

INTEGRATED APPROACHES TO THE RECONSTRUCTION OF EARLY
LAND VEGETATION AND ENVIRONMENTS FROM LOWER DEVONIAN
STRATA, CENTRAL-SOUTH WALES

VOLUME II OF II
PLATES AND APPENDICES

A THESIS SUBMITTED TO CARDIFF UNIVERSITY FOR THE DEGREE OF DOCTOR
OF PHILOSOPHY BY

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AUGUST 2009

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Plate 3.1: cf. *Cooksonia caledonica*/ *Renalia* sp. specimens

- a*: JM010a. Reniform sporangium with concave sporangial-axial junction and curved subtending axis.
- b*: JM109b. Reniform sporangium with concave sporangial-axial junction and slightly curved subtending axis. Sporangium surrounded by border (see arrow).
- c*: JM034d. Transversely-elliptical sporangium with slightly concave sporangial-axial junction (see arrow).
- d*: JM385a. Transversely-elliptical sporangium with slightly concave sporangial-axial junction (see arrow). Subtending axis is curved.
- e*: JM012b. Circular sporangium with concave sporangial-axial junction (see arrow).
- f*: RHJM04. Circular sporangium with very concave sporangial-axial junction (see arrow).
- g*: JM118. Largest cf. *Cooksonia caledonica*/ *Renalia* sp. sporangium. Transversely elliptical sporangium with slightly concave sporangial-axial junction.
- h*: JM053a. Smallest cf. *Cooksonia caledonica*/ *Renalia* sp. sporangium. Transversely elliptical sporangium with slightly concave sporangial-axial junction.
- i*: JM011a. Reniform sporangia with slightly concave sporangial-axial junctions. Sporangial borders taper in towards the sporangial-axial junctions (see arrows). Three axes appear to branch close together, suggesting pseudomonopodial branching.
- j*: JM035a. Isolated reniform sporangium with very concave sporangial base.
- k*: JM008. Anisotomously branched axes (see arrow) terminating in transversely elliptical sporangia.
- l*: JM004. Isotomously branched axes (see arrow) terminating in reniform sporangia, with very concave sporangial-axial junctions.
- m*: JM368. ? Laterally or pseudomonopodially branched axes (see arrows) terminating in reniform sporangia, with sporangial borders.

Plate 3.1: cf. *Cooksonia caledonica* / *Renalia* sp. specimens

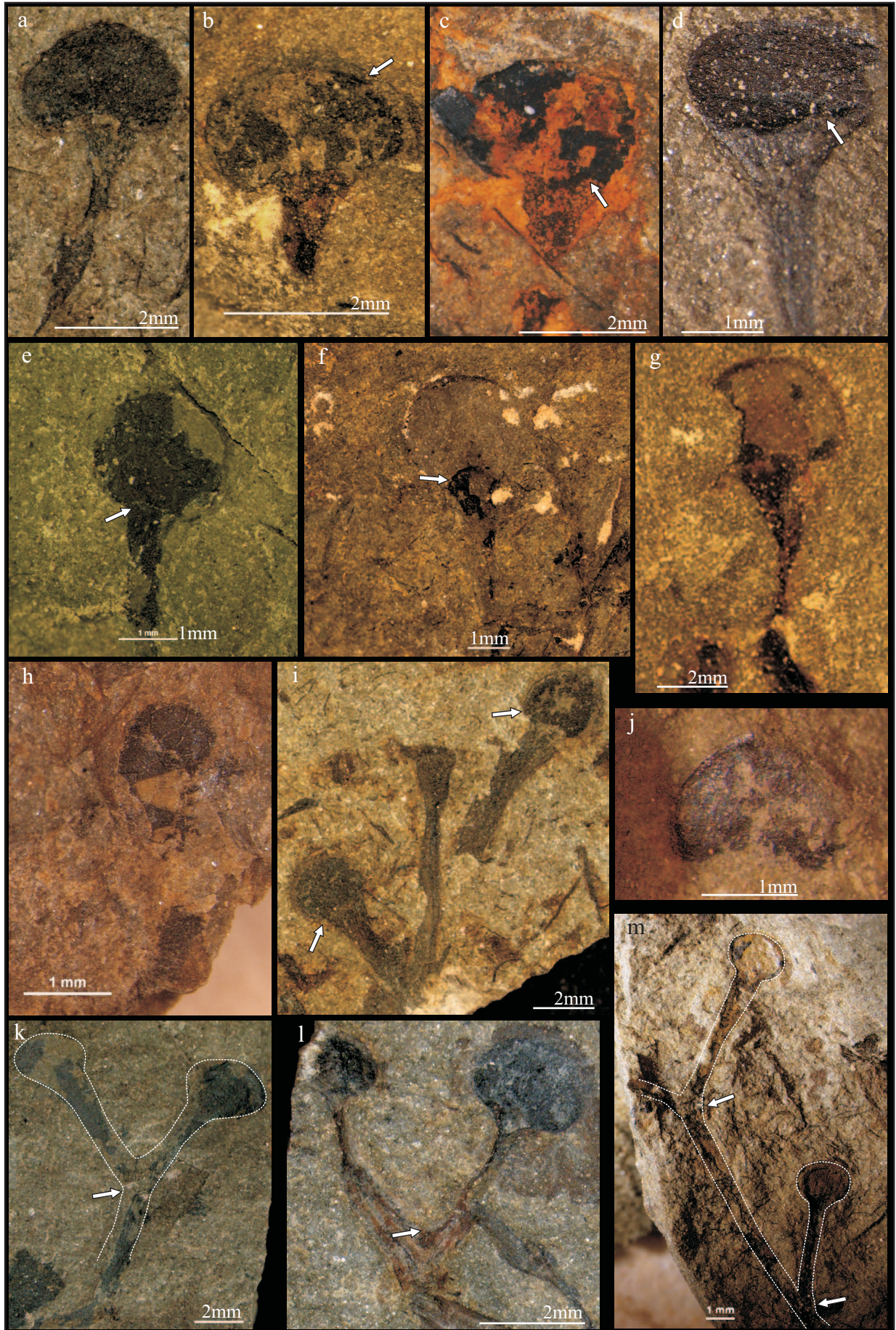


Plate 3.2: cf. *Cooksonia caledonica*/ *Renalia* sp. specimens: anatomy

- a*: JM004. SEM image of coalified compression of basal portion of reniform sporangium, and subtending axis, infilled with pyrite-limonite cubes (appear white) aligned parallel to the axis.
- b*: JM010a. SEM image of coalified compression of reniform sporangium, with pyrite-limonite cubes (appear white) aligned vertically, fanning out from the base of the sporangium (see arrow).
- c*: JM011. SEM image of central strand of coalified material preserved within subtending axis (see arrow).
- d*: JM385. SEM image of coalified compression of transversely elliptical sporangium, with peripheral crack around the sporangial margin (see arrow).
- e*: JM004. SEM image of coalified compression of reniform sporangium with blocky coalified material arranged around the sporangial margin (see arrow).
- f*: JM368. SEM image of *in situ* trilete spore with circular amb and equatorial crassitude. Laevigate to granulose proximal ornament.
- g*: *Cooksonia caledonica* Edwards 1970.
- h*: *Renalia hueberi* Gensel 1976.

Plate 3.2: cf. *Cooksonia caledonica* / *Renalia* sp. specimens: anatomy

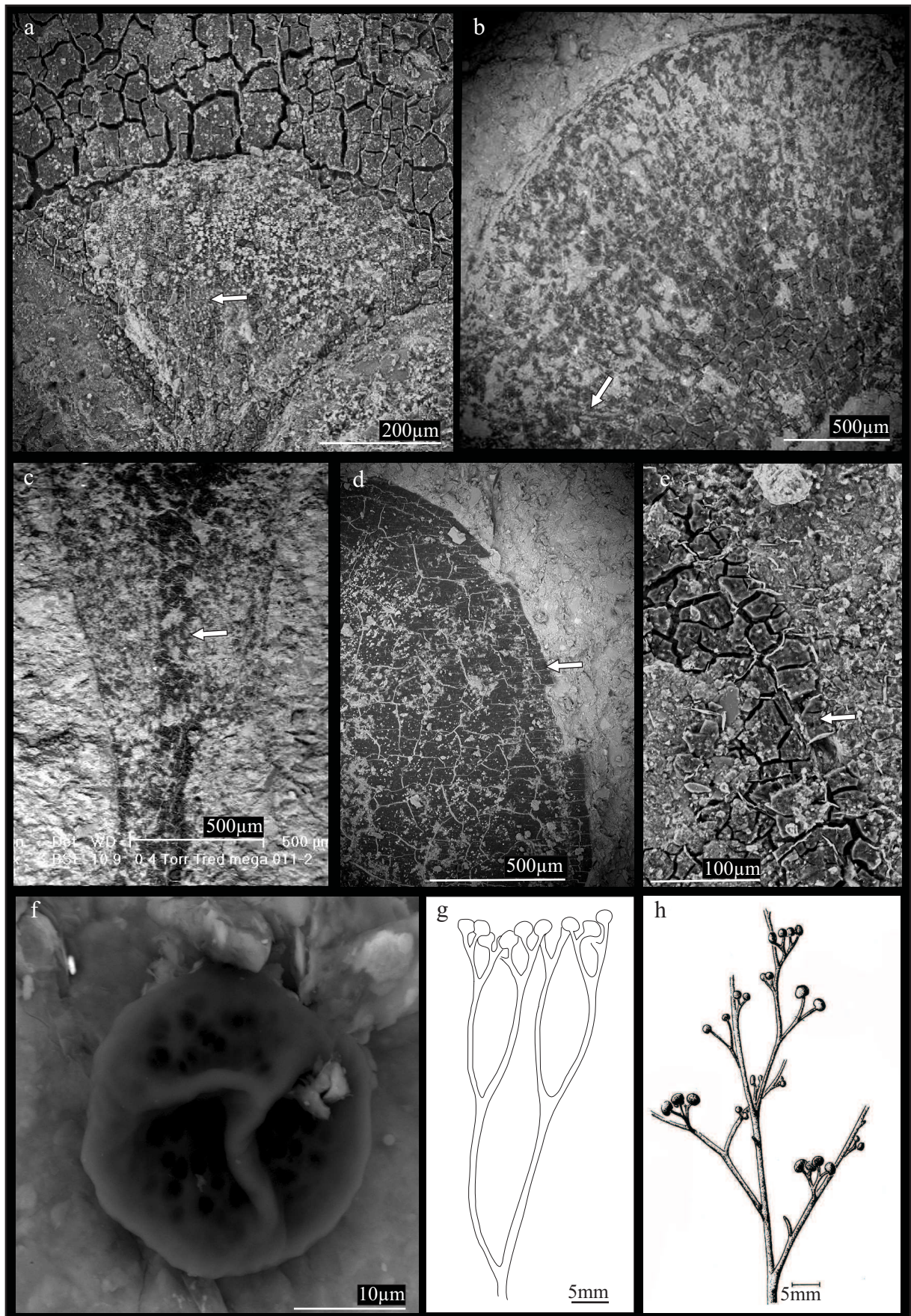


Plate 3.3: *Cooksonia hemisphaerica* specimens

- a*: JM367. Partial coalified compression and impression of hemispherical sporangium with broad, flatten apex and gradually tapering subtending axis.
- b*: JM133a. Partial coalified compression and impression of hemispherical sporangium, with flat sporangial-axial junction (see arrow), and gradually tapering subtending axis.
- c*: RH015. Partial coalified compression and impression of hemispherical sporangium, with flat sporangial-axial junction (see arrow).
- d*: JM228a. Partial coalified compression and impression of isodiametric sporangium, with flat sporangial-axial junction (see arrow), with gradually tapering subtending axis.
- e*: JM112a. Coalified compression of isodiametric sporangium with flat sporangial-axial junction (see arrow), with gradually tapering subtending axis.
- f*: JM374. Partial coalified compression and impression of sporangium, where sporangium height slightly exceeds width. Sporangium surrounded by sporangial border (see arrow).
- g*: JM121c. Partial coalified compression and impression of hemispherical sporangium with broad, flatten apex, and maximum width occurring in the top third of sporangial height. The sporangial-axial junction is flat (see arrow).
- h*: JM121b. Isodiametric sporangium with maximum width approximately half sporangial height.
- i*: JM312b. Largest *Cooksonia hemisphaerica* sporangium, with flat sporangial-axial junction (see arrow).
- j*: JM012. Isotomously branched axes terminating in hemispherical sporangia, with flat sporangial-axial junctions (see arrows).
- k*: JM312b. Anisotomously branched axes terminating in hemispherical sporangia, with flat sporangial-axial junctions (see arrows).

Plate 3.3: *Cooksonia hemisphaerica* specimens

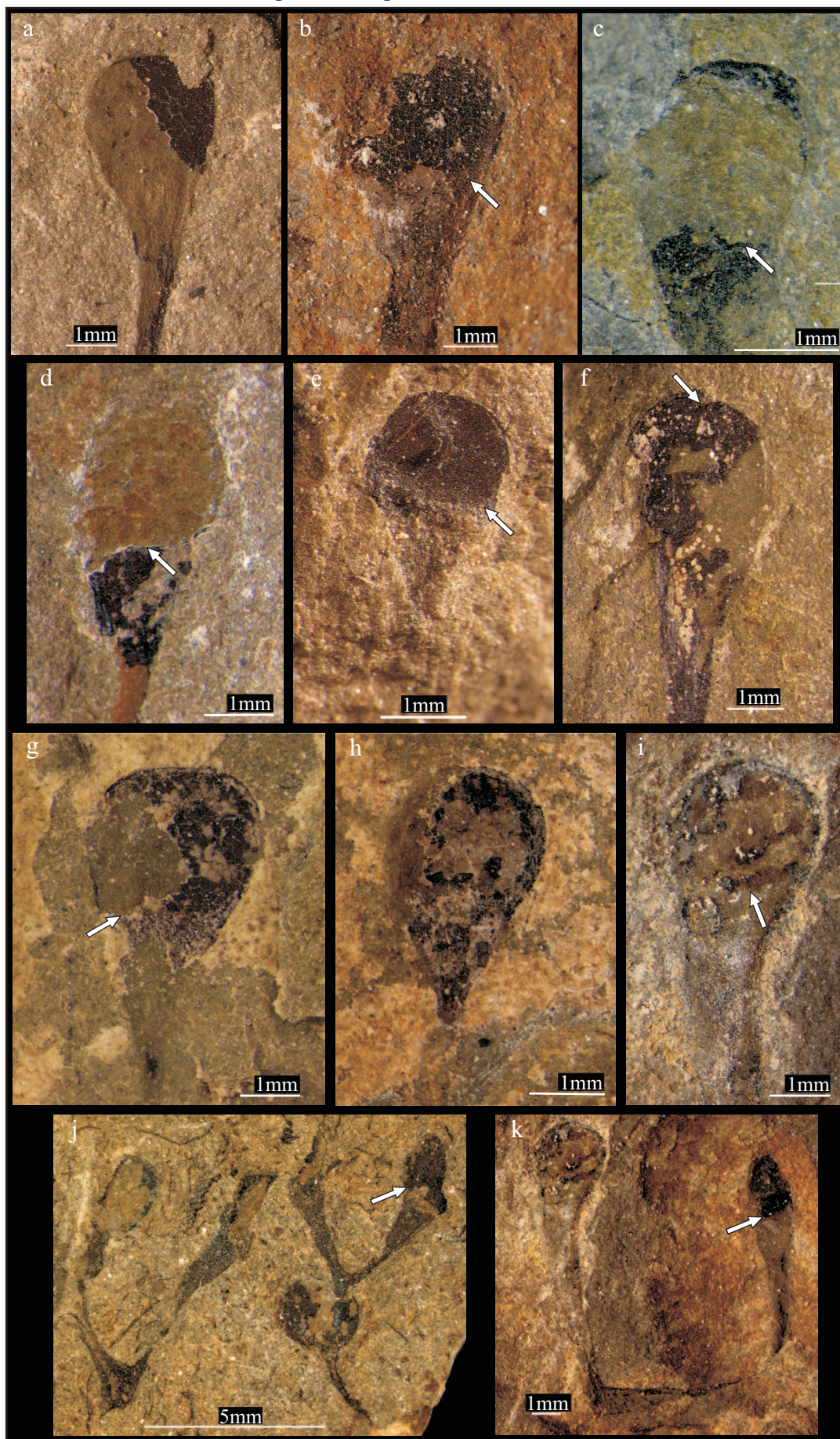


Plate 3.4: *Cooksonia hemisphaerica* specimens: anatomy

- a*: JM374. SEM image of partial coalified compression of sporangium where sporangial height exceeds width. A peripheral band of coalified material and impression surrounds the sporangium (see arrow), and may represent a compressed sporangial wall.
- b*: JM003. SEM image of partial coalified compression of the band surrounding a hemispherical sporangium, showing the impression of elongate cells (see arrow) running parallel to the sporangial edge.
- c*: JM020. SEM image of partial coalified compression of the sporangial wall at the centre of the sporangium, composed of isodiametric, randomly orientated cells (see arrow).
- d*: JM367. SEM image of partial coalified compression of subtending axis, with elongate, fusiform cracks infilled with pyrite-limonite cubes, aligned parallel to axis length (see arrow). These cracks may represent original cells.

Plate 3.4: *Cooksonia hemisphaerica* specimens: anatomy

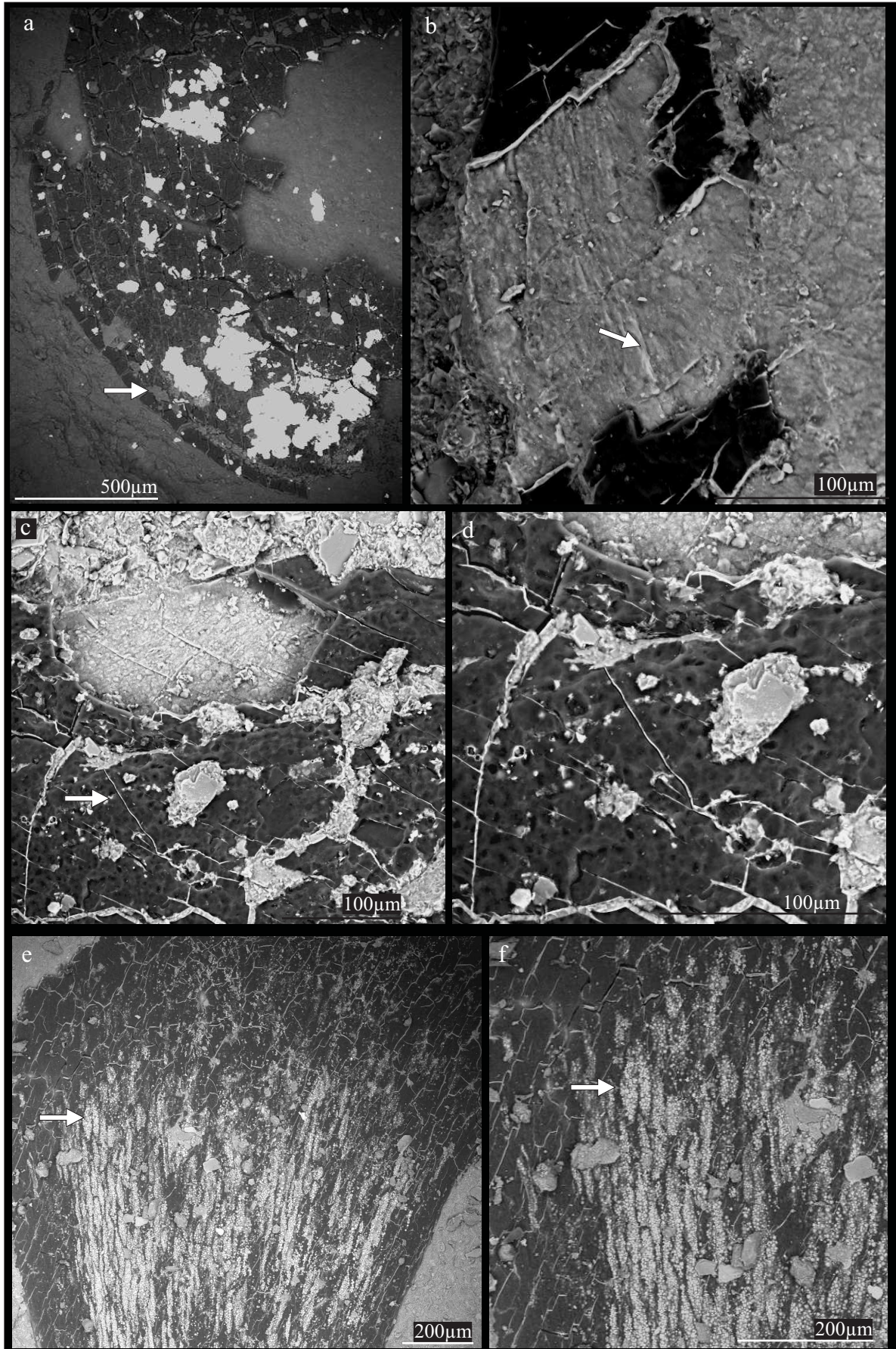


Plate 3.5: *Cooksonia* cf. *cambrensis* specimens

- a*: JM235a. Circular sporangium with slightly proximally curved sporangial-axial junction (see arrow), and parallel-sided subtending axis.
- b*: JM372c. Circular sporangium with proximally curved sporangial-axial junction (see arrow), and preferentially preserved sporangial margin. Sporangial cavity extends into the subtending axis.
- c*: RH045. Transversely elliptical sporangium, with proximally curved sporangial-axial junction (see arrow), and sporangial cavity extends into the parallel-sided subtending axis.
- d*: RH0188_1. Transversely elliptical sporangium, with proximally curved sporangial-axial junction (see arrow). Preferentially preserved sporangial margin.
- e*: JM023. Largest *Cooksonia* cf. *cambrensis* specimen. Transversely elliptical sporangium, with proximally curved sporangial-axial junction (see arrow). Preferentially preserved sporangial margin.
- f*: JM382. SEM image of a circular sporangium, showing a peripheral crack parallel to the outer sporangial margin (see arrow).

Plate 3.5: *Cooksonia* cf. *cambrensis* specimens

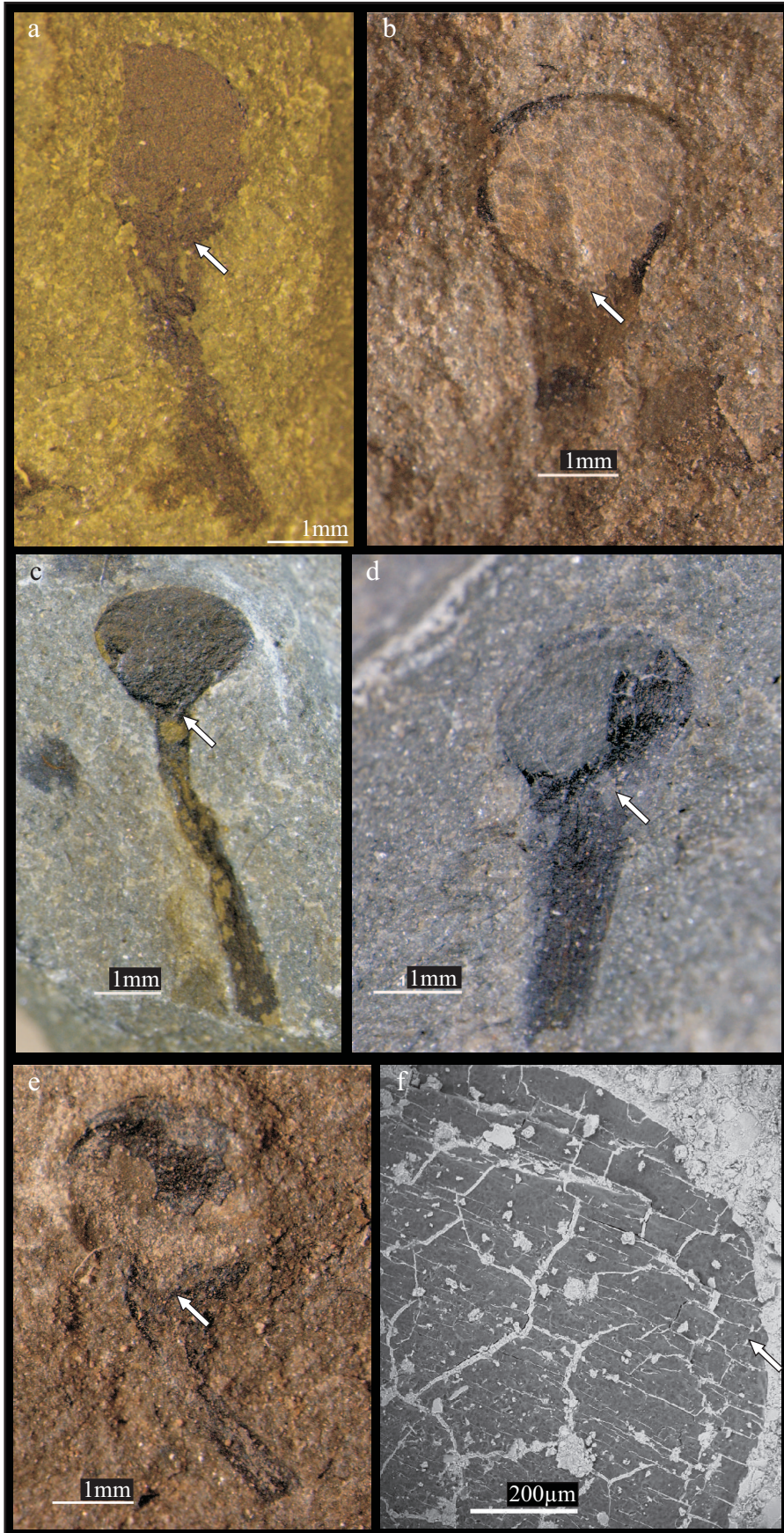


Plate 3.6: cf. *Uskiella reticulata* / *Tarrantia salopensis* specimens

- a*: JM279a. Anisotomously branched axes with two branch points (see arrows). Terminal sporangia are vertically ovate and parallel-sided.
- b*: JM013d. Isotomously branched naked axes, with anisotomous daughter branches. Terminal sporangium is vertically ovate, circular and isodiametric, with preferentially preserved sporangial border (see arrow).
- c*: JM013b. Isodiametric, circular terminal sporangium, with slightly tapering subtending axis. Preferentially preserved sporangial border (see arrow).
- d*: JM006a. Vertically ovate sporangium (height exceeds width), attached to a slightly tapering subtending axis. Possible flat sporangial-axial junction (see arrow). Preferentially preserved sporangial border (see arrow).
- e*: JM111a. Vertically ovate sporangium (height exceeds width), attached to a slightly tapering subtending axis. Preferentially preserved sporangial border (see arrow).
- f*: JM390a. Vertically ovate sporangium (height exceeds twice width), attached to a slightly tapering subtending axis.
- g*: RHSp110. Largest cf. *Uskiella reticulata* / *Tarrantia salopensis* specimen and largest sporangium. Pseudomonopodially branched axes with four branch points (see arrows). One daughter branch terminated with vertically ovate sporangium.
- h*: JM279a. Parallel-sided ovate sporangium, attached to narrow subtending axis.
- i*: JM092. Parallel-sided ovate sporangium, with slightly tapering apex and flat sporangial-axial junction (see arrow). Preferentially preserved sporangial border.
- j*: RH0008_2. Thick sporangial border (see arrow) showing an impression of elongate cells running parallel to the outer sporangial margin.
- k*: JM328a. Coalified ovate sporangium, with granulate or reticulate texture in the central sporangial wall.
- l*: JM013d. Circular sporangium attached to narrow parallel-sided subtending axis that widens just below the sporangium base. The sporangial-axial junction is unclear.

Plate 3.6: cf. *Uskiella reticulata* / *Tarrantia salopensis* specimens.

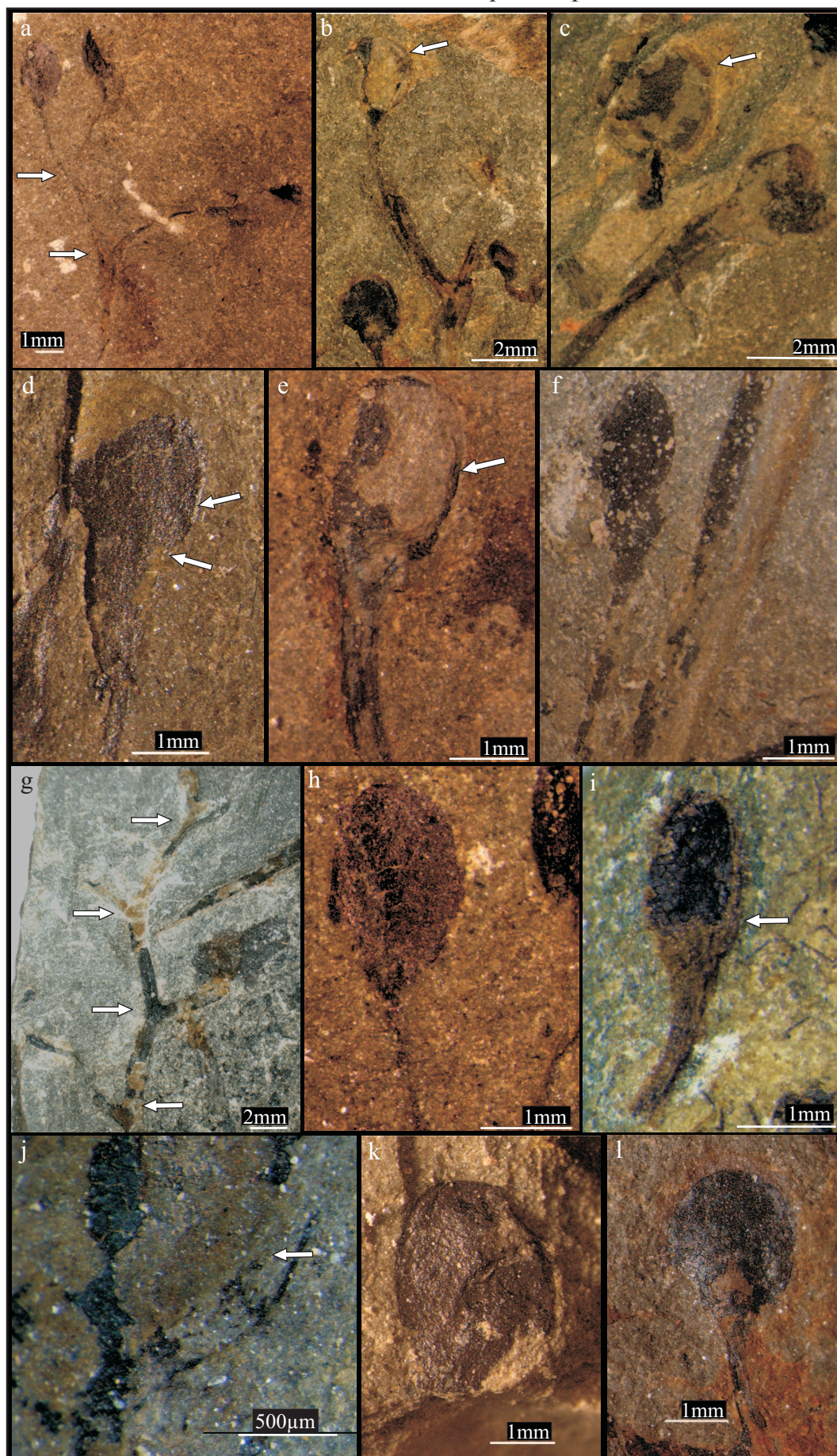


Plate 3.7: cf. *Uskiella reticulata* / *Tarrantia salopensis* specimens: anatomy

- a:* JM113. SEM image of outer margin of sporangium, with peripheral crack infilled with pyrite-limonite cubes (see arrow).
- b:* JM279. SEM image of the central area of the sporangial wall, composed of isodiametric, randomly orientated cells (see arrow).
- c:* *Uskiella spargens* Shute and Edwards 1989.
- d:* *Uskiella reticulata* Fanning et al. 1992.
- e:* *Tarrantia salopensis* Fanning et al.1992.

Plate 3.7: cf. *Uskiella reticulata* / *Tarrantia salopenensis* specimens: anatomy

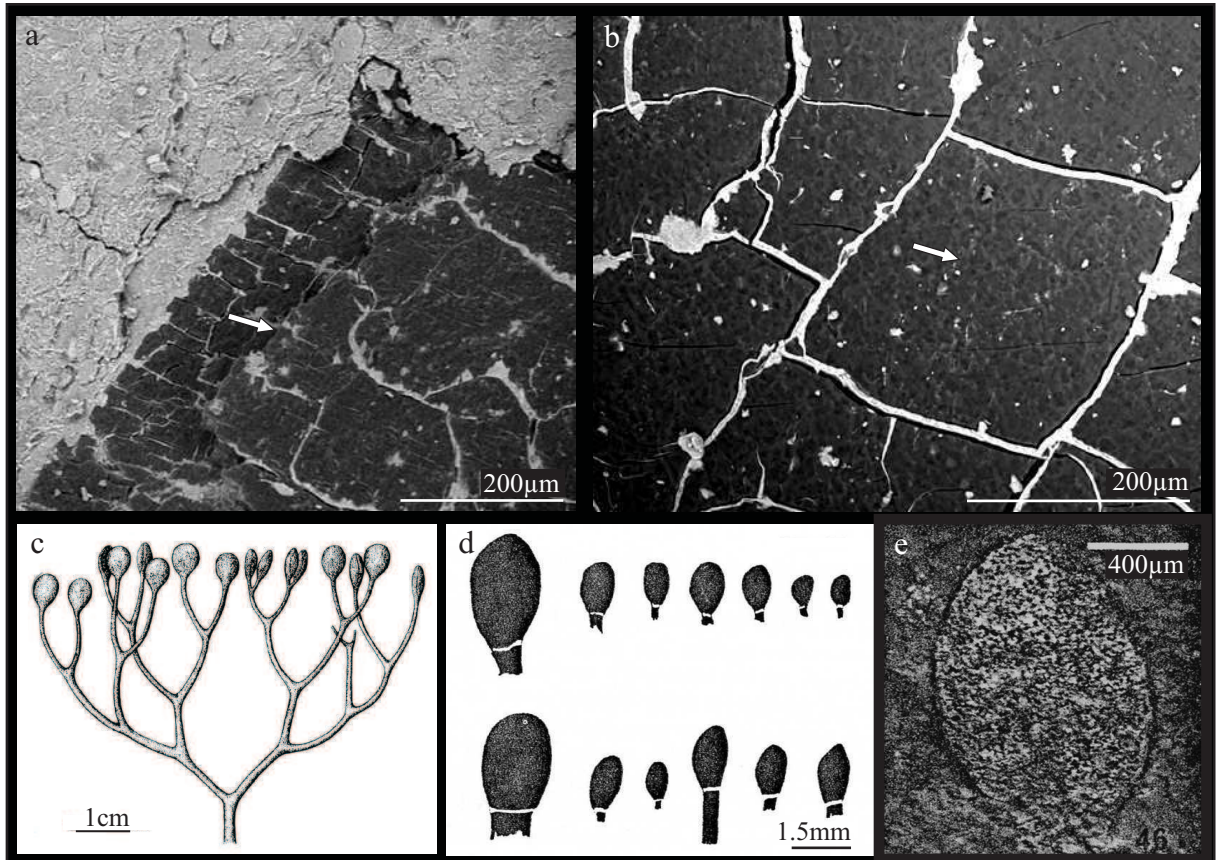


Plate 3.8: *Salopella allenii* specimens

- a*: JM005b. Partial coalified compression and impression of elongate, fusiform sporangium, with tapering apex.
- b*: JM006a. Partial coalified compression and impression of elongate fusiform sporangium, with tapering apex, and pointed tip. A layer of limonite is visible between the coalified compression and host rock (see arrow).
- c*: JM007a. Partial coalified compression and impression of elongate fusiform sporangium, with tapering apex, and flattened tip.
- d*: JM005b. Partial coalified compression and impression of elongate fusiform sporangium, with tapering apex, and globular tip.
- e*: RHSp151_1. Partially coalified, elongate fusiform sporangium, with tapering apex, and rounded tip. Largest sporangium of *Salopella allenii*.
- f*: JM006a. Slight narrowing of axis, or constriction, at sporangial–axial junction (see arrow). Note faint impressions of elongate cells running down the length of the subtending axis (see arrow).
- g*: JM289b. Anisotomously branched terminal axes, with acute branching angle.
- h*: RHSp141_1. Largest specimen of *Salopella allenii*. Acutely dichotomously branched axis, with slightly anisotomous branch point (see arrow), terminated by elongate, fusiform sporangia.

Plate 3.8: *Salopella allenii* specimens

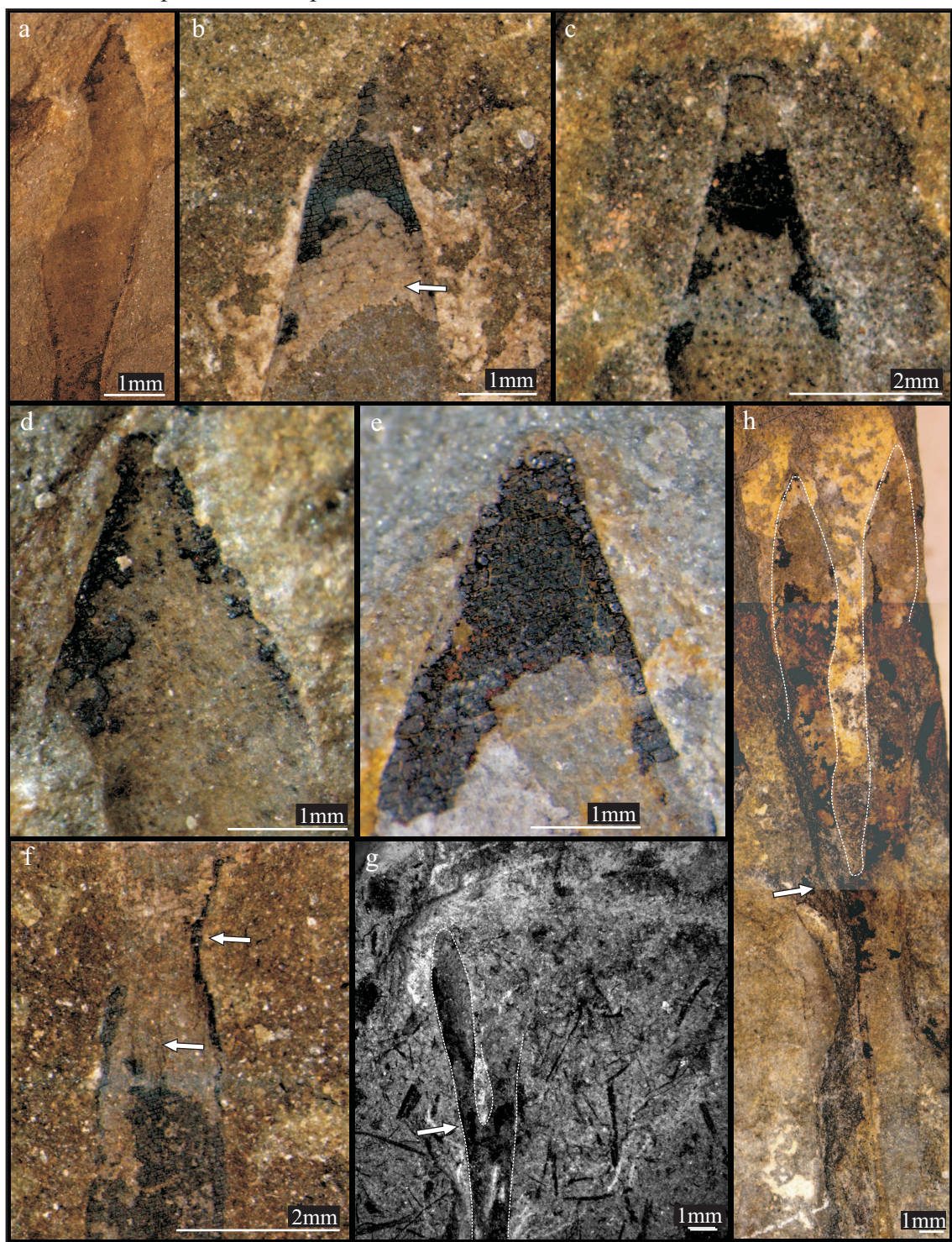


Plate 3.9: *Salopella allenii* specimens: anatomy

- a*: JM005b. Impression of sporangial wall, showing impressions of elongate cells on the host rock (see arrow) aligned at an angle of approximately 30° to the sporangial edge.
- b*: RHSp151_1. Impression of sporangial wall, showing impressions of elongate cells on the host rock (see arrow), aligned at an angle to the sporangial edge.
- c*: JM006a. SEM image of sporangial wall, showing impressions of elongate cells on the host rock (see arrow) and in the coalified compression (see arrow).
- d*: JM005b. SEM image of sporangial wall, showing impressions of elongate cells on the lost rock (see arrow).
- e*: JM006a. Elongate striations or cells, running down the length of the subtending axis.
- f*: *Salopella allenii* Edwards and Richardson 1974.
- g*: *Salopella allenii* specimen from Targrove Quarry.

Plate 3.9: *Salopella allenii* specimens: anatomy

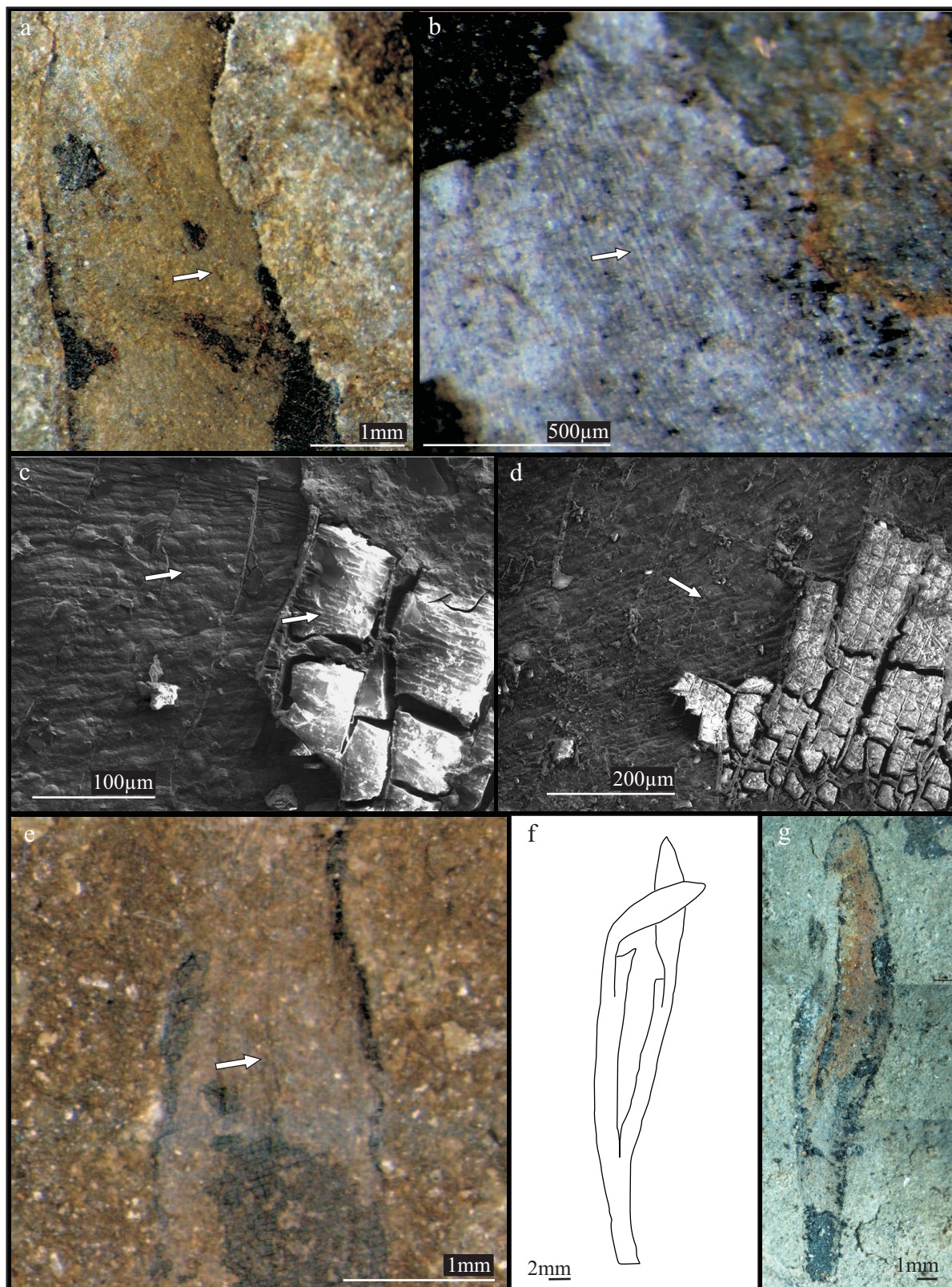


Plate 3.10: *Salopella* cf. *marcensis* specimens

- a*: RHSp304. Isotomously branched narrow axes with at least two branch points (see arrows), one terminated by a small fusiform sporangium with tapering apex and rounded tip.
- b*: JM346a. Small elongate fusiform sporangium with tapering apex and rounded tip (see arrow).
- c*: JM394b. Small elongate fusiform sporangium with tapering apex and pointed, extended tip (see arrow). Slight narrowing of the axis directly beneath the sporangial base.
- d*: JM021. Largest *Salopella* cf. *marcensis* sporangium. Small elongate fusiform sporangium with tapering apex and pointed tip (see arrow).
- e*: JM266a. Smallest *Salopella* cf. *marcensis* sporangium. Small elongate fusiform sporangium with tapering apex and rounded tip (see arrow).
- f*: JM394b. Isotomously branched narrow axes with at least three branch points (see arrows). Terminated by elongate fusiform sporangia with pointed tips (see 3.10*c*).

Plate 3.10: *Salopella* cf. *marcensis* specimens.

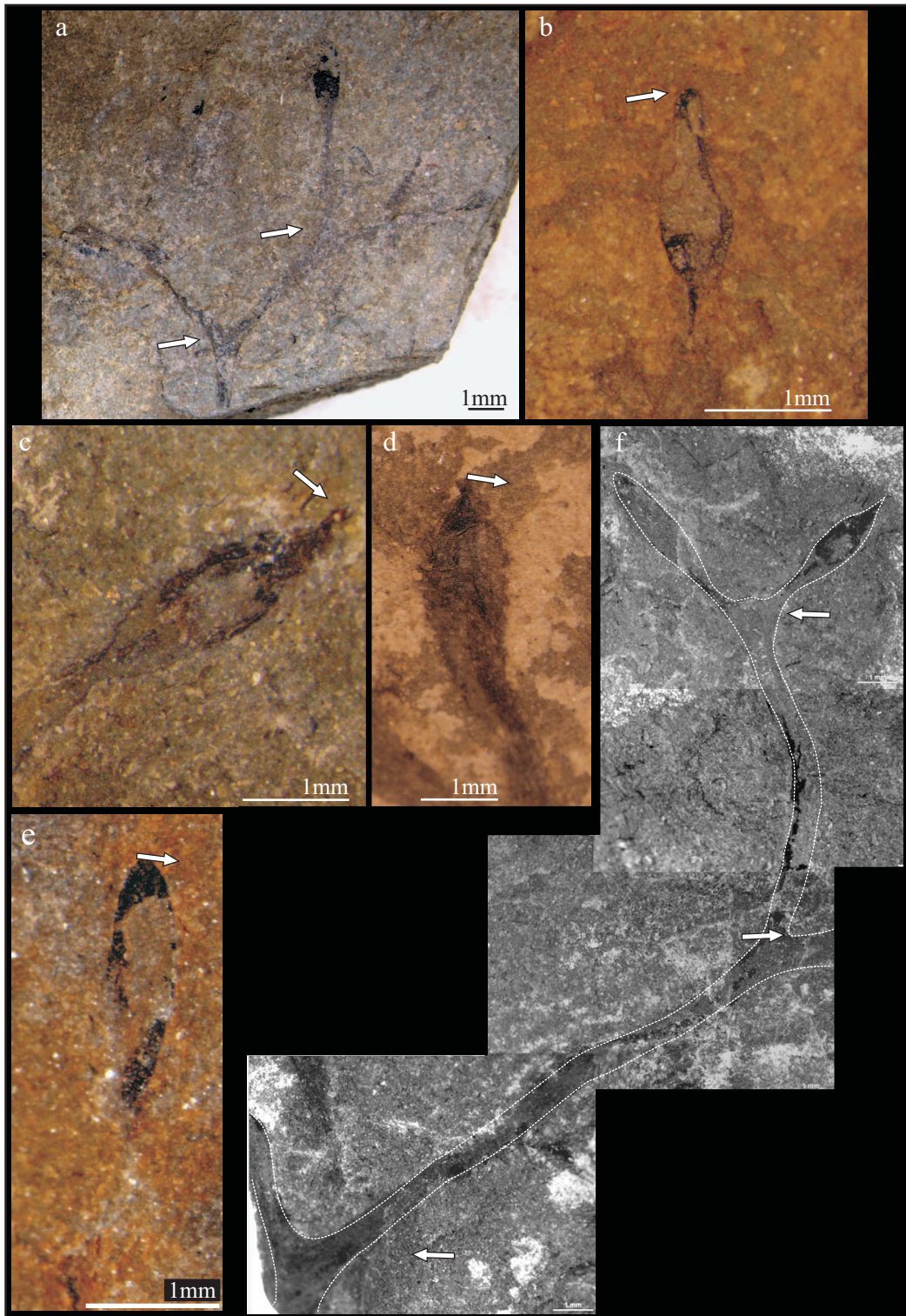


Plate 3.11: *Salopella cf. marcensis* specimens: anatomy

- a*: JM394. Elongate, fusiform sporangium, with elongate striations preserved within the coalified compression (see arrow) and counterpart impression, running parallel to the long axis of the sporangium, and tapering in the apex. Slight narrowing of the axis at the sporangial-axial junction (see arrow).
- b*: JM394. SEM image of the pointed, extended tip of the elongate, fusiform sporangium shown in 3.11*a*. Elongate cellular-like striations preserved as impressions, running parallel to the sporangium long axis.
- c*: JM394. SEM image of preferentially preserved coalified central strand within subtending axis (see arrow). Elongate cellular-like striations preserved in the remaining impression, which run parallel down the length of the axis.
- d*: JM394. SEM image of elongate cellular-like striations preserved in the impression of the subtending axis shown in 3.11*d*.
- e*: *Salopella marcensis* (Fanning, Edwards and Richardson 1992).

Plate 3.11: *Salopella* cf. *marcensis* specimens: anatomy

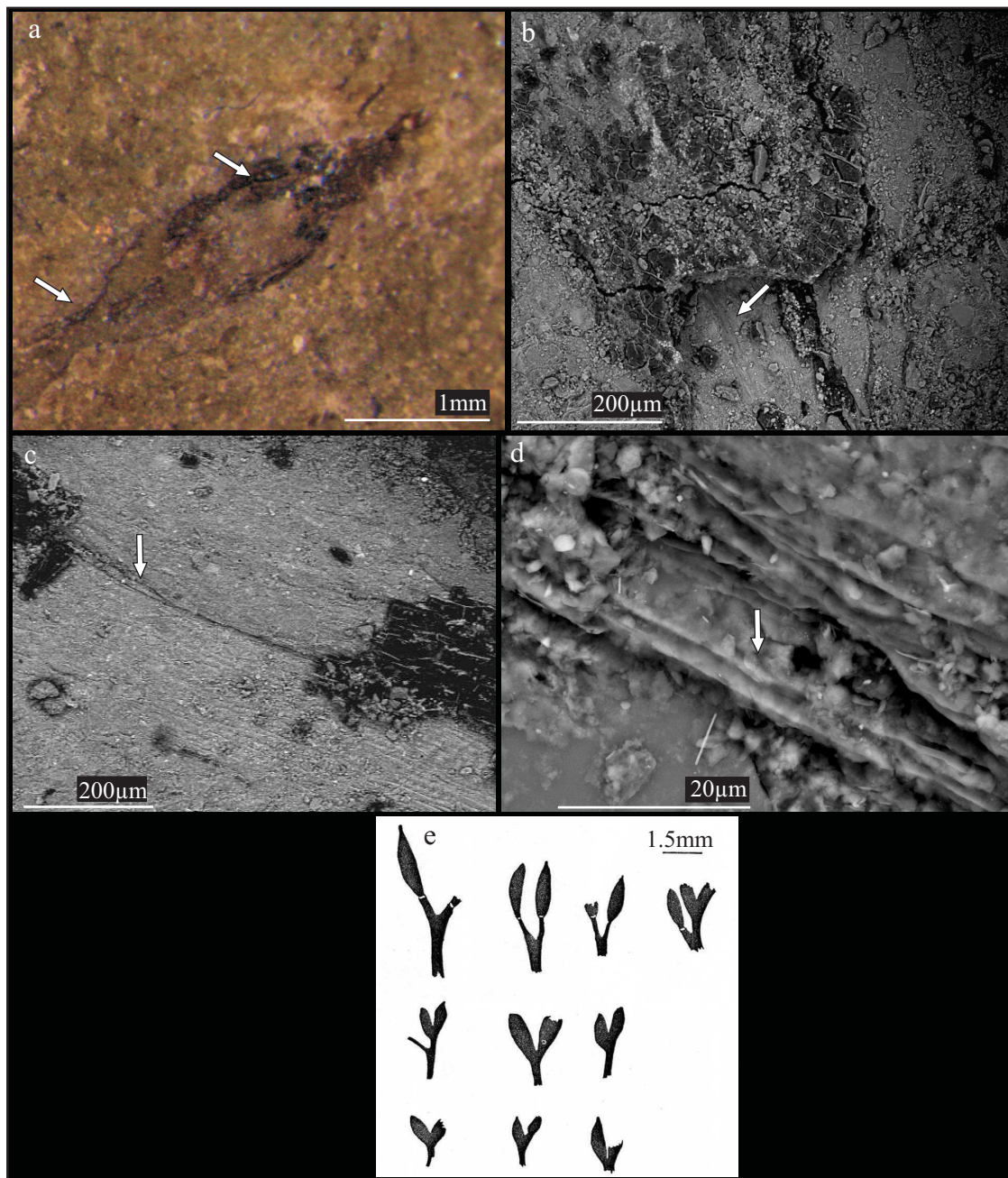


Plate 3.12: Elongate club-shaped sporangia specimens

- a*: RHPB. Dichotomously branched axes (see arrow), terminated by elongate, club-shaped sporangium, with broad, rounded apex, and maximum sporangial width occurring in the top third of sporangial height. Sporangial-axial junction unclear, but subtending axis gradually tapers down to branch point.
- b*: Diagram showing possible sporangial-axial junction positions on specimen JM016c.
- c*: RHSp20_1. Elongate, club-shaped terminal sporangium, with broad rounded apex, where maximum sporangial width is approximately positioned in the top third of sporangial height. Subtending axis gradually tapers away. Preferentially preserved sporangial border visible (see arrow). Sporangial-axial junction unclear, but possible position indicated (see arrow).
- d*: RH117_4. Elongate, club-shaped terminal sporangium, with broad rounded apex. Preferentially preserved wide sporangial border visible (see arrows). Sporangial-axial junction unclear, but possible position indicated (see arrow).
- e*: Sp034_2. Elongate club-shaped terminal sporangium, with preferentially preserved wide sporangial border visible (see arrow).
- f*: JM262a. Isotomously branched axes, with two branch points (see arrows), terminating in elongate, club-shaped sporangia, with preferentially preserved wide sporangial border visible.
- g*: JM371. The largest sporangium and specimen of all elongate club-shaped sporangia specimens. The sporangial border is visible around the whole sporangium (see arrows). The position of the sporangial-axial junction is unclear.

Plate 3.12: Elongate club-shaped sporangia specimens

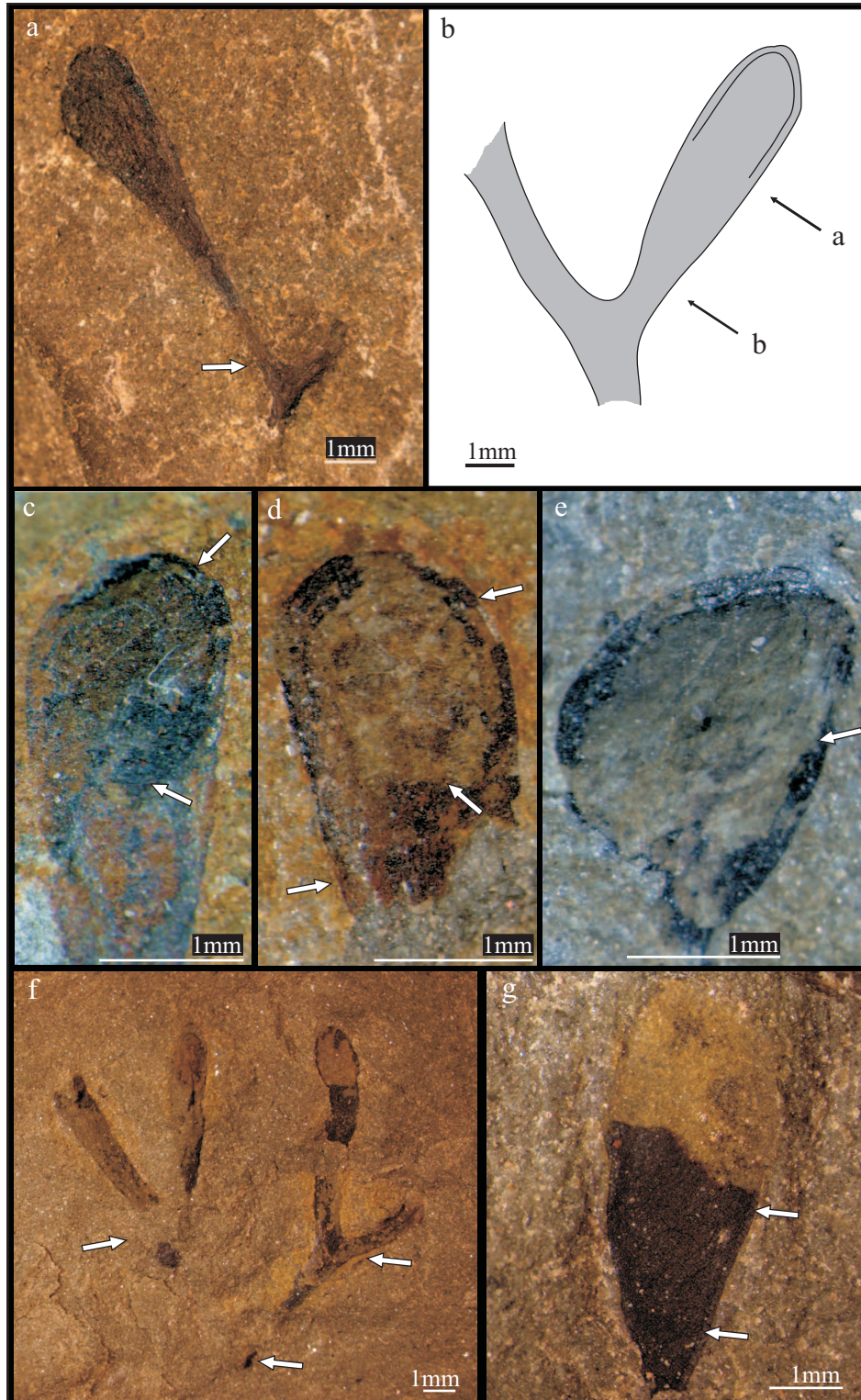


Plate 3.13: Elongate club-shaped sporangia specimens: anatomy

- a*: JM016c. SEM image of elongate, club-shaped sporangium, showing peripheral crack parallel and close to the outer margin (see arrow), filled with pyrite-limonite cubes.
- b*: JM371. SEM image of the outer margin of an elongate, club-shaped sporangium. A wide sporangial border has been preserved within the coalified compression, composed of elongate, cell-like striations running parallel to the sporangia outer margin (see arrow).
- c*: JM371. SEM image of the outer sporangial wall, of an elongate, club-shaped sporangium. Elongate cell-like striations run obliquely to the sporangia outer margin (see arrow).
- d*: JM262a. SEM image of the outer margin of an elongate, club-shaped sporangium. A wide sporangial border has been preserved within the impression (marked by thick white line). Within this border, elongate cell-like striations are running parallel to the outer sporangial margin (see arrow and thin white line). Within the central area of the outer sporangial wall, impressions of elongate cell-like striations running obliquely to the outer sporangial margin are visible (see arrow and thin white line).
- e*: JM287. SEM image of a preferentially preserved central strand (see arrow) within the subtending axis terminated by an elongate, club-shaped sporangium. Impressions of cell-like striations run parallel down the length of the subtending axis (see arrow).
- f*: JM287. SEM image of a preferentially preserved central strand (see arrow) within the subtending axis terminated by an elongate, club-shaped sporangium.

Plate 3.13: Elongate- club shaped sporangia specimens: anatomy

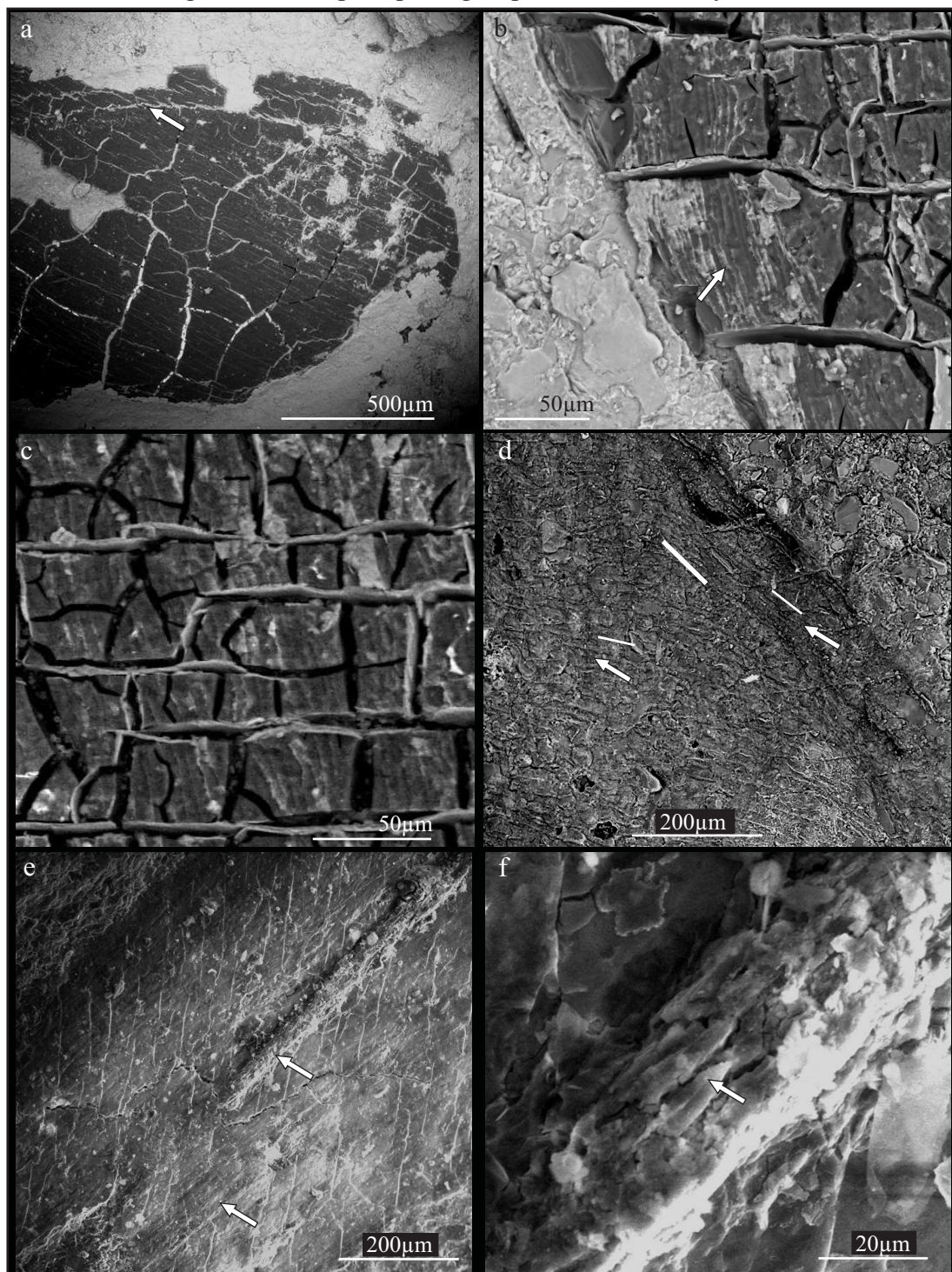


Plate 3.14: Mesofossil type A specimens

- a*: JM197b. Largest sporangium of type A. Anisotomously branched (see arrows) narrow axis, terminated by two pairs of circular sporangia.
- b*: JM190b. Terminal dichotomy (see arrow) directly beneath two circular sporangia. Sporangial-axial junction unclear.
- c*: JM086c. Terminal dichotomy (see arrow) bearing two circular sporangia. Sporangial-axial junction unclear.
- d*: RH128_1. Terminal dichotomy (see arrow) bearing two circular sporangia. Sporangial-axial junction unclear.
- e*: JM323c. Terminal dichotomy (see arrow) directly beneath two elliptical sporangia. Sporangial-axial junction unclear.
- f*: RH002_1. Terminal dichotomy (see arrow) directly beneath two elliptical sporangia. Sporangia may also be interpreted as one bifurcating sporangium.
- g*: JM095d. Terminal dichotomy (see arrow) bearing two elliptical sporangia. Sporangial-axial junction unclear.
- h*: JM194a. Dichotomously branched axis (see arrows) with three branch points; one of the final dichotomies occurs close the base of a pair of elliptical sporangia and is slightly anisotomous.
- i*: JM123a. Anisotomously branched axis (see arrows); final dichotomies close the base of two pairs of elliptical sporangia.
- j*: JM123a. Counterpart to P3.14*i*.
- k*: JM365d. Anisotomously branched axis (see arrows); final dichotomies close the base of two pairs of circular sporangia.
- l*: RHSp006. Isotomously branched axis (see arrows); final dichotomies close the base of a pair of circular sporangia.
- m*: JM153b +c. Two pairs of terminal elliptical sporangia. Alternatively, interpreted as two bifurcating elliptical sporangia.
- n*: JM365c. Bifurcating terminal elliptical sporangium.
- o*: JM365a. Anisotomously branched axis with three branch points (see arrows), terminated by two visible pairs of circular sporangia.
- p*: JM365a. Counterpart to 3.14*o*.

Plate 3.14: Mesofossil type A specimens. Scale bar =1mm.

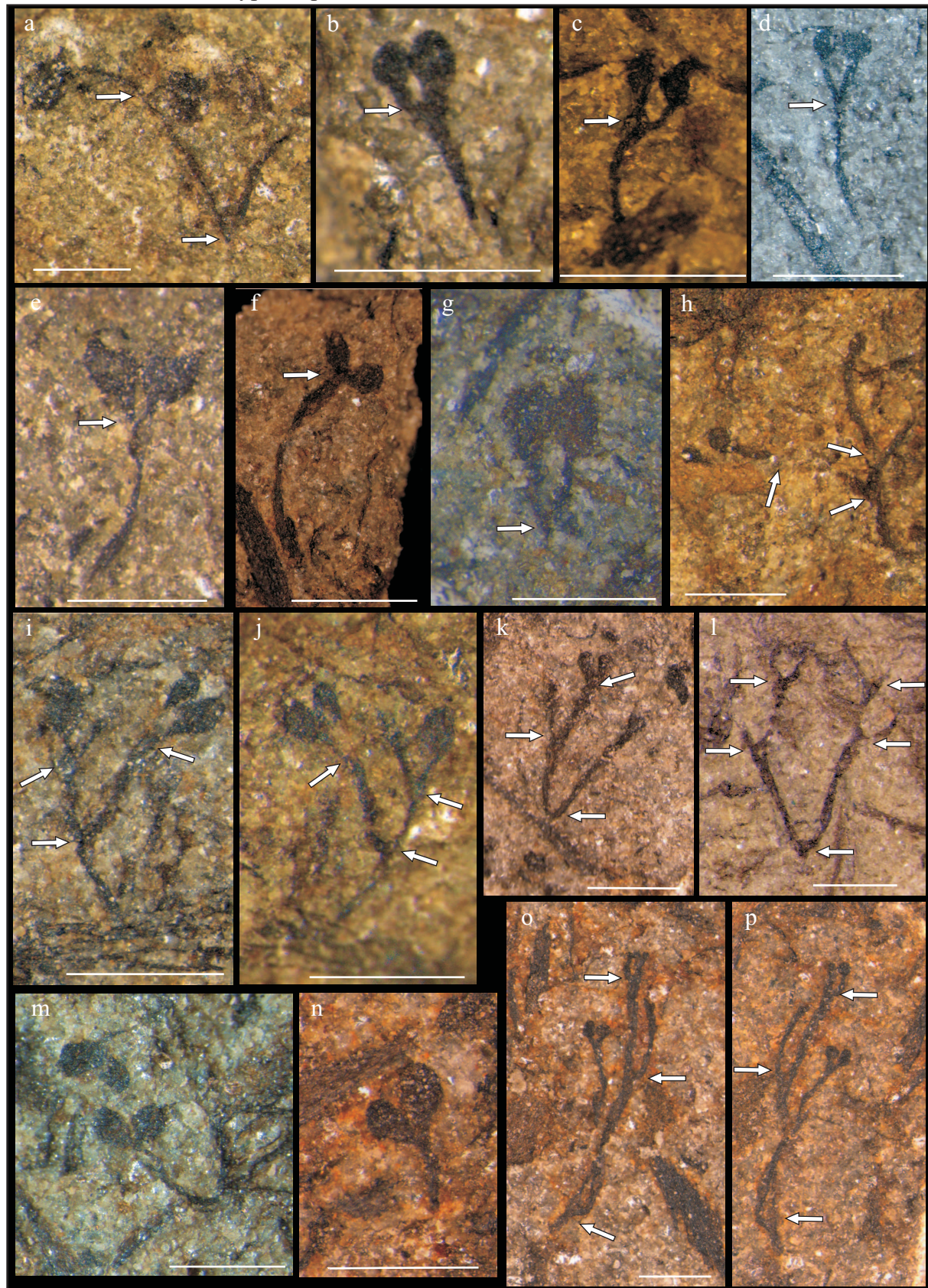


Plate 3.15: Mesofossil type B specimens

- a*: JM214a. Isotomously branched axis (see arrow), terminated by elongate, elliptical sporangia. Maximum sporangial width occurs approximately at half sporangial height.
- b*: JM206a. Dichotomously branched axis (see arrow), slightly anisotomous, terminated by elongate, elliptical sporangia. Maximum sporangial width occurs approximately at half sporangial height.
- c*: RH077a. Slightly anisotomously branched axis (see arrows), with two branch points, terminated by elongate, elliptical sporangia. Maximum sporangial width occurs approximately at half sporangial height.
- d*: JM164d. Largest sporangium specimens of mesofossil type B. Partially preserved elongate, elliptical sporangium, with short subtending axis.
- e*: JM164c. Smallest sporangium specimens of mesofossil type B. Isotomously branched axis (see arrow), terminated by elongate, elliptical sporangia.
- f*: JM364b. Slightly anisotomously branched axes (see arrow), terminated by elongate, elliptical sporangia. Subtending axes gradually tapers away from the sporangia bases and becomes parallel-sided.
- g*: JM174. Isotomously branched axes (see arrows), with three branch points, one daughter axis terminated by elongate, elliptical sporangium.
- h*: JM205a. Slightly anisotomously branched axes (see arrows), with three branch points, each terminated by elongate, elliptical sporangia.
- i*: JM364a. Isotomously branched axes (see arrows), with three branch points, two daughter axes terminated by elongate, elliptical sporangia.
- j*: JM336. Anisotomously branched axis (see arrow), terminated by elongate, elliptical sporangia.
- k*: JM178. Anisotomously branched axis (see arrow), with one daughter branch terminated by elongate, elliptical sporangium.
- l*: JM242a. Isotomously branched axis (see arrow), terminated by elongate, elliptical sporangia. Final dichotomy occurs at some distance from the base of the sporangia.
- m*: JM086d. Largest specimen of mesofossil type B. Anisotomously branched axis (see arrows), terminated by elongate, elliptical sporangia.

Plate 3.15: Mesofossil type B specimens. Scale bar =1mm.

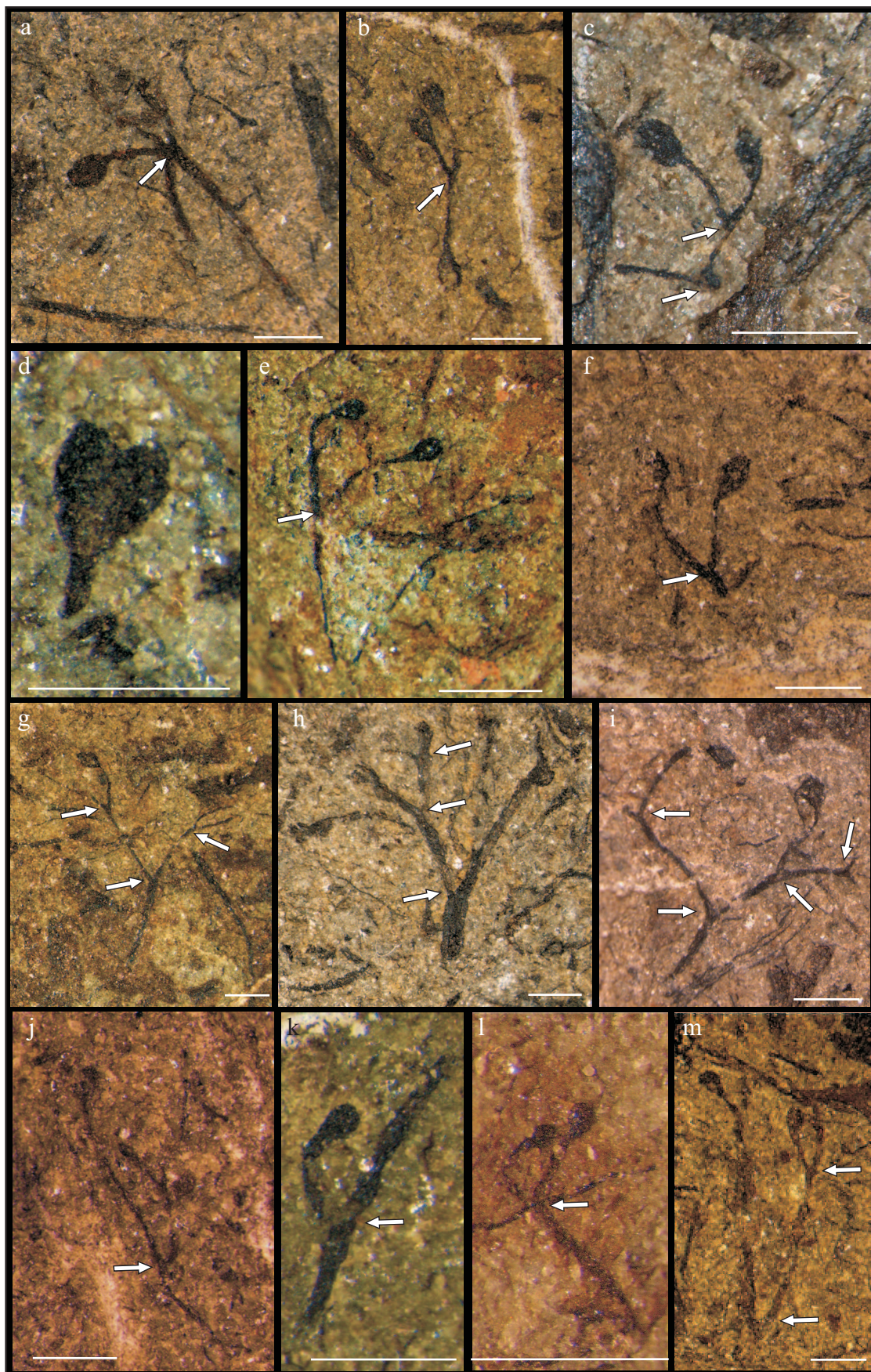


Plate 3.16: Mesofossil type C specimens

- a*: JM188. Terminal, vertically ovate sporangium and subtending axis.
- b*: JM154. Terminal, transversely ovate sporangium and subtending axis.
- c*: JM100b. Terminal circular sporangium and subtending axis.
- d*: JM230b. Isotomously branched axis (see arrow), terminated by circular sporangium with flattened tip.
- e*: JM114a. Largest sporangium of mesofossils type C. Partially preserved vertically ovate sporangium and subtending axis.
- f*: RHSp036. Smallest sporangium of mesofossils type C. SEM image of dichotomous axis, terminated by a circular sporangium.
- g*: JM197a. Terminal vertically ovate sporangium and subtending axis. Subtending axis gradually tapers downwards from the sporangial base to become parallel-sided.
- h*: JM181. Terminal circular sporangium and subtending axis. Subtending axis gradually tapers downwards from the sporangial base to become parallel-sided.
- i*: JM198a. Isotomously branched axis (see arrow) terminated by circular sporangia.
- j*: JM402. Isotomously branched axis (see arrow), with one daughter branch terminated by circular sporangium with a flattened tip.
- k*: JM190a. Isotomously branched axis with two branch points (see arrows), terminated by vertically ovate sporangia.

Plate 3.16: Mesofossil type C specimens.

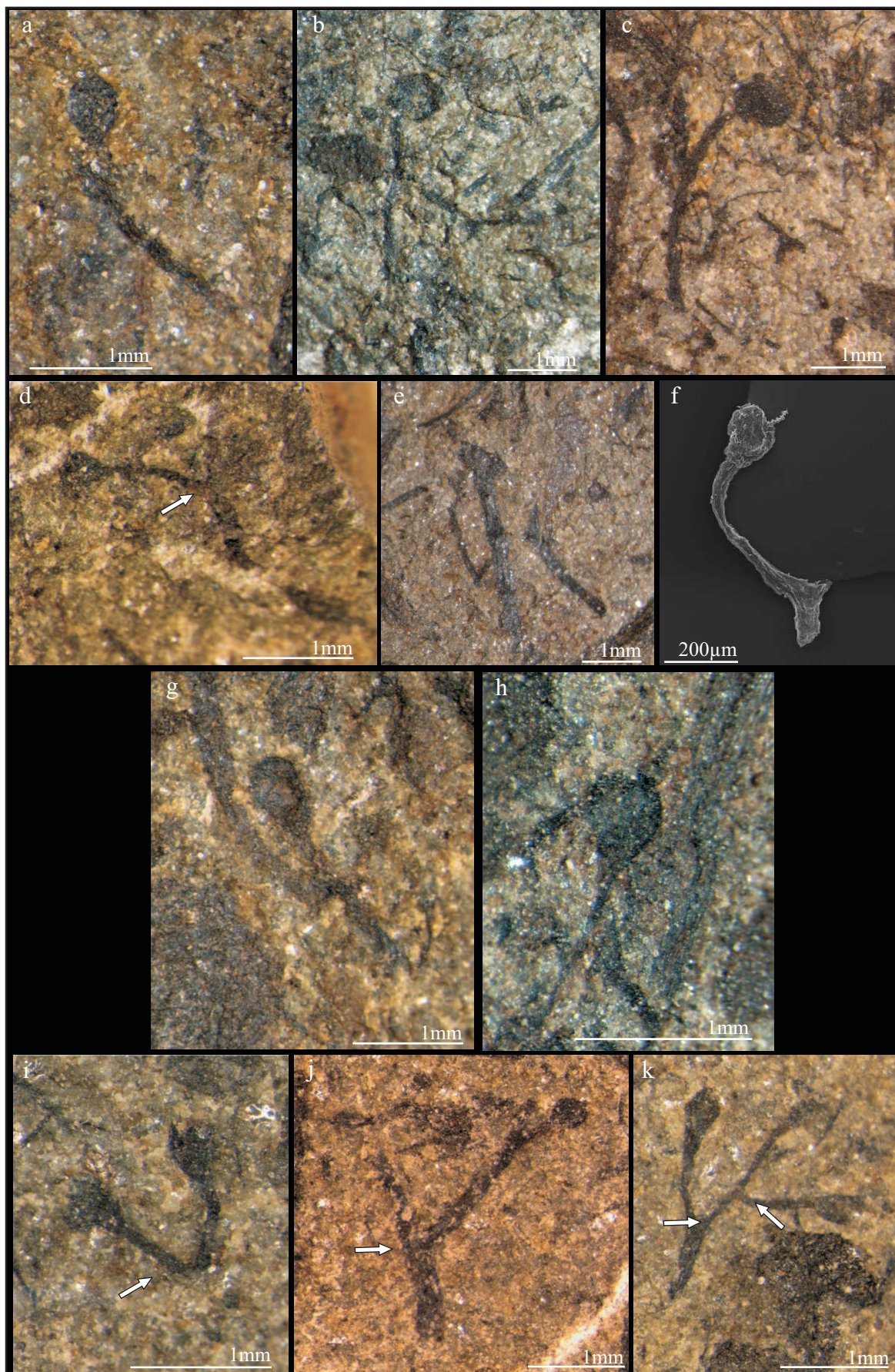


Plate 3.17: Mesofossil type D specimens

- a*: JM157c. Isotomously branched axis (see arrow), terminated by small circular sporangia.
- b*: JM187c. Isotomously branched axis (see arrow), terminated by small circular sporangia. Subtending axis curved inwards.
- c*: JM194c. Small circular terminal sporangium and parallel-sided subtending axis.
- d*: JM010f. Isotomously branched axis (see arrow), terminated by small transversely elliptical sporangia. Subtending axis curved inwards.
- e*: RH128_2. Isotomously branched axis (see arrow), terminated by small transversely elliptical sporangia.
- f*: RH050_2. Isotomously branched axis (see arrow), with one daughter branch terminated by small transversely elliptical sporangium.
- g*: JM290b. Largest sporangium of mesofossil type D. Isotomously branched axis (see arrow), terminated by small transversely elliptical sporangia. Thickening of the dichotomy centre.
- h*: JM114c. Terminal circular sporangium, with parallel-sided subtending axis.
- i*: JM110a. Isotomously branched axis (see arrow), terminated by small circular sporangia. Subtending axis curved inwards.

Plate 3.17: Mesofossil type D specimens.



Plate 3.18: *Tortilicaulis* cf. *offaeus* specimens

- a*: JM397a. Isotomously branched axis (see arrow), terminated by elongate, fusiform sporangia.
- b*: JM397a. Sporangium A of specimen JM397a. Terminal elongate, fusiform sporangium, with a tapering apex, and rounded tip.
- c*: JM397a. Sporangium B of specimen JM397a. Terminal elongate, fusiform sporangium, with a tapering apex, and pointed tip. Cell-like, elongate striations can be seen in the sporangium compression and corresponding impression beneath, with a oblique, twisted orientation compared to the sporangium edge.
- d*: RHSp012_1. Isotomously branched axis (see arrow), terminated by elongate, fusiform sporangia.
- e*: JM397a. SEM image of sporangium B of specimen JM397a. Elongate cell-like striations run obliquely to the sporangium edge, giving a twisted appearance (see arrow). Cells have a fusiform shape, in filled with pyrite-limonite cubes.
- f*: JM397a. SEM image of subtending axis of specimen JM397a. Cell-like striations can be seen in coalified compression and impression beneath (see arrow), running oblique to the axis edge, giving a twisted appearance.
- g*: JM397a. Poorly preserved stomata (?) (see arrow), on the subtending axis of JM397a.
- h*: JM397a. Poorly preserved dyads similar to the dispersed spore taxa *Dyadospora* sp., in the central area of the sporangial wall of specimen JM397a.
- i*: *Tortilicaulis* Edwards 1979.
- j*: *Tortilicaulis offaeus* Edwards et al. 1994.

Plate 3.18: *Tortilicaulis* cf. *offaeus* specimens.

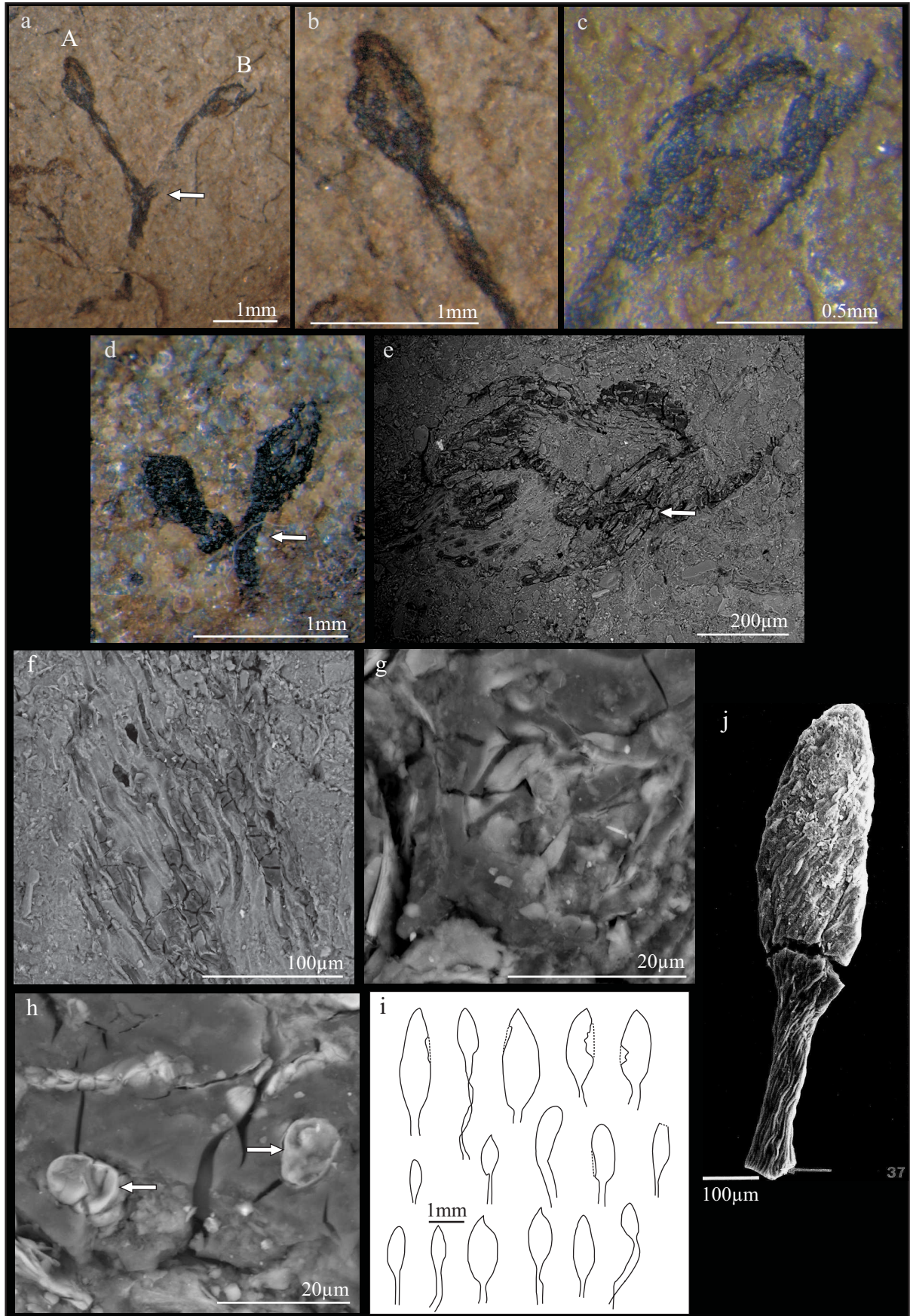


Plate 3.19: Other mesofossils with elongate sporangia

- a*: JM095b. Elongate, fusiform sporangium with short, narrow subtending axis.
- b*: RH2_8. Elongate, bulbous sporangium, attached to a narrow subtending axis.
- c*: RH248_1. Elongate, fusiform sporangium with pointed tip, attached to a narrow subtending axis.
- d*: RH005_1. Elongate, fusiform sporangium with pointed tip, attached to a subtending axis.
- e*: JM280a. Elongate, fusiform sporangium with rounded tip, attached to a subtending axis.
- f*: RHSp52b. Elongate, fusiform sporangium with rounded tip, attached to a subtending axis.
- g*: JM074b. Elongate sporangium with blunt tip, attached to a subtending axis.
- h*: JM037a. Elongate sporangium rounded tip, attached to a subtending axis. Largest sporangium of these specimens.

Plate 3.19: Other mesofossils with elongate sporangia.

