

PRELIMINARY OBSERVATIONS ON THE PALYNOLOGY OF THE PRECAMBRIAN KATANGA SEQUENCE, ZAMBIA

P.L. BINDA¹)

ABSTRACT

This is the first record of microfossils found in palynological preparations of Precambrian metasediments from the Zambian Copperbelt. Argillites and carbonates of the Lower Roan contain clusters of spherical forms, chains of cells, and filaments of algal affinity, which are similar to Precambrian microfossils reported from Australia and Europe. The Mwashia and the Kundelungu groups contain mainly isolated Sphaeromorphida.

INTRODUCTION

In the past three years several rock-samples from the Katanga Sequence have been successfully analysed for microfossils in the RCM Geologic Research Department. This paper is a preliminary report on the occurrence of palynomorphs in the Katanga Sequence of the Zambian Copperbelt; detailed work on the taxonomy and classification of the organic remains is in progress. The aim of the investigation is to attempt to apply biostratigraphy in the study of these Late Precambrian rocks, and also to gain some understanding of the paleoecology of the sulphide-bearing formations.

In the last decade, fossil traces of life have been reported from an increasing number of Precambrian metasediments, even from rocks that are older than 3 billion years such as the Onverwacht Series (Engel et al., 1968) and the Fig Tree Series (Flügel, 1966), both from the Swaziland System of South Africa.

¹) RCM Geologic Research Department, Roan Consolidated Mines Limited, Kalulushi.

Some pioneering attempts to establish a Late Precambrian biostratigraphy using the morphological characteristics of stromatolites have been made by Raaben (1969) and by Glaessner et al. (1969). A widespread Precambrian macrofossil assemblage that may also have some stratigraphic significance is the Ediacara fauna of the uppermost Proterozoic (Glaessner, 1971). From reviews by Schopf (1969 and 1970), and from a survey of the Russian literature, it would appear, however, that the best hopes for a Precambrian biostratigraphy lie in the field of palynology.

Some remarkably abundant microfossil assemblages have been recorded from Middle and Late Precambrian rocks of various parts of the world. Barghoorn and Tyler (1965) describe a number of microfossils of cyanophycean affinity and several others of unknown biological affinity from the 2000 m.y. old Gunflint Iron Formation of Canada. Schopf (1968) describes thirty microfossils referred to blue-green algae, bacteria, fungi, and green algae from the 1000 m.y. old Bitter Springs Formation of Australia. In Proterozoic rocks of Northern Europe and of the Soviet Union, large and well preserved microfossil assemblages have been recorded by Timofeev (1969).

Proterozoic metasediments approximately coeval with the rocks that have yielded good palynomorph assemblages in other parts of the world, are well represented in Central Southern Africa. They include the Katanga Sequence and correlative sequences in Congo, Angola, Gabon, Central African Republic, Burundi, Tanzania, and South-West Africa. In some

areas these rocks have undergone only mild metamorphism, and at least some of these rock units have been subjected to extensive stratigraphic study as they are the host-rocks of stratiform deposits of worldwide renown. In spite of these favourable circumstances remarkably little work has been published on the palynology of these rocks. The present writer is aware only of two early thin-section studies, one by Ashley (1937) on some microscopic algae from a pyritic black chert of the Kundelungu of Northern Zambia, and one by Cahen et al. (1946) on algal remains and other microfossils of uncertain affinity from Upper Kundelungu cherts of Katanga (Congo).

TECHNIQUES

The methods used to free the microfossils from the mineral matrix are the standard palynological methods consisting in macerating small amounts of rock in acids in order to destroy all mineral matter and thus concentrate and mount the acid resistant organic matter for microscopic examination (Brown, 1960). Through palynological techniques contaminants, such as: recent algal and fungal matter, spores and pollen, can be introduced in the residue from water and from laboratory dust. The problem of recognizing contaminants from microfossils is particularly acute working with Precambrian material since a great deal of the fossil residues reported from Precambrian sediments belong to blue-green and green algae of the same type as modern algae (Schopf, 1969). In the Geologic Research Department laboratory the following precautions and criteria are normally adopted.

