*Comparison with reference biozones.* The index species used in Euramerica and recognized all throughout the *ovalis-biornatus* Zone are *Dictyotriletes emsiensis*, *D. subgranifer* and *Verrucosisporites polygonalis*. The diversified composition of the *ovalis-biornatus* Zone seems, however, to indicate a younger biozone than the *polygonalis-emsiensis* Assemblage Zone of Richardson and McGregor (1986) and the Su Interval Zone of Streel *et al.* (1987). The occurrence of first monolete spores is interesting as they are not older than Emsian according to Traverse, 2007. However, Wellman (2006) found a unique specimen of monolete spores in an assemblage corresponding to the Su Interval Zone. In Antarctica, *Reticuloidosporites antarcticus* was found in the lower Emsian (Kemp 1972), the age of which is recently reinterpreted as Pragian by Troth *et al.* (2011). In Euramerica, first rare monolete spores occur from the Emsian *annulatus-sextantii* Assemblage Zone of Richardson and McGregor (1986). *Dibolisporites echinaceus sensu stricto* and *Emphanisporites schultzii*, the first appearance of which is known to be Emsian, combined with the last occurrences of *Chelinospora retorrida* and *Iberoespora cantabrica*, which are usually not younger than upper Pragian, suggest that the Pragian/Emsian boundary lies within the *Latosporites ovalis* Interval Zone. The occurrence of *Rhabdosporites minutus* allows to partly correlate the *Cymbosporites asymmetricus* Interval Zone to the Min Interval Zone of Streel *et al.* (1987) that is comprised in the FD Oppel Zone.

*Stages.* Upper Pragian – lower Emsian.

Latosporites ovalis *Interval Zone*

*Reference section.* No section recorded the *ovalis* Zone in its entirety, but the combination of core holes BAQA-2 (from 64.5 ft) and the lower part of BAQA-1 (to 345.5 ft) can serve as a reference section.

*Distribution.* Upper Sha'iba to the lowermost part of the Subbat members, Jauf Formation, Saudi Arabia.

*Zone base definition.* Its lower boundary corresponds to that of the *ovalis-biornatus* Zone.

*Description.* The *ovalis* Zone is also characterized by very common specimens of *Gneudnaspora divellomedia* var. *minor* and the first occurrence of the different members of the *Dictyotriletes biornatus* Morphon. Last occurrences of *Chelinospora carnosa*, *Lycospora culpa* and *Verrucosisporites onustus* and entire ranges of *Biornatispora microclavata*, *Chelinospora densa* and *Dictyotriletes ?gorgoneus* are restricted to this subzone.

Diaphanospora milleri *Interval Zone*

*Reference section.* BAQA-1 (from 345.5 to 227.1 ft).

*Distribution.* Lower Subbat Member, Jauf Formation, Saudi Arabia.

*Zone base definition.* Its lower boundary is based on the first occurrence of *Diaphanospora milleri*.

*Remarks.* The *milleri* Zone is also characterized by the first occurrence of *Dibolisporites bullatus*, *Perotrilites caperatus*, *Retusotriletes celatus* and *Reticuloidosporites antarcticus*.

Cymbosporites asymmetricus *Interval Zone*

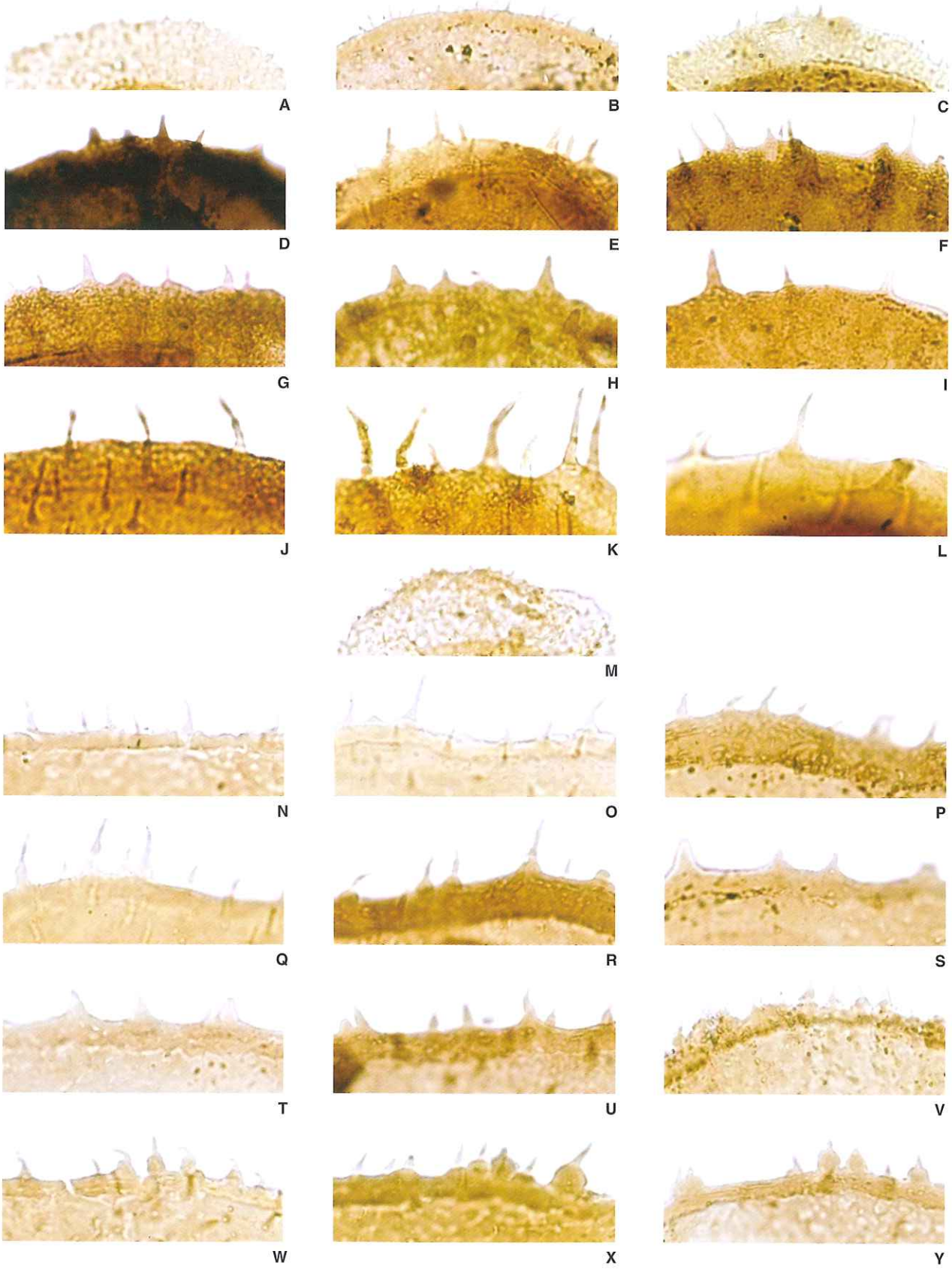
*Reference section.* BAQA-1 (from 227.1 to 161 ft).

*Distribution.* Middle Subbat Member, Jauf Formation, Saudi Arabia.

*Zone base definition.* Its lower boundary is based on the first occurrence of *Cymbosporites asymmetricus*.

