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The early Carboniferous *Spelaeotriletes balteatus - S. pretiosus* Miospore Complex: Defining the base of the *Spelaeotriletes pretiosus - Raistrickia clavata* (PC) Miospore Biozone.

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Keywords: Carboniferous, biostratigraphy, miospores, *Spelaeotriletes*, Ireland.

Abstract: The early Carboniferous *Spelaeotriletes balteatus-Rugospora polyptycha* (BP) and *Spelaeotriletes pretiosus-Raistrickia clavata* (PC) Miospore Biozones are defined on the first appearances of *S. balteatus* and *S. pretiosus,* respectively. High-resolution sampling of the Porter's Gate Formation at Hook Head, Co. Wexford lead to the detailed biometric analysis of a continuous succession of *S. balteatus-S. pretiosus* populations. This resulted in the re-description of *S. balteatus* and *S. pretiosus,* the erection of a new species; *Spelaeotriletes galearis,* and the recognition of the occurrence of the stratigraphically useful *Spelaeotriletes cabotii* in the Irish Tournaisian. The new palynological data provide a more precise definition of the base of the PC biozone. The morphological trend of increasing ornament size, overall size, and diversity of evolving *Spelaeotriletes* taxa through the Mid-Tournaisian is documented and discussed.

Palavras-chave: Carbonífero, bioestratigrafia, miosporos, *Spelaeotriletes*, Irlanda.

Resumo: As biozonas de miosporos do Carbonífero inferior, *Spelaeotriletes balteatus-Rugospora polyptycha* (BP) and *Spelaeotriletes pretiosus-Raistrickia clavata* (PC) são definidas respectivamente pela primeira ocorrência de *S. balteatus* e *S. pretiosus*. Amostragem de alta resolução efectuada na Formação de Porter's Gate em Hook Head, Co. Wexford permitiu uma análise biométrica, de grande rigor, de uma sucessão contínua de populações de *S.balteatus-S. pretiosus*. Este trabalho possibilitou a obtenção de nova descrição de *S. balteatus* e *S. pretiosus*, a definição de novas espécies, *Spelaeotriletes galearis* e o reconhecimento da ocorrência de *Spelaeotriletes cabotii*, espécie importante do ponto de vista estratigráfico do Tournaisiano da Irlanda. Os novos dados palinológicos permitiram precisar a definição da base da Bizona PC. As variações morfológicas relativamente ao aumento da ornamentação, tamanho total e a diversidade dos taxa de *Spelaeotriletes* durante o Tournaisiano médio, são documentadas e discutidas neste trabalho.

INTRODUCTION

The early Carboniferous Porter's Gate Formation at Hook Head, Co. Wexford is divided into two members; a lower sandstone dominant Houseland Sandstone Member (23.5 m) and an upper mudstone dominant Lyraun Cove Shale Member (22 m) (Sleeman *et al.,* 1974). Sedimentologically the formation can be summarised as a succession of tidal to subtidal, shallow marine deposits that form part of a continuous transgressive marine sequence between the coastal plain deposits of the Oldtown Bay Formation and the fully marine, carbonate-dominated Hook Head Limestone Formation (Figure 1). Well preserved miospores are abundant throughout the Porter's Gate Formation and have been assigned to the *Vallatisporites verrucosus - Retusotriletes incohatus* (VI), *Cristatisporites hibernicus - Umbonatisporites distinctus* (HD), *Spelaeotriletes balteatus - Rugospora polyptycha* (BP) and *Spelaeotriletes pretiosus - Raistrickia clavata* (PC) Miospore Biozones of Middle to Late Tournaisian (Lower Mississippian) age (Higgs 1975, Higgs *et al.*, 1988). Conodonts of the *Polygnathus spicatus* Partial Range Zone first appear in the middle part of the Houseland Sandstone Member and conodonts of the *Polygnathus inornatus* Local Range Zone first appear in the topmost bed of the Houseland Sandstone Member and occupy most of the overlying Lyraun Cove Shale Member (Johnston & Higgins, 1981) (Figure 3).

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The Houseland Sandstone Member forms the focus of the present study. It is dominated by a succession of non-calcareous and progressively more calcareous flaser--bedded sandstones interbedded with black to grey non--calcareous to calcareous, often sand-streaked shales. Two thin (maximum 30 cm) quartz-pebble conglomerates characterise the basal part of the member and a distinctive chaotic unit occurs 6 m below the top of the member. The chaotic unit is composed of large rafts of sandstone displaying synsedimentary deformation structures and half-formed ball and pillow features, all hosted within a 1.5 m thick dark grey shale. This shale rests directly upon a prominent, mega-rippled, coarse calcareous sandstone containing phosphatic nodules, fish teeth and calcareous bioclastic fragments.

The sedimentology and depositional setting of the chaotic horizon in the upper part of the Houseland Sandstone Member and its possible correlation with very similar horizons in the Lower Limestone Shales of South Wales forms part of a wider early Carboniferous palaeoenvironmental study being carried out by one of the authors (JMB).

High resolution biostratigraphic dating of the chaotic event horizon is necessary to allow for accurate correlations with similar aged chaotic units in Welsh Lower Limestone Shale sequences. This can only be achieved using miospore palynostratigraphy. However, previous palynological studies of the Houseland Sandstone Member were based on a relatively small number of samples. Consequently the positions of the BP and PC miospore zonal boundaries were not tightly constrained and did not provide the necessary biostratigraphic resolution for dating and correlation of the chaotic unit. It was therefore necessary to undertake a detailed palynological sampling programme through the Houseland Sandstone Member at Hook Head to more accurately characterise the local palynostratigraphy and locate the miospore zonal boundaries.

The closely spaced sampling within the Houseland Sandstone Member has provided the opportunity to analyse a continuous succession of *Spelaeotriletes balteatus* and *Spelaeotriletes pretiosus* miospore populations. These two closely morphologically related taxa are important zonal species of the Middle and Late Tournaisian as their first appearances define the bases of the BP and PC Miospore Biozones, respectively. A detailed biometric analysis of the two species has been carried out to address the following questions:

- As presently defined, are *S. balteatus* and *S. pretiosus* morphologically distinct?