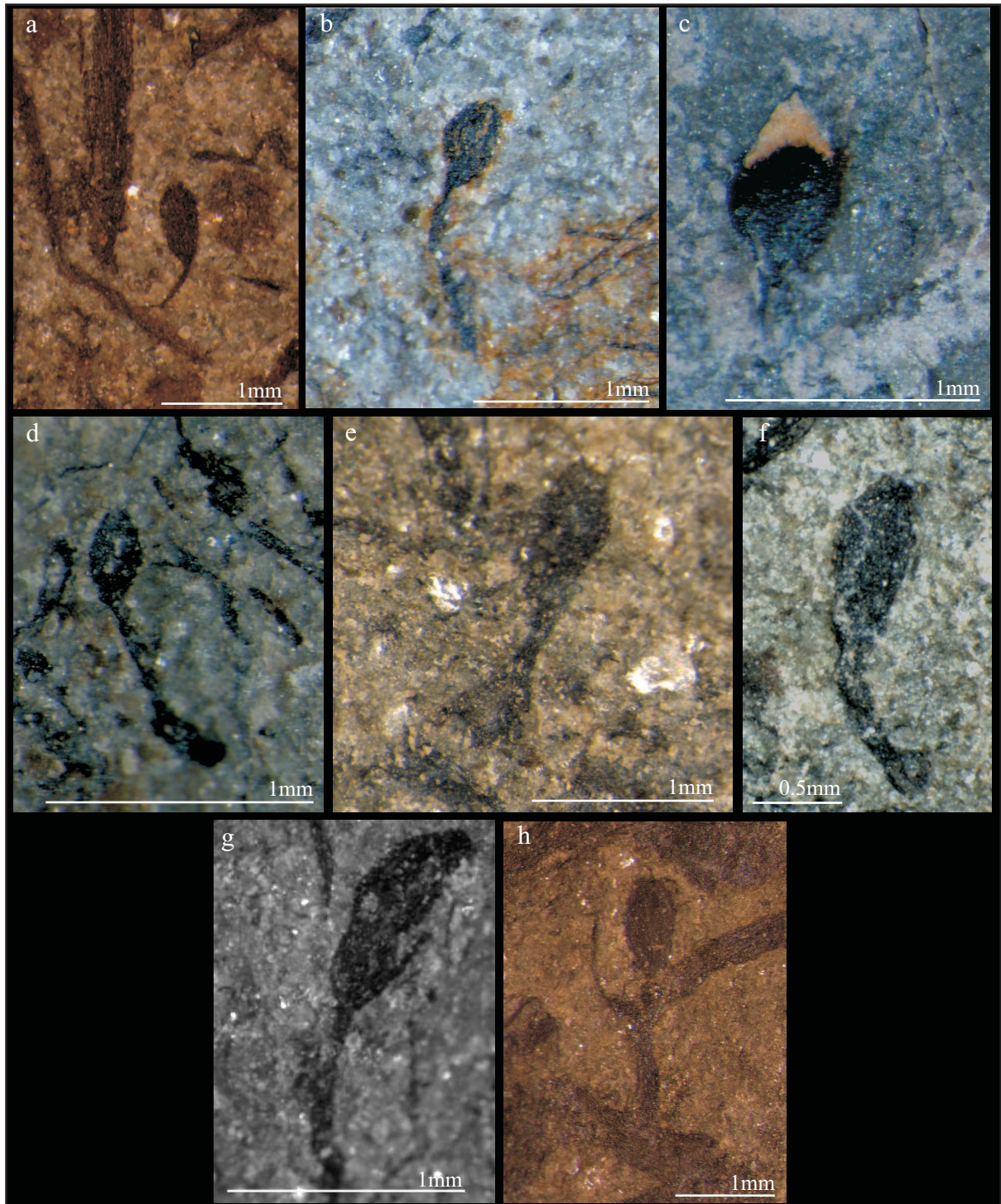


Plate 3.20: Cephalaspid fish specimen and *Prototaxites* sp. / *Nematasketum* sp. specimens

- a:* Cephalaspid fish found amongst non-embryophytes, and disseminated axial plant fossils.
- b:* SEM image of three-dimensional, wood-like, charcoalfied fragment.
- c:* Largest coalified compression fossil of *Prototaxites* sp./ *Nematasketum* sp. “axis” from Tredomen Quarry, found in Plant Bed 2.
- d:* Randomly orientated, partially eroded, coalified compressions of irregularly shaped *Prototaxites* sp./ *Nematasketum* sp., with no anatomical detail.
- e:* Irregularly-shaped fragment of *Prototaxites* sp./ *Nematasketum* sp., partially preserved three-dimensionally, with longitudinal striations preserved.
- f:* “Axial” fragment of *Prototaxites* sp./ *Nematasketum* sp., which is elongate, and tapering at one end, with a blunt tip.
- g:* Elongate, axial-like, parallel-sided fragment of *Prototaxites* sp./ *Nematasketum*, tapering at one end, with a blunt tip.
- h:* Elongate, axial-like, parallel-sided fragment of *Prototaxites* sp./ *Nematasketum* sp.
- i:* Elongate, axial-like fragment of *Prototaxites* sp./ *Nematasketum* sp. with elongate striations running parallel to the fragment edge. Oval protuberances (see arrow) with longitudinal axis parallel to the alignment of striations and fragment edge.
- j:* Elongate, axial-like fragment of *Prototaxites* sp./ *Nematasketum* sp. with three oval shaped protuberances (see arrows), maximum length parallel to the alignment of the axis.

Plate 3.20: Cephalaspid fish specimen and *Prototaxites* sp. / *Nematasketum* sp. specimens.

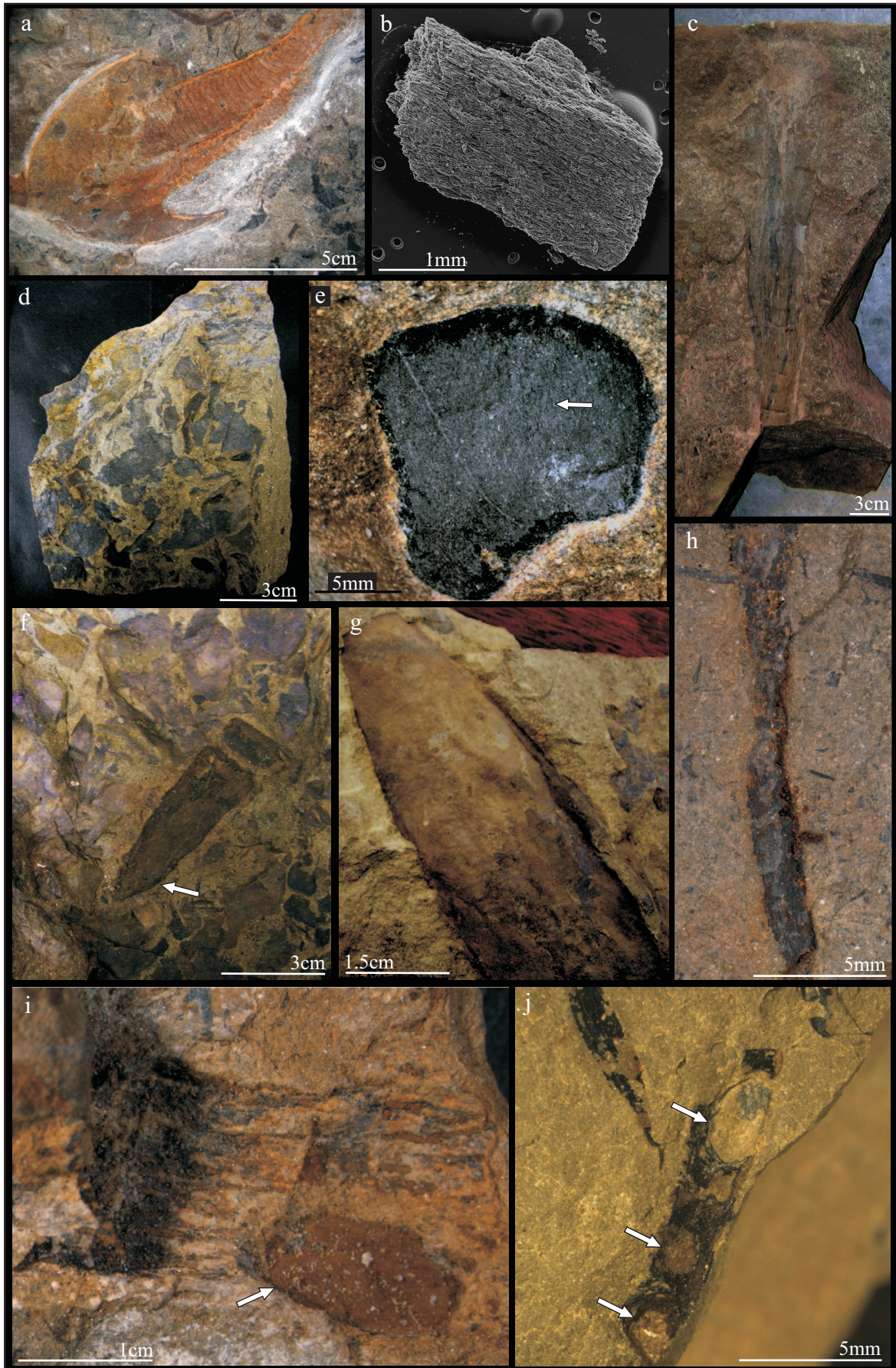


Plate 3.21: *Prototaxites* sp./ *Nematasketum* sp. specimens: anatomy

- a:* Light microscope image of partially three-dimensional coalified fragment of *Prototaxites* sp./ *Nematasketum* sp. Parallel-aligned, longitudinal striations/ tubes visible (see arrows).
- b:* Axial-like, three-dimensional charcoaled fragment of *Prototaxites* sp./ *Nematasketum* sp. Parallel-aligned tubes visible (see arrows).
- c:* Cross-section through a three-dimensional charcoaled fragment of *Prototaxites* sp./ *Nematasketum* sp., showing two of the three tube types: the wide, smooth-walled tubes (see arrows), surrounded by branching networks of narrower tubes.
- d:* Longitudinal view of three-dimensional charcoaled fragment of *Prototaxites* sp./ *Nematasketum* sp., showing densely packed, anastomosing thickenings (see arrows) on the interior wall of wide, thick-walled tube, in a matrix of narrower tubes.
- e:* Longitudinal view of three-dimensional charcoaled fragment of *Prototaxites* sp./ *Nematasketum* sp., showing anastomosing thickenings (see arrows) on the interior wall of wide, thick-walled tube.
- f:* Longitudinal view of *Prototaxites* sp./ *Nematasketum* sp. fragment, showing partially complete interior thickenings (see arrow) that are absent further along the tube.
- g:* Partial longitudinal section the *Prototaxites* sp./ *Nematasketum* sp. fragment, showing possible branching of the thickened wide tubes.
- h:* Cross-section of *Prototaxites* sp./ *Nematasketum* sp. fragment, showing partially joined wide thick-walled tubes (see arrow), possibly suggesting branching along the length of the tubes.
- i:* Cross-section of *Prototaxites* sp./ *Nematasketum* sp. fragment, showing large, wide thick-walled tubes surrounded by a network of narrow, randomly-orientated, branching tubes (see arrows).
- j:* Longitudinal section of *Prototaxites* sp./ *Nematasketum* sp. fragment, showing smaller tubes running parallel to the wider tubes (see arrows).
- k:* Cross-section view of *Prototaxites* sp./ *Nematasketum* sp. fragment, showing a high density of wide, thick-walled tubes compared with the smaller tubes.
- l:* Cross-section of *Prototaxites* sp./ *Nematasketum* sp. fragment, showing a low density of wide thick-walled tubes compared with the smaller tubes.

Plate 3.21: *Prototaxites* sp./ *Nematasketum* sp. specimens: anatomy

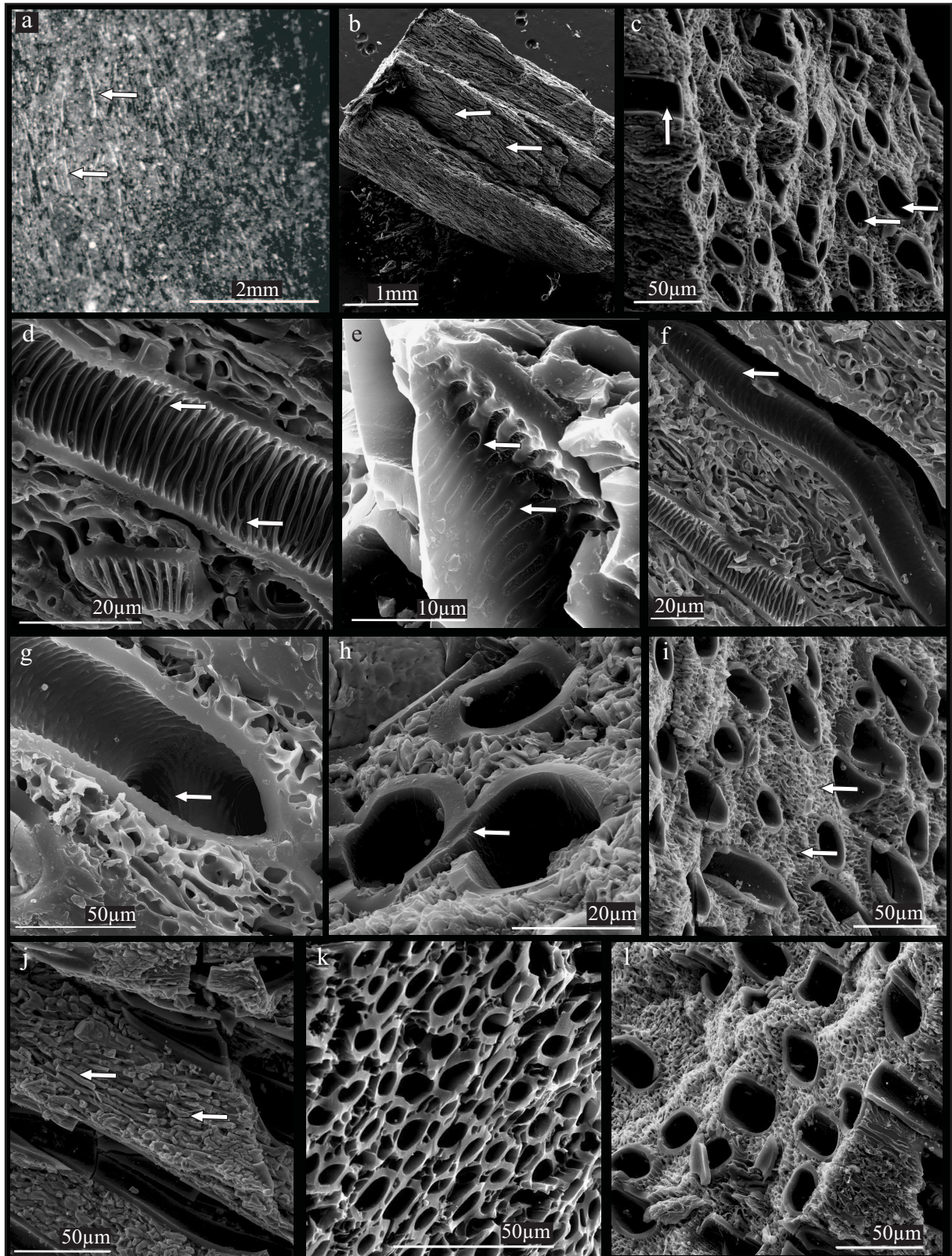


Plate 3.22: Hyphae specimens

- a:* Intertwining and bifurcating coalified narrow tubes (see arrows).
- b:* Tubes that appear to weave in and out of the top surface of rock (see arrows).
- c:* Densely packed, parallel-aligned tubes, that form an axial-like structure, which branches (see arrow).
- d:* Densely packed, mat-like narrow tubes, randomly orientated at a variety of angles to each other.
- e:* Banded tube with annular thickenings on the inner surface. Tube is filled with limonite, with the impression of annular thickenings.

Plate 3.22: Hyphae specimens

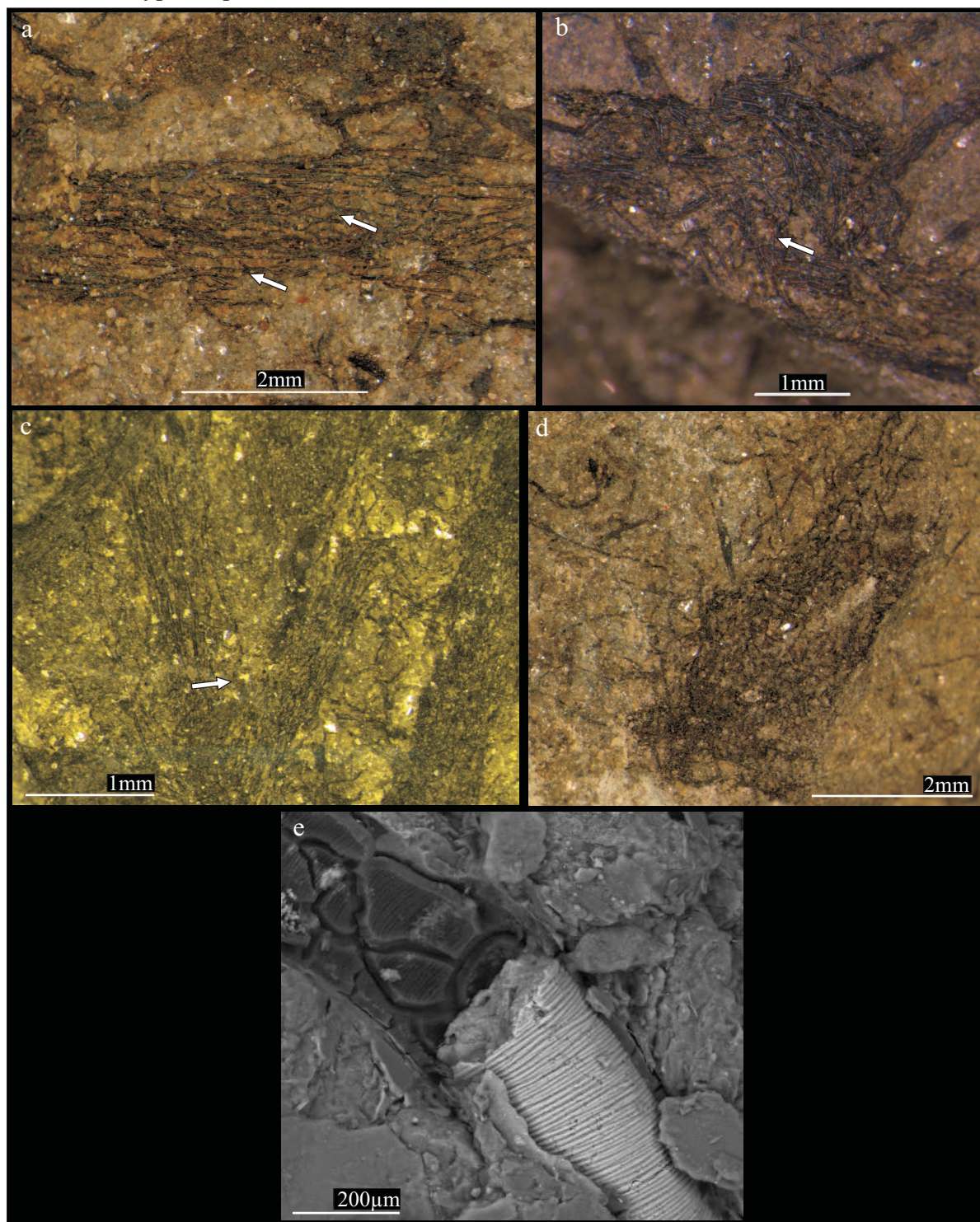


Plate 3.23: *Pachythea* specimens

- a*: Small coalified sphere with vitreous outer surface.
- b*: Partially preserved small coalified sphere. Vitreous outer surface is the only remaining part.
- c*: Cross-section of a *Pachythea* specimen, showing three layered structure: inner core (not preserved); radially-arranged tubes around the centre core, that make up the bulk of the sphere; and thin, amorphous outer layer.
- d*: Preserved portion of the central core, composed of narrow, randomly orientated bifurcating and anastomosing tubes.
- e*: Cross-section of a *Pachythea* specimen; radially-arranged tubes around the central core.
- f*: Cross-section of a *Pachythea* specimen; close up of radially-arranged tubes shown in 3.23*e*, showing annular thickenings on the inner surfaces (see arrow).
- g*: Cross-section of radially-arranged tubes shown in 3.23*e* and *f*, showing thin filaments that run down the lengths of some tubes (see arrows).
- h*: Cross-section of radially-arranged tubes, showing thin filaments that run down the lengths of some tubes (see arrows).
- i*: Cross-section of radially-arranged tubes, close to the central core, showing that many tubes have bulbous ends (see arrows).
- j*: Cross-section of radially-arranged tubes, showing the narrowing of the tubes (see arrows) just beneath outer, amorphous layer (see arrow).
- k*: Specimen showing radially-arranged tubes covered by thin, amorphous layer (see arrow).
- l*: Specimen showing thickened outer layer of *Pachythea* (see arrow). Layer has a sponge-like texture with small voids.

Plate 3.23: *Pachythea* specimens

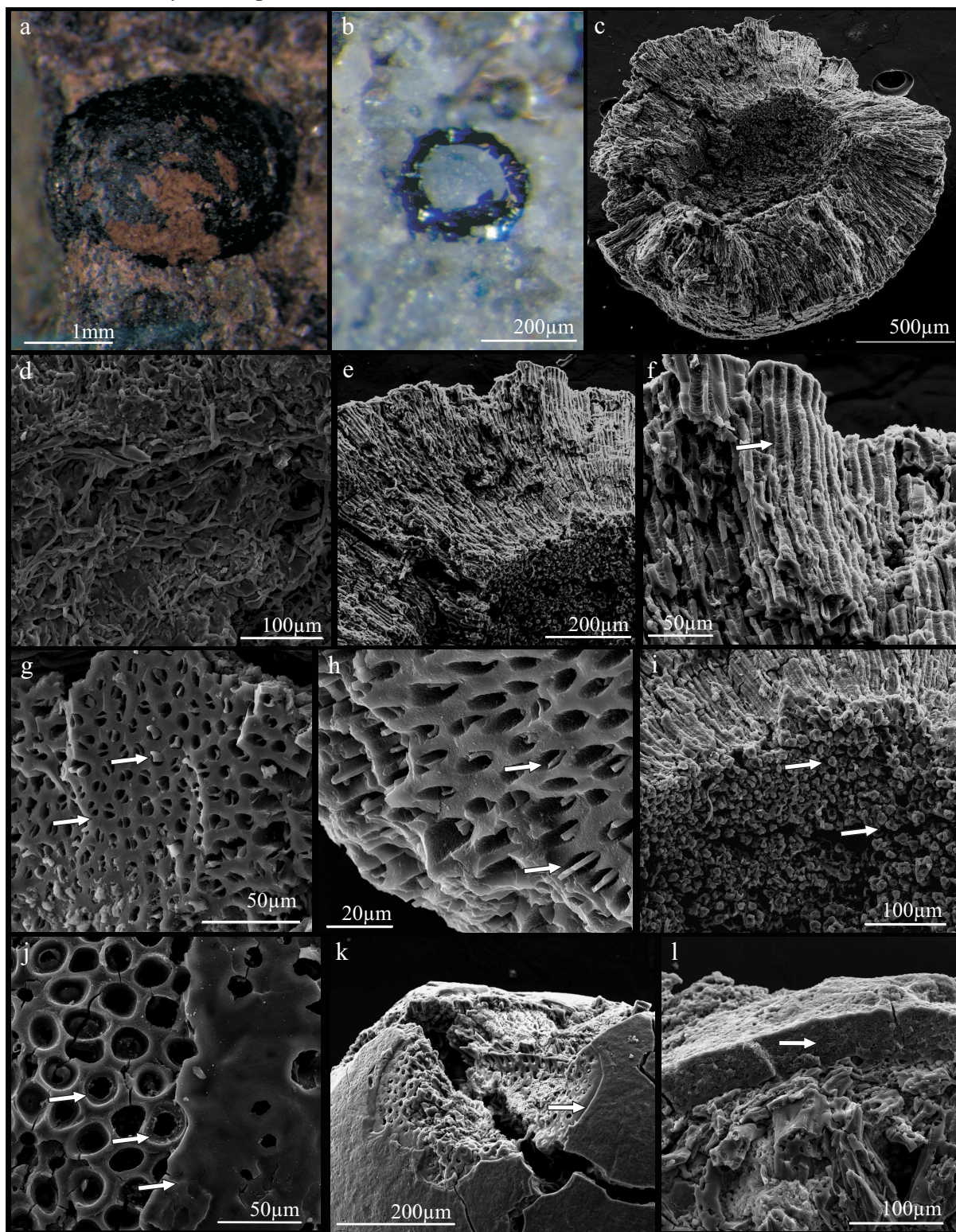


Plate 5.1: Fused laevigate tetrads

a to g: Cheilotetras caledonica

- a:* TRE1/153, Assemblage 1. Naked, fused tetrahedral tetrad with invaginated distal walls, and laevigate exine. Junction is marked by thickening of the exine.
- b:* TRE1/195, Assemblage 1. Naked, fused tetrahedral tetrad with invaginated distal walls, and laevigate exine. Junctions marked by thickening of the exine (see arrows).
- c:* TRE1/219, Assemblage 1. Naked, fused tetrahedral tetrad with invaginated distal walls, and laevigate exine. Junction is marked by the thickening of exine.
- d:* TRE1/010, Assemblage 1. Naked, fused tetrahedral tetrad with invaginated distal walls, and laevigate exine. Junctions marked by the thickening of exine (see arrow).
- e:* TQBH1-1(StubT1-1(2008)-114, Assemblage 2. Naked, fused tetrahedral tetrad with invaginated distal walls, and laevigate exine. Junctions marked by the thickening of exine.
- f:* TQBH1-1(StubT1-1(2008)-194, Assemblage 2. Naked, fused tetrahedral tetrad with invaginated distal walls, and laevigate exine. Junctions are marked by the thickening of exine.
- g:* TQBH2-1(StubT2-1(2008)-159, Assemblage 4. Naked, fused decussate (?) tetrad with invaginated distal walls and laevigate exine.

h to l: Cheilotetras sp.

- h:* TRE1/007, Assemblage 1. Naked, fused decussate tetrad, with laevigate exine.
- i:* TRE1/083, Assemblage 1. Naked, fused tetrahedral tetrad, with laevigate exine.
- j:* TRE1/084, Assemblage 1. Naked, fused tetrahedral (?) tetrad with laevigate exine.
- k:* TRE1/143, Assemblage 1. Naked, fused tetrahedral (?) tetrad with laevigate exine.
- l:* TQBH2-1(StubT2-1(2008)-069, Assemblage 4. Naked, fused tetrahedral (?) tetrad with laevigate exine.

Plate 5.1: Fused laevigate tetrads

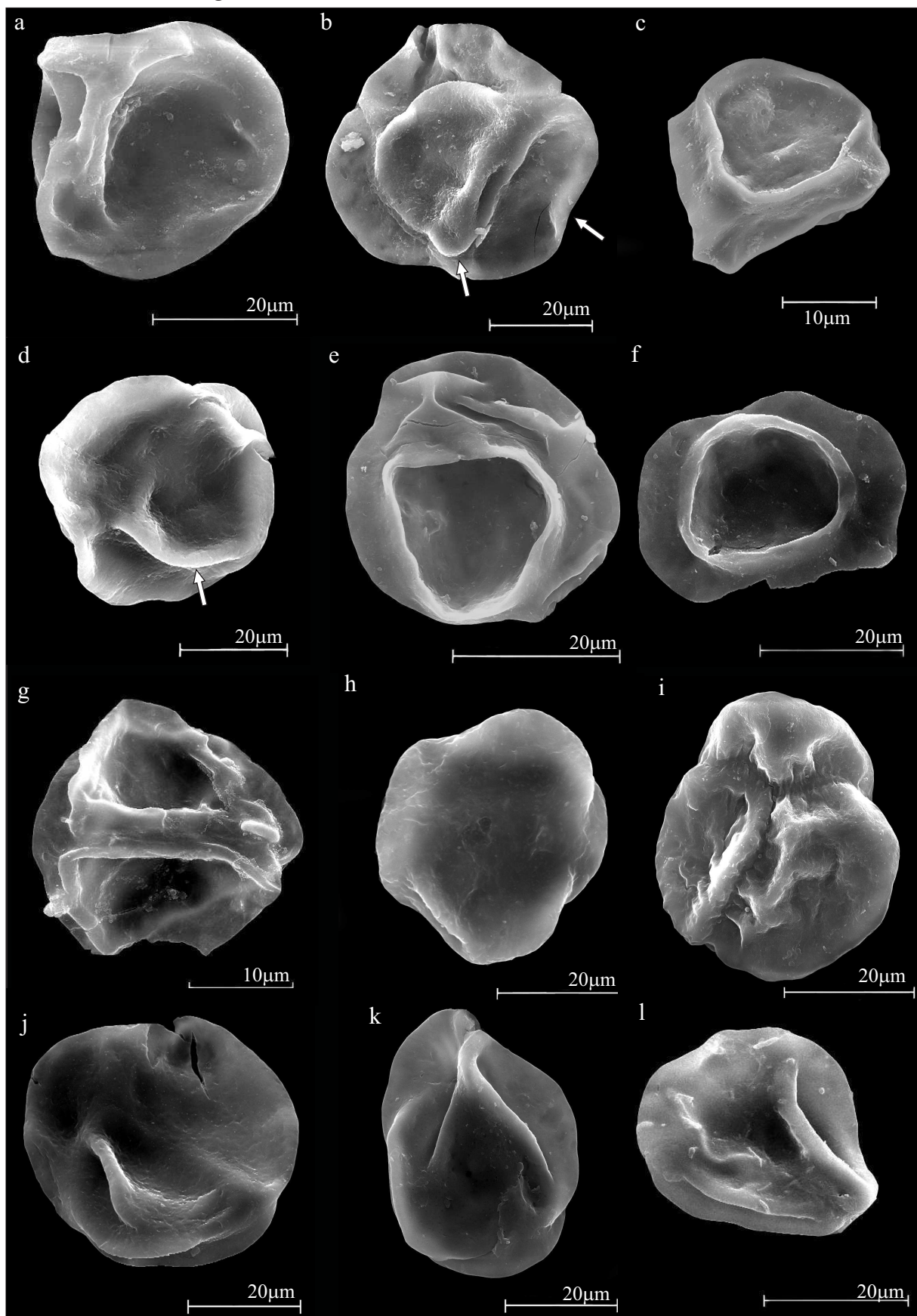


Plate 5.2: Fused laevigate dyads

a to f: Pseudodyadospora petasus

- a:* T1-6/PB0 (Stub 1-6)-266, Assemblage 1. Naked, fused dyad, with invaginated distal walls, with laevigate exine. Junction marked by a constriction (see arrow).
- b:* TQBH1-1(StubT1-2)-062, Assemblage 2. Naked, fused dyad, with invaginated distal walls, with laevigate exine. Junction marked by a constriction.
- c:* TQBH1-PB1(StubPB1-2008)-099, Assemblage 3. Partial naked, fused dyad, with invaginated walls, with laevigate exine. Junction marked by constriction (see arrow).
- d:* TQBH2-1(Stub T(2)2-1)-013, Assemblage 4. Naked, fused dyad, with invaginated distal walls, with laevigate exine.
- e:* TQBH1-3(StubT3-2)-049, Assemblage 5. Naked, fused dyad, with invaginated distal walls, with laevigate exine.
- f:* TQBH1-3(Stub T1-3(2008)-187, Assemblage 5. Naked, fused dyad, with invaginated distal walls, with laevigate exine. Junction marked by constriction.

g to l: Pseudodyadospora cf. laevigata

- g:* TRE1/045, Assemblage 1. Naked, fused dyad, with laevigate exine. No visible line of contact between sporal bodies, but exine is slightly thickened.
- h:* TRE1/047, Assemblage 1. Naked, fused dyad with laevigate exine. No visible line of contact between sporal bodies, but exine is slightly thickened (see arrow).
- i:* TQBH1-1(StubT1-1)-022, Assemblage 2. Naked, fused dyad (?) with laevigate exine. No visible line of contact between sporal bodies.
- j:* TQBH1-PB1(StubPB1-2008)-157, Assemblage 3. Naked, fused dyad with laevigate exine. No visible line of contact between sporal bodies, but exine is slightly thickened (see arrow).
- k:* TQBH2-1(StubT2-1(2008)-059, Assemblage 4. Naked, fused dyad (?) with laevigate exine.
- l:* TQBH2-1(StubT2-1(2008)-182, Assemblage 4. Naked, fused dyad with laevigate exine. No visible line of contact between sporal bodies, but exine is slightly thickened.

Plate 5.2: Fused laevigate dyads

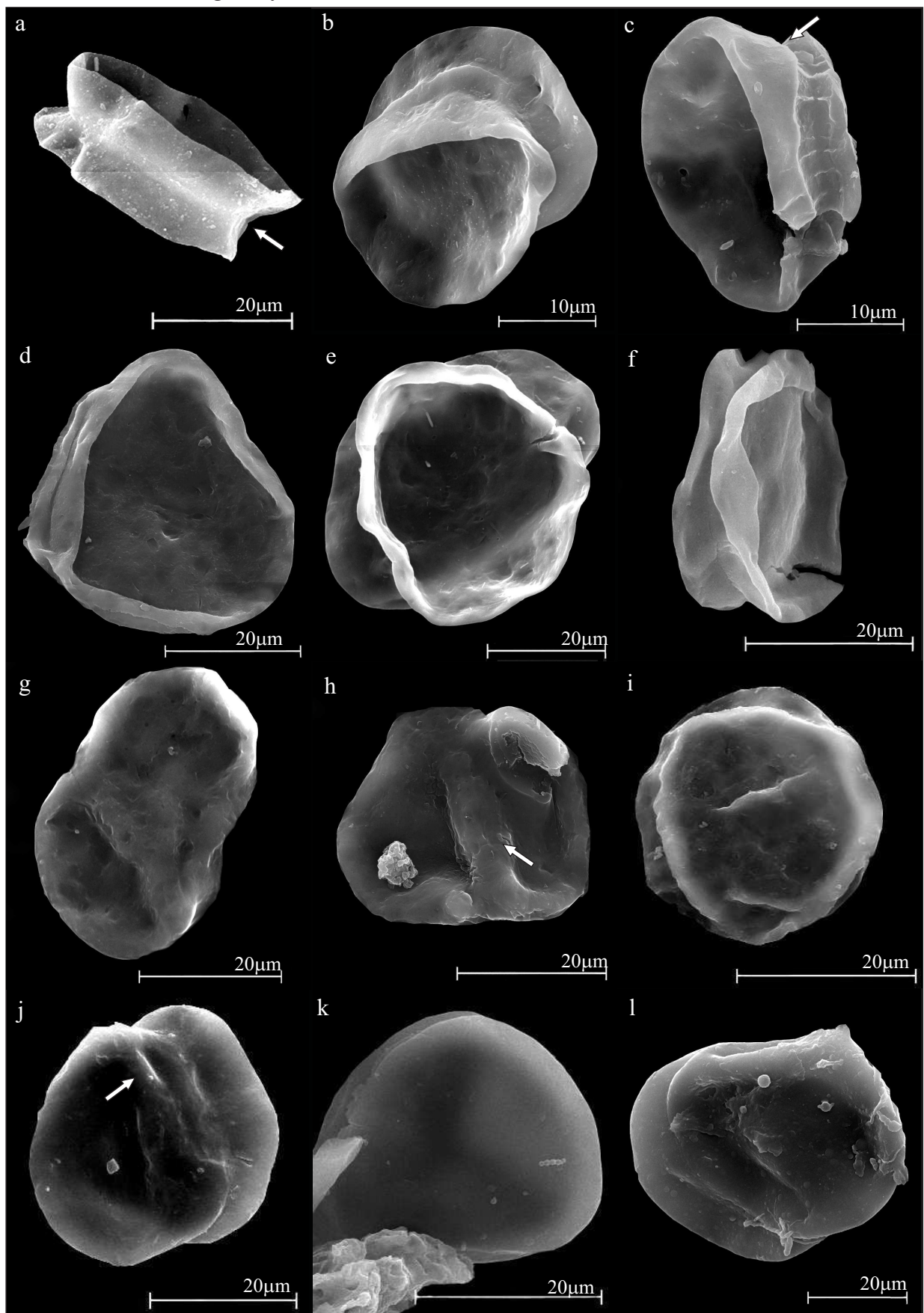


Plate 5.3: Fused, sculptured tetrads

a:* *Apiculate fused tetrad

- a:* TQBH1-3(Stub T1-3(2008)-212, Assemblage 5. Naked, fused tetrad with invaginated distal walls, and no visible contact lines. Junctions are marked by exine thickenings (see arrow). Exine sculptured with large grana and verrucae elements.

b to j:* *Verrucate fused tetrads

- b:* T1-6/PB0 (Stub 1-6)-256, Assemblage 1. Naked, fused tetrad with invaginated distal walls. Exine sculptured with irregularly sized, closely spaced verrucae and rugulae (see arrow).
- c:* TRE1/186, Assemblage 1. Naked, fused tetrad with inflated distal walls. Exine sculptured with irregularly shaped, closely spaced verrucae and rugulae.
- d:* TRE1/129, Assemblage 1. Naked, fused tetrad with inflated distal walls. Exine sculptured with irregularly shaped, closely spaced verrucae and rugulae.
- e:* TQBH1-1-037, Assemblage 2. Naked, fused tetrad with inflated distal walls. Exine sculptured with irregularly shaped, closely spaced verrucae and rugulae.
- f:* TQBH1-PB1-082, Assemblage 3. Naked, fused tetrad with inflated walls. Exine sculptured with irregularly shaped, closely spaced verrucae and rugulae.
- g:* TQBH1-PB1-109, Assemblage 3. Naked, fused tetrad with inflated walls. Exine sculptured with irregularly shaped, closely spaced verrucae and rugulae.
- h:* TQBH1-PB1-165, Assemblage 3. Naked, fused tetrad, with inflated walls. Exine sculptured with irregularly shaped, closely spaced verrucae and rugulae.
- i:* TQBH1-PB1-117, Assemblage 3. Naked, fused tetrad with inflated walls. Exine sculptured with irregularly shaped, closely spaced verrucae and rugulae.
- j:* TQBH2-1-085, Assemblage 4. Naked, fused tetrad (?) with invaginated walls. Exine sculptured with irregularly shaped, closely spaced verrucae and rugulae.

k and l:* *Murornate fused tetrads

- k:* TRE1/167, Assemblage 1. Naked, fused tetrad, with invaginated walls. Exine has murornate sculpture, which is perpendicular to the contact region (see arrow).
- l:* TQBH1-PB1-002, Assemblage 3. Naked, fused tetrad with partially inflated walls. Exine sculptured with muri.

Plate 5.3: Fused, sculptured tetrads

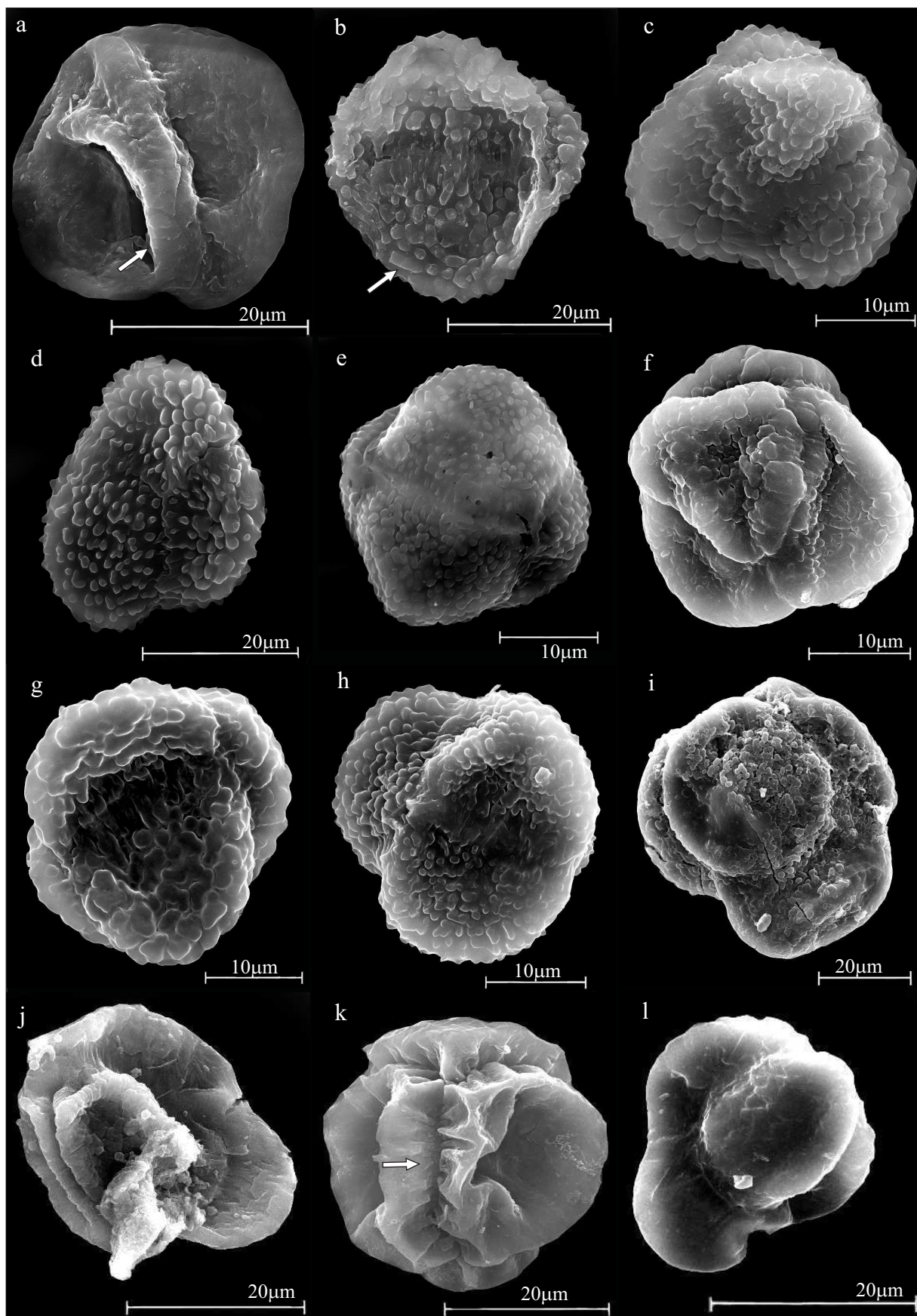


Plate 5.4: Unfused laevigate tetrads

a to f: Tetrahedraletes medinensis var. medinensis

- a:* T1-6/PB0 (Stub 1-6)-259, Assemblage 1. Naked, unfused decussate tetrad, with laevigate, invaginated distal walls. Clear contact lines are visible (see arrow). Each spore unit has an equatorial crassitude.
- b:* TQBH1-1-044, Assemblage 2. Naked, unfused tetrahedral tetrad, with partially laevigate invaginated distal walls. Clear contact lines are visible (see arrow).
- c:* TQBH1-1-093, Assemblage 2. Naked, unfused tetrahedral tetrad, with laevigate, invaginated distal walls. Clear contact lines are visible (see arrow).
- d:* TQBH2-1-072, Assemblage 4. Naked, unfused tetrahedral tetrad, with laevigate, inflated distal walls. Clear contact lines are visible (see arrow).
- e:* TQBH1-3-080, Assemblage 5. Naked, unfused tetrahedral tetrad, with some laevigate, invaginated walls, and one inflated wall (see arrow). Clear contact lines are visible.
- f:* TQBH1-3-228, Assemblage 5. Loose, naked unfused tetrahedral tetrad with partially invaginated distal walls. Clear contact lines are visible.

g to l: Tetrahedraletes medinensis var. parvus

- g:* TRE1/072, Assemblage 1. Naked, unfused decussate tetrad, with partially invaginated, laevigate distal walls. Clear contact lines are visible.
- h:* TQBH1-1-145, Assemblage 2. Naked, unfused decussate tetrad, with partially invaginated, laevigate distal walls. Clear contact lines are visible.
- i:* TQBH1-PB1-035, Assemblage 3. Naked, unfused tetrahedral tetrad, with partially invaginated, laevigate distal walls. Clear contact lines are visible.
- j:* TQBH2-1-036, Assemblage 4. Naked, unfused tetrahedral tetrad, with invaginated, laevigate distal walls. Clear contact lines are visible.
- k:* TQBH1-3(Stub T1-3(2008)-196, Assemblage 5. Naked, unfused decussate tetrad with invaginated, laevigate distal walls. Clear contact lines are visible.
- l:* TQBH1-3(Stub T1-3(2008)-216, Assemblage 5. Naked. Unfused tetrahedral tetrad with partially inflated, laevigate distal walls. Clear contact lines are visible.

Plate 5.4: Unfused laevigate tetrads

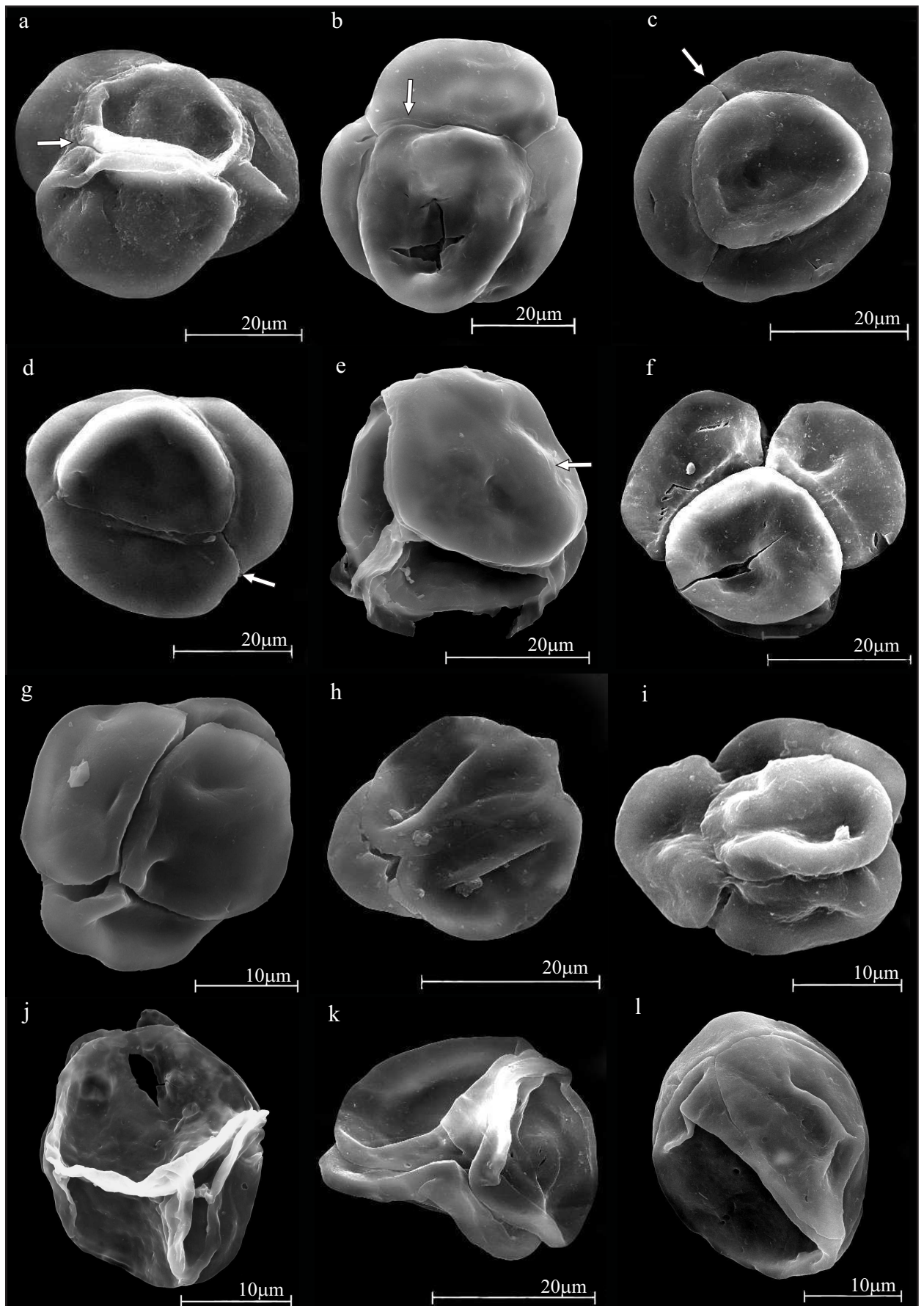


Plate 5.5: Unfused laevigate tetrads and dyads

a and b: Rimosotetras problematica

- a:* TRE1/168, Assemblage 1. Partially loose, tetrahedral tetrad, each spore unit with equatorial crassitude and invaginated distal walls. Junction marked by a constriction.
- b:* TQBH1-3-138, Assemblage 5. Partially loose, tetrahedral tetrad, each spore unit with equatorial crassitude and invaginated distal walls. Junction marked by a constriction.

c to g: Dyadospora murusdensa

- c:* TRE1/113, Assemblage 1. Naked, unfused dyad with clear contact lines. Distal walls inflated and laevigate.
- d:* TQBH2-1-044, Assemblage 4. Partially loose, naked unfused dyad, with clear contact lines. Distal walls inflated and laevigate. Hilum visible in one spore body (see arrow).
- e:* TQBH2-1-046, Assemblage 4. Naked, unfused dyad with clear contact lines. Distal walls inflated and laevigate.
- f:* TQBH1-3-004, Assemblage 5. Partially loose, naked, unfused dyad with clear contact lines. Distal walls inflated and laevigate.
- g:* TQBH1-3-033, Assemblage 5. Naked, unfused dyad, with clear contact lines. Distal walls are invaginated and laevigate.

h to l: Dyadospora murusattenuata

- h:* TRE1/205, Assemblage 1. Partially loose unfused dyad, with clear contact lines. Distal walls are thin, invaginated and laevigate.
- i:* TQBH1-1-123, Assemblage 2. Naked, unfused dyad (?) with invaginated, thin, laevigate distal walls.
- j:* TQBH1-PB1-054, Assemblage 3. Naked, unfused dyad, with invaginated, thin, laevigate distal walls.
- k:* TQBH2-1-038, Assemblage 4. Naked, unfused dyad (?) with invaginated, thin, laevigate distal walls.
- l:* TQBH1-3-090, Assemblage 5. Partially loose unfused dyad, with clear contact lines. Distal walls are thin, invaginated and laevigate.

Plate 5.5: Unfused laevigate tetrads and dyads

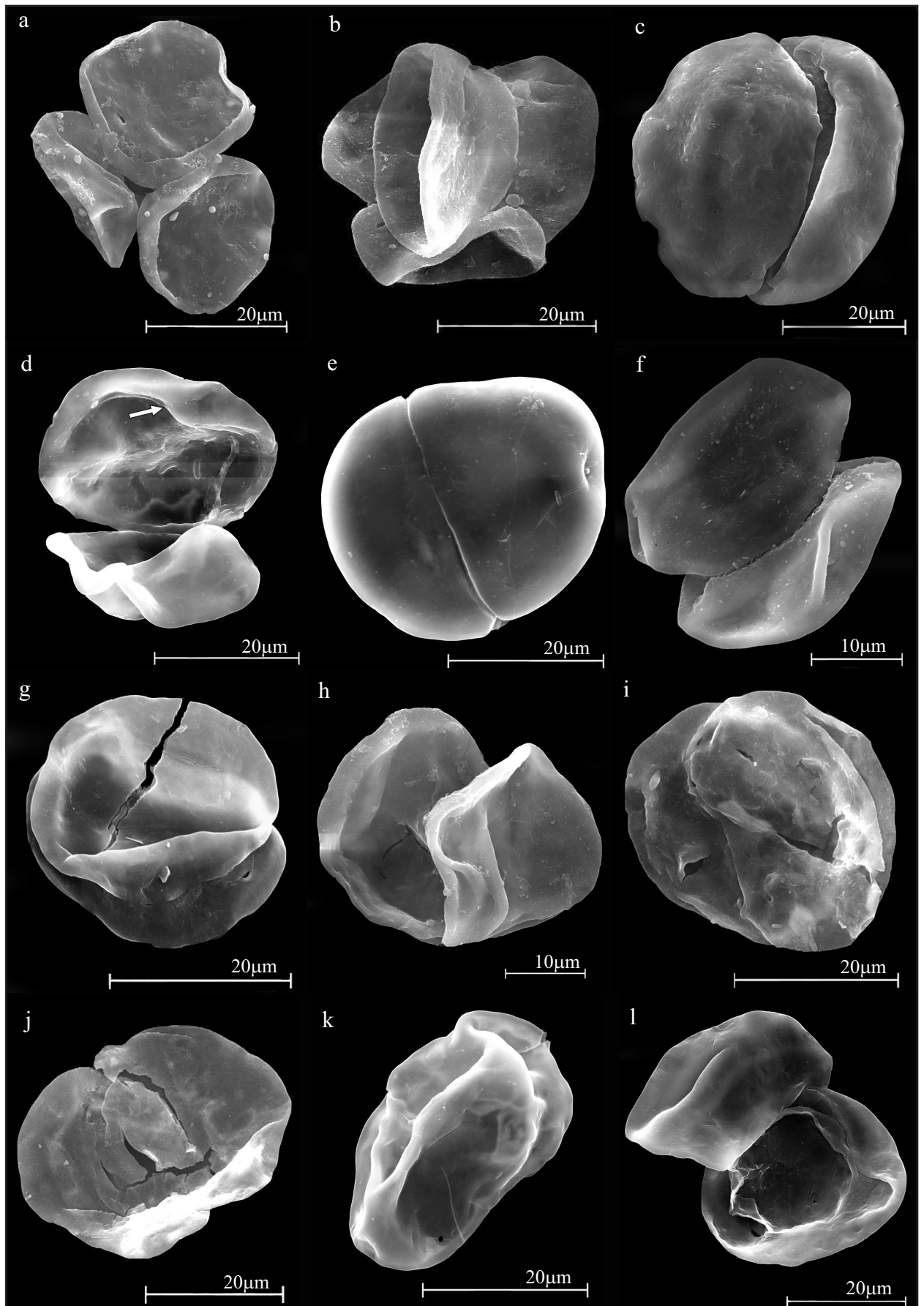


Plate 5.6: Unfused sculptured tetrads

a to f: Aconotetras inconspicus

- a:* TQBH1-PB1(StubPB1-2008)-107, Assemblage 3. Naked, unfused tetrad, with clear contact lines between units. Distal walls are invaginated, and sculptured with evenly spaced grana.
- b:* TQBH2-1(StubT2-1(2008)-082, Assemblage 4. Naked, unfused tetrad with clear contact lines between units. Distal walls are invaginated, and sculptured with evenly spaced grana. Each spore has an equatorial crassitude.
- c:* TQBH2-1(StubT2-1(2008)-112, Assemblage 4. Naked, unfused tetrad with clear contact lines between units. Distal walls are invaginated, and sculptured with evenly spaced grana. Each spore has an equatorial crassitude.
- d:* TQBH2-1(StubT2-1(2008)-115, Assemblage 4. Naked, unfused tetrad with clear contact lines between units. Distal walls are invaginated, and sculptured with irregular grana. Each spore has an equatorial crassitude.
- e:* TQBH2-1(StubT2-1(2008)-205, Assemblage 4. Naked, unfused tetrad with clear contact lines between units. Distal walls are invaginated, and sculptured with grana. Each spore has an equatorial crassitude.
- f:* TQBH1-3(Stub T1-3(2008)-227, Assemblage 5. Partial, naked unfused tetrad with clear contact lines between units. Distal walls are invaginated, and sculptured with grana. Each spore has an equatorial crassitude.

Plate 5.6: Unfused sculptured tetrads

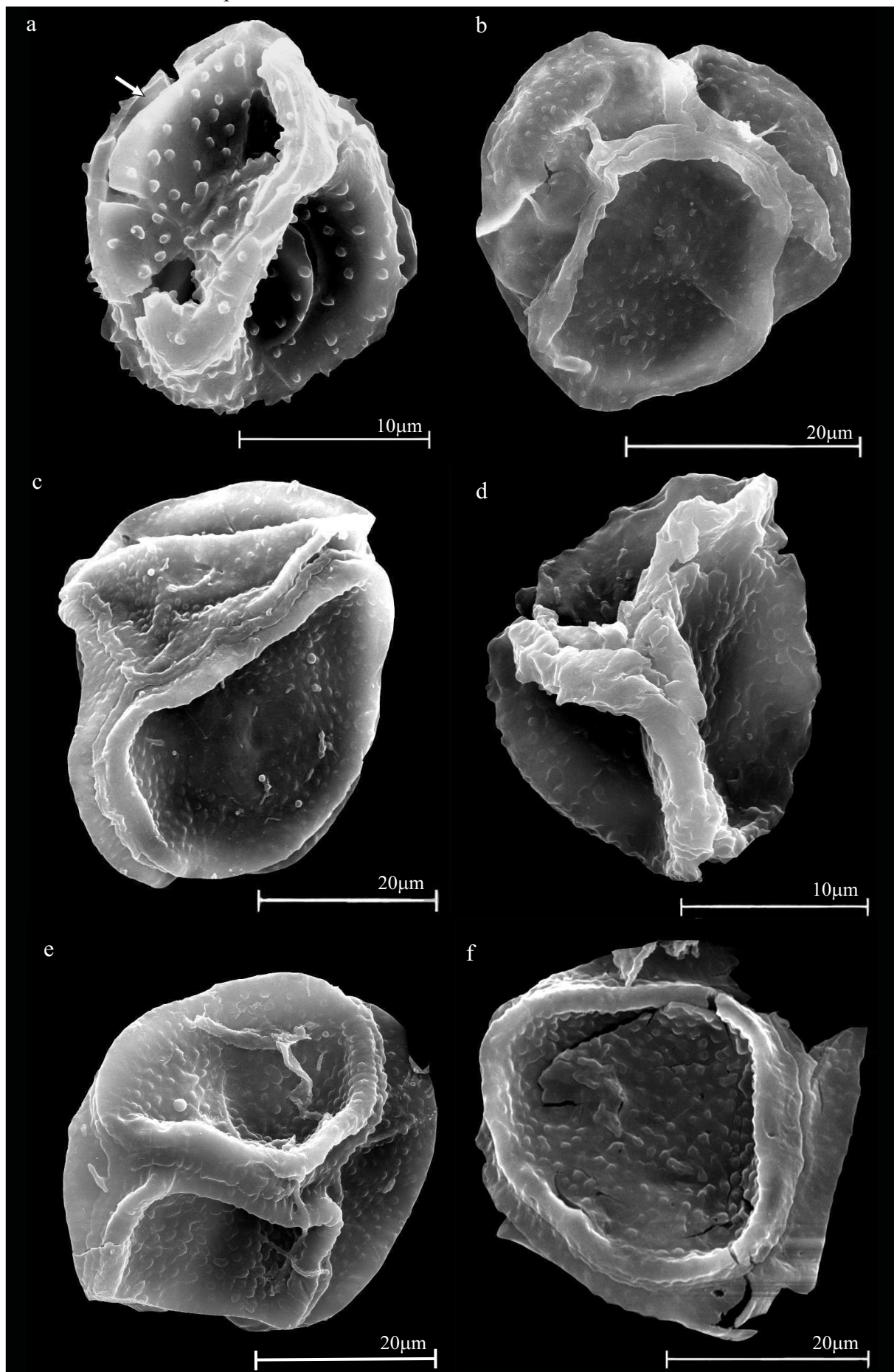


Plate 5.7: Laevigate hilate cryptospores

a to f: Laevolancis divellomedia

- a:* TRE1/091, Assemblage 1. Naked, proximally hilate alete monad with laevigate exine. Hilum has an irregular edge (see arrow).
- b:* TQBH1-1(StubT1-2)-060, Assemblage 2. Naked proximally hilate alete monad with laevigate exine. Hilum has a smooth edge (see arrow).
- c:* TQBH1-PB1(StubPB1-2008)-073, Assemblage 3. Naked, proximally hilate alete monad with laevigate exine. Hilum has an irregular edge (see arrow).
- d:* TQBH2-1(StubT(2)2-1)-032, Assemblage 4. Naked, proximally hilate alete monad with laevigate exine. Spore amb is elliptical.
- e:* TQBH2-1(StubT2-1(2008)-121, Assemblage 4. Naked, proximally hilate alete monad with laevigate exine. Hilum has an irregular edge (see arrow).
- f:* TQBH1-3(StubT3-2)-077, Assemblage 5. Naked proximally hilate alete monad with laevigate exine. Hilum has a smooth edge (see arrow).

g to l: Laevolancis plicata

- g:* TRE1/028, Assemblage 1. Naked, thin walled proximally hilate alete monads, with laevigate exine. Distal walls invaginated and folded.
- h:* TQBH1-1(StubT1-1)-034, Assemblage 2. Naked, thin walled proximally hilate alete monad with laevigate exine. Distal walls invaginated.
- i:* TQBH1-PB1(StubPB1-2008)-153, Assemblage 3. Naked, thin walled proximally hilate alete monad with laevigate exine. Distal walls invaginated and folded.
- j:* TQBH2-1(StubT(2)2-1)-037, Assemblage 4. Naked, thin walled proximally hilate alete monad with laevigate exine. Distal walls invaginated and folded.
- k:* TQBH1-3(StubT3-1)-014, Assemblage 5. Naked, thin walled proximally hilate alete monad with laevigate exine. Distal walls invaginated.
- l:* TQBH1-3(StubT3-2)-055, Assemblage 5. Naked thin walled proximally hilate alete monad with laevigate exine. Distal walls invaginated.

Plate 5.7: Laevigate hilate cryptosporidia

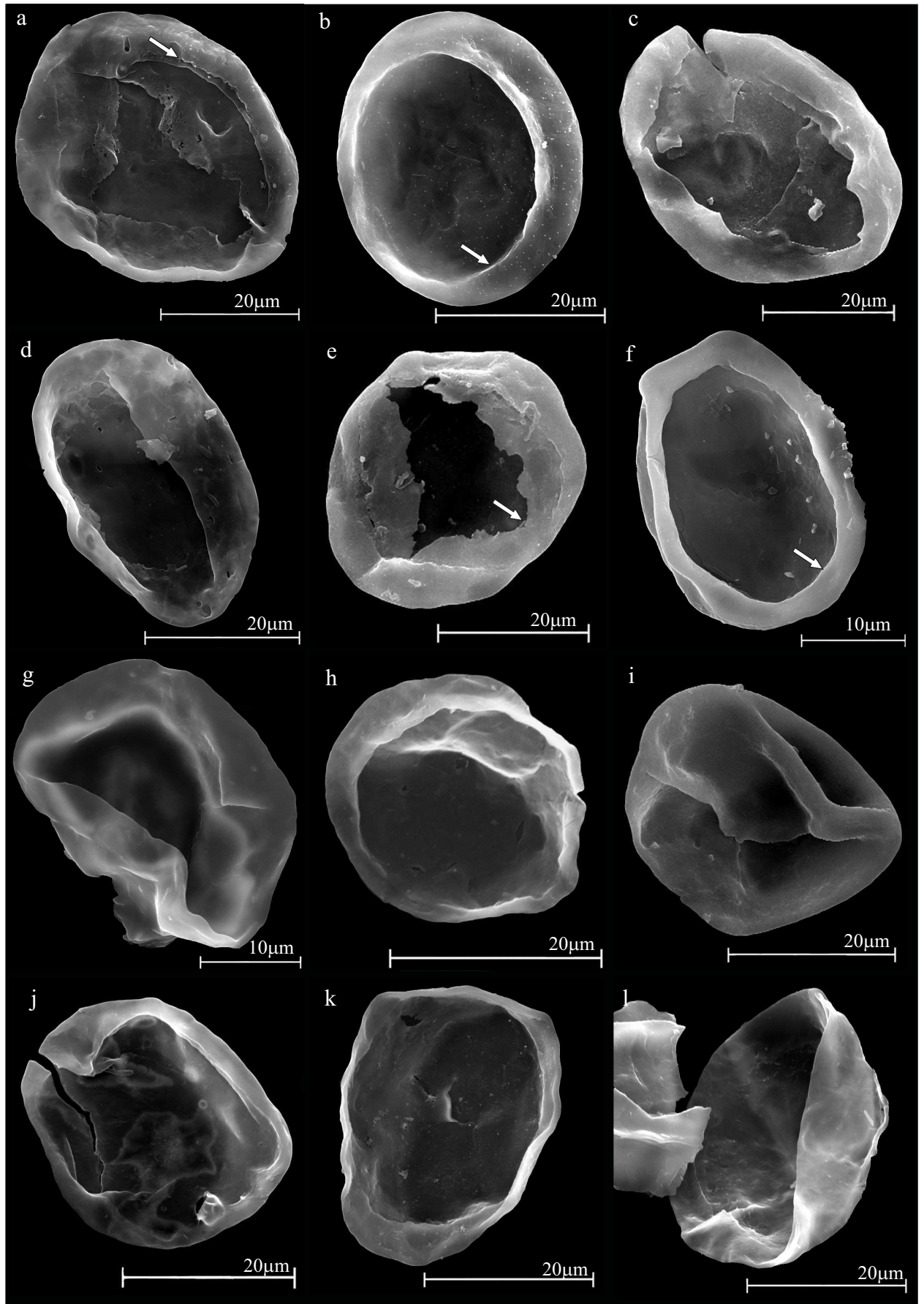


Plate 5.8: Laevigate and apiculate sculptured hilates

a and b: Artemopyra cf. robusta

- a:* TQBH2-1-034, Assemblage 4. Naked, alete monad, with laevigate distal exine and proximal irregular hilum (see arrow) sculptured with radial muri.
- b:* close up of TQBH2-1-034, Assemblage 4. Hilum sculptured with radial muri (see arrow). Muri are straight to slightly sinuous and taper towards the centre.

c to e: Artemopyra sp. A

- c:* TQBH1-3-009, Assemblage 5. Naked, alete monad, with laevigate distal exine and proximal hilum sculptured with radial muri (see arrow). Muri run from the equator to half-way into the hilum centre. Muri are straight, low and not prominent.
- d:* TQBH1-3-129, Assemblage 5. Naked, alete monad, with laevigate distal exine and proximal hilum sculptured with radial muri (see arrow).
- e:* close up of TQBH1-3-129, Assemblage 5. Hilum sculptured with radial muri, straight to slightly sinuous (see arrow).

f to l: Cymbohilates allenii var. allenii

- f:* TRE1/138, Assemblage 1. Naked hilate monad with double walled exine. Distal surface sculptured with closely and irregularly spaced micrograna. Proximal surface sculptured with concentric folds or muri.
- g:* close up of TRE1/138, Assemblage 1. Smooth hilum (see arrow), with micrograna on the distal surface.
- h:* TQBH1-1-129, Assemblage 2. Naked, hilate monad with irregular hilum (see arrow). Proximal surface smooth, with few muri. Distal surface sculptured with micrograna.
- i:* close up of TQBH1-1-129, Assemblage 2. Distal surface sculptured with micrograna (see arrow). Proximal surface sculptured with muri.
- j:* TQBH1-PB1-091, Assemblage 3. Hilate monad with closely- spaced irregular micrograna to microconi (see arrow) on the distal surface.
- k:* TQBH2-1-023, Assemblage 4. Hilate monad with closely spaced, irregularly micrograna.
- l:* close up of TQBH2-1-023, Assemblage 4. Smooth hilum (see arrow) with smooth proximal surface.

Plate 5.8: Laevigate and apiculate sculptured hilates

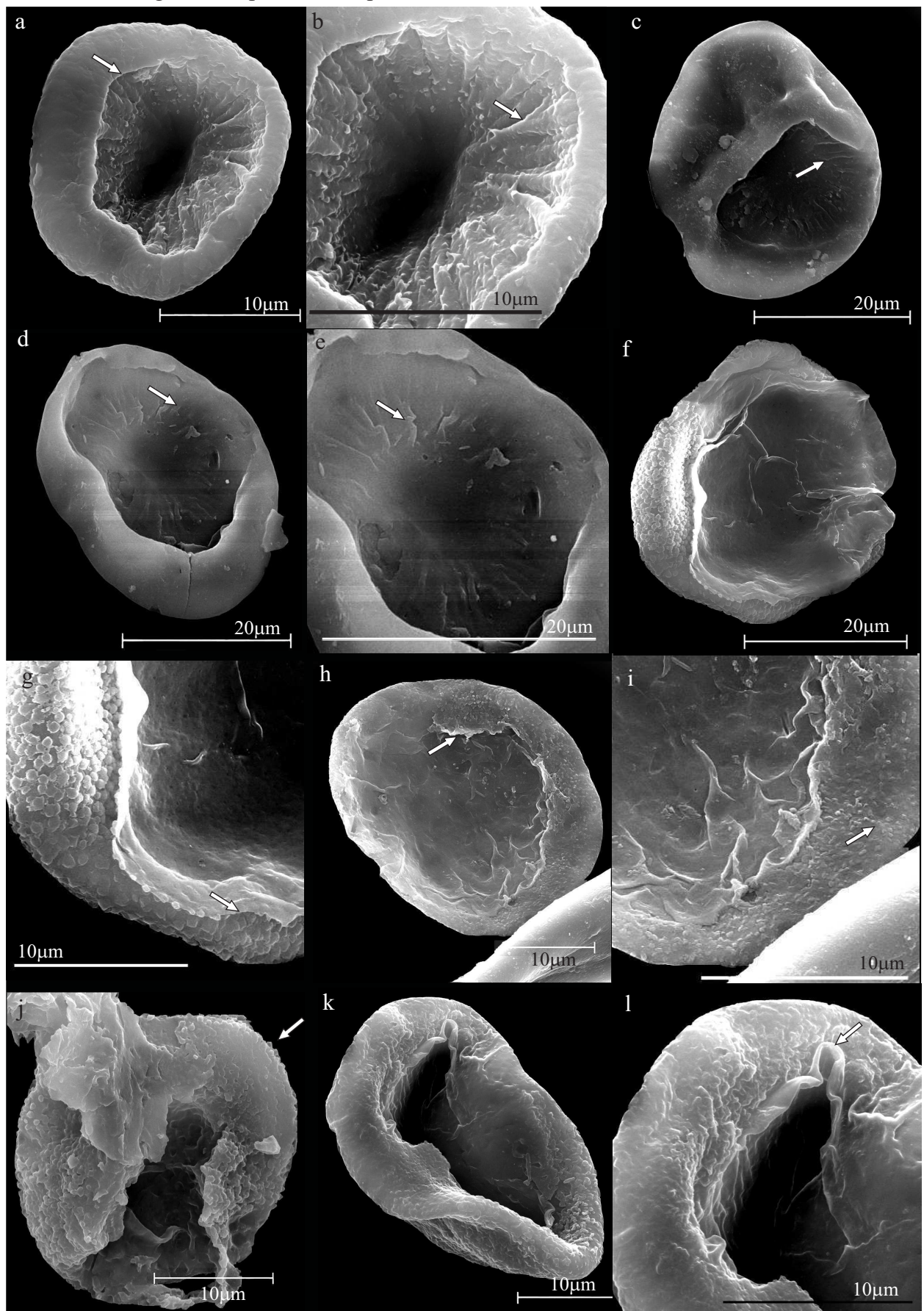


Plate 5.9: Apiculate sculptured hilates and dyad

a to h: Cymbohilates allenii var. *magnus*

- a:* TRE1/117, Assemblage 1. Naked hilate monad, with laevigate proximal surface, and distally sculptured with grana and micrograna.
- b:* TQBH1-1(StubT1-1(2008)-168, Assemblage 2. Naked, hilate monad, with proximally laevigate surface, with concentric folds and muri (see arrow). Distal surface sculptured with micrograna.
- c:* Close up of TQBH1-1(StubT1-1(2008)-168, Assemblage 2. Distal surface sculptured with micrograna.
- d:* TQBH1-PB1(StubPB1-2008)-022, Assemblage 3. Naked, hilate monad, with distally sculptured, closely packed micrograna. Proximal surface laevigate.
- e:* TQBH2-1(StubT2-1(2008)-110, Assemblage 4. Naked, unfused dyad, distal walls sculptured with closely-packed micrograna.
- f:* Close up of TQBH2-1(StubT2-1(2008)-110, Assemblage 4. Distal surface sculptured with micrograna.
- g:* TQBH1-3(Stub T1-3(2008)-203, Assemblage 5. Naked, hilate monad, with proximally laevigate hilum. Distal wall sculptured with micrograna and microconi.

h and i: Cymbohilates cf. *amplus*

- h:* TRE1/106, Assemblage 1. Large naked, hilate monad, distal walls sculptured with irregularly sized, closely packed micrograna and grana. Proximal surface not visible.
- i:* Close up of TRE1/106, Assemblage 1. Distal wall sculptured with closely packed, variable sized micrograna and grana.

Plate 5.9: Apiculate sculptured hilates and dyad

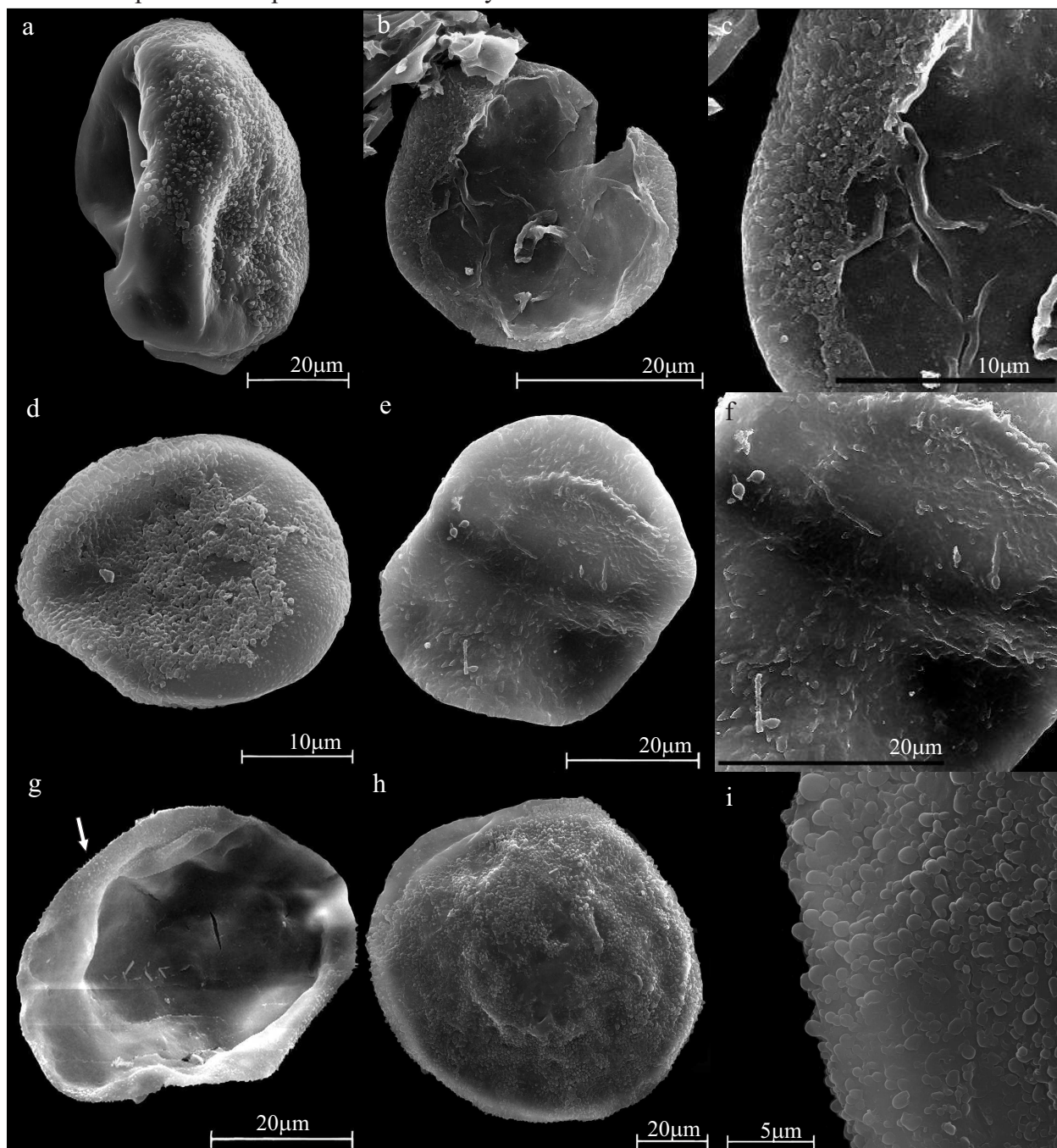


Plate 5.10: Apiculate sculptured hilates and dyads and tetrads (continued)

a to l: Cymbohilates disponerus

- a:* TQBH1-PB1(StubPB1-2008)-028, Assemblage 3. Naked, hilate monads, separated from a dyad. Proximal surface laevigate, with thick folds or muri (see arrow). Distal walls sculptured with evenly spaced, isodiametric coni and microconi.
- b:* Close up of TQBH1-PB1(StubPB1-2008)-028, Assemblage 3. Distal surface sculptured with coni and microconi (see arrow).
- c:* TQBH1-PB1(StubPB1-2008)-093, Assemblage 3. Naked, hilate monad with laevigate proximal surface, with thick folds and muri. Distal surface sculptured with evenly spaced coni and microconi (see arrow).
- d:* TQBH2-1(Stub T(2)2-1)-008, Assemblage 4. Naked, hilate monad with laevigate proximal surface, with thick folds and muri. Distal walls sculptured with coni (see arrow).
- e:* TQBH2-1(StubT2-1(2008)-106, Assemblage 4. Naked, hilate monad, with laevigate proximal surface, with thick folds and muri. Distal surface sculptured with coni (see arrow).
- f:* TQBH2-1(StubT2-1(2008)-120, Assemblage 4. Naked, hilate monad, with distal surface sculptured with coni and microconi. Proximal surface not visible.
- g:* TQBH2-1(StubT2-1(2008)-140, Assemblage 4. Naked, hilate monad, with distal surface sculptured with evenly spaced coni and microconi. Proximal surface laevigate with thick folds and muri.
- h:* TQBH1-3(StubT3-2)-086, Assemblage 5. Naked hilate monad, with laevigate proximal surface. Distal walls sculptured with closely spaced microconi.
- i:* Close up of TQBH1-3(StubT3-2)-086, Assemblage 5. Distal wall sculptured with microconi (see arrow).
- j:* TRE1/141, Assemblage 1. Naked, unfused dyad with distal walls sculptured with evenly spaced microconi.
- k:* TQBH2-1(StubT(2)2-1)-026, Assemblage 4. Naked, unfused tetrad with distal walls sculptured with evenly spaced coni to grana.
- l:* Close up of TQBH2-1(StubT(2)2-1)-026, Assemblage 4. Distal surface sculptured with evenly spaced coni to grana

Plate 5.10: Apiculate sculptured hilates, dyads and tetrad

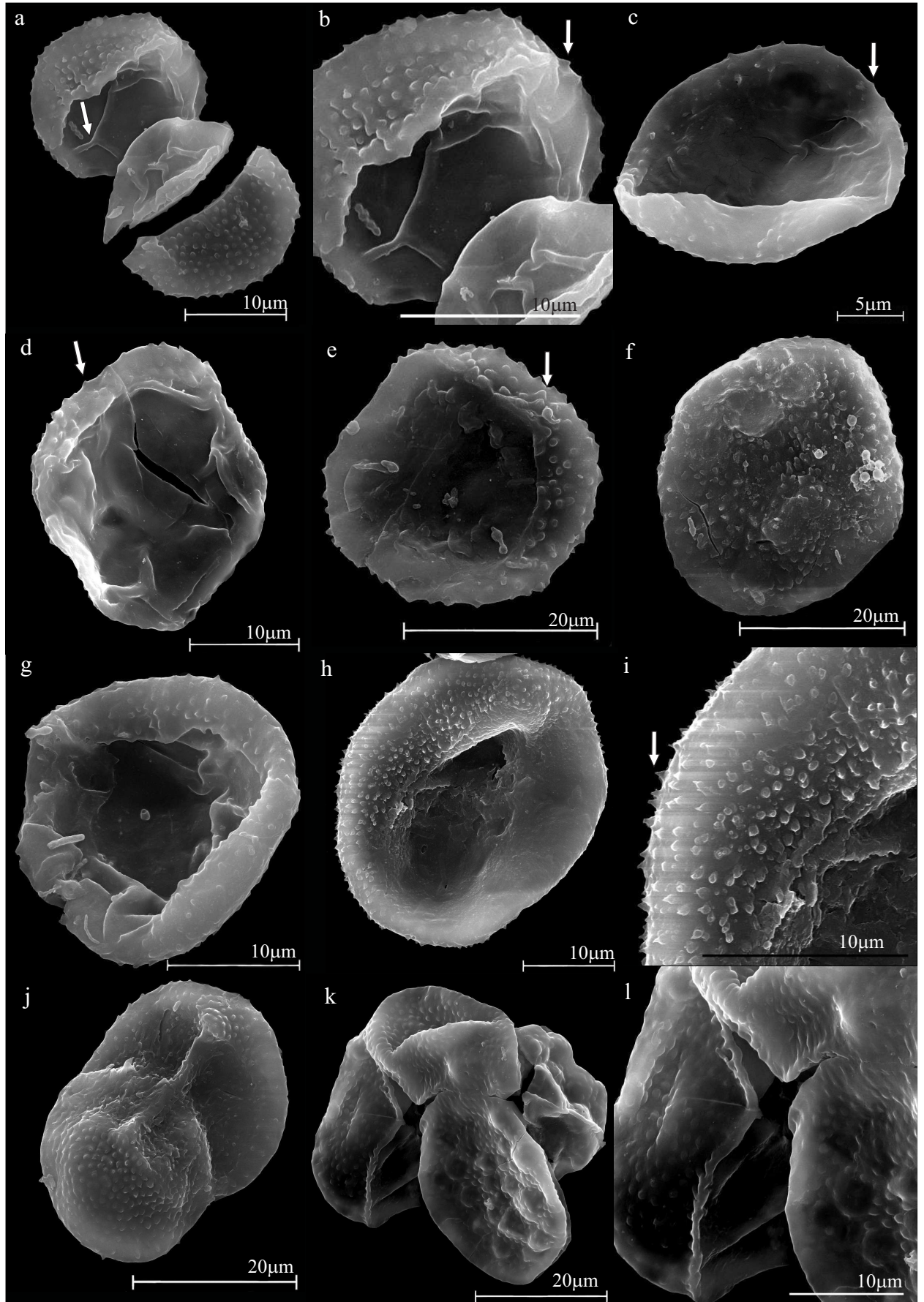


Plate 5.11: Apiculate sculptured hilates and dyads (continued)

a to c: Cymbohilates cf. microgranulatus

- a:* TQBH2-1-113, Assemblage 4. Naked, alete monad (?), distal surface sculptured with closely spaced micrograna (see arrow). Exine thickly folded.
- b:* TQBH2-1-218, Assemblage 4. Naked, alete monad, distally sculptured with closely spaced micrograna.
- c:* Close up of TQBH2-1-218, Assemblage 4. Distal surface sculptured with closely spaced micrograna (see arrow). Proximal surface laevigate, with irregular broad folds.

d to i: Cymbohilates variabilis var. variabilis

- d:* TRE1/120, Assemblage 1. Naked, hilate monad, distally sculptured with large, closely, irregularly spaced grana and verrucate.
- e:* Close up of TRE1/120, Assemblage 1. Distal wall sculptured with large grana and verrucate, in some cases fused to form rugulae (see arrow).
- f:* TQBH1-PB1-196, Assemblage 3. Naked, hilate monad, distally sculptured with large, irregularly spaced grana or verrucae.
- g:* Close up of TQBH1-PB1-196, Assemblage 3. Distal wall sculptured with large grana and verrucate, in some cases fused to form rugulae (see arrow).
- h:* TQBH2-1-193, Assemblage 4. Loose, naked, unfused dyad, distally sculptured with large grana to verrucae. Proximal surface laevigate with broad folds.
- i:* Close up of TQBH2-1-193, Assemblage 4. Loose, unfused dyad, proximal surface laevigate.

j to l: Cymbohilates variabilis var. parvidecus

- j:* TRE1/232, Assemblage 1. Naked, hilate monad. Distal wall sculptured with evenly, closely spaced large grana to verrucae. Proximally sculptured with closely spaced radial muri, fused at the proximal pole.
- k:* Close up of TRE1/232, Assemblage 1. Distal wall sculptured with closely spaced large grana and verrucae.
- l:* TQBH2-1(StubT2-1(2008)-137, Assemblage 4. Naked, hilate monad, distally sculptured with evenly, closely spaced large grana or verrucae. Some elements are fused (see arrow).

Plate 5.11: Apiculate sculptured hilates and dyad

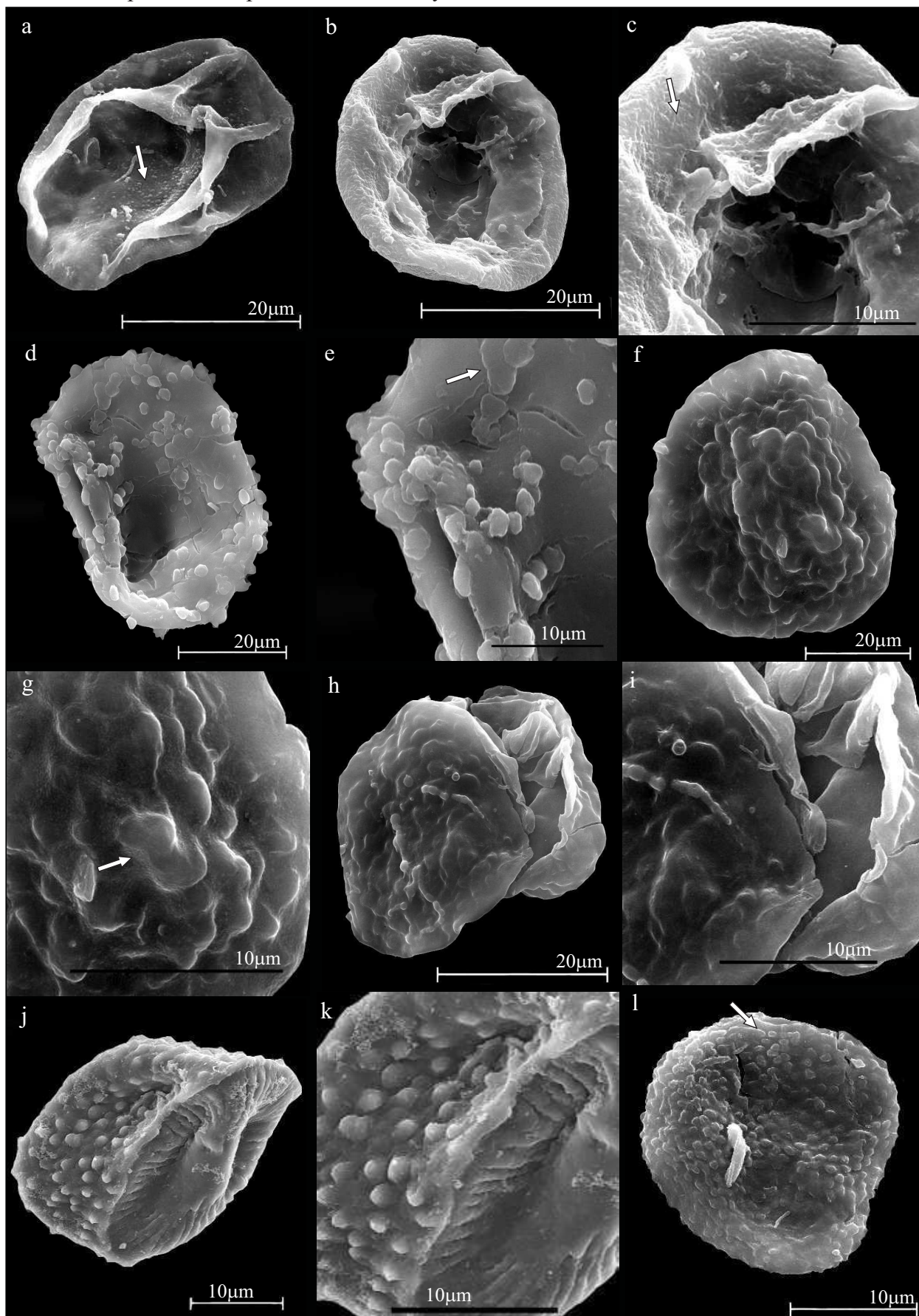


Plate 5.12: Apiculate sculptured hilates and dyads (continued)

***a to h: Cymbohilates variabilis* var. B (var. nov)**

- a:* TRE1/098, Assemblage 1. Naked, hilate monad (?). Distal walls sculptured with irregularly spaced, grana and micrograna. Proximal surface not visible.
- b:* Close up of TRE1/098, Assemblage 1. Distal wall sculptured with grana and micrograna.
- c:* TQBH1-PB1(StubPB1-2008)-069, Assemblage 3. Naked, hilate monad (?), distal wall sculptured irregularly and sparsely spaced grana, micrograna and spatulate elements. Proximal surface not visible.
- d:* Close up of TQBH1-PB1(StubPB1-2008)-069, Assemblage 3. Distal wall sculptured with irregularly spaced and irregularly shaped elements, including spatulate and rugulae elements (see arrow).
- e:* TRE1/069, Assemblage 1. Loose, naked, unfused dyad, with distal wall sculptured with irregularly and sparsely spaced elements, including micrograna.
- f:* Close up of TRE1/069, Assemblage 1. Loose, naked unfused dyad, with distal wall sculptured with irregular and sparsely spaced elements, including micrograna and rugulae.
- g:* TRE1/103, Assemblage 1. Naked, unfused dyad, with distal wall sculptured with irregularly and sparsely spaced elements, including spatulate elements (see arrow).
- h:* Close up of TRE1/103, Assemblage 1. Naked, unfused dyad. Elements close to the contact line are perpendicular (see arrow).

Plate 5.12: Apiculate sculptured hilates and dyads

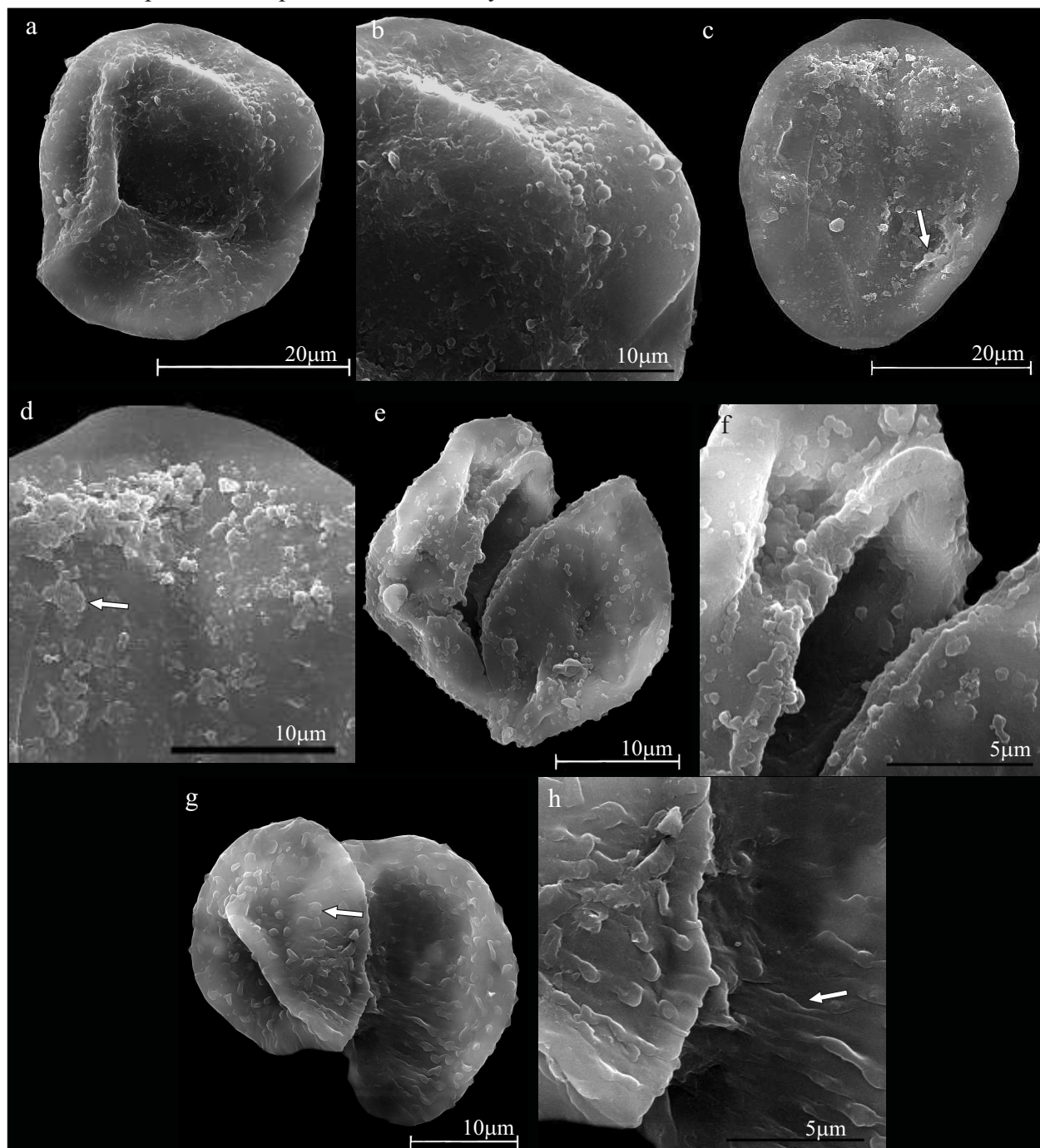


Plate 5.13: Spinose sculptured hilates and dyads

a to f: Cymbohilates cymosus

- a:* T1-6/PB0 (Stub 1-6)-277, Assemblage 1. Naked, hilate (?) monad. Distal wall sculptured with closely packed spinose elements, arranged in a star shape, with long axis of spines running parallel with the exine surface. Proximal surface not visible.
- b:* Close up of T1-6/PB0 (Stub 1-6)-277, Assemblage 1. Naked, hilate monad with distal wall sculptured with spinose elements, arranged in a star shape, with long axis of spines running parallel with exine surface (see arrow). Spines fused at the base.
- c:* TRE1/115, Assemblage 1. Naked, hilate unfused dyad with distal wall sculptured with irregularly arranged clusters of spinose elements, including biform spines (see arrow).
- d:* Close up of TRE1/115, Assemblage 1. Naked, hilate unfused dyad. Distal wall sculptured with irregularly arranged clusters of spinose elements, with long axis running parallel to the exine surface.
- e:* TRE1/236, Assemblage 1. Two naked, unfused tetrads. Distal walls sculptured with irregularly arranged clusters of spinose elements.
- f:* Close up of TRE1/236, Assemblage 1. Distal walls sculptured with irregularly arranged clusters of spinose elements.

g to i: Cymbohilates horridus

- g:* TRE1/003, Assemblage 1. Naked, unfused dyad. Distal walls sculptured with long spinose elements. Spines are fused at the base, forming muri (see arrow).
- h:* Close up of TRE1/003, Assemblage 1. Naked, unfused dyad, distal walls sculptured with spinose elements. Spines fused at the base, forming muri.
- i:* TQBH1-1(Ox1)-054, Assemblage 2. Partial naked, unfused dyad. Distal walls are sculptured with long spinose elements.