*Remarks.* The *asymmetricus* Zone is also characterized by a significant increase of *Cymbosporites senex* specimens. *Artemopyra recticosta*, *Brochotriletes crameri*, *Rhabdospor-*

**FIG. 49.** Each figured specimen is identified by borehole, sample, slide number and England Finder Co-ordinate location. All figured specimens are at magnification ×1000 except where mentioned otherwise. A–C, *Grandispora gabesensis* Loboziak and Streel, 1989. A, A1-69, 1596 ft, 26990, P39/4. B, A1-69, 1962 ft, 27278, H51. C, A1-69, 1483 ft, 26994 ft, S46/4. D–L, *Grandispora incognita* (Kedo) McGregor and Camfield, 1976. D, WELL-8, 16684.3 ft, 62427, D43. E, A1-69, 1416 ft, 26992, Q38/4. F, A1-69, 1596 ft, 26990, H36. G, A1-69, 1540 ft, 26988, Q37/2. H, A1-69, 1540 ft, 26988, N40/3. I, A1-69, 1540 ft, 26987, H37/1. J, A1-69, 1277 ft, 62636, K39. K, A1-69, 1277 ft, 62636, O41/4. L, A1-69, 1277 ft, 62636, M33. M, *Grandispora inculta* Allen, 1965, S-462, 2060–2065 ft, 63270, N30/3. N–Y, *Grandispora libyensis* Moreau-Benoit, 1980*b*. N, A1-69, 1322 ft, 27126, H36. O, A1-69, 1277 ft, 62635, Y31/2. P, A1-69, 1416 ft, 26993, G31/3. Q, A1-69, 1277 ft, 62637, M31. R, A1-69, 1416 ft, 26993, R40. S, A1-69, 1416 ft, 26992, C37/2. T, A1-69, 1416 ft, 26993, S55/2. U, A1-69, 1416 ft, 26993, O43. V, A1-69, 1277 ft, 62636, O31/3. W, A1-69, 1277 ft, 62637, L51. X, A1-69, 1174 ft, 62673, O32/3. Y, A1-69, 1416 ft, 26993, K31/3.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*ites minutus* and *Stellatispora multicostata* first occur within this subzone, whereas *Ambitisporites eslae*, *Biornatispora elegantula*, *Chelinospora condensata*, *C. laxa*, *C. vulgata*, *Raistrickia jaufensis*, *Verrucosisporites nafudensis* and *V. stictus* disappear.

Acinosporites lindlarensis–Camarozonotriletes sextantii *Assemblage Zone*

*Reference section.* The reference section is the combination of core holes JNDL-4 (from 404.8 ft) and JNDL-3 (to 222.7 ft). As the core holes are distant from about 15 km, they are easily correlated by lithostratigraphic and sedimentologic data.

*Distribution.* Upper Subbat, Hammamiyat and most of Muray members, Jauf Formation, Saudi Arabia. Ouan-Kasa Formation, Libya.

*Zone base definition.* Its lower boundary is based on the first occurrence of *Acinosporites lindlarensis*.

*Description and regional variation.* The most characteristic spore species to appear in the *lindlarensis-sextantii* Zone are *Camarozonotriletes sextantii*, *Cymbohilates heteroverrucosus*, *Dibolisporites gaspiensis*, *D. tuberculatus*, *Dictyotriletes marshallii*, *Emphanisporites erraticus* and *E. plicatus*. The present spore assemblage comprises mainly simple laevigate spores, simple sculptured spores and radial-patterned spores. The zonate spores become more common. *Dibolisporites* spp. increases in term of specimens in comparisons with the previous assemblages while *Chelinospora* spp. representatives are no longer present. Entire range of *Dictyotriletes marshallii*, *Iberoespora* cf. *guzmani* and *Emphanisporites erraticus* are restricted to the *lindlarensis-sextantii* Zone. Lots of species disappear within this zone, the most significant of which are *Ambitisporites asturicus*, *Amicosporites jonkeri*, *Brochotriletes hudsonii*, *Cirratriradites*? *diaphanus*, *Cymbohilates comptulus*, *Dictyotriletes biornatus* Morphon, *D. favosus*, *Emphanisporites schultzii*, ?*Knoxisporites riondae* and *Stellatispora multicostata*.

In Saudi Arabia, the *lindlarensis-sextantii* Zone includes the D3B Subzone of Al-Hajri *et al.* (1999), which represents a monospecific algal bloom. These leiospherid-rich, low-diversity assemblages occur in north-western Saudi Arabia not as a unique event but a series of marine pulses that extends on a 400-ft thickness (Breuer *et al.* 2007*a*, *b*, *c*). The D3B Subzone is much thicker than in eastern Saudi Arabia where it is normally several tens of feet. These leiospherid-rich assemblages alternate with normal spore-dominated assemblages.

*Comparison with reference biozones.* The presence notably of *Acinosporites lindlarensis*, *Camarozonotriletes sextantii* and *Rhabdosporites minutus* allows to partly correlate the *lindlarensis-sextantii* Zone to the *annulatus-sextantii* Assemblage Zone of Richardson and McGregor (1986) and the Min Interval Zone of Streel *et al.* (1987) that is comprised in the FD Oppel Zone.

*Stage.* Middle–upper Emsian.

Emphanisporites annulatus–Grandispora protea *Assemblage Zone*

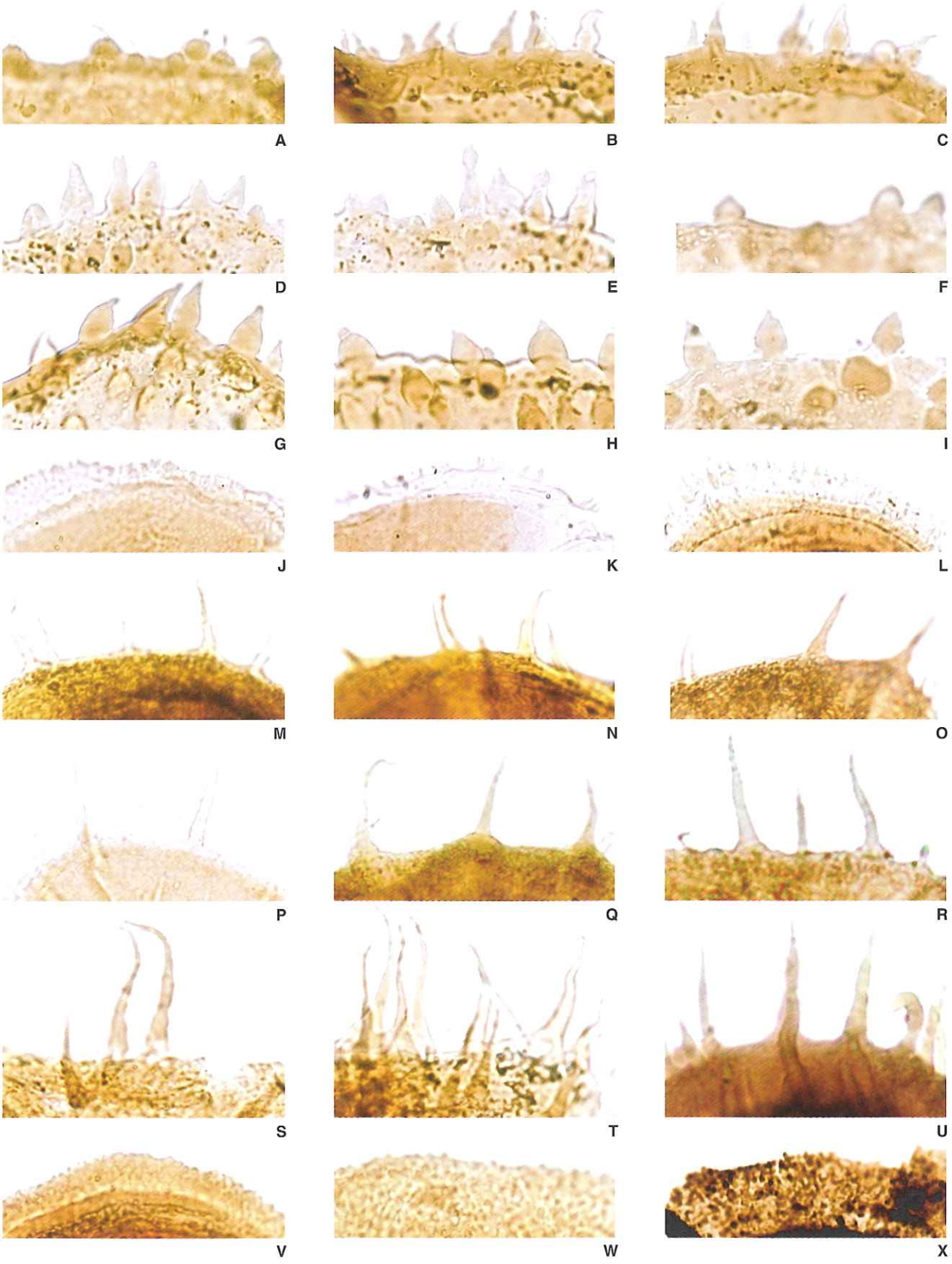
*Reference section.* Borehole A1-69 (sample 2040 ft).

