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Triassic Floras of Eurasia

I. A. Dobruskina

Edited by
H. Zapfe

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Preface by the Editor

After a lengthy interval, this series has again published a volume devoted to the Triassic. Prof. Dobruskina, formerly member of the Russian Academy of Sciences in Moscow, had the opportunity to study the development of Triassic floras, particularly those of the Asiatic region. It is my pleasure to present this first-ever overview in the framework of this series. Prof. Dobruskina has also conducted research on the Triassic plants of Austria on a number of occasions; her study therefore also represents a contribution to our knowledge of the alpine Triassic.

The completion of this comprehensive work was supported in Jerusalem by the Israeli Ministry of Immigrant Absorption, to whom special thanks are due (EVA MINSKER DE VILLAR Fund for Soviet Immigrant Scientists, Authors and Artists and the Centre for Absorption in Science). Particular thanks are also dedicated to Prof. Dr. J. Kolodny, Head of the Geological Department of the Hebrew University of Jerusalem, for his help and financial support to the author in preparing this work.

We also wish to thank the Austrian Science Foundation (Fonds zur Förderung der wissenschaftlichen Forschung) for subsidizing the printing costs in Austria.

It is my firm conviction that this extensive overview – published in a western language – will attract the attention of the international scientific community; may this impressive volume receive a warm reception worldwide.

H. ZAPFE

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Part three

LIST OF DESCRIBED AND FIGURED PLANT REMAINS FROM THE TRIASSIC OF EURASIA

To my children Ira and Kostya
who helped me with this book
and supported me very much
during hard times.

Introduction

The Triassic Period with which the Mesozoic Era begins is one of the greatest transition times of the organic world at the boundary of two eras. The changes in the fauna and flora during the transition with the extinction of some groups and the rise of others actually began in the latter half of the Permian Period and continued throughout the Triassic. Changes in the plant kingdom during the transition were accompanied by changes in the geographical distribution of plants, all of which took place against a backdrop of large scale changes on the face of the Earth. Until recently insufficient knowledge of Triassic floras and stratigraphy of the plant-bearing beds obscured the changes which occured during the Triassic.

The transitional nature of the Triassic floras to all appearance may have been the reason why they were studied so little in comparison with the antecedent and subsequent floras. It is quite natural that any transitional stage and assemblage attracts less attention, than more established stable ones. In addition it was formerly supposed that the prolonged stages of existence of stable, comparatively homogenous floras and faunas were separated by shorter transitional periods. Also, little attention was given to transitional stages in the absence of detailed stratigraphic correlation.

Accurate knowledge of the Triassic floras is essential for the reconstruction of the history of life on the Earth. Also they are important for progress in geological surveys and research because petroleum and coal deposits often occur in Triassic rocks, particularly in Eurasia.

Recently many new publications concerning the stratigraphy of the Triassic formations of Eurasia have appeared together with new descriptions of individual Triassic floras. Consequently the necessity to review recent work on the Triassic floras has become more urgent than ever and also more practical. The present book is the first attempt of review for Eurasia.

The lack of summary work of this type has created many misunderstandings. For instance, almost all Middle Triassic floras of the USSR were formerly "lost" because of incorrect correlation of the Triassic sections of the Alps and the German Basin. Thus, Lower Keuper floras in Germany were considered to be Late Triassic age (DOBRUSKINA, 1968). Also there were no floras with which the Middle Triassic plant assemblages of the USSR could be compared. Because of various interpretations of the Rhaetian stage, some floras of Western and Eastern Eurasia were once thought to be of different ages when they are actually the same age. For example, the *Lepidopteris* flora of Greenland and Western Europe and the Nariwa flora of Japan were contemporaneous. The erroneous conclusion that the Madygen flora of Soviet Middle Asia was Late Permian – Early Triassic in age, led to insuperable difficulties with the palaefloral zonation of Eurasia in the Permian and Triassic Periods.

While studying the history of the plant kingdom, Kryshtofovich (1957) concentrated his attention on the investigation and analysis of polychronous floras; a term introduced by him for stable homogeneous plant assemblages, that existed for a long time, such as the Palaeophytic flora, etc. He paid less attention to the transitional floras that existed, from his point of view, during shorter lengths of time and as a result, the transitional floras, particularly those of the Triassic, were less thoroughly investigated.

The polychronous floras, particularly the Palaephytic and Mesophytic are better defined and had more homogenous associations both in time and space in comparison with intervening transitional one. Palaeophytic floras are characterized by homogeneity only in the limits of separate large phytochoria, but the plan of the phytochoria distribution remained unchangeable during all the Palaeophytic. Mesophytic floras are also characterizes by comparative homogeneity within vast regions such as the whole of Eurasia. The plan of the Mesophytic phytochoria distribution was generally constant during the whole of Mesophytic.

The transitional floras include features of both the antecedent and the subsequent polychronous floras and some exceptional features typical only of the transitional stage itself. In contrast to the polychronous floras, the transitional ones continued changing in composition and geographic distribution during a comparatively short time span. This pattern depended on gradual extinction of the main components of the antecedent polychronous floras and on a replacement of them by new species, by the appearance of entirely new plant groups and their migration to new territories. Thus, the existence of the transitional floras was the result of a gradual replacing of one floral assemblage with another and not by a sudden catastrophe. The study of the replacement of the Palaeophytic flora by the Mesophytic flora shows, that the process of the reorganization of the plant kingdom actually took place over the period of about 60 million years. This means that the duration of the transitional flora is not much less than the time of the existence of Palaeophytic (90–110 million years) and Mesophytic (90–95 million years) polychronous floras.

This investigation of the transitional floras has made it possible to note regularities in the evolution of plants that are less obvious in polychronous floras. This can be said first of all about the process of development and migration of new plant groups, about the character of reconstruction of phytochoria, and about the definite features of the transitition from one plant assemblage to another. The knowledge of the processes of changes in the plant kingdom near the boundary of the Palaeozoic and Mesozoic Eras gives an opportunity to document the history of the origin of the Mesophytic plant kingdom of Eurasia. The data which has been used in this study can also be used for the elaboration of some other problems of organic world history, for example, the theory of origin of species, etc.

During the past the first obstacle to investigation of Triassic palaeofloristics was the incomplete knowledge of Triassic plants. Erroneous correlations of the Triassic plant-bearing beds and subsequently contradictions in age determinations was a more significant obstacle. Clearly phytogeographical zonation, establishment of stages of the Triassic flora development, determination of the history of the Triassic flora is only possible when the plant-bearing beds have been correlated accurately. It is also clear that incompleteness of stratigraphic investigations is the reason for incorrect age determinations of coal- and oil-bearing deposits in some regions and for making geological studies difficult.

For an analysis of stratigraphic relationship of plant-bearing beds, it was necessary to study Triassic fossil plants in detail. The first task in the study of the Eurasian Triassic floras was the investigation of the standard plant assemblages. Stratigraphic investigations were made simultaneously with monographic study of the most important groups of the Triassic flora and with the analysis of paleofloristic data.

In the first part of this book the geographic and stratigraphic occurence of Triassic plants and all palaeontological and geological data for the correlation of fossiliferous rocks are summarized.

The second part of the present book concerns the distribution of the Triassic floras of Eurasia in space and time. It includes an examination of flora replacement from the end of the Permian to the end of the Triassic, the determination of the stages of development of the Triassic flora and the history of the origin of the Mesophytic floras of Eurasia, and the description of the peculiarities of flora assemblages in different parts of Eurasia. All of this gives an opportunity to propose a paleofloral zonation in the Triassic of Eurasia and to evaluate the climatic variations within the territory of Eurasia during the period. In conclusion the Triassic floras of Eurasia, North America and the southern hemisphere are compared and the regularities of the Triassic floras distribution all over the world are analysed taking into consideration the theory of continental drift.

The third part of the book contains complete lists of the fossil plants described or figured from the Triassic sediments of Eurasia together with the corresponding references. The lists are arranged according to localities and regions in the same order as localities and regions are presented in the first part of this paper. If the collections have been examined several times, the most complete tables of redeterminations are given as far as possible (for Lunz, Basel, and Raibl). In addition some undescribed collections are listed here but only when the author had the possibility to study them. They include for instance those in the F. N. CHERNYSHOV Museum in Leningrad and in the Geological Institute of the Academy of Sciences of the USSR. The location of the collection and the corresponding numbers are here documented. In the present work lists of preliminary plant determinations quoted in geological papers are usually ignored if they were not confirmed by descriptions or by reference to the collection and its depository.

In addition to the published data used here, the following scientists kindly gave me permission to use their unpublished material: a manuscript by G. P. Leonov on Southern Priuralye; a sequence of Lower Mesozoic deposits of Norther Afghanistan by V. A. Samozvantsev; a map of Triassic plant localities of Soviet Primorye by S. A. Shorokhova.

The book includes an index of over two thousand genera and species of Triassic plants.

Field work was carried out by the author in Southern Ferghana and the Central Pamirs for stratigraphy and plant fossils collecting. The author also participated in expeditions to the Gornyy Mangyshlak, Southern Priuralye, and Zakavkazye. For her stratigraphic investigations and reconstructions the author has followed the stratigraphic ideas of G. P. Leonov (1953, 1973, 1974).

Besides the author's collections, other Triassic collections sent to the Geological Institute during the past were examined (a total of about six thousand specimens). The author is grateful to all the geologists who sent the fossils to the Institute. The collections from the F. N. CHERNYSHOV Museum in Leningrad (CPRG) were also studied. The names of geologists who collected the plant reamains are given in the text of description of fossils.

The advice and help of V. A. Vakhrameev, M. V. Durante, G. P. Leonov, S. V. Meyen, V. V. Menner, M. A. Shishkin, O. P. Yaroshenko were very useful during the work. The author is especially obliged to the late S. V. Meyen for his extensive consultations on palaeobotany. Some valuable comments about the manuscript were given by E. V. Movshovich, M. A. Pergament, V. A. Samylina, F. A. Stanislavsky. Advice about biogeographic zonation problems was received from A. P. Rasnitsyn. Important data were received from correspondence with the following colleagues: R. Assereto, P. D. V. Barnard, M. Boersma, V. De Zanke, K. Kilpper, W. Klaus, H. Kozur, B. Lundblad. Through the courtesy of Prof. B. Lundblad the author received for investigation samples of *Peltasperum, Antevsia* and *Lepidopteris* from Southern Sweden and East Greenland. The author expresses her heartful gratitude to all mentioned scientists.

The author appreciates very much the proposal of Prof. H. Zapfe to publish this book in Vienna. Both Prof. H. Zapfe and the members of Geologische Bundesanstalt have been very helpful in preparing the manuscript for publication.

I would like to express my sincere gratitude to Prof. S. R. Ash for this great and demanding work in improving my English. During my stay in Pretoria in 1990 Drs. John and Heidi Anderson not only discussed the subject with me but did extensive correcting of my English. I am very thankful to them.

The author thanks the Israel Ministry of Absorption for financial support and the Institute of Earth Sciences (Department of Geology) of the Hebrew

University of Jerusalem and especially Prof. Y. KOLODNY for the facilities to complete this work. My heartful gratitude goes also to Prof. J. LORCH (Department of Botany) for his help. Much attention and time were spend by my colleagues from the Geology Department in helping me with the computer. Before I came to Israel I saw such machines only from afar. Difficulties appeared at every step. I appreciate very much help of *every* person in the Department. Everybody who came to the computer room was ready at every moment to give me help and advice. It is with pleasure that I thank them very much, especially DEBBY and MENACHEM MAGEN, ISRAEL ZAK, ODED NAVON, RIVKA HOROWICZ, AMITAI KATZ, ZELDA COLODNER, ELVIRA HALICZ and DOV AVIGAT. The atmosphere of good-will and friendship at the Institute of Earth Sciences helped me to pass the difficulties of the first year in Israel and to complete this work.

I. A. DOBRUSKINA

Part one

Stratigraphic position of Triassic plant-bearing beds of Eurasia

In this book Eurasia is divided into seven regions for convenience of study. Each of these regions is characterized by the similarity of the Triassic geological history and also by their historical study. The regions are: 1) Western Europe, Svalbard and Greenland; 2) the European part of the USSR, Mangyshlak, and the Eastern Urals; 3) South-western Asia (Zakavkazye, Iran, Afghanistan, and the Pamirs); 4) Middle Asia excluding the Pamirs; 5) Eastern Siberia and Kazakhstan; 6) Central Asia, South-eastern Asia, and the Far East; and 7) Indostan. Maps of the principal exposures of Triassic deposits are given for each of these seven regions. Each region is subdivided in turn into smaller areas each with a description of geological succession and a map of the Triassic plant localities or a schematic geological map. The geological sections from which plant remains were obtained, are also provided and correlated. A correlation of the sections of these seven regions is also shown.

Chapter one

Western Europe, Svalbard, and Greenland

There are two facies in the Triassic deposits of Western Europe – German and Alpinian (fig. 1). The German facies (continental deposits in the lower and the upper part of the section and shallow marine in the middle part) are chiefly distributed in the areas of the Variscan orogeny and the western part of the Mediterranean geosynclyne and adjacent parts of the Eastern European platform. Traditionally the area of the German facies is called the German Basin. The Alpine facies (for the most part marine deposits) formed in the central part of Mediterranean geosyncline area. It is also present in the northern and southern Alps, the Carpathians, the Appennines, the Dinarids, and in the Balkans.

In the present paper the large area of Triassic exposure in Germany and north-eastern France is considered to be in the central part of the German Basin. The Triassic rocks of the central part of the German Basin dip under the younger rocks to the west, north-west and south-east and are known only from wells in those areas. Descriptions of the Triassic plants found in these wells have not yet been published. Less significant and isolated outcrops of the German facies occur in France (excluding the Vosges), Spain, England, Sweden, Poland, and Lithuanian SSR. Thise represent the margins of the German Basin and the Rhaetian floras are better known here than elsewhere.

The central part of the German Basin

Germany, France

The Triassic deposits of the German Basin are divided into three stratigraphic units: the Buntsandstein, the Muschelkalk, and the Keuper. These units have been recognized as independent stratigraphic divisions for about 100 years; in 1834 they were united into the single geological system – the Triassic.

Triassic plants were first described from the central part of the German Basin more than 150 years ago (see part two of the book). Descriptions of new plants and localities have continued to appear ever since then. The Triassic plants of the German Basin and their stratigraphic position are particularly

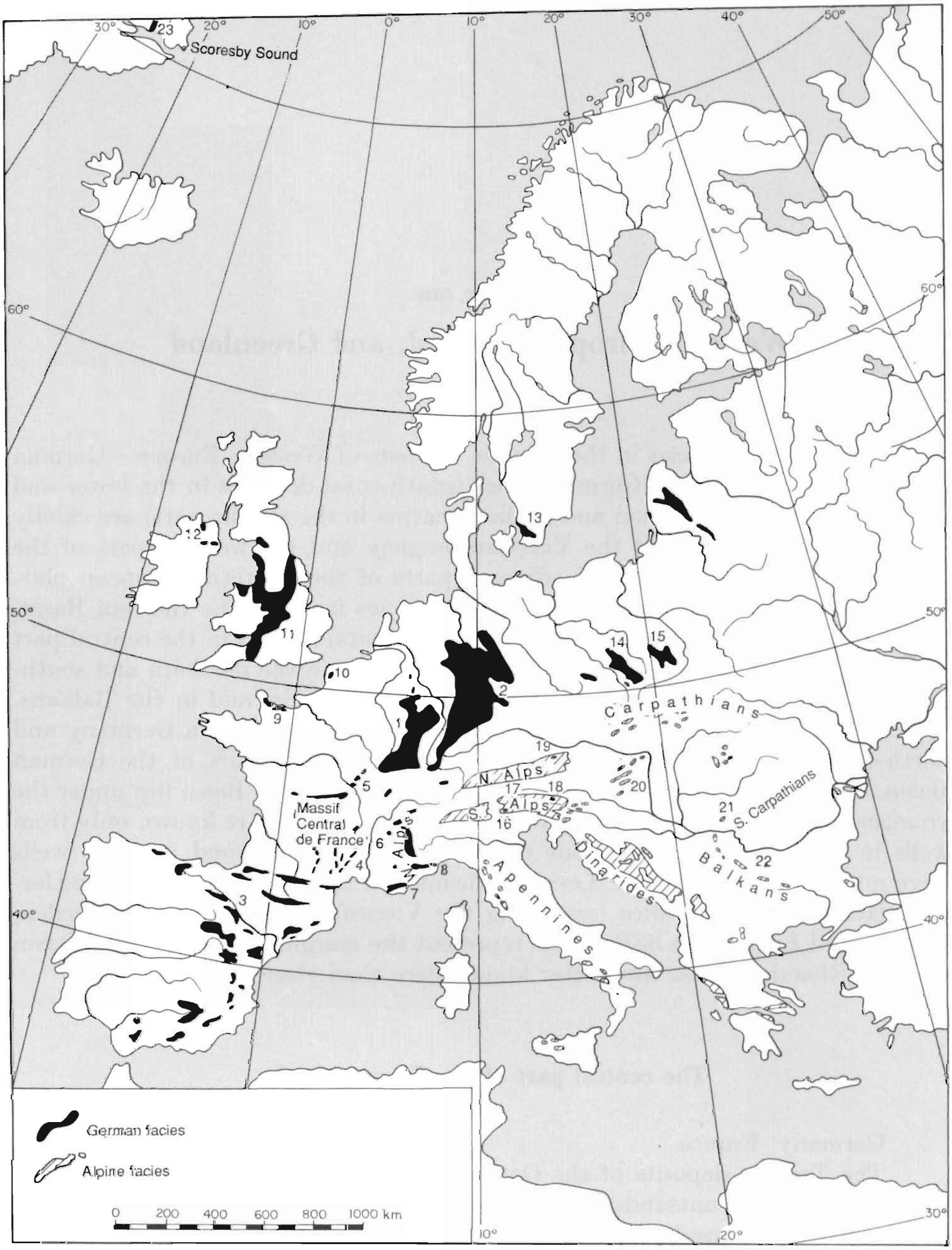
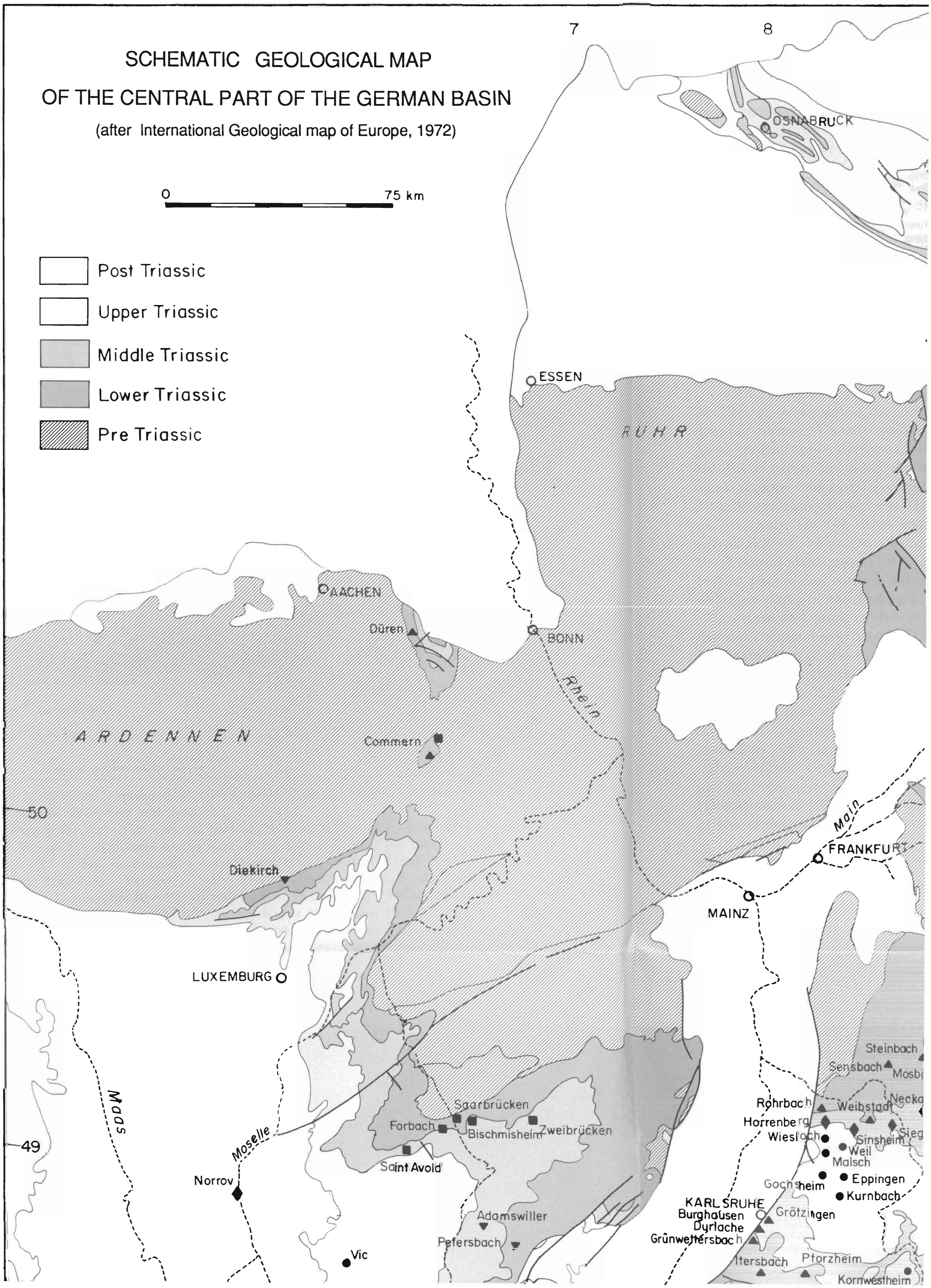
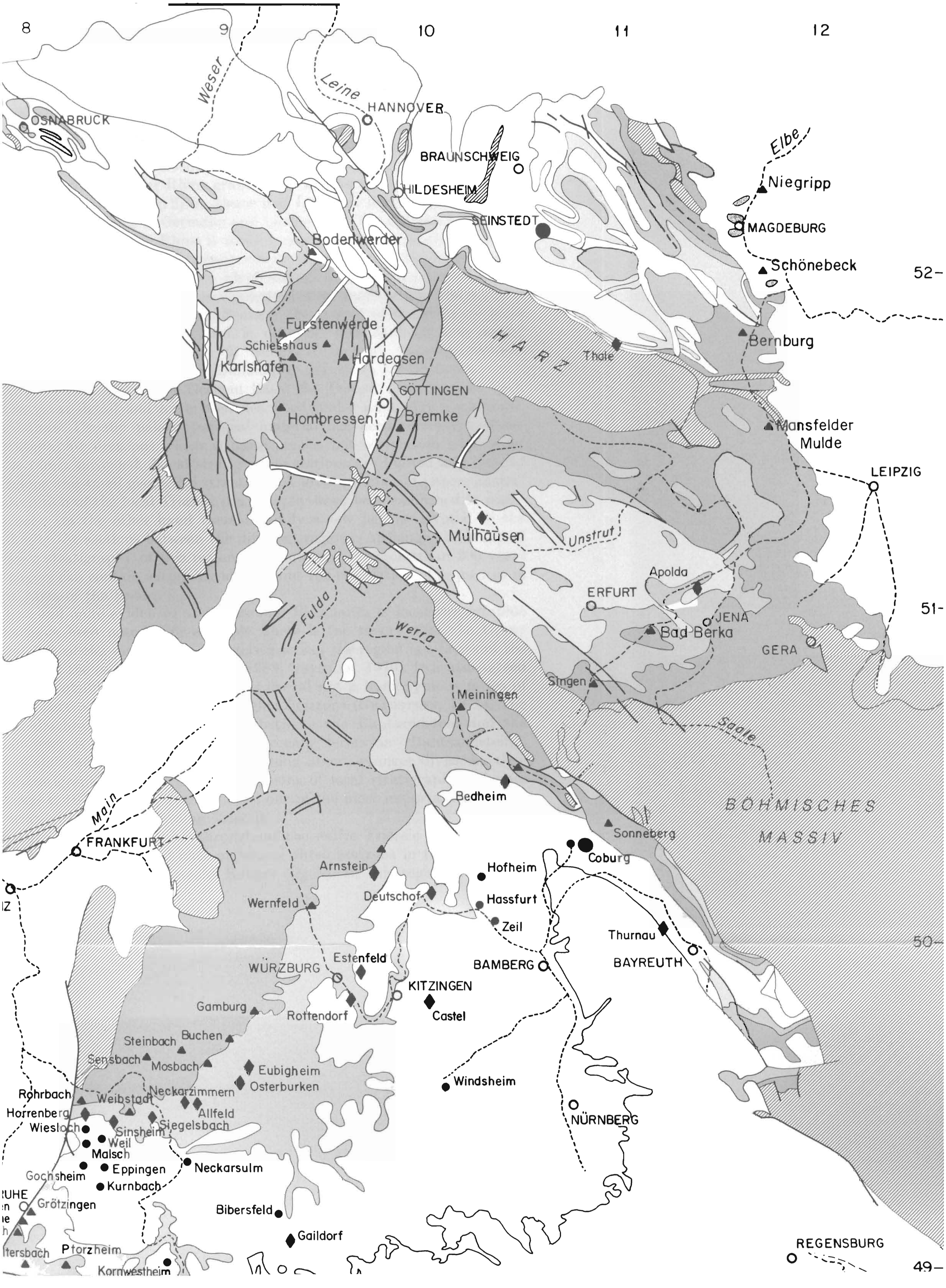


Fig. 1: Principal exposures of the Triassic deposits of Western Europe (after J. M. ANDERSON, 1973 with additions)

Ciphers in the map: 1–2 – central part of the German Basin: 1 – exposures to the west of the Rhine; 2 – exposures to the east of the Rhine; 3–15 – the margins of the German Basin: 3 – Molina de Aragon; 4 – south-east of the Central Massif; 5 – north-east of the Central Massif; 6 – Vanoise; 7 – the French Maritime Alps; 8 –the Ligurian Maritime Alps; 9 – Normandie; 10 – Pas-de-Calais; 11 – England; 12 – Ireland; 13 – southern Sweden; 14 – Oberschlesien; 15 – the Swiety Krzyz Mountains; 16–22 – the Alps, Carpathians, Balkans: 16 – Recoaro; 17 – Zoldo, Gardo, St. Cassian; 18 – Raibl; 19 – Lunz; 20 – Mecsek; 21 – Banat; 22 – Stara Planina; 23 – Eastern Greenland, Scoresby Sound.



SCHEMATIC GEOLOGICAL MAP
OF THE CENTRAL PART OF THE GERMAN BASIN
(after International Geological map of Europe, 1972)


8
9
10
11
12
Weser
Leine
HANNOVER
OSNABRUCK
BRAUNSCHWEIG
HILDESHEIM
Elbe
Niegripp
MAGDEBURG
SEINSTEDT
Bodenwerder
Schönebeck
52–
Fürstenwerde
Schiesshaus
Hardegsen
HARZ
Thale
Bernburg
Karlshafen
GÖTTINGEN
Hombressen
Bremke
Mansfelder
Mulde
LEIPZIG
Mülhausen
Unstrut
Apolda
ERFURT
JENA
51–
Fulda
Werra
Bad Berka
GERA
Singen
Meiningen
Saale
Bedheim
BÖHMISCHES
MASSIV
Main
FRANKFURT
Sonneberg
Coburg
Hofheim
Arnstein
IZ
Deutschof
Hassfurt
Wernfeld
Zeil
Thurnau
50–
Estenfeld
WÜRZBURG
BAMBERG
BAYREUTH
KITZINGEN
Castel
Rottendorf
Gamburg
Steinbach
Buchen
Sensbach
Mosbach
Eubigheim
Osterburken
Windsheim
Rohrbach
Neckarzimmern
Weibstadt
Allfeld
Horrenberg
Sinsheim
Siegelsbach
Wiesloch
Weil
Malsch
NÜRNBERG
Gochsheim
Eppingen
Neckarsulm
Kurnbach
RUHE
Grötzingen
Bibersfeld
Gaildorf
ltersbach
Pforzheim
REGENSBURG
Kornwestheim
49–

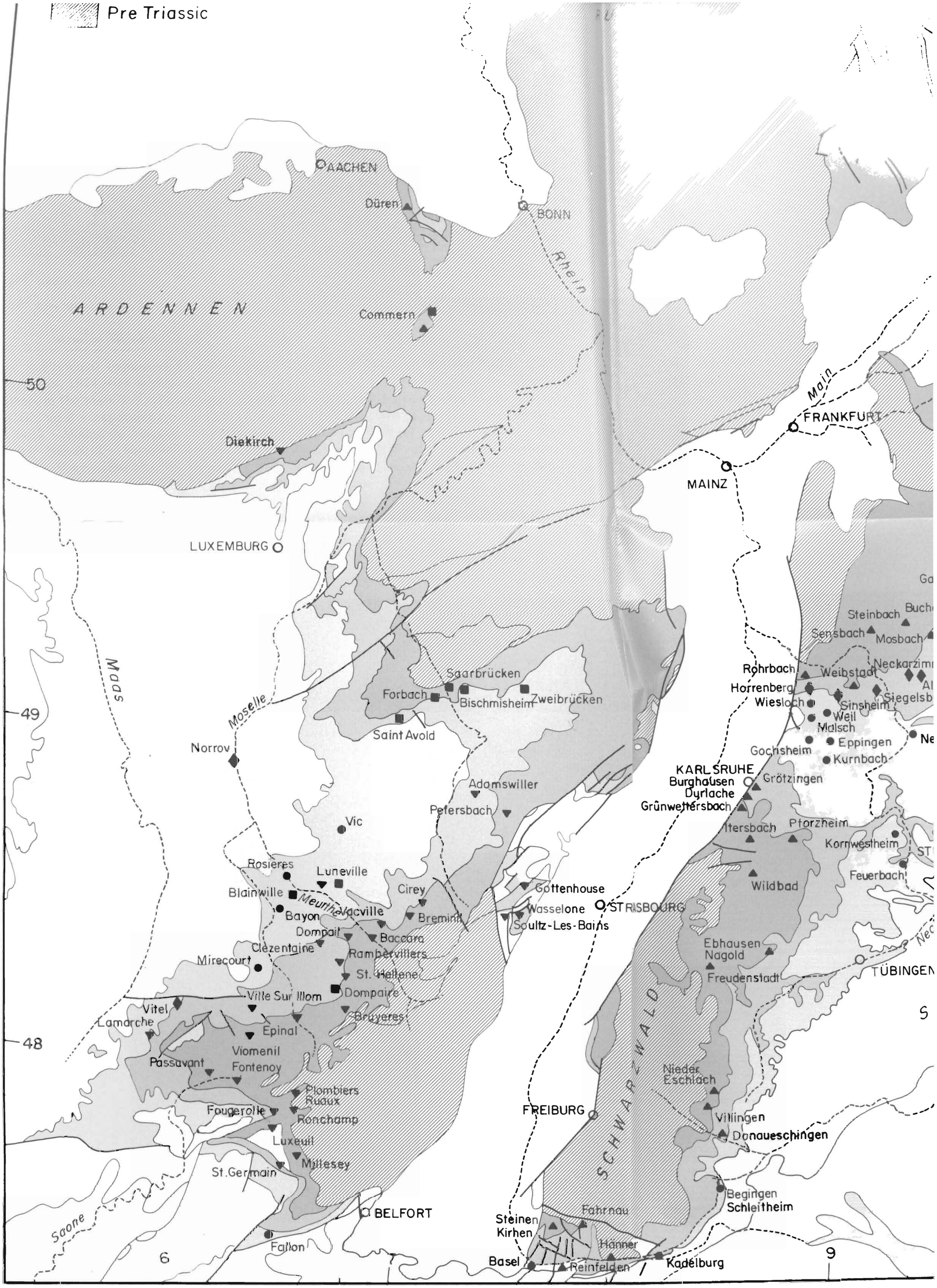
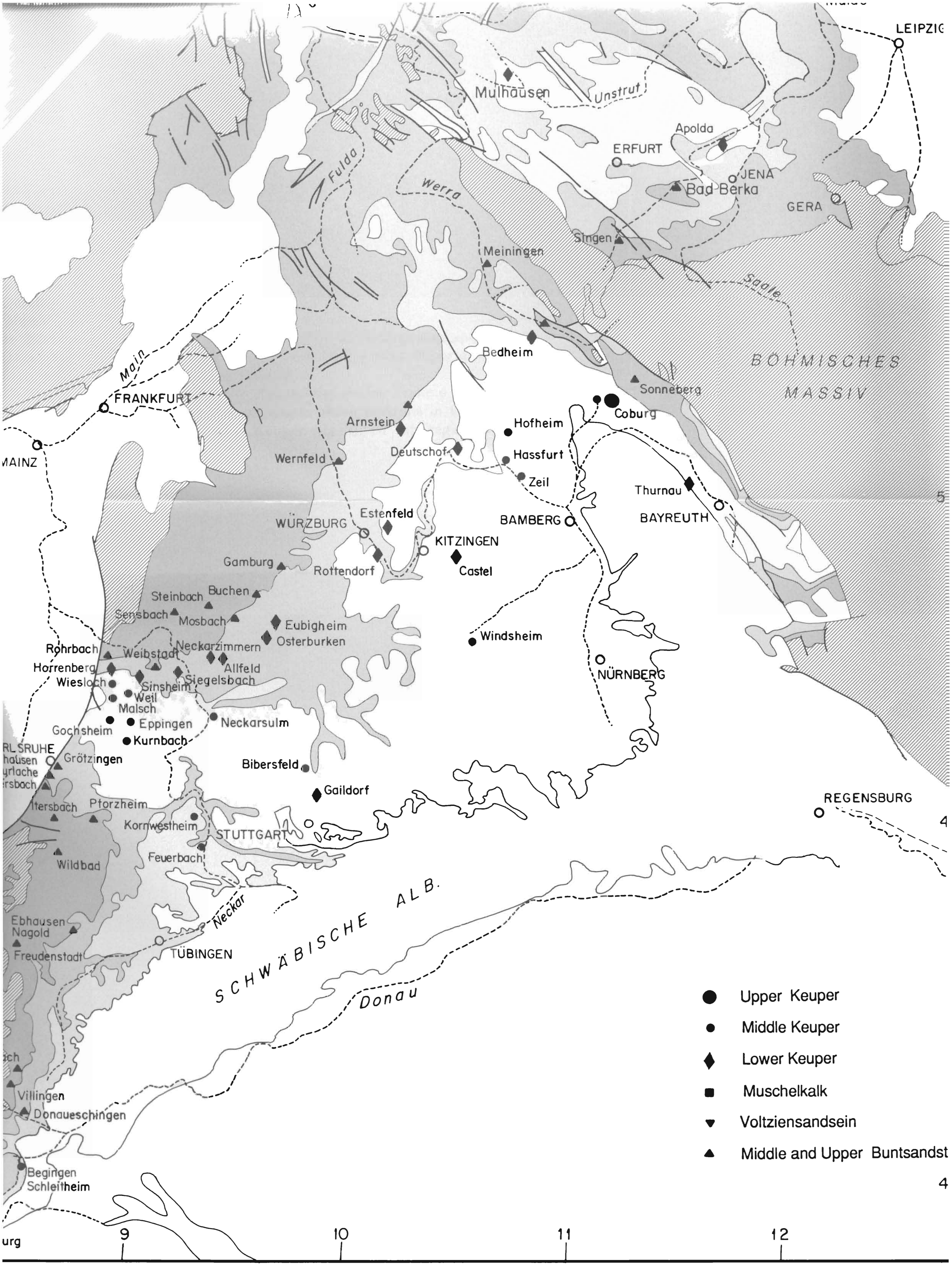


Fig. 2: Localities of the Triassic plants in the central part of the German Basin. Made by DOBRUSKINA, 1975. Geological data after "Internatic



5. Geological data after "International Geological map of Europe", 1975, simplified.

important because they are the standard of comparison for Triassic plants found in the other parts of the world. Thus knowledge of the correct composition of plant assemblages of individual localities in the German Basin, their exact geographical and stratigraphical position, and their correlation are very significant. However, to date no review was available and it has been necessary in the past to refer to numerous papers for data on these important floras.

In the central German Basin the Triassic deposits form two large outcrop areas separated by the upper Rhine graben. The smaller of the areas is situated to the west of the Rhine (fig. 2) in Alsace and Lorraine, north-eastern France, the left bank of the Rhine in Germany and Luxemburg. The outcrop area of the Triassic deposits east of the Rhine is much larger; it occupies nearly the whole southern and eastern parts of Germany where Süd Deutsche, Hessische, Subhgerzynische, and Thüringer Senken (depressions) are recognized (Garetsky, 1972). The last three depressions are characterized by more or less homogenous structure; the fourth (Süd Deutsche Senke – the largest of them) has a more complicated geological structure and is divisible into at least four areas: 1) north-eastern (Süd Thüringen); 2) central (Franken); 3) south-western (Baden-Württemberg); 4) southern (Dinkelberg – northern Switzerland).

In the central part of the German Basin the Triassic deposits have been studied in great detail and have been described under numerous local stratigraphic names. Usually palaeontological material has been referred to these local stratigraphic divisions which is quite precise but correlation with other regions is rarely provided. Local stratigraphic sections are limited as a rule to small regions and small geological structures. A great number of papers containing description of the local Triassic stratigraphy have been published in regional journals. On the other hand there are only a few papers devoted to the correlation of the sections between the different regions. Although the study of the Triassic stratigraphy of this region has continued for more than 200 years review papers can contain surprising ideas about the correlation of sequences in different parts of the basin.

More and more evidences of diachronous boundaries of local stratigraphic divisions have been noted. For example, there is the theory that the Upper Buntsandstein of the southern and western parts of the region is a facies of the Muschelkalk of the central part (Krebs, 1969; Orthlam, 1970). It is also agreed that the Lettenkohle of eastern France is coeval not a homonymous facies of the central part of the basin but of a higher horizons (Gradstein, 1971). The degree of diachronism of the boundary between the Buntsandstein and the Zechstein, etc. is still unclear. Such customary terms as "Buntsandstein", "Muschelkalk", and "Keuper", do say nothing about younger divisions, they are lithostratigraphic conceptions and divisions of local stratigraphic schemes (Dobruskina, 1976 a). Their correlation is one of the most important problems of the stratigraphy of the German Triassic.

Fossil plants do not occur throughout the entire Triassic section in the German Basin, but are found only at two or three horizons in the Buntsandstein and at three or four horizons Keuper (fig. 3). In this regard a detailed correlation of sections within the region lies outside the scope of this book. The degree of accuracy of the correlation presented in this paper depends on the correlation of the plant-bearing beds. It is necessary to understand the relationships between homonymous plant-bearing horizons in different parts of the basin to each other and how similar the plant assemblages in these homonymous stratigraphic divisions are.

For correlation purposes in the present book other palaeontological data are included. Besides the palaebotanical material they include palynological and vertebrate palaeontology data because they are most important for regional correlation of continental deposits.

*

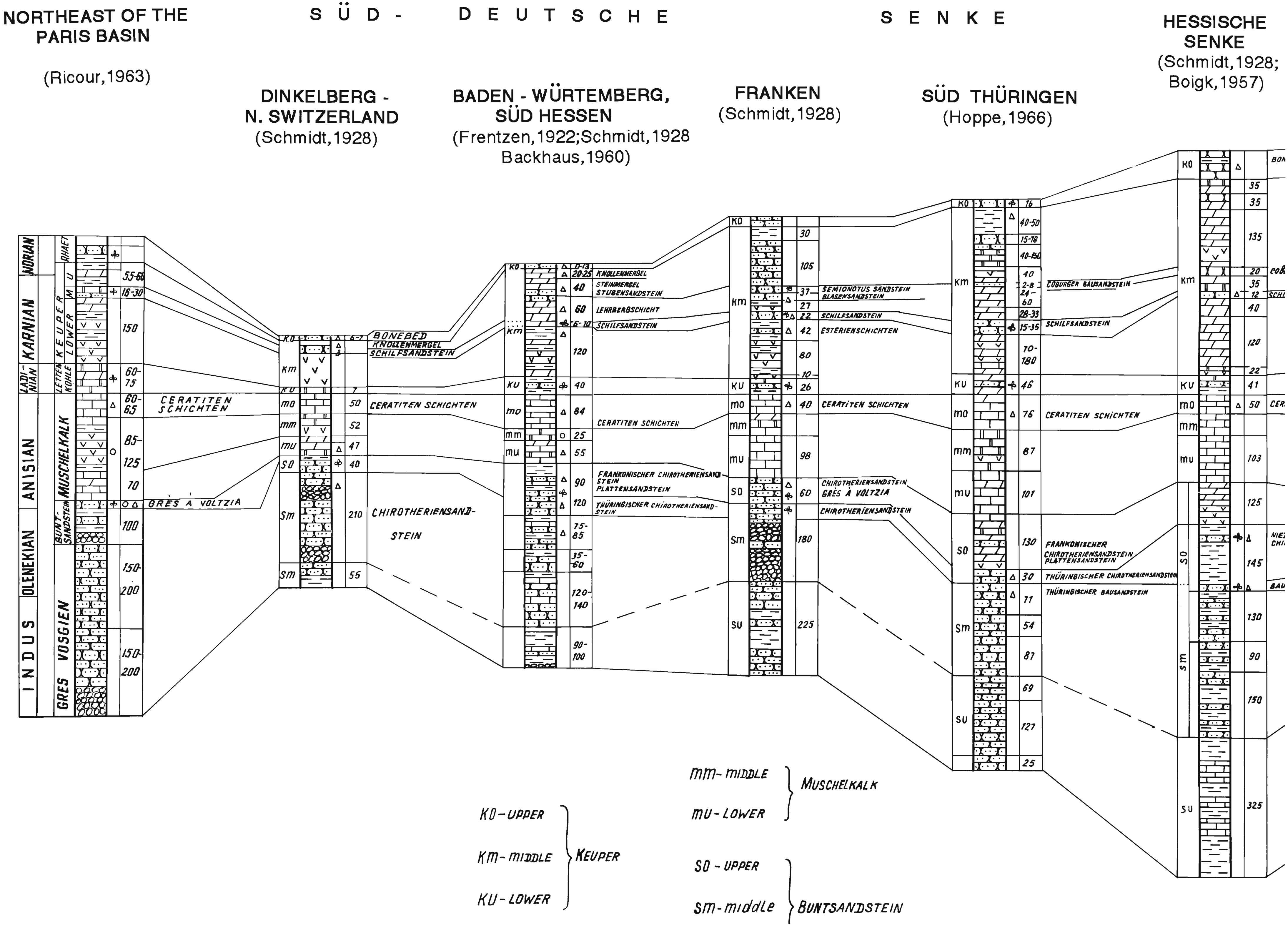
The **Buntsandstein** is divided into three parts (Lower, Middle, and Upper) in the larger part of the basin east of the Rhine. The thicknesses of these divisions are shown in the fig. 3.

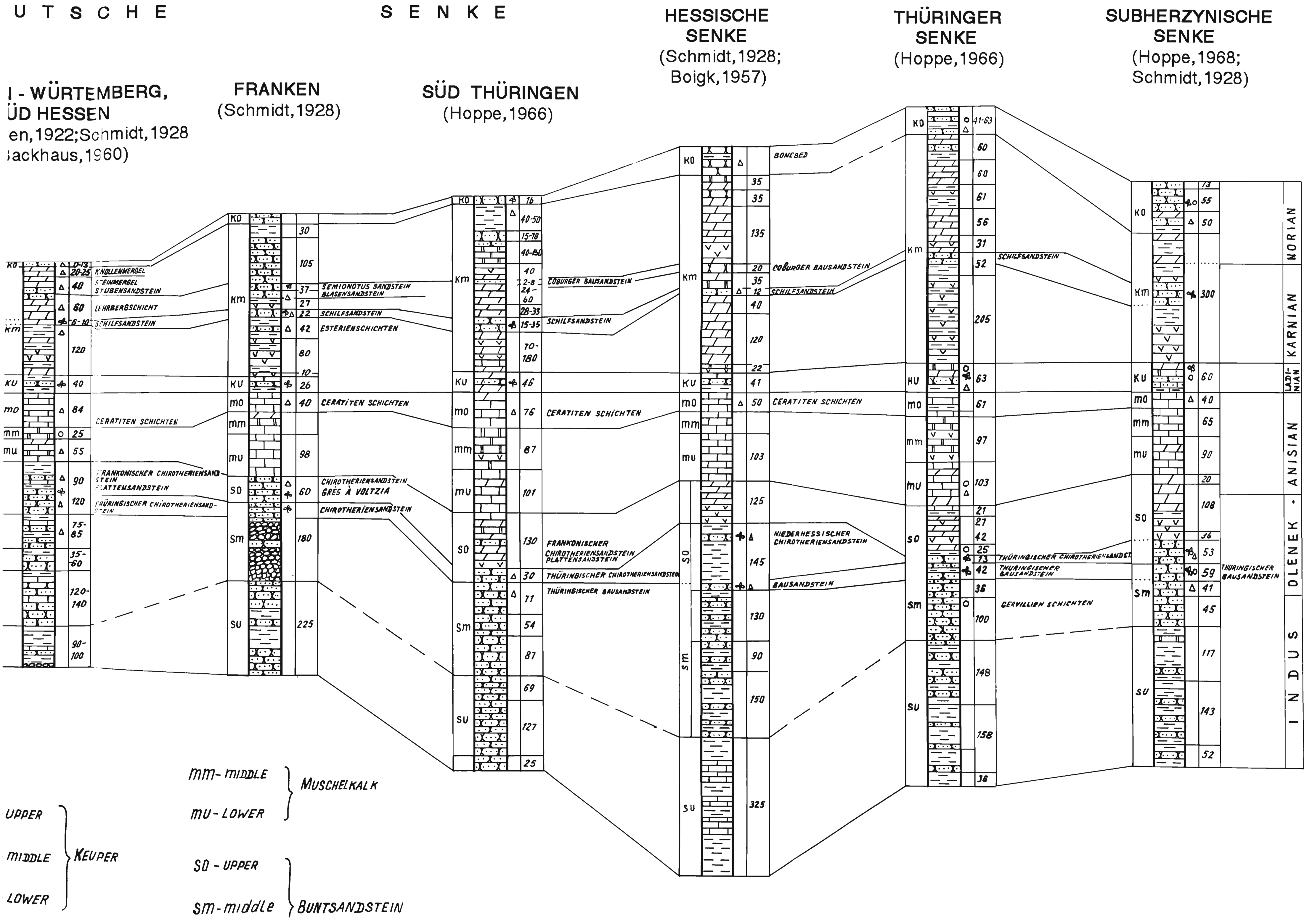
The Lower Buntsandstein consists principally of sandstone, sheet clay, and clay shale. Seams of limestone and dolomite also are present in the upper part of some sections. The Middle Buntsandstein consists predominantly of sandstone but in Schwarzwald, Odenwald, and Spessart significant amounts of conglomerate are present. The Chirotheriensandstein with footprints of tetrapods is a characteristic horizon in the Middle Buntsandstein. In the past the Chirotheriensandstein (in some sections there are two beds of the Chirotheriensandstein) was referred to as the upper Middle Buntsandstein. Some time ago when a new stratigraphic scheme with formations was proposed for the Middle Buntsandstein the upper part, including the Chirotheriensandstein, was united with the Upper Buntsandstein because of the geological history of the basin. The modern scheme was first worked out for the Hessische Senke (BOIGK, 1957). Later it was traced to the southern part of Süd Deutsche Senke (BACKHOUSE, 1960). It is often used for Thüringer Senke and Subherzynische Senke. The Upper Buntsandstein in this scheme includes the Solling Formation, the Röt, and the Myophorienschichten in Hessischer and Thüringer Senke. In Schwarzwald and Odenwald the Röt is considered to be the upper part of the Solling Formation.

The Upper Buntsandstein consists principally of sandstone and clay together with marl, dolomite, and limestone with marine invertebrates (usually pelecypods *Myophoria* and *Modiola*). In Thüringer and Subherzynische Senke it also contains gypsum.

In the French part of the basin (Alsace and Lorrain) the Buntsandstein s.l. is divided into Gres Vosgien without organic material and the Buntsandstein s.s.: Gres a *Voltzia* with fossil plants and palynological assembles. The remains of marine and terrestrial animals are found in the upper part of the Buntsandstein s.s.

Organic remains from the Lower Buntsandstein and the lower Middle Buntsandstein have not been described, although there are mentions of the


NORTHEAST OF THE PARIS BASIN
(Ricour, 1963)
SÜD- DEUTSCHE SENKE
DINKELBERG - N. SWITZERLAND
(Schmidt, 1928)
BADEN - WÜRTEMBERG, SÜD HESSEN
(Frentzen, 1922; Schmidt, 1928 Backhaus, 1960)
FRANKEN
(Schmidt, 1928)
SÜD THÜRINGEN
(Hoppe, 1966)
HESSISCHE SENKE
(Schmidt, 1928; Boigk, 1957)
NORIAN
KARNIAN
LADINIAN
ANISIAN
OLENEKIAN
INDUS
RHAET
KEUPER
M U
LOWER
LETTEN KOHLE
MUSCHELKALK
BUNTSANDSTEIN
GRES VOSGIEN
CERATITEN SCHICHTEN
GRES A VOLTZIA
BONEBED
KNOLLENMERGEL
SCHILFSANDSTEIN
CHIROTHERIENSANDSTEIN
STEINMERGEL
STUBENSANDSTEIN
LEHRBERGSCHICHT
FRANKONISCHER CHIROTHERIENSANDSTEIN
PLATTENSANDSTEIN
THÜRINGISCHER CHIROTHERIENSANDSTEIN
SEMIONOTUS SANDSTEIN
BLASENSANDSTEIN
ESTERIENSCHICHTEN
CHIROTHERIENSANDSTEIN GRES À VOLTZIA
COBURGER BAUSANDSTEIN
THÜRINGISCHER BAUSANDSTEIN
KO
Km
KU
mo
mm
mu
SO
Sm
SU
KO - UPPER
Km - MIDDLE
KU - LOWER
KEUPER
mm - MIDDLE
mu - LOWER
MUSCHELKALK
SO - UPPER
Sm - middle
BUNTSANDSTEIN


U T S C H E
S E N K E
HESSISCHE SENKE
(Schmidt, 1928; Boigk, 1957)
THÜRINGER SENKE
(Hoppe, 1966)
SUBHERZYNISCHE SENKE
(Hoppe, 1968; Schmidt, 1928)
l - WÜRTEMBERG,
ÜD HESSEN
en, 1922; Schmidt, 1928
ackhaus, 1960)
FRANKEN
(Schmidt, 1928)
SÜD THÜRINGEN
(Hoppe, 1966)
KNOLLENMERGEL
STEINMERGEL
STUBENSANDSTEIN
LEHRBERGSCHICHT
SCHILFSANDSTEIN
CERATITEN SCHICHTEN
FRANKONISCHER CHIROTHERIENSAND STEIN
PLATTENSANDSTEIN
THÜRINGISCHER CHIROTHERIENSAND-STEIN
SEMIONOTUS SANDSTEIN
BLASENSANDSTEIN
ESTERIENSCHICHTEN
CHIROTHERIENSANDSTEIN
GRÈS À VOLTZIA
COBURGER BAUSANDSTEIN
FRANKONISCHER CHIROTHERIENSANDSTEIN PLATTENSANDSTEIN
THÜRINGISCHER CHIROTHERIENSANDSTEIN
THÜRINGISCHER BAUSANDSTEIN
BONEBED
NIEDERHESSISCHER CHIROTHERIENSANDSTEIN
BAUSANDSTEIN
THÜRINGISCHER BAUSANDSTEIN
GERVILLIEN SCHICHTEN
NORIAN
KARNIAN
LADINIAN
ANISIAN
OLENEK
INDUS
ko
km
ku
mo
mm
mu
so
sm
su
mm - MIDDLE
mu - LOWER
MUSCHELKALK
UPPER
MIDDLE
LOWER
KEUPER
SO - UPPER
sm - middle
BUNTSANDSTEIN

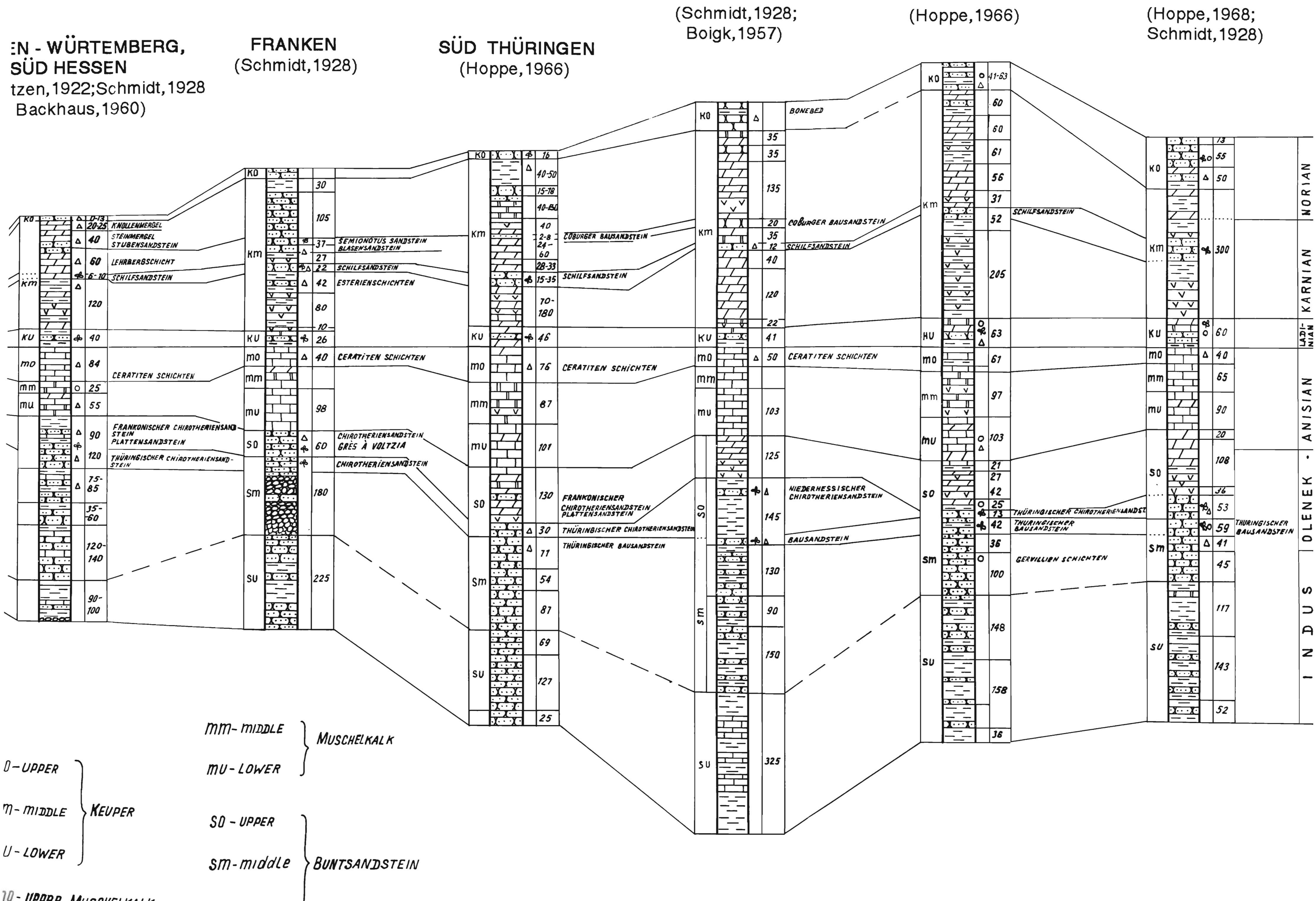


Fig. 3: Correlation of the Triassic deposits of the central part of the German Basin. For the legend see fig. 74

findings of charophytes and conchostracans. The exact position of the Permo-Triassic boundary is unclear because of the virtual absence of fossils in those horizons. There are descriptions of the organic remains from the upper half of the Middle Buntsandstein (beginning from the Hardegsen Formation) and from the Upper Buntsandstein. In the north-east of the area the majority of the described plant remains came from the Bausandstein (the Hardegsen Formation) and the Chirotheriensandstein (Solling Formation); and in the south-west – chiefly from the Plattensandstein and the Voltziensandstein (the Upper Buntsandstein of the old scheme). The fossil plants in the German part of the basin have been studied by SCHLÜTER & SCHMIDT (1927), FRENTZEN (1915, 1931), MÄGDEFRAU (1930, 1931 a, 1931 b, 1936) (see chart 1, list 1 in the third part of the book) and those of the French part – by BRONGNIART (1828), SCHIMPER and MOUGEOUT (1844), ARBER (1907, 1909), FLICHE (1905–1910), FRENTZEN (1915, 1931), WEISS (1864), BLANCKENHORN (1886), POTONIE (1904), GOTHAN (1938), GRAUVOGEL-STAMM (GRAUVOGEL, DOUBINGER & GRAUVOGEL, 1967; GRAUVOGEL-STAMM, 1968, 1972, 1978; GRAUVOGEL-STAMM & GRAUVOGEL, 1973, 1975; GRAUVOGEL-STAMM & DOUBINGER, 1983; GRAUVOGEL-STAMM & WESTPAL, 1879) and SCHAARSCHMIDT (GRAUVOGEL-STAMM & SCHAARSCHMIDT, 1982) (see list 2 in the third part of the book).

The conifer *Voltzia* from which the name Gres a *Voltzia* was derived is the dominant form in the plant assemblages to the west of the Rhine. Fossil plants are known from numerous localities in this area, the richest being Soultz-le-Bain. Only *V. heterophylla* and *Anomopteris mougeotii* were found in the majority of the localities. There are many localities where *Equisetum mougeotii* and the stems and roots of ferns and conifers occur. *Neuropteridium* (some species) and *Yuccites vogesiacus* are less common. Recently numerous reproductive structures of conifers have been described from this region by GRAUVOGEL-STAMM and SCHAARSCHMIDT (1982). They include *Willsiostrobus, Darneya, Sertostrobus*. The only specimen of *Pleuromeia sternbergii* in this part of the basin came from Chauffontaine near Luneville. MÄGDEFRAU (1930) referred this locality to the Upper Buntsandstein, because he considered the correlations in Fliche's paper on the Upper Muschelkalk to be incorrect.

Triassic fossil plants collected west of the Rhine make an indivisible assemblage and their coevality is beyond doubt. They occur at the same stratigraphic horizon (the Gres a *Voltzia* corresponds to the Upper Buntsandstein). Plant assemblages from the east bank of the Rhine (chart 1) in the vicinity of Karlsruhe (Plattensandstein in the Süd Deutsche Senke) are very similar to them, but there are other dominants – sphenopsids instead of conifers. In the majority of the localities in Baden-Württemberg only the remains of *Equisetum mougeotii* (36 localities) or *Anomopteris mougeotii* (13 localities) are found. In Süd Deutsche Senke fossil plants are known also from a lower horizon, the Chirotheriensandstein.

