, some specimens remain with their deltidial plates incompletely formed (Pl. 1, Figs 2–3, 7, 9, 10). Therefore, we are unable to conclude without the bases for appreciating the ontogenetic stages, and with the unobserved internal characters, except when the dorsal septum is revealed with the help of abrasion.

Comparisons have been made with *Sulcirhynchia* BURRI, *Lepidorhynchia* BURRI and other Barremian species mentioned in SE France (JACOB & FALLOT 1913) owing to their global shape, shape of ventral beak, shape and number of costae without positive conclusion.

The numerous costellae, fine posteriorly, show some bifurcations, the intercostae areas reveal elementary growth lines using SEM (Pl. 1, Figs 11–12).

Among species holding attention we can highlight affinities with *Lamellaerhynchia multicosata* BURRI, 1956 (Pl. 1, Figs 1–4) evoked in the Lower Barremian formations of the Jura; *Lamellaerhynchia picteti* BURRI, Upper Hauterivian to Lower Barremian (Pl. 1, Figs 5a–b) and probably *Lamellaerhynchia gillieron* (PICTET), Upper Hauterivian to Lower Barremian (Pl. 1, Figs 8a–b).

Comparisons have been made with *L. renauxiana* (D'ORBIGNY) and “*Rh.* *multiformis* ROEMER var. *rotundicostata* JACOB & FALLOT = *Belbekella rotundicostata* (JACOB & FALLOT) from SE France, but the global convexity, proportion of ventral and dorsal valves, size of foramen and shape of deltidial plates as well as shape of anterior margin have not been recognized owing to the small shell size.

Many specimens have not been mentioned owing to their size (1 mm) and/or their enigmatic proportions in relation to their size (Pl. 1, Figs 6, 10).

Order Thecideida ELLIOTT, 1958

Superfamily Thecideoidea GRAY, 1840

Family Thecideidae GRAY, 1940

Subfamily Thecideinae GRAY, 1840

***Thecidiopsis tetragona* (ROEMER, 1839)**

(Pl. 2, Figs 1–8)

**Material:** Mostly separate valves (dorsal valves = DV) for 2 complete specimens from locality 1 (30 DV, 1 VV, 1 entire; NHMW 2010/0204/0010, .../0012–0017 and NHMW 2010/0204/0039) and locality 2 (22 VD, 2 VV, 1 entire; NHMW 2010/0204/0011, 2010/0204/0040) from 2–5 mm were observed, but only few reveal visible details.

**Description:** Usually the Thecideida are small articulate ventribiconvex brachiopods living attached by cementation. Several smooth separate valves were sampled in the two first outcrops of Serre de Bleyton, but with more dorsal than ventral valves. Entire specimens are rare. The species has not been sampled at les Tonils. The valves hinged together by unsupported cyrtomatodont teeth and sockets permit an abnormally wide gape. This situation facilitates the postmortem disarticulation of valves followed by a spatial separation of dorsal from attached ventral valves, which has been increased by turbiditic transportation. This explains why more dorsal valves have been found in the samples.

The shells are transverse and most of the larger brachial valves measured are between 4 and 5 mm in width compared to a size generally up to 6–10 mm in width and 8–10 mm in length for adults. The ventral valves are thick, revealing a light uneven posterior (attached zone on the substrate), the teeth, pseudodeltidium and a small hemispondylium as well as a tuberculate interior margin (Pl. 2, Figs 1–2). The ventral interarea is well defined.

Dorsal valve interiors reveal the brachioskeletal, a straight hinge line, round rectimarginate anterior margin, a large cardinal process, well-developed inner socket ridges and converging crura. The median septum divided during growth to form lateral septa interdigitating with brachial lobes (most often damaged in the samples owing to transportation). The specimens are considered to be polyseptate (Pl. 2, Figs 3–7).

**Remarks:** Misinterpretations could appear sometimes with juveniles, which have been previously assigned to different genera (Pl. 2, Fig. 8). Although dorsal valves in the fossil record have often been found damaged, some work recalled by BAKER (1990, 1991, 2006) tried to establish their phylogeny and general course of evolution, which has been recently updated (BAKER & LOGAN 2011) with the help of early growth stages.

