

bulbous biform elements. The two morphotypes intergrade and coexist mainly in the *triangulatus-catillus* Zone. *Contagisporites optivus*, *Craspedispora ghadamesensis*, *Dictyotrilletes hemeri*, *Elenisporis gondwanensis*, *Grandispora douglastownensis*, *Scylaspora rugulata* and *Zonotrilletes rotundus* are the most characteristic species to disappear in the *triangulatus-catillus* Zone. The general diversity of the spore populations begins to decrease from the base of this assemblage. The large apiculate and spinose zonate-pseudosaccate spores show a quantitative decrease. They seem to be replaced with numerous small patinate specimens (mainly *Cymbosporites*). *Geminispora lemurata* and *Samarisporites triangulatus* are also abundant. The cryptospores are very uncommon. *Artetmopyra* vanishes at the base of the assemblage and leaves *Gneudnaspora divellomedia* var. *divellomedia* as the last survivor of this group. The megaspores are very diverse in both Saudi Arabia and North Africa; they include notably *Contagisporites optivus* and *Verrucisporites ellesmerensis*. Other megaspores are described in Steemans *et al.* (2011b).

Comparison with reference biozones. *Samarisporites triangulatus* is a widespread species and seems to appear almost at the same time everywhere. In Euramerica, the *triangulatus-catillus* Zone corresponds to the TA Oppel Zone of Streel *et al.* (1987) in spite of the absence of *Ancyrospora ancyrea* var. *ancyrea* in the studied sections. The co-occurrence of *Contagisporites optivus* and *Samarisporites triangulatus* could indicate in part the *optivus-triangulatus* Assemblage Zone of Richardson and McGregor (1986). Although it is generally correlated with the TCo Oppel Zone of Streel *et al.* (1987), *C. optivus* appears from the underlying TA Oppel Zone in Belgium (Stee-mans *et al.* 2011b). Nevertheless, the use of megaspore species for correlation is hardly reliable since they are recovered from few types of deposit environments.

Stage. Middle–Upper Givetian.

Samarisporites triangulatus Interval Zone

Reference section. Borehole A1-69 (from 1293.0 to 1277.0 ft).

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

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

Cymbosporites catillus Interval Zone

Reference section. MG-I (from 2247 to 2212.5 m).

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

Zone base definition. Its lower boundary is based on the first occurrence of specimens belonging to the *Cymbosporites catillus* Morphon.

Ancyrospora langii–*Chelinospora concinna* Assemblage Zone

Reference section. MG-I (from 2205 to 2160.6 m).

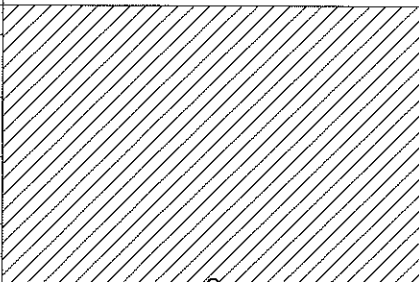
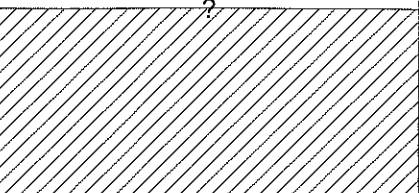
Distribution. Upper Jubah Formation, Saudi Arabia. Uppermost part of the Awaynat Wanin II Formation and the Awaynat Wanin III Formation, North Africa. Its upper stratigraphical limit of this assemblage is presently unknown, as it occurs at the highest depth sampled.

Zone base definition. Its lower boundary is based on the first occurrence of *Chelinospora concinna*.

Description. In addition to the first occurrence of *Chelinospora concinna*, this assemblage is mainly distinguished from the underlying *triangulatus-catillus* Zone by the inception of the common species *Ancyrospora langii* and *Emphanisporites laticostatus*. *Geminispora lemurata*, *Samarisporites triangulatus* and the *Cymbosporites catillus* Morphon are still represented in large amounts. The general diversity of the spore populations is still decreasing. The large apiculate and spinose zonate-pseudosaccate continue their quantitative decline started in the *triangulatus-catillus* Zone. The cryptospores are very uncommon, with a unique species, *Gneudnaspora divellomedia* var. *divellomedia*. The monolete spores are above all present with the monolete form of *Geminispora lemurata*. The megaspores are still present in number, including notably *Verrucisporites ellesmerensis*. The feature of grapnel-tipped spines seems to be more and more frequent with the reappearance of *Ancyrospora* genus and the presence of rarer specimens of *Hystricosporites*.

Comparison with reference biozones. This assemblage is the equivalent of the TCo Oppel Zone of Streel *et al.* (1987) since *Samarisporites triangulatus* and *Chelinospora concinna* are found together. The *langii-concinna* Zone

FIG. 56. Chart comparing the new biozonation with the reference spore zonations from Euramerica and Saudi Arabia. As there are any outcrops or sections that allow to correlate the different biozones, biostratigraphical correlations illustrated here are approximative. *Operational palynological zonation of Al-Hajri *et al.* (1999) updated according to PB (pers. obs.).

STAGES	Richardson and McGregor (1986)	Streel <i>et al.</i> (1987)		This paper		Al-Hajri <i>et al.</i> (1999)*		
FRASNIAN	<i>ovalis-bulliferus</i>	(IV)	B β			D1		
			B α					
			A					
		BM						
	BJ							
GIVETIAN	<i>optivus-triangularatus</i> ?	TCo		<i>langii-concinna</i>		D2		
	<i>lemurata-magnificus</i>	TA		<i>triangularatus-catillus</i>	<i>catillus</i> <i>triangularatus</i> <i>undulatus</i> <i>lemurata</i>			
		AD	Lem	<i>lemurata-langii</i>				
			Ref	<i>rugulata-libyensis</i>	<i>incognita</i>			
	Mac	<i>rugulata</i>						
EIFELIAN	<i>devonicus-naumovae</i> ?	AD		<i>rugulata-libyensis</i>	<i>incognita</i>	D3		A
	<i>velata-langii</i>							
	<i>douglstownensis</i> <i>-euryptero</i>	AP	Vel	<i>svalbardiae-eximius</i>				
			net					
Pro								
		ked	<i>annulatus-protea</i>		D3/D4		B	
	Cor							
EMSIAN	<i>annulatus-sextantii</i>	FD	Min	<i>lindlarensis-sextantii</i> D3B				
			Pra	<i>ovalis-biornatus</i>				<i>asymmetricus</i> <i>milleri</i> <i>ovalis</i>
			Fov					
	AB							
PRAGIAN	<i>polygonalis-emsiensis</i>	PoW	Su	<i>papillensis-baqaensis</i>		D4	A	
			Pa β					
			Pa α					
			W					
			Po					

also corresponds in part to the *optivus-triangularatus* Assemblage Zone of Richardson and McGregor (1986).

Stages. Upper Givetian – lower Frasnian.

Acknowledgements. We acknowledge the Saudi Arabian Ministry of Petroleum and Mineral Resources and the Saudi Arabian Oil Company (Saudi Aramco) for granting permission to publish this paper. We thank Merrell A. Miller (Saudi Aramco, Dhahran, KSA), John Filatoff (Brisbane, Australia) and Maurice Streel (University of Liège, Belgium) for their encouragement, constructive discussions and critical comments on this work. Marcella Giraldo-Mezzatesta (University of Liège) is acknowledged for processing palynological samples. Thanks are especially expressed to John E. A. Marshall (University of Southampton, UK), Charles H. Wellman (University of Sheffield, UK) and G. Clayton (Trinity College Dublin, Ireland) for comprehensively reviewing the manuscript. This contribution is part of the Saudi Aramco/CIMP joint project on the Palaeozoic of north-western Gondwanan regions.