*Distribution.* Uppermost part of Murayr Member (Jauf Formation) and the lowermost part of the Jubah Formation, Saudi Arabia. Ouan-Kasa Formation, North Africa.

*Zone base definition.* Its lower boundary is marked by the first occurrence of *Emphanisporites annulatus*.

*Description and regional variation.* The present assemblage zone is primarily characterized by the first occurrence of the large apiculate and spinose zonate-pseudosaccate spores (*Grandispora/Samarisporites* complex). The most characteristic spore species to appear in the *annulatus-protea* Zone are *Craspedispora ghadamesensis*, *Geminospora convoluta*, *Grandispora douglastownensis*, *G. protea* and *Granulatisporites concavus*. Several typical Early Devonian

**FIG. 50.** Each figured specimen is identified by borehole, sample, slide number and England Finder Co-ordinate location. All figured specimens are at magnification ×1000 except where mentioned otherwise. A–I, *Grandispora libyensis* Moreau-Benoit, 1980*b*. A, A1-69, 1174 ft, 62673, O32/3. B, A1-69, 1334 ft, 27128, H39/4. C, A1-69, 1334 ft, 27128, H39/4. D, A1-69, 1296 ft, 62644, U29/1. E, A1-69, 1296 ft, 62644, U29/1. F, A1-69, 1296 ft, 62645, F36. G, A1-69, 1296 ft, 62645, G47/2. H, A1-69, 1296 ft, 62644, T35/1. I, A1-69, 1296 ft, 62645, R43. J–L, *Grandispora maura* sp. nov. J, MG-1, 2241 m, 62966, S39/1. K, Holotype, MG-1, 2247 m, 62942, K37/3. L, MG-1, 2465 m, 62852, H35. M–U, *Grandispora naumovae* (Kedo) McGregor, 1973. M, S-462, 1710–1715 ft, 63222, G44/3. N, S-462, 1710–1715 ft, 63222, V40. O, S-462, 1710–1715 ft, 63224, F49-50. P, S-462, 1660–1665 ft, 63219, L38/4. Q, S-462, 1760–1765 ft, 63254, J30. R, S-462, 1470–1475 ft, 63213, J41/3. S–T, A1-69, 1530 ft, 26984, J34/2. U, A1-69, 1334 ft, 27127, O47. V–X, *Grandispora permulta* (Daemon) Loboziak *et al.*, 1999. V, A1-69, 1277 ft, 62637, V49/1. W, A1-69, 1322 ft, 27125, H39/4. X, WELL-1, 16358.5 ft, 61972, W31.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taxa disappear within the *annulatus-protea* Zone; they are *Amicosporites streelii*, *Biornatispora dubia*, *Clivosispora verrucata* var. verrucata, *Dictyotriletes subgranifer*, *Retusotriletes maculatus* and *Verrucosisporites polygonalis*. The cryptospores have decreased in number and seems to be still dominated by *Gneudnaspora* and *Artemopyra*.

*Densosporites devonicus* is only known in Tunisia. First specimens of *Grandispora permulta* and the spinose-verrucate representatives of *Verrucosisporites scurrus* Morphon are already present in Tunisia, whereas they occur later in Libya and Saudi Arabia from the *Scylaspora rugulata–Grandispora libyensis* Assemblage Zone.

*Comparison with reference biozones.* The first inception of the large zonate-pseudosaccate spores is known elsewhere all over the world and corresponds in Euramerica to the *douglastownensis-eurypterota* Assemblage Zone of Richardson and McGregor (1986) and the AP Oppel Zone of Streel *et al.* (1987), the index species *Acinosporites apiculatus*, *Grandispora douglastownensis* and *G. protea* of which are found in the *annulatus-protea* Zone. Note that *Densosporites devonicus* which is a nominal species of the middle Eifelian–early Givetian *devonicus-naumovae* Assemblage Zone of Richardson and McGregor (1986) and the AD Oppel Zone of Streel *et al.* (1987) seems to appear earlier in North Africa than in Euramerica. M. Streel (pers. comm. 2007), after many years of palynological consulting, considers now the first inception of *D. devonicus* as unpredictable and consequently is not a reliable criterion to mark the base of the AD Oppel Zone. Besides, Streel and Loboziak (1996) do not consider anymore this species as defining the base of the latter.

*Stage.* Uppermost Emsian.

### Geminospora svalbardiae–Samarisporites eximius *Assemblage Zone*

*Reference section.* Borehole A1-69 (from 1962 to 1830 ft).

*Distribution.* Jubah Formation, Saudi Arabia. Upper part of the Ouan-Kasa and lower part of the Awaynat Wanin I formations, North Africa.

