

ACRITARCHS FROM THE TAKORADI SHALE FORMATION OF THE SEKONDIAN GROUP

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Summary

Acritarchs have been recovered and described from the Lower Takoradi Shale Formation, Sekondi-Takoradi. The age of the formation has been established with reasonable certainty as Upper Devonian (Frasnian) by Anan-Yorke (1974) and Bar and Riegel (1974) principally from chitinozoans and microfloral assemblages respectively. The acritarchs do not give clear indication of the Frasnian age as comparison of the age of positively identified species to others documented elsewhere (North and South America, Australia, Europe) transgress the Frasnian/Famennian boundary, but certainly Upper Devonian. The abundant occurrence of the miospore species *Geminospora lemurata* Balme, supports the age assigned to the rocks by the above mentioned workers. The occurrence of members of a "recurrent species association" RSA (ie *Umbellaspahaeridium saharicum*, *Maranhites braziliensis* complex, *Navifusa bacillum*, *Stellinium micropolygonale* particularly in Ghana, West Africa and Brazil, South America on either sides of the Atlantic Ocean is supportive evidence of the contiguous positions of Africa and South America prior to the initiation of the continental drift in the late Jurassic period. The predominance of miospores over the acritarchs both in quantity and diversity indicate a near shore to continental environment for the assemblage.

Introduction

Located along the western and central coast of Ghana, the Sekondian Group (Fig.1) contains a varied sequence of disconnected and block faulted sedimentary rocks that range in age from Late Ordovician to Early Cretaceous and aggregates about 1,200m in thickness. A number of lithologic subdivisions have been defined by Crow (1952) within the Sekondian Group.

These are from bottom to top in the order of younging: Ajua Shales, Elmina Sandstone, Takoradi Sandstone, Takoradi Shale, Effia Nkwanta Beds, Lower Sekondi sandstone and the Upper Sekondi sandstone (Essikado Sandstone). The whole sequence overlies the Precambrian basement made up of hornblende granite, biotite granite, schists and granulites which are probably metamorphosed or partly granitized Birimian rocks. The Takoradi Shale formation is dominantly black and grey carbonaceous shales with some sandy shales and shaly sandstones. Also interbedded within these rocks are grits and fine grained sandstones with nodules of siderite and pyrite. The formation has a

thickness of about 200m.

Many faunal groups (brachiopods, mollusca, fish scales) have been reported by previous authors from the formation, Kitson (1928) and Cox (1964) and biostratigraphic evaluation of these has in the past led to age determinations ranging from Devonian to Carboniferous. Cox (op. cit.), however, was of the opinion that the fossil evidence did not give a clear confirmation of a Carboniferous age, but was equally, perhaps slightly more suggestive of the Devonian.

This paper describes and compares the acritarch assemblage of the well preserved palynoflora recovered from the outcrop samples of the Lower Takoradi Shales at New Takoradi beach with others reported from other parts of the world (North and South America, North Africa, Europe and Australia). It also attempts to assign an age to the formation.