Editor. Svend Stouge

REFERENCES

- AL-GHAZI, A. 2007. New evidence for the Early Devonian age of the Jauf Formation in northern Saudi Arabia. *Revue de Micropaléontologie*, **50**, 59–72.
- 2009. *Apiculiretusispora arabiensis*, new name for *Apiculiretusispora densa* Al-Ghazi, 2007 (preoccupied). *Revue de Micropaléontologie*, **52**, 193.
- AL-HAJRI, S. A. and OWENS, B. (eds) 2000. Stratigraphic palynology of the Palaeozoic of Saudi Arabia. *GeoArabia, Special Publication*, **1**, 231 pp.
- and PARIS F. 1998. Age and palaeoenvironment of the Sharawra Member (Silurian of northwestern Saudi Arabia). *Geobios*, **31**, 3–12.
- FILATOFF, J., WENDER, L. E. and NORTON, A. K. 1999. Stratigraphy and operational palynology of the Devonian System in Saudi Arabia. *GeoArabia*, **4**, 53–68.
- AL-HUSSEINI, M. and MATTHEWS, R. K. 2006. Devonian Jauf Formation, Saudi Arabia: orbital second-order depositional sequence 28. *GeoArabia*, **11**, 53–70.
- ALLEN, K. C. 1965. Lower to Middle Devonian spores of North and Central Vestspitsbergen. *Palaeontology*, **8**, 687–748.
- 1980. A review of *in situ* late Silurian and Devonian spores. *Review of Palaeobotany and Palynology*, **29**, 253–270.
- AMENÁBAR, C. R. 2009. Middle Devonian from the Chiuga Formation, Precordillera region, northwestern Argentina. 177–192. In KÖNIGSHOF, P. (ed.). *Devonian change: case studies in palaeogeography and palaeoecology*. Geological Society, London, Special Publications, **314**, 412 pp.
- ANDREWS, H. N., GENSEL, P. G. and FORBES, W. H. 1974. An apparently heterosporous plant from the Middle Devonian of New Brunswick. *Palaeontology*, **17**, 387–408.
- ARKHANGELSKAYA, A. D. 1976. Basis for Eifelian age of the *Periplecotriletes tortus* zone in central districts of the European part of the USSR. 36–66. In BYVSHEVA, T. V. (ed.). *Results of palynological research on Precambrian, Paleozoic and Mesozoic of USSR*. Trudy Vsesoluznogo Nauchno-Issledovatel'skogo Geologozvedochnogo Neftianogo Instituta, Kama Branch, 192 pp. [In Russian].
- 1978. Spores from the Lower Devonian of the Lithuanian SSR. *Paleontologicheskii Zhurnal*, **2**, 113–120. [In Russian].
- 1985. Zonal spore assemblages and stratigraphy of the Lower and Middle Devonian in the Russian Plate. 5–21. In *Atlas of spore and pollen from the Phanerozoic petroleum formations in the Russian and Turanian Plates*. Moscow. [In Russian].
- and TURNAU E. 2003. New dispersed seed-megaspores from the mid-Givetian of European Russia. *Review of Palaeobotany and Palynology*, **127**, 45–58.
- AVKHIMOVITCH, V. I., CHIBRIKOVA, E. V., OBUKHOVSKAYA, T. G., NAZARENKO, A. M., UMNova, V. T., RASKATOVA, L. G., MANTSUROVA, V. N., LOBOZIAK, S. and STREEL, M. 1993. Middle and Upper Devonian spore zonation of Eastern Europe. *Bulletin des Centres de Recherches de Exploration-Production Elf-Aquitaine*, **17**, 79–147.
- BALME, B. E. 1962. Upper Devonian (Frasnian) spores from the Carnarvon Basin, Western Australia. *The Palaeobotanist*, **9**, 1–10.
- 1988. Spores from Late Devonian (early Frasnian) strata, Carnarvon Basin, Western Australia. *Palaeontographica, Abteilung B*, **209**, 109–166.
- and HASSELL C. W. 1962. Upper Devonian spores from the Canning Basin, Western Australia. *Micropaleontology*, **8**, 1–28.
- BÄR, P. and RIEGEL, W. 1974. Les microfiores des séries paléozoïques du Ghana (Afrique occidentale) et leurs relations paléofloristiques. *Sciences Géologiques, Bulletin*, **27**, 39–57.
- BECK, J. H. and STROTHER, P. 2008. Spores and cryptospores from the Silurian section at Allenport, Pennsylvania, USA. *Journal of Paleontology*, **82**, 857–883.
- BECKER, G., BLESS, M. J. M., STREEL, M. and THOREZ, J. 1974. Palynology and ostracode distribution in the Upper Devonian and basal Dinantian of Belgium and their dependence on sedimentary facies. *Mededelingen Rijk Geologische Dienst, Nieuwe Serie*, **25**, 9–99.
- BEJU, D. 1967. Quelques spores, acritarches et chitinozoaires d'âge Dévonien inférieur de la plate-forme Moesienne (Roumanie). *Review of Palaeobotany and Palynology*, **5**, 39–49.
- BEN RAHUMA, M. M., PROUST, J.-N. and ESCHARD, R. 2008. *The stratigraphic evolution of the Devonian sequences, Awaynat Wanin area, southern Ghadamis Basin: a fieldguide book*. Libyan Petroleum Institute, Tripoli, 67 pp.
- BERRY, E. W. 1937. Spores from the Pennington Coal, Rhea County, Tennessee. *The American Midland Naturalist*, **18**, 155–160.
- BEYDOUN, Z. R. 1991. Arabian Plate hydrocarbon geology and potential – a plate tectonic approach. *American Association of Petroleum Geologists, Studies in Geology*, **33**, 1–77.
- BHARADWAJ, D. C. and TIWARI, R. S. 1970. Lower Gondwana megaspores – a monograph. *Palaeontographica, Abteilung B*, **129**, 1–70.

- BONAMO, P. 1977. *Rellimia thomsonii* (Progymnospermopsida) from the Middle Devonian of New York State. *American Journal of Botany*, **64**, 1272–1285.
- and BANKS H. P. 1967. *Tetraxylopteris schmidtii*: its fertile parts and its relationships within the Aneurophytales. *American Journal of Botany*, **54**, 755–768.
- BOOTE, D. R. D., CLARK-LOWES, D. D. and TRAUT, M. W. 1998. Palaeozoic petroleum systems of North Africa. 7–68. In MCGREGOR, D. S., MOODY, R. T. J. and CLARK-LOWES, D. D. (eds). *Petroleum geology of North Africa*. Geological Society, London, Special Publications, **132**, 442 pp.
- BOUCOT, A. J., MCCLURE, H. A., ALVAREZ, F., ROSS, J. P., TAYLOR, D. W., STRUVE, W., SAVAGE, N. N. and TURNER, S. 1989. New Devonian fossils from Saudi Arabia and their biogeographical affinities. *Senckenbergiana Lethaea*, **69**, 535–597.
- BOUMENDJEL, K., LOBOZIAK, S., PARIS, F., STEEMANS, P. and STREEL, M. 1988. Biostratigraphie des spores et des chitinozoaires du Silurien supérieur et du Dévonien dans le Bassin d'Illizi (S.E. du Sahara algérien). *Geobios*, **22**, 329–357.
- BREUER, P. and GRAHN, Y. 2011. Middle Devonian spore stratigraphy in the eastern outcrop belt of the Parnaíba Basin, northeastern Brazil. *Revista Española de Micropaleontología*, **43**, 1–21.
- STRICANNE, L. and STEEMANS, P. 2005a. Morphometric analysis of proposed evolutionary lineages of Early Devonian land plant spores. *Geological Magazine*, **142**, 241–253.
- AL-GHAZI, A., FILATOFF, J., HIGGS, K. T., STEEMANS, P. and WELLMAN, C. H. 2005b. Stratigraphic palynology of Devonian boreholes from northern Saudi Arabia. 3–9. In STEEMANS, P. and JAVAUX, E. (eds). *Pre-Cambrian to Palaeozoic palaeopalynology and palaeobotany*. Carnets de Géologie/Notebooks on Geology, Memoir, **2005/02**, 77 pp.
- FILATOFF, J. and STEEMANS, P. 2007a. Some considerations on Devonian spore taxonomy. 3–8. In STEEMANS, P. and JAVAUX, E. (eds). *Pre-Cambrian to Palaeozoic palaeopalynology and palaeobotany*. Carnets de Géologie/Notebooks on Geology, Memoir, **2007/01**, 73 pp.
- DISLAIRE, G., FILATOFF, J., PIRARD, E. and STEEMANS, P. 2007b. Support Vector assisted spore classification based on ornament spatial distribution analysis – an application to Emsian spores from Saudi Arabia. 9–15. In STEEMANS, P. and JAVAUX, E. (eds). *Pre-Cambrian to Palaeozoic palaeopalynology and palaeobotany*. Carnets de Géologie/Notebooks on Geology, Memoir, **2007/01**, 73 pp.
- AL-GHAZI, A., AL-RUWAILI, M., HIGGS, K. T., STEEMANS, P. and WELLMAN, C. H. 2007c. Early to Middle Devonian spores from northern Saudi Arabia. *Revue de Micropaléontologie*, **50**, 27–57.
- BRICE, D., BULTYNCK, P., DEUNFF, J., LOBOZIAK, S. and STREEL, M. 1979. Données biostratigraphiques nouvelles sur le Givetien et le Frasnien de Ferques (Boulonnais, France). *Annales de la Société Géologique du Nord*, **98**, 325–344.
- BURDEN, E. T., QUINN, L., NOWLAN, G. S. and BAILEY-NILL, L. A. 2002. Palynology and micropaleontology of the Clam Bank Formation (Lower Devonian) of western Newfoundland, Canada. *Palynology*, **26**, 185–215.
- BURGESS, N. D. and RICHARDSON, J. B. 1991. Silurian cryptospores and spores from the type Wenlock area, Shropshire, England. *Palaeontology*, **34**, 601–628.
- 1995. Late Wenlock to early Přídolí cryptospores and spores from south and southwest Wales Great Britain. *Palaeontographica, Abteilung B*, **236**, 1–44.
- BURJACK, M. I. A., LOBOZIAK, S. and STREEL, M. 1987. Quelques données nouvelles sur les spores dévoniennes du bassin du Paraná (Brésil). *Sciences Géologiques, Bulletin*, **40**, 381–391.
- CHALONER, W. G. 1959. Devonian megaspores from Arctic Canada. *Palaeontology*, **1**, 321–332.
- 1963. Early Devonian spores from a borehole in Southern England. *Grana Palynologica*, **4**, 100–110.
- CHI, B. I. and HILLS, L. V. 1976. Biostratigraphy and taxonomy of Devonian megaspores, Arctic Canada. *Bulletin of Canadian Petroleum Geology*, **24**, 640–818.
- CHIBRIKOVA, E. V. 1959. *Spores of the Devonian and older rocks of Bashkiria. Data on palaeontology and stratigraphy of Devonian and older deposits of Bashkiria*. Academy of Sciences of USSR, Bashkirian Branch, 1–247. [In Russian].
- 1962. *Spores of Devonian terrigenous deposits of western Bashkiria and the western slopes of the southern Urals*. Academy of Sciences of USSR, Bashkirian Branch, 353–476. [In Russian].
- CLAYTON, G. and GRAHAM, J. R. 1974. Spore assemblages from the Devonian Sherkin Formation of southwest County Cork, Republic of Ireland. *Pollen et Spores*, **16**, 565–588.
- JOHNSTON, I. S., SEVASTOPULO, G. D. and SMITH, D. G. 1980. Micropalaeontology of a Courcayan (Carboniferous) borehole section from Ballyvergin, County Clare, Ireland. *Journal of Earth Sciences Royal Dublin Society*, **3**, 81–100.
- OWENS, B., AL-HAJRI, S. A. and FILATOFF, J. 2000. Latest Devonian and Early Carboniferous spore assemblages from Saudi Arabia. 146–153. In AL-HAJRI, S. A. and OWENS, B. (eds). *Stratigraphic palynology of the Palaeozoic of Saudi Arabia*. GeoArabia, Special Publication, **1**, 231 pp.
- CLENDENING, J. A., EAMES, L. E. and WOOD, G. D. 1980. *Retusotriletes phillipsii* n. sp., a potential Upper Devonian guide palynomorph. *Palynology*, **4**, 15–22.
- COQUEL, R. and LATRÈCHE, S. 1989. Etude palynologique de la Formation d'Illère (Devono-Carbonifère) du Bassin d'Illizi (Sahara algérien occidental). *Palaeontographica, Abteilung B*, **212**, 47–70.
- and MOREAU-BENOIT A. 1986. Les spores des séries struniennes et tournaisiennes de Libye occidentale. *Revue de Micropaléontologie*, **29**, 17–43.
- 1989. A propos de quelques spores trilètes 'chambrées' du Dévonien terminal-Carbonifère inférieur d'Afrique du Nord. *Revue de Micropaléontologie*, **32**, 87–102.

