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THE PRESENT DAY STATE OF UPPER CRETACEOUS PALAEOPHYTOGEOGRAPHY ON PALYNOLOGICAL EVIDENCE

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Abstract

Based on published data and original investigations, a new synthesis is presented in this paper for the palynological palaeophytogeography of the Upper Senonian.
Key words: Palynology, Palaeophytogeography, Upper Senonian.

Introduction

The first Senonian palaeophytogeographical provinces for Upper Cretaceous time based on palynological data were published by ZAKLINSKAYA (1962). For the Northern Hemisphere; the *Normapolles, Aquilapollenites, Turkmeno-Kazakhstan, Proteaceae-Olacaceae* and *Proteaceae-Ulmaceae* provinces were distinguished. Later, based on further information, modifications and new data were emphasized in several papers. The aim of this paper is to summarize our present day knowledge in this field.

General problems

A. The problems of palaeophytogeography on the basis of spore-pollen data have been pointed out in several publications. These may be summarized as follows:

1. Stratigraphic problems. — Because of the differences in the composition of the vegetation map and evolution, the palynological time standard is not the same in different parts of the World.
1.1. The same spore or pollen species may have different stratigraphic ranges in different regions.
1.2. Different form-genera or species of different geographical regions may have the same stratigraphic importance.
2. Polar, and continental migrations may be detected on the basis of palynological palaeophytogeography.
3. On the basis of changes in the distribution of spore-pollen genera and types, the most important evolutionary phases (epacme, acme, and paracme) may be established.
4. The factors of evolution may be ascertained by the synthesis of the palaeophytogeography of all geological periods. In this respect, the problem of angiosperm

pollen grains is particularly interesting; DOYLE (1977, 1978), HICKEY and DOYLE (1977), FRIIS and SKARBY (1982), and FRIIS (1983).

B. The methods of the palaeophytogeography differ; but essentially, the presence or absence of spore-pollen groups or genera is important, but the species composition,