- i. Samples are cut so as to discard all material that has been exposed to air for any length of time.
- ii. Before palynological treatment, samples are examined in thin sections to ensure that they contain organic matter away from cracks and fissures.
- iii. The water used in the laboratory is filtered, distilled and again filtered. Large amounts of water are periodically centrifuged and the residue is mounted and examined.
- iv. When processing a batch of samples, a blank sample, i.e. granite or other unfossiliferous rock,

is also processed with the same water and chemicals and examined.

- v. Each sample is split and processed at least twice, often several months apart.
- vi. Examining possible microfossils, great weight is placed on the state of preservation of the forms: encrusting carbonaceous matter is normally taken as evidence of antiquity of the specimen.
- vii. A good indication also comes from stratigraphy: some forms appear only in rocks of the Lower Roan, others only in rocks of the Kundulungu. This does not necessarily imply an evolutionary development; it does however, suggest that the specimen is indigenous to the rock.

These precautions are normally sufficient to detect laboratory contamination; they are not always a safeguard against in situ contamination of the rocks by circulating groundwaters. Only years of painstaking work can eliminate the element of uncertainty about Precambrian palynology.

THE MICROFOSSILS

Roan Group

The Lower Roan metasediments consist of coarse clastics of continental origin at the base, passing to marine arenites, argillites, and subordinate carbonates. Overlying the dominantly clastic Lower Roan, which is the host-rock of the copper deposits in the Copperbelt, are the clean dolomites, and anhydritic or talcose dolomites of the Upper Roan. Isotopic age determinations indicate that the Lower Roan is younger than 1300 m.y. and older than 840 m.y. (Cahen, 1970), thus belonging to the Proterozoic.

Of the Roan Group, only samples from the Lower Roan have been processed for microfossils so far at the Geologic Research Department. The continental facies are generally barren and the best yields have been obtained from dark carbonaceous argillites of the "Ore-shale" horizon and from stromatolitic carbonates of the "Inter-BC" horizon at Mufulira. The stromatolites have been discussed by Malan (1964) and Paltridge (1968), especially in their relationships to the occurrence of copper sulphide. Malan (1964, p. 404) reports that in the Mufulira reefs gradations from *Collenia* to *Cryptozoon*, as well as