In the northern part of the basin fossil plants are found also in the Bausandstein and Chirotheriensandstein. The upper of them (Chirotheriensandstein) is correlated with the lower level in the southern part of the basin. The most

Chart 1: Stratigraphic position of the most important plant assemblages in the Buntsandstein east of the Rhine

	Süddeutsche Senke		Hessische Senke	Thüringer Senke	Subherzynische Senke
	Baden-Württemberg	Franken			
Plattensandstein (Röt)	Grünwettersbach Frentzen, 1915 Mägdefrau, 1930, 1931 b Grauvogel-Stamm, 1969, 1978	Wernfeld Mägdefrau, 1931 b			
Chirotheriensandstein (Sollong)		Kissingen Mägdefrau, 1931 b	Bodenwerder Mägdefrau, 1931 b	Singen Mägdefrau, 1931 a, 1936 Bad Berka Mägdefrau, 1930, 1931 a	Bernburg Niegripp Schönebeck Mägdefrau, 1931 b
Bausandstein (Hardegsen)			Bremke Schlüter, Schmidt, 1927 Grauvogel-Stamm, 1969, 1978 Fürstenberg Schlüter, Schmidt, 1927 Karlshafen Schieshaus Hombressen Mägdefrau, 1931 b	Mansfelder Mulde Mägdefrau, 1931 b	Bernburg Mägdefrau, 1931 b

Chart 2: Distribution of localities with described and figured Triassic miospre assemblages from the outcrops in the central part of the German Basin

Age		Paris Basin	Süddeutsche Senke				Hessische Senke	Türingische Senke	Subherzynische Senke
			Dinkelberg, Northern Switzerland	Baden-Württemberg, Südhessen	Franken	Südthüringen			
Keuper	upper							Seeberg b. Gotha (Reinhardt, 1962, 1962 b; Schulz, 1962, 1965; Reinhardt, Schmitz, 1965)	Helmstedt (Tiergart 1949; Reinhardt, 1962)
	middle		Birs River, Basel (Leschik, 1956)						
	lower							Apfelstadt (Reinhardt, 1964 b) Kircheilingen (Schulz, 1965, 1967)	Bad Harzburg (Mädler, 1964)
Muschelkalk	upper								
	middle	Sarrealbe (Klaus, 1964)		Kochendorf b. Heilbronn (Klaus, 1964)					
	lower							Göschwitz b. Jena (Mädler, 1964)	
Buntsandstein	upper	Soultz-les-Bains (Sulzbad) Bust-le-Haut, Adamsviller (Klaus, 1964) Villing, Vilsberg, Hangviller (Adloff, Doubinger, 1969)						Singen, Jena (Klaus, 1964) Göschwitz (Madler, 1964; Reinhardt, 1964 a, b; Reinhardt & Schmitz, 1965; Schulz 1965)	
	middle							Almenhausen, Strausfurt (Reinhardt & Schon, 1967)	Bernburg (Reinhardt & Schon, 1967) (one spesies)

widely distributed plant fossil is *Pleuromeia sternbergii*, which is found in great numbers at all localities. *Pleuromeia* is the only fossil plant in Subherzynische Senke. In the rest of the northern part of the basin *Pleuromeia* is found together with the above mentioned plants. Proportions of the individual components of the Buntsandstein flora change in different parts of the basin.

Triassic palynological assemblages have been described chiefly from Thüringer Senke where many of them were described from boreholes (chart 2). Palynological assemblages described by Klaus from Upper Buntsandstein of the east and west banks of the Rhine are practically identical which correlates with the position of Gres a *Voltzia* in comparison with the plant-bearing horizons of Thüringer Senke.

Tetrapods of the Buntsandstein (chart 3*) are known from the Middle Buntsandstein, mainly from its upper part (Chirotheriensandstein, Solling Formation) and from the Upper Buntsandstein as used in the older literature. It is interesting that Upper Buntsandstein tetrapods are known only in the southern part of the basin both east and west of the Rhine, and that the Middle Buntsandstein tetrapods occur in the whole basin most abundantly in the northern part. Tetrapods of the Lower Muschelkalk are known from Thüringen and Schwarzwald, the assemblages being different in these two regions. However, one cannot exclude the possibility that the Schwarzwald assemblage may be younger (ORTHLAM, 1970).

The distribution of fossil tetrapods over the German Basin is of interest because the conclusions of some vertebrate palaeontologists (WILD, 1972) that the tetrapods of the Upper Buntsandstein are closer to the Middle Triassic tetrapods of other parts of the world (the Alps, the Russian platform, Southern Africa, North America) than to the Early Triassic faunas. This results in the conclusion that the Upper Buntsandstein fauna is Middle Triassic in age.

The **Muschelkalk** consists mainly of limestone and shell rocks as the name suggests. In the Lower Muschelkalk the main rocks are dolomite and marl, in the Middle Muschelkalk – dolomite and gypsum, and the Upper Muschelkalk or "Hauptmuschelkalk" – limestone dolomites. There are many marine fossils in the Hauptmuschelkalk, and in its lower part there are many ceratites which makes it possible to distinguish a "Ceratiten Schichten" with several zones in it. Although marine invertebrates are the basis for correlating the Muschelkalk with the Ladinian of the Alps, the exact correlation of the boundaries of these divisions is not clear because most of the Muschelkalk fauna is endemic.

Fossil plants are practically absent in the Muschelkalk. FLICHE (1905–1910) reported the occurence of plant fossils at many localities in the Muschelkalk of Alsace and Lorraine but he only described and figured some of them

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* Chart 3 – distribution of tetrapods – is compiled after the original monographs in consultations with Dr. M. A. SHISHKIN.

hart 3: Distribution of the most important assemblages of Triassic tetrapods in the central part of the German Basin

Age		Paris Basin (North East)	Süddeutsche Senke			Südthüringen	Hessische Senke	Thüringer Senke	Subherzynische Senl
			Dinkelberg – North Switzerland	Baden-Württemberg, Südhessen	Franken				
KEUPER	Rhätkeuper		Phytosauria Angiosthorhiopsis Rutiodon	Theriodontia Oligokyphus Eosuchia Pachystropheus				Dinosauria Plateosaurus	Labyrinthodontia Plagiosaurus Metoposaurus Gerothorax Cyclotosaurus Testudinata Triassochelys cf. Chelyzoon Saurischiocomes Theriodontia Eoraetia Phytosauria Angistorhinopsis Rutiodon Crocodilia Mystriosuchus Dinosauria Pterospondylus Plateosaurus Halticosaurus Gressleyosaurus Plesiosauria Plesiosaurus
	Knollen-Mergel		Dinosauria Gresslyosaurus	Dinosauria Gresslyosaurus Plateosaurus Teratosaurus		Dinosauria Halticosaurus			
	Stubensandstein und Blasensandstein			Stubensandstein Labyrinthodontia Cyclotosaurus Testudinata Proterichereis Proganochelys Prolacertillia Tanystropheus Lacertillia Dolishosaurus Pseudosuchia Aetosaurus Phytosauria Phytosaurus Crocodilia Mystriosuchus Dinosauria Halticosaurus Teratosaurus Thecodontosaurus Plateosaurus? Saltoposuchus Procompsognatus Trematosaurus	Blasensandstein Labyrinthodontia Cyclotosaurus Metoposaurus Plagiosaurus Phytosauria Palaeorhinus Francosuchus Dinosauria Dinosaurichnium				
	Lehrberg-schichten			Labyrinthodontia Metoposaurus					
	Schilfsandstein			Labyrinthodontia Metoposaurus Cyclotosaurus Plagiosaurus Phytosauria Phytosaurus			Rhynchocephalia Polysphenodon		
	Gips-keuper			Placodontia Hanodus	Labyrinthodontia Metoposaurus Nothosauria Nothosaurus				
	Lettenkohle			Labyrinthodontia Mastodonsaurus Plagiosternum Plagiosuchus Prolacertilia „Zanclodon" Nothosauria Neusticosaurus Nothosaurus Simosaurus Pleosauria Pleosiosaurus Psephosaurus				Labyrinthodontia Mastodonsaurus Plagiosternum Plagiosuchus Metoposaurus Prolacertilia Tanystropheus Dinosauria Avipes Nothosauria Neusticosaurus Nothosaurus	
MUSCHELKALK	Upper			Labyrinthodontia Plagiosternum Plagiosuchus Testudinata Chelyzoon Prolacertilia Tanystropheus Nothosauria Nothosaurus Simosaurus	Testudinata Chelyzoon Prolacertilia Tanystropheus Dinosauria Thecodontosaurus Nothosauria Notosaurus Plesiosauria Pistosaurus Placodontia Cyamodus Ichtyosauria Mixosaurus Cymbospondylus aff. Shastosaurus				Nothosauria Elmosaurus
	Lower		Ichtyosauria Cymbospondylus Mixosaurus	Ichtyosauria Cymbospondylus Mixosaurus Shastosaurus Pessosaurus			Nothosauria Anarosaurus	Labyrinthodontia Mentosaurus Nothosauria Nothosaurus Proneusticosaurus Plesiosauria Cymatosaurus Placodontia Placodus	
STEIN	Upper	Labyrinthodontia Cyclotosaurus mechernichensis Heptasaurus (Mastodonsaurus) Stenotosaurus Rhinchosauria Eifelosaurus Pseudosuchia Chirotherium		Labyrinthodontia Eocyclotosaurus Heptasaurus (Mastodonsaurus) Stenotosaurus Procolophonia Anomoiodon Prolacertilia Macrocnemus Tanystropheus Pseudosuchia	Pseudosuchia Chirotherium				

KEUPER									Pterospondylus Plateosaurus Halticosaurus Gressleyosaurus Plesiosauria Plesiosaurus
	Knollen-Mergel		Dinosauria Gresslyosaurus	Dinosauria Gresslyosaurus Plateosaurus Teratosaurus		Dinosauria Halticosaurus			
	Stubensandstein und Blasensandstein			Stubensandstein Labyrinthodontia Cyclotosaurus Testudinata Proterichereis Proganochelys Prolacertillia Tanystropheus Lacertillia Dolishosaurus Pseudosuchia Aetosaurus Phytosauria Phytosaurus Crocodilia Mystriosuchus Dinosauria Halticosaurus Teratosaurus Thecodontosaurus Plateosaurus? Saltoposuchus Procompsognatus Trematosaurus	Blasensandstein Labyrinthodontia Cyclotosaurus Metoposaurus Plagiosaurus Phytosauria Palaeorhinus Francosuchus Dinosauria Dinosaurichnium				
	Leherberg-schichten			Labyrinthodontia Metoposaurus					
	Schilfsandstein			Labyrinthodontia Metoposaurus Cyclotosaurus Plagiosaurus Phytosauria Phytosaurus			Rhynchocephalia Polysphenodon		
	Gips-keuper			Placodontia Hanodus	Labyrinthodontia Metoposaurus Nothosauria Nothosaurus				
	Lettenkohle			Labyrinthodontia Mastodonsaurus Plagiosternum Plagiosuchus Prolacertilia „Zanclodon" Nothosauria Neusticosaurus Nothosaurus Simosaurus Pleosauria Pleosiosaurus Psephosaurus				Labyrinthodontia Mastodonsaurus Plagiosternum Plagiosuchus Metoposaurus Prolacertilia Tanystropheus Dinosauria Avipes Nothosauria Neusticosaurus Nothosaurus	
MUSCHELKALK	Upper			Labyrinthodontia Plagiosternum Plagiosuchus Testudinata Chelyzoon Prolacertilia Tanystropheus Nothosauria Nothosaurus Simosaurus	Testudinata Chelyzoon Prolacertilia Tanystropheus Dinosauria Thecodontosaurus Nothosauria Notosaurus Plesiosauria Pistosaurus Placodontia Cyamodus Ichtyosauria Mixosaurus Cymbospondylus aff. Shastosaurus				Nothosauria Elmosaurus
	Lower		Ichtyosauria Cymbospondylus Mixosaurus	Ichtyosauria Cymbospondylus Mixosaurus Shastosaurus Pessosaurus			Nothosauria Anarosaurus	Labyrinthodontia Mentosaurus Nothosauria Nothosaurus Proneusticosaurus Plesiosauria Cymatosaurus Placodontia Placodus	
BUNTSANDSTEIN	Upper	Labyrinthodontia Cyclotosaurus mechernichensis Heptasaurus (Mastodonsaurus) Stenotosaurus Rhinchosauria Eifelosaurus Pseudosuchia Chirotherium		Labyrinthodontia Eocyclotosaurus Heptasaurus (Mastodonsaurus) Stenotosaurus Procolophonia Anomoiodon Prolacertilia Macrocnemus Tanystropheus Pseudosuchia Crene leosaurus Seemannia Chirotherium	Pseudosuchia Chirotherium				
	Middle		Procolophonia Sclerosaurus Basilosaurus	Labyrinthodontia Stenotosaurus furstenbergianus Procolophonia Sclerosaurus		Procolophonia Koiloskiosaurus Anomoidon	Pseudosuchia Ctenosauriscusus	Labyrinthodontia Trematosaurus Pseudosuchia Chirotherium	Labyrinthodontia Trematosaurus Parotosuchus Prolacertilia Trachelosaurus Phytosauria Mezorhinus
		Chelonychnium				Pseudosuchia Chirotherium Rotodactylus	Labyrinthodontia Sclerothorax		Labyrinthodontia Paratosuchus Trematosaurus

(see list 3 in the third part of the book). They are *Anomopteris mougeotii*, which is also widely distributed in the Gres a *Voltzia* and stems of the conifers *Cedroxylon*, *Coniferomeylon* and *Xenoxylon*. BLANCKENHORN (1886) described a poor plant assemblage of the Gres a *Voltzia* from the Muschelkalk near Commern. SCHMIDT (1928) mentioned two species of *Endolepis* from the vicinity of Jena (Thüringen).

Palynological assemblages have been described from Thüringer Senke, Süd Deutsche Senke and the Paris Basin. The latter two assemblages are very similar confirming the correlation with the Muschelkalk of the west and east banks of the Rhine.

There are many tetrapods in the Muschelkalk of the German Basin, especially in the Upper Muschelkalk of Süd Deutsche Senke (Baden-Württemberg and Franken). The comparison of tetrapod assemblages of the Muschelkalk of Franken and the Middle Triassic of the Alps (near the boundary of the Anisian and Ladinian) made by WILD (1972) showed that the connection between these two regions was closer than it was previously thought.

*

The **Keuper** of the German Basin is divided into three parts of different thickness and lithology: the Lower Keuper (Lettenkohle), the Middle Keuper (the Hauptkeuper or Gypskeuper) and the Upper Keuper (the Rhaetian). The thickness of the Lower and Upper Keuper is not significant compared to the thickness of the Middle Keuper (see fig. 3). The Lower Keuper has close similarity with the underlying Muschelkalk in lithology as well as the presence of marine fauna. In the French part of the basin a part of this section is included in the Muschelkalk. The Upper Keuper in the German Basin in contrast to the Alps is more closely similar to the Jurassic by lithology as well as by the fossil plants it contains. In the French part of the basin the Rhaetian was referred to the Jurassic till 1963 which is why the Keuper of French geologists corresponds not to the whole Keuper but only to the Middle Keuper of German geologists.

The Lower Keuper or Lettenkohle consists of clay, coal clay, sandstone, marl, dolomite and limestone. A Bonebed occurs in the lower part of the unit near the boundary with Muschelkalk and the Grenzdolomit with *Myophoria goldfussi* and other bivalves occur in the upper part.

The Middle Keuper is composed of marl, sandstone, and shale. In the lower part a significant amount of gypsum and rock salt occurs. Because the Middle Keuper has a great thickness and variable lithology many local stratigraphical divisions are distinguished in it in different parts of the basin. Elsewhere in this book I will use names of some local stratigraphical divisions of the Middle Keuper of Württemberg and Franken. These local subdivisions are given below (after SCHMIDT, 1928). This list does not imply exact correlation of subdivisions of these two regions.

Württemberg	Franken
Knollenmergel	Zanklodon or Feuerletten
Stubensandstein	Oberer Burgsandstein
	Dolomitische Arcose
Oberer Bunter Mergel	Unterer Burgsandstein
Kieselsandstein	Coburger Bausandstein
	Semionotus Sandstein
	Blassen- und Plattensandstein
Leherbergschicht	Leherbergschichten
Unterer Bunter Mergel	Berggipsschichten
Schilfsandstein	Schilfsandstein
Estherienschichten	Estherienschichten
Mittlerer Gips	Myophorien-Schichten
Bleiglanzbank	Bleiglanzbank
Grundgips	Grundgips

The Upper Keuper or the Rhaetian consists of sandstone and shale of a few meters thickness which forms the lower part of the "Grenzschichten des

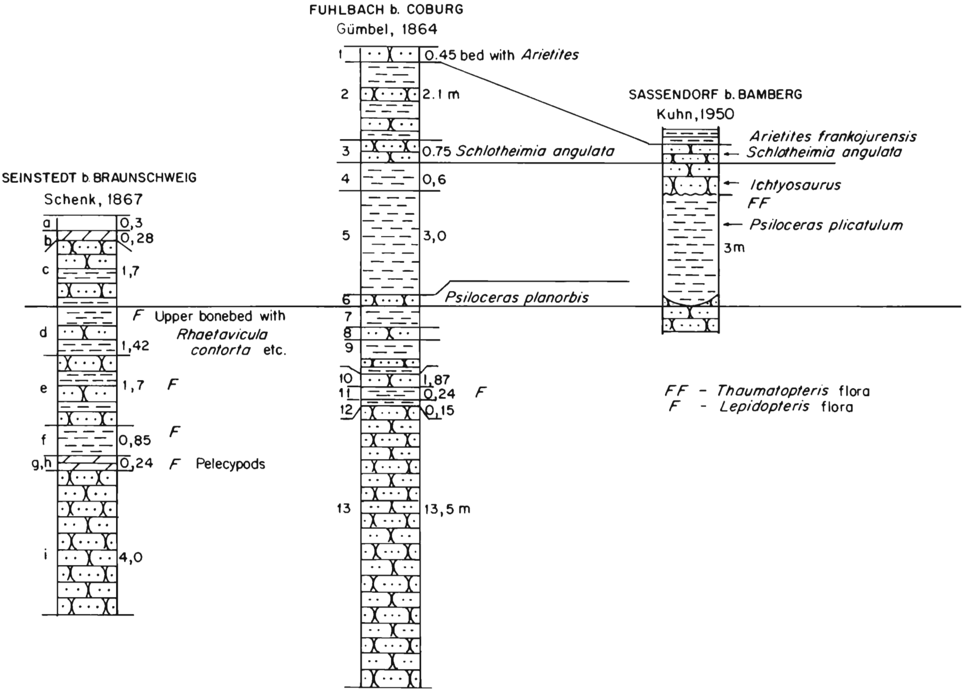


Fig. 4: Correlation of the deposits near the Triassic-Jurassic boundary in Nieder Sachsen, Süd Thüringen and Franken. For the legend see fig. 74.

Keuper und Lias" in the southern part of the German Basin. For many years the "Grenzschichten" were regarded as Rhaetian and all plant remains contained in them were considered as an indivisible assemblage. Gothan (1914) studied the "Grenzschichten" and their plants near Nürenberg and discovered that the majority of fossil plants are closely associated with or lie above the beds with *Psiloceras* or are correlated with *Psiloceras* beds, implying that the majority of these plants belong to the Lias. Fossil plants lie under *Psiloceras* beds only in two localities near Coburg (in the northern part of Süd Deutsche Senke) or are associated with *Rhaetavicula contorta* (Seinstedt in Subherzynische Senke) – fig. 4. *Rhaetavicula contorta* is a guide fossil for the Rhaetian. Latest data of alpinian geologists demonstrates that the "Rhaetian" with *Rhaetavicula contorta* is of Middle Norain age (Dobruskina, 1976 c).

Megaspores are very important for the determination of the Triassic-Jurassic boundary. They have been studied in the sections of Süd Deutsche Senke (Wicher, 1951; Jung, 1960) and from the boreholes of the north-western part of Nord Deutsche Senke (Will, 1969).

In the French part of the basin the Rhaetian consists of sandstone and shale with *Rhaetavicula contorta* (below) and the Levallois marl (above).

Plant remains occur in only certain stratigraphic horizons in the Keuper: the Lettenkohle, Schilfsandstein, Semionotus Sandstein and the Rhaetkeuper (chart 4). They were studied by Brauns (1862–1866), Schenk (1864, 1865, 1865/1866, 1867), Heer (1865, 1877), Arber (1907, 1909), Compter (1874, 1894, 1902, 1912, 1918, 1922), Leuthardt (1901, 1903/1904, 1913, 1915), Frentzen (1922 a, 1922 b, 1926, 1933), Gothan (1909), Lilienstein (1928, 1931), Linnel (1932/1933), Krausel (1929, 1939, 1943, 1952 a, 1952 b, 1955, 1956, 1958, 1959, 1960, 1966), Mägdefrau (1953, 1956, 1963), Roselt (1952/1953, 1954, 1955/1956, 1957/1958, 1960), Schaarschmidt (1966).

The Lower Keuper plants (list 4 in the part three) are the most numerous in Subherzynische Senke, in Thüringische Senke and in the north of Süd Deutsche Senke. They are less well known in the French part of the basin and in the south of Süd Deutsche Senke. In the Lettenkohle the most common plant fossils are the remains of sphenopsids. *Equisetites arenaceus* is most abundant as it is found at 16 localities in Baden-Württemberg and at 10 localities in Franken where it is the only species at many of them, the number of ferns, cycadophytes and conifers is approximately equal. Some are assigned to the same genera (but other species) as in the Bausandstein *(Neuropteris, Pecopteris, Pterophyllum, Voltzia)* but most represent new genera which are not known from the Buntsandstein *(Danaeopsis, Bernoullia, Chiropteris, Apoldia, Dioonitocarpidium)*. Pteridosperms are represented only by the genus *Scytophyllum* with two species; nevertheless the great amount of dispersed phytoleims of *Scytophyllum* type in Thüringer Senke (Bornemann, 1856) shows that this group played a much greater role in the Lettenkohle flora. Ginkgophytes (fam. Glossophyllaceae) and lycopsids (genus *Bedheimia*) are represented by only a single genus each.

The Schilfsandstein flora (list 5 a) is known chiefly from Süd Deutsche

Chart 4: Stratigraphic and geographical position of the most important plant assemblages in the Keuper of German Basin

	Süd-Deutsche Senke			Süd-Thüringen	Thüringer Senke	Subherzynische Senke
	Dinkelberg – North Switzerland	Baden-Württemberg, Hessen	Franken			
Raet-keuper				Coburg – 3 species Schenk, 1867 Gothan, 1909 Antevs, 1914 b Kräusel, 1929		Seinstedt Brauns, 1862–1864, 1866 Schenk, 1867 Gothan, 1909
Semionotus-sandstein			Hassfurt Mägdefrau, 1953, 1956, 1963			
Schilf-sandstein	Basel Schenk, 1864, 1867 Heer, 1865, 1877 Leuthardt, 1901, 1903/1904, 1914, 1915 Frentzen, 1926 Florin, 1936 Kräusel, 1943, 1952 b, 1955, 1958, 1959, 1960 Kräusel, Schaarschmidt, 1966 Schaarschmidt, 1966	Stuttgart Eppingen Gochsheim Heinsheim Tiefenbach Weiler Gothan, 1909 Frentzen 1922 a, 1933 Kräusel, 1939, 1949, 1952 a Roselt, 1952/1953 Zimmermann, 1953	Kitzingen Steigerwald Hofheim Windsheim Zeil Hassfurt Schenk, 1864 Kräusel, 1939 Mägdefrau, 1960	Haardt – 1 species Roselt, 1952/1953 Coburg – 1 species Schenk, 1864 Arber, 1909		Thale – 1 species Lilienstern, 1931
Letten-kohle		Sinsheim Siegelsbach Eubingen Gaildorf Osterburken Untergimpern Bronn, 1858 Schenk, 1864 Frentzen, 1922a Zimmermann, 1953	Kitzingen Würzburg Schweinfurt Steigerwald Arnstein Thurnau Schenk, 1864 Schonlein, 1865 Frentzen, 1933 Grauvogel-Stamm, 1978 Kelber, 1983	Bedheim Irmelshausen Lilienstern, 1928 Frentzen, 1933 Roselt, 1952/1953, 1954, 1955/56, 1957/1958, 1960	Mühlhausen Bornemann, 1856 Apolda Compter, 1874, 1894, 1902, 1912, 1918, 1922 Arber, 1907 Lilienstern, 1928 Frentzen, 1933 Linnel, 1932/1933 Wesley, 1958	Thale Lilienstern, 1931 Linnel, 1932/1933 Roselt, 1952/1953 Dobruskina, 1969

In Hessische Senke there are no lacalities of the Keuper plants

Senke. The majority of plants have been collected from numerous localities to the south of the depression of Frankonische Alb up to the Juragebirge. Very many plant remains of good preservation come from a number of localities in the vicinity of Basel (northern Switzerland) (list 5 a). The Schilfsandstein flora as well as the Lettenkohle flora is characterized by the great amount of shenopsids with the remains of *Equisetites arenaceus* at 17 localities in Baden-Württemberg and 9 localities in Franken. In addition there are a large number of indeterminable stems of sphenopsids which have given the name to this stratigraphic unit. The Dipteridaceae are much more common in comparison with the Lettenkohle. They include *Dictyopyllum serratum, Clathropteris reticulata, C. meniscoides, Camptopteris serrata, C. quercifolia*. On the whole there is a large variety of ferns, especially near Basel. *Pterophyllum* remains are one of the most numerous group in the Schilfsandstein, the species content of *Pterophyllum* being nearly the same as in the Lettenkohle. The ginkgophytes are scarce and the conifers also changed very little in comparison with the Lettenkohle. Thus, the main difference between the Lettenkohle flora and Schilfsandstein flora is the ferns. *Dadoixylon* (petrified wood) was described from the Schilfsandstein of Württemberg (ZIMMERMANN, 1953).

Outside of Süd Deutsche Senke *Clathropteris reticulata* and *Chiropteris lacerata* were identified from the Schilfsandstein of Thale in the Subherzynische Senke. Two species of *Voltzia* were described from the Schilfsandstein in the northern part of Süd Deutsche Senke to the north of the depression of the Frankonische Alb.

The flora of the Semionotus Sandstein (the Coburger Bausandstein) is known only in the north of Franken at Hassfirt am Main. It is represented by the conifers *Voltzia, Glyptolepis, Widdringtonites, Podocarpites* and the pteridosperm *Lepidopteris brevipinnata* (list 6). This assemblage is similar to the Schilfsandstein assemblage but it is much smaller.

Only petrified wood *Dadoxylon* is known from the Stubensandstein.

In the French part of the basin the Keuper flora (the Middle Keuper flora) has been described from some localities in Lorraine (Gemmelaincourt, Norroy, Suriauville, Vic) where it is represented chiefly by sphenopsids (list 7).

The Rhaetian flora of Coburg consists of two species (list 8 a): *Lepidopteris ottonis* and *Laccopteris elegans*. The Seinstedt flora (list 8 b) was collected during the middle of the last century from a small shaft. It also contains *Lepidopteris ottonis*. This flora is easily distinguished from plant assemblages of the Schilfsandstein and Lettenkohle because there are practically no common species. Sphenopsids are represented by new species and the ferns include only dipterids. All species are different in the Schilfsandstein except *Clathropteris meniscoides*. *Pterophyllum* is represented by other species too. It is important to note the first appearrance of *Nilssonia* in the flora and the diversity of species of *Taeniopteris*. Ginkgophytes and confers are unknown in the flora. The flora is based on a single locality which unfortunately now exists no longer.

In the French part of the basin *Clathropteris platyphylla* and *Cylindropodium liasinum* were mentioned from the Rhaetian (list 9).

The Keuper palynological assemblages from the outcrops of the German Basin have been poorly studied. Lower and Upper Keuper assemblages are known (see chart 2) from Thüringische Senke. Middle Keuper assemblages have been described from the Schilfsandstein of canton Basel, Switzerland from the river Birs (from the same horizon as the megaflora). In addition Lower and Middle Keuper palynological assemblages (from five horizons: the Lettenkohle, the Gipskeuper, the Schilfsandstein, the Ganziger Dolomit, the Bunte Mergel) have been described from adjacent region at Juragebirge (SCHEURING, 1970). The Triassic deposits here are also formed in the German facies.

The Keuper tetrapods (see chart 3) are best known from the Süd Deutsche Senke, particularly many have been described from the Middle Keuper of this part of the basin. The Keuper tetrapods are not known from the other parts of the basin. That is why the Lettenkohle tetrapod assemblages and the Rhaetian assemblages are of great importance inside of the German Basin. Other assemblages are important for interregional correlation.

Thus, in the central part of the German Basin fossil plants are known from three stratigraphical horizons of the Buntsandstein (the Bausandstein, Chirotheriensandstein, the Plattensandstein) and from four horizons of the Keuper (the Lettenkohle, the Schilfsandstein, the Semionotus Sandstein, the Rhaetkeuper). Their age is determined on the basis of the correlation between a section of the German Basin and a section of the Alps. The latter is used as a stratigraphical standard for the Triassic because it is directly connected with marine sections.

Until recently there was no reliable data for correlating the Zechstein and the Buntsandstein sections (and even horizons near the Permo-Triassic boundary in the Alps) with the base of the *Otoceras* zone in the Himalayas. It is very possible that the boundary between the Zechstein and Buntsandstein is diachronic.

The correlation of the sections under consideration was studied most of all by PIA (1930) and KOZUR (1972, 1974, 1975) and analyzed by me (DOBRUSKINA, 1968, 1970 b, 1976 b, 1978 a). First of all it was determined that plant-bearing horizons of the Buntsandstein correspond to the upper Lower Triassic (the Olenekian according the scheme adopted in the USSR) and to the Lower Anisian. The Buntsandstein flora resembles the Zechstein flora in which conifers also dominate and the same families of conifers and pteridosperms are present. There are no fossil plants or other palaeontological remains in the lowermost Lower Triassic of the German Basin. That is why it may be supposed that the hiatus in palaeontological findings in the lowermost Lower Triassic is connected only with the incompleteness of the geological record. A flora similar to the Buntsandstein and Zechstein floras certainly existed in Western Europe in the beginning of the Triassic. Perhaps the flora was only in local areas.

New data on tetrapods as well on other groups of fossils support the conclusion that the Gres a *Voltzia* and Röt plant-bearing beds (the Plattensandstein) on the eastern bank of the Rhine are Anisian in age.

Secondly, the Lower Keuper deposits of the German Basin (the Lettenkohle) were correlated with the Upper Ladinian deposits of the Alps and the Middle Keuper deposits (the Schilfsandstein and the Semionotus Sandstein) with the Karnain deposits of the Alps. The fact of great importance for such comparison is the similarity of plant assemblages in the Schilfsandstein of Süd Deutsche Senke and the Middle Karnian deposits of Lunz in the northern Alps (FRENTZEN, 1922 b). New palaeontological data particularly palynological confirm these conclusions. The Semionotus Sandstein flora is most likely of Late Karnian age.

The most interesting results from the point of view of the age of the plant-bearing deposits of the German Basin has recently been obtained from a comparison of the stratotypes of the Norian and the Rhaetian. The majority of Austrian and German geologists consider a large part or even the whole Rhaetian to be coeval with the type Norian, although correlations of the type Norian and type Rhaetian differ depending on the author. Even KOZUR, who insists on the independence of the Rhaetian stage (KOZUR, 1972, 1973 a), correlates the Kössen beds with the upper part of the zone *Rhabdocers suessi* in the Upper Norian. As I have shown (DOBRUSKINA, 1976 c) in the type Kössener beds (locality Weissloferbach) strata with *Rhaetavicula contorta* lie below beds with *Rhabdoceras suessi*, the zonal from of the Upper Norian. Consequently, the "Rhaetian" plant-bearing deposits of the German Basin associated with the first of these forms are most likely coeval with a part of the Norian.

The nomenclature problem about the priority of the names "Norian" and "Rhaetian" remains unsolved. I prefer to call these deposits "Norian – Rhaetian" as one cannot exclude the possibility that the Rhaetian is equivalent to the single *Choristoceras marshi* zone and is an independent stratigraphic division.

All these data results in the conclusion of the Norian – Rhaetian age (to begin from the Middle Norian) of the Rhaetian floras of Western Europe. Looking a little ahead I can say that this conclusion is also referred to as the adjacent floras of Greenland and Sweden. For all appearance they began to form at the same time as the Norian (the Middle Norian) floras of Japan and Soviet Primorye.

Thus, in spite of the abundance of plant-bearing horizons in the German Basin they actually occur in only two intervals of the section: the oldest (with three horizons) is Olenekain and Lower Anisian in age and the younger (with four plant-bearing horizons) is Late Ladinian, Karnian and Norian – Rhaetian in age, lower most Lower Triassic and middle Middle Triassic plant remains are not known in the German Basin.

The marginal parts of the German Basin

France

The main area of the Triassic is in the north-east of the country, in the Vosges (Alsace – Lorraine). It belongs to the north-eastern part of the Paris Basin. Its description was done above. In the other parts of the country Triassic deposits (also in German facies) are known as small outcrops (see fig. 1) around Massif Central France, in the Western Alps and North-Western shore.

In the north-eastern margin of Massif Central de France fossil plants are known from the Rhaetian. The richest locality (Autin) was described by Saporta (1873–1891) in the end of the last century. Fliche (1905–1910) mentioned *Clathropteris platyphylla* from few localities of north-eastern part of Massif Central de France. Not many plants of the Lower Triassic (localities Creyseilles near Privas and Lodeve west of Montpellier) and Rhaetian (locality Lozerne) are known in south-east of Massif Central de France. Lower Triassic plants are the same as in the Vosges.

To date only Keuper plants are known in the Western Alps. The most interesting locality is Vanoise, dept. Savoie. Its plant assemblage is comparable with the plant assemblage of the Schilfsandstein of Süd Deutsche Senke. Especially similar is *Pterophyllum. Equisetum mytharum* was the most common plant in this assemblage. It is also known from several other localities of the region: Vescagne (Maritimes de France), Lauce (south-east of Gapa), Monte-Charven and also Crochetta (in the Ligurian Alps of Italy) – see list 11 b in the third part of the present book.

In northern France the Triassic (Rhaetian) plants are described from the vicinity of Cherbourg (dept. Manche) and of Boulonnais, dept. Pas-de-Calais (list 12 c). The plants are accompanied by freshwater pelecypods and in the Cotentin basin by ostracods and reptiles in addition to pelecypods.

Klaus (1964) described miospore assemblages from the Upper Buntsandstein and the Middle Muschelkalk. In addition miospore assemblages have been studied from the Lettenkohle of the eastern margins of Massif Central de France (Gradstein, 1971), from the Rhaetian of the Antully plateau in the north-east Massif Central (Adloff & Doubinger, 1975) and Normandie (Muir et al., 1970). The investigations of Gradstein (1971) showed that the Lettenkohle facies in the east of the Massif Central correlate with the Schilfsandstein of the central parts of the German Basin.

Triassic tetrapods of this region are represented chiefly by footprints. Demathieu and Haubold (1974) developed the systematisation of the footprints and studied their stratigraphic distribution in this area.

England

A typical Gres a *Voltzia* flora has been known from the English Midlands for many years (fig. 5) at Bromsgrove and Nottingham (list 13). From the first of these localities *Schizoneura paradoxa, Equisetites arenaceus, Voltzia heterophylla, Yuccites vogesiacus* and *Masculostrobus* have been described. Only *S.*

paradoxa occurs at the second locality. Until 1967 the fossiliferous beds were attributed to the lower part of English "Keuper". Marine deposits of the Middle Triassic are absent in England, and the Triassic section is only represented by continental deposits. It is naturally that the exact correlation of those strata with the subdivisions of the central part of the German Basin remained unclear for a long time. Recent palynologal investigations (WARRINGTON, 1967; VISSHER, 1971) have made it possible to correlate just the upper part of English "Keuper" to the Keuper of Central Europe. The rest of it belongs to Muschelkalk and the Upper Buntsandstein (chart 5). Thus, plant-bearing deposits of the English Midlands correspond to the Gres a *Voltzia* of Middle Triassic age.

These results were confirmed by revision of tetrapod determinations from the "Lower Keuper Sandstone" of England (WALKER, 1969; PATON, 1974). Some pseudosuchia (reptiles) were regarded earlier as labyrinthodontia; now their age is revised to Early Ladinian.

Chart 5: Correlation of subdivisions of English and German Keuper according miospores and ackritarkhs (WARRINGTON, 1973)

Great Britain		Central part of the German basin		Geological scale
Rhät		Upper	Keuper	Rhät
Keuper marl		Middle		Nor Karn
		Lower		Ladin
Waterstone	Keuperstone	Upper	Muschel-kalk	
		Middle		Anis
		Lower		
		Upper	Buntsand-stein	Scyth
Unconformity Hardegsen		Middle		
Bunter Sandstone	Upper Mottled Sandstone			
	Pebbled beds	Lower		
	Lower Mottled Sandstone	Perm		

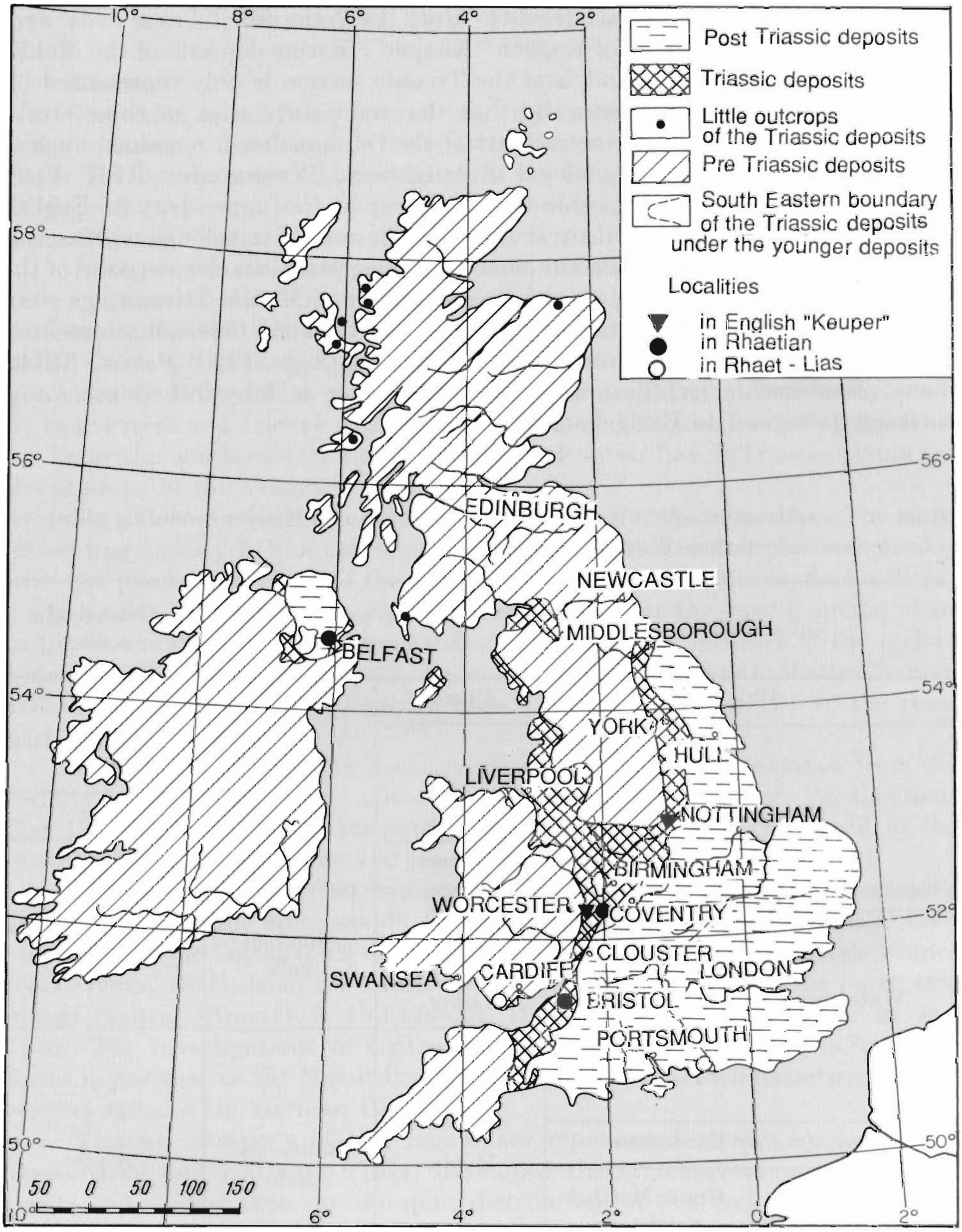


Fig. 5: Localities of the Triassic plants in England and Ireland (the map after WARRINGTON, 1973).

The only other Triassic flora known in England (list 14) occurs in the Lower Rhaetian Cotham marls (Harris, 1938). The flora consists of the liverwort *Naiadita lanceolata*. This fossil is associated with fresh water invertebrate and is known from a large area between Bristol and Birmingham. Fragments of other plants occur only south and north of this area in the Bristol and Worcester regions; their fragmentary condition suggest that they were transported a long distance. *Otozamites bechei* was described from the Rhaetian of Ireland (Harris, 1961 b).

A Liassic flora was described from Bridgend near Cardiff and from a borehole at Henfield to the east-north-east from Portsmouth (list 15), the majority of it being the remains of *Cheirolepis muensteri*. From the Rhaetian deposits of the Bristol region a Rhaetian fish *Birgeria acuminata* was described.

Triassic palynological assemblages were studied from boreholes in the North Sea (Geiger & Hopping, 1968).

Sweden

The collections of Rhaetian – Liassic plants in Europe are those from South Sweden which have been studied for more than 100 years (list 16): Nathorst (1878 a, 1878 b, 1879, 1886, 1902, 1906 a, 1906 b, 1908, 1909), Halle (1908 a, 1908 b, 1910), Moller & Halle (1913), Antevs (1914 a, 1914 b, 1914 c), Gothan (1909), Johanson (1922), Florin (1933, 1936), Harris (1937), Lundblad (1949–1959). Lundblad reviewed the Swedish Rhaetian flora. She gave descriptions of plants on the modern scientific level. Recently Triassic plants have been described from wells and the finding of *Voltzia* in borehole Hollviken II is considered to be pre-Rhaetian (Lundblad, 1949 a).

Fossil plants came from numerous outcrops in Southern Scania (fig. 6) where the lower part of coastal marine sandy shale deposits contain coal-bearing beds with plants. The thickness of plant-bearing beds is about 150 m. Nathorst (1878 a, 1878 b, 1879, 1886) referred to the whole plant-bearing section as the Rhaetian by correlating it with the Grenzenschichten of the central part of the German Basin which in his time were considered Rhaetian age.

Nathorst distinguished 15 zones in the Scania section and named them according to the characteristic fossils; the seven lower zones – after plants (chart 6). Later, however it was found that these zones did not extend a great distance, even within souther Sweden. Here as in Greenland and in Germany only two plant assemblages (analogues of *Lepidopteris* and *Thaumatopteris* Floras) can be distinguished. Later stratigraphic investigations changed the position of the Triassic-Jurassic boundary in this scheme. The most important was the discovery of ammonites *Psiloceras* sp., *Shlotheimia angulata* above the plant-bearing beds also in the analogues of the Halsingborg Formation in boreholes of Denmark and correlation of the Swedish sequence with the sequences and plant assemblages of Greenland and Germany (fig. 7). They showed that the boundary between the Triassic and Jurassic is situated between the fourth and the fifth of Nathorst's zones. It means that a considerable part of the Swedish "Rhaetian" flora is Early Liassic in age.

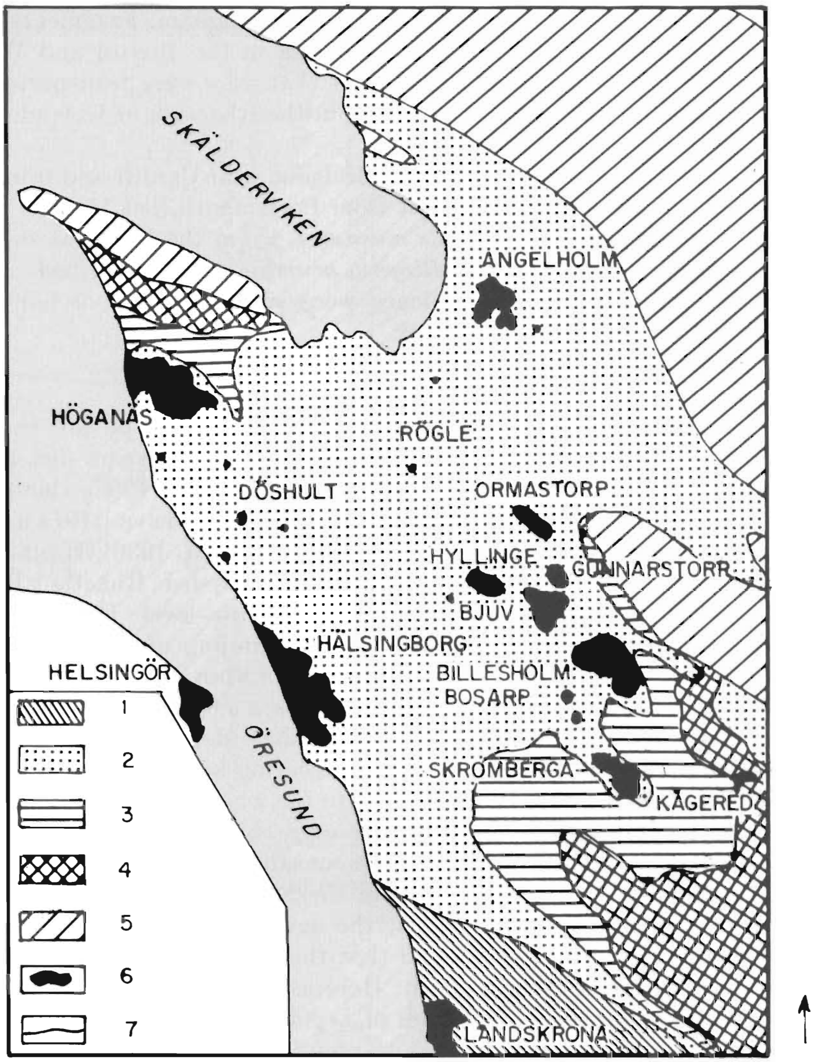


Fig. 6: Geological map of north-western Scania (from Lundblad, 1950, after Troedsson):
1 – Cretaceous; 2 – Rhaet - Lias; 3 – Kågerod Formation (Triassic); 4 – Cambro - Silurian; 5 – Archaean; 6 – coal fields; 7 – horst escarpment.

Chart 6: Stratigraphic position of the most important localities of the Rhaeto-Liassic floras in Southern Sweden

TROEDSSON, 1951; REYMENT, 1959			NATHORST, 1878–1886		
			Zones after NATHORST	Plant localities	
JURASSIC	Lower Sinemurian	Döshult Fm. 160 m	Bed with ammonites Bed with *Avicula* Bed with *Ostrea*	Hör Sofiero	Lias
	Gettangian	Ramlösa beds 20 m (bank with Pullastra)		Dompang	
		Pålsjo Fm. 40 m	11. Bed with *Cyclas nathorsti* 10. Bed with *Cardinia* 9. Bed with *Mytilus*	Rädalsberg Munka Togarp	
		Hälsingborg Fm. 50 m (bank with *Pullastra* not here – see above)	8. Zone *Nilssonia polymorpha* 7. Zone *Dictyophyllum acutilobum* [6. bank with *Pullastra*]	Pålsjo Hälsingborg Höganäs (upper)	Rhaet
TRIASSIC	Rhätian	Mine Fm. 50 m	5. Zone *Thaumatopteris schenkii*	Stabbarp – seam „J. Molin“	
			4. Zone *Equisetites gracilis*	Stabbarp – seam „N.U.G.“ Skromberga upper	
			3. Zone *Lepidopteris ottonis*	Bjuv 4 Bosarp Billesholm	
			2. Zone *Camptopteris spiralis*	Hyllinge Bjuv 2 and 3 Skromberga lower Stabbarp (clay 10) Höganas lower Bjuv 1	
			1. Zone *Dictyophyllum exile*	Bjuv a	
	Kågered Fm.		Keuper s. s.		

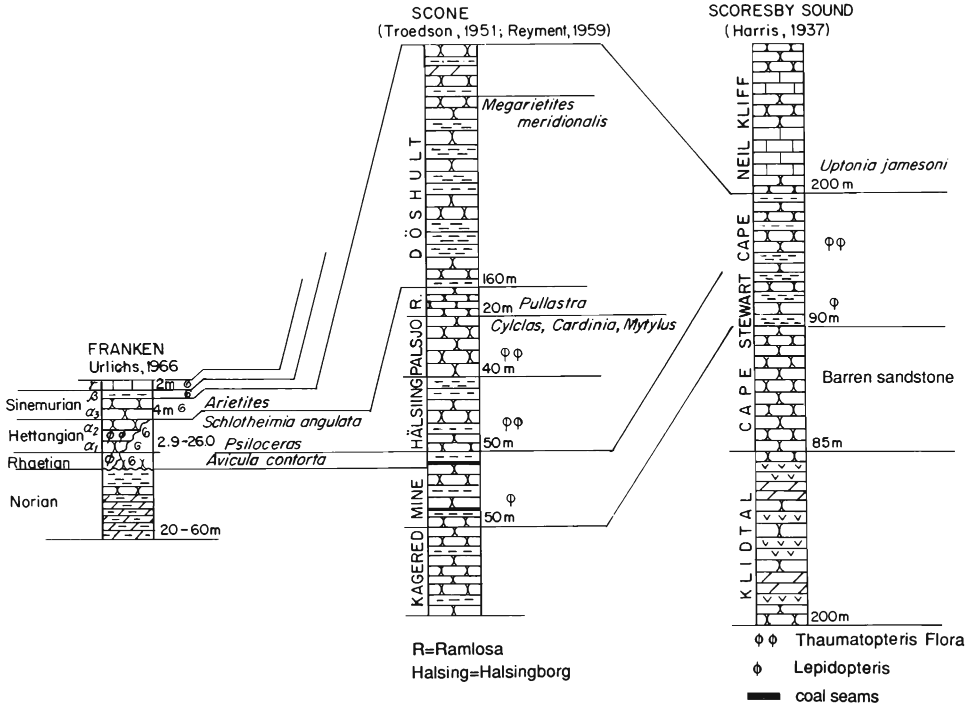


Fig. 7: Correlation of the deposits near Triassic-Jurassic boundary in Germany, Sweden and Eastern Greenland. For the legend see fig. 74.

Palynological assemblages and megaspores from the Rhaeto-Liassic deposits of southern Sweden were described mainly from boreholes (Brotzen, 1950; Nilsson, 1958; Lundblad, 1956, 1959 a). The Rhaetian palynological assemblage was described from the famous locality Bjuf (Lilsson, 1958). The remains of labyrhinthodont *Gerrothorax rhaeticus* were found in the same localities as the plants (Nilsson, 1937, 1946).

Poland

Plants from the Rhaetian deposits (list 19) of Oberschlesien (see fig. 1) were described early in the 19th century by Göppert (1836). The holotype of the Rhaetian guide fossil plant *Lepidopteris ottonis* came from the environments of Velun. The same species in association with two species of *Pterophyllum* were found in four localities south-west of Velun as reported by Schenk (1867), Gothan (1909), and Antevs (1914 b). Recently a fifth locality was found in the Kolaczkowice borehole near Rawics about 100 km to the north-west of the old localities (Piwocki, 1970). From the Muschelkalk of Oberschlesien Schmidt (1928) reported a species of *Voltzia* (list 18). *Glossopteridium J. Czarnocki*, a form unknown in the other parts of the German Basin was found in the Middle Buntsandstein (Bochenski, 1957) from borehole Radoszicse 3 in the north-western margin of the Swiety Krzyz mountains (list 17).

Palynological investigations were carried out during a study of a sequence of boreholes in the north of Poland. Particular attention was given to the drawing of the Triassic-Jurassic boundary according to the palynological assemblages and miospores taking into consideration the data of central part of the German Basin, Sweden and Greenland.

Fossil tetrapods are especially numerous in the Muschelkalk in Poland. This is the *Eryosuchus* fauna which is of the Anisian age.

Spain

The only Triassic plant known from south-west of the German Basin in Spain is *Pleuromeia sternbergii* (see fig. 1 and list 20). It occurs in the Buntsandstein of Molina-de-Aragon in the basin of the Ebro (SCHMIDT, 1937).

The Alps, Carpathians, Balkans

The occurences of Triassic plant fossils in this part of Europe are comparatively less well known than those in the German Basin. Rich plant assemblages are known only from the Karnian deposits of Lunz, the Northern Alps, and of Raibl, the Southern Alps (fig. 8, see also fig. 1). Poorly preserved plants (list 22 d) have also been described from the Upper Ladinian in Zoldo and Gardo in the Dolomiti (LEONARDI, 1953, list 22 d). An assemblage consisting mainly of confers has also been described from the Anisian deposits of Recoaro, Prealpi Veneto (list 22 b). At St. Cassian, Dolomiti, a single specimen of *Williamsonia alpina* was found (list 22 c). It occurs most likely in the Upper Triassic but the exact horizon is unknown (KRASSER, 1919). In Hungary plant assemblages at Mecsek mountain are known only by preliminary determinations (NAGY, 1960 – list 23). A small part of Rhaeto-Liassic flora of Banat, Roumania in the Southern Carpathians should probably be referred to as Rhaetian (SEMAKA & GIVULESKU, 1965 – list 24 a). Lower Triassic plants from the Balkans (Stara Planina) are similar to those of other parts of the German Basin (PANTIP, 1960; KHARKOVSKA & TENCHOV, 1963 – list 25 a, 25 b). *Pleuromeia* occurs in the Lower Triassic of the Gailtaler Alpen at two localities (CHAIR & THIEDIG, 1973; AMEROM ET AL., 1976 – list 21 a).

Recoaro

This locality is in Northern Italy east of Lake Gardo in Prealpi Veneto. An almost entire Triassic sequence (without the Karnian) of normal marine type without reef facies (see fig. 8) is present here.

The Recoaro beds are represented (from bottom to top) by the Grenzdolomit, beds with *Dadocrinus gracilis,* marls with *Voltzia* (list 21 b) and Recoaro limestones. They lie on terrigeneous deposits of the Werfen stage with *Claraia clarai* (Emm.) and *Tirolithes cassianus* Quenst. and are overlain by the Upper Anisian Tretto Limestone with *Sturia* and *Paraceratites trinodosus* Mojs. Plants (conifers) of the marls with *Voltzia* were described by Zigno (1862) who considered the strata to be Late Triassic or Early Liassic in age. The plants occur at two horizons in the "marls with *Voltzia*". The upper is considered to be of the Anisian age the lower one is now referred to Permian (letter communication of Dr. V. de Zanke from Padova).

Schenk (1868) later referred to the majority of conifers from this locality as the genus *Voltzia*. The same species of *Voltzia* – *V. recubariensis* has also been described from coeval deposits at another locality not far from Recoaro (Selli, 1938).

Klaus (1964) described five types of miospores from the Recoaro "Muschelkalk" but the horizon was not specified. They are similar to the miospores described from the Middle Muschelkalk of northern France (Sarralbe) and three are similar to some from the Middle "Muschelkalk" of Baden-Württemberg (locality Kochendorf near Heilbronn).

Raibl

The valley of the Raibl River crosses the eastern margin of the Karnian Alps from the north-east to the south-west. The Triassic section in the valley of Raibl (fig. 8) was carefully described by Suess (1867). Plant remains came from the Schwarzen Schiefer with *Trachyceras aon* Muenst., which is referred to as the Cordevolian substage of the Karnian stage. In addition undeterminable remains of horsetails occur in tuffs lying much lower. The Raibl black shales containing *trachyceras aon* lie on the "erzführenden Kalk von Raibl" and are overlain by coral limestones, "tauben Schiefer", the Raibl beds with *Spiriferina gregaria* and *myophoria kefersteini* and the Torer Schichten with *Avicula aspera*, *Megalodon*, *Myophoria* i. e. Middle and Upper Karnian marine invertebrates. The Norian Hauptdolomit lies above the Torer Schichten.

The most complete list of plants from the Raibl Schichten was given by Stur (1885). Unfortunately the fossils were not described or illustrated in the paper. Some Raibl plants were described by Bronn (1858), Schenk (1864, 1865) and Arber (1907, 1909) – list 22 a. The Raibl plant assemblage included sphenopsids *(Equisetites)*, ferns (Marattiaceae and Dipteridaceae), cycadophytes and conifers *(Voltzia* and *Cephalotaxopsis)*. The flora is Early Karnian age.

Scheuring (1970) mentioned his unpublished work on palynology of the Karnian of Raibl.

Lunz

The most famous locality for Triassic plants in the Alps is near Lunz in the Niederosterreichische Alpen, about 70 km to the south-east of the town of Linz. A detailed section of this region together with detailed description of the plant-bearing beds was published by Verloop (1908). At this locality plants occur in the so-called Lunzer Sandstein (see fig. 8) which also contains coal seams (list 22 b). The flora is of Middle Karnian age. Middle Karnian beds with *Cardita* lie in the upper part of it in this section. The Lunzer Sandstein is underlain by the Reingrabener Schiefer with *Halobia* in its lower part. The lower part of the Reingrabener Schiefer is called Wengener or Aon Schiefer (the Lower Karnian). The Opponitzer Schichten lie above the Lunzer Sandstein and contain many Late Karnian invertebrate fossils and the tetrapod cf. *Francosuchus trauthi* Huene (HUENE 1939). KRYSTYN (1978) draws the Ladinian-Karnian boundary in the upper part of Reiflinger Kalk. He considers as Karnian seven uppermost meters of the last subdivision referring to them as *aon* and *aonoides* subzones of Julain substage. In his opinion, beds with Lunz plants belong to the topmost Jul.

The Lunz flora has attracted the attention of many scientists since it was first discovered. The first complete list of the plants was given in the paper by STUR (1885) without descriptions and figures. Generic and specific diagnoses of plants in the STUR collection were published by KRASSER (1909 a, 1909 b) according to the determinations of STUR. Detailed descriptions of some Lunz plants were made in the papers of KRASSER (1918, 1919), KRAUSEL (1943, 1948, 1949, 1953), KRAUSEL and SCHAARSCHMIDT (1966), BHARADWAJ and SINGH (1956), ROSELT (1954). The majority of descriptions concerns fertile parts of cycadophytes. The sphenopsids (except for two imprints), ferns (except for *Asterotheca merianii*) and nearly all sterile leaves of cycadophytes have not yet been described.

A few years ago the author began to study the Lunz flora. I reviewed all the data concerning collections, localities, previous publications (DOBRUSKINA, 1988 a, 1989 a).

As has been mentioned repeatedly in the literature, the Karnian flora of Lunz is very similar to the Schilfsandstein flora in the vicinity of Basel, Switzerland. In both floras the Dipteridaceae and sphenopsids predominate, the conifers and ginkgophytes are poorly preserved, pteridosperms are absent. The Karnian flora of Raibl differs as it has a poorer assemblage but more conifers. The absence of new investigations on the Lunz flora impedes the comparison. However, it is worth remembering that STUR studied both floras and in his time he was the best expert for the Triassic Alpinian flora. STUR considered the difference between the Raibl and Lunz floras to be the result of palaeogeographical differences and not due to in age. However, the Raibl flora is of Early Karnian age and the Lunz flora is of Middle Karnian age. According to STUR the Raibl flora is a flora of chalky reefs south of a Central Ridge which was exposed to storms by the open sea and the Lunz flora was a peatbog flora at the south margin of Bohemian High Plateau which was situated to the north of the Central Ridge. The flora of northern Switzerland (near Basel) was similar to the Lunz flora in this respect.

