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GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

BULLETIN 76

SPORES WITH PROXIMAL RADIAL PATTERN FROM THE DEVONIAN OF CANADA

D. C. McGregor

Price, 75 cents

1961

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2,500—1960—1817

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PRINTED BY THORN PRESS
UNDER THE AUTHORITY OF
ROGER DUHAMEL, F.R.S.C., QUEEN'S PRINTER
OTTAWA, CANADA, 1961

Price 75 cents **Cat. No. M42-76**

PREFACE

Because of their wide distribution, distinctive characters, and relatively restricted time range, some fossil spores probably come nearer than any other fossils to satisfying the ideal conditions for use in stratigraphic correlation. This report describes the morphology and occurrence of a group of spores of Devonian age.

J. M. HARRISON,
Director, Geological Survey of Canada

OTTAWA, October 31, 1960

CONTENTS

SPORES WITH PROXIMAL RADIAL PATTERN FROM THE DEVONIAN OF CANADA

Abstract

Five species and one additional type of spores of Devonian age are included in a new genus, *Emphanisporites*. All but one of the species of spores described are new. They are characterized by radially disposed thickenings of the proximal wall.

The wide geographic extent of spores of this genus, whose parents have not yet been recognized, is evidence of an ubiquitous floral element existing contemporaneously with the so-called "*Psilophyton* flora". Available evidence restricts the range of *Emphanisporites* to the Lower and Middle Devonian.

Résumé

Un nouveau genre, *Emphanisporites*, comprend cinq espèces et un type supplémentaire de spores d'âge dévonien. Toutes les espèces de spores décrites sauf une sont nouvelles. Elles se caractérisent par des épaississements de la paroi proximale disposés radialement.

La grande répartition géographique des spores de ce genre, dont on n'a pas encore identifié les parents, témoigne d'un élément floral qui se rencontre partout et qui remonte à la même époque que ce qui est appelé «*psilophyton* flora». Les renseignements disponibles limitent les *Emphanisporites* au Dévonien inférieur et moyen.

INTRODUCTION

During the initial stages of study of miospores from the Battery Point formation (Gaspé Sandstone group), the writer encountered numerous trilete miospores with radially disposed ridges on their proximal face. Subsequently, collateral material was found in several sedimentary deposits of Lower and Lower-Middle Devonian age from the Gaspé region and elsewhere in Canada. In all, six spore forms of this complex have been discovered. They possess the common feature of radiating ridges or ribs that extend over the complete proximal part of the spore wall. These ridged spores, in company with a diversified population of small spores of other types, occur abundantly in the early Devonian strata so far examined. The material described in this paper is from widely separated localities in Ontario, New Brunswick and Quebec. Five species are described, as well as a form which is so far represented by only two specimens. Data on their occurrence and associated plant megafossils are summarized in Table I. A brief historical and geological account of the Gaspé and Campbellton beds is given in McGregor (1959). For fuller treatment of the geology of the Gaspé Sandstones *see* McGerrigle's more comprehensive report (1950). The Sextant formation has been reviewed by Martison, *et al.* (1953, pp. 29-30), and the Onondaga formation by Oliver (1960). The geology of the Devonian rocks of the Becaguimec River and 17-Mile Brook is being revised by officers of the Geological Survey of Canada and of the Quebec Bureau of Mines. With the exception of the Onondaga (Lower to Middle Devonian), all these beds are regarded as Lower Devonian.

The writer began palynological investigation of the Battery Point, Sextant and Onondaga formations in 1953 while at McMaster University, Hamilton, Ontario, at the suggestion of Professor N. W. Radforth whose advice and encouragement are gratefully acknowledged. The results were incorporated in a Ph.D. thesis in 1957. The National Research Council of Canada provided financial aid from 1953 to 1957. Since joining the staff of the Geological Survey of Canada the writer has extended observations to include the other strata listed in Table I.

Preparation of samples. The samples, consisting of siliceous limestone, sandstone, shale, and mudstone, were treated with mineral acids, Schulze's Reagent, and ammonium or potassium hydroxide. Both stained (with aqueous safranin) and unstained assemblages of spores were mounted on standard 1x3-inch glass slides, using corn syrup as a mounting medium (Rouse, 1959), and, more recently, using Hoyer's Solution with a cover glass (Anderson, 1954) which gives a stable, water-soluble preparation.