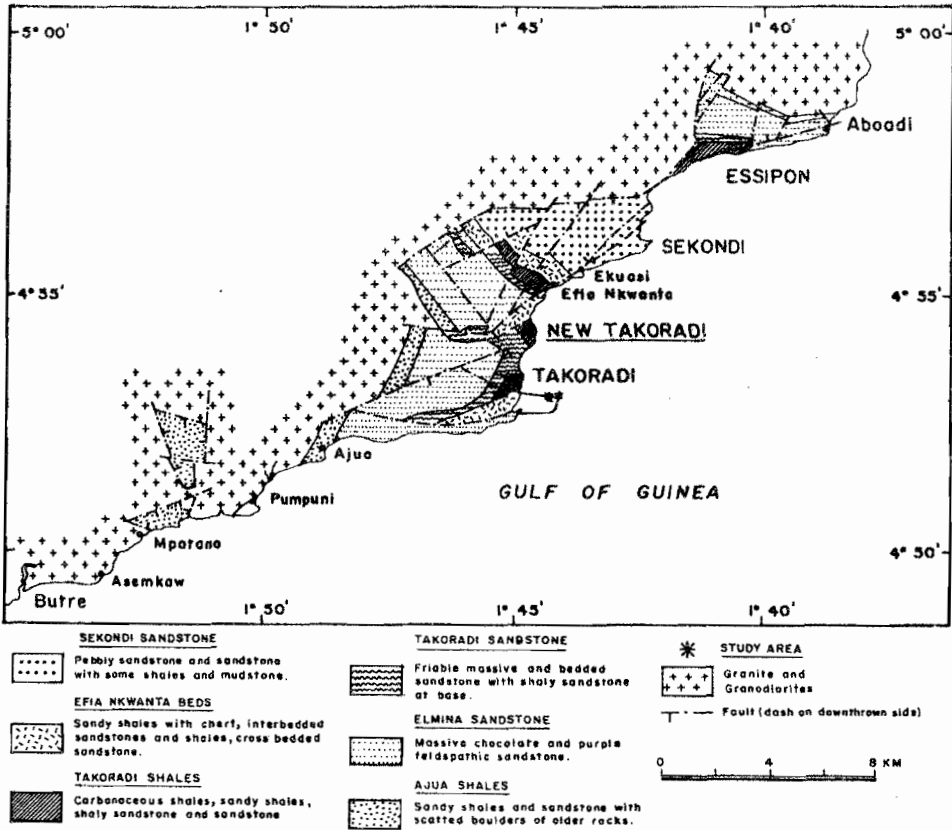


Fig. 1 Geological Map of the Sekondi Series, Sekondi-Takoradi Area (after Crow, 1952).

Previous palynological investigation

Bar and Riegel (1974) reported the occurrence of a predominately trilete spore assemblage from the Takoradi Shale Formation and proposed an Early Carboniferous age for the upper part of the formation and Late Devonian (Frasnian) age for the lower part of the formation.

Anan-Yorke (1974) based on chitinozoan and acritarch assemblages in samples from exploratory oil wells on the continental shelf and in the Keta Basin corresponding to the stratigraphic interval of the Takoradi Shales dated the lower part of the formation as early Late Devonian (Frasnian). Anan-Yorke (unpublished) has described the index miospore content of the upper part of the formation corresponding to continental facies and has dated it as Latest Devonian (Famennian Fa 2d to Late Strunian

Tn1b). Atta-Peters (unpublished) assigned a Latest Devonian (Late Strunian Tn1b) to Early Carboniferous (Tournaisian Tn2) age for the upper part of the formation at the Essipon beach.

Experimental

Lithologically, the samples consist mainly of dark grey shales and some sandy shales. All samples yielded abundant, reasonably well preserved assemblages of plant microfossils (acritarchs and miospores). Briefly the method involved the following:

- i. mechanical disintegration of about 10gms of each sample to sizes not exceeding 5mm in diameter.
- ii. treatment with dil. HCl (10%) to remove any carbonate present.
- iii. treatment with hydrofluoric acid (HF 40%) for 24 hrs or more to digest the silica-

- silicate content of the residue and release of organic matter.
- iv. oxidation of organic residue with Shultz solution (30ml saturated $KClO_3$ solution; 90ml conc. nitric acid (HNO_3) for 10 minutes.
 - v. treatment of oxidized residue with 2% Potassium hydroxide (KOH) to remove any humic compounds.
 - vi. concentration of organic residue containing palynomorphs in gelatin jelly and mounting for light microscopy.

In steps (ii) to (v) the residue is washed/centrifuged three times with distilled water after each reaction.

Systematic description

The acritarchs are generally arranged alphabetically by under the informal incertae sedis "groups" name Acritarcha.

Group ACRITARCHA Evitt, 1963

Genus *AMMONIDIUM* Lister, 1970
Ammodium sp. A. Plate 1, Figure B.

Description: Vesicle circular, with numerous (about 30 approximately) equally spaced processes crossing the outline of vesicle. Processes hollow, opening into vesicle; gradually tapering and terminating in terrafurcate filament curved inward. Processes 10-16 μ long and 1.5-2 μ wide at base; laevigate and opening into vesicle cavity.

Dimensions: Vesicle diameter 30 μ -36 μ , mean 34 μ (5 specimens measured).

Genus *BALTISPHAERIDIUM*. Eisenack, 1969
Baltisphaeridium cf. *distentum* Playford, 1977. Plate 1, Figure E.