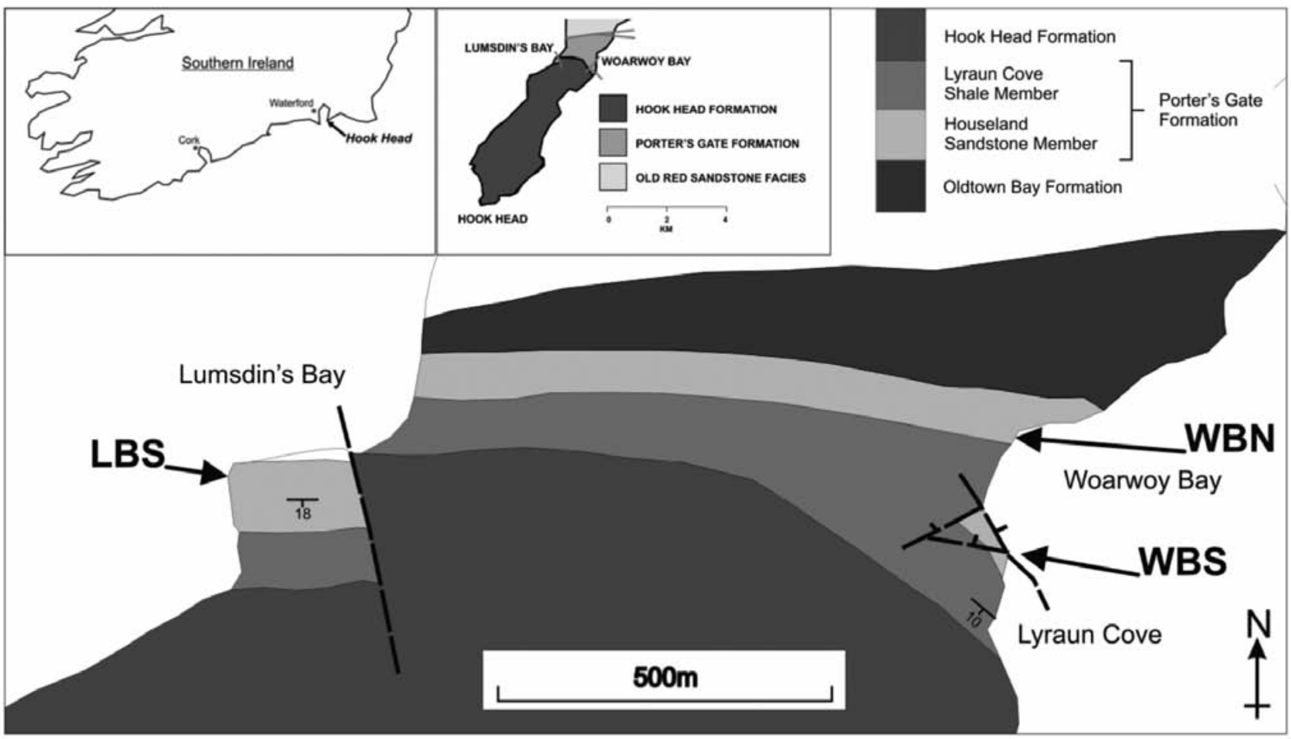

Fig. 1 – Map of the Porter's Gate Formation showing the locations of the three sections logged and sampled at Woarwoy Bay North (WBN), Woarwoy Bay South (WBS) and Lumsdin's Bay South (LBS), adapted from Sleeman, 1977 and Gardiner & Horne, 1981.

