PALYNOSTRATIGRAPHY OF THE LUKUGA SERIES IN CONGO

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ABSTRACT

During the last few years our knowledge regarding the Palynology of the Permian sediments in Congo has increased considerably. In this paper an attempt has been made to synthesize the available palynological data for recognition and correlation of the various stratigraphic members within the Lukuga Series. It has been demonstrated that the biostratigraphic results are more or less in conformity with the lithostratigraphic classification.

The Lukuga Series represents the younger part of the Palaeozoic formation starting with the Permo-Carboniferous glaciation. This Series is mostly confined to the eastern part of Congo, outcropping from Irumu in the north-east and extending almost upto the southern border of Katanga. According to CAHEN (1954) this Series was deposited in the depressions in the old basement and is easily recognizable by the universal development of the glacial formation at the base and black or grey shales above. The Lukuga Series was divided into four natural sub-divisions by CAHEN (1954) in the following order of succession:—

Permian	Assise de "transition"	Etage supérieur
	Assise à couches de houille	
	Assise des schistes noirs	Etage inférieur
Carbonifere	Assises de Walikale	

However, on the basis of studies on the mega—and microfossils from the Lukuga Series, HØeg and BOSE (1960) suggested that the assise des schistes noirs at Walikale may be different from those exposed near Greinerville. So CAHEN (1961), based on their studies, revised his original classification as follows:

Permian	Assise de "transition"
	Assise à couches de houille
	Assise des schistes noirs de la Lukuga
	Assise des schistes noirs de Walikale
?Permo—Carboniferous or Upper Carboniferous	Assises glaciaires et périglaciaires

A systematic collection of shales and coal samples were made by me in 1959 from the various stages mentioned above. Besides these collections a large number of bore-hole samples and other shale samples were received by me, from time to time, from Mr. L. Cahen, Director,

Musée Royal de l'Afrique Centrale, Tervuren. All these samples were studied for a better understanding of the palynostratigraphy of the Lukuga Series. A part of this work has already been published and quite a lot, including the final conclusion, still remains to be published. In this brief *resumé* an attempt has been made to give a broad outline of the palynostratigraphical conclusions arrived at so far.

In 1966 Bose and Kar described a rich assemblage of Palaeozoic dispersed miospores from the Elila river section near Fundi Sadi, Walikale and Kindu-Kalima regions. Bose and Maheshwari, in the same year, recorded a few miospores from the Epulu river (Ituri). Kar and Bose (1967) dealt with the *Sporae dispersae* from the assise des schistes noirs de la Lukuga while Bose and Kar (1967*a*) instituted some new miospore genera from the assise à couches de houille. Bose and Kar in the same year also reported some megaspores from the assise schistes noirs de la Lukuga and Kar (1967) discussed about the organisation of monosaccate grains in the Lukuga Series. Maheshwari and Kar (1967) recorded *Tiwariasporis* from the Palaeozoic of Congo and India. Bose and Maheshwari (1968) described miospores from the Coal Measures near lake Tanganyika, south of Albertville. Maheshwari and Bose (1969) investigated a palynological assemblage from the Kibamba river (Lukuga coalfield area). Kar (1969) described mega-and microspores from Ombela and Lokandu regions while Maheshwari in the same year also reported microfossils from a cliff section at the Lufupa-Mushyashya confluence. Palynological investigation of different coal seams from Christine, Old and 1950 pits in Greinerville region by Bose, Maheshwari and Kar is in progress. Laboratory processing of samples from various levels of Irumu and Dekese borehole is nearing completion and the identification of palynomorphs recovered is in progress. Besides these, Piérart is working on the Luena coal samples.

The palynological data so far accumulated reveals that within one particular Stage the assemblage is more or less uniform, whereas, the assemblage of a particular Stage differs both qualitatively and quantitatively when compared with the overlying or underlying stages. The clear differentiation of the palynological assemblages thus help in the demarcation of the various stages within the Lukuga Series and can conveniently be used as a tool in regional stratigraphy, especially in problems of age determination.

Assises glaciaires et périglaciaires

The oldest palynological assemblage of the assises glaciaires et pèriglaciaires is known from the Elila river (right side), near Fundi Sadi. This assemblage is dominated by monosaccate pollen grains. Out of the total 32 genera isolated, 13 belong to monosaccates contributing 70% to the assemblage. Among these, *Cannanoropollis* (40%), *Parasaccites* (10%), *Elilasaccites* (3%) and *Divarisaccus* (4%) are the commonest. The bisaccates are next in abundance and represent 20% of the total assemblage. The triletes, monoletes, polyplicates and monocolpates are meagrely represented.