Plate 5.13: Apiculate sculptured hilates, dyads and tetrad

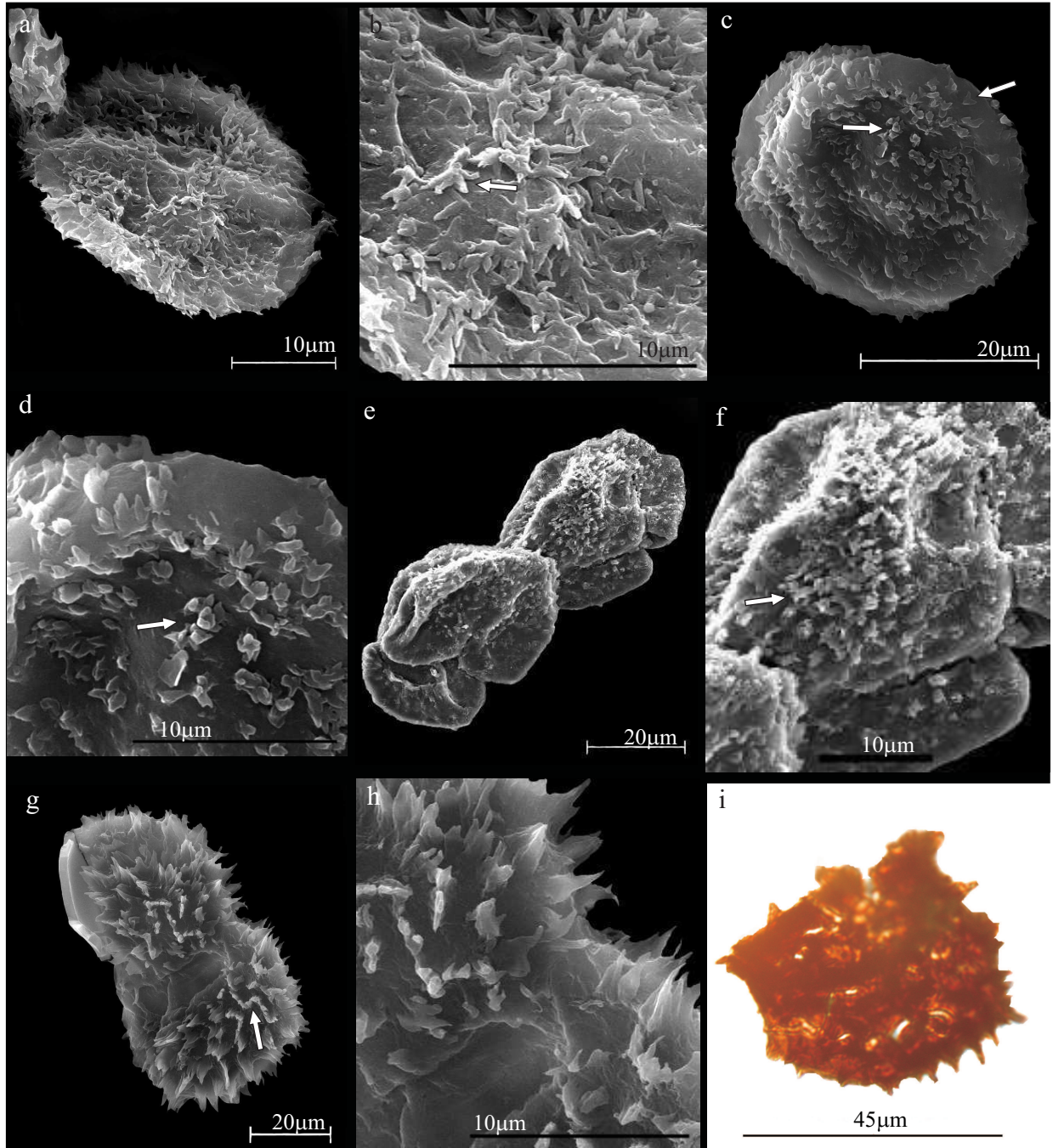


Plate 5.14: Spinose sculptured hilates and dyads

a to j: Cymbohilates horridus var. A (var. nov.)

- a:* TRE1/147, Assemblage 1. Naked hilate monad. Proximal surface is laevigate. Distal wall sculptured with small, evenly spaced spines (see arrow). Spine tips are rounded.
- b:* TQBH1-1(StubT1-2)-066, Assemblage 2. Naked hilate monad. Distal wall sculptured with small, evenly spaced spines. Spine tips are pointed.
- c:* Close up of TQBH1-1(StubT1-2)-066, Assemblage 2. Distal wall sculptured with small, evenly spaced spines (see arrow). Spine tips are pointed.
- d:* TQBH1-PB1(StubPB1-2008)-020, Assemblage 3. Naked hilate monad. Proximal surface laevigate. Distal walls sculptured with small, evenly spaced spines or coni. Spine tips are pointed.
- e:* TQBH2-1(Stub T(2)2-1)-015, Assemblage 4. Naked hilate monad (?). Distal walls sculptured with small spines or coni. Spine tips pointed (see arrow).
- f:* Close up of TQBH2-1(Stub T(2)2-1)-015, Assemblage 4. Spines small and pointed (see arrow). One element large and bulbous (see arrow).
- g:* TQBH1-1(StubT1-1)-002, Assemblage 2. Naked, unfused dyad. Distal walls sculptured with small, closely spaced spines or coni (see arrow).
- h:* Close up of TQBH1-1(StubT1-1)-002, Assemblage 2. Distal wall sculptured with small, irregularly, closely spaced spines or coni. Elements perpendicular to contact line in the junction area (see arrow).
- i:* TQBH1-PB1(StubPB1-2008)-133, Assemblage 3. Naked, unfused dyad (?). Distal wall sculptured with small, irregularly spaced spines or coni (see arrow).
- j:* Close up of TQBH1-PB1(StubPB1-2008)-133, Assemblage 3. Distal wall sculptured with irregularly arranged small spines or coni (see arrow).

k and l: Cymbohilates cf. horridus

- k:* TQBH1-3(Stub T1-3(2008)-125, Assemblage 5. Naked, hilate monad. Distal wall sculptured with sparsely distributed slender spines to bacula or pila. Distal walls broadly folded.
- l:* Close up of TQBH1-3(Stub T1-3(2008)-125, Assemblage 5. Distal wall sculptured with sparsely distributed slender spines (see arrow).

Plate 5.14: Spinose sculptured hilates and dyads

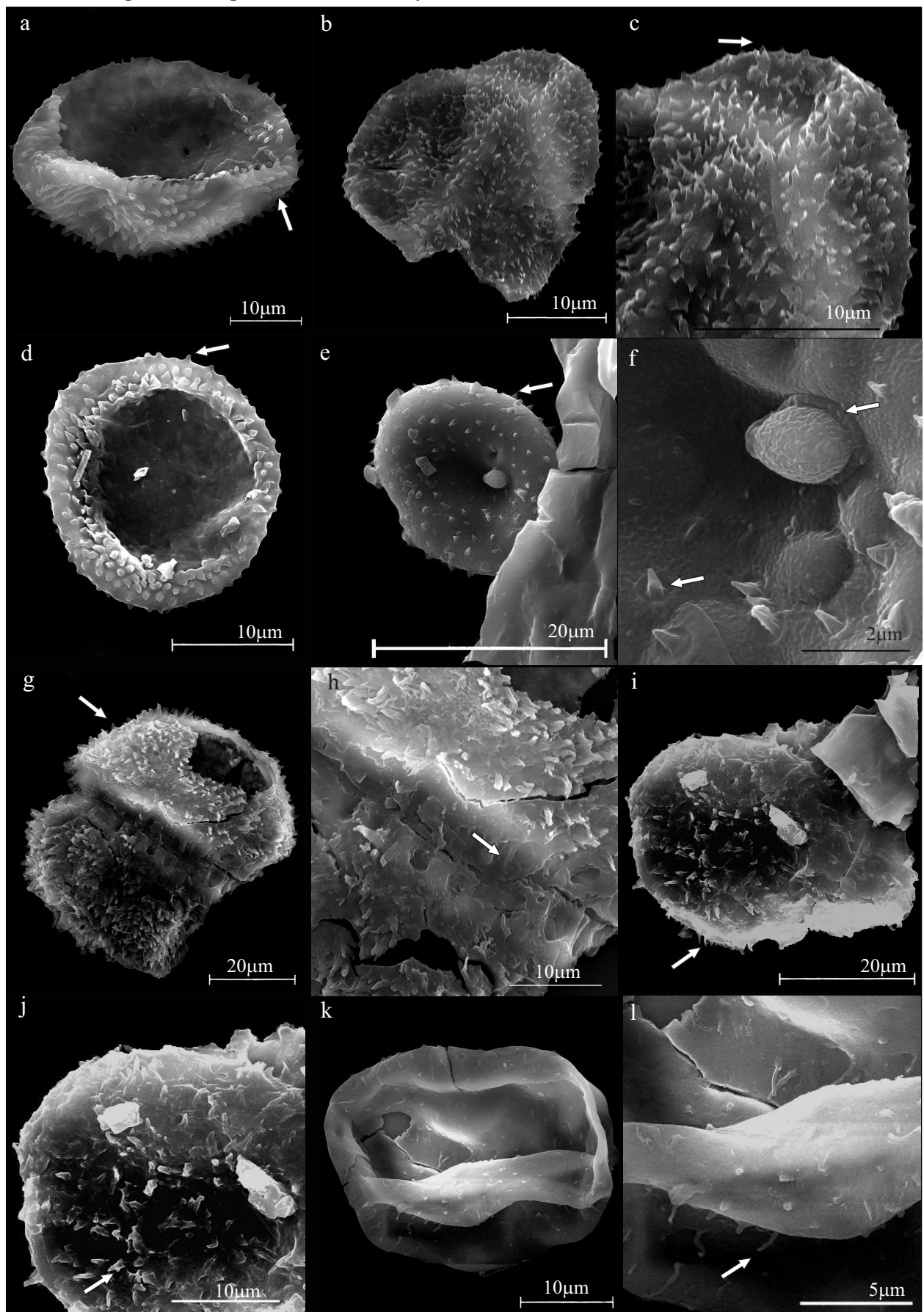


Plate 5.15: Murornate sculptured hilates, dyads and tetrads

a to g: Chelinohilates erraticus – thick muri

- a:* TRE1/109, Assemblage 1. Naked hilate monad. Distal wall sculptured with thick broad muri (see arrow). Muri connected forming a reticulate pattern, forming rectangular lumina.
- b:* TRE1/087, Assemblage 1. Naked, hilate monad. Distal wall sculptured with thick muri (see arrow). Muri connected forming a reticulate pattern, forming triangular lumina.
- c:* TRE1/204, Assemblage 1. Naked, hilate monad. Distal wall sculptured with thick muri (see arrow). Muri connected forming reticulate pattern, forming rectangular lumina.
- d:* TQBH2-1-203. Assemblage 4. Naked, unfused dyad. Distal walls sculptured with thick muri (see arrow). Muri connected forming a reticulate pattern, forming triangular lumina.
- e:* Close up of TQBH2-1-203. Assemblage 4. Distal wall sculptured with thick, sinuous muri. Muri connected forming a reticulate pattern, forming triangular lumina.
- f:* TRE1/073, Assemblage 1. Naked, unfused dyad. Distal wall sculptured with thick, sinuous muri. Muri connected forming a reticulate pattern, forming rectangular lumina.
- g:* TRE1/094, Assemblage 1. Naked, unfused tetrad. Distal wall sculptured with thick sinuous muri. Muri connected forming a reticulate pattern, forming rectangular lumina.

h to l: Chelinohilates erraticus – thin muri

- h:* TRE1/107, Assemblage 1. Naked hilate monad with distal walls sculptured with thin muri (see arrow).
- i:* TQBH1-PB1-057, Assemblage 3. Naked hilate monad with distal walls sculptured with thin, closely spaced muri (see arrow).
- j:* Close up of TQBH1-PB1-057, Assemblage 3.
- k:* TQBH2-1-054, Assemblage 4. Naked hilate monad with distal walls sculptured with thin, closely spaced muri (see arrow).
- l:* Close up of TQBH2-1-054, Assemblage 4. Proximal surface is laevigate. Hilum has a lip (see arrow).

Plate 5.15: Muornate sculptured hilates, dyads and tetrad

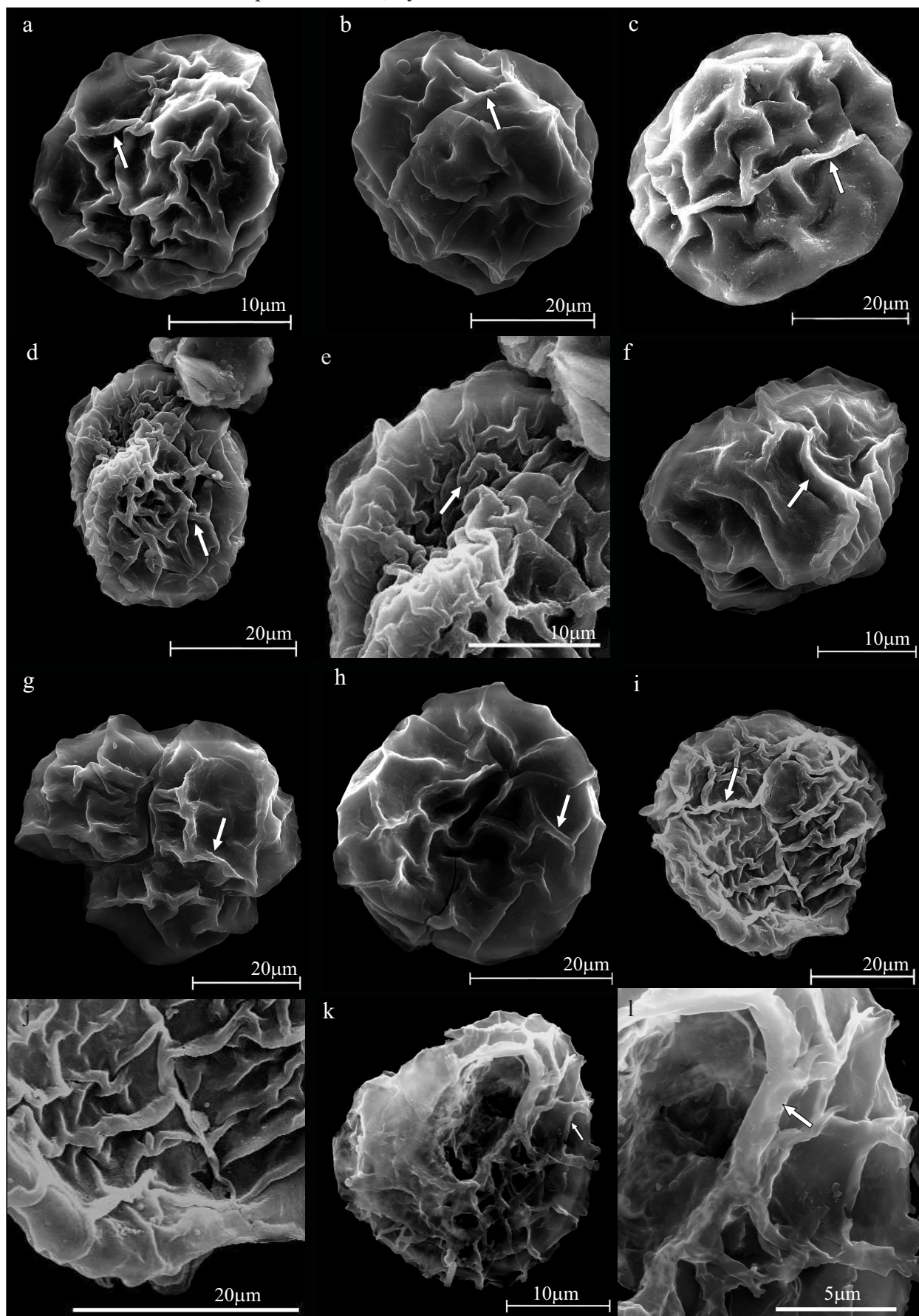


Plate 5.16: Murornate sculptured hilates, dyads and tetrads

a to f: Chelinohilates erraticus – thin muri (continued)

- a:* TQBH2-1-209, Assemblage 4. Naked, unfused dyad, with clear contact line (see arrow). Distal walls sculptured with thin, low flexuous muri and large lumina.
- b:* Close up of TQBH2-1-209, Assemblage 4. Distal walls sculptured with flexuous, thin muri, and large lumina.
- c:* TQBH1-PB1-143, Assemblage 3. Partial naked, unfused dyad. Distal walls sculptured with thin, sinuous muri, forming an irregular reticulate pattern.
- d:* Close up of TQBH1-PB1-143, Assemblage 3. Distal wall sculptured with thin, closely spaced sinuous muri and small lumina (see arrow).
- e:* TRE1/125, Assemblage 1. Naked, unfused tetrad. Distal walls sculptured with thin, sinuous muri (see arrow), forming irregular reticulate, and small lumina.
- f:* Close up of TRE1/125, Assemblage 1. Distal walls sculptured with thin, sinuous muri (see arrow), forming an irregular reticulate, and small lumina.

g to j: Chelinohilates cf. lornensis

- g:* TQBH1-1-161, Assemblage 2. Naked, hilate monad. Distal wall sculptured with broad, low muri (see arrow), forming a regular polygonal reticulum pattern. Lumina are six-sided. Exine has a blotchy appearance.
- h:* Close up of TQBH1-1-161, Assemblage 2. Distal wall sculptured with broad, low muri, forming a regular polygonal reticulum pattern. Lumina are six sided (see arrow), and exine has a blotchy appearance.
- i:* TQBH1-3-025, Assemblage 5. Naked, hilate monad (?). Distal wall sculptured with low, broad closely spaced muri, forming a regular polygonal reticulum pattern and six sided lumina.
- j:* Close up of TQBH1-3-025, Assemblage 5. Distal walls sculptured with low, broad muri, forming regular polygonal reticulum pattern.

k and l: Chelinohilates sinuosus var. sinuosus

- k:* TRE1/228, Assemblage 1. Naked, hilate monad. Distal walls sculptured with thick, bifurcating, irregularly arranged muri (see arrow). Lumina are small and irregular.
- l:* Close up of TRE1/228, Assemblage 1. Distal walls sculptured with thick bifurcating irregularly arranged muri (see arrow).

Plate 5.16: Muornate sculptured hilates, dyads and tetrad

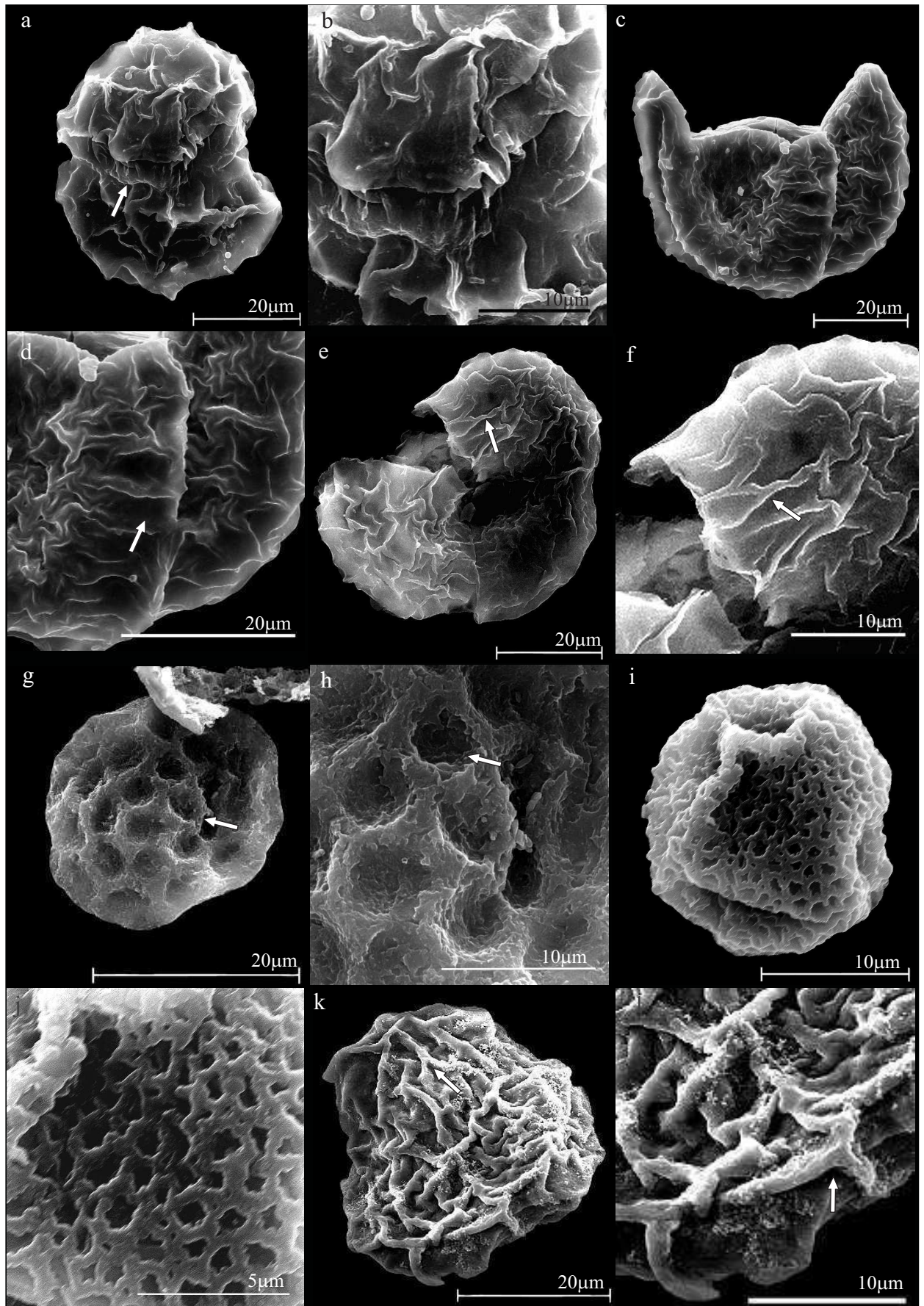


Plate 5.17: Murornate sculptured hilates and dyads

a to d: Chelinohilates sinuosus var. sinuosus (continued)

- a:* TQBH2-1-130, Assemblage 4. Naked, hilate monad (?). Distal walls sculptured with low, broad, bifurcating, irregularly arranged muri (see arrow), with small irregular lumina.
- b:* Close up of TQBH2-1-130, Assemblage 4. Distal walls sculptured with low, broad bifurcating irregularly arranged muri (see arrow).
- c:* TRE1/213, Assemblage 1. Naked, unfused dyad. Distal walls sculptured with low, broad, bifurcating muri, irregularly arranged, forming small lumina.
- d:* Close up of TRE1/213, Assemblage 1. Unfused dyad, contact line visible (see arrow). Distal walls sculptured with low, broad bifurcating irregularly arranged, forming small lumina.

e and f: Chelinohilates sinuosus var. angustus

- e:* TQBH2-1-006, Assemblage 4. Naked, hilate monad. Distal walls sculptured with low, narrow, convoluted, closely spaced muri.
- f:* Close up of TQBH2-1-006, Assemblage 4. Distal wall sculptured with low, narrow, convoluted, closely spaced muri (see arrow), forming small irregular lumina.

g to l: ?Chelinohilates sp. A

- g:* TRE1/217, Assemblage 1. Naked, hilate monad. Distal walls sculptured with distinctive murornate-apiculate sculpture. A dense, web-like network of convoluted muri, superimposed with apiculate elements.
- h:* Close up of TRE1/217, Assemblage 1. Distal walls sculptured with convoluted muri (see arrow), superimposed with apiculate elements (see arrow).
- i:* TRE1/089, Assemblage 1. Naked, hilate monad. Distal walls sculptured with a dense network of convoluted muri, superimposed with apiculate elements (see arrow).
- j:* Close up of TRE1/089, Assemblage 1. Distal walls sculptured with convoluted muri, superimposed with apiculate elements, including pila and bacula (see arrow).
- k:* TQBH2-1-012 Assemblage 4. Naked, hilate monad. Distal walls sculptured with convoluted, superimposed with apiculate elements.
- l:* Close up of TQBH2-1-012 Assemblage 4. Distal walls sculptured with convoluted, superimposed with apiculate elements.

Plate 5.17: Muornate sculptured hilates and dyad

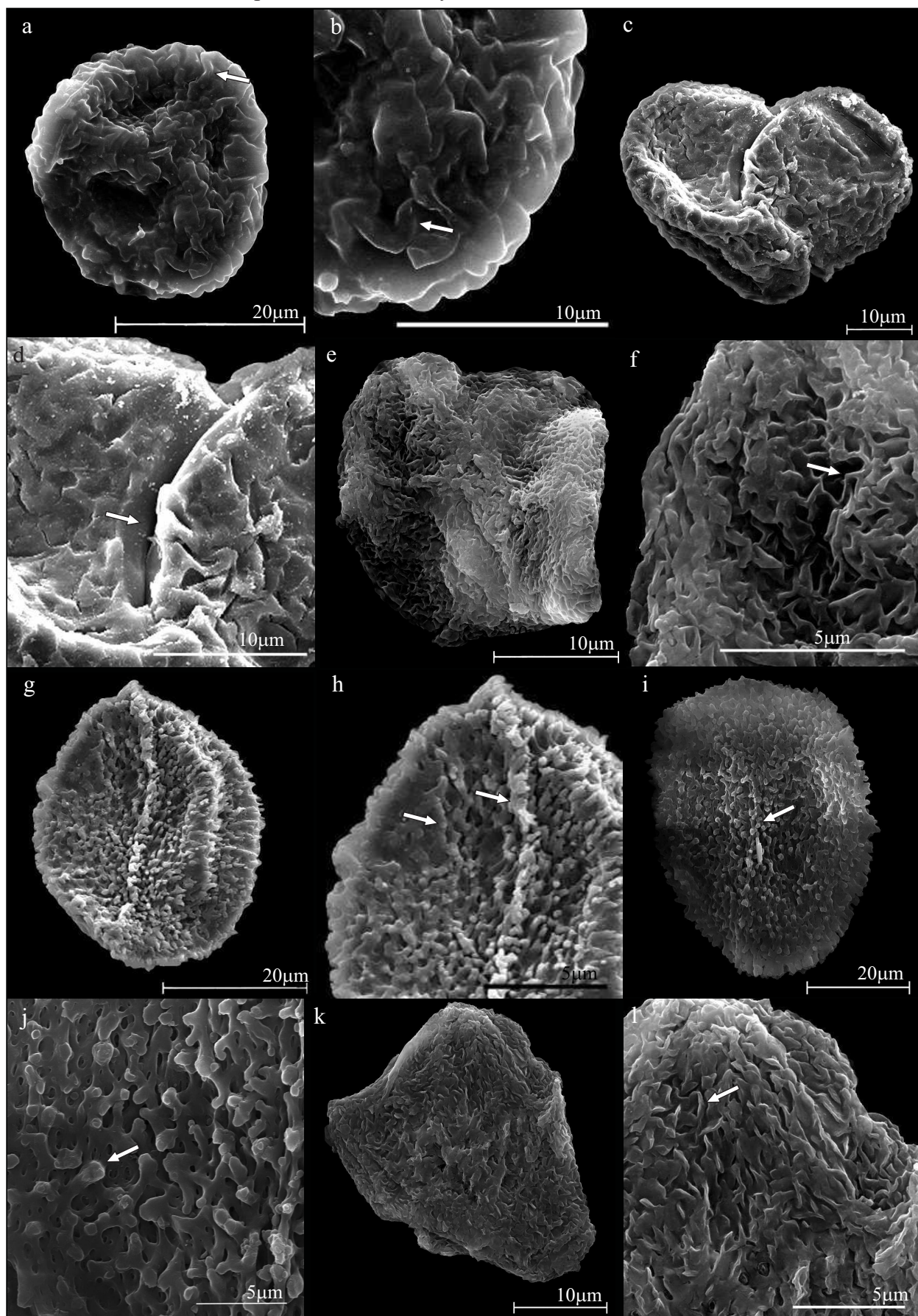


Plate 5.18: Verrucate sculptured hilates, dyads and tetrads

a and b: Hispanaedisca major

- a:* TQBH1-1-141, Assemblage 2. Naked, hilate monad. Distal walls sculptured with low, broad, widely spaced verrucae (see arrow).
- b:* Close up of TQBH1-1-141, Assemblage 2. Distal walls sculptured with low, broad, widely spaced verrucae. Some fuse together to form rugulae (see arrow).

c and d: Hispanaedisca cf. major

- c:* TQBH1-1-187, Assemblage 2. Naked, hilate monad. Distal walls sculptured with small, irregularly sized verrucae (see arrow).
- d:* Close up of TQBH1-1-187, Assemblage 2. Distal walls sculptured with small, irregularly sized verrucae (see arrow). Some verrucae fused to form rugulae.

e to l: Hispanaedisca verrucatus

- e:* TQBH1-1-070, Assemblage 2. Naked, hilate monad (?). Distal walls sculptured with low, broad, closely spaced verrucae with rounded tips. In some places verrucae are fused to form rugulae.
- f:* TQBH1-PB1-159, Assemblage 3. Naked, hilate monad (?). Distal wall sculptured with low, broad, closely spaced verrucae with rounded tips. In some places verrucae are fused to form rugulae.
- g:* TQBH1-PB1-030, Assemblage 3. Naked, hilate monad (?). Distal walls sculptured with low, broad, closely spaced verrucae with rounded tips. In places verrucae are fused to form rugulae (see arrow).
- h:* T1-6/PB0-247, Assemblage 1. Naked, unfused dyad. Distal walls sculptured with low, broad, closely spaced verrucae, some with pointed tips (see arrow).
- i:* Close up of T1-6/PB0-247, Assemblage 1. Sub-equatorial contact area with perpendicular muri to contact line (see arrow). Proximal hilum is laevigate.
- j:* T1-6/PB0-264, Assemblage 1. Naked, unfused dyad. Distal walls sculptured with low, broad, closely spaced verrucae, some with rounded tips. Some verrucae fused to form rugulae.
- k:* TRE1/081, Assemblage 1. Naked, unfused tetrad, with contact line visible (see arrow). Distal walls sculptured with closely spaced verrucae of different sizes, some fused to form rugulae (see arrow).
- l:* TQBH1-3-198, Assemblage 5. Naked, unfused tetrad. Distal walls sculptured with closely spaced, variably sized verrucae. Some verrucae fused to form rugulae.

Plate 5.18: Verrucate sculptured hilates, dyads and tetrads

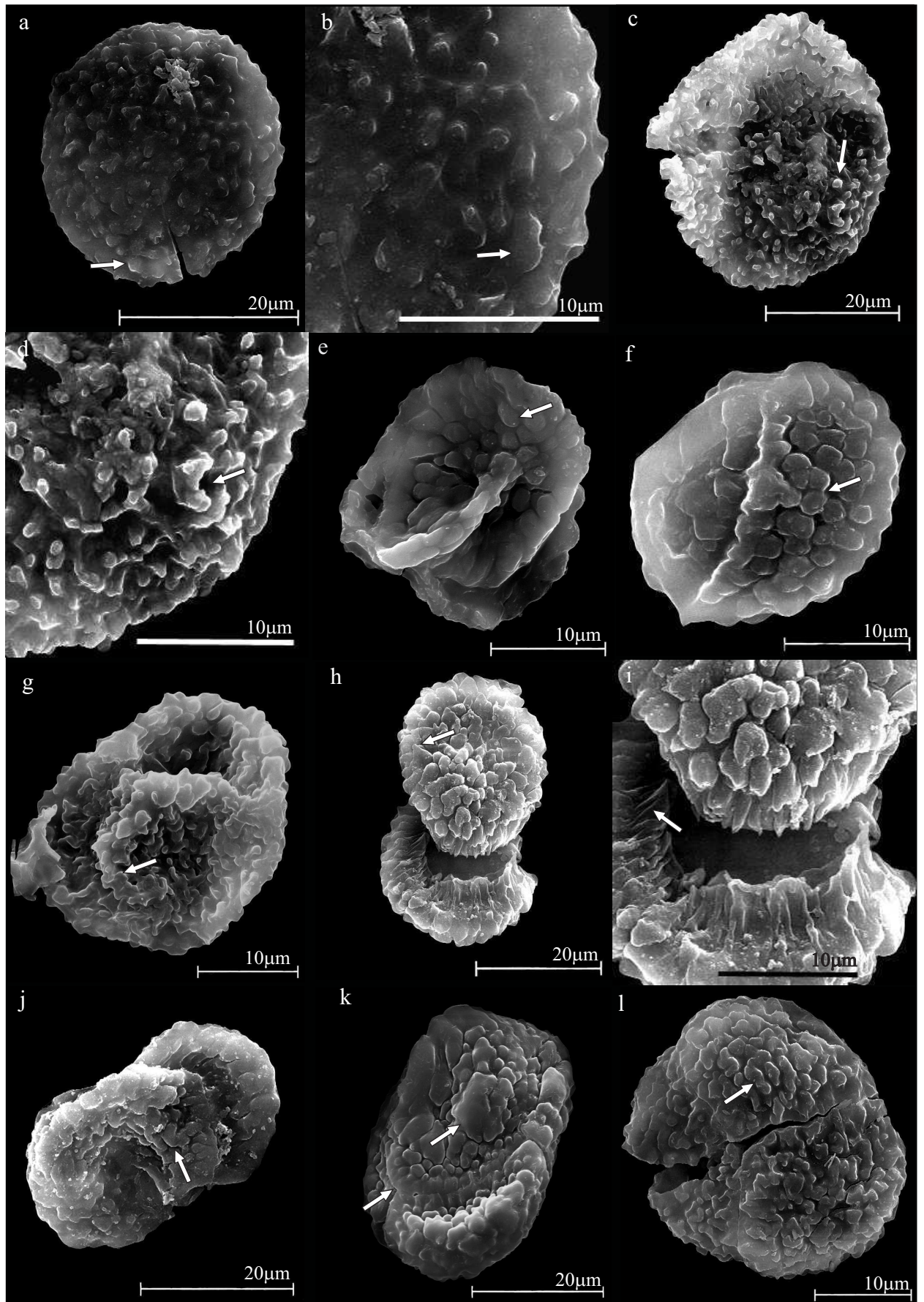


Plate 5.19: Verrucate sculptured hilates and tetrads

a and b: Hispanaediscus cf. verrucatus

- a:* TQBH2-1-131, Assemblage 4. Naked, hilate monad. Distal walls sculptured with low, broad, closely spaced verrucae, which are nearly all fused to form rugulae or low, broad muri (see arrow).
- b:* Close up to TQBH2-1-131, Assemblage 4. Distal walls sculptured with low, broad, closely spaced verrucae, which are fused to form rugulae to low muri (see arrow).

c to f: Hispanaediscus wenlockensis

- c:* TQBH1-PB1-158, Assemblage 3. Naked, hilate monad (?). Distal walls sculptured with closely spaced, equally sized verrucae with rounded tips. Only a few verrucae are fused to form rugulae.
- d:* Close up to TQBH1-PB1-158, Assemblage 3. Distal walls sculptured with closely spaced, equally sized verrucae with rounded tips. Only a few verrucae are fused to form rugulae (see arrow).
- e:* TRE1/223, Assemblage 1. Naked, unfused tetrad, with visible contact lines (see arrow). Distal walls sculptured with closely spaced, equally sized verrucae with rounded tips. Few verrucae fuse to form rugulae.
- f:* Close up of TRE1/223, Assemblage 1. Distal walls are sculptured with closely spaced verrucae with rounded tips (see arrow).

Plate 5.19: Verrucate sculptured hilates and tetrad.

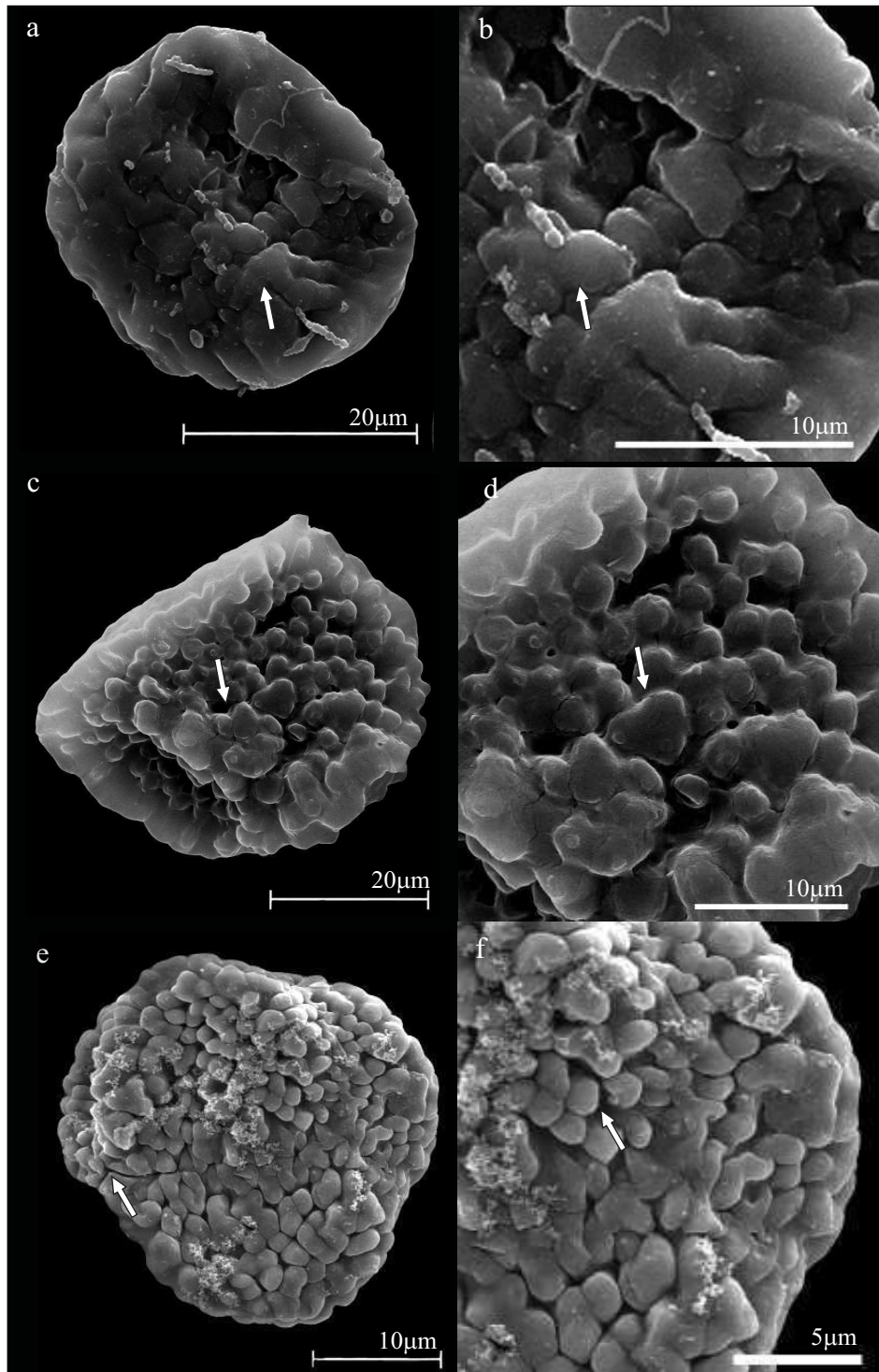


Plate 5.20: Laevigate alete monads

***a* to *l*: Laevigate alete monads.**

- a*: TRE1/105, Assemblage 1.
- b*: TRE1/130, Assemblage 1.
- c*: TQBH1-1(StubT1-1)-003, Assemblage 2.
- d*: TQBH1-1(StubT1-2)-057, Assemblage 2.
- e*: TQBH1-PB1(StubPB1-2008)-193, Assemblage 3.
- f*: TQBH2-1(StubT2-1(2008)-071, Assemblage 3.
- g*: TQBH2-1(StubT2-1(2008)-149, Assemblage 4.
- h*: TQBH2-1(StubT2-1(2008)-158, Assemblage 4.
- i*: TQBH1-3(StubT3-1)-026, Assemblage 5.
- j*: TQBH1-3(StubT3-2)-043, Assemblage 5.
- k*: TQBH1-3(StubT3-2)-054, Assemblage 5.
- l*: TQBH1-3(StubT3-2)-084, Assemblage 5.

Plate 5.20: Laevigate alete monads

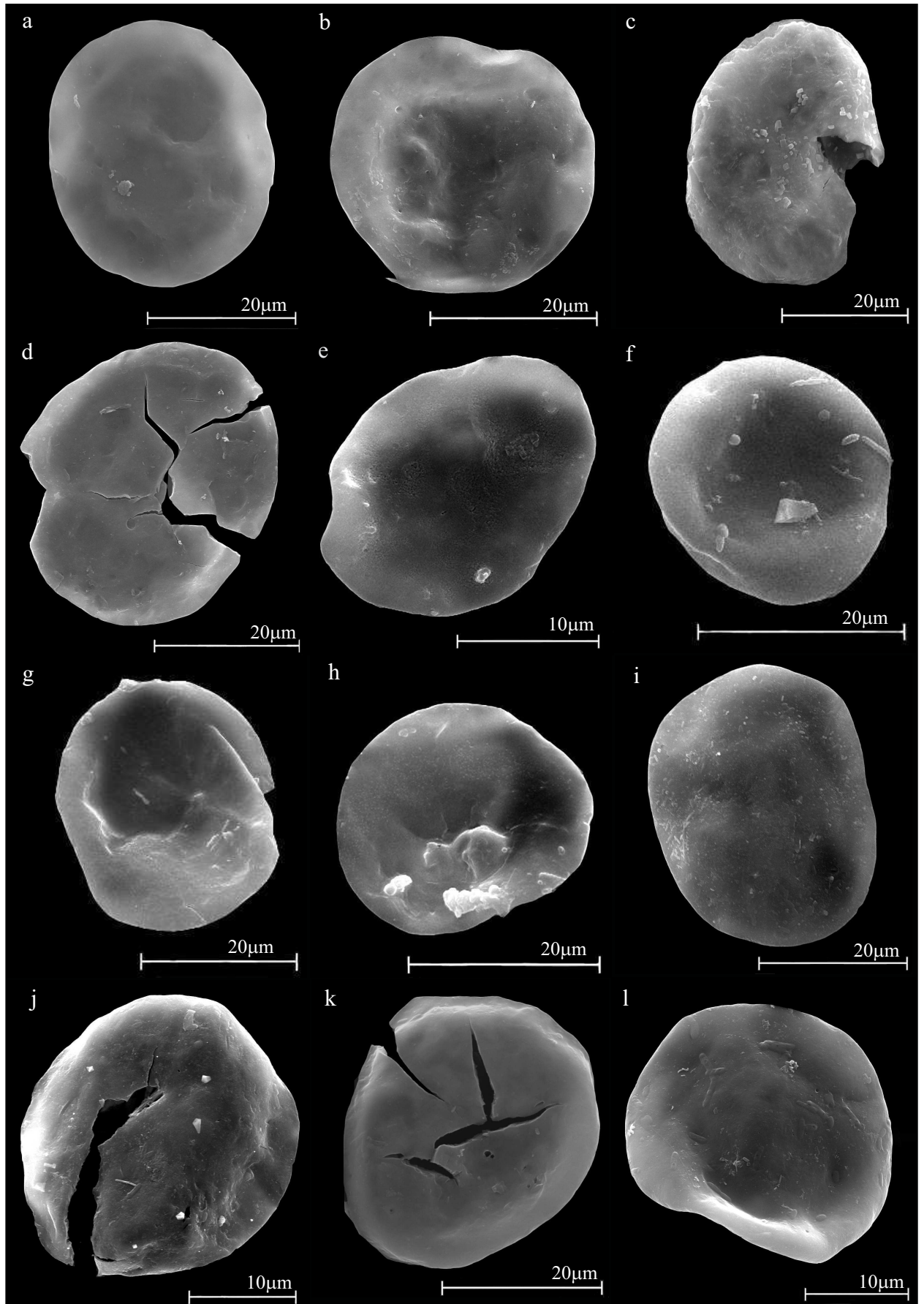


Plate 5.21: Enveloped tetrads

a to d: Velatitetras cf. reticulata

- a:* TRE1/206, Assemblage 1. Enveloped, permanent tetrahedral tetrad. Envelope sculptured with, narrow sinuous muri (see arrow), with irregular shaped reticulum.
- b:* TQBH1-PB1-053, Assemblage 3. Enveloped, permanent tetrahedral tetrad. Envelope sculptured with low, narrow sinuous muri (see arrow), with irregular shaped reticulum.
- c:* Close up of TQBH1-PB1-053, Assemblage 3. Envelope sculptured with low, narrow sinuous muri forming an irregular shaped reticulum.
- d:* TQBH2-1-146, Assemblage 4. Enveloped, permanent tetrahedral tetrad with one aborted spore unit (see arrow). Envelope sculptured with low, sinuous narrow muri forming an irregular shaped reticulum.

e to h: Velatitetras rugulata

- e:* TQBH1-1-124, Assemblage 2. Enveloped, permanent tetrahedral tetrad (?). Enveloped sculptured with low, irregularly spaced verrucae. Some verrucae fused to form rugulae (see arrow).
- f:* Close up of TQBH1-1-124, Assemblage 2. Envelope sculptured with low, irregularly spaced verrucae (see arrow).
- g:* TQBH2-1-002, Assemblage 4. Enveloped, permanent tetrahedral tetrad. Envelope sculptured with irregularly spaced verrucae (see arrow).
- h:* Close up of TQBH2-1-002, Assemblage 4. Envelope sculptured with irregularly spaced verrucae and rugulae (see arrow).

i to l: Velatitetras cf. cristata

- i:* TQBH1-1-081, Assemblage 2. Enveloped, permanent tetrahedral tetrad. Envelope sculptured with anastomosing muri, forming an irregular shaped and projecting reticulum (see arrow).
- j:* Close up of TQBH1-1-081, Assemblage 2. Envelope sculptured with anastomosing muri (see arrow).
- k:* TQBH1-3-037, Assemblage 5. Enveloped, tetrahedral tetrad, with visible contact lines (see arrow). Envelope sculptured with narrow, ill-defined anastomosing muri, forming an irregular shaped and projecting reticulum.
- l:* Close up of TQBH1-3-037, Assemblage 5. Envelope sculptured with narrow, anastomosing muri (see arrow).

Plate 5.21: Enveloped tetrads

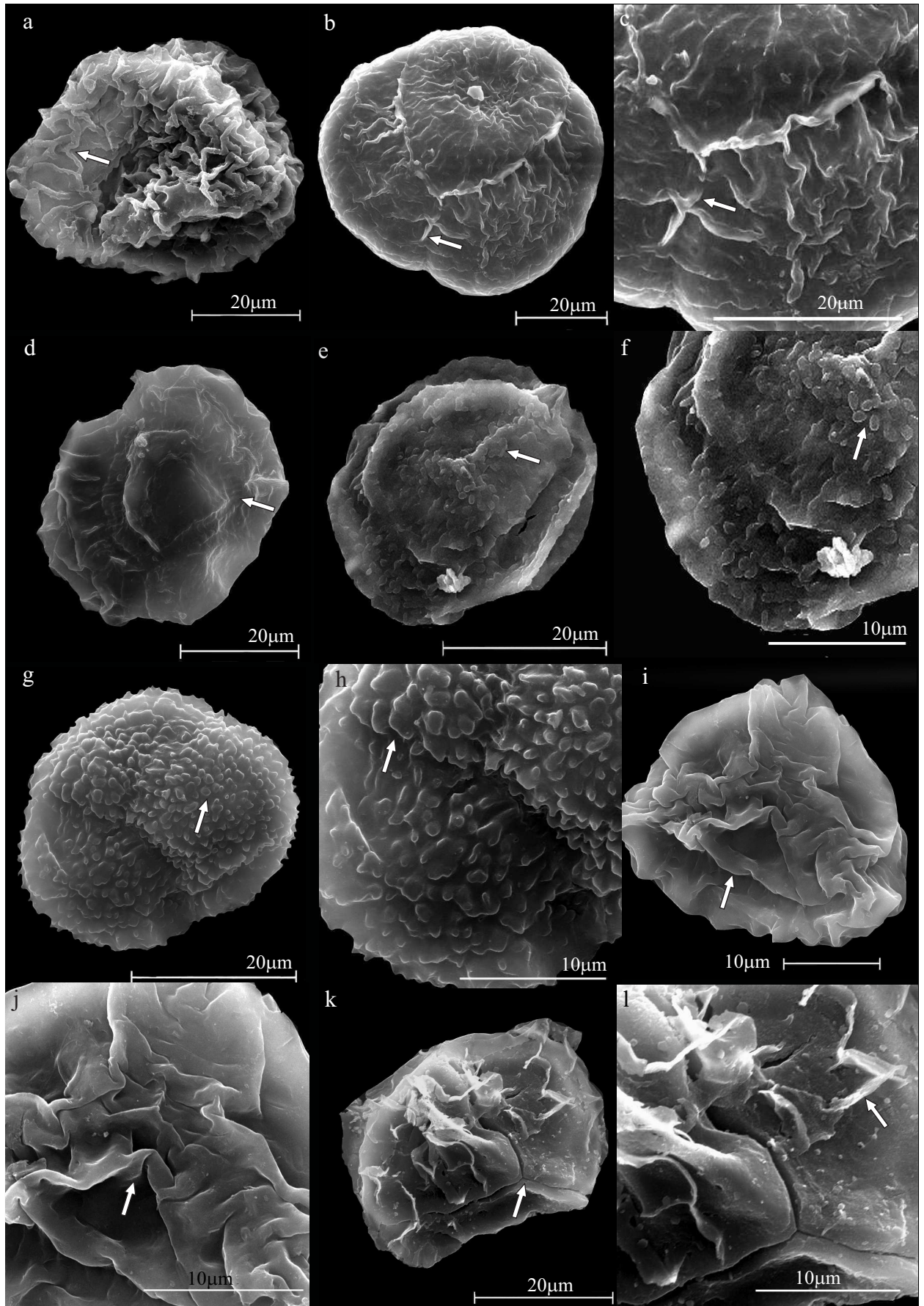


Plate 5.22: Enveloped tetrads

a to f: Velatitetras sp. B

- a:* TQBH2-1-010, Assemblage 4. Enveloped, permanent tetrahedral tetrad. Envelope sculptured with evenly spaced, regularly arranged apiculate elements, including grana (see arrow).
- b:* Close up of TQBH2-1-010, Assemblage 4. Envelope sculptured with evenly spaced, regularly arranged, grana to spatulate elements (see arrow).
- c:* TQBH2-1-151, Assemblage 4. Enveloped, permanent tetrad, sculptured with irregularly and closely spaced apiculate elements, including micrograna (see arrow).
- d:* Close up of TQBH2-1-151, Assemblage 4. Envelope sculptured with irregularly, closely spaced micrograna (see arrow).
- e:* TQBH2-1-162, Assemblage 4. Enveloped, permanent tetrad, sculptured with evenly, regularly spaced apiculate elements, including microconi (see arrow).
- f:* Close up of TQBH2-1-162, Assemblage 4. Envelope sculptured with evenly, regularly spaced apiculate elements, including microconi (see arrow).

g to j: Velatitetras sp. C

- g:* TRE1/169, Assemblage 1. Enveloped, permanent tetrad. Envelope sculptured with evenly, regularly spaced, low broad verrucae (see arrow).
- h:* Close up of TRE1/169, Assemblage 1. Enveloped sculptured with low, evenly spaced verrucae (see arrow).
- i:* TRE1/173, Assemblage 1. Enveloped, permanent tetrad. Envelope sculptured with evenly, closely spaced verrucae. Some verrucae fused to form rugulae (see arrow).
- j:* Close up of TRE1/173, Assemblage 1. Enveloped sculptured with closely spaced verrucae (see arrow).

Plate 5.22: Enveloped tetrads (continued)

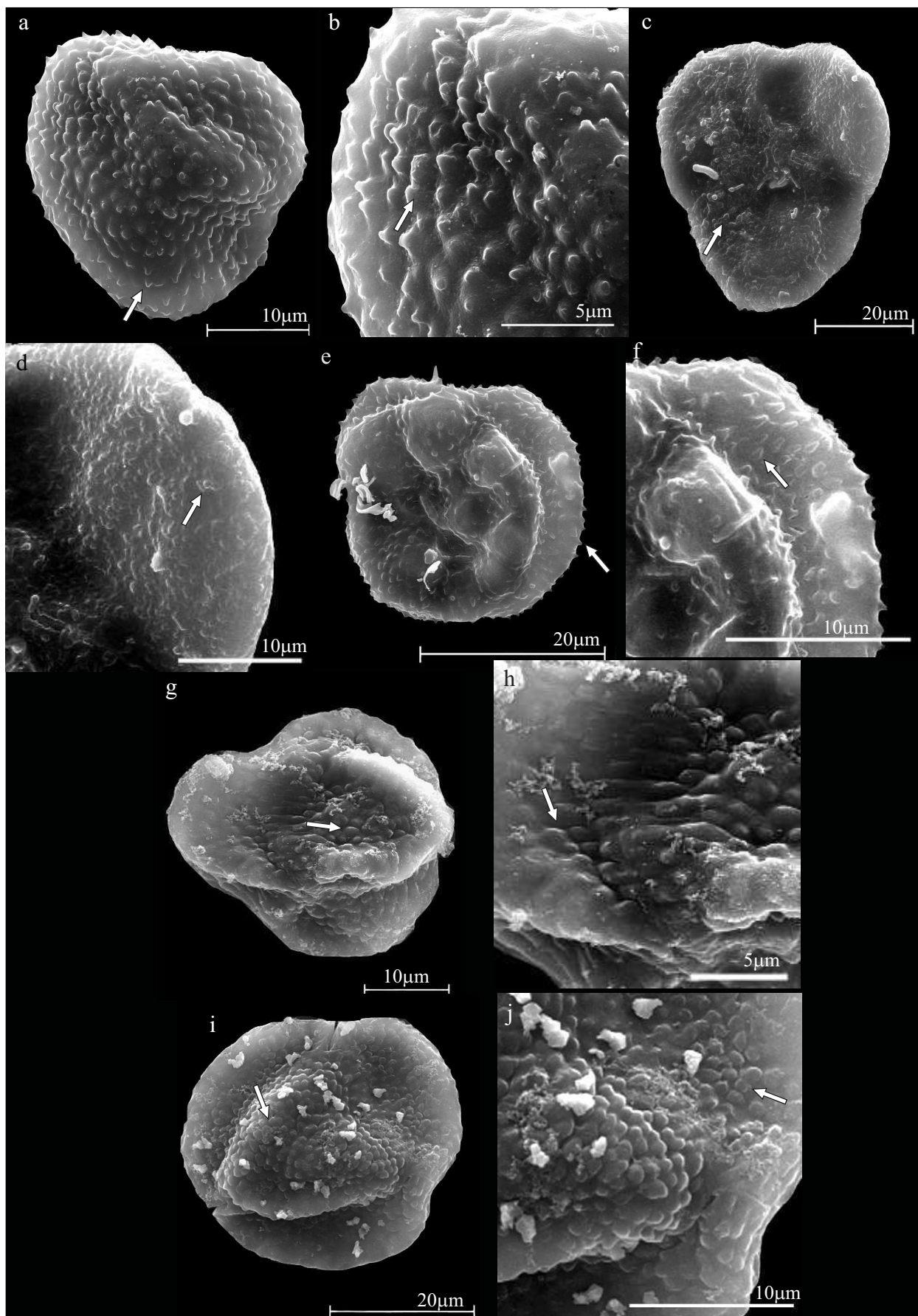


Plate 5.23: Enveloped dyads and hilates

a to d: Abditusdyadus histosus

- a:* TRE1/209, Assemblage 1. Enveloped, unfused elliptical dyad (?). Envelope sculptured with low, narrow muri, forming a regular reticulate pattern.
- b:* Close up of TRE1/209, Assemblage 1. Envelope sculptured with low, narrow muri, forming a regular reticulate pattern, forming small polygonal lumina (see arrow).
- c:* TRE1/144, Assemblage 1. Enveloped, unfused elliptical dyad. Envelope sculptured with low, narrow muri, forming a regular, polygonal reticulate pattern (see arrow).
- d:* Close up of TRE1/144, Assemblage 1. Envelope sculptured with low, narrow, muri, forming a regular, polygonal reticulate pattern (see arrow).

e and f: Segestrespora cf. membranifera

- e:* TRE1/049, Assemblage 1. Enveloped fused dyad. Envelope sculptured with narrow sinuous projecting muri (see arrow), forming irregular reticulate pattern.
- f:* Close up of TRE1/049, Assemblage 1. Envelope covering dyad contact area (see arrow). Sculptured with narrow, sinuous muri.

g and h: Qualisaspora sinuata

- g:* TRE1/121, Assemblage 1. Enveloped non-hilate monads. Envelope sculptured with regularly spaced straight to slightly sinuous muri (see arrow), which are radially arranged from the equator to the central pole. Muri are coni-shaped in profile (see arrow).
- h:* Close up of TRE1/121, Assemblage 1. Radially arranged muri coalesce at the central pole (see arrow).

Plate 5.23: Enveloped hilates and dyads

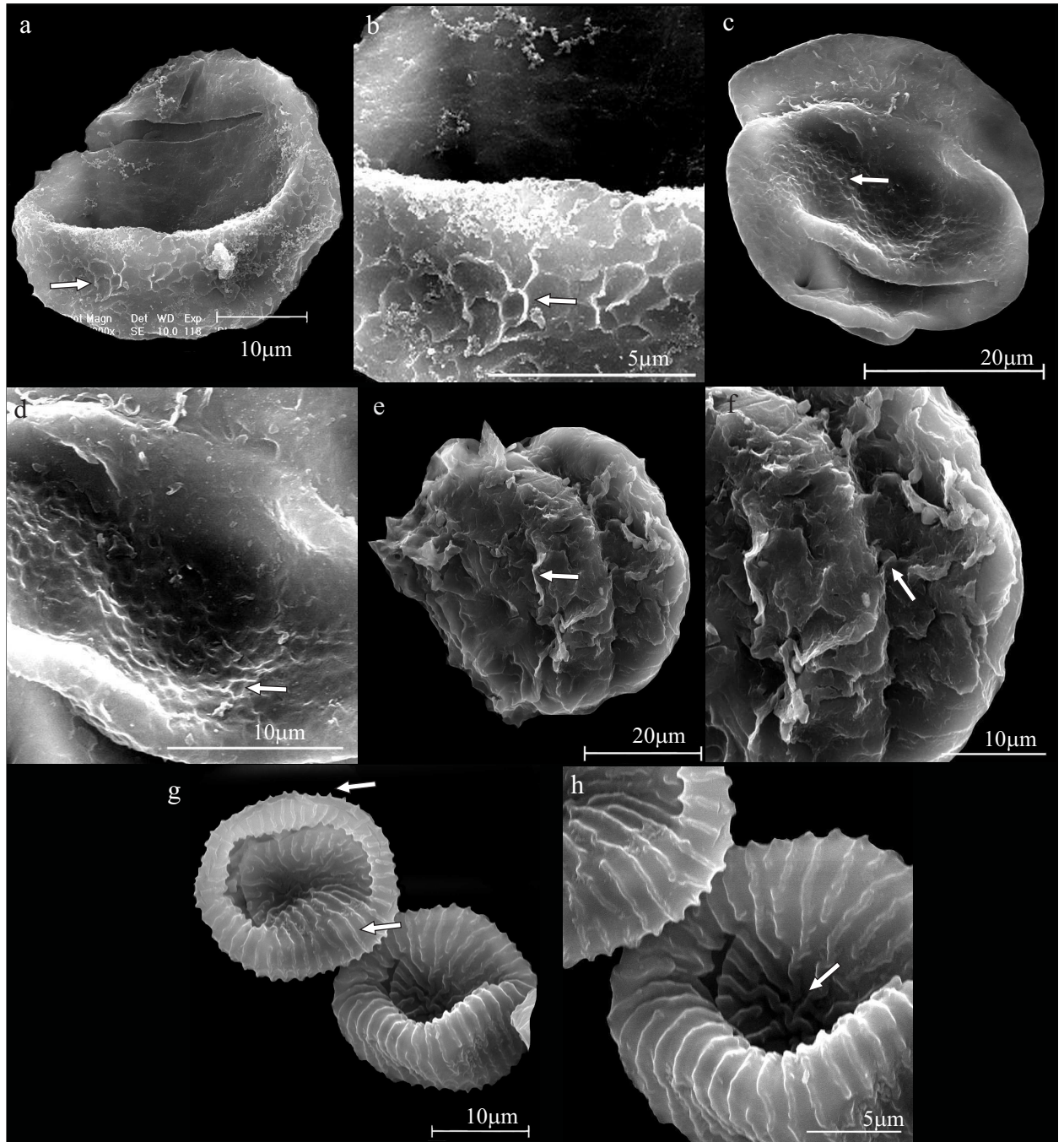


Plate 5.24: *Incertae sedis*

a to c: ?Enveloped murornate monad and tetrad with broad muri

- a:* TQBH2-1-094, Assemblage 4. Enveloped enclosed monad (?), sculptured with broad muri (see arrow), forming a broad reticulate pattern, with triangular to rectangular lumina. Superimposed with apiculate elements (grana) (see arrow).
- b:* TQBH1-3-209, Assemblage 5. Envelope enclosed tetrad (?) with visible contact lines (see arrow). Envelope sculptured with broad muri (see arrow), forming rectangular lumina. Lumina superimposed with closely spaced micrograna.
- c:* Close up of TQBH1-3-209, Assemblage 5. Envelope sculptured with broad muri, forming reticulate pattern, with rectangular lumina, superimposed with closely spaced micrograna (see arrow)

d to e: ?Enveloped murornate monad with sinuous muri

- d:* TQBH2-1-041, Assemblage 4. Naked (?) non-hilate monad. Distal and proximal (?) walls sculptured with highly irregular, closely spaced, low, sinuous muri (see arrow). Muri are often fused together and separated by small lumina.
- e:* Close up of TQBH2-1-041, Assemblage 4. Distal and proximal (?) walls sculptured with highly irregular, closely spaced, low, sinuous muri, forming irregular reticulate pattern and small lumina (see arrow).

f to i: ?Enveloped verrucate monads

- f:* TQBH2-1-007, Assemblage 4. Naked, sub-circular monad (?) Distal surface sculptured with densely packed, irregularly shaped verrucae, rugulae and muri (see arrow).
- g:* Close up of TQBH2-1-007, Assemblage 4. Densely packed, irregular, verrucae, rugulae and small muri elements (see arrow).
- h:* TQBH2-1-047, Assemblage 4. Naked, sub-circular monad (?). Distal surface sculptured with densely packed, irregularly shaped verrucae, rugulae and muri.
- i:* Close up of TQBH2-1-047, Assemblage 4. Distal surface sculptured with densely packed, irregularly shaped verrucae, rugulae and muri (see arrow).

j and k: ?Enveloped apiculate monad

- j:* TRE1/187, Assemblage 1. Enveloped (?) sub-circular hilate monad (see arrow). Distal and proximal surface sculptured with evenly spaced apiculate elements (microconi).
- k:* Close up of TRE1/187, Assemblage 1. Enveloped (?) hilate monad, distal and proximal surfaces sculptured with evenly spaced microconi (see arrow).

Plate 5.24: *Incertae sedis*

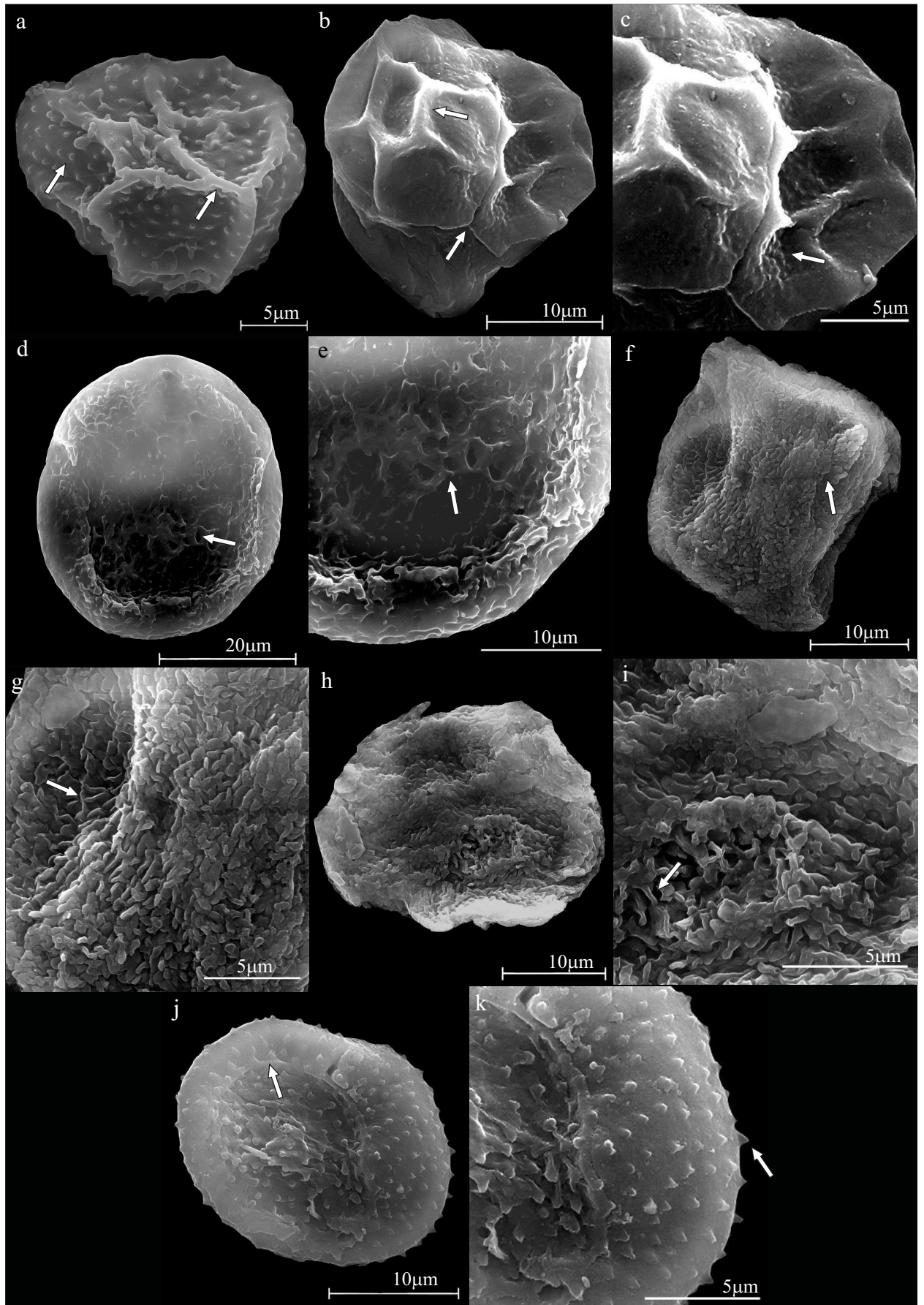


Plate 5.25: *Incertae sedis* (continued)

***a* to *h*: ?Enveloped spatulate monads and dyad**

- a*: TRE1/136, Assemblage 1. Enveloped (?) monad, sculptured with closely spaced irregular, blunt to pointed spatulate elements (see arrow), some fused to form narrow muri.
- b*: Close up of TRE1/136, Assemblage 1. Envelope sculptured with irregular blunt to pointed spatulate elements (see arrow).
- c*: TQBH2-1-053, Assemblage 4. Sub-circular enveloped (?) monad, sculptured with irregular, blunt to spatulate elements. Some fused to form rugulae.
- d*: Close up of TQBH2-1-053, Assemblage 4. Envelope sculptured with irregularly spaced, blunt to spatulate elements, some fused to form rugulae (see arrow).
- e*: TRE1/158, Assemblage 1. Enveloped sub-circular monad (?). Sculptured with closely spaced irregular spatulate elements, some fused to form rugulae or small muri.
- f*: Close up of TRE1/158, Assemblage 1. Envelope sculptured with closely spaced, irregular spatulate elements, some fused to form rugulae or small muri (see arrow).
- g*: TRE1/004, Assemblage 1. Enveloped dyad (?) Envelope sculptured with closely spaced, irregular spatulate elements, some fused to form rugulae or small muri.
- h*: Close up of TRE1/004, Assemblage 1. Envelope sculptured with closely spaced, irregular spatulate elements, some fused to form rugulae or small muri (see arrow).

***i* to *l*: ?Enveloped spinose monads with clustered spines**

- i*: TRE1/018, Assemblage 1. Enveloped monad (?). Envelope sculptured with closely spaced, irregular arranged spinose elements (see arrow). Some spines are fused at the base.
- j*: Close up of TRE1/018, Assemblage 1. Envelope sculptured with short spines, irregularly or radially arranged (see arrow). Spines are fused at the base, some fused to form rugulae or small muri.
- k*: TQBH1-1-156, Assemblage 2. Enveloped monad (?) Envelope sculptured with irregular closely spaced elements, including radially arranged short spines, grana or muri.
- l*: Close up of TQBH1-1-156, Assemblage 2. Envelope sculptured with irregular, closely spaced elements, including radially arranged, short spines (see arrow).

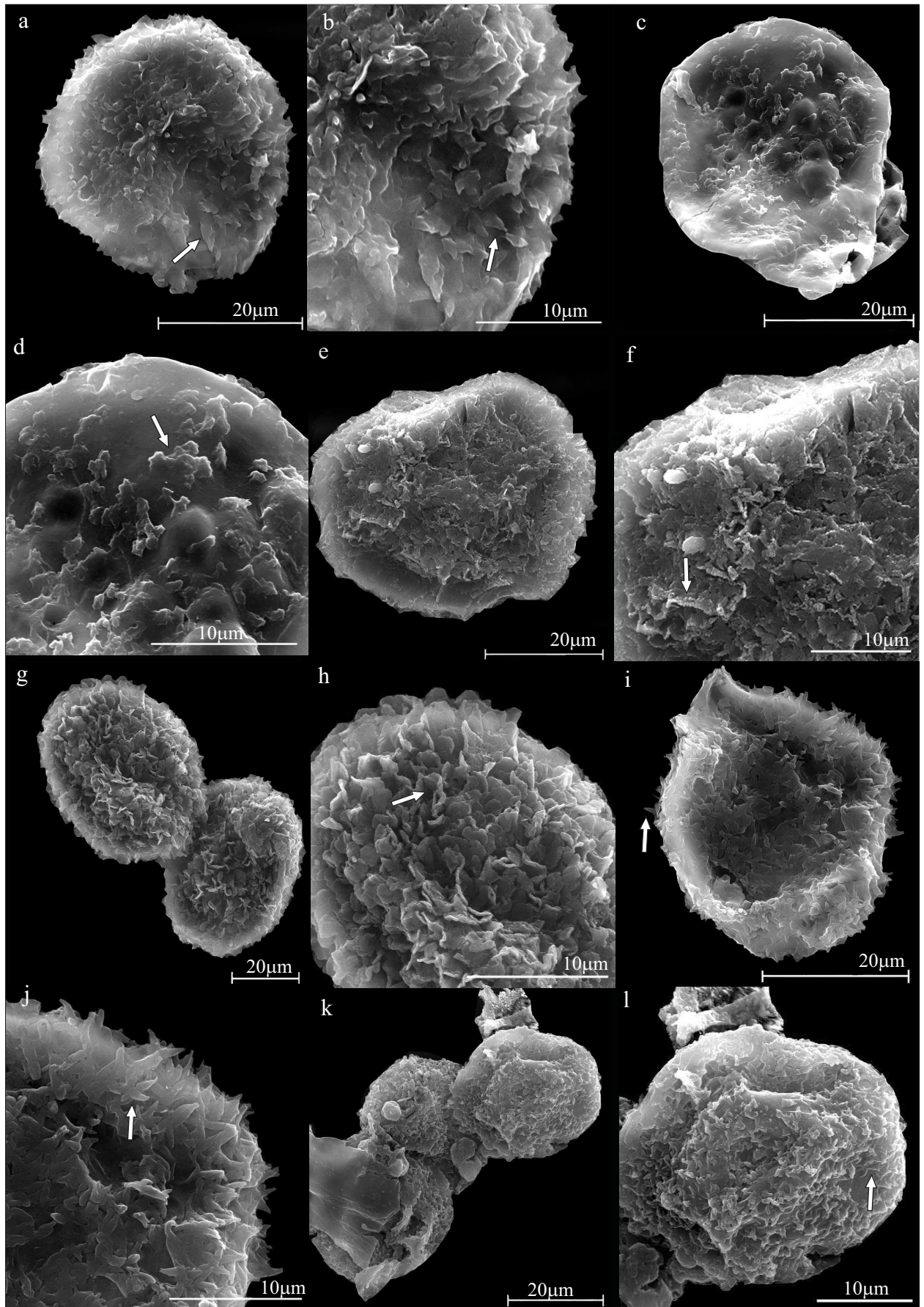


Plate 5.26: *Incertae sedis* (continued)

***a to d*: ?Enveloped spinose dyad and tetrad with clustered spines**

- a*: T1-6/PB0-255, Assemblage 1. Enveloped unfused dyad, with visible contact line (see arrow). Envelope sculptured with closely spaced, irregular spinose elements, some fused to form rugulae or muri.
- b*: Close up of T1-6/PB0-255, Assemblage 1. Envelope sculptured with closely spaced, irregular spinose elements (see arrow), some fused to form rugulae or muri.
- c*: TRE1/005, Assemblage 1. Enveloped tetrad. Envelope sculptured with closely spaced, irregular radially arranged, spinose elements, some fused to form rugulae (see arrow).
- d*: Close up of TRE1/005, Assemblage 1. Enveloped sculptured with closely spaced, irregular radially arranged, spinose elements (see arrow), some fused to form rugulae.

***e to h*: ?Enveloped spinose tetrads with slender spines**

- e*: TRE1/035b, Assemblage 1. Enveloped tetrad (?). Envelope sculptured with small evenly spaced spines with pointed tips. Some spines fused to form rugulae or muri.
- f*: Close up of TRE1/035b, Assemblage 1. Envelope sculptured with small evenly spaced spines with pointed tips (see arrow).
- g*: TRE1/128, Assemblage 1. Enveloped tetrad (?). Envelope sculptured with small irregularly spaced spines with pointed tips. Some spines are fused or biform (see arrow).
- h*: Close up of TRE1/128, Assemblage 1. Envelope sculptured with small, irregularly spaced spines, some fused at the base to form biform spines (see arrow).

Plate 5.26: *Incertae sedis*

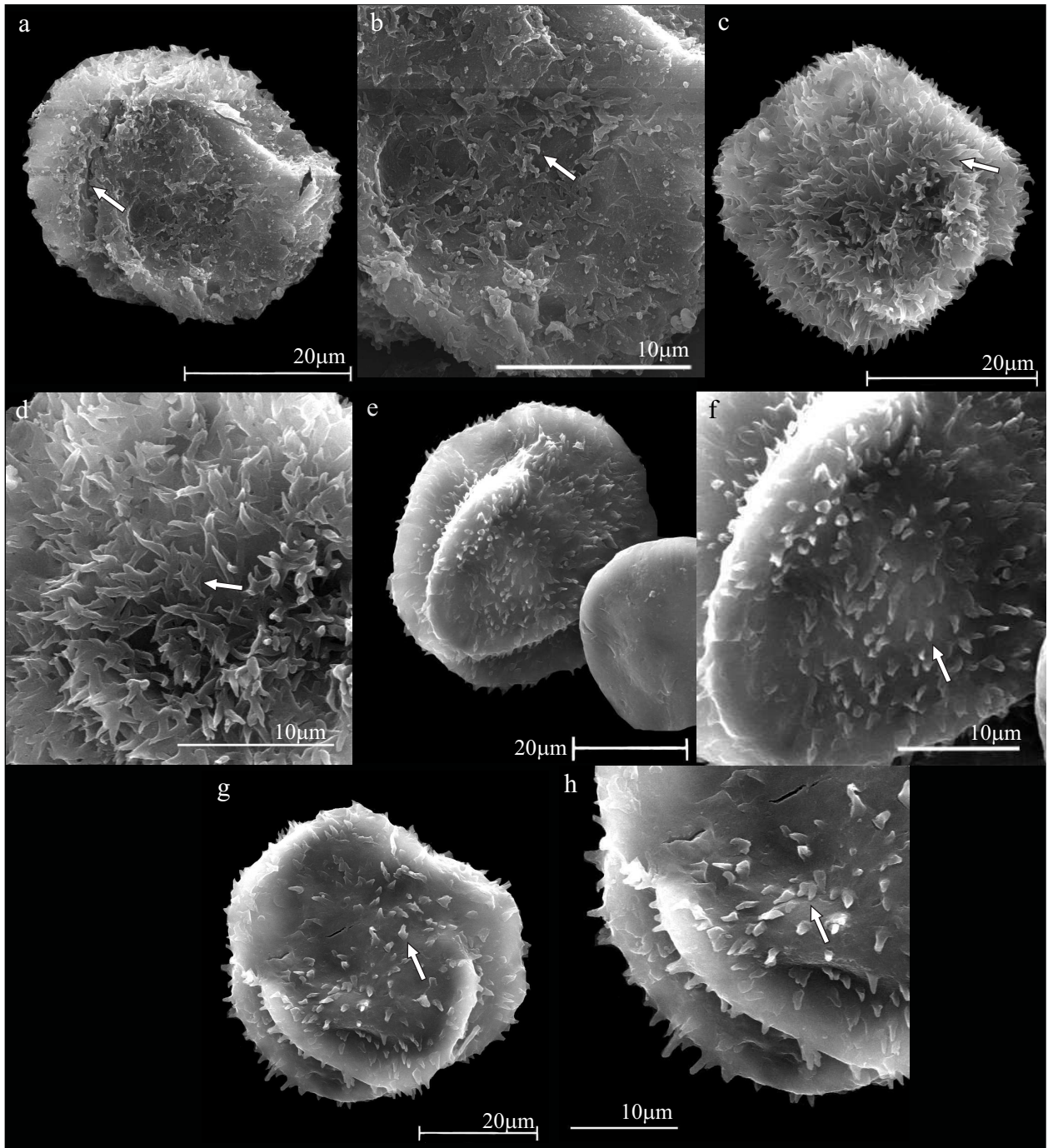


Plate 5.27: Laevigate retusoid triletes

a to d: Retusotriletes dittonensis

- a:* TQBH1-1(Ox1)-002, Assemblage 2. Retusoid, sub-circular trilete spore, with laevigate exine. Curvature perfectae is distinctive (see arrow).
- b:* TQBH1-PB1-006, Assemblage 3. Retusoid, sub-circular trilete spore, with laevigate exine. Small indentations where each laesurae meet the curvature (see arrow).
- c:* TQBH1-3-137, Assemblage 5. Retusoid, sub-circular trilete spore, with laevigate exine. Curvature perfectae is distinctive.
- d:* TQBH1-3-179, Assemblage 5. Retusoid, sub-circular trilete spore, with laevigate exine. Curvature perfectae is distinctive. Laesurae thickened into lips (see arrow).

e to j: Retusotriletes cf. dittonensis

- e:* TRE1/008, Assemblage 1. Retusoid, sub-circular trilete spore, with laevigate distal exine. Proximal surface ornamented with apiculate elements, microconi or grana. Laesurae are thin, but thicken towards the curvature perfectae (see arrow).
- f:* Close up of TRE1/008, Assemblage 1. Apiculate elements on proximal surface (see arrow).
- g:* TRE1/070, Assemblage 1. Retusoid, sub-circular trilete spore, with laevigate distal exine. Proximal surface ornamented with small apiculate elements (micrograna). Laesurae are thin, and thicken towards the curvature perfectae, with indentations where each laesurae meets the curvature (see arrow).
- h:* Close up of TRE1/070, Assemblage 1. Proximal surface ornamented with apiculate elements (micrograna).
- i:* TQBH1-1-115, Assemblage 2. Retusoid, sub-circular trilete spore, with laevigate exine. Distal walls are laevigate. Curvature perfectae distinctive. Laesurae thin, but thicken towards the curvature (see arrow). Proximal surface ornamented with micrograna.
- j:* TQBH1-3-035, Assemblage 5. Retusoid, sub-circular trilete spore. Distal wall laevigate. Proximal wall ornamented with micrograna. Laesurae thin, but thicken towards the curvature (see arrow).

Plate 5.27: Laevigate retusoid triletes

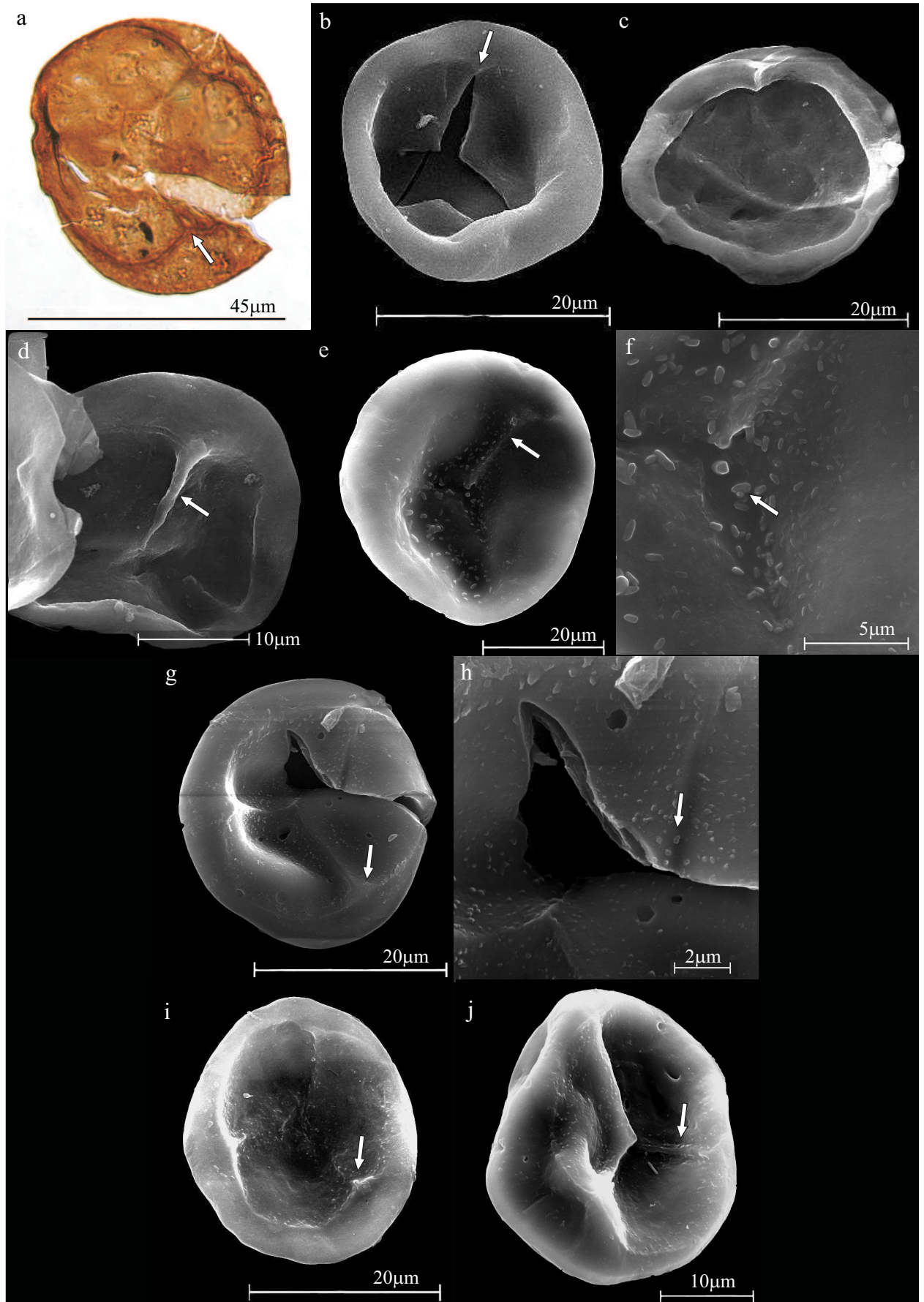


Plate 5.28: Laevigate retusoid triletes and tetrads of laevigate triletes

a and b: Retusotriletes cf. triangulatus

- a:* TQBH1-1-020, Assemblage 2. Retusoid, sub-circular trilete spore, with laevigate distal and proximal surfaces. Trilete mark surrounded by distinctive thick darkened triangular area (see arrow).
- b:* TQBH1-1-024, Assemblage 2. Retusoid, sub-circular trilete spore, with laevigate distal and proximal surfaces. Laesurae are sutured (see arrow).

c to j: Retusotriletes cf. triangulatus var. minor

- c:* TQBH1-1-031, Assemblage 2. Retusoid, sub-circular trilete spore with laevigate surfaces. Laesurae surrounded by dark, thickened triangular area (see arrow).
- d:* TQBH1-1-035, Assemblage 2. Retusoid, sub-circular trilete spore with laevigate surfaces. Laesurae surrounded by a dark, thickened triangular area (see arrow).
- e:* TQBH1-1-040, Assemblage 2. Retusoid, sub-circular trilete spore with laevigate distal and proximal surfaces. Laesurae are surrounded by a dark, thickened triangular area (see arrow).
- f:* TQBH1-1-066, Assemblage 2. Retusoid, sub-circular trilete spore with laevigate surfaces. Laesurae surrounded by a dark, thickened triangular area (see arrow).
- g:* TQBH1-1-073, Assemblage 2. Retusoid, sub-circular trilete spore with laevigate distal and proximal surfaces. Laesurae surrounded by a dark, thickened triangular area (see arrow).
- h:* TQBH1-3-003, Assemblage 5. Retusoid, sub-circular trilete spore with laevigate distal and proximal surfaces. Laesurae surrounded by a dark, thickened triangular area (see arrow).
- i:* TQBH1-3-088, Assemblage 5. Retusoid, sub-circular trilete spore with laevigate surfaces. Curvature perfectae coincident with the equatorial margin, except where the trilete laesurae meets the margin (see arrow).
- j:* TQBH1-3-105, Assemblage 5. Retusoid, sub-circular trilete spore with laevigate surfaces. Curvature perfectae coincident with the equatorial margin, except where the trilete laesurae meets the margin (see arrow).

k and l: Tetrads of laevigate triletes (Retusotriletes or Ambitisporites)

- k:* TRE1/022, Assemblage 1. Laevigate tetrad of inflated sub-triangular spore units, with clear contact lines (see arrow). Each unit has a slight equatorial crassitude.
- l:* TRE1/137, Assemblage 1. Laevigate tetrad of inflated sub-triangular spore units, with clear contact lines (see arrow). Each unit has a slight equatorial crassitude.

Plate 5.28: Laevigate retusoid triletes and tetrads of laevigate triletes

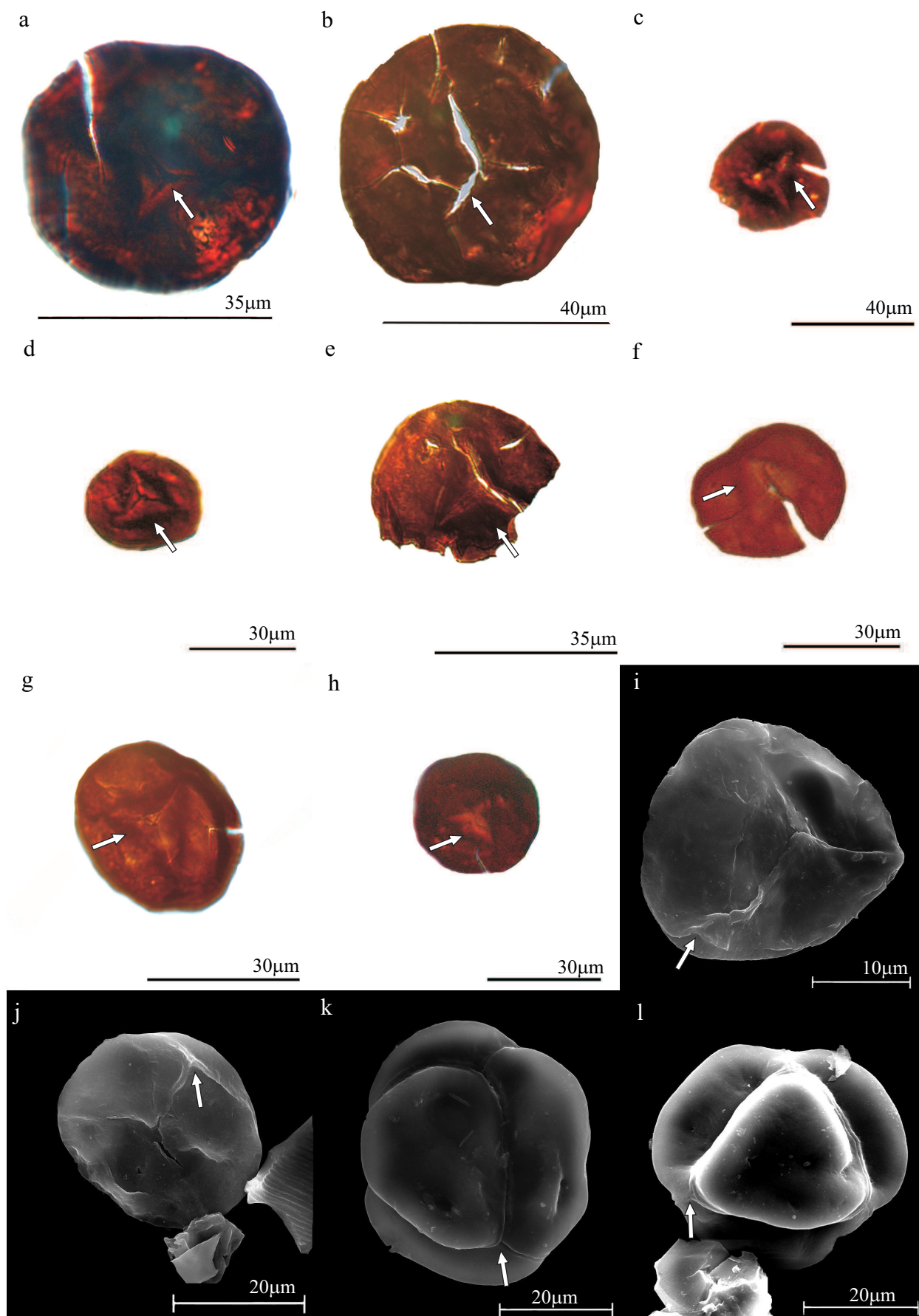


Plate 5.29: Apiculate retusoid triletes

a to l: Apiculiretusispora sp.