Table I

Known Localities of *Emphanisporites* in Canada

Formation	Geographic Location	Spore Species	Associated Megafossil Plants
Battery Point (Gaspé ss. group)	Anse-à-Brillant and d'Aiguillon, Gaspé Peninsula, Quebec. Geol. Surv., Canada, plant locality 5018.	*E. rotatus* *E. erraticus* *E. robustus* *E. quaesitus* *E.* sp.	*Psilophyton princeps* var. *ornatum* Dawson *Trimerophyton robustius* (Dawson) Hopping *Hostimella* sp.
York River (Gaspé ss. group)	25.3 miles west of Gaspé village, road-cut. GSC 5091.	*E. rotatus*	Indeterminable fragments
Sextant	Abitibi River, Ontario, east and west sides below Sextant Rapids.	*E. rotatus* *E. erraticus* *E. annulatus*	*Drepanophycus spinaeformis* Goeppert *Aphyllopteris* sp.
Onondaga	Norfolk county, Ontario, from core, exact stratigraphic position unknown.	*E. rotatus* *E. robustus* *E. obscurus*	None
17-Mile Brook beds	17-Mile Brook, central Gaspé Peninsula, Quebec. GSC 5012.	*E. rotatus*	*Taeniocrada* cf. *T. dubia* Kräusel and Weyland *Hostimella* sp. *Aphyllopteris* sp.
Unnamed beds, Becaguimec River	Becaguimec River, Carleton county, New Brunswick. GSC 5016, 5019.	*E. rotatus* *E. erraticus*	*Drepanophycus* (?) *crepini* Stockmans *Drepanophycus spinaeformis* Goeppert *Psilophytites* sp. (*Psilophyton* ?) *Hostimella* sp.
Campbellton 'beds'	Pointe-à-la-Garde, Restigouche River, Quebec. GSC 5206.	*E. rotatus*	*Drepanophycus spinaeformis* Goeppert

DESCRIPTION OF SPORES

Genus *Emphanisporites* n. gen.

Type species. *Emphanisporites rotatus* n. sp.

Diagnosis. Spore trilete, subtriangular to subcircular in transverse view. Ornamented proximally by radially disposed ridges that extend almost to the equator of the spore and are present on both the radial and interradial regions.

Comparisons. Emphanisporites differs from *Costaspora* Staplin and Jansonius (Staplin, 1960) in possessing ridges at the radial extremities, and in restriction of the ridges to the proximal hemisphere. It differs from *Radiaspora* Hoffmeister, *et al.* ex Balme (1961) in possessing proximal rather than distal ribs.

Emphanisporites rotatus n. sp.

Plate I, numbers 1 to 4

Type E17, Radforth and McGregor, 1954, p. 611, Pl. II, fig. 37.

Trilete spore with radial spoke-like thickenings on the proximal face, extending from the proximal pole to the equator. Number of ribs on each interradial sector 4 to 8. Distal part of spore laevigate. Laesurae extend to or almost to equator of spore. Wall thickness variable, from 1μ to 4μ or more, exclusive of proximal ridges. Spore rarely folded but occasionally compressed laterally. Range of greatest diameter (sixty-six specimens) 33 to 60μ.

Type. Holotype, Plate I, number 1, 42μ. Battery Point formation, Gaspé Peninsula. Slide 28-19, McMaster University Palaeobotanical Collection (MPC). Paratype, Plate I, number 2. Sextant formation, Ontario. Slide C-1-5, MPC.

Occurrence. Battery Point, York River, Sextant, and Onondaga formations; Campbellton, Becaguimec River, and 17-Mile Brook 'beds'.

Emphanisporites annulatus n. sp.

Plate I, numbers 5 and 6

Unnamed specimen, Radforth and McGregor, 1956, Pl. I, fig. 6.

Trilete spore with spoke-like thickenings on the proximal face, extending from the proximal pole as far as, but not over, the equator. On the distal part of the spore is an annulate thickening concentric to the equator, up to 6μ wide, situated about one third the distance from the equator towards the distal pole. Distal

wall laevigate. Laesurae about as long as the radius of the spore, sometimes not well defined. Spore rarely folded, and only occasionally laterally compressed. Range of greatest diameter (thirty specimens) 34 to 54μ.

Type. Holotype, Plate I, number 5, 44μ. Sextant formation, Ontario. Slide C-1-5, MPC.

Occurrence. Sextant formation.

Emphanisporites erraticus (Eisenack) n. comb.