Description: Vesicle subcircular granulate bearing six hollow, thin walled transparent and discrete processes emanating from vesicle wall 1.5 μ thick, with constricted contacts. Processes scabrate to granulate tapering gradually with a few displaying forked terminations. No commutation between the hollow processes and the vesicle due to development of basal plugs. Processes 35-54 μ long and 4-6 μ wide at base.

Dimensions: Vesicle diameter 40 μ -50 μ ,

mean 46 μ (8 specimens measured) Remarks: The specimens are comparable to *B. distentum* described by Playford (1977) from the Lower to Middle Devonian Moose River Basin, Ontario. However most of the processes of the specimens were broken and a few unbroken ones were measured. It is also large overall than *B. distentum*.

Genus *CRATERISPHAERIDIUM* Deunff, 1981
Craterisphaeridium sprucegrovense (Staplin) Turner, 1986 Plate 1, Figure C,D

Description: Vesicle spherical with numerous rod-like processes more or less equally spaced. Processes hollow, opening into vesicle and distally terminating in a network of quinquifurcate recurved flexible filaments. Processes 9-18 μ long, 2 μ wide at base with points of origin lying in the same plane. The surface of the vesicle between processes bases is foveolate, being divided into small irregular areas by low, distally rounded ridges.

Dimensions: Vesicle diameter 30 μ -40 μ , mean 36 μ (10 specimens measured).

Remarks: The above described species are structurally very similar and conforms to the description by Turner (1986) from the Upper Devonian (Frasnian) of Alberta, Canada. Turner (1986) agrees that Staplin's 1961 species under the binomen *Multiplicisphaeridium? sprucegrovenis* is the same species he has redescribed, reillustrated and given a new combination, *Craterisphaeridium sprucegrovense*. His reason being that Staplin's 1961 descriptions were often difficult to integrate with modern concepts of taxonomy and nomenclature.

Genus *EVITTIA* Brito, 1965 *Evittia geometrica* Playford, 1981 Plate 1, Figures F,G.

Description: Vesicle outline quadrate; wall of vesicle 0.5-1 μ thick, scabrate. Corners of four sides bear prominent processes with two additional ones subcentrally placed. Processes scabrate, bifurcant (up to third order); point of division variable, from near base to near distal extremity; processes 12-18 μ long, 4-10 μ wide at base. Processes have unobstructed communication with vesicle cavity; no excystment structure observed.