The type layer is the “Hilsconglomerat”, Hauterivian, Germany, but the species is generally mentioned from the Valanginian of the Swiss Jura, Czech Republic, Hauterivian of Haute-Marne, Lower Hauterivian of Germany and Lower Barremian from some Russian

locations (Konstantinovka) (PAJAUD 1970; SMIRNOVA 1962), but not yet in the Middle or Upper Barremian.

## Order Terebratulida WAAGEN, 1883

### **Terebratulida indet.**

**Material:** Many specimens mainly from locality 1 (about 200) and 23 for locality 2.

## Superfamily Terebratuloidea GRAY, 1840

### **Terebratuloidea indet.**

**Material:** NHMW2010/0204/0018 to .../0025 for the figured material, NHMW 2010/0204/0041 and 0042 respectively for the remaining material from locality 1 and 2.

## Family Sellithyrididae MUIR-WOOD, 1965

### **Sellithyrididae indet.**

(Pl. 2, Figs 9–13, 15)

**Description:** Many tiny specimens (0.6 mm to 2.5 mm in length) are suspected to belong to this family. They exhibit a relatively wide foramen, a pedicle collar exposed, a long and straight ventral beak and initial deltidial plates, (Pl. 2, Figs 9–13). It is presumptuous to assign them to a precise species among those coexisting during the Barremian in SE France and belonging to the genera *Sellithyris*, *Loriolithyris*, *Moutonithyris* and *Praelongithyris* MIDDLEMISS. Particularly, it is impossible looking at juvenile specimens selected from a true population of *Sellithyris*, for example, to pronounce a generic or specific diagnostic.

In addition somewhat more developed specimens allow a better approach, among them are found *Loriolithyris* aff. *germaini* (PICTET, 1872) from Tonils (Pl. 2, Fig. 15) and the following species.

## Subfamily Rectithyridinae, MUIR-WOOD, 1965

Genus: *Moutonithyris* MIDDLEMISS, 1976

### ***Moutonithyris* aff. *moutoniana* (D'ORBIGNY, 1847)**

(Pl. 2, Fig. 14)

**Material:** Rare specimens from locality 1 and 3.



**Description:** Small shells around 3 mm in length show affinities with *Moutonithyris moutoniana* (D'ORBIGNY) (Pl. 2, Fig. 14). The oval elongated dorsibiconvex rectimarginate shell presents a wide permesothyrid foramen. Major growth lines and punctae on a smooth surface are generally observed. The shell has some tendency to become flatter near the anterior part. The internal characteristics cannot be highlighted here, but they have been observed in a previous work (GASPARD 1988) in which Barremian specimens have been noticed. The species is known to be present from the Berriasian till the Aptian in S.E. France.

Another kind of specimen with a more elongate smooth shell (7.3 mm in length) compared to *M. moutoniana*, with a longer beak, high conjunct deltidial plates and more inclined lateral margins is observed (Pl. 2, Fig. 15). Regularly spaced growth lines are revealed externally as well as punctae when observed using the SEM. It could be assigned to the straight and elongate morphotype of the species mentioned above but this is not ascertained in absence of tertiary shell layer proof. The general shell shape, ventral umbo and posterior characteristics allow a closer comparison with a species previously recorded (see *L. germaini*).

Genus *Praelongithyris* MIDDLEMISS, 1959

***Praelongithyris* sp.**

(Pl. 2, Fig. 16)

**Material:** Rare specimens were recognized (locality 2).

**Description:** Elongate oval shell with a nearly straight beak, very wide meso to permesothyrid foramen (nearly 1 mm diameter for 5.3 mm shell length) cutting the posterior end of the ventral valve, strong conjunct deltidial plates show affinities with *Praelongithyris* MIDDLEMISS (Pl. 2, Fig. 16). At this juvenile stage some confusions could be introduced between a species of the genus *Praelongithyris* and one of *Rhombothyris* MIDDLEMISS (1959), compared to *Aniabrochus* COOPER (1983), a Capillithyrididae, smooth or faintly capillate which presents less higher deltidial plates. Nevertheless, at this stage serial sections cannot be made.

