PALYNOSTRATIGRAPHY AND PALEOENVIRONMENTAL STUDY OF HARUR FORMATION IN NAZDUR AREA, NORTHERN IRAQI KURDISTAN REGION

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ABSTRACT

The sum of ten samples were analyzed by normal Palynological processing methods, the samples are taken from outcrop in Nazdur area , Zakho district , Dohuk Governorate .They show a good deletion based on miospores for the Late Devonian and Early Carboniferous. The composition of the Miospore assemblages indicates that they can be subdivided into five Palynozones named consequently as PZ-1, PZ-2, PZ-3, PZ-4, and PZ-5, which indicate uppermost Devonian – Lower Carboniferous (Tournaisian). The great distribution of miospore with rare Acritarchs indicate a shallow marine depositional environment, the study is supported by lithological observations in the field.

دراسة طباقية بالينولوجية و البيئة القديمة لتكوين هارور في منطقة نزدور ، شمال اقليم كوردستان العراق

سرود فاروق النقشبندي

المستخلص

تم تحليل عشرة نماذج لمكاشف طباقية في منطقة نزدور في قضاء زاخو ، محافظة دهوك بالطرق العالمية المعروفة في تحضير الشرائح الزجاجية للبالينولات. وقد اظهرت النماذج تواجداً جيداً للابواغ الكبيرة العائدة الى الديفونى المتأخر والكاربونى المبكر. ووجد بأن تجمعات الابواغ ممكن ان تقسم العمود الطباقي لتكوين هارور الى خمسة انطقة بالينولوجية سميت وبالتسلسل بـ PZ-1، PZ-2، PZ-3، PZ-4 و PZ-5 والذين حددوا عمر الديفونى الاعلى والكاربونى الاسفل (Tournaisian). ان الانتشار الكبير للابواغ وندرة الاكريتارك اعطت انطباعاً بان البيئة الترسيبية هى بيئة بحرية ضحلة وكل ذلك دعمت من خلال الملاحظات الصخارية في الحقل.

INTRUDUCTION

Paleozoic formations are cropping out generally in restricted areas in Northern Iraq, exactly at North Thrust Zone (where the studied area is located) (Fig. 1.) and in the top of Rutbah Uplift, in addition to subsurface sections in few deep boreholes around Mosul vicinity (Khleisia). Paleozoic formations belong to three major depositional cycles, separated by major breaks, due to certain Caledonian and Hercynian Orogenies (Buday, 1980 and Al-Hasson, 1999).

The current studied formation (Harur) belongs to Late Devonian – Early Carboniferous cycle, in addition to Pirispiki Red Beds, Chalki Volcanics, Kaista and Ora Formations (Buday, 1980).

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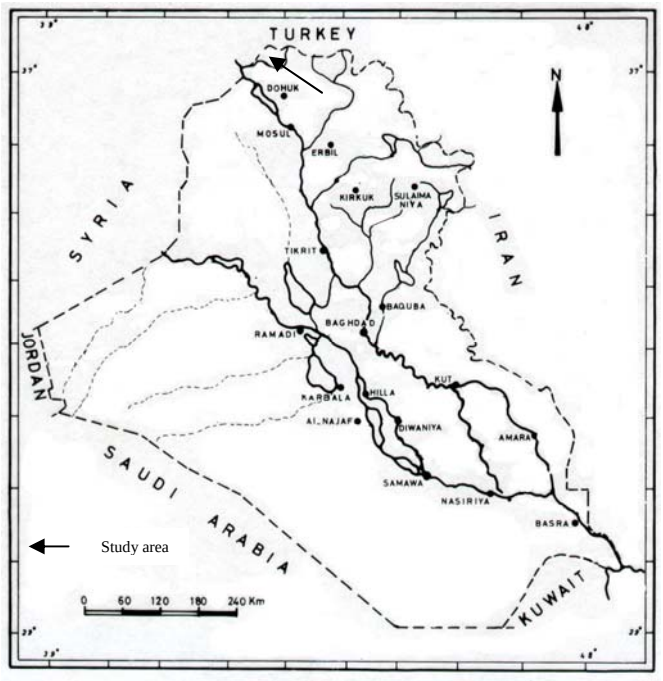


Fig. 1: Location map of the study area

AIM OF THE STUDY

The major aims of this study are:

1. Identification of miospores, other palynomorphs, and their vertical distribution in the section.
2. To indicate the exact boundary between Upper Devonian and Lower Carboniferous.
3. To reconstruct the Paleoecology of deposition for the Harur Formation.
4. To determine the age of the Harur Formation.

THE STUDIED AREA

The studied section is located in North Iraq, about 75 Km NE of Zakho district and away from Nazdur village for 1.5 Km in the same direction. There are many outcrops in the area, but the studied section is at 43° 10' longitude and 37° 18' latitude, of the Northern Thrust Zone (Figs.1 and 2).

STRATIGRAPHY

Harur Formation was first described by Wetzel and Morton (1952) in Bellen et al. (1959). The type section of the formation is in Amadiya district in the Ora fold, from the Northern Thrust Zone. The formation, in general, is composed of black, organic, detrital limestone, with interculations of black calcareous, micaceous shale in the lower and upper parts (Buday, 1980). Rich by fossil assemblages, generally brachiopods, all indicate a neretic facies (mostly reef and fore reef). According to previous researchers the given age of the formation is Lower Carboniferous. The boundary between Harur Formation and underlying Ora Formation is gradual and conformable, while the boundary with overlying Chia Zairi Formation is unconformable (Buday, 1980)

GEOLOGY AND STRUCTURE OF THE AREA

The Northern Thrust Zone term was used for the first time by Buday et al. (1973). Harur Formation is located within the area, which is the most tectonically and structurally complex area in Iraq (Sayab, et al., 1982). The previous field and structural studies showed that Kiasta anticline is a very important structure that covers most of the area. This anticline is asymmetrical and extends towards east, tectonically the area is subdivided by Buday and Jassim (1987) to:

1- External Zone (Miogeosynclin).
2- Central Zone and Internal Zone (Eugeosynclin).

Harur Formation is located in area number (5) (Fig.2), in addition to many other geological formations which belong to the Paleozoic Era and cropout in the area. They are as follows (from oldest to youngest) Kabour, Pirispiki, Kaista, Ora and Chia Zairi Formations.

MATERIALS USED

The miospore assemblages have been recovered from ten samples collected from Harur Formation at Nazdur area (The studied area).Standard palynological laboratory treatment was done to the samples, by using HCl, HF and concentrated HCl, consequently to remove all carbonate, silicate, and heavy minerals in the samples. Two or more slides from each sample were made, and studied by Leitz