- COUPER, R. A. 1953. Upper Mesozoic and Cainozoic spores and pollen grains from New Zealand. *New Zealand Geological Survey Paleontological Bulletin*, 22, 1–77.
- CRAMER, F. H. 1966a. Palynology of Silurian and Devonian rocks in Northwest Spain. *Boletín del Instituto Geológico y Minero de España*, 77, 223–286.
- 1966b. Palynomorphs from the Siluro-Devonian boundary in N. W. Spain. *Notas y Comunicaciones del Instituto Geológico y Minero de España*, 85, 71–82.
- 1969. Plant spores from the Eifelian to Givetian Gosselietia Sandstone Formation near Candás, Asturias, Spain. *Pollen et Spores*, 11, 425–447.
- and DÍEZ M. D. C. R. 1975. Earliest Devonian spores from the Province of León, Spain. *Pollen et Spores*, 17, 331–344.
- D'ERCEVILLE, M. A. 1979. Les spores des formations siluro-dévonniennes, de la coupe de Saint-Pierre-sur-Erve, synclinal armoricain. *Palaeontographica, Abteilung B*, 171, 79–121.
- DAEMON, R. F. 1974. Palinomorfos-guias do Devoniano Superior e Carbonífero Inferior das Bacias do Amazonas e Parnaíba. *Anais da Academia Brasileira de Ciências*, 46, 549–587.
- QUADROS, L. P. and DA SILVA, L. C. 1967. Devonian palynology and biostratigraphy of the Paraná Basin. 99–132. In BIGARELLA, J. J. (ed.). *Problems in Brazilian Devonian geology*. Boletim Paranaense de Geociências, 21/22, 155 pp.
- DETTMANN, M. E. 1963. Upper Mesozoic microfloras from South-Eastern Australia. *Proceedings of the Royal Society of Victoria*, 77, 1–148.
- EISENACK, A. 1944. Über einige pflanzliche Funde in Geschieben, nebst Bemerkungen zum Hystrichosphaeriden-Problem. *Zeitschrift für Geschiebeforschung*, 19, 103–124.
- ERDTMAN, G. 1952. *Pollen Morphology and Plant Taxonomy. Angiosperms*. Almqvist and Wiksell, Stockholm, 539 pp.
- EVANS, P. R. 1970. Revision of the spore genera *Perotriletes* Erdtman ex Couper, 1953 and *Diaphanospora* Balme and Hassell, 1962. *Palaeontological Papers*, 1968, Australia, Bureau of Mineral Resources, Geology and Geophysics, Bulletin, 116, 65–74.
- FANNING, U., EDWARDS, D. and RICHARDSON, J. B. 1992. A diverse assemblage of early land plants from the Lower Devonian of the Welsh Borderland. *Botanical Journal of the Linnean Society*, 109, 161–188.
- FOREY, P. L., YOUNG, V. T. and MCCLURE, H. A. 1992. Lower Devonian fishes from Saudi Arabia. *Bulletin of the British Museum of Natural History Geology*, 48, 25–43.
- FRIEND, P. F., ALEXANDER-MARRACK, P. D., ALLEN, K. C., NICHOLSON, J. and YEATS, A. K. 1983. Devonian sediments of East Greenland VI. Review of results. *Meddelelser om Grønland*, 206, 1–96.
- FUGLEWICZ, R. and PREJBISZ, A. 1981. Devonian megaspores from NW Poland. *Acta Palaeontologica Polonica*, 26, 55–72.
- GAO LIANDA. 1981. Devonian spore assemblages of China. 11–23. In OWENS, B. and VISSCHER, H. (eds). *Late Palaeozoic and Early Mesozoic stratigraphic palynology*. Review of Palaeobotany and Palynology, 34, 135 pp.
- GENSEL, P. G. 1980. Devonian *in situ* spores: a survey and discussion. *Review of Palaeobotany and Palynology*, 30, 101–132.
- GERRIENNE, P., MEYER-BERTHAUD, B., FAIRON-DEMARET, M., STREEL, M. and STEEMANS, P. 2004. *Runcaria*, a Middle Devonian seed plant precursor. *Science*, 306, 856–858.
- GHAVIDEL-SYOOKI, M. 2003. Palynostratigraphy of Devonian sediments in the Zagros Basin, southern Iran. *Review of Palaeobotany and Palynology*, 127, 241–268.
- GRAHN, Y., MELO, J. H. G. and STEEMANS, P. 2005. Integrated chitinozoan and spore zonation of the Serra Grande Group (Silurian–Lower Devonian), Parnaíba Basin, northeast Brazil. *Revista Española de Micropaleontología*, 37, 183–204.
- GREY, K. 1975. Devonian spores from the Gogo Formation, Canning Basin. 96–99. *Annual Report of Geological Survey of Western Australia for 1974*.
- 1991. A mid-Givetian spore age for the onset of reef development on the Lennard Shelf, Canning Basin, Western Australia. *Review of Palaeobotany and Palynology*, 68, 37–48.
- GRIGNANI, D., LANZONI, E. and ELATRASH, H. 1991. Palaeozoic and Mesozoic subsurface palynostratigraphy in the Al Kufrah Basin, Libya. 1159–1227. In SALEM, M. J., HAMMUDA, O. S. and ELIAGOUBI, B. A. (eds). *The geology of Libya*. Vol. IV. Elsevier, Amsterdam, 1648 pp.
- GUENNEL, G. K. 1963. Devonian spores in a Middle Silurian reef. *Grana Palynologica*, 4, 245–261.
- HABGOOD, K. S., EDWARDS, D. and AXE, L. 2002. New perspectives on *Cooksonia* from the Lower Devonian of the Welsh Borderland. *Botanical Journal of the Linnean Society*, 139, 339–359.
- HACQUEBARD, P. A. 1957. Plant spores in coal from the Horton group (Mississippian) of Nova Scotia. *Micropaleontology*, 3, 301–324.
- HAGSTRÖM, J. 1997. Land-derived palynomorphs from the Silurian of Gotland, Sweden. *GFF*, 119, 301–316.
- HAMID, M. E. P. 1974. Sporenvergesellschaftungen aus dem unteren Mitteldevon (Eifel-Stufe) des südlichen Bergischen Landes (Rheinisches Schiefergebirge). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, 147, 163–217.
- HASHEMI, H. and PLAYFORD, G. 2005. Devonian spore assemblages of the Adavale Basin, Queensland (Australia): descriptive systematics and stratigraphic significance. *Revista Española de Micropaleontología*, 37, 317–417.
- HEMER, D. O. 1965. Application of palynology in Saudi Arabia. In *Fifth Arab Petroleum Congress*. Cairo, Egypt, 28 pp.
- and NYGREEN P. W. 1967. Devonian palynology of Saudi Arabia. *Review of Palaeobotany and Palynology*, 5, 51–61.
- HODGSON, E. A. 1968. Devonian spores from the Pertnara Formation, Amadeus Basin, Northern Territory. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Bulletin*, 80, 67–82.
- HOFFMEISTER, W. S. 1959. Lower Silurian plant spores from Libya. *Micropaleontology*, 5, 331–334.
- STAPLIN, F. L. and MALLOY, R. E. 1955. Mississippian plant spores from the Hardinsburg Formation of Illinois and Kentucky. *Journal of Paleontology*, 29, 372–399.