- a:* TRE1/194, Assemblage 1. Retusoid, sub-circular trilete spores. Distal and proximal surfaces are sculptured with apiculate elements (grana) (see arrow). Curvature perfectae is coincident with the equator (see arrow).
- b:* TQBH1-1-098, Assemblage 2. Retusoid, sub-triangular trilete spore, with thick laesurae (see arrow). Proximal surface sculptured with apiculate elements, including micrograna (see arrow).
- c:* Close up to TQBH1-1-098, Assemblage 2. Proximal surface sculptured with apiculate elements, including micrograna (see arrow).
- d:* TQBH1-PB1-031, Assemblage 3. Retusoid, sub-circular trilete spore. Proximal surface sculptured with irregularly arranged apiculate elements (grana and micrograna) (see arrow).
- e:* TQBH1-PB1-061, Assemblage 3. Retusoid, sub-triangular trilete spore. Proximal surface sculptured with apiculate elements (grana) (see arrow).
- f:* Close up of TQBH1-PB1-061, Assemblage 3. Thick laesurae are sculptured with apiculate elements (grana and micrograna) (see arrow).
- g:* TQBH1-PB1-094, Assemblage 3. Retusoid, sub-circular trilete spore. Proximal wall sculptured with apiculate elements (see arrow). Curvature perfectae is coincident with the equator.
- h:* Close up of TQBH1-PB1-094, Assemblage 3. Curvature perfectae is coincident with the equator (see arrow).
- i:* TQBH1-PB1-096, Assemblage 3. Retusoid, sub-circular trilete spore. Proximal wall sculptured with apiculate elements (grana and micrograna). Curvature perfectae is coincident with the equator where the laesurae reach the equator, but is closer to the centre in between laesurae, forming muri like features (see arrow).
- j:* Close up of TQBH1-PB1-096, Assemblage 3. Proximal surface sculptured with apiculate elements (grana and micrograna) (see arrow).
- k:* TQBH1-PB1-100, Assemblage 3. Retusoid, sub-triangular trilete spore. Proximal surface sculptured with apiculate elements (grana) (see arrow). Laesurae are thick forming lips.
- l:* Close up of TQBH1-PB1-100, Assemblage 3. Laesurae form thick lips (see arrow).

Plate 5.29: Apiculate sculptured retusoid triletes

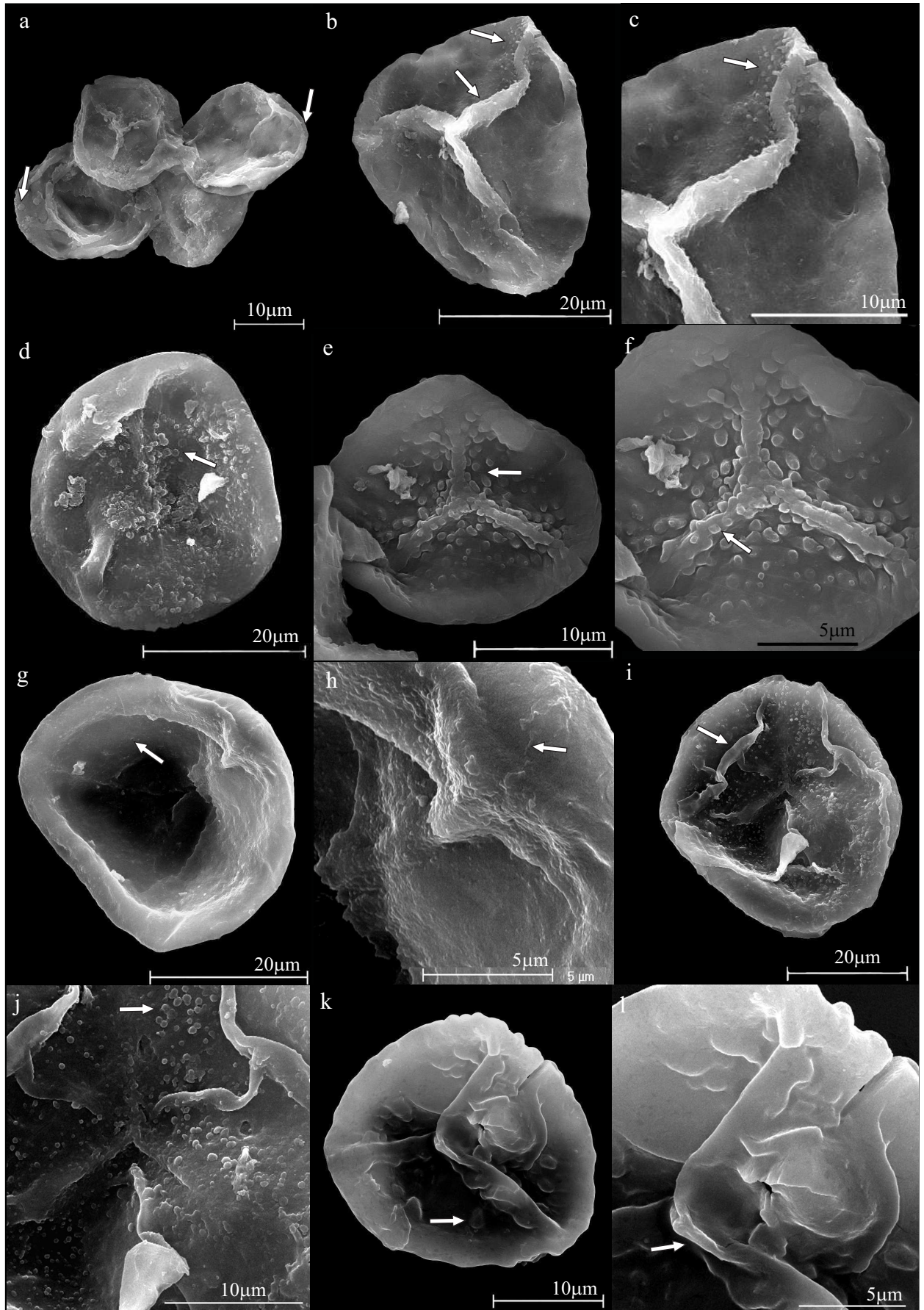


Plate 5.30: Murornate sculptured retusoid triletes

a to c: Emphanisporites protophanus

- a:* TQBH1-1-107, Assemblage 1. Sub-circular, retusoid trilete spore. Proximal surface sculptured with closely spaced radial muri (see arrow). Laesurae thin (see arrow), reaching the curvature perfectae (see arrow). Distal surface laevigate.
- b:* TQBH1-1-179, Assemblage 2. Retusoid, sub-circular trilete spore. Proximal surface is sculptured with closely spaced inconspicuous radial muri. Laesurae are thin, reaching the curvature perfectae (see arrow). Distal surface is laevigate.
- c:* Close up of TQBH1-1-179, Assemblage 2. Proximal surface sculptured with closely spaced radial muri (see arrow). Laesurae are thin (see arrow).

d to f: Emphanisporites sp. B

- d:* TQBH1-PB1-044, Assemblage 3. Retusoid, sub-circular trilete spore. Proximal surface sculptured with closely spaced distinctive radial muri (see arrow), with thin laesurae (see arrow). Distal surface sculptured with evenly spaced large verrucae (see arrow).
- e:* TQBH1-3-124, Assemblage 5. Retusoid, sub-circular trilete. Proximal surface sculptured with closely spaced sinuous radial muri, and distinctive laesurae (see arrow). Distal surface sculptured with evenly spaced verrucae (see arrow).
- f:* Close up of TQBH1-3-124, Assemblage 5. Proximal surface sculptured with sinuous radial muri (see arrow).

g to l: Emphanisporites sp.

- g:* TQBH1-1-103, Assemblage 2. Retusoid, sub-circular trilete spore. Proximal surface sculptured with low-lying inconspicuous radial muri. Laesurae are thin (see arrow), reaching the curvature perfectae.
- h:* Close up of TQBH1-1-103, Assemblage 2. Proximal surface sculptured with low-lying inconspicuous radial muri (see arrow).
- i:* TQBH1-1-112, Assemblage 2. Retusoid, sub-circular trilete spore. Proximal surface sculptured with inconspicuous radial muri. Laesurae are thin (see arrow).
- j:* Close up of TQBH1-1-112, Assemblage 2. Proximal surface sculptured with inconspicuous radial muri (see arrow).
- k:* TQBH1-3-134, Assemblage 5. Retusoid, sub-triangular trilete spore. Proximal surface sculptured with inconspicuous radial muri.
- l:* Close up of TQBH1-3-134, Assemblage 5. Proximal surface sculptured with inconspicuous radial muri (see arrow).

Plate 5.30: Murornate sculptured retusoid triletes.

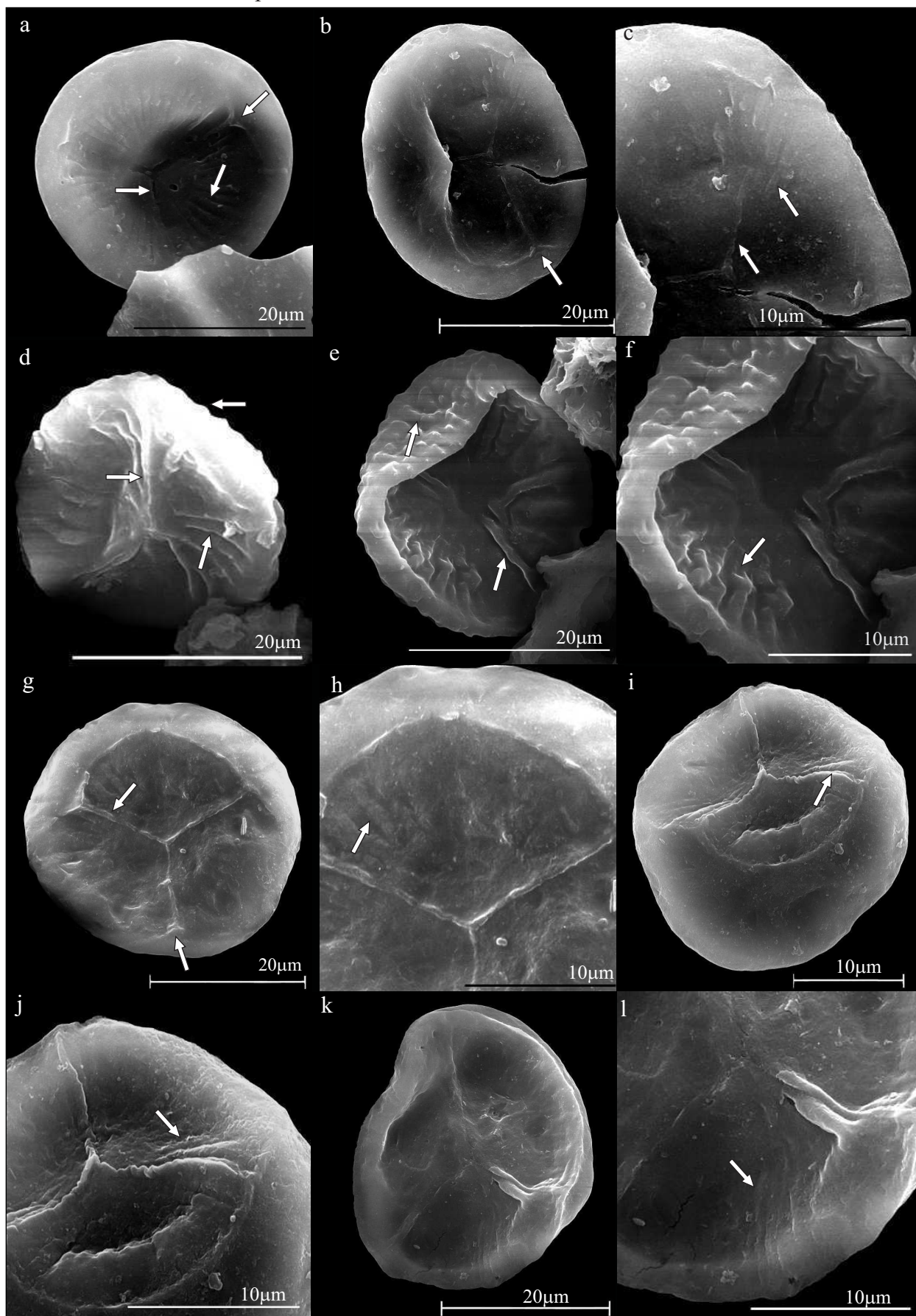


Plate 5.31: Laevigate crassitate triletes

a to d: Ambitisporites avitus

- a:* TRE1/142, Assemblage 1. Crassitate, sub-triangular trilete spore. Distal and proximal surfaces laevigate. Laesurae thick and raised (see arrow), reaching the inside of the equatorial crassitude (see arrow).
- b:* Close up of TRE1/142, Assemblage 1. Proximal surface sculptured with microgranular ornamentation (see arrow).
- c:* TQBH1-1-065, Assemblage 3. Crassitate, sub-triangular trilete spore. Distal and proximal surfaces laevigate. Laesurae is thick and slightly raised (see arrow).
- d:* TQBH1-1-113, Assemblage 3. Crassitate, sub-triangular trilete spore. Distal and proximal surfaces laevigate. Laesurae is thick and slightly raised, reaching the inside of the equatorial crassitude (see arrow).

e to l: Ambitisporites avitus var. minor

- e:* T1-6/PB0-274, Assemblage 1. Crassitate, sub-triangular trilete spore. Distal and proximal surfaces are laevigate. Laesurae are thick, and reach the equatorial crassitude (see arrow).
- f:* TRE1/044, Assemblage 1. Crassitate, sub-circular trilete spore. Distal and proximal surfaces are laevigate. Laesurae are thin, reaching the equatorial crassitude (see arrow).
- g:* TQBH1-1-134, Assemblage 2. Crassitate, sub-triangular trilete spore. Distal and proximal surfaces are laevigate. Laesurae are thin and inconspicuous (see arrow), reaching the equatorial crassitude.
- h:* TQBH1-1(Ox1)-036, Assemblage 2. Crassitate, sub-triangular trilete spore. Distal and proximal surfaces are laevigate. Laesurae are thick (see arrow), reaching the equatorial crassitude.
- i:* TQBH1-PB1-011, Assemblage 3. Crassitate, sub-circular trilete spore. Distal and proximal surfaces are laevigate. Laesurae are thick (see arrow).
- j:* TQBH1-PB1-149, Assemblage 3. Crassitate, sub-triangular trilete spore. Distal and proximal surfaces are laevigate. Laesurae are thick, forming lips (see arrow), and reach the equatorial crassitude.
- k:* TQBH2-1-030, Assemblage 4. Crassitate, sub-circular trilete spore. Distal and proximal surfaces laevigate. Laesurae (see arrow) reach the equatorial crassitude.
- l:* TQBH2-1-155, Assemblage 5. Crassitate, sub-triangular trilete spore. Laesurae are thick, forming lips (see arrow) and reach the equatorial crassitude.

Plate 5.31: Laevigate crassitate triletes.

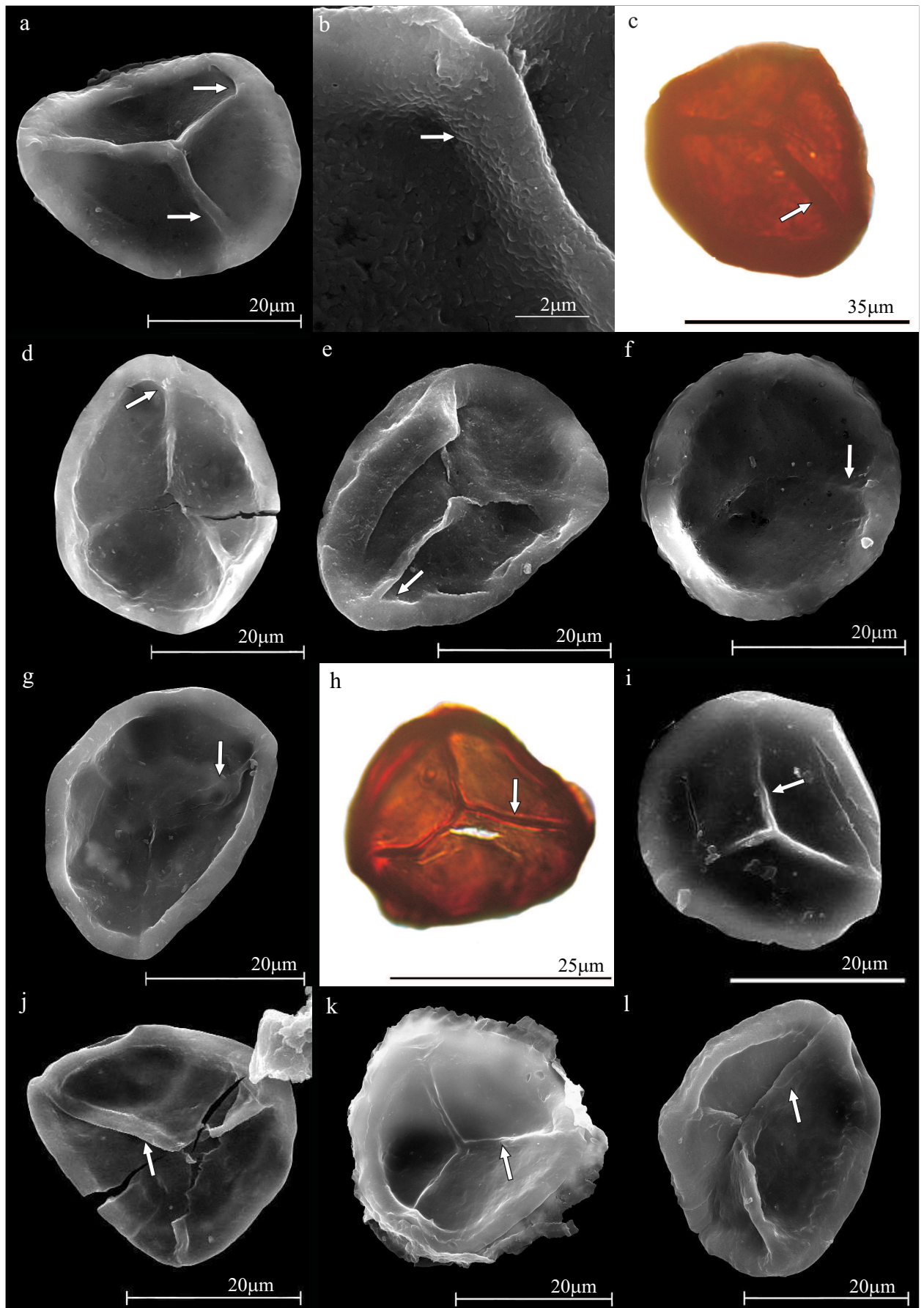


Plate 5.32: Laevigate crassitate triletes

a to f: Ambitisporites dilutus

- a:* TRE1/009, Assemblage 1. Crassitate, sub-triangular trilete spore. Distal and proximal surfaces laevigate. Laesurae are thick, forming lips (see arrow), reaching the thin equatorial crassitude.
- b:* TQBH1-1-027, Assemblage 2. Partial crassitate sub-circular trilete spore. Distal and proximal surfaces are laevigate. Laesurae are sutured (see arrow), reaching the equatorial crassitude.
- c:* TQBH1-PB1-025, Assemblage 3. Crassitate sub-circular trilete spore. Distal and proximal surfaces laevigate. Laesurae are thin (see arrow), reaching a thin equatorial crassitude.
- d:* TQBH2-1-055, Assemblage 4. Crassitate sub-circular trilete spore. Distal and proximal surfaces laevigate. Laesurae are sutured (see arrow), reaching the equatorial crassitude.
- e:* TQBH1-3-217, Assemblage 5. Crassitate sub-triangular trilete spore. Distal and proximal surfaces laevigate. Laesurae are thick and folded, reaching the equatorial crassitude (see arrow).
- f:* Close up of TQBH1-3-217, Assemblage 5. Laesurae are thick and folded (see arrow).

g to k: Ambitisporites warringtonii

- g:* TRE1/102, Assemblage 1. Crassitate, sub-circular trilete spore. Distal and proximal surfaces laevigate. Equatorial crassitude is thick, which thins out in the inter-radial areas. Laesurae are thick, but taper to the apical zone (see arrow).
- h:* Close up of TRE1/102, Assemblage 1. Proximal surface laevigate. Equatorial crassitude is thick, which thins out in the inter-radial areas (see arrow).
- i:* TQBH1-1-131, Assemblage 2. Crassitate sub-circular trilete spore. Laesurae are thin (see arrow), reaching a thick equatorial crassitude.
- j:* TQBH1-PB1-113, Assemblage 3. Crassitate sub-circular trilete spore. Laesurae are thin and sutured reaching a thick equatorial crassitude (see arrow).
- k:* TQBH1-PB1-043, Assemblage 3. Crassitate sub-triangular trilete spore. Laesurae are thin and sutured, reaching a thick equatorial crassitude (see arrow).

l: Ambitisporites sp. A

- l:* TQBH1-1(Ox1)-079, Assemblage 2. Crassitate, sub-circular trilete spore. Distal and proximal surfaces laevigate. Central dark apex at the apical pole.

Plate 5.32: Laevigate crassitate triletes (continued)

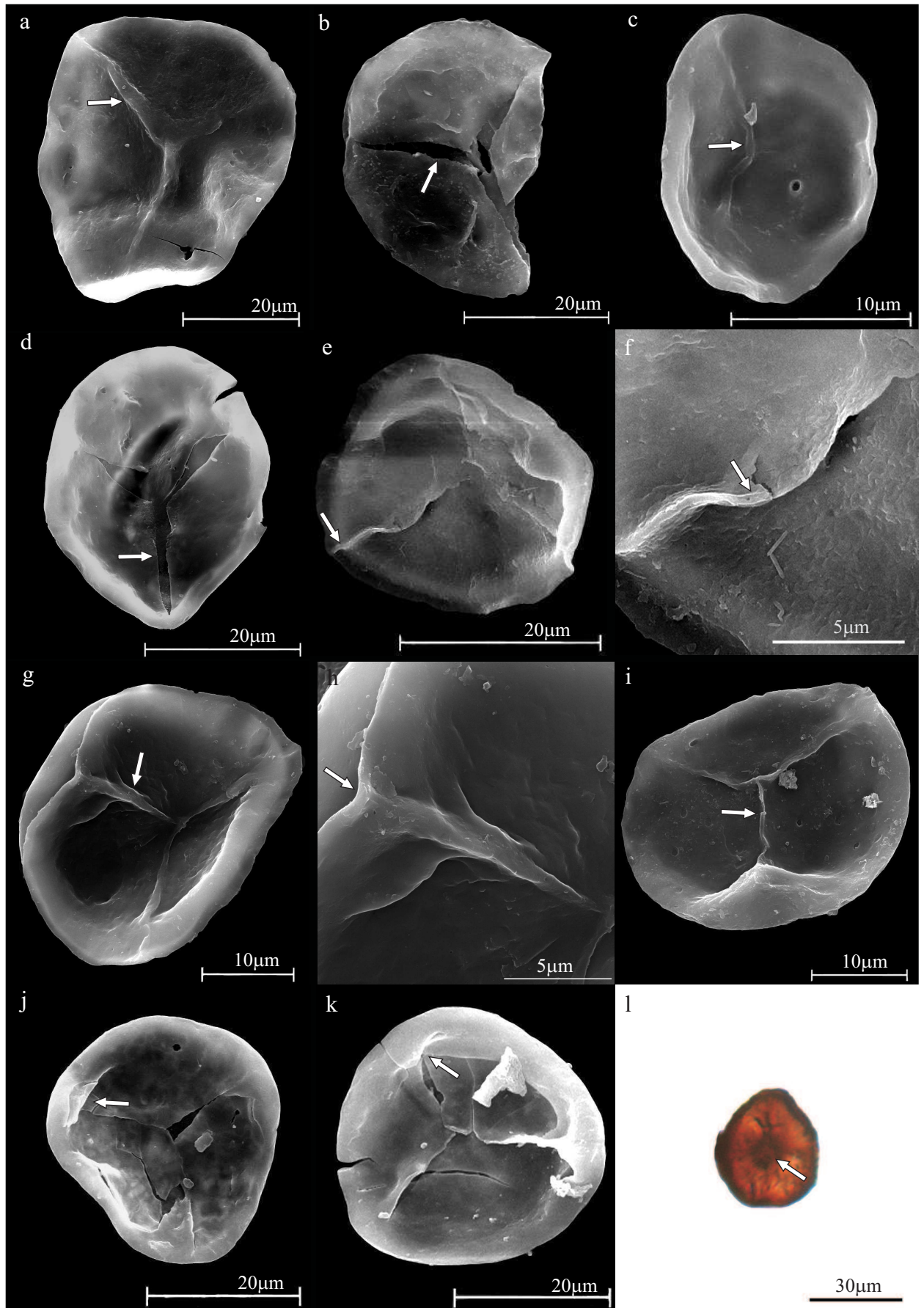


Plate 5.33: Apiculate sculptured crassitate triletes

a to d: Streelispora newportensis

- a:* TRE1/172, Assemblage 1. Crassitate, sub-circular trilete spore. Proximal surface sculptured with three inter-radial rounded papillae. Papillae are attached to equator and laesurae by small folds. Laesurae are thick (see arrow). Distal wall sculptured with broad conical elements (see arrow).
- b:* Close up of TRE1/172, Assemblage 1. Proximal wall sculptured with inter-radial rounded papillae (see arrow), attached to the equator and laesurae by small folds (see arrow).
- c:* TQBH2-1-021, Assemblage 4. Crassitate, sub-circular trilete spore. Proximal surface sculptured with inter-radial rounded papillae (see arrow). Distal wall sculptured with small apiculate elements (conical) (see arrow).
- d:* Close up of TQBH2-1-021, Assemblage 4. Proximal surface sculptured with inter-radial papillae, attached to laesurae and equator by small folds (see arrow).

e to l: Aneurospora sp.

- e:* TRE1/093, Assemblage 1. Crassitate, sub-circular trilete spores. Proximal surface laevigate, with simple laesurae (see arrow). Distal surface sculptured with apiculate elements (grana) (see arrow).
- f:* TQBH1-PB1-009, Assemblage 3. Crassitate, sub-triangular trilete spores. Proximal surface laevigate, with simple laesurae (see arrow). Distal surface sculptured with apiculate elements (grana and conical) (see arrow).
- g:* Close up of TQBH1-PB1-009, Assemblage 3. Distal surface sculptured with apiculate elements (grana and conical) (see arrow).
- h:* TRE1/019, Assemblage 1. Crassitate, sub-circular trilete spore. Distal wall sculptured with evenly spaced grana and microconical elements (see arrow).
- i:* TQBH1-PB1-049, Assemblage 3. Crassitate, sub-circular trilete spore. Distal wall sculptured with evenly spaced grana and microconical elements (see arrow).
- j:* TQBH1-PB1-088, Assemblage 3. Crassitate, sub-circular trilete spore. Distal wall sculptured with evenly spaced grana and microconical elements (see arrow).
- k:* TQBH2-1-139, Assemblage 4. Tetrad of crassitate sub-circular trilete spores. Distal walls sculptured with evenly spaced grana and microconical elements (see arrow).
- l:* Close up of TQBH2-1-139, Assemblage 4. Tetrad of crassitate sub-circular trilete spores. Proximal surface is laevigate. Distal surface sculptured with evenly spaced grana (see arrow).

Plate 5.33: Apiculate sculptured crassitate triletes

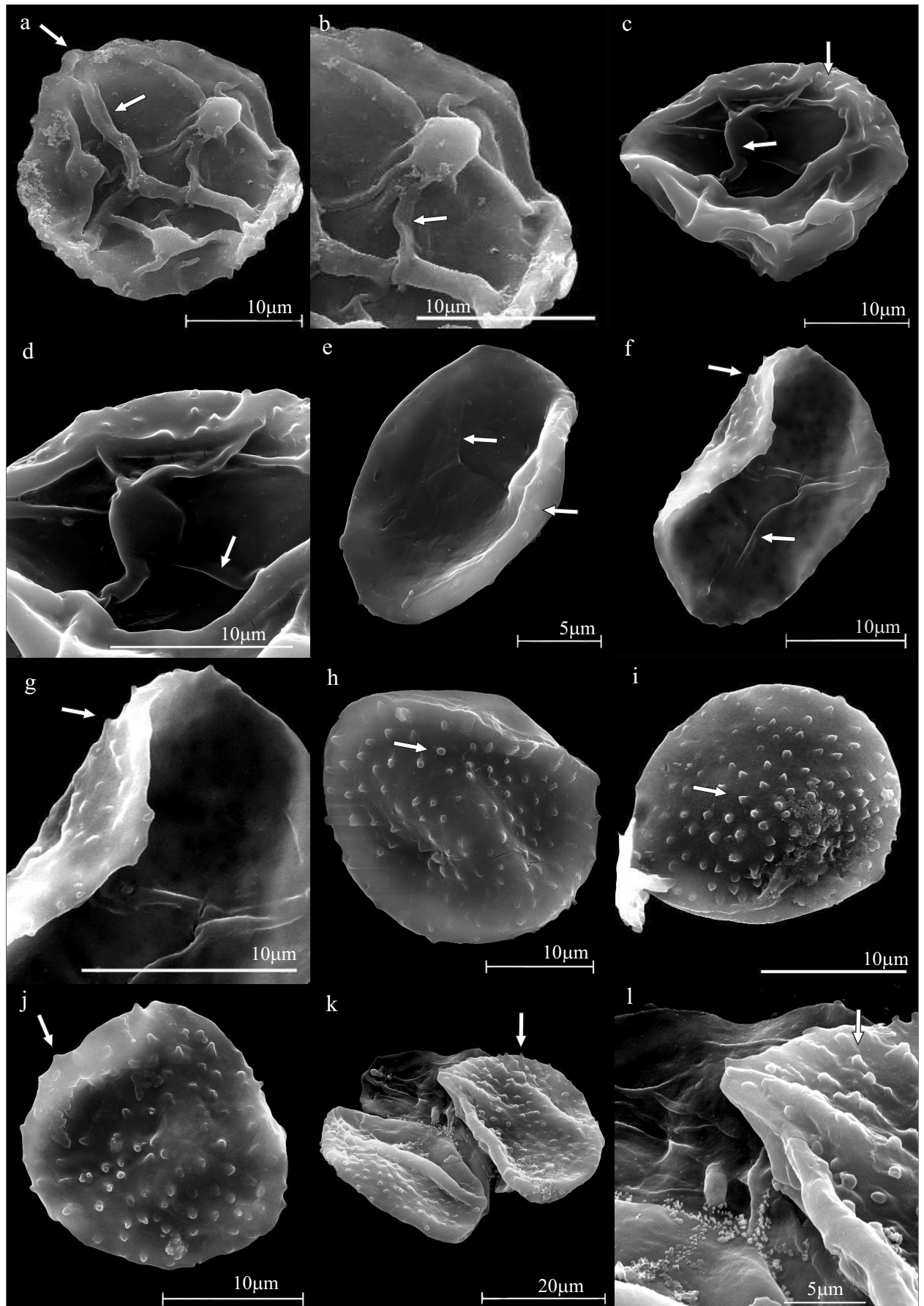


Plate 5.34: Murornate sculptured crassitate triletes

a and b: Scylaspora cf. scripta

- a:* TQBH1-3-067, Assemblage 5. Crassitate, sub-circular trilete spore. Proximal surface sculptured with irregular arranged, low convoluted muri and rugulae. Laesurae are sutured, with laevigate lips (see arrow).
- b:* Close up of TQBH1-3-067, Assemblage 5. Proximal surface sculptured with low convoluted muri and rugulae (see arrow).

c to h: Scylaspora downiei

- c:* TQBH1-1-109, Assemblage 2. Crassitate, sub-circular trilete spore. Laesurae are thin and slightly sinuous (see arrow). Proximal surface is sculptured with closely spaced, irregularly arranged large verrucae to rugulae.
- d:* Close up of TQBH1-1-109, Assemblage 2. Proximal surface is sculptured with closely spaced, irregularly arranged large verrucae to rugulae (see arrow).
- e:* TQBH1-1-092, Assemblage 2. Crassitate, sub-circular trilete spore. Laesurae thin and sinuous (see arrow). Proximal surface sculptured with closely spaced, irregular verrucae to rugulae (see arrow).
- f:* Close up of TQBH1-1-092, Assemblage 2. Proximal surface sculptured with closely spaced, irregular verrucae to rugulae (see arrow).
- g:* TQBH1-PB1-071, Assemblage 3. Crassitate, sub-circular trilete spore. Laesurae are thin (see arrow). Proximal surface sculptured with low, inconspicuous verrucae and rugulae.
- h:* Close up of TQBH1-PB1-071, Assemblage 3. Proximal surface sculptured with low, inconspicuous verrucae and rugulae (see arrow).

i: Scylaspora cf. kozlica

- i:* TQBH1-3(Ox1)-034, Assemblage 5. Crassitate, sub-triangular trilete spore. Trilete mark simple, reaching equatorial crassitude. Proximal surface sculptured with micrograna.

j to l: Scylaspora sp.

- j:* TQBH2-1-229, Assemblage 4. Crassitate (see arrow), sub-circular trilete spore. Proximal surface sculptured with irregular verrucae and rugulae.
- k:* Close up of TQBH2-1-229, Assemblage 4. Proximal surface sculptured with irregular verrucae and rugulae (see arrow).
- l:* TQBH1-3-188, Assemblage 5. Crassitate, sub-triangular trilete spore. Verrucae or rugulae elements ornamented apical zone of proximal surface (see arrow).

Plate 5.34: Murornate sculptured crassitate triletes

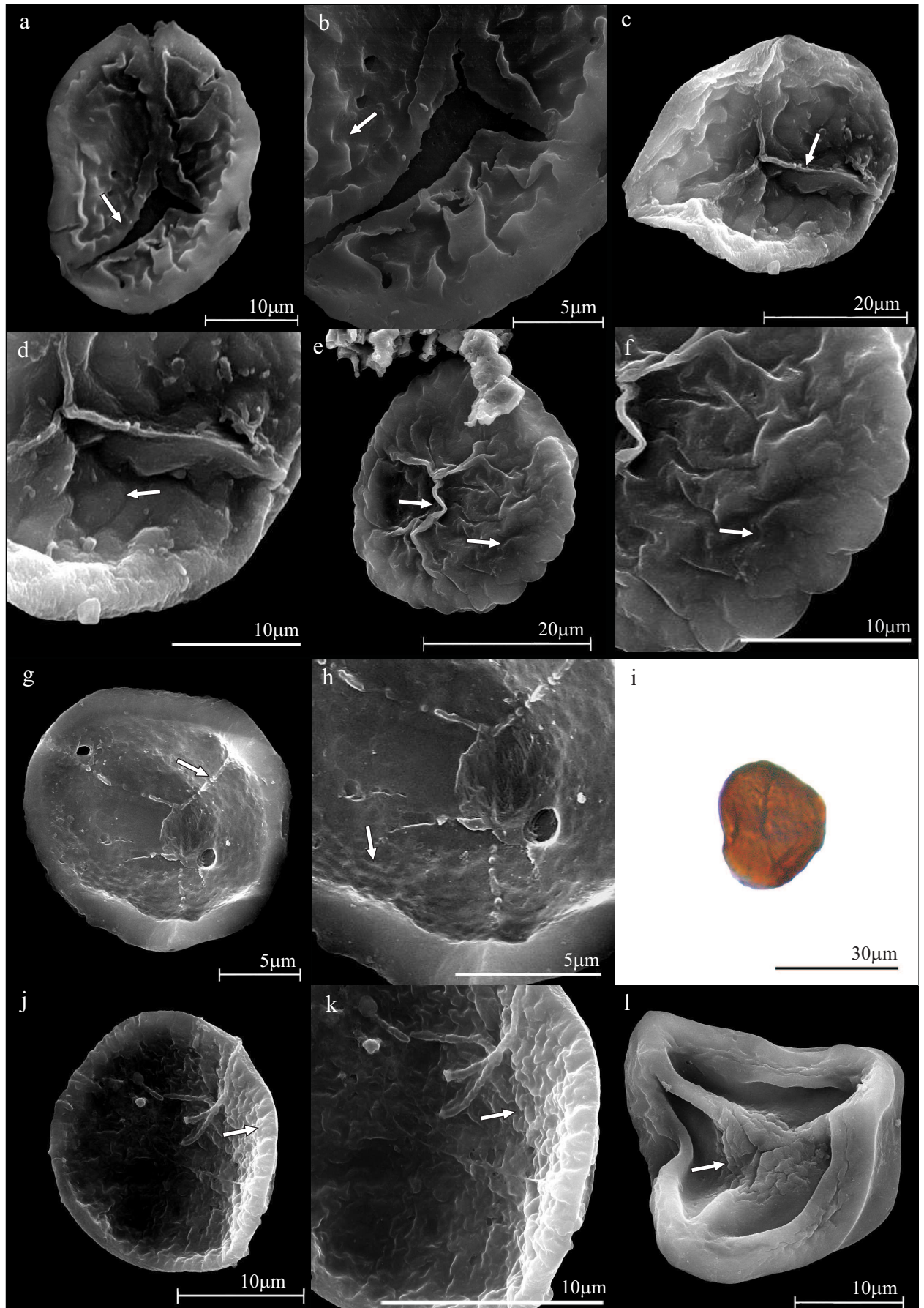


Plate 5.35: Verrucate sculptured crassitate triletes

a to d: Synorisporites sp. A.

- a:* T1-6/PB0 (Stub 1-6)-268, Assemblage 1. Crassitate, sub-circular trilete spore. Proximal surface sculptured with inter-radial papillae. Laesurae are narrow, surrounded by thick lips. Distal surface sculptured with verrucae (see arrow).
- b:* Close up of T1-6/PB0 (Stub 1-6)-268, Assemblage 1. Proximal surface sculptured with rounded inter-radial papillae (see arrow).
- c:* TQBH2-1(StubT(2)2-1)-051, Assemblage 4. Crassitate, sub-triangular trilete spore. Proximal surface sculptured with rounded inter-radial papillae. Distal surface sculptured with verrucae to coni elements (see arrow).
- d:* Close up of TQBH2-1(StubT(2)2-1)-051, Assemblage 4. Proximal surface sculptured rounded inter-radial papillae (see arrow).

e to j: Synorisporites sp.

- e:* TQBH1-PB1(StubPB1-2008)-166, Assemblage 3. Crassitate, sub-circular trilete spore. Proximal surface sculptured with broad rugulae and convoluted muri. Distal surface sculptured with irregular broad verrucae or rugulae (see arrow).
- f:* Close up of TQBH1-PB1(StubPB1-2008)-166, Assemblage 3. Proximal surface sculptured with broad rugulae and convoluted muri (see arrow).
- g:* TQBH1-PB1(StubPB1-2008)-152, Assemblage 3. Crassitate, sub-circular trilete spore. Distal surface sculptured with closely spaced, irregular verrucae (see arrow). Proximal surface sculptured with low, convoluted verrucae or rugulae (see arrow).
- h:* Close up of TQBH1-PB1(StubPB1-2008)-152, Assemblage 3. Proximal surface sculptured with low, convoluted verrucae or rugulae (see arrow).
- i:* TQBH1-PB1(StubPB1-2008)-085, Assemblage 3. Crassitate, sub-triangular trilete spore. Proximal surface sculptured with irregular verrucae or rugulae. Distal surface sculptured with closely spaced verrucae (see arrow).
- j:* Close up of TQBH1-PB1(StubPB1-2008)-085, Assemblage 3. Proximal surface sculptured with irregular verrucae or rugulae. Laesurae are thin, surrounded by thick lips (see arrow).

Plate 5.35: Verrucate sculptured crassitate triletes

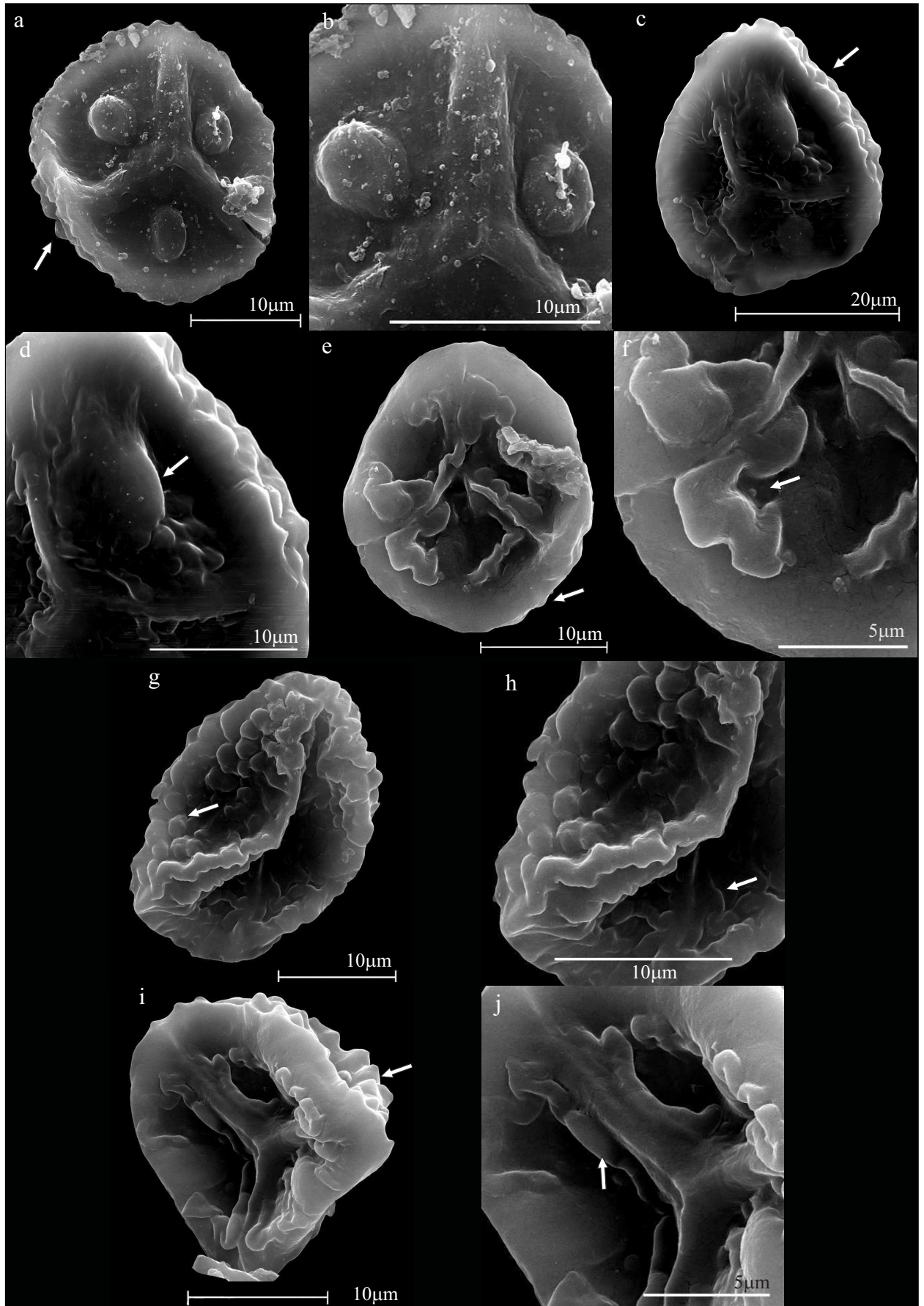


Plate 5.36: Laevigate patinate triletes

a: Archaeozonotriletes chulus var. nanus

- a:* TRE1/200, Assemblage 1. Patinate, sub-triangular trilete spore. Exine thickened in equatorial regions (see arrow). Distal and proximal surfaces are laevigate.

b to e: Archaeozonotriletes chulus var. chulus

- b:* TQBH2-1(StubT2-1(2008)-096, Assemblage 4. Patinate, sub-triangular trilete spore. Proximal and distal surfaces laevigate. Laesurae thin and simple (see arrow). Exine thickened in equatorial region.
- c:* Close up of TQBH2-1(StubT2-1(2008)-096, Assemblage 4. Exine thickened in equatorial region (see arrow).
- d:* TQBH2-1(StubT2-1(2008)-136, Assemblage 4. Patinate, sub-circular trilete spore. Proximal and distal surfaces laevigate. Exine thickened in equatorial region (see arrow).
- e:* Close up of TQBH2-1(StubT2-1(2008)-136, Assemblage 4. Proximal surface laevigate. Laesurae thin or sutured (see arrow).

f and g: Archaeozonotriletes chulus var. inframurinatus

- f:* TRE1/024, Assemblage 1. Patinate, sub-triangular trilete spore. Proximal surface sculptured with inconspicuous radial muri. Central apical zone is thickened (see arrow).
- g:* Close up of TRE1/024, Assemblage 1. Proximal sculptured with inconspicuous radial muri (see arrow).

Plate 5.36: Laevigate patinate triletes

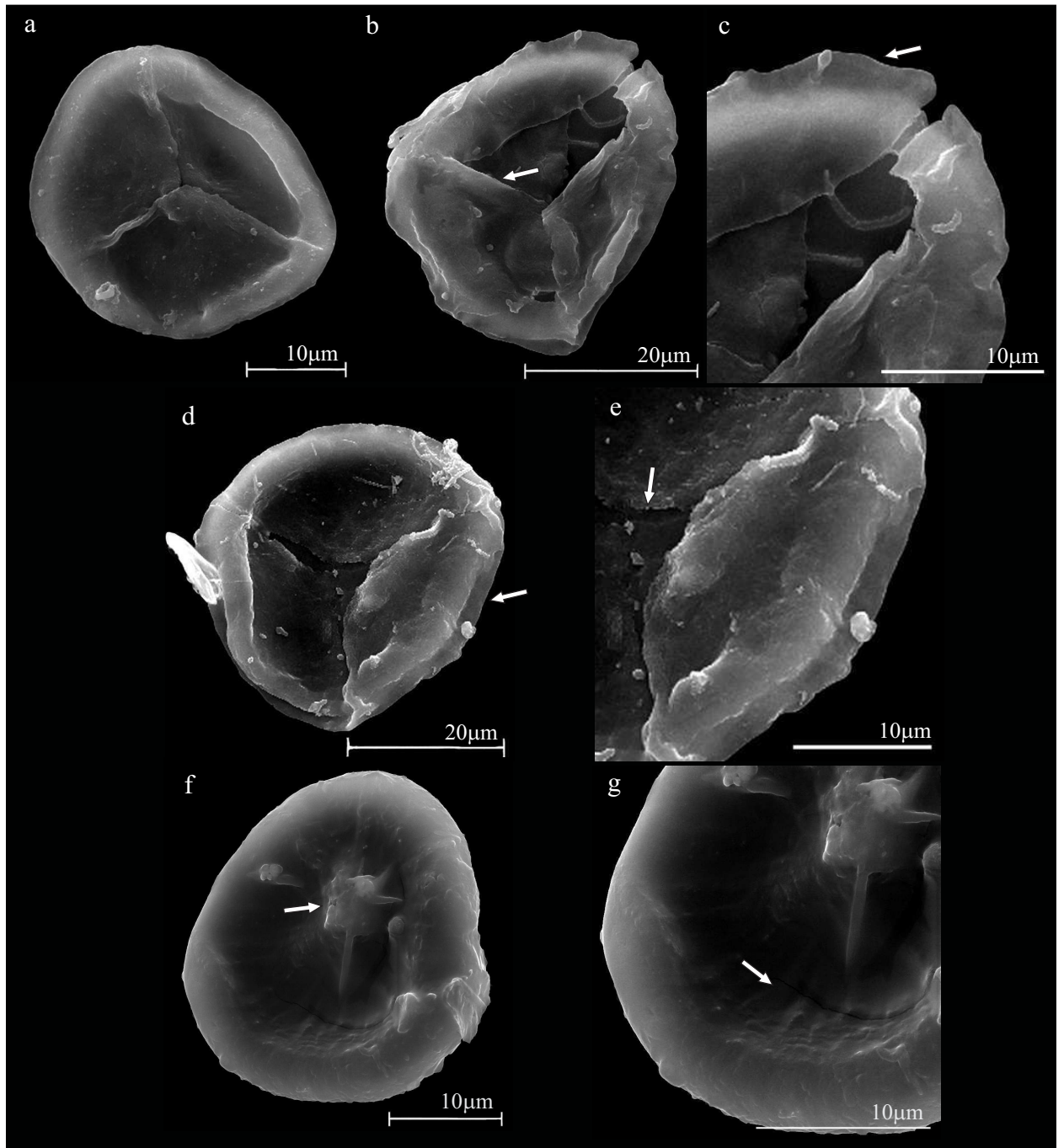


Plate 5.37: Murornate sculptured patinate triletes

a to g: Chelinospora sp.

- a:* TRE1/097, Assemblage 1. Patinate, sub-circular trilete spore. Proximal surface sculptured with irregular, sinuous muri forming a reticulate pattern (see arrow). Trilete mark is raised and slightly sinuous (see arrow).
- b:* Close up of TRE1/097, Assemblage 1. Proximal surface sculptured with sinuous muri forming a reticulate pattern. Laesurae slightly sinuous (see arrow).
- c:* TRE1/229, Assemblage 1. Patinate, sub-triangular trilete spore. Proximal surface sculptured with irregular, sinuous muri, forming a reticulate pattern (see arrow). Laesurae slightly sinuous (see arrow).
- d:* TQBH2-1(StubT2-1(2008)-189, Assemblage 4. Patinate, sub-triangular trilete spore. Proximal surface sculptured with irregular rugulae to muri. Laesurae highly sinuous (see arrow).
- e:* Close up of TQBH2-1(StubT2-1(2008)-189, Assemblage 4. Proximal surface sculptured with irregular, bifurcating rugulae to muri (see arrow).
- f:* TQBH1-3(StubT3-2)-042, Assemblage 5. Patinate, sub-triangular trilete spore. Distal and proximal surfaces sculptured with irregular verrucae, rugulae and muri. Laesurae highly sinuous (see arrow).
- g:* Close up of TQBH1-3(StubT3-2)-042, Assemblage 5. Proximal surfaces sculptured with irregular verrucae and rugulae (see arrow).

h to l: Perotriletes microbaculatus

- h:* TRE1/183, Assemblage 1. Sub-triangular trilete spore with thin perine (see arrow). Exine laevigate with equatorial crassitude. Perine sculptured with micrograna.
- i:* TRE1/170, Assemblage 1. Sub-circular trilete spore with thin perine (see arrow). Exine laevigate with equatorial crassitude. Perine sculptured with micrograna.
- j:* TQBH1-1(StubT1-1(2008)-101, Assemblage 2. Sub-circular trilete spore with thin perine, sculptured with micrograna. Contact area laevigate. Laesurae sinuous and folded (see arrow).
- k:* Close up of TQBH1-1-101, Assemblage 2. Perine sculptured with micrograna (see arrow).
- l:* TQBH1-1-132, Assemblage 2. Sub-circular trilete spore, with perine. Perine sculptured with micrograna (see arrow).

Plate 5.37: Murornate sculptured patinate triletes, and triletes with perispores

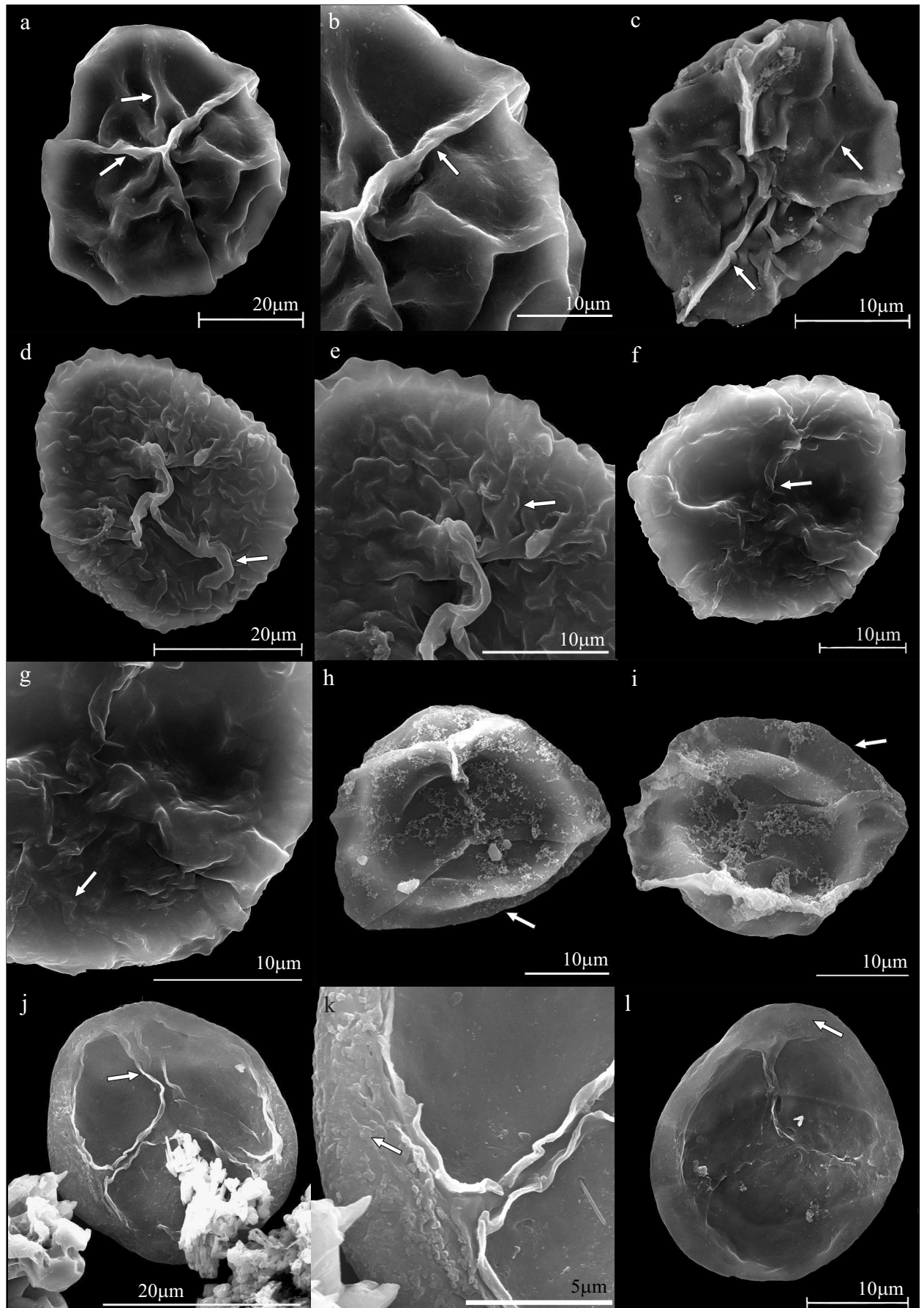


Plate 6.1: Intraformational conglomerates from Tredomen Quarry

***a* and *b*: Green intraformational conglomerates**

- a*: Green intraformational conglomerate with white calcareous nodule clasts, green argillaceous clasts, and a few red mudstone clasts, in a medium-grained green sandstone matrix. Bed 1, borehole 1, 0.8m below the surface.
- b*: Intraformational conglomerate with green argillaceous clasts in a sparry calcite matrix. Bed 1, borehole 1, 1.2m below the surface.

***c* to *e*: Red intraformational conglomerates**

- c*: Red intraformational conglomerate, with red argillaceous clasts and calcareous nodule clasts. Bed 62, borehole 2, 19.80m below the surface.
- d*: Red intraformational conglomerate with an argillaceous matrix. Bed 62, borehole 2, 20.10m below the surface.
- e*: Normal grading of red intraformational conglomerates. Bed 62, borehole 2, 19.40m below the surface.

Plate 6.1: Intraformational conglomerates from Tredomen Quarry

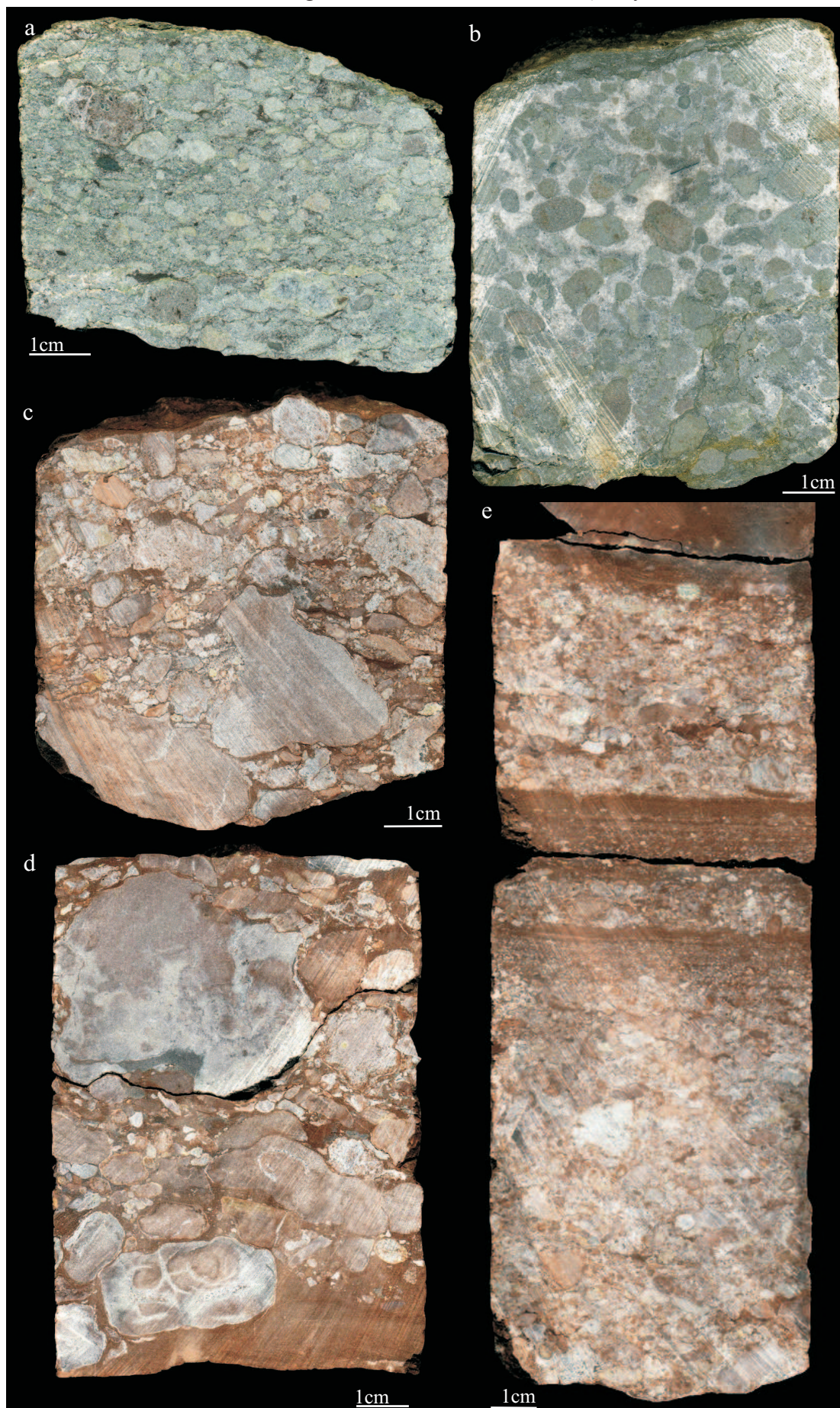


Plate 6.2: Green-grey sandstones from Tredomen Quarry

***a to f*: Medium-grained green to grey sandstones**

- a*: Medium-grained green sandstone with angular, red argillaceous gravel-sized clast horizons. Bed 6, borehole 1, 4.0m below the surface.
- b*: Planar-bedded medium-grained green sandstone. Bed 36, borehole 1, 29.5m below the surface.
- c*: Green, planar-bedded medium-grained sandstone in outcrop (1) (appears red on outer surface due to quarry workings), overlain by planar-cross-bedded medium-grained sandstone (2). Dotted line = boundary between 1 and 2.
- d*: Parting lineations on weathered bedding plane of medium-grained green sandstone.
- e*: Planar-cross-bedding of green medium-grained sandstone. Bed 2, borehole 1, 2.0m below the surface.
- f*: Trough-cross-bedding of green medium-grained sandstone. Bed 24, borehole 2, 8.0m below the surface.

***g and i*: Fine-grained green sandstones**

- g*: Field outcrop of fine-grained green sandstone units (1) in outcrop, with concave bases, pinching out into, and interbedded with dark green siltstones (2). Plant bed 1 indicated.
- h*: Planar-bedding and trough-cross-bedding of fine-grained green sandstone. Bed 45, borehole 2, 14.7m below the surface.
- i*: Small-scaled cross-ripple-laminations of green fine-grained sandstones. Bed 25, borehole 1, 20.5m below the surface.

Plate 6.2: Green-grey sandstones from Tredomen Quarry

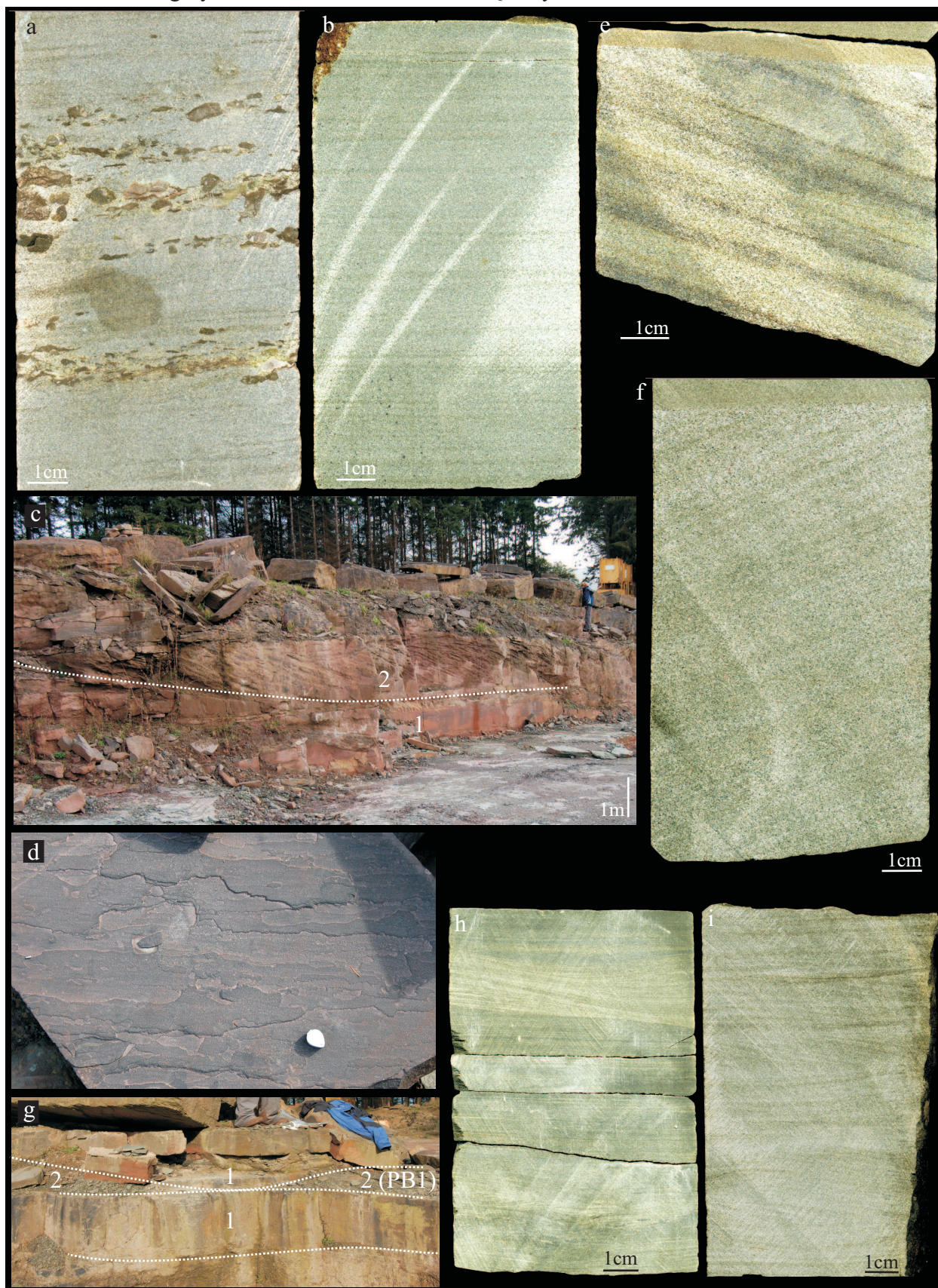


Plate 6.3: Siltstones from Tredomen Quarry

***a to d:* Green to grey siltstones**

- a:* Field outcrop of green to grey siltstones (2), interbedded with red siltstones (1).
- b:* Planar and wavy-ripple-laminated green to grey siltstones. Bed 41, borehole 2, 14.0m below the surface.
- c:* Wavy and cross-ripple-laminated green to grey siltstones. Bed 77, borehole 2, 27.5m below the surface.
- d:* Field outcrop of grey-green siltstones (1) overlain by red siltstones (2). Arrow points to iron-oxide spots within grey-green siltstones. Beds 7 to 6, quarry log A, 6.5m.
- e:* Iron - oxide spots occurring within horizons of weathered green siltstones. Bed 15, borehole 2, 5.0m below the surface.

***f and g:* Red siltstones**

- f:* Planar-laminated red siltstones. Bed 2, borehole 2, 1.4m below the surface.
- g:* Wavy and cross-ripple-laminated red siltstones. Bed 13, borehole 2, 4.4m below the surface.

Plate 6.3: Siltstones from Tredomen Quarry

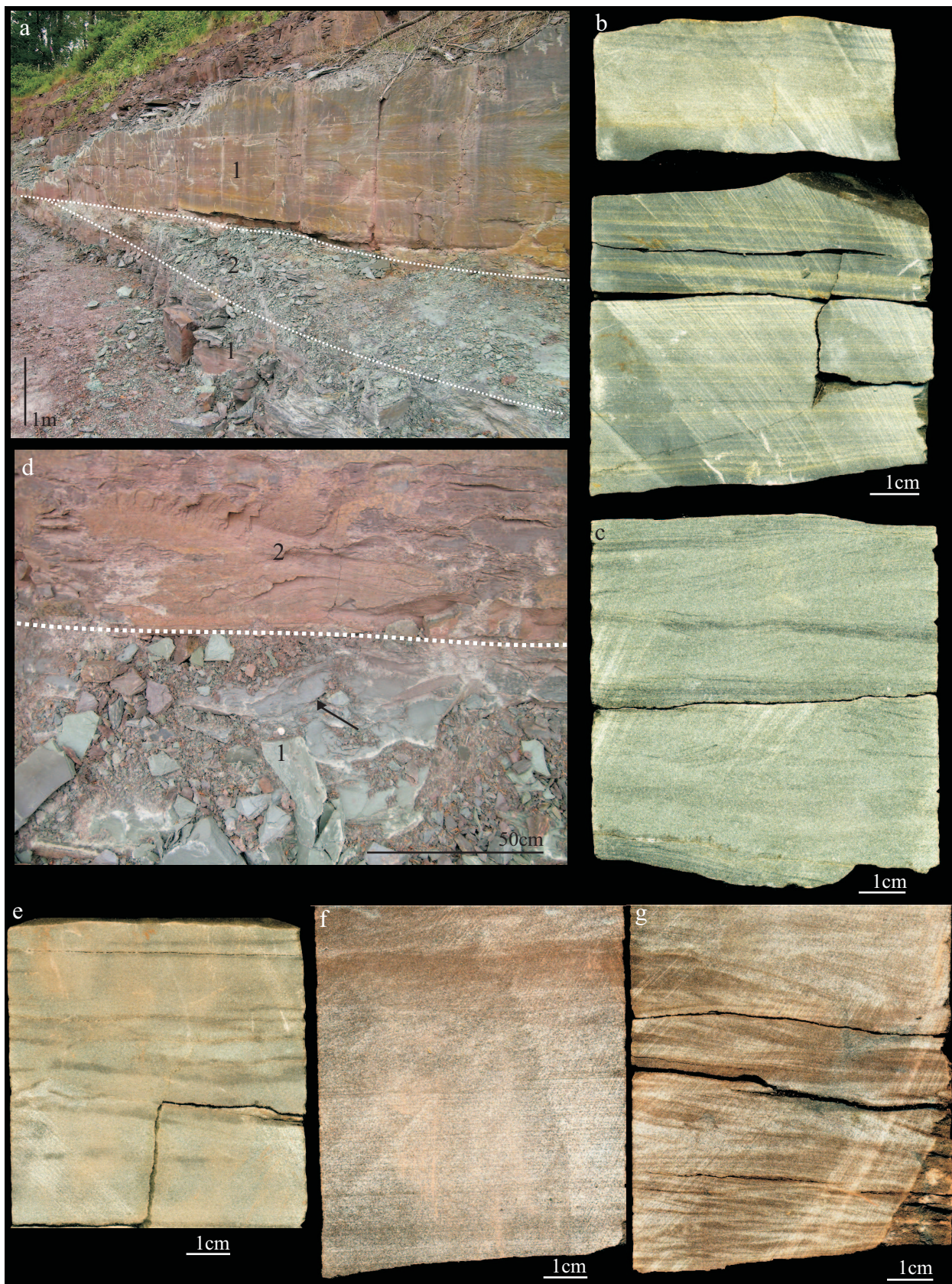


Plate 6.4: Siltstones from Tredomen Quarry (continued)

a to *g*: Red siltstones

- a*: Cephalaspid trails (*Undichna*) on the bedding plane of red siltstones (pound coin 2.25cm in diameter). Approximately bed 6, quarry log A, ~6.3m.
- b*: Arthropod trackways (*Diplithnites gouldi*) on bedding plane of red siltstones (pound 2.25cm in diameter). Approximately bed 6, quarry log A, ~6.3m.
- c*: Iron-oxide spots within red siltstone horizons (Camera lens cap 52mm in diameter). Approximately base of bed 6, quarry log A, ~6.5m.
- d*: Bedding plane of red siltstone, with irregular, undulating surface (pound coin 2.25cm in diameter). Approximately bed 5, quarry log A, ~5.5m.
- e*: Vertical bifurcating feature surrounded by drab halo in red-grey siltstone. Base of bed 6, borehole 1, 4.2m below the surface.
- f*: Polygonal cracking on the bedding plane of red siltstones. (Handlens 25mm in diameter). Bed 10, quarry log A, 9.2m.
- g*: *Beaconites barretti* burrows on the bedding plane of red siltstones. Bed 11, quarry log A, ~9.9m.

Plate 6.4 : Siltstones from Tredomen Quarry (continued)



Plate 6.5: Heterolithics from Tredomen Quarry

***a* to *e*: Heterolithics**

- a*: Basal beds: Gravel lens (see arrow) within heterolithic unit. Bed 5, borehole 2, 2.2m below the surface.
- b*: Basal beds: Field outcrop of gravel lens (see arrow) composed of carbonate nodules within heterolithic unit.
- c*: Basal beds: Field outcrop of heterolithic units with internal inclined bedding (1), interbedded with structureless mudstones (2). Approximately beds 2,3 and 4 in quarry log A, ~1 to 4m.
- d*: Basal beds: Planar-cross and trough-cross-bedded heterolithic unit. Sparsely distributed small carbonate nodules are also visible (see arrow). Bed 21, borehole 1, 16.7m below the surface.
- e*: Basal beds: Planar-bedded heterolithic unit. Bed 21, borehole 1, 16.0m below the surface.
- f*: Upper beds: Wavy and cross-ripple-laminated fine-grained heterolithic unit. Bed 57, borehole 2, 18.0m below the surface.
- g*: Upper beds: Green-grey mottles within fine-grained heterolithic unit. Bed 8, borehole 1, 4.6m.

Plate 6.5: Heterolithics from Tredomen Quarry

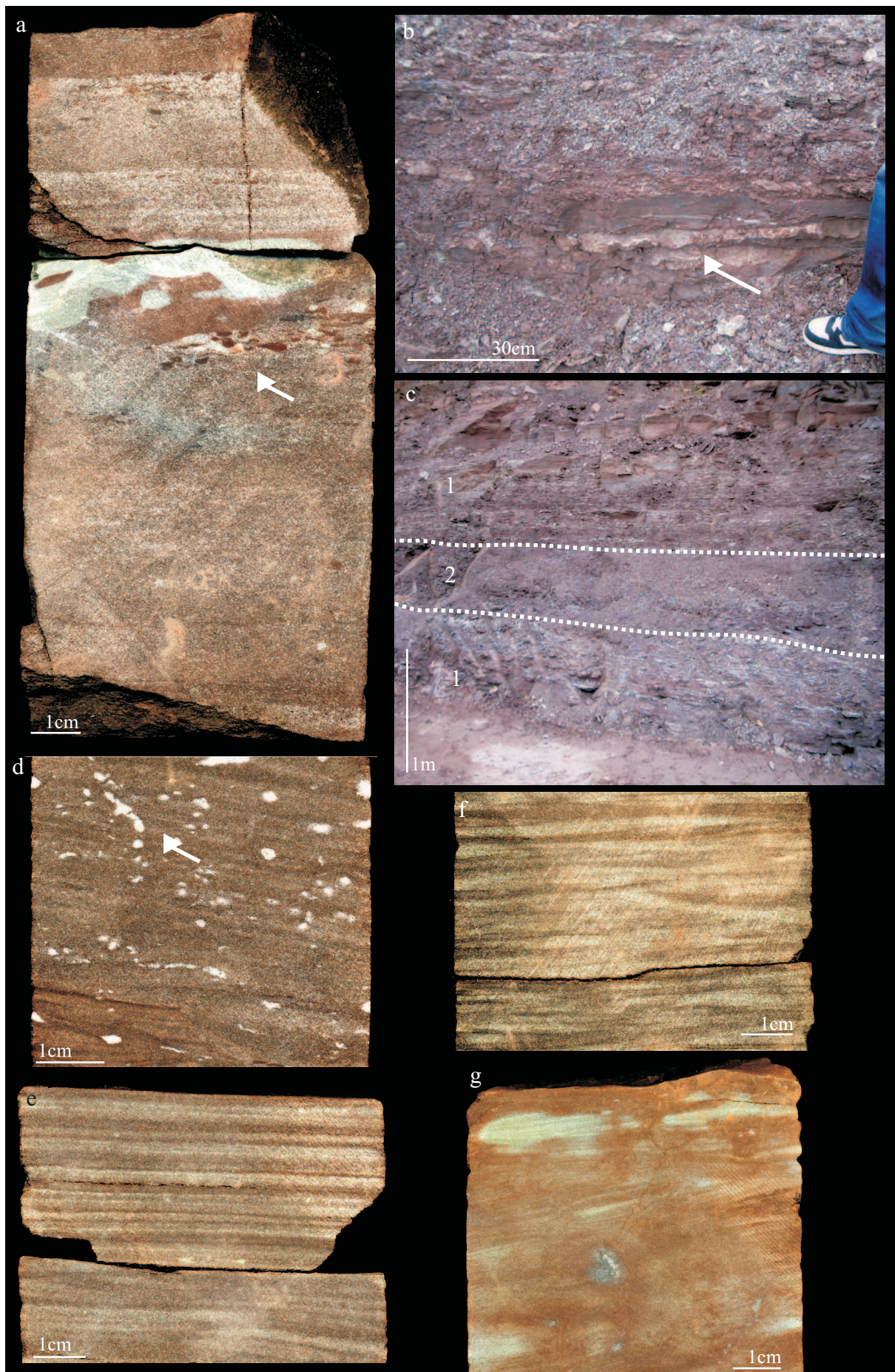


Plate 6.6: Mudstones from Tredomen Quarry

***a to e:* Massive, mud-pellet aggregate mudstones**

- a:* Massive structure of red mudstones. Bed 199, borehole 2, 101m below the surface.
- b:* Small carbonate nodules associated with drab haloes within massive red mudstones. Bed 193, borehole 2, 90.5m from surface.
- c:* Linear feature surrounded by drab halo (see arrow), within massive red mudstones. Mud aggregate visible (circled), surrounded by slightly coarser grained mud.
- d:* Mud aggregates visible within structureless red mudstone (circled). Linear feature surrounded by drab halo (see arrow).
- e:* Carbonate clasts 'floating' within red mudstone (see arrow), that is interbedded with heterolithic units.

Plate 6.6: Mudstones from Tredomen Quarry

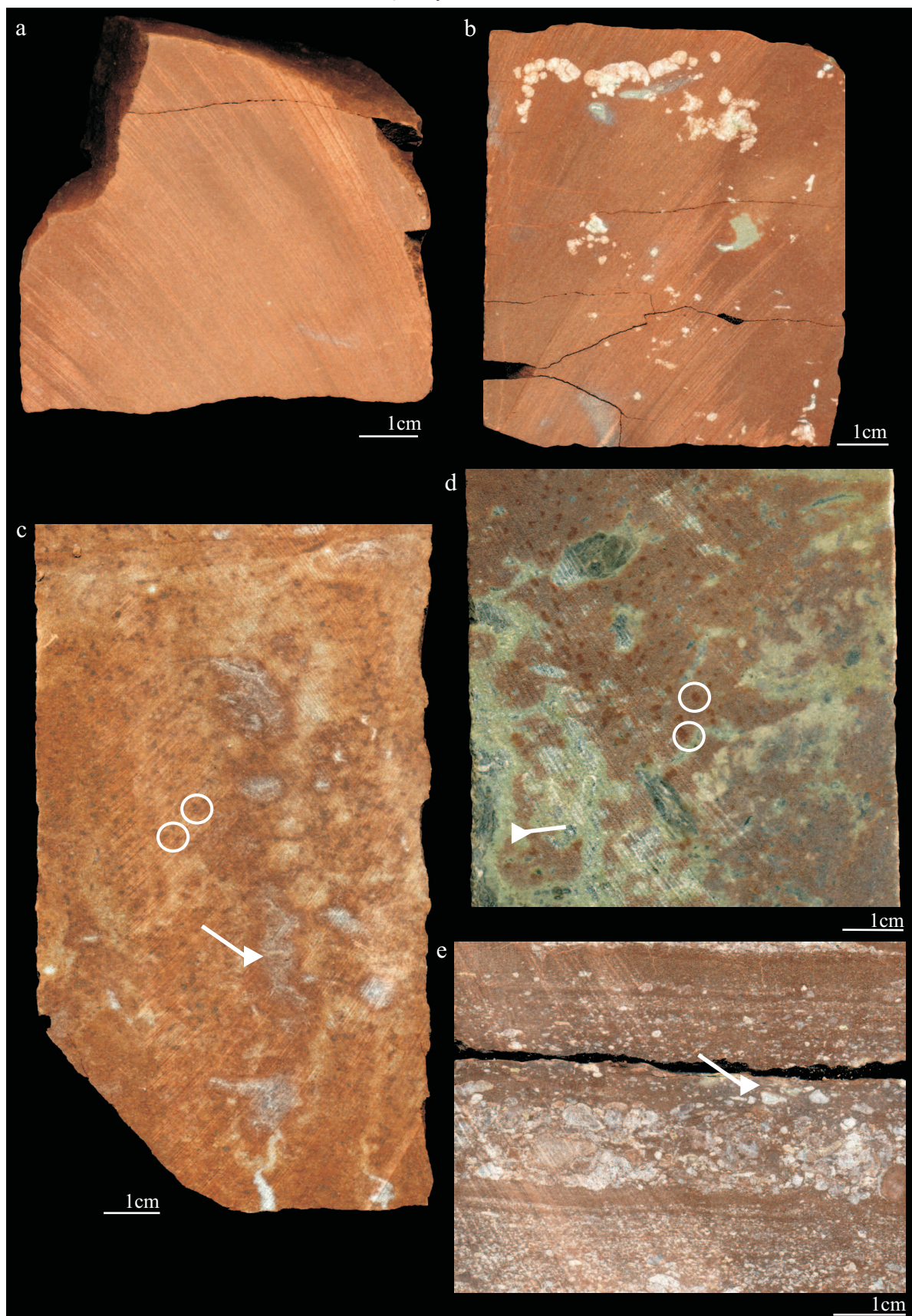


Plate 6.7: Pedified mudstones from Tredomen Quarry

***a to f*: Pedified profile type 1**

- a*: Dark, vertically linear features of the upper horizon (see arrow). Bed 173, borehole 2, 75m below the surface.
- b*: Field outcrop of curved slickensided, pseudo-anticlinal slip-plane surfaces (see arrow) of the middle horizon (see text). Here the middle horizon is superimposed by dark, vertically linear features (indicated by dashed line). Approximately bed 10, quarry log A, ~9.5m.
- c*: Lower horizon (see text). Sparsely distributed and individual small sub-spherical carbonate nodules within red mudstones. Fractures are non-pedogenic.
- d*: Lower horizon (see text). Elongate carbonate rods within red mudstones.
- e*: Lower horizon (see text). Large, partially coalesced carbonate nodules and rods within red mudstones. Bed 169, borehole 2, 68.5m below the surface.
- f*: Lower horizon (see text). Almost full replacement of parent red mudstone by coalescing carbonate nodules. Calcite spar cement is visible, forming the infill of non-pedogenic horizontal and vertical fractures (see arrows). Bed 82, borehole 1, 66.1m below the surface.

***g and h*: Pedified profile type 2**

- g*: Weak vertical features and carbonate nodules surrounded by drab haloes with red mudstones. Fracture is non-pedogenic. Bed 74, borehole 2, 25.8m below the surface.
- h*: Lower horizon (see text). Coalescing carbonate nodules within red mudstones. Calcite spar cement is visible, forming the infill of non-pedogenic horizontal and vertical fractures (see arrows). Bed 172, borehole 2, 74.5m below the surface.

Plate 6.7: Pedified mudstones from Tredomen Quarry

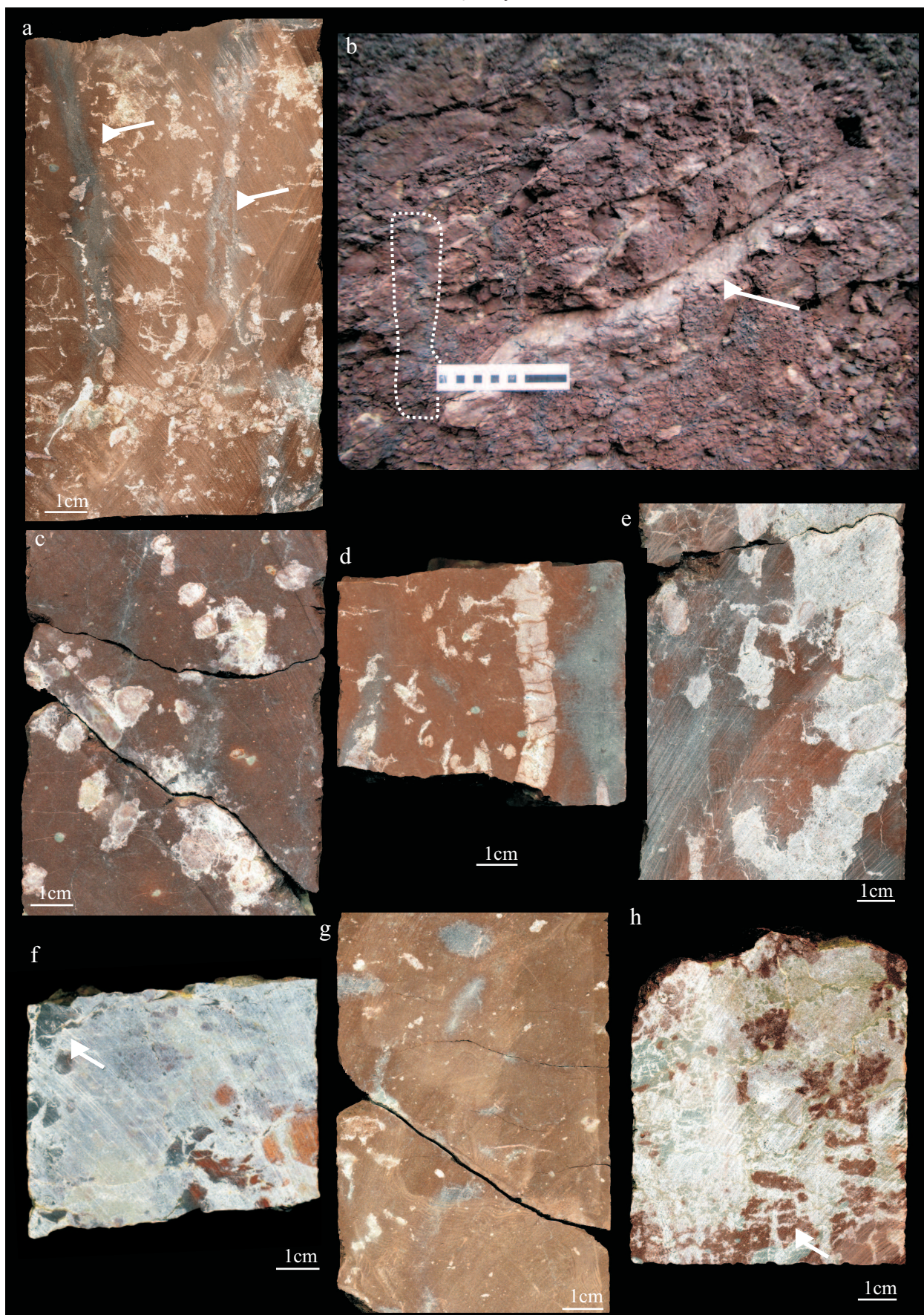


Plate 6.8: Intraformational conglomerates and sandstones from Targrove Quarry

***a*: Red to yellowish-brown intraformational conglomerates**

- a*: Red intraformational conglomerate (1) incising into red sandstone unit (2), incision marked by dashed line. Beds 25 and 26, Targrove Quarry log, ~1m.

***b to d*: Red sandstones**

- b*: Red medium-grained sandstone (1) grading normally into fine-grained sandstone (2). Basal beds are planar-bedded; upper units trough-cross-bedded fine-grained sandstone. Beds 24 and 25, Targrove Quarry log, ~2.6m.
- c*: Fissure infilled with carbonate (marked by dashed line), at the top of a medium-grained sandstone unit, truncated by intraformational conglomerates. Bed 1, Targrove Quarry log, ~13.0m.
- d*: Lower quarry profile at Targrove Quarry, showing red medium-grained sandstones (1), interbedded with siltstone-mudstone sequences (2). Beds 1 to 15, Targrove Quarry log.

Plate 6.8: Intraformational conglomerates and sandstones from Targrove Quarry

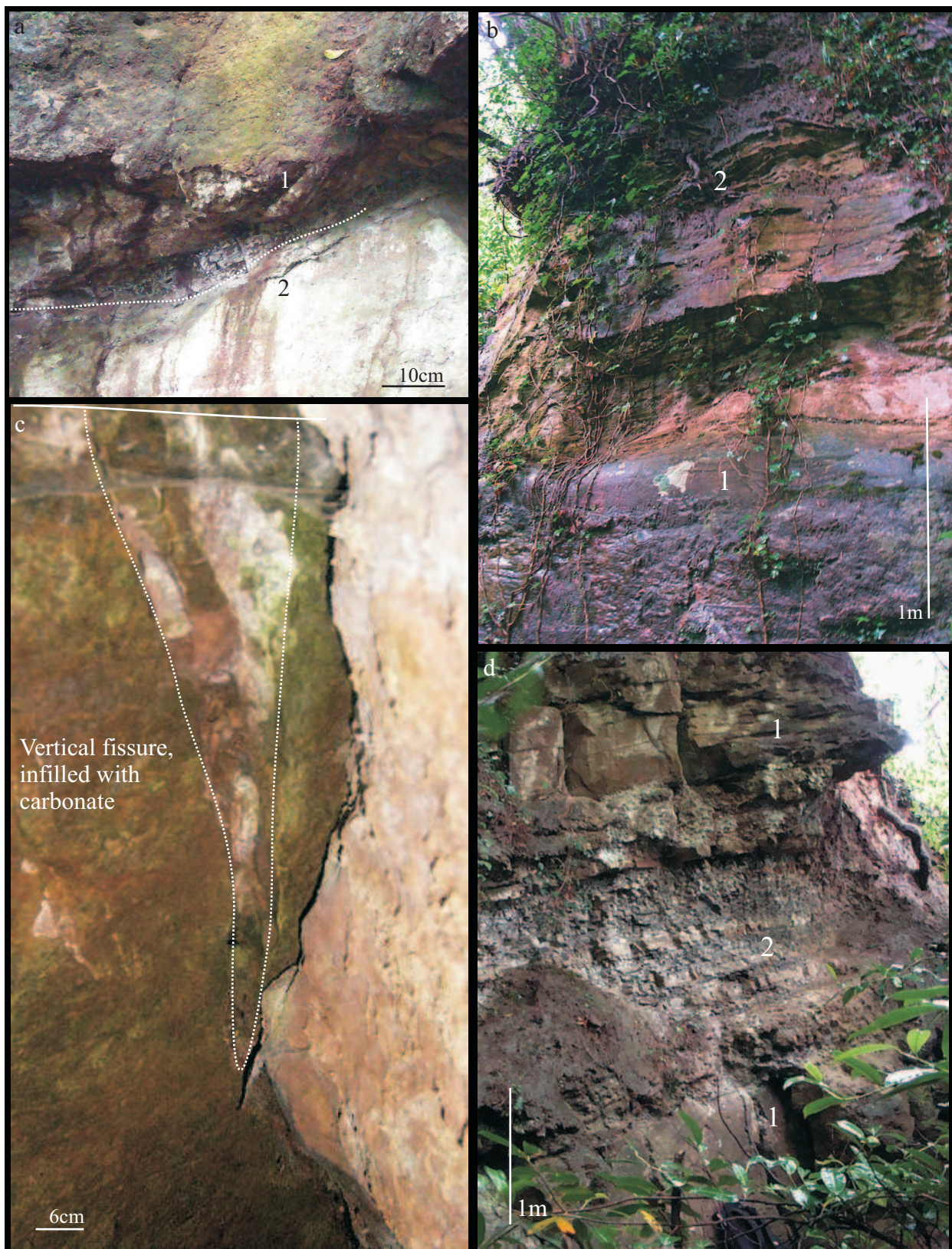


Plate 6.9: Siltstones and mudstones from Targrove Quarry

***a to c:* Interbedded siltstones and mudstones**

- a:* Close up of yellow-brown siltstone units (1) with sharp planar boundaries, interbedded with dark grey mudstones (2). Beds 4 to 7, Targrove Quarry log.
- b:* Interbedded siltstone (1) – mudstone (2) sequence. Beds 4 to 9, Targrove Quarry log.
- c:* Interbedded siltstone (1) – mudstone (2) sequence, showing lateral extent of beds, and slight wedging/ pinching out of mudstone beds. Beds 5 to 9, Targrove Quarry log.