**Remarks:** *Praelongithyris salevensis* (DE LORIO) is one of the species occurring in the Barremian of SE. France.

Superfamily Cancellothyridoidea THOMSON, 1926

Family Cancellothyrididae THOMSON, 1926

Subfamily Cancellothyridinae THOMSON, 1926

Genus *Terebratulina* D'ORBIGNY, 1847



***Terebratulina* aff. *biauriculata* D'ORBIGNY, 1847**

(Pl. 3, Figs 1–2)

**Material:** Rare specimens from locality 1 (1) and 3 (1) were recognized (NHMW2010/0204/0026, .../0043).

**Remarks:** The species mentioned in synonymy with *T. auriculata* ROEMER is rectified (1847, p. 271) as *Terebratulina biauriculata* by the author.

The unique specimen observed entire from locality 1 (12 mm length, 10 mm width) is somewhat compressed (Pl. 3, Fig. 1). It is assigned as follows: *Terebratulina* aff. *biauriculata* D'ORBIGNY. The biconvex shell is elongate-oval and uniplicate. The capillate to costellate valves surface presents several levels of bifurcation, the first one is initiated at 2 mm from the posterior dorsal umbo followed by three or four other divisions or intercalations (Pl. 3, Fig. 2).

In absence of loop details, the shell is maintained in the genus *Terebratulina*. At the posterior brachial valve, two light auriculate zones are revealed leading one to associate the specimen with the species name *Terebraulina biauriculata* D'ORBIGNY. A large foramen, mesothyrid to permesothyrid, (about 1 mm diameter), is bordered by two disjunct triangular deltidial plates. The hinge line is narrow and straight.

Observed using the SEM, the shell reveals numerous small punctae and several major growth lines near the margins (Pl. 3, Fig. 2). The abrasion, leading to a diagenetic evolution, at the external surface prevents observation of the alignment of small nodules on the auriculate zones.

Suborder Terebratellidina MUIR-WOOD, 1955

Superfamily Laqueoidea THOMSON 1927

Family Laqueidae THOMSON, 1927

Subfamily Terebrataliopsinae SMIRNOVA, 1990

Genus *Psilothyris* COOPER, 1955

***Psilothyris tamarindus* (J. DE C. SOWERBY in FITTON, 1836)**

(Pl. 3, Figs 3–10, 13)

**Material:** The species is recognized from the 1<sup>st</sup> outcrop at Serre de Bleyton (50 entire shells, 2 DV – NHMW2010/0204/0029, 0032 figured specimens and NHMW2010/0204/0044 for remaining material) and (4 DV – NHMW2010/0204/0027, 0028, 0030–0033, figured specimens and NHMW2010/0204/0045 for remaining material) from the 2<sup>nd</sup> outcrop, as well as NHMW2010/0204/0046 from Tonils.

**Description:** Some shells, 2.8–7 mm in length, consistent with COOPER's (1955) genus, commonly found in Haute Marne, Yonne and Jura (D'ORBIGNY 1847–51), have been

observed with a round to pentagonal shape, sometimes smooth (Pl. 3, Figs 3–10, 13). A parallel can be drawn between them and small specimens of *Psilothyris tamarindus* (J DE C SOWERBY) found in the Lower Barremian of eastern Serbia (POLAVDER & RADULOVIC 2005), as they bear comparison with the illustrations of OWEN (1965). Rare dorsal valve interiors were found and observed exhibiting the median septum, supporting the septalium and high internal ridge dental sockets (Pl. 3, Fig. 5). However, the shells sampled are mostly ragged (Pl. 3, Figs 4, 6–7, 10), which reveals the dorsal median septum (sometimes proportionally longer compared to adult stage) supporting the septalium (Pl. 3, Figs 7, 10, 13), and stripped fibres surrounding numerous punctae (about 20 µm in diameter) (Pl. 3, Fig. 9). The foramen is wide, bordered by two disjunct deltidial plates. The shell is rec-timarginate with, exceptionally, a very light suggestion of uniplication.