- HOLLAND, C. H. and SMITH, D. G. 1979. Silurian rocks of the Capard inlier, County Laois. *Proceedings of the Royal Irish Academy, Series B*, **79**, 99–110.
- HUGHES, N. F. and PLAYFORD, G. 1961. Palynological reconnaissance of the Lower Carboniferous of Spitsbergen. *Micropaleontology*, **7**, 27–44.
- IBRAHIM, A. C. 1933. Sporenformen des Ägirhorizontes des Ruhrreviers. Dissertation, Technische Hochschule, Berlin, 46 pp.
- ISHCHENKO, A. M. 1952. *Atlas of the microspores and pollen of the Middle Carboniferous of the western part of the Donetz Basin*. Akademiya Nauk Ukrainskoy SSR, Trudy Instituta Geologicheskikh Nauk, Kiev, 83 pp. [In Russian].
- JÄGER, H. 2004. Facies dependence of spore assemblage and new data on sedimentary influence on spore taphonomy. 121–140. In SERVAIS, T. and WELLMAN, C. H. (eds). *New directions in Palaeozoic palynology*. Review of Palaeobotany and Palynology, **130**, 299 pp.
- JANSONIUS, J. and HILLS, L. V. 1987. *Genera file of fossil spores*. Supplement. Special Publication, Department of Geology and Geophysics, University of Calgary, Canada.
- JARDINÉ, S. and YAPAUDJIAN, L. 1968. Lithostratigraphie et Palynologie du Dévonien–Gothlandien gréseux du Bassin de Polignac (Sahara). *Revue de l'Institut Français du Pétrole*, **23**, 439–469.
- JERSEY, N. J. DE. 1966. Devonian spores from the Adavale Basin. *Geological Survey of Queensland, Publication 334, Palaeontological Papers*, **3**, 1–28.
- KEDO, G. I. 1955. Spores of the Middle Devonian of the northeastern Byelorussian SSR. *Academy of Sciences of BSSR, Institute of Geological Sciences, Paleontology and Stratigraphy*, **1**, 5–59. [In Russian].
- KEMP, E. M. 1972. Lower Devonian palynomorphs from the Horlick Formation, Ohio Range, Antarctica. *Palaeontographica, Abteilung B*, **139**, 105–124.
- KERR, J. W., MCGREGOR, D. C. and MCLAREN, D. J. 1965. An unconformity between Middle and Upper Devonian rocks of Bathurst Island, with comments on Upper Devonian faunas and microfloras of the Parry Islands. *Bulletin of Canadian Petroleum Geology*, **13**, 409–431.
- KOSANKE, K. M. 1950. Pennsylvanian spores of Illinois and their use in correlation. *Illinois State Geological Survey, Bulletin*, **74**, 1–128.
- KRASSILOV, V. A., RASKATOVA, M. G. and ISTCHENKO, A. A. 1987. A new archaeopteridalean plant from the Devonian of Pavlovsk, U.S.S.R. *Review of Palaeobotany and Palynology*, **53**, 163–173.
- LAKE, P. A., OSWIN, W. M. and MARSHALL, J. E. A. 1988. A palynological approach to terrane analysis in the South Portuguese Zone. *Trabajos de Geología*, **17**, 125–131.
- LALOUX, M., DEJONGHE, L., GEUKENS, F., GHYSEL, P. and HANCE, L. 1996. *Limbourg-Eupen*, 43/5–6. *Carte Géologique de Wallonie: 1/25.000*. Direction Générale des Ressources Naturelles de l'Environnement, Brussels, 83 pp.
- LANG, W. H. 1925. Contributions to the study of the Old Red Sandstone flora of Scotland. 1. On plant remains from the fish beds of Cromarty. *Transactions of the Royal Society of Edinburgh: Earth Sciences*, **54**, 253–272.
- LANNINGER, E. P. 1968. Sporen-Gesellschaften aus dem Ems der SW-Eifel (Rheinisches Schiefergebirge). *Palaeontographica, Abteilung B*, **122**, 95–170.
- LANZONI, E. and MAGLOIRE, L. 1969. Associations palynologiques et leurs applications stratigraphiques dans le Dévonien supérieur et Carbonifère inférieur du Grand Erg occidental (Sahara algérien). *Revue de l'Institut Français du Pétrole*, **24**, 441–468.
- LE HÉRISSE, A. 1983. Les spores du Dévonien inférieur du Synclinorium de Laval (Massif Armoricain). *Palaeontographica, Abteilung B*, **188**, 1–81.
- RUBINSTEIN, C. and STEEMANS, P. 1997. Lower Devonian palynomorphs from the Talacasto Formation, Cerro del Fuerte Section, San Juan Precordillera, Argentina. 497–515. In FATKA, O. and SERVAIS, T. (eds). *Acritarcha in Praha*, 1996. Acta Universitatis Carolinae, Geologica, **40**, 293–717.
- LECLERCQ, S. and BONAMO, P. 1971. A study of the fructification of *Milleria (Protopteridium) thomsonii* Lang from the Middle Devonian of Belgium. *Palaeontographica, Abteilung B*, **136**, 83–114.
- LELE, K. M. and STREEL, M. 1969. Middle Devonian (Givetian) plant microfossils from Goé (Belgium). *Annales de la Société Géologique de Belgique*, **92**, 89–121.
- LESSUISE, A., STREEL, M. and VANGUESTAINE, M. 1979. Observations palynologiques dans le Couvinien (Emsien terminal et Eifelien) du bord oriental du Synclinorium de Dinant, Belgique. *Annales de la Société Géologique de Belgique*, **102**, 325–355.
- LOBOZIAK, S. 2000. Middle to early Late Devonian spore biostratigraphy of Saudi Arabia. 134–145. In AL-HAJRI, S. A. and OWENS, B. (eds). *Stratigraphic palynology of the Palaeozoic of Saudi Arabia*. GeoArabia, Special Publication, **1**, 231 pp.
- and MELO J. H. G. 2002. Devonian spores successions of Western Gondwana: update and correlation with Southern Euramerican spores zones. *Review of Palaeobotany and Palynology*, **121**, 133–148.
- and STREEL M. 1980. Spores in Givetian to Lower Frasnian sediments dated by conodonts from the Boulonnais, France. *Review of Palaeobotany and Palynology*, **29**, 285–299.
- — 1988. Synthèse palynostratigraphique de l'intervalle Givetien–Famennien du Boulonnais (France). 71–77. In BRICE D. (ed.). *Le Dévonien de Ferques. Bas-Boulonnais (N. France)*. Biostratigraphie du Paléozoïque, **7**. Université de Bretagne Occidentale, Brest, 520 pp.
- — 1989. Middle–Upper Devonian spores from the Ghadames Basin (Tunisia–Libya): systematics and stratigraphy. *Review of Palaeobotany and Palynology*, **58**, 173–196.
- — 1995a. West Gondwanan aspects of the Middle and Upper Devonian spore zonation in North Africa and Brazil. 147–155. In LE HÉRISSE A., OWENS, B. and PARIS, F. (eds). *Palaeozoic palynomorphs of the Gondwana–Euramerican interface*. Review of Palaeobotany and Palynology, **86**, 173 pp.
- — 1995b. Late Lower and Middle Devonian spores from Saudi Arabia. 105–114. In OWENS B., AL-TAYYAR, H., VAN DER EEM, J. G. L. A. and AL-HAJRI, S. A. (eds). *Palaeozoic palynostratigraphy of the Kingdom of Saudi Arabia*. Review of Palaeobotany and Palynology, **89**, 150 pp.

- and VANGUESTAINE M. 1983. Spores et acritarches de la Formation d'Hydrequent (Frasnien supérieur à Famennien inférieur, Boulonnais, France). *Annales de la Société Géologique de Belgique*, **106**, 173–183.
- and BURJACK M. I. A. 1988. Spores du Dévonien Moyen et Supérieur du Bassin du Parana, Brésil: systématique et stratigraphie. *Sciences Géologiques, Bulletin*, **41**, 351–377.
- and WEDDIGE K. 1990. Spores, the *lemurata* and *triangulatus* levels and their faunal indices near the Eifelian/Givetian boundary in the Eifel (F.R.G.). *Annales de la Société Géologique de Belgique*, **113**, 1–15.
- STEEMANS, P., STREEL, M. and VACHARD, D. 1992a. Biostratigraphie par spores du Dévonien inférieur à supérieur du sondage MG-1 (Bassin d'Hammadeh, Tunisie) – comparaison avec les données des faunes. *Review of Palaeobotany and Palynology*, **74**, 193–205.
- STREEL, M., CAPUTO, M. V. and MELO, J. H. G. 1992b. Middle Devonian to Lower Carboniferous spore stratigraphy in the Central Parnaíba Basin (Brazil). *Annales de la Société Géologique de Belgique*, **115**, 215–226.
- and MELO J. H. G. 1999. *Grandispora* (al. *Contagisporites*) *permulta* (Daemon, 1974) Loboziak, Streel et Melo, comb. nov., a senior synonym of *Grandispora riegeli* Loboziak et Streel, 1989 – nomenclature and stratigraphic distribution. *Review of Palaeobotany and Palynology*, **106**, 97–102.
- LOVE, L. G. 1960. Assemblages of small spores from the Lower Oil Shale Group of Scotland. *Proceedings of the Royal Society of Edinburgh, Section B*, **67**, 99–126.
- LU LICHANG 1980. On the occurrence of *Archaeoperisaccus* in E. Yunnan. *Acta Palaeontologica Sinica*, **19**, 500–503. [In Chinese].
- 1988. Middle Devonian microflora from Haikou Formation at Shijiapo in Zhanyi of Yunnan, China. *Memoirs of Nanjing Institute of Geology and Palaeontology, Academia Sinica*, **24**, 109–234. [In Chinese].
- and OUYANG SHU 1976. The Early Devonian spore assemblage from the Xujiachong Formation at Cuifengshan in Qujing of Yunnan. *Acta Palaeontologica Sinica*, **15**, 21–43. [In Chinese].
- LUBER, A. A. and WALTZ, I. E. 1938. Classification and stratigraphic value of spores of some Carboniferous coal deposits in the USSR. *Trudy Tsentral'nogo Nauchno-Issledovatel'skogo Geologo-Razvedochnogo Instituta*, **105**, 1–43. [In Russian].
- MAGLOIRE, L. 1968. Etude stratigraphique par la palynologie des dépôts argilo-gréseux du Silurien et du Dévonien inférieur dans la région du Grand Erg Occidental (Sahara algérien). *International Symposium on the Devonian System, Calgary*, **2**, 473–495.
- MARSHALL, J. E. A. 1988. Devonian spores from Papa Stour, Shetland. *Transactions of the Royal Society of Edinburgh: Earth Sciences*, **79**, 13–18.
- 1996. *Rhabdosporites langii*, *Geminospora lemurata* and *Contagisporites optivus*: an origin for heterospory within the Progymnosperms. *Review of Palaeobotany and Palynology*, **93**, 159–189.
- 2000. Devonian (Givetian) spores from the Walls Group, Shetland. 473–483. In FRIEND, P. F. and WILLIAMS, B. P. J. (eds). *New perspectives on the Old Red Sandstone*. Geological Society, London, Special Publications, **180**, 623 pp.
- and ALLEN K. C. 1982. Devonian spore assemblages from Fair Isle, Shetland. *Palaeontology*, **25**, 277–312.
- and FLETCHER T. P. 2002. Middle Devonian (Eifelian) spores from a fluvial dominated lake margin in the Orcadian Basin, Scotland. *Review of Palaeobotany and Palynology*, **118**, 195–209.
- and HEMSLEY A. R. 2003. A Mid Devonian seed-megaspore from East Greenland and the origin of the seed plants. *Palaeontology*, **46**, 647–670.
- ROGERS, D. A. and WHITELEY, M. J. 1996. Devonian marine incursions into the Orcadian Basin, Scotland. *Journal of the Geological Society*, **153**, 451–466.
- MILLER, M. A., FILATOFF, J. and AL-SHAHAB, K. 2007. Two new Middle Devonian megaspores from Saudi Arabia. *Revue de Micropaléontologie*, **50**, 73–79.
- MASSA, D. 1988. Paléozoïque de Libye occidentale: stratigraphie et paléogéographie. Unpublished PhD thesis, Université de Nice, France, 514 pp.
- and MOREAU-BENOIT A. 1976. Essai de synthèse stratigraphique et palynologique du Système Dévonien en Libye occidentale. *Revue de l'Institut Français du Pétrole*, **41**, 287–333.
- 1985. Apport de nouvelles données palynologiques à la biostratigraphie et à la paléogéographie du Dévonien en Libye (sud du bassin de Rhadamès). *Sciences Géologiques Bulletin*, **38**, 5–18.
- COQUEL, R., LOBOZIAK, S. and TAUGOUR-DEAU-LANTZ, J. 1980. Essai de synthèse stratigraphique et palynologique du Carbonifère en Libye occidentale. *Annales de la Société Géologique du Nord*, **9**, 429–442.
- MCGREGOR, D. C. 1960. Devonian spores from Melville Island, Canadian Arctic Archipelago. *Palaeontology*, **3**, 26–44.
- 1961. Spores with proximal radial pattern from the Devonian of Canada. *Geological Survey of Canada, Bulletin*, **76**, 1–11.
- 1964. Devonian spores from the Ghost River Formation, Alberta. *Geological Survey of Canada, Bulletin*, **109**, 1–31.
- 1967. Composition and range of some Devonian spore assemblages of Canada. *Review of Palaeobotany and Palynology*, **1**, 173–183.
- 1969. Devonian plant fossils of the genera *Kryshovichia*, *Nikitinsporites*, *Archaeoperisaccus*. *Geological Survey of Canada, Bulletin*, **182**, 91–106.
- 1970. Paleobotany. In *Geology and economic minerals of Canada, economical geology*, Fifth edition. Geological Survey of Canada, Report, **1**, 663–670.
- 1973. Lower and Middle Devonian spores of Eastern Gaspé, Canada. I. Systematics. *Palaeontographica, Abteilung B*, **142**, 1–77.
- 1974. Early Devonian spores from central Ellesmere Island, Canadian Arctic. *Canadian Journal of Earth Sciences*, **11**, 70–78.
- 1977. Lower and Middle Devonian spores of Eastern Gaspé, Canada. II. Biostratigraphic significance. *Palaeontographica, Abteilung B*, **163**, 111–142.
- 1984. Late Silurian and Devonian spores from Bolivia. *Academia Nacional de Ciencias*, **69**, 1–57.