Several palynological assemblages have been studied from the Lunzer Schichten. Five species of miospores which are important for stratigraphical correlations were described from there by KLAUS (1960) and 37 species were described by BHARADWAJ and SINGH (1963/1964) from the coal measures in the Lunzer Schichten. In addition KLAUS has studied palynological assemblages from correlatives of the Lunzer Schichten: the beds with *Cardita* in the Gailtaler

Alpen (localities Bleiberg and Victorhütte) and the beds with *Halobia*, which underlie the Lunzer Schichten in the environments of Salzburg.

Palynological assemblages were also studied from the Lunzer Schichten of the Carpathians (PLANDEROVA, 1972), the Rhaetian deposits of the Kendelbachgraben in Salzkammergut, the Northern Alps (MORBEY & NEVES, 1974) and from the Rhaetian Kössen facies of the Bakony mountains in Hungary (VENKATACHALA & GOCZAN, 1964).

Fish and reptiles are known in the Alps (besides Lunz) in the boundary beds of Anisian and Ladinian age in the Tessiner Alpen, Switzerland to the south of San Gottard (PEYER, 1937; KUHN, SCHNYDER & PEYER, 1965). The pseudosuchian *Ticinosuchus ferox* Rvebs. was described from coeval deposits of another site – Mont San Giorgio south of lake Lugano, Switzerland (KREBS, 1965).

Seefeld

Triassic plants from Seefeld in Tirol have not been described at all. They occur in Seefeld beds (Seefeld bituminose marls of or Seefeld fish shales) to the north of Innsbruck in the Karwendel massif – between Seefeld and Achensee. Seefeld beds represent a facies of the upper part of the Norian Hauptdolomit (BRANDNER, 1984). They are laterally replaced by "normal" Plattenkalk and overlain by Kössen beds. Following BRANDNER and POLESCHINSKI they occupy a position at the boundary of the Alaun and Sevat. It means either Middle – Upper Norian or Norian-Rhaetian age depending on the point of view on the correlation of the Norian and Rhaetian stratotypes (see DOBRUSKINA, 1976 c).

The conifers form 90% of Seefeld flora. They are twigs and cones of a single genus and maybe of a single species. It was a plant related to *Voltzia* or *Brachyphyllum*. On the labels in the Innsbruck collections there are also other generic names: *Widdringtonites, Araucarites, Cupressites,* but they belong to the same species.

Seefeld conifers are now being studied by the author in cooperation with Dr. L. GRAUVOGEL-STAMM. The problem is that the genera *Voltzia* and *Brachyphyllum* are not well defined. Type material came from the Vosges but has not been revised since the beginning of the last century and partly lost. There is great deal of new conifer material from the type localities in the collections of GRAUVOGEL-STAMM in Strasbourg (as well as the old type material). So the first step in studying Seefeld conifers is a revision of the type material and then a comparison with the Seefeld plants. Such an investigation is now in progress.

There are about 70 specimens of conifers mentioned above in collections at Innsbruck. In addition there are four leaves of *Yuccites,* one leaf of *Equisetites,* one of *Peltaspermum* and one specimen (with counterpart) similar to *Annalepis*. The last one is badly preserved and it is hardly possible to decide if it really is a lycopsid or a scale of a conifer cone.

Seefeld flora has not much in common with the well-known Norian-Rhaetian floras of Germany, Sweden and Greenland and their correlatives in Asia. It is more similar to the Anisian, Ladinian and Lower Karnian floras of the

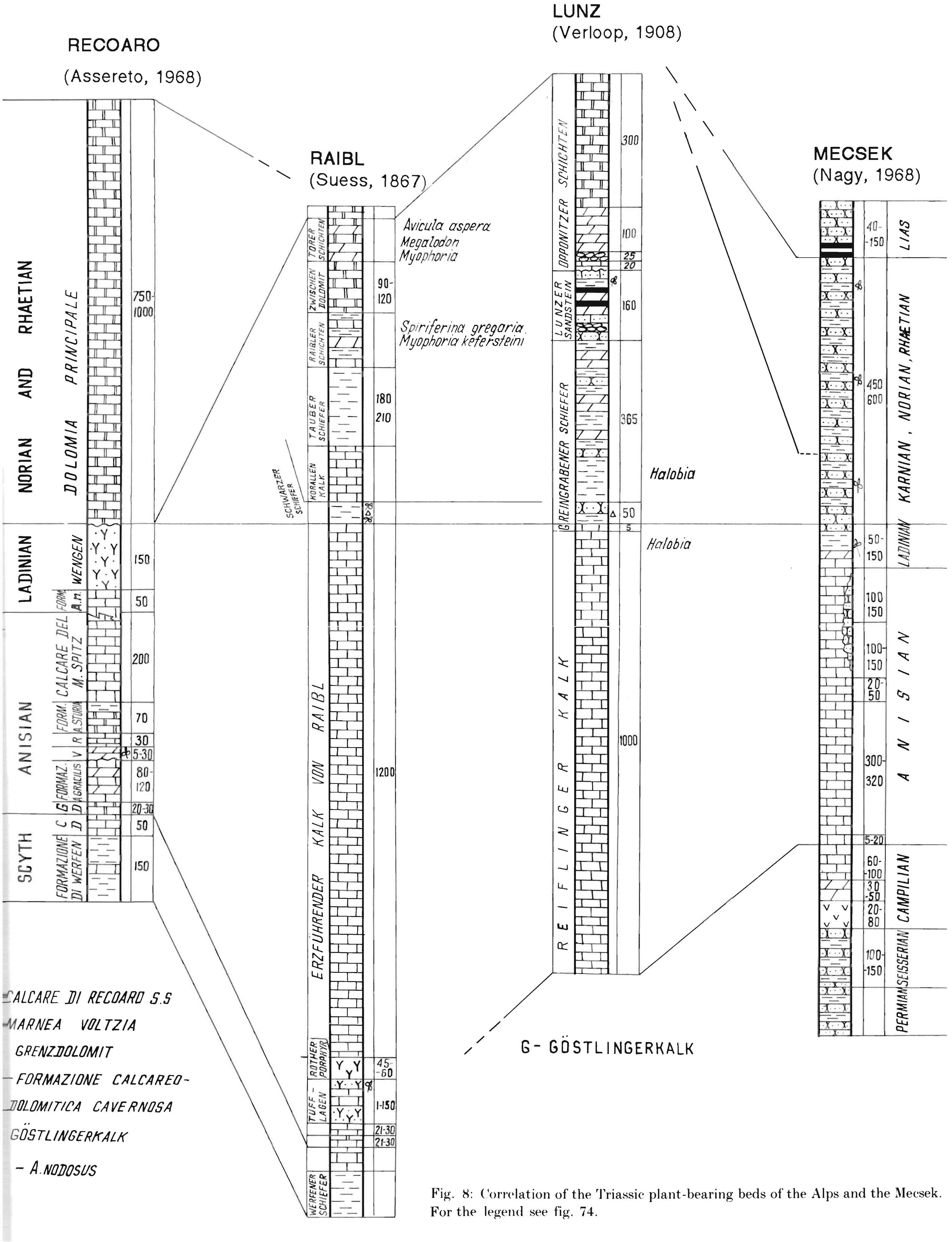


Fig. 8: Correlation of the Triassic plant-bearing beds of the Alps and the Mecsek. For the legend see fig. 74.

Southern (and partly Northern) Limestone Alps which also consist mainly of conifers. It is clear that this indicates a similarity of ecology in comparison to the Lunz and Basel marsh floras.

Plant assemblages of the lower part of the Norian have not yet been recorded in Eurasia. If the Seefeld flora belongs to this interval it will be the first flora of this age from Eurasia. If it belongs to the Norian-Rhaetian it represents a very special plant assemblage for this age compared to coeval floras widely spread in Eurasia.

The Gailtaler Alps

There are two reports about the occurence of *Pleuromeia* in the Gailtaler Alps (list 21 a). The first describes an occurence along its eastern margin (Chair & Thieding, 1973) and the second describes a locality near the western margin (Amerom, et al. 1976 a, 1976 b) where only rizophores were found. Both findings occur in the Lower Triassic Werfener Schichten.

The Mecsek Mountains

The Triassic alpinian facies are also known in the Mecsek mountains in southern Hungary (see fig. 8). The Triassic marine sequence with alpinian fauna in this area was carefully studied by Nagy (1968). All the Triassic stages were distinguished by him. Poorly preserved plants are directly associated with the marine invertebrates (list 23).

Nagy recalled that Stur compared the Ladinian flora of Mecsek with the flora of Wengener Schichten considering *Pterophyllum bronnii* to be a guide fossil. Nagy believes that the Rhaetian Mecsek assemblage is older than the Rhaeto-Liassic flora known in Western Europe. Unfortunately it is not possible to evaluate this because the plants have not been described or illustrated.

The Southern Carpathians

Some fossil plants are known from the Rhaeto-Liassic in the west of the Southern Carpathians in Banat, Roumania (Semaka & Givulesku, 1965 – list 24). To all appearance most of the fossils are Early Liassic in age and only *Thinnfeldia* sp. from the locality at Sirinka Bach is Rhaetian in age.

Some palynological assemblages were studied from the Lower Triassic and the Middle Triassic deposits from the Moesian platform, Roumania by Antonesku (1968–1969, 1970), Antonesku, Patrulius and Popesku (1976/1977), Antonesku and Taugordeau – Lanz (1973), Venkatachala, Bejau and Kar (1967).

The Balkans

Lower Triassic plants including species that occur in central Europe Buntsandstein are known in the Stare Planine mountains near the boundary of Yugoslavia and Bulgaria (list 25 – Pantip, 1960; Kharkovska & Tenchov, 1963).

Eastern Greenland

Two imprints of *Selaginellites* were described from the Lower Triassic of Greenland (LUNDBLAD, 1949 b – list 26). They occur in the Olenekian (?) of the peninsula Hold-withHope and the island Trail (fig. 9).

The rich Rhaeto-Liassic flora of Scoresby Sound was thoroughly studied by HARRIS (1926–1937), the first publication being made by HARTZ (1896) – list 27. This flora is being reinvestigated by PEDERSEN (1976, 1980, 1984) who is studying both plant megafossils and microspores. The Rhaeto-Liassic plant-bearing beds of the Scoresby Sound and Harry fiord (fig. 10) occur in the upper part of Cape Stewart Formation. The lower part of this formation consists of Barren Sandstone (see fig. 7) and overlies the Klitdal Formation (red marl, gypsum and arcose). The Neill Cliff Formation which contains *Uptonia jamesoni* SOV.) at the base overlies the Cape Stewart Formation. Vertebrates (represented by a marine fish *Hybodus* sp.) and pelecypods with thin shells are found in the upper part of the plant-bearing beds and *Estheria* sp. cf. *E. minuta* (GOLFf.) and a wing of a beetle – near its base.

The plant-bearing beds can be conveniently devided into two parts on the basis of the plants. Plants of the so-called *Thaumatopteris* flora (after the most

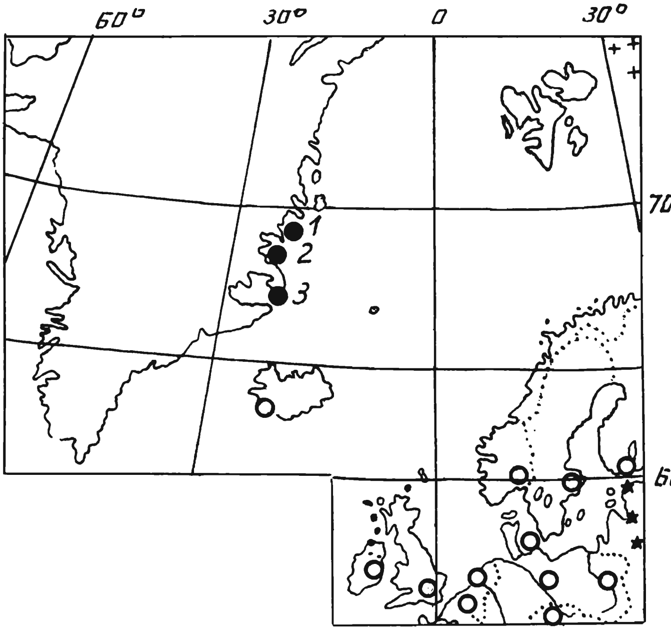


Fig. 9: Localities of the Triassic plants in Eastern Greenland:
1 – peninsula Hold-with-hope; 2 – island Traill; 3 – bay Scoresby.

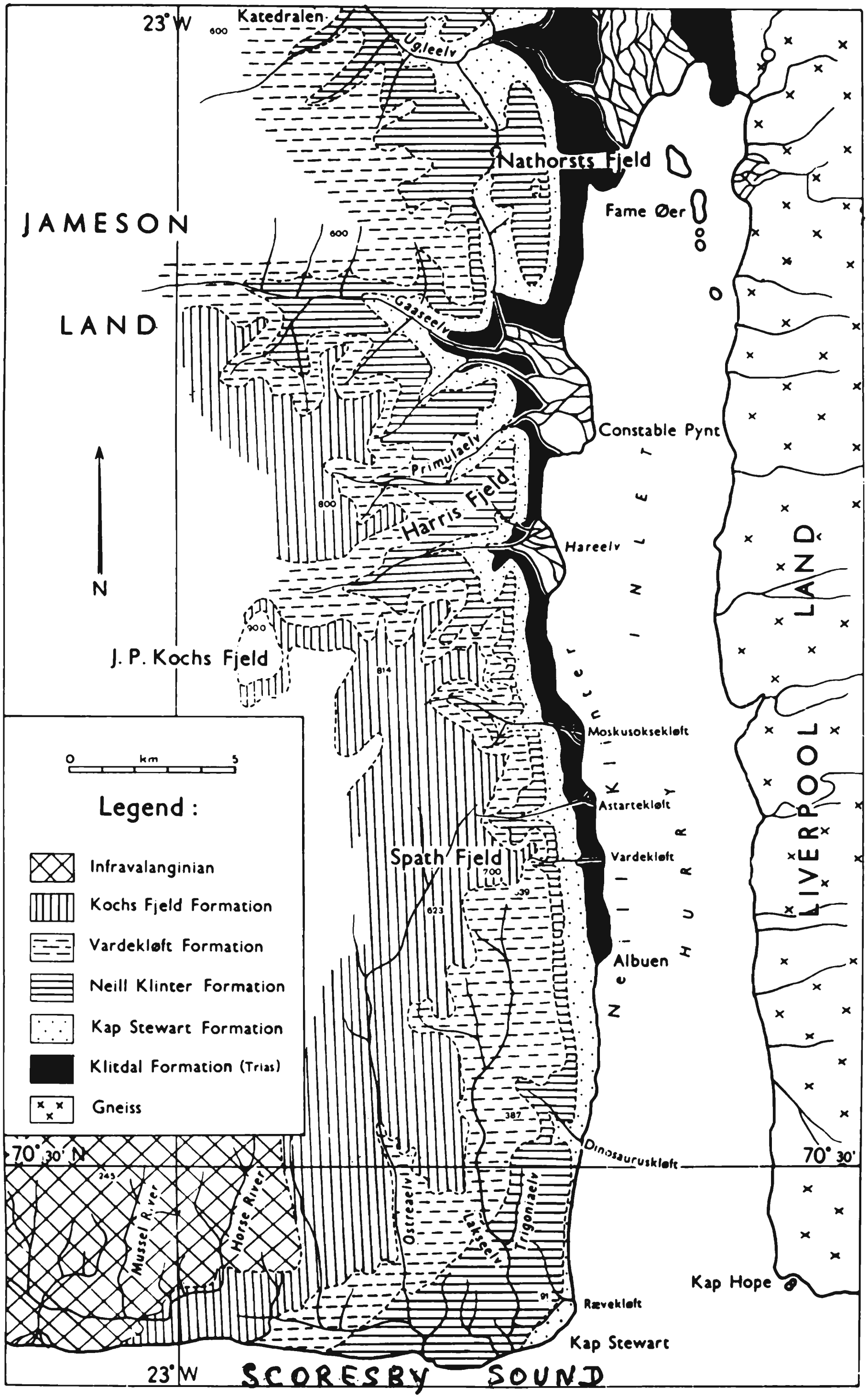


Fig. 10: Geological map of the areas near Scoresby Sound and Hurry inlet (after DONOVAN, 1957).

typical fern *T. schenkii*) occur in the upper 60 m of the section; the plants of the *Lepidopteris* flora (after the pteridosperm *L. ottonis)* occur in the lower 30 m. In spite of the similarity of the species and family content these floras have almost no species in common. Species of both assemblages occur together only in 5 m thick transitional bed. The plant-bearing beds of Greenland include the upper part of the Triassic and the lower part of the Jurassic. Above them there are Jurassic ammonites, below are the Triassic fossils. HARRIS (1937) considered the *Lepidopteris* flora to be of the Rhaetian age, and the *Thaumatopteris* flora to be of Early Jurassic age (approximately the Gettangian – the Lower Sinemurian).

The more ancient *Lepidopteris flora* is similar to the Rhaetian flora of Europe and the overlying *Thaumatopteris* flora is similar to the Liassic flora of the same region. For example the *Thaumatopteris* flora is very similar to the Grenzenschichten flora of Germany and Southern Sweden.

The boundary between these floras corresponds approximately to the Triassic-Jurassic boundary. HARRIS (1937) also mentioned that the age of the lower part of the *Lepidopteris* flora is uncertain and that it possibly includes the Norian, but Norian floras were not known in Europe. Recent studies confirm the Norian-Rhaetian age of the *Lepidopteris* flora (DOBRUSKINA, 1976 c).

HARRIS also studied megaspores from both plant assemblages and showed that the megaspore *Lycostrobus scottii* – which later was named by JUNG (1958) *Nathorstisporites* - is typical of the younger plant assemblage and the megaspore *Triletes (Banksisporites) pinguis* – is typical of the older one. With the help of these megaspores it is possible to define the boundary between the Triassic and Jurassic, or, in any case, the boundary between *Lepidopteris* and *Thaumatopteris* floras. Investigations of these megaspores were fruitfully continued by LUNDBLAD (1956) in Sweden, chiefly on borehole cores, by WILL (1969) in northern Germany, by WICHER (1951) and JUNG (1958, 1960) in southern Germany, and by MARCINKEWICZ (1971) in Poland.

Svalbard

The Triassic flora of Svalbard (list 28) has been studied in detail by VASSILEVSKAJA (1972). Detailed biostratigraphic correlation of Svalbard Triassic deposits was made by PCHELINA (1972) and KORCHINSKAJA (1972). The whole sequence is well characterized by marine invertebrates which allow zonal subdivision and correlation with other regions of the Arctic including North America. This is of importance because the Triassic sequence of Northern America has been proposed as the "standard for Triassic time" (TOZER, 1967).

Until recently the Rhaetian and even the Early Liassic was thought to be the age of the flora. Soviet geologists have collected Triassic plants from ten localities (fig. 11) in the Kapp Toscana Formation on different islands of the archipelago. They occur in two horizons (fig. 12). The lower was clearly dated as Karnian because of the occurence of the Karnian ceratites and pelecypods both below and above the plant horizon. The upper plant horizon was conditionally

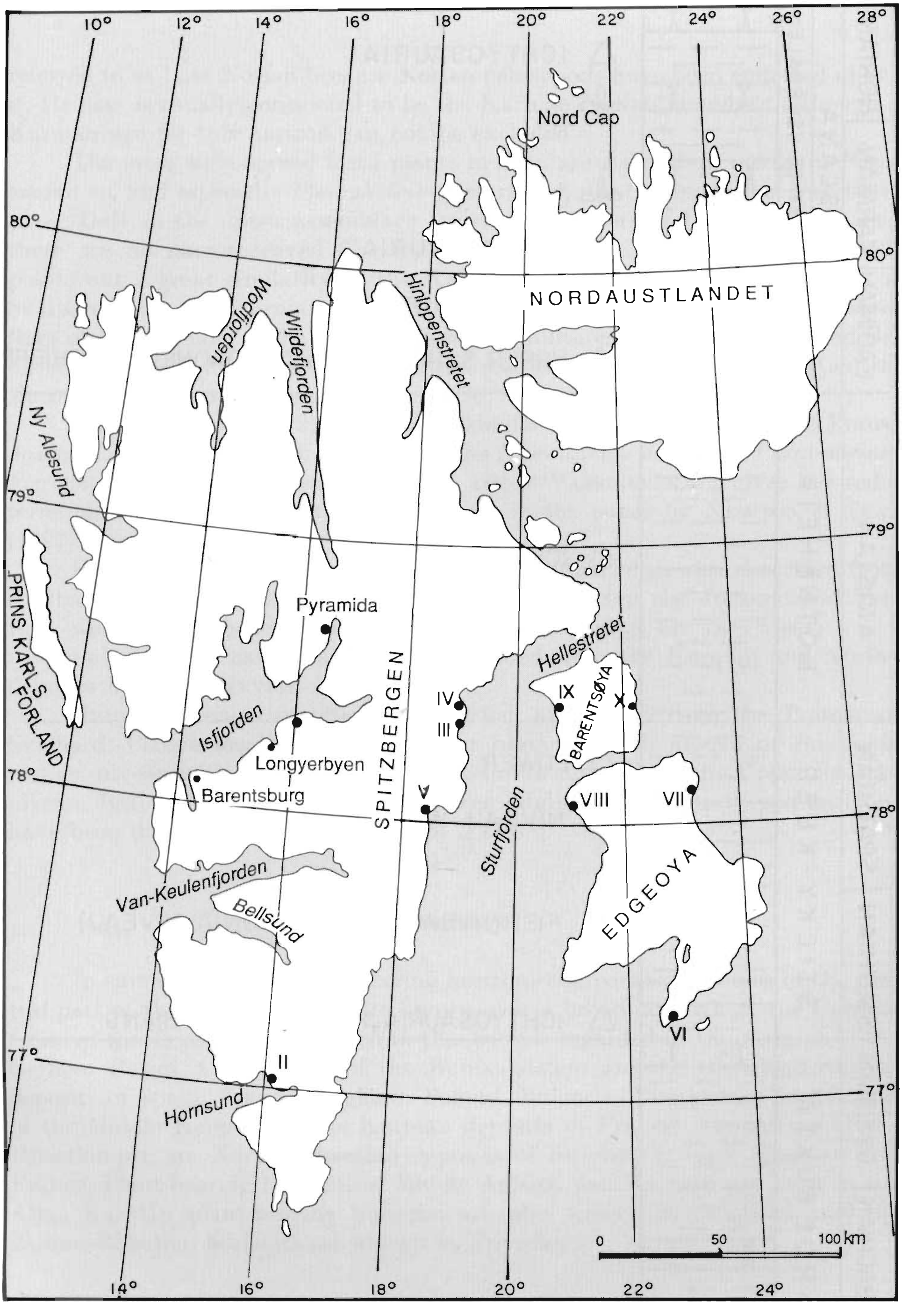


Fig. 11: Late Triassic flora localities of Svalbard (after VASSILEVSKAJA, 1972): I – Wiman mountain; II – Hurnefjellet; III – Teistberget mountain; IV – Uiche Bay; V – Agard Bay; VI – Negr Cape; VII – Pehuel-Lesha Cape, Lindeman mountain; VIII – Li Cape; IX – Vosse Bay; X – Shvenburt mountain.

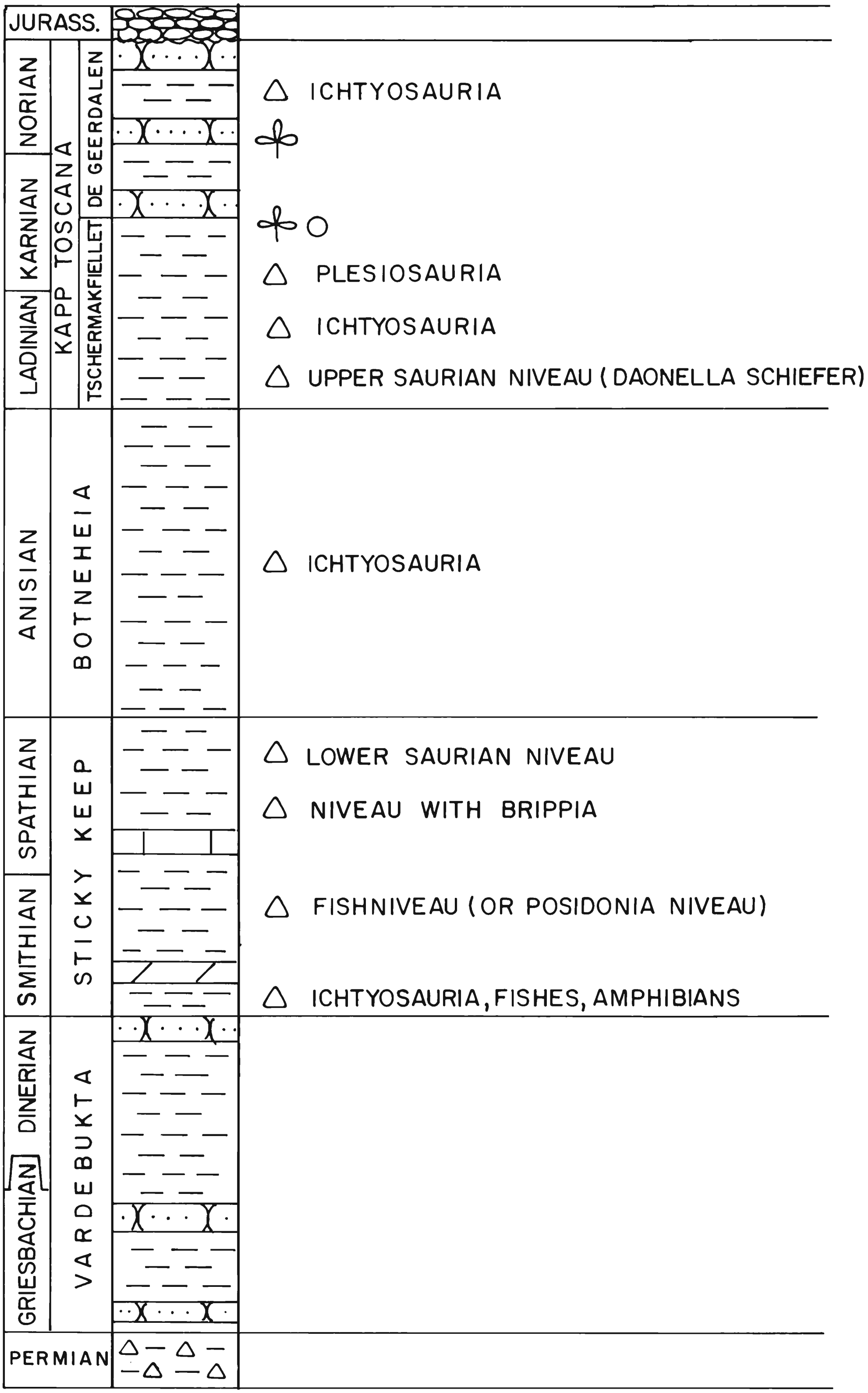


Fig. 12: Sequence of the Svalbard Triassic deposits (after Cox & Smith, 1973 and Vassilevskaja, 1972).

referred to as Late Norian because Norian pelecypods have been collected above it. Its base is usually considered to be the Karnian-Norian boundary although a Karnian age for this horizon can not be excluded.

The most wide spread fossil plants in flora are *Asterotheca merianii, Paratatrina* sp. and especially *Pterophyllum jaegeri* and also *Glossophyllum ? spetsbergense*. Only in the upper assemblage are there members of Dipteridaceae. Also there are no narrow-leaved *Taeniopteris* in the flora. VASSILEVSKAJA (1972) points out a great similarity of the Karnian (or the Karnian-Norian) flora of Svalbard with the Karnian flora of Lunz (the Alps) and the Schilfsandstein flora of Basel (south of the German Basin). Simultaneously she summarized the difference of this flora from the Rhaetian (the Rhaeto-Liassic) floras of Central Europe, Sweden and Greenland.

VASSILEVSKAJA (1972) reports on a similar flora of the same age on Franz-Joseph Land (Zemlya Georga). It contains *Neocalamites merianii, Paratatarina, Pterophyllum, Glossophyllum* (?). In this article VASSILEVSKAJA gives her redeterminations of fossils based on the figures in the paper by NEWTON & TEAL (1897).

Besides the leaves, woods with indistinct annual rings were described from Svalbard (GOTHAN, 1910). They differ very much from the Jurassic and Tertiary woods from the same region in which annual rings are very clear.

Palynological assemblages were described from the Karnian and Norian deposits by KOROTKEVICH (1969).

Many occurences of tetrapods and fish are known from the Triassic of Svalbard. Classic localities occur in four horizons: Fish niveau or *Posidonia* niveau, niveau with *Grippia*, the Lower Saurian niveau and the Upper Saurian niveau. Recently new collections have been studied and new tetrapod horizons have been distinguished (COX & SMITH, 1973).

Summary

In summary, then, plant-bearing horizons comparable to those of the central part of the German Basin are known over a broad area where the German facies of the Triassic occur (which in this book is regarded as the margins of the German Basin). Correlatives of the Buntsandstein are the Olenekian-Anisian deposits of Spain, France, England, Poland, Bulgaria, Yugoslavia; correlatives of the Middle Keuper are the Karnian deposits of France; correlatives of the Rhaetkeuper are Norian-Rhaetian deposits of Sweden, Poland, England and France. Plant-bearing horizons of Middle Anisian and Karnian age exist in the Alps. Karnian plant-bearing horizons are also known in Svalbard and the Norian-Rhaetian horizons are known in Greenland.

Chapter two

European part of the USSR, Mangyshlak, the Eastern Urals

Triassic continental deposits (fig. 13) are widely spread in the European part of the USSR (DOBRUSKINA, 1985 b). They can be regarded as the continuation of the Western European German facies. The Alpine facies are developed in the area of Alpine orogeny in the Soviet Carpathians, the Crimea, the northern Caucasus. Triassic fossil plants are rarely found in these areas. In fact only one sporophyll of *Pleuromeia* is known from the Caucasus. A great thickness Triassic rocks have been discovered in wells in the Prikaspian depression, mostly in Predkavkazie and in the Dnjepro-Donets depression. These deposits consist predominantly of continental strata. Marine deposits occur only in the southern part of the region in the Prikaspian depression and eastern Predkavkazie. The marine deposits here represent the middle part of the Triassic which is only partly coeval with the Muschelkalk of Central Europe (MOVSHOVICH & KOZUR, 1975).

The Moscow syneclise

In the Moscow syneclise Lower Triassic rocks are chiefly developed. They are mostly referred to as the Vetluga series. In the southern part of the syneclise (the Upper Volga) fossil remains were collected from grey-coloured sandy-clay deposits of the Rybinsk Formation (DOBRUSKINA, 1985 b), which is a part of the upper subseries of the Vetluga series (fig. 14). Plants (list 29 a in the third part) occur in 15 boreholes, one outcrop on the right bank of the Volga and from the old foundation pit of "Volgastroy" which is now submerged by the Rybinsk reservoir. The Geological Institute collections contain more than 300 specimens of the lycopod *Pleuromeia rossica* (NEUBURG, 1960; DOBRUSKINA, 1974, 1982 b). It is now renamed to *Lycomeia rossica* – DOBRUSKINA, 1985 b). The collection also contains four specimens which belong to *Sphenobaiera, Elatocladus* and a fern (DOBRUSKINA, 1982 b, plate 1). They indicate that other plant asemblages existed here at the same time as the Pleuromeiaceae but that they have disappeared and were not included in the geological record. The remains of another lycopsid *Tomiostrobus* were found in two localities at Moscow syneclise: Koslan and Zheshard (list 29 b). The undeterminable remains of sphenopsids

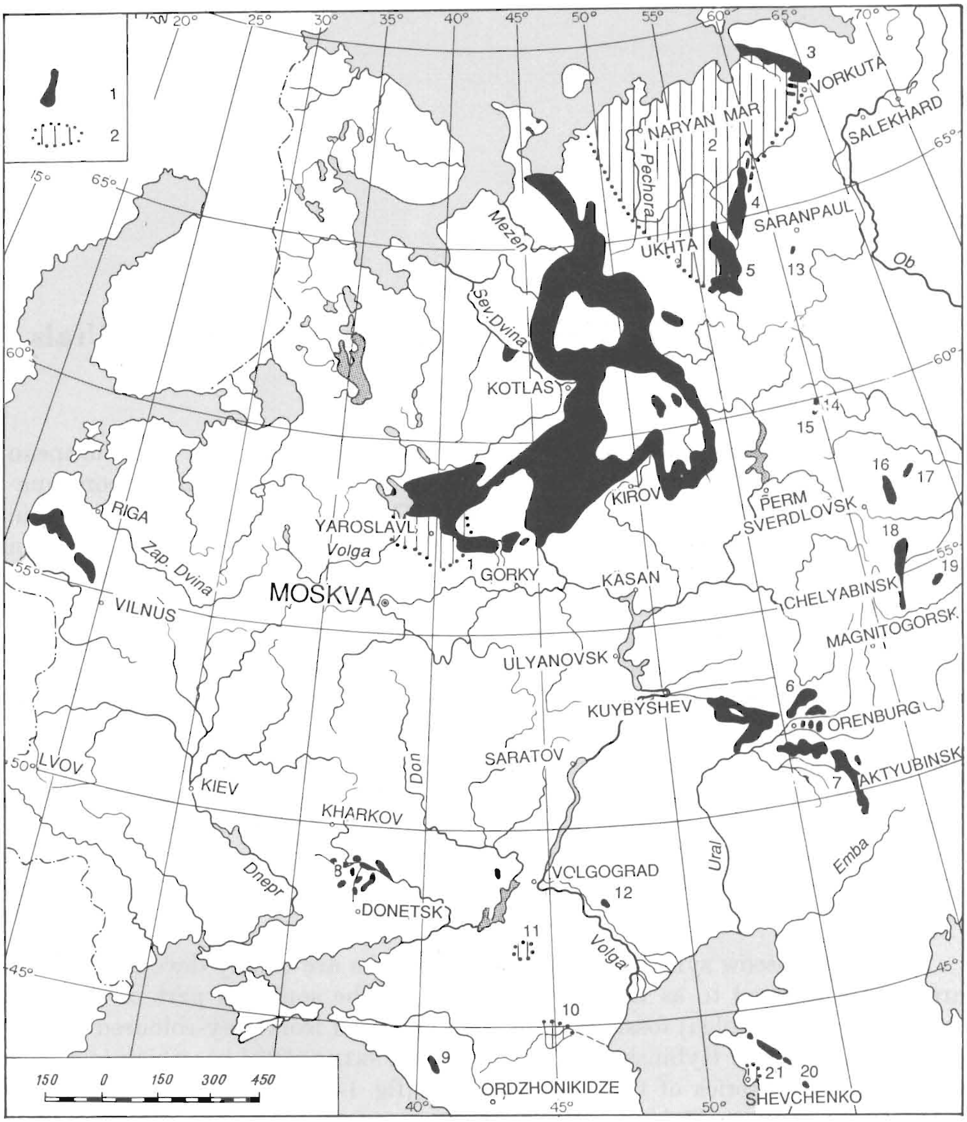


Fig. 13: Triassic deposits in the European part of the USSR, in the Urals and Mangyshlak (after Geological map of the Russian platform and its adjacent areas, 1965): 1 – exposures of the Triassic deposits (Triassic and Jurassic in the eastern Urals depressions); 2 – Triassic deposits with plant remains in boreholes. Ciphers in the map: 1 – upper raches of the Volga River, 2 – Pechora syneclise, 3 – Korotaikha Depression, 4 – Bolshaya Synya Depression, 5 – Upper Pechora Depression, 6 – Orenburg and Bashkiriya Priuralye, 7 – Aktyubinsk Priuralye, 8 – north-western margins of the Donbass, 9 – Northern Caucasus, 10 – Eastern Predkavkazye, 11 – Pricaspian Depression, borehole Sadovaya 1, 12 – Big Bogdo Mountain; 13–19 – Mesozoic depressions of the eastern slope of the Urals: 13 – Lyulino, 14 – Volchansk, 15 – Bogoslovsk and Veselovsk, 16 – Bulanash-Elkino, 17 – Anochino, 18 – Chelyabinsk, 19 – Yulamanovsk; 20–21 – Mangyshlak: 20 – Mountaneous Mangyshlak, 21 – Southern Mangyshlak.

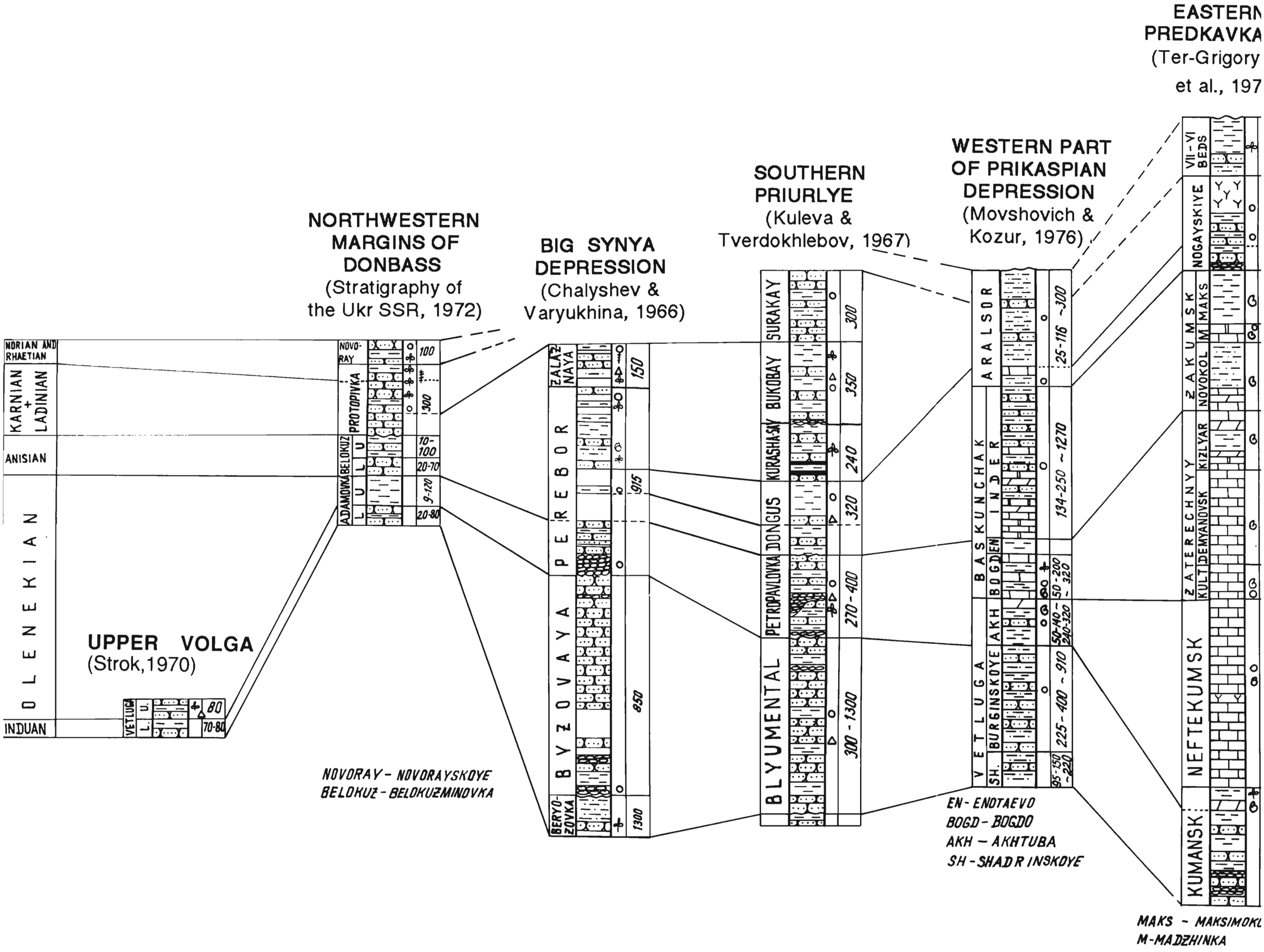
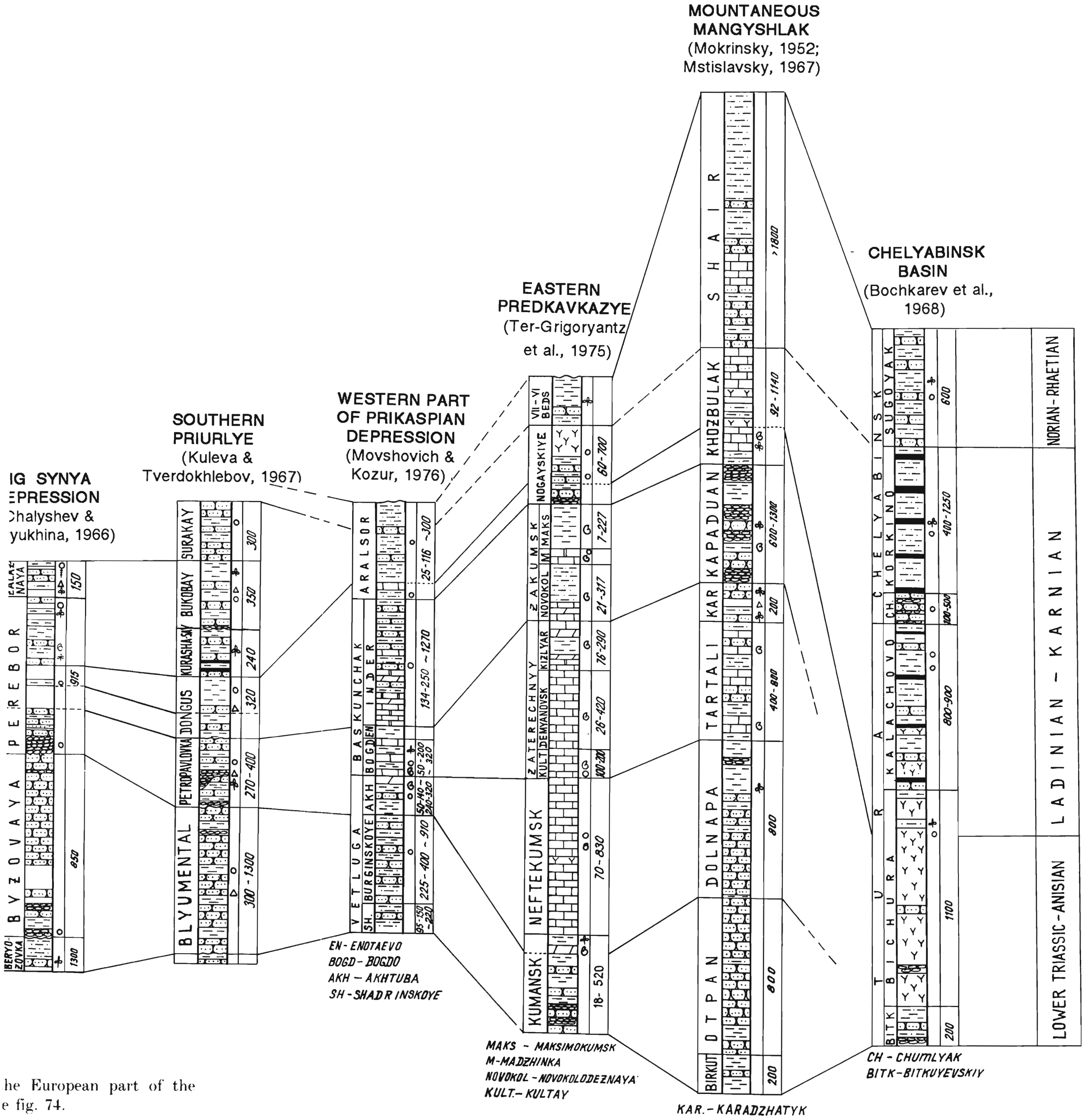


Fig. 14: Correlation of the Triassic plant-bearing beds of the European part of the USSR, Mangyshlak and the Eastern Urals. For the legend see fig. 74.



he European part of the
e fig. 74.

are found sporadically throughout the entire Triassic section of the Moscow syneclise.

The Rybinsk Formation is also characterized by remains of tetrapods and fish (SHISHKIN & OTSCHEV, 1967), ostracods (MISHINA, 1965) and palynological assemblages (KUNTZEL, 1965). Tetrapods of the Vetluga Series belong to the Neorachitome and *Tupilacosaurus* groups. LOZOVSKY ET AL. (1973) consider the upper part of the Vetluga Series of Moscow syneclise (including the Rybinsk Formation) to be Olenekian in age because similar tetrapods occur in rocks dated by marine invertebrates.

The Permo-Triassic boundary on the Eastern European platform is drawn at the first appearance of the Neorachitome fauna, which is correlated with the fauna of the *Lystrosaurus* zone of South Africa. This zone is usually considered to be the base of the Triassic although there is not enough data for correlation of its base with the base of *Otoceras* zone in the Himalayas (DOBRUSKINA, 1976 b). The tetrapod *Lystrosaurus* was first discovered on the Russian platform not long ago (KALANDADZE, 1975).

Novaya Zemlya and Franz-Joseph Land

During the last decade new findings of Triassic plants were made at the islands Novaya Zemlya and Franz-Joseph Land. At the Northern island of Novaya Zemlya (Admiralteystvo peninsula, bay Nivelir) lycopsids *Tomiostrobus* (list 31 d) were found in variegated deposits of the upper part of Admiralteysvo Formation 1260 m thickness of Lower Triassic age (VASSILEVSKAJA, 1984 a, 1984 b).

Ladinian-Karnian plants occur in the separated concretions of siderite. They are similar to those of Surakay Formation in Southern Priuralye. Plant assemblages are also similar. In two concretions at the Northern Island (bay Krestovaya) VASSILEVSKAJA (1983 a, 1984 a, 1984 b, 1985) determined *Equisetites* sp., *Neocalamites* sp., *Phlebopteris* sp., *Cladophlebis (Asterotheca ?)* sp., *Cladophlebis* cf. *yanschinii, Scytophyllum* sp., *Anomozamites* (?) *anomalis, Macrptaeniopteris novosemelica, Taeniopteris kryshtofovichii, Taeniopteris* cf. *tenuinervis, Cycadolepis* (?) sp., *Drepanozamites (?) ambiquus, Putyospermum* sp., *Yuccites novosemelicus, Desmiophyllum variabile, Phyllites cordaitaeformis* (for described or figured species see list 32 b). At the Southern Island (peninsula Britvin, the Britvinka River) VASSILEVSKAJA (1983 a, 1984 a, 1984 b, 1985) determined *Equisetites tcherkesovii, Asterotheca* cf. *merianii, Sphenopteris* sp., Scytophyllum sp., *Taeniopteris* ex gr. *ensis, Yuccites (?)* sp., *Desmiophyllum variabile.*

At the **Franz-Joseph Land** fossil plants were known from the end of last century. NEWZON & TEAL (1897) described them as Permian and NATHORST in 1900–1901 considered them Rhaetian (VASSILEVSKAJA (1972, 1985). They occured in cape Stephan at the southern part of the island Zemlya Georga. VASSILEVSKAJA considered according pictures that there were *Neocalamites merianii, Paratatarina, Pterophyllum* and *Glossophyllum.*

Beginning from the fifties Triassic plants were found also at other islands of archipelago (VASSILEVSKAJA, 1985). VASSILEVSKAJA determined *Neocalamites* sp. from the islands Viner-Neistadt and Cheiss, *Equisetites* sp. at the Big Komsomolskyy island. At the island Greem Bell in the Upper Triassic brown ferruginate sandstone she found *Neocalamites* sp., *Equisetites tcherkesovii,* Arthropsida, ferns of Dipteridaceae, *Carpolithes.* In borehole "Severnaya", depth 949–951 m (island Greem Bell) the same author determined *Neocalamites* sp., *Asterotheca* aff. *merianii, Cladophlebis* sp. and at the depth of 1411 m *Strobilites* sp. cf. *Voltzia novomundensis.* Plants-bearing layers occur between the layers with Early Karnian *Halobia korkodonica* POLUB. and Early Norian *Pterosirenites* sp. indet. and *Halobia* ex gr. *aotii* KOB. & ICHIKAWA. In the borehole Cheiss, depth 2389 (island Cheiss) *Schizoneura* cf. *grandifolia* and *Tomiostrobus* sp. occur with the Ladinaian fauna and at the depth of 740–780 m – *Neocalamites* sp., *Equisetites* sp., *Dictyophyllum* sp., *Glossophyllum* (?) sp., *Carpolithes* sp. The last assemblage after Vassilevskaja is coeval to the Karnian assemblage from the Greem Bell island. For described and figured species see list 332 d and 32 e.

The Donets Basin

Triassic deposits with plant remains are also known from the northwestern margins of the Donets Basin south of Kharkov. At this locality plant remains (list 30) are confined to the upper part of the variegated Protopivka Formation and the grey-coloured Novorayskoe Formation (fig. 14). The Novorayskoe Formation lies on the Protopivka Formation without break but the latter one is separated from the underlying red-coloured deposits by an unconformity.

The oldest Triassic flora in the Donets Basin comes from the gully Dubovaya near the village Nikolaevka (fig. 15). According to the data of STANISLAVSKY (1976) it consists of new species except for three forms. *Glossophyllum* dominates in this assemblage. This genus supposedly represents an old group of ginkgophytes. *Podozamites guttiformis* (conifer) is the second most common form and *Desmiophyllum acuminata* (ginkgophyte?) is the third. There are many peltasperms and some cycadophytes in the flora. STANISLAVSKY (1976) considers the Nikolaevka flora to be Early Noraian in age, however a number of common and close species allows its correlation with the Middle Karnian flora of the German Basin.

Lepidopteris, *Podozamites*, *Cycadocarpidium* with three seeds and *Borysthenia* dominate in the Garazhovka flora according to STANISLAVSKY (1976). There are also a few sphenopsids, ferns and ginkgophytes in this flora but no cycadophytes. The Garazhovka flora has no species in common with the underlying Nikolaevka flora. The Garazhovka flora although much richer has more in common with the younger Novorayskoe flora. Besides, there is another correlation of different plant groups in it. The presence of the Dipteridaceae in the flora is

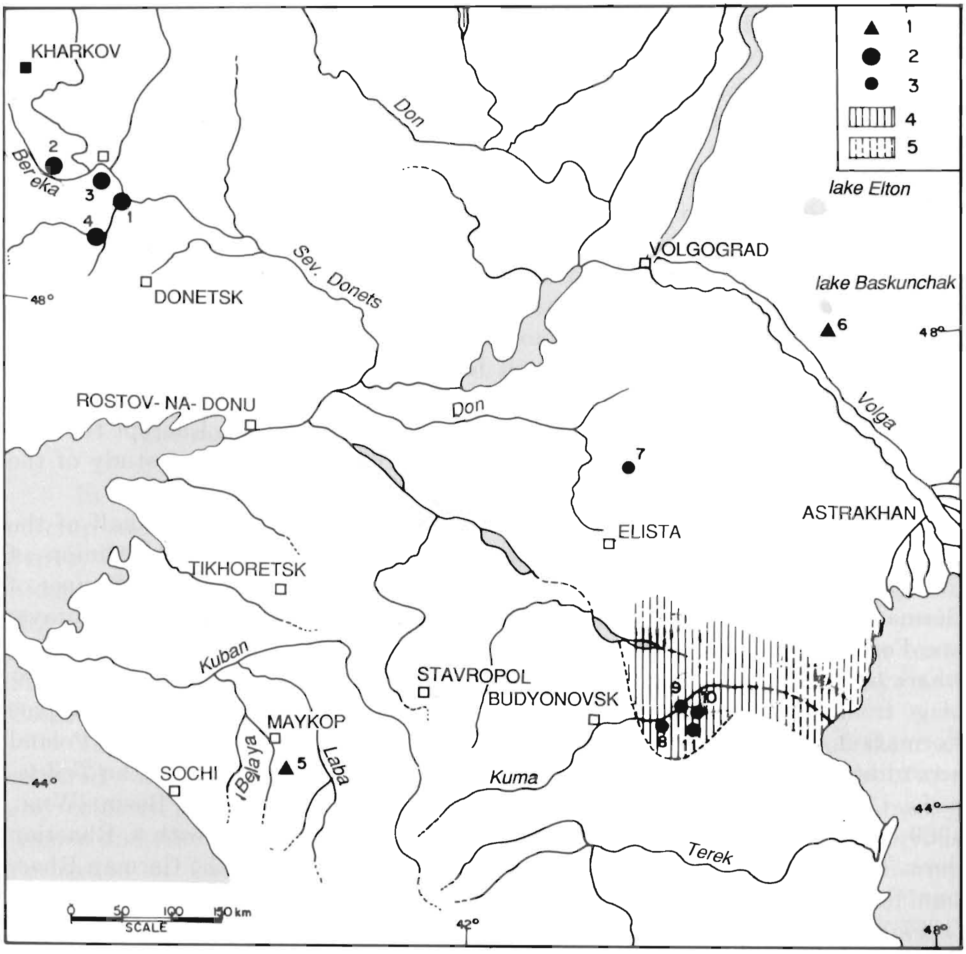


Fig. 15: Localities of the Triassic plants in the south of the European part of the USSR: 1 – the first half of the Triassic; 2 – the second half of the Triassic; 3 – boreholes with Triassic deposits with Pleuromeia ; 4 – distribution of the Upper Triassic plant-bearing beds in Stavropol Kray (after ZHATKOVA); 5 – possible analogs of these beds in Kalmyk and Dagestan.
Ciphers in the map: 1 – Nikolayevka; 2 – Garazhovka; 3 – Kamenka; 4 – Rayskoye; 5 – gully Svinachya; 6 – Mount Big Bogdo; 7 – borehole Sadovaya 1; 8 – Neftekumskaya area; 9 – Pravoberezhnaya area; 10 – Zimnyaya Stavka area; 11 – Molodyezhnaya area.

the only feature which brings it closer to the Middle Keuper floras of Western Europe. STANISLAVSKY (1976) considers the Garazhovka flora to be Late Norian, because it lies under Novorayskoe Rhaetian flora. Taking into account new data about the age of the European "Rhaetian" flora (i. e. that it begins from the Middle Norian) the Garazhovka flora seems to be more ancient – Early Norian or Late Karnian (DOBRUSKINA, 1977 a). The flora from Sukhaya Kamenka known up to now only by lists in geological papers is situated between the Garazhovka flora and the Novorayskoe flora in the uppermost part of the Protopivka Formation.

The Novorayskoe flora, like the Garazhovka flora, is characterized by a dominance of Dipteridaceae and the Osmundaceae, cycadophytes and ginkgophytes. The importance of pteridosperms is much less, and the three seed *Cycadocarpidium* is absent. In addition to the species typical of the Rhaetian deposits of Western Europe species known only from the Liassic are present in the Novorayskoe flora. It was the reason for a discussion (LAPKIN ET AL., 1975) about the Liassic (point of view of PRYNADA, MIGACHEVA, STERLIN) or the Rhaetian (STANISLAVSKY) age of the Novorayskoe Formation. I accept the conclusion of STANISLAVSKY (1971) which is based on a monographic study of the Novorayskoe flora.

Palynological assemblages have been studied from the upper half of the Protopivka Formation and the Novorayskoe Formation. In the opinion of SEMENOVA (1973) there is only a single species from the upper Middle Keuper of Germany in the upper part of the Protopivka Formation; and in the Novorayskoe Formation there are many miospores typical of the Rhaetian of Germany, where they are guide forms. These forms differentiate the Novorayskoe assemblage from the Liassic assemblages of Germany. In her opinion the Novorayskoe Formation is also well correlated with the Velekhovo beds of Western Poland according to palynological data. The Velekhovo beds correspond to the *Triletes* beds, i. e the very upper level of the Rhaetian in the German Basin (WILL, 1969), which is situated in Germany above the *Contorta* beds with a Rhaetian flora. Thus, the Novorayskoe flora evidently is younger than the German Rhaetian flora and corresponds to the *Equisetites gracilis* zone of Sweden. KOPIK (1967) correlated *Triletes* beds of Germany with the *Equisetites gracilis* zone of Sweden and Velekhovo beds of the Liassic. Without discussing the possibility of changing the position of the Triassic-Jurassic boundary I can only say that in this book all above named levels are considered to be Late Triassic in age.

According to the data of GLUZBAR (1973) three palynological assemblages are present in Novorayskoe Formation and two are present in the upper Protopivka Formation. This palynologist also refers the Novorayskoe Formation to the Rhaetian and the upper half of the Protopivka Formation to the Middle Keuper of the German Basin. In other words palynological data suggest a Karnian age for the plant-bearing beds of Nikolaevka and Garazhovka.

SAIDAKOVSKY (1971 a, 1971 b) has studied charophytes over the entire Triassic section of the south of the European part of the USSR. He determined that the charophytes of zone III are present in the upper Adamovka Subformation which allowed correlation with the Bogdo Formation of the Prikaspian depression (the Olenekian stage). Charophyta of the Lower Belokuzminovka Subformation are correlated by him with the charophyta of the Anisian stage of Bulgaria. The charophyta of the upper Belokuzminovka Subformation are regarded as Ladinian in age. At first Saidakovsky referred the upper half of the Protopivka Formation to the Rhaetian (charophyta zone VII based on the agglomerate loam of the Sukhaya Kamenka gully). Later the agglomerate loam was included in the Novorayskoe Formation which is why the zone VII with its Rhaetian age characterizes the Novorayskoe Formation. This change resulted in a change of the age determination of the upper half of the Protopivka Formation. The upper part of the Protopivka Formation is included in the poorly characterized now zone VI. SAIDAKOVSKY correlates zone VI with the Early and Middle Keuper meaning that the age of zone VI is Ladinian-Karnian (not Karnian-Norian).

The north-eastern part of the Eastern-European Platform

In the north-eastern part of the Eastern-European Platform the Triassic outcrop areas occur in the Fore-Urals Depression (the Upper Pechora, Big Synya, Kosyu-Rogovo and Khorotaikha depressions and the Chernyshov Ridge). Numerous borings have been drilled in the Pechora syneclise (fig. 16). Here the Triassic deposits are represented principally by red-coloured rocks among which there are rare thin beds of greenish-grey rocks in the lower part. These strata are referred to as the Byzovaya Formation or the Byzovaya and Ustberezovka Formations.

Variegated deposits lie above them and in it; the amount of the red-coloured rocks is also great especially in the lower part; and the role of the grey-coloured rocks is also insignificant. These strata are referred to as Krasnyy Kamen and Above-Krasnyy Kamen Formations of GORSKY (1960), the Perebor Formation of CHALYSHEV (CHALYSHEV & VARUKHINA, 1966), the Krasnyy Kamen Formation including lower red-coloured and and upper variegated Members and Perebor beds of ENTSOVA and KALANTAR (1974), the Perebor Formation and the lower part of the Big Synya Formation of CHRAMOVA (1974). At the top of the sequence lie grey-coloured sandy-shale deposits assigned to the Synya Formation of GORSKY (1960), the Zalaznaya Formation of CHALYSHEV (CHALYSHEV & VARUKHINA, 1966), the Big Synya Formation of ENTSOVA and KALANTAR (1976), the upper part of the Big Synya Formation of CHRAMOVA (1974). The thickness of all formations and the quantity of coarse clastic rocks increases eastward-towards the Urals.