A supposed pre-*Glossopteris* assemblage described by Hart (1963) from the Lower Karroo sediments of the Orange Free State is very distinct from the assemblage of the Elia river by its overwhelming dominance of triletes. The palynological assemblage from the Bacchus Marsh Tillite of Australia described by Virkki (1946), Pant and Mehra (1963) and that of Talchir shales of Goraia in the South Rewa Gondwana basin of India described by Potonié and Lele (1961) closely resemble the Elila river assemblage in the overwhelming dominance of monosaccates. In all of them *Cannanoropollis* is found in prolific numbers while the pteridophytic spores are rare.

The miospores recovered from the Epulu river (Ituri) shale samples are also dominated by monosaccates. The bisaccates are next in abundance, whereas, triletes, polyplicates and

monocoplates are rare. Among the monosaccates, *Cannanoropollis* is maximum in number. *Potonieisporites* and *Vestigisporites* are also quite common. This assemblage is very similar to that of the Elila river as in both these assemblages, *Cannanoropollis* is most common, whereas, triletes, monoletes, polyplicates and monocoplates are meagrely represented.

Out of the samples obtained from Irumu bore-hole, only a few have yielded miospores. The assemblage closely compares the Elila and Epulu river assemblages with some minor differences. Here the monosaccates are 63%, among them *Cannanoropollis* is very common and *Divarisaccus*, *Parasaccites* and *Potonieisporites* are frequently met with.

The palynological assemblage from the Dekese borehole samples too supports an assises glaciaires et périglaciaires age and comes very near to Epulu and Irumu assemblages.

The monosaccates (54%) are also dominant in the Ombela and Lokandu assembleges. The bisaccates are next in abundance (32%) while the monocolpates and triletes contribute 7% and 6% respectively. *Cannanoropollis* is dominant in both the assemblages while *Parasaccites*, *Caheniasaccites* and *Divarisaccus* are also commonly met with. The present assemblage though closely resembles all the above mentioned assemblages but here it may be mentioned that in Ombela and Lokandu regions the monosaccates, though dominant, are less in number than in Elila river (70%) assemblage. Moreover, the triletes and bisaccates which are rather meagrely represented in the Elila assemblage are found in good percentages in Ombela and Lokandu regions. The bisaccates viz. *Hø egiasaccites* and *Walikalesaccites* which are commonly found in assise des schistes noirs de Walikale are also met with in these assemblages. Because of this difference and the presence of megaspore genus *Duosporites* it is assumed that the Ombela and Lokandu beds are slightly younger than the Elila river beds but older than Walikale beds described by Bose and Kar (1966).

The palynological assemblage from a cliff section at the Lufupa-Mushyashya confluence described by Maheshwari (1969) has 50 genera and 107 species. Here, too, monosaccates are dominant (55%) and striate bisaccates (27%) are next in abundance. Triletes (17%) are also commonly met with while the monoletes, polyplicates, and monocolpates are rare. Among the monosaccates, *Parasaccites* and *Vesicaspora* are the commonest. This assemblage resembles most the assemblages from the Ombela and Lokandu regions in the dominance of monosaccates and has 25 genera in common. It may, however, be mentioned that the triletes are more in number at Lufupa-Mushyashya confluence than at Ombela and Lokandu. Moreover, *Cannanoropollis* which is dominant at Ombela and Lokandu regions has yielded to *Parasaccites* in Lufupa-Mushyashya assemblage. From the available data it seems that both the assemblages are more or less of same age or perhaps Lufupa-Mushyashya bed is slightly younger than Ombela and Lokandu regions. The Lufupa-Mushyashya palynological assemblage also resembles the assemblages from the Giridih and Talcher coalfields in India described by Bharadwaj (1966) and Navale and Tiwari (1966). In all the three assemblages *Parasaccites* is dominant while *Potonieisporites*, *Plicatipollenites*, *Lunatisporites*, *Striatites* and *Sulcatisporites* are also frequently met with.