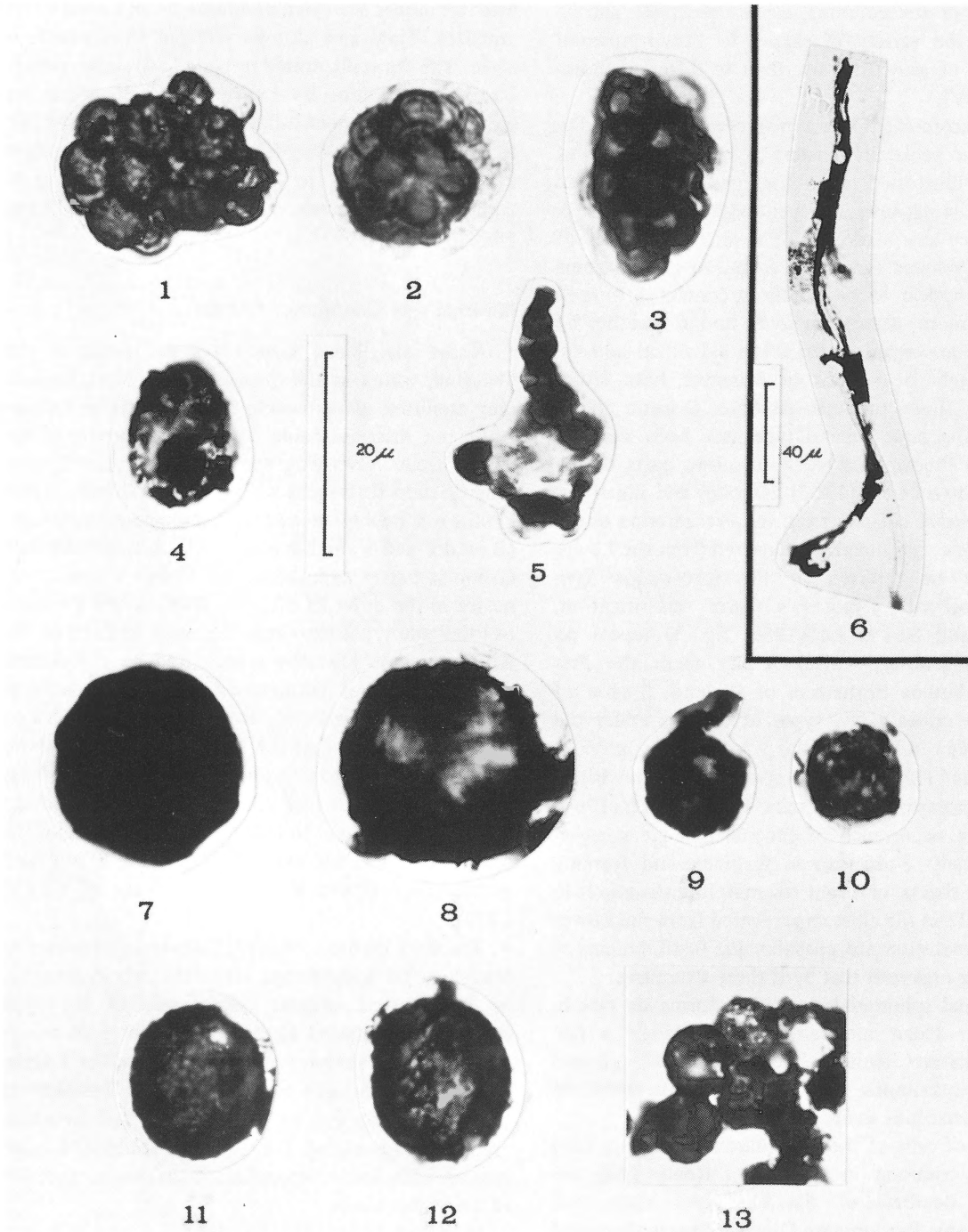


Plate 1

Photomicrographs of microfossils from the Katanga Sequence of the Zambian Copperbelt. All microfossils magnified X1650 except no. 6 (X 400).

1-3: Lower Roan, clusters of spherical forms
 4: Lower Roan, ovoidal form
 5: Lower Roan, chain of cells

6: Lower Roan, filament
 7-10: Mwashia, Sphaeromorphida
 11-13: Lower Kundelungu, Sphaeromorphida

digitations of the columns, can be observed, and he attributes the variety of shapes to "environmental conditions of growth rather than to different biological species".

The microfossils that are most commonly found in Lower Roan rocks are clusters of spherical bodies of the types illustrated in photographs 1, 2, and 3 of Plate I. The clusters are yellowish-brown to dark brown, they are made up of a variable number of individual spheres (generally 6 to 20) that in some specimens appear to be merely in contact with each other but more often seem to be bound together by an amorphous organic matrix. The individual spheres, approximately 5 microns in diameter, have either smooth or finely ornamented walls. Organic microfossils of the same general type have been reported from Late Precambrian rocks in other parts of the world. Timofeev (1969) describes and illustrates several types of clusters from the Precambrian of the Soviet Union; the material recovered from the Lower Roan can be referred to the form-genus *Synsphaeridium* of Timofeev's form classification. Tynni and Siivola (1966, fig. 3) report an analogous cluster-type algal colony from the Precambrian Muhos Formation of Finland. Schopf (1968), describes a few types of clusters under the extant-order Chroococcales of the phylum Cyanophyta (Blue-Green Algae) from the Bitter Springs Formation of Australia. Gebelein (1969) reports the occurrence of coccoid blue-green algae, approximately 7 microns in diameter and forming palmelloid sheets, in recent stromatolitic structures in Bermuda. Thus the clusters recovered from the Lower Roan stromatolites are probably the fossil remains of the binding organism that built these structures.