In fig. 14 the Triassic section of the northeast of the European part of the USSR is represented by the section along the Big Synya River because it is the best one. It is derived from the original subdivisions by CHALYSHEV who was the first to publish it and the majority of specimens in the Geological Institute were collected by him and can be shown very exactly in this section.

Correlation of the stratigraphical scheme of **Chalyshev** with the schemes of other authors is carefully discussed in the papers by **Chramova** (1977) and **Kalantar** (1976). According to the findings of **Kalantar** (1976) the Naryan-Mar Formation of the Pechora syneclise corresponds to the Big Synya Formation of the northern part of the Fore-Urals depression; the Shapkina Formation with the Variegated and red-coloured Members, the Krasnyy Kamen Formation with its equivalents, the Charkabozh Formation with the Byzovaya and Ustberezovka Formations. Palaebotanical data does not contradict these interpreta-

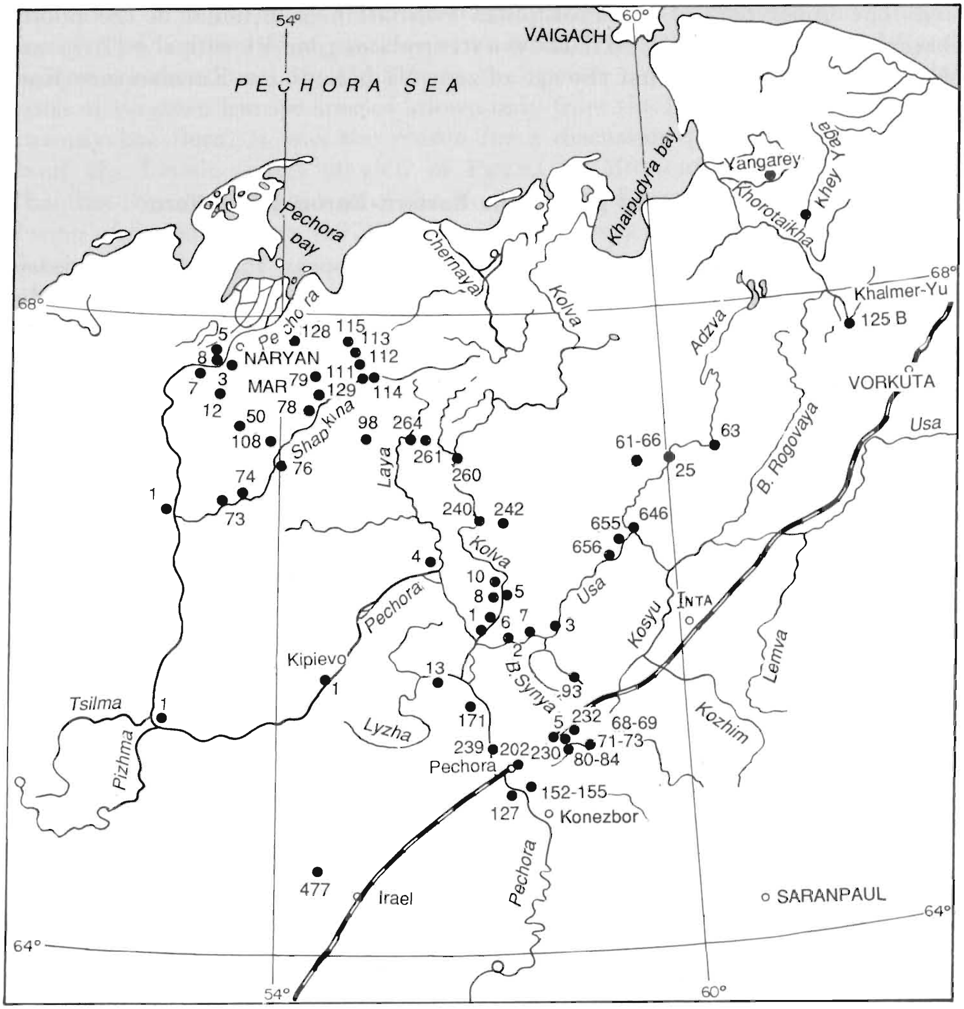


Fig. 16: Localities of the Triassic plants in the Pechora Basin. Ciphers in the map are numbers of boreholes.

tions but unfortunately either add anything new to the suggested correlation because the changes in the plant assemblages are insignificant.

A few plant remains are known in the lower part of the Triassic deposits (list 31) as well as from the iseland Novaya Zemlya (list 31 e). The majority of plant remains came from the upper part of the sequence from the grey-coloured and variegated deposits (list 32 and 33). The grey-coloured deposits of the Big Synya depression and the Pechora syneclise are especially rich in plants. Fewer plants were collected in the Korotaikha depression and are poorly preserved.

Pseudoaraucarites gorskii (Vladimirovich et al., 1967), now *Tomiostrobus gorskii* (Sadovnikov, 1982 a) was described from the lower part of the sequence – from Ust-Berezovka Formation of the right bank of the Pechora River near the village Byzovaya and from the Adzva River. Similar imprints and also *Glossophyllum* ? sp. are present in the collections of the Geological Institute (see list 31) and have been also described by Fefilova (1983) from the same locality. The third locality with *Tomiostrobus* in this region is the borehole Kush-Shor.

Plant remains from the upper part of the sequence were studied originally by Neuburg (1959) who was the first to recognize their Triassic age. Then Chramova (1973, 1977), Pavlov (Chramova & Pavlov, 1971) and I worked on the flora (Dobruskina, 1969, 1980). I had at my disposal about 1500 specimens in addition to dipersed phytoleims from the basins of the Pechora and Khei-Yaga Rivers, which were collected by Chalyshev, Entsova, Kalantar, Abramov and Khaizer.

Pteridosperms (chiefly Peltaspermaceae) and ginkgophytes (Glossophyllaceae) comprise the majority of the plant assemblages and include approximately half of all studied imprints. There are many sphenophytes but they are undeterminable. A few are ferns and there are quite a few cycadophytes and conifers.

The flora of the upper part of the Triassic section of the Pechora Basin can be regarded as an undivisible assemblage. Attempts to recognize vertical changes in it (between the variegated and grey-coloured deposits) as well as over the Big Synya and the Pechora syneclise show only insignificant differences.

The floras of the Pechora Basin are similar to the Lower and Middle Keuper floras of Western Europe in composition, especially the Marattiaceae, ginkgophytes and conifers. The absence of the Dipteridaceae makes them even more similar to the Lower Keuper (the Ladinian) floras and differentiates them from the Middle Keuper (the Karnian) ones. For example, the similarity with the Donbass flora (the Nikolaevka flora and the Garazhovka flora) consists only of a large number of peltaspermous pteridosperms. The difference in turn consists of the presence in Garazhovka flora of the Dipteridaceae, abundant Cycadocarpidiaceae and of the absence of cycadophytes. Plant remains in the Pechora Basin do not indicate the presence of any Norian-Rhaetian deposits.

Chalyshev (Chalyshev & Varukhina, 1966) based on the occurence of pelecypods, genus *Gervillia* in the lower part of the plant-bearing beds concluded about the Lower Triassic (Olenekian) age. Kalantar (1976) determined the age of the plant-bearing beds to be from the Anisian to Norian stages. CHRAMOVA (1974) considered them to be Karnian. In all cases the conclusions were confirmed by following palynologists: VARUKHINA (CHALYSHEV & VARUKHINA, 1966), GOLUBEVA (KALANTAR, 1976), KULIKOVA (CHRAMOVA, 1974). The stratigraphic significance of the pelecypod *Gervillia* can not be used to determine the exact age, especially since they are only tentatively identified and in addition poorly preserved.

The discovery of the labirinthodont *Heptasaurus* sp.in the Upper Khey-Yaga Series of the Korotaikha depression below all the plant localities is very interesting. This genus had been known only from the Upper Buntsandstein of Anisian age in the Sud Deutsche Senke. SHISHKIN and OCHEV (1967) believe that it corresponds approximately in age with the Middle Triassic (Anisian) *Eryosuchus* fauna of the southern Fore-Urals.

The southern Fore-Urals

In the southern Fore-Urals Triassic outcrops occur along the rivers Ilek, Ural, Sakmara, Belaya from were they pass to the hills of Obchshiy Syrt and to outcrops along the rivers Samara, Kinel and Sok. The lower part of the section – the Blumental and Petropavlovka Formations – consists of coarse clastic deposits, conglomerate and pebble beds with clay interlayers (see fig. 14). It is characterized by the Neorachitome tetrapod fauna and the *Paratosuchus* tetrapod fauna. In the Petropavlovka Formation near the village Petropavlovka (fig. 17) some plant remains were collected (list 34). They are *Equisetites* sp., *Neocalamites* sp., *Voltzia heterophylla, Carpolithes* sp. (author's determinations). The middle part of the section – the Donguz Formation – lies conformably on the lower part and does not contain plants. It consists of clays and shales with some interlayers of sand and sandstone and is characterized by *Eryosuchus* tetrapod fauna.

The Kurashasay Formation of the Aktubinsk Fore-Urals lies above the Donguz Formation also conformably and consists of interbeds of light grey-coloured sands, variegated and grey-coloured clays with interlayers and lenses of brown coal. Its plant remains were described by BRICK (1952) and partly by the author using the collections of LIPATOVA and LOPATO (DOBRUSKINA, 1969, 1975, 1980). The Bukobay Formation lies above Kurashasay Formation with erosional disconformity; it has pebble beds in the base and consists of sandstone interlayers and lenses in the lower part and of variegated clays with the *Mastodonsurus* tetrapod fauna and fossil plants in the upper part (BRICK, 1952). The uppermost part of the section here is the Surakay Formation which lies on the Bukobay Formation with erosional unconformity. The Surakay Formation consists of light grey-coloured conglomeratic sandstone.

Here we have a nomenclature problem. The name "Bukobay" Formation is used in only one part of the Orenburg Fore-Urals: in the vicinity of the type section (ravine Bukobay and river Burtya). The same deposits are called

"Kurayli Formation" in the adjacent Ilek Basin. When Brick (1952, p. 8) indicated embedding variegated clays as "the lower part of the Kurayli Formation" she spoke about the same beds which are called in this book "variegated clays of the Bukobay Formation". The different names for the same rocks have historical reasons (see Dobruskina, 1980, p. 37), but their coevality is certain. Thus it is better not to use the old name "Kurayli Formation" for the variegated clays that contain plant remains in the Ilek River Basin. Brick mentioned *Yuccites uralensis* from the uppermost part of our Bukobay Formation from Terensay but did not figure the fossil.

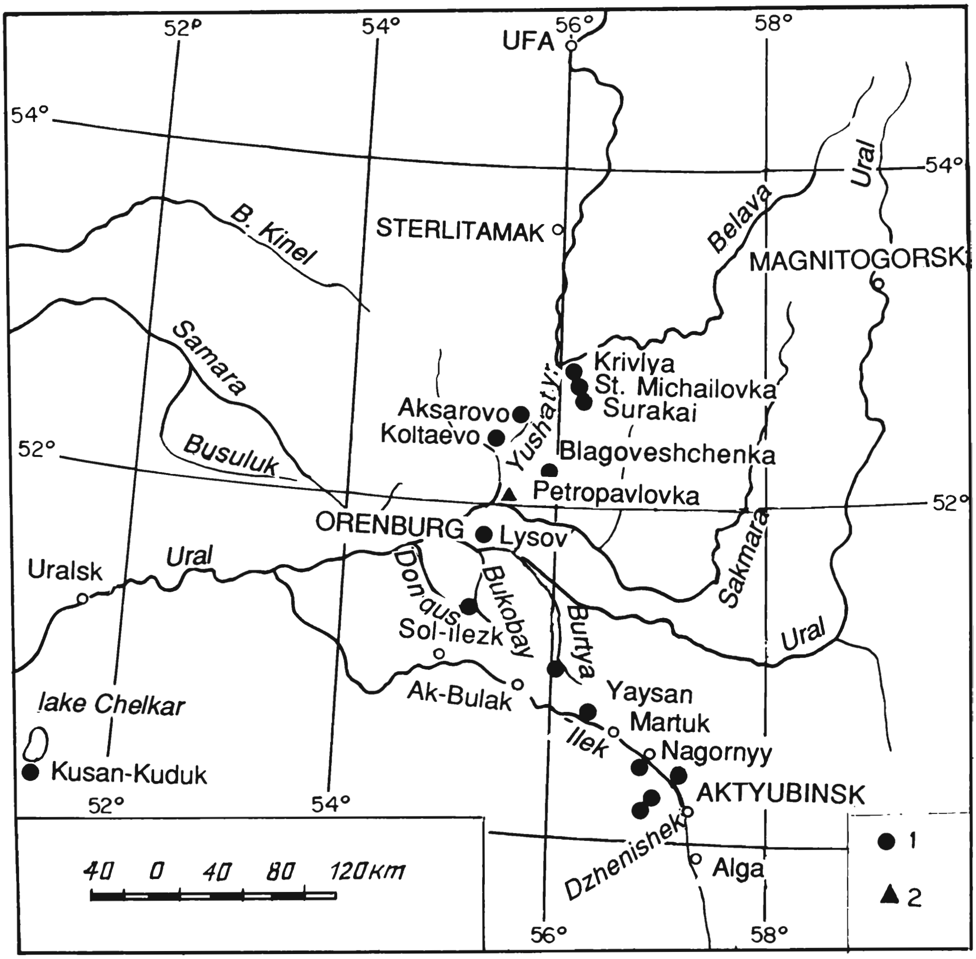


Fig. 17: Localities of the Triassic plants in the Southern Priuralye:
1 – of the first half of the Triassic; 2 – of the second half of the Triassic.

Thus, the stratigraphic position of the Triassic plant localities in the Ilek Basin and in the country between the rivers Ilek and Ural can be considered clear. The position in the sequence of the old localities (Koltayevo, Aksarovo, Krivlya, Staro-Mikhaylovka, Surakay) situated over the country between the rivers Sakmara and Belaya is not clear however. Contradictory opinions have been made about their age in the literature. At the locality Koltayevo plant remains were collected together with the *Mastodonsaurus* fauna and the locality is now referred to as the Bukobay Formation. The localities Aksarovo and Krivlya are situated in the isolated blocks and their stratigraphic position is unclear. The deposits of Staro-Mikhaylovka and Surakay were considered to occupy a higher stratigraphic position than the deposits with the *Mastodonsurus* fauna and they were assigned to the Surakay Formation. However palynological studies of MAKAROVA (in: TVERDOKHLEBOV & MAKAROVA, 1976) showed that the so-called SURAKAY formation contains palynological assemblages similar to those of the Donguz and Bukobay Formations and also younger assemblages. Beds with plant remains from Surakay, Staro-Mikhaylovka, Khutor Lysov and boring 53 – Blagovechshenka are now referred to the Bukobay Formation.

The Triassic flora of the southern Fore-Urals was studied by BRICK (1952), ZALESSKY (1936), PRYNADA (OSNOVY PALEONTOLOGII . . ., 1963), PRYNADA and TURUTANOVA-KETOVA (1962), VLADIMIROVICH (1972) – list 35. I have studied all available materials on the fossil floras of the region including the collections of the Geological Institute of the USSR Academy of Sciences in Moscow, the CHERNYSHOV Museum in Leningrad and the Museum in the Botanical Institute of the USSR Academy of Sciences in Leningrad (list 36). The assemblages themselves do not indicate which of the localities are younger and which are older. Difference to all appearance are related to varietes of species and all of these above named floras should be regarded as a single plant assemblage.

In the southern Fore-Urals plant assemblage the gonkgophytes dominate. The sphenopsids, ferns and pteridosperms are approximately in equal portions. There are fewer cycadophytes and conifers. The percentage of the main groups of plants are very close to these of the Pechora Basin. The composition of the plant assemblages of these two regions is very close. The only serious difference is the abundance (in great numbers) of *Kalantarium* (DOBRUSKINA, 1980) in the north and its complete absence in the south of the Fore-Urals. The fact that the floras of the southern and northern Fore-Urals are very similar and yet very different from other floras testifies to their coevality with the limits of the Ladinian-Karnian.

Many tetrapod fossils were collected from the Upper Permian and the Triassic deposits of the southern Fore – Urals and the terrritory of the Obchshiy Syrt. They were first studied by Efremov and VYUSHKOV (1949, 1956) and recently by SHISHKIN and OTSCHEV (1967). They have studied the distribution of the tetrapod remains over the section and area, determined the sequence of the faunas and faunistic grouping and correlated them with faunas of other parts of the East European platform and German Basin (chart 7) and also with

Chart 7: Correlation of Triassic deposits of the European part of the USSR and German Basin according tetrapods (after Shishkin & Ochev, 1967 with additions of Lozovsky et al., 1973 and Chudinov & Ochev, 1975)

<table>
<tr><th rowspan="2">Age</th><th rowspan="2" colspan="2">Succesion of tetrapod faunas</th><th colspan="2">Moscow syneclise</th><th rowspan="2">Obshchy Syrt (Blom, 1966, 1969)</th><th rowspan="2" colspan="2">Southern Priuralye (Ochev et al., 1964; Tverdokhlebov, 1970)</th><th rowspan="2">German Basin</th></tr>
<tr><th>West (Strok, 1970)</th><th>East (Lozovsky, 1969)</th></tr>
<tr><td>Rhaetian
Norian
Karnian</td><td colspan="2">Dinosaurus</td><td></td><td></td><td></td><td colspan="2"></td><td>Upper Keuper
Middle Keuper</td></tr>
<tr><td>Upper Ladinian</td><td colspan="2">Mastodonsaurus</td><td></td><td></td><td></td><td colspan="2">Bukobay Fm.
Kurashasay Fm.</td><td>Lower Keuper</td></tr>
<tr><td>Lower Ladinian</td><td colspan="2">Eryosuchus</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2" colspan="2">Donguz Fm.</td><td>Muschelkalk</td></tr>
<tr><td>Anisian</td><td colspan="2">Geptasaurus</td><td>Upper Buntsandstein</td></tr>
<tr><td rowspan="2">Olenekian</td><td colspan="2">Parotosuchus</td><td></td><td>Gam horizon
Federovka horizon</td><td></td><td colspan="2">Petropavlovka Fm.</td><td>Middle Buntsandstein</td></tr>
<tr><td rowspan="2">Neorachitomus</td><td>Vetlugasaurus</td><td>Bereznikovka beds
Yuryevets Fm.
Rybinsk Fm.</td><td>Vakhnevo horizon</td><td>Romashkino Fm.
Tananyk Fm.</td><td rowspan="2">Blyumental Fm.</td><td>Kzylsay Fm.
Staritsa horizon</td><td rowspan="2">Lower Buntsandstein</td></tr>
<tr><td>Indus</td><td>Tupilacosaurus</td><td>Lower subseries of Vetluga series</td><td>Vokhmino horizon</td><td>Buzuluk Fm.</td><td>Kopansk horizon</td></tr>
</table>

southern Africa. According to their data the Bukobay Formation with the remains of *Mastodonsaurus* correlates with the Lower Keuper of the German Basin, i. e. it is Ladinian. MOVSHOVICH (1980) considers the lower part of Surakay Formation to compare with the boundary horizons of the Anisian and Ladinian.

The Pricaspian Depression

To the southwest, in the Pricaspian Depression the remains of the lycopsid *Pleuromeia sternbergii* were found at Big Bogdo mountain (DOBRUSKINA, 1974, 1982 b) in the Bogdo Formation of Olenekian age (list 40 a) and in its equivalents in the western part of the Pricaspian depression in the boring Sadovaya I (list 40 b) at a depth of 3893–3900 m (see fig. 13, 14). In the Aralsor Formation KUKHTINOV has found a piece of the fern *Clathropteris meniscoides* with unusual small netted venetaion (list 41). It occurs in the northern part of the Pricaspian depression on the left bank of the Ural river to the south of lake Chelkar in the boring Kusan-Kuduk II-36 at a depth 2333–2338 m (see fig. 15). This species is known in the Upper Triassic and the Liassic.

KOZUR (in: MOVSHOVICH & KOZUR, 1975) has studied the megaspores in the *Gemmanella* beds. The flora includes two new genera and a new species of *Bacutriletes* and *Nathorstisporites* (KOZUR & MOVSHOVICH, 1976 a). Dispersed megaspores of *Pleuromeia* were recognized in the Bogdo and Enotaevsk Formations by MOVSHOVICH (1977). Conodont elements have also been figured from the Bogdo Formation (KOZUR & MOVSHOVICH, 1976 b).

The Eastern Predkavkazye (Fore-Caucasus)

In the eastern Predkavkazye (Fore-Caucasus) the Triassic plants came from the upper part of the variegated Kumansk Formation (see fig. 14) which lies on metamorphic rocks that are possibly of Carboniferous age. They have also been collected from the grey-coloured rocks of beds VII and VI of the local oil nomenclature which lie on the volcano-sedimentary Nogayskaya Formation and on older deposits. Carbonate deposits of the Neftekumsk Formation and the Zaterechnyy Series (with limestone interlayers) and volcano-sedimentary deposits of the Nogayskaya Formation are situated between two plant-bearing horizons in the Eastern Predkavkazye. The middle part of the section contains different amount of carbonate rocks rich with marine invertebrates which indicate that rocks are of Olenekian and Anisian age.

The greatest controversies between different authors concern the age of the Kumansk and Nogayskaya Formations. Remains of *Pleuromeia sternbergii* (DOBRUSKINA, 1977 c, 1982 b) were found in five borings in the Upper Kumansk Formation (list 37). Pelecypods and brachiopods found in the same horizon or lower were determined by some palaeontologists to be Late Permian in age and by others as Early Triassic. These invertebrates, however, are very poorly preserved. Furthermore pelecypods and brachiopods from the end of the Permian and the beginning of the Triassic are so similar that their differentiation is practically impossible (see DOBRUSKINA, 1977 b). In addition Lower Triassic faunas are so poorly known on the whole that there is little to compare new discoveries with. On the other hand the genus *Pleuromeia* has distinct features and occurs in the upper part of the Kumansk Formation in all borings, i. e. at the same stratigraphic level. This genus has wide geographic distribution over Eurasia from Western Europe up to Japan and the mouth of the Olenek. It is found in great quantities and in most localities, it associates with ammonoideas of Olenekian and Anisian age. Its presence indicates a Triassic age for the upper part of the Kumansk Formation of Eastern Predkavkazye.

The grey-coloured deposits of beds VII and VI were considered to be Early and Middle Jurassic in age untill recently because the dominant plant fossils that were known at the time were forms that had a wide distribution in the Upper Triassic and the Middle Jurassic. This was changed by the discovery by ZHATKOVA of plant fossils which are not known in the Jurassic (VAKHRAMEEV ET AL., 1977; VAKHRAMEEV ET AL., 1983). Among them there are: *Asterotheca merianii, Danaeopsis fecunda, Dictyophyllum exile, Lepidopteris toretziensis, Pterophyllum brevipenne, Cycadocarpidium swabii* and so on (list 38). Analysis of the stratigraphic distribution of the fossil plant species made by VAKHRAMEEV and the author showed that the flora of Predkavkazie was most similar to the flora of the Novorayskoe Formation of the Donets Basin and the Dakhrud Formation of central Iran. Palynological data of YAROSHENKO (VAKHRAMEEV ET AL., 1977) confirm the Norian-Rhaetian age of beds VII and VI.

The age of the Nogayskiye Series which underlies beds VII and VI must also be revised. Apparently it has to be considered as Middle or Late Triassic age (older than the Norian). According to the data of Movshovich Lower Anisian ostracods occur in the lower part of the Nogayskiye Series in Kalmyk.

The Northern Caucasus

In the Northern Caucasus a sporophyll of *Pleuromeia sternbergii* (list 39) was found in the Lower Triassic deposits in the Belaya River Basin. Miospores from the Triassic deposits of the Western Caucasus were studied by YAROSHENKO (1978).

Mangyshlak

Pleuromeia sternbergii was also found from numerous localities in Mountaneous Mangyshlak (list 42 a) and in the borehole Rakushechnaya (in the city Shevchenko) at a depth of 3750–3753 m in Southern Mangyshlak (list 42 b) (see fig. 13). In the Mountaneous Mangyshlak section this lycopsid is found in the upper part of the Dolnapa Formation, in the Tartali, Karadzhatyk and Karaduan Formations and in the lower part of the Khozbulak Formation (DOBRUSKINA, 1974, 1982 b).

The Tartali and Karadzhatyk Formations contain a large number of ammonoids of the *Ovenites* and *Stacheites* zones of the Olenekian stage. In the Karaduan Formation only poorly preserved pelecypods occur and they cannot be used to determine its age with assurance. Pelecypods of the Khozbulak Formation (also poorly preserved) were determined with **cf., aff., sp.** Earlier they were considered to be of Karnian age. However, their preservation does not allow the exact age determination. The presence of such "Karnian" pelecypods in the Anisian of northeastern Boulgaria (OLFERYEV, 1976) confirms my opinion (DOBRUSKINA, 1974) about the Anisian age of the lower part of the Khozbulak Formation. The discovery of Upper Anisian pelecypods in the *Gemmanella* beds of the Prikaspian depression (MOVSHOVICH & KOZUR, 1975) which are correlated with the lower part of the Khozbulak Formation (MOVSHOVIOCH 1975) may also be considered to be an indirect confirmation of this opinion.

The upper part of the Dolnapa Formation is referred to the Olenekian for the same reasons. There are no certain data on the Permian age of the Dolnapa Formation. LEVENKO (1966) mentioned lycopsids from very base of the sequence in the Mountaneous Mangyshlak but these determinations were disproved by MEYEN (personal communication) who had seen these specimens and considered them undeterminable. VINYUKOV (1963) mentioned ostracods from the Dolnapa Formation, but dominants belong to genera which are now also known in the Triassic. The Dolnapa Formation as well as the Otpan Formation and Birkuta Formation were originally considered Permian in age without any proof. The only reason was that the formations of the upper part of the Mangyshlak sequence contained marine fauna of Triassic age were referred to as the Triassic while the underlying deposits (without fauna) were referred to as the Permian. The discovery of *Pleuromeia sternbergii* is the most important evidence for the age of Dolnapa Formation (DOBRUSKINA, 1974). At least its upper part belongs to the Olenekian. Conchostracan fauna from these deposits (MOLIN, 1965) confirms this opinion.

The eastern slope of the Urals

Along the eastern slope of the Urals Triassic deposits only occur in some isolated depressions, the largest of which is the Chelyabinsk Basin. The sequence of the Triassic deposits is most complete in this basin (fig. 18) which is divided into the lower Tura Series (effusive sedimentary) and the upper Chelyabinsk Series (coal-bearing) which is overlain by the variegated deposits. In the Bulanash-Yolkino depression coal-bearing deposits are known as well as the effusive-sedimentary ones; and in Bogoslovsk depression there are only coal-bearing deposits whereas in the Anokhino depression only effusive-sedimentary ones are

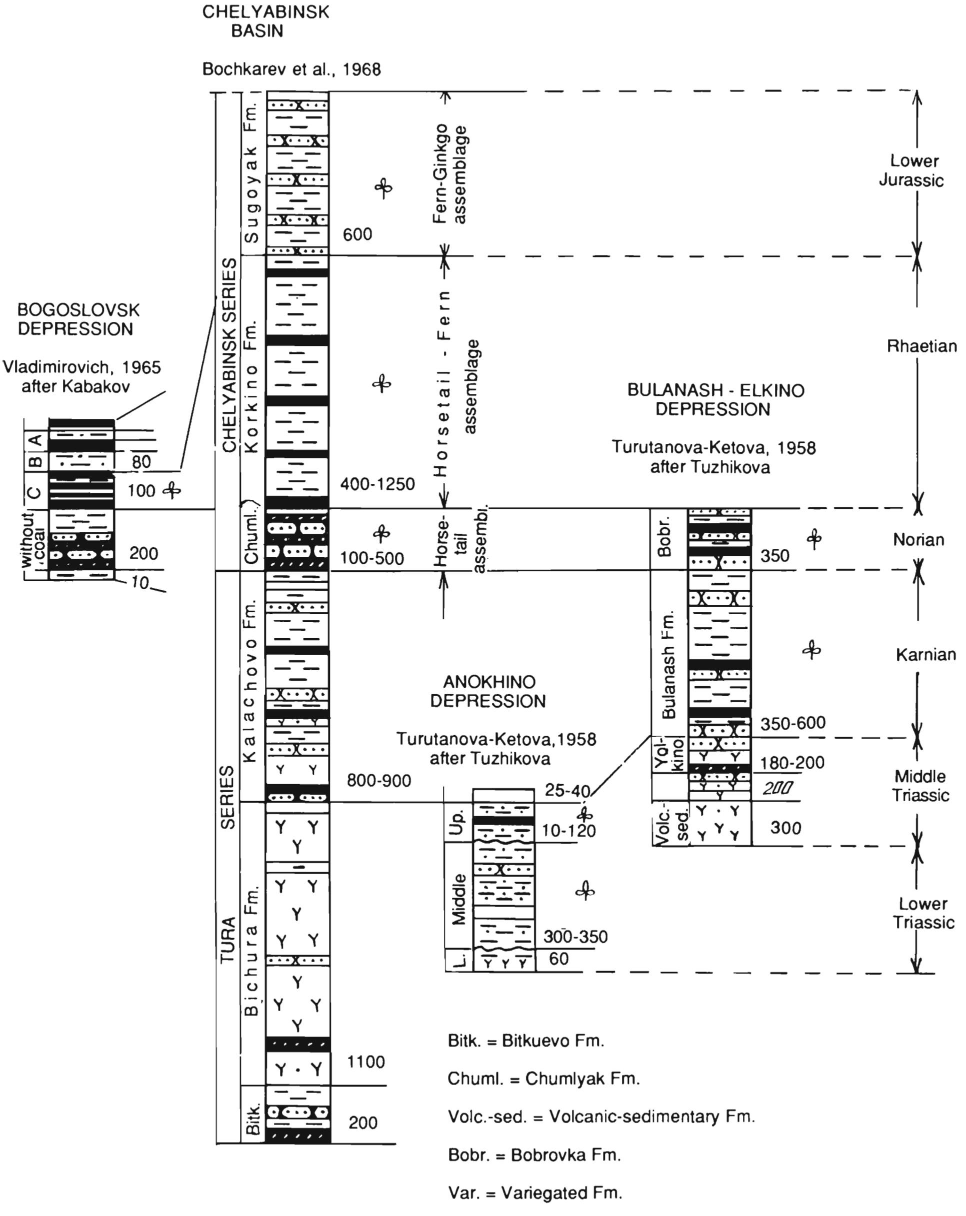


Fig. 18: Correlation of the Triassic plant assemblages of the eastern slope of the Urals (after KIRICHKOVA, 1961). For the legend see fig. 74.

known. Fossil plants are known from the coal-bearing deposits of the Chelyabinsk Basin, Lyulino coal mine of the Polar Urals, Volchanka, Veselovka and Bogoslovsk coal mines, Bulanash-Yolkino and Yulomanovsk depressions (list 44). Rare fossil plants were described from the Tura Series (list 43) from the Anokhino and Kvashnino depressions and one species was described from the Tura series of the Chelyabinsk Basin. Descriptions of plants from the Urals were published by KRYSHTOFOVICH (1912), KRYSHTOFOVICH & PRYNADA (1933 b), PRYNADA (1940), TURUTANOVA – KETOVA (1958), VLADIMIROVICH (1958 a, 1958 b, 1959, 1960 b, 1965, 1968 a, 1968 b), VLADIMIROVICH, PRYNADA & SREBRODOLSKAYA (1960), VLADIMIROVICH, PRYNADA & RADCZENKO (1960), KIRICHKOVA (1962 b, 1969), BOYAKOVA, VLADIMIROVICH & MOGUTCHEVA (1972), OSNOVY PALEONTOLOGII . . ., 1963).

The dominant fossils in the flora of the coal-bearing deposits of the western Urals are the ferns (numerous *Cladophlebis*), sphenopsids which occupy the second place and the conifers (chiefly *Podozamites* and *Cycadocarpidium*) are in third place. Ginkgophytes and pteridosperms are found in small but approximately equal quantities. Among the cycadophytes onlv *Taeniopteris* is of significance. From the Tura Series mainly pteridosperms were described.

Among the Eastern Urals flora only the flora of the coal-bearing deposits of the Bogoslovsk Depression and flora of the volcanic-sedimentary deposits of the Anokhino depression are similar to the Priuralye floras which are situated nearby. In these floras the peltaspermous pteridosperms are similar to those of Priuralye. The flora of the coal-bearing deposits of the Chelyabinsk Basin and the Bulanash-Yolkino depressions has nothing in common with the Ladinain-Karnian floras of Priuralye. STANISLAVSKY (1976) pointed out the greatest similarity of these floras with the Garazhovka flora of the Donets Basin. The similarity with the Keuper floras of Western Europe is insignificant (only *Neocalamites* of Chelyabinsk and Bulanash and *Scytophyllum* of Bogoslovsk are similar).

KRYSHTOFOVICH and PRYNADA (1933 b) were the first to study plant remains from the coal-bearing beds of the Chelyabinsk Basin. They determined that the beds are Rhaetian-Liassic in age rather than the Rhaetian. Prynada just considered the age of coal-bearing beds of the Chelyabinsk Basin and the Bogoslovsk coal mine to be Rhaetian but "older than typical European Rhaetian". It is not clear which floras he compared with the Urals flora. The criteria which later scientists used to determine the age of the Urals plant assemblages are also unclear. To all appearance according to the tradition dating from KRYSHTOFOVICH and PRYNADA the flora of the coal-bearing beds is considered to be Rhaetian (older than European Rhaetian). The flora of the overlying variegated deposits is Liassic and the flora of the underlying volcanic-sedimentary deposits are dated from the Early Triassic to Norian.

The peculiarity of the Urals flora evidently is the result of its geographical situation which makes its exact correlation with known floras difficult. Correlation of the fern-ginkgo assemblage of KIRITCHKOVA (1961) with the Norian-Rhaetian and the correlation of the two older floras with the Ladinian-Karnian are the most probable. However, the age of these floras cannot be considered to be well determined.

As to the age of the Tura Series the opinion of ROVNINA (1968) is closest to the author's. On the basis of palynological data Rovnina concluded that the Tura and Chelyabinsk Series are facies equivivalents to a considerable extent. This is certainly true at least for that part of the Tura Series from which plant remains have been described namely from Anokhino and to that part of the Chelyabinsk Series which contains plants in Bogoslovsk.

Several new species have been described by VLADIMIROVICH (1960 b, 1968) and VLADIMIROVICH, PRYNADA & SREBRODOLSKAYA (1960) from different localities in the **Turgay Basin.** To judge by the collections of the Chernyshov Museum in Leningrad these plants are similar to those of the Eastern Urals.

Summary

There are five plant-bearing beds in the Triassic deposits in the territory of the European part of the USSR, Mangyshlak and Eastern Urals (see fig. 14):

1) The Ust-Berezovka Formation with *Tomiostrobus* and *Glossophyllum* (the early Early Triassic, approximately Induan);

2) The Petropavlovka Formation (late Early Triassic, approximately the Olenekian) with *Voltzia heterophylla;*

3) The Rybinsk, the Bogdo, the Kumansk, the Dolnapa, the Tartali, the Karadzhatyk, the Karaduan and the lower part of the Khozbulak Formations (Olenekian-Anisian) with *Pleuromeia*;

4) The Protopivka, the Perebor, the Zalaznaya, the Kurashsay, the Bukobay Formations, the Tura Series and the Series "C" of Bogoslovsk (Ladinian-Karnian) with plant assemblages where peltaspermous pteridosperms dominate. To all appearances comparable floras of these formations are the horsetail and horsetail-fern assemblages of the Eastern Urals;

5) The Novorayskoye Formation and the beds VI and VII of the Estern Predkavkazye (Norian-Rhaetian) with Dipteridaceae, cycadophytes, ginkgophytes of the Glossophyllaceae and Sphenobaieraceae. It is possible that the fern-ginkgo assemblage of the Eastern Urals is the equivalent of this flora.

Thus in Eastern Europe besides the equivalents of the plant assemblages described from the Western Europe older plants (Induan?) are present.

Chapter three

South-western Asia

Plant remains of Triassic age occur at several localities in the central part of the Mediterranian geosynclinal area (fig. 19). They are found in the terrigeneous coal-bearing deposits which contain Karnian, Norian and Rhaetian invertebrates in the lower part. The coal-bearing beds lie above Lower and Middle Triassic carbonate deposits and are overlain by Upper Jurassic or Cretaceous limestones. Sometimes the coal-bearing beds are divided into two parts by a bed of limestone of Toarcian or Aalenian age.

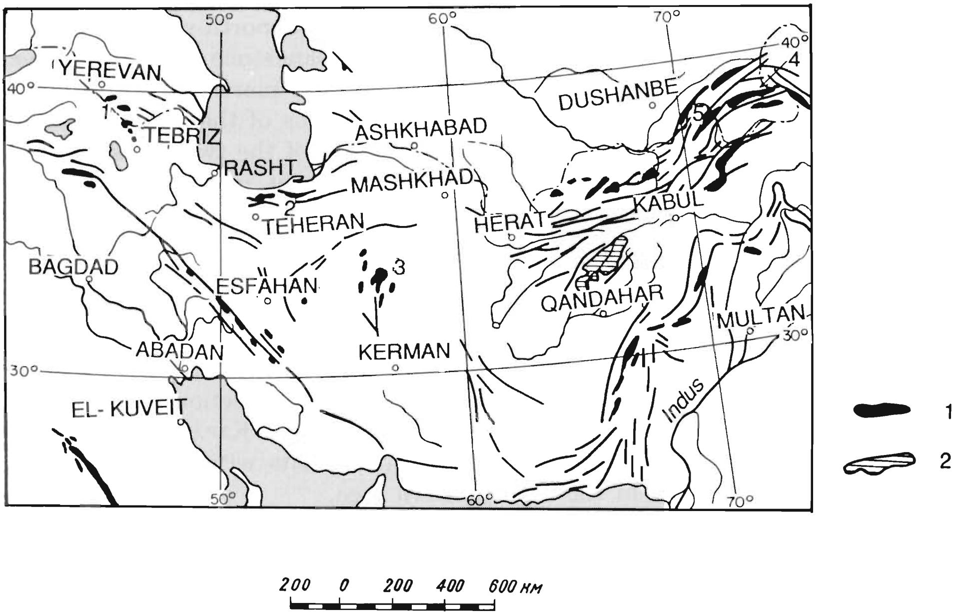


Fig. 19: Outcrop areas of the Triassic (1) and the Permo-Triassic (2) deposits in South Western Asia (after ANDERSON, 1973):
1 – The Vedi River; 2 – The Elburz Range; 3 – The Kerman Depression.

Zakavkazye

In Zakavkazye the terrigeneous Triassic deposits are known only in the valley of the Vedi River (Vedichay), left tributary of the Araks River, about 35 km southeast of Yerevan. This coal field has been studied since the beginning of the 1930s and the geology has been described in more than 20 reports and papers (Nazaraan, 1956; Azaryan, 1963; Arakelyan, 1964; Azaryan & Azizbekov, 1973). Fossil plants from this locality were described and figured by Kryshtofovich and Prynada in 1933 (list 46). Unfortunately the exact position of the fossil plant localities in the geological sequence has not been given. Lists of fossil plants were given in a paper by Nazaryan (1956). Preliminary determinations are given there following Ppynada's determination of Nazaryan's collections.

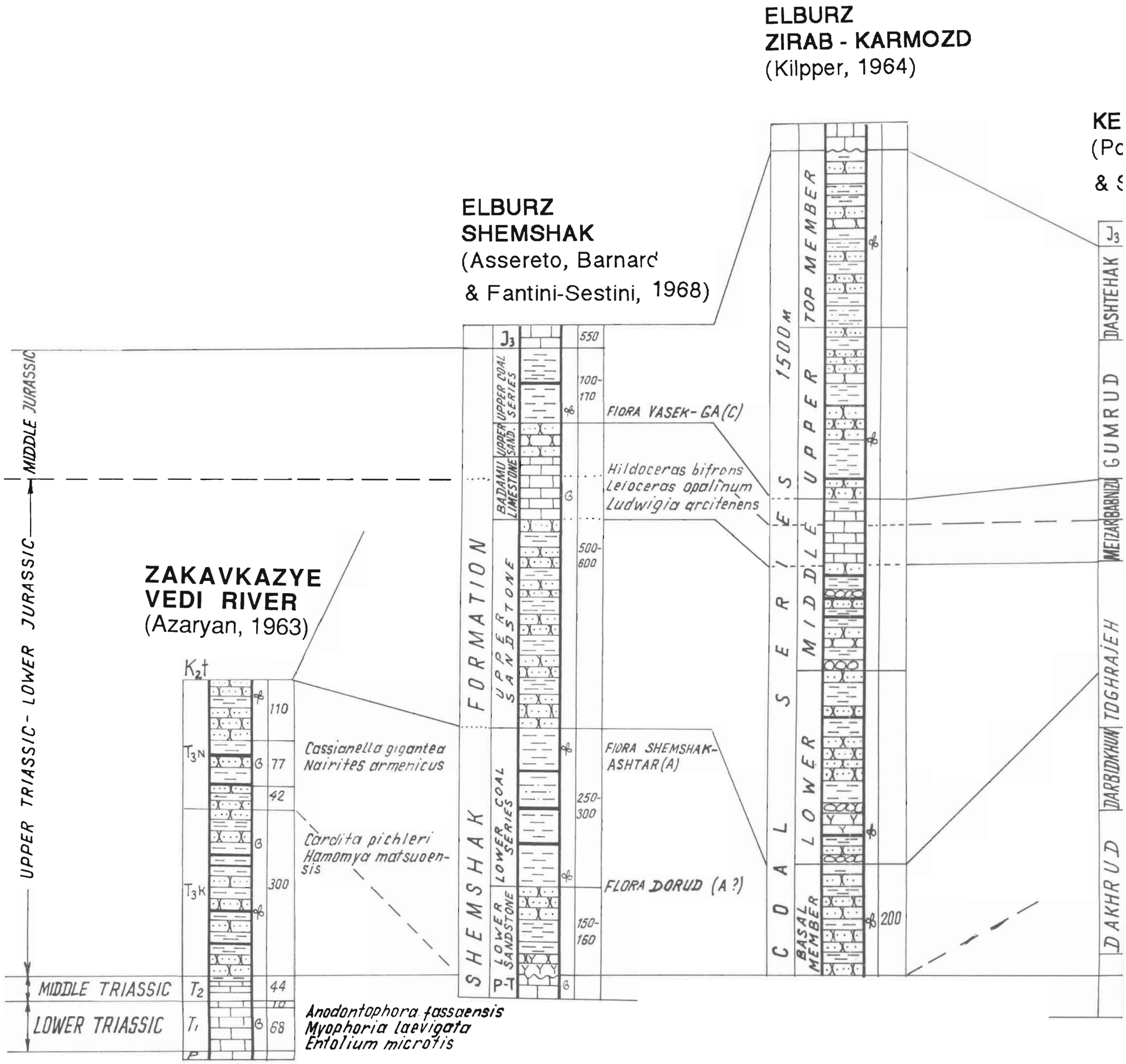
Near the abandoned village of Dzermanis at the Vedi river terrigeneous Triassic deposits occur in two isolated outcrop areas. They are divided by exposures of younger or older deposits and by large faults. The whole area of exposures is no more than 5 sq. km. The same deposits have also been intersected by nearly 20 borings in this and nearby areas.

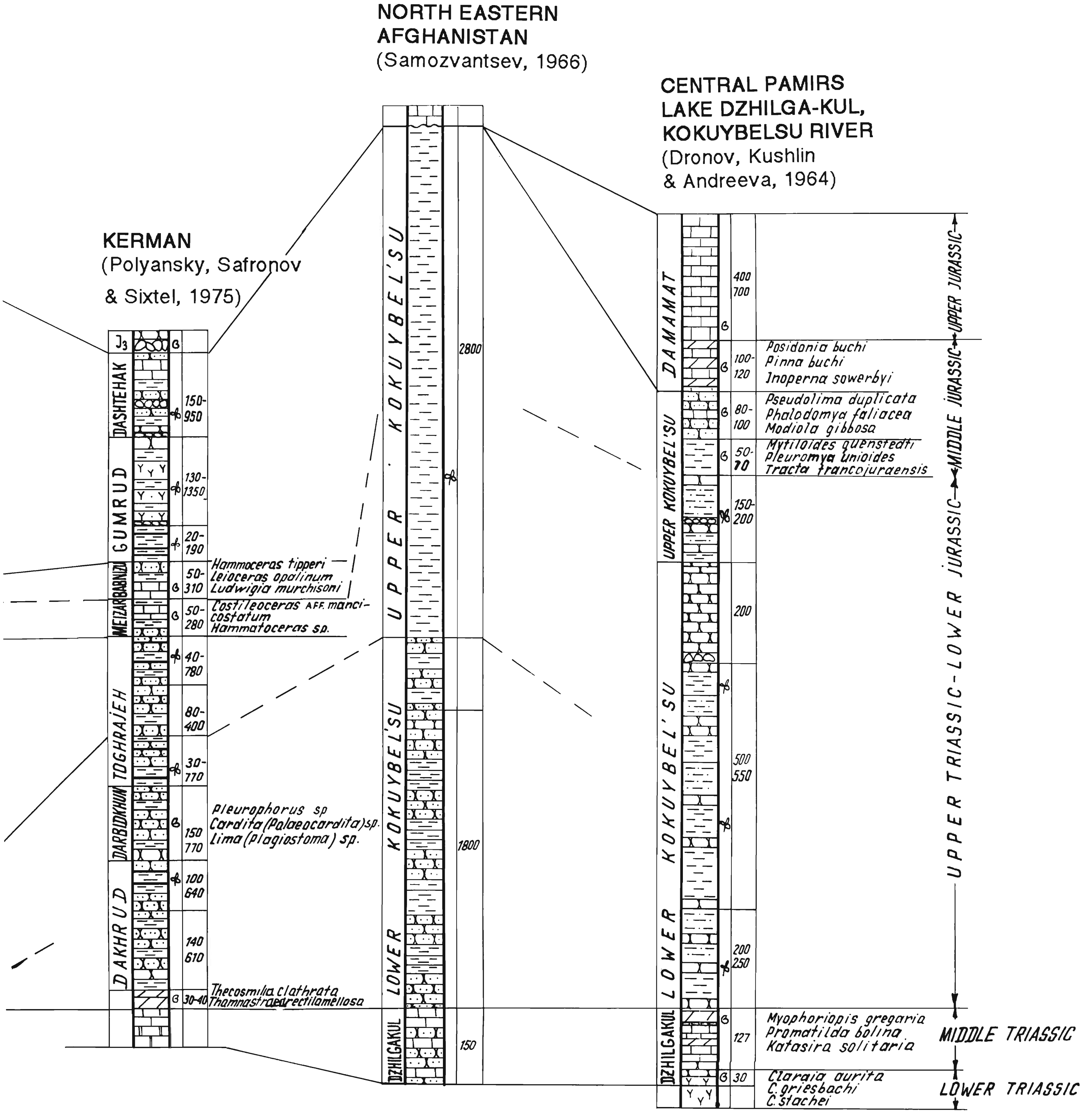
Terrigeneous beds represented by the intercalation of sandstone, siltstone, shale and coal (fig. 20) are underlain by carbonate deposits of Early and Middle Triassic age in the southeastern area. The Early Triassic strata are characterized by *Anodontophora fassaensis, Myophoria laevigata, Entholium micratis.* The structure of these beds in the south-eastern and north-western areas is similar but in the latter they are thicker, and the sandstone beds form ridges on the right bank of Dzermanis gorge. There are also more coal-seams in the north-western area. Geologists correlate the coal seams of these two areas differently which is why the correlation of the sections of the two areas varies in different papers. Nevertheless there is no disagreement in the interpretation that the youngest part the sequence is the uppermost bed of the north-western area.

The Norian age of the Dzermanis Formation was determined in the thirties by Robinson (1936, 1937) who compared the marine fauna of the terrigeneous deposits of Zakavkazye with the fauna of the Neiband Formation of Iran. Azaryan together with Kiparisova (Kiparisova & Azaryan, 1963, 1965) described and figured pelecypods and ammonites from this section which include *Cassianella gigantea* and *Nairites armenicus.* Azaryan and Kiparisova were the first to determine the presence of the Karnian deposits with *Cardita pichleri, Homomya matsuensis* etc. in the south-eastern area.

Kkryshtofovich and Prynada (1933 a) described the Dipteridaceae, the Matoniaceae and numerous cycadophytes from the locality. An abundance of cycadophytes including several genera indicate that the Dzhermanis flora is similar to the Rhaetian-Liassic floras of Western Europe and Greenland and also to the Norian-Rhaetian floras of Soviet Primorye and Japan. The Dzhermanis flora is especially close to the floras of Iran, Afghanistan, the Pamirs and Vietnam. Lists of plants in the paper of Nazaryan (1956) are in agreement with

Fig. 20: Correlation of the Lower Mesozoic plant-bearing deposits of South-Western Asia. For the legend see fig. 74.




NORTH EASTERN AFGHANISTAN
(Samozvantsev, 1966)
CENTRAL PAMIRS
LAKE DZHILGA-KUL,
KOKUYBELSU RIVER
(Dronov, Kushlin
& Andreeva, 1964)
KERMAN
(Polyansky, Safronov
& Sixtel, 1975)
J3
DASHTEHAK
150-
950
GUMRUD
130-
1350
20-
190
BABNIZU
50-
310
Hammoceras tipperi
Leioceras opalinum
Ludwigia murchisoni
MEIZAR
50-
280
Costileoceras AFF. manci-
costatum
Hammatoceras sp.
TOGHRAJEH
40-
780
80-
400
30-
770
DARBIDKHUN
150
770
Pleurophorus sp
Cardita (Palaeocardita) sp.
Lima (plagiostoma) sp.
DAKHRUD
100
640
140
610
30-40
Thecosmilia clathrata
Thamnastraea rectilamellosa
UPPER KOKUYBEL'SU
2800
LOWER KOKUYBEL'SU
1800
DZHILGAKUL
150
DAMAMAT
400
700
100-
120
Posidonia buchi
Pinna buchi
Inoperna sowerbyi
UPPER KOKUYBEL'SU
80-
100
Pseudolima duplicata
Phalodomya faliacea
Modiola gibbosa
50-
70
Mytiloides quenstedti
Pleuromya unioides
Tracta francojuraensis
150-
200
LOWER KOKUYBEL'SU
200
500
550
200
250
DZHILGAKUL
127
Myophoriopis gregaria
Promatilda bolina
Katasira solitaria
30
Claraia aurita
C. griesbachi
C. stachei
UPPER JURASSIC
MIDDLE JURASSIC
UPPER TRIASSIC-LOWER JURASSIC
MIDDLE TRIASSIC
LOWER TRIASSIC

the conclusion about the age of the Dzhermanis flora. In these lists there are no plants which suggest a Karnian age.

Iran

In Iran Lower Mesozoic plants are known from two regions: the Elburz mountains in the north (list 47 a–47 l) and the Kerman Basin (list 47 m) in the centre of the country. The first mention of the **Elburz** flora occured during the middle of the last century. Descriptions and figures of plants from Hif, Tasch and Asterabad (fig. 21) were published by SCHENK (1887). Later KRASSER (1891) described plants from Sapuhin and ZEILLER (1905) described some from Fechend, and Laloun. All of these paleobotanists considered the Elburz flora to be Rhaetian in age comparing it with the Grenzschichten flora of Central Europe.

KILPPER and BARNARD began to study the Elburz flora in the 1960s. The areas investigated by KILPPER were situated on the northen slope of the eastern Elburz near Zirab and Karmozd. On the other hand BARNARD studied the flora of the southern slope of the central Elburz near Shemshak, Ashtar, Dorud, etc. (see fig. 20). KILPPER (1964, 1971, 1975) beleived that the coal-bearing deposits with plants in his area were Rhaetian (Zirab 5, Shirkola, Apun) as well as Liassic in age (Zirab 1, 2, 3, 4, 6, 7, 8, 9). The former contains forms known in the Rhaetian and the Liassic as well as forms known exclusively from the Rhaetian.

BARNARD (1965, 1967) considered that the plant assemblages he determined from Dorud, Shemshak and Ashtar were Early Liassic (his "flora A") and he correlated them with the flora of Hif and Tasch studied by SCHENK and also with the flora of Zirab 1, 2, 3, 4, 5, 7 described by KILPPER. The flora of Zirab 6 and 9 was considered to be younger Late Liassic in age (his "flora B"). In addition to the Triassic flora a Middle Jurassic flora also occurs in both regions ("flora C" of BARNARD). The Middle Jurassic flora is the flora Vasek-Ga from Shemshak and the flora of the upper member from Zirab-Karmozd which lies above the Toarcean-Aaleian limestones with the marine invertebrates *Hildoceras bifrons, Leioceras opalinum, Ludwigia arcitensis.*

SADOVNIKOV (1977) distinguished three floras in the coal-bearing deposits of the Elburz on the basis of three years study. The "lowest flora" is referred by him to the Rhaetian and correlated with "flora A" of BARNARD (Dorud, Shemshak, Ashtar and Zirab 5). BARNARD considered "flora A" to be Early Liassic in age, because it did not contain plants such as *Lepidopteris, Scytophyllum* etc. which are characteristic of the Triassic floras of Europe and Greenland. Such forms, however, have been collected by SADOVNIKOV.

The "middle flora" of SADOVNIKOV corresponds approximately to the flora B of BARNARD and is considered to be Liassic in age. The "upper flora" corresponds to flora C of BARNARD and was determined to be Middle Jurassic in age. The two lower floras were collected from coal-bearing deposits which are underlain by marine deposits which contain Norian-Rhaetian pelecypods and

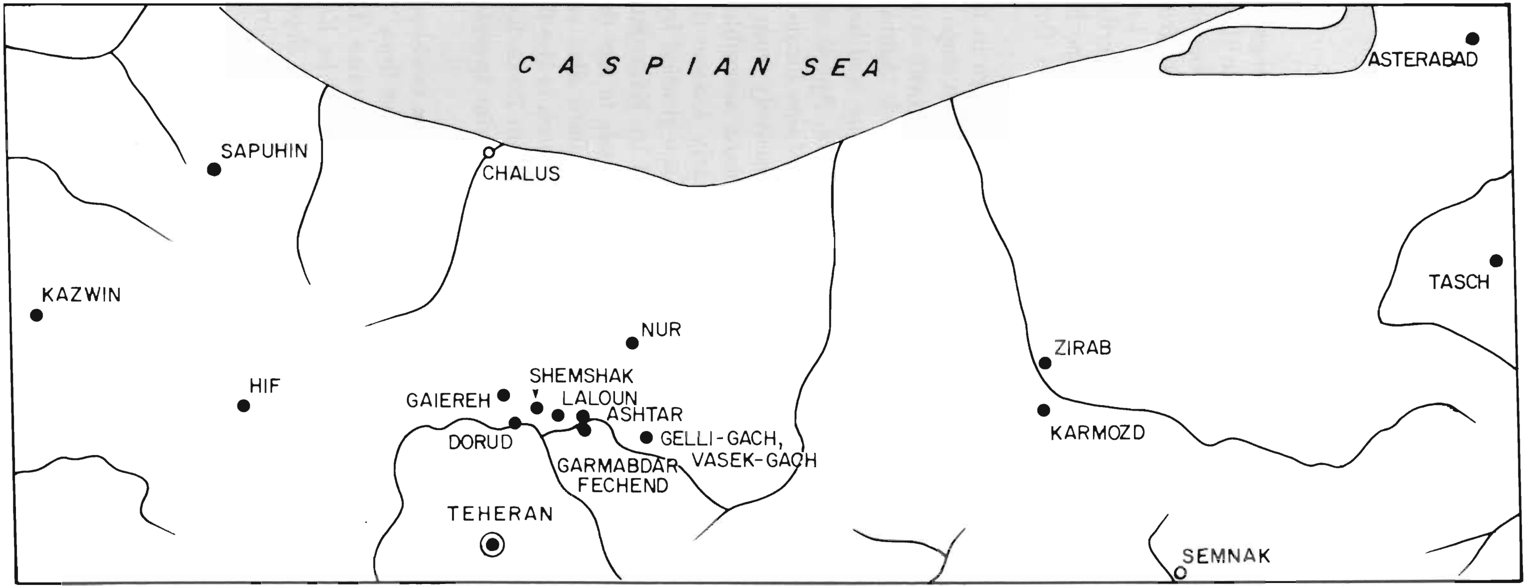


Fig. 21: Localities of the Early Mesozoic plants in the Elburz Range.

are overlain by the Toarcean-Aalenian strata. Thus the determination of a more exact age for the floras can only be made on the basis of an analysis of the floras themselves. Before these investigations the author accepted the opinion of KILPPER about the absence of the Triassic floras in the coal-bearing deposits of the Elburz (GOMOLOTSKY & DOBRUSKINA, 1973). The new research of SADOVNIKOV (1977) has made me change my mind.

CORSIN and STAMPFLI (1977) distinguish three plant assemblages in the Shemshak section of Shah Pasande – to the north-east from Asterabad (see fig. 21). In the oldest of them the ferns dominate in the number of species. The presence of the fern *Lobifolia* in the flora is interesting because it was not previously known in the Triassic. The cycadophytes are in second place. In addition two species of sphenopsida and two species of conifers are present. The authors correlate the lower assemblage with the lower part of the deposit containing flora A of BARNARD and consider it to be the Rhaetian in age. In the middle assemblage cycadophytes dominate *(Nilssonia, Pterophyllum, Zamites, Otozamites, Williamsoniella)* and there are fewer ferns than in the lower assemblage. It also contains a few sphenopsids and conifers. The middle assemblage is correlated with floras A and B of BARNARD and they refer it to the Liassic. The upper assemblage is correlated with flora C of BARNARD which is Aalenian. It seems that two lower assemblages correspond to the first flora of SADOVNIKOV (1977). In this case both are Norian-Rhaetian in age. The presence of *Conioipteris hymenophylloides* in the upper assemblage indicates that it is not older than Late Liassic.

Fossil plants recently became known from the **Kerman Basin** following geological investigations of Soviet geologists (POLYANSKY ET AL., 1975). The collections were studied by Sixtel and other palaeobotanists (unpublished). The fossil plants are listed in that paper according to the formations from which they were collected. Figures of some of them are given without descriptions and exact position. The fossil plants occur in the coal-bearing deposits (see fig. 20) which are underlain by marine deposits containing Norian-Rhaetian pelecypods: *Thecosmila clatrata, Thamnostrea rectilomelosa.* The coal-bearing deposits are devided by a limestone member which contains various marine invertebrates of Toarcean, Aalenian and Bajocean age: *Castiloceras* aff. *manicostatum, Hymmatoceras* sp., *Hammoceras tipperi, Leioceras opalinum, Ludwigia murchisoni.* The age of the fossil plants in the Dahrud and Toghardeh Formations is an interval of the latest Triassic to the Toarcean . It means that they are the equivalents of floras A and B of Elburz. The Darbid-Khun Formation which occurs between the plant-bearing Dahrud and Toghardeh Formations contains poorly preserved marine pelecypodes such as *Pleurophorus* sp., *Cardita (Palaeocardita)* sp., *Lima (Plagiostoma)* sp.