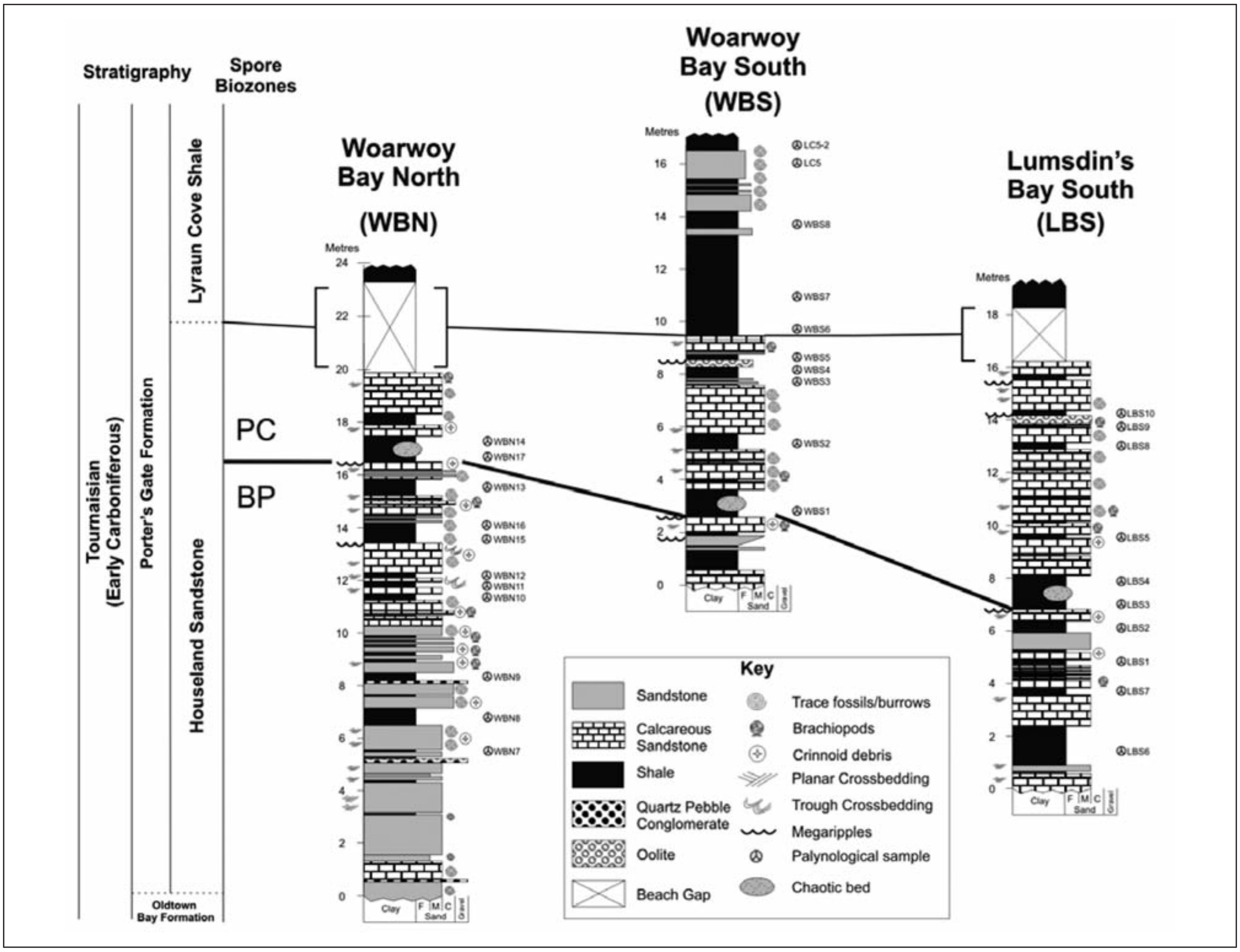

Fig. 2 – Measured logs of the sections at Woarwoy Bay North, Woarwoy Bay South and Lumsdins Bay South showing the stratigraphy, locations of samples collected, and location of the BP-PC miospore biozonal boundary.

- Can the morphological definition of these species be more clearly defined?
- Does any intraspecific morphological continuum exist between these taxa?
- Can a more accurate designation of the BP-PC miospore biozonal boundary be determined?

LOCATION OF SECTIONS AND SAMPLES STUDIED

The Porter's Gate Formation crops out on the eastern side of Hook Head at Woarwoy Bay and Lyraun Cove (the type section for the formation) and on the western side, at Lumsdin's Bay (Figure 1). Three sections of the Houseland Sandstone Member were measured and sampled in detail at Woarwoy Bay North (WBN), Woarwoy Bay South (WBS), and Lumsdin's Bay South (LBS) (Figures 1 and 2). The Woarwoy Bay North section is the most complete and continuous section of the Houseland Sandstone Member and is the only section where the base of the member is exposed. However, the top 3 m of the member and the base of the Lyraun Cove Shale are obscured by modern beach sediments. The Woarwoy Bay South section provides a continuous section through the upper part of the Houseland Sandstone and the base of the Lyraun Cove Shale. The Lumsdin's Bay South section on the eastern side of the peninsula exposes the upper part of the Houseland Sandstone Member. Although the contact with the Lyraun Cove Member is not seen, the section displays excellent exposures of the chaotic unit, which crops out laterally for 50 m across the foreshore at low tide.

Thirty-one palynological samples were collected from the black to grey shales throughout the three sections logged

