

Silurian and Lower Emsian spores in Saudi Arabia

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Received 11 June 1993; revised and accepted 17 August 1994

Abstract

Silurian cryptospores and Silurian to Lower Devonian miospores are identified in cuttings from three wells situated in Saudi Arabia between longitudes 42 and 51°E and latitudes 23 and 29°N. All samples are contaminated by caved younger spores and pollen. The biostratigraphic scheme defined in western Europe is tentatively applied. The identical succession of first occurrences of the key-species approximately dates the levels sampled. A discordance is demonstrated between the Silurian and the Lower Devonian deposits in each examined well. The ages of the first Lower Devonian sediments in these wells suggest a transgressive direction from SE to NW. Two new taxa are formally introduced: *Cymbosporites dammanensis* Steemans, *sp. nov.* and *Chelinospora arabiensis* Steemans, *sp. nov.*

1. Introduction

Cutting samples obtained from three Saudi Arabian wells ranging from longitudes 42 to 51°E and from latitudes 23 to 29°N have been palynologically examined. These three wells, TRBH-1, DMMM-45 and UDYN-1 (Fig. 1), penetrated presumed Silurian and Lower Devonian strata. The samples described here have been obtained from these strata.

The study has been extensively complicated by abundant contaminations, clearly demonstrated by the occurrence of post-Lower Devonian material. The composition of the spore assemblages in the samples is uncertain because of poor preservation.

These boreholes are not suitable to construct a local biostratigraphic zonal scale because of the extensive contamination. We have, therefore, applied the existing biozonations of Richardson and McGregor (1986), StreeL et al. (1987), Richardson (1988), and Steemans (1989).

It is assumed that the key-species of the biozone found in the cutting samples occur in the same

succession as in the Ardenno-Rhenish type sections, that this succession is not affected by contamination, and that the biozone limits are close to the depth of the examined intervals.

2. Stratigraphic palynology

2.1. Well DMMM-45

Seventeen cutting samples between 13120 and 12500 ft have been examined from well DMMM-45 (Fig. 1). The intervals 13100–13120 ft, 12920–12940 ft and 12770–12790 ft are barren. The Devonian section is separated from the underlying Silurian Qalibah Formation by a discordance in the interval 13100–13220 ft. Fig. 2 shows the most important spore species identified.

The intervals 13110–13120 ft and 13100–13110 ft from the upper part of the Sharawra member of the Qalibah Formation yielded very few specimens. No biostratigraphically significant species have been identified apart from *Synorisporites*

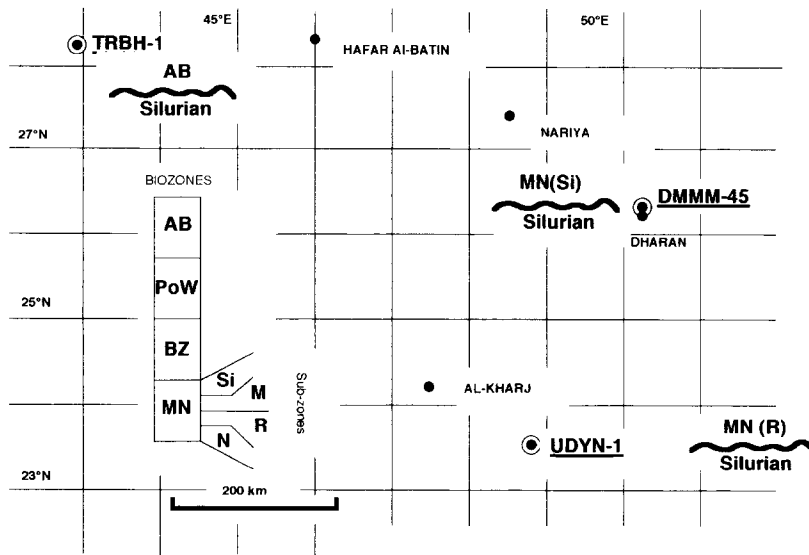


Fig. 1. Location of wells and the unconformity between the Silurian and the Devonian.

verrucatus, ranging from the Silurian into the Lochkovian (Steemans, 1989).

The assemblage in the interval 13090–13110 ft contains a greater number of palynomorphs, but only one index species has been found: *Tetraedraletes medinensis* which, together with *Emphanisporites neglectus* and *Synorisporites verrucatus*, could probably indicate a Wenlock–Ludlow age (Burgess and Richardson, 1991). The presence of *Apiculiretusispora pygmaea* is probably due to caving.

The interval 12940–13000 ft from the lower part of the Tawil Formation is assumed to be of Lochkovian age because of the presence of *Chelinospora retorrada*, *Emphanisporites novellus*, and a poorly preserved specimen related possibly to *?Emphanisporites micornatus* var. *sinuosus*. These species are characteristic of the Lochkovian MN Assemblage Biozone. The presence of *Cymbosporites multiconus* and *?E. micornatus* var. *sinuosus*, probably indicates middle Lochkovian Phylozone Si (for the biostratigraphic scale, see Stree et al., 1987; Steemans, 1989).

Perotrilites reticulatus has been observed in the interval 12900–12940 ft, together with non-stratigraphically diagnostic taxa. This species is only known in Belgium from Biozones Si to Z

Phylozones (being rare in the latter), and is considered as reworked in the Pragian Biozone Su (Steemans, 1989). The interval 12900–12940 ft is therefore believed to range from the Lochkovian Si to Z Biozones. A new species, *Cymbosporites dammamensis* (see section on taxonomy below) is observed in the interval 12540–12550 ft.

Species obtained from the interval 12880–12890 ft are characteristic of the BZ Assemblage Biozone, and more particularly of the E Interval Biozone. *Aneurospora bollandensis*, *Emphanisporites novellus*, *Amicosporites streeii*, and *Dibolisporites* sp. E (in Steemans, 1989) have been identified. The E Interval Biozone spans the Lochkovian–Pragian boundary.