***d and e:* Chapel Point Calcrete at Llansteffan**

- d:* Chapel Point Calcrete at Llansteffan. Stage III to stage IV stacked calcrete horizons (1), each approximately 1 to 1.5m in height.
- e:* Strata just above the Chapel Point Calcrete at Llansteffan: massive mudstones (1); palaeo-Vertisols, with pseudo-anticlinal slip planes overprinted with carbonate nodules (2); heterolithics (3), followed by more massive mudstones (4).

Plate 6.9: a to c: Siltstones and mudstones from Targrove Quarry.
d and e: Chapel Point Calcrete at Llansteffan

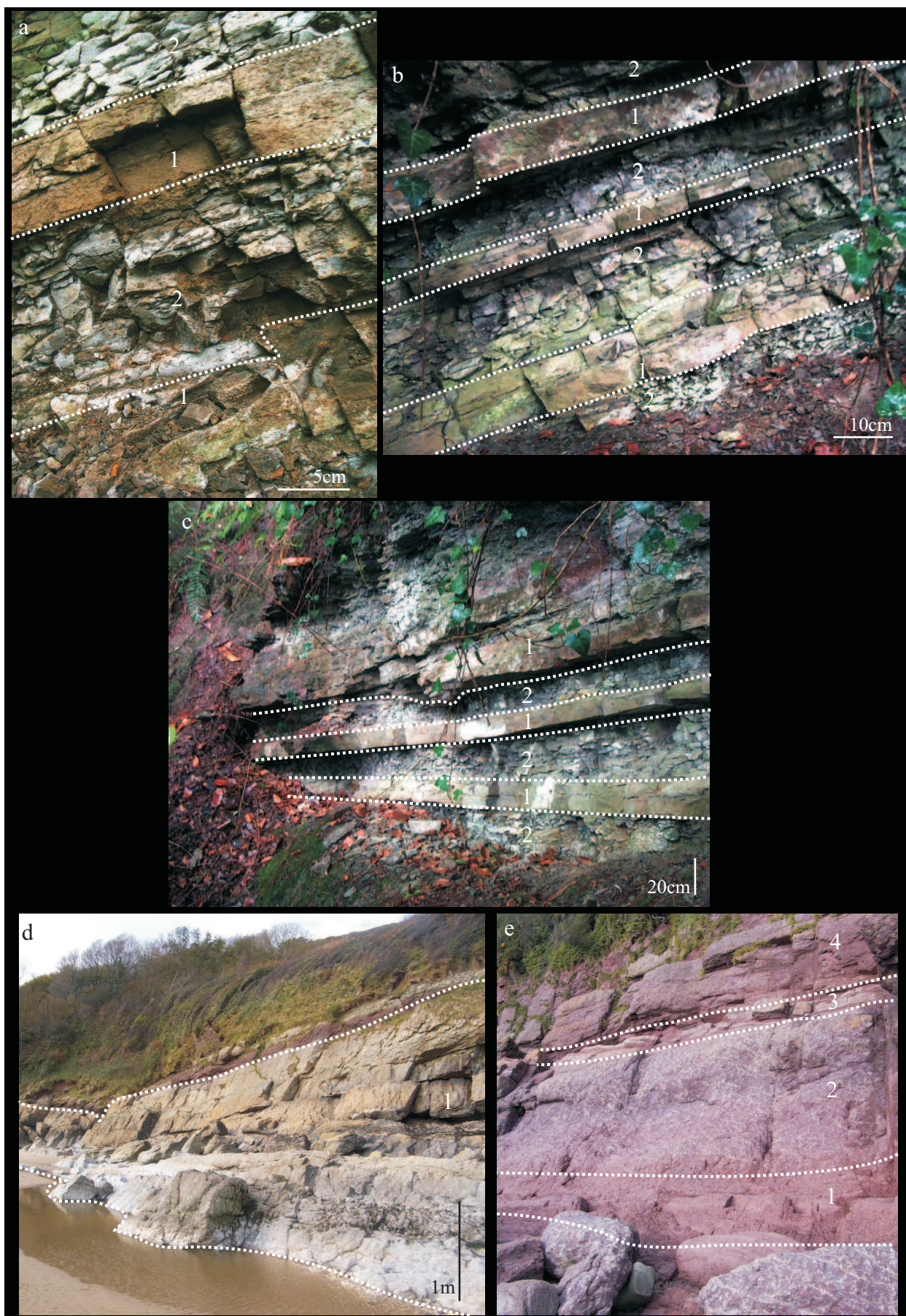


Plate 7.1: Taphofacies 1 and 2

Taphofacies 1

- a:* Fragment of *Prototaxites* under light microscopy, extracted from intraformational conglomerate.
- b:* Fragment of *Prototaxites* under SEM, extracted from intraformational conglomerate. Surface texture striated, with parallel-aligned tubes (see arrow).
- c:* Cross section of *Prototaxites* under SEM, showing tube internal wall with secondary thickenings (see arrow).
- d:* Cross section of *Prototaxites* under SEM, showing cell homogenisation as a result of charcoalification.
- e:* Cross section of *Pachythea* under SEM, extracted from intraformational conglomerate.

Taphofacies 2

- f:* Bedding plane of medium-grained green sandstone, with coalified and charcoalified compressions of thalloid, non-embryophytes (see arrow).
- g:* Coalified compression of *Cooksonia hemisphaerica* within medium-grained green sandstone.
- h:* Coalified compression of thalloid, non-embryophyte fragment on bedding plane of medium-grained green sandstone. Fragment is elongate and axial-like, tapering towards the end, with a rounded tip.
- i:* Thalloid, non-embryophyte charcoalified fragment, with irregular morphology and internal anatomy preserved, of parallel-aligned tubes (see arrow).
- j:* Cephalaspid fish remains within medium-grained green sandstone.
- k:* Disseminated vegetative debris occurring along the bedding plane surfaces of planar cross-bedded medium-grained green sandstone (see arrows).
- l:* Disseminated vegetative debris occurring along the bedding plane surfaces of planar cross-laminated fine-grained green sandstone (see arrow).

Plate 7.1: Taphofacies 1 and 2.

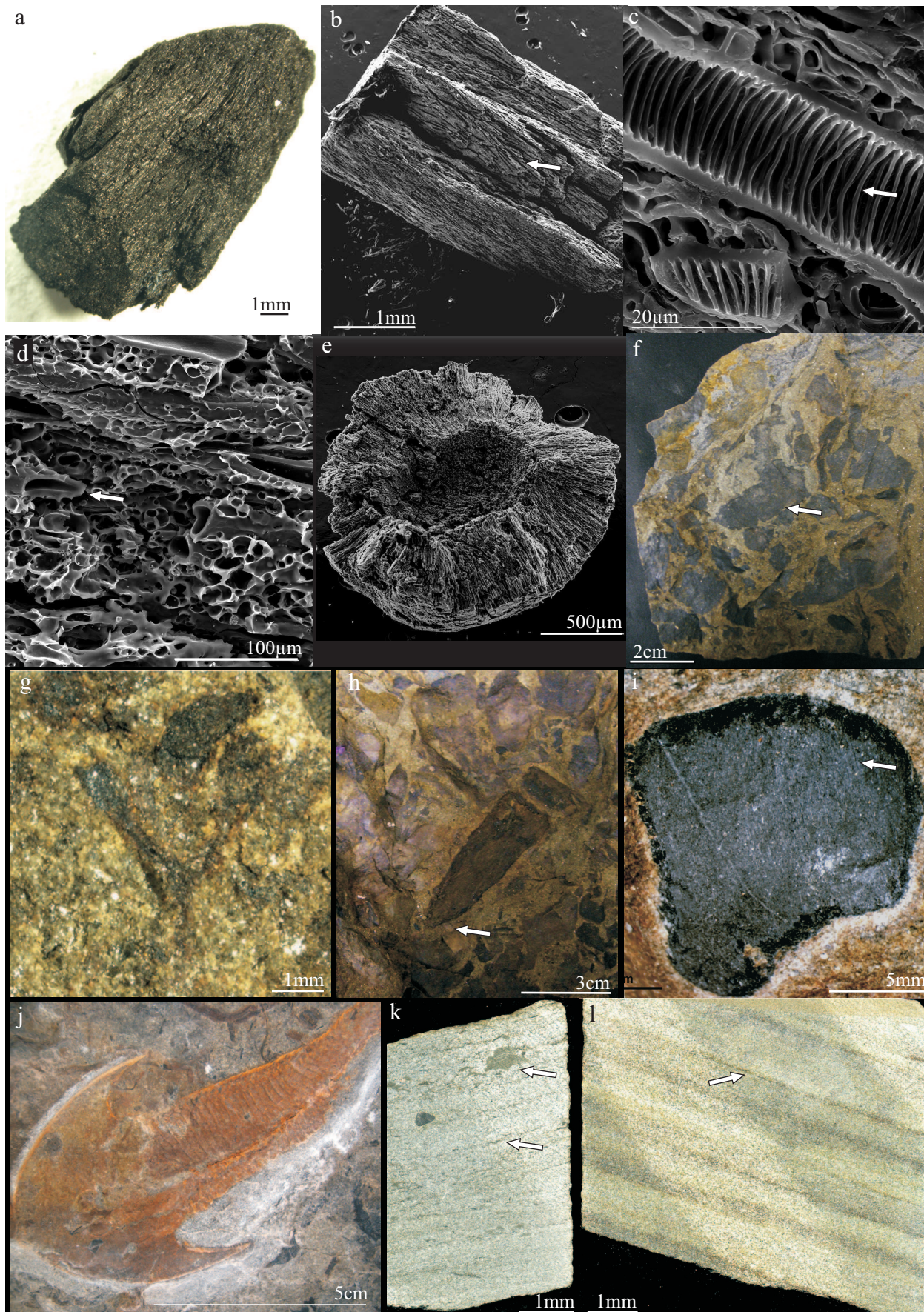


Plate 7.2: Taphofacies 3 and 4

Taphofacies 3

- a:* Vegetative debris along the bedding planes of horizontal and wavy-ripple laminated fine-grained sandstones to siltstones (see arrows).
- b:* cf. *Cooksonia caledonica* specimen within fine-grained horizontally bedded fine-grained green sandstones.
- c:* *Cooksonia hemisphaerica* specimen within fine-grained horizontally bedded fine-grained green sandstones.
- d:* Coalified compression fossil of *Salopella allenii*, with corresponding impression within fine-grained hydrated-iron-oxide rich coating (see arrow).
- e:* Three-dimensional preservation of cf. *Cooksonia caledonica* sporangia within fine-grained green sandstone. Three-dimensional preservation is a result of pyritisation, now converted to hydrated iron-oxide (see arrow).
- f:* Specimen of cf. *Cooksonia caledonica* arranged slightly oblique to bedding plane of fine-grained green sandstone (see arrow).
- g:* Disseminated vegetative debris along the foresets of trough-cross laminated fine-grained sandstone (see arrow).

Taphofacies 4

- h:* Bedding plane of green siltstone, with disseminated vegetative debris, including thalloid, non-embryophyte fragments (see arrow) and narrow branching and non-branching axial fragments (see arrow).
- i:* Mesofossil specimen lying parallel to the bedding plane of green siltstone (see arrow).
- j:* Mesofossil specimen lying parallel to the bedding plane of green siltstone (see arrow).
- k:* Mesofossil specimen lying parallel to the bedding plane of green siltstone (see arrow). Associated with limonite covering.
- l:* Irregular thalloid, non-embryophyte coalified fragment lying parallel to the bedding plane of green siltstone.

Plate 7.2: Taphofacies 3 and 4.

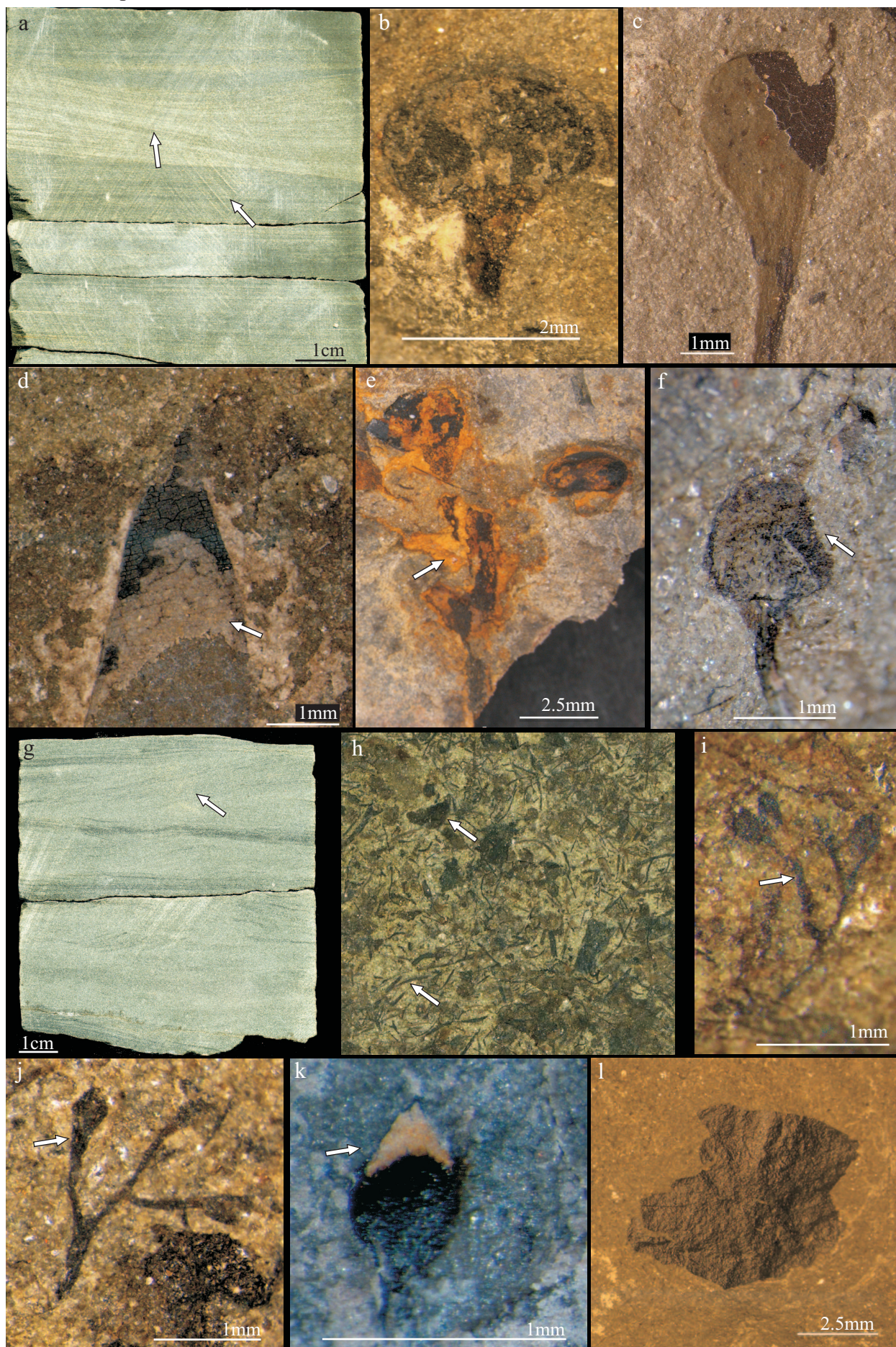


Plate 7.3: Taphofacies 5 and 6

Taphofacies 5

- a:* Minute, hyphal-like tubes occurring as part of a network (see arrow). Tubes parallel-aligned, and appear to intertwine and /or bifurcate across the top surface of siltstone bedding plane.
- b:* Minute, hyphal-like tubes occurring as part of a network (see arrow). Tubes are randomly arranged, and appear to intertwine.
- c:* SEM image of internal mould of one hyphal-like tube, showing banded character of internal surface (see arrow). Preserved in limonite.

Taphofacies 6

- d:* Horizontally-laminated, yellowish-brown, very-fine-grained sandstone collected from Targrove Quarry, packed with vegetative debris, including coalified compressions of non-embryophytes (see arrow).
- e:* Poorly preserved fragments of non-embryophytes, possibly *Nematothallus* cuticle (see arrows).
- f:* Coalified compression of non-embryophyte, with striation running parallel to the fragment long axis (see arrow). Possible fragment of *Prototaxites* sp./
Nematasketum.
- g:* Cross section of poorly preserved *Pachythea* sphere. Internal portions replaced by limonite. Coalified outer portions covered with iron-oxide coating.
- h:* Coalified compression of small, fertile dichotomously branched axis, possibly *Cooksonia hemisphaerica*.

Plate 7.3: Taphofacies 5 and 6.

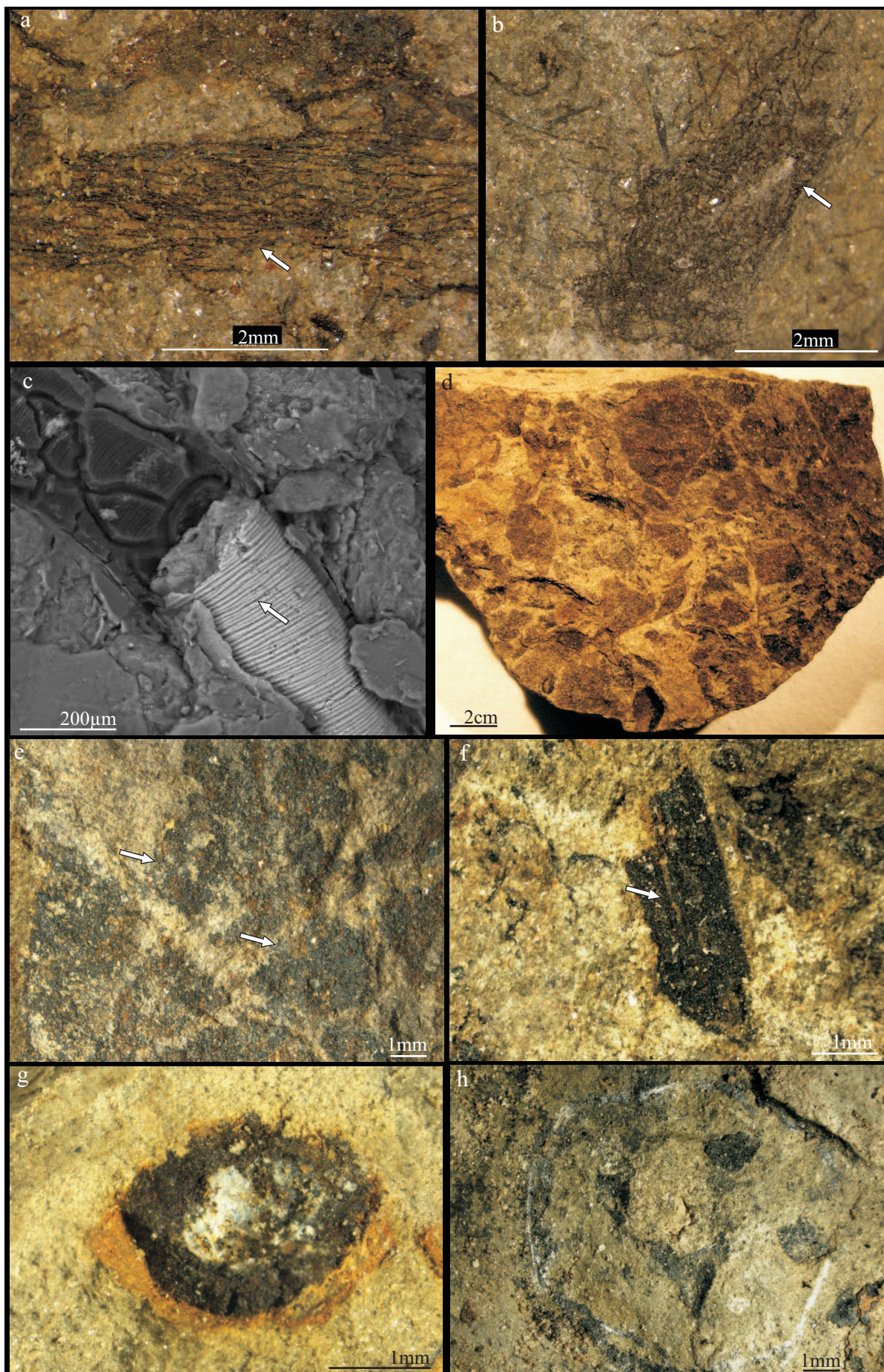


Plate 7.4: Taphofacies 7, 8 and 9

Taphofacies 7

- a:* Horizontally-laminated, yellow-brown siltstones at Targrove Quarry.
- b:* Coalified compression of sterile, dichotomously branched, naked axis (see arrow); early embryophyte.
- c:* Coalified compression of *Salopella allenii* sporangium, an early embryophyte.
- d:* Poorly preserved coalified compression of thalloid non-embryophyte, possibly *Nematothallus* cuticle.

Taphofacies 8

- e:* Coalified compression of thalloid non-embryophyte, possibly *Nematothallus* cuticle.

Taphofacies 9

- f:* Equivocal bifurcating, axial-like features that occur on the bedding planes of wavy or horizontally laminated red siltstone. In places, preserved in three dimensions, with a striated appearance (see arrow). Possibly *Prototaxites* sp. / *Nematasketum*.
- g:* Equivocal bifurcating, axial-like features that occur on the bedding planes of wavy or horizontally laminated red siltstone. Possibly *Prototaxites* sp. / *Nematasketum*.

Plate 7.4: Taphofacies 7, 8 and 9.

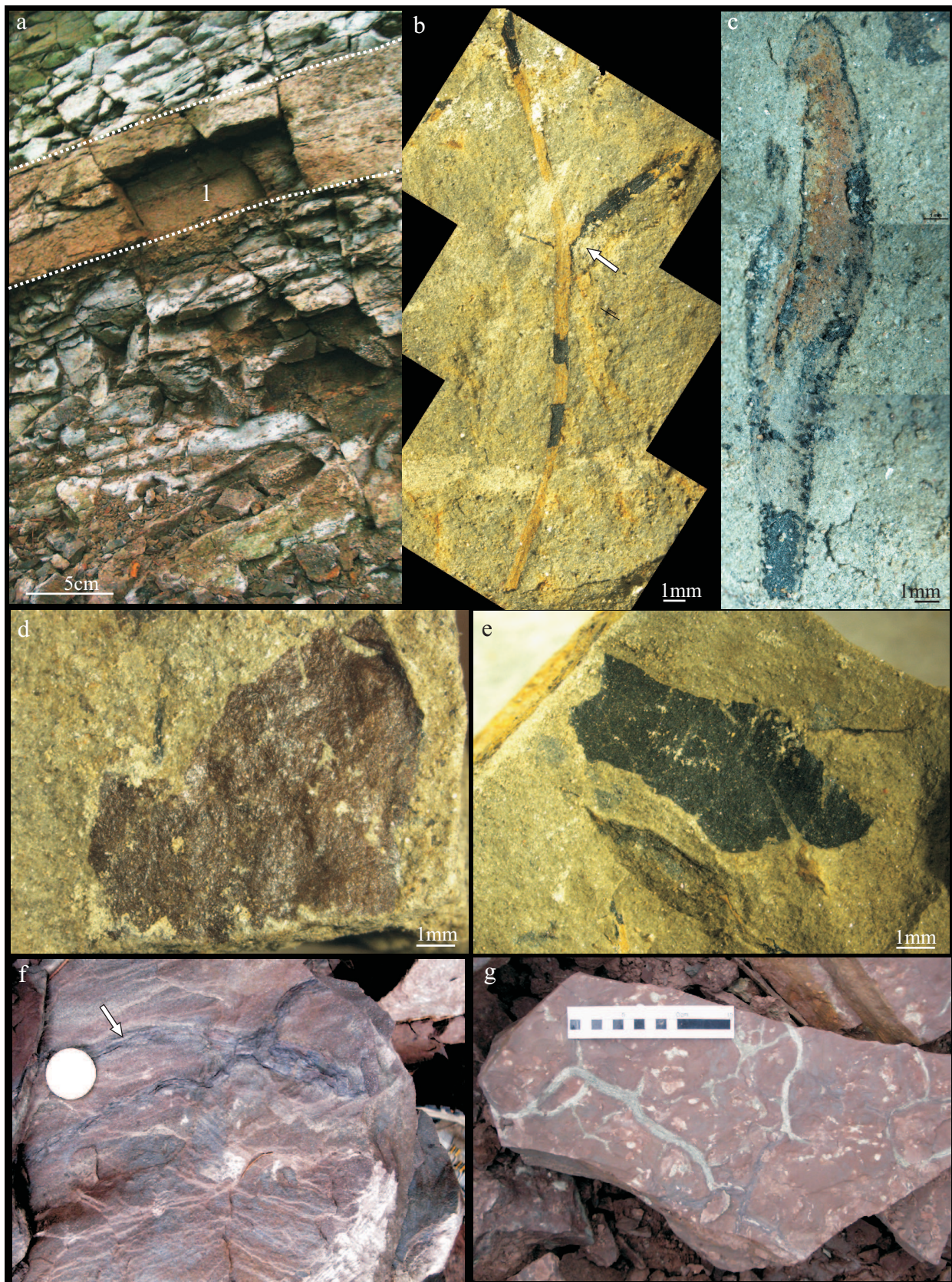


Plate 8.1: Carbonate nodules from Tredomen Quarry, selected for isotopic analysis

***a to d:* Nodule 1**

- a:* Nodule 1, within a stage I to II palaeo-Vertisol, from at a depth of 2.4m from the top of borehole 2 (approximately 17.4m from the quarry surface). Semi-spherical to slightly elongate, medium-sized nodule. The nodule has a sharp boundary and surrounded by radial cracks (see arrow).
- b:* Thin section of nodule 1. Groundmass is composed of microcrystalline calcite, being a light pink colour where stained. Small patches of segregated iron are distributed throughout the nodule (see arrow).
- c:* Thin section of nodule 1. Crack within carbonate nodule infilled with sparry calcite up to 0.5mm in diameter.
- d:* Thin section of nodule 1. Crack within carbonate nodule infilled with sparry calcite and lined with iron (see arrow).

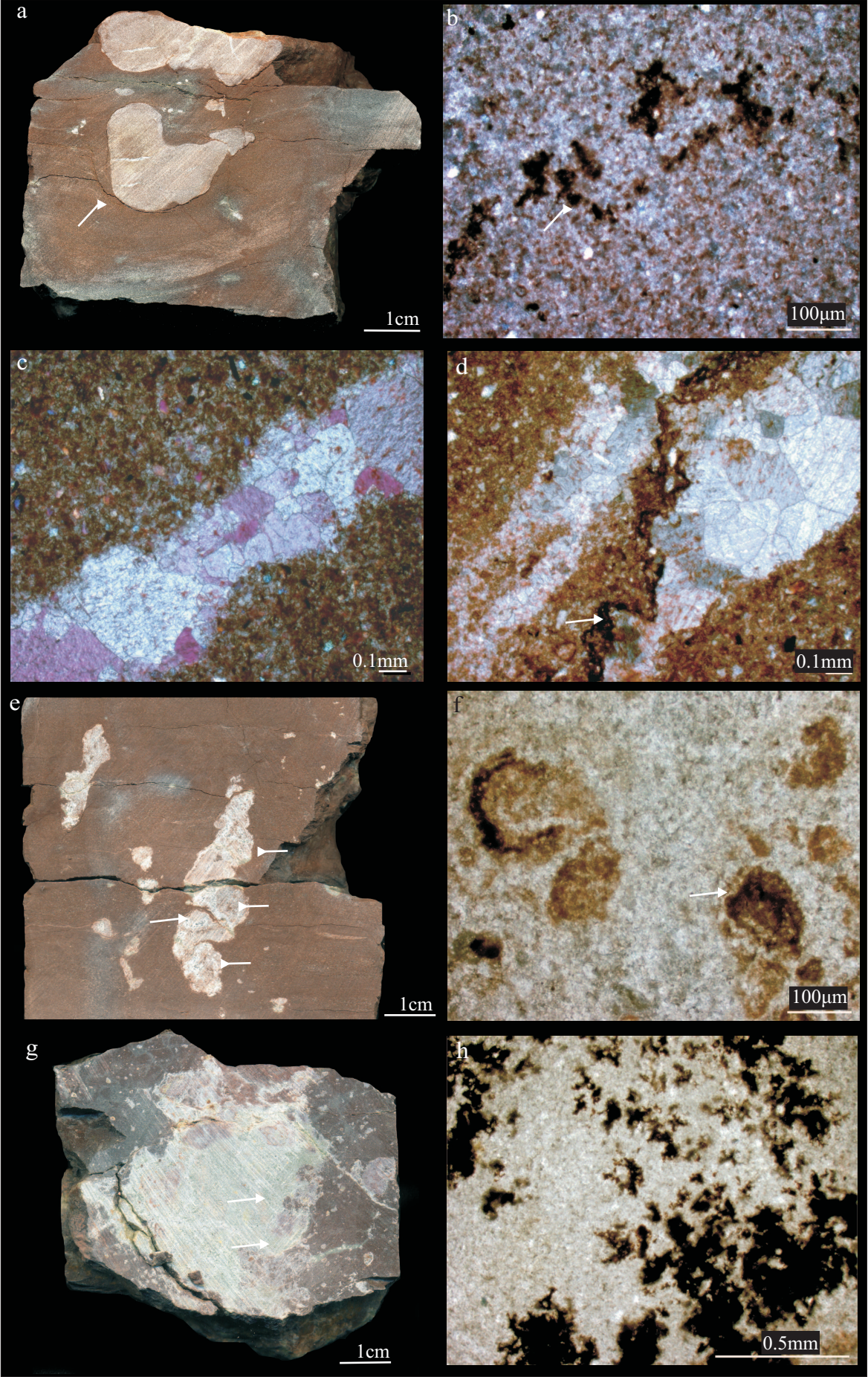
***e and f:* Nodule 4**

- e:* Nodule 4, within a stage I to II palaeo-Vertisol, from at a depth of 18.95m from the top of borehole 2 (approximately 33.05m from the quarry surface). Elongate or cylindrical, medium-sized nodule. This nodule is actually composed of several coalesced nodules (see arrows) in a matrix of larger-sized calcite crystals.
- f:* Thin section of nodule 4. Groundmass of microcrystalline calcite, stained light pink to slightly purple, suggesting that the presence of some ferroan calcite. Patches of iron segregation (see arrow).

***g and h:* Nodule 8**

- g:* Nodule 8, within a stage II palaeo-Vertisol from at a depth of 40.10m from the top of borehole 2 (approximately 55.1m from the quarry surface). Large-sized spherical nodule, with the appearance of several smaller coalesced nodules (see arrows), separated by larger calcite grains.
- h:* Thin section of nodule 8. Groundmass is composed of microcrystalline calcite, staining light pink in colour. Iron segregation occurs throughout the nodule.

Plate 8.1: Carbonate nodules from Tredomen Quarry, selected for isotopic analysis



**Plate 8.2: Carbonate nodules from Tredomen Quarry, selected for isotopic analysis
(continued)**

a: Nodule 8

- a:* Thin section of nodule 8. Iron segregation at the centre of a small nodule (see arrow), coalesced with other small nodule to form nodule 8.

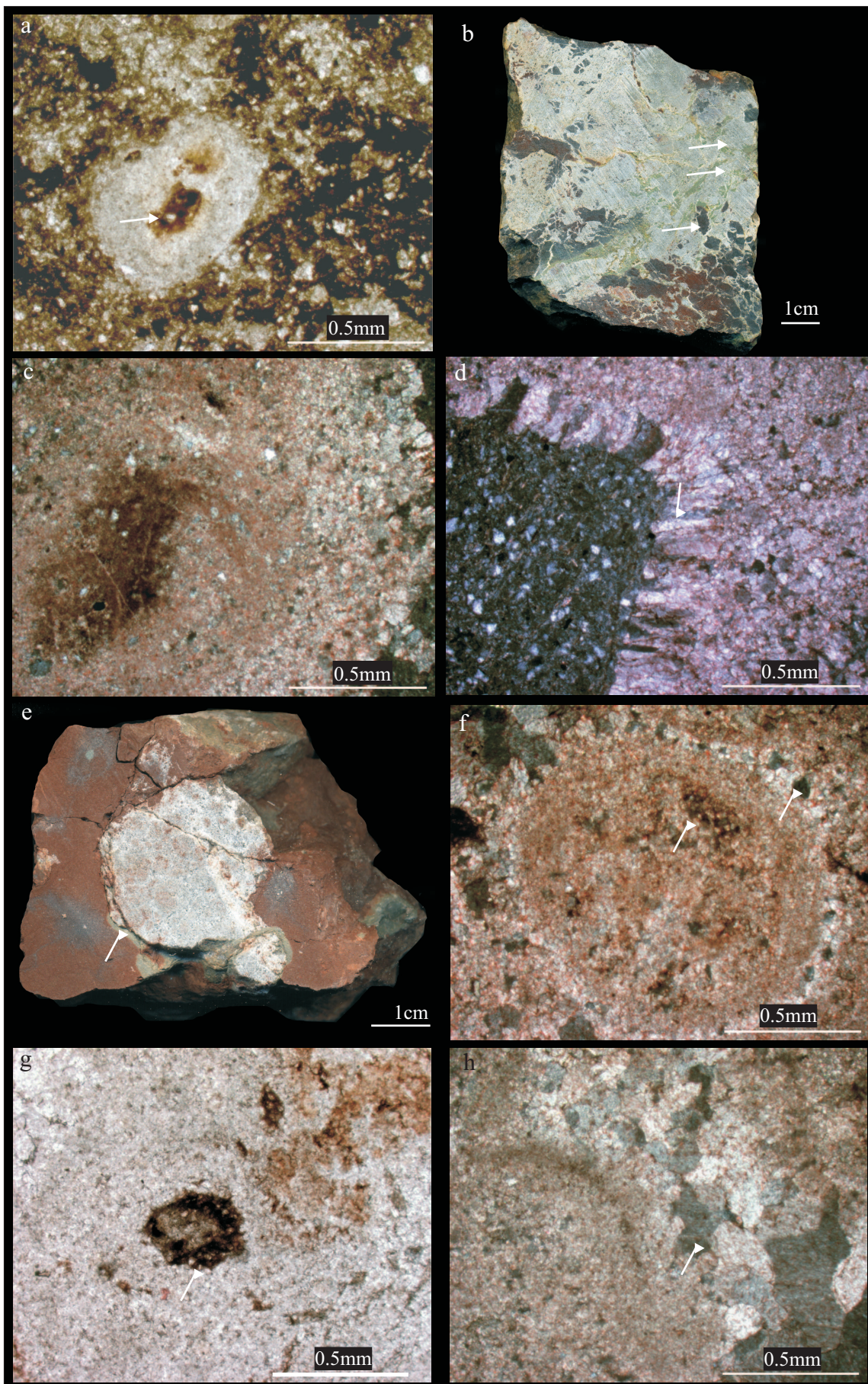
b to d: Nodule 9

- b:* Nodule 9, within a stage II to III palaeo-Vertisol, from a depth of 48.40m from the top of borehole 2 (approximately 63.4m from the quarry surface). C-horizon consists almost completely coalesced spherical carbonate nodules (see arrow), with some displaced angular-edged mudstone fragments (see arrow).
- c:* Thin section of nodule 9. Each small nodule is composed of microcrystalline calcite, stained a light pink colour. Calcite grains increase in size slightly from the centre of the nodule, up to a maximum of 0.05mm in diameter towards the edge of the nodule. Iron segregation is also present, particularly in the nodule centre.
- d:* Thin section of nodule 9. Angular-edged displaced mudstones are surrounded by radially arranged sparry calcite (see arrow), which also occurs between coalesced nodules.

e to h: Nodule 12

- e:* Nodule 12, within a stage I to II non-Vertic palaeosol, from a depth of 58.70m from the top of borehole 2 (approximately 73.7m from the quarry surface). Large spherical nodule, composed of smaller coalesced spherical nodules, with a sharp boundary, surrounded by radial cracks (see arrow).
- f:* Thin section of nodule 12. Individual nodules are composed of microcrystalline calcite, stained light pink, with some degree of iron segregation (see arrow). Secondary sparry calcite can be found between some coalesced nodules (see arrow).
- g:* Thin section of nodule 12. Individual nodule composed of microcrystalline calcite, with iron segregation in the nodule centre (see arrow).
- h:* Thin section of nodule 12. Individual nodule surrounded by a thin layer of secondary sparry calcite (see arrow) where coalesced to another nodule.

Plate 8.2: Carbonate nodules from Tredomen Quarry, selected for isotopic analysis (continued)



APPENDIX I : TREDOMEN PALAEOBOTANY COLLECTION DATABASE

a: Mega- and mesofossil collection.....on DVD

b: Palynological collection.....on DVD

APPENDIX II: MEGAFOSSIL MEASUREMENTS

pII-1 to pII-10

APPENDIX II: MEGAFOSSIL MEASUREMENTS

A CF. COOKSONIA CALEDONICA/ RENALIA SP.

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Length-width ratio	Sporangial area (mm2)	Axis length mm	Axis width mm	Width of subtending axis mm	Max width to junction width ratio	Length of axis taper mm	Distance between sporangia mm	Axes angle	Axes thickness before branching mm	Axes thickness after branching mm	Identification
1 JM004	1.6	2.2	0.72	3.52	13	0.2	0.8	2.75	0.20	/	70	/	/	C. cf. caledonica
2 JM008a	1.9	2.9	0.65	5.51	11	0.8	1	2.90	0.30	4	70	0.8	0.8	C. cf. caledonica
JM008a c.p.														
3 JM010a	1.8	2.6	0.69	4.68			1.1	2.36	0.50					C. cf. caledonica
4 JM010c	1.9	2.4	0.79	4.56	3	0.7	1	2.40	0.60	/	/	/	/	C. cf. caledonica
5 JM011a	1.2	1.7	0.7	2.04	0.5	0.5	0.5	3.40	0.40	/	/	/	/	C. cf. caledonica
JM011a c.p.														
6 JM012b	1.9	2.4	0.79	4.56	20	0.8	1	2.40	0.40	0.7	75	0.8	0.8	C. cf. caledonica
7 JM020a	1.7	2.5	0.68	4.25	20	0.8	1	2.50	0.50	0.5	60	0.8	1	C. cf. caledonica
8 JM034c	2.2	2.4	0.91	5.28	2.4	0.5	0.8	3.00	0.40	/	/	/	/	C. cf. caledonica
JM012b														
9 JM034d	1.2	1.7	0.7	2.04	/	/	/			/	/	/	/	C. cf. caledonica
10 JM035a	1.9	2.9	0.65	5.51	10.25	0.46	0.88	3.30	0.30		20.56	0.77	0.46	C. cf. caledonica
11 JM052	1.5	2.8	0.53	4.2			1.54	1.82	/	/	/	/	/	C. cf. caledonica
JM034d														
12 JM053a	1.3	1.8	0.72	2.34	/	/	/			/	/	/	/	C. cf. caledonica
13 JM109	1.4	1.8	0.77	2.52	0.95	0.39	0.78	2.31	0.10	/	/	/	/	C. cf. caledonica
JM052														
14 JM118	0.8	1.4	0.57	1.12	/	/	/			/	/	/	/	C. cf. caledonica
15 JM221 + c.p.	1.6	2.4	0.66	3.84	1.33	0.5	0.97	2.47	0.60	/	/	/	/	C. cf. caledonica
JM222 + c.p.														
16 JM232 + c.p.	1.5	2.2	0.68	3.3	1.2	0.4	0.6	3.67	0.30	/	/	/	/	C. cf. caledonica
JM232 + c.p.														
17 JM234c	1.4	2.4	0.58	3.36	2	0.8	1.5	1.60	0.60	/	/	/	/	C. cf. caledonica
JM234c														
18 JM234d	1.7	2.4	0.7	4.08						/	/	/	/	C. cf. caledonica
19 JM260 + c.p.	1.9	2.4	0.79	4.56	12	0.8	1	2.40	0.10	/	/	/	/	C. cf. caledonica
JM260 + c.p.														
20 JM279	1.2	2	0.6	2.4	15	1	0.8	2.50	0.30		90	1.2	0.8	C. cf. caledonica
21 JM368	1.5	1.9	0.78	2.85	11.5	0.7	1	1.90	0.80	6	30	0.6	0.5	C. cf. caledonica
JM368 c.p.														
22 JM375	1.3	1.8	0.72	2.34										C. cf. caledonica
JM375														
23 JM385	1.4	2.1	0.66	2.94	1.6	0.3	0.82	2.56	1.00	/	/	/	/	C. cf. caledonica
JM385														
24 RHSp145_2	1.5	2.5	0.6	3.75	9.8	0.5	1	2.50	0.80	/	/	/	/	C. cf. caledonica
RHSp145_2														
25 RH0157	1.2	1.22	0.98	1.46	1.74	0.23	0.64	1.91	0.40	/	/	/	/	C. cf. caledonica
RH0157														
26 RH_1	1.53	2.31	/	3.5343	/	/	/	/	/	/	/	/	/	C. cf. caledonica
RH_1														
27 RHJM04	1.55	1.97	/	3.0535	/	/	/	/	/	/	/	/	/	C. cf. caledonica
RHJM04														
28	2.25	2.87	0.78397	6.4575	3.8	0.68	1.32	2.17	/	/	/	/	/	C. cf. caledonica

Mfn	0.80	1.22	0.53	1.12	0.50	0.20	0.50	1.60	0.10	0.50	20.56	0.60	0.46
Max	2.40	2.90	0.98	6.72	21.00	1.00	1.54	3.67	1.00	6.00	90.00	1.20	1.00
Averages	1.57	2.20	0.71	3.58	7.76	0.60	0.98	2.45	0.46	2.80	59.37	0.83	0.73

B COOKSONIA HEMISPHAERICA

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Length-width ratio	Sporangial area (mm ²)	Axis length mm	Axis width mm	Width of subtending axis mm	Max width to junction width ratio	Length of axis taper mm	Distance between sporangia mm	Axes angle	Axes thickness before branching mm	Axes thickness after branching mm	Identification
1 JM001	1.2	1.1	1.09	1.32	3.4	0.6	0.9	1.22	1.20	/	100	0.6	0.3	<i>C.hemisphaerica</i>
2 JM002	2	2.2	0.9	4.4	1.8	0.6	1.4	1.57	1.80	/	/	/	/	<i>C.hemisphaerica</i>
3 JM003a	1.8	1.7	1.06	3.06	2.2	0.3	1.4	1.21	0.90	/	/	/	/	<i>C.hemisphaerica</i>
4 JM005a	1.4	1.4	1	1.96	2.5	0.3	1	1.40	1.50	/	45	0.3	0.15	<i>C.hemisphaerica</i>
5 JM010 b	1	0.8	1.25	0.8	2	0.6	0.4	2.00	0.70	/	45	0.6	0.2	<i>C.hemisphaerica</i>
6 JM012a	2.1	2.1	1	4.41	5.4	1	0.8	2.63	1.80	3	60	1	0.5	<i>C.hemisphaerica</i>
JM012a c.p.	2.2	2.1	1.1	4.62	/	/	/	/	1.90	/	/	/	/	<i>C.hemisphaerica</i>
7 JM012b	2	2.1	0.95	4.2	2.8	0.4	1	2.10	1.60	2	60	0.4	0.2	<i>C.hemisphaerica</i>
JM012b c.p.	2	2.1	0.95	4.2	/	/	/	/	1.80	/	/	/	/	<i>C.hemisphaerica</i>
8 JM014a	2.2	2	1.1	4.4	9	1	1.5	1.33	2.40	8	65	1	0.6	<i>C.hemisphaerica</i>
9 JM015	2.3	2.2	1.05	5.06	2.4	0.3	1.2	1.83	1.50	/	/	/	/	<i>C.hemisphaerica</i>
10 JM022a	1.5	1.6	0.93	2.4	0.4	0.4	1.4	1.14	0.80	/	/	/	/	<i>C.hemisphaerica</i>
11 JM025	1.8	2	0.9	3.6	2.2	0.6	1.5	1.33	1.20	/	/	/	/	<i>C.hemisphaerica</i>
12 JM032	1.9	1.5	1.26	2.85	0.9	0.5	0.55	2.73	1.00	/	/	/	/	<i>C.hemisphaerica</i>
13 JM048	2	1.8	1.1	3.6	2.1	0.2	1.4	1.29	0.60	/	/	/	/	<i>C.hemisphaerica</i>
14 JM058	2	1.8	1.1	3.6	0.4	0.4	0.4	4.50	0.40	/	/	/	/	<i>C.hemisphaerica</i>
15 JM060a	1.7	1.9	0.89	3.23	1.5	0.5	1.2	1.58	1.50	/	/	/	/	<i>C.hemisphaerica</i>
16 JM060b	1.6	1.6	1	2.56	3.6	0.5	1	1.60	1.00	/	45	0.5	0.5	<i>C.hemisphaerica</i>
17 JM065	2.8	2.8	1	7.84	4.2	0.7	0.8	3.50	1.20	/	80	0.7	0.4	<i>C.hemisphaerica</i>
18 JM068	2.2	2.1	1.04	4.62	2.1	0.8	1	2.10	1.20	/	/	/	/	<i>C.hemisphaerica</i>
19 JM077	1.5	1.2	1.25	1.8	16	1.4	1.1	1.09	2.00	/	100	1.4	0.5	<i>C.hemisphaerica</i>
20 JM078	1.6	1.5	1.06	2.4	0.8	1	1	1.50	0.20	/	/	/	/	<i>C.hemisphaerica</i>
21 JM081b	1.7	1.2	1.42	2.04	4.8	0.8	1	1.20	1.20	/	93	0.8	0.2	<i>C.hemisphaerica</i>
22 JM081c	1.8	1.7	1.05	3.06	2.8	0.3	1.3	1.31	1.20	/	/	/	/	<i>C.hemisphaerica</i>
23 JM093b	1	1	1	1	6.6	0.6	0.8	1.25	0.70	/	100	0.6	0.5	<i>C.hemisphaerica</i>
24 JM097a	1.3	1.5	0.86	1.95	0.6	0.8	1	1.50	0.60	/	/	/	/	<i>C.hemisphaerica</i>
25 JM097b	1.8	1.5	1.2	2.7	2	0.6	1	1.50	0.80	/	/	/	/	<i>C.hemisphaerica</i>
26 JM097c	2	1.8	1.1	3.6	/	/	/	/	/	/	/	/	/	<i>C.hemisphaerica</i>
27 JM098a	1.4	1.6	0.875	2.24	2.6	0.3	1.2	1.33	0.90	/	/	/	/	<i>C.hemisphaerica</i>
28 JM103	1.9	1.7	1.11	3.23	2.8	0.15	0.9	1.89	1.60	/	/	/	/	<i>C.hemisphaerica</i>
29 JM104	1.6	1.7	0.94	2.72	2.9	0.4	1	1.70	0.40	/	/	/	/	<i>C.hemisphaerica</i>
30 JM112	1.7	1.6	1.06	2.72	1	0.4	0.7	2.29	1.00	/	/	/	/	<i>C.hemisphaerica</i>
31 JM115	1.5	1.5	1	2.25	2	0.5	0.8	1.88	1.60	/	/	/	/	<i>C.hemisphaerica</i>
32 JM119	1.1	1.4	0.78	1.54	2.2	0.5	1	1.40	1.40	/	/	/	/	<i>C.hemisphaerica</i>
33 JM121a	1.5	1.3	1.15	1.95	6.8	0.8	1	1.30	0.90	3	100	0.8	0.2	<i>C.hemisphaerica</i>
JM121a c.p.	1.6	1.4	1.14	2.24	/	/	0.8	1.75	0.90	/	/	/	/	<i>C.hemisphaerica</i>
34 JM121b	2.4	2.2	1.09	5.28	1	0.4	0.8	2.75	1.00	/	/	/	/	<i>C.hemisphaerica</i>

35	JM121c	2.2	2.9	0.75	6.38	2	0.5	1	2.90	2.00/	/	/	/	/	C.hemisphaerica
36	JM133a	2.2	2.8	0.78	6.16	3	1	2	1.40	1.60/	/	/	/	/	C.hemisphaerica
37	JM152a	1	0.7	1.43	0.7	4	0.4	0.4	1.75	0.50/	60	0.4	0.4	0.4	C.hemisphaerica
38	JM225	1.2	0.8	1.5	0.96	0.8	0.2	0.5	1.60	0.80/	/	/	/	/	C.hemisphaerica
39	JM226	1.2	1.4	0.85	1.68	1.2	0.6	0.6	2.33	0.00/	/	/	/	/	C.hemisphaerica
40	JM228a	2	2	1	4	2.5	0.4	1.6	1.25	2.00/	/	/	/	/	C.hemisphaerica
41	JM228b	2.4	2.2	1.09	5.28	1	1	1.5	1.47	1.00/	/	/	/	/	C.hemisphaerica
42	JM228c	2	1.5	1.33	3	1	0.3	0.4	3.75	0.20/	/	/	/	/	C.hemisphaerica
43	JM231a	1.2	1.2	1	1.44	1.2	0.8	0.8	1.50	0.00/	/	/	/	/	C.hemisphaerica
44	JM232	2.3	2.2	1.04	5.06	3	1	1.4	1.57	0.65/	/	/	/	/	C.hemisphaerica
45	JM235b	2	2	1	4	/	/	/	/	/	/	/	/	/	C.hemisphaerica
46	JM242d	2.2	1.8	1.2	3.96	2	0.5	1.2	1.50	1.20/	/	/	/	/	C.hemisphaerica
47	JM250	1.8	1.7	1.05	3.06	2	0.5	1.2	1.42	1.00/	/	/	/	/	C.hemisphaerica
48	JM252	1.6	1.6	1	2.56	0.6	0.6	0.8	2.00	0.60/	/	/	/	/	C.hemisphaerica
49	JM255	2.4	2.2	1.09	5.28	0.8	0.6	0.8	2.75	0.40/	/	/	/	/	C.hemisphaerica
50	JM259	1.8	1.8	1	3.24	2	0.4	1.2	1.50	1.20/	/	/	/	/	C.hemisphaerica
51	JM265a	1.4	1.2	1.16	1.68	1	0.6	0.8	1.50	0.40/	/	/	/	/	C.hemisphaerica
52	JM265b	1.7	1.6	1.06	2.72	1.2	0.4	0.5	3.20	0.40/	/	/	/	/	C.hemisphaerica
53	JM283	2.2	2	1.1	4.4	/	/	/	/	/	/	/	/	/	C.hemisphaerica
54	JM312a	2.6	2.6	1	6.76	2.8	1	1.2	2.17	3.00/	/	/	/	/	C.hemisphaerica
55	JM312b	2.80	2.60	1.07	7.28	1.80	0.60	2.50	1.04	1.50	/	/	/	/	C.hemisphaerica
56	JM316a	2	1.7	1.17	3.4	1.5	0.4	0.6	2.83	1.00/	/	/	/	/	C.hemisphaerica
57	JM316b	1.8	1.6	1.125	2.88			0.6	2.67	/	/	/	/	/	C.hemisphaerica
58	JM325	2.4	3	0.8	7.2	3	1	2.2	1.36	2.40/	/	/	/	/	C.hemisphaerica
59	JM326	2.3	2.6	0.88	5.98	1.6	1	2	1.30	1.60/	/	/	/	/	C.hemisphaerica
60	JM341	1.7	1.8	0.94	3.06	3	0.3	1.2	1.50	1.20/	/	/	/	/	C.hemisphaerica
61	JM358	1.4	1.6	0.875	2.24	2	0.8	1	1.60	1.00/	/	/	/	/	C.hemisphaerica
62	JM367	2.3	2.4	0.95	5.52	7	0.6	1.2	2.00	1.80/	/	/	/	/	C.hemisphaerica
63	JM370a	2	2	1	4	3	0.4	1.3	1.54	1.30/	/	/	/	/	C.hemisphaerica
64	JM370b	2.4	2.3	1.04	5.52	3	0.6	1.4	1.64	2.80/	/	/	/	/	C.hemisphaerica
65	JM374	2.6	2.5	1.04	6.5	3.8	0.6	1.4	1.79	2.10/	/	/	/	/	C.hemisphaerica
66	JM378a	2	2	1	4	2.2	0.5	1.2	1.67	1.00/	/	/	/	/	C.hemisphaerica
67	JM378b	1.8	1.9	0.94	3.42	1.6	1.2	1.2	1.58	0.00/	/	/	/	/	C.hemisphaerica
68	JM381	1.7	1.6	1.06	2.72	2.6	0.7	1.2	1.33	0.80/	/	/	/	/	C.hemisphaerica
69	JM383a	2	2.6	0.76	5.2	2	0.8	1.2	2.17	1.20/	/	/	/	/	C.hemisphaerica
70	JM383b	1.4	1.2	1.16	1.68	1.9	0.8	1	1.20	0.00	/	/	/	/	C.hemisphaerica
71	JM383c	2.4	3.1	0.77	7.44	1.9	1	1.2	2.58	1.90	/	/	/	/	C.hemisphaerica
72	JM384	2.2	1.8	1.2	3.96	1.2	0.2	0.8	2.25	1.20/	/	/	/	/	C.hemisphaerica

73	JM386a	2.4	2.2	1.09	5.28	2.2	0.8	1.2	1.83	1.90/	/	/	/	/	C.hemisphaerica
74	JM386b	2	1.8	1.1	3.6	3	0.6	1.2	1.50	0.90					C.hemisphaerica
75	JM387b	2.3	2.4	0.95	5.52	3.5	0.6	1.2	2.00	1.80/	/	/	/	/	C.hemisphaerica
76	JM388a	2	1.6	1.25	3.2	2	0.6	0.6	2.67	0.70/	/	/	/	/	C.hemisphaerica
77	JM388b	2.1	1.8	1.16	3.78			0.6	3.00	1.20					C.hemisphaerica
78	JM393	1.3	1.5	0.86	1.95	0.6	0.6	0.8	1.88	0.80/	/	/	/	/	C.hemisphaerica
79	JM396	2.2	1.8	1.22	3.96	3	0.8	1	1.80	0.80/	/	/	/	/	C.hemisphaerica
80	RH008_1	1.15	1.10	1.05	1.27	1.72	0.13	0.81	1.36	1.50/	89	0.27	0.13	0.13	C.hemisphaerica
81	RH118	1.06	1.00	1.06	1.06	2.73	0.61	0.57	1.75	0.40/	51	0.61	0.47	0.47	C.hemisphaerica
82	RH109	2.36	2.26	1.04	5.33	2.03	0.88	1.56	1.45	0.40/	/	/	/	/	C.hemisphaerica
83	RH117_1	1.51	1.52	0.99	2.30	1.53	0.53	1.19	1.28	1.53/	/	/	/	/	C.hemisphaerica
84	RH117_2	0.89	0.96	0.93	0.85	2.63	0.51	0.81	1.19	0.20/	/	/	/	/	C.hemisphaerica
85	RH001_1	2.03	1.99	1.02	4.04	0.60	0.73	1	1.99	0.60/	/	/	/	/	C.hemisphaerica
86	RH001_2	1.73	1.69	1.02	2.92/		0.54	1.03	1.64/	/	/	/	/	/	C.hemisphaerica
87	RH015	1.74	1.87	0.93	3.25	4.41	0.57	1.21	1.55	1.40/	/	/	/	/	C.hemisphaerica
88	RH020_2	1.49	1.48	1.01	2.21	3.53	0.41	0.94	1.57	3.53/	/	/	/	/	C.hemisphaerica
89	RH153	1.80	1.51	1.19	2.72	12.72	0.57	1.05	1.44	2.20/	/	/	/	/	C.hemisphaerica
90	RH150_1	1.53	1.63	0.94	2.49	2.77	0.34	1.11	1.47	2.77/	/	/	/	/	C.hemisphaerica
91	RH150_2	2.34	1.92	1.22	4.49	12.26	0.47	1.2	1.60	0.60/	73	0.88	0.47	0.47	C.hemisphaerica
92	RH025_1	1.65	1.49	1.11	2.46	0.88	0.75	1.02	1.46	0.30/	/	/	/	/	C.hemisphaerica
93	RH025_2	1.18	1.17	1.01	1.38	4.01	0.45	0.83	1.41	0.00/	/	/	/	/	C.hemisphaerica
94	RH033_1	1.72	1.94	0.89	3.34	1.14	0.43	1.03	1.88	1.14/	/	/	/	/	C.hemisphaerica
95	RH0108_1	2.42	1.99	1.22	4.82	0.97	0.97	1.03	1.93	0.97/	/	/	/	/	C.hemisphaerica
96	RH151_3	2.23	1.73	1.29	3.86	2.01	0.34	1.04	1.66	1.20/	/	/	/	/	C.hemisphaerica
97	RH151_4	1.52	1.43	1.06	2.17	2.88	0.47	1.06	1.35	1.80/	/	/	/	/	C.hemisphaerica
98	RH074_1	1.39	1.56	0.89	2.17	2.22	0.44	1.29	1.21	1.60/	/	/	/	/	C.hemisphaerica
99	RH(01)_1	1.64	1.68	0.98	2.76	1.99	0.42	0.91	1.85	1.99/	/	/	/	/	C.hemisphaerica
100	RH028_1	1.66	1.79	0.93	2.97	1.22	0.76	1.14	1.57	1.20/	/	/	/	/	C.hemisphaerica
101	RH028_2	2.51	2.01	1.25	5.05	5.24	0.52	1.54	1.31	1.00/	/	/	/	/	C.hemisphaerica
102	RH031_1	2.18	2.20	0.99	4.80	7.02	0.61	1.32	1.67	1.20/	/	/	/	/	C.hemisphaerica
103	RH136_1	2.28	1.74	1.31	3.97/		0.73	1.12	1.55	0.40/	/	/	/	/	C.hemisphaerica
104	RH166_1	2.49	1.80	1.38	4.48/		/	0.78	2.31	/	/	/	/	/	C.hemisphaerica
105	RH160_1	1.59	1.48	1.07	2.35/		/	/	/	/	/	/	/	/	C.hemisphaerica
106	RH(02)_1	2.52	2.13	1.18	5.37	4.84	0.36	1.35	1.58	1.20/	/	/	/	/	C.hemisphaerica

107	RH216_1	2.72	2.37	1.15	6.45	2.84	0.64	1.42	1.67	1.40	/	/	/	/	C.hemisphaerica
108	RH200_1	1.80	1.51	1.19	2.72	1.34	0.34	0.85	1.78	1.00	/	/	/	/	C.hemisphaerica
109	RH200_2	1.95	2.19	0.89	4.27	2.15	0.43	1.25	1.75	1.00	/	/	/	/	C.hemisphaerica
110	RH2_2	1.97	2.09	0.94	4.12	2.99	0.33	1.33	1.57	2.99	/	/	/	/	C.hemisphaerica
111	RH2_3_2	1.73	1.67	1.04	2.89	4	0.43	1.28	1.30	0.80	/	/	/	/	C.hemisphaerica
112	RH2_5	1.82	1.64	1.11	2.98	3.06	0.28	1.02	1.61	0.80	/	/	/	/	C.hemisphaerica
113	RHSp102a	2.70	2.30	1.17	6.21	1	0.5	0.7	3.29	1.00	/	/	/	/	C.hemisphaerica
114	RHSp99_2	1.10	1.10	1.00	1.21	0.8	0.4	0.8	1.38	0.80	/	/	/	/	C.hemisphaerica
115	RHSp116	1.50	1.20	1.25	1.80	3.4	0.6	0.8	1.50	0.80	/	30	0.6	0.4	C.hemisphaerica
116	RH0097b	1.48	1.67	0.89	2.47	4.67	0.53	1.43	1.17	/	3	85	0.72	0.53	C.hemisphaerica
117	RH0158	1.81	1.87	0.96791	3.3847	1.94	0.4	1.37	1.36	/	/	/	/	/	C.hemisphaerica
118	RH0054	1.25	1.49	0.83893	1.8625	3.57	0.33	1.26	1.18	/	/	/	/	/	C.hemisphaerica
119	RH0044	1.63	1.64	0.9939	2.6732	4.6	0.7	1.43	1.15	/	/	/	/	/	C.hemisphaerica
120	RH049	1.81	1.51	1.19868	2.7331	4.53	0.98	1.18	1.28	/	/	/	/	/	C.hemisphaerica
121	RHJM01	1.56	1.15	1.35652	1.794	8.38	0.3	0.9	1.28	/	6.61	66	0.76	0.3	C.hemisphaerica
122	RHJM02	1.8	1.85	0.97297	3.33	12	0.5	1.19	1.55	/	15	63	0.8	0.5	C.hemisphaerica
123	RHJM03	1.89	1.72	1.09884	3.2508	1.34	0.47	1.13	1.52	/	/	/	/	/	C.hemisphaerica

MIN	0.89	0.70	0.75	0.70	0.40	0.13	0.40	1.04	0.00	2.00	30.00	0.27	0.13
MAX	2.80	3.10	1.50	7.84	16.00	1.40	2.50	4.50	3.53	15.00	100.00	1.40	0.60
AVERAGE	1.85	1.78	1.05	3.46	2.96	0.57	1.08	1.76	1.17	5.80	70.50	0.69	0.37

C COOKSONIA CF. CAMBRENSIS

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Length-width ratio	Sporangial area mm2	Axis length mm	Axis width mm	Width of subtending axis mm	Max width to junction width ratio	Length of axis taper mm	Distance between sporangia mm	Axes angle	Axes thickness before branching	Axes thickness after branching	Identification
1 RH045	1.76	2.37	0.74	4.17	5.01	0.55	0.84	2.82	/	/	/	/	/	C. cf. cambrensis
2 RH0188_1	1.68	2.28	0.74	3.83	2.84	0.94	1.38	1.65	/	/	/	/	/	C. cf. cambrensis
3 JM023	2.3	2.7	0.85	6.21	2	0.6	1	2.70	/	0.80	/	/	/	C. cf. cambrensis
4 JM073	2	2	1.00	4.00	2.2	0.6	1	2.00	/	0.00	/	/	/	C. cf. cambrensis
5 JM235a	2.3	2.2	1.05	5.06	2.5	0.6	0.6	3.67	/	0.10	/	/	/	C. cf. cambrensis
6 JM372	2.4	2.5	0.96	6.00	1.7	1	1.4	1.79	/	1.70	/	/	/	C. cf. cambrensis
7 JM382	2	2	1.00	4.00	1	0.6	0.8	2.50	/	1.00	/	/	/	C. cf. cambrensis

MIN	1.68	2.00	0.74	3.83	1.00	0.55	0.60	1.65	/	0.00	0.00	0.00	0.00	
MAX	2.40	2.70	1.05	6.21	5.01	1.00	1.40	3.67	/	1.70	0.00	0.00	0.00	
AVERAGE	2.06	2.29	0.91	4.75	2.46	0.70	1.00	2.45	/	0.72	0.00	0.00	0.00	

D CF. USKIELLA RETICULATA/TARRANTIA SALOPENSIS

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Length-width ratio	Sporangial area mm2	Axis length mm	Axis width mm	Width of subtending axis mm	Max width to junction width ratio	Length of axis taper mm	Distance between sporangia mm	Axes angle	Axes thickness before branching	Axes thickness after branching	Identification
1 JM006a	2.2	1.8	1.2	3.96	2	0.6	1	1.80			/	/	/	cf. <i>U. reticulata</i>
2 JM013a	2.2	2.2	1	4.84	7	0.4	1		/	/	/	/	/	cf. <i>U. reticulata</i>
3 JM013b	2.4	2.7	0.88	6.48	1.2	0.6	0.6		/	/	/	/	/	cf. <i>U. reticulata</i>
4 JM013c	2.4	2.2	1.09	5.28	2	0.2	0.2		/	/	/	/	/	cf. <i>U. reticulata</i>
5 JM013d	2.8	2.6	1.07	7.28	9.5	0.8	0.6		/	/	45	0.8	0.6	cf. <i>U. reticulata</i>
6 JM047	2.3	1.65	1.39	3.795	2.2	0.6	1.5	1.10	/	/	/	/	/	cf. <i>U. reticulata</i>
7 JM092	2	1	2	2	1.4	0.3	0.45	2.22	/	/	/	/	/	cf. <i>U. reticulata</i>
8 JM111	2.3	1.6	1.25	3.68	5.9	0.47	0.79	2.03	/	/	/	/	/	cf. <i>U. reticulata</i>
9 JM113a	2	1.4	1.42	2.8	1.8	0.6	0.6	2.33	/	/	/	/	/	cf. <i>U. reticulata</i>
10 JM143	2.5	1.3	1.92	3.25	2.5	0.6	0.6	2.17	/	/	/	/	/	cf. <i>U. reticulata</i>
11 JM144	3	2	1.5	6	0.6	0.6	0.6	3.33	/	/	/	/	/	cf. <i>U. reticulata</i>
12 JM279a	2.4	1.5	1.6	3.6	2.5	0.2	0.5	3.00	/	1	60	0.2	0.2	cf. <i>U. reticulata</i>
JM279a ii	2.2	1.4	1.57	3.08	2.5	0.2	0.5		/	/	/	/	/	cf. <i>U. reticulata</i>
13 JM328	3	2.2	1.36	6.6	/	/	/	/	/	/	/	/	/	cf. <i>U. reticulata</i>
14 JM353	1.9	1.4	1.3	2.66	2.8	0.4	0.6	2.33	/	/	/	/	/	cf. <i>U. reticulata</i>
15 JM354	1.9	1.3	1.46	2.47	0.5	0.4	0.6	2.17	/	/	/	/	/	cf. <i>U. reticulata</i>
16 JM369	3	1.5	2	4.5	1	0.2	0.2	7.50	/	/	/	/	/	cf. <i>U. reticulata</i>
17 JM390	2.8	1	2.8	2.80	1.4	0.3	0.5	2.00	/	/	/	/	/	cf. <i>U. reticulata</i>
18 RH008-2	2.85	2.44	1.17	6.95	0.82	0.6	1.03	2.37	/	/	/	/	/	cf. <i>U. reticulata</i>
19 RH079	1.8	1.28	1.41	2.30	3.34	0.33	0.4	3.20	/	/	/	/	/	cf. <i>U. reticulata</i>
20 RH019	1.13	1.08	1.05	1.22	1.51	0.59	0.9	1.20	/	/	/	/	/	cf. <i>U. reticulata</i>
21 RH154	2.87	2	1.44	5.74	1.99	0.55	0.91	2.20	/	/	/	/	/	cf. <i>U. reticulata</i>
22 RH125_2	2.2	1.29	1.71	2.84	/	/	/	/	/	/	/	/	/	cf. <i>U. reticulata</i>
23 RH125_3	1.4	1.09	1.28	1.53	1.57	0.44	0.7	1.56	/	/	/	/	/	cf. <i>U. reticulata</i>
24 RH198_1	2.38	1.81	1.31	4.31	2.17	1.3	1.3	1.39	/	/	/	/	/	cf. <i>U. reticulata</i>
25 RH187_1	1.97	1.52	1.30	2.99	9.23	0.42	0.82	1.85	/	/	/	/	/	cf. <i>U. reticulata</i>
26 RH266_1	2.59	2.08	1.25	5.39	2.1	0.63	1.04	2.00	/	/	/	/	/	cf. <i>U. reticulata</i>
27 RH291_1	1.69	1.33	1.27	2.25	2.11	0.79	0.97	1.37	/	/	/	/	/	cf. <i>U. reticulata</i>
28 RH2_3_1	1.63	1.35	1.21	2.20	2.57	0.61	1.07	1.26	/	/	/	/	/	cf. <i>U. reticulata</i>
29 RH2_6	2.43	1.74	1.40	4.23	/	/	/	/	/	/	/	/	/	cf. <i>U. reticulata</i>
30 RH2_7	2.51	2.63	0.95	6.60	10.09	1.04	1.23	2.14	/	/	/	/	/	cf. <i>U. reticulata</i>
31 RHSp110	3.6	2.6	1.38	9.36	4.75	1	1.2	2.17	/	/	80	1	0.9	cf. <i>U. reticulata</i>

	1.13	1.00	0.88	1.22	0.50	0.20	0.20	1.10		1.00	45.00	0.20	0.20
MAX	3.60	2.70	2.80	9.36	10.09	1.30	1.50	7.50		1.00	80.00	1.00	0.90
AVERAGE	2.32	1.72	1.40	4.16	3.07	0.54	0.77	2.28		1.00	61.67	0.67	0.57

E SALOPELLA ALLENII

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Length-width ratio	Sporangial area mm ²	Axis length mm	Axis width mm	Width of subtending axis mm	Max width to junction width ratio	Length of axis taper mm	Distance between sporangia mm	Axes angle	Axes thickness before branching	Axes thickness after branching	Identification
1 JM005a	10.5	3.1	3.38	32.55	1	1.6	1.5	2.07	/	/	/	/	/	Salopella allenii
JM005b	10.5	3.1	3.38	32.55	1	2	1.2	2.58	/	/	/	/	/	Salopella allenii
2 JM006a	11	2.8	3.92	30.8	2.3	1.4	0.8	3.50	/	/	/	/	/	Salopella allenii
JM006b	10.6	2.5	4.24	26.5	2.7	1.6	0.8	3.13	/	/	/	/	/	Salopella allenii
3 JM007	10	2.4	4.2	24	30	1.3	0.8	3.00	/	/	/	/	/	Salopella allenii
JM007b	9.6	2.4	4	23.04	30	1.1								Salopella allenii
4 JM009	9.9	2.4	4.125	23.76	9.2	0.9	1.1	2.18	/	/	/	/	/	Salopella allenii
5 JM081 + c.p.	7.4	2.2	3.36	16.28	11.7	1.5	1.5	1.47	/	/	/	/	/	Salopella allenii
6 JM377	8.4	2.3	3.6	19.32	/	/	/		/	/	/	/	/	Salopella allenii
7 JM289b	5.9	1.3	4.5	7.67	17.7	1.8	1	1.30	/	/	15	1.4	1	Salopella allenii
8 JM060c	4	1	4	4	3	0.5	0.3	3.33		1	15	0.5	0.2	Salopella allenii
9 RHSp127	10.22	2.49	4.1	25.4478	20.5	1.57	1.23	2.02	/	/	/	/	/	Salopella allenii
10 RHSp151_1	11.19	3.14	3.56	35.1366	/	/	/	/	/	/	/	/	/	Salopella allenii
11 RHSp034_1	8.42	2.01	4.18	16.9242	30	1.64	0.82	2.45	/	/	/	/	/	Salopella allenii
12 RHSp141_1	8.3	2.64	3.14	21.912	48	1.79	1.79	1.47486034		1	10	1.75	1.25	Salopella allenii
RHSp141_1	10.3	3	3.43	30.9	/	/	/	/	/	/	/	/	/	Salopella allenii
13 RHSp181_1	9.85	2.36	4.17	23.246	30	2	2	1.18	/	/	/	/	/	Salopella allenii
14 RHSp99	9.81	2.41	4.07	23.6421	30	1.59	1.39	1.73381295	/	/	/	/	/	Salopella allenii
15 RHSp125b	9.69	3.04	3.1875	29.4576	/	/	/	/	/	/	/	/	/	Salopella allenii
16 RHJM07	8.93	2.5	3.572	22.325	4	1.4	1.59	/	/	/	/	/	/	Salopella allenii

MIN	4.00	1.00	3.14	4.00	1.00	0.50	0.30	1.18		1.00	10.00	0.50	0.20
MAX	11.19	3.14	4.50	35.14	48.00	2.00	2.00	3.50		1.00	15.00	1.75	1.25
AVERAGE	9.23	2.45	3.81	23.47	16.94	1.48	1.19	2.24		1.00	13.33	1.22	0.82

17 JM106	3.72	1.38	2.6	5.1336	0.75	0.56	0.56		/	/	/	/	/	Salopella allenii
18 JM069	8.1	3	2.7	24.3	45.3	2.7	2		/	/	39	2.7	2	Salopella allenii

F SALOPELLA CF. MARCENSIS

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Length-width ratio	Sporangial area mm2	Axis length mm	Axis width mm	Width of subtending axis mm	Max width to junction width ratio	Length of axis taper mm	Distance between sporangia mm	Axes angle	Axes thickness before branching	Axes thickness after branching	Identification
1 JM021	3.38	1.50	2.25	5.06	6.95	0.63	0.63	2.40		3.75	85.00	0.63	0.50	S cf marcensis
JM021b	2.75	1.00	2.75	2.75										S cf marcensis
2 JM266 + c.p.	1.60	0.50	3.20	0.80	2.30	0.20	0.20	2.50	/	/	35.00	0.20	0.20	S cf marcensis
3 JM346a	1.70	0.60	2.80	1.02	/	/	/		/	/	/	/	/	S cf marcensis
4 JM346b	2.60	0.65	4.00	1.69	2.80	0.15	0.15	4.33	/	/	/	/	/	S cf marcensis
5 JM394	2.50	0.80	3.13	2.00	19.80	0.60	0.30	2.67		6.50	90.00	0.80	0.60	S cf marcensis
JM394 b	3.10	0.80	3.88	2.48										S cf marcensis
6 RHSp120	2.36	0.92	2.56	2.17	1.19	0.24	0.23	4.00						S cf marcensis
7 RHSp302_1	2.21	0.71	3.11	1.57	9.61	0.55	0.20	3.55			90.00	0.70	0.50	S cf marcensis
8 RH040	2.52	1.44	1.75	3.63	2.68	0.51	1.03	1.40	/	/	/	/	/	S cf marcensis

MIN	1.60	0.50	1.75	0.80	1.19	0.15	0.15	1.40		3.75	35.00	0.20	0.20	
MAX	3.38	1.50	4.00	5.06	19.80	0.63	1.03	4.33		6.50	90.00	0.80	0.60	
Averages	2.47	0.89	2.94	2.32	6.48	0.41	0.39	2.98		5.13	75.00	0.58	0.45	

G ELONGATE CLUB-SHAPED SPORANGIA

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Length-width ratio	Sporangial area mm2	Axis length mm	Axis width mm	Width of subtending axis mm	Max width to junction width ratio	Length of axis taper mm	Distance between sporangia mm	Axes angle	Axes thickness before branching	Axes thickness after branching	Identification
1 JM016	5.20	1.70	8.84	3.05	3.00	0.50	0.50	3.40		/	50.00	1.20	0.50	Elongate club
2 JM262a	4	1.3	5.20	3.07	/	/	/	/	/	/	/	/	/	Elongate club
JM262b	5.00	1.20	6.00	4.10	/	/	/	/	/	/	/	/	/	Elongate club
3 JM287	4.30	1.50	6.45	2.86	8.50	0.80	0.80	1.88		/	90.00	0.80	0.80	Elongate club
4 JM371	5.60	2.30	12.88	2.40	/	/	/	/	/	/	/	/	/	Elongate club
5 RH117_4	2.16	1.42	3.07	1.52	/	/	/	/	/	/	/	/	/	Elongate club
6 RH020_1	1.52	1.43	2.17	1.06	4.79	0.4	1.36				/	/	/	Elongate club
7 RH034_1	2.06	1.73	3.56	1.19	/	/	/	/	/	/	/	/	/	Elongate club
8 RH2_1_1	2.42	1.76	4.26	1.38	0.9	/	1.24		/	/	/	/	/	Elongate club
9 RHSp102b	2	1.5	3.00	1.33	5.2	0.6	1			/	/	/	/	Elongate club
10 RHSp156	4	2.5	10.00	1.60	/	/	/	/	/	/	/	/	/	Elongate club
11 RHPB	3.65	1.75	6.39	2.09	4.77	0.56	0.74				73.00	0.56	0.37	Elongate club

MIN	1.52	1.20	2.17	1.06	0.90	0.40	0.50	1.88		0.00	50.00	0.80	0.50	
MAX	5.60	2.50	12.88	4.10	8.50	0.80	1.36	3.40		0.00	90.00	1.20	0.80	
AVERAGE	3.49	1.67	5.99	2.14	4.53	0.57	0.94	2.64		0.00	70.00	1.00	0.65	

APPENDIX III : MESOFOSSIL MEASUREMENTS

pIII-1 to pIII-11

APPENDIX III: MESOFOSSIL MEASUREMENTS
MESOFOSSILS : TYPE A

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Length-width ratio	Sporangial area (mm ²)	Axis length mm	Axis width mm	Width of subending axis mm	Max width to junction width ratio	Distance between sporangia	Axes angle	Axes thickness before branching mm	Axes thickness after branching mm	Identification
JM1010e	0.4	0.3	1.33	0.12	0.7	0.1	0.1	3.00	0	0	0.1	0.1	mesofossil type A
JM10eii	0.4	0.3	1.33	0.12			0.1	3.00					mesofossil type A
JM1079a	0.6	0.5	1.20	0.3	0.8	0.1	0.2	2.50	/	/	/	/	mesofossil type A
JM1079aai	0.6	0.5	1.20	0.3			0.2	2.50					mesofossil type A
JM1086c	0.2	0.15	1.30	0.03	0.6	0.15	0.15	1.00	0.05	10	0.15	0.15	mesofossil type A
JM1086cii	0.2	0.2	1.00	0.04			0.15	1.33					mesofossil type A
JM1095c	0.4	0.3	1.30	0.12	0.2	0.1	0.1	3.00	0.05	10	0.1	0.1	mesofossil type A
JM1095cii	0.3	0.3	1.00	0.09			0.1	3.00					mesofossil type A
JM1095d	0.4	0.3	1.14	0.12	0.7	0.1	0.1	3.00	0.1	30	0.1	0.1	mesofossil type A
JM1095dii	0.5	0.4	1.25	0.2			0.1	4.00					mesofossil type A
JM123a	0.3	0.2	1.50	0.06	4.5	0.1	/	/	/	/	/	/	mesofossil type A
JM123aai	0.4	0.25	1.60	0.1			/						mesofossil type A
JM123b	0.4	0.3	1.33	0.12	1.5	0.11	0.15	2.00	0.5	45	0.1	0.1	mesofossil type A
JM123bii	0.3	0.2	1.50	0.06			0.15	1.33					mesofossil type A
JM125b	0.55	0.6	0.91	0.33	1.2	0.2	0.2	3.00	/	/	/	/	mesofossil type A
JM153a	0.65	0.45	1.44	0.2925	/	/	/	/	/	/	/	/	mesofossil type A
JM153aai	0.65	0.45	1.44	0.2925			/						mesofossil type A
JM153b	0.35	0.3	1.16	0.105	1	0.1	0.1	3.00	/	/	/	/	mesofossil type A
JM153bii	0.35	0.3	1.16	0.105			0.1	3.00					mesofossil type A
JM153c	0.3	0.4	0.75	0.12	0.3	0.1	0.1	4.00	/	/	/	/	mesofossil type A
JM162a	0.35	0.3	1.16	0.105	0.65	0.15	0.1	3.00	0.15	40	0.15	0.1	mesofossil type A
JM162b	0.45	0.3	1.50	0.135	0.8	0.1	0.1	3.00	0.5	50	0.1	0.1	mesofossil type A
JM164a	0.3	0.3	1.00	0.09	0.6	0.1	0.1	3.00	0	0	/	/	mesofossil type A
JM164ai	0.35	0.25	1.40	0.0875			0.1	2.50					mesofossil type A
JM175	0.75	0.5	1.50	0.375	0.7	0.15	0.15	3.33	0	30	/	/	mesofossil type A
JM175ii	0.55	0.5	1.10	0.275			0.15	3.33					mesofossil type A
JM180b	0.33	0.25	1.32	0.0825	0.5	0.15	0.07	3.57	/	50	/	/	mesofossil type A
JM185	0.5	0.33	1.51	0.165	0.35	0.1	0.1	3.30	0	~10	/	/	mesofossil type A
JM185ii	0.25	0.3	0.83	0.075			0.1	3.00					mesofossil type A
JM186	0.4	0.2	2.00	0.08	1.4	0.15	0.15	1.33	/	42	/	/	mesofossil type A
JM187a	0.23	0.2	1.15	0.046	1.4	0.1	0.07	2.86	/	70	/	/	mesofossil type A
JM188a	0.28	0.3	0.93	0.084	1.3	0.1	0.1	3.00	0.15	35	/	/	mesofossil type A

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21	JM188a	0.3	0.3	1.00	0.09				0.1	0.1	3.00	0							mesofossil type A
	JM190b	0.3	0.19	1.57	0.057	0.7	0.1	0.07	0.1	0.07	2.71	0	35	0.1	0.07				mesofossil type A
	JM190bii	0.3	0.2	1.50	0.06			0.07		0.07	2.86								mesofossil type A
22	JM191a	0.25	0.2	1.25	0.05	0.6	0.1	0.1	0.1	0.1	2.00	/	/	/	/				mesofossil type A
23	JM191b	0.4	0.2	2.00	0.08	0.15	0.15	0.07	0.15	0.07	2.86	/	35	0.15	0.07				mesofossil type A
24	JM194a	0.35	0.25	1.40	0.0875	.	0.2	0.1	0.2	0.1	2.50	1.5	70	0.2	0.1				mesofossil type A
	JM194a	0.35	0.25	1.40	0.0875			0.1		0.1	2.50								mesofossil type A
	JM194a	0.2	0.15	1.33	0.03			0.1		0.1	1.50								mesofossil type A
25	JM194d	0.4	0.4	1.00	0.16	0.7	0.15	0.15	0.15	0.15	2.67	0.2	65	0.15	0.15				mesofossil type A
26	JM197b	0.9	0.5	1.80	0.45	1.8	0.15	0.1	0.15	0.1	5.00	1.5	105	0.2	0.1				mesofossil type A
	JM197bii	0.8	0.6	1.33	0.48			0.1		0.1	6.00								mesofossil type A
27	JM202a	0.2	0.15	1.33	0.03	0.35	0.1	0.05	0.1	0.05	3.00	0.1	30	0.1	0.05				mesofossil type A
	JM202a	0.2	0.15	1.33	0.03			0.05		0.05	3.00								mesofossil type A
	JM202a	0.2	0.13	1.54	0.026			0.05		0.05	2.60								mesofossil type A
28	JM202b	0.8	0.5	1.60	0.4	2.7	0.25	0.15	0.25	0.15	3.33	0.1	65, 60	0.25	0.15				mesofossil type A
	JM202bii	0.5	0.4	1.25	0.2			0.15		0.15	2.67								mesofossil type A
29	JM202e	0.18	0.12	1.50	0.0216	0.2	0.08	0.05	0.08	0.05	2.40	/	60	0.08	0.05				mesofossil type A
30	JM204b	0.3	0.15	2.00	0.045	0.35	0.1	0.07	0.1	0.07	2.14	0	40	0.1	0.07				mesofossil type A
	JM204bii	0.3	0.15	2.00	0.045			0.07		0.07	2.14								mesofossil type A
31	JM211a	0.2	0.15	1.33	0.03	0.45	0.1	0.1	0.1	0.1	1.50	0.1	20	0.1	0.1				mesofossil type A
	JM211a	0.2	0.15	1.33	0.03			0.1		0.1	1.50								mesofossil type A
	JM211a	0.2	0.15	1.33	0.03			0.1		0.1	1.50								mesofossil type A
32	JM323a	0.6	0.4	1.50	0.24	4.8	0.1	0.1	0.1	0.1	4.00	0.1	40	0.1	0.1				mesofossil type A
	JM323a	0.65	0.45	1.44	0.2925			0.1		0.1	4.50								mesofossil type A
	JM323a	0.45	0.3	1.50	0.135			0.1		0.1	3.00								mesofossil type A
33	JM323b	0.2	0.15	1.33	0.03			0.1		0.1	1.50								mesofossil type A
	JM323b	0.2	0.15	1.33	0.03			0.1		0.1	1.50								mesofossil type A
	JM323b	0.3	0.2	1.50	0.06			0.1		0.1	2.00								mesofossil type A
34	JM363a	0.4	0.3	1.30	0.12	2.4	0.1	0.1	0.1	0.1	3.00	0	65, 58	0.1	0.1				mesofossil type A
	JM363a	0.3	0.3	1.00	0.09			0.1		0.1	3.00								mesofossil type A
35	JM363b	0.3	0.2	1.50	0.06	0.5	0.15	0.1	0.15	0.1	2.00	0	30	0.15	0.1				mesofossil type A
	JM363b	0.25	0.2	1.25	0.05			0.1		0.1	2.00								mesofossil type A
36	JM365a	0.2	0.2	1.00	0.04	3.8	0.15	0.1	0.15	0.1	2.00	0	15	0.15	0.1				mesofossil type A

37	JM365aii	0.2	0.2	1.00	0.04				0.1	2.00								mesofossil type A
	JM365aiii	0.2	0.2	1.00	0.04				0.1	2.00								mesofossil type A
	JM365aiv	0.2	0.2	1.00	0.04				0.1	2.00								mesofossil type A
	JM365c	0.45	0.35	1.28	0.1575	0.6	0.15	0.15	0.15	2.33	/	100	/					mesofossil type A
	JM365cii	0.35	0.32	1.09	0.112				0.15	2.13								mesofossil type A
38	JM365d	0.2	0.15	1.33	0.03	1.6	0.1	0.1	0.1	1.50	0.1	35	0.1	0.1				mesofossil type A
	JM365dii	0.18	0.15	1.33	0.027				0.1	1.50								mesofossil type A
39	JM365e	0.4	0.3	1.33	0.12	0.6	0.1	0.1	0.1	3.00	0	30	/					mesofossil type A
	JM365eii	0.35	0.35	1.00	0.1225				0.1	3.50								mesofossil type A
40	RH128_1	0.22	0.24	0.92	0.0528	1.36	0.08	0.08	0.08	3.00	0.18	34	0.09	0.07				mesofossil type A
41	RH183_1	0.39	0.35	1.11	0.1365	0.91	0.1	0.09	0.09	3.89	/	/	/	/				mesofossil type A
	RH183_1	0.36	0.33	1.09	0.1188	/	/	/	/	/				/				mesofossil type A
42	RH169_1	0.34	0.215	1.58	0.0731	0.17	0.07	0.085	0.085	2.53	/	48	/					mesofossil type A
43	RH301_1	0.27	0.27	1.00	0.0729	0.63	0.04	0.04	0.04	6.75	/	/	/	/				mesofossil type A
44	RH288_1	0.49	0.29	1.69	0.1421	1.45	0.11	0.07	0.07	4.14		53	0.11	0.11				mesofossil type A
45	RH032_1	0.56	0.31	1.81	0.1736	1.18	0.1	0.1	0.1	3.10	/	/	/	/				mesofossil type A
46	RH032_2	0.31	0.28	1.11	0.0868	0.23	0.05	0.05	0.05	5.60	/	/	/	/				mesofossil type A
47	RH032_3	0.39	0.27	1.44	0.1053	1.16	0.07	0.07	0.07	3.86	/	/	/	/				mesofossil type A
48	RHSp87a	0.1	0.1	1.00	0.01	2	0.1	0.12	0.12	0.83	0	0	/	/				mesofossil type A
49	RHSp77a	0.15	0.2	0.75	0.03	1.2	0.1	0.1	0.1	2.00	0	0	/	/				mesofossil type A
50	RH005_2	0.54	0.38	1.42	0.2052	1.99	0.1	0.07	0.07	5.43	/	/	/	/				mesofossil type A
51	RH002	0.25	0.2	1.25	0.05	1.74	0.15	0.11	0.11	1.82	0	89	/	/				mesofossil type A
52	RH087b	0.1	0.1	1.00	0.01	2.00	0.1	0.12	0.12	0.83	/	/	/	/				mesofossil type A
53	RH077b	0.6	0.4	1.50	0.24	1	0.15	0.15	0.15	2.67	0.5	45	0.15	0.15				mesofossil type A

MIN	0.10	0.10	0.75	0.01	0.15	0.04	0.04	0.83	0.00	0.08	0.05
MAX	0.9	0.6	2.00	0.48	4.8	0.25	0.2	6.75	105	0.25	0.15
AVERAGE	0.36	0.28	1.30	0.12	1.17	0.12	0.10	2.76	39.74	0.13	0.10

MESOFOSSILS : TYPE B

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Length-width ratio	Sporangial area (mm2)	Axis length mm	Axis width mm	Width of subtending axis mm	Max width to junction width ratio	Distance between sporangia	Axes angle	Axes thickness before branching mm	Axes thickness after branching mm	Identification
JM074a	0.4	0.2	2.00	0.08	2	0.1	0.15	1.33	0.5	40	/	/	mesofossil type B
JM074aii	0.5	0.2	2.50	0.1			0.15	1.33					mesofossil type B
JM086d	0.5	0.4	1.25	0.2	4.5	0.15	0.15	2.67	/	40	/	/	mesofossil type B
JM086dii	0.5	0.35	1.43	0.175			0.15	2.33					mesofossil type B
JM124a	0.55	0.4	1.38	0.22	0.3	0.05	0.05	8.00	/	/	/	/	mesofossil type B
JM157b	0.5	0.3	1.67	0.15	0.7	0.1	0.1	3.00	/	/	/	/	mesofossil type B
JM164b	0.45	0.32	1.41	0.144	2.7	0.25	0.1	3.20	/	/	0.25	0.15	mesofossil type B
JM164c	0.33	0.19	1.74	0.0627	2	0.1	0.07	2.71	0.6	45	0.1	0.1	mesofossil type B
JM164cii	0.3	0.2	1.50	0.06			0.07	2.86					mesofossil type B
JM164d	0.7	0.55	1.27	0.385	0.25	0.1	0.1	5.50	/	/	/	/	mesofossil type B
JM174	0.55	0.33	1.67	0.1815	2.9	0.2	0.05	6.60	/	70	0.2	0.1	mesofossil type B
JM178a	0.35	0.2	1.75	0.07	2	0.1	0.07	2.86	/	45	0.1	0.07	mesofossil type B
JM180a	0.6	0.3	2.00	0.18	2.2	0.1	0.1	3.00	/	40	/	/	mesofossil type B
JM184	0.5	0.4	1.25	0.2	0.5	0.05	0.05	8.00	/	/	/	/	mesofossil type B
JM187b	0.4	0.25	1.60	0.1	3	0.2	0.1	2.50	/	50	0.2	0.1	mesofossil type B
JM189	0.45	0.35	1.29	0.1575	2	0.2	0.1	3.50	0.1	35	/	/	mesofossil type B
JM189ii	0.48	0.4	1.20	0.192			0.1	4.00					mesofossil type B
JM190c	0.4	0.2	2.00	0.08	1	0.1	0.1	2.00	/	85	0.1	0.1	mesofossil type B
JM194b	0.55	0.3	1.83	0.165	3	0.1	0.1	3.00	/	/	/	/	mesofossil type B
JM195a	0.5	0.4	1.25	0.2	0.6	0.1	0.1	4.00	/	/	/	/	mesofossil type B
JM195b	0.45	0.45	1.00	0.2025	0.5	0.1	0.15	3.00	/	/	/	/	mesofossil type B
JM195c	0.5	0.45	1.11	0.225	0.4	0.1	0.1	4.50	/	/	/	/	mesofossil type B
JM197e	0.5	0.35	1.43	0.175	0.3	0.1	0.12	2.92	/	/	/	/	mesofossil type B
JM197f	0.6	0.4	1.50	0.24	0.6	0.1	0.1	4.00	/	/	/	/	mesofossil type B
JM197fii	0.6	0.4	1.50	0.24			0.1	4.00					mesofossil type B
JM204a	0.35	0.25	1.40	0.0875	0.4	0.1	0.12	2.08	0.1	/	/	/	mesofossil type B
JM204aii	0.3	0.3	1.00	0.09			0.12	2.50					mesofossil type B
JM205a	0.45	0.5	0.90	0.225	4	0.45	0.3	1.67	1.7	50	0.4	0.25	mesofossil type B
JM205aii	0.6	0.4	1.50	0.24			0.3	1.33					mesofossil type B