The Kerman floras are very close to the Elburz floras. SADOVNIKOV (personal communication in 1976) considered the Dahrud and Lower Toghradjeh floras to be the equivalents of the Rhaetian "first flora" of the Elburz. He also considers the Upper Toghradjeh flora to be the equivalent of the Liassic "second flora". This differs from the opinion of CORSIN and STAMPFLI who consider the Triassic-Jurassic boundary to be in the base of the Toghradjeh Formation. The floras of Gumrud and Dashtekhak Formations are Middle Triassic in age.

Afghanistan

In Afghanistan Early Mesozoic plants are known from the northern part of the country. Until recently only a few Triassic plants had been described from the basin of the Kalawch River (list 48 a), the left tributary of the Shiva River (Barnard, 1970) – fig. 22. In the collections of the Geological Institute in Moscow there are Triassic plants from the left bank of the Pyandzh River, 15–20 km below the mouth of the Bartang River (coll. N 3778, collected by Samozvantsev in 1966). They came from the Upper Kokuybelsu (Upper Vomar) Formation (list 48 b). In both localities the rocks are the same as the rocks of the Central Pamirs where enormous quantities of fossil plants have been collected from many localities. The Central Pamirs zone of black shales which has been more thoroughly studied in the USSR can be traced to the northeastern part of Afghanistan. The fossil plants in Afghanistan are quite similar to the pamirian ones.

The Central Pamirs

"The black shales of the Pamirs" which occur in the Central Pamirs were described by Prynada (1934). Fossil plants in them are widely distributed over the whole Pamirs along the rivers Bartang, Kudara, Tanymas, Kokuybelsu, Murgab, Oksu (fig. 22). These deposits, referred in 1970s to the Vomar or Kokuybelsu Formation, have a thickness of about 1000 m (Kushlin, 1963). They consist of argillite, siltstone and sandstone with subordinate amount of conglomerate (see fig. 20). Sometimes conglomerate is very abundant. In some places (in the Pyandzh valley near village Rushan and to the south of it – near the Kudara intrusion etc.) these rocks are strongly metamorphised to garnet slates. Fossil plant assemblages are the same although the fossil plants are worthless in the metamorphosed areas. The Vomar Formation is underlaid by limestones and marls of the Dzhilgakul Formation which contains the remains of marine invertebrates of Early and Middle Triassic age: *Claraia aurita, C. griesbachi, C. stachei, Myophoriopsis gregaria, Promatilda bolina* and *Katasira solitaria*.

The Kokuybelsu Formation is divided into two subformations the lower of which is considered to be Late Triassic in age and the upper to be Early and Middle Jurassic in age. In the upper part of the Upper Kokuybelsu Subformation and in the lower part of the overlaying Damamat Formation, marine pelecypods of Middle Jurassic occur such as *Mytiloides quenstedti, Pleuromya unioides, Tracta fracojurensis, Pseudolima duplicata, Pholadomya foliacea, Modiola gibbosa, Posidonia buchi, Pinna buchi* and *Inoperna sowerbyi*. The boundary between the

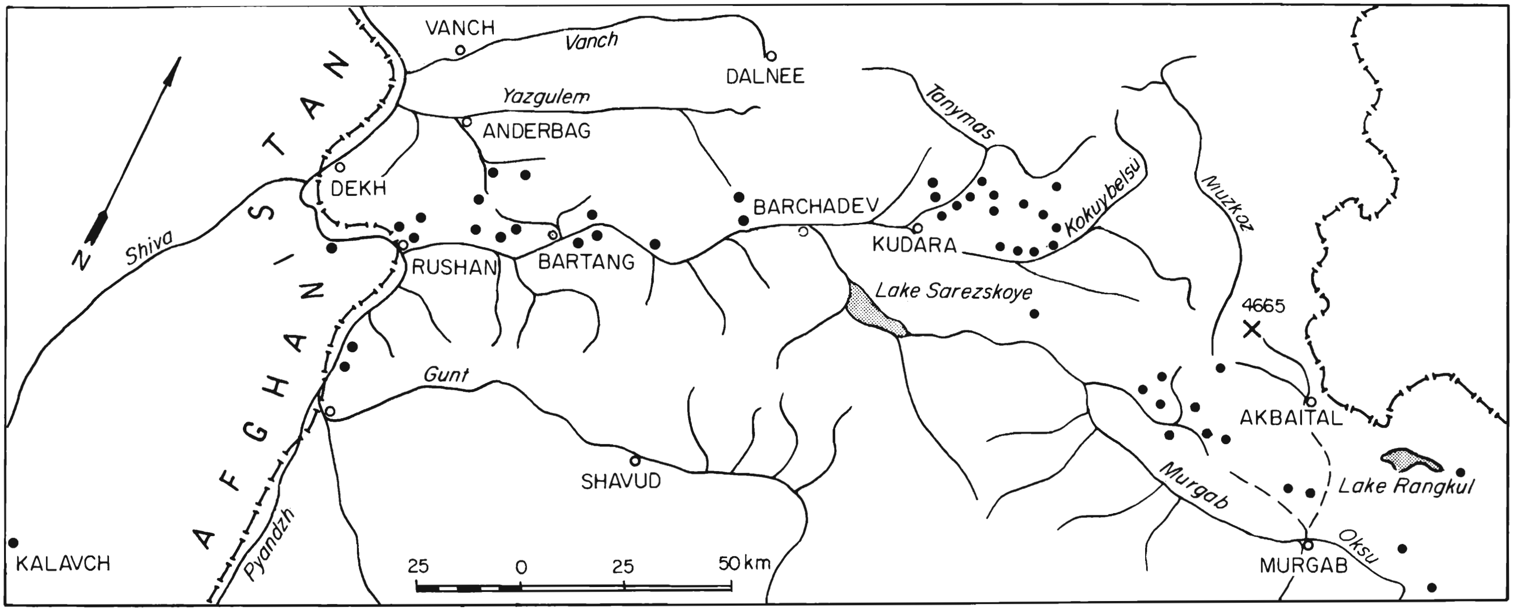


Fig. 22: Localities of the Early Mesozoic plants at the Central Pamirs and north Eastern Afghanistan (after Prynada, 1934; Kushlin, 1963; Barnard, 1970; and materials of Dobruskina).

lower and the upper subformations is drawn conditionally by the occurence of olive-green shales with the Liassic? plants in the basins of Kokuybelsu and Yazgulem Rivers or by the change of dark green coloured terrigeneous deposits to variegated in the Muzkol Range (KUSHLIN, 1963). The lower part of the formation is richer in fossil plants than the upper part. The conditional character of the subdivision of this formation and the position of the Triassic-Jurassic boundary within it is emphasized in all these papers. For example KUSHLIN (1963, p. 84) says: "In the lower part of the Bartang River Kokuibelsu Formation deposits which are not different from the Triassic ones contain Early Jurassic and even Middle Jurassic organic remains among which marine molluscs are present."

Descriptions of the Pamir plants were published by PRYNADA (1934) whose collections of about 200 specimens are housed in the CHERNYSHOV Museum, Leningrad. Additional determinations were made by SIXTEL (1960), VLADIMIROVICH (1958 b – one species) and IMINOV (1971, 1976). There were more than 300 specimens at the author's disposal including some collected by herself as well by YU. G. LEONOV, M. G. LEONOV, S. V. RUZHENTSEV, M. S. DUFUR, A. V. LUKYANOV and B. V. POLYANSKY (list 49).

Cycadophytes comprise the overwhelming majority of the fossils (70%) in the plant assemblage but are chiefly referred to just as two genera *Pterophyllum* and *Nilssonia*. Second place belongs to *Yuccites*? (or *Pelourdea*) and the third to the ferns. The role of the sphenopsids, pteridosperms and conifers is insignificant. The Pamir flora differs from the Ladinian and Karnian floras and is closer to the Norian-Rhaetian floras as shown by the abundance of cycadophytes, the presence of Dipteridaceae and by the insignificant role of pteridosperms. In the Pamir flora typical Jurassic forms are present as well as the forms that are more typical of the upper part of the Triassic. Among the former there is *Thaumatopteris shenkii*, the guide form for the Liassic *Thaumatopteris* zone of Greenland and Sweden. Unfortunately we cannot find the exact position of the Triassic-Jurassic boundary or draw a boundary between the different plant assemblages, as there do not seem to be succesive changes in the assemblages through the sequence. In most of the Central Pamirs it is impossible to find a single complete section because of the complicated tectonics in the area with many faults and much folding.

The only section where it is possible to collect fossil plants bed-by-bed is the famous one along the right bank of the Kokuybelsu River. After studying this section in the field it was possible for the author to determine the exact position of the localities which yielded the plants in Prynada's collections (they have exact geographic location) and of the plants collected by POLYANSKY.

The succesion of plant assemblages in the Vomar (Kokuybelsu) Formation on the right bank of the Kokuybelsu River (from the top to base) are as follows:

The Upper Vomar Subformation

N 8: *Clathropteris meniscoides, Phlebopteris angustiloba, Taeniopteris vittata*

N 12: *Podozamites sp.*

N 10: *Phlebopteris angustiloba, Pityophyllum* ? sp., *"Yuccites"?* sp.

N 70/48: *Clathropteris* sp., *Cladophlebis denticulata, ? Nilssonia pseudobrevis, ? Taeniopteris* sp.

N 70/33: *Clathropteris meniscoides, Dictyophyllum muensteri, Phlebopteris muensteri, Nilssonia pseudobrevis*

The Lower Vomar Subformation

N 15: *Clathropteris meniscoides, Cladophlebis haiburnensis, Pterophyllum pshartense, P. propinquum, P. braunsii, Anomozamites* sp., *Nilssonia pseudobrevis, N. rajmahalensis, Nilssonia* sp., *Taeniopteris vittata, Taeniopteris* sp., *Otozamites bucklandii, Sagenopteris ?* sp., *Hyrcanopteris tchuenkoi, Yuccites latifolius, Y. angustifolius, Carpolithes* sp.

N 70/19: *Pterophyllum pschartense, P. braunsii*

N 70/8: *Pterophvllum pshartense*

N 70/6: *Clathropteris obovata, Pterophyllum pshartense*

N 70/2: *Equisetites* sp., *Scytophyllum persicum, Nilssonia pseudobrevis, Otozamites pamiricus, Pterophyllum pshartense, "Yuccites" angustifolius*

N 70/1: *Scytophyllum persicum, Nilssonia pseudobrevis, Pterophyllum pshartense, P. braunsii, Macrotaeniopteris virgulata, "Yuccitec" angustifolius*

N 7: *Pterophyllum pshartense, Taeniopteris vittata, Pseudoctenis* sp., *Tanymasia pamirica, Yuccites latifolius*

N 5: *Yuccites angustifolius*

N 1, 2, 3: *Clathropteris meniscoides, Plebopteris muensteri, Cladophlebis* sp., *Nilssonia pseudobrevis*

As the list shows the species are distributed throughout the section. The discovery of *Scytophyllum persicum* is of importance as it is a characteristic species of the Norian-Rhaetian assemblages of Iran. In this section it is found 300 m above the base of Vomar Formation (specimen N 70/1).

Kushlin (1963) reported four sequences in the Pamirs where he distinguished two or three assemblages and he did not report any changes in the assemblages:

1) The Kokuybelsu River: differences in two assemblages are insignificant. *Daeniopsis fecunda* which is known from the Rhaetian of Sweden is listed as a characteristic species for the lower assemblage which is considered to be Karnian; other forms are known from the Jurassic only or from the both Triassic and Jurassic.

2) The Aksay River in the basin of the Eastern Pshart River: three horizons are reported and a summarized list is given.

3) The right bank of the Oksu River: *Clathropteris meniscoides* and two forms determined to genus are listed for the lower assemblage; the three may be found from the middle of the Triassic to the middle of the Jurassic.

4) The left bank of the Yazgulem River: two short lists are given, the first consisting of two species and the second consisting of three species. The only conclusion is that *Uralophyllum* was found below *Coniopteris* and *Nilssonia vittaeformis*.

Limestones underlying the plant-bearing beds in the Central Pamirs are of Ladinian-Karnian age which agrees well with the age of the flora. In the peripheral, marginal and intermediate zones of the Pamirs the upper boundary of limestones lies within the Karnian. In the axial zone of south-eastern Pamirs limestones are Norian (Middle Norian or Late Norian) in age. Small numbers of plants werer collected from the overlying shales in the south - eastern Pamirs and apparently are not older than Norian. Fresh water pelecypods from the plant-bearing beds of Dzhankaindy (collections of E. A. Uspenskaya and of the author) testify to the Late Triassic-Early Jurassic age of the rocks following the conclusions of G. G. Martinson (Kushlin, 1963).

The Lower Vomar (Lower Kokuybelsu) Subformation probably correlates with the upper part of the deposits with flora "A" of Iran, and the Upper Vomar (Upper Kokuybelsu) Subformation may correlate with the upper part of the lower subformation with the deposits containing flora "B".

Chapter four

Middle Asia

In Middle Asia the Triassic deposits have limited distribution (fig. 23). Except for the occurence of *Voltzia heterophylla* in the area between the Isfara and Sokh rivers the plant-bearing deposits of the lower part of the Triassic are known for certain only in the south-western Darvaz. The plant-bearing deposits of the upper half of the Triassic usually occur in the base of continental sequences of great thickness which contain Jurassic fossil plants at the top.

South-western Darvaz

In south-western Darvaz in the Vasmikukh Range in the Yokunzh and Obipitoudu rivers valleys, fossil plants were collected by LUCHNIKOV from the Alikagar Formation and the lower part of the Yokunzh Formation (list 50). They consist solely of *Pleuromeia, P. jokunzhica* (DOBRUSKINA, 1985 b). It is usual for *Pleuromeia* localities that other plant remains are absent. In the Alikagar Formation (fig. 24) they occur with Olenekian ammonites *(Meekocears* sp., *Kashmirites* aff. *acutangulatus, Dieneroceras* aff. *dieneri)* and pelecypods *(Eumorphotis* cf. *venetziana)*. Below them in the Vasmikukh Formation, the Olenekian ammonites *(Meekoceras carpilense* and *Doricranites)* and pelecypods *(Eumorphotis multiformis, Anodontophora fassaensis)* also were collected. In the overlying Yokunzh Formation a fossil fauna is not known, but in the Gring Formation which lies above the Yokunzh Formation Jurassic plants were collected. Thus the age of the Yokunzh Formation ranges from Anisian to the end of the Triassic. The *Pleuromeia*-bearing beds apparently correspond to the Anisian.

To the south-south-east of these localities in the area between the rivers Zorbuz and Gring, fossil plants were first collected by DAVYDOV (1976). They occur in the upper part of the Yolikhar Formation which is composed chiefly of coarse clastic red coloured deposits. The relationships between the underlying and overlying horizons are not clear because of diorite intrusions and poor exposures. In the area with plants remains the upper Yolikhar Formation is overlain by the Gring Formation of Jurassic age and is underlain by the Lower

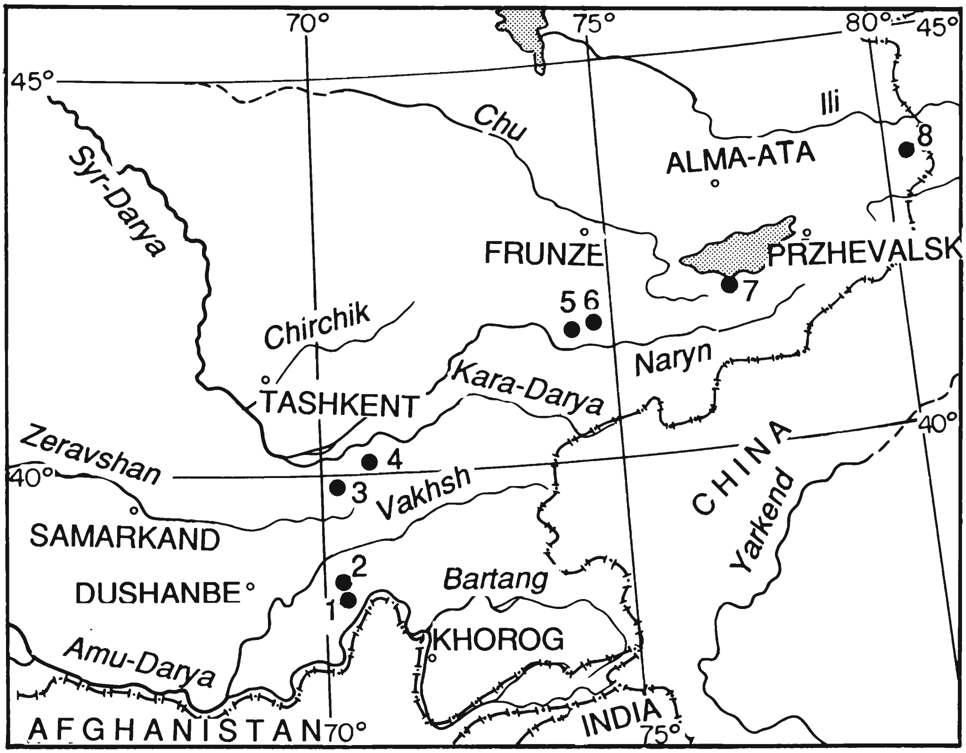


Fig. 23: Localities of the Triassic plants in Middle Asia (exept the Pamirs) and Eastern Kazakhstan:
1 – The Obiniou River; 2 – The Yokunzh and Obipitoudu Rivers; 3 – Madygen; 4 – Kamyshbashi; 5 – Minkush (Kavak-Tau); 6 – Kara-Kiche (Kavak-Tau); 7 – Soguty (Issyk-Kul); 8 – The Ketmen Range.

Yolikhar Subformation. It is not clear if this last contact is conformable or not and whether fossils occur in the Yolikhar Formation. Lithologically similar deposits are more usual in the Triassic deposits of the Darvaz (in particular in the Yokunzh Formation).

Schizoneura sp., *Bernoullia* sp., *Pecopteris* sp., *Sphenopteris* aff. *chowkiawanensis*, *Macrotaeniopteris lata*, *Podozamites* ex gr. *shenkii* and the bark of uncertain systematic position are present in the Davydov plant collection (list 51). The bark cannot be identified with either *Sigillaria* or with other Palaeozoic lycopods judging its structure. MEYEN indicated (oral communication in 1975) that such bark is unknown in the Carboniferous and Permian. It is not similar to *Pleuromeia* and nor *Ferganodendron* as well. The *Schizoneura* is similar to the lower Triassic forms and to the Upper Triassic ones, but its poor preservation does not allow certain identification. The fertile fern leaf is very similar to *Ber-*

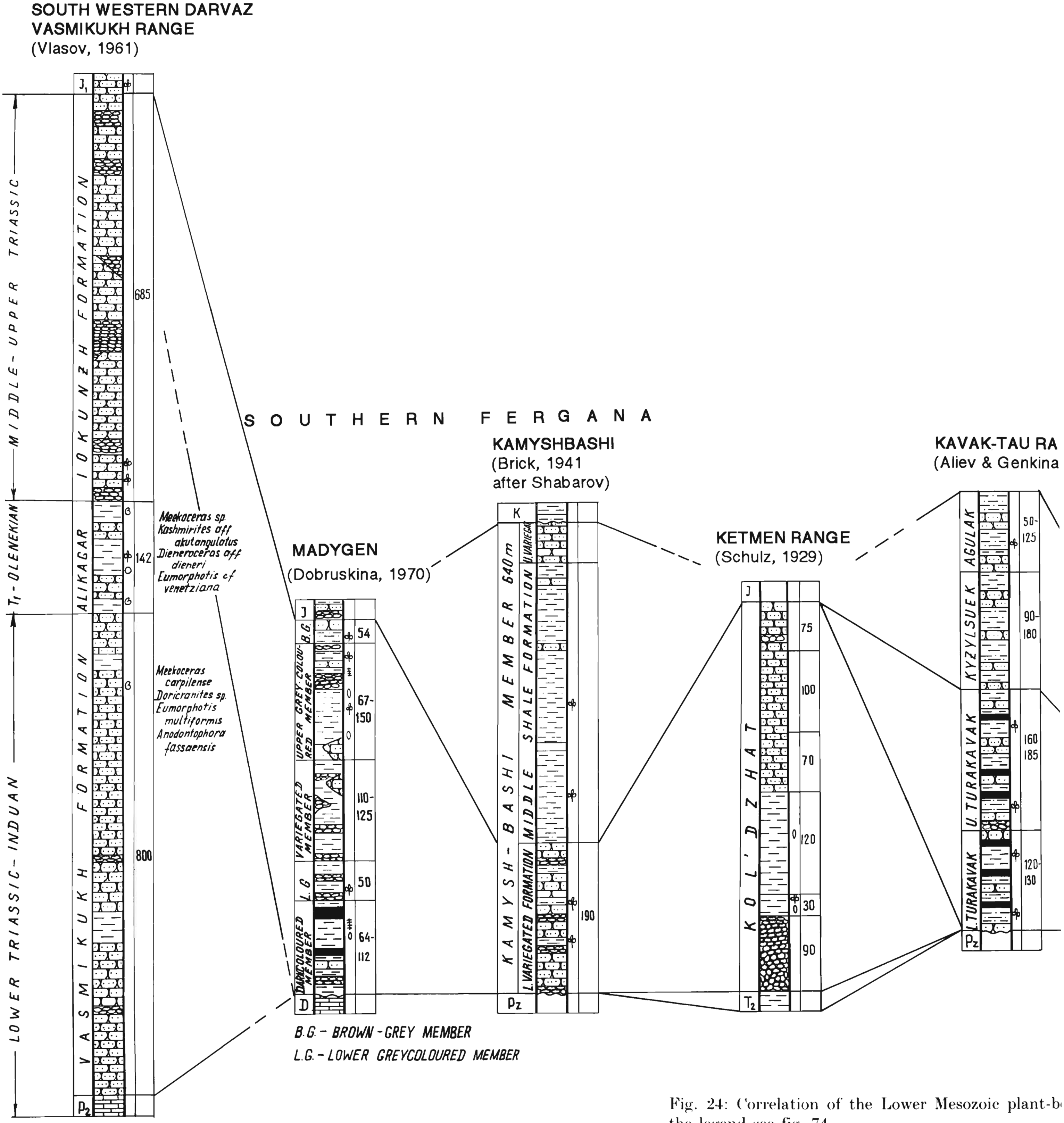


Fig. 24: Correlation of the Lower Mesozoic plant-b
the legend see fig 74.

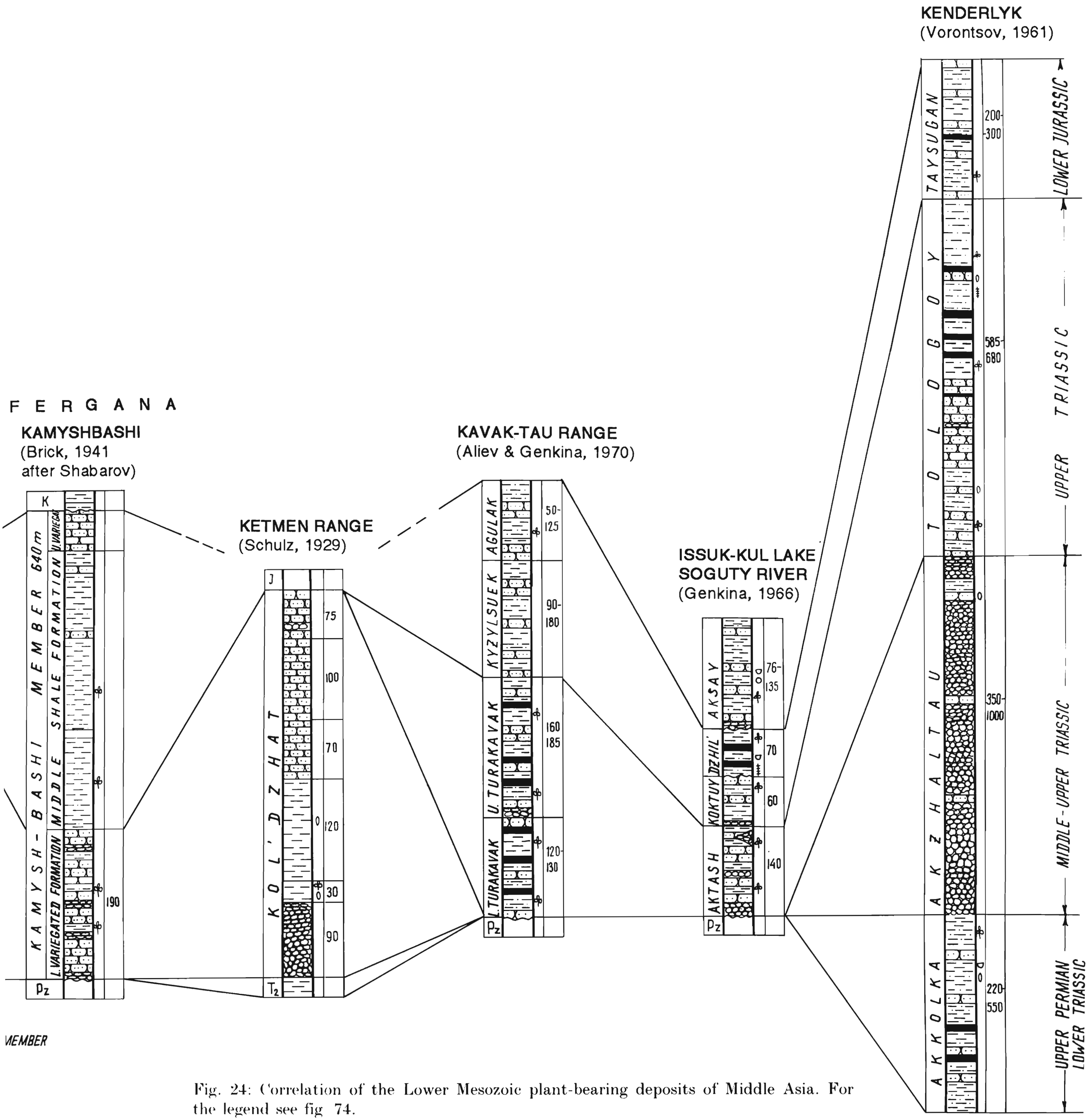


Fig. 24: Correlation of the Lower Mesozoic plant-bearing deposits of Middle Asia. For the legend see fig 74.

noullia from the Yenchang Formation of Northern China, the Upper Triassic of Verkhoyanye, the Kurashasay and Bukobay Formations of Southern Priuralye and Big Synya Formation of the Pechora Basin. The fern *Sphenopteris* constitutes the majority of all impressions and is most similar to Chinese Yenchang *Sphenopteris ? chowkiawanensis*. It is also similar to some forms from Korvunchana Formation of the Tunguska Basin and Parsora Formation of India. *Macrotaeniopteris (M. lata)* may occur in the Palaeozoic as well as in the Mesozoic deposits. The genus *Podozamites* is represented by a single imprint which cannot be accurately identified although the genus is known only after the Ladinian. Thus the most probable age of this assemblage is Middle-Upper Triassic.

Madygen and Kamyshbashi (Southern Fergana)

In Southern Fergana floras of the first half of the Triassic are known from the area between the rivers Isfara and Sokh *(Voltzia heterophylla* – list 52) and of the second half – from the vicinity of the abandoned village Madygen (list 53) and from the Kamyshbashi valley (list 54). Large scale mapping of the distribution of the Madygen Formation was carried out by the author in 1967. During the field work sequences of the Madygen Formation were studied at five isolated outcrop areas. Maps of 1 : 25 000 were used for mapping the subdivisions of the Madygen Formation. The sequences of the terrigeneous deposits of the different areas were correlated (see composite section in fig. 24). The Madygen Formation lies uncomformably on limestones of Middle Devonian or Lower Carboniferous or have a fault boundary with metamorphosed shales and conglomerates of the Upper Carboniferous. Jurassic deposits disconformably overlie the Madygen Formation (see fig. 24).

The most important conclusion of this work (Dobruskina, 1970 a, 1986 b) was the proof of the coevality of the "Lower Triassic" deposits of the Sauk-Tanga area with plants (Brick, 1936) and the "Upper Permian" deposits with plants of the south-western Area (Sixtel, 1962 b). Study of the Madygen plants permitted me to revise some of the previous determinations (Dobruskina, 1974, 1975; 1982 b, list 53, p. 121) and to show that Upper Permian and Lower Triassic plants are absent and the flora actually consists of typical Keuper forms. In the Madygen flora the main role belongs to the pteridosperms and ginkgophytes which together constitute about 55% of all the fossils. Other plant groups are found in smaller numbers.

The Madygen flora is closest to the lower flora of Kamyshbashi, the flora of Nikolayevka in the Donbass, the floras of Southern Priuralye, the Ketmen Range and of northern China. The data of palaeozoologists who studied insects, crustacea and fish from the same deposits (Bekker – Migdisova, 1953; Novojilov, 1959; Vorobyeva, 1967; Sharov, 1968, 1970; Ponomarenko, 1969; Rasnitsyn, 1969; Novojilov, 1970;, Sukacheva, 1973) agree with my conclusions.

In Kamyshbashi (near Isfara) plant remains were described from the lower Variegated Formation and from the middle Shale Formation by BRICK (1941) and SIXTEL (1960). Plant-bearing beds disconformably lie on Palaeozoic deposits and are disconformably overlain by Cretaceous deposits. *Neocalamites carrerei* is found in great numbers in the older plant assemblage together with *Todites kamyshbashensis* and *Cladophlebis haiburnensis*. Their species are represented by single imprints. This plant assemblage is similar to the Madygen, Ketmen, Yenchang and other assemblages of the Ladinian-Karnian in the occurence of *Neocalamites,* the Marattiaceae, *Cladophlebis shensiensis* and *Lepidopteris*. The presence of *Podozamites* and *Cycadocarpidium* brings it closer to the floras of the Donbass and Japan.

The younger assemblage is smaller which always makes comparison difficult. Only sphenopsids occur in great numbers. The appearance of *Clathropteris meniscoides* and *Sphenobaiera* cf. *pulchella* and the absence of *Danaeopsis, Cladophlebis shensiensis* and *Lepidopteris* differentiates it from the more ancient assemblage. BRICK (1941) considered it Early Liassic and correlated it with the flora of the Lower Shurab horizon. SIXTEL (1958) considered it to be Rhaetian-Liassic in age. GOMOLITSKY and DOBRUSKINA (1973) compared it with Lower Jurassic plant assemblages.

The Ketmen Range

Fossil plants which can be compared with the Madygen and Kamyshbashi plants were described by Orlovskaja from the Koldzhat Formation of the Ketmen Range (see fig. 24 and list 55). Numerous crustacea and rare fish (CHERNYSHOV, 1940; NOVOJILOV, 1957, 1959) were found with plants. Originally PRYNADA determined the age of the rocks as Lower Jurassic after the first discovery of a single *Nilssonia* and sphenopsids. As a result, the crustacan *Kazachartra* which was found together with plants was considered Lower Jurassic. Later ORLOVSKAJA (1968) proved with much more material the Upper Triassic age of the Ketmen flora, but *Kazachartra* continued to be considered Lower Jurassic. It resulted in determination of the Madygen Formation as Lower Jurassic in age by NOVOJILOV because he compared it (quite correctly) with the Koldzhat Formation. The similarity of the Madygen and Koldzhat *Kazachartra* (crustacean) testifies to the coevality of these formations.

The Kavak-Tau, Issyk-Kul and Kenderlyk

Younger assemblages of plants are known from the lower part of the Kavak-Tau plant-bearing beds of great thickness (list 56), the Issyk-Kul (list 57) and Kenderlyk (list 58) – see fig. 23 and 24. In the first two regions plant-bearing deposits lie unconformably on Palaeozoic deposits; in the third they are underlain by deposits of similar composition with phyllopods and ostracods which were compared with Lower and Upper Triassic forms by ZASPELOVA. In the Akkolka Formation *Thallites undulatus* and *Equisetites* sp. are found. In each of these mentioned regions several plant assemblages were studied (TURUTANOVA-KETOVA, 1931, 1960, 1962, 1963*, 1968 a, 1968 b), SIXTEL (1960), GENKINA (1964, 1966, 1970**), KOVALCHUK (1961). The majority of them belong to the Lower and Middle Jurassic. Most of the controversies arose in connection with the age of the older formations.

After studying the stratigraphic distribution of plant species known in the lower parts of continental deposits of Middle Asia GOMOLOTSKY and DOBRUSKINA (1973) concluded that these plant assemblages may be divided into two groups. In the first only forms known from the *Thaumatopteris* flora are present, and these floras are Early Liassic an age. In the second group members of the *Lepidopteris* flora of Greenland and Western Europe are present along with these forms. These floras are "mixed" floras. The Norian floras of Japan are also "mixed" in comparison with the Greenland and European floras. The number of the "young" forms increases from west to east.

The picture described above suggests that "mixed floras" in Middle Asia and the Far East occupy the stratigraphic position corresponding to *Lepidopteris* flora, i. e. they are the Norian-Rhaetian. To these floras belong the assemblages from the Turakavak Formation in the Kavak-Tau Range, Aktash Formation in the area of the Issyk-Kul Lake, Tologoy Formation in the Kenderlyk Range. In other regions of Middle Asia (Sulyukta, Shurab, Arkit, the Gissar Range, the Fergana Range) the Triassic deposits are absent.

A great number of insects were collected in the plant-bearing beds of the Issyk-Kul area and in the upper part of the Tologoy Formation of Kenderlyk which is usual for the Upper Triassic and the Lower Jurassic deposits of Asia. In the Tologoy Formation the crustacean *Kazachartra* and phyllopods were also found. *Kazachartra* occur in the lower part of the Formation and is similar to the Koldzhat *Kazachartra*. The phyllopods are similar to the Upper Triassic and Lower Triassic forms of Siberia, Asia, Northern America and Western Europe.

Summary

Until recently a wide distribution of Upper Triassic plant-bearing deposits was supposed for Middle Asia. The same may be said about the Lower Triassic plant-bearing deposits. The Madygen Formation is now considered to be Ladinian-Karnian. Earlier it was considered to be the Late Permian Early Triassic in age. The presence of Lower Triassic deposits in the Khanaka Formation of

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* See OSNOVY PALEONTOLOGII . . ., 1963.

** See ALIEV & GENKINA, 1970.

the Gissar Range (SIXTEL, 1960, 1966, 1968; SIXTEL & KHUDAYBERDYEV, 1968) was not proved later. Plants were recollected from the Khanaka Formation by LUCHNIKOV in 1971 on the left bank of the Khanaka River below the village Shamal and were determined by MEYEN (oral communication in 1970). They include *Sphenopteris* sp., *Walchia* sp. 1, *Walchia* sp. 2, *Ernestiodendron filiformie* (Schloth.) Florin, *Cordaites* sp., *Samaropsis* sp. 1, *Samaropsis* sp. 2, *Cordaicarpus* and a very large monosacate pollen of the *Florinites* type. It appears from the geological map that Luchnikov collected from the same horizon as Sixtel did – from a bed of grey siltstone in the Upper Khanaka Subformation. It confirms also by the presence of pollen *Florinites* in both lists. In MEYEN's opinion the combined occurence of numerous *Walchia, Ernestiodendron filiciforme, Cordaites* and *Florinites* indicates it is Early Permian in age.

The age of Kysylnura Formation of the Kurama Range is still unclear because of poor material. SIXTEL (1960, 1972) described from there *Equisetites* sp., *Williamsonia artemovae, Pseudovoltzia liebeana, Angrenia angustifolia* (locality Bash – Kysyl – Say).

Chapter five

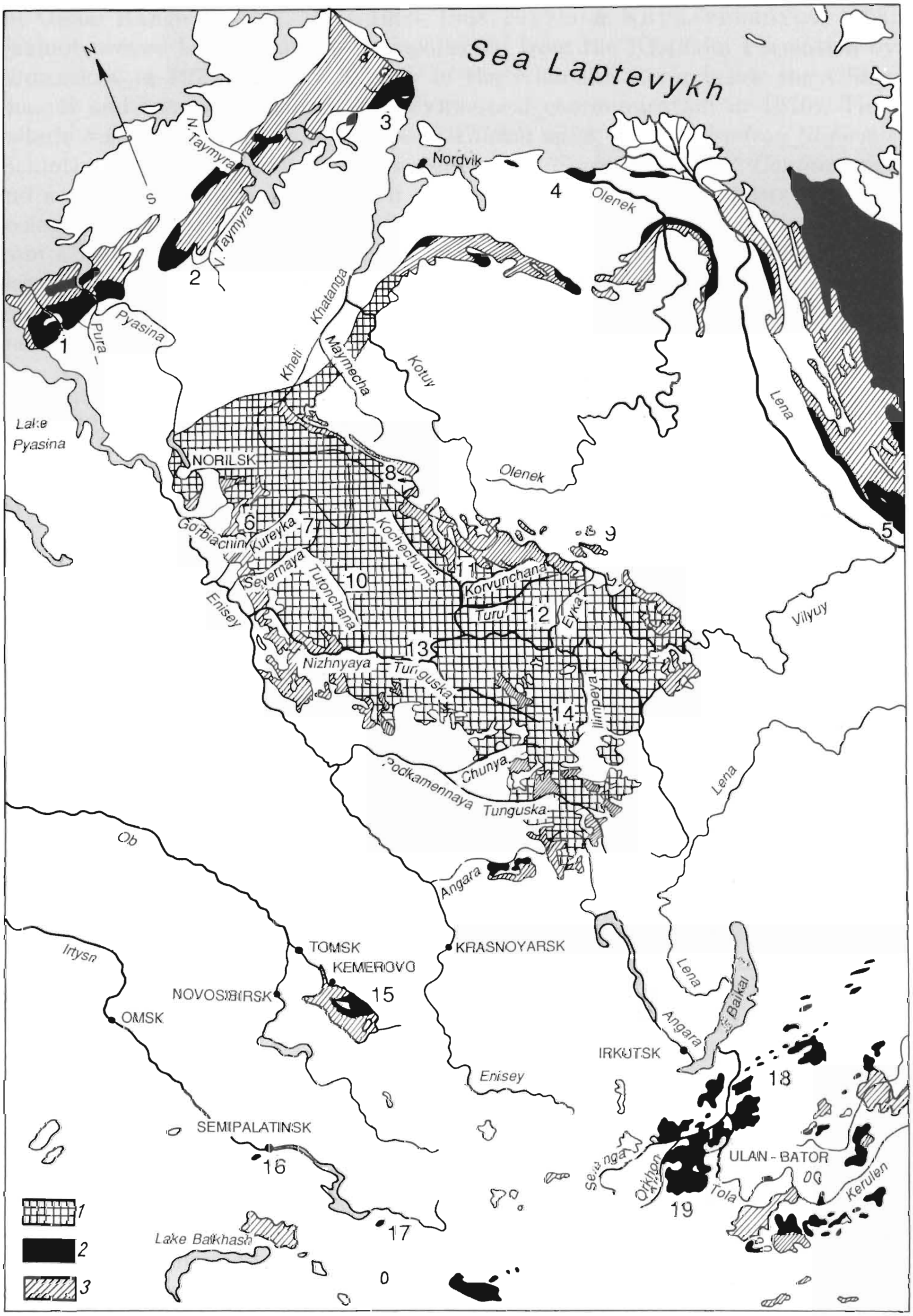
Eastern Siberia and Northern Kazakhstan

In Eastern Siberia and Northern Kazakhstan Triassic deposits are widely distributed in the Tunguska syneclise (fig. 25), relatively large outcrop areas occur along the margins of Northern Taymyr anticlinorium and the Verkhoyansk anticline zone and also in Zabaykalye and adjacent regions of Mongolia. Small outcrops are found in the Kuznetsk Basin and in Northern Kazakhstan in the Kenderlyk Mulda and the Semeytau Mountains.

The Semeytau Mountains

Fossil plants here (list 64 b) were collected from the interlayers of tufo-sandstones in the middle part of the Semeytau Formation (fig. 26) which is composed of ignimbrites and basaltic lava, trachites and liparites. It lies transgressively on the Permian-Carboniferous effusive-sedimentary deposits and is also overlain transgressively by Palaeogene sandstones. SHCHEGOLEVA (1978) believes that the Semeytau lavas have kainotype appearance and in this are very different from the Palaeozoic lavas of Kazakhstan. She compared their composition and appearance with the effusives of the Tura Series of the Western Urals and Zauralye.

Preliminary determinations of fossil plants from the Semeytau Formation were given by Salmenova (in: ISTOMIN & SALMENOVA, 1964). Later considerable collections (more than 250 specimens) of Semeytau plants came to the Geological Institute from M. F. MIKUNOV, S. S. KUZMIN and L. A. SHCHEGOLEVA. Although these collections need a monographic study, we can draw some conclusions at this time. The author considers the remains which were determined by SALMENOVA as the bark of *Pleuromeia (Pleuromeiopsis)* to be cycadophytic and probably are the remains of bennettitalean reproductive organs. They closely resemble the reproductive organs of the bennettitalean plants studied by KRASSER (1919) from the Karnian deposits of Lunz in the Alps. These remains constitute about a third of Semeytau fossils; cycadophyte leaves assigned to the genus *Taeniopteris* are also present. Pteridosperms *(Lepidopteris, Peltaspermum)* and conifers *(Voltzia, Podozamites,* scales and seeds) are also abundant. Sphenopsids


Sea Laptevykh
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N. Taymyra
V. Taymyra
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Pyasina
Khatanga
Kheti
Maymecha
Kotuy
Olenek
Olenek
Lena
Lake Pyasina
NORILSK
Gorbiachin
Kureyka
Severnaya
Tutonchana
Kochechuma
Korvunchana
Turu
Eyka
Vilyuy
Enisey
Nizhnyaya
Tunguska
Ilimpeya
Chunya
Podkamennaya
Tunguska
Lena
Ob
Angara
Irtysh
TOMSK
KEMEROVO
NOVOSIBIRSK
KRASNOYARSK
OMSK
Lena
Baikal
Angara
IRKUTSK
Enisey
SEMIPALATINSK
Selenga
Orkhon
Tola
ULAN - BATOR
Kerulen
Lake Balkhash
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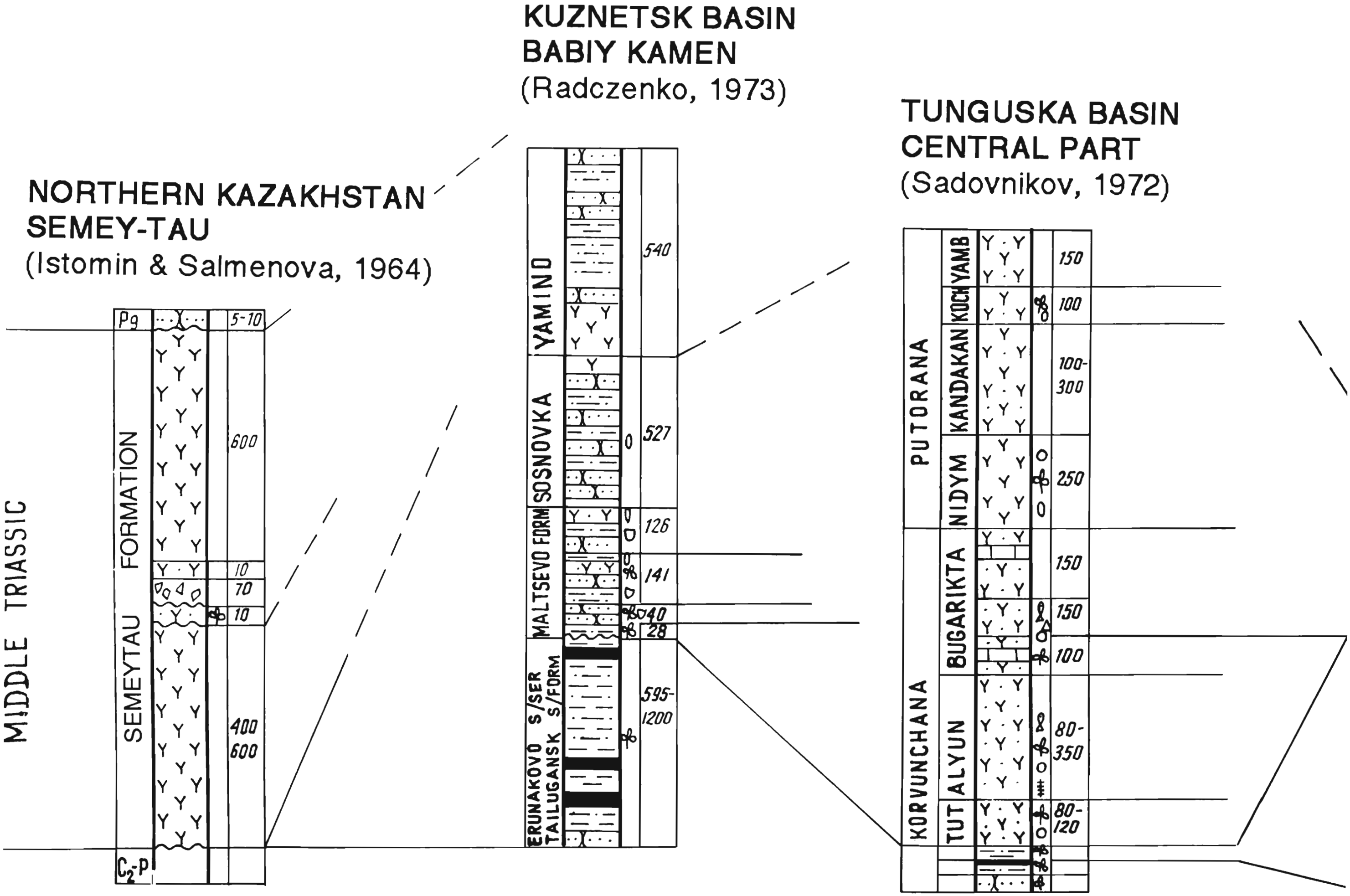
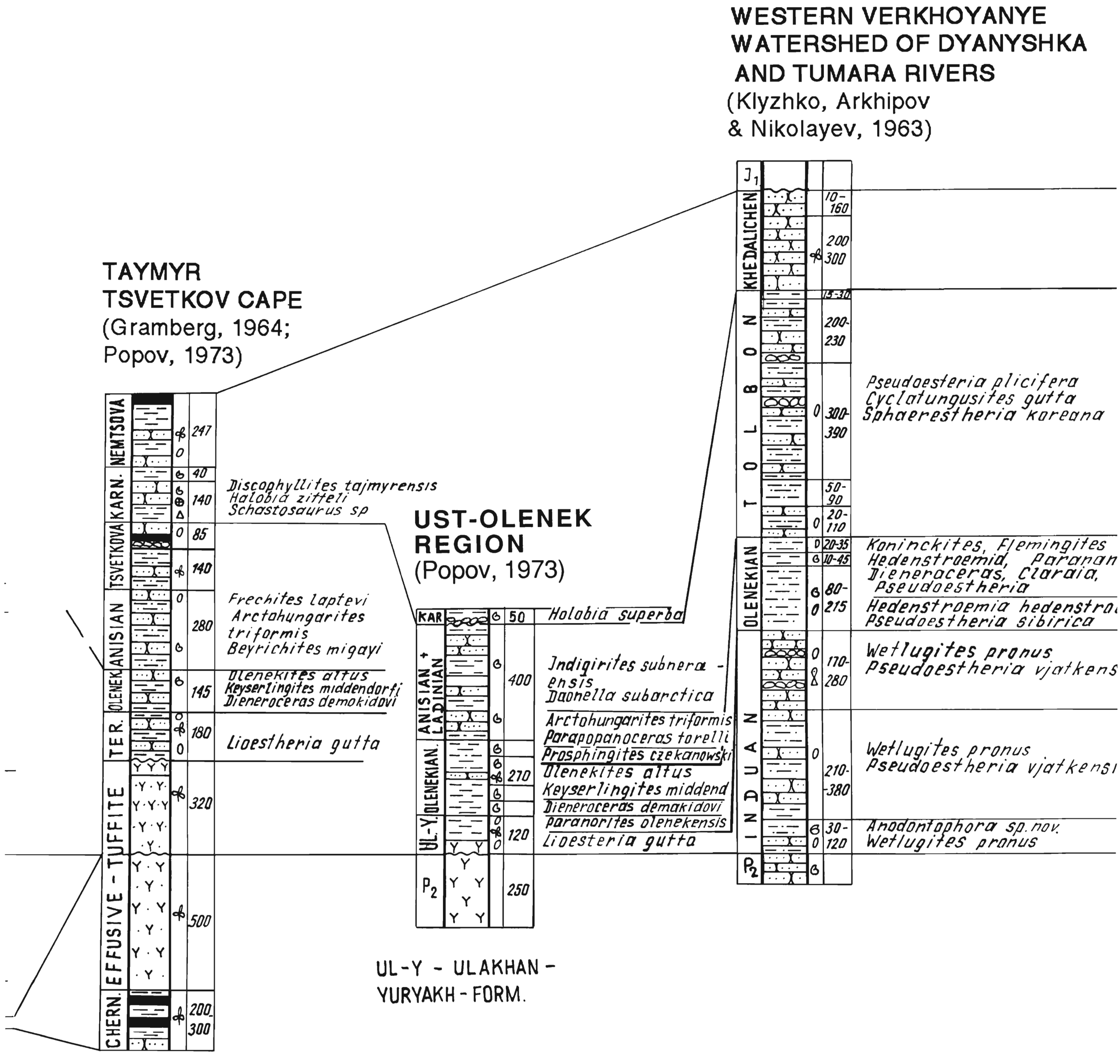
3



TUT - TUTOHCHANA
KOCH-KOCHECHUM
YAMB-YAMBUKAN

TER -
CHERN



TER - TERRIGENIOUS FORM.
CHERN - CHERNOYAROVKA

Fig. 26: Correlation of the Triassic plant-bearing deposits of Eastern Sib
legend see fig. 74.

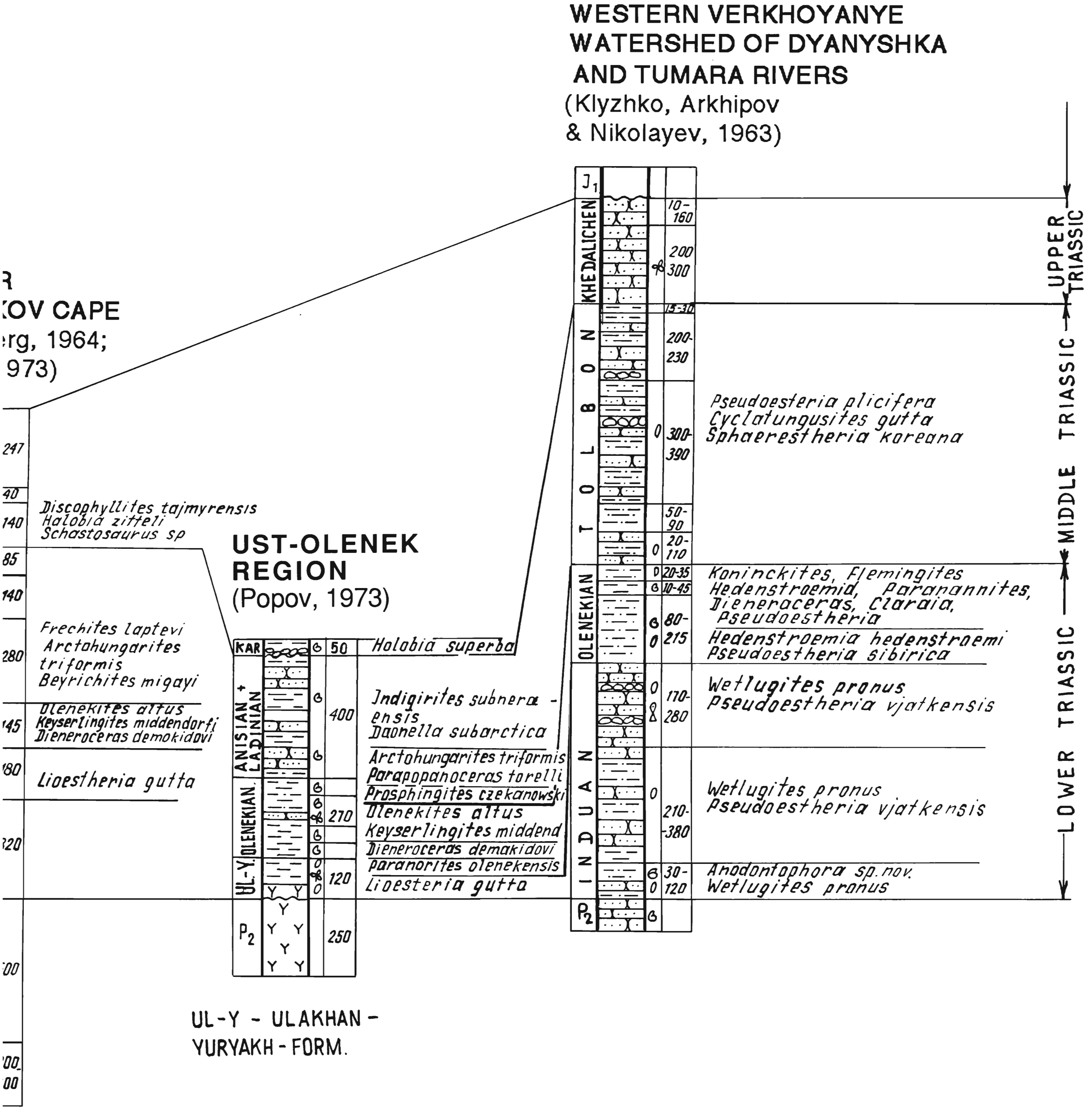


Fig. 26: Correlation of the Triassic plant-bearing deposits of Eastern Siberia. For the legend see fig. 74.

are represented by poorly preserved Equisetalean stems. Imprints of a few fern leaves *(Cladophlebis, Sphenopteris)* and two doubtful ginkgophyte leaves are also present in this flora.

Palaeozoic plants are absent in this plant assemblage and it is most similar as a whole to the Ladinian-Karnian assemblages.

The Kuznetsk Basin

In the Kuznetsk Basin the plant assemblage from the coal-bearing deposits consists chiefly of *Cordaites;* other plants are recorded in list 59. *Cordaites* is completely absent in the overlying deposits where many ferns, conifers and sphenopsids appear. These deposits do not contain coals.

Neuburg (1936) was the first to describe in detail the sequence along the Tom River. She described a direct contact of coal-bearing deposits (with *Cordaites* flora) and the barren deposits (no coal) with another flora. These deposits (fig. 27) do not show a visible unconformity (Neuburg, 1936), so the boundary is drawn at the top of the uppermost coal seam (within the interval of about 5 m). Above it only thin lenses of coal are found. Below this boundary there are normal sedimentary rocks. Above it lie dark coloured tuffogeneous deposits which contain interbeds of basalt not less than 350 m in thickness. Neuburg named them "Formation III", which was later called Maltsevo Formation (Vladimirovich, 1967; Vladimirovich et al., 1967; Radczenko, 1973) and divided into four horizons according to their palaebotanical characteristics (see fig. 26).

Twenty five species have been described from the Maltsevo Formation (Neuburg, 1936; Radczenko, 1936; New Species . . ., 1960; Vladimirovich et al., 1967), the majority of them coming from the locality "Babiy Kamen". This section is shown in the fig. 27. Nearly all plant remains occur in the lower part of this section: 2,5 m–33 m counting from the base of the formation. This part

← Fig. 25: Exposures of the Triassic deposits in Eastern Siberia (after Anderson, 1973 with additions):
1 – Triassic deposits in the Tunguska Basin; 2 – Triassic deposits in the other regions; 3 – Permian deposits.
Ciphers in the map: 1 – watershed of the rivers Uboynaya and Pura; 2 – the Fadyu-Kuda River; 3 – cape Tsvetkova; 4 – lower part of the Olenek River; 5 – Western Priverkhoyanye; 6 – Keta – Gorbiachin region; 7 – Kureyka – Severnaya region; 8 – the Kotuy and Maymecha Rivers; 9 – watershed of the rivers Marcha (tributary of the Vilyuy) and Alakit (tributary of the Olenek); 10 – the Tutonchana River Basin; 11 – the Korvunchana River Basin; 12 – the Pirda River; 13 – the Lower Tunguska River; 14 – the upper reaches of the Taymura, Ilimpeya and Chunya Rivers; 15 – the Kuznetsk Basin; 16 – the Semeytau Mountains; 17 – the Kenderlyk Depression; 18 – Zabaykalye; 19 – Northern Mongolia.

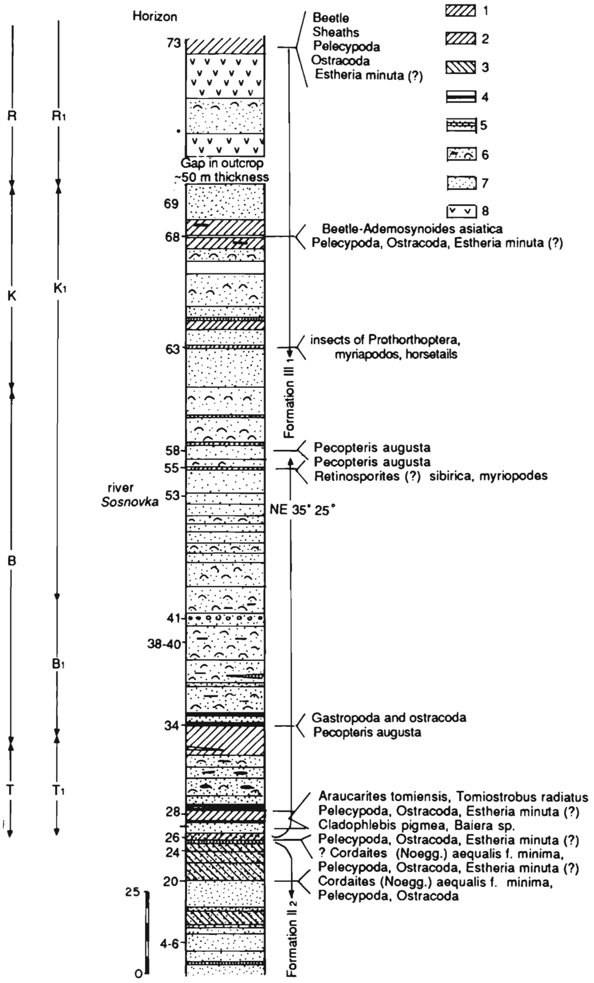


Fig. 27: The section of the Triassic deposits along the right bank of the river Tom in the outcrop "Babiy Kamen" (Neuburg, 1936):
1 – shales and argillites; 2 – sandy argillits; 3 – clay sandstones and sandy argillits; 4 – coal; 5 – marl; 6 – tuffs sandstones with shelly separateness; 7 – thick bedded massive sandstones; 8 – basalts.
At the left the subdivision of the section is shown after Vladimirovich et al., 1967 (T – Tarakanikha beds, B – Barsuchiy beds, K – Kedrovka beds, R – Ryaboy Kameshek beds) and after Radczenko, 1973 (T-1 – Tarakanikha beds, B-1 – Barsuchiy beds, K-1 – Kedrovka beds, R-1 – Ryaboy Kameshek beds).

of the formation was distinguished by RADCZENKO and VLADIMIROVICH as the Tarakanikha beds (later Tarakanikha horizon). It is worth listing all these species because their descriptions are dispersed in many different papers: *Paracalamites triassica***, *Schizoneura altaica*, *Neokoretrophyllites annularioides***, *Pecopteris ? pseudotchichatchevii***, *Pecopteris augusta**, *Cladophlebis pygmea*, *C. lobifera*, *Tersiella beloussovae*, *T. serrata**, *Glossozamites kryshtofovichii**, *Taeniopteris* sp.*, *Tomia radczenkoi*, *T. malzevskiana*, *Rhipidopsis triassica*, *Baiera* sp.**, *Retinosporites? sibirica*, *Araucarites tomiensis* (now *Tomoistrobus radiatus*: see SADOVNIKOV, 1982), *Tomiostrobus radiatus*, *Elatocladus linearis***.