Dibolisporites wetteldorfensis, the index species for the W Interval Biozone in the PoW Assemblage Biozone, has been observed in the intervals 12770–12780 ft, 12590–12640 ft and 12550–12560 ft of the upper Tawil Formation. The following main taxa have been identified from the interval 12770–12780 ft: *Amicosporites splendidus*, *Apiculiretusispora pygmaea*, *Cymbosporites dammamensis*, and *Dibolisporites wetteldorfensis*. The following have been recorded from the interval 12550–12560 ft: *Apiculiretusispora pygmaea*, *Dictyotriletes emsiensis*, *Cirratiradites diaphanus*,

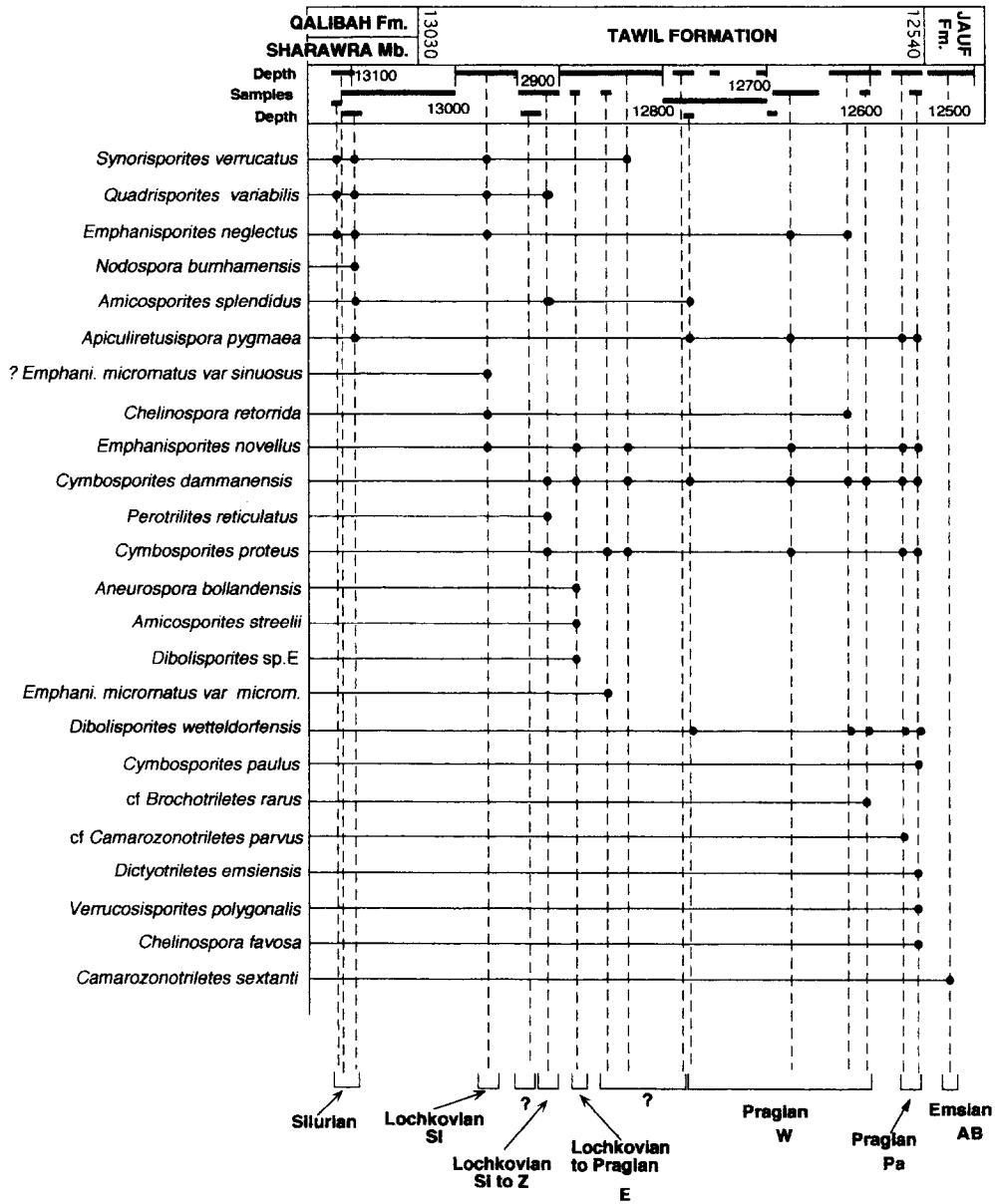


Fig. 2. Stratigraphic distributions of some selected spores in well DMMM-45.

Chelinospora favosa, and *Verrucosisporites polygonalis*. The latter together with *Dibolisporites wetteldorfensis* allows the assignment of these two horizons to the Praglan W Biozone.

The possible occurrence of *Camarozonotriletes parvus* indicates a Praglan age (Pa Interval Biozone) for the intervals 12540–12580 ft and

12550–12560 ft. The biostratigraphic boundary, therefore, occurs between 12540 and 12550 ft as indicated by the results obtained from the preceding interval. *Dibolisporites wetteldorfensis* and *Cymbosporites dammamensis* are still recognised in these horizons.

The occurrence of *Camarozonotriletes sextanti*

in the interval 12520–12540 ft of the Jauf Formation suggests that at least the AB Assemblage Biozone (Early Emsian) has been penetrated (Streel et al., 1991).

2.2. Well UDYN-1

Ten samples have been examined. They were obtained from the interval 14460–15320 ft. The interval between 14920 and 14930 ft was found to be barren. The Devonian is unconformable with the underlying Silurian Qalibah Formation at an estimated depth of 15358 ft. The succession of the most important identified taxa in these samples is shown in Fig. 3.

The interval 15320–15360 ft from the upper part of the Sharawra member and the lowermost part of the Tawil Formation contains only very few palynomorphs. Trilete spores and cryptospores (Richardson et al., 1984) have been identified. Amongst the cryptospores are *Tetraedraletes medinensis*, *Dyadospora murusdensa*, and *Laevolancis divellomedium*. Trilete miospores are somewhat more numerous and the following species have been identified: *Ambitisporites dilutus*, *A. avitus*, Trilete miospore type 1 (in Burgess and Richardson, 1991), cf. ?*Lophozonotriletes poecilomorphus*, *Emphanisporites neglectus*, *Amicosporites splendidus*, *Synorisporites verrucatus*. The incertae sedis *Hoegisphaera* sp. A (in Gao and Ye, 1987) has also been identified.

The overlying interval 15290–15300 ft in the Tawil Formation also contains mixed trilete spores and cryptospores. In addition to the cryptospores mentioned in the first sample, *Quadrisporites variabilis*, *Segestrespora membranifera* and Hilate cryptospore type 1 (in Burgess and Richardson, 1991) have been recognised. Only two trilete spore species were found: *Ambitisporites dilutus* and *Synorisporites verrucatus*.