Family Terebrataliidae RICHARDSON, 1975

Subfamily Gemmarculinae ELLIOTT, 1947

Genus *Ismenia* KING, 1850

***Ismenia* sp.**

(Pl. 3, Figs 11–12, 14–15)

**Material:** Two fragmented valves.

**Description:** The larger incomplete transverse valve 8.8 mm in length and 6.8 mm in width, ornamented with 5 round prominent plicae, observed along its internal and external surfaces, is assigned to the genus *Ismenia* (Pl. 3, Figs 11–12) by comparison with complete specimens sampled in a mud-flow series of the Lower Barremian from SE France. This valve does not reveal any remaining parts of its internal characters, but a dense net of wide punctae (more than 25 µm for the largest) is observed using the SEM. As well, major growth lines, enhanced in the anterior half of the shell, are revealed (Pl. 3, Figs 14–15).

## Conclusion

The reworked Barremian material in the turbiditic formations of Serre de Bleyton, essentially containing juvenile specimens of brachiopod species, does not permit us to provide a zonal reference. Nevertheless these juvenile representatives of Rhynchonelliiform brachiopods have been approached, and some identified with the help of adult Barremian species sampled near the Barremian stratotype and from Southeastern France (GASPARD, submitted). The main interest of the sampled small outcrops is the wonderful diversity not only of the brachiopods, but also of numerous other associated groups of fossils. However, it is the opportunity to highlight the fact that description of juveniles and of all age groups of species, when available, should be of outstanding importance what will ensure us not being deprived of important information. Another interesting point to be emphasized is

the presence of thecideoid brachiopods, and particularly of juvenile thecideoids, which are rarely observed or mentioned in the Barremian formations of Southeastern France.

The largest specimens observed, when worn, reveal inside numerous small grains confined between valves or in the foramen aperture, they are pseudo-oolitic grains generally mentioned in turbiditic formations (see Pl. 1, Figs 4, 8a, 10; Pl. 2, Figs 5–7, 13, 14) and susceptible to give a sedimentary signature in relation to their size.

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## Plate 1

### Cyclothyridinae

Figs 1a–b. *Lamellaerhynchia* aff. *multicostata* BURRI, 1956, from locality 1, Serre de Bleyton, dorsal (a) and anterior (b) views; scale bar equals 2 mm. NHMW 2010/0204/0001.

Fig. 2. *Lamellaerhynchia* aff. *multicostata* BURRI, 1956, Tonils; scale bar equals 1 mm. NHMW 2010/0204/0002.

Fig. 3. *Lamellaerhynchia* aff. *multicostata* BURRI, 1956, Tonils, details of fig 2: deltidial plates and foramen; scale bar equals 500  $\mu$ m.

Fig. 4. *Lamellaerhynchia* aff. *multicostata* BURRI, 1956, Tonils; scale bar equals 1 mm. NHMW 2010/0204/0003.

Figs 5a–b. *Lamellaerhynchia* sp., locality 3, Serre de Bleyton; scale bar equals 2 mm. NHMW 2010/0204/0004.

Fig. 6. Juvenile Rhynchonellid with initial deltidial plates; scale bar equals 1 mm. NHMW 2010/0204/0005.

Fig. 7. *Lamellaerhynchia* sp., juvenile specimen from Serre de Bleyton with initial deltidial plates; scale bar equals 1 mm. NHMW 2010/0204/0006.