Plate I, numbers 7 to 11

Triletes erraticus (Sporentyp K) Eisenack, 1944, p. 114, Pl. 2, fig. 9.
Unnamed specimen, Radforth and McGregor, 1954, Pl. II, fig. 59.
Unnamed specimen, Radforth and McGregor, 1956, Pl. III, fig. 17.

Trilete spore with proximally situated radiating ridges which extend from an equatorially situated thickened girdle towards the proximal pole. Ridges tend to converge at loci located in each interradial sector, about three quarters of the distance to the pole. On some specimens, shorter ridges radiate from these loci towards the laesurae. On the distal part of the spore is a second annulate thickening concentric to the equatorial one, located about halfway between the equator and the pole. Spore wall laevigate (Pl. I, No. 7) to granular (Pl. I, No. 11). Laesurae almost as long as the radius. Observed range of greatest dimension (eighteen specimens) 40 to 80μ. Eisenack's (1944) single specimen ca. 90μ.

Type. Lectotype, Eisenack (1944), p. 114, Pl. 2, fig. 9. Paratypes, Plate I, number 7, 68μ; number 11, 68μ. Sextant formation, Ontario. Slide A-3-3, MPC.

Occurrence. Battery Point and Sextant formations, and Becaguimec River 'beds'; glacial erratic from Estonia (Eisenack, 1944).

Emphanisporites robustus n. sp.

Plate I, number 13

Trilete spore with prominent radiating ridges that extend from the proximal pole as far as, but not over, the equator. Ridges widen to as much as 9μ near the equator, and may be up to 3μ high. Distal wall laevigate. Laesurae extend almost to the equator, are often obscured by the strongly developed radial bands. Wall up to 5μ thick equatorially, exclusive of ridge thickness. Range of maximum diameter (twelve specimens) 51 to 78μ.

Type. Holotype, Plate I, number 13, 68μ. Battery Point formation, Gaspé Peninsula. Slide 28-12, MPC.

Occurrence. Battery Point and Onondaga formations.

Emphanisporites obscurus n. sp.

Plate I, number 14

Trilete spore with indistinct radiating spoke-like pattern (ridges?) extending from the proximal pole to the equator. The pattern is assumed to represent ridges that are imperceptibly raised above the surface of the spore. Distal wall laevigate. Laesurae distinct, extending almost to the equator of the spore. Range of greatest diameter (eight specimens) 61 to 76μ.

Type. Holotype, Plate I, number 14, 76μ. Onondaga formation, Ontario. Slide 432-15, MPC.

Occurrence. Onondaga formation.

Emphanisporites sp.

Plate I, number 12

Trilete spore with proximal ridges aligned approximately parallel to one another, extending from the equator to the margin of the commissure forming a 'herring-bone' pattern. Laesurae distinct, as long as the radius of the spore. Maximum diameters of the two observed specimens, 51μ and 55μ. Slide 28-14, MPC.

Occurrence. Battery Point formation.

DISCUSSION

The single specimen which Eisenack (1944) named *Triletes erraticus* came from an erratic boulder judged by him to be of Middle or Upper Devonian age (ibid., and personal communication). Eisenack arrived at his conclusion regarding the age of the specimen partly on the basis of the presence of Lang's spore type G, which made up the bulk of the spores in the assemblage. On this evidence, *T. erraticus* could be as old as early Middle Devonian, since Eisenack (ibid., p. 116) also discovered spores similar to Lang's type G in Eifelian deposits of Wetteldorf (Germany), thus establishing the presence of the grapnel-spine feature at least as early as the Eifelian. The occurrence of type G with *Emphanisporites* (*Triletes*) *erraticus* in a Middle Devonian boulder would therefore not be surprising. Furthermore, *E. erraticus* has not been reported by other workers during studies of Eifelian or post-Eifelian deposits (Lang, 1925; Richardson, 1960; and others) whereas the grapnel-spine feature is a characteristic one in assemblages of this age. *E. erraticus* may therefore have been near the upper limit of its range where Eisenack found it. Perhaps it was for this reason that he found only one specimen in his preparations. The species certainly is not rare in the Sextant formation or the Gaspé Sandstone. It seems therefore to be mainly a Lower Devonian species, abundant at least locally in beds of early Devonian (Emsian) age in North America, and present but rarely in the Middle Devonian (Eifelian?).