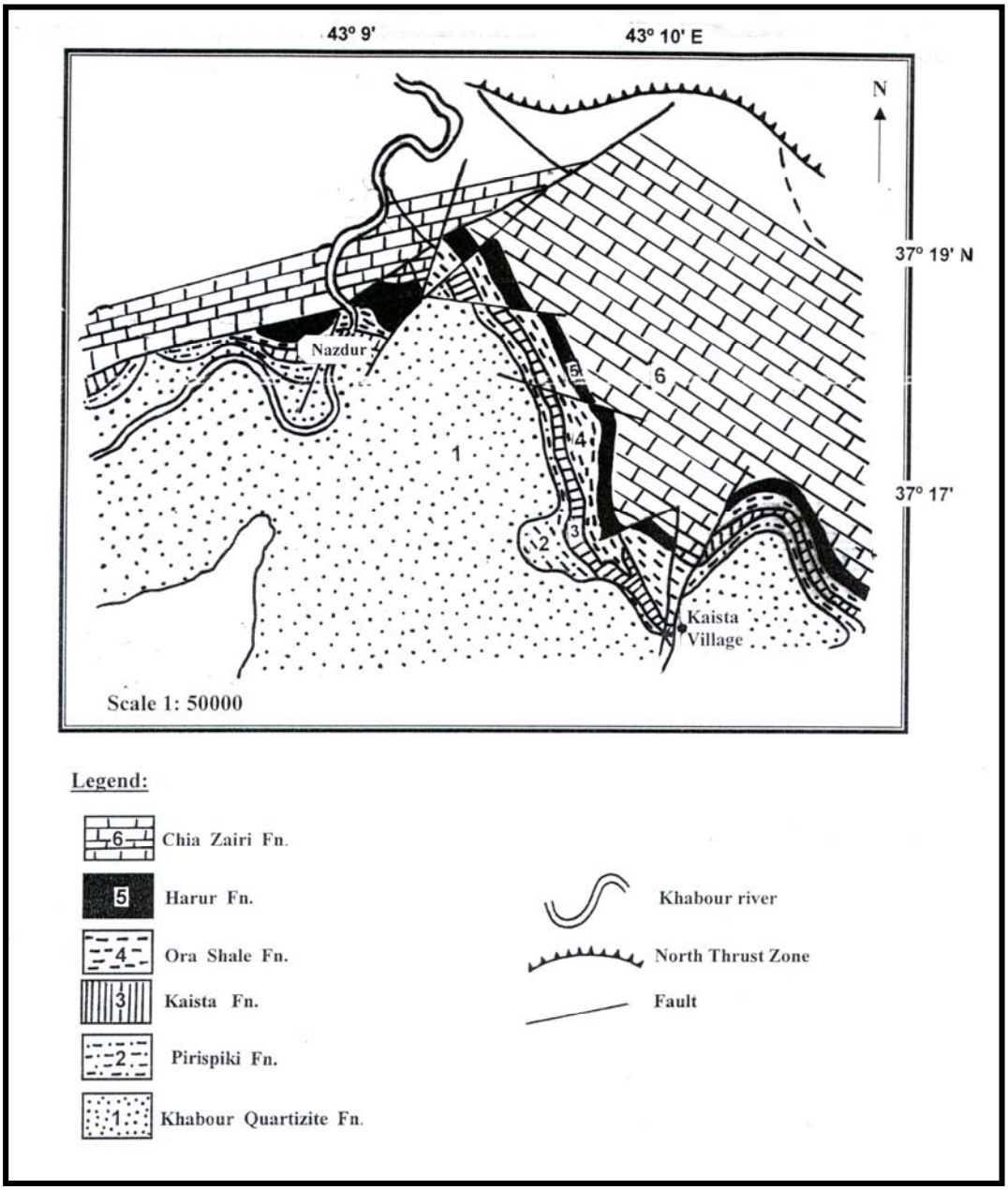


Fig. 2: Geological map of the Northern Thrust Zone of Iraq (after Pesl and Isaac,1975 and 1976)

microscope in Geology Department, College of Science, Salahaddin University, to identify the miospore assemblages and other Palynomorphs.

PREVIOUS PALYNOLOGICAL STUDIES

Paleozoic succession in Iraq was mainly studied from boreholes in Western Iraqi Desert as a part of hydrogeological investigation. Al-Jubori and Al-Beerakdar (1985) studied Suffi Formation in borehole KH 5/1; they concluded Upper Silurian – Lower Carboniferous age for the section. Al-.Naqishbandi (1988) studied the same borehole, and gave a Llandoverian – Late Gedinnian age to the studied section. Al-Ameri et al. (1991) studied the Lower Silurian age from the lower part of Suffi Formation. Nadir (1993) studied the same above formation in KH5/1, in Western Desert. Babban (1996) studied two stratigraphic sections from oil wells Akkas-1 in western Iraqi Desert and Khleisia-1. Hasson, (1999) studied the Upper Devonian – Lower Carboniferous in borehole Khleisia-1, NW Iraq. We can notice that none of the previous studies was dealt with outcrops, especially at Northern Thrust Zone in Iraq, so this study is the first one, which deals with outcrops.

STRATIGRAPHY AND PALYNOLOGY

Harur Formation contains rich and diversified marine fauna. The main observed fossils in the field are brachiopods, which are very common especially in the lower part of the formation. This is mainly observed by field investigation. While the miospore assemblages found in a very rich and diverse situation, accordingly, we can divide the studied section to five Palynozones named shortly as (PZ), started from (PZ-1) to (PZ-5).

The miospores recorded in Harur Formation are;

Acanthotrilete parvispinosus, Ancyrospora Lungi, A. Greggsii, Apiculiretusispora granulata, Aratrisporites Saharaensi Archaeozonotriletes cff semilucensis, Auroraspora solisortus, Camarozonotriletes earlinesis, Colatisporites denticulatus, Convolutispora tuberculata Crassispora ef. Drucei, Densosporites variablis, Dictytriletes submarginatus,Geminosporal decora, Hymenzonotriletes celeber H.. explanatus, Kraeselisporites echinatus, k .orantus, Laevigatisporites sp. Leiotriletes glaber, L..incomptus, Lophozonotriletes macropunctatus, prolycospora rugulosa, protroleiosphaeridium orbiculatum, punctatispora ef. irrasus, P. preineri, P. minutus, Retusotriletes communis, R. crossus, R. microthelis, R. minutus, Rhabdosporites Langi, Spelaeotriletes crustatus, S. triangulus, Tergobulasporities immensus, Umboanatisporites distinctus,Valltisporites agadensi , V. verrucosus, V. pergranulata, in addition to presence of Acritarchs , with low presence and diversity like veryhachium europacium, and V. trispinosum, Multiplicisphaeridium sp (Figs.4 – 11).

By comparing the identified miospores in our study with the following references, we could establish five Palynozones. The used references are,

Mcgregor (1975), Clyton and Loboziak (1985), Tunaue (1985), McMillian et al. (1988), Stampien and Turnau (1988), Loboziak et al. (1992), Loboziak et al. (1994), Coquel et al. (1995), Loboziak and Street (1995), Loboziac et al. (1996), Al-Hasson (1999), Molyneux et al. (2000) and Turnau (2002)

Only the aforementioned mentioned miospores were used to establish a range chart (Fig. 3), which represents the age and the new zones of the formation. The zones are:

1- Palynozone 1 (PZ – 1) Late Devonian (Strunian)

This zone represents the gradual conformable change from Ora Formation to Harur Formation. The lower boundary of the zone starts by the first appearances of *Ancyrospora Langii, Comarozonotriletes earlinsis, Convolutispora tuberculata, Densosporites variables, Hymenozontriletes celebres, H. explanatus, Kraenselisporites echinatus, Punctatisporites greineri, Retusotriletes communis, R. minuls, Umbonatisporites dilinetus, Valatisporites agadesi, Verrucosisporites pregranulatus,* and ended by the first appearance of *Aaneurospora greggsi, colatisporites denticulatus, Retusotriletes crassus, Rhabdosporites langi, and Valatisporites verrucosus* , while the lithologicall criteria infront of this zone shows black detritus shally limestone interfingering with thin beds of shale .

2- Palynozone 2 (PZ – 2) Early Carboniferous (Touraniasian)

The zone starts by the first appearance of the following miospores:

Anuerospora greggsi, Colatisporites denticulatus, Retusotriletes earssus, Rhabdosporites laugi, Valatisporites verrucosus, and ended by the first appearance of *Apiculiretusispora granulata, Aratrisporites saharanesis, Archaeozootriletes aff semilucensis, Leiotriletes incomptus Lophozonotriletes macropunctatus, Protroleisphaeridium orbiculatum, Punctatisporites minutus, Retusotriletes microthelis, speluetriletes tringulus* and last appearance of *Rhabdosporites Laugii*, while part of the following miospore ranges are restricted within this Palynozone. *Convolutispora tuberculatos, Punctatisporites greineri, Retusotriletes communis*. The lithology of the succession restricted by this zone is mainly composed of shally limestone with very thin beds of shale.