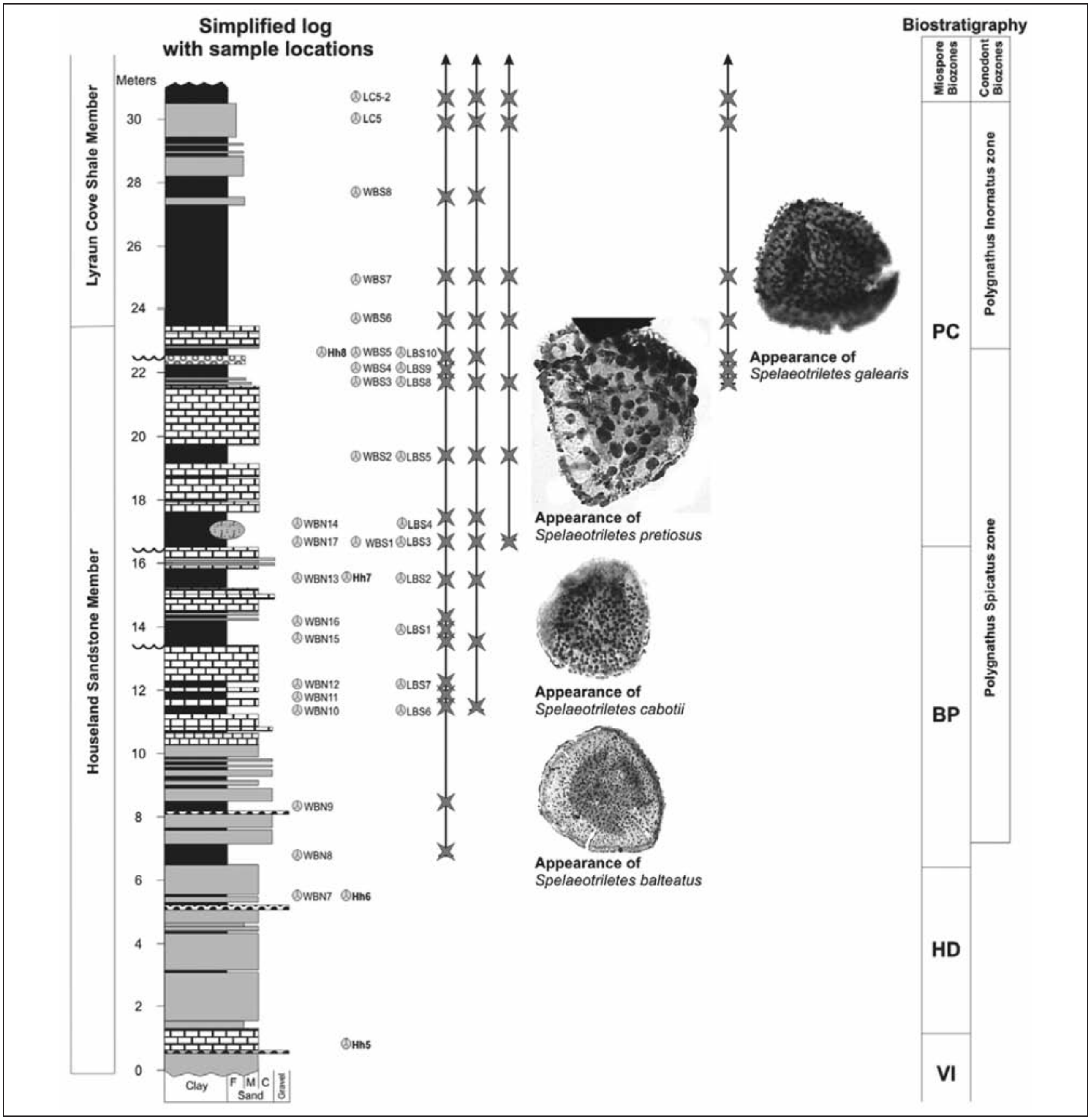

Fig. 3 – Simplified log showing sample locations, appearances of the miospores, and biozonal boundaries; Conodont biozones from JOHNSTON & HIGGINS, 1981, and samples Hh5-8 from HIGGS, 1975.

(Figures 2 and 3). The samples were processed using standard preparation techniques including the digestion of carbonate and silicate content with hydrochloric and hydrofluoric acids, and heavy mineral separation with Zinc Bromide. The organic residues were oxidised in Shultze solution; oxidation times varied from 20 minutes for less carbonised samples to 1.5 hours for the more carbonised samples.

SYSTEMATIC PALAEONTOLOGY

Introduction: The bases of the BP and PC Biozones are defined on the first appearances of *S. balteatus* and *S. pretiosus,* respectively. *S. balteatus* was originally described from the early Carboniferous (Mississippian) of Spitsbergen (PLAYFORD, 1963) and *S. pretiosus* was described from the Mississippian Horton Group in eastern Canada (PLAYFORD, 1964).

The two species are morphologically very similar and are primarily distinguished by their ornament type, size and shape. It is generally straight forward to distinguish between dominantly large verrucate/mammillate ornamented forms of *S. pretiosus* and the dominantly small spinose/cristate ornamented forms of *S. balteatus*. However, difficulties arise when studying *S. pretiosus* - *S. balteatus* spore populations close to the base of *S. pretiosus* range. At this level, early *S. pretiosus* assemblages typically contain specimens that possess much smaller sized ornamental elements and assigning a given specimen to either *S. balteatus* or *S. pretiosus* using the original descriptions of PLAYFORD (1963, 1964) proved difficult.

To overcome this problem it was necessary to describe in detail the Irish *S. balteatus* and *S. pretiosus* material at the level of the BP-PC biozonal boundary and determine whether any distinct morphological criteria could be used to clearly distinguish between these two species without changing the original morphological concept of the taxa. This resulted in the recognition of a new species; *S. galearis*, as well as revised descriptions of *S. balteatus, S. pretiosus,* and *S. cabotii* from these Irish samples.

SYSTEMATIC DESCRIPTIONS

Anteturma **PROXIMEGERMINANTES** R. POTONIE, 1970
Turma **TRILETES** REINSCH emend. DETTMANN, 1963
Suprasubturma **PSEUDOSACCITITRILETES** RICHARDSON, 1965
Infraturma **MONOPSEUDOSACCITI** SMITH & BUTTERWORTH, 1967
Genus **SPELAEOTRILETES** NEVES & OWENS, 1966
Type Species: *Spelaeotriletes triangulus* NEVES & OWENS, 1966

Spelaeotriletes balteatus (PLAYFORD) HIGGS, 1996
(Plate 1, A-F.)
1963 *Spinozonotriletes balteatus,* PLAYFORD, p. 657, pl. 94, figs. 4-6
1964 *Crassispora balteata,* (PLAYFORD) SULLIVAN, p. 376
1971 *Grandispora balteata,* (PLAYFORD) PLAYFORD, p. 46
1975 *Spelaeotriletes balteatus,* (PLAYFORD) HIGGS, p. 400, pl. 6, fig 10 (Combination invalid)
1996 *Spelaeotriletes balteatus,* (PLAYFORD) HIGGS, p. 291-292, pl. 6, fig. 10

Description: Trilete camerate miospores. Amb rounded to convexly triangular. Trilete obscure but occasionally distinct, often with narrow sinuous labrae extending to the equatorial margin and terminating in curvaturae. Equatorial margin of exoexine often darkened. Proximal surface laevigate except at the radial extremities. Distal exoexine densely ornamented with small wide based coni and subordinate grana up to 2.5μm in height. In some specimens rare small mammillae and verrucae are present with maximum basal width ≤2μm. Ornament discrete but bases may fuse to form low short rugulae and cristae (e.g., Plate 1, C.), particularly in the distal polar area. Intexine thin, laevigate, perceptible to obscure outline, conformable with amb, forming 50-75% of the total spore diameter.

Size: ***Exoexine:*** 36-109μm, average 71.2μm; ***Intexine:*** 20-80μm, average 45μm, (63% of total spore diameter), based on 88 specimens.

Remarks: As noted by PLAYFORD *et al.,* (2001), *S. balteatus* is distinguished by predominantly distal exoexinal sculpture of small spines with subordinate coni and grana. The specimens described generally conform to this specific concept but differ slightly from the original description in two respects. Firstly, PLAYFORD (1963) described an ornament basal diameter of 0.5-2.5μm, however the Hook Head specimens have a maximum basal diameter of 2μm. Secondly, some of the Irish specimens of *S. balteatus* possess rare verrucae and mammillae. However, any specimens of *S. balteatus* possessing subordinate verrucate/mammillate elements can be differentiated from *S. pretiosus* by the ≤2μm size limit and from *S. cabotii* by the dominance of spinose/cristate ornament.