The reason for the absence of *E. erraticus* (or any other species of the genus) in Thompson's "unter Koblenz" preparations (1952) from Münstereifel is conjectural. The Ontario, Quebec and New Brunswick strata that contain it may be younger than the Münstereifel beds, in which case the geological range of *Emphanisporites* is further restricted. Alternatively palæogeographic factors may have restricted its distribution in the lower Emsian.

There are few records in the literature of spores resembling *E. rotatus*. Naumova (1953) illustrated one specimen of lower Givetian age, labelling it *Stenozonotriletes ornatissimus* but giving no description. Since she made no reference to any diagnosis or type specimen, and since efforts to obtain information by correspondence have not been successful, it is not possible to assess her specimen accurately. More recently, Chibrikova (1959, p. 79) described *S. ornatissimus* and established a holotype. Her description conforms closely to that of *Emphanisporites rotatus* except that one still is not told whether the radiating pattern of *S. ornatissimus* is proximal or distal. The pattern does cover one hemisphere of the spore which is also true for *Emphanisporites*. Chibrikova (loc. cit.) mentioned the similarity of the Russian species to *Orbiactinotriletes mosoloviensis* of Zharkova (1952), a paper not seen by the present author.

If the spore mentioned and figured as "An unpublished genus of Stanley age . . ." (Namurian) by Hoffmeister, Staplin and Malloy (1955) does in fact

possess radial ribs on its *distal* side, it would depart rather radically from the proximally patterned spores described here. Hoffmeister kindly examined photographs of some of the Gaspé specimens and stated that they ". . . definitely do not belong to the genus 'Radiaspora' as noted by Hoffmeister, Staplin and Malloy in 1955" (personal communication).

Balme (in press) has recently validated the name *Radiaspora,* based on material from marine Frasnian sediments of western Australia. The type species, *Radiaspora aprica* Balme, is ornamented on the distal side by radiating ridges. *Radiaspora* therefore differs markedly from *Emphanisporites* in the position of the ribs. The Upper Devonian spore labelled *Rotaspora* which is illustrated in "Coal Research in C.S.I.R.O." (1958) is probably a *Radiaspora.* The Jurassic species *Heterolateritriletes incertus* (Bolch.) Sladkov (1960) is probably not related to either *Emphanisporites* or *Radiaspora.*

Radiaspora Hoffmeister, *et al.* ex Balme must, according to published records, be regarded as an Upper Devonian genus. Its occurrence in Givetian deposits is tentative until such time as the distal position of the ribs or costae on specimens of this age is proved. Regarding the specimen figured in 1955, Hoffmeister (personal communication) has observed that the material from which it was prepared is probably older than Stanley (Namurian).

Emphanisporites on the other hand is abundant in certain Lower Devonian strata in Canada, and has not been detected in any beds of definite Middle or Upper Devonian age examined by the author. The one specimen that has been reported from Europe is probably no older than Eifelian (Eisenack, 1944), and *Stenozonotriletes ornatissimus* Naumova ex Chibrikova would be a lower Givetian record if its ribbed pattern is proximal.

The existence of both proximally and distally ribbed spores would present a problem in interpretation of the structure of dispersed specimens, as it is often not easy to distinguish the position of the ribs on strongly flattened individuals, unless they happen to have been compressed in any plane other than the transverse plane.

The somewhat fold-like appearance of the radiating pattern of some specimens of *E. rotatus* (Pl. I, No. 1) introduced the possibility that the spores may be radially folded rather than ridged. Re-examination of the Canadian specimens of *Emphanisporites* again forced the conclusion that the 'ridges' are truly thickenings of the proximal wall. This feature is most obvious on tipped specimens, and is readily confirmed for *E. rotatus, E. annulatus* and *E. erraticus* by inspection of Plate I, numbers 2, 6 and 9. The ridged character of *E. erraticus* was so interpreted by Eisenack (1944).

One may speculate concerning the botanical implications of the *Emphanisporites* complex, but most conclusions must be tentative. Opinions are by no means unanimous concerning the degree to which spore features parallel criteria used to separate the natural plant groups. Neither is there agreement as to whether spores may represent variations equivalent to familial, generic, or even

specific differences in sporophyte parents. There is, however, considerable evidence that certain features of mature living and fossil spores are associated with particular plant taxa. Chaloner (1957) quotes several examples which support the consistency of fossil spores as indicators of natural species, and Harris (1955, p. 9), considering present-day pteridophytes, states that ". . . features of the spore coat provide, in many cases, constant characters by which the parent genus or even species may be recognized".