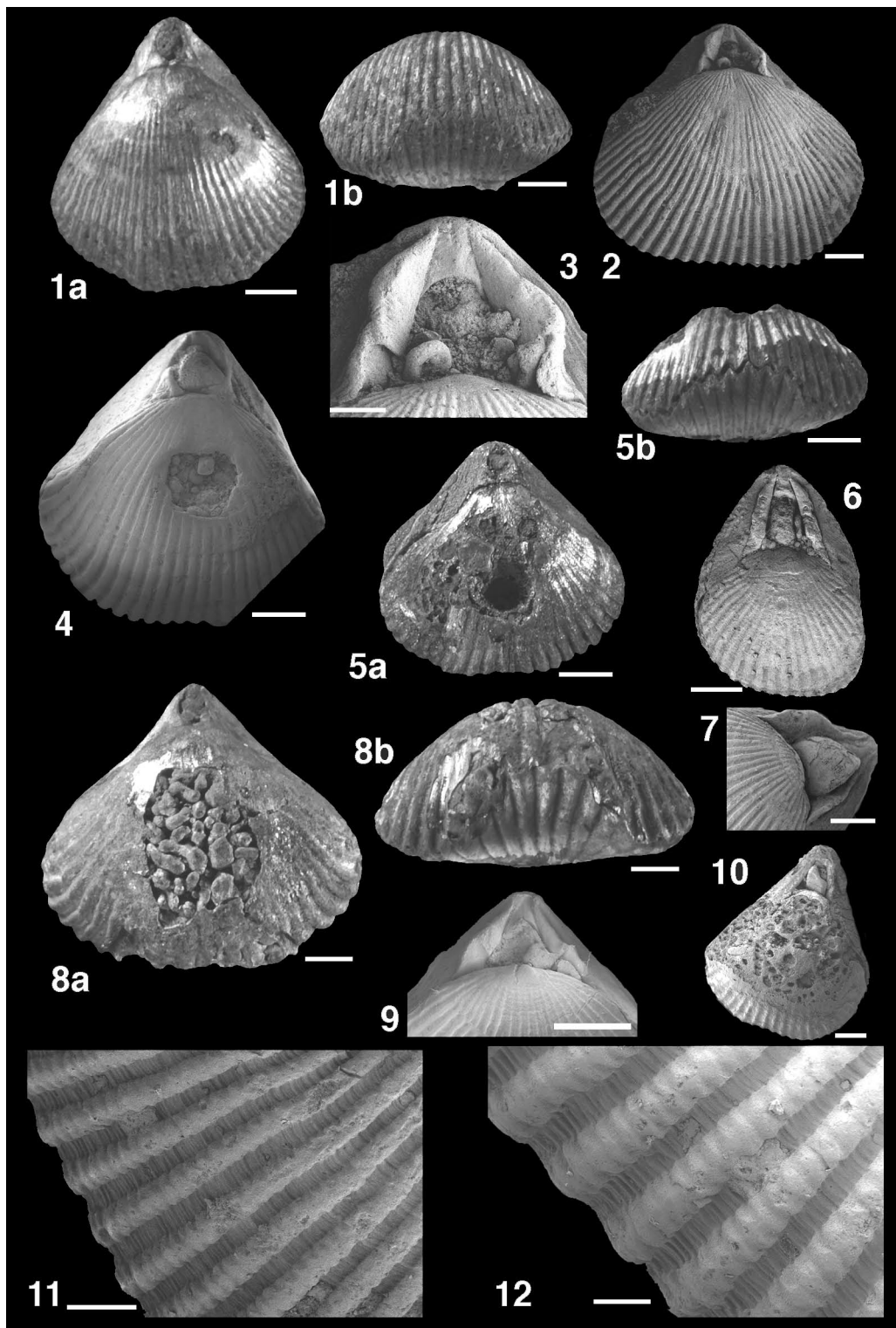
Fig. 8a–b. *Lamellaerhynchia* sp., worn specimen from locality 3 at Serre de Bleyton, revealing coarser costae and pseudo–oolitic grains inside the shell; scale bar equals 2 mm. NHMW 2010/0204/0007.

Fig. 9. View highlighting the initial deltidial plates in a juvenile specimen from Tonils; scale bar equals 1 mm. NHMW 2010/0204/0008.

Fig. 10. Juvenile worn specimen of *Lamellaerhynchia* sp., showing the imprints of pseudo–oolitic grains inside the shell, and the initial deltidial plates; scale bar equals 1 mm. NHMW 2010/0204/0009.