These two intervals can be considered together since they are characterised by the occurrence of cryptospores which are absent elsewhere in the well. On the other hand, the same trilete spores are found both in these two intervals and in higher parts of the well. It is therefore not possible to decide whether these trilete spores and cryp-

tosporae are really contemporaneous. *Segestrespora membranifera* is known only from the *S. membranifera*–*Segestrespora* sp. B Biozone (Richardson, 1988). Some other species, such as *T. medinensis* and *D. murusdensa*, may be contemporaneous with *S. membranifera*. This biozone ranges from the upper part of Ashgill to the early Aeronian (Richardson, 1988; Burgess, 1991; Steemans, unpubl. data). *A. avitus* and *A. dilutus* appear in the overlying biozone of which they are the index species. They are still present in the Lower Devonian. *S. verrucatus* and Hilate cryptospore type 1 (in Burgess and Richardson, 1991) appear in the immediately younger cf. *protophanus*–*verrucatus* biozone. This biozone was described for the first time by Richardson and McGregor (1986) and revised by Burgess and Richardson (1991). In Great Britain, it extends from Upper Wenlock to the Lower Ludlow (Homerian–Gorstian). ?*L. poecilomorphus* is characteristic of the overlying biozone (*libycus*–*poecilomorphus*). Nevertheless, Richardson and McGregor (1986, fig. 3) indicated this species as being already present, together with *E. neglectus*, in the cf. *protophanus*–*verrucatus* biozone.

The occurrence of *S. membranifera* at 15300 ft indicates an Ashgillian or Lower Silurian age for the interval 15290–15300 ft. *Synorisporites verrucatus* and Hilate cryptospore type 1 (in Burgess and Richardson, 1991) indicate that Wenlock or even Ludlow strata must exist between 15300 and 15260 ft (where the Lower Devonian is penetrated).

The spore assemblage of the intervals 15220–15260 ft, 15170–15210 ft, 15120–15170 ft and 15070–15120 ft have been considered together. The interval 15220–15260 contains, among others, *Cymbosporites proteus*, *C. paulus* and *Chelinospora retorrída*. These species appear in the *Streelispora newportensis*–*Emphanisporites microratus* var. *microratus* Assemblage Biozone (MN Assemblage Biozone in Steemans, 1989) (Richardson and McGregor, 1986; Steemans, 1989; Streel et al., 1987). The occurrence of *C. retorrída* indicates that the R Interval Biozone has been penetrated. The first occurrence of a new spore species from that interval is of importance: *Chelinospora arabensis* Steemans, sp. nov. (see section on taxonomy

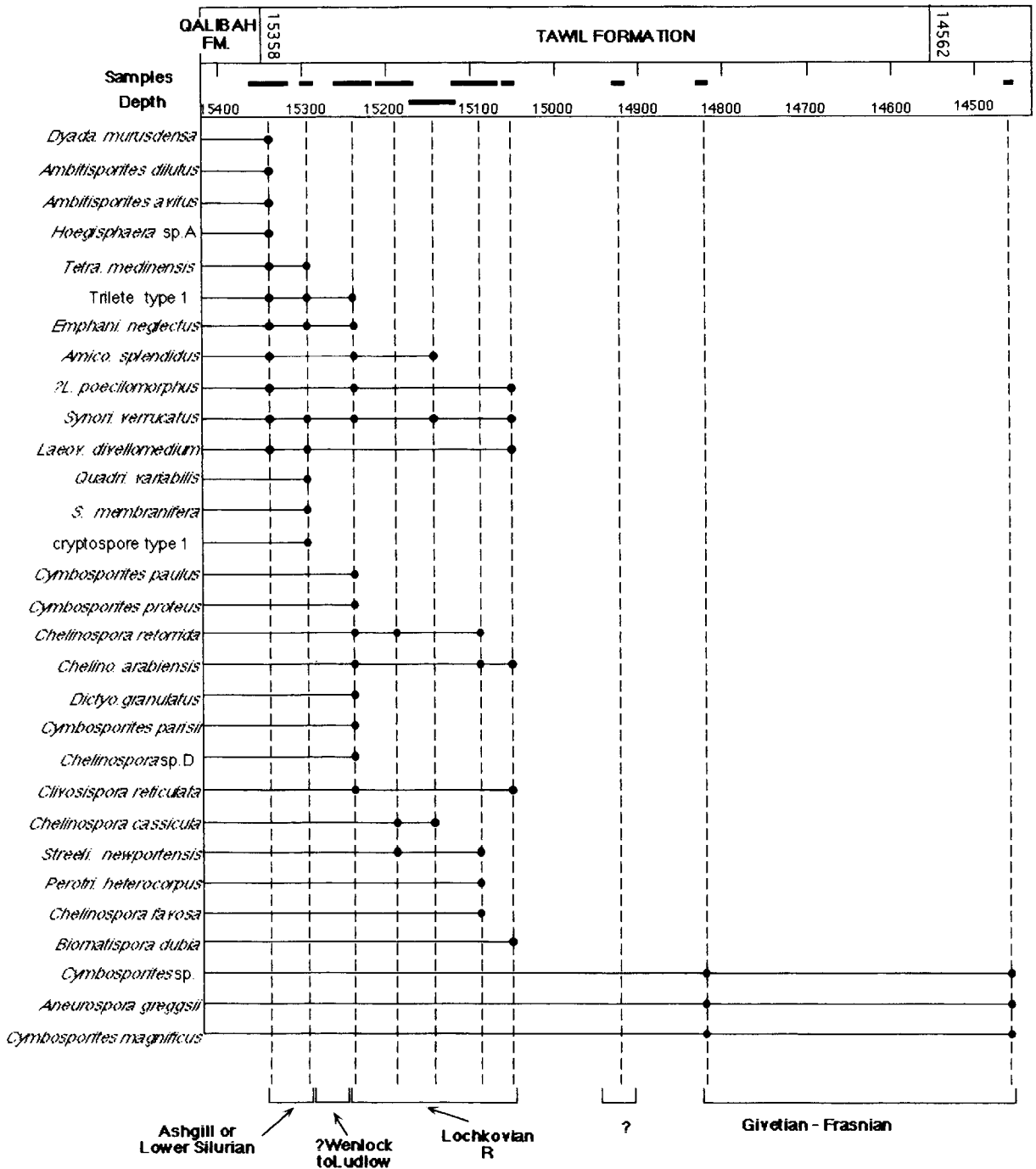


Fig. 3. Stratigraphic distributions of some selected spores in well UDYN-1.

below). *Amicosporites splendidus*, *Dictyotriletes granulatus*, *Cymbosporites parisii*, *Emphanisporites neglectus*, *Chelinospora* sp. D (in Steemans, 1989), and *Clivosispora reticulata* have also been observed.