For the various species of *Emphanisporites,* their distinctive ribbing and their apparently relatively restricted geological range do suggest a rather close phyletic relationship. It seems reasonable to suppose that several species of plants, perhaps diverging from a common type in earliest Devonian or earlier, could have produced the several observed variants of proximally ribbed spores, and then become extinct during the Middle Devonian. Persistence of the parents or derivatives of the complex into later time would surely have been accompanied by records of proximally ribbed spores. *Costaspora* Staplin and Jansonius (Staplin, 1960) of Chester age may be a relict form; if this is true, some evidence of the spores in the intervening time might be expected. Any affinity between *Costaspora* and *Emphanisporites* is probably remote however, since Staplin (personal communication) regards *Costaspora* as a specialized type of *Granulatisporites* with fine proximal striation.

Present evidence affords a tempting comparison between *Emphanisporites* and the various genera with grapnel-tipped spines (*Archaeotriletes, Nikitinsporites, Hystricosporites, Ancyrospora,* etc.). Proximal radial ridges of the *Emphanisporites* type and grapnel-spines appear to be largely, if not completely, restricted to the Devonian period. They are tantalizingly suggestive of megafloral components which were widespread in Lower-to-Middle Devonian and Middle-to-Upper Devonian floras respectively. Unfortunately, none of the Devonian sporangia from which spores have been recognized has contained spores even suggestive of either of these groups (except *Kryshtofovichia africani* Nikitin (1934) which has not been proven to have lycopsid affinities).

Emphanisporites spp., as well as *Archaeotriletes* spp., etc., may eventually be assignable to plant taxa of which representatives are already known as megafossils. There may exist for example a demonstrable affiliation between *Emphanisporites* and elements of the so-called "*Psilophyton* flora". On the other hand, they may express a segment of the Devonian vegetation as yet undetected in the megafossil record. The most obvious explanation for the latter possibility would be that they represent herbaceous and/or upland elements. As a group, their parents must have been adapted to a broad range of habitat, or if not, their preferred environment must have been widespread in the Devonian period. *Emphanisporites* has been recognized in almost all the Lower Devonian spore assemblages of Eastern Canada that have been examined by the writer, and the grapnel-spined spores have been reported from three continents. With only one exception (Eisenack, 1944) the ranges of the two complexes have not been found to overlap.

Such sporae dispersae of wide areal occurrence probably come nearer than any other fossils to satisfying conditions for regional chronostratigraphic correlation, assuming that fossils that occur in large numbers in very small volume of sediment, and in both marine and non-marine rocks, are more significant in this respect than those which do not. *Emphanisporites,* particularly certain species that are easily separable from *Radiaspora,* possesses the additional characteristic of very unusual construction, and hence is readily recognizable wherever it occurs. This is especially important for the early Devonian, where the worker might be expected to have to contend with an array of circular to triangular, laevigate to granular spores which, although exhibiting considerable multiplicity of type within these limits, possesses a relatively restricted scope of variable features (Radforth and McGregor, 1956).

Perhaps the most immediate practical implication of the *Emphanisporites* group would follow demonstration of its restriction to a narrow specific time range. Devonian rocks from several areas of Canada are being examined in order to support or emend the range suggested here, i.e., the equivalent of parts of the Emsian and Eifelian stages of Europe.[1]

[1]The graph for 'radial striations' shown by Radforth and McGregor, 1956, Plate I, requires some amendments to comply with the more recent observations outlined in the present paper.

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PLATE I

(All figures are ×500)

Numbers 1-4. *Emphanisporites rotatus* n. sp. 1, holotype, Battery Point formation, McMaster University Palaeobotanical Collection (MPC) slide 28-19; 2, paratype, tetrad, Sextant formation, MPC slide C-1-5; 3, specimen slightly tipped, MPC slide A-3-2; 4, specimen slightly tipped, MPC slide 28-12. (Page 3.)