PLATE 1

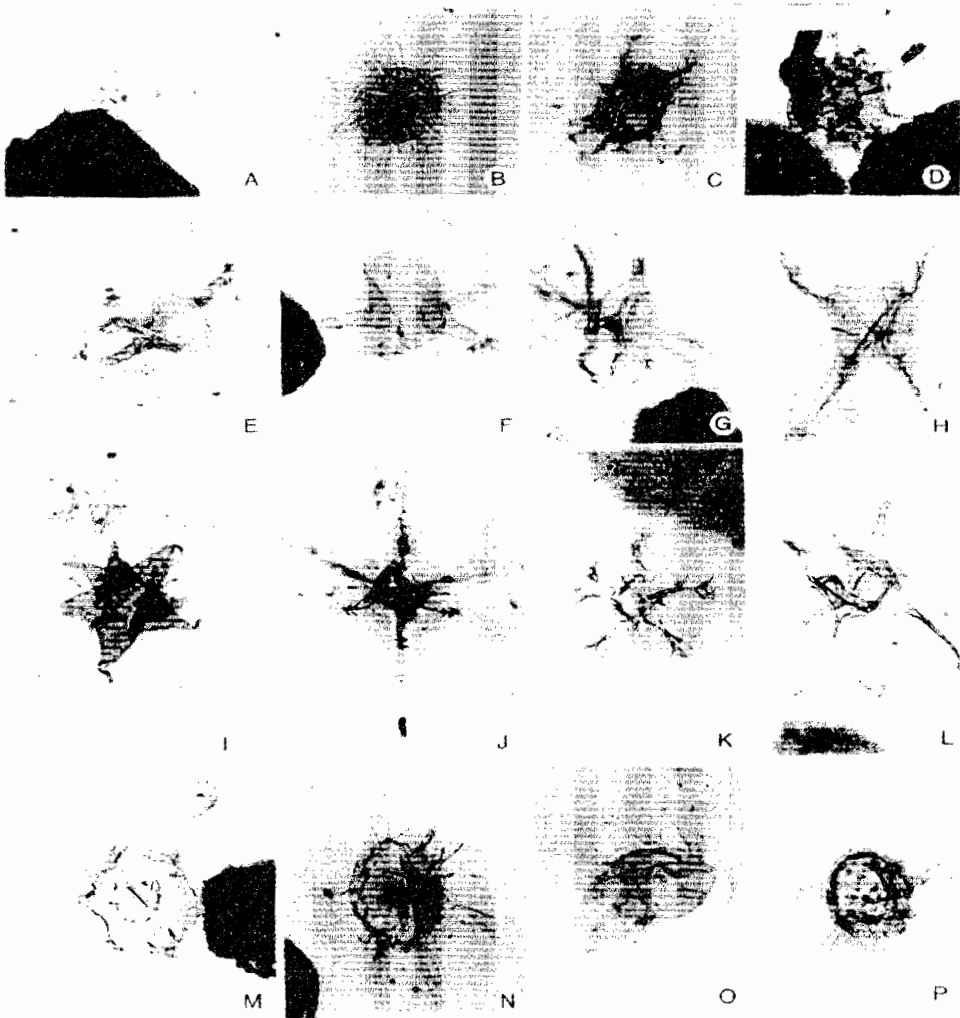


Plate 1: All figures X 500 unless otherwise stated.

Figure A: *Gorgonisphaeridium separatum* Wicander.

C,D: *Craterisphaeridium seprucegrovense* (Staplin) Turner.

F,G: *Evittia geometrica* Playford.

J: *Eisenackidium cf. martensianum* Stockmans and Williere

K: *Multiplicisphaeridium ramusculosum* (De flandre) Lister.

M: *Polydrixium cf. rabians* Cramer.

O,P: *Umbellasphaeridium saharicum* Jardine *et al.*

B: *Ammonidium* sp. A

E: *Baltisphaeridium cf. distentum* Playford.

H: *Eisenackidium* sp. A.

I: *Goniosphaeridium* sp. A.

L: *Veryhachium cf. polyaster* Staplin.

N: *Pterospermella* sp. A.

Dimensions: Vesicle diameter 28μ - 45μ , mean 34μ (12 specimens measured).

Remarks: Species conforms very well to the description of Playford and Dring (1981) from the Carnarvon basin, Western Australia. The specimen photographed by Anan-Yorke (1974, Plate XIX, Fig.3) as *Multiplicisphaeridium ramusculosum* (Deflandre) Lister in my opinion is not because it has a quadrate vesicle outline as *E. geometrica* whilst *M. ramusculosum* has circular to subcircular vesicle outline. Moreover, the disposition and nature of the processes are akin to that of *E. geometrica*.

Genus *EISENACKIDIUM* Cramer, 1968

Eisenackidium sp. A. Plate 1, Figure H.

Description: Vesicle quadrate in outline with a thin transparent inner body conformable to outline; wall surface, laevigate; four generally straight laevigate processes, 36 - 45μ long, 14 - 16μ wide at base, drawn out from each corner of vesicle and in the same plane; processes spine-like, tapering from base to distal pointed tip; processes do not open into vesicle cavity but tips are connected by thin transparent strandlike bodies into the vesicle cavity. No excystment structure observed.

Dimensions: Vesicle diameter 30μ - 45μ , mean 42μ (8 specimens measured)

Remarks: Specimens described are structurally similar to *Veryhachium lairdii* Deflandre ex Deunff. However *V. lairdii* has smaller vesicle diameter (12μ - 19μ), unobstructed communication between vesicle and processes interior and also lack strandlike bodies connecting process tip to vesicle cavity.

Eisenackidium cf. martensianum Stockmans & Williere, 1969. Plate 1, Figure J.

Description: Vesicle outline polyhedral, with a thin transparent inner body conformable to outline; wall surface laevigate; six straight laevigate processes, 48 - 52μ long, 10 - 16μ wide at base, drawn from each corner of vesicle and in the same plane. Most of the processes are broken off at different places; processes spinline tapering from base to blunt distal tips. Thin stringlike structures connect processes tips to the inner body which join together in the centre of the inner body as a darkened patch. Processes

do not open into vesicle cavity. Excystment is by a simple slit.

Dimensions: Vesicle diameter 36μ - 42μ , mean 40μ (6 specimens measured).