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44	JM364bii	0.5	0.3	1.67	0.15			0.1	3.00								mesofossil type B
45	JM365b	0.5	0.35	1.43	0.175	0.8	0.15	0.1	3.50	/	50	0.1	0.1				mesofossil type B
46	RH2_4	0.53	0.36	1.47	0.1908	1.44	0.12	0.121	2.98	/	/	/	/				mesofossil type B
	RH77a	0.41	0.33	1.24	0.1353	1.37	0.08	0.11	3.00	0.45	70	0.13	0.08				mesofossil type B

MIN	0.28	0.19	0.90	0.06	0.25	0.05	0.05	0.05	1.00	0.00	15.00	0.10	0.07				
MAX	0.80	0.55	2.73	0.39	4.50	0.45	0.45	0.30	8.00	1.70	85.00	0.40	0.25				
AVERAGE	0.49	0.32	1.59	0.16	1.75	0.14	0.14	0.13	2.84	0.51	50.59	0.16	0.12				

MESOFOSSILS : TYPE C

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Sporangium	Length-width ratio	Sporangial area (mm ²)	Axis length mm	Axis width mm	Width of subending axis mm	Max width to junction width ratio	Distance between sporangia	Axes angle	Axes thickness before branching mm	Axes thickness after branching mm	Identification
JM030a	0.6	0.4		1.50	0.24	1	0.05	0.05	8.00	/	100	0.05	0.05	mesofossil type C
JM075a	0.8	0.55		1.45	0.44	1.2	0.2	0.2	2.75	/	/	/	/	mesofossil type C
JM085a	0.4	0.3		1.33	0.12	1.33	0.1	0.1	3.00	/	/	/	/	mesofossil type C
JM085b	0.25	0.2		1.25	0.05	1.25	0.1	0.1	2.00	/	/	/	/	mesofossil type C
JM086a	0.5	0.3		1.67	0.15	0.8	0.1	0.2	1.50	/	50	0.1	0.1	mesofossil type C
JM086b	0.5	0.3		1.67	0.15	0.6	0.15	0.15	2.00	/	/	/	/	mesofossil type C
JM095a	0.5	0.5		1.00	0.25	0.2	0.3	0.3	1.67	/	/	/	/	mesofossil type C
JM098b	0.7	0.5		1.40	0.35	1.6	0.2	0.3	1.67	/	/	/	/	mesofossil type C
JM100a	0.7	0.6		1.17	0.42	0.8	0.2	0.2	3.00	/	/	/	/	mesofossil type C
JM100b	0.8	0.7		1.14	0.56	0.6	0.15	0.2	3.50	/	/	/	/	mesofossil type C
JM114a	1.1	0.8		1.38	0.88	1	0.2	0.3	2.67	/	/	/	/	mesofossil type C
JM114d	0.8	0.6		1.33	0.48	1.2	0.2	/	/	/	/	/	/	mesofossil type C
JM124b	0.6	0.4		1.50	0.24	0.4	0.1	0.1	4.00	/	/	/	/	mesofossil type C
JM124c	0.4	0.35		1.14	0.14	0.6	0.1	0.1	3.50	/	/	/	/	mesofossil type C
JM125a	0.7	0.6		1.17	0.42	1.8	0.1	0.2	3.00	/	/	/	/	mesofossil type C
JM125c	0.65	0.45		1.44	0.2925	1.29	0.33	0.33	1.36	/	92	0.33	0.21	mesofossil type C
JM125d	0.75	0.65		1.15	0.4875	1.2	0.15	0.15	4.33	/	124	0.15	0.06	mesofossil type C
JM152b	0.7	0.6		1.17	0.42	1.5	0.2	0.2	3.00	0.5	60	0.2	0.2	mesofossil type C
JM152bii	0.7	0.6		1.17	0.42			0.2	3.00					mesofossil type C
JM154	0.7	0.65		1.08	0.455	1.7	0.15	0.15	4.33	/	/	/	/	mesofossil type C
JM157a	0.6	0.55		1.09	0.33	0.5	0.1	0.1	5.50	/	/	/	/	mesofossil type C
JM160 + c.p.	0.55	0.55		1.00	0.3025	2.2	0.1	0.1	5.50	/	/	0.1	0.1	mesofossil type C
JM166a	0.47	0.47		1.00	0.2209	0.85	0.1	0.1	4.70	/	/	/	/	mesofossil type C
JM178b	0.47	0.4		1.18	0.188	0.6	0.05	0.1	4.00	/	/	/	/	mesofossil type C
JM178bii	0.3	0.3		1.00	0.09			0.1	3.00					mesofossil type C
JM178c	0.45	0.42		1.07	0.189	0.8	0.05	0.1	4.20	/	/	/	/	mesofossil type C
JM178d	0.55	0.42		1.31	0.231	0.8	0.05	0.1	4.20	/	/	/	/	mesofossil type C
JM178e	0.5	0.45		1.11	0.225	0.4	0.1	0.1	4.50	/	/	/	/	mesofossil type C
JM179a	0.65	0.7		0.93	0.455	1.3	0.15	0.15	4.67	/	/	/	/	mesofossil type C
JM181	0.45	0.42		1.07	0.189	0.45	0.1	0.1	4.20	/	/	/	/	mesofossil type C
JM188b	0.55	0.45		1.22	0.2475	1.8	0.15	0.15	3.00	/	/	/	/	mesofossil type C
JM190a	0.4	0.3		1.33	0.12	1.5	0.2	0.1	3.00	0.5	52	0.3	0.1	mesofossil type C

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MESOFOSSILS: TYPE D

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Length-width ratio	Sporangial area (mm2)	Axis length mm	Axis width mm	Width of subending axis mm	Max width to junction width ratio	Distance between sporangia	Axes angle	Axes thickness before branching mm	Axes thickness after branching mm	Identification
JM010f	0.20	0.30	0.67	0.06	1.40	0.15	0.15	2.00	0.00	10.00	0.15	0.15	mesofossil type D
JM010fii	0.15	0.25	0.60	0.04			0.15	1.67					mesofossil type D
JM029a	0.20	0.25	0.80	0.05	0.50	0.10	0.10	2.50	/	/	/	/	mesofossil type D
JM075b	0.30	0.30	1.00	0.09	0.75	0.10	0.10	3.00	/	/	/	/	mesofossil type D
JM083a	0.20	0.20	1.00	0.04	0.30	0.10	0.10	2.00	/				mesofossil type D
JM083b	0.25	0.20	1.25	0.05	0.70	0.10	0.10	2.00	/				mesofossil type D
JM110a	0.18	0.15	1.20	0.03	1.20	0.13	0.11	1.36	0.05	40.00	0.13	0.11	mesofossil type D
JM114c	0.30	0.20	1.50	0.06	3.00	0.10	0.10	2.00	/	/	/	/	mesofossil type D
JM157c	0.22	0.20	1.10	0.04	0.70	0.30	0.10	2.00	0.60	90.00	0.30	0.10	mesofossil type D
JM157cii	0.20	0.20	1.00	0.04			0.10	2.00					mesofossil type D
JM187c	0.20	0.15	1.33	0.03	0.62	0.10	0.08	1.88	0.15	25.00	/	/	mesofossil type D
JM187cii	0.17	0.15	1.13	0.03			0.08	1.88					mesofossil type D
JM194c	0.18	0.18	1.00	0.03	0.50	0.07	0.07	2.57	/	/	/	/	mesofossil type D
JM339	0.25	0.20	1.25	0.05	0.70	0.10	0.10	2.00	/	/	/	/	mesofossil type D
RH128_2	0.25	0.29	0.86	0.07	0.09	0.09	0.10	0.19		33	0.09	0.09	mesofossil type D
RH128_2	0.23	0.26	0.88	0.06	/	/	/	/	/	/	/	/	mesofossil type D
RH050_2	0.15	0.18	0.83	0.03	0.07	0.07	0.10	/		83	0.07	0.07	mesofossil type D
JM290b	0.4	0.3	1.33	0.12	1.6	0.1	0.1	3.00	1	80	0.1	0.1	mesofossil type D
JM290bii	0.4	0.3	1.33	0.12			0.1	3.00					mesofossil type D

MIN	0.15	0.15	0.60	0.03	0.07	0.07	0.07	0.19	0.00	10.00	0.07	0.07	0.07
MAX	0.40	0.30	1.50	0.12	3.00	0.30	0.15	3.00	1.00	90.00	0.30	0.15	0.15
AVERAGE	0.23	0.22	1.06	0.05	0.87	0.12	0.10	2.06	0.36	51.57	0.14	0.10	0.10

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TORTILICAULIS CF. OFFAEUS

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Length-width ratio	Sporangial area (mm2)	Axis length mm	Axis width mm	Width of subrending axis mm	Max width to junction width ratio	Distance between sporangia	Axes angle	Axes thickness before branching mm	Axes thickness after branching mm	Identification
JM397a	0.95	0.45	2.10	0.43	2.00	0.20	0.10	4.50	1.50	60.00	0.30	0.15	Tortilicaulis
JM397aii	0.80	0.40	2.00	0.32	2.00	0.20	0.10	4.00	1.50	60.00	0.30	0.20	Tortilicaulis
RHSp012_1	0.83	0.37	2.24	0.31	0.62	0.18	0.18	2.06	/	/	/	/	Tortilicaulis

1

2

MIN	0.80	0.37	2.00	0.31	0.62	0.18	0.10	2.06	1.50	60.00	0.30	0.15
MAX	0.95	0.45	2.24	0.43	2.00	0.20	0.18	4.50	1.50	60.00	0.30	0.20
AVERAGE	0.86	0.41	2.11	0.35	1.54	0.19	0.13	3.52	1.50	60.00	0.30	0.18

OTHER ELONGATE SPORANGIA

Box / Sample ID	Sporangium max height mm	Sporangium max width mm	Length-width ratio	Sporangial area (mm2)	Axis length mm	Axis width mm	Width of subrending axis mm	Max width to junction width ratio	Distance between sporangia	Axes angle	Axes thickness before branching mm	Axes thickness after branching mm	Identification
1 JM037iii	0.94	0.51	1.84	0.48	1.36	0.12	0.12	4.25	/	/	/	/	elongate
2 JM074b	0.9	0.4	2.25	0.36	1	0.1	0.1	4.00	/	/	/	/	elongate
3 JM095b	0.6	0.31	1.94	0.19	0.34	0.1	0.1	3.10	/	/	/	/	elongate
4 JM280a	0.9	0.45	2.00	0.41	0.45	0.1	0.13	3.46	/	/	/	/	elongate
5 RH005_1	0.35	0.21	1.67	0.07	0.86	0.07	0.07	3.00	/	/	/	/	elongate
6 RH2_8	0.46	0.34	1.35	0.16	1.04	0.07	0.12	2.83	/	/	/	/	elongate
7 RHSp53b	0.9	0.4	2.25	0.36	0.5	0.15	0.18	2.22	/	/	/	/	elongate
8 RH248_1	0.69	0.45	1.53	0.31	/	/	/	/	/	/	/	/	elongate

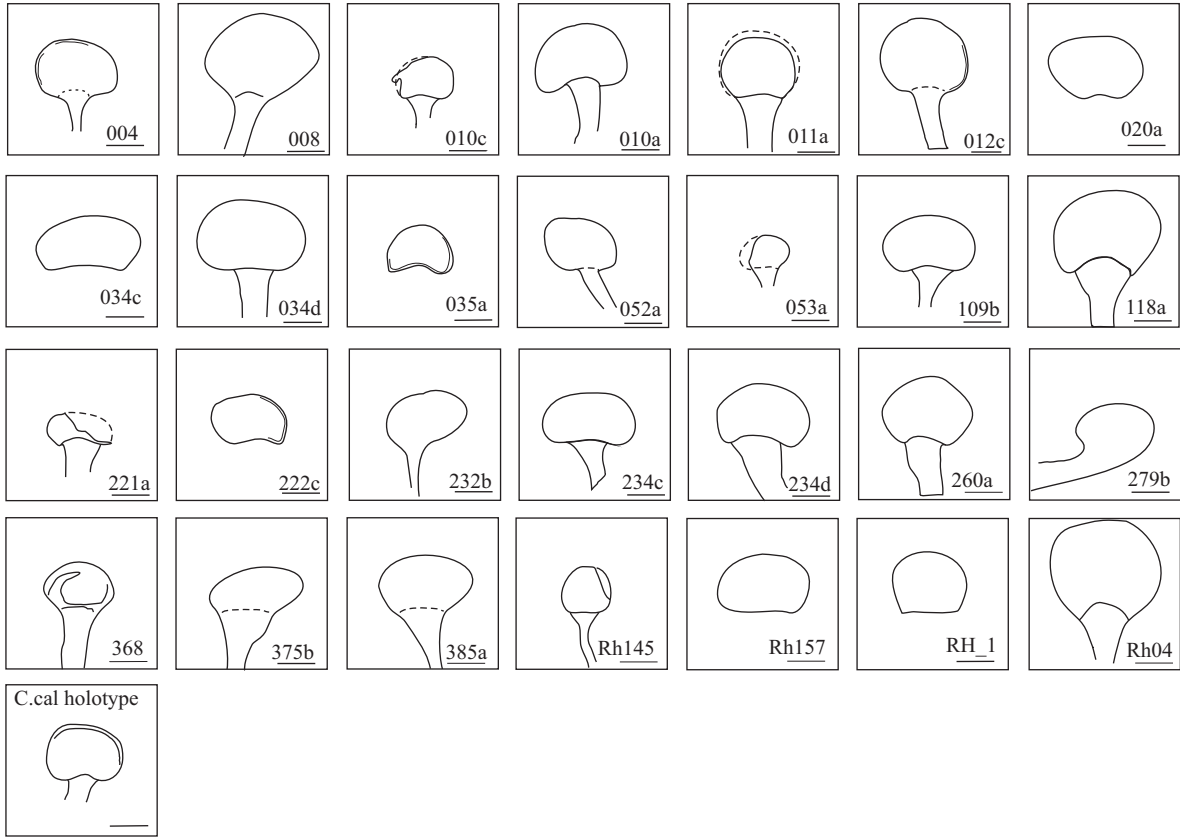
MIN	0.35	0.21	1.35	0.07	0.34	0.07	0.07	2.22	0.00	0.00	0.00	0.00
MAX	0.94	0.51	2.25	0.48	1.36	0.15	0.18	4.25	0.00	0.00	0.00	0.00
AVERAGE	0.72	0.38	1.85	0.29	0.79	0.10	0.12	3.27	/	/	/	/

APPENDIX IV: SHAPES USED IN GEOMETRIC MODELS

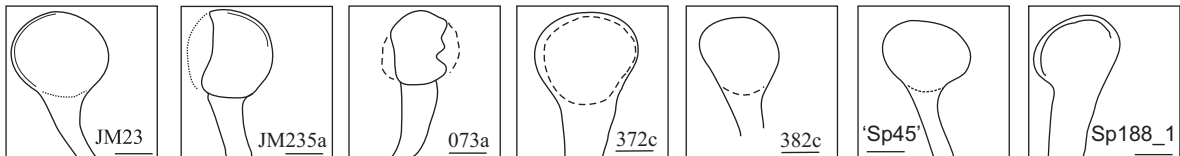
pIV-1 to pIV-6

APPENDIX IV: SHAPES USED IN GEOMETRIC MODELS

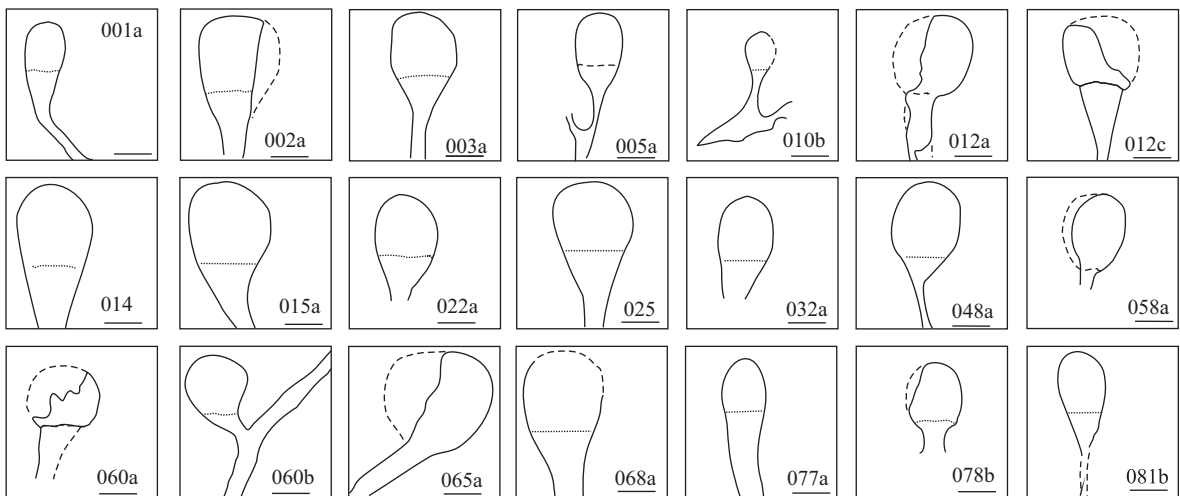
cf. *Cooksonia caledonica* / *Renalia* sp.



Cooksonia cf. *cambrensis*

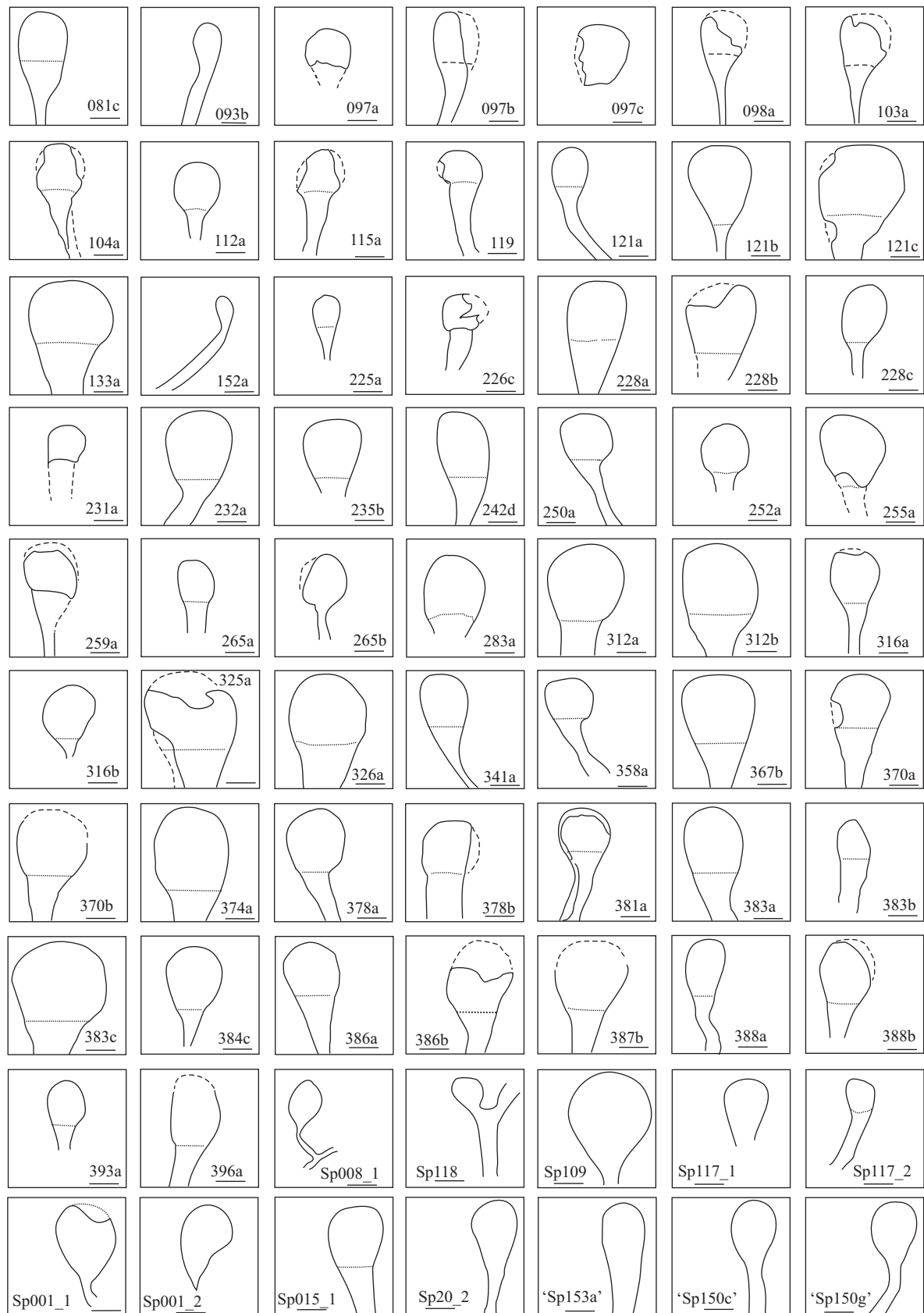


Cooksonia hemisphaerica



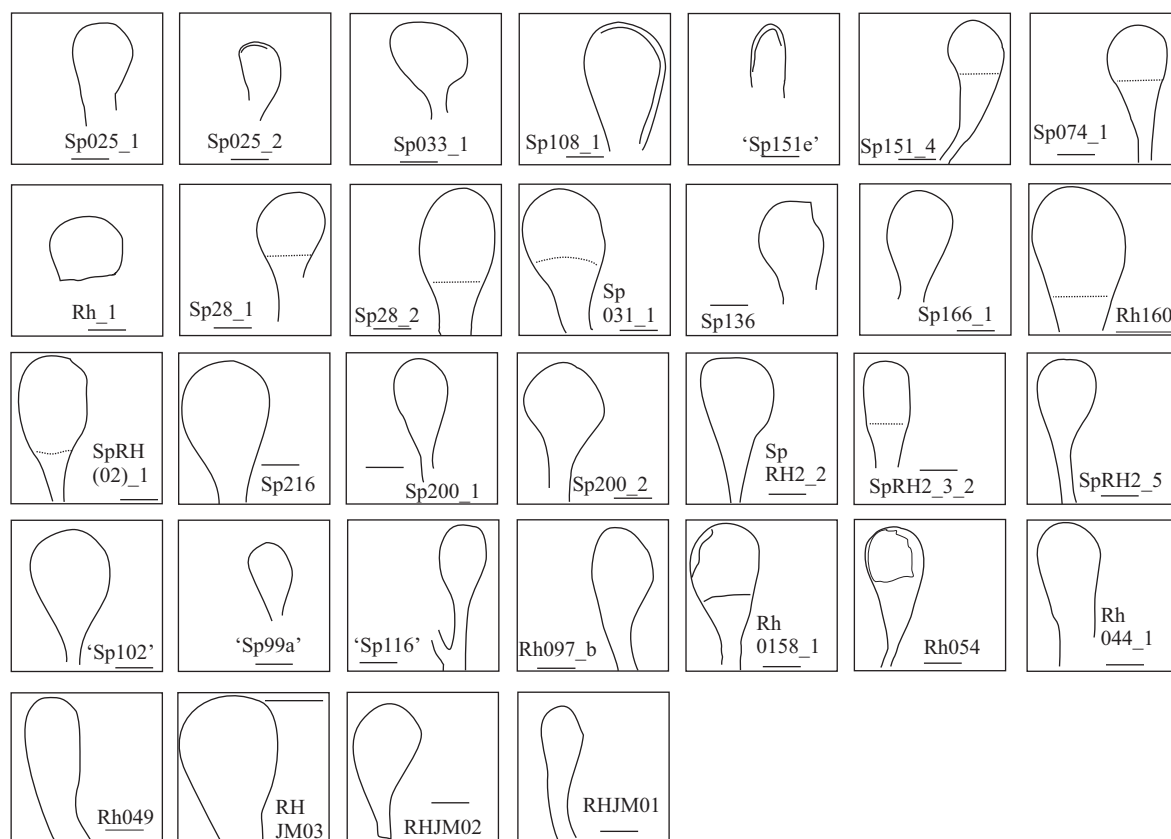
APPENDIX IV: SHAPES USED IN GEOMETRIC MODELS (continued)

Cooksonia hemisphaerica (continued)

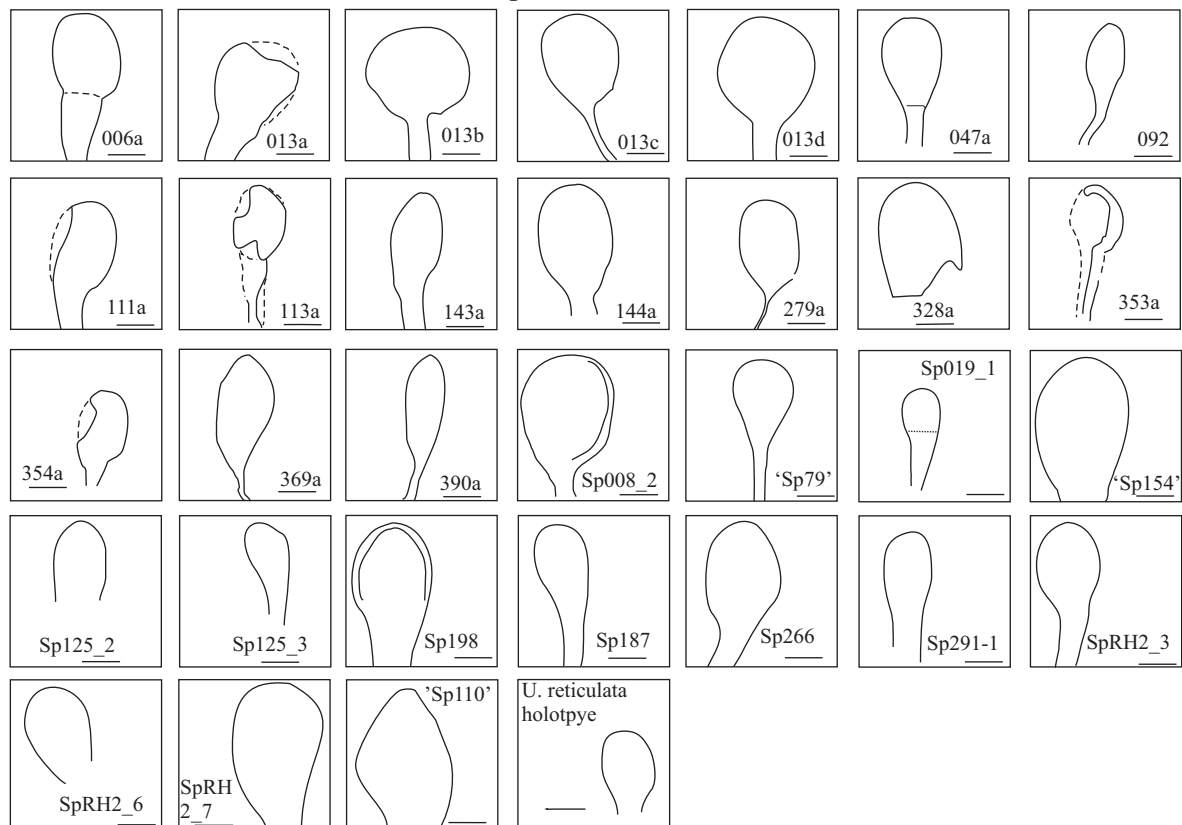


APPENDIX IV: SHAPES USED IN GEOMETRIC MODELS (continued)

Cooksonia hemisphaerica (continued)

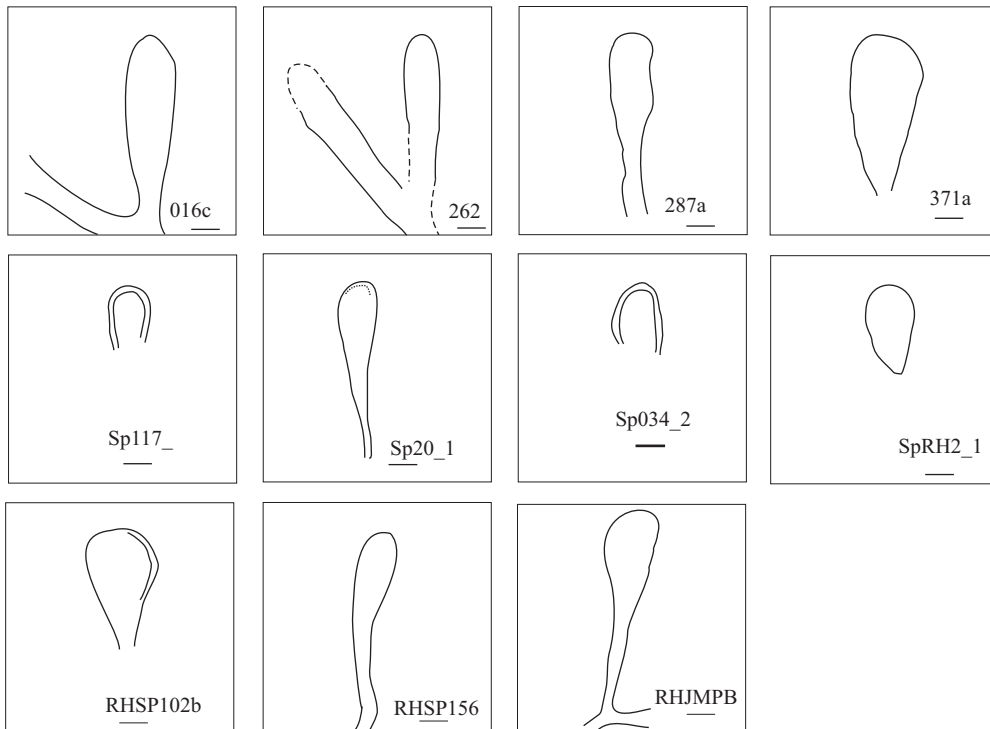


cf. *Uskiella reticulata* / *Tarrantia salopensis*

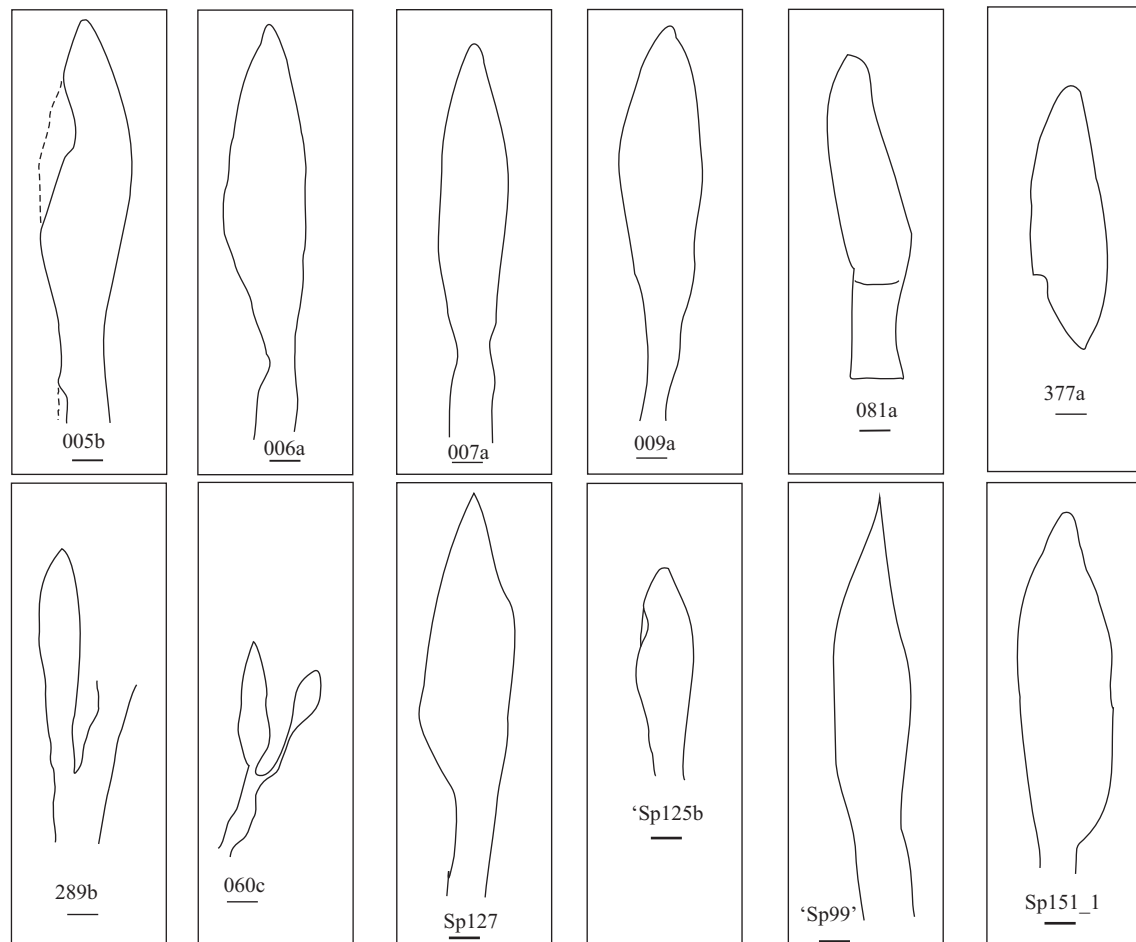


APPENDIX IV: SHAPES USED IN GEOMETRIC MODELS (continued)

Elongate club-shaped sporangia

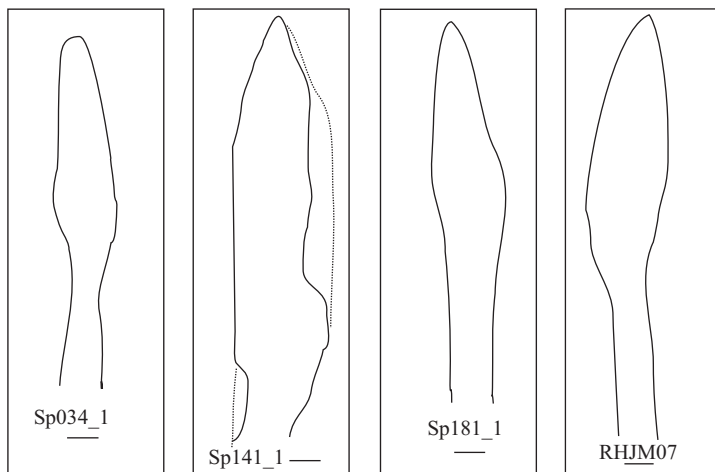


Salopella allenii

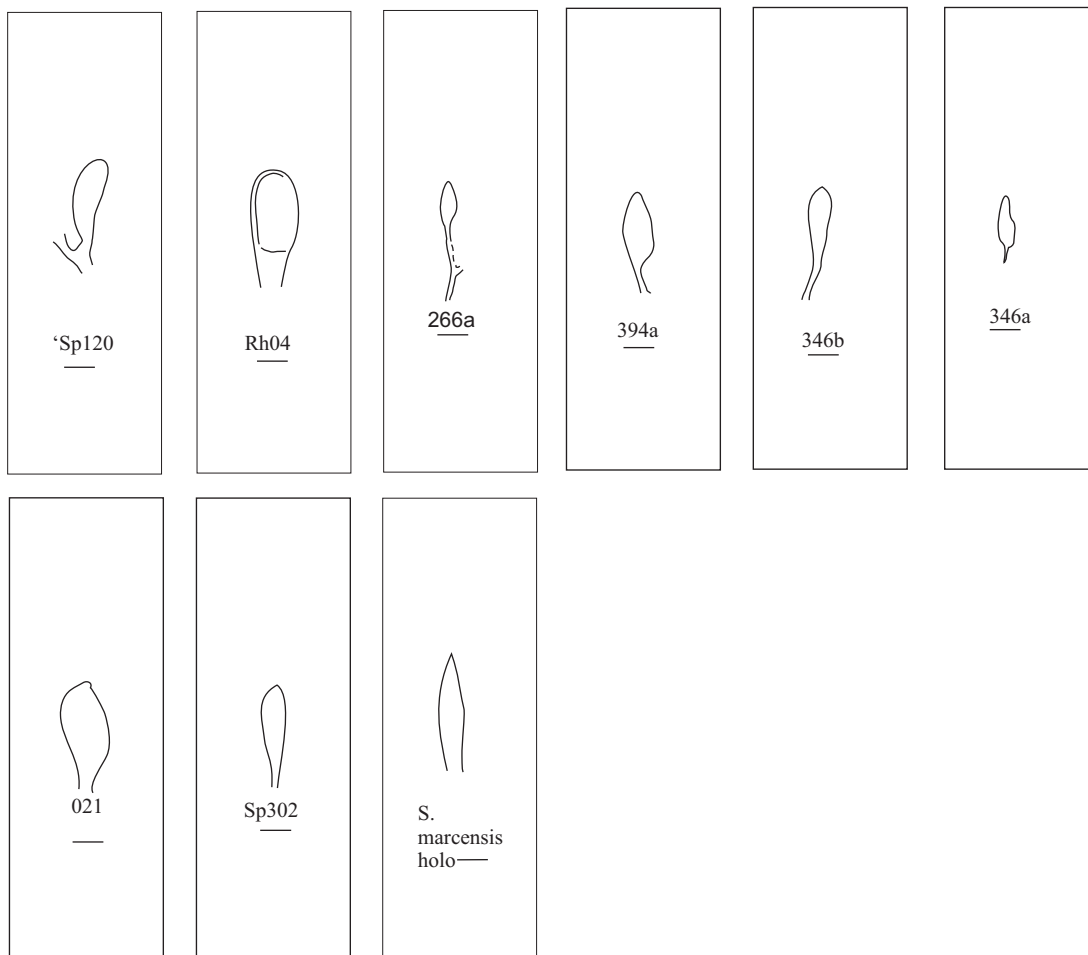


APPENDIX IV: SHAPES USED IN GEOMETRIC MODELS (continued)

Salopella allenii (continued)



Salopella cf. *marcensis*



APPENDIX V: PALYNOLOGICAL COUNTS AND MEASUREMENTS

- a: Palynological assemblages collected from Tredomen Quarry surface and core..... pV-2*
- b: Palynological counts of each assemblage..... pV-3*
- c: Spore morphotypes..... pV-27*
- d: Spore size ranges..... on DVD*

References numbered:

1. Wellman and Richardson 1993
2. Wellman 1996
3. Strother and Traverse 1979
4. Burgess 1991
5. Richardson 1996
6. Johnson 1985
7. Burgess and Richardson 1991
8. Wellman and Richardson 1996
9. Burgess and Richardson 1995
10. Richardson and Lister 1969
11. Streel 1967
12. Hoffmeister 1959

APPENDIX Va : PALYNOLOGICAL ASSEMBLAGES COLLECTED FROM TREDOMEN QUARRY SURFACE AND CORE

Location	Sample number	Assemblage	Depth from surface in m	Lithofacies	Productive sporomorph assemblage?	Date
Quarry Surface	BH1-6	1	0.00	Green fine-grained sandstone and siltstones	Yes	Spring 2006
Quarry Surface	PB0	/	0.00	Green intraformational conglomerates	No	Autumn 2006
Borehole 1	BH1-1	2	11.28	Green fine-grained trough-cross-bedded sandstones	Yes	Spring 2006
Borehole 1	PB1	3	11.80	Green medium-grained planar-bedded sandstones	Yes	Autumn 2006
Borehole 2	PB4	/	21.30 (7.30)	Green medium grained cross-bedded sandstone	No	Autumn 2006
Borehole 2	BH2-1	4	21.60 (7.60)	Green planar-laminated mudstone	Yes	Autumn 2006
Borehole 1	PB2	/	22.50	Green medium grained planar-bedded sandstones	No	Autumn 2006
Borehole 2	PB5		22.70 (8.70)	Green medium grained planar-bedded sandstones	No	Autumn 2006
Borehole 1	BH1-2	/	23.20	Green mudstone to siltstone - no bedding	No	Spring 2006
Borehole 1	BH1-3	5	28.20	Green planar-laminated siltstones	Yes	Spring 2006
Borehole 2	BH2-2	/	28.45 (14.45)	Green planar-laminated siltstones	No	Autumn 2006
Borehole 2	PB6	/	28.80 (14.80)	Green fine-grained trough-cross-bedded sandstones	No	Autumn 2006
Borehole 1	BH1-4	/	30.30	Green intraformational conglomerates	No	Spring 2006
Borehole 1	PB3	/	30.80	Green intraformational conglomerates	No	Autumn 2006
Borehole 1	BH1-5	/	30.90	Green intraformational conglomerates (gravel clasts)	No	Spring 2006
Borehole 2	BH2-3	/	51.20 (37.20)	Green cross-ripple and wavy -laminated siltstones	No	Autumn 2006
Borehole 2	BH2-4	/	51.40 (37.40)	Green cross-ripple and wavy -laminated siltstones	No	Autumn 2006
Borehole 2	PB7	/	51.70 (37.70)	Green intraformational conglomerate	No	Autumn 2006

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 6 (0m - QUARRY SURFACE)

Cryptospores		<i>n</i>
Naked		
Permanent fused tetrads		
Laevigati	<i>Cheilotetras caledonica</i>	9
	<i>Cheilotetras</i> sp.	5
Sculptured	Fused apiculate tetrad	0
	Fused verrucate tetrad	4
	Fused murornate tetrad	3
Permanent unfused tetrads		
Laevigati	<i>Tetrahedraletes medinensis</i> var. <i>medinensis</i>	12
	<i>Tetrahedraletes medinensis</i> var. <i>parvus</i>	13
	<i>Rimosotetras problematica</i>	1
Apiculati	<i>Acontotetras inconspicua</i>	0
	Tetrad of <i>Cymbohilates cymosus</i>	1
Synorati	Tetrad of <i>Chelinohilates erraticus</i>	4
	Tetrad of <i>Hispanaediscus verrucatus</i>	2
	Tetrad of <i>Hispanaediscus wenlockensis</i>	1
Total		55
Triads		
Apiculati	Apiculate triad	2
Synorati	Murornate triad	1
	Verrucate triad	1
Total		4
Pseudodyads		
Laevigati	<i>Pseudodyadospora</i> cf. <i>laevigata</i>	2
	<i>Pseudodyadospora petasus</i>	9
Total		11
True dyads		
Laevigati	<i>Dyadospora murusattenuata</i>	4
	<i>Dyadospora murusdensa</i>	10
Apiculati	Dyads of <i>Cymbohilates allenii</i> var. <i>magnus</i>	0
	Dyads of <i>Cymbohilates cymosus</i>	2
	Dyads of <i>Cymbohilates disponerus</i>	2
	Dyads of <i>Cymbohilates horridus</i>	1
	Dyads of <i>Cymbohilates horridus</i> var. A	0
	Dyads of <i>Cymbohilates</i> cf. <i>microgranulatus</i>	0
	Dyads of <i>Cymbohilates variabilis</i> var. <i>variabilis</i>	0
	Dyads of <i>Cymbohilates variabilis</i> var. B	2
	Dyads of <i>Chelinohilates erraticus</i>	2
Synorati	Dyads of <i>Chelinohilates sinuosus</i> var. <i>sinuosus</i>	1
	Dyads of <i>Hispanaediscus verrucatus</i>	3
Total		27

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 6 (0m - QUARRY SURFACE) (CONTINUED)

Hilates		
Laevigati	<i>Artemopyra</i> sp. A (?sp. nov.)	0
	<i>Artemopyra</i> cf. <i>robusta</i>	0
	<i>Laevolancis divellomedia</i>	25
	<i>Laevolancis plicata</i>	2
Apiculati	<i>Cymbohilates allenii</i> var. <i>allenii</i>	4
	<i>Cymbohilates allenii</i> var. <i>magnus</i>	4
	<i>Cymbohilates</i> cf. <i>amplus</i>	2
	<i>Cymbohilates cymosus</i>	1
	<i>Cymbohilates disponerus</i>	0
	<i>Cymbohilates horridus</i> var. A (?sp. nov.)	5
	<i>Cymbohilates</i> cf. <i>horridus</i>	0
	<i>Cymbohilates</i> cf. <i>microgranulatus</i>	0
	<i>Cymbohilates variabilis</i> var. <i>parvidecus</i>	3
	<i>Cymbohilates variabilis</i> var. <i>variabilis</i>	2
	<i>Cymbohilates variabilis</i> var. B (?sp. nov.)	1
	<i>Cymbohilates</i> spp.	0
Synorati	<i>Chelinohilates erraticus</i>	26
	<i>Chelinohilates</i> cf. <i>lornensis</i>	0
	<i>Chelinohilates sinuosus</i> var. <i>angustus</i>	0
	<i>Chelinohilates sinuosus</i> var. <i>sinuosus</i>	1
	<i>Chelinohilates</i> spp.	1
	<i>Chelinohilates</i> sp. A (?sp. nov.)	2
	<i>Hispanaediscus verrucatus</i>	0
	<i>Hispanaediscus</i> cf. <i>verrucatus</i>	0
	<i>Hispanaediscus wenlockensis</i>	0
	<i>Hispanaediscus major</i>	0
	<i>Hispanaediscus</i> cf. <i>major</i>	0
Total		79
Non-hilates		
Laevigati	Laevigate alete monads	9
Total		9
Enveloped		
Permanent unfused tetrads		
Apiculati	<i>Velatitetras</i> sp. B. (?sp. nov.)	0
Synorati	<i>Velatitetras</i> cf. <i>cristata</i>	0
	<i>Velatitetras</i> cf. <i>reticulata</i>	4
	<i>Velatitetras rugulata</i>	0
	<i>Velatitetras</i> sp. C (?sp. nov.)	2
Total		6
Permanent unfused dyads		
Synorati	<i>Abditusdyadus histosus</i>	2
Total		2
Permanent fused dyads		
Synorati	<i>Segestrespora</i> cf. <i>membranifera</i>	1
Total		1
Non-hilates		
Synorati	<i>Qualisaspora sinuata</i>	2
Total		2

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 6 (0m - QUARRY SURFACE) (CONTINUED)

Incertae sedis		
?Enveloped spactulate cryptospores		
	Monads	2
	Dyads	2
?Enveloped cluster spinose cryptospores		
	Monads	1
	Dyads	1
	Tetrads	1
?Enveloped slender spinose cryptospores		
	Monads	2
?Enveloped apiculate cryptospores		
	Monads	1
?Enveloped murornate cryptospores		
	Monads with broad muri	0
	Monads with sinuous muri	0
?Enveloped verrucate cryptospores		
	Monads	0
Total		10
Unidentified cryptospores		7
Cryptospore total		213
Trilete spores		
Laevigate		
Retusoid	<i>Retusotriletes dittonensis</i>	0
	<i>Retusotriletes</i> cf. <i>dittonensis</i>	2
	<i>Retusotriletes</i> cf. <i>triangulatus</i>	0
	<i>Retusotriletes</i> cf. <i>triangulatus</i> var. <i>minor</i> (var. nov.)	0
	<i>Retusotriletes</i> spp.	2
Crassitate	<i>Ambitisporites avitus</i>	3
	<i>Ambitisporites avitus</i> var. <i>minor</i> (var. nov.)	3
	<i>Ambitisporites dilutus</i>	5
	<i>Ambitisporites</i> spp.	1
	<i>Ambitisporites</i> sp. A (?sp. nov.)	0
	<i>Ambitisporites warringtonii</i>	6
Patinate	<i>Archaeozonotriletes chulus</i> var. <i>inframurinus</i>	1
	<i>Archaeozonotriletes chulus</i> var. <i>chulus</i>	0
	<i>Archaeozonotriletes chulus</i> var. <i>nanus</i>	2
	<i>Archaeozonotriletes</i> spp.	1
Tetrad	Laevigate tetrad (? <i>Ambitisporites</i> spp.)	2
Total		28

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 6 (0m - QUARRY SURFACE) (CONTINUED)

Sculptured		
Retusoid	<i>Apiculiretusispora</i> spp.	1
	<i>Emphanisporites</i> spp.	0
	<i>Emphanisporites protophanus</i>	0
	<i>Emphanisporites</i> sp. B	0
Crassitate	<i>Streelispora</i> spp./ <i>Aneurospora</i> spp.	2
	<i>Aneurospora</i> sp.	6
	<i>Streelispora newportensis</i>	1
	<i>Scylaspora</i> sp.	0
	<i>Scylaspora</i> cf. <i>scripta</i>	0
	<i>Scylaspora downiei</i>	0
	<i>Scylaspora</i> cf. <i>kozlica</i>	0
	<i>Synorisporites</i> sp.	0
	<i>Synorisporites tripapillatus</i>	1
Patinate	<i>Chelinospora</i> spp.	4
Perispore	? <i>Perotrilites microbaculatus</i>	2
Tetrad	Tetrad of <i>Aneurospora</i> / <i>Streelispora</i>	2
Total		19
Unidentified triletes		7
Trilete total		54
Acritarch		5
Cuticle		2
Tube		4
Modern pollen grain		3
Unidentified		1
Sediment grain		1
TOTAL		283
SUB TOTAL (- others and unidentified)		258

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 1 (11.28m - BH1-1)

Cryptospores		<i>n</i>
Naked		
Permanent fused tetrads		
Laevigati	<i>Cheilotetras caledonica</i>	6
	<i>Cheilotetras</i> sp.	0
Sculptured	Fused apiculate tetrad	0
	Fused verrucate tetrad	2
	Fused murornate tetrad	0
Permanent unfused tetrads		
Laevigati	<i>Tetrahedraletes medinensis</i> var. <i>medinensis</i>	15
	<i>Tetrahedraletes medinensis</i> var. <i>parvus</i>	15
	<i>Rimosotetras problematica</i>	0
Apiculati	<i>Acontotetras inconspicua</i>	0
	Tetrad of <i>Cymbohilates cymosus</i>	0
Synorati	Tetrad of <i>Chelinohilates erraticus</i>	1
	Tetrad of <i>Hispanaediscus verrucatus</i>	4
	Tetrad of <i>Hispanaediscus wenlockensis</i>	0
Total		43
Triads		
Apiculati	Apiculate triad	0
Synorati	Murornate triad	0
	Verrucate triad	0
Total		0
Pseudodyads		
Laevigati	<i>Pseudodyadospora</i> cf. <i>laevigata</i>	2
	<i>Pseudodyadospora petasus</i>	5
Total		7
True dyads		
Laevigati	<i>Dyadospora murusattenuata</i>	6
	<i>Dyadospora murusdensa</i>	14
Apiculati	Dyads of <i>Cymbohilates allenii</i> var. <i>magnus</i>	0
	Dyads of <i>Cymbohilates cymosus</i>	0
	Dyads of <i>Cymbohilates disponerus</i>	0
	Dyads of <i>Cymbohilates horridus</i>	1
	Dyads of <i>Cymbohilates horridus</i> var. A	1
	Dyads of <i>Cymbohilates</i> cf. <i>microgranulatus</i>	0
	Dyads of <i>Cymbohilates variabilis</i> var. <i>variabilis</i>	0
	Dyads of <i>Cymbohilates variabilis</i> var. B	0
	Dyads of <i>Chelinohilates erraticus</i>	1
Synorati	Dyads of <i>Chelinohilates sinuosus</i> var. <i>sinuosus</i>	0
	Dyads of <i>Hispanaediscus verrucatus</i>	0
Total		23

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 1 (11.28m - BH1-1) (CONTINUED)

Hilates		
Laevigati	<i>Artemopyra</i> sp. A (?sp. nov.)	0
	<i>Artemopyra</i> cf. <i>robusta</i>	0
	<i>Laevolancis divellomedia</i>	59
	<i>Laevolancis plicata</i>	9
Apiculati	<i>Cymbohilates allenii</i> var. <i>allenii</i>	3
	<i>Cymbohilates allenii</i> var. <i>magnus</i>	9
	<i>Cymbohilates</i> cf. <i>amplus</i>	1
	<i>Cymbohilates cymosus</i>	0
	<i>Cymbohilates disponerus</i>	0
	<i>Cymbohilates horridus</i> var. A (?sp. nov.)	1
	<i>Cymbohilates</i> cf. <i>horridus</i>	0
	<i>Cymbohilates</i> cf. <i>microgranulatus</i>	3
	<i>Cymbohilates variabilis</i> var. <i>parvidecus</i>	1
	<i>Cymbohilates variabilis</i> var. <i>variabilis</i>	1
	<i>Cymbohilates variabilis</i> var. B (?sp. nov.)	0
	<i>Cymbohilates</i> spp.	0
Synorati	<i>Chelinohilates erraticus</i>	3
	<i>Chelinohilates</i> cf. <i>lornensis</i>	1
	<i>Chelinohilates sinuosus</i> var. <i>angustus</i>	0
	<i>Chelinohilates sinuosus</i> var. <i>sinuosus</i>	0
	<i>Chelinohilates</i> spp.	5
	<i>Chelinohilates</i> sp. A (?sp. nov.)	0
	<i>Hispanaediscus verrucatus</i>	2
	<i>Hispanaediscus</i> cf. <i>verrucatus</i>	0
	<i>Hispanaediscus wenlockensis</i>	0
	<i>Hispanaediscus major</i>	1
	<i>Hispanaediscus</i> cf. <i>major</i>	1
Total		100
Non-hilates		
Laevigati	Laevigate alete monads	20
Total		20
Enveloped		
Permanent unfused tetrads		
Apiculati	<i>Velatitetras</i> sp. B. (?sp. nov.)	1
Synorati	<i>Velatitetras</i> cf. <i>cristata</i>	1
	<i>Velatitetras</i> cf. <i>reticulata</i>	0
	<i>Velatitetras rugulata</i>	3
	<i>Velatitetras</i> sp. C (?sp. nov.)	0
Total		5
Permanent unfused dyads		
Synorati	<i>Abditusdyadus histosus</i>	1
Total		1
Permanent fused dyads		
Synorati	<i>Segestrespora</i> cf. <i>membranifera</i>	0
Total		0
Non-hilates		
Synorati	<i>Qualiaspora sinuata</i>	0
Total		0

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 1 (11.28m - BH1-1) (CONTINUED)

Incertae sedis		
?Enveloped spactulate cryptospores		
	Monads	0
	Dyads	0
?Enveloped cluster spinose cryptospores		
	Monads	3
	Dyads	0
	Tetrads	0
?Enveloped slender spinose cryptospores		
	Monads	0
?Enveloped apiculate cryptospores		
	Monads	0
?Enveloped murornate cryptospores		
	Monads with broad muri	0
	Monads with sinuous muri	0
?Enveloped verrucate cryptospores		
	Monads	0
Total		3
Unidentifiable cryptospores		7
Cryptospore total		209
Trilete spores		
Laevigate		
Retusoid	<i>Retusotriletes dittonensis</i>	1
	<i>Retusotriletes</i> cf. <i>dittonensis</i>	2
	<i>Retusotriletes</i> cf. <i>triangulatus</i>	4
	<i>Retusotriletes</i> cf. <i>triangulatus</i> var. <i>minor</i> (var. nov.)	11
	<i>Retusotriletes</i> spp.	2
Crassitate	<i>Ambitisporites avitus</i>	5
	<i>Ambitisporites avitus</i> var. <i>minor</i> (var. nov.)	5
	<i>Ambitisporites dilutus</i>	6
	<i>Ambitisporites</i> spp.	4
	<i>Ambitisporites</i> sp. A (?sp. nov.)	1
	<i>Ambitisporites warringtonii</i>	4
Patinate	<i>Archaeozonotriletes chulus</i> var. <i>inframurinus</i>	0
	<i>Archaeozonotriletes chulus</i> var. <i>chulus</i>	0
	<i>Archaeozonotriletes chulus</i> var. <i>nanus</i>	0
	<i>Archaeozonotriletes</i> spp.	0
Tetrad	Laevigate tetrad (? <i>Ambitisporites</i> spp.)	0
Total		45

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 1 (11.28m - BH1-1) (CONTINUED)

Sculptured		
Retusoid	<i>Apiculiretusispora</i> spp.	1
	<i>Emphanisporites</i> spp.	2 ?
	<i>Emphanisporites protophanus</i>	2
	<i>Emphanisporites</i> sp. B	0
Crassitate	<i>Streelispota</i> spp./ <i>Aneurospora</i> spp.	0
	<i>Aneurospora</i> sp.	0
	<i>Streelispota newportensis</i>	0
	<i>Scylaspora</i> sp.	0
	<i>Scylaspora</i> cf. <i>scripta</i>	0 ?
	<i>Scylaspora downiei</i>	2
	<i>Scylaspora</i> cf. <i>kozlica</i>	0
	<i>Synorisporites</i> sp.	0
	<i>Synorisporites tripapillatus</i>	0
Patinate	<i>Chelinospora</i> spp.	0
Perispore	? <i>Perotrilites microbaculatus</i>	2
Tetrad	Tetrad of <i>Aneurospora</i> / <i>Streelispota</i>	0
Total		9
Unidentified triletes		6
Trilete total		60
Acritarch		4
Cuticle		4
Tube		6
Modern pollen grain		0
Unidentified/ Other		6
Sediment grain		0
TOTAL		289
SUB TOTAL (- others and unidentified)		260

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 2 (11.80m - PB1)**Cryptospores****Naked****Permanent fused tetrads**

Laevigati	<i>Cheilotetras caledonica</i>	1
	<i>Cheilotetras</i> sp.	0
Sculptured	Fused apiculate tetrad	0
	Fused verrucate tetrad	6
	Fused murornate tetrad	1

Permanent unfused tetrads

Laevigati	<i>Tetrahedraletes medinensis</i> var. <i>medinensis</i>	4
	<i>Tetrahedraletes medinensis</i> var. <i>parvus</i>	5
	<i>Rimosotetras problematica</i>	0
Apiculati	<i>Acontotetras inconspicua</i>	1
	Tetrad of <i>Cymbohilates disponerus</i>	1
Synorati	Tetrad of <i>Chelinohilates erraticus</i>	1
	Tetrad of <i>Hispanaediscus verrucatus</i>	0
	Tetrad of <i>Hispanaediscus wenlockensis</i>	0

Total 20**Triads**

Apiculati	Apiculate triad	0
Synorati	Murornate triad	0
	Verrucate triad	0

Total 0**Pseudodyads**

Laevigati	<i>Pseudodyadospora</i> cf. <i>laevigata</i>	1
	<i>Pseudodyadospora petasus</i>	7

Total 8**True dyads**

Laevigati	<i>Dyadospora murusattenuata</i>	2
	<i>Dyadospora murusdensa</i>	12
Apiculati	Dyads of <i>Cymbohilates allenii</i> var. <i>magnus</i>	0
	Dyads of <i>Cymbohilates cymosus</i>	0
	Dyads of <i>Cymbohilates disponerus</i>	4
	Dyads of <i>Cymbohilates horridus</i>	0
	Dyads of <i>Cymbohilates horridus</i> var. A	1
	Dyads of <i>Cymbohilates</i> cf. <i>microgranulatus</i>	0
	Dyads of <i>Cymbohilates variabilis</i> var. <i>variabilis</i>	0
	Dyads of <i>Cymbohilates variabilis</i> var. B	0
	Dyads of <i>Chelinohilates erraticus</i>	2
Synorati	Dyads of <i>Chelinohilates sinuosus</i> var. <i>sinuosus</i>	0
	Dyads of <i>Hispanaediscus verrucatus</i>	0

Total 21

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 2 (11.80m - PB1) (CONTINUED)

Hilates		
Laevigati	<i>Artemopyra</i> sp. A (?sp. nov.)	0
	<i>Artemopyra</i> cf. <i>robusta</i>	0
	<i>Laevolancis divellomedia</i>	45
	<i>Laevolancis plicata</i>	2
Apiculati	<i>Cymbohilates allenii</i> var. <i>allenii</i>	2
	<i>Cymbohilates allenii</i> var. <i>magnus</i>	6
	<i>Cymbohilates</i> cf. <i>amplus</i>	0
	<i>Cymbohilates cymosus</i>	0
	<i>Cymbohilates disponerus</i>	13
	<i>Cymbohilates horridus</i> var. A (?sp. nov.)	1
	<i>Cymbohilates</i> cf. <i>horridus</i>	0
	<i>Cymbohilates</i> cf. <i>microgranulatus</i>	2
	<i>Cymbohilates variabilis</i> var. <i>parvidecus</i>	5
	<i>Cymbohilates variabilis</i> var. <i>variabilis</i>	4
	<i>Cymbohilates variabilis</i> var. B (?sp. nov.)	1
	<i>Cymbohilates</i> spp.	3
Synorati	<i>Chelinohilates erraticus</i>	3
	<i>Chelinohilates</i> cf. <i>lornensis</i>	0
	<i>Chelinohilates sinuosus</i> var. <i>angustus</i>	0
	<i>Chelinohilates sinuosus</i> var. <i>sinuosus</i>	0
	<i>Chelinohilates</i> spp.	0
	<i>Chelinohilates</i> sp. A (?sp. nov.)	0
	<i>Hispanaediscus verrucatus</i>	3
	<i>Hispanaediscus</i> cf. <i>verrucatus</i>	0
	<i>Hispanaediscus wenlockensis</i>	2
	<i>Hispanaediscus major</i>	0
	<i>Hispanaediscus</i> cf. <i>major</i>	0
Total		92
Non-hilates		
Laevigati	Laevigate alete monads	2
Total		2
Enveloped		
Permanent unfused tetrads		
Apiculati	<i>Velatitetras</i> sp. B. (?sp. nov.)	0
Synorati	<i>Velatitetras</i> cf. <i>cristata</i>	0
	<i>Velatitetras</i> cf. <i>reticulata</i>	1
	<i>Velatitetras rugulata</i>	0
	<i>Velatitetras</i> sp. C (?sp. nov.)	0
Total		1
Permanent unfused dyads		
Synorati	<i>Abditusdyadus histosus</i>	0
Total		0
Permanent fused dyads		
Synorati	<i>Segestrespora</i> cf. <i>membranifera</i>	0
Total		0
Non-hilates		
Synorati	<i>Qualisaspora sinuata</i>	0
Total		0

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 2 (11.80m - PB1) (CONTINUED)

Incertae sedis		
?Enveloped spactulate cryptospores		
	Monads	0
	Dyads	0
?Enveloped cluster spinose cryptospores		
	Monads	0
	Dyads	0
	Tetrads	0
?Enveloped slender spinose cryptospores		
	Monads	0
?Enveloped apiculate cryptospores		
	Monads	0
?Enveloped murornate cryptospores		
	Monads with broad muri	1
	Monads with sinuous muri	0
?Enveloped verrucate cryptospores		
	Monads	0
Total		1
Unidentifiable cryptospores		0
Cryptospore total		145
Trilete spores		
Laevigate		
Retusoid	<i>Retusotriletes dittonensis</i>	2
	<i>Retusotriletes</i> cf. <i>dittonensis</i>	1
	<i>Retusotriletes</i> cf. <i>triangulatus</i>	0
	<i>Retusotriletes</i> cf. <i>triangulatus</i> var. <i>minor</i> (var. nov.)	0
	<i>Retusotriletes</i> spp.	2
Crassitate	<i>Ambitisporites avitus</i>	2
	<i>Ambitisporites avitus</i> var. <i>minor</i> (var. nov.)	6
	<i>Ambitisporites dilutus</i>	2
	<i>Ambitisporites</i> spp.	3
	<i>Ambitisporites</i> sp. A (?sp. nov.)	0
	<i>Ambitisporites warringtonii</i>	3
Patinate	<i>Archaeozonotriletes chulus</i> var. <i>inframurinus</i>	0
	<i>Archaeozonotriletes chulus</i> var. <i>chulus</i>	0
	<i>Archaeozonotriletes chulus</i> var. <i>nanus</i>	0
	<i>Archaeozonotriletes</i> spp.	0
Tetrad	Laevigate tetrad (? <i>Ambitisporites</i> spp.)	0
Total		21

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 2 (11.80m - PB1) (CONTINUED)

Sculptured		
Retusoid	<i>Apiculiretusispora</i> spp.	6
	<i>Emphanisporites</i> spp.	0
	<i>Emphanisporites protophanus</i>	0
	<i>Emphanisporites</i> sp. B	1
Crassitate	<i>Streelispota</i> spp./ <i>Aneurospora</i> spp.	8
	<i>Aneurospora</i> sp.	6
	<i>Streelispota newportensis</i>	0
	<i>Scylaspora</i> sp.	0 ?
	<i>Scylaspora</i> cf. <i>scripta</i>	0
	<i>Scylaspora downiei</i>	3
	<i>Scylaspora</i> cf. <i>kozlica</i>	0
	<i>Synorisporites</i> sp.	5
	<i>Synorisporites tripapillatus</i>	0
Patinate	<i>Chelinospora</i> spp.	0
Perispore	? <i>Perotrilites microbaculatus</i>	0
Tetrad	Tetrad of <i>Aneurospora</i> / <i>Streelispota</i>	0
Total		29
Unidentified triletes	PB064	1
Trilete total		51
Acritarch		4
Cuticle		0
Tube		0
Modern pollen grain		0
Unidentified/ Other		0
Sediment grain		0
TOTAL		200
SUB TOTAL (- others and unidentified)		199

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 2 - SAMPLE 1 (7.6m BH2 correlated with 21.6m in BH1)**Cryptospores****Naked****Permanent fused tetrads**

Laevigati	<i>Cheilotetras caledonica</i>	3
	<i>Cheilotetras</i> sp.	1
Sculptured	Fused apiculate tetrad	0
	Fused verrucate tetrad	2
	Fused murornate tetrad	0

Permanent unfused tetrads

Laevigati	<i>Tetrahedraletes medinensis</i> var. <i>medinensis</i>	8
	<i>Tetrahedraletes medinensis</i> var. <i>parvus</i>	7
	<i>Rimosotetras problematica</i>	0
Apiculati	<i>Acontotetras inconspicua</i>	5
	Tetrad of <i>Cymbohilates disponerus</i>	1
Synorati	Tetrad of <i>Chelinohilates erraticus</i>	1
	Tetrad of <i>Hispanaediscus verrucatus</i>	1
	Tetrad of <i>Hispanaediscus wenlockensis</i>	0

Total 29**Triads**

Apiculati	Apiculate triad	0
Synorati	Murornate triad	0
	Verrucate triad	1

Total 1**Pseudodyads**

Laevigati	<i>Pseudodyadospora</i> cf. <i>laevigata</i>	3
	<i>Pseudodyadospora petasus</i>	9

Total 12**True dyads**

Laevigati	<i>Dyadospora murusattenuata</i>	2
	<i>Dyadospora murusdensa</i>	17
Apiculati	Dyads of <i>Cymbohilates allenii</i> var. <i>magnus</i>	1
	Dyads of <i>Cymbohilates cymosus</i>	0
	Dyads of <i>Cymbohilates disponerus</i>	0
	Dyads of <i>Cymbohilates horridus</i>	0
	Dyads of <i>Cymbohilates horridus</i> var. A	0
	Dyads of <i>Cymbohilates</i> cf. <i>microgranulatus</i>	1
	Dyads of <i>Cymbohilates variabilis</i> var. <i>variabilis</i>	2
	Dyads of <i>Cymbohilates variabilis</i> var. B	0
	Dyads of <i>Chelinohilates erraticus</i>	9
Synorati	Dyads of <i>Chelinohilates sinuosus</i> var. <i>sinuosus</i>	0
	Dyads of <i>Hispanaediscus verrucatus</i>	1

Total 33

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 2 - SAMPLE 1 (7.6m BH2 correlated with 21.6m in BH1) (CONTINUED)

Hilates		
Laevigati	<i>Artemopyra</i> sp. A (?sp. nov.)	1
	<i>Artemopyra</i> cf. <i>robusta</i>	1
	<i>Laevolancis divellomedia</i>	47
	<i>Laevolancis plicata</i>	13
Apiculati	<i>Cymbohilates allenii</i> var. <i>allenii</i>	2
	<i>Cymbohilates allenii</i> var. <i>magnus</i>	2
	<i>Cymbohilates</i> cf. <i>amplus</i>	2
	<i>Cymbohilates cymosus</i>	0
	<i>Cymbohilates disponerus</i>	6
	<i>Cymbohilates horridus</i> var. A (?sp. nov.)	2
	<i>Cymbohilates</i> cf. <i>horridus</i>	0
	<i>Cymbohilates</i> cf. <i>microgranulatus</i>	3
	<i>Cymbohilates variabilis</i> var. <i>parvidecus</i>	4
	<i>Cymbohilates variabilis</i> var. <i>variabilis</i>	0
	<i>Cymbohilates variabilis</i> var. B (?sp. nov.)	0
	<i>Cymbohilates</i> spp.	0
Synorati	<i>Chelinohilates erraticus</i>	8
	<i>Chelinohilates</i> cf. <i>lornensis</i>	0
	<i>Chelinohilates sinuosus</i> var. <i>angustus</i>	1
	<i>Chelinohilates sinuosus</i> var. <i>sinuosus</i>	1
	<i>Chelinohilates</i> spp.	3
	<i>Chelinohilates</i> sp. A (?sp. nov.)	1
	<i>Hispanaediscus verrucatus</i>	2
	<i>Hispanaediscus</i> cf. <i>verrucatus</i>	1
	<i>Hispanaediscus wenlockensis</i>	0
	<i>Hispanaediscus major</i>	0
	<i>Hispanaediscus</i> cf. <i>major</i>	0
Total		100
Non-hilates		
Laevigati	Laevigate alete monads	11
Total		11
Enveloped		
Permanent unfused tetrads		
Apiculati	<i>Velatitetras</i> sp. B. (?sp. nov.)	4
Synorati	<i>Velatitetras</i> cf. <i>cristata</i>	0
	<i>Velatitetras</i> cf. <i>reticulata</i>	1
	<i>Velatitetras rugulata</i>	3
	<i>Velatitetras</i> sp. C (?sp. nov.)	0
Total		8
Permanent unfused dyads		
Synorati	<i>Abditusdyadus histosus</i>	0
Total		0
Permanent fused dyads		
Synorati	<i>Segestrespora</i> cf. <i>membranifera</i>	0
Total		0
Non-hilates		
Synorati	<i>Qualisaspora sinuata</i>	0
Total		0

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 2 - SAMPLE 1 (7.6m BH2 correlated with 21.6m in BH1) (CONTINUED)

Incertae sedis		
?Enveloped spactulate cryptospores		
	Monads	2
	Dyads	0
?Enveloped cluster spinose cryptospores		
	Monads	0
	Dyads	0
	Tetrads	0
?Enveloped slender spinose cryptospores		
	Monads	0
?Enveloped apiculate cryptospores		
	Monads	0
?Enveloped murornate cryptospores		
	Monads with broad muri	1
	Monads with sinuous muri	1
?Enveloped verrucate cryptospores		
	Monads	3
Total		7
Unidentified cryptospores		1
Cryptospore total		202
Trilete spores		
Laevigate		
Retusoid	<i>Retusotriletes dittonensis</i>	1
	<i>Retusotriletes</i> cf. <i>dittonensis</i>	0
	<i>Retusotriletes</i> cf. <i>triangulatus</i>	0
	<i>Retusotriletes</i> cf. <i>triangulatus</i> var. <i>minor</i> (var. nov.)	0
	<i>Retusotriletes</i> spp.	1
Crassitate	<i>Ambitisporites avitus</i>	0
	<i>Ambitisporites avitus</i> var. <i>minor</i> (var. nov.)	3
	<i>Ambitisporites dilutus</i>	4
	<i>Ambitisporites</i> spp.	2
	<i>Ambitisporites</i> sp. A (?sp. nov.)	0
	<i>Ambitisporites warringtonii</i>	1
Patinate	<i>Archaeozonotriletes chulus</i> var. <i>inframurinus</i>	0
	<i>Archaeozonotriletes chulus</i> var. <i>chulus</i>	2
	<i>Archaeozonotriletes chulus</i> var. <i>nanus</i>	0
	<i>Archaeozonotriletes</i> spp.	0
Tetrad	Laevigate tetrad (? <i>Ambitisporites</i> spp.)	0
Total		14

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 2 - SAMPLE 1 (7.6m BH2 correlated with 21.6m in BH1) (CONTINUED)

Sculptured		
Retusoid	<i>Apiculiretusispora</i> spp.	0
	<i>Emphanisporites</i> spp.	0
	<i>Emphanisporites protophanus</i>	0
	<i>Emphanisporites</i> sp. B	0
Crassitate	<i>Streelispora</i> spp./ <i>Aneurospora</i> spp.	1
	<i>Aneurospora</i> sp.	0
	<i>Streelispora newportensis</i>	1
	<i>Scylaspora</i> sp.	2
	<i>Scylaspora</i> cf. <i>scripta</i>	0
	<i>Scylaspora downiei</i>	0
	<i>Scylaspora</i> cf. <i>kozlica</i>	0
	<i>Synorisporites</i> sp.	2
	<i>Synorisporites tripapillatus</i>	1
Patinate	<i>Chelinospora</i> spp.	1
Perispore	? <i>Perotrilites microbaculatus</i>	0
Tetrad	Tetrad of <i>Aneurospora</i> / <i>Streelispora</i>	2
Total		10
Unidentified triletes		0
Trilete total		24
Acritarch		2
Cuticle		0
Tube		0
Modern pollen grain		2
Unidentified		0
Sediment grain		0
TOTAL		230
SUB TOTAL (- others and unidentified)		227

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 3 (28.2m T1-3)**Cryptospores****Naked****Permanent fused tetrads**

Laevigati	<i>Cheilotetras caledonica</i>	0
	<i>Cheilotetras</i> sp.	0
Sculptured	Fused apiculate tetrad	1
	Fused verrucate tetrad	0
	Fused murornate tetrad	0

Permanent unfused tetrads

Laevigati	<i>Tetrahedraletes medinensis</i> var. <i>medinensis</i>	15
	<i>Tetrahedraletes medinensis</i> var. <i>parvus</i>	22
	<i>Rimosotetras problematica</i>	1
Apiculati	<i>Acontotetras inconspicua</i>	1
	Tetrad of <i>Cymbohilates cymosus</i>	0
Synorati	Tetrad of <i>Chelinohilates erraticus</i>	1
	Tetrad of <i>Hispanaedisca verrucatus</i>	2
	Tetrad of <i>Hispanaedisca wenlockensis</i>	0

Total 43**Triads**

Apiculati	Apiculate triad	0
Synorati	Murornate triad	1
	Verrucate triad	1

Total 2**Pseudodyads**

Laevigati	<i>Pseudodyadospora</i> cf. <i>laevigata</i>	0
	<i>Pseudodyadospora petasus</i>	16

Total 16**True dyads**

Laevigati	<i>Dyadospora murusattenuata</i>	8
	<i>Dyadospora murusdensa</i>	17
Apiculati	Dyads of <i>Cymbohilates allenii</i> var. <i>magnus</i>	0
	Dyads of <i>Cymbohilates cymosus</i>	0
	Dyads of <i>Cymbohilates disponerus</i>	0
	Dyads of <i>Cymbohilates horridus</i>	0
	Dyads of <i>Cymbohilates horridus</i> var. A	0
	Dyads of <i>Cymbohilates</i> cf. <i>microgranulatus</i>	0
	Dyads of ? <i>Cymbohilates variabilis</i> var. <i>variabilis</i>	0
	Dyads of <i>Cymbohilates variabilis</i> var. B	0
	Dyads of <i>Chelinohilates erraticus</i>	0
Synorati	Dyads of <i>Chelinohilates sinuosus</i> var. <i>sinuosus</i>	0
	Dyads of <i>Hispanaedisca verrucatus</i>	0

Total 25

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 3 (28.2m T1-3) (CONTINUED)**Hilates**

Laevigati	<i>Artemopyra</i> sp. A (?sp. nov.)	2
	<i>Artemopyra</i> cf. <i>robusta</i>	0
	<i>Laevolancis divellomedia</i>	72
	<i>Laevolancis plicata</i>	14
Apiculati	<i>Cymbohilates allenii</i> var. <i>allenii</i>	0
	<i>Cymbohilates allenii</i> var. <i>magnus</i>	1
	<i>Cymbohilates</i> cf. <i>amplus</i>	0
	<i>Cymbohilates cymosus</i>	0
	<i>Cymbohilates disponerus</i>	1
	<i>Cymbohilates horridus</i> var. A (?sp. nov.)	0
	<i>Cymbohilates</i> cf. <i>horridus</i>	1
	<i>Cymbohilates</i> cf. <i>microgranulatus</i>	0
	<i>Cymbohilates variabilis</i> var. <i>parvidecus</i>	0
	<i>Cymbohilates variabilis</i> var. <i>variabilis</i>	1
	<i>Cymbohilates variabilis</i> var. B (?sp. nov.)	0
	<i>Cymbohilates</i> spp.	2
Synorati	<i>Chelinohilates erraticus</i>	3
	<i>Chelinohilates</i> cf. <i>lornensis</i>	2
	<i>Chelinohilates sinuosus</i> var. <i>angustus</i>	0
	<i>Chelinohilates sinuosus</i> var. <i>sinuosus</i>	0
	<i>Chelinohilates</i> spp.	3
	<i>Chelinohilates</i> sp. A (?sp. nov.)	0
	<i>Hispanaediscus verrucatus</i>	0
	<i>Hispanaediscus</i> cf. <i>verrucatus</i>	0
	<i>Hispanaediscus wenlockensis</i>	0
	<i>Hispanaediscus major</i>	0
	<i>Hispanaediscus</i> cf. <i>major</i>	0
Total		102

Non-hilates

Laevigati	Laevigate alete monads	22
Total		22

Enveloped**Permanent unfused tetrads**

Apiculati	<i>Velatitetras</i> sp. B. (?sp. nov.)	0
Synorati	<i>Velatitetras</i> cf. <i>cristata</i>	1
	<i>Velatitetras</i> cf. <i>reticulata</i>	0
	<i>Velatitetras rugulata</i>	0
	<i>Velatitetras</i> sp. C (?sp. nov.)	0
Total		1

Permanent unfused dyads

Synorati	<i>Abditusdyadus histosus</i>	0
Total		0

Permanent fused dyads

Synorati	<i>Segestrespora</i> cf. <i>membranifera</i>	0
Total		0

Non-hilates

Synorati	<i>Qualisaspora sinuata</i>	0
Total		0

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 3 (28.2m T1-3) (CONTINUED)

Incertae sedis		
?Enveloped spactulate cryptospores		
	Monads	0
	Dyads	0
?Enveloped cluster spinose cryptospores		
	Monads	0
	Dyads	0
	Tetrads	0
?Enveloped slender spinose cryptospores		
	Monads	0
?Enveloped apiculate cryptospores		
	Monads	0
?Enveloped murornate cryptospores		
	Monads with broad muri	1
	Monads with sinuous muri	0
?Enveloped verrucate cryptospores		
	Monads	0
Total		1
Unidentifiable cryptospores		4
Cryptospore total		216
Trilete spores		
Laevigate		
Retusoid	<i>Retusotriletes dittonensis</i>	4
	<i>Retusotriletes</i> cf. <i>dittonensis</i>	2
	<i>Retusotriletes</i> cf. <i>triangulatus</i>	0
	<i>Retusotriletes</i> cf. <i>triangulatus</i> var. <i>minor</i> (var. nov.)	6
	<i>Retusotriletes</i> spp.	2
Crassitate	<i>Ambitisporites avitus</i>	2
	<i>Ambitisporites avitus</i> var. <i>minor</i> (var. nov.)	1
	<i>Ambitisporites dilutus</i>	4
	<i>Ambitisporites</i> spp.	5
	<i>Ambitisporites</i> sp. A (?sp. nov.)	0
	<i>Ambitisporites warringtonii</i>	3
Patinate	<i>Archaeozonotriletes chulus</i> var. <i>inframurinus</i>	0
	<i>Archaeozonotriletes chulus</i> var. <i>chulus</i>	0
	<i>Archaeozonotriletes chulus</i> var. <i>nanus</i>	0
	<i>Archaeozonotriletes</i> spp.	0
Tetrad	Laevigate tetrad (? <i>Ambitisporites</i> spp.)	0 ?
Total		29

APPENDIX Vb : PALYNOLOGICAL COUNTS

BOREHOLE 1 - SAMPLE 3 (28.2m T1-3) (CONTINUED)

Sculptured		
Retusoid	<i>Apiculiretusispora</i> spp.	0
	<i>Emphanisporites</i> spp.	1
	<i>Emphanisporites protophanus</i>	0
	<i>Emphanisporites</i> sp. B	1
Crassitate	<i>Streelispora</i> spp./ <i>Aneurospora</i> spp.	0
	<i>Aneurospora</i> sp.	0
	<i>Streelispora newportensis</i>	0
	<i>Scylaspora</i> sp.	2
	<i>Scylaspora</i> cf. <i>scripta</i>	1
	<i>Scylaspora downiei</i>	0
	<i>Scylaspora</i> cf. <i>kozlica</i>	1
	<i>Synorisporites</i> sp.	1
	<i>Synorisporites tripapillatus</i>	0
Patinate	<i>Chelinospora</i> spp.	1
Perispore	? <i>Perotrilites microbaculatus</i>	1
Tetrad	Tetrad of <i>Aneurospora</i> / <i>Streelispora</i>	0
Total		9
Unidentified triletes		6
Trilete total		44
Acritarch		1
Cuticle		3
Tube		1
Modern pollen grain		0
Unidentified/ Other		2
Sediment grain		0
TOTAL		267
SUB TOTAL (- others and unidentified)		251

APPENDIX Vb : PALYNOLOGICAL COUNTS

GRAND TOTAL**Cryptospores****Naked****Permanent fused tetrads**

Laevigati	<i>Cheilotetras caledonica</i>	19
	<i>Cheilotetras</i> sp.	6
Sculptured	Fused apiculate tetrad	1
	Fused verrucate tetrad	14
	Fused muornate tetrad	4

Permanent unfused tetrad

Laevigati	<i>Tetrahedraletes medinensis</i> var. <i>medinensis</i>	54
	<i>Tetrahedraletes medinensis</i> var. <i>parvus</i>	62
	<i>Rimosotetras problematica</i>	2
Apiculati	<i>Acontotetras inconspicus</i>	7
	Tetrad of <i>Cymbohilates</i> spp.	3
Synorati	Tetrad of <i>Chelinohilates erraticus</i>	8
	Tetrad of <i>Hispanaediscus verrucatus</i>	9
	Tetrad of <i>Hispanaediscus wenlockensis</i>	1

Total 190**Triads**

Apiculati	Apiculate triad	2
Synorati	Muornate triad	2
	Verrucate triad	3

Total 7**Pseudodyads**

Laevigati	<i>Pseudodyadospora</i> cf. <i>laevigata</i>	8
	<i>Pseudodyadospora petasus</i>	46

Total 54**True dyads**

Laevigati	<i>Dyadospora murusattenuata</i>	22
	<i>Dyadospora murusdensa</i>	70
Apiculati	Dyads of <i>Cymbohilates allenii</i> var. <i>magnus</i>	1
	Dyads of <i>Cymbohilates cymosus</i>	2
	Dyads of <i>Cymbohilates disponerus</i>	6
	Dyads of <i>Cymbohilates horridus</i>	2
	Dyads of <i>Cymbohilates horridus</i> var. A	2
	Dyads of <i>Cymbohilates</i> cf. <i>microgranulatus</i>	1
	Dyads of <i>Cymbohilates variabilis</i> var. <i>variabilis</i>	2
	Dyads of <i>Cymbohilates variabilis</i> var. B	2
	Dyads of <i>Chelinohilates erraticus</i>	14
Synorati	Dyads of <i>Chelinohilates sinuosus</i> var. <i>sinuosus</i>	1
	Dyads of <i>Hispanaediscus verrucatus</i>	4

Total 129

APPENDIX Vb : PALYNOLOGICAL COUNTS

GRAND TOTAL (CONTINUED)

Hilates		
Laevigati	<i>Artemopyra</i> sp. A (?sp. nov.)	3
	<i>Artemopyra</i> cf. <i>robusta</i>	1
	<i>Laevolancis divellomedia</i>	248
	<i>Laevolancis plicata</i>	40
Apiculati	<i>Cymbohilates allenii</i> var. <i>allenii</i>	11
	<i>Cymbohilates allenii</i> var. <i>magnus</i>	22
	<i>Cymbohilates</i> cf. <i>amplus</i>	5
	<i>Cymbohilates cymosus</i>	1
	<i>Cymbohilates disponerus</i>	20
	<i>Cymbohilates horridus</i> var. A (?sp. nov.)	9
	<i>Cymbohilates</i> cf. <i>horridus</i>	1
	<i>Cymbohilates</i> cf. <i>microgranulatus</i>	8
	<i>Cymbohilates variabilis</i> var. <i>parvidecus</i>	13
	<i>Cymbohilates variabilis</i> var. <i>variabilis</i>	8
	<i>Cymbohilates variabilis</i> var. B (?sp. nov.)	2
	<i>Cymbohilates</i> spp.	5
Synorati	<i>Chelinohilates erraticus</i>	43
	<i>Chelinohilates</i> cf. <i>lornensis</i>	3
	<i>Chelinohilates sinuosus</i> var. <i>angustus</i>	1
	<i>Chelinohilates sinuosus</i> var. <i>sinuosus</i>	2
	<i>Chelinohilates</i> spp.	12
	<i>Chelinohilates</i> sp. A (?sp. nov.)	3
	<i>Hispanaediscus verrucatus</i>	7
	<i>Hispanaediscus</i> cf. <i>verrucatus</i>	1
	<i>Hispanaediscus wenlockensis</i>	2
	<i>Hispanaediscus major</i>	1
	<i>Hispanaediscus</i> cf. <i>major</i>	1
Total		473
Non-hilates		
Laevigati	Laevigate alete monads	64
Total		64
Enveloped		
Permanent unfused tetrads		
Apiculati	<i>Velatitetras</i> sp. B. (?sp. nov.)	5
Synorati	<i>Velatitetras</i> cf. <i>cristata</i>	2
	<i>Velatitetras</i> cf. <i>reticulata</i>	6
	<i>Velatitetras rugulata</i>	6
	<i>Velatitetras</i> sp. C (?sp. nov.)	2
Total		21
Permanent unfused dyads		
Synorati	<i>Abditusdyadus histosus</i>	3
Total		3
Permanent fused dyads		
Synorati	<i>Segestrespora</i> cf. <i>membranifera</i>	1
Total		1
Non-hilates		
Synorati	<i>Qualisasporea sinuata</i>	2
Total		2

APPENDIX Vb : PALYNOLOGICAL COUNTS

GRAND TOTAL (CONTINUED)

Incertae sedis		
?Enveloped spactulate cryptospores		
	Monads	4
	Dyads	2
?Enveloped cluster spinose cryptospores		
	Monads	4
	Dyads	1
	Tetrads	1
?Enveloped slender spinose cryptospores		
	Monads	2
?Enveloped apiculate cryptospores		
	Monads	1
?Enveloped murornate cryptospores		
	Monads with broad muri	3
	Monads with sinuous muri	1
?Enveloped verrucate cryptospores		
	Monads	3
Total		22
Unidentifiable cryptospores		19
Cryptospore total		966
Trilete spores		
Laevigate		
Retusoid	<i>Retusotriletes dittonensis</i>	8
	<i>Retusotriletes</i> cf. <i>dittonensis</i>	7
	<i>Retusotriletes</i> cf. <i>triangulatus</i>	4
	<i>Retusotriletes</i> cf. <i>triangulatus</i> var. <i>minor</i> (var. nov.)	17
	<i>Retusotriletes</i> spp.	9
Crassitate	<i>Ambitisporites avitus</i>	12
	<i>Ambitisporites avitus</i> var. <i>minor</i> (var. nov.)	18
	<i>Ambitisporites dilutus</i>	21
	<i>Ambitisporites</i> spp.	15
	<i>Ambitisporites</i> sp. A (?sp. nov.)	1
	<i>Ambitisporites warringtonii</i>	17
Patinate	<i>Archaeozonotriletes chulus</i> var. <i>inframurinus</i>	1
	<i>Archaeozonotriletes chulus</i> var. <i>chulus</i>	2
	<i>Archaeozonotriletes chulus</i> var. <i>nanus</i>	2
	<i>Archaeozonotriletes</i> spp.	1
Tetrad	Laevigate tetrad (? <i>Ambitisporites</i> spp.)	2
Total		137

GRAND TOTAL (CONTINUED)			
Sculptured			
Retusoid	<i>Apiculiretusispora</i> spp.	8	
	<i>Emphanisporites</i> spp.	3	
	<i>Emphanisporites protophanus</i>	2	
	<i>Emphanisporites</i> sp. B	2	
Crassitate	<i>Streelispora</i> spp./ <i>Aneurospora</i> spp.	11	
	<i>Aneurospora</i> sp.	12	
	<i>Streelispora newportensis</i>	2	
	<i>Scylaspora</i> sp.	4	
	<i>Scylaspora</i> cf. <i>scripta</i>	1	
	<i>Scylaspora downiei</i>	5	
	<i>Scylaspora</i> cf. <i>kozlica</i>	1	
	<i>Synorisporites</i> sp.	8	
	<i>Synorisporites tripapillatus</i>	2	
Patinate	<i>Chelinospora</i> spp.	6	
Perispore	? <i>Perotrilites microbaculatus</i>	5	
Tetrad	Tetrad of <i>Aneurospora</i> / <i>Streelispora</i>	4	
		Total	76
Unidentified triletes		20	
Trilete total			233
Acritarch		16	
Cuticle		9	
Tube		11	
Modern pollen grain		5	
Unidentified/ Other		9	
Sediment grain		1	
			1269
SUB TOTAL (- others and unidentified)			1195