- and CAMFIELD M. 1976. Upper Silurian? to Middle Devonian spores of the Moose River Basin, Ontario. *Geological Survey of Canada, Bulletin*, **263**, 1–63.
- 1982. Middle Devonian spore from the Cape De Bray Weatherall, and Hecla Bay Formations of northeastern Melville Island, Canadian Arctic. *Geological Survey of Canada, Bulletin*, **348**, 1–105.
- and NARBONNE G. M. 1978. Upper Silurian trilete spores and other microfossils from the Read Bay Formation, Cornwallis Island, Canadian Arctic. *Canadian Journal of Earth Sciences*, **15**, 1292–1303.
- and OWENS B. 1966. Devonian spores of eastern and northern Canada. *Geological Survey of Canada, Paper*, **66**, 1–66.
- and PLAYFORD G. 1992. Canadian and Australian Devonian spores: zonation and correlation. *Geological Survey of Canada, Bulletin*, **438**, 1–125.
- and UYENO T. T. 1972. Devonian spores and conodonts of Melville and Bathurst Islands, District of Franklin. *Geological Survey of Canada, Paper*, **71**, 1–37.
- SANFORD, B. V. and NORRIS, A. W. 1970. Palynology and correlation of Devonian formations in the Moose River Basin, northern Ontario. *Geological Association of Canada, Proceedings*, **22**, 45–54.
- MEHLQVIST, K. 2009. The spore record of early land plants from upper Silurian strata in Klinta 1 well, Skåne, Sweden. Unpublished MSc thesis, Lunds University, Sweden, 29 pp.
- MEISSNER, C. R. Jr, DINI, S. M., FARASANI, A. M., RIDDLER, G. P., VAN HECK, M. and ASPINALL, N. C. 1988. Preliminary geological map of the Al Jawf Quadrangle, sheet 29D, Kingdom of Saudi Arabia. Open-file report USGS-OF-09-1. Ministry of Petroleum and Minerals, Deputy Ministry for Mineral Resources, Jeddah, Saudi Arabia.
- MELO, J. H. G. and LOBOZIAK, S. 2003. Devonian–Early Carboniferous spore biostratigraphy of the Amazon Basin, Northern Brazil. *Review of Palaeobotany and Palynology*, **124**, 131–202.
- MENDLOWICZ MAULLER, P., MACHADO CARDOSO, T. R., PEREIRA, T. R. and STEEMANS, P. 2007. Resultados Palinoestratigráficos do Devoniano da Sub-Bacia de Alto Garças (Bacia do Paraná – Brasil). 607–619. In CARVALHO, I. S., CASSAB, R. C. T., SCHWANKE, C., CARVALHO, M. A., FERNANDES, A. C. S., RODRIGUES, M. A. C., CARVALHO, M. S. S., ARAI, M. and OLIVEIRA, M. E. Q. (eds). *Paleontologia: cenários de Vida*, Vol. 2. Interciência, Rio de Janeiro, 632 pp.
- MIKHAILOVA, N. I. 1966. Spores from the Givetian deposits of Rudnyi Altai. *Transactions of Satpaev Institute of Geological Sciences, Academy of Sciences of Kazakhstan SSR*, **17**, 195–213. [In Russian].
- MOREAU-BENOIT, A. 1967. Premiers résultats d'une étude palynologique du Dévonien de la carrière des Fours à Chaux d'Angers (Maine-et-Loire). *Revue de Micropaléontologie*, **9**, 219–240.
- 1974. Recherches de palynologie et de planctologie sur le Dévonien de quelques formations siluriennes dans le Sud-Est du Massif Armoricain. *Mémoires de la Société Géologique et Minéralogiques de Bretagne*, **18**, 248 pp.
- 1976. Les spores et débris végétaux. 27–58. In LARDEUX, H. (ed.). *Les schistes et calcaires éodévonien de Saint-Cénére (Massif Armoricain, France)*. Mémoires de la Société géologiques et minéralogique de Bretagne, **19**, 323 pp.
- 1979. Les spores du Dévonien de Libye. Première partie. *Cahiers de Micropaléontologie*, **4**, 1–58.
- 1980a. Les spores et les débris végétaux. 59–90. In PLUSQUELLEC, Y. (ed.). *Les schistes et calcaires de l'Armorique*. Mémoires de la Société géologique et minéralogiques de Bretagne, **23**, 313 pp.
- 1980b. Les spores du Dévonien de Libye. Deuxième partie. *Cahiers de Micropaléontologie*, **1**, 1–53.
- 1988. Considérations nouvelles sur la palynozonation du Dévonien moyen et supérieur du Bassin de Rhadamès, Libye occidentale. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **307**, 863–869.
- 1989. Les spores du Dévonien moyen et supérieur de Libye occidentale: compléments-systématique-répartition stratigraphique. *Cahiers de Micropaléontologie*, **4**, 1–32.
- COQUEL, R. and LATRÈCHE, S. 1993. Étude palynologique du Dévonien du bassin d'Illizi (Sahara Oriental Algérien). Approche biostratigraphique. *Geobios*, **26**, 3–31.
- MORGAN, J. L. 1955. Spores of McAlester Coal. *Oklahoma Geological Survey, Circular*, **36**, 1–52.
- MORTIMER, M. G. 1967. Some lower Devonian microfloras from southern Britain. *Review of Palaeobotany and Palynology*, **1**, 95–109.
- and CHALONER W. G. 1972. The palynology of the concealed Devonian rocks of southern England. *Bulletin of the Geological Survey of Great Britain*, **39**, 1–56.
- NADLER, Y. S. 1966. Spores in Devonian deposits of the western part of Sayano-Altai mountainous region. 51–54. In *The importance of palynological analysis for stratigraphical and palaeofloristic investigations*. Akademiya Nauk SSSR, Institut Geografii i Geologicheskii, Izdatelstvo Nauka, Moskva. [In Russian].
- NAUMOVA, S. N. 1939. Spores and pollen of the coals of the USSR. 353–364. In *17th International Geological Congress, Report 1*. Moscow, Russia. [In Russian].
- 1953. Spore-pollen assemblages of the Upper Devonian of the Russian Platform and their stratigraphic value. *Akademiya Nauk SSSR, Institut Geologii Nauk*, **143**, Geological Series 60, 203 pp. [In Russian].
- NAZARENKO, A. M. 1965. Characterization of spore assemblage of Middle Devonian deposits of Volgograd district. *Transactions of Volgograd Scientific Research, Institute of Petroleum and Gas Industry (VNIING)*, **3**, 39–47. [In Russian].
- NEVES, R. 1961. Namurian plant spores from the southern Pennines, England. *Palaeontology*, **4**, 247–279.
- and OWENS B. 1966. Some Namurian spores from the English Pennines. *Pollen et Spores*, **8**, 337–360.
- OBRHEL, J. 1959. Neue Pflanzenfunde in den Srbsko-Schichten (Mitteldevon). *Věstník Ústředního Ústavu Geologického*, **34**, 384–388.
- OTTONE, G. E. 1996. Devonian palynomorphs from the Los Monos Formation, Tarija Basin, Argentina. *Palynology*, **20**, 105–155.