In the interval 15170–15210 ft, 15120–15170 ft and 15070–15120 ft from the lower part of the Tawil Formation, *Streelisporea newportensis*, one of the MN Biozone index species, has been identified, together with numerous other characteristic miospores from the R Biozone. The interval 15070–15120 ft contains *Perotrilites heterocarpus*. This spore is only known from the N and R Interval Biozones in Ardenne and in Britain (Steemans, 1989). There is only one report of this species in younger strata (Upper Pragian), where it had probably been reworked. It is assumed that these four intervals probably belong to the R Biozone and the strata between 15260 and 15070 ft are therefore tentatively assigned to the lower part of the Lochkovian.

The interval 15050–15060 ft contains on one hand *Synorisporites verrucatus*, the vertical extension of which does not exceed the MN Assemblage Biozone (Steemans, 1989) and, on the other hand, *Biornatispora dubia*, with its first occurrence in the BZ Assemblage Biozone. The vertical extensions of these two spore species are thus inconsistent. Some other species, e.g. *Laeovancis divellomedium*, *Clivosispora reticulata*, *?Lophozonotriletes poecilomorphus*, show strong affinities with the Lochkovian MN Biozone. Thus, we conclude that this interval belongs, as the four previously described, to the R Interval Biozone, and is contaminated by post-R caved material.

The intervals 14820–14830 ft, from the middle and upper part of the Tawil Formation, and 14460 ft, from the Jauf Formation, mainly contain very large specimens (50–80 µm in diameter) including *Aneurospora greggsii* and *Cymbosporites magnificus*. These two intervals can be assigned to the Givetian–Frasnian.

2.3. Well TRBH-1

The samples analysed here are obtained from cuttings in the intervals 3701–3753 ft and

3806–3832 ft from the Sharawra member of the Qalibah Formation. These two intervals have yielded numerous acritarchs, but some chitinzoans have also been observed (*Ancyrochitina* sp., *Angochitina thadeui*, *Clatrochitina* sp. and *Sphaerochitina pistiliformis*; Verniers, pers. commun., 1992). About 50 spore specimens have been identified and these show Silurian and/or Lower Devonian affinities. Together with these spores, some cryptospores have been identified (*Tetrahedraletes medinensis*). A Silurian age is therefore assumed for these two intervals.

The overlying intervals, which belong to the lower part of the Tawil Formation, have been examined by Loboziak and Streel (1995–this issue); samples of the interval 3596–3622 ft are determined to be Emsian in age (AB Assemblage Biozone).

3. Biostratigraphy and palaeogeographic implications

Results obtained from the three wells prove that it is possible to use the biozonation established in Ardenno-Rhenan type outcrops in the Gondwanan area. These results show that the Biozone R, recognised in the well UDYN-1, where *Chelinospora arabiensis* Steemans, *sp. nov.* is first described, is not penetrated by the well DMMM-45, where *Cymbosporites dammamensis* Steemans, *sp. nov.* is defined. This last species is not found in well UDYN-1. The two new species seem to have at least a local biostratigraphic value. The absence of *C. arabiensis* in well DMMM-45 and of *C. dammamensis* in well UDYN-1 may indicate that the Lower Devonian strata are indeed of different age in the two wells, tentatively based on the Ardenno-Rhenan biozonation (Fig. 4).

In the three analysed wells, the Lower Devonian strata are unconformably situated on the Silurian (Fig. 1). The magnitude of missing beds increases in a SE–NW direction. The first Devonian levels in well UDYN-1 belong to the R Interval Biozone (lower part of the Lochkovian), in well DMMM-45 they range from the Si Biozone to the Z Biozone (upper part of the Lochkovian), whilst