3- Palynozone 3 (PZ – 3) Early Carboniferous (Lower Tournaisian)

The third Palynozone starts by the first appearance of *Acanthotrilete parvispnosus, Apiculiretusispora granulata, Aratisporites saharaensis, Archaeozonotriletes cff semilucesis, Leiotriletes in comptus, Lophozonotriletes macropunctatus, Protoleisphaeridium orbiculatum, Punctestisporites minutus,*

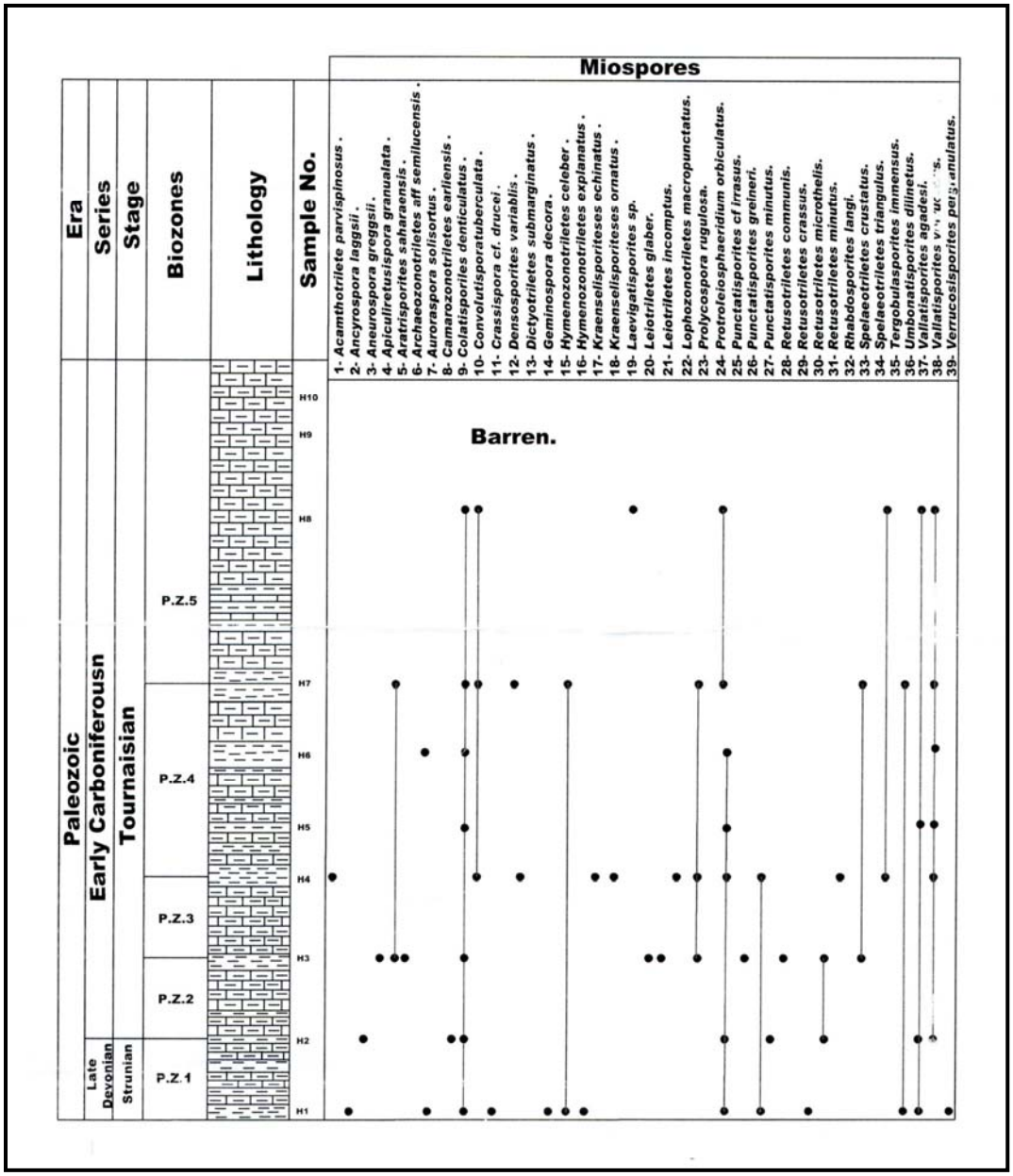
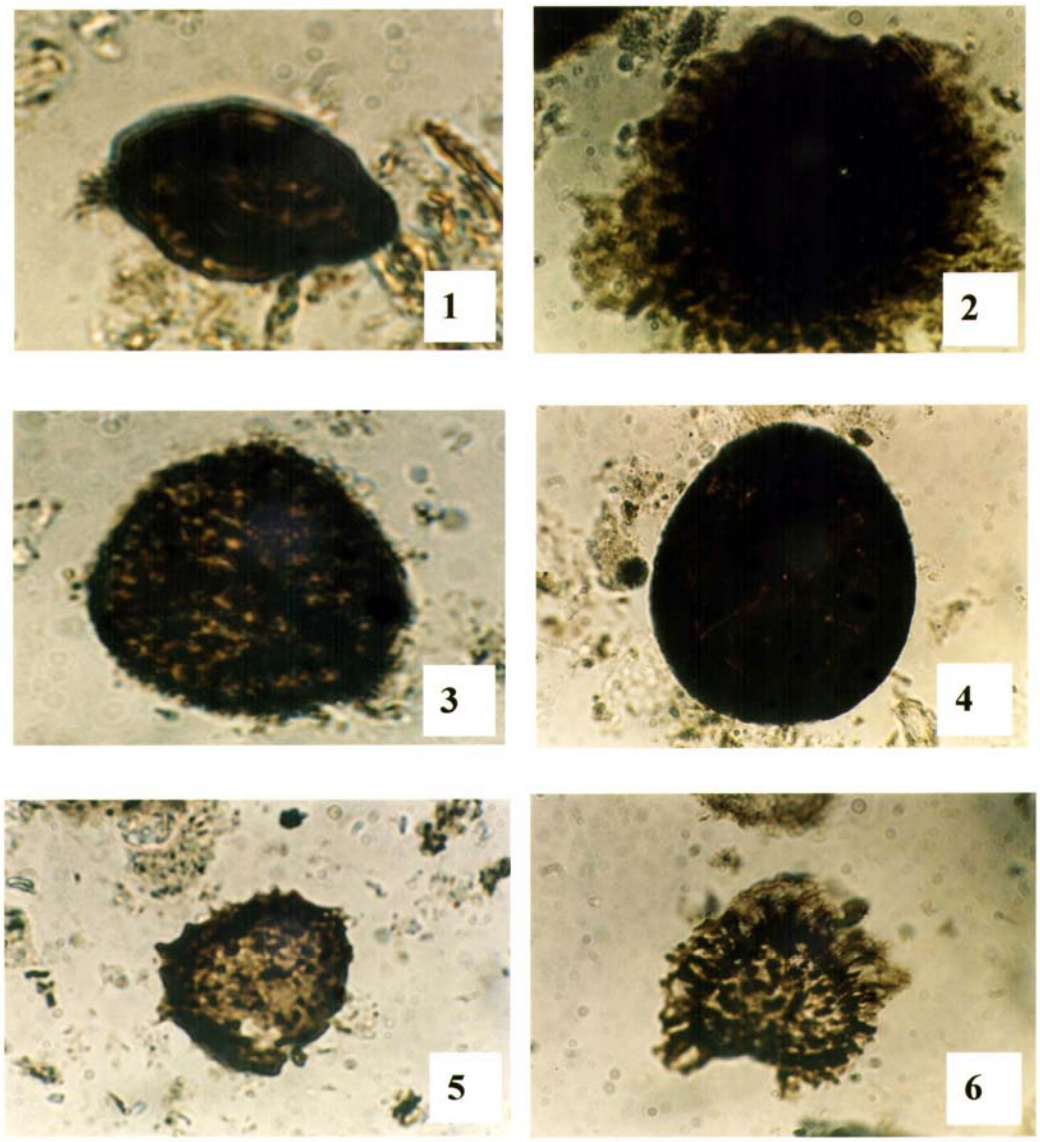