Figs 11–12. Detail of the surface of the shell illustrated Fig. 2 (median zone (11) and antero–lateral zone (12)) revealing details of the costae and microgrowth–lines; scale bar equals 500  $\mu$ m.







## Plate 2

### *Thecidiopsis tetragona* (ROEMER, 1839)

Fig. 1. Ventral valve, from locality 1; scale bar equals 1 mm. NHMW 2010/0204/0010.

Fig. 2. Ventral valve interior from locality 2; scale bar equals 1 mm. NHMW 2010/0204/0011.

Figs 3–7. Young dorsal valve (DV), from locality 1, illustrating part of the development of the brachioskeletal and revealing the cardinal process, the inner sockets ridges, the median septum with median concavity obviously announcing the coming lateral septae (3–4), small tubercles delineating brachial lobes (4: white arrows), and the polyseptate aspect (5–7); scale bar equals 1 mm. NHMW 2010/0204/0012–0016.

Fig. 8. Early juvenile stage (DV); scale bar equals 500  $\mu$ m. NHMW 2010/0204/0017.

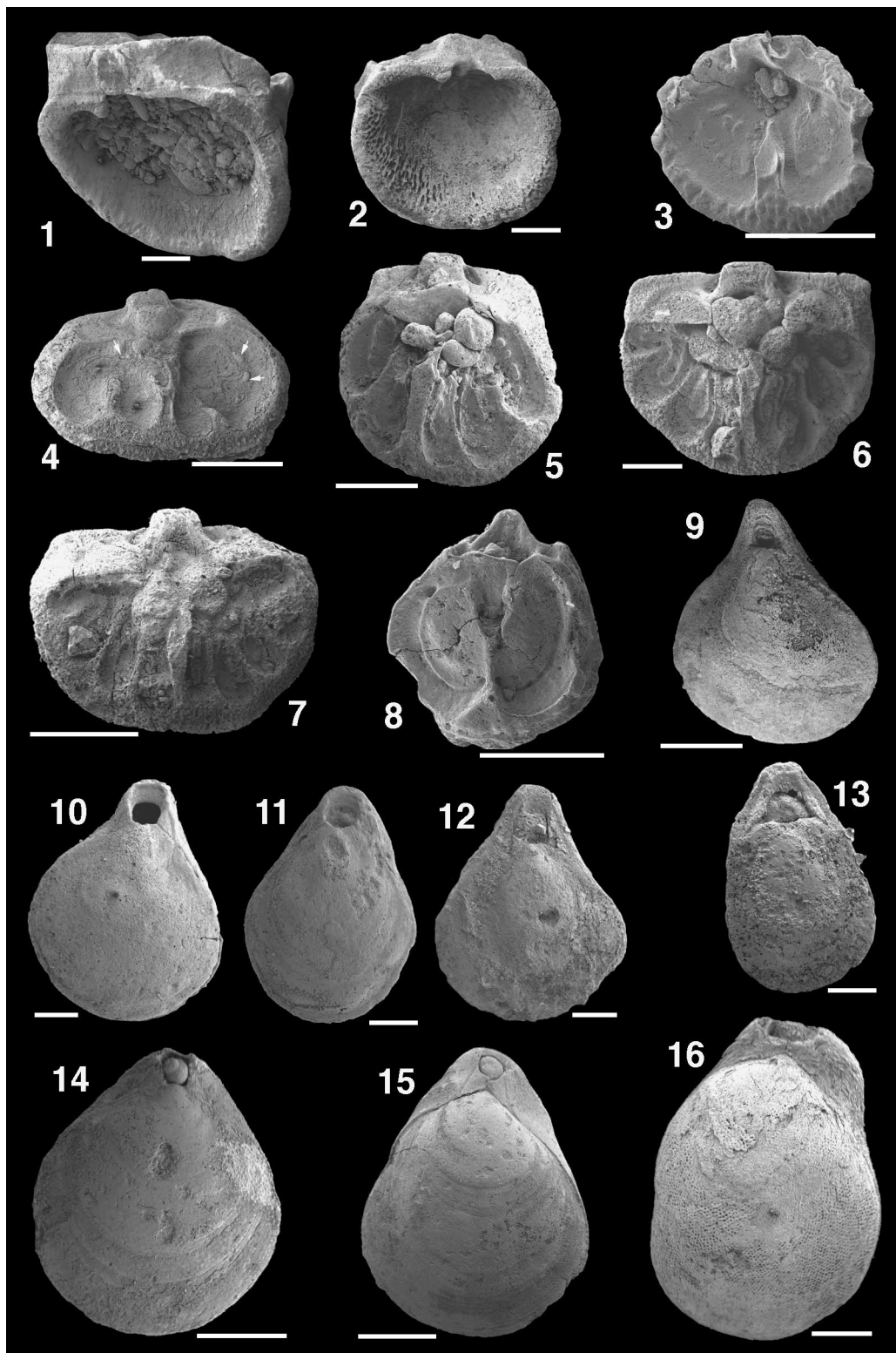
### Terebratulida

Figs 9–13. Young different terebratulid representatives, from locality 2 (10–12) and locality 1 (13), revealing the hypothyrid foramen, a well exposed pedicle collar and the initial deltidial plates; scales respectively = 1 mm (9–10), 500  $\mu$ m, (10–12) and 250  $\mu$ m (13). NHMW 2010/0204/0018 – 0022.

Fig 14. *Moutonithyris* aff. *moutoniana* (D'ORBIGNY, 1847), locality 2 of Serre de Bleyton; scale bar equals 1 mm. NHMW 2010/0204/0023.