Only *Tersiella beloussovae* and *Glossophyllum kryshtofovichii* were found together at a level of 45–48 m above the base of the Maltsevo Formation (in Barsuchiy beds) and *Neokoretrophyllites annularioides* and *Rhipidopsis triassica* at a level of 120–135 m above the base (this level corresponds to the Barsuchiy beds of VLADIMIROVICH, 1967 and VLADIMIROVICH AND AL., 1967 or to the Kedrovka beds of RADCZENKO, 1973) – see fig. 27. No other plants have been described from the Barsuchiy and Kedrovka beds at Babiy Kamen. No species have been published from the Ryaboy Kameshek beds. *Lutuginia furcata* is the only species described from the Sosnovka Formation. No species are known from Yamino Formation.

At present we have palaebotanical characteristics of just the Tarakanikha beds. The relationships between the plant horizons from other parts of the Kuzbass (fig. 28) with the section described above is unclear. From other parts of the Kuzbass the following species have been described: *Schizoneura altaica*, *Neokoretrophyllites annularioides***, *Todites korvunchanica***, *Tungussopteris cladophleboides***, *Cladophlebis augusta*, *Cladophlebis* sp. ex gr. *concinna*, *Madygenia borealis***, *Tersiella beloussovae*, *Glossozamites kryshtofovichii***.

The author believes, that we can use for comparison only the described and figured species from the Kuzbass because the lists in geological papers contain many undescribed new taxa (nomina nuda). Also the lists in different papers give different data on the stratigraphic position of the species, some of them being contradicted by the localities listed in the descriptions. As can be seen in the list given above nearly all of these fossils are new species (see index of latin names at the end of the book), the majority of them being described from the Tunguska Basin in the same paper (NEW SPECIES . . ., 1960; VLADIMIROVICH ET AL., 1967).

Ten species known from the Kuznetsk Basin occur in the Tunguska Basin and seven others are similar. Nearly all species from the Kuzbass occur in the Tunguska and it is possible to find similar forms in the Korvunchana flora. Only the genus *Tomiostrobus (Pseudoaraucarites)* is not widespread in the Tunguska Basin. At present it is known only from the northern part of the

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* Species similar to the species from the Tunguska Basin.

** Species common with the species from the Tunguska Basin.

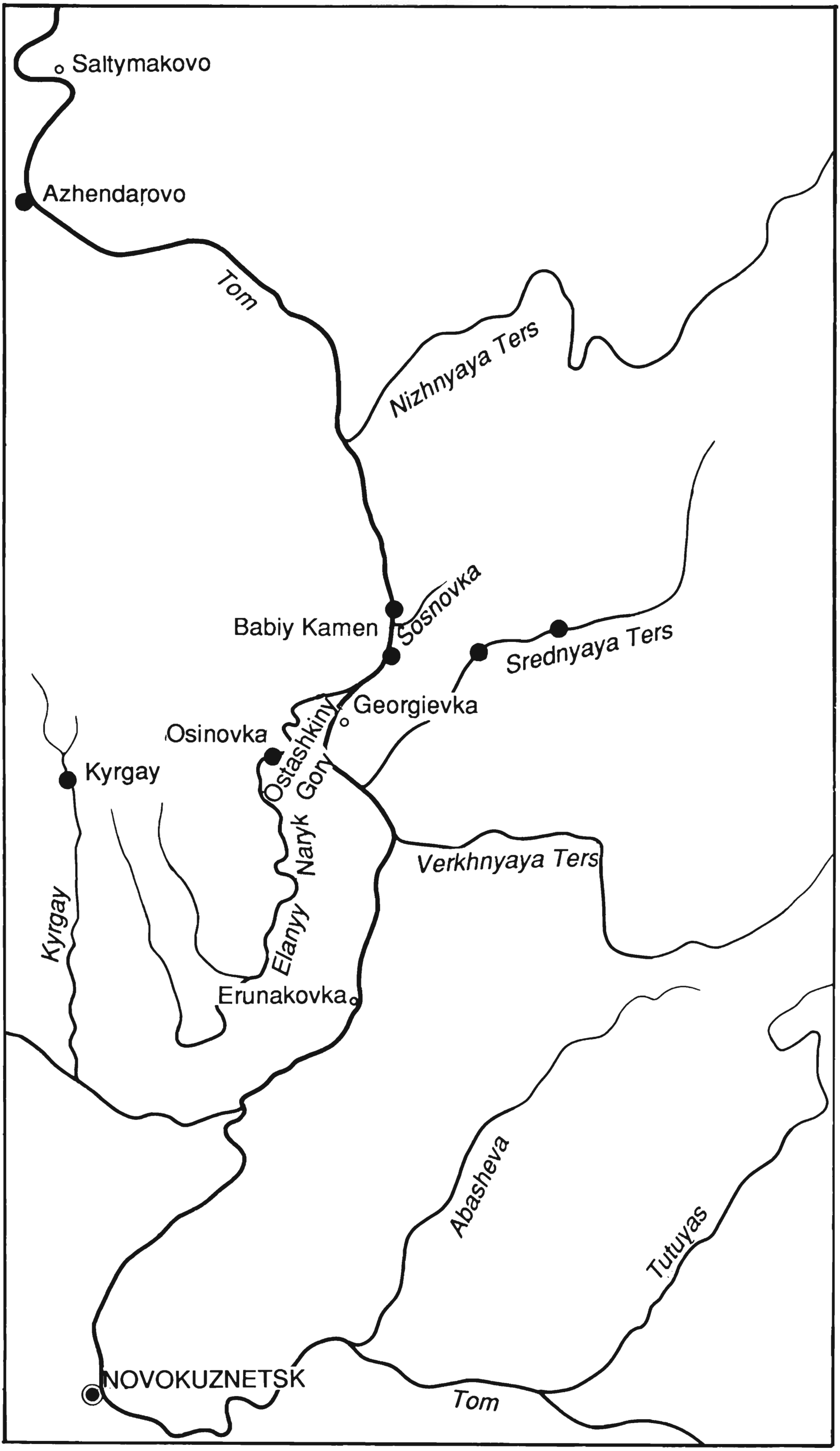


Fig. 28: Localities of the Triassic plants in the Kuzbass.

Tunguska Basin (Prianabarye) and southern part (the Iritka River), whereas it is abundant in the Kuznetsk Basin, Verkhoyanye, Olenekian coast and the Pechora Basin.

In the Russian edition of the book (DOBRUSKINA, 1980) I could not correlate between the Kuznetsk Basin and the Tunguska Basin at the level of horizons. But after the work of MOGUTCHEVA (1980) and our cooperative work (DOBRUSKINA & MOGUTCHEVA, 1987) such a correlative scheme can be attempted (fig. 29). The table also includes correlations with Taymyr and Verkhoyanye. The comparison of the similar plant assemblages of this large region will be discussed later in this book. Apparently the differences are due to facies and palaeogeography rather than age.

Pelecypods do not give a clear answer on how the horizons of the Kuznetsk and Tunguska Basin correlate, but phyllopods (NOVOJILOV in: MALOVETSKAYA ET AL., 1976) indicate that the equivivalents of the Tutonchana and Chichikan formations as well as the Lower Bugarikta subformation are absent in the Kuzbass. MALOVETSKAYA, NOVOJILOV and SADOVNIKOV (1976) correlate the base of the Maltsevo Formation (Tarakanikha beds) with the base of the Upper Bugarikta subformation, whereas VLADIMIROVICH and others (1967) did not find analogs of the Tarakanikha horizon in the Tunguska Basin and believed that Tarakanikha horizon is older than all volcanics of the Tunguska Basin. The correlation of MOGUTCHEVA accepted by the author (fig. 28) differs from correlation made by VLADIMIROVICH as well as SADOVNIKOV.

The age of the Maltsevo Formation is considered Early Triassic chiefly because the majority of geologists believe that the change in the composition of the Kuznetsk flora marks the Permo-Triassic boundary. New data confirms this suggestion (MOGUTCHEVA, 1981; DOBRUSKINA, 1984, 1985 a, 1986 a, 1986 b; MOGUTCHEVA & DOBRUSKINA, 1986; DOBRUSKINA & MOGUTCHEVA, 1987). The data will be discussed in the following part.

The Tunguska Basin

In the Tunguska Basin as well as in the Kuznetsk Basin strong change in plant assemblages occurs at the boundary of the coal-bearing and volcanic deposits (see fig. 26). In the coal-bearing deposits up to 90% of the plant fossils are cordaitalean whereas in the volcanic deposits the cordaitaleans are completely absent. Only *Yavorskyia* and *Rhipidopsis* occur both in coal-bearing and volcanic deposits. The plant assemblages in the latter ones are traditionally considered Mesophytic. The idea of the Mesophytic aspect of the Korvunchana flora evidently originates from the fact that the abundance of ferns is unusual for the Angarida Palaeozoic floras whereas it is more usual for the Mesozoic floras of the Siberian province. But the species of the Korvunchana ferns are very different from the widespread Mesozoic ferns of the Siberia Province. On the other hand an abundance of ferns is not unusual for other palaeofloristic

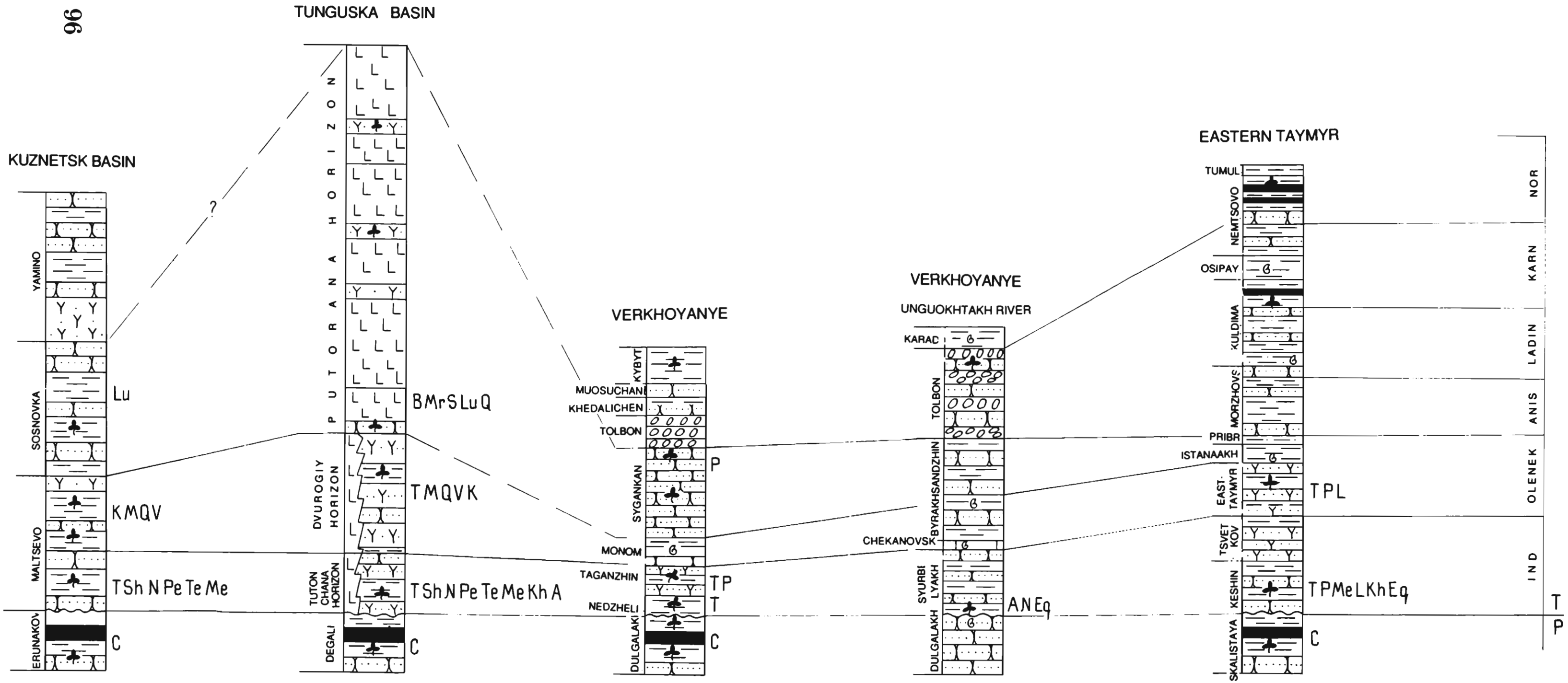


Fig. 29: Correlation of the Triassic plant-bearing deposits of the Kuznetsk and Tunguska basins, Verkhoyanye and Taymyr (after MOGUTCHEVA). Letters from the right are the first letters of generic names of fossil plants: L – *Lutuginia*. K – *Katasiopteris lebedevii*. M – *Madygenia*. Q – *Ouadrocladus*, V – *Voltzia*. T – *Tomiostrobus*, Sh – *Schvedopteris*. N – *Neokoretrohvllites linearis*. P – *Pecoperis ? pseudotchichatcheyii*. Te – *Tersiella*, Me – *Mesenteriophyllum*. B – *Boreopteris*. Mr – *Mertensides*. S – *Scytophyllum*, Kh – *Khonomakidium*. P – *Pleuromeia*. A – *Arthropitys*. Eq – *Equisetites sixteliae*. L – *Lepidopteris*, C – *Cordaites*.

areas, for example the Cathaysia and Euramerica areas in the Palaezoic. In fact the Korvunchana ferns are very similar to the ferns of these two areas.

Investigation of fossil plants from Tunguska volcanics was studied before world war II by PRYNADA, but his results were only published in 1960 and in 1970 after his death. Single species were described from the Tunguska volcanics by SREBRODOLSKAYA, VLADIMIROVICH, RADCZENKO and small collections were described by SCHVEDOV and TOLSTYCH (for references see list 60 in the third part of this book). At present Korvunchana plants are being studied by MOGUTCHEVA, SADOVNIKOV and the author.

The occurence of fossil plants in the stratigraphic sequence is shown in fig. 30 for the three parts of the Tunguska Basin. These three parts of the basin have different stratigraphic schemes. Besides the differences in stratigraphy which are caused by the geological peculiarities there are differences in the stratigraphic schemes used by the two principal institutions – "Aerogeologia" in Moscow and "SNIIGGIMS" in Novosibirsk – which deal with the Tunguska volcanics. The author now accepts the scheme of the SNIIGGIMS because it is based on the investigations of Mogutcheva.

Rocks containing the Korvunchana flora consist of volcanic sedimentary deposits in the lower part. In the upper part sedimentary rocks become rare and lava covers appear. The lava deposits can be traced with confidence over great distances and can be used as marker horizons for stratigraphic correlations. They also can be used for determining the exact position of the fossil localities.

The Korvunchana flora as a whole can be called a fern – conifer flora (list 60 a–i). Ferns constitute more than two thirds of all the plants in the flora. They are similar to the Carboniferous and Permian ferns of the Cathaysia and Euramerica areas although common species are absent. Single forms seem to be similar to the Keuper ferns but the presence of common genera is doubtfull. These ferns are not similar to the ferns of the Buntsandstein.

Conifers are more abundant in the upper part of the sequence but most of them have not been described. Conifers are similar to those from the Voltziensandstein of the German Basin and differ from Permian conifers. Sphenopsids, pteridosperms, cycadophytes and ginkgophytes occur in equal quantities. All the sphenopsids are assigned to the Palaeozoic genera. The cycadophytes are monotonous and do not show peculiarities. The peltaspermous pteridosperms and the Glossophyllaceae connect the Korvunchana flora with the Keuper flora and with the Permian floras of the eastern part of European USSR.

The Korvunchana flora is younger than all known Upper Permian floras of Angarida because it lies directly above the uppermost Permian coal-bearing deposits with the *Cordaites* flora. There are no direct data concerning its upper limit in the Tunguska and Kuznetsk Basins. The problem is to find the stratigraphic equivalent of the base of the *Otoceras* zone, because this level is accepted as the Permo-Triassic boundary in the International Geological Time scale. In Siberia the transition from continental to marine deposits of this age cannot be traced laterally, as can be done, for example, in southern China

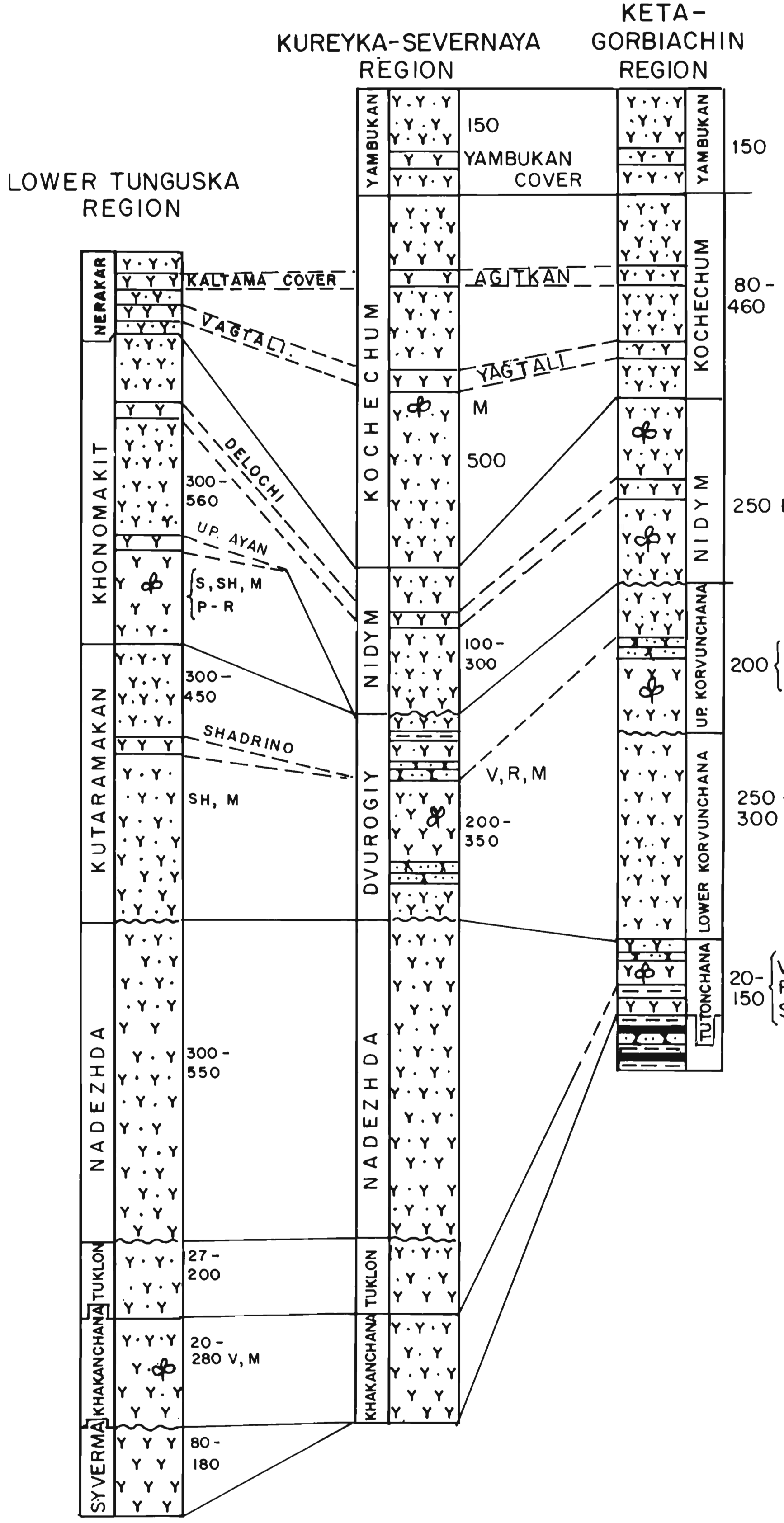


Fig. 30: Correlation of the Triassic deposits of the Tunguska Basin (MOGUTCHEVA, 1973; MOGUTCHEVA et al., 1976): Letters near the columns mean the names of the palaeobotanists who described the fossil plants from the corresponding beds: S – SREBRODOLSKAJA, SH – SCHVEDOV, M – MOGUTCHEVA, V – VLADIMIROVICH, R – RADCZENKO, P – PRYNADA, Sa – SADOVNIKOV. For the legend see fig. 74.

with the uppermost Permian deposits. Therefore correlation can be made only by comparisions of palaeontological, palaeomagnetic, lithologic, and geochemical data.

In the Tunguska and the Kuznetsk Basins the vertical change from coal-bearing beds to volcanics coincides with the change in plant assemblages. The coal-bearing beds contain the *Cordaites* flora (about 90% leaves are *Cordaites*), whereas the volcanics contain the conifer-fern flora, the so-called Korvunchana flora. These two floras do not have any species in common and they have only two common genera, which are not dominant. When this level was discovered it was considered to be the boundary between the Permian and the Triassic mainly because of the fact that ferns are the major constituents of Siberian Mesozoic floras. Later it became clear, however, that nearly all ferns are endemic, and as a whole they are closer to Palaeophytic groups than to Mesophytic ones. Pteridosperms and conifers of the Korvunchana flora are also comparable with those of the Late Palaeophytic floras.

Floras of the Late Permian and of the first half of the Triassic which are considered to be Late Palaeophytic include the Zechstein flora of Western Europe, the *Tatarina* flora of Eastern Europe and Northern China, the flora of the Shischienfeng Group of northern China, and some floras of southern China which lie above the continental analogs of the Changsinian Stage. These floras differ from earlier Palaeophytic ones in two ways: 1) the extinction of dominant groups of the Palaeophytic flora kingdoms, and 2) the flourishing of pteridosperms, conifers and ferns which were rare in the older floras. Precise correlations of different plant horizons of the Korvunchana flora with the horizons of the Late Palaeophytic can help us to locate the Permo-Triassic boundary in Siberia.

New data by Chinese and Soviet palaeobotanists (see DOBRUSKINA, 1984) shows a wide distribution of conifers in China and Siberia. These conifers : *Voltzia, Quadrocladus, Darneya, Masculostrobus* (see MOGUTCHEVA, 1984 a; MOGUTCHEVA & DOBRUSKINA, 1986) are closer to conifers of the Voltziensandstein than to those of the Zechstein and of the Tatarian stages. Also, their abundance is the common feature of the upper parts of the sections. The lower parts of the sections in China and Siberia have no conifers, whereas in Europe the Lower Buntsandstein has no fossils at all. Correlation of sections in these three regions on the basis of floral content, the development of the flora, and faunal content also confirms (DOBRUSKINA, 1985 a) the Triassic age of the Tunguska volcanics, which contain the Korvunchanian flora (fig. 31). These results are in agreement with the comparative study of Triassic plants of the Tunguska and the Kuznetsk Basins and the Taymyr Peninsula and the Verkhoyansk Range made by MOGUTCHEVA (MOGUTCHEVA, LEBEDEV & GRIGORYEVA, 1976).

Most palaeozoologists who deal with fossil ostracods, conchostracans, nonmarine pelecypods, fish, and tetrapods from the Tunguska volcanics considered them to be of Triassic age, although some of them think they are Permian in age. This controversy can be decided only after monographic studies of the fossils are completed. There is also the possibility that some controversies in age

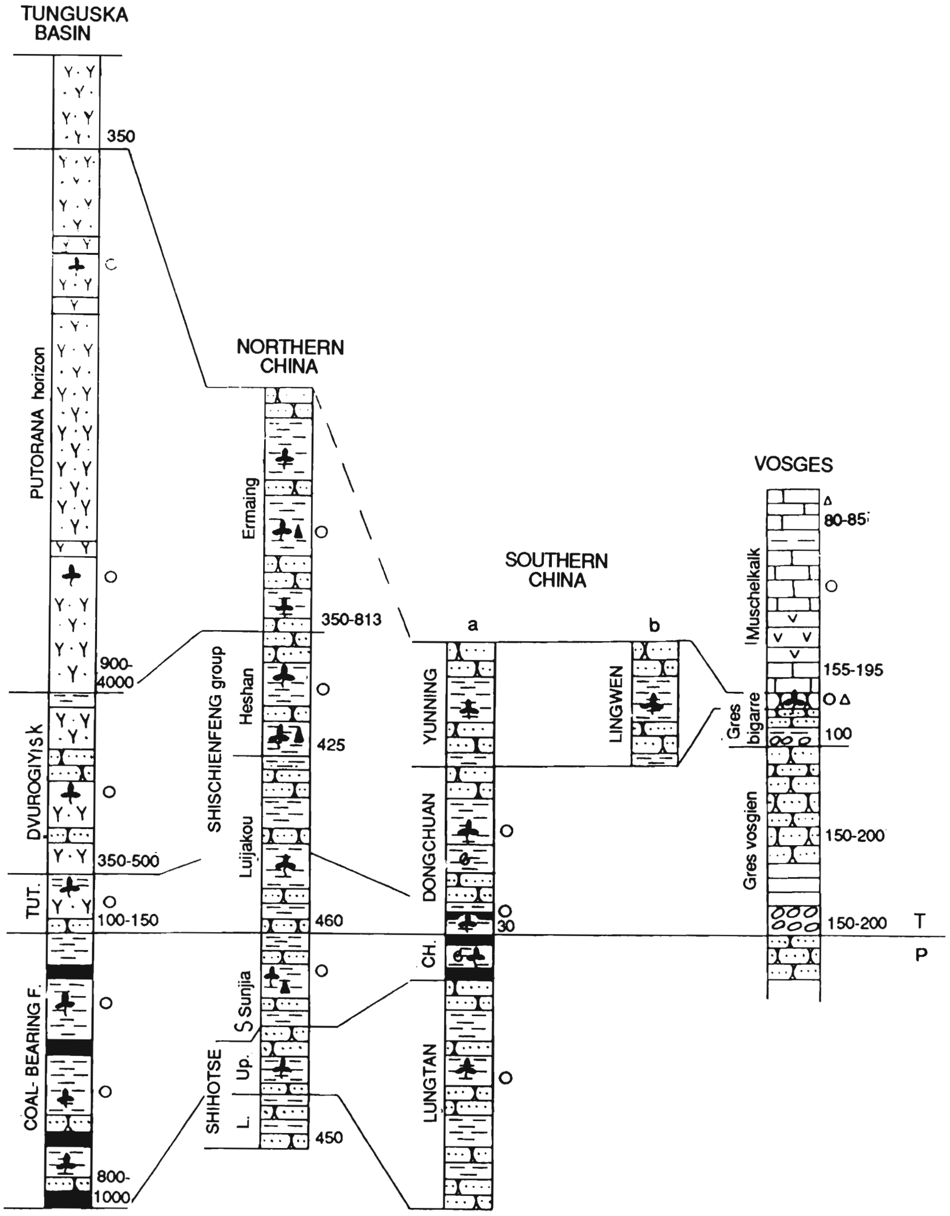


Fig. 31: Correlation of the Lower Triassic of Siberia, China and Western Europe. The Tunguska Basin is given after "Reshenia . . ., 1981"; Northern China after Wang et al., 1978, Wang & Wang, 1982, Huang & Zhou, 1980; Southern China (a) – Yunan – Guizhow after Yao, 1978; Southern China (b) – Guandong after Zhou & Li, 1979; the Vosges after Ricour, 1963. For the legend see fig. 74.

determination arose as a result of incorrect correlations of some of the volcanic beds during geological mapping of the Tunguska Basin.

It is of interest that both Palaeophytic and Mesophytic miospore assemblages are present in the Tunguska volcanics. OBONITSKAYA (1970, 1974) considers the Palaeophytic fossils to be re-worked, whereas KRUGOVYCH (1982) has found in them the equivalents of all Permian miospore complexes known in the underlying coal-bearing beds. Until now, macrofossil remains have not been found together with such miospore assemblages, but in some geological papers *Cordaites* has been noted in the volcanics. Thus one cannot avoid the idea that volcanic activity began during the Permain in Siberia. However, the Korvunchana flora appeared later – in the Triassic.

The Taymyr peninsula

In the Taymyr peninsula Triassic plants are known in three localities according to the papers of SCHVEDOV (1958, 1960 a, 1960 b) – fig. 32; see also fig. 25 and list 61. The sequence begins with volcanic-sedimentary formations (tuffs – lava, lava or effusive – tuffites), in the lower part of which *Cordaites* is present ("Noeggerathiopsis" matveevensis). A pterodophytic assemblages (in Western Taymyr – list 61 a) or pteridophytic-lepidophytic assemblages (in Eastern Taymyr – list 61 c, 61 d: Keshin, "Marininskiy", "Fadyukuda" formations, list 61 e) occurs in the upper part of the unit.

Lepitopteris arctica occurs in great numbers in the Keshin Formation, whereas other Korvunchana plants are present in smaller quantities. *Tomiostrobus* is also found in the overlying Terrigeneous Member (= Eastern Taymyr Formation) (list 61 d) together with the Lower Triassic estherias *Lioestheria gutta*. The Eastern Taymyr Formation is overlain by with the Olenekian ammonites: *Olenekites alatus, Kwyserlingites middendorfi, Dieneroceras demokidovi.* From the overlying Anisian deposits *Frechites laptevi, Arctohungarites friformis* and *Beyrechites migayi* are known (POPOV, 1973).

The lower part of the Mamonov Formation of Central Taymyr (list 61 b partly) also belongs to the lower half of the Triassic.

It is now known that the genus *Tomiostrobus* is widespread in the Siberian palaeofloristic area from the very beginning of the Triassic. Thus, in the Taymyr the boundary between the Permian and the Triassic is drawn within the volcanics: the lower part with the *Cordaites* flora is Permian in age and the upper part with *Tomiostrobus, Lepidopteris* etc. is Triassic in age.

The plants of the upper half of the Triassic are known from the Central and Eastern Taymyr. In the basin of the Fadyu-Kuda River they occur in the Mamonov Formation (list 61 b partly), in the cape Tsvetkov they occur in the Kuldima or Tsvetkov Formation and in the Nemtsov Formation (MOGUTCHEVA, 1984 a, list 61 d). The two formations are separated by marine deposits of Karnian age containing *Discophyllites tajmyrensis* and *Halobia zitteli.* In these deposits the vertebrate *Schastosaurus* sp. is also found.

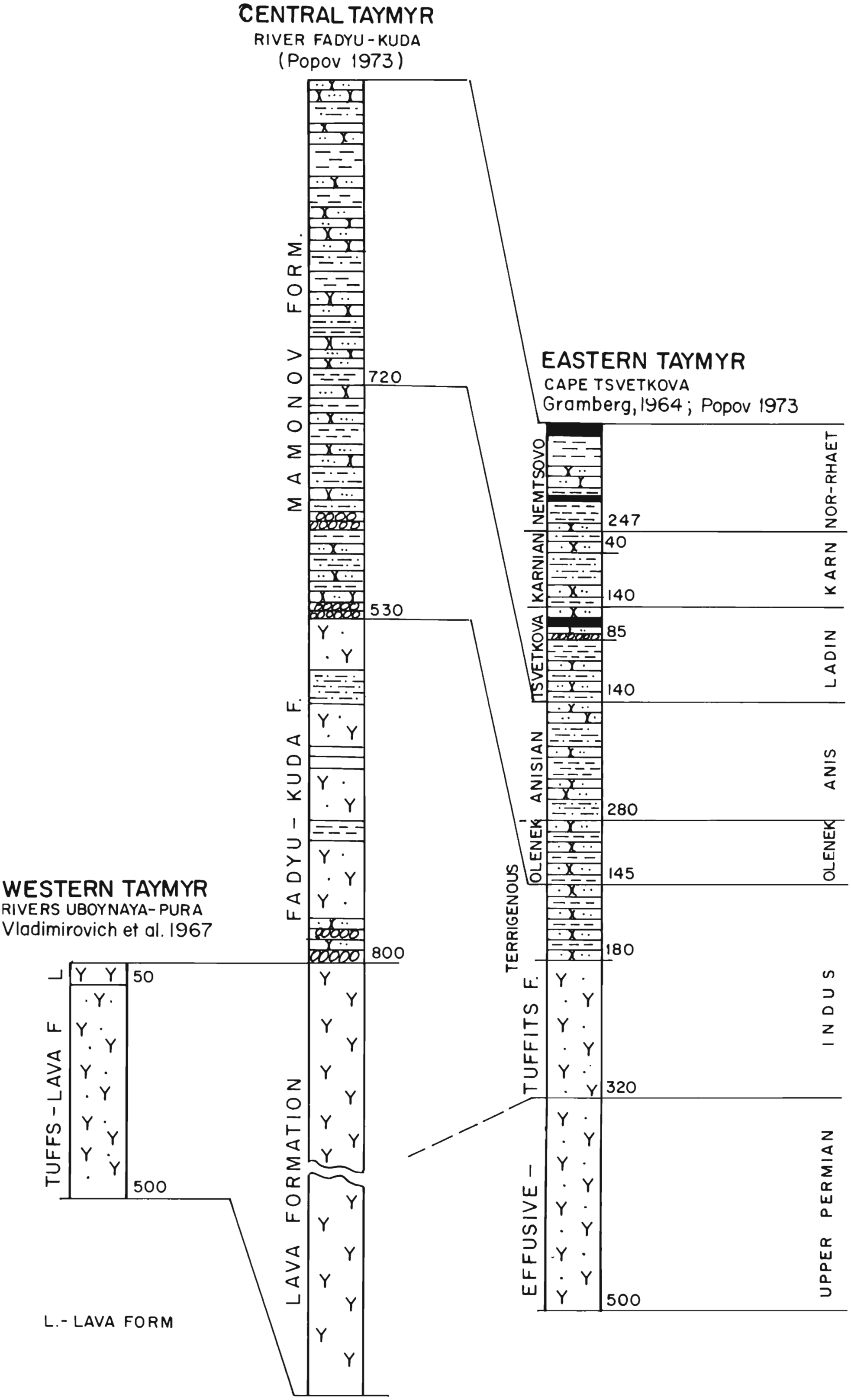


Fig. 32: Correlation of the Triassic deposits of Taymyr. For the legend see fig. 74.

Schvedov (1960 a, 1960 b) compared *Neocalamites carcinoides, N. hoerensis, Glossophyllum ?* and *Podozamites,* described by him, with similar plants from Yenchang Formation of northern China and also from the Kurashasay Formation of southern Priuralye. His opinion was that they are of Ladinian-Karnian age. But poor preservation and small quantity of Taymyr plants do not permit to give exact age determination. The fossil recently discovered by Mogutcheva (1983) in the Nemtsov Formation of the Taymyr (mys Tsvetkova) are abundant and well preserved but the study of them is not finished. Preliminary results permit her to compare this flora with the flora of the Eastern Urals in general (Norian-Rhaetian).

The Northern Coast

In the Northern Coast plant-bearing beds of Induan age are called Ulakhan-Yuryakh formation and composed of volcanics in the lower part and of terrigeneous rocks in the upper part (as in Taymyr). They contain *Tomiostrobus migayi* in great numbers. Together with plants an estheria was found *(Lioestherua gutta)*. The Ulakhan-Yuryakh formation is underlain by the Upper Permian volcanics (see fig. 26) and overlain by the Olenekian deposits with the ammonites *Prosphingites czekanowski, Olenekites alatus, Keyserlingites middendorfi, Dieneroceras demokidovi, Paranorites olenekensis.* In the middle part of the Olenekian *Pleuromeia olenekensis* (Krassilov & Zakharov, 1975 a, 1975 b) was found at the mouth of the Olenek River (list 62 c). Above the Olenekian deposits marine Anisian and Ladinian deposits with *Indigirites subneraensis, Daonella subarctica, Arctohungaritestriformis, Parapapanoceras torelli* occur. The Ladinian strata are overlain by Karnian deposits containing *Halobia superba.*

Mogutcheva (1984 c) collected lower Triassic plants, chiefly *Tomiostrobus* not far from the mouth of the Olenek River at the locality Ystynaakh-Khocho (list 62 b). She also described Middle Triassic plants from the Anabar Coast (list 62 a). Poorly preserved *Pleuromeia* sp. was found by Lozovsky in the Buur River in the basin of the Olenek River (list 62 d) and near the mouth of the Lena River (list 62 a), both from the Olenekian (determinations of the author).

The Western Verkhoyanye and Vilyuy syneclise

In the Western Verkhoyanye many localities of *Tomiostrobus* are known (list 63). They are the Kharaulakh mountains, the rivers Syncha, Sobopol, Seymcheen, Yulegiir, Tokur-Yureech, Dyolbuun (Tuchkov & Popov, 1973; Sadovnikov, 1982 a). Most of them are Induan, and only one locality at the Syncha River is Olenekian (list 63 d from Sygynkan Formation).

A typical Korvunchana flora is found in the Orulgan Range (the Unguokhtakh River – list 63 b) below the horizon with Triassic conchostraca and above the Upper Permian bed with gigantic *Kolymia* (Durante & Biterman, 1978; Mogutcheva, 1984 c). Mogutcheva compares this plant assemblages with the plant assemblages of Tutonchana horizon in the Tunguska Basin, i. e. with the lowest formation of the Tunguska volcanics with the Korvunchana flora. This is additional evidence for the Triassic age of the Korvunchana flora because the rocks with the Unguokhtakh flora are correlated with the Otoceras zone of the eastern slope of the Verkhoyansk Ridge.

Tomiostrobus is also known from the equivalent of the Induan Nedzhelinsk and Taganzinsk Formations of Verkhoyanye and in the Vilyuy syneclyse (list 62 f) according to preliminary determinations made by Mogutcheva.

An Upper Triassic flora in the West Verkhoyanye was reported from the basin of the Tumara River, a tributary of the Aldan (list 63 j). Only one species *Bernoullia* sp. was described from the Khedalichen Formation which is conditionally considered to be Late Triassic in age (Abramova, 1960). The formation is underlain by continental deposits of the Tolbon Formation with conchostracians *Pseudoestheria plicifera, Cyclotungusites gutta, Sphaeroestheria koreana.* The Formation in turn is underlain by Olenekian deposits containing ammonites, pelecypodes and conchostraca: *Koninckites, Flemingites, Hedenstroemia hedenstroemi, Parananannites, Dieneroceras, Claraia, Pseudoestheria sibirica.* Below the Olenekian rocks the terrigeneous deposits contain *Wetlugites propus* and *Pseudoestheria vjatkensis* and near their base *Anodontophora.* These beds were referred to as Induan.

The north-east of the USSR

From the north-east of the USSR only *Sagenopteris* is reported from the Triassic (list 63 k). It was collected at least from the three regions: Anadyr, Big Anuy and Omolon rivers.

Zabaykalye

In Zabaykalye the Triassic plants are known only from preliminary determinations; descriptions and figures are absent.

Summary

Plant-bearing deposits with flora of the Korvunchana type is widely distributed in Eastern Siberia. Dominants in it are ferns and conifers. It is most completely developed in the Tunguska syneclise. In the Kuzbass its equivalent contain similar but a poorer complex of plant remains. One locality of the Korvunchana flora is known in the Verkhoyanye. In the Taymyr and Olenekian Coast, Korvunchana plants are also present, but here other plant groups dominate: pteridosperms, *Lepidopteris arctica* or lycopsids *Tomiostrobus*. Lycopsid *Tomiostrobus* and sometimes *Pleuromeia* are dominant in the margins of Siberian platform and in the adjacent areas (the Kuznetsk Basin, the Verkhoyanye, the Olenekian Coast, the Taymyr, the Pechora Basin). In the Kuznetsk Basin lycopsids dominate in the lowermost part of the section which is characterized by the best preserved fossil plants. The lower horizons in the Tunguska and Kuznetsk Basins have no conifers, conifers occur in the second horizon. In the Kuznetsk Basin the amount of conifers increases towards the top of the Maltsevo Formation. According to the correlation with Western Europe and China the age of the Tunguska volcanics containing the Korvunchana flora is considered to range from Induan to Anisian in age (see fig. 31).

Younger plant-bearing deposits are less widely distributed in this territory and are characterized by small plant assemblages. These are the Ladinian deposits of the Semeytau mountains and of the Taymyr, the Norian-Rhaetian deposits of the Taymyr and the Upper Triassic deposits of the basin of the Aldan River (the Taymura River).

Chapter six

Central Asia, South-eastern Asia, and the Far East

Exposures of the Triassic deposits of this region are shown in fig. 33 and correlation of the plant-bearing beds are given in fig. 34.

Mongolia

In Mongolia the Triassic deposits are exposed in the central and north-eastern parts of the country; small outcrops are also present in the very south (fig. 35). They are composed of marine terrigeneous deposits (fig. 36) with the remains of marine invertebrates of Olenekian age in the lower part (determinations of KIPARISOVA and OKUNEVA). Continental deposits with many fossil plants lie above them in the Abzog Depression, the Selenga River Basin where they are divided into two parts (GRETSKAYA & MOSSAKOVSKY, 1969; TOMURTOGOO, 1973). The lower part consists of continental grey coloured coarse clastic deposits that include rare interbeds of volcanics (lava and pyroclastic rocks of intermediate composition). The upper part is composed of effusives of middle and acid composition and sedimentary rocks also occur in them, chiefly in the lower part.

Plant remains are known only from the terrigeneous member (list 65, 66). RADCZENKO and VLADIMIROVICH (in: AMANTOV et al., 1970) considered the lower part of the coarse clastic deposits to be Early Triassic in age and the middle and the upper parts to Middle and Late Triassic. Fossil plants which are in the author's collections came from terringeneous deposits in the Abzog depression. The fossils were collected by MOSSAKOVSKY and TOMURTOGOO from the Abzog Formation in the area between the rivers Orkhon and Tola and occur in three stratigraphic levels. Two lower levels are confined to the "second member" of MOSSAKOVSKY and TOMURTOGOO, the third – to the top of the "fourth member". There are 130 imprints from the Abzog Formation in the collection of the Geological Institute. Detailed comparison of plants from different levels showed that they are very similar except for the absence of *Danaeopsis* and *Cladophlebis shensiensis* in the fourth member (the uppremost); all the plants belong to a single assemblage.

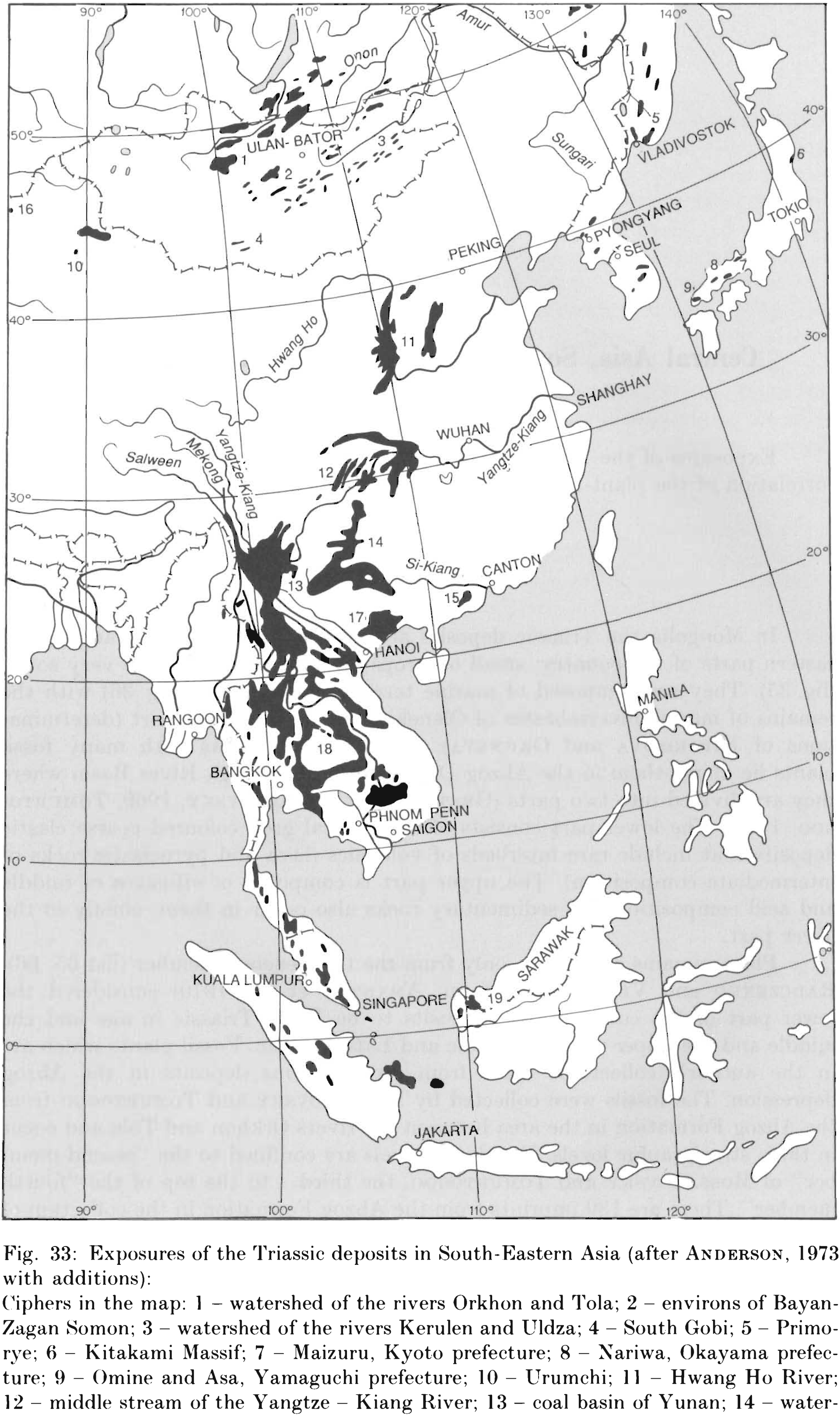
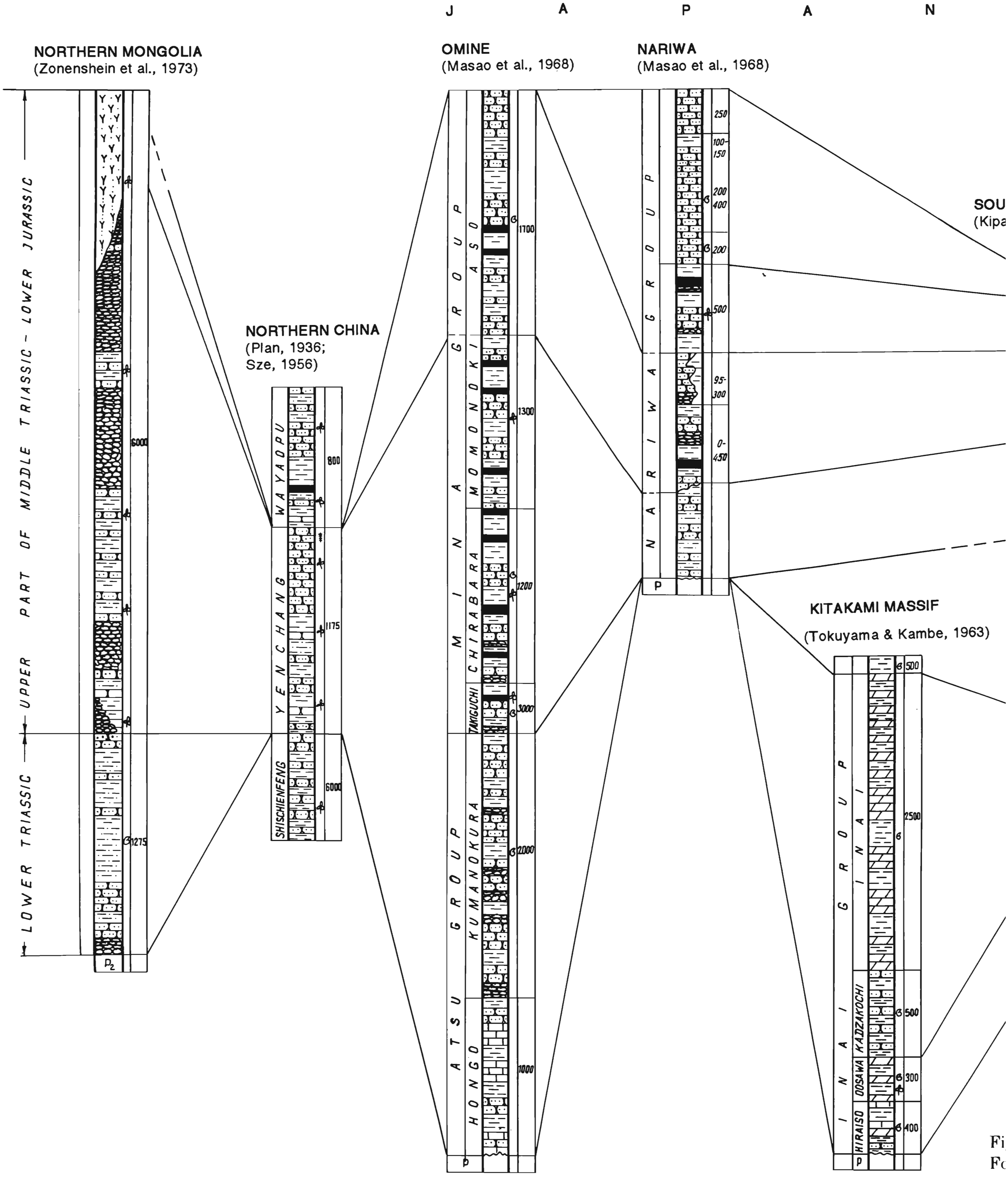


Fig. 33: Exposures of the Triassic deposits in South-Eastern Asia (after ANDERSON, 1973 with additions):
Ciphers in the map: 1 – watershed of the rivers Orkhon and Tola; 2 – environs of Bayan-Zagan Somon; 3 – watershed of the rivers Kerulen and Uldza; 4 – South Gobi; 5 – Primorye; 6 – Kitakami Massif; 7 – Maizuru, Kyoto prefecture; 8 – Nariwa, Okayama prefecture; 9 – Omine and Asa, Yamaguchi prefecture; 10 – Urumchi; 11 – Hwang Ho River; 12 – middle stream of the Yangtze – Kiang River; 13 – coal basin of Yunan; 14 – watershed of the rivers Yangtze – Kiang and Si-Kiang; 15 – Kaomin; 16 – Chinese Dzhungaria; 17 – Northern Viet Nam; 18 – Thailand, Khorat plateau; 19 – Sarawak, Crusin.


J A P A N
NORTHERN MONGOLIA
(Zonenshein et al., 1973)
LOWER TRIASSIC
UPPER PART OF MIDDLE TRIASSIC - LOWER JURASSIC
P2
1275
6000
NORTHERN CHINA
(Plan, 1936;
Sze, 1956)
SHISCHIENFENG
YENCHANG
WAYAOPU
6000
1175
800
OMINE
(Masao et al., 1968)
ATSU GROUP
MINA GROUP
HONGO
KUMANOKURA
TAKIGUCHI
CHIRABARA
MOMONOKI
ASO
P
1000
2000
3000
1200
1300
1700
NARIWA
(Masao et al., 1968)
NARIWA GROUP
P
0-450
95-300
500
200
200-400
100-150
250
KITAKAMI MASSIF
(Tokuyama & Kambe, 1963)
INAI GROUP
HIRAISO
OOSAWA
KADZAKOCHI
INAI
P
400
300
500
2500
500
SOU
(Kipa

Fi
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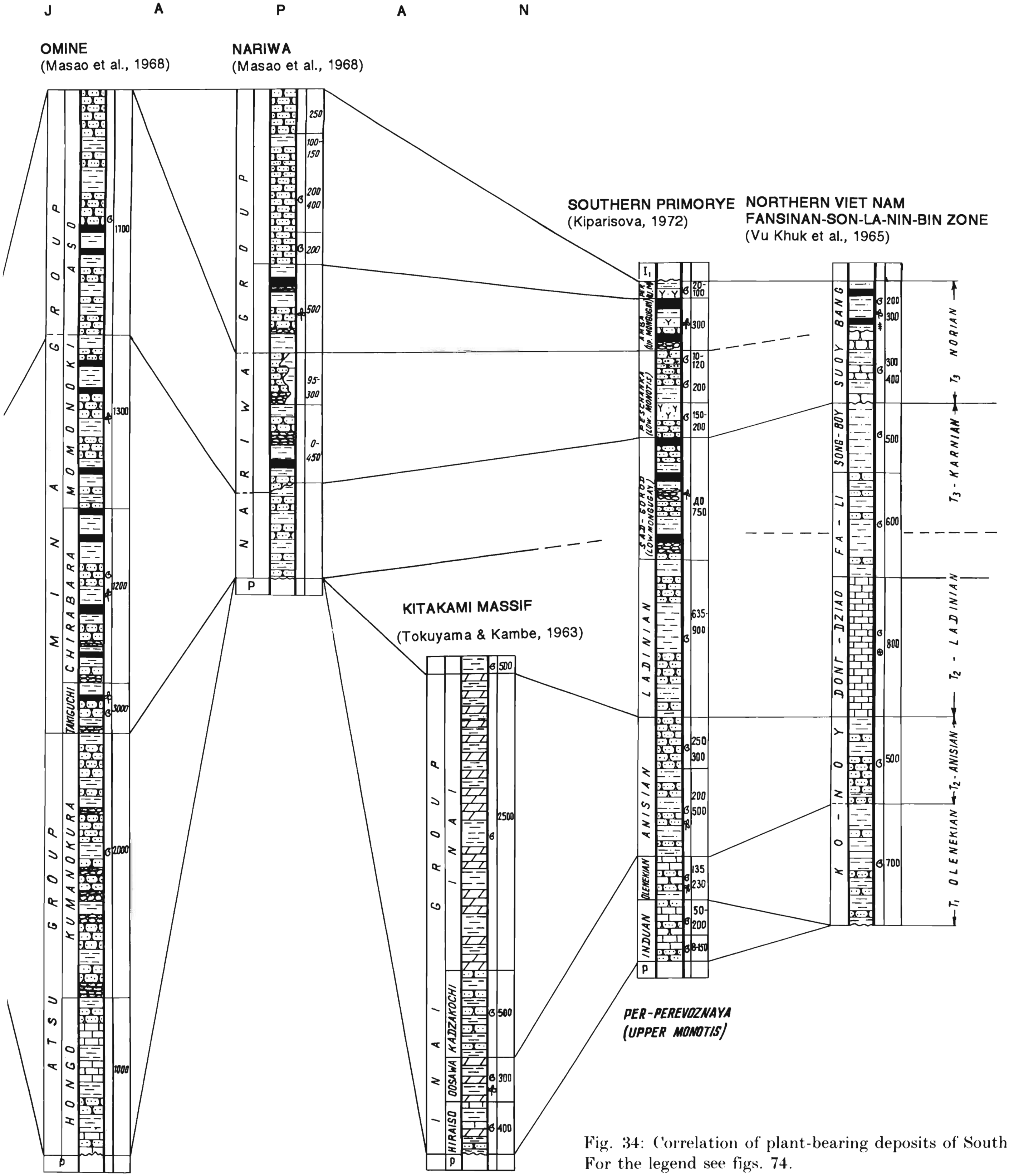

Fig. 34: Correlation of plant-bearing deposits of South Eastern Asia. For the legend see figs. 74.

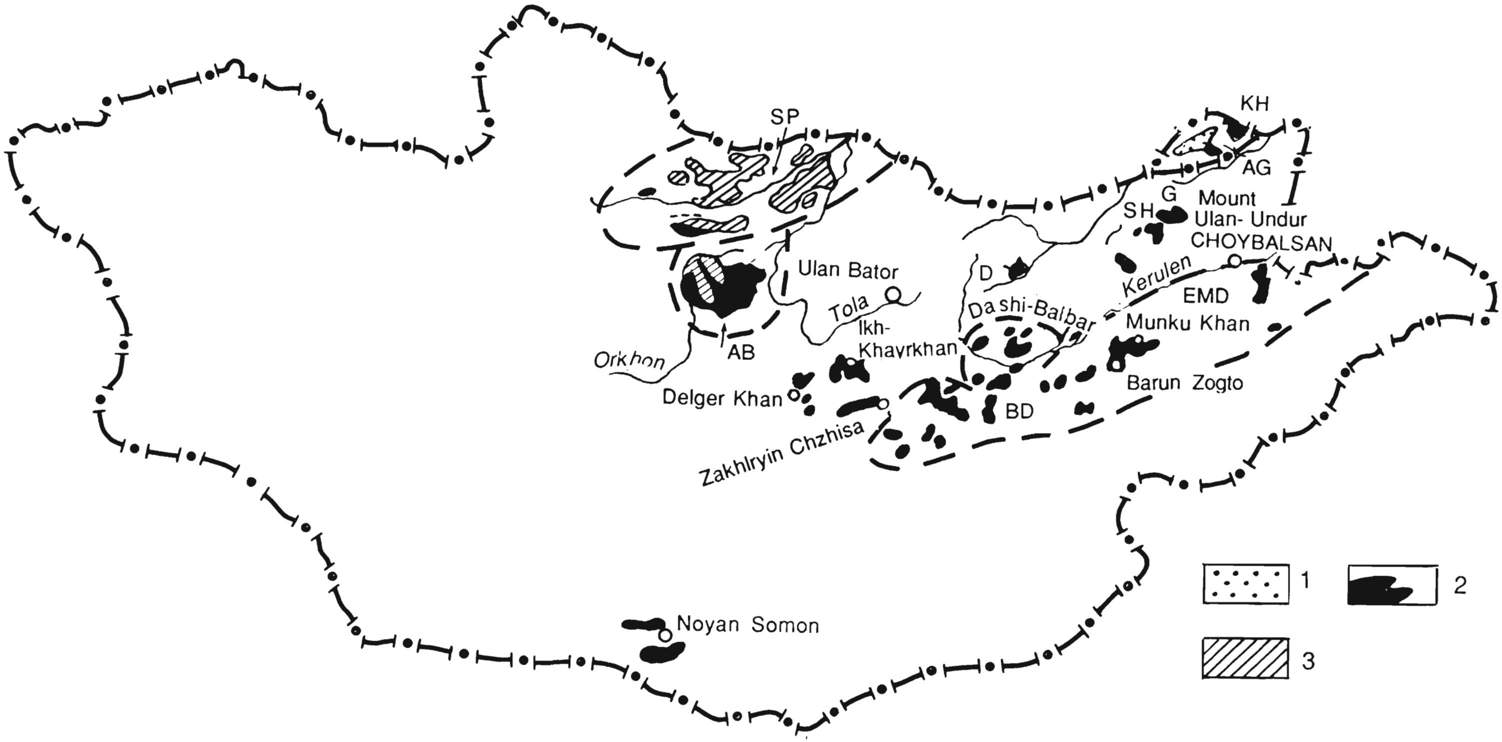

Fig. 35: Exposures of the Triassic deposits of Mongolia (after "GEOLOGY OF MONGOLIAN PEOPLE'S REPUBLIC", 1973): 1 – undivided deposits of the Upper Permian-Lower Triassic; 2 – Triassic; 3 – undivided deposits of the Upper Triassic-Lower Jurassic.