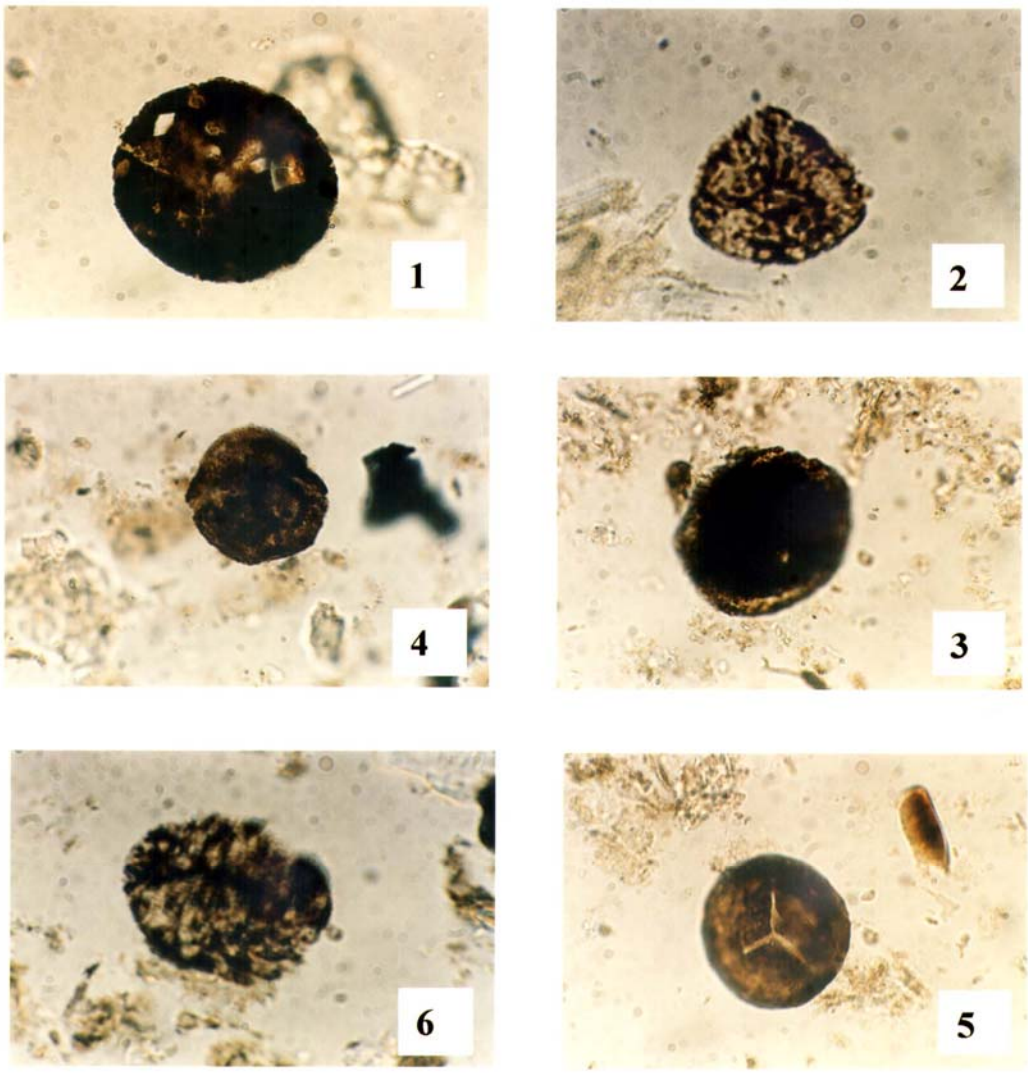
Fig. 3: Range chart of Miospores of selected samples from Harur Formation



Figs. 4.1 – 4.6

Figs. 4.1 – 4.6

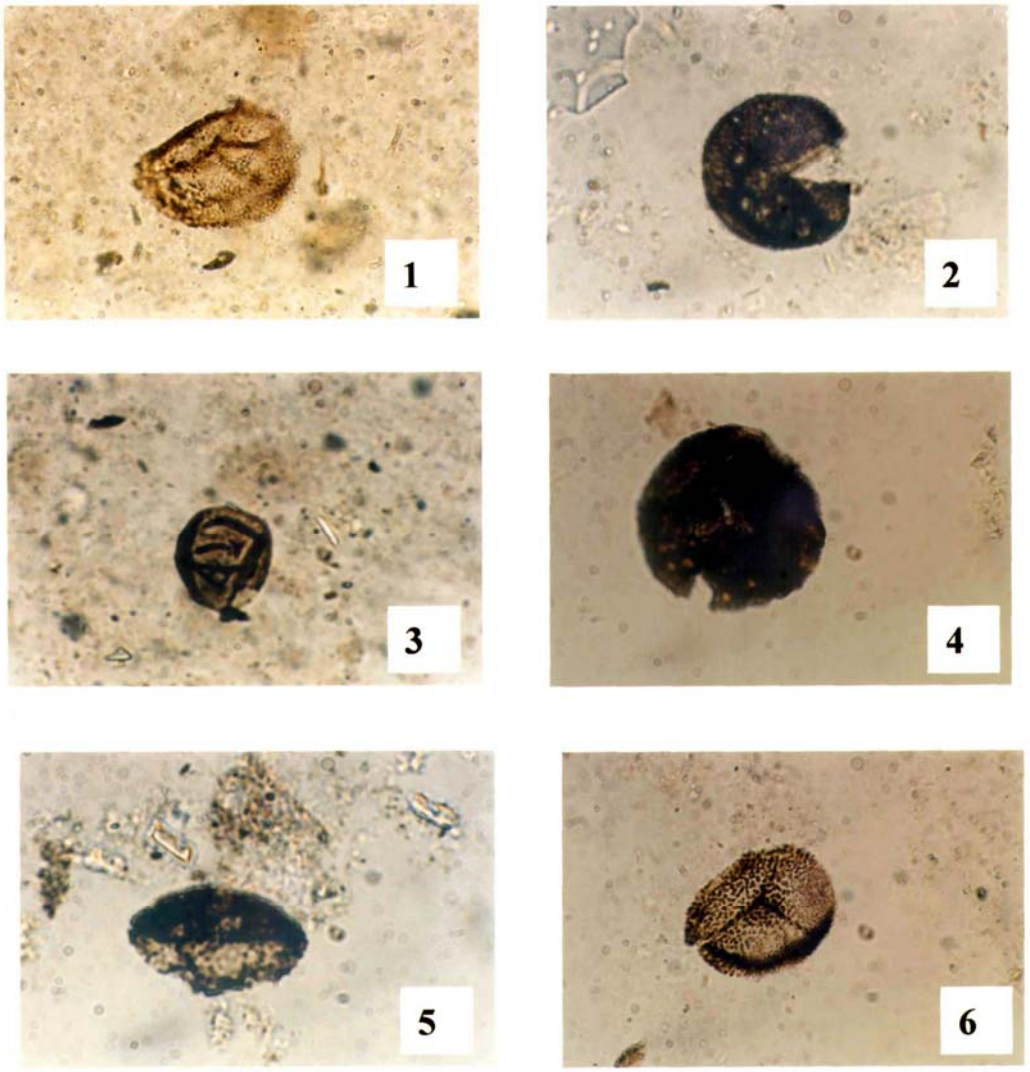
1. *Rhabdosporites langii*, Graham and Richardson, 1983, Harur.9, 58.2 –32.2, 10x100.
2. *Ancirospora langii Rau n*, 1988, Harur.1, 54 – 35.5, 10x100.
3. *Camarozonotriletes earliensi s*, Raun , 1988, Harur.1, 62 –37, 10x100.
4. *Retusotriletes minutus*, Butterworth and Mahdi, 1982, Harur.1, 67.5 – 38.25, 10x100.
5. *Kraeuselisporites ornatus* (Neves) Owens, Mishell and Marashall , 1976, Harur.18, 70.8 – 25.5, 10x100
6. *Kraeuselisporites echinatus*, Owens, Mishell and Marashall, 1976, Harur.1, 66.5 – 34.8, 10x100.