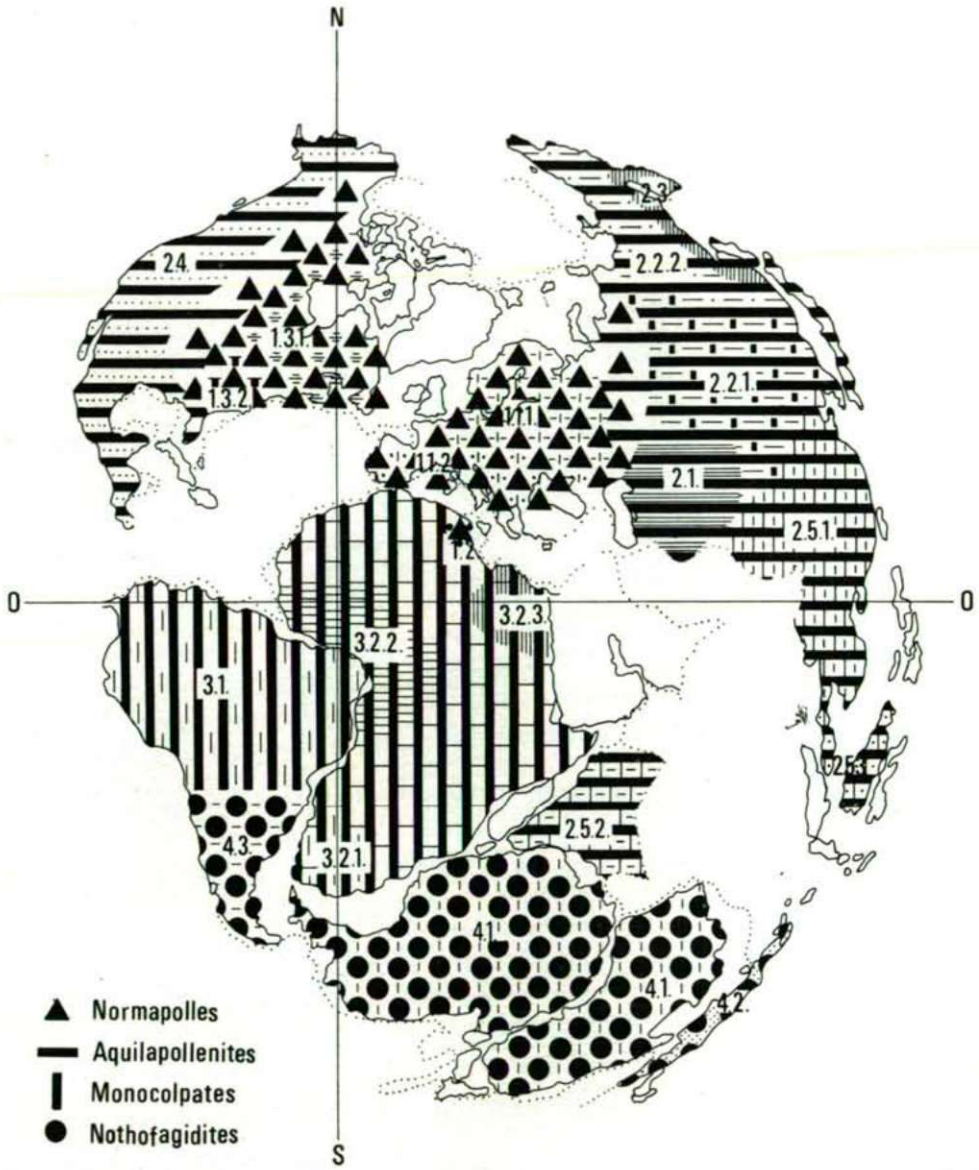

Fig. 1. The present day state of Upper Cretaceous palaeophytogeography on palynological evidence, based on published data and original investigations, compiled by the author in the autumn of 1983.

and the general aspect of the spore-pollen assemblage is also taken into consideration. The effects of the three rules of the fossil spore-pollen assemblages (1. production, 2. dispersion, 3. selective fossilisation) may also differ.

C. The palynological palaeophytogeographical taxa are not yet elaborated. ZAKLINSKAYA (1976) used the kingdom as the highest category. At the present time, however, the province is the most commonly used large palaeophytogeographical unit so that the taxa used are as follows:

province
sub-province
region
sub-region

For our map, we have used fig. 5. of the paper of BRIDEN, DREWRY and SMITH (1974). The decimal system of the text is also indicated on the map, fig. 1.

The Senonian palaeophytogeography of the World based on palynological data

1. province: **Normapolles**

As a palaeophytogeographical unit, this was used first in the paper of KRUTZSCH (1960), but for Lower Tertiary palynomorphs. The most important characteristic feature is the abundance of the early *Amentiflorae* pollen taxa — *Normapolles* —. Geographically this includes the Northern Hemisphere, the Atlantic Coast of North America and Tunisia. Pollen of this group may occur in other regions too, but these occurrences are not of the first rank from the palaeophytogeographical point of view.

1962, ZAKLINSKAYA—*Normapolles* Province
1967, KRUTZSCH—*Normapolles* Provincia
1970, MULLER — North Atlantic—European Province
1971, KHLONOVA — European—Turanian Province
1978, GRUAS—CAVAGNETTO — European—N. Atlantic Province
1978, SRIVASTAVA—*Normapolles* Province
1980, HERNGREEN — The Upper Cretaceous *Normapolles* Province
1981, HERNGREEN and CHLONOVA — *Normapolles* Province

From the literature, we refer the following opinions:

GRUAS-CAVAGNETTO (1978), p. 7: "La flore américaine aurait évolué plus rapidement que la flore européenne, si l'on en juge par le remplacement des pollens de *Normapolles* par des pollens de taxons actuels qui s'est effectué plus lentement en Europe qu'en Amérique du Nord." TSCHUDY (1980) published a World map of the end of the Cretaceous modified from DIETZ and HOLDEN (1971) and TEDFORD (1974). Later TSCHUDY (1981) discussed the geographic distribution of *Normapolles* genera in North America and established the following; p. 283: "At least six genera having *Normapolles* characteristics occur in eastern North America but have not yet been recorded from Europe. Two additional genera with *Normapolles* characteristics have been reported only from the *Aquilapollenites* province of western North America.", p. 310: "The first *Normapolles* genera to migrate to North America did so in Cenomanian time, probably via the still-open North Atlantic corridor. Limited

secondary migrations from eastern North America to the Western Interior took place across the midcontinental epeiric seaway during the Late Cretaceous, and further migrations continued after the withdrawal of the sea up until the final extinction of this group in late Eocene time." Taking into consideration the details, several parts may be distinguished inside the *Normapolles* province. KRUTZSCH (1967, in GÓCZÁN et al.) distinguished the Mediterranean part of the *Normapolles* province in Europe, and he added to this the northern part of North Africa (North Morocco, Algeria and Tunisia). MÉDUS (1973) followed this distinction with nomenclatural modification and introduced the Mesogean region (=Mediterranean) of the *Normapolles* province. The northern part is the Boreal region. Based on data from Senonian palynomorphs of Portugal together with other palynomorphs from the Mesogean region, KEDVES and DINIZ (1983) published the following:

1.1. sub-province: **European**

This sub-province may be characterized by the greatest number of *Normapolles* genera, most of them occurring only within this territory.

1.1.1. region: *Boreal*

The most abundant genera: *Trudopollis, Pseudoplicapollis, Plicapollis, Minorpollis, Pseudovacuopollis, Interporopollenites, Pseudoculopollis, Vacuopollis, Bohemiapollis, Oculopollis, Semioculopollis, Pecakipollis, Papillopollis, Pseudotrudopollis, Extratriporopollenites, Magnoporopollis.*

1.1.2. region: *Mesogean (=Mediterranean)*

MÉDUS (1973) pointed out the following as Mesogean genera: *Bakonyipollis, Capipollis, Endopollis, Hungaropollis, Laudaypollis, Primipollis, Pseudopapillopollis Schulzipollis, Szoerenyipollis.*

1.1.2.1. sub-region: *Ibero-lusitanian*

Abundant genara: *Interporopollenites, Vacuopollis, Papillopollis.* By their presence important genera: *Vancampopollenites, Triangulipollis, Trevisanaepollenites, Prenudopollis, Mediterraneipollenites, Boltenhagenipollenites, Magnoporopollis, Aveiropollenites.*

1.1.2.2. sub-region: *Pyrenean*

The following are worth mentioning: *Interporopollenites, Suemegipollis, Oculopollis, Papillopollis, Heidelbergipollis, Magnoporopollis, Longanulipollis, Trudopollis, Emscheripollis, Krutzschipollis, Pompeckjoidaepollenites.*

1.1.2.3. sub-region: *Carpathian*

Characteristic genera: *Complexiopollis, Oculopollis, Laudaypollis, Hungaropollis, Longanulipollis, Suemegipollis, Krutzschipollis, Verruoculopollis, Portaepollenites, Semioculopollis, Papillopollis, Interporopollenites.*

1.2. sub-province: **Tunisian**

MEON and DONZE (1983) investigated the Upper Maestrichtian — Danian sporepollen assemblages of Kef (N. W. Tunisia). The following *Normapolles* genera were shown from this material: Cf. *Elsikipollenites, Hofkeripollenites, Lusatipollis, Magnoporopollis, Minorpollis, Nudopollis, Oculopollis, Plicapollis, Pseudoculopollis, Semioculopollis, Stephanoporopollenites, Trudopollis.* In this way, the Upper Cretaceous flora of Tunisia seems to be completely different from those in Egypt or other parts of North Africa.