Spelaeotriletes cabotii **UTTING *el al.,* 1989**
(Plate 1, G-K.)
1989 *Spelaeotriletes cabotii* UTTING *el al.*, p. 133, pl. 5.3, figs. 8-13 and 15

Description: Trilete camerate miospores. Amb rounded to convexly triangular. Trilete distinct to indistinct with sinuous labrae extending almost to the equatorial margin and terminating in curvaturae. Exine infragranulate, 2-3μm thick at the equator. Exoexine and equatorial regions ornamented with abundant low simple verrucae and/or mammilate verrucae, generally 2-4μm wide but sometimes up to 5μm, and up to 3μm in height, with subordinate small wide-based coni, grana and spinae. Ornament normally evenly distributed but in sometimes more concentrated at the distal pole. Bases of verrucae/mammillae

generally discrete and subcircular but may be fused in irregularly shaped clusters of 3 to 4 elements. Intexine thin, laevigate and generally visible, outline conformable with amb and forming 50-75% of total spore diameter.
Size: ***Exoexine:*** 40-95µm, average 69.1µm; ***Intexine:*** 25-63µm, average 45.6µm, 66% of total spore diameter, based on 64 specimens.
Remarks: *S. cabotii* differs from *S. balteatus* mainly on ornament type. *S. balteatus* is dominated by spinose/cristate ornament whereas *S. cabotii* is dominated by small verrucate/mammilate ornament, as shown in Plate 1.
There are two principal criteria that distinguish Irish *S. cabotii* specimens from *S. pretiosus* (PLAYFORD) UTTING, 1987. Firstly, Irish *S. cabotii* specimens have an exoexinal diameter range of 40-95µm. This is much smaller than Irish *S. pretiosus* specimens, which have a diameter range of 98-120 µm. Secondly, the maximum ornament width of *S. cabotii* is 5 µm, whereas *S. pretiosus* has an ornament width range of up to 8µm. Although the two species are similar in many respects, the size differences are significant.
UTTING *et al.,* (1989) noted that the recognition of *S. cabotii* as a different species to *S. pretiosus* had significant value in refining the Biostratigraphic Zonation of Tournaisian rocks in Canada. The present study confirms this stratigraphic value, as *S. cabotii* can be used to further refine the European Zonal Scheme, as illustrated in Figures 3 and 4.

Spelaeotriletes pretiosus, **(PLAYFORD) UTTING, 1987**
(Plate 2, A-D.)
1964 *Pustulatisporites pretiosus,* PLAYFORD, p. 19 pl. 4, figs. 7-9, pl. 5, fig. 1; text fig. 1a.
1969 *Pustulatisporites* cf. *pretiosus* PLAYFORD *in* LANZONI & MAGLOIRE, p. 454, pl. 1, figs. 17-19.
1970 *Spelaeotriletes pretiosus,* (PLAYFORD) NEVES & BELT, p. 124 (Combination invalid)
1987 *Spelaeotriletes pretiosus,* (PLAYFORD) UTTING, p. 33.
Description: See PLAYFORD, 1964, and UTTING, 1987
Remarks: The specimens of *S. pretiosus* from Hook Head are smaller on average than the original descriptions of PLAYFORD (1964) and UTTING (1987, revised UTTING & GILES, 2004) with an exoexinal diameter range of 98--120µm; average 103µm (98-195µm range given in PLAYFORD, 1964), an ornament diameter range of 4-8 µm, and an ornament height range of 1-2 µm, based on 28 specimens.

Spelaeotriletes galearis **sp. nov.**
(Plate 2, E-K.)
Holotype: Plate 2 I and K, (LBS10aX23), ***Type locality:*** Lumsdin's Bay South, Hook Head, Co. Wexford, Ireland. 1m below the top of the Houseland Sandstone Member, Porter's Gate Formation.
Diagnosis: Trilete, camerate miospores. Amb rounded to convexly triangular. Trilete distinct to indistinct with sinuous labrae extending to the equatorial margin and terminating in curvaturae. Exine infragranulate, 2-3µm thick at the equator. Distal surface of exoexine and equatorial margin densely ornamented with regularly to irregularly distributed galeae; subordinate spinae and coni may also occur. Elements normally discrete and well spaced, but bases may be fused. Ornament basal diameter 1-10µm; height 0.5-5µm, holotype height 1-5µm; basal diameter 1.5-4µm. Intexine thin, laevigate, forming 50-75% of total spore diameter, but often poorly discernable due to density of ornament.
Size: ***Exoexine:*** 60-104µm, *holotype* 81µm, average 81.8µm; ***Intexine:*** 40-72µm, *holotype* 53µm, average 51.3µm, 63% of total spore diameter, based on 17 specimens.
Remarks: *Spelaeotriletes galearis* sp. nov. is distinguished from others of the genus by its predominantly galeate ornament. *S. cabotii* and *S. pretiosus* also possess biform sculptural elements, but these are low mammilate elements. The morphologically closest taxon to *S. galearis* is *Spelaeotriletes ybertii* (MARQUES-TOIGO) PLAYFORD *et al.,* 2001, a significantly younger taxon, ranging from Late Carboniferous to Lower Permian in age. *S. ybertii* possesses a greater diversity of ornament that comprises baculae, galeae, coni and rare spinae. The ornament in *S. galearis* is also less densely distributed and slightly larger in size.

BIOSTRATIGRAPHIC IMPLICATIONS

The study of successive *S. balteatus* and *S. pretiosus* assemblages throughout the Houseland Sandstone Member allows for more accurate positioning of the BP/PC miospore biozonal boundary, as shown in Figures 3 and 4. *Spelaeotriletes balteatus* first appears in sample WBN8, 6.5 m above the base of the Houseland Sandstone Member, thus marking the base of the BP miospore biozone. This is also close to the base of the *Polygnathus spicatus* Conodont Biozone defined by JOHNSTON & HIGGINS (1981).