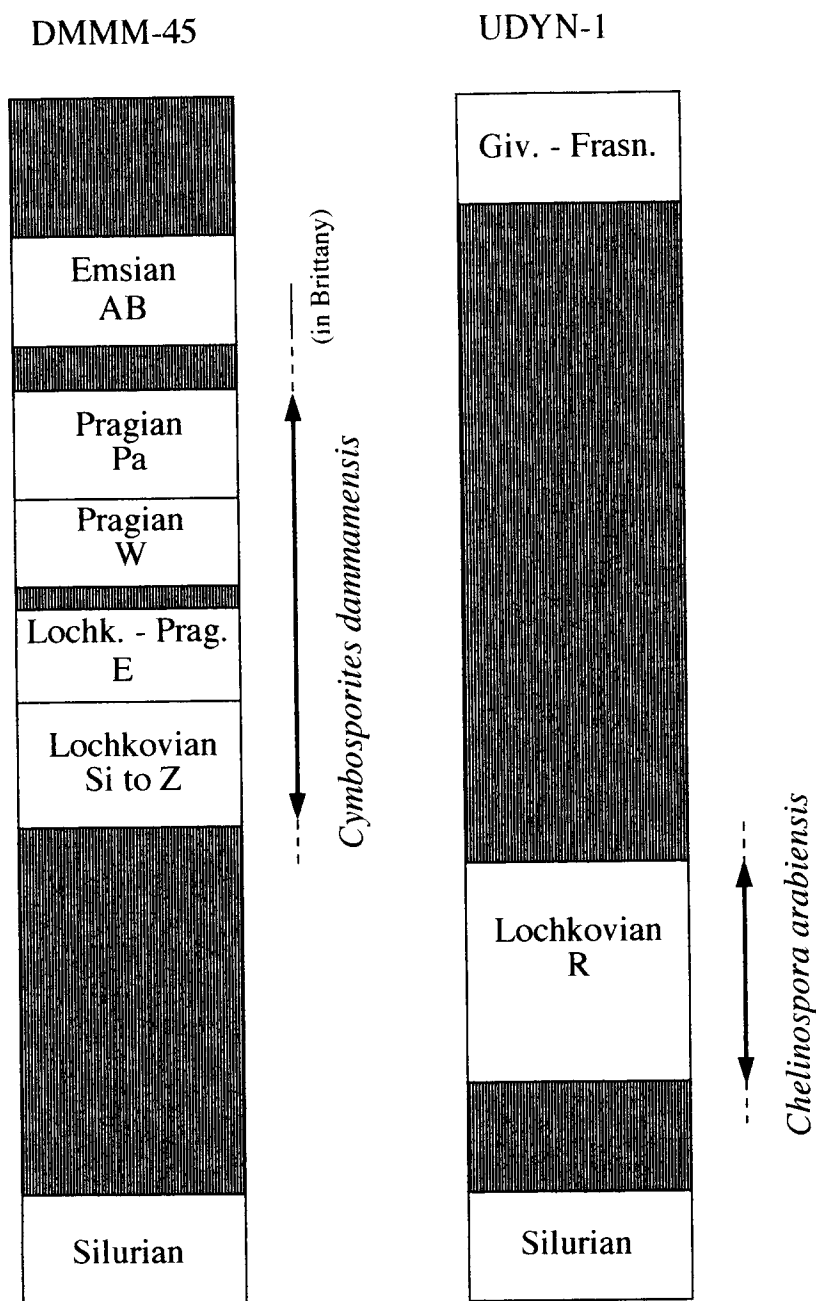
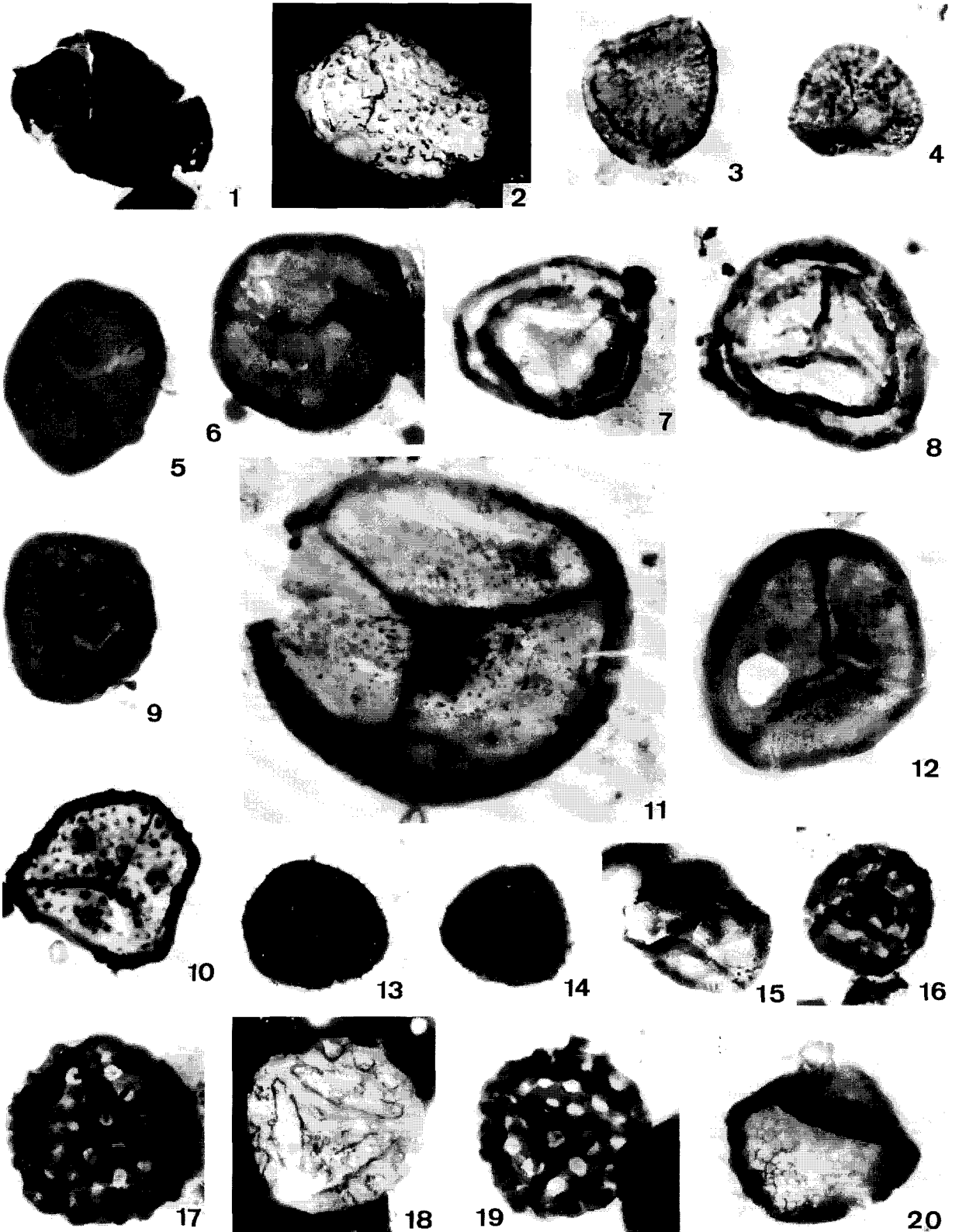


Fig. 4. Biostratigraphic distributions of the two new taxa in wells UDYN-1 and QMMM-45.

in well TRBH-1 they are indicative of the AB Assemblage Biozone (Early Emsian). These biostratigraphic data may suggest a Devonian transgression on the Silurian tectonised continent

in an approximate SE–NW direction. The above-mentioned hiatus is part of an unconformity and can be followed from central Saudi Arabia through Egypt, Libya, North Africa to Ghana, across to

PLATE I



Brazil in South America, where it extends in a SW direction (Boucot, 1985; Gray, 1985).

4. Systematics

Two new species which could have biostratigraphic and palaeogeographic implications are described here. All the other listed species, some of which are illustrated here, have already been fully described elsewhere and therefore do not need further descriptions.

Genus *Chelinospora* Allen, 1965

Type: *Chelinospora concinna* Allen, 1965.

Chelinospora arabiensis Steemans, sp. nov. (Plate I, 16–19)

Holotype: UDYN-1 Well-1, sample at 15070–15120 ft, reference slide coordinate: V44.

Stratigraphic occurrence: Due to the extensive caving, the present stratigraphic range may have to be revised. The specimens were only found in

sediments of the MN Assemblage Biozone (Interval Biozone R) (Lochkovian) of well UDYN-1.

Diagnosis: Trilete circular miospore. Distal surface and proximo-equatorial margin are thickened by a patina. The patina shows an enlargement in the interrational zone, giving a triangular outline to the contact area surface. Trilete mark reaches the internal margin of the patina and is bordered by three thick ribs delimiting a triangular area with thickened concave sides (2–3 µm wide). The patina is foveolate on its entire surface. Foveae are subcircular, 2–3 µm in diameter and regularly separated by muri 1–3 µm wide. These foveae seen at the equatorial margin are U-shaped, 1–2 µm deep; 10–20 foveae are visible at the equatorial margin. *Diameter:* Equatorial diameter 23–34 µm (average: 30 µm), 3 specimens measured.