Figs. 5.1 – 5.6

Figs. 5.1 – 5.6

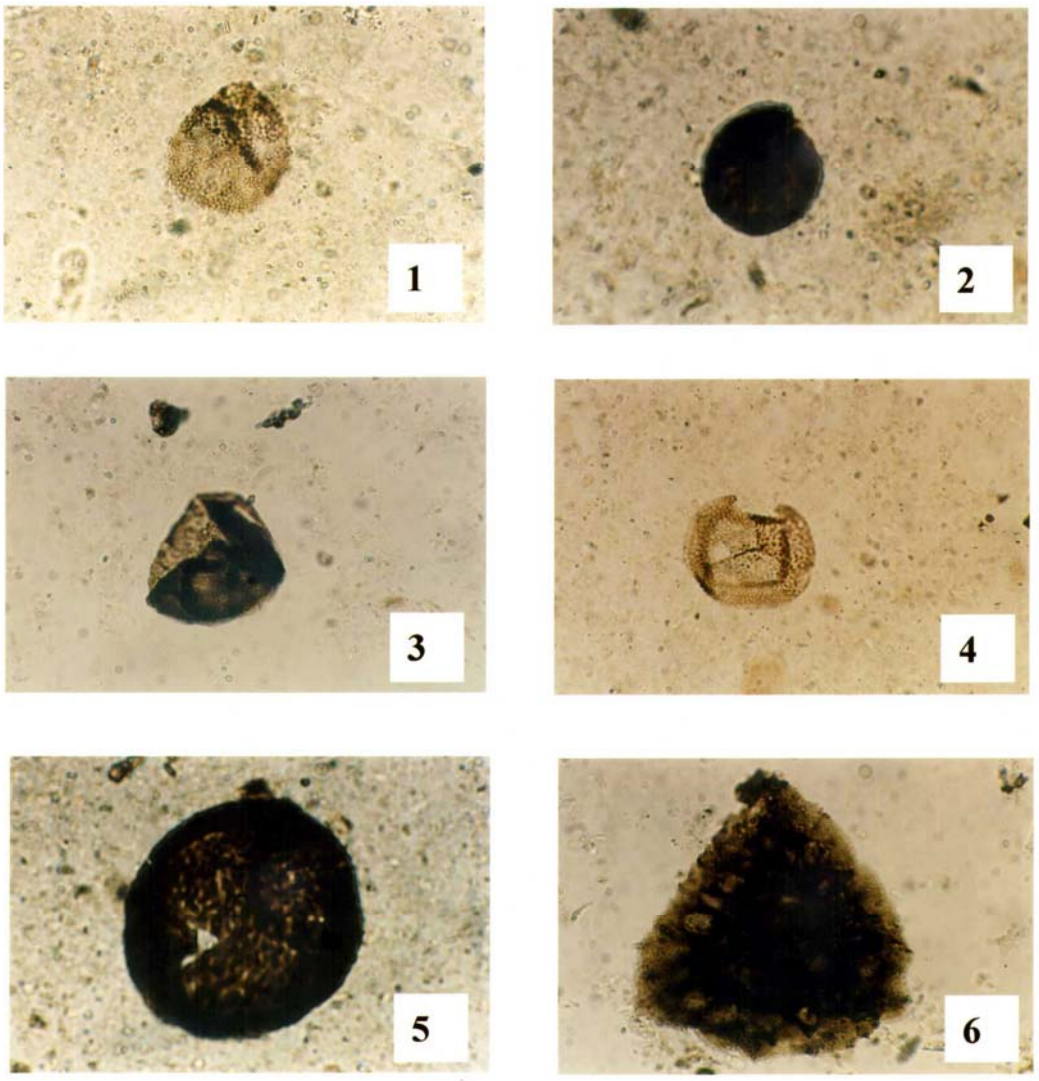
1. *Retusotriletes communis* Naumova, 1953, Harur.18, 96.25 – 23.5, 10x100.
2. *Vallatisporite*s *verrucosus* Hacqueberd, 1957, Harur.18, 96.5 – 16.5, 10x100.
3. *Colatisporites denticulatu*, Neville, guenn, Clyton, Loannide, and Kruskewska, 1973, Harur.9, 61 – 21, 10x100.
4. *Ancurospor greggsii* (Mc gregor) Streel, 1986, Harur.9, 59 – 32.2, 10x100.
5. *Retusotriletes Cf crassus*, Clyton, Jonhson, Serastopolo, and Smith, 1980, Harur.9, 96 – 15.5, 10x100.
6. *Valatisporites verrucosus*, Hacqueband, 1957, Harur.9, 67 – 23.5, 10x100.



Figs. 6.1 – 6.6

Figs. 6.1 – 6.6

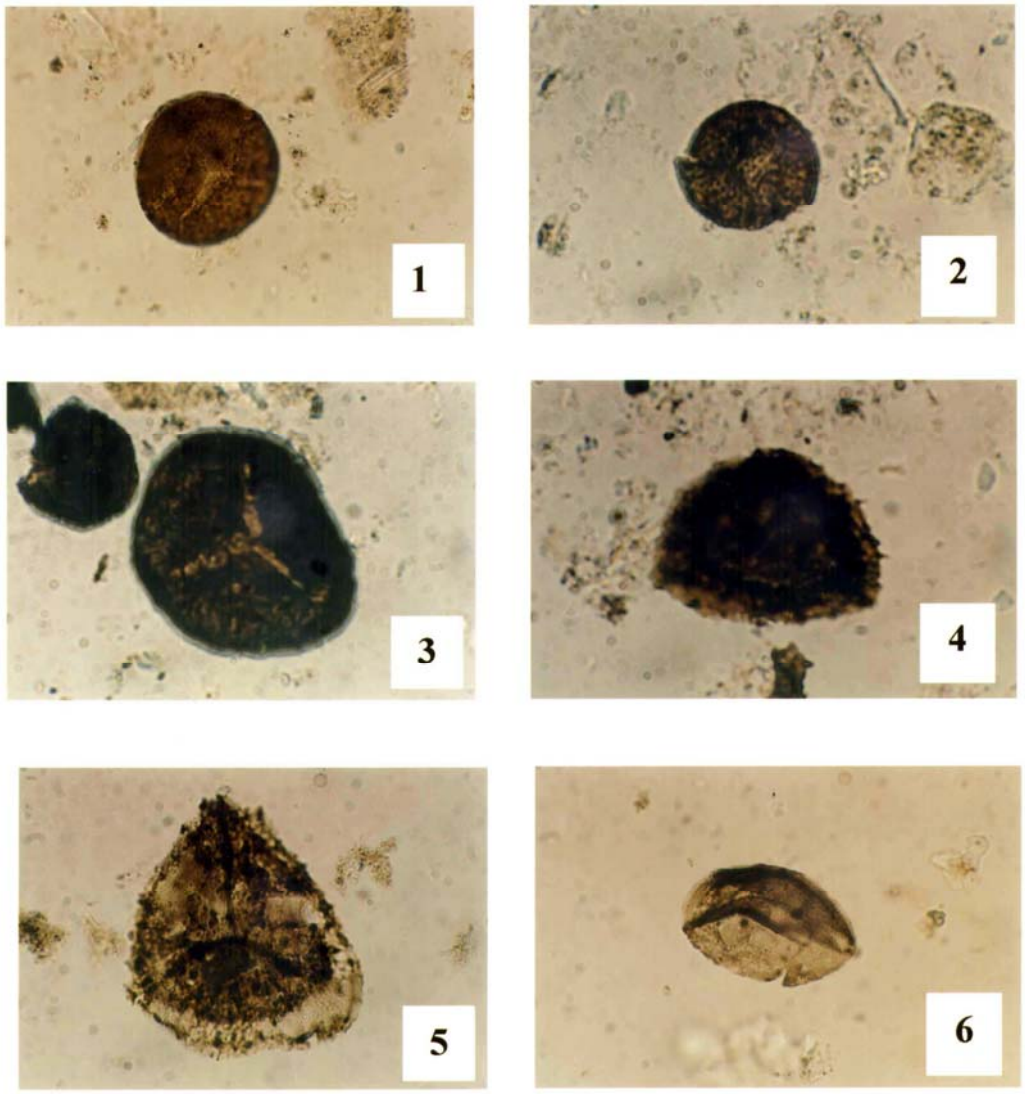
1. *Spelaeotriletes trangulus*, neves and owens, 1966 Harur.14, 58.2 – 11.8, 10x100.
2. *Grassispora cf drucei*, Playford, 1976, Harur.14, 62 – 28.2, 10x100
3. *Protoleiosphaeridium orbiculatum*, Staplin, 1975, Harur.14, 62 – 12.2, 10x100.
4. *Leiotriletes glober* (Waltz) Schenko, 1963, H.21, 67.5, 30.6, 10x100.
5. *Aratrisporites saharaensis*, Loboziak, clayton, and Owens, 1986, Harur.25, 71.2 – 24.6 10x100.
6. *Lophozonotriletes macropunctayus*, Naumova, 1963, H. 14, 64.2 – 25.2, 10x100.