- OWENS, B. 1971. Spores from the Middle and Early Upper Devonian rocks of the Western Queen Elizabeth Island, Arctic Archipelago. *Geological Survey of Canada, Paper*, **70-38**, 1-157.
- PANSHINA, L. N. 1971. New species of spores of the lower part of the Frasnian Stage in the Volga-Ural Oblast. 90-96. In *Palynology and Stratigraphy of Paleozoic, Mesozoic, and Paleogene deposits of European part of USSR and Central Asia*. Trudy Vsesoluznogo Nauchno-Issledovatel'skogo Geologoazvedchnogo Neftianogo Instituta, Kama Branch, 106 pp. [In Russian]
- PARIS, F., RICHARDSON, J. B., RIEGEL, W., STREEL, M. and VANGUESTAINE, M. 1985. Devonian (Emsian-Famennian) palynomorphs. 49-81. In THUSU, B. and OWENS, B. (eds). *Palynostratigraphy of North-East Libya*. Journal of Micropalaeontology, **4**, 182 pp.
- PASHKEVICH, N. G. 1964. New Devonian species of *Archaeoperisaccus* (Gymnospermae) from northern Timan. *Paleontologische Zhurnal*, **4**, 126-129. [In Russian].
- PEPPERS, R. A. and DAMBERGER, H. H. 1969. Palynology and petrography of a Middle Devonian coal in Illinois. *Illinois State Geological Survey, Circular*, **445**, 1-35.
- PEREZ-LEYTON, M. A. 1990. Spores du Dévonien Moyen et Supérieur de la coupe de Bermejo-La Angostura (Sud-Est de la Bolivie). *Annales de la Société Géologique de Belgique*, **113**, 373-389.
- PLAYFORD, G. 1962. Lower Carboniferous microfloras of Spitsbergen. *Palaeontology*, **5**, 550-618.
- 1971. Lower Carboniferous spores from the Bonaparte Gulf Basin, Western Australia and Northern Territory. *Bureau of Mineral Resources, Geology and Geophysics, Bulletin*, **115**, 1-102.
- 1976. Plant microfossils from the Upper Devonian and Lower Carboniferous of the Canning Basin, Western Australia. *Palaeontographica, Abteilung B*, **158**, 1-71.
- 1983. The Devonian spore genus *Geminospora* Balme 1962: a reappraisal based upon topotypic *G. lemurata* (type species). *Memoirs of the Association of Australasian Palaeontologists*, **1**, 311-325.
- 1991. Australian Lower Carboniferous spores relevant to extra-Gondwanic correlations: an evaluation. 85-125. In BRECKLE, P. L. and MANGER, W. L. (eds). *International division and correlation of the carboniferous system*. Courier Forschungsinstitut Senckenberg, **130**, 350 pp.
- POTONIÉ, H. 1893. Die flora des Rothliegenden von Thüringen. *Abhandlungen der Königlich-Preussischen Geologischen Landesanstalt, Neue Folge*, **9**, 298 pp.
- POTONIÉ, R. 1956. Synopsis der Gattungen der *Sporae dispersae*. I. Teil: sporites. *Beihefte zum Geologische Jahrbuch*, **23**, 1-103.
- 1970. Synopsis der Gattungen der *Sporae dispersae*. V. Teil: nachträge zu allen Gruppen (Turmae). *Beihefte zum Geologische Jahrbuch*, **87**, 1-222.
- and KREMP, G. O. W. 1954. Die Gattungen der paläozoischen *Sporae dispersae* und ihre Stratigraphie. *Geologisches Jahrbuch*, **69**, 111-194.
- 1955. Die *Sporae dispersae* des Ruhrkarbons. Ihre Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und Zeitabschnitte. Teil I. *Palaeontographica Abteilung B*, **98**, 1-136.
- POWERS, R. W. 1968. *Asie: Arabie Saoudite. Lexique Stratigraphique Internationale*. Edition du CNRS, Paris, 177 pp.
- RAMIREZ, L. F., REDMOND, C. D. and ELBERG, E. L. JR 1966. Sedimentary geology of Saudi Arabia. *Geology of the Arabian Peninsula, United States Geological Survey, Professional Paper*, **560D**, 1-147.
- PUNT, W., HOEN, P. P., BLACKMORE, S., NILSSON, S. and LE THOMAS, A. 2007. Glossary of pollen and spore terminology. *Review of Palaeobotany and Palynology*, **143**, 1-81.
- RADFORTH, N. W. and MCGREGOR, D. C. 1954. Some plant microfossils important to pre-Carboniferous stratigraphy and contributing to our knowledge of the early floras. *Canadian Journal of Botany*, **32**, 601-621.
- 1956. Antiquity of form in Canadian plant microfossils. *Transactions of the Royal Society of Canada* **50**, 27-33.
- RAHMANI-ANTARI, K. and LACHKAR, G. 2001. Contribution à l'étude biostratigraphique du Dévonien et du Carbonifère de la plate-forme marocaine. Datation et corrélations. *Revue de Micropaléontologie*, **44**, 159-183.
- RASKATOVA, L. G. 1969. *Spore and pollen assemblages of Middle and Upper Devonian in the south-east of the Central Devonian Field*. Voronezh State University, Voronezh, 166 pp. [In Russian].
- RAUSCHER, R. and ROBARDET, M. 1975. Les microfossiles (Acritarches, Chitinozoaires et Spores) des couches de passage du Silurien au Dévonien dans le Cotentin (Normandie). *Annales de la Société Géologique du Nord*, **95**, 81-92.
- RAVN, R. L. and BENSON, D. G. 1988. Devonian spores and reworked acritarchs from southeastern Georgia, U.S.A. *Palynology*, **12**, 179-200.
- REGALI, M. S. P. 1964. Resultados palinológicos de amostras paleozóicas de bacia de Tucano-Jatobá. *Boletim Técnico da Petrobras, Rio de Janeiro*, **7**, 165-180.
- REINSCH, P. 1881. *Neue Untersuchungen über die mikrostruktur der steinkohle des carbon, der Dyas und Trias*. Leipzig, T. O. Weigel, 124 pp.
- RICHARDSON, J. B. 1960. Spores from the Middle Old Red Sandstone of Cromarty, Scotland. *Palaeontology*, **3**, 45-63.
- 1962. Spores with bifurcate processes from the Middle Old Red Sandstone of Scotland. *Palaeontology*, **5**, 171-194.
- 1965. Middle Old Red Sandstone spore assemblages from the Orcadian Basin north-east Scotland. *Palaeontology*, **7**, 559-605.
- 1967. Some British Lower Devonian spore assemblages and their stratigraphic significance. *Review of Palaeobotany and Palynology*, **1**, 111-129.
- 1996. Taxonomy and classification of some new Early Devonian cryptospores from England. 7-40. In CLEAL, C. J. (ed.). *Studies on early land-plant spores from Britain*. Special Papers in Palaeontology, **55**, 145 pp.
- and IOANNIDES N. 1973. Silurian palynomorphs from the Taneezucht and Acacus Formations, Tripolitania, North Africa. *Micropaleontology*, **19**, 257-307.
- and LISTER T. R. 1969. Upper Silurian and Lower Devonian spore assemblages from the Welsh Borderland and South Wales. *Palaeontology*, **12**, 201-252.