Small verrucate/mammillate sculptured forms assignable to *S. cabotii,* first appear in sample WBN10. However, it should be noted that *S. cabotii* is rare in the sample (<1%) and in the overlying samples up to the level of the chaotic unit. Above this level it becomes a progressively

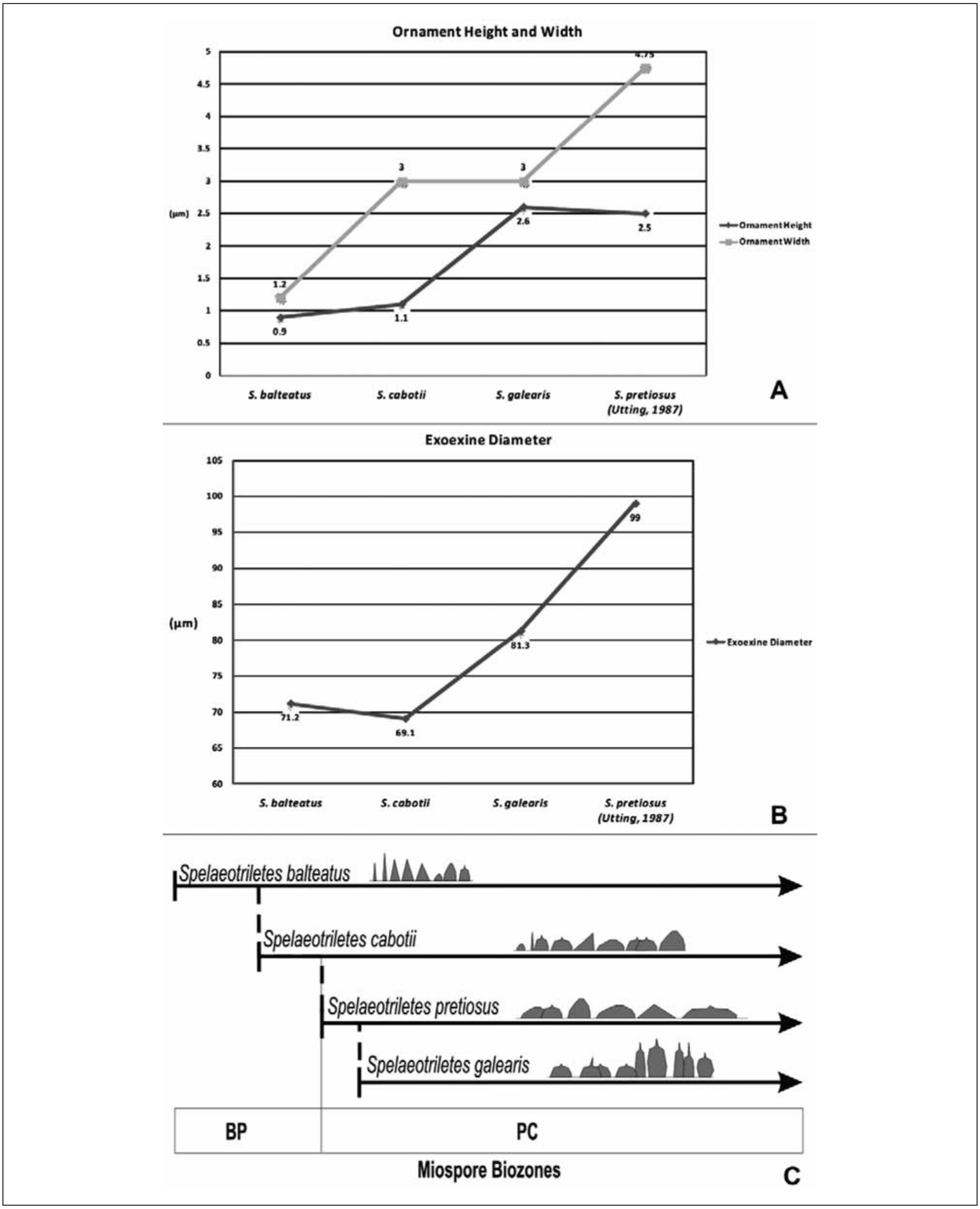

Fig. 4 – **(A)** Graph showing increase in ornament size for each species. **(B)** Graph showing increase in overall exoexine diameter for each species. **(C)** Diagram of appearances of each species over time and ornament shapes.

more common component (~10%).

The larger sized and more coarsely verrucate *S. pretiosus* first appears in sample WBN17, (see figure 3) from the basal part of the chaotic unit. This marks the base of the PC Miospore Biozone, and coincides with an increase in the abundance of *S. cabotii* in the assemblages. *S. pretiosus* is initially rare (<1%) but becomes more abundant (~10%) in samples WBS3 to WBS5 and LBS8 to LBS10 close to the top of the Houseland Sandstone Member. A gradual increase in *S. pretiosus* size from older to younger samples was also apparent. The appearance of the distinctive galeate form *Spelaeotriletes galearis* in samples WBS3 and LBS8, 1 m below the top of the Houseland Sandstone, coincides with this increase in *S. pretiosus* size and abundance.

One of the original aims of this palynological study was to accurately define the age of chaotic unit in the upper part of the Houseland Sandstone Member and the new palynological data clearly correlates this distinctive horizon with the base of the PC Biozone (Figure 3). The significance of this chaotic event horizon at the base of the PC Biozone on a more regional scale remains to be seen.

In terms of correlation with the conodont biostratigraphy there is close correlation between the base of the BP Biozone and the base of the *Polygnathus spicatus* Partial Range Conodont Zone, as shown in Figure 3, but this is unclear as there are no conodont samples below this level (JOHNSTON & HIGGINS, 1981). The BP Biozone and the BP-PC biozonal boundary in the Hook Head sections equate with the *Polygnathus spicatus* Partial Range Zone of mid-Tournaisian age. The appearance of abundant and morphologically diverse *Spelaeotriletes* assemblages and the appearance of *S. galearis* correlate closely with the *Polygnathus spicatus-Polygnathus inornatus* conodont biozonal boundary.

The first appearance of *S. cabotii* is a useful stratigraphic marker species for the recognition of the upper BP Biozone, and, with further study, may form the basis of a new subzone. Its stratigraphic value in refining the Biostratigraphic Zonation Scheme for the Tournaisian of Atlantic Canada was noted by UTTING *et al.,* in 1989, when the species was used as an upper subzone marker taxon of the *V. vallatus* Biozone in Nova Scotia.