Figs. 7.1 – 7.6

Figs. 7.1 – 7.6

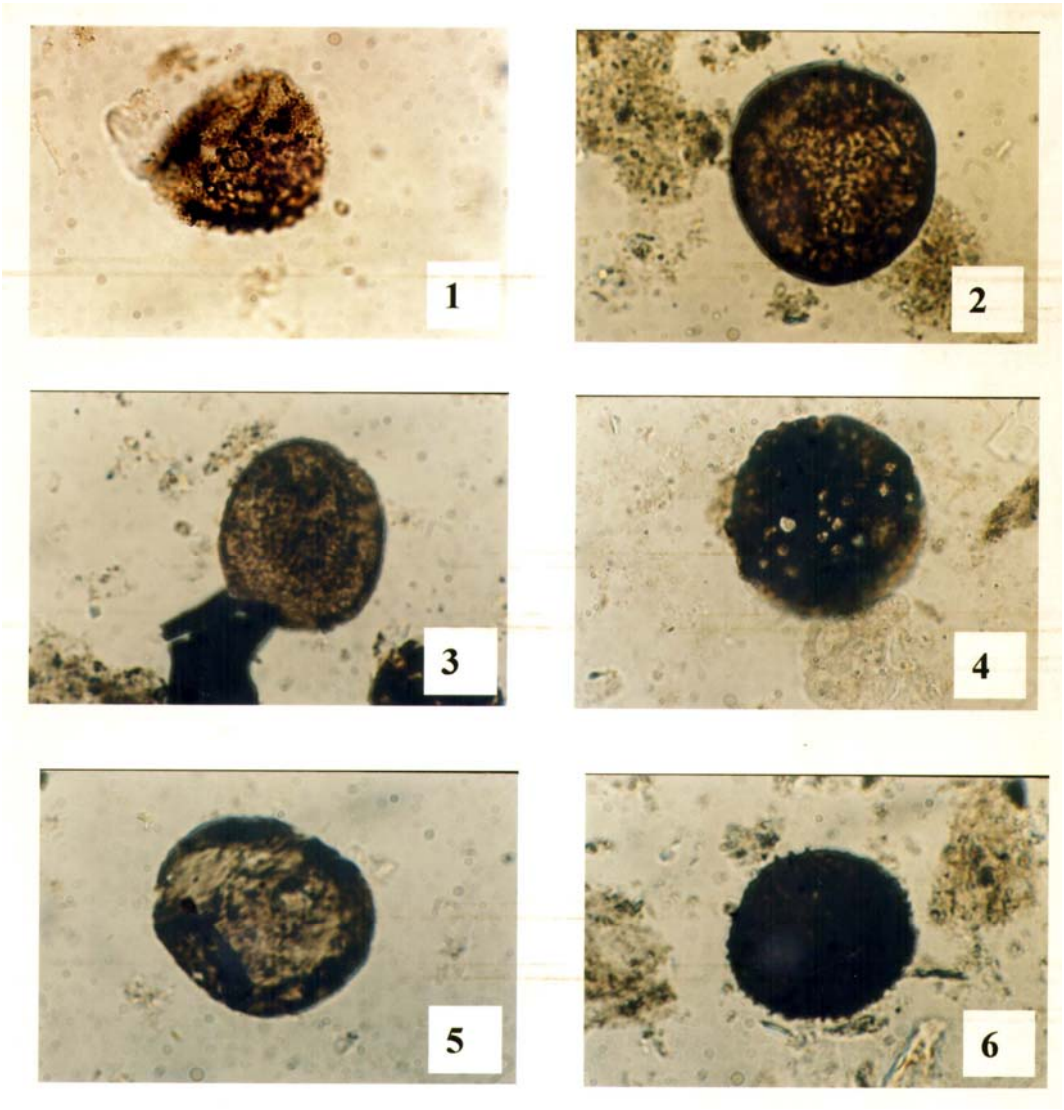
1. *Apiculiretusispora granulate*, owens, 1971, Harur18, 62.5 – 17.5, 10x100.
2. *Retusotriletes minutus*, Butterworth, and Mahdi, 1980, Harur.14, 61.5 – 11.5, 10x100.
3. *Leiotriletes incomptus*(flex and Burbridge) Higgs, Clyton, and Keegan, 1988, H.14, 61.1 – 26.5, 10 x 100.
4. *Archaozonotriletes semilucensis*, Naomova, 1963, Harur.14, 63.5 – 19.5, 10x100.
5. *Retusotriletes microthelis*, Naumova, 1963, Harur.14, 64.2 – 15, 10x100.
6. *Hymenozonotriletes explanatus*, (Lubex) Kedo, 1963, Harur.1, 64.2 – 16, 10x100.



Figs. 8.1 – 8.6

Figs. 8.1 – 8.6

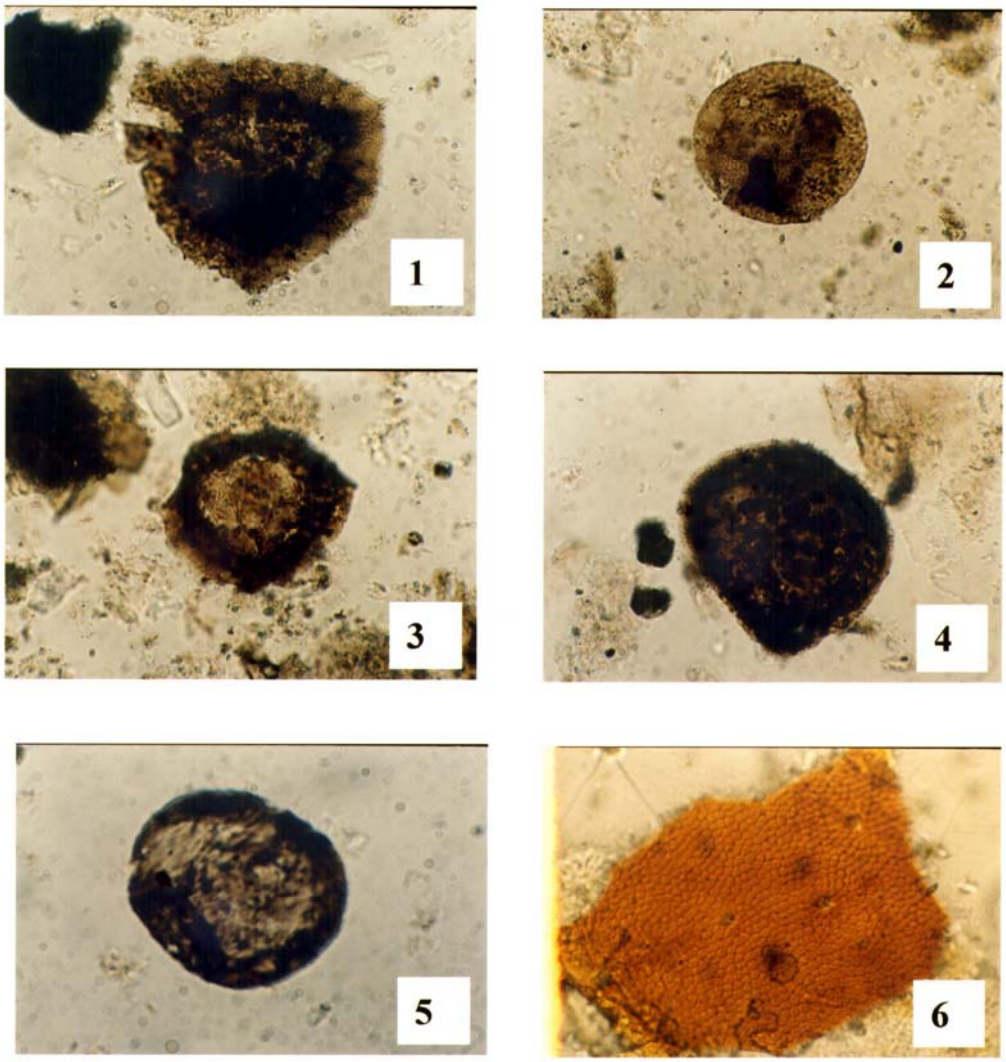
1. *Retusotriletes communis* , Naumova , 1953, Harur.1, 64.5 – 38.9, 10x100.
2. *Punctatisporites minitus* Kosanke, 1950, Harur.1, 70.5 – 25.5, 10x100 .
3. *Retusotriletes communis* , Naumova , 1953, Harur.1, 68.2 – 28.5, 10x100.
4. *Hymenozonotriletes celeber*, Chibrikova, 1968, Harur.1, 67.2 – 35.5, 10x100.
5. *Geminospora decora* (Naumova) Arukh, 1995, Harur.18, 69.5 – 24.1, 10x100.
6. *Laevigatisporites sp.* ,naumova, 1995, Harur18, 21.8 – 70.5, 10x100.