- and MCGREGOR D. C. 1986. Silurian and Devonian spore zones of the Old Red Sandstone Continent and adjacent regions. *Geological Survey of Canada, Bulletin*, **364**, 1–79.
- and RASUL S. M. 1978. Palynomorphs in Lower Devonian sediments from the Apley Barn Borehole, southern England. *Pollen et Spores*, **20**, 423–462.
- STREEL, M., HASSAN, A. and STEEMANS, P. 1982. A new spore assemblage to correlate between the Breconian (British Isles) and the Gedinian (Belgium). *Annales de la Société Géologique de Belgique*, **105**, 135–143.
- BONAMO, P. and MCGREGOR, D. C. 1993. The spores of *Leclercqia* and the dispersed spore *Morphon Acinosporites lindlarensis* Riegel: a case of gradualistic evolution. *Bulletin of the Natural History Museum, Geology Series*, **49**, 121–155.
- RODRIGUEZ, R. M. and SUTHERLAND, S. J. E. 2001. Palynological zonation of Mid- Palaeozoic sequences from the Cantabrian Mountains, NW Spain: implications for inter-regional and interfacies correlation of the Ludford/Pridoli and Silurian/Devonian boundaries, and plant dispersal patterns. *Bulletin of the Natural History Museum, Geology Series*, **57**, 115–162.
- RIEGEL, W. 1968. Die Mitteldeven-Flora von Lindlar (Rheinland). 2. *Sporae dispersae*. *Palaeontographica, Abteilung B*, **123**, 76–96.
- 1973. Sporenformen aus den Heisdorf-, Lauch- und Nohn-Schichten (Emsium und Eifelium) der Eifel, Rheinland. *Palaeontographica, Abteilung B*, **142**, 78–104.
- RODRIGUEZ, R. M. 1978a. Spores de la Formation San Pedro (Silurien–Devonien) à Corniero (Province de León, Espagne). *Revue de Micropaléontologie*, **20**, 216–221.
- 1978b. Miosporas de la Formación San Pedro/Furada (Silurico superior–Devonico Inferior), Cordillera Cantábrica, NO de España. *Palinología*, **1**, 407–433.
- 1983. *Palinología de las Formaciones del Silurico superior–Devonico inferior de la Cordillera Cantábrica*. Servicio de Publicaciones, Universidad de León, León, 231 pp.
- RODRIGUEZ, R., LOBOZIAK, S., MELO, J. H. G. and ALVES, D. B. 1995. Geochemical characterization and spore biostratigraphy of the Frasnian anoxic event in the Parnaíba Basin, northeast Brazil. *Bulletin des Centres de Recherches de Exploration-Production Elf-Aquitaine*, **19**, 319–327.
- RUBINSTEIN, C. and STEEMANS, P. 2002. Spore assemblages from the Silurian–Devonian boundary, in A1-61 borehole, Ghadames Basin, Libya. *Review of Palaeobotany and Palynology*, **118**, 397–421.
- 2007. New palynological data from the Devonian Villavicencio Formation Precordillera of Mendoza, Argentina. *Ameghiniana*, **44**, 3–9.
- and TORO B. A. 2006. Aeronian (Llandovery, Lower Silurian) palynomorphs and graptolites from the Lipeón Formation, Eastern Cordillera, north-west Argentina. *Geobios*, **39**, 103–111.
- MELO, J. H. G. and STEEMANS, P. 2005. Lochkovian (earliest Devonian) spores from the Solimões Basin, northwestern Brazil. *Review of Palaeobotany and Palynology*, **133**, 91–113.
- SANFORD, B. V. and NORRIS, A. W. 1975. Devonian stratigraphy of the Hudson Platform. *Geological Survey of Canada, Memoir*, **379**, 1–124.
- SCHEMEL, M. P. 1950. Carboniferous plant spores from Dagget County, Utah. *Journal of Paleontology*, **24**, 232–244.
- SCHOPF, J. M., WILSON, L. R. and BENTALL, R. 1944. An annotated synopsis of Paleozoic fossil spores and the definition of generic groups. *Illinois State Geological Survey, Report of Investigations*, **91**, 1–66.
- SCHRANK, E. 1987. Palaeozoic and Mesozoic palynomorphs from northeast Africa (Egypt and Sudan) with special reference to Late Cretaceous pollen and dinoflagellates. *Berliner Geowissenschaftliche Abhandlungen, A*, **75**, 249–310.
- SCHULTZ, G. 1968. Eine unterdevonische Mikroflora aus den Klerfer Schichten der Eifel (Rheinisches Schiefergebirge). *Palaeontographica, Abteilung B*, **123**, 4–42.
- SCOTTESE, C. R. 2000. PALEOMAP Project. <http://www.scotese.com/earth.html>.
- SCOTT, R. A. and DOHER, L. I. 1967. Palynological evidence for Devonian age of the Nation River Formation, east-central Alaska. *United States Geological Survey, Professional Paper*, **575B**, 45–49.
- SCOTT, D. L. and ROUSE, G. E. 1961. *Perforosporites*, a new genus of plant spores from the Lower Devonian of eastern Canada. *Journal of Paleontology*, **35**, 977–980.
- SHARLAND, P. R., ARCHER, R., CASEY, D. M., DAVIES, R. B., HALL, S. H., HEWARD, A. P., HORBURY, A. D. and SIMMONS, M. D. (eds). 2001. Arabian Plate sequence stratigraphy. *GeoArabia, Special Publication*, **2**, 371 pp.
- SMITH, A. H. V. 1971. Le genre *Verrucosisporites* Ibrahim 1933 emend. 35–87. In *Microfossiles organiques du Paléozoïque. Commission Internationale de Microflore du Paléozoïque, Spores*, 4. Editions du Centre National de la Recherche Scientifique, Paris, 114 pp.
- SOMERS, Y. 1972. Révision du genre *Lycospora* Schopf, Wilson and Bentall. 11–110. In *Microfossiles organiques du Paléozoïque. Commission Internationale de Microflore du Paléozoïque, Spores*, 5. Editions du Centre National de la Recherche Scientifique, Paris, 112 pp.
- SPINA, A. and VECOLI, M. 2009. Palynostratigraphy and vegetational changes in the Siluro-Devonian of the Ghadamis Basin, North Africa. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **282**, 1–18.
- STAPLIN, F. L. and JANSONIUS, J. 1964. Elucidation of some Paleozoic densosporites. *Palaeontographica, Abteilung B*, **114**, 95–117.
- STEEMANS, P. 1981. Etude stratigraphique des spores dans les couches de transition 'Gedinien–Siegenien' à Nonceveux et à Spa (Belgique). *Annales de la Société Géologique de Belgique*, **104**, 41–59.
- 1989. Palynostratigraphie de l'Eodévonien dans l'ouest de l'Europe. *Service Géologique de Belgique, Mémoires pour servir à l'Explication des Cartes Géologiques et Minières de la Belgique*, **27**, 453 pp.
- 1995. Silurian and Lower Emsian spores in Saudi Arabia. *Review of Palaeobotany and Palynology*, **89**, 91–104.
- 2000. Spore evolution from the Ordovician to the Silurian. *Review of Palaeobotany and Palynology*, **113**, 189–196.

- and GERRIENNE P. 1984. La micro- et macroflore du Gédinnien de la Gileppe, Synclinorium de la Vesdre, Belgique. *Annales de la Société Géologique de Belgique*, **107**, 51–71.
- LE HÉRISSE, A. and BOZDOGAN, N. 1996. Ordovician and Silurian cryptospores and spores from Southeastern Turkey. *Review of Palaeobotany and Palynology*, **93**, 35–76.
- DEBBAUT, V. and FABER, A. 2000a. Preliminary survey of the palynological content of the Lower Devonian in the Oesling, Luxembourg. *Bulletin de la Société de la Nature Luxembourgaise*, **100**, 171–186.
- HIGGS, K. T. and WELLMAN, C. H. 2000b. Cryptospores and trilete spores from the Llandoverly, Nuayyim-2 Borehole, Saudi Arabia. 92–115. In AL-HAJRI, S. A. and OWENS, B. (eds). *Stratigraphic palynology of the Palaeozoic of Saudi Arabia*. GeoArabia, Special Publication, **1**, 231 pp.
- RUBINSTEIN, C. and MELO, J. H. G. 2008. Siluro-Devonian spore biostratigraphy of the Urubu River area, western Amazon Basin, northern Brazil. *Geobios*, **41**, 263–282.
- PETUS, E., BREUER, P., MENDLOWICZ MAULLER, P. and GERRIENNE, P. 2012. Palaeozoic innovations in the micro- and megafossil plant record: from the earliest plant spores to the earliest seeds. 437–477. In TALENT, J. A. (ed.). *Extinction intervals and biogeographic perturbations through time earth and life*. Springer, Heidelberg, 1107 pp.
- BREUER, P., PRESTIANNI, C., PETUS, E., VILLE DE GOYET, F. DE. and GERRIENNE, P. 2011b. Diverse assemblages of Mid Devonian megaspores from Libya. *Review of Palaeobotany and Palynology*, **165**, 154–174.
- STEINEKE, M., BRAMKAMP, R. A. and SANDER, N. J. 1958. Stratigraphic relations of Arabian oil. 1294–1329. In WEEKS, L. G. (ed.). *Habitat of oil: a symposium conducted by the American Association of Petroleum Geologists*. American Association of Petroleum Geologists, Tulsa, 1384 pp.
- STREEL, M. 1964. Une association de spores du Givétien inférieur de la Vesdre, à Goé (Belgique). *Annales de la Société Géologique de Belgique*, **87**, 1–30.
- 1965. Techniques de préparation des roches détritiques en vue de l'analyse palynologique quantitative. *Annales de la Société Géologique de Belgique*, **88**, 107–117.
- 1967. Associations de spores du Dévonien inférieur belge et leur signification stratigraphique. *Annales de la Société Géologique de Belgique*, **90**, 11–53.
- 1972. Dispersed spores associated with *Leclercqia complexa* Banks, Bonamo and Grierson from the late Middle Devonian of eastern New York State (U.S.A.). *Review of Palaeobotany and Palynology*, **14**, 205–215.
- and LOBOZIAK S. 1987. Nouvelle datation par spores du Givétien-Frasnien des sédiments non marins du sondage de Boischot (Bassin de Campine, Belgique). *Bulletin de la Société belge de Géologie*, **96**, 99–106.
- — 1996. Middle and Upper Devonian spores. 575–587. In JANSONIUS J. and MCGREGOR, D. C. (eds). *Palynology: principles and applications*, Vol. 2. American Association of Stratigraphic Palynologists Foundation, Dallas, 910 pp.
- and PAPROTH E. 1982. Mitteldevonische Sporen aus der Bohrung Schwarzbachtal 1. *Senckenbergiana Lethaea*, **63**, 175–181.
- FAIRON-DEMARET, M., OTAZO-BOZO, N. and STEEMANS, P. 1981. Etude stratigraphique des spores du Dévonien inférieur au bord sud du Synclinorium de Dinant (Belgique) et leurs applications. *Annales de la Société Géologique de Belgique*, **104**, 173–191.
- HIGGS, K., LOBOZIAK, S., RIEGEL, W. and STEEMANS, P. 1987. Spore stratigraphy and correlation with faunas and floras in the type marine Devonian of the Ardenno-Rhenish regions. *Review of Palaeobotany and Palynology*, **50**, 211–229.
- PARIS, F., RIEGEL, W. and VANGUESTAINE, M. 1988. Acritarch, chitinozoan and spore stratigraphy from the Middle and Late Devonian of northeast Libya. 111–128. In EL-ARNAUTI, A., OWENS, B. and THUSU, B. (eds). *Subsurface palynostratigraphy of Northeast Libya*. Garyounis University Press Publications, Benghazi, 276 pp.
- FAIRON-DEMARET, M., GERRIENNE, P., LOBOZIAK, S. and STEEMANS, P. 1990. Lower and Middle Devonian spore-based stratigraphy in Libya and its relation to the megaflores and faunas. *Review of Palaeobotany and Palynology*, **66**, 229–242.
- LOBOZIAK, S., STEEMANS, S. and BULTYNCK, P. 2000. Devonian spore stratigraphy and correlation with the global stratotype sections and points. 9–23. In BULTYNCK, P. (ed.). *Subcommission on Devonian stratigraphy. Fossil groups important for boundary definition*, **220**. Courier Forschungsinstitut Senckenberg, Frankfurt am Main, 205 pp.
- STROTHER, P. K. and TRAVERSE, A. 1979. Plant microfossils from the Llandoveryan and Wenlockian rocks of Pennsylvania. *Palynology*, **3**, 1–21.
- STUMP, T. E., AL-HAJRI, S. A. and VAN DER EEM, J. G. L. A. 1995. Geology and biostratigraphy of the Late Precambrian through Palaeozoic sediments of Saudi Arabia. 5–17. In OWENS, B., AL-TAYYAR, H., VAN DER EEM, J. G. L. A. and AL-HAJRI, S. A. (eds). *Palaeozoic palynostratigraphy of the Kingdom of Saudi Arabia*. Review of Palaeobotany and Palynology, **89**, 150 pp.
- TAUGOURDEAU-LANTZ, J. 1960. Sur la microflore du Frasnien Inférieur de Beaulieu (Boulonnais). *Revue de Micropaléontologie*, **3**, 144–154.
- 1967. Spores nouvelles du Frasnien du Bas Boulonnais (France). *Revue de Micropaléontologie*, **10**, 48–60.
- TAYLOR, W. A., GENSEL, P. G. and WELLMAN, C. H. 2011. Wall ultrastructure in three species of the dispersed spore *Emphanisporites* from the Early Devonian. *Review of Palaeobotany and Palynology*, **163**, 264–280.
- TEKBALI, A. O. and WOOD, G. D. 1991. Silurian spores, acritarchs and chitinozoans from the Bani Walid Borehole of the Ghadames Basin, northwest Libya. 1243–1273. In SALEM, M. J., HAMMUDA, O. S. and ELIAGOUBI, B. A. (eds). *The geology of Libya*, Vol. IV. Elsevier, Amsterdam, 1648 pp.
- THOMSON, P. W. and PFLUG, H. 1953. Pollen und Sporen des Mitteleuropäischen Tertiärs. *Palaeontographica, Abteilung B*, **94**, 1–138.
- TIWARI, R. S. and SCHAARSCHMIDT, F. 1975. Palynological studies in the Lower and Middle Devonian of the Prüm Syncline, Eifel (Germany). *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, **534**, 1–129.