Fig 15. *Loriolithyris* aff. *germaini* (PICTET, 1872) from Tonils; scale bar equals 2 mm. NHMW 2010/0204/0024.

Fig 16. *Praelongithyris* sp., locality 1, Serre de Bleyton; scale bar equals 1 mm. NHMW 2010/0204/0025.



### Plate 3

#### ***Terebratulina* aff. *biauriculata* D'ORBIGNY, 1847**

Fig. 1. Dorsal view, locality 1, Serre de Bleyton: scale bar equals 2 mm. NHMW 2010/0204/0026.

Fig. 2. Detailed antero–lateral surface of Fig. 1 highlighting the intercalations of the costae (arrows) and major growth–lines (arrow heads); scale bar equals 500 µm.

#### ***Psilothyris tamarindus* (J. DE C. SOWERBY in FITTON, 1836)**

Fig. 3. Dorsal view of a specimen from locality 2; scale bar equals 1 mm. NHMW 2010/0204/0027.

Figs 4,8. Partly ragged specimens, the primary layer has disappeared leaving the secondary layer exposed with the punctae, locality 2 and 1 respectively; scale bar equals 1 mm. NHMW 2010/0204/0028, 0032.

Fig. 9. Detailed external surface of specimen illustrated Fig. 8; scale bar equals 50 µm.

Fig. 5. Ventral valve interior revealing the cardinal process (top of image), the dental sockets, the median septum supporting the septalium and the attached point of the broken brachial loop on it, locality 1 at Serre de Bleyton; scale bar equals 500 µm. NHMW 2010/0204/0029.

Figs 6, 7, 10. Dorsal view of specimens progressively ragged what reveals the presence of the median septum and part of the septalium from the external part of the shell, locality 2; scale bar equals 1 mm. NHMW 2010/0204/0030 – 0031, 0033.