Figs. 9.1 – 9.6

Figs. 9.1 – 9.6

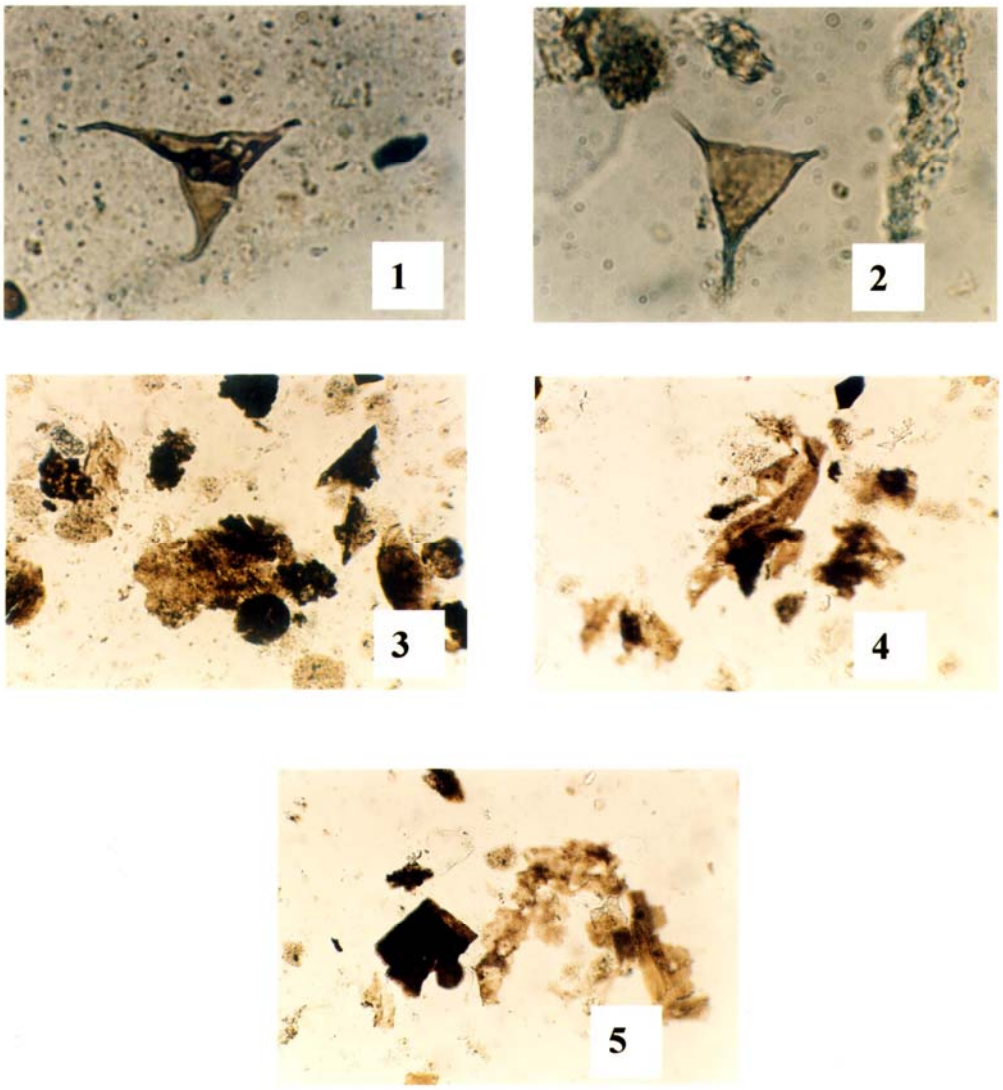
1. *Acanthotriletes parvisponosus*, (Luber) Jush, 1963, Harur.18, 64 – 21.2, 10x100.
2. *Prolycospora Rugulosa* (Butterworth and Spinner) Turma, 1978, Harur.18, 24.2 – 64, 10x100.
3. *Aratrisporites saharaensis*, Lobosiak, Clayton and Owens, 1986, Harur.25, 71.2 – 24.6, 10x100.
4. *Convolusispora tubercolata* (Waltz) Hoffmeister, Staplin and Maloy, 1955, Harur.1, 70.5 – 25, 10x100.
5. *Dictyotriletes Submargnatus*, Playford, 1964, Harur.21, 68 – 25.5, 10x100.
6. *Convolutispora tuberculata* (Waltz) Hoffmeister, Staplin and Maloy, 1955, *Harur*.1, 70.5 – 25, 10x100.



Figs. 10.1 – 10.6

Figs. 10.1 – 10.6

1. *Hymenozonotriletes explanatus* (Luber) Kedo, 1963, Harur 1, 70 – 29.45, 10x100
2. *Punctatisporites gereineri*, Varna, 1969, Harur.1, 71 – 25,10x100.
3. *Densosporites Variablis* (Waltz) Potonie and Cremp, 1956, Harur.1 ,70.5 – 43.5, 10x100.
4. *Vallatisporites agadesy*, Loboziak and Alpern, 1978, Harur.1, 69.7 – 33, 10x100.
5. *Dictyotriletes submarginatus*, playford, 1964, Harur.25, 68 – 25.5, 10x100.
6. Plant cortex , Harur.32,71.8 – 26.5.



Figs. 11.1 – 11.5

Figs. 11.1 – 11.5

1. *Veryhachium europaeum*, Fran, Stockmans, 1960, Harur.14,68 – 15.5 10x100
2. *Veryhachium trispinosum*, (Eisenack) Deunff, 1956, Harur.18, 69.2 – 25.6 10x100
3. Organic matters, Harur.1, 70 – 32.5, 40x10.
4. Organic matters, Harur.1, 67 – 38.2, 25x10
5. Organic matter, Harur.1, 68 – 38.2, 25x10.

Retusotriletes microthelis, Spelaetriletes triangulatus while zone eneded by first appearances of Acanthotriletes paravispinosus, Crassispora drucie, Dictyotriletes submarginatus, Kraenselisporites ornatus, Laevigatisporite sp., Prolycospora regulusa, Spelaeotriletes crustantus, Tergobulasporites immensus and last of *Retusotriletes communis,* while a part of the following miospores are restricted by this zone, *Convolutispora tuberculata, Hymenzonotriletes explanatus, Punctatisporites grieneri* .

4- Palynozone 4 (PZ – 4) Early Carboniferous (Middle Tournaisian)

The lower boundary of this zone is marked by the first appearance of *Acanthotriletes paravispinosus, Crassispora drucie. Germinospora decora, Kraenselisporites ornatus, Laevigatisporites sp., Prolycospora rugulosa, Spelaetriletes crustantus, Tergobulasporites immensus,* while the upper boundary is marked by the last appearance of the following miospores. *Aratrisporites granulatus Hymenozonotriletes explanatus, Protrolaeisphaeridius orbiculatus, Spelaetriletes triangul Umbonatisporites distinctus*. A part of the following miospore ranges are restricted within this zone *Convolutispora tuberculata, Valatisporites agadensi, V. verrucosis*.