Assise des schistes noirs de Walikale

The *Sporae dispersae* from Walikale and Kindu-Kalima regions was described by Bose and Kar (1966). The assemblage has 40 different genera and in it the bisaccates (37%) dominate, being 14 in number. The triletes (30%) are next in abundance (10 genera) while monosaccates (28%) are represented by 9 and polyplicates (9%) monocolpates (4%) by 5 genera. Among the bisaccates, the striate forms are more common than the non-striate though at places they are more or less equally distributed. The Walikale and Kindu-Kalima

assemblages differ considerably from the Elila river and related assemblages, belonging to assises glaciaires et périglaciaires, by having more of bisaccates and in having besides monosaccates, good percentage of triletes, polyplicates and monocolpates. The typical genera, within the assemblage from Walikale and Kindu-Kalima regions, are *Caheniasaccites*, *Mabuitasaccites*, *Hoegiasaccites*, *Walikalesaccites*, *Boutakoffites* and *Fusacolpites*. This assemblage is very characteristic of assise des schistes noirs de Walikale and is quite different from all the so far known miospore assemblages from the southern hemisphere.

Assise des schistes noirs de la Lukuga

The miospore assemblage from assise des schistes noirs de la Lukuga was described by Kar and Bose (1967). Unlike the previous assemblages, in the present Stage, the triletes (80%) are dominant, the bisaccates (10%) and monosaccates (5%) are meagrely represented while the monoletes, polyplicates (3%) and monocoplates (1%) are either absent or rare. The trilete genera, such as *Leiotriletes*, *Punctatisporites*, *Apiculatisporis*, *Cyclogranisporites* and *Lophotriletes* are well represented in this assemblage. Assise des schistes noirs de la Lukuga assemblage differs from the assemblages from assises glaciaires et périglaciaires and assise des schistes noirs de Walikale in having overwhelming dominance of triletes. The present assemblage resembles most the assemblage described by Bharadwaj and Tiwari (1964) and Tiwari (1965) from Korba coalfield of India belonging to the Lower Barakar Stage. The latter, however, differs in having more of *Indotriradites* and *Dentatispora*.

Assise à couches de houille

Coal and shale samples from three different coal mine pits (Christine, Old and 1950 pits) belonging to assise à couches de houille in Greinerville region have been processed for miospores. Out of these, Christine and 1950 pits have three coal seams, whereas, in old pit there are only two seams. On the basis of miospores, isolated from the various samples, an attempt has been made to correlate the different seams. The work is yet to be completed for publication. From whatever little is known at present, it seems the population is dominated by pteridophytic spores (77%). The gymnospermous bisaccate pollen grains (12%) are next in abundance. The monosaccate (4%), monocolpate (1%) and polyplicate (2%) pollen grains are scantily represented. Among the pteridophytes, laevigate trilete spores are found in great abundance and are generally represented by genera like *Psilalacinites*, *Punctatisporites*, *Lutorimites* and *Neocalamospora*. The cingulate trilete spore genera like *Indotriradites* and *Enigmaspora* are also commonly met with. The apiculate trilete genera viz. *Apiculatisporis*, *Cyclogranisporites* and *Lophotriletes* are meagrely represented. Within the bisaccates, *Striatites*, *Strotersporites*, *Striatopiceites* and *Sulcatisporites* are common.

In the dominance of trilete spores, the Greinerville assemblage may be compared with the assemblage from the assise des schistes noir de la Lukuga. It may, however, be mentioned here that in the former, ornamented, simple, trilete spores are rare, whereas, in the latter both laevigate and apiculate trilete genera like *Leiotriletes*, *Punctatisporites*, *Apiculatisporis*, *Cyclogranisporites* and *Lophotriletes* are well represented.

The miospores from the shale and coal samples from Luena region, belonging to assise à couches de houille has not yet been worked out in detail. So far only a few spore and pollen grains have been described by Piérart (1959, 1966). It seems the general assemblage is more like the assemblage from assise à couches de houille in Greinerville region.