APPENDIX Vc: SPORE MORPHOTYPES

Tredomen quarry surface		
Sporomorph	0m n	%
Cryptospores		
<i>Permanent fused tetrads - laevigate</i>	14	5.43%
<i>Permanent fused tetrads - sculptured</i>	7	2.71%
<i>Permanent unfused tetrads- laevigate</i>	26	10.08%
<i>Permanent unfused tetrads- sculptured</i>	8	3.10%
<i>Triads- sculptured</i>	4	1.55%
<i>Pseudodyads - laevigate</i>	11	4.26%
<i>True dyads - laevigate</i>	14	5.43%
<i>True dyads - sculptured</i>	13	5.04%
<i>Hilates - laevigate</i>	27	10.47%
<i>Hilates - sculptured</i>	52	20.16%
<i>Non-hilates - laevigate</i>	9	3.49%
<i>Enveloped unfused tetrads - sculptured</i>	6	2.33%
<i>Enveloped unfused dyads - sculptured</i>	2	0.78%
<i>Enveloped fused dyads - sculptured</i>	1	0.39%
<i>Enveloped non-hilates -sculptured</i>	2	0.78%
<i>Sculptured ?enveloped cryptospores</i>	10	3.88%
Sub-total		
	258	100.0%
Triletes		
<i>Laevigate triletes</i>	28	10.85%
<i>Sculptured triletes</i>	17	6.59%
<i>Perispore triletes</i>	2	0.78%
<i>Acritarchs</i>	5	1.94%
Sub-total		
	258	100.0%
Unidentified/ others		
	25	
Total		
	283	

Tredomen borehole 1-1 palynology		
Sporomorph	n	11.28m %
Cryptospores		
<i>Permanent fused tetrads - laevigate</i>	6	2.31%
<i>Permanent fused tetrads - sculptured</i>	2	0.77%
<i>Permanent unfused tetrads- laevigate</i>	30	11.54%
<i>Permanent unfused tetrads- sculptured</i>	5	1.92%
<i>Triads- sculptured</i>	0	0.00%
<i>Pseudodyads - laevigate</i>	7	2.69%
<i>True dyads - laevigate</i>	20	7.69%
<i>True dyads - sculptured</i>	3	1.15%
<i>Hilates - laevigate</i>	68	26.15%
<i>Hilates - sculptured</i>	32	12.31%
<i>Non-hilates - laevigate</i>	20	7.69%
<i>Enveloped unfused tetrads - sculptured</i>	5	1.92%
<i>Enveloped unfused dyads - sculptured</i>	1	0.38%
<i>Enveloped fused dyads - sculptured</i>	0	0.00%
<i>Enveloped non-hilates -sculptured</i>	0	0.00%
<i>Sculptured ?enveloped cryptospores</i>	3	1.15%
Sub-total		
	260	100.0%
Triletes		
<i>Laevigate triletes</i>	45	17.31%
<i>Sculptured triletes</i>	7	2.69%
<i>Perispore triletes</i>	2	0.77%
<i>Acritarchs</i>	4	1.54%
Sub-total		
	260	100.0%
Unidentified/ others		
	29	
Total		
	289	

APPENDIX Vc: SPORE MORPHOTYPES

Tredomen borehole plant bed 1 palynology			11.80m
Sporomorph	n	%	
Cryptospores			
<i>Permanent fused tetrads - laevigate</i>	1	0.50%	
<i>Permanent fused tetrads - sculptured</i>	7	3.52%	
<i>Permanent unfused tetrads- laevigate</i>	9	4.52%	
<i>Permanent unfused tetrads- sculptured</i>	3	1.51%	
<i>Triads- sculptured</i>	0	0.00%	
<i>Pseudodyads - laevigate</i>	8	4.02%	
<i>True dyads - laevigate</i>	14	7.04%	
<i>True dyads - sculptured</i>	7	3.52%	
<i>Hilates - laevigate</i>	47	23.62%	
<i>Hilates - sculptured</i>	45	22.61%	
<i>Non-hilates - laevigate</i>	2	1.01%	
<i>Enveloped unfused tetrads - sculptured</i>	1	0.50%	
<i>Enveloped unfused dyads - sculptured</i>	0	0.00%	
<i>Enveloped fused dyads - sculptured</i>	0	0.00%	
<i>Enveloped non-hilates -sculptured</i>	0	0.00%	
<i>Sculptured ?enveloped cryptospores</i>	1	0.50%	
Triletes			
<i>Laevigate triletes</i>	21	10.55%	
<i>Sculptured triletes</i>	29	14.57%	
<i>Perispore triletes</i>	0	0.00%	
<i>Acritarchs</i>	4	2.01%	
Sub-total	199	100.0 %	
<i>Unidentified/ others</i>			1
Total	200		

Tredomen borehole 2 sample 1			21.60m
Sporomorph	n	%	
Cryptospores			
<i>Permanent fused tetrads - laevigate</i>	4	1.76%	
<i>Permanent fused tetrads - sculptured</i>	2	0.88%	
<i>Permanent unfused tetrads- laevigate</i>	15	6.61%	
<i>Permanent unfused tetrads- sculptured</i>	8	3.52%	
<i>Triads- sculptured</i>	1	0.44%	
<i>Pseudodyads - laevigate</i>	12	5.29%	
<i>True dyads - laevigate</i>	19	8.37%	
<i>True dyads - sculptured</i>	14	6.17%	
<i>Hilates - laevigate</i>	62	27.31%	
<i>Hilates - sculptured</i>	38	16.74%	
<i>Non-hilates - laevigate</i>	11	4.85%	
<i>Enveloped unfused tetrads - sculptured</i>	8	3.52%	
<i>Enveloped unfused dyads - sculptured</i>	0	0.00%	
<i>Enveloped fused dyads - sculptured</i>	0	0.00%	
<i>Enveloped non-hilates -sculptured</i>	0	0.00%	
<i>Sculptured ?enveloped cryptospores</i>	7	3.08%	
Triletes			
<i>Laevigate triletes</i>	14	6.17%	
<i>Sculptured triletes</i>	10	4.41%	
<i>Perispore triletes</i>	0	0.00%	
<i>Acritarchs</i>	2	0.88%	
Sub-total	227	100.0 %	
<i>Unidentified/ others</i>			3
Total	230		

APPENDIX Vc: SPORE MORPHOTYPES

Tredomen borehole 1-3 palynology	n	28.20m %
Sporomorph		
Cryptospores		
<i>Permanent fused tetrads - laevigate</i>	0	0.00%
<i>Permanent fused tetrads - sculptured</i>	1	0.40%
<i>Permanent unfused tetrads- laevigate</i>	38	15.14%
<i>Permanent unfused tetrads- sculptured</i>	4	1.59%
<i>Triads- sculptured</i>	2	0.80%
<i>Pseudodyads - laevigate</i>	16	6.37%
<i>True dyads - laevigate</i>	25	9.96%
<i>True dyads - sculptured</i>	0	0.00%
<i>Hilates - laevigate</i>	88	35.06%
<i>Hilates - sculptured</i>	14	5.58%
<i>Non-hilates - laevigate</i>	22	8.76%
<i>Enveloped unfused tetrads - sculptured</i>	1	0.40%
<i>Enveloped unfused dyads - sculptured</i>	0	0.00%
<i>Enveloped fused dyads - sculptured</i>	0	0.00%
<i>Enveloped non-hilates -sculptured</i>	0	0.00%
<i>Sculptured ?enveloped cryptospores</i>	1	0.40%
Triletes		
<i>Laevigate triletes</i>	29	11.55%
<i>Sculptured triletes</i>	8	3.19%
<i>Perispore triletes</i>	1	0.40%
<i>Acritarchs</i>	1	0.40%
Sub-total	251	
<i>Unidentified/ others</i>	16	
Total	267	100.0%

	PB0	BH1-1	PB1	BH2-1	BH1-3	Total
	0m	11.28m	11.80m	21.60m	28.20m	
Miospores sculptured	17	9	29	8	9	72
Cryptospores sculptured	107	51	64	80	23	325
Cryptospores laevigate	101	151	81	123	189	645
Miospores laevigate	28	45	21	14	29	137
Acritarchs	5	4	4	2	1	16
	258	260	199	227	251	1195

APPENDIX VI: TREDOMEN QUARRY AND TARGROVE QUARRY
SEDIMENTOLOGICAL DATABASE

pVI-2 to pVI-8

ID	Log	Bed	facies	transition	Thickness m
1	Quarry A	1	3b	/	?
2	Quarry A	2	5b	3b-5b	0.7
3	Quarry A	3	1a	5b-1a	0.15
4	Quarry A	4	2a	1a-2a	1.4
5	Quarry A	5	2b	2a-2b	0.95
6	Quarry A	6	3a	2b-3a	0.85
7	Quarry A	7	3b	3a-3b	0.35
8	Quarry A	8	4	3b-4	2.4
9	Quarry A	9	5b	4-5b	1.95
10	Quarry A	10	4	5b-4	0.55
11	Quarry A	11	4	4-4	?
12	Quarry B	1	5b	/	?
13	Quarry B	2	1a	5b-1a	0.1
14	Quarry B	3	2a	1a-2a	2.15
15	Quarry B	4	3a	2a-3a	0.35
16	Quarry B	5	3a	3a-3a	0.5
17	Quarry B	6	4	3a-4	0.9
18	Quarry B	7	5b	4-5b	0.75
19	Quarry B	8	5b	5b-5b	0.05
20	Quarry B	9	5b	5b-5b	0.9
21	Quarry B	10	4	5b-4	0.4
22	Quarry B	11	4	4-4	0.6
23	Quarry B	12	4	4-4	0.55
24	Quarry B	13	4	4-4	1.05
25	Quarry B	14	5b	4-5b	1.75
26	Quarry B	15	5b	5b-5b	0.4
27	Quarry B	16	1a	5b-1a	0.1
28	Quarry B	17	2a	1a-2a	?
29	BH1	82	5b	/	0.75
30	BH1	81	5b	5b-5b	0.55
31	BH1	80	5b	5b-5b	0.5
32	BH1	79	5b	5b-5b	1.05
33	BH1	78	4	5b-4	0.55
34	BH1	77	4	4-4	0.5
35	BH1	75	4	4-4	0.6
36	BH1	76	4	4-4	1.2
37	BH1	74	5a	4-5a	0.9
38	BH1	73	5b	5a-5b	0.6
39	BH1	72	5b	5b-5b	0.75
40	BH1	71	5b	5b-5b	3.95
41	BH1	70	5b	5b-5b	0.65
42	BH1	69	5b	5b-5b	0.45
43	BH1	68	5b	5b-5b	0.45
44	BH1	67	5b	5b-5b	0.45
45	BH1	66	5b	5b-5b	0.6
46	BH1	65	5b	5b-5b	0.45
47	BH1	64	5b	5b-5b	0.45
48	BH1	63	4	5b-4	0.3
49	BH1	62	4	4-4	0.3
50	BH1	61	5b	4-5b	0.9

ID	Log	Bed	facies	transition	Thickness m
51	BH1	60	5b	5b-5b	1.6
52	BH1	59	5b	5b-5b	0.9
53	BH1	58	5b	5b-5b	0.35
54	BH1	57	5a	5b-5a	1.35
55	BH1	56	5a	5a-5a	1.45
56	BH1	55	5b	5a-5b	0.45
57	BH1	54	5b	5b-5b	0.45
58	BH1	53	5b	5b-5b	0.6
59	BH1	52	5b	5b-5b	0.6
60	BH1	51	5b	5b-5b	1.5
61	BH1	50	5b	5b-5b	0.3
62	BH1	49	4	5b-4	0.6
63	BH1	48	3b	4-3b	0.6
64	BH1	47	5a	3b-5a	1.2
65	BH1	46	3b	5a-3b	0.3
66	BH1	45	4	3b-4	0.3
67	BH1	44	5a	4-5a	0.45
68	BH1	43	4	5a-4	0.25
69	BH1	42	3b	4-3b	0.6
70	BH1	41	4	3b-4	0.45
71	BH1	40	3b	4-3b	1.00
72	BH1	39	5b	3b-5b	0.9
73	BH1	38	1b	5b-1b	0.6
74	BH1	37	1a	1b-1a	1.1
75	BH1	36	2a	1a-2a	0.85
76	BH1	35	3a	2a-3a	0.6
77	BH1	34	5b	3a-5b	0.3
78	BH1	33	1a	5b-1a	0.2
79	BH1	32	2a	1a-2a	0.7
80	BH1	31	3b	2a-3b	0.8
81	BH1	30	5a	3b-5a	1.1
82	BH1	29	5b	5a-5b	0.8
83	BH1	28	5b	5b-5b	0.6
84	BH1	27	5b	5b-5b	0.4
85	BH1	26	1a	5b-1a	0.4
86	BH1	25	2a	1a-2a	3.6
87	BH1	24	3a	2a-3a	5.5
88	BH1	23	3b	3a-3b	0.6
89	BH1	22	5b	3b-5b	0.6
90	BH1	21	4	5b-4	2.95
91	BH1	20	5b	4-5b	3.00
92	BH1	19	1a	5b-1a	0.15
93	BH1	18	2a	1a-2a	0.3
94	BH1	17	2b	2a-2b	1.45
95	BH1	16	5b	2b-5b	0.6
96	BH1	15	5b	5b-5b	0.5
97	BH1	14	1b	5b-1b	0.3
98	BH1	13	4	1b-4	1.1
99	BH1	12	5a	4-5a	0.3
100	BH1	11	5b	5a-5b	0.6

ID	Log	Bed	facies	transition	Thickness m
101	BH1	10	4	5b-4	1.2
102	BH1	9	3b	4-3b	0.55
103	BH1	8	4	3b-4	0.45
104	BH1	7	5b	4-5b	0.3
105	BH1	6	4	5b-4	1.1
106	BH1	5	1a	4-1a	0.15
107	BH1	4	3a	1a-3a	0.2
108	BH1	3	1a	3a-1a	0.15
109	BH1	2	2b	1a-2b	1.40
110	BH1	1	1a	2b-1a	?
111	BH2	199	5b	/	?
112	BH2	198	5b	5b-5b	0.45
113	BH2	197	5a	5b-5a	0.85
114	BH2	196	5b	5a-5b	0.8
115	BH2	195	5b	5b-5b	2.5
116	BH2	194	5b	5b-5b	3.1
117	BH2	193	5b	5b-5b	1.65
118	BH2	192	5b	5b-5b	1.35
119	BH2	191	5b	5b-5b	0.6
120	BH2	190	5b	5b-5b	0.8
121	BH2	189	5b	5b-5b	0.7
122	BH2	188	5b	5b-5b	0.6
123	BH2	187	5b	5b-5b	0.65
124	BH2	186	5b	5b-5b	0.7
125	BH2	185	5b	5b-5b	0.5
126	BH2	184	5b	5b-5b	1.05
127	BH2	183	5b	5b-5b	0.3
128	BH2	182	5b	5b-5b	0.5
129	BH2	181	5b	5b-5b	1.95
130	BH2	180	5b	5b-5b	1.1
131	BH2	179	5b	5b-5b	0.85
132	BH2	178	5a	5b-5a	0.65
133	BH2	177	1b	5a-1b	0.4
134	BH2	176	4	1b-4	0.7
135	BH2	175	4	4-4	0.5
136	BH2	174	5a	4-5a	0.45
137	BH2	173	5b	5a-5b	0.35
138	BH2	172	5a	5b-5a	1.5
139	BH2	171	5b	5a-5b	1.9
140	BH2	170	5b	5b-5b	0.65
141	BH2	169	5b	5b-5b	2.85
142	BH2	168	5b	5b-5b	0.75
143	BH2	167	5b	5b-5b	0.25
144	BH2	166	5b	5b-5b	0.2
145	BH2	165	5b	5b-5b	0.2
146	BH2	164	5b	5b-5b	0.2
147	BH2	163	5b	5b-5b	0.4
148	BH2	162	3b	5b-3b	1.9
149	BH2	161	5b	3b-5b	0.4
150	BH2	160	1b	5b-1b	0.05

ID	Log	Bed	facies	transition	Thickness m
151	BH2	159	3b	1b-3b	0.95
152	BH2	158	1b	3b-1b	0.01
153	BH2	157	3b	1b-3b	1.2
154	BH2	156	5b	3b-5b	0.05
155	BH2	155	3b	5b-3b	0.4
156	BH2	154	4	3b-4	0.45
157	BH2	153	5a	4-5a	0.55
158	BH2	152	5b	5a-5b	0.85
159	BH2	151	5b	5b-5b	0.75
160	BH2	150	5b	5b-5b	1.2
161	BH2	149	5b	5b-5b	0.2
162	BH2	148	5b	5b-5b	1.25
163	BH2	147	5b	5b-5b	1.3
164	BH2	146	5b	5b-5b	1.0
165	BH2	145	5b	5b-5b	0.2
166	BH2	144	5b	5b-5b	0.6
167	BH2	143	5b	5b-5b	0.6
168	BH2	142	5b	5b-5b	0.75
169	BH2	141	5b	5b-5b	0.65
170	BH2	140	5b	5b-5b	0.4
171	BH2	139	5b	5b-5b	0.2
172	BH2	138	5b	5b-5b	0.4
173	BH2	137	5b	5b-5b	2.4
174	BH2	136	5b	5b-5b	0.3
175	BH2	135	5b	5b-5b	0.25
176	BH2	134	2b	5b-2b	0.3
177	BH2	133	5b	2b-5b	0.05
178	BH2	132	5a	5b-5a	0.1
179	BH2	131	4	5a-4	0.3
180	BH2	130	4	4-4	0.55
181	BH2	129	5b	4-5b	0.25
182	BH2	128	4	5b-4	0.15
183	BH2	127	3b	4-3b	0.4
184	BH2	126	3b	3b-3b	0.3
185	BH2	125	4	3b-4	0.35
186	BH2	124	3b	4-3b	0.25
187	BH2	123	3b	3b-3b	0.2
188	BH2	122	3b	3b-3b	0.75
189	BH2	121	3b	3b-3b	0.4
190	BH2	120	5b	3b-5b	1.4
191	BH2	119	5b	5b-5b	0.2
192	BH2	118	5b	5b-5b	2.05
193	BH2	117	5b	5b-5b	1.40
194	BH2	116	1a	5b-1a	0.35
195	BH2	115	2b	1a-2b	0.25
196	BH2	114	3a	2b-3a	0.15
197	BH2	113	1a	3a-1a	0.05
198	BH2	112	2a	1a-2a	0.05
199	BH2	111	3a	2a-3a	0.05
200	BH2	110	3a	3a-3a	0.10

ID	Log	Bed	facies	transition	Thickness m
201	BH2	109	1a	3a-1a	0.15
202	BH2	108	2b	1a-2b	0.10
203	BH2	107	1a	2b-1a	0.13
204	BH2	106	3b	1a-3b	0.4
205	BH2	105	4	3b-4	0.5
206	BH2	104	4	4-4	0.05
207	BH2	103	4	4-4	0.05
208	BH2	102	4	4-4	0.15
209	BH2	101	3b	4-3b	0.4
210	BH2	100	5b	3b-5b	0.2
211	BH2	99	3b	5b-3b	0.3
212	BH2	98	4	3b-4	0.05
213	BH2	97	4	4-4	0.2
214	BH2	96	5b	4-5b	0.5
215	BH2	95	5b	5b-5b	0.2
216	BH2	94	5b	5b-5b	0.4
217	BH2	93	5b	5b-5b	0.55
218	BH2	92	4	5b-4	0.1
219	BH2	91	5b	4-5b	0.6
220	BH2	90	3b	5b-3b	0.05
221	BH2	89	5b	3b-5b	0.15
222	BH2	88	3b	5b-3b	0.05
223	BH2	87	3b	3b-3b	0.3
224	BH2	86	5b	3b-5b	0.85
225	BH2	85	3b	5b-3b	0.1
226	BH2	84	5b	3b-5b	0.55
227	BH2	83	3b	5b-3b	0.2
228	BH2	82	5b	3b-5b	0.4
229	BH2	81	5b	5b-5b	0.1
230	BH2	80	4	5b-4	0.2
231	BH2	79	4	4-4	0.3
232	BH2	78	4	4-4	0.6
233	BH2	77	3a	4-3a	0.35
234	BH2	76	3a	3a-3a	0.1
235	BH2	75	5b	3a-5b	1.05
236	BH2	74	5b	5b-5b	1.05
237	BH2	73	4	5b-4	0.2
238	BH2	72	5b	4-5b	0.1
239	BH2	71	5b	5b-5b	0.6
240	BH2	70	5b	5b-5b	0.75
241	BH2	69	5b	5b-5b	0.45
242	BH2	68	5b	5b-5b	0.25
243	BH2	67	5b	5b-5b	0.2
244	BH2	66	4	5b-4	0.1
245	BH2	65	5b	4-5b	0.95
246	BH2	64	5b	5b-5b	0.6
247	BH2	63	4	5b-4	0.2
248	BH2	62	1b	4-1b	0.8
249	BH2	61	4	1b-4	0.2
250	BH2	60	5b	4-5b	0.3

ID	Log	Bed	facies	transition	Thickness m
251	BH2	59	5b	5b-5b	0.3
252	BH2	58	4	5b-4	0.1
253	BH2	57	4	4-4	0.6
254	BH2	56	5b	4-5b	0.1
255	BH2	55	4	5b-4	0.3
256	BH2	54	5b	4-5b	0.1
257	BH2	53	4	5b-4	0.05
258	BH2	52	4	4-4	0.2
259	BH2	51	5b	4-5b	0.3
260	BH2	50	5b	5b-5b	0.25
261	BH2	49	1a	5b-1a	0.8
262	BH2	48	2a	1a-2a	0.12
263	BH2	47	1a	2a-1a	0.05
264	BH2	46	2a	1a-2a	0.15
265	BH2	45	2a	2a-2a	0.3
266	BH2	44	2b	2a-2b	0.6
267	BH2	43	3a	2b-3a	0.1
268	BH2	42	2a	3a-2a	0.3
269	BH2	41	3a	2a-3a	0.6
270	BH2	40	3a	3a-3a	0.1
271	BH2	39	2b	3a-2b	0.3
272	BH2	38	3b	2b-3b	0.35
273	BH2	37	3b	3b-3b	0.2
274	BH2	36	3b	3b-3b	0.9
275	BH2	35	3b	3b-3b	0.2
276	BH2	34	5b	3b-5b	0.45
277	BH2	33	4	5b-4	0.1
278	BH2	32	3b	4-3b	0.45
279	BH2	31	3b	3b-3b	0.55
280	BH2	30	5b	3b-5b	0.5
281	BH2	29	5b	5b-5b	0.15
282	BH2	28	3b	5b-3b	0.35
283	BH2	27	5b	3b-5b	0.25
284	BH2	26	1a	5b-1a	0.15
285	BH2	25	2a	1a-2a	0.2
286	BH2	24	2a	2a-2a	0.95
287	BH2	23	3a	2a-3a	0.05
288	BH2	22	2a	3a-2a	0.3
289	BH2	21	3a	2a-3a	0.15
290	BH2	20	2a	3a-2a	0.3
291	BH2	19	3a	2a-3a	0.1
292	BH2	18	3a	3a-3a	0.45
293	BH2	17	3a	3a-3a	0.45
294	BH2	16	3a	3a-3a	0.15
295	BH2	15	3a	3a-3a	0.65
296	BH2	14	3b	3a-3b	0.2
297	BH2	13	3b	3b-3b	0.1
298	BH2	12	3b	3b-3b	0.65
299	BH2	11	3b	3b-3b	0.2
300	BH2	10	3b	3b-3b	0.1

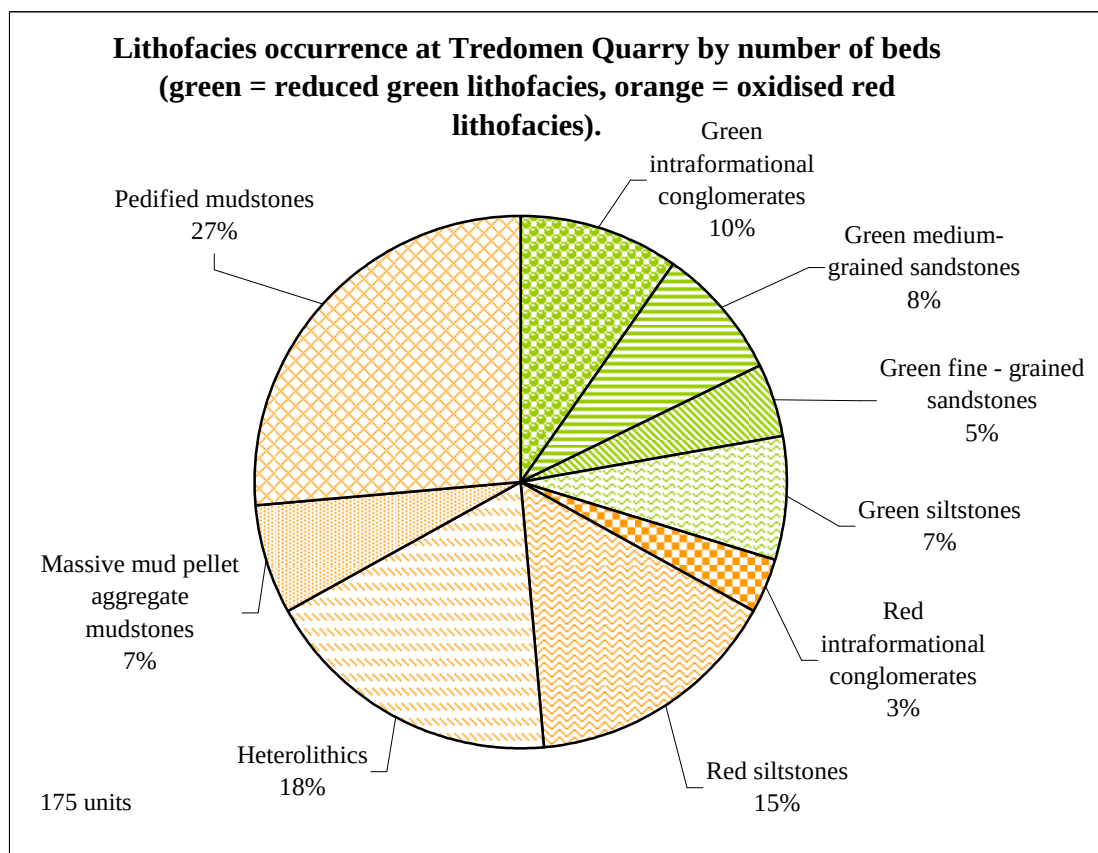
ID	Log	Bed	facies	transition	Thickness m
301	BH2	9	3b	3b-3b	0.15
302	BH2	8	3b	3b-3b	0.15
303	BH2	7	5b	3b-5b	0.45
304	BH2	6	3b	5b-3b	0.45
305	BH2	5	3b	3b-3b	0.35
306	BH2	4	3b	3b-3b	0.25
307	BH2	3	3b	3b-3b	0.15
308	BH2	2	3b	3b-3b	0.4
309	BH2	1	5b	3b-5b	?
310	Targrove	1	2c	/	(2.25)
311	Targrove	2	1a	2c-1a	0.4
312	Targrove	3	1c	1a-1c	0.2
313	Targrove	4	2d	1c-2d	0.1
314	Targrove	5	3c	2d-3c	0.2
315	Targrove	6	2d	3c-2d	0.1
316	Targrove	7	3c	2d-3c	0.2
317	Targrove	8	2d	3c-2d	0.1
318	Targrove	9	3c	2d-3c	0.2
319	Targrove	10	2d	3c-2d	0.1
320	Targrove	11	3c	2d-3c	0.2
321	Targrove	12	2d	3c-2d	0.2
322	Targrove	13	1a	2d-1a	0.5
323	Targrove	14	1b	1a-1b	0.5
324	Targrove	15	2c	1b-2c	2.5
325	Targrove	16	2c	2c-2c	0.7
326	Targrove	17	2d	2c-2d	0.1
327	Targrove	18	3c	2d-3c	0.2
328	Targrove	19	2d	3c-2d	0.15
329	Targrove	20	1b	2d-1b	0.6
330	Targrove	21	2d	1b-2d	0.1
331	Targrove	22	3c	2d-3c	0.15
332	Targrove	23	2d	3c-2d	0.1
333	Targrove	24	2c	2d-2c	0.24
334	Targrove	25	2c	2c-2c	0.16
335	Targrove	26	1b	2c-1b	0.25
336	Targrove	27	2c	1b-2c	?(0.8)

APPENDIX VII: TREDOMEN QUARRY AND TARGROVE QUARRY

SEDIMENTOLOGICAL ANALYSIS

<i>a: Sedimentary analysis of Tredomen Quarry</i>	<i>pVII-2 to pVII-12</i>
<i>b: Sedimentary analysis of Targrove Quarry.....</i>	<i>pVII-13 to pVII-17</i>

APPENDIX VII - SEDIMENTARY ANALYSIS OF TREDOMEN QUARRY SEQUENCE
LITHOFACIES OCCURRENCES



r	Green intraformational conglomerates	17
r	Green medium- grained sandstones	14
r	Green fine - grained sandstones	8
r	Green siltstones	13
o	Red intraformational conglomerates	6
o	Red siltstones	27
o	Heterolithics	32
o	Massive mud pellet aggregate mudstones	12
o	Pedified mudstones	46

(based on where lithology changes).

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APPENDIX VII - SEDIMENTARY ANALYSIS OF TREDOMEN QUARRY SEQUENCE
LITHOFACIES OCCURRENCE BY THICKNESS (in m) (continued)

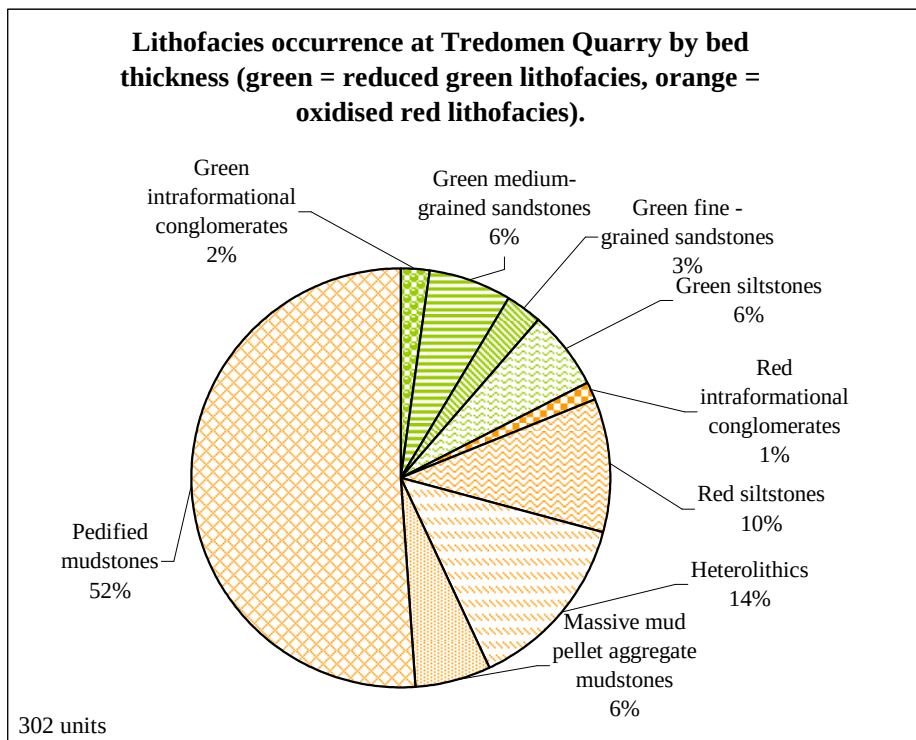
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APPENDIX VII - SEDIMENTARY ANALYSIS OF TREDOMEN QUARRY SEQUENCE
LITHOFACIES OCCURRENCE BY THICKNESS (in m) (continued)

1a	1b	2a	2b	3a	3b	4	5a	5b
								0.95
								0.6
								0.3
								0.3
								0.1
								0.1
								0.3
								0.25
								0.45
								0.5
								0.15
								0.25
								0.45

Number of beds	16	6	15	8	21	45	49	13	129
Thickness total	4.18	2.16	11.67	5.35	11.55	19.5	33.55	10.85	95.05
Average thickness	0.26	0.36	0.78	0.67	0.55	0.43	0.66	0.83	0.74
Min	0.05	0.01	0.05	0.10	0.05	0.05	0.05	0.10	0.05
Max	1.1	0.8	3.6	1.45	5.5	1.9	4	1.5	3.95

Total (based on 302 total number of beds minus the upper and lower unit thickness).



Thickness in m		
r	Green intraformational conglomerates	4.18
r	Green medium- grained sandstones	11.67
r	Green fine - grained sandstones	5.35
r	Green siltstones	11.55
o	Red intraformational conglomerates	2.16
o	Red siltstones	19.5
o	Heterolithics	25.55
o	Massive mud pellet aggregate mudstones	10.85
o	Pedified mudstones	95.05

APPENDIX VII - SEDIMENTARY ANALYSIS OF TREDOMEN QUARRY SEQUENCE
LITHOFACIES BOUNDARIES by percentage

UPPER BOUNDARIES (Facies 1a-?)

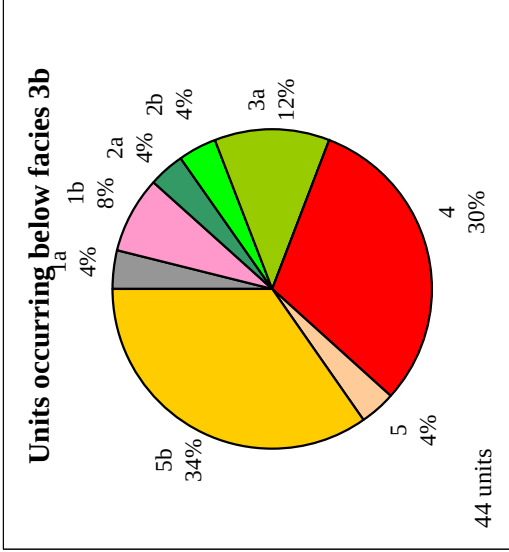
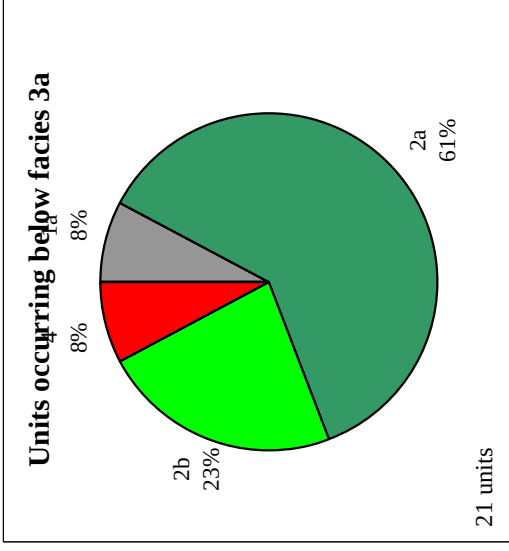
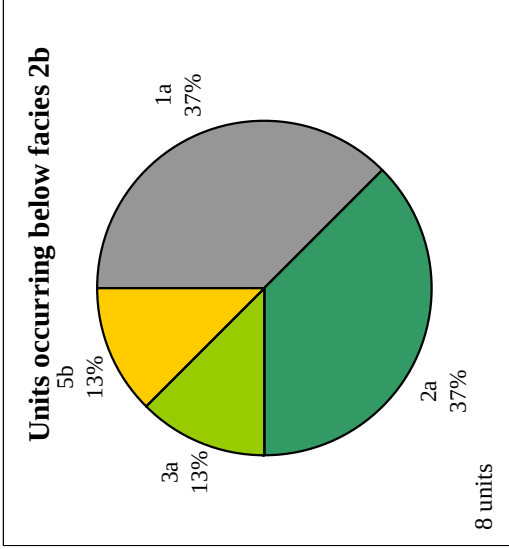
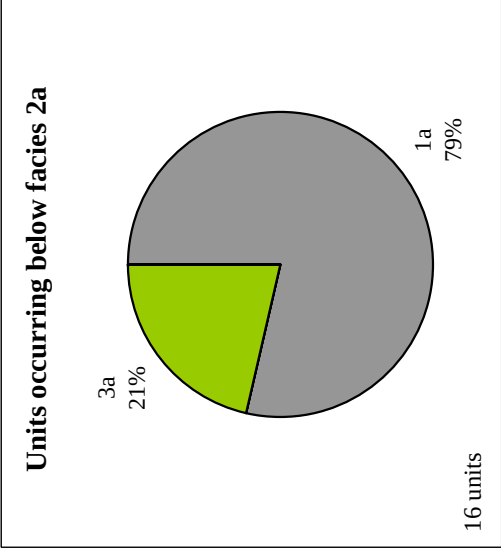
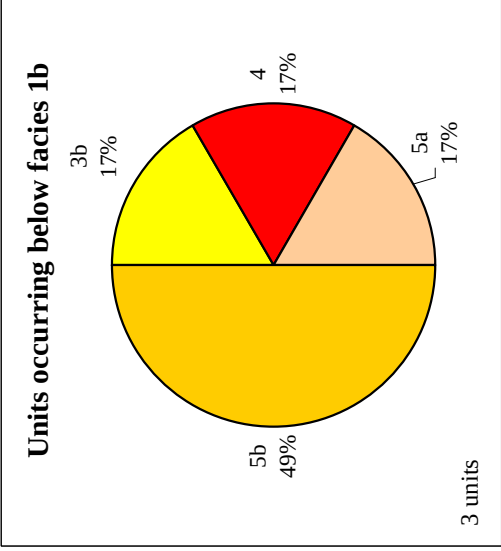
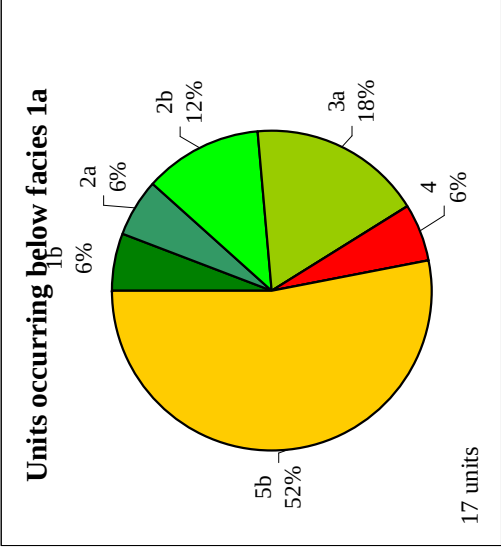
		TO																	
FACIES	1a	%	1b	%	2a	%	2b	%	3a	%	3b	%	4	%	5a	%	5b	5b%	Row total
FROM	1a	0	0	0	0	11	1	3	0	1	0	1	0	0	0	0	0	0	16
	1b	1	0	0	0	0	0	0	0	0	0	2	0	3	1	0	0	0	6
	2a	1	0	0	0	0	0	3	0	8	1	1	0	0	0	0	0	0	13
	2b	2	0	0	0	0	0	0	0	3	0	1	0	0	0	0	2	0	8
	3a	3	0	0	0	3	0	1	0	0	0	3	0	1	0	0	2	0	13
	3b	0	0	0	0	0	0	0	0	0	0	0	0	8	0	2	0	1	27
	4	1	0	1	0	0	0	0	0	1	0	8	0	0	5	0	15	0	31
	5	0	0	1	0	0	0	0	0	0	0	1	0	2	0	0	8	1	12
	5b	9	0	3	0	0	0	1	0	0	0	9	0	18	0	5	0	0	45
																			171

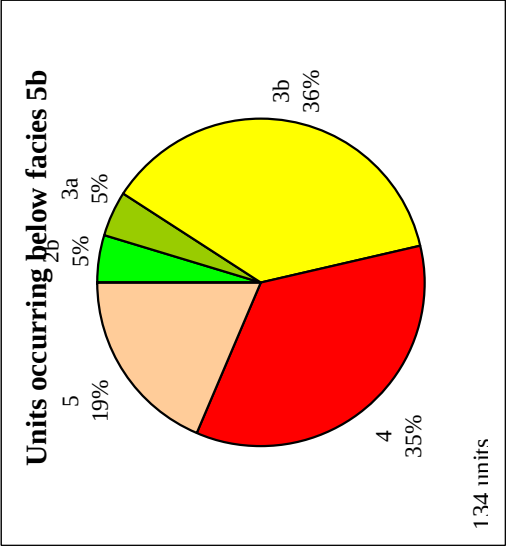
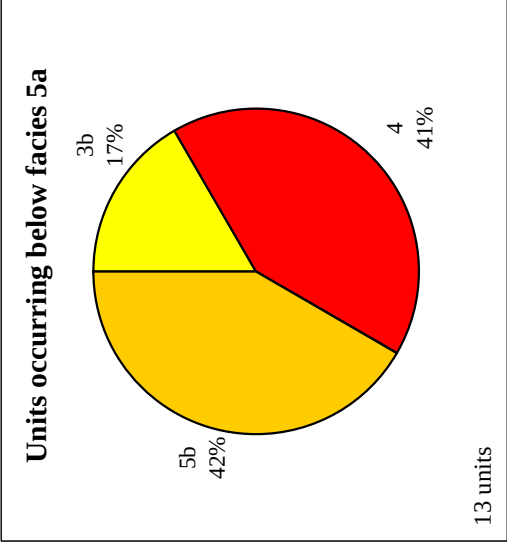
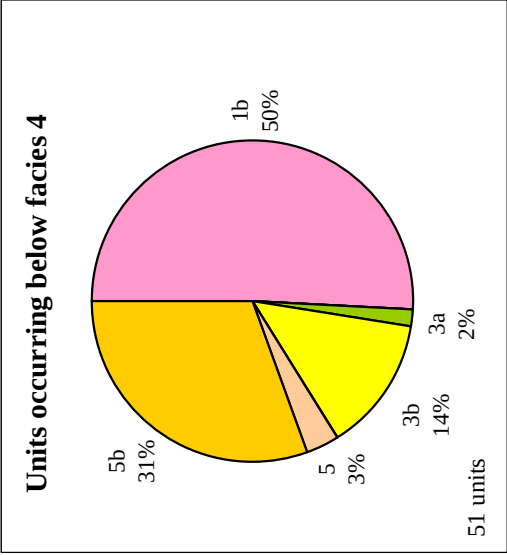
(based on where lithologies change and removing the upper and lower boundaries)

LOWER BOUNDARIES (Facies ?-1a)

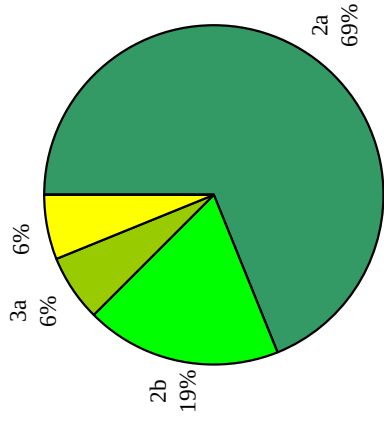
		TO																			
FACIES	1a	%	1b	%	2a	%	2b	%	3a	%	3b	%	4	%	5a	%	5b	%			
1a	0	0	0	0	11	79	3	38	1	8	1	4	0	0	0	0	0	0	16		
1b	1	6	0	0	0	0	0	0	0	0	2	8	3	94	0	0	0	0	6		
2a	1	6	0	0	0	0	3	38	8	62	1	4	0	0	0	0	0	0	13		
2b	2	12	0	0	0	0	0	0	3	23	1	4	0	0	0	0	2	5	8		
3a	3	18	0	0	3	21	1	13	0	0	3	12	1	3	0	0	2	5	13		
3b	0	0	1	17	0	0	0	0	0	0	0	0	8	25	2	17	16	37	27		
4	1	6	1	17	0	0	0	0	1	8	8	31	0	0	5	42	15	35	31		
5a	0	0	1	17	0	0	0	0	0	0	1	4	2	6	0	0	8	19	12		
5b	9	53	3	50	0	0	1	13	0	0	9	35	18	56	5	42	0	0	45		
Column total	17		6		14		8		13		26		32		12		43		171		

(based on where lithologies change and removing the upper and lower boundaries)



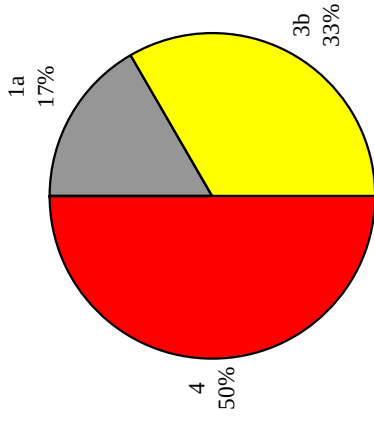


Units occurring above facies 1a



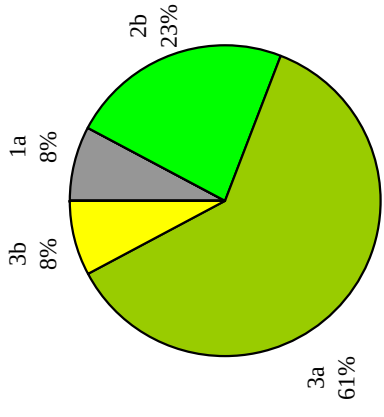
16 units

Units occurring above facies 1b



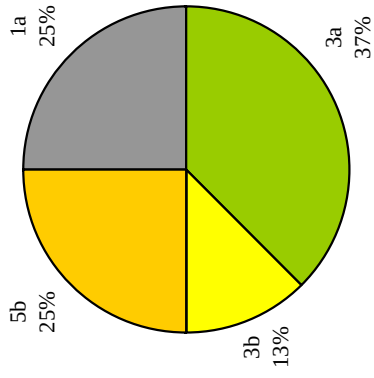
3 units

Units occurring above facies 2a



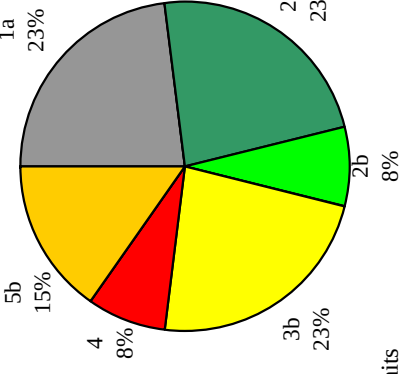
15 units

Units occurring above facies 2b



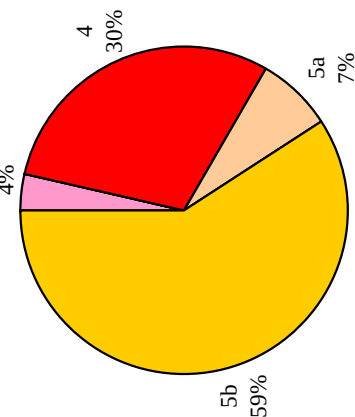
8 units

Units occurring above facies 3a



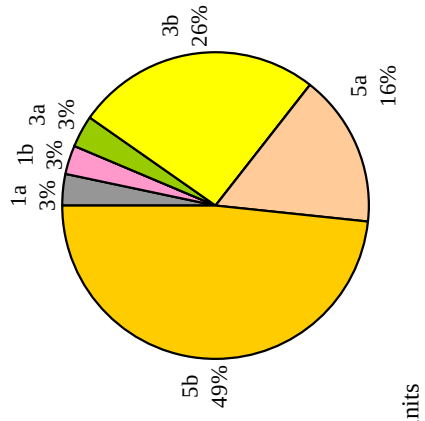
21 units

Units occurring above facies 3b



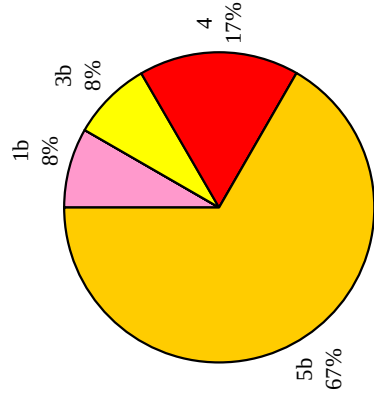
45 units

Units occurring above facies 4



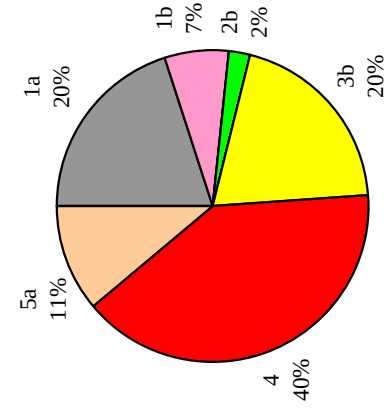
50 units

Units occurring above facies 5a



13 units

Units occurring above facies 5b



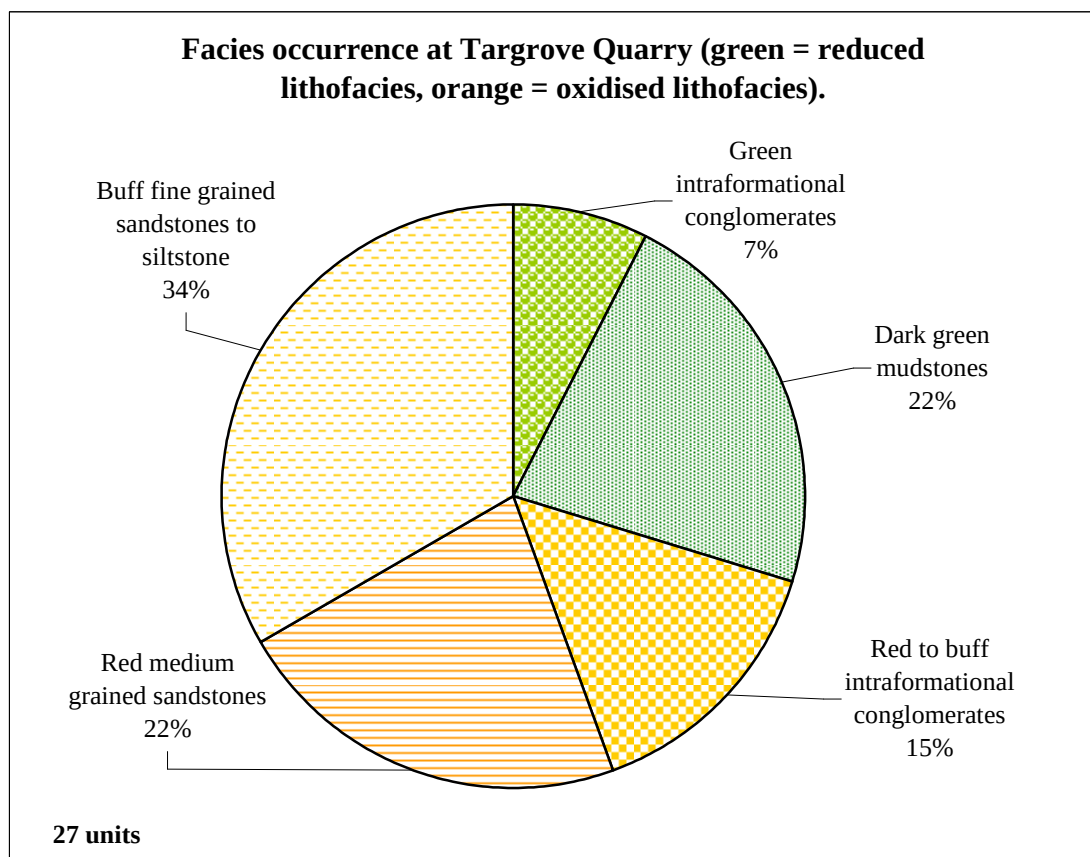
133 units

CLAST SIZE ANALYSIS

APPENDIX VII - SEDIMENTARY ANALYSIS OF TREDOMEN QUARRY SEQUENCE

[illegible]

APPENDIX VII - SEDIMENTARY ANALYSIS OF TARGROVE QUARRY SEQUENCE
LITHOFACIES OCCURRENCES



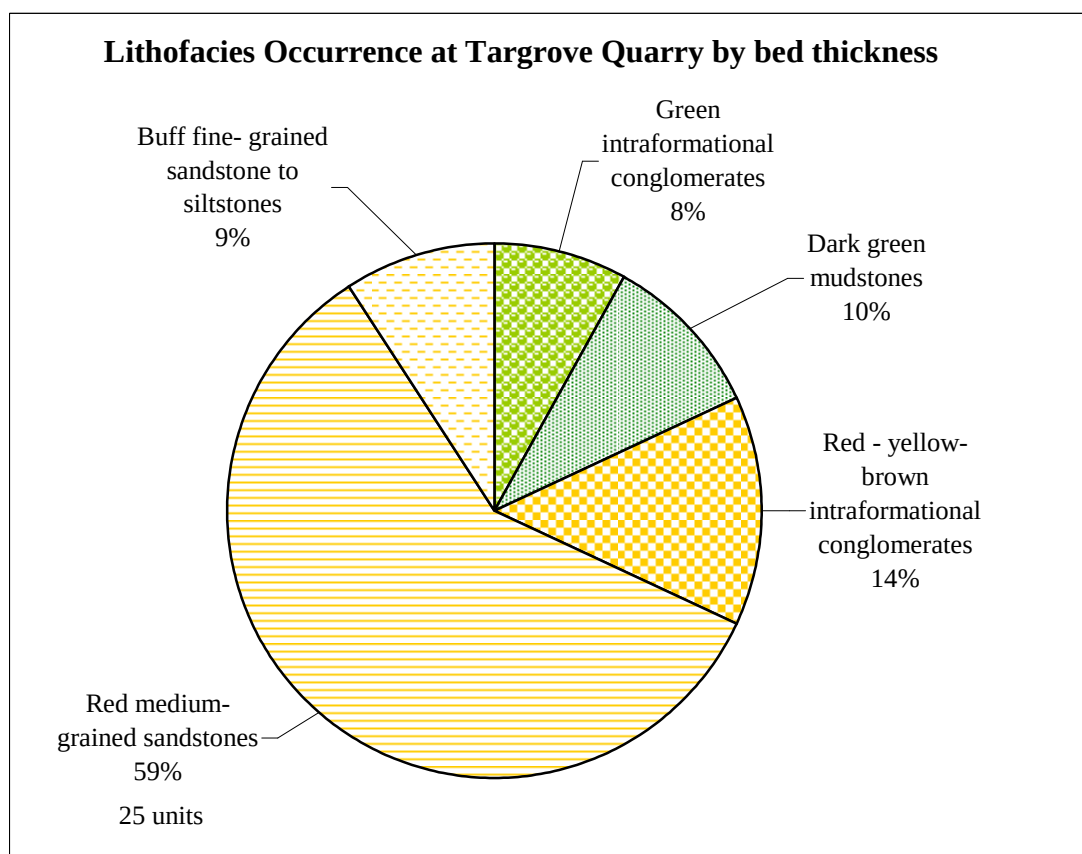
r	Green intraformational conglomerates	2
r	Dark green mudstones	6
o	Red to buff intraformational conglomerates	4
o	Red medium grained sandstones	6
o	Buff fine grained sandstones to siltstone	9

(based on where lithology changes)

APPENDIX VII - SEDIMENTARY ANALYSIS OF TARGROVE QUARRY SEQUENCE
LITHOFACIES OCCURRENCE BY THICKNESS (in m)

1a	1b	2c	3c	5c
0.4	0.2	2.5	0.1	0.2
0.5	0.5	0.7	0.1	0.2
	0.6	0.24	0.1	0.2
	0.25	0.16	0.1	0.2
		2.25	0.2	0.2
		0.8	0.1	0.15
			0.15	
			0.1	
			0.1	

					Total	
Number of beds	2	4	4	9	6 25	(based on total number of beds minus the upper and lower unit thickness).
Thickness total	0.9	1.55	6.65	1.05	1.15 11.3	
Average thickness	0.45	0.39	1.11	0.12	0.19	
Min	0.4	0.2	0.16	0.1	0.15	
Max	0.5	0.6	2.5	0.2	0.2	



	Thickness in m
r Green intraformational conglomerates	0.9
r Dark green mudstones	1.15
o Red - yellow-brown intraformational conglomerates	1.55
o Red medium-grained sandstones	6.65
o Buff fine- grained sandstone to siltstones	1.05

APPENDIX VII - SEDIMENTARY ANALYSIS OF TARGROVE QUARRY SEQUENCE
LITHOFACIES BOUNDARIES

UPPER BOUNDARIES (Facies 1a-?)

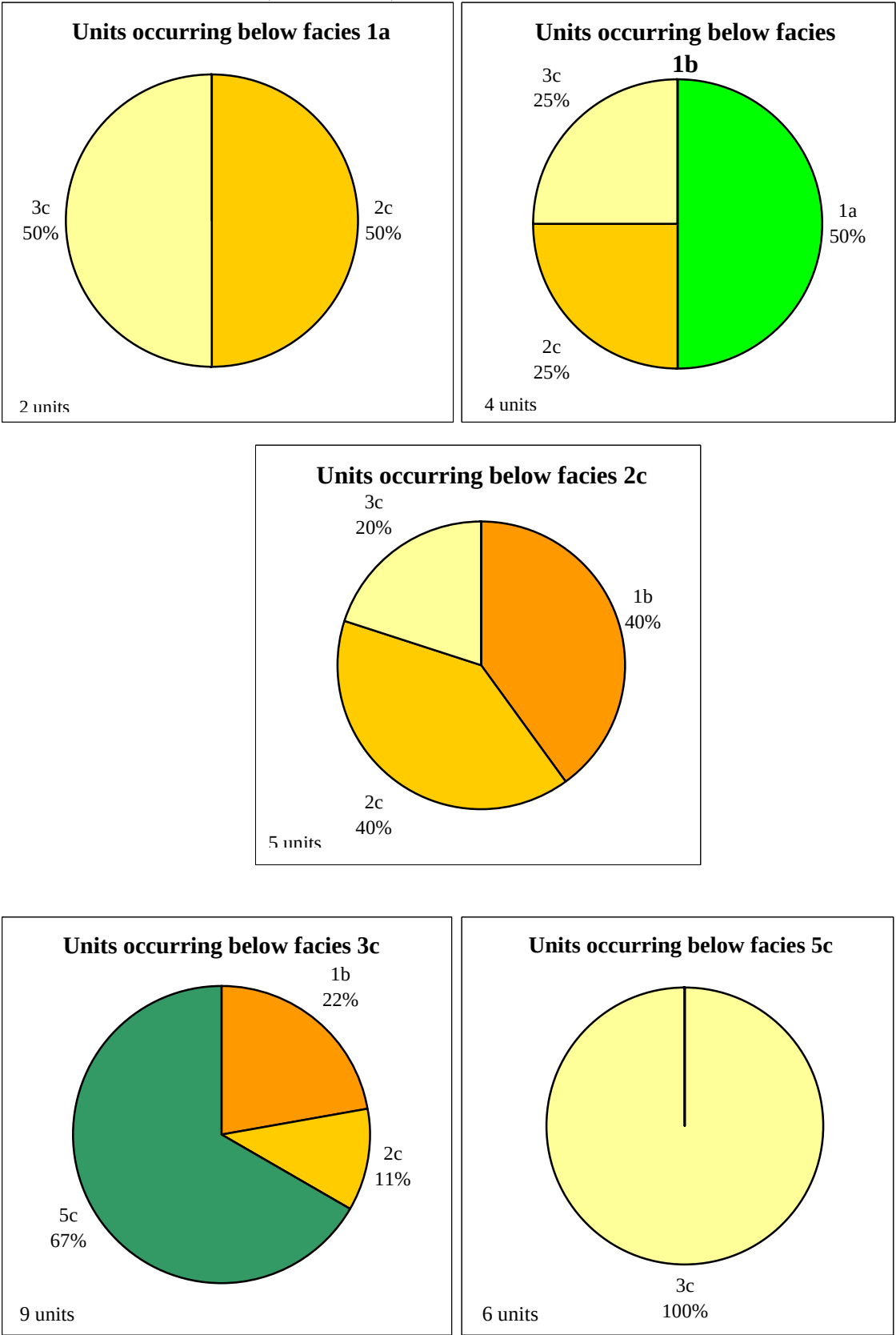
		TO											
FROM	FACIES	1a	%	1b	%	2c	%	3c	%	5c	%	Row total	
	1a	0	0	2	100	0	0	0	0	0	0	2	8
	1b	0	0	0	0	2	50	2	50	0	0	4	15
	2c	1	20	1	20	2	40	1	20	0	0	5	19
	3c	1	11	1	11	1	11	0	0	6	67	9	35
	5c	0	0	0	0	0	0	6	100	0	0	6	23
													26

(based on where lithologies change and
removing the upper and lower boundaries)

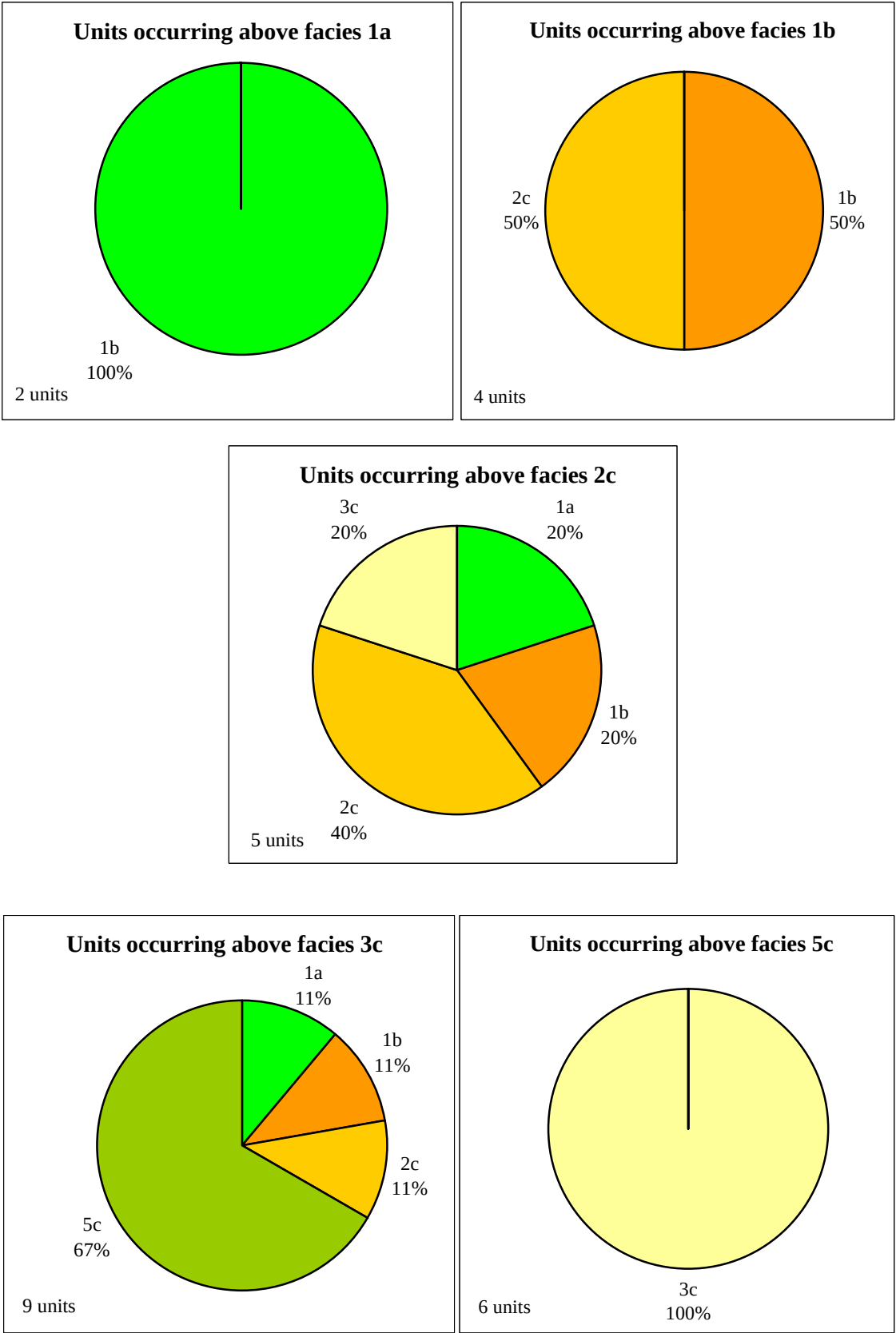
LOWER BOUNDARIES (Facies ?-1a)

		TO											
FROM	FACIES	1a	%	1b	%	2c	%	3c	%	5c	%		
	1a	0	0	2	50	0	0	0	0	0	0		
	1b	0	0	0	0	2	40	2	22	0	0		
	2c	1	50	1	25	2	40	1	11	0	0		
	3c	1	50	1	25	1	20	0	0	6	100		
	5c	0	0	0	0	0	0	6	67	0	0		
Column total		2		4		5		9		6			26

APPENDIX VII - SEDIMENTARY ANALYSIS OF TARGROVE QUARRY SEQUENCE
LITHOFACIES BOUNDARIES (CONTINUED)



APPENDIX VII - SEDIMENTARY ANALYSIS OF TARGROVE QUARRY SEQUENCE
LITHOFACIES BOUNDARIES (CONTINUED)



APPENDIX VIII: MARKOV CHAIN ANALYSIS

<i>a: Markov Chain Analysis of total Tredomen Quarry sequence.....</i>	<i>pVIII-2</i>
<i>b: Markov Chain Analysis of lower Tredomen Quarry sequence.....</i>	<i>pVIII-5</i>
<i>c: Markov Chain Analysis of upper Tredomen Quarry sequence.....</i>	<i>pVIII-8</i>
<i>d: Embedded Markov Chain Analysis of total Tredomen Quarry sequence...</i>	<i>pVIII-12</i>
<i>e: Embedded Markov Chain Analysis of lower Tredomen Quarry sequence..</i>	<i>pVIII-26</i>
<i>f: Embedded Markov Chain Analysis of upper Tredomen Quarry sequence..</i>	<i>pVIII-41</i>
<i>g: Markov Chain Analysis results summary.....</i>	<i>pVIII-53</i>

APPENDIX VIII - MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Markov Chain Analysis of total Tredomen Quarry sequence, using 10cm intervals

Observed transitions matrix

		TO									
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	Row totals
	1a	35	0	11	3	1	0	1	0	0	51
	1b	1	20	0	0	0	4	3	1	0	29
	2a	1	0	107	3	8	1	0	0	0	120
	2b	2	0	0	46	3	1	0	0	2	54
	3a	3	0	3	1	52	3	1	0	2	65
	3b	0	2	0	0	0	154	5	2	15	178
	4	1	1	0	0	1	6	225	4	15	253
	5a	0	2	0	0	0	1	1	90	6	100
	5b	9	3	0	1	0	8	18	3	994	1036
Column totals		52	28	121	54	65	178	254	100	1034	1886
Grand total											1886
Number of transitions											1885

Observed transitions matrix as fractions

		TO									
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	0.69	0.00	0.22	0.06	0.02	0.00	0.02	0.00	0.00	1.00
	1b	0.03	0.69	0.00	0.00	0.00	0.14	0.10	0.03	0.00	1.00
	2a	0.01	0.00	0.89	0.03	0.07	0.01	0.00	0.00	0.00	1.00
	2b	0.04	0.00	0.00	0.85	0.06	0.02	0.00	0.00	0.04	1.00
	3a	0.05	0.00	0.05	0.02	0.80	0.05	0.02	0.00	0.03	1.00
	3b	0.00	0.01	0.00	0.00	0.00	0.87	0.03	0.01	0.08	1.00
	4	0.00	0.00	0.00	0.00	0.00	0.02	0.89	0.02	0.06	1.00
	5a	0.00	0.02	0.00	0.00	0.00	0.01	0.01	0.90	0.06	1.00
	5b	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.96	1.00

APPENDIX VIII - MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
Markov Chain Analysis of total Tredomen Quarry sequence, using 10cm intervals (continued)

Fixed probability vectors

1a	0.03
1b	0.02
2a	0.06
2b	0.03
3a	0.03
3b	0.09
4	0.13
5a	0.05
5b	0.55

Expected transitions probabilities matrix

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	0.03	0.02	0.06	0.03	0.03	0.09	0.13	0.05	0.55	51
	1b	0.03	0.02	0.06	0.03	0.03	0.09	0.13	0.05	0.55	29
	2a	0.03	0.02	0.06	0.03	0.03	0.09	0.13	0.05	0.55	120
	2b	0.03	0.02	0.06	0.03	0.03	0.09	0.13	0.05	0.55	54
	3a	0.03	0.02	0.06	0.03	0.03	0.09	0.13	0.05	0.55	65
	3b	0.03	0.02	0.06	0.03	0.03	0.09	0.13	0.05	0.55	178
	4	0.03	0.02	0.06	0.03	0.03	0.09	0.13	0.05	0.55	253
	5a	0.03	0.02	0.06	0.03	0.03	0.09	0.13	0.05	0.55	100
	5b	0.03	0.02	0.06	0.03	0.03	0.09	0.13	0.05	0.55	1036

Expected transitions matrix

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	1.38	0.78	3.25	1.46	1.76	4.82	6.85	2.71	28.03
	1b	0.78	0.45	1.85	0.83	1.00	2.74	3.89	1.54	15.94
	2a	3.25	1.85	7.64	3.44	4.14	11.33	16.11	6.37	65.95
	2b	1.46	0.83	3.44	1.55	1.86	5.10	7.25	2.86	29.68
	3a	1.76	1.00	4.14	1.86	2.24	6.14	8.72	3.45	35.72
	3b	4.82	2.74	11.33	5.10	6.14	16.81	23.89	9.44	97.83
	4	6.85	3.89	16.11	7.25	8.72	23.89	33.96	13.42	139.05
	5a	2.71	1.54	6.37	2.86	3.45	9.44	13.42	5.31	54.96
	5b	28.03	15.94	65.95	29.68	35.72	97.83	139.05	54.96	569.39

APPENDIX VIII - MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Markov Chain Analysis of total Tredomen Quarry sequence, using 10cm intervals (continued)

<i>T</i>	<i>O</i>	<i>E</i>	$((O-E)^2)/E$
1a-4	1	6.85	4.99
1a-5b	0	28.03	28.03
1b-5b	0	15.94	15.94
2a-2a	107	7.64	1292.35
2a-3b	1	11.33	9.42
2a-4	0	16.11	16.11
2a-5a	0	6.37	6.37
2a-5b	0	65.95	65.95
2b-3b	1	5.10	3.30
2b-4	0	7.25	7.25
2b-5b	2	29.68	25.81
3a-3b	3	6.14	1.60
3a-4	1	8.72	6.84
3a-5b	2	35.72	31.84
3b-2a	0	11.33	11.33
3b-2b	0	5.10	5.10
3b-3a	0	6.14	6.14
3b-3b	154	16.81	1119.76
3b-4	5	23.89	14.94
3b-5a	2	9.44	5.87
3b-5b	15	97.83	70.13
4-1a	1	6.85	4.99
4-2a	0	16.11	16.11
4-2b	0	7.25	7.25
4-3a	1	8.72	6.84
4-3b	6	23.89	13.40
4-4	225	33.96	1074.81
4-5a	4	13.42	6.61
4-5b	15	139.05	110.67
5a-2a	0	6.37	6.37
5a-3b	1	9.44	7.55
5a-4	1	13.42	11.50
5a-5a	90	5.31	1352.16
5a-5b	6	54.96	43.62
5b-1a	9	28.03	12.92
5b-1b	3	15.94	10.50
5b-2a	0	65.95	65.95
5b-2b	1	29.68	27.71
5b-3a	0	35.72	35.72
5b-3b	8	97.83	82.48
5b-4	18	139.05	105.38
5b-5a	3	54.96	49.12
5b-5b	994	569.39	316.65

$$\chi^2 = 6117.35 \quad \text{with 64 degrees of freedom} = (\text{number of states} - 1)^2$$

critical value at 5% significance level for 64 degrees of freedom = 83.675

Therefore, the series of states are not independent of one another.

That is the series exhibits a first order Markovian property.

APPENDIX VIII - MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Markov Chain Analysis of lower sequence of Tredomen Quarry sequence, using 10cm intervals

Observed transitions matrix

		TO									
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	Row totals
	1a	0	0	0	0	0	0	0	0	0	0
	1b	0	1	0	0	0	2	1	0	0	4
	2a	0	0	0	0	0	0	0	0	0	0
	2b	0	0	0	0	0	0	0	0	0	0
	3a	0	0	0	0	0	0	0	0	0	0
	3b	0	1	0	0	0	33	1	0	2	37
	4	0	0	0	0	0	0	18	2	0	20
	5a	0	1	0	0	0	0	0	35	4	40
	5b	0	1	0	0	0	2	1	3	481	488
Column totals		0	4	0	0	0	37	21	40	487	589
Grand total											589
Number of transitions											588

Observed transitions matrix as fractions

		TO									
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1b	0.00	0.25	0.00	0.00	0.00	0.50	0.25	0.00	0.00	1.00
	2a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3b	0.00	0.03	0.00	0.00	0.00	0.89	0.03	0.00	0.05	1.00
	4	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.10	0.00	1.00
	5a	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.88	0.10	1.00
	5b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	1.00

APPENDIX VIII - MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Markov Chain Analysis of lower sequence of Tredomen Quarry sequence, using 10cm intervals (continued)

Fixed probability vectors

1a	0.000
1b	0.007
2a	0.000
2b	0.000
3a	0.000
3b	0.063
4	0.034
5a	0.068
5b	0.830

Expected transitions probabilities matrix

		TO									
		1a	1b	2a	2b	3a	3b	4	5a	5b	Row totals
FROM	1a	0.000	0.007	0.000	0.000	0.000	0.063	0.034	0.068	0.830	0
	1b	0.000	0.007	0.000	0.000	0.000	0.063	0.034	0.068	0.830	4
	2a	0.000	0.007	0.000	0.000	0.000	0.063	0.034	0.068	0.830	0
	2b	0.000	0.007	0.000	0.000	0.000	0.063	0.034	0.068	0.830	0
	3a	0.000	0.007	0.000	0.000	0.000	0.063	0.034	0.068	0.830	0
	3b	0.000	0.007	0.000	0.000	0.000	0.063	0.034	0.068	0.830	37
	4	0.000	0.007	0.000	0.000	0.000	0.063	0.034	0.068	0.830	20
	5a	0.000	0.007	0.000	0.000	0.000	0.063	0.034	0.068	0.830	40
	5b	0.000	0.007	0.000	0.000	0.000	0.063	0.034	0.068	0.830	488

Expected transitions matrix

		TO								
		1a	1b	2a	2b	3a	3b	4	5a	5b
FROM	1a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1b	0.00	0.03	0.00	0.00	0.00	0.25	0.14	0.27	3.32
	2a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3b	0.00	0.25	0.00	0.00	0.00	2.33	1.26	2.52	30.71
	4	0.00	0.14	0.00	0.00	0.00	1.26	0.68	1.36	16.60
	5a	0.00	0.27	0.00	0.00	0.00	2.52	1.36	2.72	33.20
	5b	0.00	3.32	0.00	0.00	0.00	30.71	16.60	33.20	405.01

APPENDIX VIII - MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Markov Chain Analysis of lower sequence of Tredomen Quarry sequence, using 10cm intervals (continued)

<i>T</i>	<i>O</i>	<i>E</i>	$((O-E)^2)/E$
3b-5b	2	30.71	26.84
4-5b	0	16.60	16.60
5a-5b	4	33.20	25.68
5b-3b	2	30.71	26.84
5b-4	1	16.60	14.66
5b-5a	3	33.20	27.47
5b-5b	481	405.01	14.26

$\chi^2 = 152.34$ with 64 degrees of freedom = (number of states -1)²
critical value at 5% significance level for 64 degrees of freedom = 83.675
 Therefore, the series of states are not independent of one another.
 That is the series exhibits a first order Markovian property.

APPENDIX VIII - MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
Markov Chain Analysis of upper sequence of Tredomen Quarry sequence, using 10cm intervals

Observed transitions matrix

		TO								Row totals	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	35	0	11	3	1	0	1	0	0	51
	1b	1	15	0	0	0	0	2	0	0	18
	2a	1	0	107	3	8	1	0	0	0	120
	2b	2	0	0	46	3	1	0	0	2	54
	3a	3	0	3	1	52	3	1	0	5	68
	3b	0	0	0	0	0	121	9	2	13	145
	4	1	1	0	0	1	8	207	3	15	236
	5a	0	0	0	0	0	1	1	62	3	67
	5b	9	2	0	1	0	6	18	0	502	538
Column totals		52	18	121	54	65	141	239	67	540	1297
Grand total											1297
Number of transitions											1296

Observed transitions matrix as fractions

		TO									
		1a	1b	2a	2b	3a	3b	4	5a	5b	
FROM	1a	0.69	0.00	0.22	0.06	0.02	0.00	0.02	0.00	0.00	1.00
	1b	0.06	0.83	0.00	0.00	0.00	0.00	0.11	0.00	0.00	1.00
	2a	0.01	0.00	0.89	0.03	0.07	0.01	0.00	0.00	0.00	1.00
	2b	0.04	0.00	0.00	0.85	0.06	0.02	0.00	0.00	0.04	1.00
	3a	0.04	0.00	0.04	0.01	0.76	0.04	0.01	0.00	0.07	1.00
	3b	0.00	0.00	0.00	0.00	0.00	0.83	0.06	0.01	0.09	1.00
	4	0.00	0.00	0.00	0.00	0.00	0.03	0.88	0.01	0.06	1.00
	5a	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.93	0.04	1.00
	5b	0.02	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.93	1.00

APPENDIX VIII - MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Markov Chain Analysis of upper sequence of Tredomen Quarry sequence, using 10cm intervals
 (continued)
Fixed probability vectors

1a	0.039
1b	0.014
2a	0.093
2b	0.042
3a	0.052
3b	0.112
4	0.182
5a	0.052
5b	0.415

Expected transitions probabilities matrix

		TO								Row totals	
		1a	1b	2a	2b	3a	3b	4	5a		5b
FROM	1a	0.039	0.014	0.093	0.042	0.052	0.112	0.182	0.052	0.415	51
	1b	0.039	0.014	0.093	0.042	0.052	0.112	0.182	0.052	0.415	18
	2a	0.039	0.014	0.093	0.042	0.052	0.112	0.182	0.052	0.415	120
	2b	0.039	0.014	0.093	0.042	0.052	0.112	0.182	0.052	0.415	54
	3a	0.039	0.014	0.093	0.042	0.052	0.112	0.182	0.052	0.415	68
	3b	0.039	0.014	0.093	0.042	0.052	0.112	0.182	0.052	0.415	145
	4	0.039	0.014	0.093	0.042	0.052	0.112	0.182	0.052	0.415	236
	5a	0.039	0.014	0.093	0.042	0.052	0.112	0.182	0.052	0.415	67
	5b	0.039	0.014	0.093	0.042	0.052	0.112	0.182	0.052	0.415	538

Expected transitions matrix

		TO								
		1a	1b	2a	2b	3a	3b	4	5a	5b
FROM	1a	2.01	0.71	4.72	2.13	2.68	5.71	9.29	2.64	21.17
	1b	0.71	0.25	1.67	0.75	0.94	2.01	3.28	0.93	7.47
	2a	4.72	1.67	11.11	5.00	6.30	13.43	21.85	6.20	49.81
	2b	2.13	0.75	5.00	2.25	2.83	6.04	9.83	2.79	22.42
	3a	2.68	0.94	6.30	2.83	3.57	7.61	12.38	3.52	28.23
	3b	5.71	2.01	13.43	6.04	7.61	16.22	26.40	7.50	60.19
	4	9.29	3.28	21.85	9.83	12.38	26.40	42.98	12.20	97.97
	5a	2.64	0.93	6.20	2.79	3.52	7.50	12.20	3.46	27.81
	5b	21.17	7.47	49.81	22.42	28.23	60.19	97.97	27.81	223.34

APPENDIX VIII - MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Markov Chain Analysis of upper sequence of Tredomen Quarry sequence, using 10cm intervals
 (continued)

<i>T</i>	<i>O</i>	<i>E</i>	$((O-E)^2)/E$
1a-3b	0	5.71	5.71
1a-4	1	9.29	7.39
1a-5b	0	21.17	21.17
1b-5b	0	7.47	7.47
2a-2b	3	5.00	0.80
2a-3a	8	6.30	0.46
2a-3b	1	13.43	11.50
2a-4	0	21.85	21.85
2a-5a	0	6.20	6.20
2a-5b	0	49.81	49.81
2b-2a	0	5.00	5.00
2b-3b	1	6.04	4.21
2b-4	0	9.83	9.83
2b-5b	2	22.42	18.60
3a-2a	3	6.30	1.73
3a-3b	3	7.61	2.79
3a-4	1	12.38	10.46
3a-5b	5	28.23	19.11
3b-1a	0	5.71	5.71
3b-2a	0	13.43	13.43
3b-2b	0	6.04	6.04
3b-3a	0	7.61	7.61
3b-3b	121	16.22	676.71
3b-4	9	26.40	11.47
3b-5a	2	7.50	4.03
3b-5b	13	60.19	37.00
4-1a	1	9.29	7.39
4-2a	0	21.85	21.85
4-2b	0	9.83	9.83
4-3a	1	12.38	10.46
4-3b	8	26.40	12.83
4-4	207	42.98	626.04
4-5a	3	12.20	6.94
4-5b	15	97.97	70.27
5a-2a	0	6.20	6.20
5a-3b	1	7.50	5.63
5a-4	1	12.20	10.28
5a-5b	3	27.81	22.14
5b-1a	9	21.17	7.00
5b-1b	2	7.47	4.01
5b-2a	0	49.81	49.81

APPENDIX VIII - MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Markov Chain Analysis of upper sequence of Tredomen Quarry sequence, using 10cm intervals
 (continued)

<i>T</i>	<i>O</i>	<i>E</i>	$((O-E)^2)/E$
5b-2b	1	22.42	20.46
5b-3a	0	28.23	28.23
5b-3b	6	60.19	48.79
5b-4	18	97.97	65.28
5b-5a	0	27.81	27.81
5b-5b	502	223.34	347.70

$\chi^2 = 2375.05$ with 64 degrees of freedom = (number of states -1)²
critical value at 5% significance level for 64 degrees of freedom = 83.675
 Therefore, the series of states are not independent of one another.
 That is the series exhibits a first order Markovian property.

Embedded Markov Chain Analysis of total Tredomen Quarry sequence using 10cm intervals.

		TO									
		<i>1a</i>	<i>1b</i>	<i>2a</i>	<i>2b</i>	<i>3a</i>	<i>3b</i>	<i>4</i>	<i>5a</i>	<i>5b</i>	Row totals
	<i>1a</i>		0	11	3	1	0	1	0	0	16
	<i>1b</i>	1		0	0	0	4	3	1	0	9
	<i>2a</i>	1	0		3	8	1	0	0	0	13
	<i>2b</i>	2	0	0		3	1	0	0	2	8
FROM	<i>3a</i>	3	0	3	1		3	1	0	2	13
	<i>3b</i>	0	2	0	0	0		5	2	15	24
	<i>4</i>	1	1	0	0	1	6		4	15	28
	<i>5a</i>	0	2	0	0	0	1	1		6	10
	<i>5b</i>	9	3	0	1	0	8	18	3		42
Column totals		17	8	14	8	13	24	29	10	40	163

		TO									
		1a	1b	2a	2b	3a	3b	4	5a	5b	Row totals
FROM	1a	1000.00	0.00	11.00	3.00	1.00	0.00	1.00	0.00	0.00	1016.00
	1b	1.00	1000.00	0.00	0.00	0.00	4.00	3.00	1.00	0.00	1009.00
	2a	1.00	0.00	1000.00	3.00	8.00	1.00	0.00	0.00	0.00	1013.00
	2b	2.00	0.00	0.00	1000.00	3.00	1.00	0.00	0.00	2.00	1008.00
	3a	3.00	0.00	3.00	1.00	1000.00	3.00	1.00	0.00	2.00	1013.00
	3b	0.00	2.00	0.00	0.00	0.00	1000.00	5.00	2.00	15.00	1024.00
	4	1.00	1.00	0.00	0.00	1.00	6.00	1000.00	4.00	15.00	1028.00
	5a	0.00	2.00	0.00	0.00	0.00	1.00	1.00	1000.00	6.00	1010.00
5b	9.00	3.00	0.00	1.00	0.00	8.00	18.00	3.00	1000.00	1042.00	
Column totals		1017.00	1008.00	1014.00	1008.00	1013.00	1024.00	1029.00	1010.00	1040.00	9163.00

[illegible]

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE

Embedded Markov Chain Analysis of total Tredomen Quarry sequence using 10cm intervals (continued).

Estimates of transition frequencies 2

		TO									
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	Row totals
	1a	112.65	0.00	11.00	3.00	1.00	0.00	1.00	0.00	0.00	128.65
	1b	1.00	111.11	0.00	0.00	0.00	4.00	3.00	1.00	0.00	120.11
	2a	1.00	0.00	111.99	3.00	8.00	1.00	0.00	0.00	0.00	124.99
	2b	2.00	0.00	0.00	110.89	3.00	1.00	0.00	0.00	2.00	118.89
	3a	3.00	0.00	3.00	1.00	111.99	3.00	1.00	0.00	2.00	124.99
	3b	0.00	2.00	0.00	0.00	0.00	114.44	5.00	2.00	15.00	138.44
	4	1.00	1.00	0.00	0.00	1.00	6.00	115.33	4.00	15.00	143.33
	5a	0.00	2.00	0.00	0.00	0.00	1.00	1.00	111.33	6.00	121.33
	5b	9.00	3.00	0.00	1.00	0.00	8.00	18.00	3.00	118.49	160.49
Column totals		129.65	119.11	125.99	118.89	124.99	138.44	144.33	121.33	158.49	1181.22

Estimate of transition probabilities for diagonals 2

		TO								
		1a	1b	2a	2b	3a	3b	4	5a	5b
FROM	1a	0.1089								
	1b		0.1017							
	2a			0.1058						
	2b				0.1006					
	3a					0.1058				
	3b						0.1172			
	4							0.1213		
	5a								0.1027	
	5b									0.1359

Estimates of transition frequencies 3

		TO									
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	Row totals
	1a	14.01	0.00	11.00	3.00	1.00	0.00	1.00	0.00	0.00	30.01
	1b	1.00	12.21	0.00	0.00	0.00	4.00	3.00	1.00	0.00	21.21
	2a	1.00	0.00	13.23	3.00	8.00	1.00	0.00	0.00	0.00	26.23
	2b	2.00	0.00	0.00	11.97	3.00	1.00	0.00	0.00	2.00	19.97
	3a	3.00	0.00	3.00	1.00	13.23	3.00	1.00	0.00	2.00	26.23
	3b	0.00	2.00	0.00	0.00	0.00	16.22	5.00	2.00	15.00	40.22
	4	1.00	1.00	0.00	0.00	1.00	6.00	17.39	4.00	15.00	45.39
	5a	0.00	2.00	0.00	0.00	0.00	1.00	1.00	12.46	6.00	22.46
	5b	9.00	3.00	0.00	1.00	0.00	8.00	18.00	3.00	21.81	63.81
Column totals		31.01	20.21	27.23	19.97	26.23	40.22	46.39	22.46	61.81	295.53

Estimate of transition probabilities for diagonals 3

Estimates of transition frequencies 4

Estimate of transition probabilities for diagonals 4

[illegible]

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE

Embedded Markov Chain Analysis of total Tredomen Quarry sequence using 10cm intervals (continued).

Estimates of transition frequencies 5

		TO									
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	Row totals
	1a	1.80	0.00	11.00	3.00	1.00	0.00	1.00	0.00	0.00	17.80
	1b	1.00	0.55	0.00	0.00	0.00	4.00	3.00	1.00	0.00	9.55
	2a	1.00	0.00	1.17	3.00	8.00	1.00	0.00	0.00	0.00	14.17
	2b	2.00	0.00	0.00	0.43	3.00	1.00	0.00	0.00	2.00	8.43
	3a	3.00	0.00	3.00	1.00	1.17	3.00	1.00	0.00	2.00	14.17
	3b	0.00	2.00	0.00	0.00	0.00	4.31	5.00	2.00	15.00	28.31
	4	1.00	1.00	0.00	0.00	1.00	6.00	6.07	4.00	15.00	34.07
	5a	0.00	2.00	0.00	0.00	0.00	1.00	1.00	0.68	6.00	10.68
	5b	9.00	3.00	0.00	1.00	0.00	8.00	18.00	3.00	15.44	57.44
Column totals		18.80	8.55	15.17	8.43	14.17	28.31	35.07	10.68	55.44	194.62

Estimate of transition probabilities for diagonals 5

		TO								
		1a	1b	2a	2b	3a	3b	4	5a	5b
FROM	1a	0.0915								
	1b		0.0491							
	2a			0.0728						
	2b				0.0433					
	3a					0.0728				
	3b						0.1455			
	4							0.1751		
	5a								0.0549	
	5b									0.2951

Estimates of transition frequencies 6

		TO								Row totals	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.63	0.00	11.00	3.00	1.00	0.00	1.00	0.00	0.00	17.63
	1b	1.00	0.47	0.00	0.00	0.00	4.00	3.00	1.00	0.00	9.47
	2a	1.00	0.00	1.03	3.00	8.00	1.00	0.00	0.00	0.00	14.03
	2b	2.00	0.00	0.00	0.37	3.00	1.00	0.00	0.00	2.00	8.37
	3a	3.00	0.00	3.00	1.00	1.03	3.00	1.00	0.00	2.00	14.03
	3b	0.00	2.00	0.00	0.00	0.00	4.12	5.00	2.00	15.00	28.12
	4	1.00	1.00	0.00	0.00	1.00	6.00	5.96	4.00	15.00	33.96
	5a	0.00	2.00	0.00	0.00	0.00	1.00	1.00	0.59	6.00	10.59
	5b	9.00	3.00	0.00	1.00	0.00	8.00	18.00	3.00	16.95	58.95
Column totals		18.63	8.47	15.03	8.37	14.03	28.12	34.96	10.59	56.95	195.15

Estimate of transition probabilities for diagonals 6

FROM

FROM

Column totals

Estimate of transition probabilities for diagonals 7

Estimates of transition frequencies 8

Estimate of transition probabilities for diagonals 8

[illegible]

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE

Embedded Markov Chain Analysis of total Tredomen Quarry sequence using 10cm intervals (continued).