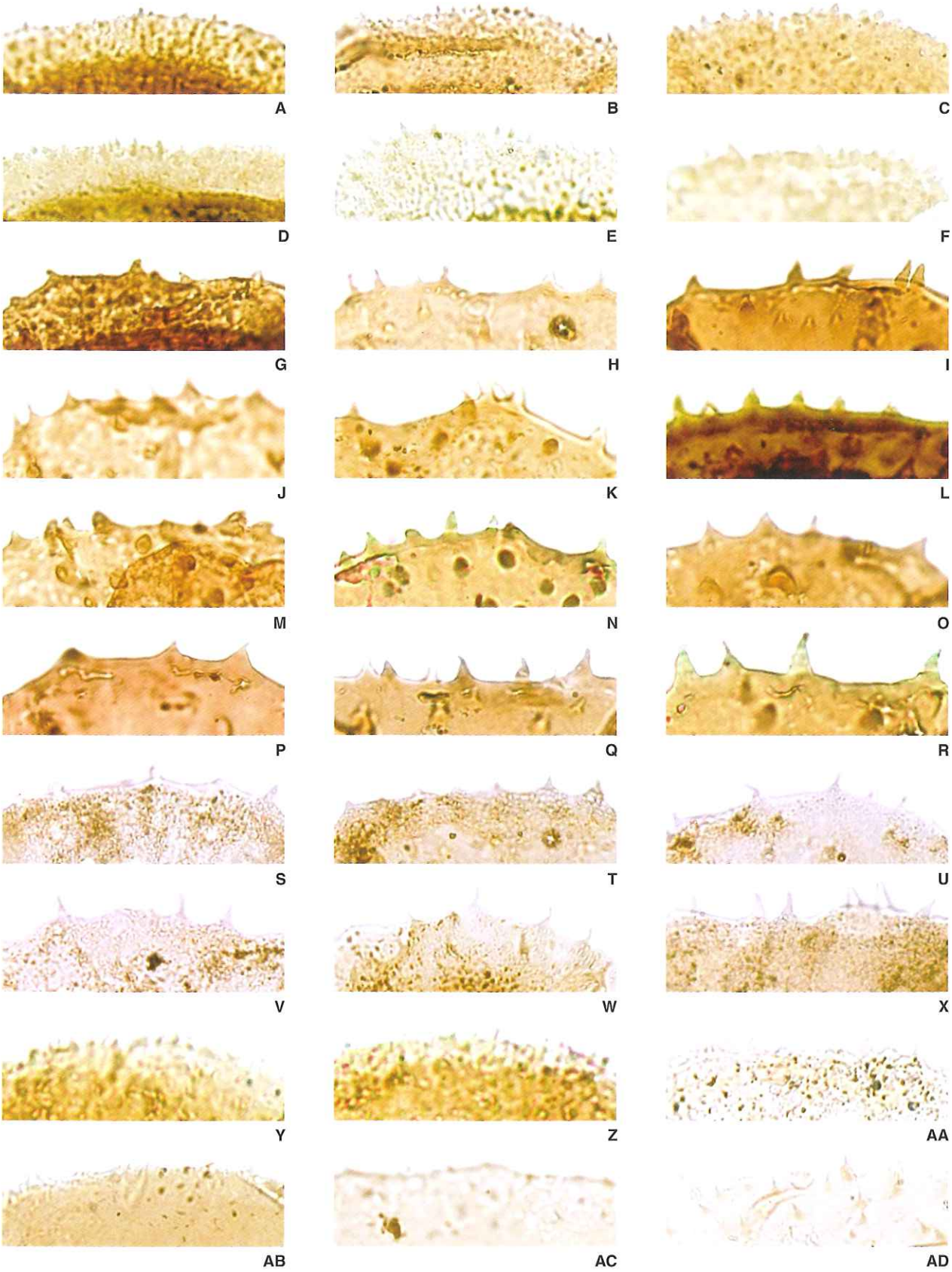
*Zone base definition.* Its lower boundary is based on the first occurrence of *Geminospora svalbardiae*, which is common.

*Description.* The most characteristic spore species to appear in the *svalbardiae-eximius* Zone are *Acinosporites acanthomammillatus*, *Ancyrospora nettersheimensis*, *Auroraspora minuta*, *Camarozonotriletes rugulosus*, *Grandispora cassidea*, *G. gabesensis*, *G. velata*, *Samarisporites eximius*, *S. praetervisus*, *Zonotriletes armillatus* and *Z. simplicissimus*. Other ancient species including the last typical Early Devonian holdovers disappear in the *svalbardiae-eximius* Zone; these are *Brochotriletes crameri*, *Camarozonotriletes sextantii*, *Cymbohilates baqaensis*, *Cymbosporites senex*, *Dictyotriletes emsiensis*, *Granulatisporites concavus* and *Synorisporites papillensis*. The large apiculate and spinose zonate-pseudosaccate spores proliferate and become abundant throughout the assemblage. They diversify again more with new forms of *Grandispora* and *Samarisporites*. In addition, other pseudosaccate genera (*Auroraspora* and *Geminospora*) are also well represented. The typical feature of grapnel-tipped spines (*Ancyrospora*) appears for the first time.

In Saudi Arabia, the cryptospores (*Artemopyra*, *Cymbohilates* and *Gneudnaspora*) constitute a significant part of the spore assemblages where they may represent up to about 20 per cent of the whole spore assemblage. *Acinosporites tristratus*, *Dibolisporites Pilatus* and *Squamispora arabica* are restricted to *svalbardiae-eximius* Zone and endemic to Saudi Arabia. Relatively small megaspores (*Jhariatriletes emsiensis*) first appear in this assemblage in North Africa.

*Comparison with reference biozones.* In Euramerica, *Ancyrospora nettersheimensis* possesses an acme zone (net) in the AP Oppel Zone of Streel *et al.* (1987) and is also known in the *douglastownensis-eurypterota* Assemblage

**FIG. 51.** Each figured specimen is identified by borehole, sample, slide number and England Finder Co-ordinate location. All figured specimens are at magnification ×1000 except where mentioned otherwise. A–F, *Grandispora permulta* (Daemon) Loboziak *et al.*, 1999. A, A1-69, 1277 ft, 62637, U47/1. B, A1-69, 1483 ft, 26995, W43/3. C, A1-69, 1296 ft, 62643, G34/1. D, A1-69, 1596 ft, 26989, U46/3. E, A1-69, 1530 ft, 26984, R46/4. F, A1-69, 1596 ft, 26989, T43. G–R, *Grandispora protea* (Naumova) Moreau-Benoit, 1980*b*. G, JNDL-1, 495.0 ft, 60854, P51. H, A1-69, 1962 ft, 27278, T36/3. I, JNDL-1, 156.0 ft, 60840, Q32. J, JNDL-1, 174.6 ft, 60848, P34. K, JNDL-1, 174.6 ft, 60848, S43/4. L, A1-69, 1530 ft, 26984, T54/1. M, JNDL-1, 174.6 ft, PPM008, Q39/4. N, JNDL-1, 177.0 ft, 60849, L51/2. O, A1-69, 1962 ft, 27278, T44/4. P, JNDL-1, 172.7 ft, 60845, O40/2. Q, A1-69, 1962 ft, 27278, M49/1. R, JNDL-177.0 ft, 60849, K51/1. S–X, *Grandispora rarispinosa* Moreau-Benoit, 1980*b*. S, S-462, 1710–1715, 63222, X40. T, MG-1, 2182.4 m, 62527, Q32. U, MG-1, 2285 m, 62845, L26/3. V, MG-1, 2161.8 m, 62529, E50/4. W, MG-1, 2413 m, 62776, R35/2. X, MG-1, 2160.6 m, 62746, Q27/4. Y–AA, *Grandispora* (*Calyptosporites*) *stolidota* (Balme) comb. nov. Y, A1-69, 1322 ft, 27126, Q39/3. Z, A1-69, 1322 ft, 27126, R42. AA, MG-1, 2465 m, 62852, L52/3. AB–AD, *Grandispora velata* (Richardson) McGregor, 1973. AB, A1-69, 1416 ft, 26992, U47/2. AC, A1-69, 1540 ft, 26987, F41. AD, A1-69, 1530 ft, 26984, H40/1.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Zone of Richardson and McGregor (1986). *Grandispora velata* and *Acinosporites acanthomammillatus*, present in this assemblage, mark the base of the *velata-langii* Assemblage Zone of Richardson and McGregor (1986), and the former is the nominal species of the Vel Interval Zone of Streel *et al.* (1987).

*Stage.* Lower Eifelian.

Scylaspora rugulata–Grandispora libyensis *Assemblage Zone*

*Reference section.* Borehole MG-1 (from 2536 to 2367 m).

*Distribution.* Jubah Formation, Saudi Arabia. Awaynat Wanin I Formation and the lower part of the Awaynat Wanin II Formations, North Africa.