- TRAVERSE, A. 2007. *Paleopalynology*, Second edition. Springer, Heidelberg, 814 pp.
- TROTH, I., MARSHALL, J. E. A., RACEY, A. and BECKER, R. T. 2011. Devonian sea-level change in Bolivia: a high palaeolatitude biostratigraphical calibration of the global sea-level curve. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **304**, 3–20.
- TURNAU, E. 1986. Lower to Middle Devonian spores from the vicinity of Pionki (Central Poland). *Review of Palaeobotany and Palynology*, **46**, 311–354.
- 1996. Spore stratigraphy of Middle Devonian deposits from Western Pomerania. *Review of Palaeobotany and Palynology*, **93**, 107–125.
- and MATYJA H. 2001. Timing of the onset of Devonian sedimentation in northwestern Poland: palynological evidence. *Annales Societatis Geologorum Poloniae*, **71**, 67–74.
- and RACKI G. 1999. Givetian palynostratigraphy and palynofacies: new data from the Bodzentyn Syncline (Holy Cross Mountains, central Poland). *Review of Palaeobotany and Palynology*, **106**, 237–271.
- MILACZEWSKI, L. and WOOD, G. D. 2005. Spore stratigraphy of Lower Devonian and Eifelian (?), alluvial and marginal marine deposits of the Radom-Lublin area (central Poland). *Annales Societatis Geologorum Poloniae*, **75**, 121–137.
- VAN DER ZWAN, C. J. 1979. Aspects of Late Devonian and Early Carboniferous palynology of southern Ireland. I. The *Cyrtospora cristifer* morphon. *Review of Palaeobotany and Palynology*, **28**, 1–20.
- VAN VEEN, P. M. 1981. Aspects of Late Devonian and Early Carboniferous palynology of southern Ireland. IV. Morphological variation within *Diducites*, a new form-genus to accommodate camerate spores with two-layered outer wall. *Review of Palaeobotany and Palynology*, **31**, 261–287.
- VECOLI, M., DELABROYE, A., SPINA, A. and HINTS, O. 2011. Cryptospore assemblages from Upper Ordovician (Katian–Hirnantian) strata of Anticosti Island, Québec, Canada, and Estonia: palaeophytogeographic and palaeoclimatic implications. *Review of Palaeobotany and Palynology*, **166**, 76–93.
- VIGRAN, J. O. 1964. Spores from Devonian deposits, Mimerdalen, Spitsbergen. *Norsk Polarinstitutt, Skrifter*, **132**, 1–30.
- VILLE DE GOYET, F. DE., BREUER, P., GERRIENNE, P., STEEMANS, P. and STREEL, M. 2007. Middle Devonian (Givetian) megaspores from Belgium (Ronquières) and Libya (A1-69 borehole). 68–73. In STEEMANS, P. and JAVAUX, E. (eds). *Pre-Cambrian to Palaeozoic palaeopalynology and palaeobotany*. Carnets de Géologie/Notebooks on Geology, Memoir, **2007/01**, 73 pp.
- WALLACE, C. A., DINI, S. M. and AL-FARASANI, A. A. 1996. *Explanatory notes to the geological map of the Ash Shuwahitiyah Quadrangle, Kingdom of Saudi Arabia*. Geoscience Map GM-126C, scale 1:250,000, sheet 30D. Deputy Ministry for Mineral Resources, Ministry of Petroleum and Mineral Resources, Kingdom of Saudi Arabia, 27 pp.
- — — 1997. *Explanatory notes to the geological map of the Al Jawf Quadrangle Kingdom of Saudi Arabia*. Geoscience Map GM-128C, scale 1:250,000, sheet 29D. Deputy Ministry for Mineral Resources, Ministry of Petroleum and Mineral Resources, Kingdom of Saudi Arabia, 31 pp.
- WELLMAN, C. H. 1993. A Lower Devonian sporomorph assemblage from the Midland Valley of Scotland. *Transactions of the Royal Society of Edinburgh: Earth Sciences*, **84**, 117–136.
- 2001. Morphology and ultrastructure of Devonian spores: *Samarisporites* (*Cristatisporites*) *orcadensis* (Richardson) Richardson, 1965. 87–108. In GERRIENNE, P. and BERRY, C. M. (eds). *Contributions to early land plant research*. Review of Palaeobotany and Palynology, **116**, 158 pp.
- 2002. Morphology and wall ultrastructure in Devonian spores with bifurcate-tipped processes. *International Journal of Plant Sciences*, **163**, 451–474.
- 2006. Spore assemblages from the Lower Devonian 'Lower Old Red Sandstone' deposits of the Rhynie outlier, Scotland. *Transactions of the Royal Society of Edinburgh: Earth Sciences*, **97**, 167–211.
- 2009. Ultrastructure of dispersed and *in situ* specimens of the Devonian spore *Rhabdosporites langii*: evidence for the evolutionary relationships of progymnosperms. *Palaeontology*, **52**, 139–167.
- and GENSEL P. G. 2004. Morphology and wall ultrastructure of the spores of the Lower Devonian plant *Oocampsa catheta* Andrews *et al.*, 1975. 269–295. In SERVAIS, T. and WELLMAN, C. H. (eds). *New directions in Palaeozoic palynology*. Review of Palaeobotany and Palynology, **130**, 299 pp.
- and RICHARDSON J. B. 1993. Terrestrial plant microfossils from Silurian inliers of the Midland Valley of Scotland. *Palaeontology*, **36**, 155–193.
- — 1996. Sporomorph assemblages from the 'Lower Old Red Sandstone' of Lorne Scotland. 41–101. In CLEAL C. J. (ed.). *Studies on early land-plant spores from Britain*. Special Papers in Palaeontology, **55**, 145 pp.
- HIGGS, K. T. and STEEMANS, P. 2000a. Spores assemblages from a Silurian sequence in Borehole Hawiyah-151 from Saudi Arabia. 116–133. In AL-HAJRI, S. A. and OWENS, B. (eds). *Stratigraphic palynology of the Palaeozoic of Saudi Arabia*. GeoArabia, Special Publication, **1**, 231 pp.
- HABGOOD, K., JENKINS, G. and RICHARDSON, J. B. 2000b. A new plant assemblage (microfossil and megafossil) from the Lower Old Red Sandstone of the Anglo-Welsh Basin: its implications for the palaeoecology of early terrestrial ecosystems. *Review of Palaeobotany and Palynology*, **109**, 161–196.
- WILSON, L. R. and COE, E. Z. 1940. Descriptions of some unassigned plant microfossils from the Des Moines Series of Iowa. *The American Midland Naturalist*, **23**, 182–186.
- WINSLOW, M. R. 1962. Plant spores and other microfossils from Upper Devonian and Lower Mississippian rocks of Ohio. *United States Geological Survey, Professional Paper*, **364**, 1–93.

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Printed in Singapore by Ho Printing Pte Ltd

ISSN 0038-6804