1.3. sub-province: **Atlantic Coast of North America**

As was pointed out in several papers the number of *Normapolles* genera is less than in Europe, but on the other hand there are characteristic North American types too. TSCHUDY (1975) pointed out the following; p. 1: "At the present time, 57 *Normapolles* genera have been reported from Europe, 47 from boreal Middle Europe and 10 from western Hungary. Only four *Normapolles* genera are common to the two European regions. In Mississippi embayment rocks I have found pollen assignable to 18 of the European *Normapolles* genera, to 2 additional genera previously described from the United States, and to 4 new genera that I have proposed."

1.3.1. region: *North Atlantic Coastal Plain*

TSCHUDY (1981) published the following form-genera: *Atlantopollis, Basopollis, Bohemiapollis, Complexiopollis, Choanopollenites Emscheripollis, Endoinfundibulapollis, Extremipollis, Heidelbergipollis, Interpollis, Kyandopollenites, Longanulipollis, Megatriopollis, Minorpollis, Nudopollis, Osculapollis, Pecakipollis, Piolencipollis, Plicapollis, Pompeckjoidaepollenites, Praebasopollis, Praecursipollis, Primipollis, Pseudatlantopollis, Pseudosculapollis, Pseudoplicapollis, Pseudovacuopollis, Quedlinburgipollis, Semioculopollis, Thomsonipollis, Trudopollis, Vacuopollis.*

1.3.2. region: *Mississippi embayment*

Form-genera list after TSCHUDY (1981): *Atlantopollis, Basopollis, Complexiopollis Choanopollenites, Endoinfundibulapollis, Extremipollis, Interpollis, Kyandopollenites, Megatriopollis, Minorpollis, Nudopollis, Osculapollis, Pecakipollis, Plicapollis, Pompeckjoidaepollenites, Praecursipollis, Pseudatlantopollis, Pseudoculopollis, Pseudoplicapollis, Pseudovacuopollis, Semioculopollis, Thomsonipollis, Trudopollis, Vacuopollis, Interporopollenites.*

2. province: **Aquilapollenites**

The most important characteristic feature is the presence of *Triprojectacites* (see STANLEY, 1970) and other genera for example *Wodehouseia, Orbiculapollis* etc. Geographically, Northern Hemisphere, Siberia, Far East, the Pacific Region of North America, the southern part of Asia, including China and India. *Aquilapollenites* occurs in the British Isles, and in Equatorial Africa also. It seems that the first evolution centre was in Siberia, but this was not the only centre of occurrence. Another important centre is the Equatorial African one. The European (British Isles) occurrence is an interesting and curius local one.

1962, ZAKLINSKAYA — *Aquilapollenites* Province
1967, KRUTZSCH — Siberian—Pacific Province
1970, MULLER—E. Siberian—N. Pacific Province
1971, KHLONOVA — Siberian—Pacific Province; Siberian—Canadian Province
1978, GRUAS—CAVAGNETTO — Pacific—Siberian Province
1978, SRIVASTAVA — *Aquilapollenites* Province
1980, HERNGREEN — The Upper Cretaceous *Aquilapollenites* Province
1981, HERNGREEN and CHLONOVA — *Aquilapollenites* Province

KEDVES and KIRÁLY (1970) discussed the regional distribution of the different types of *Triprojectacites (Aquilapollenites)* and *Wodehouseia, Azonia, Jacutiana, Orbiculapollis* and *Expressipollis*. The southern borders of these pollen in Siberia are further south than in North America.

2.1. sub-province: **Turkmeno-Kazakhstan**

1962, ZAKLINSKAYA — Turkmeno-Kazakhstan Province
1971, KHLONOVA — Turkmeno-Kazakhstan Province
1978, GRUAS—CAVAGNETTO — Turkmeno-Kazakhstan Sub-province

There is a peculiar mixed flora here. Based on the publication of POLUMISKOVA et al. (1966), the following form-genera are worth mentioning: *Mancicorpus, Aquilapollenites, Wodehouseia, Proteacidites, Trudopollis, Plicapollis, Oculopollis.* The genus *Betpakdalina* (ZAKLINSKAYA, 1966) is a characteristic feature of this sub-province.