5- Palynozone 5 (PZ – 5) Early Carboniferous (Late Tournaisian)

The zone starts by the last appearances of *Aratrisporite saharaensis Hymenozonotri Protroleisphaeridium orbiculatum, Spelaeotriletes explanata, triangulatus Umbonatisporites dilinatus* and first appearance of *Dactyotriletes submarginatus,* while the zone ends by the last appearance of many miospores which are not indicated in this study, because the top of the studied section is almost vertical and unexcessable. Therefore, the uppermost part was not sampled.

The last appeared miospores are *Convolutispora tuberculata, Crassispora of drucie, Punctatisporites of irracus, Tergobolasporites immensus, Valatisporites agadensi, V. verrucosus.* The last two samples were found barren, although they were analysed for several times, and some dolomitization features were observed.

ORGANIC THERMAL MATURATION

The color of the spores and palynodebris can be used to find the level of thermal maturation (Staplin, 1969 and Ibrahim, 1997, in Ibrahim, et. al., 2000). The increase of temperature due to burial is an essential factor to change the color of the spores and the thermal alteration index (TAI) is deduced from the changes in color with depth, even this happens generally in wells not in outcrops, due to oxidization.

In our study, we could not observe a major changes in the color of spores of the studied sediments, the main color of the spores ranges form light brown to orange and dark brown. The change in the color indicates that the formation is highly maturated; this is all due to old age of the formation and huge sediments deposited through this time (Figs. 4 – 9).

PALEOENVIRONMENTAL DETERMINATION

The Palynomorph assemblages recovered from the Harur Formation in Nazdur outcrop show a large number of miospores. The overall composition of the Palynomorph assemblages indicates that the deposition of this formation probably took place in shallow marine water (coastal environment). This is due to a large number and diversity of miospores, if compared with a fingerecounted Acritarchs. Although spores can reach to a distance more than 1970 Km by the winds, some times by currents, but a high concentration of miospores, in the sediments of the formation indicates a very shallow marine environment. This is supported by the type of the sediments and assemblages of Brachiopods.

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REFERENCES

Al-Ameri, T., Al-Naqishbandi, S.F. and Al-Jubori, F., 1991. Lower Silurian Palynomorphs from Western Iraqi Desert and the Paleoclimate; J. Sci.Nat.Vol 1, No.1 p. 57 – 65.

Al-Naqishbandi, S.F., 1988. Palynological study for the determination of Biostratigraphy and Paleoecology of Suffi Formation, W. Desert, Iraq, unpublished thesis, Salahaddin. University. 123pp.

Al-Hasson, M.A. Mustafa, 1999. Palynostratigraphy of Upper Devonian – Lower Carboniferous strata from borehole Khleisia-1, N. W. Iraq. Unpublished Ph. D. Thesis, Mousul University.

Al-Jubori, F. and, Al-Beerakdar, A., 1985. A Preliminary Palynological study of Paleozoic sediments in well Risha-1, Jordan. National Oil Company Lib, Baghdad.

Al-Jubori, F., and Al-Beerakdar, A., 1985. A preliminary palynological study of Paleozoic sediments in well K.H.5/1, Western Desert, Iraq, National Oil Company Lib. Baghdad.

Al-Sayyab, A., Al-Ansari, N., Al-Rawi, D., Al-Jassim, J, Al-Omeri , F.,and Al-Shaik, Z., 1982. Geology of Iraq: Dar Al-Kutib Pub. Mousul University (Arabic), 277pp.

Babban, D., 1996. Palynostratigraphy and Maturation of Lower Paleozoic strata in Western Iraqi Desert; Unpublished Ph.D Thesis, Baghdad University .

Bellen, Van, R.C., Dunnigton, H.V., Wetzel, R., and Morton, D.M., 1959. Lexique Stratigraphique International, Vol. 3, Asie, Fasc, 10a Iraq , Paris, 333pp.

Buday, T., 1980. The Regional Geology of Iraq, Stratigraphy and Paleogeology, Dar Al-Kutib Pub. House, Mosul, Iraq , 445 pp.

Buday, T., Aqif, A., Sattran, V., and Tyrack, J, 1973. The Regional Geology of Iraq (Volume 2). GEOSURV Lib, Baghdad, 552 pp.

Buday, T. and Jassim, S.Z., 1987. The Regional Geology of Iraq, Part2: Tectonism, Magmatism and Metamorphism. GEOSURV., Baghdad, 352pp.

Clayton, G. and Loboziak, S., 1985. Early carboniferous aspects of the Middle and Upper Devonian miospore zonation in North Africa and Brazil, Rev. of Paleob. and Paly. 86. p. 147 – 155.

Couqel, R., Lang, J., and Yahya, M., 1995. Palynologic du Carbonifera du Nord Niger et de la Plate-form saharienne-implications stratigraphique et Paleogeographique., Rev. of Paleob. and Paly. 89. p. 319 – 334.

Herisse, A., Servais, T., and Vicander, R., 2000. Devonian Acritarches and related forms: Cour. Forsch. – Inst. Senckenberg, FrankFurt.

Ibrahim, M.I.A., and Hitmi, H.H.A., 2000. Albian – Cenomanian Palynology, Paleoecology and Organic Thermal Maturity of Well DK-B in the Dokhan Oil Field of Western Qatar; National Inst. of Oceanography and Fisheries, Alexandria, Egypt.

Loboziak, S., Streel, M., and Vanguestains, M., 1983. Miospores at Acritarches DeLa Formation D'Hydrequent (Frasnien Superiur A Fammenien inferieur, Boulonnias, France) Ann. De. La. Soc. Geo. De Belgique. T. 106, p. 173 – 183.

Loboziak, S., and Streel, M., 1992. West Gondwanan aspects of the Middle and Upper Devonian miospore zonation in North Africa and Brazil. , Rev. of Paleob. and Paly. 86, p. 147–155.

Loboziak, M., Street, M. Dusar, F. Boulvian, and De Geyter, G., 1993. Late Devonian– Early Carboniferous miospores from the Menen Borehole, Namur Synclinorium, Belgium. Rev. of Paleob., and Paly. 80, Elsevier Science B.V. Amsterdam. p.55–63 .

Loboziak, S., Avkhimovetch, V., and Street, M., 1996. Miospores from the type locality of the Middle Famennian Esneux Formation in the Ourthe valley, Estern Belgium, Ann. De la Soc. Geo. De Belgique, T. 9, Fac.-2, p. 111 – 118.

McGregor, D., 1975. Early and Middle Devonian spores from the Northeastern slope of Sadair: Geo. Survey, USSR , Liningrad.

McMillan, N.J., Embry A.F., and Glass, D.J., 1988. Devonian of the world: Vol.III, Paleontology, Paleoeco., and Biostr. Canadian Sos. Of Petr. Geo., Calgary, Alberla, Canada.

Molyneux, S.G., Le Herisse, A., and Wicander, R., 1996. Paleozoic phytoplankton: S.G. Molyneux, AASP. Foundation, Vol.2, p. 493 – 529.

Pesl,V. and Issac E.A., 1975. Geology of Dafaf – Keshan area, Northern Thrust Zone, GEOSURV, Baghdad.

Pesl,V. and Issac, E.A., 1976. Geology of Middle part of North Thrust Zone, GEOSURV, Baghdad .

Stempien, M., and Turnau, E., 1988. Upper Visien (Brigantian) Miospores from the Eastern part of the Lublin coal, Basin (Poland), and their Stratigraphical Significant. Ann., Soc. Geo. Poloniae, Vol. 58, p. 287 – 305.

Turnau, E., 1985: Devonian – Carboniferous Boundary in the borehole Kowala-1 (Southern Holy cross Mst). Poland: Spore, Bul. Of the Polish Acad. Of Scie. Earth. Scie. Vol. 33 No. 1 – 2.

Turnau, E., 2002. Two new Devonian spore genera from Euramerical and their Stratigraphic and geographic distribution: Inst. Of, Geo., Sci., Krakaw Res., Center, Senaka-1.