Comparison: The nature of the proximal surface distinguishes it from all other species of *Chelinospora*.

Genus *Cymbosporites* Allen, 1965

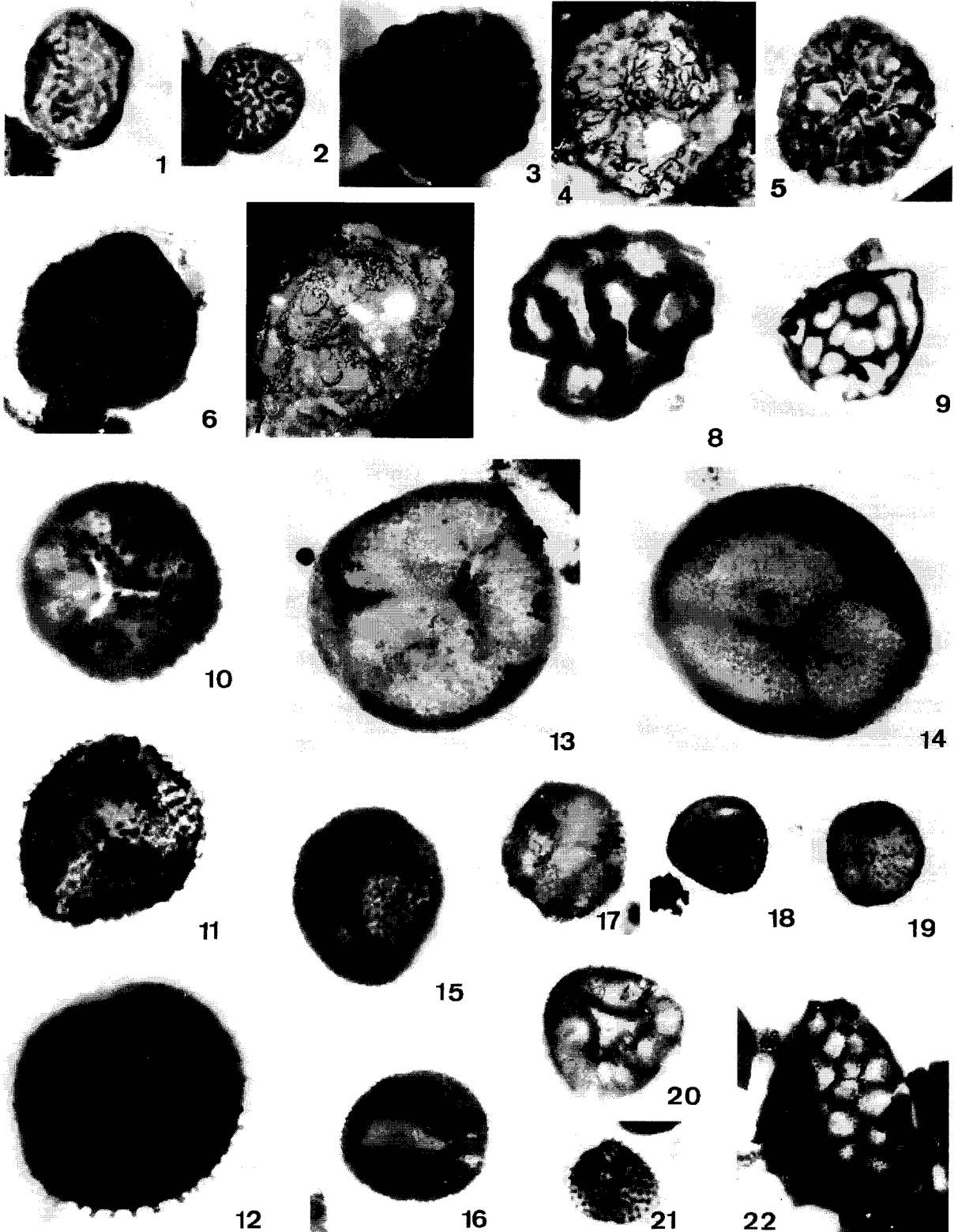
Type: *Cymbosporites cyathus* Allen, 1965.

PLATE I

All photographs × 1000.

- 1, 2. Hilate cryptospore type 1 (in Burgess and Richardson, 1991) (2, reflected light). UDYN-1 15290–15300 ft, K62/–, FM 625.
- 3, 4. Trilete miospore type 1 (in Burgess and Richardson, 1991).
3. UDYN-1 15220–15260 ft, K61/–, FM 626.
4. UDYN-1 15220–15260 ft, L47/2, FM 627.
5. *Ambitisporites avitus*. UDYN-1 15320–15360 ft, P50/3, FM 628.
6. *Ambitisporites dilutus*. UDYN-1 15320–15360 ft, W42/–, FM 629.
- 7, 8. *Amicosporites splendidus*.
7. UDYN-1 15220–15260 ft, Q43/4, FM 630.
8. UDYN-1 15220–15260 ft, L44/1 FM 631.
9. *Amicosporites streelii*. DMMM-45 12880–12890 ft, O43/4, FM 632.
10. *Aneurospora bollandensis*. DMMM-45 12880–12890, L43/–, FM 633.
- 11, 12. *Aneurospora greggsii*.
11. UDYN-1 14460 ft, N51/2, FM 634.
12. UDYN-1 14460 ft, M37/3–4, FM 635.
13. *Apiculiretusispora pygmaea*. DMMM-45 12850–12860, P44/–FM 636.
14. *Biornatispora dubia*. UDYN-1 15050–15060 ft, L48/2 FM 637.
15. cf. *Camarozonotriletes parvus*. DMMM-45 12540–12580, P31/3, FM 638.
- 16–19. *Chelinospora arabiensis*.
16. UDYN-1 15220–15260 ft, P45/–, FM 639.
- 17, 18. UDYN-1 15050–1560 ft, M52/2, FM 640. (18, reflected light).
19. Holotype, UDYN-1 15070–15120, V44/–, FM 641.
20. *Chelinospora favosa*. DMMM-45 12550–12560 ft, O47/4, FM 642.