Estimates of transition frequencies 9

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.58	0.00	11.00	3.00	1.00	0.00	1.00	0.00	0.00	17.58
	1b	1.00	0.46	0.00	0.00	0.00	4.00	3.00	1.00	0.00	9.46
	2a	1.00	0.00	1.00	3.00	8.00	1.00	0.00	0.00	0.00	14.00
	2b	2.00	0.00	0.00	0.36	3.00	1.00	0.00	0.00	2.00	8.36
	3a	3.00	0.00	3.00	1.00	1.00	3.00	1.00	0.00	2.00	14.00
	3b	0.00	2.00	0.00	0.00	0.00	4.00	5.00	2.00	15.00	28.00
	4	1.00	1.00	0.00	0.00	1.00	6.00	5.85	4.00	15.00	33.85
	5a	0.00	2.00	0.00	0.00	0.00	1.00	1.00	0.57	6.00	10.57
	5b	9.00	3.00	0.00	1.00	0.00	8.00	18.00	3.00	18.52	60.52
Column totals		18.58	8.46	15.00	8.36	14.00	28.00	34.85	10.57	58.52	196.33

Estimate of transition probabilities for diagonals 9

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	0.0895								
	1b		0.0482							
	2a			0.0713						
	2b				0.0426					
	3a					0.0713				
	3b						0.1426			
	4							0.1724		
	5a								0.0538	
	5b									0.3083

Estimates of transition frequencies 10

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.57	0.00	11.00	3.00	1.00	0.00	1.00	0.00	0.00	17.57
	1b	1.00	0.46	0.00	0.00	0.00	4.00	3.00	1.00	0.00	9.46
	2a	1.00	0.00	1.00	3.00	8.00	1.00	0.00	0.00	0.00	14.00
	2b	2.00	0.00	0.00	0.36	3.00	1.00	0.00	0.00	2.00	8.36
	3a	3.00	0.00	3.00	1.00	1.00	3.00	1.00	0.00	2.00	14.00
	3b	0.00	2.00	0.00	0.00	0.00	3.99	5.00	2.00	15.00	27.99
	4	1.00	1.00	0.00	0.00	1.00	6.00	5.84	4.00	15.00	33.84
	5a	0.00	2.00	0.00	0.00	0.00	1.00	1.00	0.57	6.00	10.57
	5b	9.00	3.00	0.00	1.00	0.00	8.00	18.00	3.00	18.66	60.66
Column totals		18.57	8.46	15.00	8.36	14.00	27.99	34.84	10.57	58.66	196.44

Estimate of transition probabilities for diagonals 10

Estimates of transition frequencies 11

Estimate of transition probabilities for diagonals 11

[illegible]

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE

Embedded Markov Chain Analysis of total Tredomen Quarry sequence using 10cm intervals (continued).

Estimates of transition frequencies 12

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.57	0.00	11.00	3.00	1.00	0.00	1.00	0.00	0.00	17.57
	1b	1.00	0.45	0.00	0.00	0.00	4.00	3.00	1.00	0.00	9.45
	2a	1.00	0.00	1.00	3.00	8.00	1.00	0.00	0.00	0.00	14.00
	2b	2.00	0.00	0.00	0.36	3.00	1.00	0.00	0.00	2.00	8.36
	3a	3.00	0.00	3.00	1.00	1.00	3.00	1.00	0.00	2.00	14.00
	3b	0.00	2.00	0.00	0.00	0.00	3.99	5.00	2.00	15.00	27.99
	4	1.00	1.00	0.00	0.00	1.00	6.00	5.82	4.00	15.00	33.82
	5a	0.00	2.00	0.00	0.00	0.00	1.00	1.00	0.57	6.00	10.57
	5b	9.00	3.00	0.00	1.00	0.00	8.00	18.00	3.00	18.77	60.77
Column totals		18.57	8.45	15.00	8.36	14.00	27.99	34.82	10.57	58.77	196.52

Estimate of transition probabilities for diagonals 12

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	0.0894								
	1b		0.0481							
	2a			0.0712						
	2b				0.0425					
	3a					0.0712				
	3b						0.1424			
	4							0.1721		
	5a								0.0538	
	5b									0.3092

Estimates of transition frequencies 13

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.57	0.00	11.00	3.00	1.00	0.00	1.00	0.00	0.00	17.57
	1b	1.00	0.45	0.00	0.00	0.00	4.00	3.00	1.00	0.00	9.45
	2a	1.00	0.00	1.00	3.00	8.00	1.00	0.00	0.00	0.00	14.00
	2b	2.00	0.00	0.00	0.36	3.00	1.00	0.00	0.00	2.00	8.36
	3a	3.00	0.00	3.00	1.00	1.00	3.00	1.00	0.00	2.00	14.00
	3b	0.00	2.00	0.00	0.00	0.00	3.99	5.00	2.00	15.00	27.99
	4	1.00	1.00	0.00	0.00	1.00	6.00	5.82	4.00	15.00	33.82
	5a	0.00	2.00	0.00	0.00	0.00	1.00	1.00	0.57	6.00	10.57
	5n	9.00	3.00	0.00	1.00	0.00	8.00	18.00	3.00	18.79	60.79
Column totals		18.57	8.45	15.00	8.36	14.00	27.99	34.82	10.57	58.79	196.54

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE

Embedded Markov Chain Analysis of total Tredomen Quarry sequence using 10cm intervals (continued).

Estimates of transition frequencies 15

		TO									
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	Row totals
	1a	1.57	0.00	11.00	3.00	1.00	0.00	1.00	0.00	0.00	17.57
	1b	1.00	0.45	0.00	0.00	0.00	4.00	3.00	1.00	0.00	9.45
	2a	1.00	0.00	1.00	3.00	8.00	1.00	0.00	0.00	0.00	14.00
	2b	2.00	0.00	0.00	0.36	3.00	1.00	0.00	0.00	2.00	8.36
	3a	3.00	0.00	3.00	1.00	1.00	3.00	1.00	0.00	2.00	14.00
	3b	0.00	2.00	0.00	0.00	0.00	3.98	5.00	2.00	15.00	27.98
	4	1.00	1.00	0.00	0.00	1.00	6.00	5.82	4.00	15.00	33.82
	5a	0.00	2.00	0.00	0.00	0.00	1.00	1.00	0.57	6.00	10.57
	5b	9.00	3.00	0.00	1.00	0.00	8.00	18.00	3.00	18.81	60.81
Column totals		18.57	8.45	15.00	8.36	14.00	27.98	34.82	10.57	58.81	196.56

Estimate of transition probabilities for diagonals 15

		TO								
		1a	1b	2a	2b	3a	3b	4	5a	5b
FROM	1a	0.0894								
	1b		0.0481							
	2a			0.0712						
	2b				0.0425					
	3a					0.0712				
	3b						0.1424			
	4							0.1721		
	5a								0.0538	
	5b									0.3094

Estimates of transition frequencies 16

		TO								Row totals	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.57	0.00	11.00	3.00	1.00	0.00	1.00	0.00	0.00	17.57
	1b	1.00	0.45	0.00	0.00	0.00	4.00	3.00	1.00	0.00	9.45
	2a	1.00	0.00	1.00	3.00	8.00	1.00	0.00	0.00	0.00	14.00
	2b	2.00	0.00	0.00	0.36	3.00	1.00	0.00	0.00	2.00	8.36
	3a	3.00	0.00	3.00	1.00	1.00	3.00	1.00	0.00	2.00	14.00
	3b	0.00	2.00	0.00	0.00	0.00	3.98	5.00	2.00	15.00	27.98
	4	1.00	1.00	0.00	0.00	1.00	6.00	5.82	4.00	15.00	33.82
	5a	0.00	2.00	0.00	0.00	0.00	1.00	1.00	0.57	6.00	10.57
5b	9.00	3.00	0.00	1.00	0.00	8.00	18.00	3.00	18.81	60.81	
Column totals		18.57	8.45	15.00	8.36	14.00	27.98	34.82	10.57	58.81	196.56

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE

Embedded Markov Chain Analysis of total Tredomen Quarry sequence using 10cm intervals (continued).

Fixed probability vectors

1a	0.0894
1b	0.0481
2a	0.0712
2b	0.0425
3a	0.0712
3b	0.1424
4	0.1721
5a	0.0538
5b	0.3094

Expected transitions probabilities matrix

		TO								
		1a	1b	2a	2b	3a	3b	4	5a	5b
FROM	1a	0.0080	0.0043	0.0064	0.0038	0.0064	0.0127	0.0154	0.0048	0.0277
	1b	0.0043	0.0023	0.0034	0.0020	0.0034	0.0068	0.0083	0.0026	0.0149
	2a	0.0064	0.0034	0.0051	0.0030	0.0051	0.0101	0.0123	0.0038	0.0220
	2b	0.0038	0.0020	0.0030	0.0018	0.0030	0.0061	0.0073	0.0023	0.0132
	3a	0.0064	0.0034	0.0051	0.0030	0.0051	0.0101	0.0123	0.0038	0.0220
	3b	0.0127	0.0068	0.0101	0.0061	0.0101	0.0203	0.0245	0.0077	0.0440
	4	0.0154	0.0083	0.0123	0.0073	0.0123	0.0245	0.0296	0.0093	0.0532
	5a	0.0048	0.0026	0.0038	0.0023	0.0038	0.0077	0.0093	0.0029	0.0166
	5b	0.0277	0.0149	0.0220	0.0132	0.0220	0.0440	0.0532	0.0166	0.0957

Expected transitions matrix

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	1.57	0.85	1.25	0.75	1.25	2.50	3.02	0.94	5.44
	1b	0.85	0.45	0.67	0.40	0.67	1.35	1.63	0.51	2.93
	2a	1.25	0.67	1.00	0.59	1.00	1.99	2.41	0.75	4.33
	2b	0.75	0.40	0.59	0.36	0.59	1.19	1.44	0.45	2.58
	3a	1.25	0.67	1.00	0.59	1.00	1.99	2.41	0.75	4.33
	3b	2.50	1.35	1.99	1.19	1.99	3.98	4.81	1.50	8.66
	4	3.02	1.63	2.41	1.44	2.41	4.81	5.82	1.82	10.46
	5a	0.94	0.51	0.75	0.45	0.75	1.50	1.82	0.57	3.27
	5b	5.44	2.93	4.33	2.58	4.33	8.66	10.46	3.27	18.81

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE

Embedded Markov Chain Analysis of total Tredomen Quarry sequence using 10cm intervals (continued).

Expected frequencies without estimates

		TO									
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	Rows total
	1a		0.85	1.25	0.75	1.25	2.50	3.02	0.94	5.44	16.00
	1b	0.85		0.67	0.40	0.67	1.35	1.63	0.51	2.93	9.00
	2a	1.25	0.67		0.59	1.00	1.99	2.41	0.75	4.33	13.00
	2b	0.75	0.40	0.59		0.59	1.19	1.44	0.45	2.58	8.00
	3a	1.25	0.67	1.00	0.59		1.99	2.41	0.75	4.33	13.00
	3b	2.50	1.35	1.99	1.19	1.99		4.81	1.50	8.66	24.00
	4	3.02	1.63	2.41	1.44	2.41	4.81		1.82	10.46	28.00
	5a	0.94	0.51	0.75	0.45	0.75	1.50	1.82		3.27	10.00
	5b	5.44	2.93	4.33	2.58	4.33	8.66	10.46	3.27		42.00
Column totals		16.00	9.00	13.00	8.00	13.00	24.00	28.00	10.00	42.00	163.00

Original Observed Transitions matrix

		TO								Row total	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a		0	11	3	1	0	1	0	0	16.00
	1b	1		0	0	0	4	3	1	0	9.00
	2a	1	0		3	8	1	0	0	0	13.00
	2b	2	0	0		3	1	0	0	2	8.00
	3a	3	0	3	1		3	1	0	2	13.00
	3b	0	2	0	0	0		5	2	15	24.00
	4	1	1	0	0	1	6		4	15	28.00
	5a	0	2	0	0	0	1	1		6	10.00
5b	9	3	0	1	0	8	18	3		42.00	
Column totals		17.00	8.00	14.00	8.00	13.00	24.00	29.00	10.00	40.00	163.00

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded Markov Chain Analysis of total Tredomen Quarry sequence using 10cm intervals (continued).

<i>T</i>	<i>O</i>	<i>E</i>	$((O-E)^2)/E$
1a-5b	0.00	5.44	5.44
3b-5b	15.00	8.66	4.65
4-5b	15.00	10.46	1.97
5b-1a	9.00	5.44	2.34
5b-3b	8.00	8.66	0.05
5b-4	18.00	10.46	5.43
orange	3	7.26	2.50
pink	1	6.92	5.06
light blue	4.00	6.73	1.11
red	9.00	6.54	0.93
light yellow	2.00	7.06	3.62
green	7.00	8.66	0.32
bright pink	7.00	6.60	0.02
turquoise	5.00	6.68	0.42
purple	18.00	5.76	25.97
aqua	1.00	5.52	3.71
lime	8.00	5.10	1.65
teal	9.00	5.91	1.61
tan	0.00	7.49	7.49
blue-grey	6.00	6.26	0.01
dark blue	5.00	8.98	1.76
grey	2.00	5.08	1.87
light green	4.00	5.00	0.20
maroon	7.00	6.32	0.07

$$\chi^2 = 78.19 \text{ with 55 degrees of freedom} = (\text{number of states} - 1)^2$$

critical value at 5% significance level for 55 degrees of freedom = 73.31

Therefore, the series of states are not independent of one another.

That is the series exhibits a first order Markovian property.

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded Markov Chain Analysis of lower Tredomen sequence using 10cm intervals (continued)
Estimates of transition frequencies 2

		TO								Row totals	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	110.85	0	0	0	0	0	0	0	0	110.85
	1b	0	111.52	0	0	0	2	1	0	0	114.52
	2a	0	0	110.85	0	0	0	0	0	0	110.85
	2b	0	0	0	110.85	0	0	0	0	0	110.85
	3a	0	0	0	0	110.85	0	0	0	0	110.85
	3b	0	1	0	0	0	111.74	1	0	2	115.74
	4	0	0	0	0	0	0	111.30	2	0	113.30
	5a	0	1	0	0	0	0	0	111.96	4	116.96
	5b	0	1	0	0	0	2	1	3	112.41	119.41
Column totals		110.85	114.52	110.85	110.85	110.85	115.74	114.30	116.96	118.41	1023.34

Estimate of transition probabilities for diagonals 2

		TO								
		1a	1b	2a	2b	3a	3b	4	5a	5b
FROM	1a	0.1083								
	1b		0.1119							
	2a			0.1083						
	2b				0.1083					
	3a					0.1083				
	3b						0.1131			
	4							0.1107		
	5a								0.1143	
	5b									0.1167

Estimates of transition frequencies 3

		TO								Row totals	
		1a	1b	2a	2b	3a	3b	4	5a		5b
FROM	1a	12.01	0	0	0	0	0	0	0	0	12.01
	1b	0	12.82	0	0	0	2	1	0	0	15.82
	2a	0	0	12.01	0	0	0	0	0	0	12.01
	2b	0	0	0	12.01	0	0	0	0	0	12.01
	3a	0	0	0	0	12.01	0	0	0	0	12.01
	3b	0	1	0	0	0	13.09	1	0	2	17.09
	4	0	0	0	0	0	0	12.54	2	0	14.54
	5a	0	1	0	0	0	0	0	13.37	4	18.37
	5b	0	1	0	0	0	2	1	3	13.93	20.93
Column totals		12.01	15.82	12.01	12.01	12.01	17.09	15.54	18.37	19.93	134.78

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded Markov Chain Analysis of lower Tredomen sequence using 10cm intervals (continued)

Estimates of transition frequencies 5

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	0.03	0	0	0	0	0	0	0	0	0.03
	1b	0	0.64	0	0	0	2	1	0	0	3.64
	2a	0	0	0.03	0	0	0	0	0	0	0.03
	2b	0	0	0	0.03	0	0	0	0	0	0.03
	3a	0	0	0	0	0.03	0	0	0	0	0.03
	3b	0	1	0	0	0	1.04	1	0	2	5.04
	4	0	0	0	0	0	0	0.35	2	0	2.35
	5a	0	1	0	0	0	0	0	1.54	4	6.54
	5b	0	1	0	0	0	2	1	3	2.87	9.87
Column totals		0.03	3.64	0.03	0.03	0.03	5.04	3.35	6.54	8.87	27.56

Estimate of transition probabilities for diagonals 5

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	0.0011								
	1b		0.1322							
	2a			0.0011						
	2b				0.0011					
	3a					0.0011				
	3b						0.1828			
	4							0.0852		
	5a								0.2372	
	5b									0.3581

Estimates of transition frequencies 6

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	0.00	0	0	0	0	0	0	0	0	0.00
	1b	0	0.48	0	0	0	2	1	0	0	3.48
	2a	0	0	0.00	0	0	0	0	0	0	0.00
	2b	0	0	0	0.00	0	0	0	0	0	0.00
	3a	0	0	0	0	0.00	0	0	0	0	0.00
	3b	0	1	0	0	0	0.92	1	0	2	4.92
	4	0	0	0	0	0	0	0.20	2	0	2.20
	5a	0	1	0	0	0	0	0	1.55	4	6.55
	5b	0	1	0	0	0	2	1	3	3.53	10.53
Column totals		0.00	3.48	0.00	0.00	0.00	4.92	3.20	6.55	9.53	27.69

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded Markov Chain Analysis of lower Tredomen sequence using 10cm intervals (continued)

Estimates of transition frequencies 8

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	0.00	0	0	0	0	0	0	0	0	0.00
	1b	0	0.42	0	0	0	2	1	0	0	3.42
	2a	0	0	0.00	0	0	0	0	0	0	0.00
	2b	0	0	0	0.00	0	0	0	0	0	0.00
	3a	0	0	0	0	0.00	0	0	0	0	0.00
	3b	0	1	0	0	0	0.85	1	0	2	4.85
	4	0	0	0	0	0	0	0.17	2	0	2.17
	5a	0	1	0	0	0	0	0	1.53	4	6.53
	5b	0	1	0	0	0	2	1	3	4.32	11.32
Column totals		0.00	3.42	0.00	0.00	0.00	4.85	3.17	6.53	10.32	28.29

Estimate of transition probabilities for diagonals 8

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	3E-24								
	1b		0.121							
	2a			3E-24						
	2b				0.0000					
	3a					3E-24				
	3b						0.1714			
	4							0.0767		
	5a								0.2308	
	5b									0.4002

Estimates of transition frequencies 9

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	0.000	0	0	0	0	0	0	0	0	0.00
	1b	0	0.414	0	0	0	2	1	0	0	3.41
	2a	0	0	0.000	0	0	0	0	0	0	0.00
	2b	0	0	0	0.000	0	0	0	0	0	0.00
	3a	0	0	0	0	0.000	0	0	0	0	0.00
	3b	0	1	0	0	0	0.831	1	0	2	4.83
	4	0	0	0	0	0	0	0.166	2	0	2.17
	5a	0	1	0	0	0	0	0	1.507	4	6.51
	5b	0	1	0	0	0	2	1	3	4.530	11.53
Column totals		0.00	3.41	0.00	0.00	0.00	4.83	3.17	6.51	10.53	28.45

Estimate of transition probabilities for diagonals 9

Estimates of transition frequencies 10

Estimate of transition probabilities for diagonals 10

[illegible]

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded Markov Chain Analysis of lower Tredomen sequence using 10cm intervals (continued)

Estimates of transition frequencies 11

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	0.000	0	0	0	0	0	0	0	0	0.00
	1b	0	0.407	0	0	0	2	1	0	0	3.41
	2a	0	0	0.000	0	0	0	0	0	0	0.00
	2b	0	0	0	0.000	0	0	0	0	0	0.00
	3a	0	0	0	0	0.000	0	0	0	0	0.00
	3b	0	1	0	0	0	0.814	1	0	2	4.81
	4	0	0	0	0	0	0	0.164	2	0	2.16
	5a	0	1	0	0	0	0	0	1.474	4	6.47
	5b	0	1	0	0	0	2	1	3	4.772	11.77
Column totals		0.00	3.41	0.00	0.00	0.00	4.81	3.16	6.47	10.77	28.63

Estimate of transition probabilities for diagonals 11

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	2E-189								
	1b		0.119							
	2a			2E-189						
	2b				0.0000					
	3a					2E-189				
	3b						0.1681			
	4							0.0756		
	5a								0.2261	
	5b									0.4112

Estimates of transition frequencies 12

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	0.000	0	0	0	0	0	0	0	0	0.00
	1b	0	0.405	0	0	0	2	1	0	0	3.41
	2a	0	0	0.000	0	0	0	0	0	0	0.00
	2b	0	0	0	0.000	0	0	0	0	0	0.00
	3a	0	0	0	0	0.000	0	0	0	0	0.00
	3b	0	1	0	0	0	0.809	1	0	2	4.81
	4	0	0	0	0	0	0	0.164	2	0	2.16
	5a	0	1	0	0	0	0	0	1.464	4	6.46
	5b	0	1	0	0	0	2	1	3	4.840	11.84
Column totals		0.00	3.41	0.00	0.00	0.00	4.81	3.16	6.46	10.84	28.68

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded Markov Chain Analysis of lower Tredomen sequence using 10cm intervals (continued)

Estimates of transition frequencies 14

		TO									
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	Row totals
	1a	0.00	0	0	0	0	0	0	0	0	0.00
	1b	0	0.40	0	0	0	2	1	0	0	3.40
	2a	0	0	0.00	0	0	0	0	0	0	0.00
	2b	0	0	0	0.00	0	0	0	0	0	0.00
	3a	0	0	0	0	0.00	0	0	0	0	0.00
	3b	0	1	0	0	0	0.80	1	0	2	4.80
	4	0	0	0	0	0	0	0.16	2	0	2.16
	5	0	1	0	0	0	0	0	1.45	4	6.45
	6	0	1	0	0	0	2	1	3	4.92	11.92
Column totals		0.00	3.40	0.00	0.00	0.00	4.80	3.16	6.45	10.92	28.74

Estimate of transition probabilities for diagonals 14

		TO								
		1a	1b	2a	2b	3a	3b	4	5a	5b
FROM	1a	0								
	1b		0.1184							
	2a			0						
	2b				0.0000					
	3a					0				
	3b						0.1671			
	4							0.0753		
	5a								0.2245	
	5b									0.4147

Estimates of transition frequencies 15

		TO									
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	Row totals
	1a	0.00	0	0	0	0	0	0	0	0	0.00
	1b	0	0.40	0	0	0	2	1	0	0	3.40
	2a	0	0	0.00	0	0	0	0	0	0	0.00
	2b	0	0	0	0.00	0	0	0	0	0	0.00
	3a	0	0	0	0	0.00	0	0	0	0	0.00
	3b	0	1	0	0	0	0.80	1	0	2	4.80
	4	0	0	0	0	0	0	0.16	2	0	2.16
	5a	0	1	0	0	0	0	0	1.45	4	6.45
5b	0	1	0	0	0	2	1	3	4.94	11.94	
Column totals		0.00	3.40	0.00	0.00	0.00	4.80	3.16	6.45	10.94	28.76

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded Markov Chain Analysis of lower Tredomen sequence using 10cm intervals (continued)

Estimates of transition frequencies 17

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	0.00	0	0	0	0	0	0	0	0	0.00
	1b	0	0.40	0	0	0	2	1	0	0	3.40
	2a	0	0	0.00	0	0	0	0	0	0	0.00
	2b	0	0	0	0.00	0	0	0	0	0	0.00
	3a	0	0	0	0	0.00	0	0	0	0	0.00
	3b	0	1	0	0	0	0.80	1	0	2	4.80
	4	0	0	0	0	0	0	0.16	2	0	2.16
	5a	0	1	0	0	0	0	0	1.44	4	6.44
	5b	0	1	0	0	0	2	1	3	4.97	11.97
Column totals		0.00	3.40	0.00	0.00	0.00	4.80	3.16	6.44	10.97	28.78

Estimate of transition probabilities for diagonals 17

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	0								
	1b		0.1182							
	2a			0						
	2b				0.0000					
	3a					0				
	3b						0.1668			
	4							0.0751		
	5a								0.2239	
	5b									0.4159

Estimates of transition frequencies 18

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	0.00	0	0	0	0	0	0	0	0	0.00
	1b	0	0.40	0	0	0	2	1	0	0	3.40
	2a	0	0	0.00	0	0	0	0	0	0	0.00
	2b	0	0	0	0.00	0	0	0	0	0	0.00
	3a	0	0	0	0	0.00	0	0	0	0	0.00
	3b	0	1	0	0	0	0.80	1	0	2	4.80
	4	0	0	0	0	0	0	0.16	2	0	2.16
	5a	0	1	0	0	0	0	0	1.44	4	6.44
	5b	0	1	0	0	0	2	1	3	4.98	11.98
Column totals		0.00	3.40	0.00	0.00	0.00	4.80	3.16	6.44	10.98	28.79

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded Markov Chain Analysis of lower Tredomen sequence using 10cm intervals (continued)
Estimate of transition probabilities for diagonals 18

	TO								
	1a	1b	2a	2b	3a	3b	4	5a	5b
FROM	1a	0							
	1b		0.1182						
	2a			0					
	2b				0.0000				
	3a					0			
	3b						0.1668		
	4							0.0751	
	5a								0.2238
	5b								0.4161

Estimates of transition frequencies 19

	TO									Row totals
	1a	1b	2a	2b	3a	3b	4	5a	5b	
FROM	1a	0.00	0	0	0	0	0	0	0	0.00
	1b	0	0.40	0	0	2	1	0	0	3.40
	2a	0	0	0.00	0	0	0	0	0	0.00
	2b	0	0	0	0.00	0	0	0	0	0.00
	3a	0	0	0	0	0.00	0	0	0	0.00
	3b	0	1	0	0	0	0.80	1	2	4.80
	4	0	0	0	0	0	0	0.16	2	2.16
	5a	0	1	0	0	0	0	0	1.44	6.44
	5b	0	1	0	0	0	2	1	3	4.98
Column totals										28.79

Fixed probability vectors

1a	0
1b	0.1182
2a	0
2b	0
3a	0
3b	0.1668
4	0.0751
5	0.2238
6	0.4161

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded Markov Chain Analysis of lower Tredomen sequence using 10cm intervals (continued)
Expected transitions probabilities matrix

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1b	0.0000	0.0140	0.0000	0.0000	0.0000	0.0197	0.0089	0.0264	0.0492
	2a	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2b	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	3a	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	3b	0.0000	0.0197	0.0000	0.0000	0.0000	0.0278	0.0125	0.0373	0.0694
	4	0.0000	0.0089	0.0000	0.0000	0.0000	0.0125	0.0056	0.0168	0.0313
	5a	0.0000	0.0264	0.0000	0.0000	0.0000	0.0373	0.0168	0.0501	0.0931
	5b	0.0000	0.0492	0.0000	0.0000	0.0000	0.0694	0.0313	0.0931	0.1732

Expected transitions matrix

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1b	0.00	0.40	0.00	0.00	0.00	0.57	0.26	0.76	1.42
	2a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3b	0.00	0.57	0.00	0.00	0.00	0.80	0.36	1.07	2.00
	4	0.00	0.26	0.00	0.00	0.00	0.36	0.16	0.48	0.90
	5a	0.00	0.76	0.00	0.00	0.00	1.07	0.48	1.44	2.68
	5b	0.00	1.42	0.00	0.00	0.00	2.00	0.90	2.68	4.98

Expected frequencies without estimates

		TO								Rows total	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1b	0.00		0.00	0.00	0.00	0.57	0.26	0.76	1.42	3.00
	2a	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2b	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
	3a	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
	3b	0.00	0.57	0.00	0.00	0.00		0.36	1.07	2.00	4.00
	4	0.00	0.26	0.00	0.00	0.00	0.36		0.48	0.90	2.00
	5a	0.00	0.76	0.00	0.00	0.00	1.07	0.48		2.68	5.00
	5b	0.00	1.42	0.00	0.00	0.00	2.00	0.90	2.68		6.99
Column totals		0.00	3.00	0.00	0.00	0.00	4.00	2.00	5.00	6.99	21.00

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded Markov Chain Analysis of lower Tredomen sequence using 10cm intervals (continued)
Original Observed Transitions matrix

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a		0	0	0	0	0	0	0	0	0.00
	1b	0		0	0	0	2	1	0	0	3.00
	2a	0	0		0	0	0	0	0	0	0.00
	2b	0	0	0		0	0	0	0	0	0.00
	3a	0	0	0	0		0	0	0	0	0.00
	3b	0	1	0	0	0		1	0	2	4.00
	4	0	0	0	0	0	0		2	0	2.00
	5a	0	1	0	0	0	0	0		4	5.00
	5b	0	1	0	0	0	2	1	3		7.00
Column totals		0.00	3.00	0.00	0.00	0.00	4.00	3.00	5.00	6.00	21.00

T	O	E	$((O-E)^2)/E$
orange	5.00	5.00	0.00
purple	5.00	5.83	0.12
pink	11.00	10.16	0.07

$\chi^2 = 0.19$ with 55 degrees of freedom = (number of states -1)²
critical value at 5% significance level for 55 degrees of freedom = 73.31
 Therefore, the series of states are independent of one another.
 That is the series does not exhibits a first order Markovian property.

[illegible]

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded markov chain analysis of upper Tredomen sequence using 10cm intervals (continued)
Estimates of transition frequencies 2

		TO								Row totals	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	112.77	0.00	11.00	3.00	1.00	1.00	0.00	0.00	0.00	129
	1b	1.00	109.90	0.00	0.00	0.00	0.00	2.00	0.00	0.00	113
	2a	1.00	0.00	112.10	3.00	8.00	1.00	0.00	0.00	0.00	125
	2b	2.00	0.00	0.00	111.00	3.00	1.00	0.00	0.00	2.00	119
	3a	3.00	0.00	3.00	1.00	112.10	3.00	1.00	0.00	2.00	125
	3b	0.00	0.00	0.00	0.00	0.00	114.32	7.00	2.00	14.00	137
	4	1.00	1.00	0.00	0.00	1.00	8.00	115.67	3.00	15.00	145
	5a	0.00	0.00	0.00	0.00	0.00	1.00	2.00	111.66	8.00	123
	5b	9.00	2.00	0.00	1.00	0.00	7.00	17.00	2.00	117.70	156
Column totals		129.77	112.90	126.10	119.00	125.10	136.32	144.67	118.66	158.70	1171

Estimate of transition probabilities for diagonals 2

		TO								
		1a	1b	2a	2b	3a	3b	4	5a	5b
FROM	1a	0.1099								
	1b		0.0964							
	2a			0.1068						
	2b				0.1016					
	3a					0.1068				
	3b						0.1172			
	4							0.1235		
	5a								0.1047	
	5b									0.1329

Estimates of transition frequencies 3

		TO								Row totals	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	14.16	0.00	11.00	3.00	1.00	1.00	0.00	0.00	0.00	30
	1b	1.00	10.88	0.00	0.00	0.00	0.00	2.00	0.00	0.00	14
	2a	1.00	0.00	13.36	3.00	8.00	1.00	0.00	0.00	0.00	26
	2b	2.00	0.00	0.00	12.09	3.00	1.00	0.00	0.00	2.00	20
	3a	3.00	0.00	3.00	1.00	13.36	3.00	1.00	0.00	2.00	26
	3b	0.00	0.00	0.00	0.00	0.00	16.10	7.00	2.00	14.00	39
	4	1.00	1.00	0.00	0.00	1.00	8.00	17.87	3.00	15.00	47
	5a	0.00	0.00	0.00	0.00	0.00	1.00	2.00	12.85	8.00	24
	5b	9.00	2.00	0.00	1.00	0.00	7.00	17.00	2.00	20.70	59
Column totals		31.16	13.88	27.36	20.09	26.36	38.10	46.87	19.85	61.70	285

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded markov chain analysis of upper Tredomen sequence using 10cm intervals (continued)
Estimates of transition frequencies 5

		TO								Row totals	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.92	0.00	11.00	3.00	1.00	1.00	0.00	0.00	0.00	18
	1b	1.00	0.07	0.00	0.00	0.00	0.00	2.00	0.00	0.00	3
	2a	1.00	0.00	1.25	3.00	8.00	1.00	0.00	0.00	0.00	14
	2b	2.00	0.00	0.00	0.46	3.00	1.00	0.00	0.00	2.00	8
	3a	3.00	0.00	3.00	1.00	1.25	3.00	1.00	0.00	2.00	14
	3b	0.00	0.00	0.00	0.00	0.00	4.20	7.00	2.00	14.00	27
	4	1.00	1.00	0.00	0.00	1.00	8.00	7.04	3.00	15.00	36
	5a	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.88	8.00	12
5b	9.00	2.00	0.00	1.00	0.00	7.00	17.00	2.00	13.11	51	
Column totals		18.92	3.07	15.25	8.46	14.25	26.20	36.04	7.88	54.11	184

Estimate of transition probabilities for diagonals 5

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	0.0973								
	1b		0.0167							
	2a			0.0773						
	2b				0.0459					
	3a					0.0773				
	3b						0.1477			
	4							0.1957		
	5a								0.0645	
	5b									0.2775

Estimates of transition frequencies 6

		TO								Row totals	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.74	0.00	11.00	3.00	1.00	1.00	0.00	0.00	0.00	18
	1b	1.00	0.05	0.00	0.00	0.00	0.00	2.00	0.00	0.00	3
	2a	1.00	0.00	1.10	3.00	8.00	1.00	0.00	0.00	0.00	14
	2b	2.00	0.00	0.00	0.39	3.00	1.00	0.00	0.00	2.00	8
	3a	3.00	0.00	3.00	1.00	1.10	3.00	1.00	0.00	2.00	14
	3b	0.00	0.00	0.00	0.00	0.00	4.02	7.00	2.00	14.00	27
	4	1.00	1.00	0.00	0.00	1.00	8.00	7.05	3.00	15.00	36
	5a	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.77	8.00	12
	5b	9.00	2.00	0.00	1.00	0.00	7.00	17.00	2.00	14.18	52
Column totals		18.74	3.05	15.10	8.39	14.10	26.02	36.05	7.77	55.18	184

Estimate of transition probabilities for diagonals 6

[illegible]

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded markov chain analysis of upper Tredomen sequence using 10cm intervals (continued)

Estimates of transition frequencies 8

		TO								Row totals	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.70	0.00	11.00	3.00	1.00	1.00	0.00	0.00	0.00	18
	1b	1.00	0.05	0.00	0.00	0.00	0.00	2.00	0.00	0.00	3
	2a	1.00	0.00	1.07	3.00	8.00	1.00	0.00	0.00	0.00	14
	2b	2.00	0.00	0.00	0.38	3.00	1.00	0.00	0.00	2.00	8
	3a	3.00	0.00	3.00	1.00	1.07	3.00	1.00	0.00	2.00	14
	3b	0.00	0.00	0.00	0.00	0.00	3.93	7.00	2.00	14.00	27
	4	1.00	1.00	0.00	0.00	1.00	8.00	7.03	3.00	15.00	36
	5a	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.75	8.00	12
	5b	9.00	2.00	0.00	1.00	0.00	7.00	17.00	2.00	15.06	53
Column totals		18.70	3.05	15.07	8.38	14.07	25.93	36.03	7.75	56.06	185

Estimate of transition probabilities for diagonals 8

		TO								
		1a	1b	2a	2b	3a	3b	4	5a	5b
FROM	1a	0.0956								
	1b		0.0165							
	2a			0.076						
	2b				0.0453					
	3a					0.076				
	3b						0.1455			
	4							0.1947		
	5a								0.0635	
	5b									0.2868

Estimates of transition frequencies 9

		TO								Row totals	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.69	0.00	11.00	3.00	1.00	1.00	0.00	0.00	0.00	18
	1b	1.00	0.05	0.00	0.00	0.00	0.00	2.00	0.00	0.00	3
	2a	1.00	0.00	1.07	3.00	8.00	1.00	0.00	0.00	0.00	14
	2b	2.00	0.00	0.00	0.38	3.00	1.00	0.00	0.00	2.00	8
	3a	3.00	0.00	3.00	1.00	1.07	3.00	1.00	0.00	2.00	14
	3b	0.00	0.00	0.00	0.00	0.00	3.92	7.00	2.00	14.00	27
	4	1.00	1.00	0.00	0.00	1.00	8.00	7.02	3.00	15.00	36
	5a	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.75	8.00	12
	5b	9.00	2.00	0.00	1.00	0.00	7.00	17.00	2.00	15.22	53
Column totals		18.69	3.05	15.07	8.38	14.07	25.92	36.02	7.75	56.22	185

Estimate of transition probabilities for diagonals 9

[illegible]

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded markov chain analysis of upper Tredomen sequence using 10cm intervals (continued)

Estimates of transition frequencies 11

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.69	0.00	11.00	3.00	1.00	1.00	0.00	0.00	0.00	18
	1b	1.00	0.05	0.00	0.00	0.00	0.00	2.00	0.00	0.00	3
	2a	1.00	0.00	1.07	3.00	8.00	1.00	0.00	0.00	0.00	14
	2b	2.00	0.00	0.00	0.38	3.00	1.00	0.00	0.00	2.00	8
	3a	3.00	0.00	3.00	1.00	1.07	3.00	1.00	0.00	2.00	14
	3b	0.00	0.00	0.00	0.00	0.00	3.91	7.00	2.00	14.00	27
	4	1.00	1.00	0.00	0.00	1.00	8.00	7.00	3.00	15.00	36
	5a	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.74	8.00	12
	5b	9.00	2.00	0.00	1.00	0.00	7.00	17.00	2.00	15.34	53
Column totals		18.69	3.05	15.07	8.38	14.07	25.91	36.00	7.74	56.34	185

Estimate of transition probabilities for diagonals 11

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	0.0955								
	1b		0.0165							
	2a			0.0759						
	2b				0.0452					
	3a					0.0759				
	3b						0.1453			
	4							0.1943		
	5a								0.0634	
	5b									0.2879

Estimates of transition frequencies 12

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.69	0.00	11.00	3.00	1.00	1.00	0.00	0.00	0.00	18
	1b	1.00	0.05	0.00	0.00	0.00	0.00	2.00	0.00	0.00	3
	2a	1.00	0.00	1.07	3.00	8.00	1.00	0.00	0.00	0.00	14
	2b	2.00	0.00	0.00	0.38	3.00	1.00	0.00	0.00	2.00	8
	3a	3.00	0.00	3.00	1.00	1.07	3.00	1.00	0.00	2.00	14
	3b	0.00	0.00	0.00	0.00	0.00	3.91	7.00	2.00	14.00	27
	4	1.00	1.00	0.00	0.00	1.00	8.00	7.00	3.00	15.00	36
	5a	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.74	8.00	12
	5b	9.00	2.00	0.00	1.00	0.00	7.00	17.00	2.00	15.36	53
Column totals		18.69	3.05	15.07	8.38	14.07	25.91	36.00	7.74	56.36	185

Estimate of transition probabilities for diagonals 12

[illegible]

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded markov chain analysis of upper Tredomen sequence using 10cm intervals (continued)

Estimate of transition probabilities for diagonals 14

		TO									Row totals
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a	1.69	0.00	11.00	3.00	1.00	1.00	0.00	0.00	0.00	18
	1b	1.00	0.05	0.00	0.00	0.00	0.00	2.00	0.00	0.00	3
	2a	1.00	0.00	1.07	3.00	8.00	1.00	0.00	0.00	0.00	14
	2b	2.00	0.00	0.00	0.38	3.00	1.00	0.00	0.00	2.00	8
	3a	3.00	0.00	3.00	1.00	1.07	3.00	1.00	0.00	2.00	14
	3b	0.00	0.00	0.00	0.00	0.00	3.91	7.00	2.00	14.00	27
	4	1.00	1.00	0.00	0.00	1.00	8.00	6.99	3.00	15.00	36
	5a	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.74	8.00	12
	5b	9.00	2.00	0.00	1.00	0.00	7.00	17.00	2.00	15.37	53
Column totals		18.69	3.05	15.07	8.38	14.07	25.91	35.99	7.74	56.37	185

Fixed probability vectors

1a	0.0955
1b	0.0165
2a	0.0759
2b	0.0452
3a	0.0759
3b	0.1452
4	0.1943
5a	0.0634
5b	0.2881

Expected transitions probabilities matrix

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	0.0091	0.0016	0.0072	0.0043	0.0072	0.0139	0.0185	0.0061	0.0275
	1b	0.0016	0.0003	0.0013	0.0007	0.0013	0.0024	0.0032	0.0010	0.0047
	2a	0.0072	0.0013	0.0058	0.0034	0.0058	0.0110	0.0148	0.0048	0.0219
	2b	0.0043	0.0007	0.0034	0.0020	0.0034	0.0066	0.0088	0.0029	0.0130
	3a	0.0072	0.0013	0.0058	0.0034	0.0058	0.0110	0.0148	0.0048	0.0219
	3b	0.0139	0.0024	0.0110	0.0066	0.0110	0.0211	0.0282	0.0092	0.0418
	4	0.0185	0.0032	0.0148	0.0088	0.0148	0.0282	0.0377	0.0123	0.0560
	5a	0.0061	0.0010	0.0048	0.0029	0.0048	0.0092	0.0123	0.0040	0.0183
	5b	0.0275	0.0047	0.0219	0.0130	0.0219	0.0418	0.0560	0.0183	0.0830

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded markov chain analysis of upper Tredomen sequence using 10cm intervals (continued)
Expected transitions matrix

		TO								
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b
	1a	1.69	0.29	1.34	0.80	1.34	2.57	3.44	1.12	5.10
	1b	0.29	0.05	0.23	0.14	0.23	0.44	0.59	0.19	0.88
	2a	1.34	0.23	1.07	0.64	1.07	2.04	2.73	0.89	4.05
	2b	0.80	0.14	0.64	0.38	0.64	1.22	1.63	0.53	2.41
	3a	1.34	0.23	1.07	0.64	1.07	2.04	2.73	0.89	4.05
	3b	2.57	0.44	2.04	1.22	2.04	3.91	5.23	1.71	7.75
	4	3.44	0.59	2.73	1.63	2.73	5.23	6.99	2.28	10.37
	5a	1.12	0.19	0.89	0.53	0.89	1.71	2.28	0.74	3.38
	5b	5.10	0.88	4.05	2.41	4.05	7.75	10.37	3.38	15.38

Expected frequencies without estimates

		TO								Rows total	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a		0.29	1.34	0.80	1.34	2.57	3.44	1.12	5.10	16
	1b	0.29		0.23	0.14	0.23	0.44	0.59	0.19	0.88	3
	2a	1.34	0.23		0.64	1.07	2.04	2.73	0.89	4.05	13
	2b	0.80	0.14	0.64		0.64	1.22	1.63	0.53	2.41	8
	3a	1.34	0.23	1.07	0.64		2.04	2.73	0.89	4.05	13
	3b	2.57	0.44	2.04	1.22	2.04		5.23	1.71	7.75	23
	4	3.44	0.59	2.73	1.63	2.73	5.23		2.28	10.37	29
	5a	1.12	0.19	0.89	0.53	0.89	1.71	2.28		3.38	11
	5b	5.10	0.88	4.05	2.41	4.05	7.75	10.37	3.38		38
Column total		16.00	3.00	13.00	8.00	13.00	23.00	29.00	11.00	38.00	154

Original Observed Transitions matrix

		TO								Row totals	
FROM		1a	1b	2a	2b	3a	3b	4	5a	5b	
	1a		0	11	3	1	1	0	0	0	16
	1b	1		0	0	0	0	2	0	0	3
	2a	1	0		3	8	1	0	0	0	13
	2b	2	0	0		3	1	0	0	2	8
	3a	3	0	3	1		3	1	0	2	13
	3b	0	0	0	0	0		7	2	14	23
	4	1	1	0	0	1	8		3	15	29
	5a	0	0	0	0	0	1	2		8	11
	5b	9	2	0	1	0	7	17	2		38
Column totals		17.00	3.00	14.00	8.00	13.00	22.00	29.00	7.00	41.00	154

APPENDIX VIII - EMBEDDED MARKOV CHAIN ANALYSIS OF TREDOMEN QUARRY SEQUENCE
 Embedded markov chain analysis of upper Tredomen sequence using 10cm intervals (continued)

<i>T</i>	<i>O</i>	<i>E</i>	$((O-E)^2)/E$
1a-5b	0.00	5.10	5.10
3b-4	7.00	5.23	0.60
3b-5b	14.00	7.75	5.04
4-3b	8.00	5.23	1.47
4-5b	15.00	10.37	2.07
5b-1a	9.00	5.10	2.99
5b-3b	7.00	7.75	0.07
5b-4	17.00	10.37	4.24
orange	3.00	7.35	2.57
purple	1.00	5.34	3.52
pink	10.00	5.66	3.32
light green	5.00	5.66	0.08
turquoise	1.00	6.79	4.93
grey	2.00	8.39	4.87
teal	0.00	8.32	8.32
dark blue	4.00	5.76	0.54
peach	4.00	5.67	0.49
red	11.00	6.72	2.73
lime	6.00	6.43	0.03
bright pink	0.00	5.82	5.82
yellow	9.00	5.84	1.70
grey-blue	18.00	5.01	33.62
maroon	3.00	8.36	3.43

$$\chi^2 = 97.55 \text{ with 55 degrees of freedom} = (\text{number of states} - 1)^2$$

critical value at 5% significance level for 55 degrees of freedom = 73.31

Therefore, the series of states are not independent of one another.

That is the series exhibits a first order Markovian property.

APPENDIX VIII - MARKOV CHAIN AND EMBEDDED MARKOV CHAIN ANALYSIS
OF TREDOMEN QUARRY SEQUENCE

Markov Chain Analysis Results

	Series	t	m	v	χ^2	critical value $\alpha 0.05$	critical value $\alpha 0.01$
Markov Chain Analysis	Total	1885	9	64	6117.35	83.68	93.22
	Upper sequence	1296	9	64	2375.05	83.68	93.22
	Lower sequence	588	5	16	152.34	26.29	32.00
Embedded Markov Chain Analysis	Total	163	9	55	78.19	73.31	82.29
	Upper sequence	154	9	55	97.55	73.31	82.29
	Lower sequence	21	5	11	0.189	19.68	24.73

N.B.

Upper sequence defined as above the mature calcrete bands, interpreted as the Bishops Frome Limestone
Includes quarry series, BH1 beds 1-77, BH2 beds 1-135.

Lower sequence defined as below the mature calcrete bands, interpreted as the Bishops Frome Limestone
number of transitions in the series (grand total -1 in Markov Chain Analysis)

t number of states in the series

v degrees of freedom. For Markov Analysis $v = (m-1)^2$.
For Embedded Markov Analysis $v = (m-1)^2 - m$

χ^2 χ^2 statistic

$\alpha 0.05$ 5% significance level

$\alpha 0.01$ 1% significance level

APPENDIX IX

IS THE CHANNEL COUNTRY OF CENTRAL AUSTRALIA A SUITABLE ANALOGUE FOR THE OLD RED SANDSTONE?

In collaboration with the Lake Eyre Basin Analogues Research Group, Australian School of Petroleum, University of Adelaide.

INTRODUCTION

The river systems of the Channel Country, part of the Lake Eyre Basin of central Australia, have been described as mud-dominated braided or anabranching (specifically anastomosing) dryland rivers with complex floodplains (Rust 1981, Nanson et al. 1986, Rust and Nanson 1986, Gibling et al. 1998, Fagan and Nanson 2004). The mud-dominated fluvial and floodplain deposits of the Channel Country are often quoted as modern analogues for ancient dryland mudstone-dominated formations, in particular the Upper Silurian sequences of the Old Red Sandstone of the Anglo-Welsh Basin (Marriott and Wright 1993, 1996, Wright and Marriott 2007, Hillier et al. 2007).

The comparison between the Old Red Sandstone sequences and the Channel Country rivers was first made based on the presence of sand-sized, pedogenically-formed, mud aggregate pellets, found in both the modern Channel Country river channel deposits and the ancient mudstone sequences of the upper Přídolí of the Anglo-Welsh Basin (Ékes 1993, Marriott and Wright 1996, Wright and Marriott 2007). In both the Channel Country and the Old Red Sandstone sequences there is evidence of Vertisols (Gibling et al. 1998) and palaeo-Vertisols (Allen 1986, Marriott and Wright 1993) development of the floodplain sequences, suggesting a similar climatic regime of an overall moisture deficient, semi-arid to arid climate, but with strong seasonality. The sand-sized mud aggregates are thought to originate from the pedogenically-altered floodplain muds, later to be reworked and transported as bedload in muddy ephemeral channels and deposited in various fluvial elements (Rust 1981, Gibling et al. 1998, Wright and Marriott 2007). Inclined heterolithics units recognised from the ancient Moor Cliffs Formation (Marriott and Wright 2004) and the Conigar Pit Sandstone (Hillier et al. 2007) from the Anglo-Welsh Basin have been interpreted as lateral accretion on accretionary benches of sinuous, ephemeral shallow channels, analogous to those of the anastomosing mud-dominated channels of the Channel Country.

Despite these noted similarities in some sediment type and channel and floodplain elements, there are many differences between the ancient Old Red Sandstone sequences and the modern Channel Country rivers which need to be investigated e.g. differences in sediment size ranges, channel elements and inferred fluvial landforms, as well as potential influences from flora and fauna. This study aims to make some direct comparisons between collected data from the Diamantina River, one of the largest rivers of the Channel Country and the Upper Silurian to Lower Devonian Old Red Sandstone sequences of the Anglo-Welsh Basin to test the suitability of the Channel Country as a modern analogue. This study also aims to better understand the geomorphology of the Channel Country, which if proved a suitable analogue, can be used to infer the geomorphology of the Old Red Sandstone Continent landscape.

LOCALITIES

Lake Eyre Basin

The Lake Eyre Basin covers approximately one fifth of the land area of Australia (Figure 1a), at $1.3 \times 10^6 \text{ km}^2$, and can be separated into four main areas: the Channel Country, consisting of three major tributaries (Cooper Creek (the Barcoo-Thomson in the northern headwaters), the Diamantina-Warburton and the Georgina); Lake Eyre, a salt pan around 15m below sea level; western Lake Eyre Basin; and the Simpson Desert, predominately aeolian dune systems (Gibling et al. 1998) (Figure 1b). The low gradient rivers (0.1 to 0.2 m/km, Maroulis et al. 2007) of the Channel Country rise in the northern uplands of the basin, and flow over 1000km to the southwest to drain internally into Lake Eyre (Gibling et al. 1998). The rivers of the Channel Country are typically ephemeral, and form a complex network of anastomosing channels, braided channels and associated braid bars, waterholes and aeolian dunes, that have been aggregating slowly over the past 100ka (Rust and Nanson 1986, Nanson et al. 1986, Gibling et al. 1998).

The Lake Eyre Basin lies on the ancient Australian stable craton, and much of the alluvial plain of the Channel Country lies below 150m elevation, with very low gradients (Gibling et al. 1998). The fluvial patterns of the Channel Country rivers are mainly controlled by gentle anticlines and synclines, as a result of Tertiary tectonism (Rust 1981, Maroulis et al. 2007). Localised exposed bedrock include the Cretaceous Winton Formation (composed of grey mudstones and lithic sandstone) (Wopfner 1963), as well as Tertiary wind-abraded gravel

Figure 1a: Map of Australia, showing the location of Lake Eyre Basin

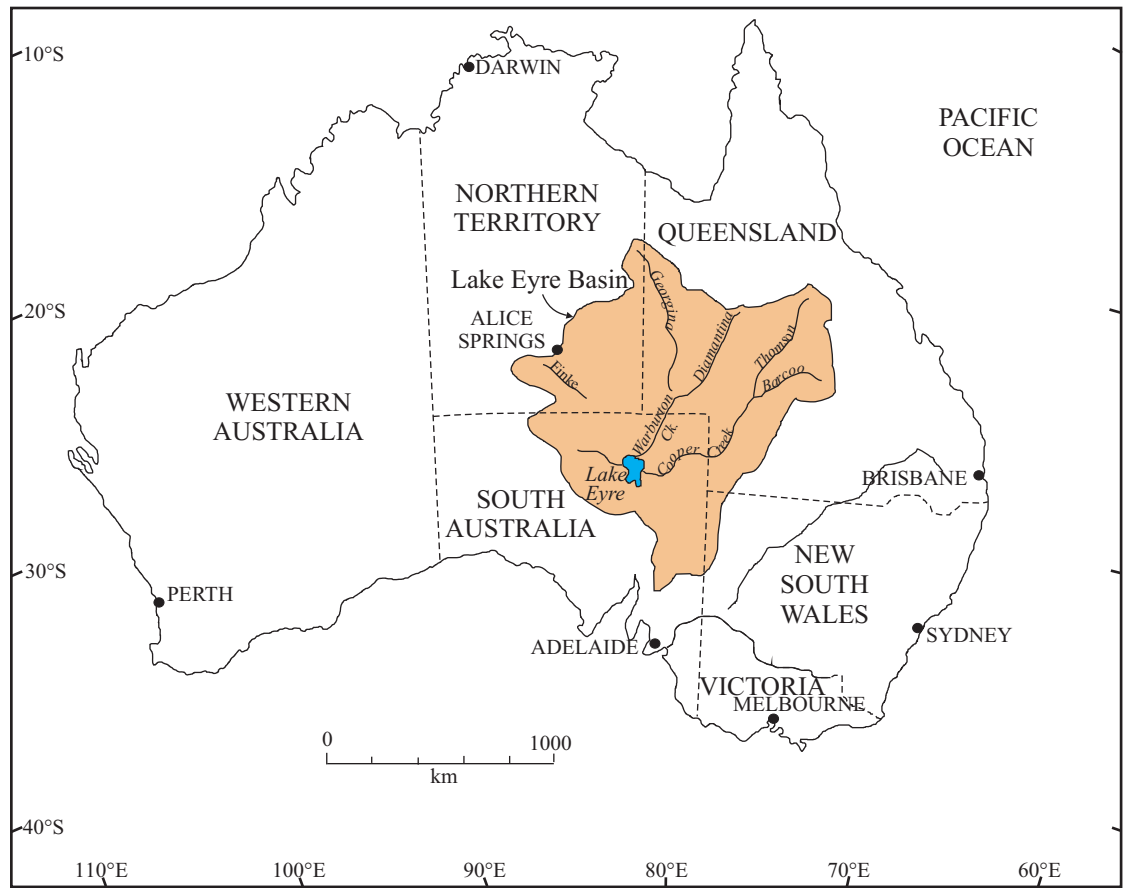
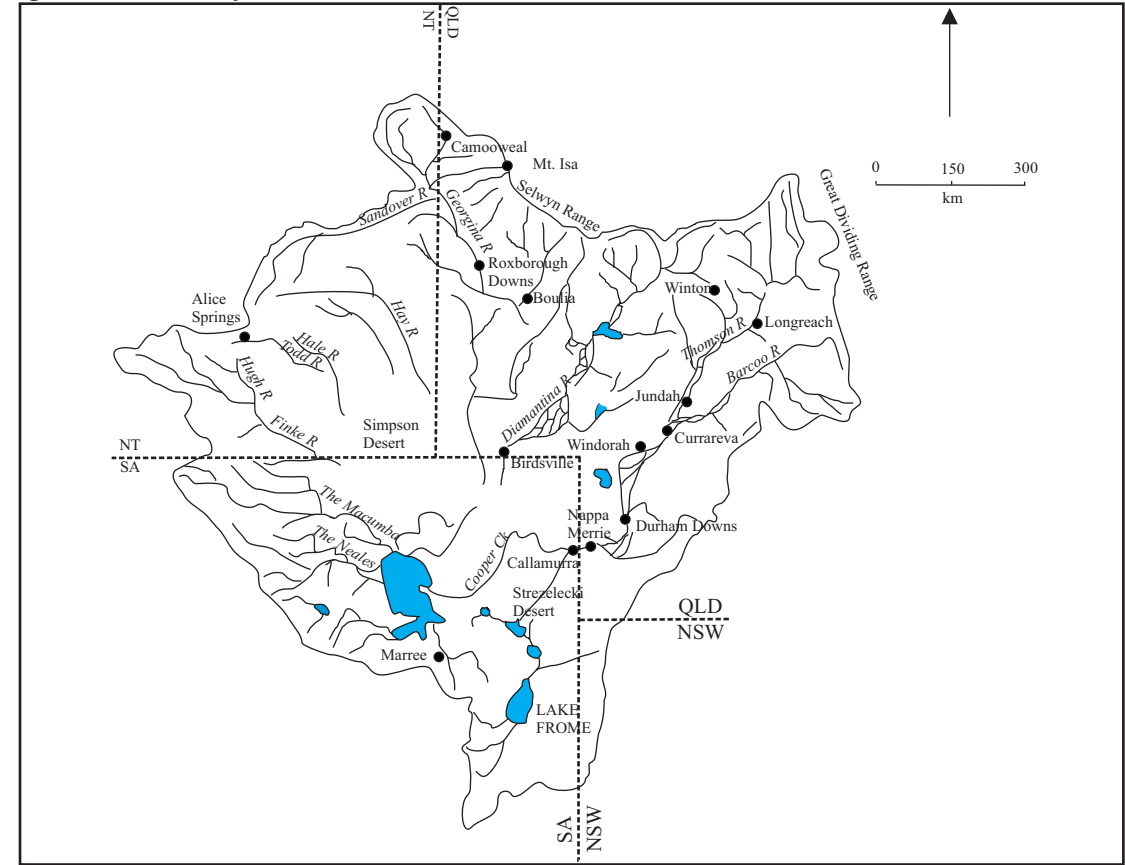


Figure 1b: Lake Eyre Basin



(gibber plains) and silcrete duricrusts (Gibling et al. 1998). These local exposures of older strata provide local source material for the Quaternary river systems.

The overall climate across the Lake Eyre Basin is semi-arid to arid, with a mean annual rainfall of less than 250mm. However rainfall is not equally distributed across the basin, with approximately 400 to 500mm in the headwaters, to less than 100mm close to Lake Eyre (Knighton and Nanson 2001, Maroulis et al. 2007). Evaporation rates also vary across the basin, approximately 2400 mm/a in the northern headwaters to 3600 mm/a around Lake Eyre (Maroulis et al. 2007).

Discharge is primarily controlled by moist tropical air that passes over the Great Dividing Range from the north Australian summer monsoon (November to March). This discharge varies annually, some years with no rainfall and others producing major floods, such as the summer of 1974 when Lake Eyre filled to the highest level recorded (Rust 1981). The wet season is highly erratic and occurs over a relatively short time period, followed by a prolonged dry season.

Along the banks and levees of Channel Country watercourses, including the anastomosing and splay channels, large gum trees (including *Eucalyptus microtheca*) are often established, and are able to survive through the dry season to be replenished during the wet season. Occasionally trees have established mid-channel, either causing sediment build up resulting in the formation of vegetation shadow bars or are growing on previously established mid-channels bars. These large trees provide bank cohesion with large rooting structures, and may to some extent restrict lateral incision. Riparian vegetation, including small shrubs and grasses are also present, but rely heavily on a water source, and so during the dry seasons are restricted to waterholes. The braid bar tops are very sparse of vegetation.

Evidence of faunal activity can be found within the channels and waterholes, including the remains of crabs, bivalves and gastropods. Fresh crab, beetle larvae and crayfish burrows are focussed around waterholes during the dry season. Freshwater sponges are also present, commonly forming around dead tree branches. Evidence of spiders and termite mounds has been found on braid bar tops.

Through surface and sub-surface observations early workers of the Channel Country rivers (particularly Cooper Creek) considered that the braided channels and associated bars were relicts and not actively accreting as a result of the modern muddy anastomosing fluvial system (Veevers and Rundle 1979, Rust 1981). They interpreted the anastomosing channels as post-dating and incising into the braided sand bars beneath. They inferred that this shift from braided system to an anastomosing system was primarily due to climate change (Rust

1981). Rust 1981 hypothesised that the relict braid bars represented a pluvial event, where as the modern muddy anastomosing channels represent fluvial adjustment to increased aridity, which began at least 5000 years ago.

Rust and co-workers reinvestigated Cooper Creek (Rust and Nanson 1986, Nanson et al. 1986) and collected more subsurface data. They discovered that the muddy facies deposited by the modern anastomosing fluvial system was just a thin veneer, overlying a significant sand sheet body. They also determined that the braid bars of the Cooper Creek were in fact composed of clay in the form of sand-size mud aggregate pellets, and were not associated with the sand body beneath (Rust and Nanson 1986). Therefore the modern fluvial system produced co-existing anastomosing channels and braided channels which are thought to operate at different flow levels, with braided channels active during flood events, whilst the anastomosing channels operate during moderate flows (Nanson et al. 1986). Trough cross ripple lamination and large-scale cross-bedded units within the significant underlying sand sheet body were interpreted as lateral accretion on a meander point bar, leading to interpretation that the sand sheet represents a meandering fluvial system, likely to have been formed in a wetter climate (Rust and Nanson 1986).

Using thermoluminescence (TL) dating, Nanson et al. (1992) correlated the deposition of significant sand bodies with wetter interglacial periods, and dune building during drier glacial periods. The cross-bedded sand sheet discovered underlying the muddy veneer by Rust and Nanson (1986) represent pluvial events that have been linked to interglacials stage 7 and stage 5 in the marine isotope record (Nanson et al. 1992). Since the stage 5 pluvial event approximately 110ka B.P. aridity has gradually increased, and the meandering fluvial systems were replaced by anastomosing and braided systems, with oldest muds dated to about 85ka B.P. (Nanson et al. 1992).

More recently Maroulis et al. (2007) has studied the interaction between fluvial activity and sand-dominated dune building. As the dunefields around Cooper Creek have been rejuvenated, the dates obtained from TL may not be reliable, and therefore the dunes may be significantly older. Maroulis et al. (2007) hypothesised that instead of dune building occurring during periods of aridity, they were in fact formed during wetter periods by strong prevailing south-south-westerly winds (between stage 8-6 in the marine isotopic record) and sourced from sandy meandering channels.

This study focuses on two sites of the Diamantina River (Figures 1a and 1b). Site 1 is located approximately at the half way point of the river's course, near Davenport Downs (approximately 45km north east of Monkira Aerodrome), where an anastomosing to single

river channel is associated with a braid bar system with splays (Figures 2a and 2b). Site 2 is located approximately 250km further upstream in the headwaters, at Mt. Rourke Creek, approximately 8km NNW from Middleton on the Kennedy Development Road between Winton and Boulia (Figures 2c and 2d). Fieldwork was conducted during September 2008 and therefore during the dry season.

Anglo-Welsh Basin

The Anglo-Welsh Basin was one of several basins which formed on the edge of equatorial Laurussia (also known as the Old Red Sandstone Continent), an amalgamation of three separate landmasses: Laurentia, Baltica and Avalonia, brought together by the closure of the Iapetus Ocean between the Late Ordovician and the Early Devonian (Figure 3). Although models by Dewey and Strachan (2003) and Soper and Woodcock (2003) differ in collision nature and timing, both recognise a significant gap in time between the closure of the Iapetus Ocean by the Scandian Orogeny between 425Ma and 410Ma and the compressive regime of the Acadian Orogeny in 395Ma. During this time gap it has been modelled that strike-slip and transtensional tectonics formed several basins across the Old Red Sandstone Continent, subsequently infilled with coarsening upwards sediments, with a marine to terrestrial transition (Soper and Woodcock 2003).

Palaeogeographic and palaeomagnetic reconstructions are in agreement that the Old Red Sandstone Continent lay from the equator to approximately 30° south, and that the Anglo-Welsh Basin lay on the margin at approximately 17° south (Scotese 2003, Channell et al. 1992) (Figure 3). In today's climate this would place the basin into the sub-tropics, with distinct wet and dry seasons. Rainfall in these regions is between 500-2000mm and temperature ranges from 16-20°C. It is therefore likely that the Old Red Sandstone margin would have experienced a semi-arid to arid climate. This is confirmed by the presence of palaeo-Vertisols, a type of palaeosol that contains calcium carbonate horizons that are typically formed in semi-arid climates with distinct wet and dry seasons (Allen 1986, Marriott and Wright 1993).

The Anglo-Welsh Basin was an extramontane and coastal basin, distal to the older Caledonian mountain range to the northwest (Friend et al. 2000). Essentially the basin filled with post orogenic detritus, brought southward to the coastline by large river systems. During the Early Silurian, although progressively retreating, there was still a significant marine

Figure 2: Investigated sites of the Diamantina River

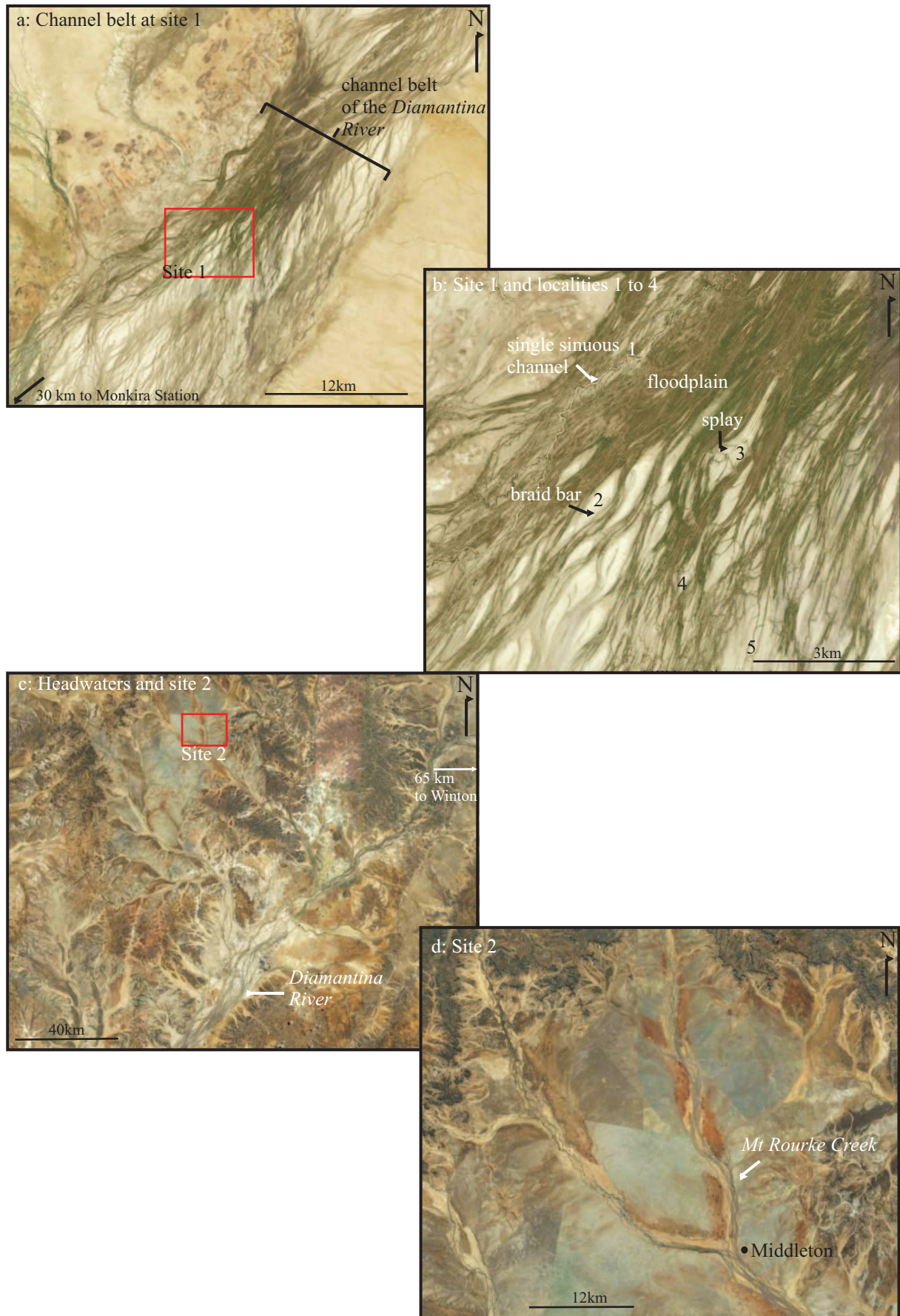


Figure 3: Reconstruction of the Old Red Sandstone Continent during the early Devonian (modified after Ron Blakey).



influence. Strata of the Upper Silurian Old Red Sandstone contain plentiful mica grains, as well as staurolite and kyanite (Allen and Crowley 1983), sourced from weathered metamorphic strata. Simon and Bluck (1982) hypothesised that sediment was sourced from the newly-formed Caledonian mountains, and transported in a south-easterly direction by large fluvial systems to the coastal margins of the Old Red Sandstone Continent, infilling tectonically active basins. These rivers, approximately 500km in length, are thought to have connected the Anglo-Welsh Basin with other Lower Old Red Sandstone basins. A significant change in facies type and sedimentary style occurred in the Lower Devonian (Dittonian), from the Raglan Mudstone Formation to the St. Maughans Formation, and their equivalents. This may be due to local tectonic uplift (Allen and Crowley 1983). There is little evidence for any marine influence, and it has been hypothesised that broad fluvial channels occupied low-lying, muddy floodplains. Sediments are less micaceous, suggesting a halt to dispersal from the distant Caledonides (Allen and Crowley 1983). A greater proportion of igneous debris has been recorded, potentially transported from a more local source, such as the Irish Sea High or Bristol Landmass (Allen and Crowley 1983). There was also a higher degree of intra-basinal sediment re-working (Marriott and Wright 1996).

The first land plants evolved during the Late Ordovician and Early Silurian, although the earliest body fossils are not found until the Wenlock (Edwards and Feehan 1980). By the Early Devonian, small, dichotomising branching vascular plants, such as *Cooksonia* (belonging to the rhyniophytes) would have inhabited the banks of the Anglo-Welsh Basin rivers (see Chapter 3, review by Edwards and Richardson 2004). Additionally, large fungal-like organisms, such as *Prototaxites* would likely to have dominated the Early Devonian landscape (Hueber 2001, Boyce et al. 2007).

OBSERVATIONS AT THE DIAMANTINA RIVER SITES

Site 1

1. Anastomosing to single sinuous channel

The wide channel belt at site 1 (approximately 12km wide, Figure 2a) is composed of a number of different components, the most obvious being a sinuous, single to anastomosing river channel (Figures 2b, 4a and 4b) which is typical of Lake Eyre Basin rivers. At locality 1 (Figure 2b), the main channel is approximately 4m deep, 39.9m in width, flat-based, with relatively steep sides (up to an angle of 52°) (Figure 4b). In straight sections, the downstream profiles are symmetrical (Figure 4b), whilst in sinuous sections the profiles are asymmetrical.

Figure 4: Main single sinuous channel of the Diamantina River at site 1



At sinuous points, shallow accretionary point bars have developed on the convex side (Figure 4c). Some accretionary bars are associated with a terrace (Figure 4c).

At locality 1 the channel base has been deepened further, and the underlying sandstone bedrock (the Winton Formation) has been exposed (Figure 4d). This section of the channel has been deepened enough to form a waterhole, an ephemeral standing body of water (Figure 4b) that provides a refuge of fauna such as crayfish and crabs (Figure 4e), and riparian vegetation (Figure 4c). Very distinctive lap lines can be seen on the channel sides (Figure 4f), indicating previous water levels of the waterhole.

Shallow, broad levees line the channels, and are inhabited by large gum trees (Figure 4b). Although the gum trees are restricted to the channel edge, smaller shrubs extend beyond the levees, on to a slight depression between the levees and the braid bar tops (area marked floodplain on Figure 4a). Networks of smaller, shallower secondary channels were found in this area (Figure 4a), acting as tributaries or overflow channels (Figure 4g) to the main channel, likely to operate only during flood events.

Two trenches were excavated through the channel at locality 1, one parallel and one perpendicular to flow. At the top of both trenches, thick units of blocky mud composed of sand-sized mud aggregates, with desiccation cracks and partially decayed organic material were exposed, interbedded with subordinate layers of ripple-laminated very-fine and fine-grained sand (Figure 4h). With increased depth, mud and sandy mud layers are platy, with remnant desiccation cracks and burrows infilled with sandy mud, with some evidence of mottling and manganese and carbonate nodules no bigger than a coarse sand grain. These features suggest incipient soil formation and therefore these sequences are likely to be older than the channel incising into them.

2. Braid bars

Shallow, broad braid bars are the second component of the wide channel belt of the Diamantina River at site 1 (Figures 2a and 2b). These lozenge-shaped bars (locality 2, Figure 2b) are generally the only highs in the landscape, but only by approximately a metre above the channels. Bar tops are sparse of vegetation, with few dead riparian vegetative remains (Figure 5a). The main features on the surface of the braid bars are desiccation cracks (Figure 5b), although excavation discovered that these cracks are only superficial. At location 2 (Figure 2b), the sediments of the braid bar tops are very hard, and excavation of only 35cm was possible. At the surface, a layer of silt to very fine-grained sand is powdery and easy to crumble. Although rare, small gravel-sized exotic clasts were found lying on top of these

Figure 5: Braid bars of the Diamantina River at site 1



sediments (Figure 5c). Additionally, fine to medium-grained quartz grains appeared to be sticking out of the silt-sand layer (circled in Figure 5c), suggesting that this may be a deflation surface. Beneath this top layer of fine-grained sand and silt, harden silt and clay units were platy to angular and very hard to crumble. Partially decayed organic material (roots or fungal hyphae) as well as manganese nodules were found in the lowermost units. An old spider burrow was found cutting vertically down into the bar top (Figure 5d).

3. Splays

A number of braid bars are incised by splays (Figure 6a), which act as overflow from the main channels during flood events (localities 3, 4 and 5, Figure 2b). These distributary splay systems consist of a main splay channel, with several distributaries, becoming more frequent downstream (D1 to D5 in Figure 6c). At locality 4 (Figure 2b), at the upstream reaches of the splay, the main channel is approximately 2m deep, and 22.7m wide (measured between levees). The channel is highly sinuous and asymmetric in profile, with a narrow thalweg (Figure 6b). A large portion of the bank has been eroded away, and an associated bank-attached bar has developed beneath (Figure 6c). This feature could be a flood pathway from the main channel or the floodplain into the splay. The upper reaches of the splay is fed by an asymmetric tributary channel (T in Figure 6a), with a vegetated chute bar at the junction with the main splay channel (Figure 6d). Minor tributaries also flow into the upper reaches of the splay, and are generally a step up from the main splay channel (Figure 6e), and have been interpreted as interfluvial drainage channels (see section 4).

Further downstream, the main splay channel begins to widen out and become shallower, with a near flat base, although the asymmetric profile remains (Figure 6f). Along the mid-course straight section of the splay at locality 4 (Figure 6a), several in channel vegetated bars have developed (Figure 6g). Both living and dead gum trees inhabit these bars. These may be vegetative shadow bars or mid-channels bars that have been vegetated post –sedimentation. Excavation of one of these bars, parallel to flow direction, exposed interbedded layers of very fine to fine-grained sand with layers of sand-sized mud aggregates (Figure 6h). With further excavation the proportion of mud aggregates increased.

In the distal part of the splay, the main channel begins to dissipate into 5 distributaries. Some channels are shallower and narrower than the main splay channel (Figure 7a), whilst others appeared to deepen (Figure 7b). Lap lines on the banks of these distributaries suggest that these distal channels were once waterholes. Although evidence of faunal activity can be found along the full course of the main splay channel, there is an abundance of gastropod and

Figure 6: Splays of the Diamantina River at site 1



Figure 7: Distal splays and interfluvial floodplain drainage of the Diamantina River at site 1



clam shells (Figure 7c), spider burrows (Figure 7c) crab and crayfish burrows (Figure 7d) and fresh water sponges (Figure 7e) found in these deeper parts of the distal splay.

4. Floodplain and interfluvial drainage

Between the levees of the main anastomosing to single channels and the highs of the braid bars and associated splays, there are areas of low-lying floodplain (Figures 4a and 6a). These floodplain areas are often partially vegetated, represented by the green-grey colour on the satellite images (Figures 4a and 6a). During the dry season the floodplains are covered in shrubs and small riparian plants (Figure 7f) that are either recently dead or dormant, to be revitalised during the wet season. Therefore the channel paths and floodplain areas can easily be recognised by the vegetation (Figure 7g). Desiccation cracks are more prominent on these floodplains than seen on the braid bar tops (Figure 7h). Small, shallow incipient drainage channels are also a key feature of the floodplain, forming a network across the floodplain, subsequently flowing into splays or the main channel (Figure 7i). These ephemeral channels would likely operate at small-scale flood or local rainfall events, draining the floodplain, transporting water into the waterholes.

Another feature of the floodplain area are rare cobble-sized clasts, lying on the floodplain surface, often caught up in the gum trees along the levees and banks of the main channels and splays (Figures 8a, 8b and 8c). These cobbles could only have been transported by large, fast-flowing floodwaters, sweeping across the whole channel belt, depositing the cobbles where a tree provided some resistance. Mounds of dead gum tree branches and roots, as well as seeds and shells have also been transported the same way, only being deposited when against a resistant feature (Figures 8d, 8e, 8f and 8g). The large-scale floodwaters would have flowed into the main channels and splays via floodways, where large portions of the levee are washed away (Figure 6c).

Site 2

1. Anastomosing sinuous channels

Anastomosing sinuous rivers stretch over a channel belt approximately 0.78 km wide at site 2 (Mt. Rourke Creek, Figures 2a, 2b and 9a). This channel belt is much narrower than further downstream at site 1. The main channels are highly sinuous (Figure 9b) and anastomosing, although there are straight section (Figure 9c). At locality 1 (Figure 9a), the channel is approximately 3m deep and between 5 and 12m wide. Straight sections of river have symmetrical profiles with steep sides and flat bases (Figure 9b), whilst sinuous sections have

Figure 8: Evidence of large floods on the floodplains of the Diamantina River at site 1



Figure 9: Anastomosing channels and braid bars of the headwaters of the Diamantina River, Mt. Rourke Creek, site 2.



asymmetrical profiles (Figure 9c). Sinuous sections often have shallow accretionary benches on the convex riverbank, with a steep, eroded bank on the opposite side (Figure 9c). Generally channel sections are shallow, but in some areas have deepened, to form waterholes (Figure 9d). Evidence of faunal activity includes crayfish burrows (Figure 9e) and crabs (Figure 9f). Gum trees are established on the riverbanks (Figure 9g), or occur mid-channel (Figure 9h). Vegetation debris, including gum branches and scrubs are often found against mid-channel trees (Figure 10a). Mid-channel trees and vegetation debris then act as a sediment trap, forming shadow bars, which are subsequently vegetated (Figure 10b).

Excavation of the channel base revealed interbedded planar-laminated layers of very fine-grained sand and silt with layers of pelleted mud aggregates (Figure 10c). Deepening of the channels has resulted in erosion of the bedrock (sandstone of the Winton Formation) may be a possible source sand (Figure 10d). Small patches of wind-abraded gravel or pebbles have been found on the channel floors (Figures 10e and 10f).

2. Braid bars

The braid bars at site 2 are smaller than those of site 1, and are more vegetated (Figure 10g), which suggests more frequent flooding of the braid bar surface. Small scrubs are still living, although their roots are often exposed (Figure 10h), suggesting vertical erosion of the braid bar tops. Desiccation cracks occur over the braid bar surfaces, but are superficial, with hardened, blocky mud occurring beneath the top layer of sediment.

On either side of the channel belt, the floodplain has been eroded down to the silcrete bedrock, to form 'gibber' plains (Figures 11a and 11b), a likely source for the wind-abraded gravel found in the channel floor, transported by high velocity floodwaters from the floodplain.

3. Incipient floodplain drainage

Running perpendicular to the main channels, small incipient channels have developed, acting as drainage for the floodplains (Figure 11c). These small channels may have developed from deep desiccation cracks close to the main channel (Figures 11d and e). Mud was transported from the floodplain in this way, and deposited on the channel floor (Figure 11f).

Figure 10: Mt Rourke Creek, headwaters of the Diamantina River, site 2.



Figure 11: Mt Rourke Creek, headwaters of the Diamantina River, site 2.



COMPARISONS WITH THE LOWER DEVONIAN OLD RED SANDSTONE LITHOFACIES

Raglan Mudstone Formation

The following lithofacies have been recognised from the uppermost Silurian Raglan Mudstone Formation from Tredomen Quarry cores (see Chapter 6 for complete descriptions and interpretations): red, thinly-bedded intraformational conglomerates (lithofacies 1b); red planar and wavy-laminated siltstones (lithofacies 3b); planar-bedded and cross-bedded heterolithics (lithofacies 4); massive mudstones, composed of pelleted mud aggregates (lithofacies 5a); and pedogenically-altered mudstones (lithofacies 5b, mostly pedified profile type 2).

Of the deposits observed from the Diamantina River, only the massive muds composed of mud aggregates and the planar-cross and cross-bedded heterolithics (interbedded mud aggregates and siltstone to very fine-grained sand layers) are similar to lithofacies 5a and 4 of the Raglan Mudstone Formation. These deposits were found in accretionary bars, bank-attached bars, shadow bars and channel bases of the Diamantina River. The heterolithics and mud aggregates found in the Raglan Mudstone Formation may have been deposited in similar channel elements of sinuous, possibly anastomosing, shallow ephemeral channels similar to those of the Diamantina River. Waterholes are one of the main components of the Diamantina River, and are the main refuge for fauna such as crayfish and crabs, leaving the sediment around the waterhole heavily bioturbated. Similarly, the bedding planes of wavy and planar-laminated siltstones of lithofacies 3b from the Raglan Mudstone Formation, interpreted as ephemeral lake deposits, are covered with arthropod tracks and burrows as well as fish trails.

Gravel or pebble clasts were found only in channel deposits in the headwaters of the Diamantina River, close to local sources, such as the ‘gibber’ plains. Compared to the intraformational conglomerates of the Raglan Mudstone Formation (lithofacies 1b), these are small, insignificant deposits. This may be due to a lack of source material for Lake Eyre Basin rivers. Source material is restricted to reworked muddy floodplain material and small local outcrops of the Winton Formation (sandstone) and silcretes (wind-abraded gravel and pebbles on ‘gibber’ plains). In addition, the intraformational conglomerates of the Raglan Mudstone Formation are predominantly composed of reworked floodplain material, in particular reworked carbonate nodules. Very small carbonate nodules grains were found in deposits of the Diamantina River, but only from very weakly pedified mudstones. The soils

of the Diamantina River floodplains / braid bars are too under-developed to produce carbonate nodules of the size seen in lithofacies 5b of the Raglan Mudstone Formation.

St. Maughans Formation

The following lithofacies have been observed from the Lower Devonian St. Maughans Formation of the Anglo-Welsh Basin (see Chapter 6 for complete descriptions and interpretations): green planar-bedded intraformational conglomerates (lithofacies 1a); medium-grained green-grey sandstones (lithofacies 2a); fine-grained green-grey sandstones (lithofacies 2b); green to grey planar and wavy-laminated siltstones (lithofacies 3a); red wavy to planar-laminated siltstones (lithofacies 3a); planar-bedded and cross-bedded heterolithics (lithofacies 4); massive mudstones composed of mud aggregates (lithofacies 5a); and pedogenically-altered mudstones (lithofacies 5b) (pedified profile type 1). Again the only similarities with the deposits of the Diamantina River are the massive mudstones composed of pelleted mud aggregates (lithofacies 5a), the heterolithics (interbedded muds and silt-sand layers) (lithofacies 4) and the wavy laminated siltstones (lithofacies 3a). Unlike the Raglan Mudstone Formation, the St. Maughans Formation is characterised by significant sandstone fining-upwards complexes (lithofacies 2a, 2b and 3a), with basal intraformational conglomerates (lithofacies 1a). Sand-sized grains are uncommon in the Diamantina River, occurring only within heterolithic units as thin laminations. Increases in the proportion of sand does occur where local outcrops of the Winton Formation occur, but appears to be transported short distances and deposited close by. Where sand deposits do occur along the Diamantina River, they are not associated with gravel or pebble deposits beneath, as seen in the St. Maughans Formation sandstone complexes and basal intraformational conglomerates.

The pedogenically-altered mudstones of St. Maughans Formation are very distinctive of modern calcic-Vertisols, with pseudo-anticlinal slickensided slip-planes, representing the shrinking and swelling of clay during soil formation at depth. These slip-planes are represented on the surface by 'gilgai' structures (Wilding and Tessier 1988). These features are not present on the floodplains/ braid bars of the Diamantina River. Either calcic-Vertisols have not developed in this area due to prolonged aridity or the soils are too immature. Carbonate horizons from the St. Maughans Formation indicate palaeosols of at least stage II (lithofacies 5b).

CONCLUSIONS

The mud-dominated rivers of Lake Eyre Basin can be considered as a suitable analogue for the river systems of the uppermost Silurian of the Anglo-Welsh Basin, which deposited the Raglan Mudstone Formation, and an ephemeral, mud-dominated anastomosing river system model can be inferred. However, the deposits of the Diamantina River do not contain significant conglomerates, this may be explained by a lack of source material. The Lake Eyre Basin sits on the Australian stable craton with no significant source area and very low gradient landscapes. In addition, the soils of the Diamantina River floodplains are immature and therefore have not developed significant carbonate nodule horizons as seen in the palaeosols of the Raglan Mudstone Formation.

With no evidence of any substantial sand deposition along the Diamantina River, it is less appropriate as an analogue for the St Maughans Formation of the Lower Devonian, which is characterised by fining upwards sandstone complexes with basal intraformational conglomerates typical of perennial meandering rivers. Palaeosols are typically stage II to III palaeo-calci-Vertisols. There is no evidence of any significant calci-Vertisol development on the floodplains of the Diamantina River. However, beneath the thin veneer of mud facies of the Lake Eyre Basin, a significant sand sheet has been reported (Rust and Nanson 1986, Nanson et al. 1986). It was found to consist of cross-bedded sandstones similar to point bar deposits of perennial, meandering rivers (Rust and Nanson 1986). This sand sheet has been linked with interglacial stages 7 and 5 from the marine isotope record, representing a wetter 'phase' than the present aridity. A similar switch from a dry 'phase' to a wet 'phase' as a result of global climate change may explain the shift in sedimentology from the muddy ephemeral channels of the Raglan Mudstone Formation to the sandier, perennial and meandering channels of the St. Maughans Formation across the Silurian-Devonian boundary.

ACKNOWLEDGEMENTS

This work was funded by and in collaboration with LEBARG (Lake Eyre Basin Analogues Research Group, Australian School of Petroleum, Adelaide University (Kathryn Amos, Carmen Krapf, Marianne Sandstrom, Rachel Nanson) and Steve Hasiotis (University of Kansas) and Joanna Morris (University of Durham).

REFERENCES

- ALLEN J.R.L. 1986. Pedogenic calcretes in the Old Red Sandstone facies (Late Silurian-Early Carboniferous) of the Anglo-Welsh Area, southern Britain. In WRIGHT V.P. (ED). *Paleosols: their recognition and interpretation*, Blackwell Scientific, London: 58-86.
- ALLEN J.R.L. AND CROWLEY S.J. 1983. Lower Old Red Sandstone fluvial dispersal systems in the British Isles. *Transactions of the Royal Society of Edinburgh* **74**: 61-68.
- BOYCE K.C., HOTTON C.L., FOGEL M.L., CODY G.D., HAZEN R.M., KNOLL A.H. AND HUEBER F.M. 2007. Devonian landscape heterogeneity recorded by a giant fungus. *Geology* **35**: 399-402.
- CHANNELL J.E.T., MCCABE C. AND WOODCOCK N.H. 1992. Early Devonian (pre-Acadian) magnetisation directions in the Lower Old Red Sandstone of South Wales (UK). *Geophysical Journal International* **108**: 883-894.
- DEWEY J.F. AND STRACHAN R.A. 2003. Changing Silurian-Devonian relative plate motion in the Caledonides: sinistral transpression to sinistral transtension. *Journal of the Geological Society* **160**: 219- 299.
- EDWARDS D. AND FEEHAN J. 1980. Records of *Cooksonia*-type sporangia from late Wenlock strata in Ireland. *Nature* **287**: 41-42.
- ÉKES C. 1993. Bedload-transported pedogenic mud aggregates in Lower Old Red Sandstone in Southwest Wales. *Journal of the Geological Society, London* **150**: 469-471.
- FAGAN S.D. AND NANSON G.C. 2004. The morphology and formation of floodplain surface channels, Cooper Creek Australia. *Geomorphology* **60**: 107-126.
- FRIEND P.F., WILLIAMS B.P.J., FORD M. AND WILLIAMS E.A. 2000. Kinematics and dynamics of Old Red Sandstone basins. In FRIEND P.F. AND WILLIAMS B.P.J. (EDS.) *New Perspectives on the Old Red Sandstone*. London, Geological Society Special Publication **180**: 29-60.

- GIBLING M.R., NANSON G.C. AND MAROULIS J.C. 1998. Anastomosing river sedimentation in the Channel Country of central Australia. *Sedimentology*, **45**: 595-619.
- HILLIER R.D., MARRIOTT S.B., WILLIAMS B.P.J. AND WRIGHT V.P. 2007. Possible climate variability in the Lower Old Red Sandstone Conigar Pit Sandstone Member (Early Devonian), South Wales, UK. *Sedimentary Geology* **202** (1-2): 35-57.
- HUEBER F.M. 2001. Rotted wood-alga-fungus: the history and life of *Prototaxites* Dawson 1859. *Review of Palaeobotany and Palynology* **116**: 123-158.
- KNIGHTON A.D. AND NANSON G.C. 2001. An event-based approach to the hydrology of arid zone rivers in the Channel Country of Australia. *Journal of Hydrology* **254**: 102-123.
- MAROULIS J.C., NANSON G.C., PRICE D.M. AND PIETSCH T. 2007. Aeolian-fluvial interaction and climate change: source-bordering dune development over the past ~100 ka on Cooper Creek, central Australia. *Quaternary Science Reviews* **26**: 386 - 404.
- MARRIOTT S.B. AND WRIGHT V.P. 1993. Palaeosols as indicators of geomorphic stability in two Old Red Sandstone alluvial suites, South Wales. *Journal of the Geological Society, London* **150**: 1109-1120.
- MARRIOTT S.B. AND WRIGHT V.P. 1996. Sediment recycling on Siluro-Devonian floodplains. *Journal of the Geological Society, London* **153**: 661-664.
- MARRIOTT S.B. AND WRIGHT V.P. 2004. Mudrock deposition in an ancient dryland system: Moor Cliffs Formation, Lower Old Red Sandstone, southwest Wales, UK. *Geological Journal* **39**: 277-298.
- NANSON G.C., RUST B.R. AND TAYLOR G. 1986. Coexistent mud braids and anastomosing channels in an arid-zone river: Cooper Creek, central Australia. *Geology*, **14**: 175-178.
- NANSON G.C., PRICE D.M. AND SHORT S.A. 1992. Wetting and drying of Australia over the past 300 ka. *Geology* **20**: 791-794.

- RUST B.R. 1981. Sedimentation in an arid-zone anastomosing fluvial system: Cooper's Creek, central Australia. *Journal of Sedimentary Petrology*, **51** (3): 745-755.
- RUST B.R. AND NANSON G.C. 1986. Contemporary and paleo channel patterns and the Late Quaternary stratigraphy of Cooper Creek, southwest Queensland, Australia. *Earth Surface Processes and Landforms* **11**: 581-590.
- SCOTese C. 2003. Paleomap Project website. <http://www.scotese.com>.
- SOPER N.J. AND WOODCOCK N.H. 2003. The lost Old Red Sandstone of England and Wales: a record of post-Iapetan flexure or Early Devonian transtension? *Geological Magazine* **140**(6): 627-647.
- SIMON J.B. AND BLUCK B.J. 1982. Palaeodrainage of the southern margin of the Caledonian mountain chain in the northern British Isles. *Transactions of the Royal Society of Edinburgh: Earth Sciences* **73**: 11-15.
- VEEVERS J. J. AND RUNDLE A. S. 1979. Channel Country fluvial sands and associated facies of central-eastern Australia: modern analogues of Mesozoic desert sands of South America. *Palaeogeography, Palaeoclimatology, Palaeoecology* **26**: 1-16.
- WOPFNER H. 1963. Post-Winton sediments of probable Upper Cretaceous age in the central Great Artesian Basin. *Trans. R. Soc. South Aust.* **86**: 247-253.
- WRIGHT V.P. AND MARRIOTT S.B. 2007. The dangers of taking mud for granted: lessons from Lower Old Red Sandstone dryland river systems of South Wales. *Sedimentary Geology* **195**: 91-100.