Individual spheroidal or ovoidal forms are rare in the Lower Roan metasediments, although a few rather indistinct ovoidal bodies about 15 microns along the maximum diameter, have been recovered from carbonaceous shales (plate I: 4).

Chains of cells of the type illustrated in plate I (5) are fairly common in the Lower Roan. They are probably members of the blue-green algae, and resemble some Precambrian Oscillatoriaceae described by Schopf (1968). The presence of algae related to present-day Oscillatoriaceae in rocks of the Katanga Sequence was already noticed by Ashley (1937) and by Cahen et al. (1946). A large number of hyaline filaments 200-300 microns long and a few

microns across are often encountered in Lower Roan argillites. They can also be referred to filamentous algae. The form illustrated in plate I (6) shows clearly a carbonitized outer layer partially detached from the inner hyaline filament following nitric acid treatment. It must be noted that filamentous blue-green algae can constitute up to 95 percent of the organic component of recent stromatolites (Gebelein, 1968).

Mwashia and Kundulungu Groups

Above the Roan Group lie the rocks of the Mwashia, which in the Copperbelt are black to dark grey argillites, often passing to carbonates and sometimes not distinguishable from the dolomites of the Upper Roan. Overlying the Mwashia is the Kundulungu Group that starts with the Great Conglomerate (Tillite), a pebbly mudstone of glaciomarine origin (Binda and van Eden, 1971). The Kundulungu Group is better exposed in the Congo where thicknesses in the order of 6000 to 7000 m and a variety of lithologic types have been reported. In Zambia, the Kundulungu is generally represented by carbonates, carbonaceous and calcareous argillites, with arenites and conglomerates locally well developed. Robert (1956) speculated that the Kundulungu Group above the tillite is Phanerozoic, encompassing the time lapse from Cambrian to Devonian. However, isotopic age determinations seem to indicate that the whole of the Kundulungu was deposited before 620 ± 20 m.y. and is therefore Upper Proterozoic in age (Cahen, 1970).

The dark carbonaceous argillites and carbonates of Mwashia and Kundulungu are often rich in spherical or subspherical organic microfossils of the type commonly attributed to the Sphaeromorphida group.

Some rock samples and slides from the Kundulungu have been sent to Professor B.V. Timofeev at the Institute for Precambrian Geology and Geochronology in Leningrad for detailed study and comparison with Sphaeromorphida from the Precambrian of the Soviet Union.

In plate I (7 to 13) a few typical forms are shown. These microfossils are generally dark brown to completely black. Photograph 7 shows a specimen that is completely carbonitized and no detail of the wall structure is visible. In the form of photograph 8 it is possible to distinguish a dark carbonitized outer

layer partially covering a yellowish-brown smooth wall. The walls of these microfossils are often finely sculptured with small mounds and conical projections generally smaller than one micron in diameter (scabrate), as in plate I (10, 11, 12), and can possibly be referred to the form-genus *Protosphaeridium* Timofeev.

A few spherical forms have short appendages projecting from the main body (plate I: 9), thus slightly resembling some microfossils with long tails, and similar to extant Phycomyces, described by Timofeev (1970) from the Rifean of the Soviet Union. The microfossils recovered from the Mwashia, however, are much smaller (10-15 μ) than the forms described by Timofeev.

Although the typical clusters of spherical bodies that are common in the Lower Roan have not yet been found in the Mwashia and Kundelungu, groups of small sphaeromorphs in close contact with each other, and some apparently attached, have been recovered in large numbers from black carbonates overlying the Great Conglomerate. It is interesting to note that the rocks in question are extremely rich in pyritic spheres of the same size as the microfossils. The association might not be merely coincidental but could be analogous to some microfossils contained in pyrite which have been described by Love (1958).