*Zone base definition.* Its lower boundary is based on the first occurrence of a series of common species which appear more or less coeval. It comprises *Camarozonotriletes*? *concavus*, *Chelinospora timanica*, *Craspedispora paranaensis*, *Dictyotriletes hemeri*, *Grandispora libyensis*, *G. naumovae*, *G. stolidota*, *Scylaspora rugulata* and *Verrucosisporites premnus*. Note that the first specimens of *G. libyensis* are a morphotype with rather slender spines.

*Description.* In addition to the new species, *Camarozonotriletes asperulus*, *Elenisporis gondwanensis* and *Grandispora incognita* appear within the *rugulata-libyensis* Zone. In the upper part of the zone, the most common species to appear are *Archaeozonotriletes variabilis* and *Cristatisporites streelii*. *Grandispora permulta*, and all members of the *Verrucosisporites scurrus* Morphon, some of which already occur in Tunisia, are henceforth present and are particularly characteristic of this interval and constitute a main component of the spore assemblages. The *rugulata-libyensis* Zone also marks the vanishing of ancient common species such as *Ancyrospora nettersheimensis* and *Grandispora protea*. The large apiculate and spinose zonate-pseudosaccate spores reach their acme in the *svalbardiae-eximius* Zone. Laevigate zonate spores markedly decrease in comparison with the underlying *svalbardiae-eximius* Zone. The cryptospores are much rarer in the *rugulata-libyensis* Zone; *Gneudnaspora divellomedia* var. *divellomedia* is sometimes found, whereas *Artemopyra* specimens are very rare.

*Comparison with reference biozones.* *Grandispora naumovae* and *Verrucosisporites premnus* mark the base of the *devonicus-naumovae* Assemblage Zone of Richardson and McGregor (1986), whereas *Scylaspora rugulata* occur a bit earlier within the *velata-langii* Assemblage Zone in Euramerica. *Archaeozonotriletes variabilis* occurs in the second half of the *devonicus-naumovae* Assemblage Zone. The *rugulata-libyensis* Zone seems to correspond likely to the latter or also the AD-pre Lem Oppel Zone defined in Loboziak and Melo (2002). This last biozone appear undifferentiated here up to the first appearance of *Geminospora lemurata* whose inception marks the base of the Lem Interval Zone of Streel *et al.* (1987).

*Stages.* Upper Eifelian – lowermost Givetian.

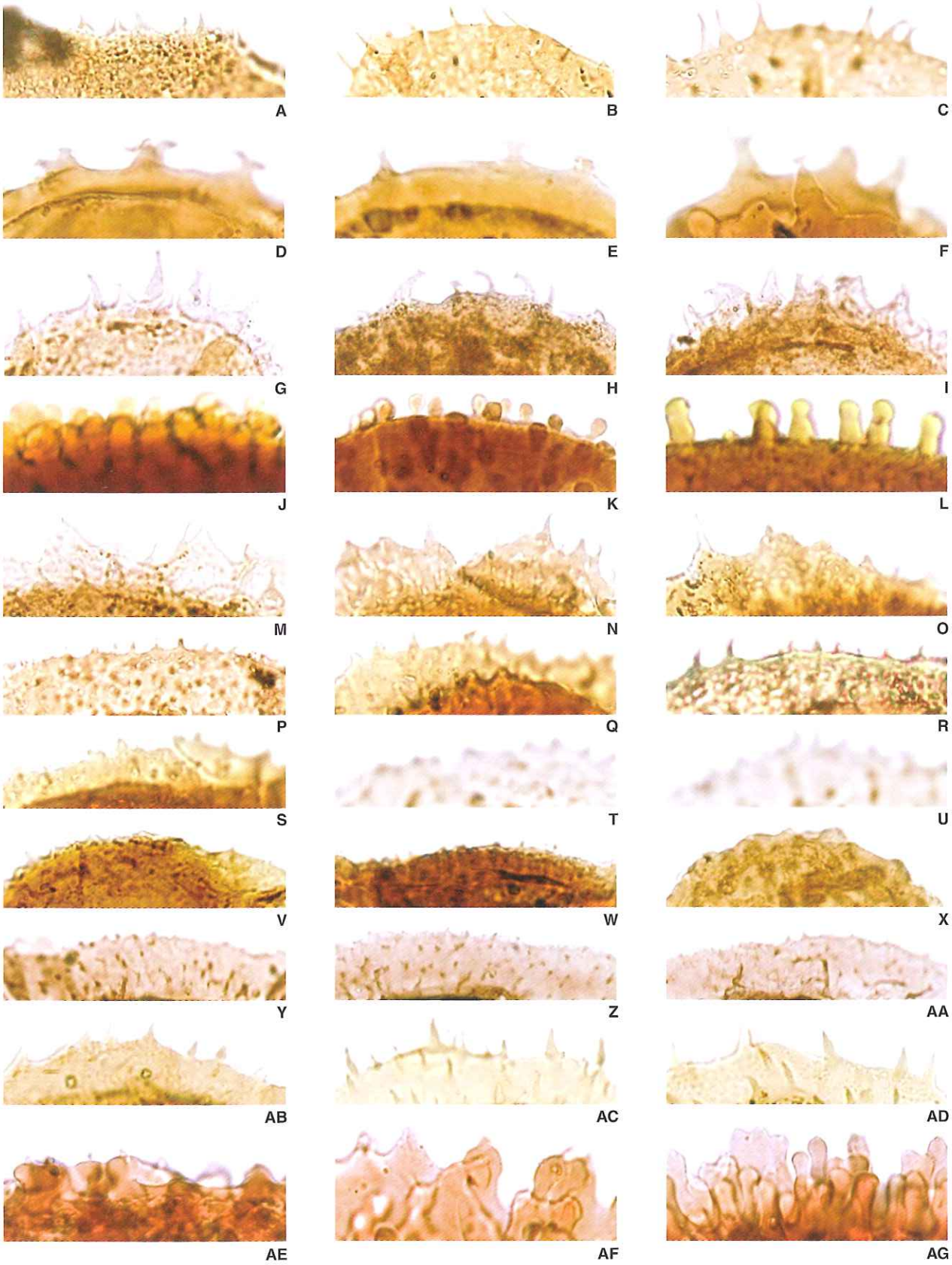
Scylaspora rugulata *Interval Zone*

*Reference section.* Borehole MG-1 (sample 2536 to 2518 m).

*Distribution.* Awaynat Wanin I Formation, North Africa.