Abbreviations: SP – Selenga volcanic belt; AB – Abzog Depression; AG – Aga Field; BD – Bayan – Dzhargalantuin Depression; EMD – Eastern Mongolian volcanic belt; D – Dzhargalantuin graben-syncline; SH – Shaldza graben-syncline; G – Gertuin graben-syncline; KH – Khutuinnur graben-syncline.

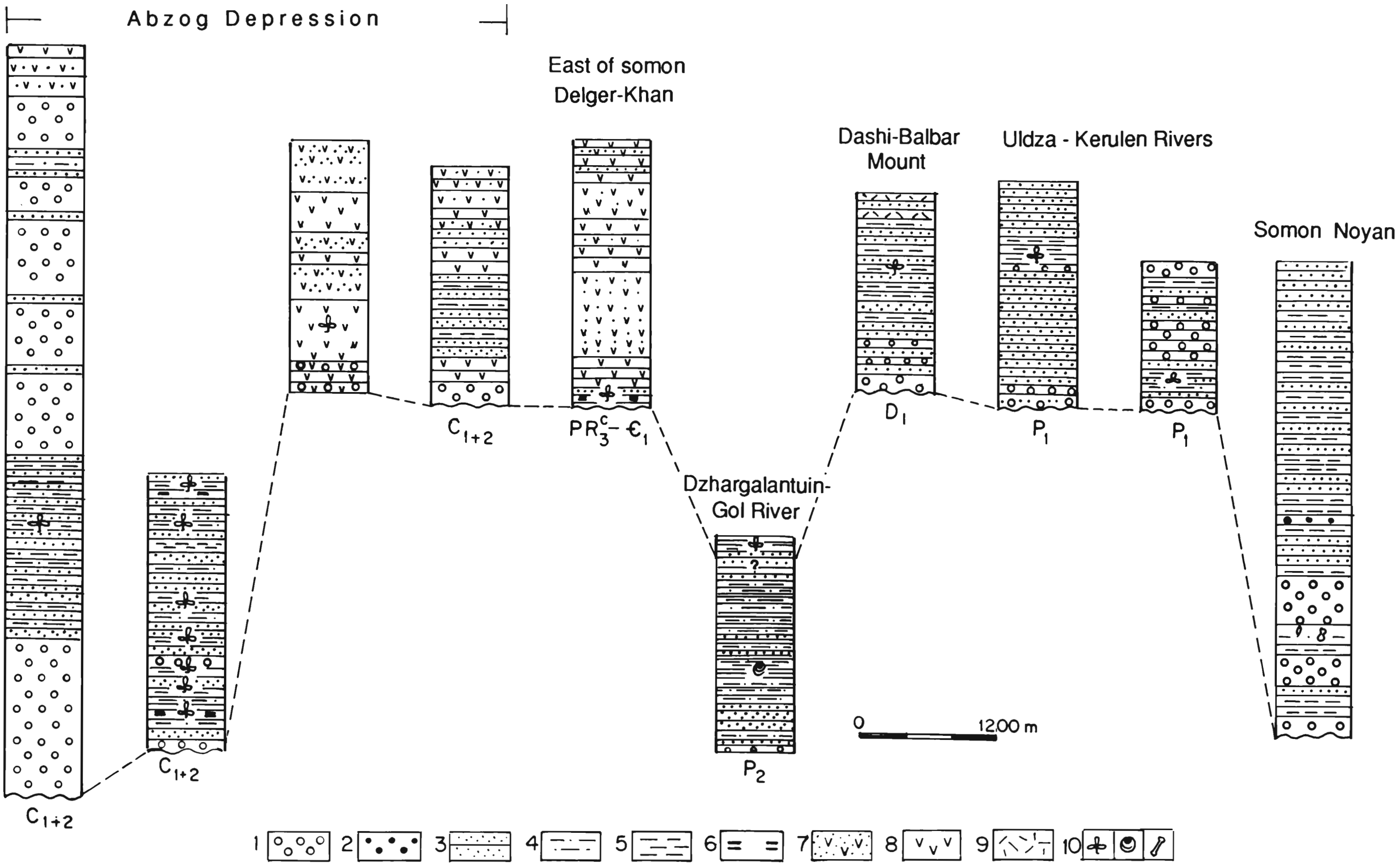

Fig. 36: Correlation of the Triassic deposits of Mongolia (after "GEOLOGY OF MONGOLIAN PEOPLE'S REPUBLIC", 1973 with additions; SOMON NOYAN – after ZAYTSEV et al., 1973):
1 – conglomerates; 2 – gravelites; 3 – sandstones; 4 – siltstones; 5 – argillites; 6 – tuffites; 7 – tuffo-sandstones; 8 – effusives of middle contents; 9 – effusives of acid contents; 10 – fossil remains: – plants, – invertebrates, tetrapods.

My examination of the descriptions and schematic drawings of the Lower Triassic plants from the Abzog River and Somon Abzog in the paper of RADCZENKO and VLADIMIROVICH (in: AMANTOV ET AL., 1970) led to the following conclusions: 1) *Nilssonia undulata* and *Tologoella abzogensis* are undeterminable, 2) *Tychtopteris ? ovalis*, *Mongolophyllum amantovii* and *M. linearis* are actually species of *Uralophyllum* (i. e. "*Thinnfeldia nordenskioldii*" in old papers) similar to those from northern China and very usual for the Middle and Upper Triassic plant assemblages in Mongolia, and 3) *Taeniopteris toliensis* is undistinguishable from *Taeniopteris ensis*. It is apparent that the fossil plants give no basis for distinguishing two plant assemblages of different age in the Abzog depression.

In more eastern parts of Mongolia most fossil plants localities are confind to coarse clastic deposits which fill isolated depressions (fig. 37). In the upper part of such deposits, acid, intermediate and alkaline effusives are present although they are more abundant in the west. In the south in the area of Noyan Somon only terrigeneous deposits occur.

Plant assemblages in different parts of Mongolia are similar to each other. The differences consist mainly of the degree of preservation and the species diversity whereas the generic composition is the same at the various localities. Often the same or similar species of a genus are present in all parts of Mongolia. In the collections of the Geological Institute this complex consists of more than 900 specimens.

Sphenopsids *(Equisetites, Neocalamites)* together with the ferns *(Danaeopsis, Bernoullia, Cladophlebis)* dominate. Pteridosperms *(Scytophyllum, Uralophyllum)*, cycadophytes, ginkgophytes and conifers are not so numerous. Numerous conifers were found in the basin of the Selenga River. This assemblage is very similar to the assemblage in the Yenchang Formation of Northern China (SZE, 1956), being distinguished by the presence of the Czekanowskiales and *Cycadocarpidium*, the abundance of *Podozamites* and a small diversity of ferns.

Most of these rocks were considered to be Upper Permiam until fossil plants were discovered in them during the geological investigations of Soviet scientists in the sixties and seventies. Fossil plants show that the molasse deposits range from Ladinian to Karnian in age; the overlying volcanic deposits without plants are thought to be Norian in age or younger.

China

Many new discoveries of Triassic fossil plants were made here in last decade (list 67 and 68; fig. 38). The most interesting are the Lower Triassic plant assemblages which were previously unknown. The most important Lower Triassic localities are in the Hwang Ho River Basin: in the boundary area of Yunnan and Guizhou provinces and on Hainan island. In the Hwang Ho Basin fossil plants occur in the variegated Shischienfeng group (WANG L. X. ET AL.,

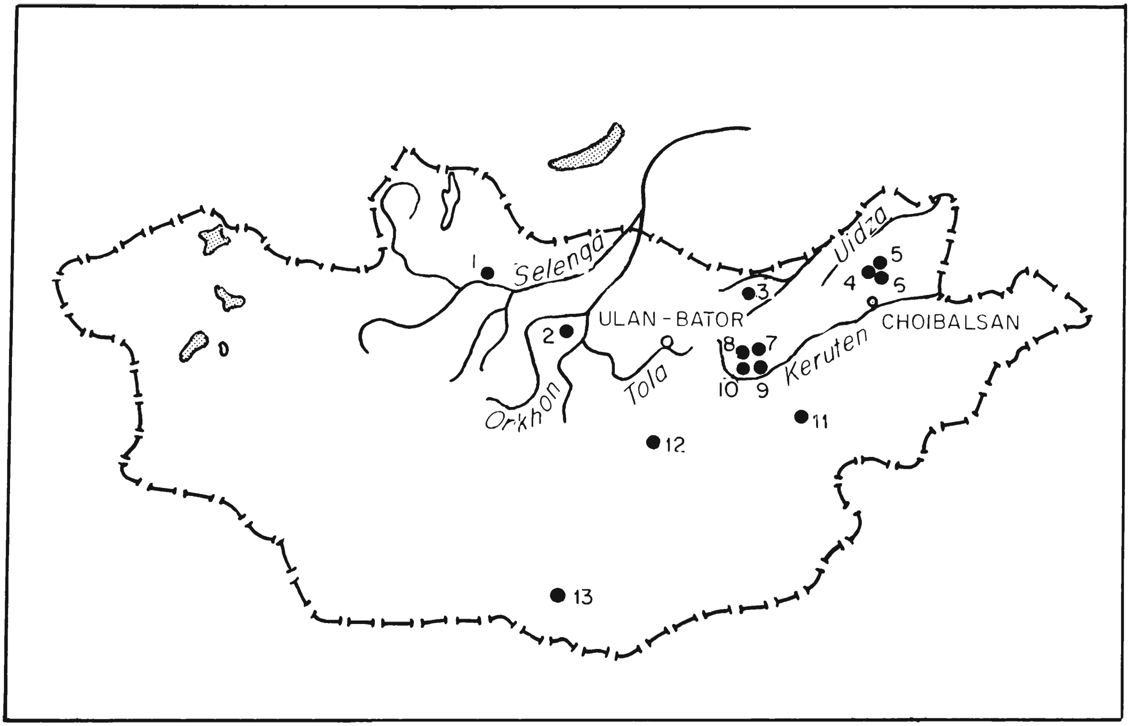

Fig. 37: Localities of the Triassic plants in Mongolia:
1 – Selenga River; 2 – watershed of the Orkhon and Tola rivers; 3 – Dzhargalantuin Gol River; 4 – Shaldza Depression; 5 – Gertuin Depression; 6 – Khutuinnur Depression; 7–9 – Muron Gol grabens; 10 – Dashibalbar; 11 – Barun Zogto; 12 – environs of Bayan Zagan Somon; 13 – Noyan Somon; 14 – Selenga River; 15 – Orkhon River; 16 – Ulan Bator; 17 – Kerulen River; 18 –Uldza River; 19 – Choybalsan.

1978; Wang Z. Q. & Wang L. X., 1982; Wang Z. Q., 1983 a, 1983 b), which is overlain by the Yenchang Formation (see later). The underlying Sunjiakou Formation is Late Permian in age and contains *Pseudovoltzia liebeana* (Wang Z. Q., 1985) and Upper Permian tetrapods equivalent to the *Cistecephalus* zone of South Africa and comparable to the Tatarian ones from the Russian platform. This is confirmed by correlation of this section with the sections of southern China (Yao Z. Q. & Ouyang S., 1980) – see fig. 31.

The Luijakou Formation contains *Pleuromeia* (endemic species), sphenopsids, *Taenipoteris* and rare *Yuccites* and *Willsiostrobus*. The overlying Heshan and Ermaing formations contain *Pleuromaia* (European species) and *Annalepis* (which is very close or maybe identical with *Tomiostrobus*), and several forms

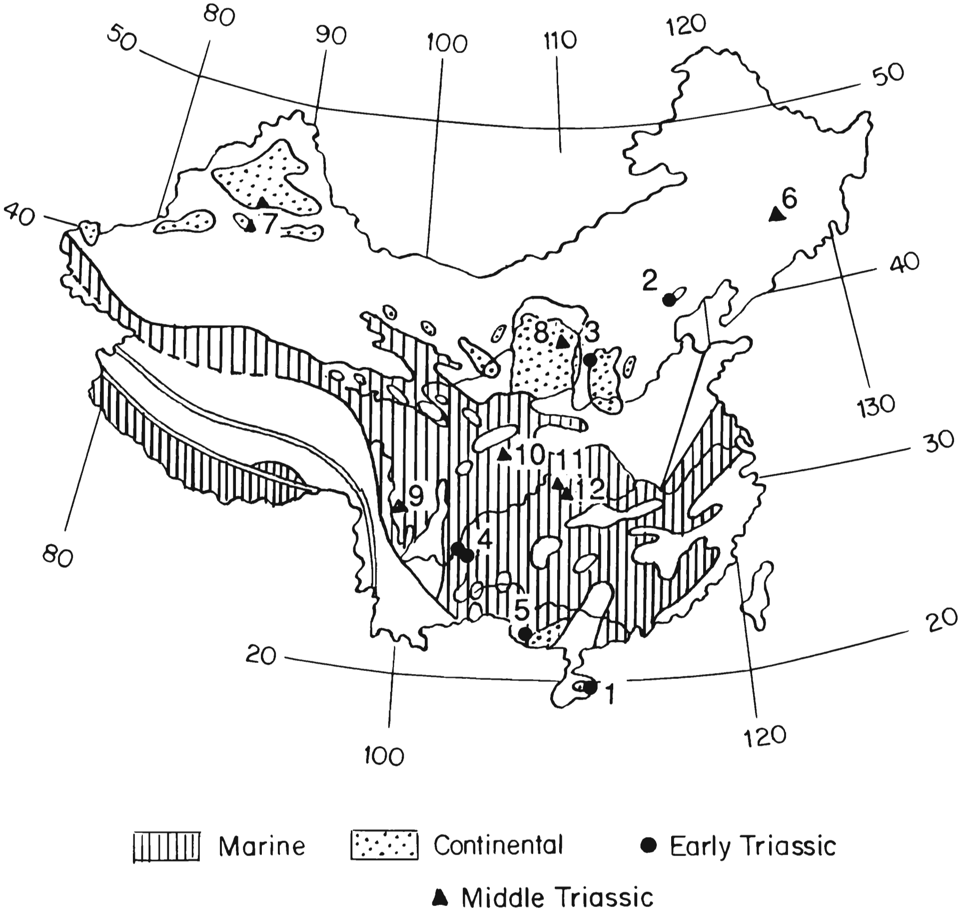

Fig. 38: Localities of Early and Middle Triassic plants in China (from Kimura, 1984 after Zhou Z. Y. & Li B. X., 1979; Wang L. X. et al., 1978; Wang Z. Q. & Wang L. X., 1982; Zhang J. H., 1978; Zhang W. et al., 1980; Gu D. Y. & Hu Y. F., 1979; Huang Z. Q. & Zhou H. Q., 1980; Li P. J. et al., 1976; Ye M. N., 1979; Feng et al., 1977): 1 – Qioghai, Hainan island; 2 – Chengde, Hebei; 3 – Jiaocheng, Pingyao and Yushe, Qinshui Basin, Shanxi; 4 – Pan, Western Guizhou, and Fuyuan and Xuanwei, Eastern Yunnan (these localities had stratigraphically been considered to belong to the Permian); 5 – Yanshuitan, Western Guangxi; 6 – Linjia, Benxi, Liaoning; 7 – Junggar and Turpan Basins, Northern Xinjiang, and Northern margin of Tarim Basin, Southern Xijiang; 8 – Ordos; 9 – North-western Yunnan, Weishan and Jiangchuan Formation; 10 – Jiangyou, Northern Sichuan; 11 – Badong, Western Hubei; 12 – Hongjiaguan, Sangzhi, Hunan.

which are characteristic of the Voltziensandstone of Western Europe: *Anomopteris mougeotii, Yuccites?* sp., *Voltzia* sp. Palynological assemblages from this part of the sequence contain up to 60% Gymnospermae whereas in the Luijakou Formation they are less common.

The tetrapods in the Ermaing Formation correspond to the tetrapods of the *Cynognatus* zone of South Africa and the Donguz Formation of South Priuralye which indicates that the Ermaing is Olenekian-Anisian in age. This conclusion agrees with the correlation of the Ermaing and Heshan Formations with the Olenekian-Anisian beds of the Buntsandstein of Western Europe. Tetrapods of the Heshan Formation are less distinctive and do not indicate a more exact dating than the Triassic. It is worth mentioning that the remains of *Ceratodus* and conchostracan *Cornia* in the Heshan Formation indicate an Early Triassic age.

From the stratigraphic point of view the region at the boundary of Yunnan and Guizhow provinces (YAO Z. Q., 1978; HUANG Z. G. & ZHOU H. C., 1980) is interesting because the equivalents of the Changhsinian stage are found there. The Changhsinian is the uppermost subdivision of the Permian system. In the east of China it is represented by marine facies with "*Paratirolithes*" and fusulinids; toward the west it is gradually replaced by coal-bearing deposits with plants and pelecypods of the Changhsinian stage. Fossil plants in the formation are typical Cathaysian *Gigantopteris* flora. These deposits are overlain by coal-bearing deposits of the Dongchuan Formation. The latter contains in the lower part sphenopsids, ferns and pteridosperms and in the upper part – deposits with abundant *Elatocladus*. The palynological assemblage from the lower part of the Dongchuan is represented by a mixed Palaeozoic-Mesozoic complex in which Gymnospermae constitute less than 30%. In the upper part of that formation Gymnospermae dominate up to 60%.

The Yunningzheng Formation lying above the Donchuan Formation contains *Annalepis* and *Equisetites;* it is correlated with the Lingwen Formation from the Qionghai district, Hainan island (ZHOU Z. G. & LI B. X., 1979). The Lingwen Formation contains conifers and pteridosperms which are very close to those from Gres a *Voltzia* de Vosges, such as *Albertia, Voltzia, Aetophyllum, Masculostrobus* and *Neuropteridium.*

The Triassic age of the Donchuan and Yunningzheng Formations is indicated by the position above the Changhsinian stage – the uppermost Permian. According to the plant assemblages they can be correlated to the Gres a *Voltzia* of Western Europe and of the Ermaing Formation of northern China (DOBRUSKINA, 1985 a). Consequently the age of the Yunningzheng Formation is Olenekian-Anisian, the age of the Donchuan Formation is Induan-Olenekian.

It was said above that Luijakou and Lower Donchuan Formations are correlated by the author with the lower part of the Tutonchana Formation (without conifers) of the Tunguska Basin. The upper formations of China are correlated with the Dvurogiy and Putorana horizons (which include conifers) of the Tunguska Basin (DOBRUSKINA, 1985 a).

*

For the plant assemblages of the second part of the Triassic the most famous is the flora of the Yenchang Formation in the Hwang Ho Basin, which lies above the Shischienfeng group. Yenchang plants are known from many localities in the middle part of the Hwang Ho River (P'an, 1936; Sze, 1956) as shown in fig. 39. The fossil bearing deposits are represented by the intercalation of massive purple and green sandstone and clay shales (see fig. 32). They lie on the sandstones and shales of the Shischienfeng and are overlain by grey coloured deposits of the Waiaopu Formation. For many years the Waiaopu formation was referred to as the Jurassic although it contains a plant assemblage that is similar to the one in the Yenchang formation. It is now included in the Yenchang formation (Huang Z. G. & Zhou H. C., 1980).

The most numerous fossils in the Yenchang Formation are ferns which is a characteristic feature of the formation. They constitute about the half of all imprints and include *Danaeopsis, Bernoullia,* and *Cladophebis.* Sphenopsids are represented by numerous *Equisetites* and *Neocalamites* while pteridosperms, cycadophytes, ginkgophytes and conifers occur in small quantities.

In northern China two further localities are known. From the first only *Lepidopteris ottonis* was reported but it may be another species (see localities 24 and 25– Urumchi – on the map in fig. 39). In the other (locality Dzhungaria – NW of Urumchi) plants analogous to those described from the Yenchang Formation were collected.

A distinct plant complex is known in southern China. It occurs in the middle part of the rivers Yangtse-Kiang and Si-Kiang. The ferns are the most distinctive and include many representatives of the Dipteridaceae, a species of *Cladophlebis,* and many endemics such as *Rireticopteris, Luereticopteris* etc. The diversity of ferns may be compared only with the diversity of cycadophytes in these floras. Spenopsids are not common and the same as in the Yenchang Formation. Pteridosperms and conifers occur in small quantities and the ginkgophytes are rare.

While analysing the history of development of plants in the Mesozoic Sze (1955 b) distinguished two series in the Lower Mesozoic of China: *Danaeopsis – Bernoullia* series and *Dictyophyllum – Clathropteris* series. According Sze to the Yenchang flora belongs to the first series; Sze stressed its similarity to the floras of the Kurashasay and the Bukobay Formation of Priuralye and to the Keuper floras of Western Europe and North America.

The floras of southern China, the Tonkin flora of northern Vietnam and also the Lower Jurassic floras belong to the second series. He referred the *Danaeopsis – Bernoullia* series to the Ladinian-Karnian stage and the *Dictyophhylum – Clathropteris* series to the Norian-Rhaetian stage.

Recently Chinese palaebotanists discovered that these two floras are partly synchronous and are often facies equivalents (Li P. J. & Wu X. W., 1982; Li X. X. & Yao Z. G., 1982 Kimura, 1984 after Li P. X. et al., 1979 and Li P. X. & Zhou Z. J., 1979). The *Danaeopsis – Bernoullia* (now *Danaeopsis – Symopteris*) flora originated in the continental parts of the country whereas *Dictyophyllum – Clathropteris* flora flourished in coasts and areas near the sea or on

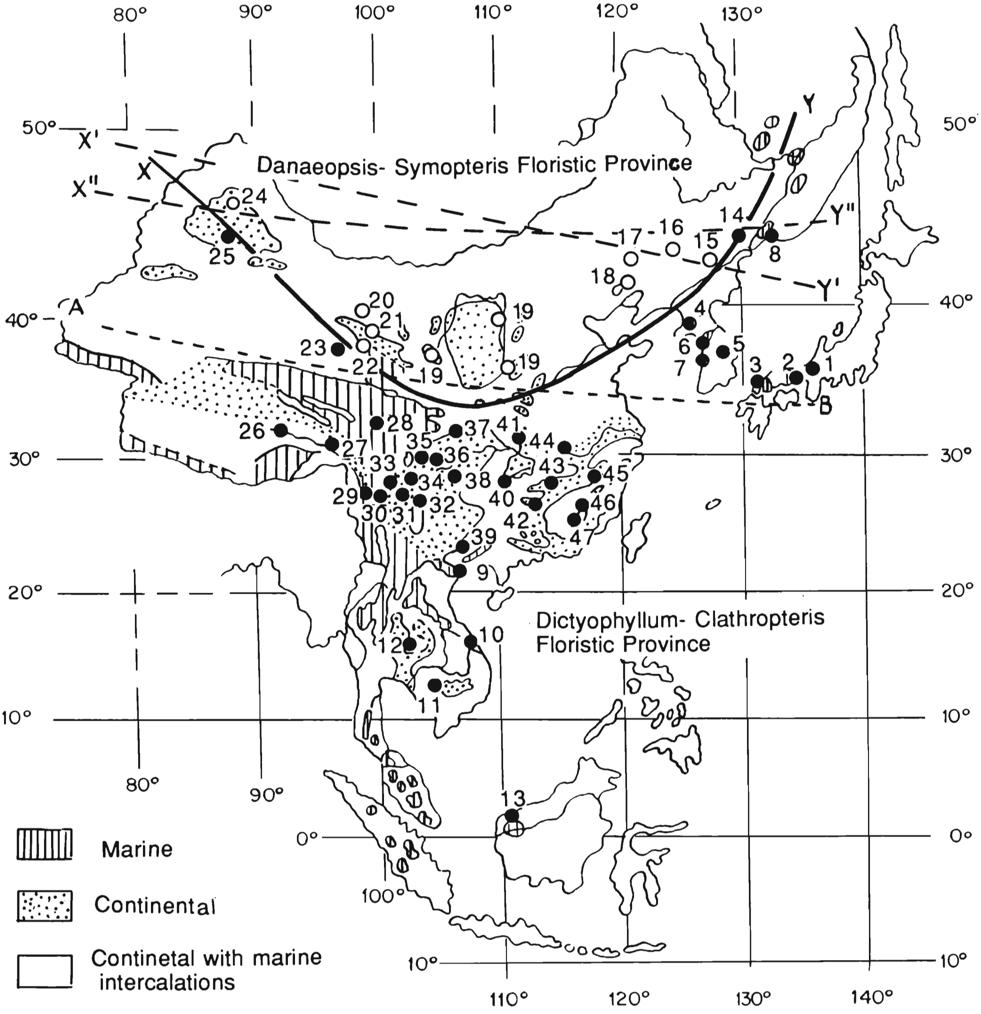

Fig. 39: Phytogeography and fossil plant-bearing localities of the Late Triassic of Eastern Asia (from Kimura, 1985). The numbers in the map indicate the following localities (mark* shows that localities are extensively scattered):

Japan (Kimura, 1980; Kimura et al., 1980; Yamazaki & Tsunada, 1981, 1982; Yamazaki et al., 1980): 1 – Shitaka, 2 – Nariwa, 3 – Asa, Aso and Omine areas;

Korean peninsula (Kimura & Kim, 1985): 4 – Daedong coal-field, 5 – Mungyeong coal-field, 6 – Gimpo and Yeoncheon coal-field, 7 – Chungam coal-field;

USSR, Primorye (Srebrodolskaja, 1960, 1961, 1968 a, 1968 b, 1968 c, 1968 d; Krassilov & Schorochova, 1970; Schorochova, 1975; Schorochova & Srebrodolskaja, 1979): 8 – "Mongugay";

Viet Nam : 9 – Hongay coal field (Zeiller, 1902–1903; Akagi, 1954; Oishi & Huzioka, 1941; Srebrodolskaja 1969 a, 1969 b), 10 – Annam (Zeiller, 1902–1903; Counillon, 1914; Vozenin-Serra, 1977); →

islands. These authors distinguish two palaeofloristic areas with these two floras. The first is in the nothern part of the country and the second is in the southern part of it.

One cannot exclude such a situation but more information about the stratigraphy of the plant-bearing beds and their content is needed to analyse the new data and conclusions. Before obtaining this information I must keep the old subdivisions on the maps and continue to consider the *Danaeopsis – Bernoullia* flora to be the Ladinian-Karnian in age and the *Dictyophyllum – Clathropteris* flora Norian-Rhaetian in age.

Japan

In Japan the Triassic plants studied by Kon'no (1961, 1962 a, 1962 b, 1973) occur in the northeast and southwest of the Honsu islands (see fig. 33). The first locality is situated in the Kitakami Massif (list 69). Occurence of *Pleuromeia (P. hatai)* is confined to marine deposits of the Oosava Formation of the Inai group. The marine invertebrates including ammonites found with *Pleuromeia* as well as above and below indicate that the deposits are Upper Scythian (nearly Olenekian) in age. *Neocalamites muratae* is also found in the Inai group.

→ Cambodia (Vozenin-Serra & Laroche, 1974; Corsin & Desreumaux, 1971): 11 – Phum Laak*;
Thailand (Kon'no & Asama, 1973): 12 – Khorat;
Malaysia (Kon'no, 1968, 1972): 13 – Krusin;
North Eastern China : 14 – Malugou (Sun Ge, 1979, 1981), 15 – Beishan (Zhang et al., 1980), 16 – Dajianggang (Sun Ge et al., 1983), 17 – Laohugou (Zhang et al., 1980; Zhang, 1982), 18 – Yancaugou (Zhou H. Q., 1981);
Northern China: 19 – Yanchang* (P'an, 1936; Sze, 1956; Huang & Zhou H. Q., 1980);
North-Western China: 20 – Nanyinger* (He et al., 1979; He, 1980), 21 – Mole* (ibidem); 22 – Babaoshan (ibidem), 23 – Jieza* (ibidem), 24 – Xiaoquangou, northern part (Gu & Hu, 1979), 25 – Xiaoquangou, southern part (ibidem.);
South-Western China: 26 – Tumaingela (Wu, 1982 a; 1982 b), 27 – Quamdo (ibidem), 28 – Lamaya (Chen Y. L. et al., 1978), 29 – Baizizu (Li P. J. et al. (1976), 30 – Shizhongshan (ibidem.), 31 – Xiangyun (ibidem), 32 – Yipinglang (ibidem), 33 – Baiguowan (Chen Y., et al., 1978), 34 – Baoding (Hsu et al., 1979), 35 – Dagiaode (Hsu et al., 1974, 1975, 1979; Chen Y. et al., 1979 a, 1979 b, 1979 c), 36 – Dajing (Hsu et al., 1974, 1975, 1979; Chen Y. et al., 1978), 37 – Xujiahe (Li P. J., 1964; Chen Y. et al., 1978), 38 – Ergiao (Zhang J. H., 1978), 39 – Fulongao and Pinjong (ibidem), 40 – Xiaojiangkou (Feng et al., 1977);
South-Eastern China: 41 – Shazhenxi (Feng et al., 1977; Wu et al., 1980), 42 – Xiaoping* (Tsao, 1965; Feng et al., 1977), 43 – Anyuan* (Feng et al., 1977; Zhang C. F, 1981, 1982), 44 – Wuchang (ibidem), 45 – Jiaoken (Zhou T. S., 1978), 46 – Dakeng (ibidem), 47 – Wenbinshan (ibidem).

Younger floras are found in the southwestern part of the island (list 70) where they have been known since the end of last century (YOKOYAMA, 1905; YABE, 1922; OISHI, 1930, 1931, 1932 a, 1932 b, 1940; TAKAHASHI, 1950, 1951; HUZIOKA, 1970; KON'NO, 1961, 1962 a, 1962 b). They occur in two regions: in Yamaguchi prefecture (Karnian floras) and in Okayama prefecture in the environs of Nariwa (Norian floras).

In the Yamaguchi region (fig. 40) Triassic deposits occur in two adjacents areas, the Atsu-Mine (Omine) in the north and Asa in the south, which are separated by granite plutons and faults. The sequence in Omine area is studied better though the most famous plant localities are in the Asa area. Most of the fossil plants of the Asa area occur in the Yamanoi formation which constitutes the middle part of the Habu group. In the Omine area fossil plants occur in coal-bearing terrigeneous deposits of Momonoki, Hirabara and Takiguchi formation of Karnian age (KON'ON, 1961). Small quantities of fossil plants also occur in the Momonoki formation together with the remains of insects.

In Omine sequence marine and coastal-marine deposits are intercalated with many marine pelecypods. These pelecypods were used to subdivide the Triassic deposits in this region. In the Aso Formation plant-bearing beds are overlain by strata containing the pelecypods *Tosapecten suzuki* KOB., *Oxytoma zitteli* TELL., *Eumorphotis* aff. *spitsbergensis* (BOHM.) of Early Norian age. Equivalents of the Aso Formation in other parts of Japan where marine deposits are more completely developed are overlain by beds with *Monotis ochotica* (KEUYS) as for example in Sakawa Basin. *Oxytoma zitteli* TELL. and *Minetrigonia bregiensis* occur in marine interbeds of the Momonoki Formation. *Lima haumani* KOB. et SCHIK., which is a component of the beds with *Halobia* of Karnian age occur in the Sakawa Basin in marine interbeds of the Hinabata Formation. The underlying deposits (the Atsu group) contain Ladinian fossils. The Yamanoi Formation (the middle part of the Habu group) is of Early Norian age. The age of the underlying Tsubuta group is Ladinian.

Fossil plants from Omine area and Asa area are very similar. In both the Momonoki Formation in the Omine area and Yamanoi Formation in Asa area the dominants are sphenopsida (*Neocalamites, Equisetites, Annulariopsis*). Among ferns the Dipteridaceae (*Dictyophyllum, Clathropteris*) and also *Cladophlebis* and *Todites* are present. There are many ginkgophytes with the leaves *Ginkgoites sibirica*, being the most common in the Omine area (OKAFUJI, 1971). Conifers have been studied carefully and most are assigned to *Podozamites* and *Cycadocarpidium* and also to certain endemic genera (*Nagatostrobus, Minetaxites*). Cycadophytes are not common.

The plant assemblage described by KON'NO (1961, 1962 a, 1962 b) from the Ladinian Tsubuta group is small, but it contains all main components of the Karnian floras in this region including sphenopsids, conifers and a single species of the Dipteridaceae (*Dictyophyllum falcatum*). Ginkgophytes are totally absent.

The Karnian flora of Japan is one of the few Triassic floras of Eurasia where the age can be determined directly from marine invertebrates. Another is the *Pleuromeia* flora which is usually associated with marine fossils.

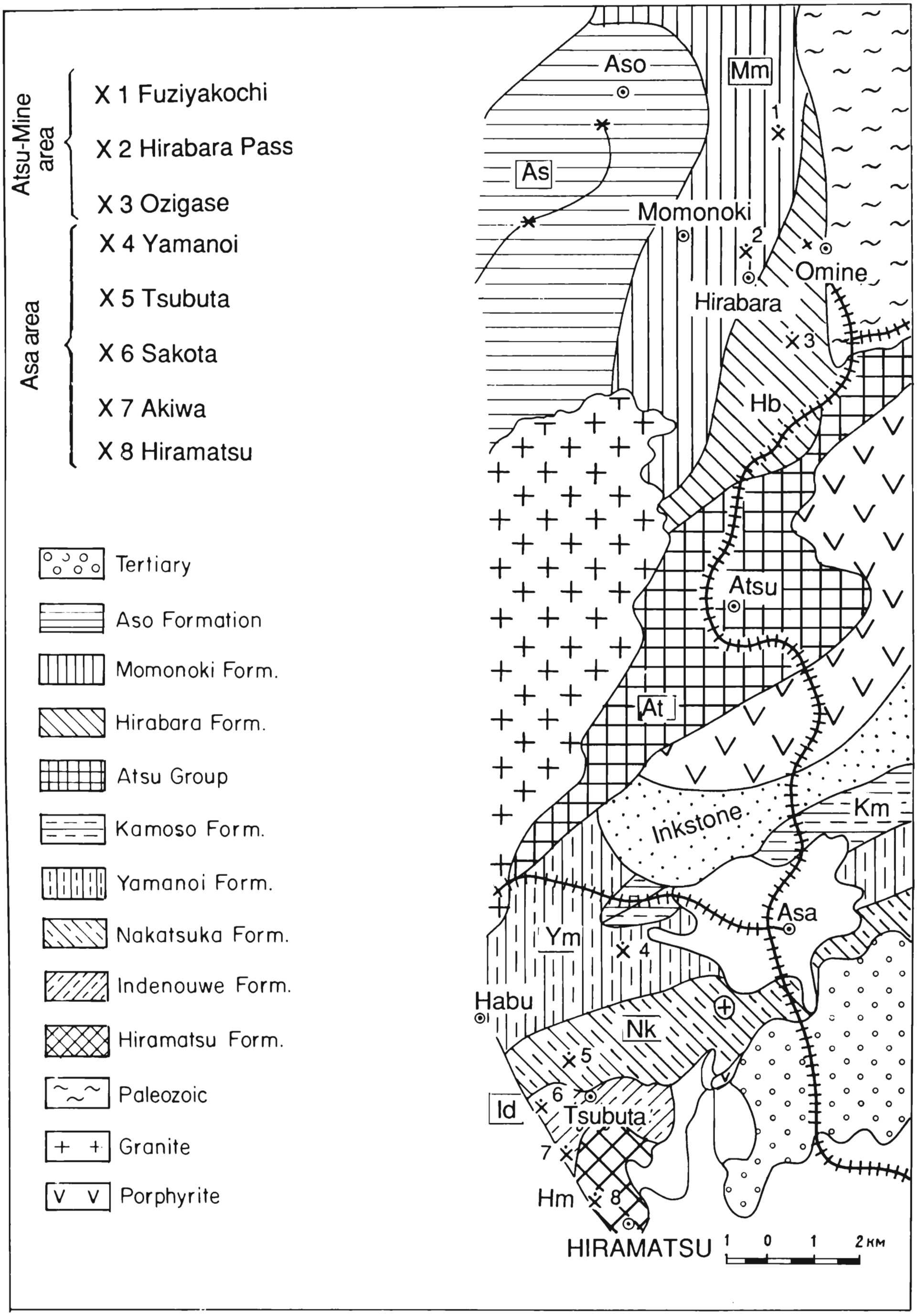

Fig. 40: Geological map and Triassic plant localities at the areas Atsu-Mine and Asa, Yamaguchi prefecture, Japan (KON'NO, 1961 after HASE).

Numerous Triassic plant localities occur in the vicinity of Nariva (fig. 41). They occur in the Hinabata Formation of the Nariwa group (see fig. 34). This formation is overlain by marine deposits of the Dzito Formation with numerous *Monotis* of Norian age. The underlying plant-bearing deposits of the Mogamiyama Formation are usually correlated with the Aso Formation of the Omine area. Consequently it is considered middle Norian in age. In this region intercalation of marine and continental (or coastal-marine) deposits also occur.

Ferns are especially common and diverse in the Nariwa flora. The Dipteridaceae are common as are the cycadophytes. Ginkgophytes and conifers are rare and *Podozamites* is less diverse than in the Karnian flora. *Cycadocarpidium* does not occur there. The sphenopsids are similar to the Karnian forms but they are rare. A few pteridosperms are present. Originally OISHI (1930, 1931, 1932 a, 1932 b, 1940) considered this flora to be Rhaeto-Liassic based on the great similarity to the Rhaeto-Liassic floras of Western Europe and Greenland. This similarity was accepted also by T. M. HARRIS who studied the Greenland flora. OISHI (1936) tried to recognize the equivalents of the *Lepidopteris* and *Thaumatopteris* floras in the Nariwa flora. However the occurence of Norian pelecypoids in the top of the Hinabata Formation showed that the Nariwa flora is Norian in age, in spite of its similarity to the Rhaeto-Liassic floras of Europe.

Small floras of Shitaka Formation (Maizuru coal-field, prov. Kyoto) is considered now again to be Upper Triassic (KIMURA, 1987). It was described by OISHI (1932 a) – see list 70 e in the part three in this book.

Soviet Primorye (the Soviet Far East)

In Soviet Primorye numerous remains of *Pleuromeia* were collected together with ammonites in the Olenekian and Anisian deposits (list 71). In this region there are many plant localities confined to the short interval the Olenekian and the Middle Anisian – in which anly *Pleuromeia* occurs in great quantities, as is true in many other regions. One pinnule of fern, one imprint of *Lepidopteris* sp. and undeterminable leaf were found in the only one locality together with *Pleuromeia.*

KRYSHTOFOVICH (1924) originally compared them with the European species *Pleuromeia sternbergii*. Later KRYSHTOFOVICH himself renamed this fossil as *Pleuromeia obrutschevii* (Obrutschev, 1926). This name was accepted by KRASSILOV (KRASSILOV & ZAKHAROV, 1975 a, 1975 b) for the Far East *Pleuromeia* because he considers it to be a distinctive species.

Most of the plant localities of the second part of the Triassic occur in the Southern Primorye and only a few are situated to the north (fig. 42). Plant-bearing deposits are confined to two formations, the Sad-Gorod (in previous papers Lower Mongugay Formation) and Amba (previously Upper Mongugay Formation) formations separated by marine deposits of the Peschanka Formation (previously Lower *Monotis* Formation). The plant-bearing formations are overlain by marine deposits with Norian pelecypods (see fig. 34) in the Perevoznaya

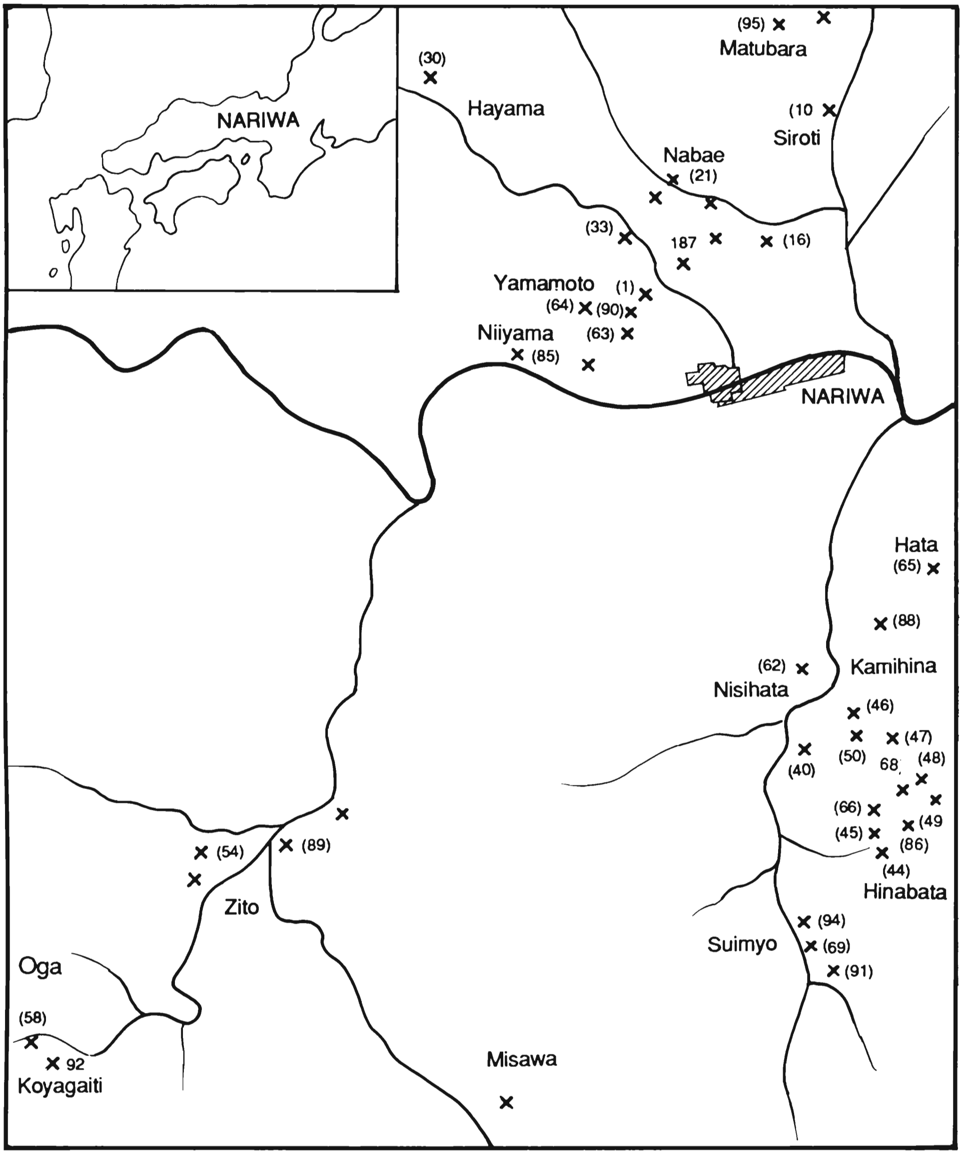

Fig. 41: Localities of the Triassic plants in the environs of Nariwa, Okayama prefecture (Oishi & Huzioka, 1938).

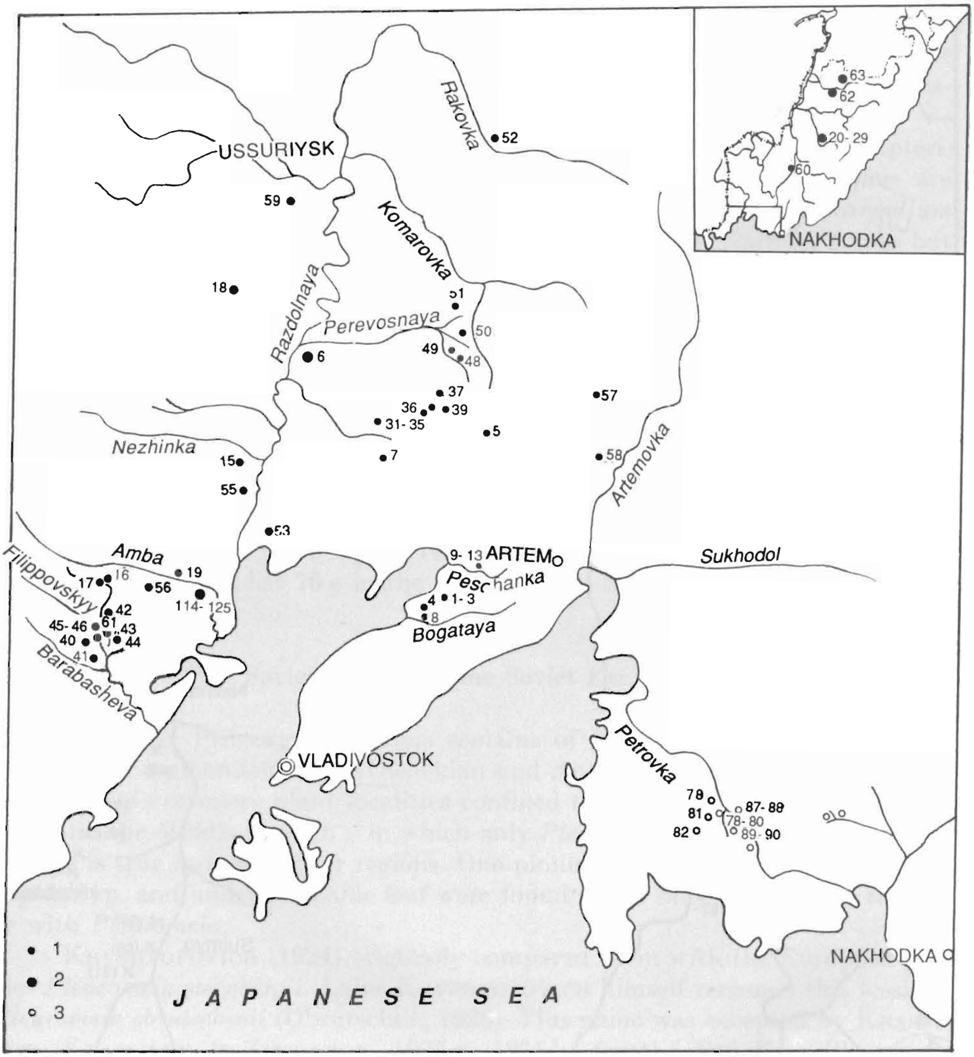

Fig. 42: Localities of the Late Triassic and Early Jurassic plants in Primorye (after SCHOROCHOVA, 1975):
1 – Karnian; 2 – Norian; 3 – Early Jurassic. Ciphers in the map are the numbers of outcrops in Schorochova, 1975.

(previously Upper *Monotis* Formation). The lower plant-bearing formation is underlain by marine deposits with Ladinian pelecypods. Both the Lower and Upper *Monotis* Formation contain representatives of the genus *Monotis* which indicates that they are Norian in age. Most geologists draw the lower boundary of the Norian stage at the base of the *Tozapecten suzuki* zone.

The presence of marine pelecypods in the sequence indicates that the Amba Formation is Middle Norian in age and correlates with the plant-bearing deposits of the Nariwa Group. Less clear is the exact age of the Sad-Gorod Formation because it lies between faunistically characterized deposits of the Ladinian and Karnian. The tradition is to consider it Karnian because the overlying Lower *Monotis* Formation previously was thought to be Late Karnian age. However, its position between the Lower Norian to the Upper Ladinian is equally probable. To all appearance it is the equivalent of the plant-bearing formations of the Mine group in Yamaguchi, but one cannot exclude the possibility that its base corresponds with the upper part of the Azu group, i. e. it includes the upper part or the Ladinian.

BURIY (oral communication in 1975) correlates the Kiparisovka Formation with the Ladinian and believes that it lies between the Sad-Gorod Formation and marine Ladinian deposits. He divides the Kiparisovka Formation into a Quartz Sandstone Member at the base and a Plate Sandstone Member with plants at the top. The latter is referred by SHOROKHOVA (1975 b) and other scientists (SHOROKHOVA & SREBRODOLSKAYA, 1979) to the Sad-Gorod Formation. According to Buriy the beds with *Daonella* lie above the Quartz Sandstone Member which indicates that it is of Ladinian age as well as the underlying Quartz Sandstone Member. SHOROKHOVA (1975 b) objects to this because the sequence is repeated due to faulting in the type area of the spring Tractornyy and the mount Zemlyanichnaya. Without trying to decide who is right it is worth mentioning that a Ladinian age for the Lower part of the Sad-Gorod Formation (probably including the Quartz Sandstone Member) seems to be probable. The same plant assemblage occurs in the main part of the Sad-Gorod Formation and in the Quartz Sandstone Member which supports this idea. We can see the similar situation in Japan where the Ladinian floras of the Tsubuta group like the Quartz Sandstone flora have the same composition as the Karnian floras of the Mine group but contain less taxons. This is also true in Western Europe where the Lower Keuper (Ladinian) floras are very close to the Middle Keuper (Karnian) floras.

The most complete sequence of Triassic deposits is present in the South Primorye. In the south western Primorye analogs of the Sad-Gorod Formation are mainly developed and in the northern Primorye analogs of the Amba and Perevoznaya Formations and the upper part of the Peschanka Formation occur (fig. 43).

Study of the Primorye Triassic floras was begun by KRYSHTOFOVICH (1910, 1921). SREBRODOLSKAYA (1960 c, 1961, 1968 a, 1968 b, 1968 c, 1968 d, 1980) and SHOROKHOVA (1975 a, 1975 b) studied these floras more completely. These floras were published only in part and the descriptive papers do not give

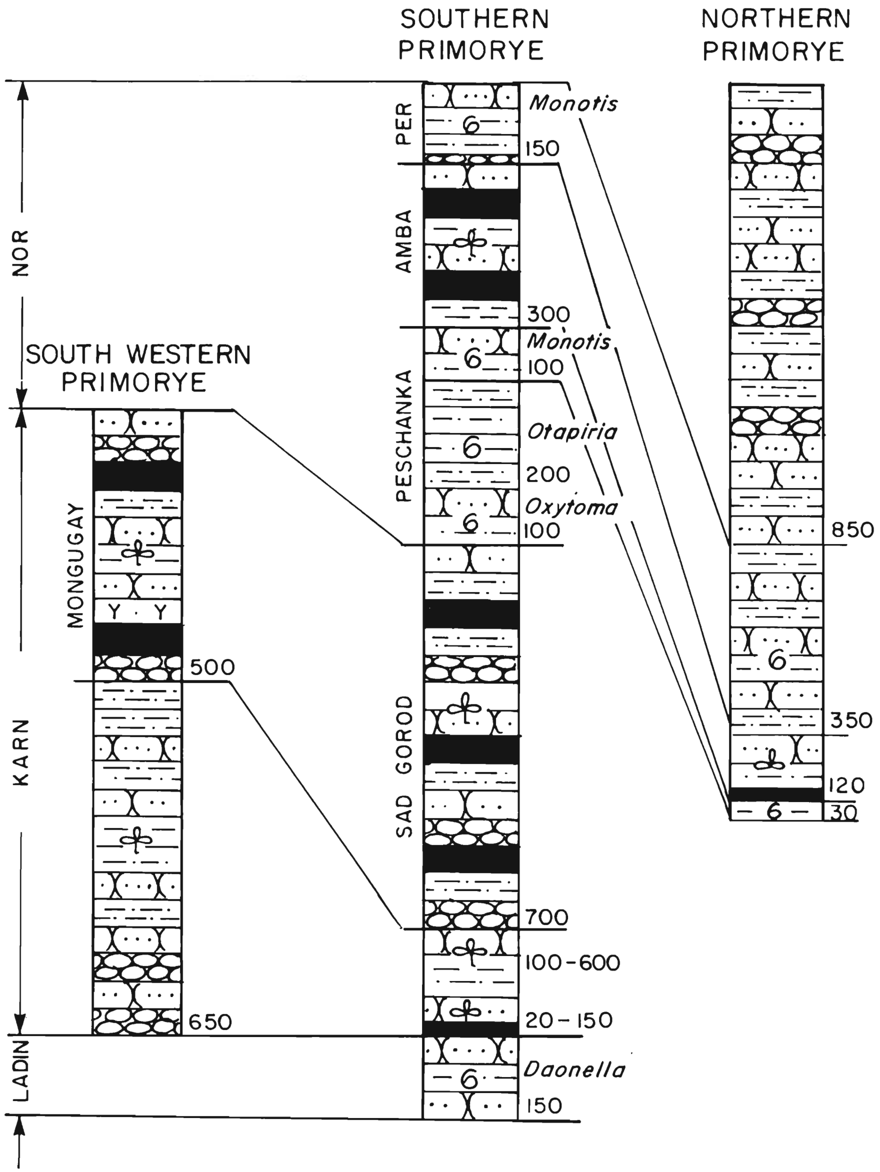

Fig. 43: Correlation of the Triassic deposits of Primorye (after SCHOROCHOVA, 1975). For the legend see fig. 74.

a complete view of them and their stratigraphic distribution. Large collections were made after KRYSHTOFOVICH completed his work. Unfortunately SREBRODOLSKAYA had the possibility to publish only new species and SHOROKHOVA published descriptions of only a small part of her collections although most of them were described in her unpublished thesis.

As in Japan, the Karnian assemblage (list 72) is smaller and less diverse than the Norian, the main components of these floras being the same. In Japan each genus is represented by more species and the Dipteridaceae is represented by more genera. Cycadophytes are also more diverse in Japan according to published lists of genera and species but their relative numbers (if the genus *Taeniopteris* in Primorye is excluded) is small in both floras. Sphenopsids are rare, pteridosperms absent (if endemic *Imania* and *Tudovakia* are not pteridosperms) and the conifers *Podozamites* and *Cycadocarpidium* are dominants in both floras.

The Amba plant assemblage differs from the Sad-Gorod plant assemblage (like the corresponding assemblage in Japan) by the abundance of cycadophytes, Dipteridaceae and ginkgophytes in it. Sphenopsids in the flora are similar to the Sad-Gorod taxa (*Neocalamites, Equisetites*), the pteridosperms? *Imania* and *Tudovakia* as well as *"Thinnfeldia"* are present in the Amba assemblage and the conifers differ only in numbers of species. The Amba assemblage is richer than the other floras.

The Amba plant assemblage differs from the Nariwa plant assemblage (like the Sad-Gorod assemblage from the coeval flora of Japan) by the small generic and specific diversity. This includes the sphenopsids and ferns. For example in Primorye the genus *Thaumatopteris* is absant whereas in Japan it is represented by six species. In Primorye *Hausmannia, Goeppertella* and *Marattiopsis* are absent as well as cycadophytes (such as *Otozamites, Ptilozamites, Sagenopteris, Nilssonia*). The difference in ginkgophytes is less. Only a species diversity is bigger in Japan. The conifers are similar. The richness of Japan floras seems to be related to their geographic position south of the Primorye flora.

Korea

In Korea Triassic plants were studied by YABE (1922), KAWASAKI (1925, 1926, 1939), YABE and OISHI (1929), KON'NO (1944, 1962 a), KOBOTAKE (1954) and recently by KIMURA and KIM (1982, 1984, 1985) and by KIMURA and his students (KIMURA et al., 1982, 1983) see list 73. The Daedong Supergroup which contains the Daedong (Daido in Japanese in earlier papers) flora is of terrestrial origin and is distributed in several isolated sedimentary basins in the southern part of the peninsula such as the Daedong, Gimpo, Yencheon, Mungyeong, Danyang and Chungham coal-fields and in several small scattered basins in the northern part of the peninsula (fig. 44). The Daedong Supergroup is represented in the Daedong caol-field by the Daedong Group, in the Gimpo coal-field by the

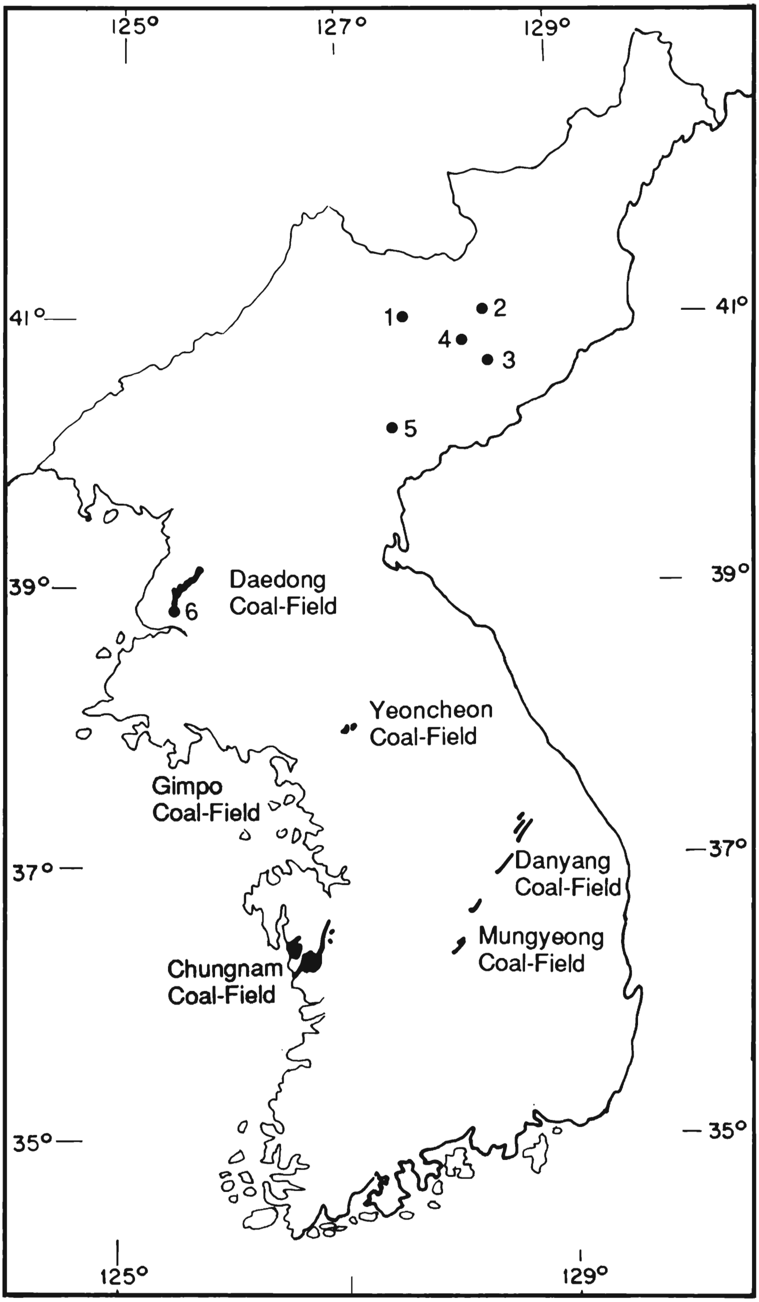

Fig. 44: Distribution of the Daedong Supergroup with Triassic plants in Korea (after Kimura & Kim, 1985):
1–6 – scattered areas of distribution.

Gimpo group, in the Yeoncheon coal-field by the Gimpo Group equivalents, in the Mungyeong, the Danyang coal-fields and Lanyang coal-field by the Bansong Group, and by Nambo Group in the Chungnam coal-field (KIMURA & KIM, 1984, 1985).

The Daedong flora is a typical representative of the *Dictyophyllum – Clathropteris* flora of Asia. The following taxa are considered by KIMURA and KIM (1984, 1985) typical of the Triassic or to be relicts of the Permian floras: *Lobatannularia, Chiropteris, Anthrophyopsis, Drepanozamites, Baiera* cf. *furcata, Podozamites* ex gr. *schenkii, Cycadocarpidium* and *Taeniopteris mungyeonensis.* They are found in the Tonjin Formation, Amisan Formation in the Nampo Group and the upper formations of Bansong Group. Thus, the geological age of the Tonjin and Amisan Formations as well as Bansong Group is now considered by KIMURA and KIM Late Triassic instead of Early and Middle Jurassic as formerly presumed by YABE, KAWASAKI, OISHI and others.