Remarks: Species is comparable to that of Stockmans and Williere (1969) from the Famennian of Belgium.

Genus *GONIOSPHAERIDIUM* Eisenack, 1969
Goniosphaeridium sp. A. Plate 1, Figure I.

Description: Central portion of vesicle subspherical to polygonal formed by the fusion of the bases of six to eight processes. Processes hollow, 20 - 24μ long, 14 - 18μ wide at base; processes taper from base to distal point tips. Processes interior open into the vesicle cavity. Vesicle wall and processes granular.

Dimensions: Vesicle diameter 28μ - 32μ , mean 31μ (4 specimens measured).

Genus *GORGONISPHAERIDIUM* Staplin, Jansonius and Pocock, 1965
Gorgonisphaeridium separatum Wicander, 1974
Plate 1, Figure A.

Description: Vesicle spherical in outline, wall 1.5μ thick, surface scabrate; numerous processes evenly distributed over vesicle surface, processes solid, flexible, laevigate, 6 - 10μ long and 1.5μ wide at base. Processes tapers from base to distal tip where it bifurcates. Simple slit in vesicle serves as excystment aperture.

Dimension: Vesicle diameter 30μ - 50μ , mean 42μ (10 specimens measured.)

Remarks: The specimens above conforms to the description of *G. separatum* by Wicander and Loeblich (1977) from the Upper Devonian Antrim Shale, Indiana, U.S.A. In their description, they reported that bifurcation ranges from near base to almost at the distal tip.

Genus *MARANHITES* (Brito) Daemon, Quadros & da Silva, 1967. *Maranthites braziliensis* Brito, 1965. Form M. Daemon *et al.*, 1967 Plate 2, Figure F,G.

Description: Flattened, circular body. Teguments on the edge considerably thickened in dense circular zones arranged in the form of lobes and saddles.

Dimensions: 64μ - 100μ , mean, 82μ (15 specimens measured)

Maranhites braziliensis Brito 1965 Form R. Daemon *et al.*, 1967 Plate 2, Figure E.

Description: Flattened grains, circular. Teguments (three) appear completely isolated on the edge of the grain and assume a semicircular to circular shape.

Dimensions: 60 μ -70 μ , mean 64 μ (10 specimens measured).

Remarks: Ghanaian specimens of "*Maranhites braziliensis* complex" are closely similar to that from the Brazilian Devonian sediments. The species are of major importance as a biostratigraphic index for sediments of the Brazilian Devonian, a fact which is enhanced by their wide geographic occurrence, abundance and ease of recognition.

Genus *MULTIPLICISPHAERIDIUM* Staplin, Jansonius & Pocock, 1965 *Multiplicisphaeridium ramusculosum* (Deflandre) Lister, 1970 Plate 1, Figure K.

Description: Vesicle circular to subcircular in outline, vesicle wall about 0.5 μ thick, surface laevigate; eight to fourteen, hollow subcylindrical process opening into vesicle interior; proximal contacts curved, the remaining nearly cylindrical to point of furcation, where processes furcate up to fourth order; distal tips sharply pointed. Processes 10 μ -16 μ long, 2-5 μ wide at base. No excystment structure observed.

Dimensions: Vesicle diameter: 20 μ -30 μ mean 24 μ (10 specimens measured)

Remarks: Species described is similar to that of Playford and Dring (1981) and Wicander and Playford (1985). However, the vesicle diameter recorded by Wicander and Playford (*op. cit.*) is smaller than that recorded above. *M. ramusculosum* is cosmopolitan in distribution and ranges from Late Ordovician through Late Devonian.

Genus *NAVIFUSA* Combaz, Lange and Pansart, 1967 *Navifusa bacillum* (Deunff) Playford, 1977 Plate 2, Figure L.

Description: Vesicle straight, cylindrical with ends rounded and closed; wall transparent to translucent, two layered. Pores visible under high magnification.

Dimension: Length 152-186 μ , mean 162 μ (10 specimens measured)

Remarks: Legaults' (1973) specimens

which he called *Quisquilites widderensis* is synonymous to *Navifusa bacillum*. This species was first described from the Devonian of the Maranhao Basin Brazil by Brito and Santos (1965). The species is restricted to the Middle and Upper Devonian sediments in the Parana Basins, Brazil (Lange, 1967).