2.2. sub-province: **Siberian**

Characteristic are the *Triprojectacites,* with *Wodehouseia, Azonia* etc. SAMOILOVICH (1967) published the following distinction: 1. Yenisey—Amur, and 2. Khatanga—Lena provinces. These are considered as regions according to our system. They display the following palynological characteristics based on the publication of SAMOILOVICH (1967).

2.2.1. region: *Yenisey—Amur*

Palmae gen. sp., *Beaupreaidites, Proteacidites* fspp., *Loranthacidites, Elythranthe, Aquilapollenites* fspp., *Mancicorpus, Parviprojectus, Expressipollis, Orbiculapollis, Wodehouseia.*

2.2.1.1. sub-region: *Ust—Yenisey*

Anacolosidites grandis, Duplosporis ocliferus, D. borealis, Pemphixipollenites fspp. *Integricorpus.* BONDARENKO (1973) published the following important taxa: *Aquilapollenites* fspp., *Anacolosidites grandis, Mancicorpus, Pemphixipollenites* fspp., *Ulmoideipites, Expressipollis, Orbiculapollis, Parviprojectus, Myrica, Almus, Ulmaceae, Pterocarya, Loranthacites, Azonia reticulata, Wodehouseia calvata, Beaupreaidites, Triprojectus, Syncolpites, Proteacidites, Trudopollis, Nudopollis.*

2.2.1.2. sub-region: *Middle Yenisey*

Proteacidites fspp., *Symplocacites sibiricus, Aquilapollenites* fspp., *Projectoporites* fspp.

2.2.1.3. sub-region: *Baikal—Zeya—Bureya*

Ulmoideipites fspp., *Symphyonema, Santalumidites, Haloragacidites,* cf. *Nyssa, Tricolpites mataurensis.*

2.2.2. region: *Khatanga—Lena*

Myrica, Comptonia spp., *Juglans, Pterocarya, Quercites, Menispermum, Symplocacites, Tetraporites, Gothanipollis* fspp., *Duplodemicolpate, Retitricolpites* fspp., *Integricorpus* fspp., *Aquilapollenites* fspp., *Parviprojectus* fspp., *Mancicorpus, Wodehouseia* fspp., *Azonia* fspp., *Jacutiana.*

2.3. sub-province: **Primorsko-Sakhalin**

1969, BRATZEVA — Primorsko—Sakhalin Sub-province
1977, ZAKLINSKAYA — Primorsko—Sakhalin Province
1978, GRUAS—CAVAGNETTO — Primorsko—Sakhalin sous-province
1982, KREMP — Primorsk—Sachalin Province

ZAKLINSKAYA (1977) described the following form-genera from the Senonian sediments of Sakhalin: *Aquilapollenites, Integricorpus, Scollardia, Cranwellia, Orbiculapollis.* Japan is very important within this sub-province. New data have been provided by the monographical work of TAKAHASHI and SHIMONO (1982). They

published a typical *Aquilapollenites* type assemblage from the Maestrichtian layers of the Miyadani-gawa Formation, Hida district, Central Japan. As important genera, we enumerate the following: *Cranwellia, Orbiculapollis, Wodehouseia, Aquilapollenites, Hemicorpus, Pseudointegricorpus, Triprojectus, Fibulapollis, Mancicorpus.*

2.4. sub-province: **Pacific Coast of North America**

TSCHUDY (1980) emphasized the following; p. 5: "In North America during the Cretaceous, these two provinces were separated by a great north-south-trending epeiric sea..." "Fossil pollen from the western segment of North America during latest Cretaceous time is characterized by pollen of many species of the genus *Aquilapollenites* and by several other genera, such as *Cranwellia, Scollardia* and *Wodehouseia*, ..."