REFERENCES

- Ashley, B.E. (1937) – Fossil algae from the Kundelungu Series of Northern Rhodesia. *Jour. Geology*, 45, p. 332-335.
- Barghoorn, E.S. and Tyler, S.A. (1965) – Microorganisms from the Gunflint chert. *Science*, 147, p. 563-577.
- Binda, P.L. and van Eden, J.G. (1971) – Sedimentology of the Great Conglomerate (Tillite) at Ndola East and Itawa. RCM company report, GR37, 19 pages.
- Brown, C.A. (196) – Palynological Techniques. Publ. by the author, Baton Rouge, La., 188 pages.
- Cahen, L. (1970) – État actuel de la géochronologie du Katangien. *Ann. Musée Royal Afrique Centrale, Tervuren, Belgium*, 65, p. 7-14.
- Cahen, L., Jamotte, A. and Mortelmans, G. (1946) – Sur l'existence de microfossils dans l'horizon des cherts du Kundelungu supérieur. *Ann. Soc. Géol. Belg.*, 70, p. B55-B65.
- Engel, A.E.J., Nagy, B., L.A., Engel, C.G., Kremp, G.O.W. and Drew, C.M. (1968) – Alga-like forms in the Onverwacht Series, South Africa: oldest recognized lifelike forms on earth. *Science*, 16, p. 1005-1008.
- Gebelein, C.D. (1969) – Distribution, morphology, and accretion rate of recent subtidal algal stromatolites, Bermuda. *Jour. Sed. Pet.*, 39, p. 49-69.
- Glaessner, M.F. (1971) – Geographic distribution and time range of the Ediacara Precambrian fauna. *Geol. Soc. America Bull.*, 82, p. 509-514.
- Glaessner, M.F., Preiss, W.V. and Walter, M.R. (1969) – Precambrian columnar stromatolites in Australia: morphological and stratigraphic analysis. *Science*, 164, p. 1056-1058.
- Love, L.G. (1958) – Micro-organisms and the presence of syngenetic pyrite. *Quart. Jour. Geol. Soc. London*, 113, p. 429-440.
- Malan, S.P. (1964) – Stromatolites and other algal structures at Mufulira, Northern Rhodesia. *Econ. Geol.*, 59, p. 397-415.
- Paltridge, I.M. (1968) – An algal biostrome fringe and associated mineralization at Mufulira, Zambia. *Econ. Geol.*, 63, p. 207-216.
- Pflug, H.D. (1966) – Structured organic remains from the Fig Tree Series of the Barberton Mountain land. *Econ. Geol. Res. Unit, Univ. Witwatersrand, Johannesburg, Inform. Circ.* 28, 14 pages.
- Raaben, M.E. (1969) – Columnar stromatolites and Late Precambrian stratigraphy. *Am. Jour. Sci.*, 267, p. 1-18.
- Robert, M. (1956) – Géologie et géographie du Katanga. Hayez, Bruxelles, 620 pages.
- Schopf, J.W. (1968) – Microflora of the Bitter Springs Formation, Late Precambrian, Central Australia. *Jour. Paleontology*, 42, p. 651-688.
- (1969) – Recent advances in Precambrian paleobiology. *Grana Palynologica*, 9, p. 147-168.
- (1970) – Precambrian micro-organisms and evolutionary events prior to the origin of vascular plants. *Biological Reviews*, 45, p. 319-352.
- Timofeev, B.V. (1969) – Proterozoic Sphaeromorphida. Publ. "NAUKA", Leningrad, 146 pages (in Russian).
- (1970) – Une décourte de Phycomyces dans le Précambrien. *Rev. of Palaeobotany and Palynology*, 10, p. 79-81.
- Tynni, R. and Siivola, J. (1966) – On the Precambrian microfossils flora in the siltstone of Muhos, Finland, *Compte Rendus Soc. Géol. Finlande*, p. 127-133.