Genus *POLYEDRYXIUM* Deunff ex Deunff, 1961. *Polyedryxium cf. rabians* Cramer, 1964. Plate 1, Figure M.

Description: Vesicle polyhedral with slightly convex faces bounded by six to eight membranous well defined ridges radiating from a central position to each of the vesicle edge. Vesicle wall single layered, surface, scabrate. No excystment structure observed.

Dimensions: Vesicle diameter 40 μ -52 μ , mean 45 μ (6 specimens measured)

Remarks: Specimens are structurally comparable to *P. rabians* reported by Cramer (1964) from the Lower to Middle Devonian San Pedro and La Vid Formations in North Western Spain. However, the few specimens measured are larger in vesicle diameter than that of Cramer.

Genus *PTEROSPERMELLA* Eisenack, 1972 *Pterospermella* sp. A. Plate 1, Figure N.

Description: Vesicle circular in outline; about 1 μ thick; thin diaphanous membrane wholly surrounds vesicle equatorially and displays fine radial folding; membranous flange projects about 18-30 μ beyond vesicle.

Dimensions: Vesicle diameter 36 μ -50 μ , mean 40 μ (6 specimens measured) Overall diameter 80 μ -110 μ , mean 92 μ .

Remarks: Specimens are structurally similar to *Pterospermopsis* sp. 1 described by Anan-Yorke (1974) from exploratory oil wells on the shelf and coastal regions of Ghana. The author prefers to use *Pterospermella* instead of *Pterospermopsis* because of remarks given by Loeblich and Wicander (1976) that "circumstantial evidence suggests that Wetzel's *Pterospermopsis* is in reality the dinoflagellate *Thalassiphora* Eisenack and Gocht, 1960.

Genus *STELLINUM* Jardine, Combaz, Magloire, Peniguel and Vachey, 1972. *Stellinium micropolygonale* (Stockmans and Williere)-Playford, 1977. Plate 2, Figure A.



Plate 2: All figures X 500 unless otherwise stated.

Figure A: *Stellinium micropolygonale* (Stockmans and Williere) Playford.

B: *Veryhacium europeum* Stockmans and Williere. C: *Veryhacium cf. polyaster* Staplin.

D: *Veryhacium* sp. (not described).

E: *Maranhites braziliensis* Brito. Form R. Daemon *et al.*

F, G: *Maranhites braziliensis* Brito. Form M. Daemon *et al.*

H: *Tasmanites* sp. A X 250 (not described). I: *Tasmanites huronensis* (Dawson) Winslow X 250.

J: *Tasmanites* sp. B X 250 (not described).

K: *Geminospora lemurata* Balme (trilete spore not described).

L: *Navifusa bacillum* (Deunff) Playford.

Description: Vesicle polygonal outline stellate and granulate; eight broad based, distinct, hollow processes drawn out from vesicle, tapering to a blunted or sharply pointed distal tip. Processes $10\mu-16\mu$ long, $8-16\mu$ wide at base, evenly distributed and open into vesicle interior; processes surfaces granulate with low median ridge along each process extending onto vesicle surface and merging with others near centre of vesicle.

Dimensions: Vesicle diameter $26\mu-32\mu$, mean 28μ (12 specimens measured). Overall diameter $50\mu-70\mu$, mean 58μ .

Remarks: Specimens conform to description by Playford (1976), Playford (1977), Playford and Dring (1981) and Wicander and Playford (1985). Specimens observed show broader basal processes than those reported by Playford (1977) from the Moose River Basin, Ontario and also Wicander and Playford (1985) from the Lime Greek Formation, Iowa. Published records of *Stellinium micropolygonale* mentioned by Playford (1976, 1977) Paris *et al.*, (1985), Wicander and Loeblich (1977) and Cramer and Diez (1976), indicate that it has wide geographic distribution and ranges from Siegenian through Famennian.

Genus *TASMANTITES* Newton, 1975. *Tasmanites huronensis* (Dawson) Winslow, 1962 Plate 2, Figure I.

Description: Large planktonic algae with thick walled disseminule with puncta internally flared.

Dimensions: $80\mu-100\mu$, mean 92μ (15 specimens measured).

Remarks: Species of *Tasmanites* presents a wide vertical range and are therefore of less biostratigraphic significance. It has been recorded in rocks of Siluro-Devonian and Permian-Carboniferous ages in Brazil. (Daemon *et al.*, 1967).