(2.4.1.) region: *Southern Rocky Mountains*
(2.4.2.) region: *Northern Rocky Mountains*
(2.4.3.) region: *Western Canada*
(2.4.4.) region: *California.*

The most important characteristic palynological features of these regions are not yet elaborated and because of this, they are not represented on our figure.

2.5. sub-province: **South Asiatic**

The presence of the *Aquilapollenites* is important here, but there is a lack of *Wodehouseia* and other forms of the "oculata" type.

2.5.1. region: *South East Asiatic*

We refer to the data of the following papers: SUNG TZE-CHEN and LEE MANY-ING (1976), WANG DA-NING and ZHAO YING-NIANG (1979), SONG ZHI-CHEN (1980), SONG ZHICHEN et al. (1980). The following are worth mentioning: *Aquilapollenites, Parviprojectus, Translucentipollis, Cranwellia, Morinoipollis, Jianghanpollis, Jiangsupollis, Myoporumpollenites, Lythraites, Crassimarginipollenites, Bozhengpollis.* Based on the paper of SONG ZHI-CHEN (1980), two sub-regions may be distinguished in the Upper Cretaceous vegetation of China.

2.5.1.1. sub-region: *Northeast China*

SONG ZHI-CHEN (1980), p. 2: "The palynological assemblages of the Northeastern China Region are characterized by 1) a greater number of *Cyatheaceae* and *Polypodiaceae*, and less a number of *Schizaeoisporites* in spores; 2) the more abundant pollen grains of saccated elements in conifer than those of *Classopollis*, 3) the *Aquilapollenites* developing more than those of the Central China Region and 4) the absence of *Bozhengpollis* and *Jiangsupollis*."

2.5.1.2. sub-region: *Central China*

SONG ZHI-CHEN (1980), p. 2: "The palynological assemblages of the floristic regions of Central China are dominated by *Schizaeoisporites, Pterisisporites* and *Classopollis*. The *Aquilapolles* are rather less than those of the former region, and the species of *Bozhengpollis* and *Jiangsupollis striatus*, etc. are more or less recorded, ..."

2.5.2. region: *Indian*

The Indian peninsular province was described first by SRIVASTAVA (1978). GRUAS—CAVAGNETTO (1978) pointed out the following; p. 7: "Dans les régions orientales, les palynoflores sont assez semblables à celles de Bornéo au Crétacé supérieur et au Paléocène, ..." "Dans le Sud de l'Inde, on rencontre des rélictes gondwaniens au Crétacé supérieur et la palynoflore est semblable à celle d'Australie. A re-

marquer la présence, dans cette région d'*Aquilapollenites*, élément typique de la province sibérienne." The following genera are important: *Aquilapollenites, Cranwellia, Scollardia, Pulcheripollenites* and *Proxapertites*. Gondwana elements: *Andreisporis, Constantinisporis, Victorisporis*.

2.5.3. region: *Malaysian*

1978, GRUAS—CAVAGNETTO — Malaise province

MULLER (1968) described Upper Cretaceous spore-pollen assemblages from Borneo. The following form-genera are important: *Spinizonocolpites, Proxapertites, Dicolpopollis, Triorites, Verrutriporites, Echitriporites, Aquilapollenites, Rugutriporites, Retitriporites*. Later MULLER (1970) emphasized the following; p. 433: "It is significant that in Borneo no proteaceous pollen types occur..."