The appearance of *S. cabotii* in the BP Biozone of Western Europe is significantly earlier in the Tournaisian than was recognised in Canada, where its range has been given as occurring in the PC biozonal equivalent.

EVOLUTIONARY IMPLICATIONS

The detailed study of successive BP and PC miospore assemblages from Hook Head provides ample evidence for a distinct morphological development of the evolving parent plants of Spelaeotriletes through the Mid-Tournaisian. This trend involves gradually more diversification of ornament type and increase in spore size over time within the various Spelaeotriletes taxa studied.

This trend is shown in Figures 3 and 4, and is summarised as follows:

- appearance of spinose/conate forms *(S. balteatus)* at the base of the BP Biozone;
- appearance of small verrucate/mammillate forms with subordinate coni and spinae, *(S. cabotii)* in the middle part of the BP Biozone;
- appearance of large verrucate/mammillate forms *(S. pretiosus)* at the base of the PC Biozone;
- appearance of galeate forms *(S. galearis)* in the lower part of the PC Biozone.

This trend of increasing morphological diversity of the *Spelaeotriletes* taxa appears to continue into the upper part of the PC Biozone (Late Tournaisian age) because the larger original specimens of *S. pretiosus* described by PLAYFORD (1964) from the Tournaisian Horton Group of Canada and the subsequent species such as *S. bellii* and *S. windsorensis* described by UTTING (2004) from the Viséan Windsor Group of Canada, are possible end members of this morphological development.

Carboniferous land plants evolved relatively slowly after the end-Devonian plant extinction event. This is evidenced from the fact that basal Tournaisian microfloras of VI Biozone age are typically of low taxonomic diversity, being dominated by species of long ranging acamerate, laevigate and apiculate genera (CLAYTON, 1996). However, as palaeoenvironmental conditions improved, new plants became established and this is reflected by increasing miospore diversity and abundance in the middle to late Tournaisian. The morphological diversity seen within the genus *Spelaeotriletes* through the middle to late Tournaisian (Lower Mississippian) at Hook Head is one part of the overall picture of land plant recovery in the early Carboniferous.

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PLATES

PLATE I

A-F – *Spelaeotriletes balteatus* (Playford) Higgs, 1996

A – *S. balteatus,* Hh8fS21, x400

B – *S. balteatus,* Hh8fS31, x400

C – *S. balteatus,* Hh8fO32-1, x400

D – *S. balteatus,* LBS10aF40-1, x400

E – *S. balteatus,* LBS10bE46-1, x400

F – *S. balteatus,* WBS7aC40, x400

G-L – *Spelaeotriletes microverrucosus* sp. nov.

G – *S. microverrucosus,* Hh8fM24-1, x400

H – *S. microverrucosus,* **Holotype**, WBS3aQ46, x400

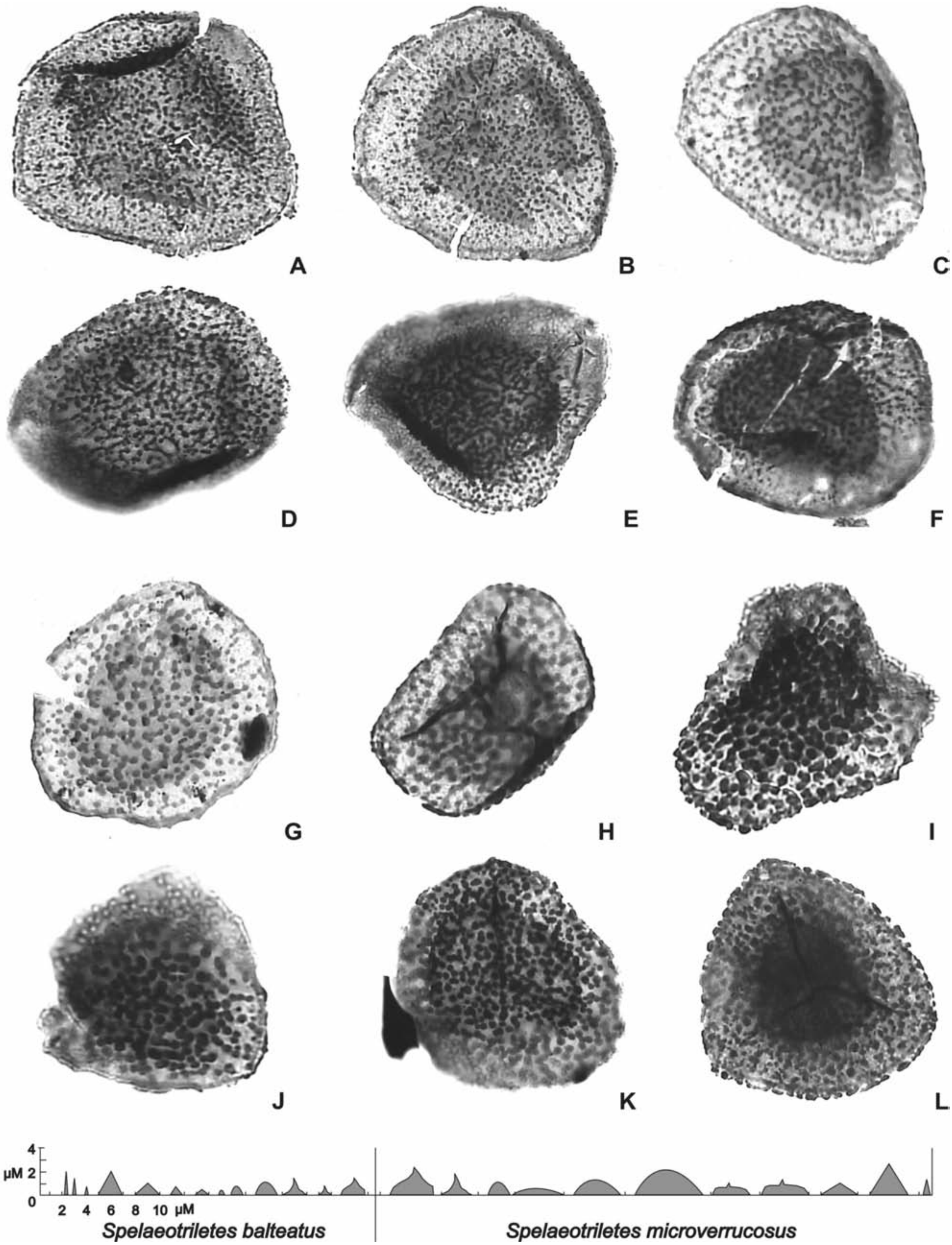
I – *S. microverrucosus*, LBS10aE47-3, x400