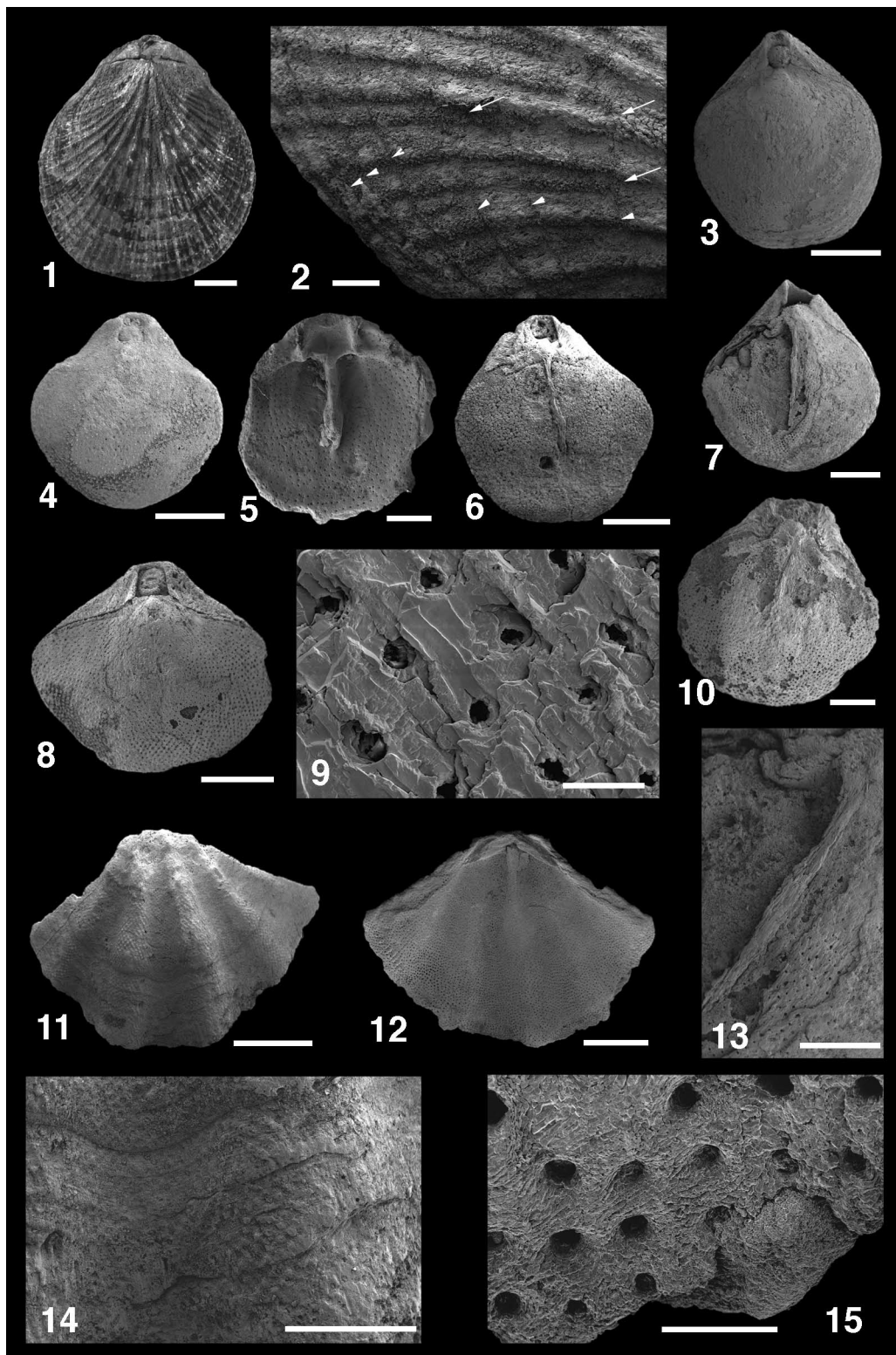
Fig. 13. Detail of Fig. 7 revealing the exposed fibrous median septum and left part of the septalium; scale bar equals 500 µm.

#### ***Ismenia* sp.**

Figs 11–12. External (11) and internal dorsal valve (12); scale bar equals 2 mm. NHMW 2010/0204/0034 – 0035; locality 1 at Serre de Bleyton.

Fig. 14. Detailed external surface of the specimen illustrated Fig. 11, major growth–lines and punctae are revealed; scale bar equals 1 mm.

Fig. 15. Detailed dorsal valve interior illustrated Fig. 12, revealing wide punctae surrounded by the fibre ends near the anterior margin; scale bar equals 100 µm.



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