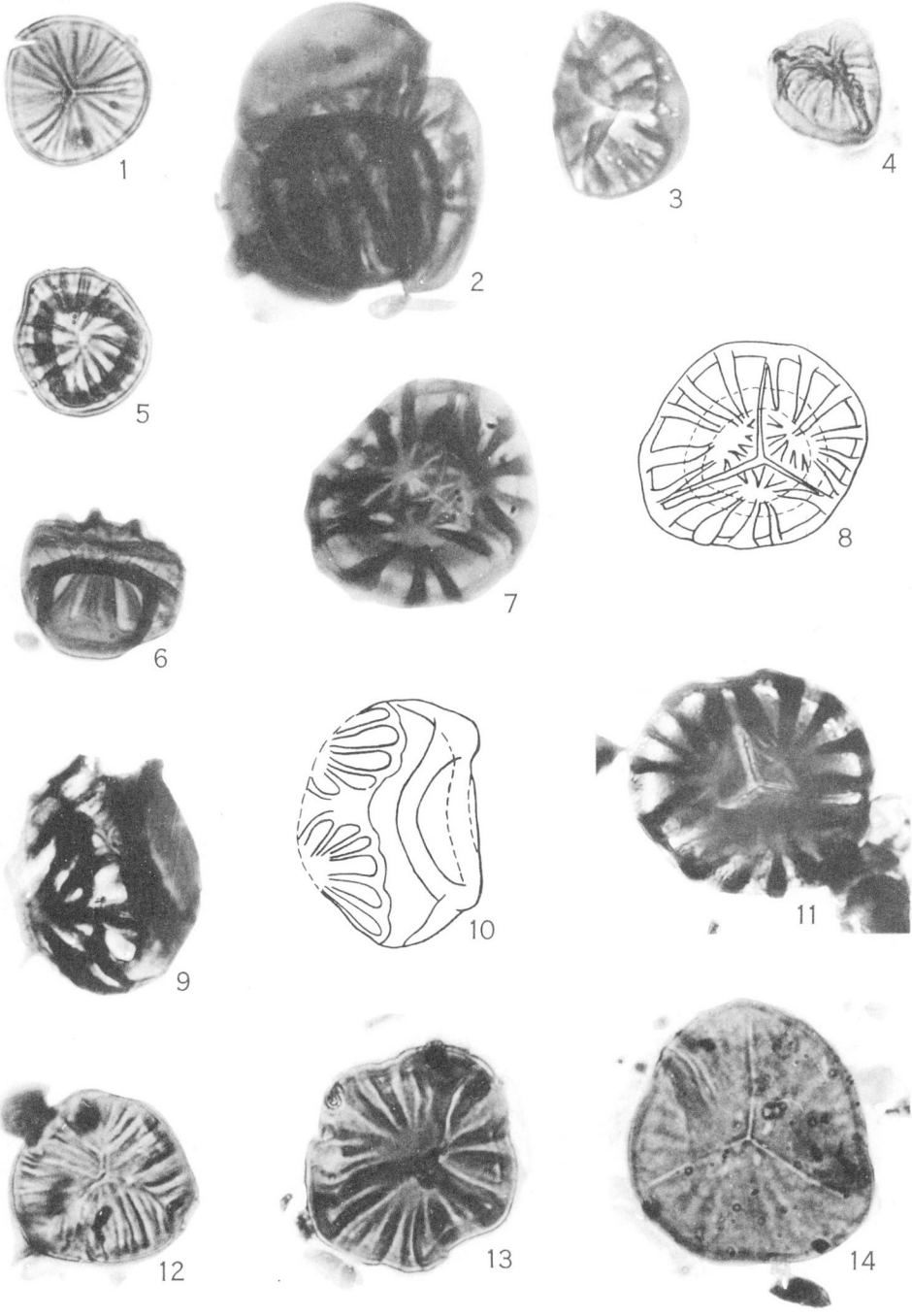
Numbers 5, 6. *Emphanisporites annulatus* n. sp. 5, holotype, Sextant formation, MPC slide C-1-5; 6, specimen laterally compressed, MPC slide C-1-6. (Page 3.)

Numbers 7-11. *Emphanisporites erraticus* (Eisenack) n. comb. 7, paratype, Sextant formation, MPC slide A-3-3; 8, proximal view, diagrammatic; 9, specimen laterally compressed, MPC slide A-3-3; 10, lateral view, diagrammatic; 11, paratype, Sextant formation, MPC slide A-3-3. (Page 4.)

Number 12. *Emphanisporites* sp. Battery Point formation, MPC slide 28-14. (Page 5.)

Number 13. *Emphanisporites robustus* n. sp. Holotype, Battery Point formation, MPC slide 28-12. (Page 4.)

Number 14. *Emphanisporites obscurus* n. sp. Holotype, Onondaga formation, MPC slide 432-15. (Page 5.)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