Genus *UMBELIASPHAERIDIUM* Jardine, Combaz, Magloire, Peniguel and Vachey, 1972. *Umbellasphaeridium saharicum* Jardine *et al.*, 1972. Plate 1, Figure O.P.

Description: Vesicle subrounded to elliptical bearing five or six processes, cylindrical at base, and flared terminally into a funnel shape $10-26\mu$ across, Processes $16-30\mu$ long, $4-6\mu$

wide at base. Vesicle 1-2 μ thick laevigate to scabrate.

Dimensions: Vesicle diameter $35\mu-50\mu$, mean 42μ (12 specimens measured).

Remarks: The specimens conform to the description of Jardine *et al.*, (1972). It differs from *Umbellasphaeridium deflandrei* (Moreau-Benoit) Jardine *et al.*, (1972), in having fewer (5-6) and longer ($16-30\mu$) processes. *U. deflandrei* has more (up to 20) and shorter ($5-12\mu$) processes. Wood (1984) indicates that *U. saharicum* appear in a "recurrent species association" with the "*Maranhites braziliensis* complex", *Navifusa bacillum* and *Stellinium octoaster*, that appears in the Lower Devonian (Emsian) and persist as a group into Upper Devonian (Famennian/Early Touranian) of Africa, South America and North America. Genus *VERYHACHIUM* Deuff ex. Downie, 1959. *Veryhachium europeum* Stockmans and Williere, 1969 Plate 2, Figure B.

Description: Vesicle triangular in outline, sides of vesicle slightly convex and almost equal in length. Vesicle wall about 1μ thick, surface laevigate. Three, hollow and generally straight processes drawn out from corners of vesicle and in same plane; processes spinelike $14\mu-36\mu$ long, $3-4\mu$ wide at base, opening into vesicle interior. An auxillary or minor spine process also spinelike arising from the surface of vesicle also open into the vesicle interior.

Dimensions: Vesicle diameter $17\mu-30\mu$, mean 21μ (10 specimens measured).

Remarks: Specimens conform to the description of Wicander and Playford (1985). However, the processes length recorded by Wicander and Playford (op. cit.) are shorter than that measured above, Downie (1984) indicated that in the British Isles sequence its known range is Frasnian to Famennian.

Veryhachium cf. polyaster Staplin, 1961 Plate 1, Figure L; Plate 2 Figure C

Description: Vesicle polygonal in outline, wall laevigate to scabrate; five to six hollow spinelike processes, most of them broken; unbroken ones $30-40\mu$ long, $10-20\mu$ wide at base drawn out from vesicle, four in one plane with the other one or two sticking out from the plane containing the four; processes broad based and tapering to a sharp distal tip; processes open into

vesicle interior.

Dimensions: Vesicle diameter $30\mu-40\mu$, mean 34μ (4 specimens measured)

Comparison: The broken processes of this specimen make it difficult to give a correct range of processes length. Specimens are structurally comparable to *V. polyaster* Staplin (1961) described by Wicander and Playford (1985), especially in its orientation of processes. However, specimens described have a greater vesicle diameter and basal width of processes.

Discussion

Acritarchs from the outcropping Lower Takoradi Shale Formation at the New Takoradi beach are not abundant and diverse in comparison with other reported Upper Devonian acritarch assemblages (Staplin, 1961; Wicander, 1974; Wicander & Loeblich, 1977; Playford & Dring, 1981; Playford, 1981; Martin, 1984; Wicander & Playford, 1985). The associated miospores however, show appreciable abundance and diversity. Of the 22 species recovered from the sample, 11 are positively identifiable, 4 are closely comparable with positively established taxa and 7 species appear new.

Comparison of the stratigraphic ranges of previously described acritarch species (Wicander & Playford, 1985; Playford & Dring, 1981) to that recovered from the Lower Takoradi Shale Formation indicate that non of the species are restricted to the Frasnian stage of the Upper Devonian but transgress the Frasnian/Famennian boundary. Some of the species are similar to others reported from Upper Devonian rocks in North and South America, Australia, Europe and North Africa.