*Zone base definition.* Its lower boundary corresponds to that of the *rugulata-libyensis* Zone. It is based on the first occurrence of *Scylaspora rugulata.*

**FIG. 52.** Each figured specimen is identified by borehole, sample, slide number and England Finder Co-ordinate location. All figured specimens are at magnification ×1000 except where mentioned otherwise. A–C, *Grandispora velata* (Richardson) McGregor, 1973. A, A1-69, 1867 ft, 26969, R53/4. B, JNDL-1, 177.0 ft, 60849, F32/1. C, A1-69, 1962 ft, 27277, F32/4. D–F, *Hystricosporites brevispinus* sp. nov. D, Holotype, MG-1, 2295 m, 63007, P37. E, Paratype, MG-1, 2375 m, 62772, H34/1. F, MG-1, 2295 m, 63006, L52/3. G–I, *Hystricosporites* sp. 1. G, MG-1, 2160.6 m, 62746, N49. H, MG-1, 2161.8 m, 62528, Q44. I, MG-1, 2160.6 m, 62727, E49. J–L, *Jhariatriletes* (*Verruciretusispora*) *emsiensis* (Moreau-Benoit) comb. nov. J, A1-69, 1962 ft, 27277, T45/4. K, A1-69, 1962 ft, 27278, J42. L, A1-69, 1962 ft, 27277, Q40. M–O, *Samarisporites angulatus* (Tiwari and Schaarschmidt) Loboziak and Streel, 1989. M, A1-69, 1596 ft, 26990, K40/2. N, A1-69, 1870 ft, 26973, K41. O, A1-69, 1867 ft, 26969, D37. P–R, *Samarisporites eximius* (Allen) Loboziak and Streel, 1989. P, JNDL-1, 162.3 ft, PPM005, S45/3. Q, A1-69, 1334 ft, 27127, N53/2. R, JNDL-1, 177.0 ft, 60849, O39. S–U, *Samarisporites praetervisus* (Naumova) Allen, 1965. S, A1-69, 1334 ft, 27127, K48. T–U, Holotype, MG-1, 2258 m, 62947, M39/2. V–X, *Samarisporites triangulatus* Allen, 1965. V, A1-69, 1277 ft, 62636, X31/1. W, A1-69, 1277 ft, 62637, T29/1. X, MG-1, 2182.4 m, 62527, Q29/2. Y–AA, *Samarisporites tunisiensis* sp. nov. Y, MG-1, 2741.4 m, 62611, L28/1. Z, Holotype, MG-1, 2741.4 m, 62611, P39/2. AA, MG-1, 2741.4 m, 62611, K41. AB–AD, *Samarisporites* sp. 2. AB, A1-69, 1596 ft, 26989, G38/1. AC, A1-69, 1596 ft, 26989, S55. AD, A1-69, 1596 ft, 26990, N36. AE–AG, *Verrucisporites ellesmerensis* (Chaloner) Chi and Hills, 1976. AE, S-462, 1710–1715 ft, 63222, H31/3. AF, S-462, 1860–1865 ft, 63258, N31/2. AG, S-462, 1860–1865 ft, 63259, H38.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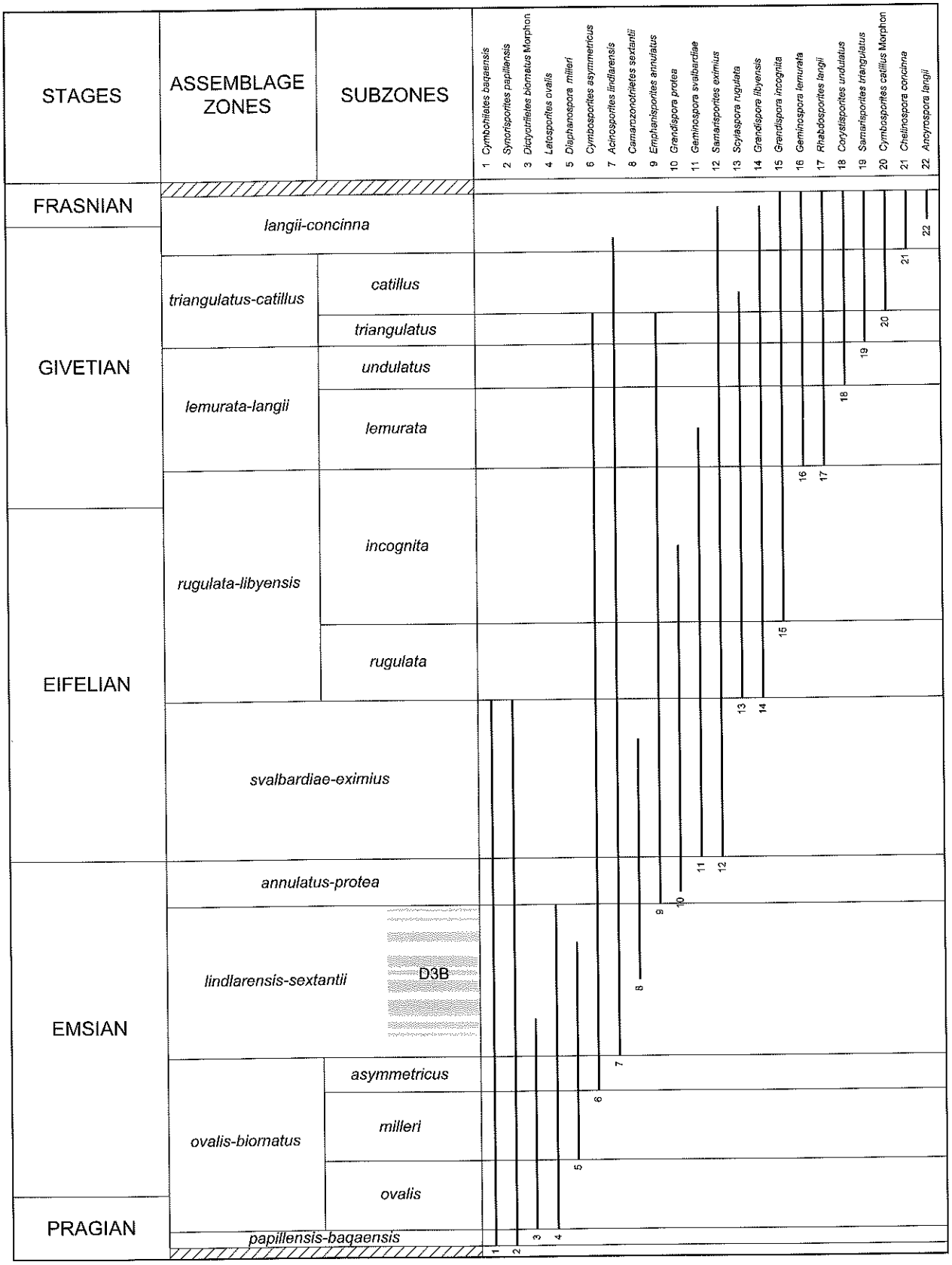


**FIG. 53.** Stratigraphical ranges of nominal species of the spore assemblage zones. Dashed lines indicate imprecisely defined limits.