The palynological assemblage from the Coal Measures near lake Tanganyika, south of Albertville worked out by Bose and Maheshwari (1968) is also dominated by the trilete

spores (65%) and the bisaccates (10%) come next in abundance. The trilete spores are well represented by genera like *Leiotriletes*, *Punctatisporites*, *Granulatisporites*, *Acanthotriletes*, and

TABLE—1

?Assise de "transition"	A carbonaceous shale bed from Kibamba river (about 2.5 km. from the Lukuga-Kibmaba, (age and stratigraphic position doubtful).	Triletes dominant (56%), bisaccates subdominant (17%), monocolpates common (6%), aletes fairly well represented (14%). *Important genera—Leiotriletes, Punctatisporites, Microbaculispora, Sulcatisporites, Ginkgocycadophytus and Spheripollenites.*
Assise à couches de houille	Coal measures near lake Tanganyika, south of Albertville.	Triletes dominant (65%), bisaccates (10%) and aletes (15%) next in abundance. Monoletes (4%), monosaccates (3%) and monocolpates (2%) rarely represented. *Important genera—Leiotriletes, Punctatisporites, Granulatisporites, Acanthotriletes, Apiculatisporis, Densosporites, Sulcatisporites,* and *Pilasporites.*
	?Luena—Miospore assemblage not yet completely known. May be of same age as Greinerville coalfields. Christine, Old and 1950 coal mine pits at Greinerville.	Triletes dominant (75%), bisaccates (12%) and monosaccates (4%) scantily represented. Monoletes (2%), polyplicates (2%) and monocolpates (1%) very meagrely represented or absent. *Important genera—Punctatisporites, Lutorimites, Neocalamospora, Strotersporites* and *Striatopiceites.*
Assise des schistes noirs de la Lukuga	Assise des schistes noirs-f 7 and Sondage 10 (see Jamotte, 1932).	Triletes dominant (80%), bisaccates (10%) and monosaccates (5%) meagrely represented. Monoletes, polyplicates (3%) and monocolpates (1%) rare or absent. *Important genera—Leiotriletes, Punctatisporites, Cyclogranisporites, Lophotriletes, Striatopiceites* and *Punctacolpites.*
Assise des schistes noirs de Walikale	Walikale and Kindu-Kalima	Bisaccates dominant (37%), triletes (30%) next in abundance. Monosaccates (20%), polyplicates (9%) and monocolpates (4%) common. *Important genera—Punctatisporites, Cyclogranisporites, Hφegiasaccites, Walikalesaccites, Strotersporites, Striatopiceites* and *Fusacolpites.*
Assises glaciaires et périglaciaires	Lufupa-Mushyashya	Monosaccates dominant (55%), bisaccates (27%) next in abundance and triletes (17%) fairly common. *Important genera—Punctatisporites, Cannanoropollis, Parasaccites, Vesicaspora* and *Striatopiceites.*
	Ombela and Lokandu	Monosaccates dominant (54%), bisaccates (32%) next in abundance, triletes (6%) and monocolpates (7%) also commonly met with. *Important genera—Cannanoropollis, Parasaccites, Divarisaccus, Strotersporites, Striatopiceites* and *Fusacolpites.*
	Epulu river (Ituri), Irumu and Dekese bore-holes. Elila river, near Fundi Sadi.	Monosaccates dominant (70%), bisaccates (20%), fairly common, triletes rare (6%). *Important genera—Cannanoropollis, Parasaccites, Potonieisporites, Vestigisporites, Divarisaccus* and *Cuneatisporites.*

Apiculatisporis. The cingulate spores are also quite common in the assemblage. This population resembles the assemblage from Greinerville (assise à couches de houille) in the abundance of laevigate trilete and cingulate spores. However, the former is distinguishable by its equally abundant apiculate trilete spores and also some alete forms.

?Assise de "transition"

From a highly carbonaceous shale sample, collected from a bed about 2.5 km. from the Lukuga-Kibamba confluence, a fairly rich assemblage of miospores was described by Maheshwari and Bose (1969). The exact stratigraphic position of this bed is not known. According to Jamotte (1932, pl. 1) it may belong to Assise de "transition". The miospores isolated are dominated by trilete spores; cingulates, zonates and monosaccates are rare, or even do not come in the frequency count. Among the triletes (56%), *Leiotriletes*, *Punctatisporites*, *Acanthotriletes* and *Microbaculisopora* are well represented. The bisaccates (17%) are mostly represented by *Sulcatisporites* and *Striatopiceites* and among the monocolpates (6%) *Ginkgocycadophytus* is the commonest. This assemblage closely resembles the assemblage from assise à couches de houille in Greinerville region by its dominance of laevigate trilete genera (*Leiotriletes* and *Punctatisporites*) and the bisaccate genus *Sulcatisporites*. *Ginkgocycadophytus* which contributes about 5% in the former assemblage, however, is hardly represented in the latter.

Based on the work, mentioned above, the stratigraphic correlation of the various beds in the Lukuga Series is summarized in Table 1.

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