Craterisphaeridium sprucegroense has been reported from the Upper Devonian (Frasnian) of Alberta, Canada (Staplin, 1961; Tuner 1986). This species occur in the Ghanaian assemblage. *Evittia geometrica* recovered from the Ghanaian samples have also been reported from the Upepr Devonian (Frasnian) Carnarvon Basin, Western Australia (Playford & Dring, 1981; Playford, 1981). *Gorgonisphaeridium separatum* from the Lower Takoradi Shale Formation has also been reported from the Upper Devonian (Frasnian-Famennian) of Indiana, U.S.A. (Wicander & Loeblich, 1977).

Multiplicisphaeridium ramusculosum

recovered from the Ghanaian assemblage is similar to that reported from the Late Devonian (Frasnian) of Western Australia (Playford & Dring, 1981; Playford (1981), the Upper Devonian (Upper Frasnian) of Iowa, USA (Wicander & Playford, 1985) and also from the Upper Devonian (Frasnian-Famennian) of Ontario, Canada (Legault & Norris, 1982).

The Lower Takoradi Shales yielded *Stellinium micropolygonale*. This species has also been reported widely from the Upper Devonian (Frasnian) of Alberta Canada (Staplin, 1961), the Upper Devonian (Frasnian-Famennian) of Indiana, USA (Wicander and Loeblich, 1977), the Upper Devonian (Frasnian) of Western Australia (Playford & Dring, 1981; Playford, 1981). The specie has also been reported from the Upper Devonian (Frasnian-Lower Famennian) of Belgium (Martin, 1982, 1984). Lanzoni and Magloire (1969) and Jardine *et al.* (1974) have reported the occurrence of *Stellinium micropolygonale* from the Upper Devonian (Famennian-Strunian) of Sahara, Algeria, and so has Daemon (1974) from the Upper Devonian (Famennian-Strunian) of Brazil, and Wood (1984) from the Upper Devonian (Frasnian) of Peru. *Veryhachium europaeum* recovered from the Ghanaian samples have been reported from the Upper Devonian (Upper Frasnian) of Iowa, USA (Wicander & Playford, 1985), the Upper Frasnian-Lower Famennian of Belgium (Stockmans & Williere, 1974) and the Frasnian-famennian of the British Isles (Downie, 1984). *Umbellasphaeridium saharicum* has been reported particularly from North Africa and South America. The Ghanaian specimens are similar to those reported from the Upper Devonian (Famennian-Strunian) of Sahara, Algeria (Lanzoni & Magloire, 1969) and the Upper Devonian (Frasnian-Famennian) of Sahara, Algeria (Jardine *et al.*, 1972, 1974).

In South America, it has been reported together with *Maranhites braziliensis* complex and *Navifusa bacillum* from the Upper Devonian (Frasnian) Tucano-Jatoba Basin, Brazil (Regali, 1964; Brito, 1965, 1976) and the Upper Devonian (Famennian-Strunian) Amazon and Parnaiba Basin, Brazil (Daemon, 1974).

Maranhites braziliensis complex and *Navifusa bacillum* have been reported widely in South America and is of major importance as a

biostratigraphic index for sediments in the Brazilian Devonian. These species are abundant in the Ghanaian assemblage. Together with *Umbellasphaeridium Saharicum* and *Stellinium micropolygonale*, these four species are members of a "recurrent species association" RSA (Wood, 1984) and they occur on either sides of the Atlantic ocean. The close similarity and distribution of these "recurrent species association", RSA in Ghana, West Africa and Brazil, South America on either sides of the Atlantic ocean is strong evidence in support of the contiguous position of Africa and South America prior to the initiation of the continental drift in the late Jurassic period.

A Frasnian stage of the Upper Devonian has been proposed by Anan-Yorke (1974) and Bar and Riegel (1974) on chitinozoans and microfossil assemblages respectively. The acritarch assemblage recovered do not indicate an unequivocal assignment of the Frasnian age even though an Upper Devonian age cannot be ruled out. The occurrence and abundance of the miospore species *Geminospira lemurata* Balme in the Ghanaian assemblage, which has been well documented in North and South America, Europe and Australia as a characteristic species of the Upper Devonian (Frasnian) age, supports the proposed age by the above-mentioned authors. The less abundant and non diverse nature of the acritarch assemblage as opposed to the abundant and diverse nature of the miospores in the Lower Takoradi Shale formation probably indicate a near shore to more continental environment of deposition for the formation.

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