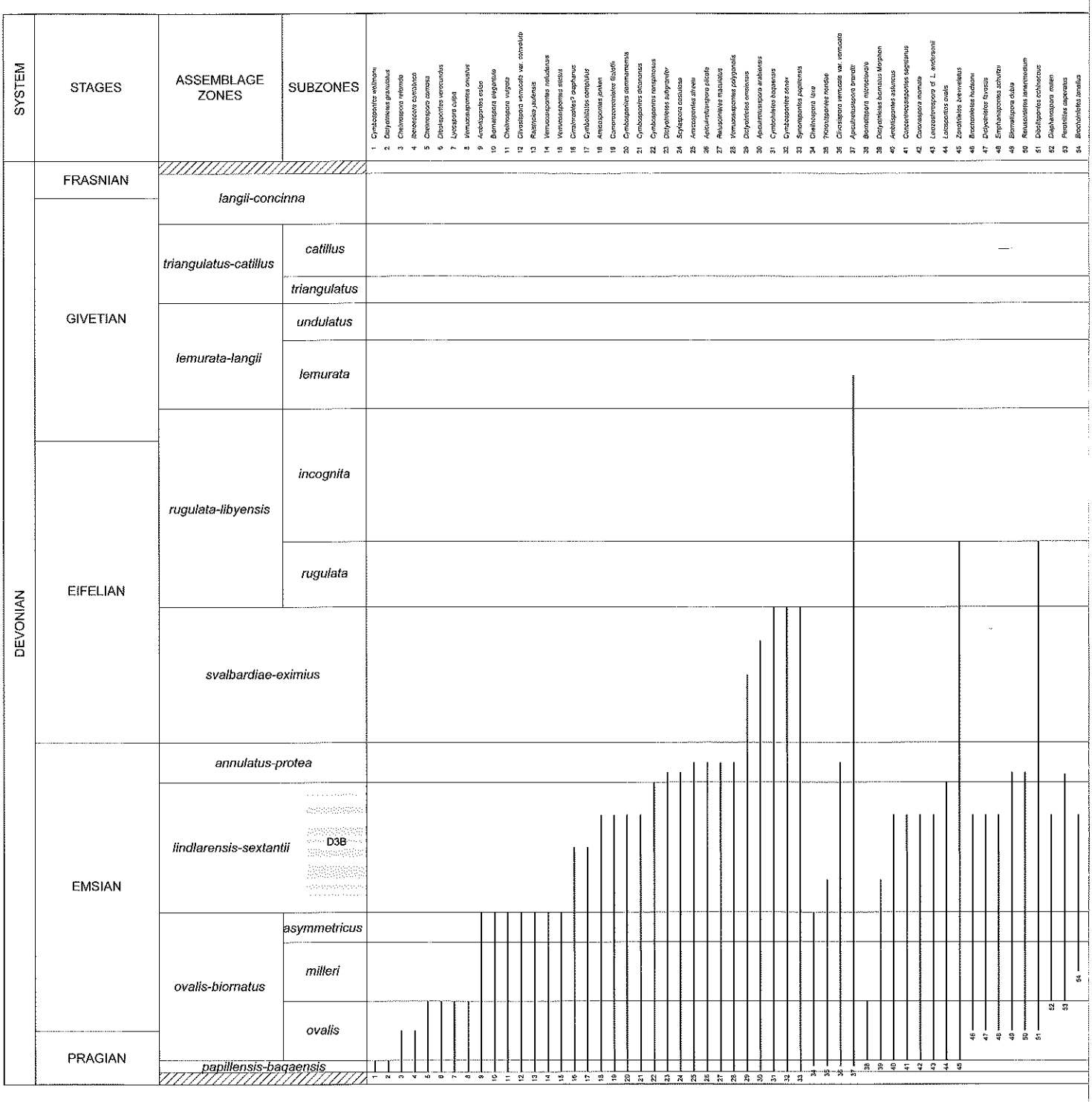


**FIG. 54.** Stratigraphical ranges of characterizing species of the spore assemblage zones. For ranges of the nominal species only see Figure 53. Dashed lines

The entire Fig. 54 is below, after the Fig. 55

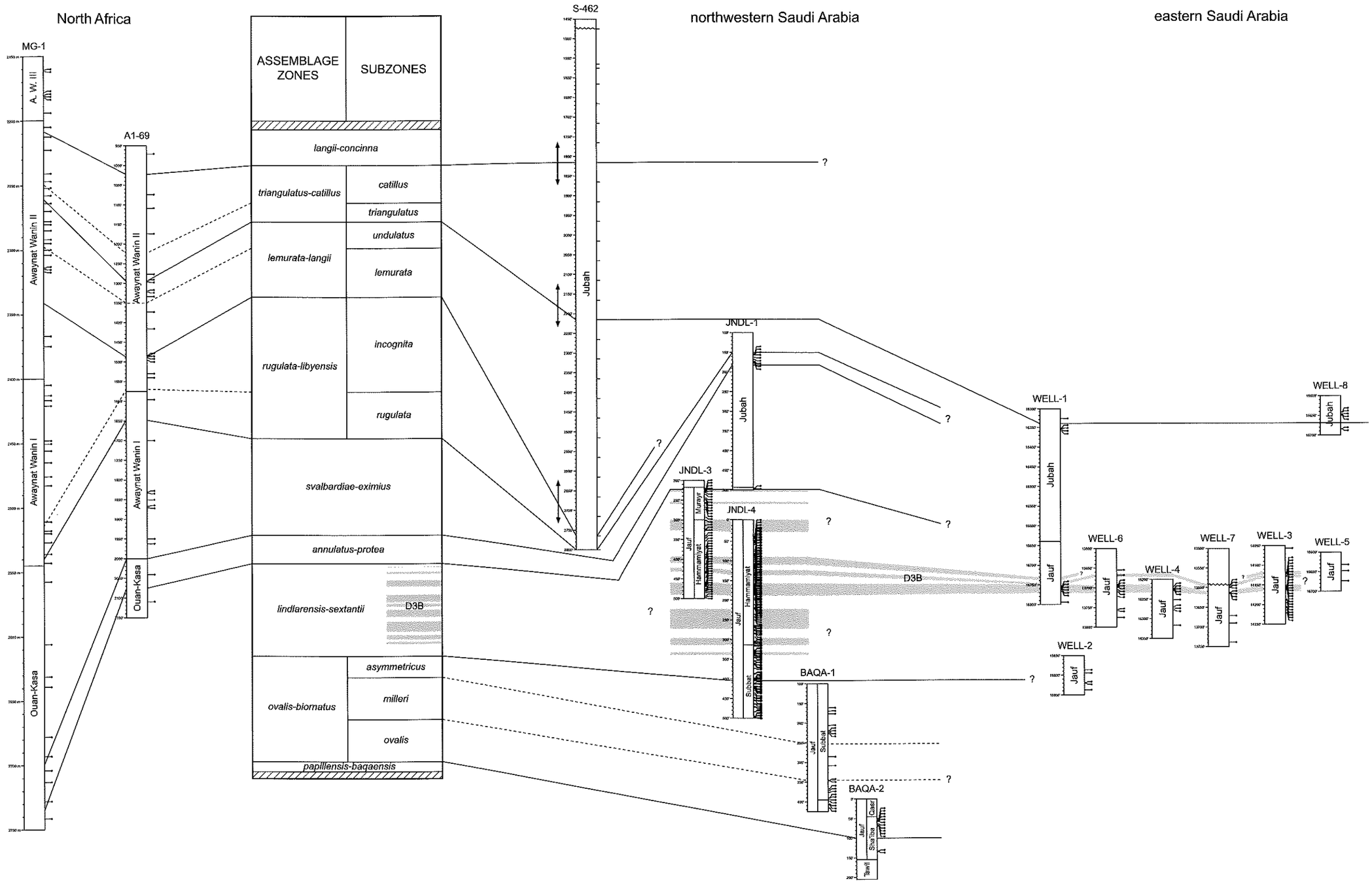


**FIG. 55.** Spore-based correlation of studied sections. Dots indicate the core samples. Cuttings in S-462 are plotted at tops of composite sample ranges. Continuous and dashed lines indicate, respectively, assemblage and interval zone boundaries.