3. province: **Monocolpates**

1967, KRUTZSCH — African—?South American Province
1978, GRUAS—CAVAGNETTO — Africano—Sud-American Province
1978, SRIVASTAVA — *Galeacornea—Constantinisporis* Province
1980, HERNGREEN — The Late Cretaceous *Palmae* Province of Africa and Northern South America
1981, HERNGREEN and CHLONOVA — *Palmae* Province

The most important elements are *Cycadopites, Monocolpopollenites, Retimonocolpites* and *Liliacidites*. Geographically Africa, except Tunisia, and the northern part of South America belong to this province. Some selected remarks: MULLER (1970); p. 432: "There are indications that the W. African and N. South American microfloras of this period were rather similar. For instance the form-genus *Buttinia* is characteristic for this period in both areas." JARDINÉ et al. (1974); p. 81: "—à ce moment apparaissent des pollens triporés ornés caractéristiques du type *Echitriporites* ou *Proteacidites* dans presque tous les bassins africains et américains, y compris la Colombie et la Venezuela (GERMERAAD et al., 1968). — des espèces comme *Auriculiidites articulatus* au Santonien-Maestrichtien; *Buttinia andreevi* et *Spinizonocolpites baculatus* au Maestrichtien soulignent également une communauté pan-afro—sud-américaine jusqu'à la fin du Crétacé." GRUAS—CAVAGNETTO (1978), p. 7: "La province 'Africano—Sud-Américaine' englobe l'Ouest africain et le Nord de l'Amérique du Sud. Le genre *Buttinia* caractérise cette province." SRIVASTAVA (1978, 1981) distinguished the *Constantinisporis* province for the northern part of South America and for the middle and/or northern part of Africa.

3.1. sub-province: **Northern part of South America**

As was previously emphasized, there are similarities between the microflora of northern South America and Africa. It is necessary, however, to pointed out the differences too. *Aquilapollenites* sensu stricto is absent in South America, and *Crassitricolpites, Crassitriaperturites* and *Psilastephanocolporites* are the characteristic elements here.

3.2. sub-province: **African**

The Senonian flora of Africa is more complex than was previously belived. For example, the Senonian flora of North Africa (excluding Tunisia) is also different. The monocolpate group may be characteristic with other elements, which have further regional value.

3.2.1. region: *South African*

The first publication of Upper Cretaceous palynomorphs was that of KIRCHHEIMER (1932) from "Arbot" Pipe on the Bushmanland Plateau in Namaqualand. In this assemblage, the pollen of *Myrica* was dominant, but bisaccate gymnosperm and proteaceous types also occurred. Based on a letter from DR. J. A. COETZEE (Bloemfontein, Orange Free State), the geological age of these layers may be younger than Senonian, however new research is in progress (SCHOLTZ, 1984). Thus the age of this region is in question, but it must be emphasized that up until this time, the form-genus *Nothofagidites* has not been published from this region. In spite of this, SRIVASTAVA (1981) included South Africa in the *Nothofagidites* province.

3.2.2. region: *West-Equatorial African*

Including: Gabon, Cameroon, Nigeria, Ivory Coast, Senegal and the Mali-Niger syncline. This is the most elaborated region. The most important elements are the following: *Buttinia, Pediculisporis, Aquilapollenites, Translucentipollis, Andreisporis,* and *Constatinisporis.*

3.2.3. region: *Egyptian*

The regional distribution of this spore-pollen assemblage type is not well known at the moment. Sudan and Libya may belong here in part. Arabia is also a problematical area. The most important elements include: **Saadipollenites, *Dettmannaepollenites, *Souwonmiaepollenites, Beaupreaidites, Annutriporites, *Minquaripollenites.* The from-genera designated with an asterisk will appear in a monographical study of the Upper Cretaceous spore-pollen assemblages of Egypt which is currently in preparation.

4. province: **Nothofagidites**

1978, SRIVASTAVA — *Proteacidites—Nothofagidites* Province
1980, HERNGREEN — The Senonian *Nothofagidites* Microfloral Province
1981, HERNGREEN and CHLONOVA — *Nothofagidites* Province.

The most important characteristic features here are *Nothofagidites* and *Proteaceae* pollen grains. Geographically: Australia, New Zealand, Antarctica, and the southern part of South America.