J – *S. microverrucosus*, WBS6bN28, x400

K – *S. microverrucosus*, LBS10bQ14-1, x400

L – *S. microverrucosus*, LBS10aG24-1, x400

Bottom page. Comparison of ornament shapes of *Spelaeotriletes balteatus* and *Spelaeotriletes microverrucosus*.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Spelaeotriletes balteatus
Spelaeotriletes microverrucosus

PLATE II

A-D – *Spelaeotriletes pretiosus* (Playford) Utting, 1987

A – *Spelaeotriletes pretiosus*, Hh8fM24-1, x400

B – *Spelaeotriletes pretiosus*, Hh8fD8, x400

C – *Spelaeotriletes pretiosus*, LBS10aM16, x400

D – *Spelaeotriletes pretiosus,* Hh8fR23-1, x400

E-K: – *Spelaeotriletes galearis* sp. nov.

E – *Spelaeotriletes galearis,* **Holotype**, LBS10aX23, x1000

F – *Spelaeotriletes galearis,* LBS10aG39, x400

G – *Spelaeotriletes galearis,* LBS10aJ31-3, x400

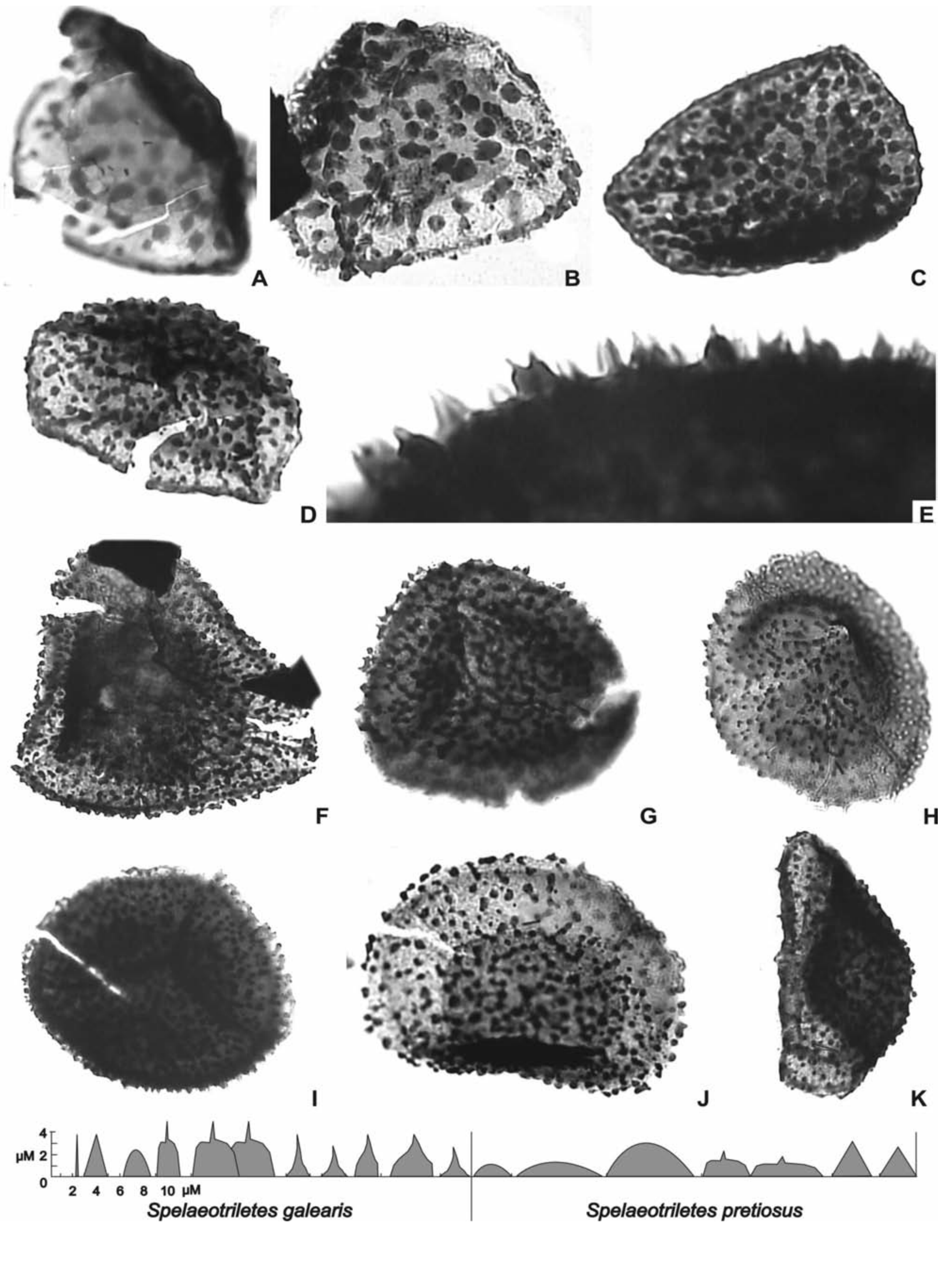
H – *Spelaeotriletes galearis,* LBS10aC28, x400

I – *Spelaeotriletes galearis* **Holotype**, LBS10aX23, x400

J – *Spelaeotriletes galearis,* LBS10aK12, x400

K – *Spelaeotriletes galearis,* WBS7aC43, x400

Bottom page. Comparison of ornament shapes of *Spelaeotriletes pretiosus* and *Spelaeotriletes galearis.*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Spelaeotriletes galearis
Spelaeotriletes pretiosus