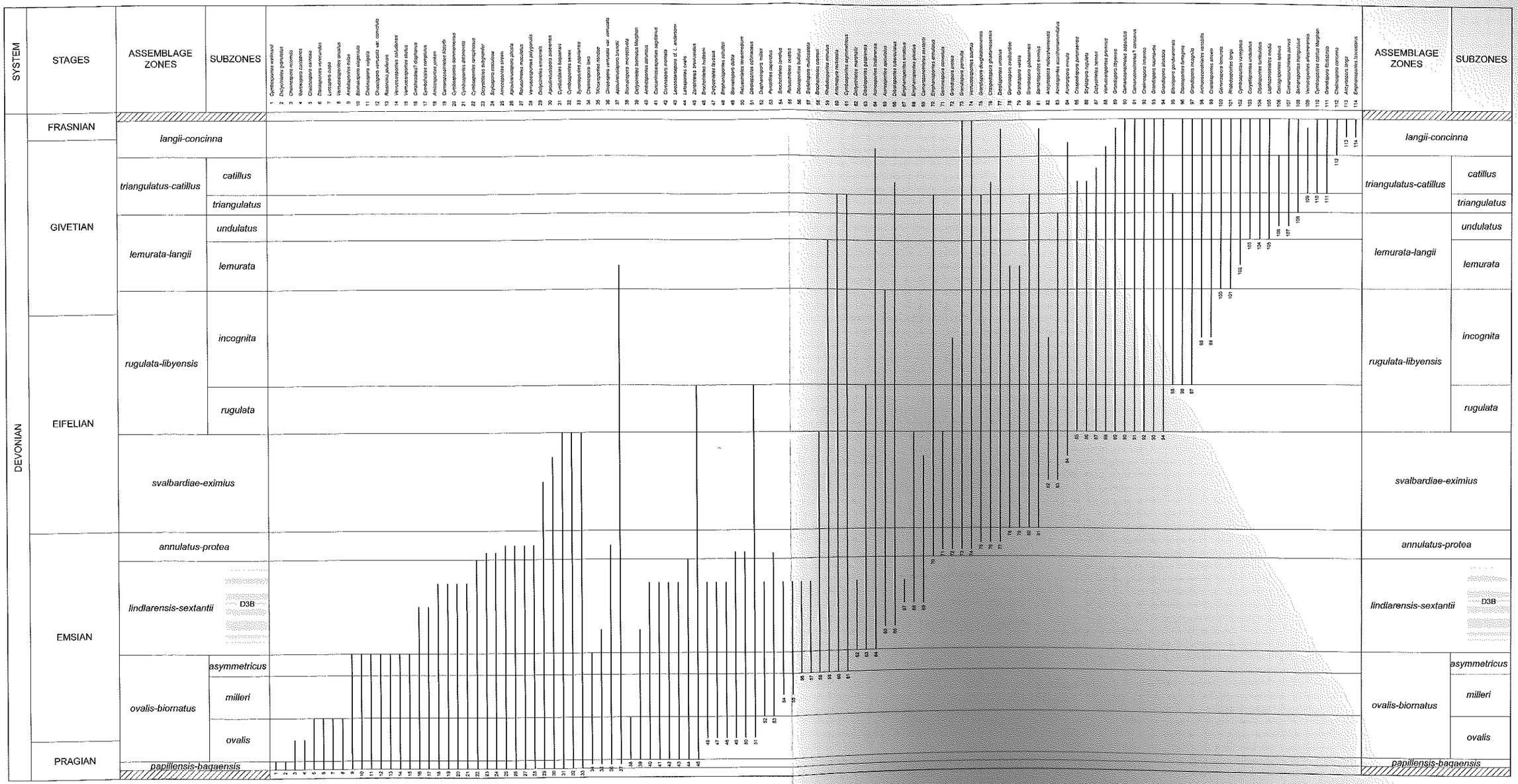


**FIG. 54.** Stratigraphical ranges of characterizing species of the spore assemblage zones. For ranges of the nominal species only see Figure 53. Dashed lines indicate imprecisely defined limits.

Grandispora incognita *Interval Zone*

*Reference section.* Borehole A1-69 (from 1596 to 1490 ft).

*Distribution.* Upper part of the Awaynat Wanin I and the lower part of Awaynat Wanin II formations, North Africa.

*Biozone boundary definition.* Its lower boundary is based on the first occurrence of *Grandispora incognita*.

Geminospora lemurata–Rhabdosporites langii *Assemblage Zone*

*Reference section.* Borehole Al-69 (from 1486 to 1296 ft).

*Distribution.* Jubah Formation, Saudi Arabia. Awaynat Wanin II Formation, North Africa.

*Zone base definition.* The lower boundary is based on the first occurrence of *Geminospora lemurata*.

*Description and regional variation. Geminospora punctata* and *Rhabdosporites langii* make their first inception more or less in the meantime as *G. lemurata*. *Cymbosporites variegatus, Camarozonotriletes parvus, Corystisporites undulatus, Dibolisporites turriculatus* and *Lophozonotriletes media* appear within the *lemurata-langii* Zone. First specimens of *Contagisporites optivus* appear near the top of this interval. *Apiculiretusispora brandtii, Geminospora svalbardiae, Grandispora velata* and *Rhabdosporites minutus* are the most characteristic species to vanish in the *lemurata-langii* Zone. The cryptospores are uncommon; only specimens of *Gneudnaspora* and *Arternopyra* are found. The monolete spores seem to reappear inconspicuously after a distinct decline in the underlying assemblages. Monolete *Geminospora lemurata* are not so uncommon and rare large cavate monolete spores (*Archaeoperisaccus* cf. *A. rhacodes*) first occur in Tunisia. More and more megaspore specimens (including *Contagisporites optivus*) appear throughout the *lemurata-langii* Zone. Most of them are unstudied in this work but described in Steemans *et al.* (2011*b*).

*Comparison with reference biozones.* This assemblage characterized above all by the widespread first occurrence of *Geminospora lemurata* equals the Lem Interval Zone of Streel *et al.* (1987) and the lower part of the *lemurata-magnificus* Assemblage Zone of Richardson and McGregor (1986) in Euramerica. The stratigraphically important species *Rhabdosporites langii* appears later here than in Euramerica. *Lophozonotriletes media*, which is the index species of the Frasnian BM Oppel Zone of Streel *et al.* (1987), is found earlier than in Euramerica. This difference is probably explained by the use of a larger concept of *L. media* in this work (M. Streel, pers. comm. 2007). As specimens attributed to *L. media* seem to be very variable in time and space, it could be an unreliable key species for precise biostratigraphy.

*Stage.* Lower Givetian but not the lowermost.

Geminospora lemurata *Interval Zone*

*Reference section.* Borehole A1-69 (from 1486 to 1416 ft).

*Distribution.* Jubah Formation, Saudi Arabia. Awaynat Wanin II Formation, North Africa.

*Zone base definition.* The lower boundary is based on the first occurrence of *Geminospora lemurata*.

*Remarks.* The lower boundary of the *lemurata* Zone corresponds to that of the *lemurata-langii* Zone as it is based on the first occurrence of *Geminospora lemurata*.

Corystisporites undulatus *Interval Zone*

*Reference section.* Borehole Al-69 (from 1416 to 1296 ft).

*Distribution.* Jubah Formation, Saudi Arabia. Awaynat Wanin II Formation, North Africa.

*Zonal base definition.* Its lower boundary is based on the first occurrence of *Corystisporites undulatus*.

Samarisporites triangulatus–Cymbosporites catillus *Assemblage Zone*

*Reference section.* Borehole A1-69 (from 1293 to 1074 ft).

*Distribution.* Jubah Formation, Saudi Arabia. Awaynat Wanin II Formation, North Africa.

*Zone base definition.* Its lower boundary is only based on the first occurrence of *Samarisporites triangulatus*.

*Description.* The first inception of *Cymbosporites catillus, C. cyathus, Grandispora fibrilabrata* and *Verrucisporites ellesmerensis* is likely a little bit younger than that of *Samarisporites triangulatus*. The specimens of *G. libyensis* possess rather slender spines as well as more massive