The following remarks seems to be importants: MULLER (1970), p. 433: "In the south, the Australian—Antarctic province can be distinguished, with dominance of *Nothofagus* and proteaceous pollen types." The Quiriquina Formation (Upper Cretaceous, Senonian) according to DOUBINGER (1972) is similar to tropical South America (Colombia, Venezuela) and to Occidental Africa (Senegal, Gabon). GRUAS—CAVAGNETTO (1978), p. 7: "Dans la province 'Antarctico—Australienne' dominent les pollens de *Nothofagus* et de Protéacées." HERNGREEN (1980), p. 82: "The late Cretaceous assemblages from Australia, New Zealand, Antarctica and Fuegia/Patagonia are characterized by the occurrence of *Nothofagidites.* Other diagnostic forms are *Proteacidites* spp., and trisaccate gymnosperms." MILDENHALL (1980), p. 197: "A similar vegetational history of *Nothofagus* in Australia, New Zealand and South America can only be explained if the gene pool was similar in each area; this implies continual contact." SRIVASTAVA (1981) added South Africa too to this province.

4.1. sub-province: **Antarctio-Australian**

1970, MULLER — Australian—Antarctic Province
1976, ZAKLINSKAYA — Australian—Antarctic Province.

We have palynological data principally from Australia; the following form-genera are important: *Microcachrydites, Phyllocladidites, Proteacidites, Propylipollis, Nothofagidites*. From Antarctica, there is less information, see for example the paper of WILSON (1968).

4.2. sub-province: **New Zealandian**

ZAKLINSKAYA (1977) distinguished this palaeophytogeographical unit. Based on the monographical work of COUPER (1960), the following form-genera are worth mentioning: *Liliacidites, Beaupreaidites, Proteacidites, Triorites, Nothofagidites.*

4.3. sub-province: **Patagonian**

Geographically, the southern part of South America, with *Nothofagidites*. As regards the world-wide distribution of this above mentioned form-genus, see the paper of CRANWELL (1964). For this sub-province, further information comes from ARCHANGELSKY and ROMERO (1974).

Discussion and conclusions

The LAMBERT equal-area projection method, used for Cretaceous time by BRIDEN et al. (1974) is very useful for the solution and proposal of questions. Based on our new data the following may be pointed out:

1. From a palaeophytogeographical point of view, in Senonian time, Madagascar is most important, because it is situated near three provinces *(Aquilapollenites, Nothofagidites* and *Monocolpates)*. Therefore, a peculiar mixed pollen flora may be presumed here.
2. Further interesting areas, for palynological investigations:

2.1. Southern part of Arabia; question: is the genus *Aquilapollenites* present here together with the so-called Gondwana elements?

2.2. Iraq and Iran; the presence of *Normapolles* and *Aquilapollenites* is in question here.

2.3. Guinea and Sumatra have peculiar importance for the *Aquilapollenites* — *Nothofagidites* province border.

2.4. The western part of North Africa, principally Morocco, may also belong to the *Normapolles* province, together with Tunisia.

3. The southern border of the *Normapolles* and *Aquilapollenites* province is asymetric; in Eurasia it is more southerly than in North America (cf. KEDVES and KIRÁLY, 1970). The LAMBERT equal-area projection method demonstrates this well.
4. In the northern and the southern hemispheres a "biological asymetry" may also be established, based on the following:

4.1. The *Nothofagidites* pollen type is identical with recent *Nothofagus* pollen. The Upper Cretaceous distribution is approximately the same as at present. The problem of the *Monocolpates (Cycadales, Palmae)* pollen type is similar.

4.2. The *Normapolles,* and the *Aquilapollenites (Triprojectacites)* group are extinct pollen types, without well established botanical affinities, so there are no recent distributions.

This is the essence of this "biological asymetry". Finally there are a number of problems to solve, I hope, that the present contribution will be useful for further research.

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