PLATE II



***Cymbosporites dammamensis* Steemans, sp. nov.**
(Plate II, 10–12)

- 1983 *Raistrickia* sp. A—Le Hérisse, pp. 24–25, pl. 4, figs. 2, 8a,b.
1983 *Raistrickia* sp. B—Le Hérisse, p. 25, pl. 4, fig. 3.
1983 *Raistrickia* sp. D—Le Hérisse, p. 25, pl. 4, figs. 6, 7.
?1973 *Raistrickia* sp.—McGregor, pp. 35–36, pl. 4, figs. 9, 10.

Holotype: Well DMMM-45, sample at 12550–12560 ft, reference slide coordinate: X65/2.

Stratigraphic occurrence: Due to the extensive caving, the present stratigraphic range may have to be revised. The specimens were observed in sediments of the MN Assemblage Biozone (Phylozone Si) (Lochkovian) to the PoW Assemblage Biozone (Interval Biozone Pa?) (Pragian) of well DMMM-45.

Le Hérisse found this species in Britain in his Assemblages 2 and 3 (Pragian and Emsian).

Diagnosis: Trilete circular miospore. Proximal face very smooth, frequently collapsed. Trilete mark

very fine, generally observable as a slit with a “Y” shape. Distal face is thickest, 1–3 µm thick. The structure is a patina, ornamented by bacula and pila. Pila may have concave sides. The upper part of the pila are one to two times thicker than the lower part. The top is flat or concave, with occasionally bifurcate shape. The ornaments are regular, 1–2 µm wide and high, 1–3 µm apart.

Diameter: Equatorial diameter 29–43 µm (average: 34 µm) 10 specimens measured.

Comparison: The different specimens described by Le Hérisse (1983) are very similar to the specimens observed here. The ornamentation of *Raistrickia* sp. (in McGregor, 1973) is similar but there is no description of the thickness of the exine.

5. Conclusions

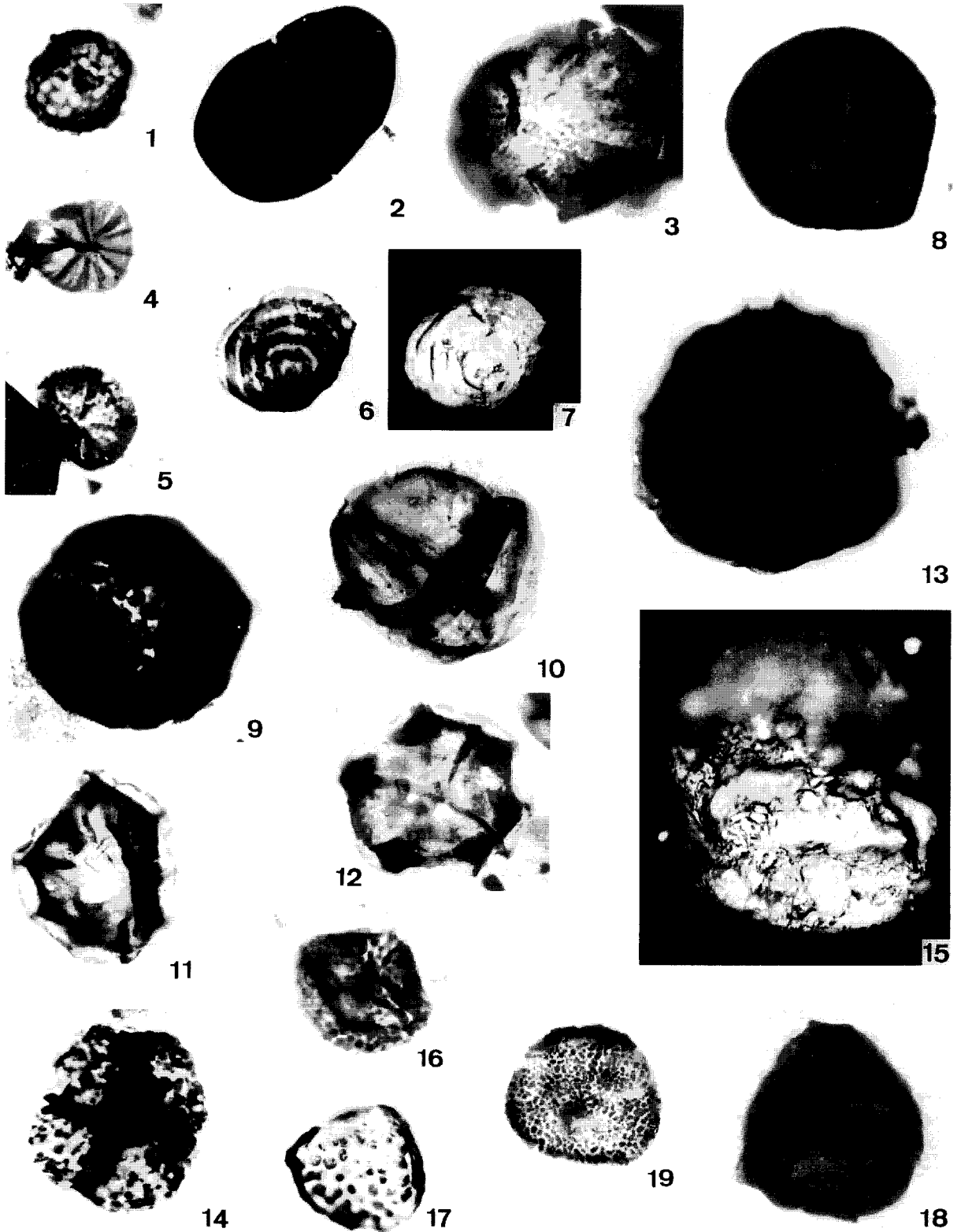
This study has proved that it is possible to use the Lower Devonian biozonation established in

PLATE II

All photographs × 1000.

- 1, 2. *Chelinospora retorrída*.
1. UDYN-1 15220–15260 ft, R50/1, FM 643.
2. UDYN-1 15170–15210 ft, J56/2, FM 644.
- 3–5. *Chelinospora* sp. D (in Steemans, 1989).
- 3, 4. UDYN-1 15220–15260 ft, G49/3, FM 645. (4, reflected light).
5. UDYN-1 15220–15260 ft, T46/–, FM 646.
- 6, 7. *Cirratiradites diaphanus*. DMMM-45 12550–12560 ft, J41/2, FM 647. (7, reflected light).
- 8, 9. *Clivispora reticulata*.
8. UDYN-1 15170–15210 ft, J59/4, FM 648.
9. UDYN-1 15220–15260 ft, G61/1, FM 649.
- 10–12. *Cymbosporites dammamensis*.
10. Holotype, DMMM-45 12550–12560 ft, slide 12-2, X65/2, FM 650.
11. DMMM-45 12550–12560 ft, slide 12-2, V37/1, FM 651.
12. DMMM-45 12900–12940 ft, slide 17559, O37/4, FM 652.
- 13, 14. *Cymbosporites magnificus*.
13. UDYN-1 14460 ft, L43/4, FM 653.
14. UDYN-1 14460 ft, U43/2, FM 654.
- 15, 16. *Cymbosporites parisii*.
15. UDYN-1 15070–15120 ft, G56/1, FM 655.
16. UDYN-1 15070–15120 ft, W46/3, FM 656.
17. *Cymbosporites paulus*. DMMM-45 12540–12580 ft, U25/2, FM 657.
- 18, 19. *Cymbosporites proteus*.
18. DMMM-45 12850–12860 ft, L42/–, FM 658.
19. DMMM-45 12900–12940 ft, slide 17559, X48/4, FM 659.
20. *Dibolisporites wetteldorfensis*. DMMM-45 12540–12580 ft, X30/1, FM 660.
21. *Dibolisporites* sp. E (in Steemans, 1989). DMMM-45 12880–12890 ft, Q46/–, FM 661.

PLATE III



Europe for the Gondwanan region. The same succession of first occurrences of the characteristic species is recognised. Two new species are described which may have biostratigraphic value. The biostratigraphic data obtained suggest a Devonian transgression on the Silurian continent in an approximate SE–NW direction.

Appendix 1. List of species

- Hilate cryptospore type 1, in Burgess and Richardson, 1991
 Trilete miospore type 1, in Burgess and Richardson, 1991
Ambitisporites avitus Hoffmeister, 1959
Ambitisporites (Punctatisporites) dilutus (Hoffmeister) Richardson and Lister, 1969
Amicosporites splendidus Cramer, 1967
Amicosporites streelii Steemans, 1989
Aneurospora bollandensis Steemans, 1989
Aneurospora greggsii (McGregor) Streeel, in Becker et al., 1974
Apiculiretusispora pygmaea McGregor, 1973
Biornatispora (Camptotriletes) dubia (McGregor) Steemans, 1989
 cf. *Camarozonotriletes parvus* Owens, 1971
Camarozonotriletes sextantii McGregor and Camfield, 1976
Chelinospora arabiensis Steemans, sp. nov.
Chelinospora (Dictyotriletes) favosa (McGregor and Camfield) Steemans, 1989
Chelinospora retorrada Turnau, 1986
Chelinospora sp. D in Steemans, 1989
Cirratriradites diaphanus Steemans, 1989
Clivosispora reticulata Rodriguez, 1978
Cymbosporites dammamensis Steemans, sp. nov.
Cymbosporites magnificus McGregor and Camfield, 1982
Cymbosporites parisii Steemans, 1989
Cymbosporites paulus McGregor and Camfield, 1976
Cymbosporites proteus McGregor and Camfield, 1976
Dibolisporites wetteldorfensis Lanninger, 1968
Dibolisporites sp. E, in Steemans, 1989
Dictyotriletes (Reticulatisporites) emsiensis (Allen) McGregor, 1973
Dictyotriletes granulatus Steemans, 1989
Dyadospora murusdensa Strother and Traverse, 1979
Emphanisporites micornatus Richardson and Lister var. *micornatus* Steemans and Gerrienne, 1984
Emphanisporites micornatus Richardson and Lister var. *sinuosus* Steemans and Gerrienne, 1984
Emphanisporites neglectus Vigran, 1964
Emphanisporites novellus McGregor and Camfield, 1976
Hoegisphaera sp. A, in Gao and Ye, 1987
Laevovancis (Archaeozonotriletes) divellomedium (Chibrikova) Burgess and Richardson, 1991
Lophozonotriletes? poecilomorphus Richardson and Ioannides, 1973
Perotriletes heterocarpus Steemans, 1989
Quadriflorites (Tetrasporites) variabilis (Cramer) Strother, 1991
Segestrespora (Dyadospora) membranifera (Johnson) Burgess, 1991
Segestrespora (Pseudodyadospora) sp. B (Richardson) Steemans, unpubl. data
Synorisporites verrucatus Richardson and Lister, 1969
Tetrahedraletes medinensis Strother and Traverse, 1979
Verrucosisporites polygonalis Lanninger, 1968

PLATE III

All photographs × 1000.

1. *Dictyotriletes granulatus*. UDYN-1 15220–15260 ft, N45/1-2, FM 662.
2. *Dyadospora murusdensa*. UDYN-1 15320–15360 ft, T51/1-3, FM 663.
3. ?*Emphanisporites micornatus* var. *sinuosus*. UDYN-1 12940–13000 ft, Q63/1, 664.
4. *Emphanisporites neglectus*. UDYN-1 15070–15120 ft, G57/4, FM 665.
5. *Emphanisporites novellus*. DMMM-45 12880–12890 ft, M61/4, FM 666.
- 6, 7. *Hoegisphaera* sp. A (in Gao, 1987). UDYN-1 15320–15360 ft, P58/-, FM 667. (7, reflected light).
8. *Laevovancis divellomedium*. UDYN-1 15290–15300 ft, H52/1, FM 668.
9. *Lophozonotriletes? poecilomorphus*. UDYN-1 15320–15360 ft, X52/2, FM 669.
10. *Tetrahedraletes medinensis* UDYN-1 15320–15360 ft, N45/2, FM 670.
- 11, 12. *Perotriletes heterocarpus*.
 11. UDYN-1 15070–15120 ft, U60/1, FM 671.
 12. UDYN-1 15070–15120 ft, T57/2, FM 672.
13. *Perotriletes reticulatus*. DMMM-45 12900–12940 ft, F56/4, FM 673.
14. *Quadriflorites variabilis*. UDYN-1 15290–15300 ft, R39/-, FM 674.
15. *Segestrespora membranifera*. Reflected light, UDYN-1 15290–15300 ft, T61/3, FM 675.
16. *Streelispora newportensis*. UDYN-1 15070–15120 ft, J47/3, FM 676.
17. *Synorisporites verrucatus*. UDYN-1 15320–15360 ft, Y42/2, FM 677.
18. *Tetrahedraletes medinensis*. UDYN-1 15320–15360 ft, M46/4, FM 678.
19. *Verrucosisporites polygonalis*. DMMM-45 12550–12560 ft, F41/-, FM 679.

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