This point of view is supported by the associated conchostracans which indicate that the Tonjin and Amisan formations are Late Triassic in age. The recent discovery of *Lobatannularia* in the Baegunsa Formation of the Chungnam coal-field together with the other fossil plants also indicate the Late Triassic age of this formation (KIMURA & KIM, 1984, 1985).

The geological age of the Daedong Group, Gimpo Group equivalents in the Yeoncheon coal-field and the Bansong Group is still uncertain because of absence of fossils which are indicative of a precise age. However, KIMURA and KIM (1984, 1985) are sure that these groups are Late Triassic – Early Jurassic or Late Triassic – Middle Jurassic in age. Furthermore they think that the Late Triassic Daedong flora belongs to the Eastern Subprovince of the *Dictyophyllum – Clathropteris* province of Asia that is correlated with the Late Triassic floras of Japan, southern Primorye and Eastern Jilin (north-east China) in this subprovince.

Vietnam

In Northern Vietnam the Triassic flora (list 74 a) has been known from the very beginning of this century from the coast of Tonkin Bay and in the nearby islands in the Hongai Formation. Recently Triassic plants were collected in the western part of Northern Vietnam from Suoy-Bang Formation. According to the data of SADOVNIKOV (1971 a), three plant-bearing horizons can be recognized in both formations. That is why the stratigraphic position of plant-bearing deposits in the west part of the country (see fig. 32) can be related to the plant-bearing deposits of its eastern part, to the so-called Tonkin flora. In the west, plant-bearing deposits contain marine pelecypods and are also underlain by deposits with marine pelecypods. The pelecypods from the Suoy-Bang Formation were identified as Rhaetian in part and Norian. According to a new conception (DOBRUSKINA, 1976 c), this part of the sequence is considered to be Norian or Norian-Rhaetian in age (as it is accepted in other parts of Eurasia).

In other words, stratigraphic data indicate the coevality of the Northern Vietnam flora with the Nariwa flora of Japan and the Amba flora of the Primorye. This conclusion was confirmed by the description of *Lepidopteris* from the Lyon collection (Dobruskina, 1987 b).

The Northern Vietnam flora was originally described by Zeiller (1902–1903) in the beginning of this century. Now this collection belongs to the Geological Department of The Lyon University in France. Small collections were later described by Pelourde (1913), Colani (1915), Akagi (1954). More recently some new species were published by Srebrodolskaya (1969). Nyat May (1985) is now studying this flora. In the Tonkin flora ferns and cycadophytes are dominant, other plants are found in smaller numbers, although in some layers the proportions may be different.

The next sequence of plant assemblage (from the base to the top) occurs in Northern Vietnam in the west as well in the east according to Sadovnikov (1971 a) as follows:

1) Only sphenopsids *Equisetites* are found in the lower part of the coal-bearing deposits, they may also occur in small quantities in the upper horizons;

2) Extremely wide development and great diversity of the Dipteridaceae, a great role of other ferns, subordinate position of cycadophytes which are represented almost exclusively by *Pterophyllum* and *Taeniopteris* are the characteristic features of the second assemblage. This assemblage corresponds to the Hatu system of Zeiller (1902–1903);

3) A predominance and great diversity of cycadophytes and a nearly complete absence of Dipteridaceae (represented by *Clathropteris* only) is characteristic for the third assemblage. It corresponds to the Nagotna system of Zeiller (1902–1903) and is very similar with the above described floras of the Pamirs and Armenia, Zakavkazye;

4) The *Nilssonia* horizon in which folded *Nilssonia* are mainly represented. Such *Nilssonia* are also widespread in the Pamirs.

As it was said in the description of the Iran flora, Sadovnikov believes that the succession of the Triassic floras is the same in Iran and Vietnam.

In Central Vietnam practically the same plants (list 74 b) are found as in Northern Vietnam (Zeiller, 1902–1903), Counillon, 1914).

Thailand, Cambodia and Sarawak

In Thailand (list 75 a) fossil plants occur in the lower part of the Khorat Group (Norian-Rhaetian). Plant remains were collected from shales and sandstones with the thickness of 40 m, which are separated from the base of the Khorat Group by about 100 m of carbonate conglomerates. According to Kon'no (Kon'no & Asama, 1973) the flora includes sphenopsids, ferns (dominants) and cycadophytes.

Fossil plants from the Karnian deposits of Cambodia (Phum Laak) were mentioned without descriptions (KIMURA, 1985 after VOSENIN-SERRA & LAROCHE and CORSIN & DESREUMAUX).

In Crusin (Sarawak) Triassic plants (list 76) were collected from beds near the basal conglomerates of the *Halobia* series. The locality is situated near the south western boundary of Sarawak. The age of the plant assemblage is Karnian, i. e. it is equivalent to the Yamaguchi flora of Japan and the Sad-Gorod flora of Primorye. It includes, according KON'NO (1972) sphenopsids, ferns, cycsdophytes and conifers. It is suggested by KON'NO that this flora is the early stage of development of a large unknown flora.

Chapter seven

Indostan Peninsula

In Indostan as in Europe two types of Triassic deposits are present: the alpian facies in the Mediterraneoun geosyncline belt and the Gondwana facies in the platform part (fig. 45). In the Salt Range and in the Himalayas, the Triassic marine deposits are of the alpian facies represented by predominantly by carbonate deposits with abundant marine invertebrates such as ammonites and pelecypopds. The strata lie on marine Upper Perian deposits. The Permo-Triassic boundary horizons of the Salt Range and the Himalayas are used as the standards of the International Geological Scale. Here a complete sequence of Triassic marine deposits occurs which can be correlated with the marine Triassic sequence of the Alps. In the Salt Range a few fossil plants were collected above the faunistical characterized Lower Triassic deposits and about three meters below the massive white Jurassic sandstones. KUMMEL (1966) considered the plant-bearing beds to be at the base of the Middle Triassic. The plants are poorly preserved. They include *Equisetites* sp., *Sphenopteris* sp., *Cladophlebis* sp., *Indotheca sakesarensis, Triletes sahnii, Sporites* sp. The locality is situated at the left bank of the Indus River west of the village Sarai (SITHOLEY, 1943, 1954). Spores from these deposits were studied by PANT (1949) and PANT and SRIVASTAVA (1964).

The Gondwana facies in contrast to the German facies in Europe do not occur in a broad extensive basin, but are confined to isolated depressions so that direct correlating of these deposits is impossible. Deposits of similar lithology often turn out to be characterized by different plant assemblages and vice versa.

The Series Panchet (list 81) and Parsora (list 80) as well as the Nidpur beds (lists 77, 78, 79) are usually considered Triassic in age and some investigators also refer the Kamti beds (list 83) to the Triassic.

Panchet Series

The Panchet Series occurs in the coal-basin of the Damodar River and in its west continuation, the coal-fields Auranga, Ramkola and Tatapani. The

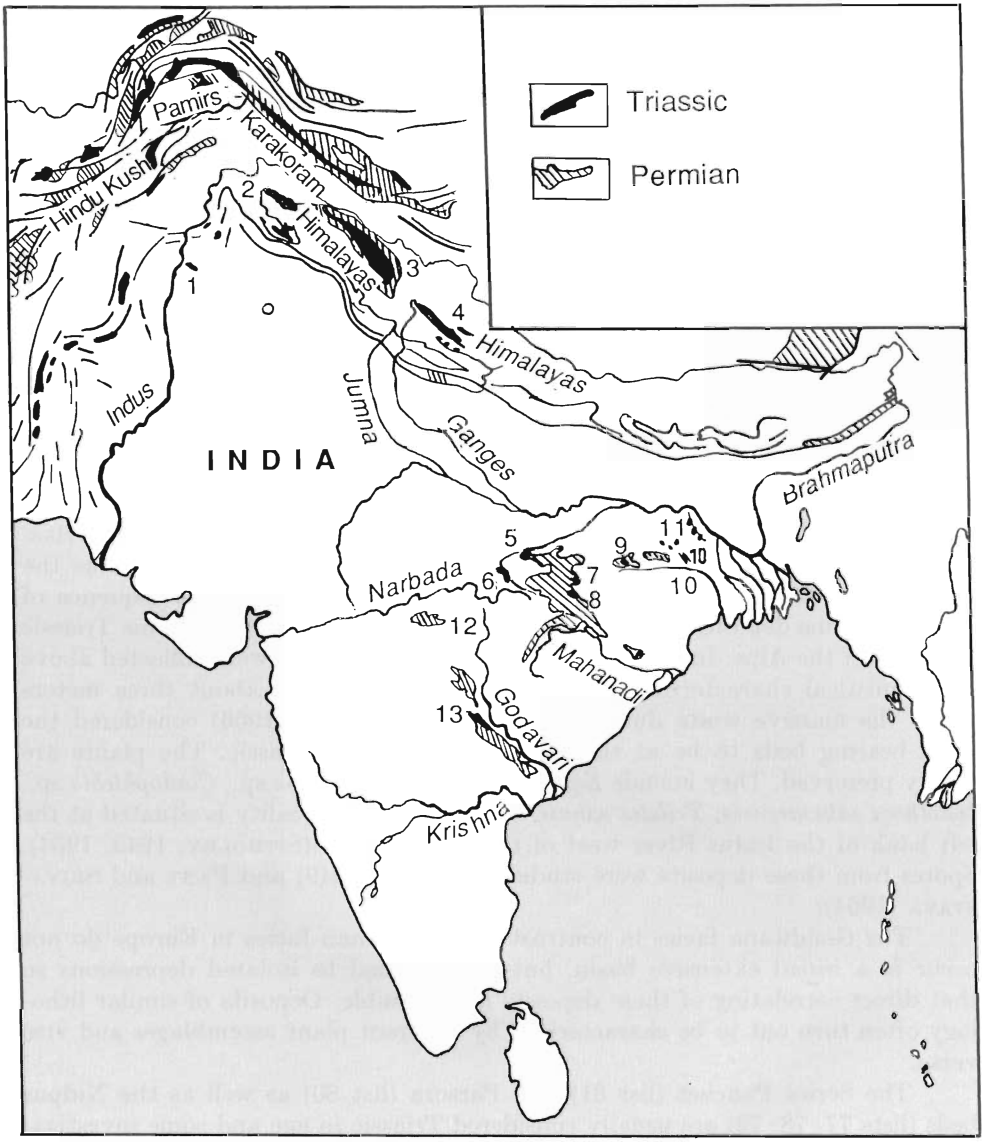

Fig. 45: Exposures of the Triassic and Permian deposits in India and ajacent areas (after ANDERSON, 1973):
1 – Salt Range; 2 – Himalayas, Kashmir; 3 – Himalayas, Spiti; 4 – Himalayas, Painkhanda; 5 – Nidpur; 6 – South Rewa; 7 – Tatapani; 8 – Ramkola; 9 – Auranga; 10 – Raniganj; 11 – Radjmahal Hills; 12 – Rorighat; 13 – valley of the Pranhita – Godawari rivers.

Panchet Series is composed of red coloured deposits lying conformably on the coal-bearing deposits of the Raniganj Series. It is divided into two parts: the Maitur Formation (below) and the Hirapur Formation. Fossil plants occur in the Maitur and tetrapods occur in the Hirapur.

Nearly all the fossil plants of the Raniganj coal-field were collected from a locality between Maitur and Asansol near the base of the Panchet Series (FEISTMANTEL, 1880–1881). Plant-bearing beds of the thickness 76–90 m lie on the Raniganj sandstones with a slight angular disconformity.

MAHESHWARI (1974) states that it is practically impossible to draw a boundary between the Rainganj and Panchet Series on the base of fossil plants because only a few plants occur in the upper part of the Raniganj, and because the main component in both floras is *Glossopteris*. Usually the absence of *Gangamopteris* in the Panchet Series is considered to be the important difference between the two floras. However, MAHESHWARI states that the specimens attributed to this genus in the upper part of the Raniganj are doubtfully identified. The discovery of *Pecopteris concinna* and *Cyclopteris pachyrhachys* described by FEISTMANTEL (1880–1881) from the Maitur was not confirmed later by new findings in the Panchet Series. MAHESHWARI believes that the only difference in the two floras is the decrease in the number of fossil plants in the younger flora.

MAHESHWARI (1974) correlates the Panchet Series s. s. (i. e. deposits of the Panchet Series at the Raniganj coal-field) with the Lower Beaufort flora of Southern Africa and not with the Middle Beaufort flora a sit was accepted before him. In other words he believes that the base of the Hirapur Formation corresponds to the base of the Middle Beaufort because both formations contain tetrapods of *Lystrosaurus* zone. As the base of the Middle Beaufort is considered by him to be the Permo-Triassic boundary, he refers the Maitur Formation of India to the Permian. And consequently he referred the plant-bearing Panchet (Maitur) beds of Raniganj coal-field to the Permian.

MAHESHWARI does not consider the Panchet deposits of the Raniganjcoal field to be coeval with the Panchet deposits of the Auranga, Ramkola and Tatpani coal-field (FEISTMANTEL, 1880–1881, 1886). MAHESHWARI collected here in contrast to the Raniganj coal-field *Dicroidium* together with the abundant glossopterids. That's why he correlates these beds not with the Panchet Series s. s. but with those horizons of the Parsora Series which contain *Dicroidium* together with *Glossopteris*.

BOSE (1974) refers the floras of the Panchet Series of the Raniganj coal-field, floras of Autanga, Ramkola, Tatpani coal-field, floras of the Daighaon beds of South Rewa and Nidpur beds to the same stratigraphic horizon. All these floras are considered by him to be Early Triassic in age. He points out that they have several common features, including the presence of *Lepidopteris* type of cuticle and appearence of *Podozamites*. In these floras *Phyllotheca* and *Spenophyllum* are absent, *Schizoneura* is abundant, ferns are scarce and the *Glossopteris* leaves are small.

FEISTMANTEL (1880–1881) referred the Almod beds fossil plants from the basin of the Satpura River (Rorighat) to the Panchet Series. The fossil include *Schizoneura gondwanensis, Vertebraria indica* and *Glossopteris angustifolia.*

As can be seen from this, scientists assign different ages to the Panchet Series.

The Permian age of the Panchet Series or its lower part (the Maitur Formation) was also discussed by other specialists. The conclusion of LOZOVSKY et al. (1973) that the Maitur Formation was Permian in age was based on the correlation of the Hirapur Formation (after tetrapods) with the base of the Lower Triassic section of Greenland. They also referred the Hirapur Formation to the lowermost Triassic and the Maitur Formation to the Perimian. COSGRIFF (1969) studied tetrapods from the BRM-10 boring of Western Australia and came to the conclusion on the base of their evolutionary development that they occupy the position between the terapods of the *Lystrosaurus* and *Cynognathus* zones. These tetrapods were found together with Lower Triassic marine invertebrates. Consequently COSGRIFF considered the whole *Lystrosaurus* zone to be Permian in age. But SHISHKIN (oral communication in 1975) thinks that COSGRIFF's material does not allow certain correlation of the Australian and African tetrapods.

If the conclusion that the Lower Panchet is Permian is not completely acceptable it is necessary to keep in mind that evidence for a Triassic age is not much stronger.

Nidpur beds

The flora of the Nidpur beds in the basin of the Son River (to the north west of South Rewa) has been described in many modern publications by BOSE and SRIVASTAVA (1969/1970, 1970/1971, 1970/1972, 1973 a, 1973 b, etc.; see list 77 in the third part of the present paper). The genus *Dicroidium* (three species with bipinnate fronds) dominate here together with the genus *Glossopteris* (three new species); *Taeniopteris* is found in great numbers. This flora contains a single imprint of *Lepidopteris* and rare specimens of *Rhabdotenia.* In addition there are new species of *Glottolepis* and fructifications of endemic genera *Nidistrobus, Nidia, Satsangia* and *Pteruchus.* The remains of *Noeggerathopsis* sp. and *Conites* sp. are rare and fragmentary. In palynological assemblages non-striate bisacate pollen dominate and trilete and monolete spores are rare. SRIVASTAVA (1972, 1974) believes that the Nidpur flora is younger than the Panchet flora because of the abundance of *Dicroidium* and older than the Parsora flora. He notes its similarity to the Narrabine flora of Eastern Australia, the Upper Beaufort flora of South Africa, the Madagascar, and the Arctic floras. He dated it as late Early Triassic. SRIVASTAVA is of the opinion that the palynological content of the Nidpur beds is close to that of the Raniganj Series and the Lower Panchet Series, but differs from them by the subordinate role of Permian spores. The presence of *Satsangisaccites* makes it closer to the Middle Triassic floras of Australia.

MAHESHWARI (1974) puts the Nidpur flora at the same horizon with the Upper Panchet floras of Auranga, Ramkola, Tatapani and with the "mixed" floras of the Parsora Series. BOSE (1974) considers the differences between the Nidpur flora and Parsora flora to be very large: ferns are absent in the first of them and are abundant in the second; glossopterids are common in the Nidpur flora whereas in the Parsora flora they are very rare. *Dicroidium* in the Nidpur flora is presented by forms with bipinnate leaves and in the Parsora flora by forms with forked leaves.

Parsora Series

The Parsora Series in South Rewa is characterized by an Upper Gondwana appearance of the rocks themselves (medium coarse grained sandstones with micaceous and ferrous interbeds) but fossil plants in it are Upper Gondwanian (*Dicroidium* etc.) as well as the Lower Gondwanian (*Glossopteris*). FEISTMANTEL, SEWARD, SAHNI, RAO, LELE, and SAKSENA have described the Parsora flora (for references see list 80 in the third part of the present paper). The assumption of SAHNI (SEWARD & SAHNI, 1920) that fossil plants of two different horizons were mixed in Parsora collections was not confirmed by recent workers. After field work SAKSENA (1952) showed that in South Rewa there are three types of localities: 1) Salaia, Karkati with *Glossopteris* flora only and without younger elements, 2) Chicharia, Bhaursen, Barnauda with *Dicroidium* flora only and without *Glossopteris;* 3) Parsora, Kamtadand, Daigaon, Dhaurai with both *Dicroidium* and *Glossopteris*. The occurence of the Lower Gondwana plants in the apparent Upper Gondwana rocks was the reason for distinguishing the Middle Gondwanian, i. e. transitional deposits.

Among the localities with mixed flora it is possible to differentiate two types: in the first of them *Glossopteris* is dominate and *Dicroidium* is subordinate (Daigaon, Dhurai); in the second type the situation is reversed (Parsora, Kamtadand, Beli).

A Permian age for the localities with the *Glossopteris* flora and without young elements does not seem to be unreasonable. The greatest controversies are connected with the age of the Parsora Series itself. Tetrapods and intraregional correlations are used as a basis for determining the age of the Panchet Series and its flora and palynological data is used for determining the age of the Nidpur flora. Unfortunately there is nothing to use to date the Parsora flora except the flora itself. Direct comparisons of Indian floras with those of other continents are of little importance because as we can now judge the *Dicroidium* flora existed in the southern hemisphere from at least the end of the Lower Triassic (the Olenekian) to the middle or to the end of the Upper Triassic. In addition mixed *Glossopteris* – *Dicroidium* floras are absent on the all continents except India. *Glossopteris* and *Schizoneura* occur together with tetrapods in the *Lystrosaurus* zone of South Africa without *Dicroidium*. In Australia *Glossopteris* was not found in certain Triassic deposits. It seems more natural to correlate the Indian mixed flora with the first stage of the existance of the *Dicroidium* flora, i. e. with the second half of the Lower Triassic (approximately Olenekian).

Some forms of younger appearance were reported from the Parsora flora (Lele, 1961/1962). They were compared with Jurassic forms, but Bose (1974) believes that all of them were incorrectly identified. The fact that the "scales of *Araucarites*" are the leaves of lycopsids is of great importance. They are very similar to the leaves of *Pleuromeia* (Lele, 1961/1962, tabl. IV, figs. 33–40). Retallack (1975) also draw attention to this resemblance when he studied the Pleuromeiaceae from Australia where they also have a short stratigraphic range in just the upper part of the Lower Triassic. The present author considers the age of the Parsora flora to be Olenekain because of the correspondence of it to the early stage of development of *Dicroidium* floras as well as to the presence of *Pleuromeia* in it. The author could not find any serious evidence for a younger age of the Parsora flora. However one cannot exclude a younger age for the pure *Dicroidium* floras of Southern Rewa.

Kamthi beds

The age of the Kamthi beds in the basin of the Pranhita-Godawari Rivers is still unclear. Fossil plants from the Kamthi beds were studied by Feistmantel (1880–1881). *Dicroidium* is absent here and the glossopterids are not numerous. *Neoeggerathiopsis* differs very much from the Triassic leaves such as *Yuccites* and *Pelourdea* as well as from *Cordaites*. At least in younger Indian floras (Panchet, Nidpur, Parsora) leaves of this type are unknown.

In the Godawari Basin the Triassic deposits contain fossil tetrapods which establish the age of the Mangli and Yerapali Formations: the Mangli correlates with the *Lystrosaurus* zone and the Yerapali correlates with the *Cynognathus* zone.

Maleri Formation

The Maleri Formation correlates with the Karnian and the Lower Norian (Robinson, 1969). The fossil plants were collected from the Maleri Formation (list 82). They include *Elatocladus jabalpurensis, Athrotaxites feistmantelii, Araucarites cutchensis, Mesembeyoxylon godaverianum* (Sahni, 1931). This assemblage differs very much from the plant assemblage of Parsora.

Upper Triassic tetrapods and fish are known from the Tiki Formation which overlies the Parsora Series.

Almod beds and Middle Triassic of the Salt Range

It is worth mentioning two small florulas of India. The former one is from Almod beds (list 84), the latter from the Middle Triassic of the Salt Range (list 85).

Summary

Although it is not possible to accurately correlate the Triassic deposits of India it is possible nevertheless to come to some general conclusions. There are in India

1) pure *Glossopteris* floras at Raniganj, South Rewa, the Godawari Basin;

2) mixed *Glossopteris* – *Dicroidium* floras at Auranga, Ramkola, Tatpani, Nidpur, South Rewa;

3) pure *Dicroidium* flora at South Rewa; and

4) conifer florula of Maleri without glossopterids as well as the Corystospermaceae.

Glossopterid leaves in younger floras (beginning from the Panchet) are characterized by small size and perhaps by some other features which have not yet been analysed.

In any case very sharp change in the floral composition took place simultaneously with the change from coal-bearing deposits to the deposits without coal at the boundary between the Raniganj and Panchet series. The changes included a significant impoverishment of floras with the extinction of the genus *Gangamopteris* and large glossopterous leaves typical of the Palaeozoic.

The *Glossopteris* and *Dicroidium* floras of India are astonishingly different from coeval floras of other Eurasia and Northern American localities and are as well astonishingly similar to the corresponding floras of the Southern hemisphere. This situation existed in the Palaeozoic and the first half of the Triassic. In the Middle Jurassic the Indian floras are similar to the floras of the rest Eurasia. It is impossible now to say when and how connections of the Indian floras were changed, because the Lower Jurassic floras of India are unknown and the floras of the second half of the Triassic in India are also poor.

Chapter eight

Correlation of plant-bearing beds of Eurasia

The stratigraphic relationships of the Triassic plant-bearing beds were described above and it was shown that their geological age can be directly determined (according to the marine scale) for those which are distributed along the margins of Eurasia: in Western Europe, Svalbard, Greenland, the Far East, the Northern Coast of Asia and in Southern Eurasia (DOBRUSKINA, 1976 a).

Among them it is possible to differentiate four plant assemblages of different age which are here considered to be **standards:**

(1) The Induan. This assemblage is represented by the Taymyr and Verkhoyanye flora and consists mainly of the genus *Tomiostrobus* with subordinate quantities of other genera. It lies under marine Olenekian deposits and in some cases it can be correlated with strata containing Induan ammonites.

The Lower Korvunchana and the Lower Maltsevo flora without conifers, the Ust Berezovka flora of the Pechora Basin and the pteridophytic flora of China also are correlated with this assemblage. The miospores, ostracods, conchostracians and freshwater pelecypods do not contradict this correlation.

(2) The Olenekian. This assemblage is represented in Western Europe by the Buntsandstein flora in which the dominants are the conifer *Voltzia* and the lycopsid *Pleuromeia*. In the south and north of Eurasia, in the Far East and China this assemblage consists of large quantities of *Pleuromeia* with scarce remains of other plants. *Pleuromeia* remains were found together with ammonites in the Prikaspian depression, the Mangyshlak, the Darvaz, the Olenek mouth, Soviet Primorye and Japan. The *Voltzia* flora is dated by marine invertebrates in the Alps.

The *Voltzia* flora from the Petropavlovka Formation of Priuralye, from China, from Upper Korvunchana and Upper Maltsevo flora with abundant conifers of European type, the *Pleuromeia* flora from the Rybinsk Formation of the Upper Volga, the Kumansk and Neftekumsk Formations of Predkavakzye, the Khozbulak, Dolnapa, Birkut Formations of the Mountaneous Mangyshlak and from the Yokunzh Formation of the Darvaz are correlated with this assemblage. Such correlation is confirmed by tetrapods. In the case of the Kumansk and Neftekumsk Formations there is contradictary evidence because they contain poorly preserved and unstudied pelecypods and brachiopods. The pelecypods from the Khozbulak Formation were considered to be Karnian in age, but the same pelecypods have been found recently in the Anisian deposits of Bulgaria and in the Middle Triassic deposits of Predkavkazye.

It seems that the Upper Anisian and the Lower Ladinian deposits are not characterized by a fossil flora and represent a gap in our knowledge.

(3) The Ladinian-Karnian. This assemblage is represented in Western Europe by the floras of the Lower and Middle Keuper of the German Basin, the Karnian of the Alps and Svalbard in the west of Eurasia and Ladinian-Karnian deposits of Japan and in Soviet Primorye. Plant assemblages from the west and east of Eurasia are remarkably similar to each other.

Plant assemblages of northern and southern Priuralye, from the Anokhino Formation of the Eastern Urals, the Flora of Nikolayevka in the Donbass, the Madygen, Kamyshbashi (the early assemblage) the Koldzhat floras of Middle Asia, the floras of Mongolia, the Yenchang flora of Northern China, probably the Bogoslovsk flora of the Eastern Urals and the plant assemblage from "Yolikhar" Formation of Darvaz are correlated with the third assemblage. In all these cases palaeozoological evidence is practically absent to help with correlation; palynological data are controversal and insufficient, that's why the main conclusions are made on the basis of individual plant fossils assemblages.

Comparison with a standard assemblage allow correlation with Ladinian-Karnian assemblage as a whole because we cannot distinguish two assemblages in this interval. In the intercontinental parts of Eurasia, some groups of plants in these floras are more similar to the western floras and other groups are similar to the eastern floras.

(4) The Norian-Rhaetian. This assemblage is represented by the *Lepidopteris* flora of Greenland and Western Europe in the west and by the Norian floras of Soviet Primorye and Japan in the east. As has been repeatedly stated new data on the stratotypes of the Norian and Rhaetian stages lead to the conclusion of the coevality of these floras.

The Novorayskoye flora of the Donbass, the flora of beds VI and VII of Predkavkazye, the Dzhermanis flora of Zakavkazye, the Shemshak flora of the Elburz, the flora of "black shales" of the Pamirs and northern Afghanistan, the Aktash, Turakavak, Tologoy floras of Middle Asia and floras of southern China are correlated with the fourth assemblage.

Although the *Lepidopteris* and *Thaumatopteris* floras in the west of Euroasia contain no common species they are very similar in generic and family composition. Towards the east the picture changes and the *Lepidopteris* flora contain species which in the west are characteristic of only the *Thaumatopteris* flora. The number of these forms increases and reaches a maximum in Japan (where their migration apparently originated).

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The Garazhovka flora of the Donbass lies in the sequence between the Nikolayevka and Novorayskoye floras and probably corresponds with those deposits of Western Europe which are not characterized by fossil plants, the

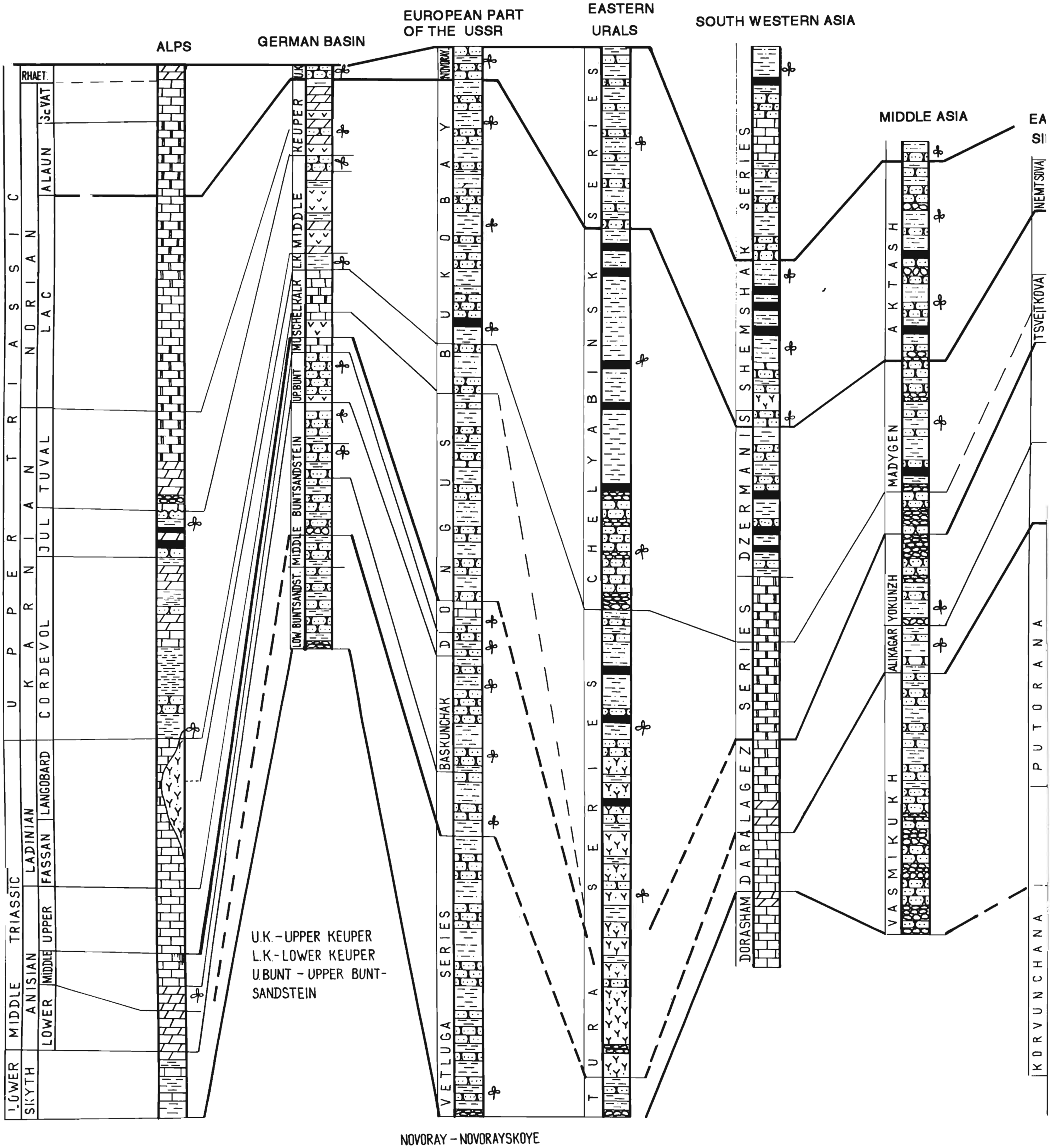
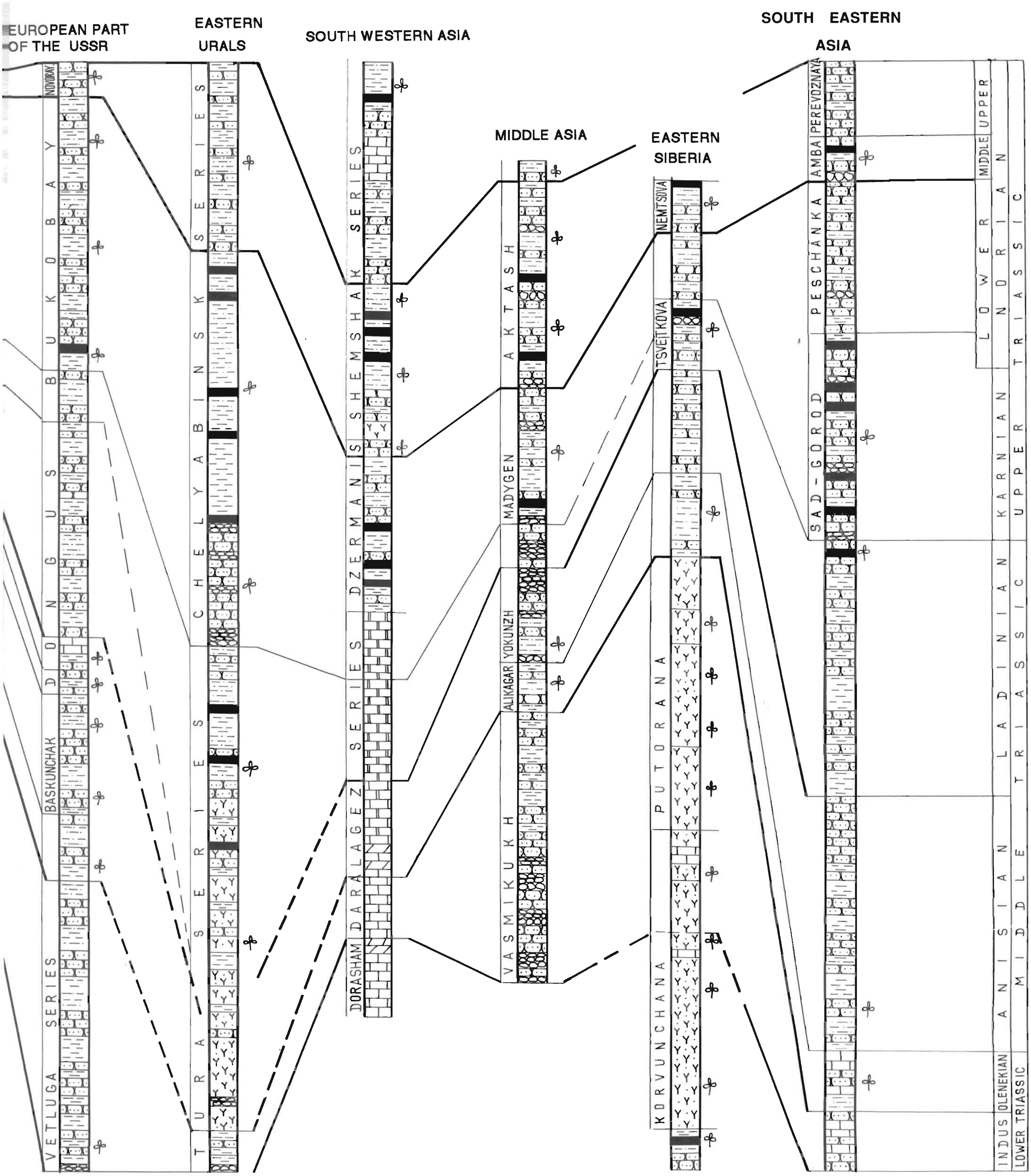


Fig. 46: Correlation of the Triassic plant-bearing deposits of Eurasia (exept India). For the legend see fig. 74.



NOVORAY – NOVORAYSKOYE

posits of Eurasia (exept India). For the legend see fig. 74.

Stubensandstein of the Lower Norian. The Garazhovka flora is closer to the Ladinian-Karnian floras by the abundance of pteridosperms but the presence of common species makes it similar to the Norian-Rhaetian Novorayskoye flora. Plant assemblages of coal-bearing deposits of the Eastern Urals are similar to the Garazhovka flora and to an undescribed flora from the Nemtsova Formation of the Taymyr. Stanislavsky (1976) believes all the floras of the Eastern Urals to be coeval with the Garazhovka flora and considers the latter flora to be late Norian in age. Kirichkova (1969) and Vladimirovich (1969) refer the lower part of the plant-bearing beds of the Urals to the Rhaetian and the upper part to the Liassic. This question has not been determined with assurance. A monographic study of the new Taymyr collection may help to decide the question.

In India the Nidpur flora is considered to be Early Triassic and the *Dicroidium* flora of the Parsora Series is considered to be approximately equivalent to the Olenekian and the Maleri flora is thought to be Late Triassic in age.

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If geological and palaeontological data are of importance for the correlation of plant-bearing deposits inside the region with homogenous geological structure, for extraregional correlation we almost exclusively use palaeontological remains. The only exception has been the attempt to use climatic changes for the correlation of the lower boundary of Korvunchana flora-bearing beds with corresponding plant-bearing beds of India. The formation of coals ceased in Siberia at the lower boundary of the Tunguska volcanics and in India it ceased before the Panchet. In both regions succession of coal formation was accompanied by abrupt change in the plant assemblages. Both of these phenomena might be due to the increase in temperature in both regions. It is natural to suppose that they were coeval in both regions.

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Thus, four stratigraphic intervals characterized by different plant assemblages are differentiated in the plant-bearing deposits of Eurasia in the Triassic (fig. 46).

The first stratigraphic interval corresponds approximately to the Induan. This part of the sequence is characterized by the Korvunchana conifer-fern flora in the Tunguska and Kuznetsk Basins and the Western Verkhoyanye (lower part of these floras without conifers), the *Tomiostrobus* flora of the Western Verkhoyanye, the Olenekian coast, the Taymyr and the Pechora Basin. and the pteridophytic Lower Triassic flora of China with very rare conifers. The equivalents of this plant assemblage is not known in Western Europe.

Remains of *Tomiostrobus* are found at most localities without any other plant remains; that is in the Northern Coast, in Verkhoyanye, in three localities in the Tunguska Basin itself – at the margins of the basin. But in the Kuzbass they are found in the typical Korvunchana flora. In Taymyr other plants also were found together with *Tomiostrobus*, especially *Lepidopteris* is abundant. All of associated plants are known from the Korvunchana flora of the Tunguska Basin. The difference is in the numbers of representatives of various plant groups in these two regions. In the Pechora Basin *Tomiostrobus* is found with *Glossophyllum*, which also occur in the Korvunchana flora.

Volanics with the Korvunchana flora are underlain in the Tunguska and Kuznetsk Basins by coal-bearing deposits which contain a *Cordaites* flora that is quite different from Korvunchana flora. *Cordaites* flora was replaced by the Korvunchana flora at the boundary of the Permian and the Triassic. The correlation of the Korvunchana flora with the *Tatarina* flora of the Russian platform which was accepted earlier by the author (Dodruskina, 1980, p. 33) does not seem to be correct (Dobruskina, 1984, 1985 a). Until recently occurences of *Tomiostrobus* were confined to the Induan. For example it was found in northern Siberia together with *Metophiceras* sp. and *Myalina shamarae* Bittn. or below the Olenekian ammonites. Several occurence of *Pleuromeia* were made at this stratigraphical level a few years ago but only one of them has been published (Sadovnikov, 1982 b). This discovery probably shows that *Pleuromeia* occurs in the Induan. The exact age of this assemblage has not been established with assurance and it is possible that this assemblage is either latest Induan or earliest Olenekian in age.

The second stratigraphic interval includes all or most of the Olenekian and of the Anisian without its upper part. In the western Eurasia it is called the Buntsandstein flora and includes the *Voltzia* and the *Pleuromeia* floras which have been together as well as separately in coeval strata. The *Voltzia* flora is known in the German Basin, in the Southern Priuralye, Southern Fergana and China. The Upper Korvunchana flora with abundant conifers is the equivalent of the *Voltzia* flora which in its typical form is very close to the Zechstein flora of Western Europe.

A great number of localities containing *Pleuromeia* flora have been described from all over Eurasia, from the German Basin and the Alps in the west to Japan in the east and from the Darvaz in the south to the Olenekian coast in the north. In the majority of localities *Pleuromeia* has been found in marine deposits in association with Olenekian and Anisian ammonoideas. *Pleuromeia* was found also in deposits underlying or overlying the marine strata containing ammonoideas of Olenekian age. There are three *Pleuromeia* localities which were situated far from the sea shore: the Upper Volga region, central India and northern China.

During the lower half of the Triassic in Eurasia there were distinct floras in different areas. They included the Korvunchana flora in Siberia, the *Voltzia* flora in the area from Western Europe to China, the *Dicroidium* flora in India. Also the *Pleuromeia* flora was widespread all over Eurasia within the areas of the three floras mentioned above. Only in the central parts of the Tunguska Basin has *Pleuromeia* not yet been found.

The third stratigraphic interval includes the upper part of the Ladinian, the Karnian and possibly the lowermost part of the Norian. It is characterized by the flora of Keuper type ("pre Rhetian Keuper flora" as it was called earlier in Russian literature) and by Yamaguchi-type flora. In spite of provincal peculiarites all local floras of this time contain many common forms. One can observe gradual changes in floral content from the west toward to the east. So it is impossible to distinguish separate floras in different areas. All of them constitute the *Scytophyllum* flora. This name was derived from the very typical pteridosperm of the Ladinian-Karnian floras. *Scytophyllum* occurs in all Eurasian regions except in Far East and the Far Southeast.

The Fourth stratigraphic interval extends from the middle Norian to the end of the Triassic. Taking into account the uncertainty regarding the validity of the Rhaetian stage, this interval is now termed the Norian-Rhaetian (until the Triassic subcommission makes a formal decision about this matter). The problem of the correlation of the upper boundary of this plant assemblage with the Triassic-Jurassic boundary has already been discussed (GOMOLITSKY & DOBRUSKINA, 1973).

Floras of this age are similar all over Eurasia although some gradual changes of content from the north to be south and from the west to the east may be observed. All of these floras comprise the *Lepidopteris* flora which is here used in wider sense than T. M. HARRIS used it. Originally the name was proposed by HARRIS (1973) for the Rhaetian (= Norian-Rhaetian) floras of Greenland and Western Europe. In the present paper it also is used for the coeval floras of the eastern Eurasia which were not known to contain the remains of *Lepidopteris* untill recently (DOBRUSKINA, 1987 b). *Lepidopteris* has been recognized in a collection of fossils from Tonkin that is stored at Lyon University thanks to the remark of LUNDBLAD (1950 b). It seems preferable to use the term *Lepidopteris* flora instead of introducing a new term.

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The correlation scheme described above therefore permits division of the plant-bearing deposits of Eurasia into four stratigraphic intervals. Each of these corresponds approximately two stages of International Geochronological Scale. More detailed subdivision and correlation using Triassic plants for all Eurasia is impossible at present but more detailed divisions may be traced through limited areas. For example, in the German Basin three plant-bearing divisions can be distinguished in the Olenekian-Anisian interval and also three in the Ladinian-Karnian interval. Beyond the German Basin, however, they cannot be recognized. In Iran, the Pamirs, Vietnam three or four plant-bearing divisions have been distinguished but they also cannot be traced outside of the belt.

The correlation scheme described above for the Triassic plant-bearing beds of Eurasia is the basis for establishing a phytogeographic zonation of Eurasia in the Triassic (see chapter twelve), for the study of stages in development of Eurasian flora in the Triassic (chapter thirteen), for the understanding of the history of this flora, i. e. the rise history of the Mesophytic floras in Eurasia during the Triassic (chapter fourteen).

Part two

Distribution of Eurasian Triassic floras in space and time

Chapter nine

Historical sketch and the present state of knowledge of the Triassic floras of Eurasia

Study of the Triassic flora began about 150 years ago in Central Europe when JAEGER (1827) published a monograph that included the description and drawings of plants from the Bausandstein in Stuttgart's environs. Other floras described at about this time included the Buntsandstein flora in the Vosges (BRONGNIART, 1828), the "Coburger Sandstein" flora of Coburg's environs (BERGER, 1832) and the flora in the sandstones of Upper Silesia (GOEPPERT, 1836). There was no Triassic System in the modern meaning before 1831 and the local stratigraphic subdivisions existed by themselves. Consequently the question of their correlation was not yet an issue. The first two localities mentioned above are now assigned to the upper half of the Lower Triassic, the third one to the Middle Keuper and the fourth one to the Rhaetian. A second monograph concerning the Vosges flora (Buntsandstein), was published in 1844 by SCHIMPER and MOUGEOT.

It was in 1843, that the first figure of the rather typical Lower Triassic lycopsid *Pleuromeia* (MUNSTER, 1843) was published. As it was found later it was of great importance to the characteristics of the Lower Triassic landscapes not only of Eurasia but of nearly the whole world (exept North America). In the 1850s this plant attracted the attention of several investigators, including BEYRICH (1850), GERMAR (1852), BISCHOF (1853, 1855), SPIEKER (1853, 1854). They compared it to the Palaeozoic genus *Sigillaria* (after MUNSTER). These descriptions established and defined the genus *Pleuromeia*. The name *Pleuromeia* was introduced later (CORDA, in GERMAR, 1852). Among the ferns described at that time by GOEPPERT (1836) one can find *Lepidopteris ottonis*, a pteridosperm (the holotype for the guidfossil of the Norian and Rhaetian).

Descriptions of plants from new localities in the German Basin appeared in the middle of the 19th century. They included plant fossils from the Lettenkohle of Thüringia (BORNEMANN, 1865; COMPTER, 1874, 1894, 1902, 1912, 1918, 1922). The Lettenkohle and Schilfsandstein of Franken (SCHENK, 1864), the Seinstedt sandstones of Lower Saxony (BRAUNS, 1862–1866), the Grenzschichten from the Keuper to Lias of Franken (SCHENK, 1867), as well as from the Buntsandstein of Rhineland (WEISS, 1864). The Buntsandsteinflora of the left-bank of the Rhine turned out to be similar to the Vosges flora. The "Rhaetian" flora from Franken was considered by SCHENK (1867) to be the same age as the previously described floras of Upper Silesia and Lower Saxony. He followed GUMBEL's (1864) conception on the lithology and distribution of the Rhaetian formation. During the 50 years after SCHENK's work the "Grenzschichten des Keuper und Lias" were assigned to the Rhaetian. In 1914 GOTHAN divided the strata in two horizons, showing that the upper flora was of Early Jurassic age. From the plant assemblages described by SCHENK (1864, 1867), GOTHAN considered to be Rhaetian only the floras of Coburg and Seinstedt, Upper Silesia, i. e. the localities where SCHENK determined the existance of the genus *Lepidopteris*.

The rich flora of Basel in north Switzerland was discovered at that time and was considered by HEER (1865, 1877) to be analogous to the Lettenkohle flora. On the other hand the geological data seemed to indicate that the plant-bearing rocks correlated with the Schilfsandstein. The exact correlation of the Alpine floras of the Raibl beds (BRONN, 1858; SCHENK, 1865) with the floras in the German Basin was a matter of great difficulty. The Lettenkohle and Schilfsandstein floras were not characterized sufficiently and the characteristics of each of these two floras depended on the inclusion of the Basel flora in one of them. Also one of the key problems in the correlation of the Raibl beds, whether they are correlate with the Lower (Lettenkohle) or the Middle (Schilfsandstein) Keuper.

The Alpine Recoaro beds flora (ZIGNO, 1862), first thought to be Anisian, turned out to be more similar to the Buntsandstein flora of the German Basin (SCHENK, 1868; SELLI, 1938).

Among the palaeobotanic monographs mentioned above BORNEMANN'S work (1856) is of particular interest. During the study of the Triassic flora in Thüringia (Mühlhausen) he studied the epidermal structure of the plant fossils – a technique which is now recognized as one of the important features used in the study of fossil floras. He proposed the technique of the chemical treatment of the phytoleims, that made it possible for their microscopic study.

A description of Rhaetian floras was contained in the four-volume summary of the Jurassic flora of France (SAPORTA, 1873–1891), because until recently the Rhaetian beds were included in the Jurassic System in France. It is interesting to note that later on some reviews on the Triassic floras of France were written though without description and illustrations, whereas similar works for the German part of the basin are absent. Only the formal summary of stratigraphy and palaeontology was made by SCHMIDT (1928, 1938).

In 1876–1890 the first works by Nathorst were published. They included descriptions and illustrations of "Rhaetian" (Rhaetian-Liassic according to the present notion) floras of southern Sweden. These investigations were continued by other palaeobotanists such as MOLLER (MOLLER & HALLE, 1913), HALLE (1908 a, 1908 b, 1910, 1921), ANTEVS (1914 a, 1914 b, 1914 c), JOHANSSON (1922). The plant-bearing section was divided by Nathorst into several zones according to the typical plants and pelcypods.

Some descriptions of the plants from newly discovered localities in Central Europe appeared at the same time. These plants which were from the Buntsandstein and Muschelkalk of Eifel (BLANKENHORN, 1886), Buntsandstein of Baden (FRENTZEN, 1915), Lower Saxony (SCHLUTER & SCHMIDT, 1927), England (ARBER, 1907, 1909; WILLS, 1910) turned out to be similar to those from the Vosges. A large monograph on the Vosges Triassic floras appeared about the same time (FLICHE, 1905–1910). In the late 19th century an important plant locality was discovered in the Karnian deposits near Lunz in the Northern Alps, a locality which is nearly coeval with the Raibl locality. STUR (1885) was the first to give a list of the Lunz fossils although he did not describe or illustrate them. The list was given together with the list of the Raibl plants. STUR considered the differences of these two flora not to be related to age but to their geographical position. Later on KRASSER (1909 a) gave the diagnose of the ferns Marattiacean based on the determinations by STUR. Later he (KRASSER, 1909 b, 1918, 1919) also examined a considerable amount of Cycadophytes from these deposits. Unfortunately, his work on the Lunz flora was never completed.

LEUTHARDT (1901, 1903/1904, 1914, 1916) published some papers on the Basel flora and FRENTZEN (1922 a, 1922 b, 1926, 1933) carried out a comparative analysis of the Keuper floras of the southern part of the German Basin. He came to the conclusion that the flora of Basel, Switzerland as well as the floras of Lunz and Raibl should be considered the Middle Keuper analogue of the Schilfsandstein flora, but not of the Lower Keuper Lettenkohle flora. As a result the Lower Keuper sediments and corresponding floras of the German Basin turned out to be of Ladinian age. While correlating the Alpine and German Triassic sections PIA (1930) accepted that point of view which matched some other palaeontological data. Later it was proved by some additional evidences, primarily by palynological studies.

While studying the floras of "Grenzschichten" of the Nürnberg area GOTHAN (1914) determined that these beds covered the interval from the Rhaetian to the Lower Triassic. The lower part of these beds is associated with the Rhaetian guide fossil – *Rhaetavicula contorta* – or is overlain by *Psiloceras planorbis* beds which marks the base of the Jurassic. The upper part of these beds includes the Jurassic fauna. Within the South German depression all the fossil floras of the boundary beds except those in the Coburg area were included by GOTHAN (1914) in the Lower Liassic.

At approximately that time some European geologists began to collect Triassic plants from other countries. At first these collections were examined only by European palaeobotanists. At the end of the last century descriptions of some Triassic plants were published. They were from India (FEISTMANTEL, 1880–1881, 1882, 1886), Indochina and southern China (ZEILLER, 1902–1903; PELOURDE, 1913; COUNILLON, 1914; HALLE, 1927), Persian (SCHENK, 1887; KRASSER, 1891; ZEILLER, 1905), Greenland (HARTZ, 1896), Spitzbergen (NATHORST, 1897), Australia (ANTEVS 1913–1919), New Zealand (ARBER, 1913). It was found out that the Triassic floras from India, Australia and New Zealand were so peculiar that it was impossible to correlate them with the European ones. Other palaeontological evidence was also not sufficient for accurate correlation. At that time the floras of Indochina, southern China, Persia, Greenland and Spitzbergen were considered Rhaetian (before GOTHAN's investigations of "Grenzschichten").

The first work on the Triassic floras in North America was by FONTAINE (1883), in Japan and China by YOKOYAMA (1905, 1906) and YABE (1922). In 1910 and 1912 the first works of KRYSHTOFOVICH on the Triassic floras of Primorye and the eastern Urals were published. He also compared the floras with the Rhaetian stage.

Consequently by the beginning of the 20th century there were a great number of Triassic plants which had been described and illustrated. Now it was time for a critical revision of the accumulated palaeobotanical data, and NATHORST began this work. Basing his work on the plant remains found in Sweden, NATHORST published several monographs dedicated to the investigation and revision of certain genera of fossil plants. These papers were published under the general title of "Palaebotanische Notizen" (NATHORST, 1902, 1906 a, 1906 b, 1908, 1909). This type of investigation marked a new stage in the study of Triassic plants. To that stage of the study one can also attribute a detailed monograph of SOLMS-LAUBACH (1899) on the genus *Pleuromeia,* and an important summary by POTONIE "Abbildungen und Beschreibungen fossiler Pflanzenresten", which included two Triassic genera: *Pleuromeia* (POTONIE, 1904) and *Lepidopteris* (GOTHAN, 1909) as well as the works of HALLE (1908 a, 1908 b, 1910, 1921) on the Rhaetian-Liassic plants of Sweden, the revision of the Gondwana flora made by SEWARD and SAHNI (SEWARD & SAHNI, 1920; SAHNI, 1931; SEWARD, 1932). A monograph was published by SCHMIDT (1928, 1938) in which an attempt was made to include all the palaeontological data of the German part of the German Basin available at that time. The revision was limited. Nevertheless up until now this paper was the only one summarizing all the geological, palaeobotanical and palaeozoological data for the central part ot the German Basin.

The modern stage of the palaeobotanical investigations began with the works of FLORIN (1933, 1936) and HARRIS (1931, 1932, 1935, 1937). Their first publication appeared in the middle of the 1920s. FLORIN did not especially study Triassic plants although he described several; his investigations of epidermis structure of Cycadales, Bennettitales, Coniferales were of greater importance. The principal Triassic contribution of HARRIS (1926, 1931, 1932, 1935, 1937) was a monograph on the Rhaetian-Liassic flora of Eastern Greenland. The Greenland flora was studied by him as thoroughly as was possible. He studied the morphology and the anatomy of each specimen, made precise and detailed drawings and photographs, gave a full revision of each genus and species found in the Greenland Triassic. He stated that the Greenland flora consisted of two assemblages very similar in general view, but which did not include a single common species. He compared these assemblages with the coeval plant assemblages in Europe. For detailed correlations HARRIS also studied the Swedish and German floras and their stratigraphical significance. For instance, he confirmed by means of palaeobotany the conclusion drawn by the geologists about the Rhaetian and Liassic age of the Swedish "Rhaetian". Finally Harris also carried out the first attempts of the palaeophytogeographic zonation of Eurasia in the Triassic.

The 1930s was a period of discovery and intensive study of new Triassic plant localities, especially within the USSR, China and Japan. While investigating the Jurassic flora of the Issyk–Kul Lake region Turutanova-Ketova (1931) suggested that the lower coal-bearing formation might be Triassic in age. About this time a Rhaetian age was proposed for the Armenian flora (Kryshtofovich & Prynada, 1933 a) and for the flora of the Chelyabinsk Basin (Kryshtofovich & Prynada, 1933 b). The age of the flora of the Pamirs was determined by Prynada (1934) as being somewhat older, "possibly the Keuper" in age. Approximately the same age was suggested for the flora of the lower plant-bearing horizon in Kamyshbashi in southern Fergana (Brick, 1941). But she was mistaken when she assigned the Madygen Formation flora in southern Fergana to the Lower Triassic. A small collection from Priuralye, Surakay was described by Zalessky (1936).

Prynada studied also the fossil plants from the Upper Triassic sediments of the Donbass, Priuralye and the Eastern Urals (Prynada, 1940; Prynada & Turutanova-Ketova, 1962). He worked much, but in the 1940s he had no possibilities to publish his works. He died in 1949 and parts of his manuscript were published later by his friends and students, but most of his collections remained undescribed in the F. N. Chernyshov museum in Leningrad (collections NN 5556, 6807, 7406, 7121, 6816).

The Rhaetian (in the older sense) assemblages of Western Europe as well as the Lettenkohle and Schilfsandstein, and Karnian assemblages of the Alps were used to determine the age of the plant-bearing sediments. The last three assemblages–the Lettenkohle, Schilfsandstein and Alpine Karnian–were usually used for comparison as a single assemblage. In the Russian literature this united assemblage was often considered to be "Keuper, but older than the Rhaetian" and was correlated with the Pamirs, Priuralye and Donbass floras.

A Lower Triassic flora was discovered in the Kuznetsk Basin (Neuburg, 1936; Radczenko, 1936) which appeared to be unlike the Western European one.

At the same time the two assemblages of Upper Triassic plants were discovered in China which were similar to the Russian ones. The older flora was determined approximately as Keuper-Rhaetian in age (P'an, 1936) and the younger was approximately Rhaetian but closely connected with Jurassic floras (Sze, 1933 a, 1933 b, 1949). Simultaneously Oishi and his collaborators were studying the Triassic flora in the southwest part of Honsu Island, Japan (Oishi, 1930, 1931, 1932 a, 1932 b, 1938, 1940; Oishi & Huzioka, 1938; Oishi & Takahasi, 1936). This flora turned out to be similar in appearance to the Rhaetian-Liassic floras of Greenland and Western Europe. Both Oishi (1938) and Harris (1961 a) expressed their opinion about the resemblance of these floras. Although it is hard to confirm because of the absence of cuticules in the Japanese imprints. Prior to World War II and especially after much new geological evidence was found which indicated an older age of the plant-bearing beds of Japan. It was determined not younger than Norian. This contradiction was discussed mainly in stratigraphical and palaeobotanical works. The latest interpretation which based on re-examination of the Norian and Rhaetian stratotypes shows that the lower boundary of the formations containing the European and Greenland "Rhaetian" flora is to be related most closely with the Middle Norian. Thus, the floras of the eastern and western Eurasia are approximately of the same age (DOBRUSKINA, 1976 b).

Detailed study of the old fossil plant collections in European museums has continued along with the publishing of the new discoveries. MÄGDEFRAU described the Lower Triassic floras of Germany in 1930–1936. The most interesting and most careful studied plant was the genus *Pleuromeia* (MÄGDEFRAU, 1931 a, 1931 b). LINNEL (1932, 1933) described thoroughly the morphology and the epidermal structure of some Lower Keuper plants from Thüringia which were in the Stockholm museum. HIRMER and HORHAMMER 1936) studied the morphology, epidermis and geographical distribution of the fossil and recent Matoniaceae.

A comparison of the Karnian flora of Lunz in the Northern Alps and the flora of the Basel environs in Northern Switzerland was begun by KRAUSEL before World War II. The coevality of these floras was recognized long ago. KRAUSEL (1922, 1923, 1943, 1949, 1953) studied only cycadophytes and ginkgophytes of that flora. The Alpine Triassic flora has been studied especially irregularily: some of the plants have been described several times while others were never described and illustrated. STUR who was considered to be the best to know the Alpine Triassic flora had so broad interests which did not permit him to carry out a monographic study of the flora. He only published a list. Neither KRASSER or KRAUSEL had time to describe thoroughly this rather interesting flora. Noboby in Austria is studying the Alpine flora now. The fossils are scattered among different West European museums in Vienna, Berlin, Stuttgart, Tübingen, Frankfurt am Main, Meiningen, Lyon etc. Recently the author of the present paper began to study Lunz flora (DOBRUSKINA, 1988 a, 1989 a).

Knowledge of the Triassic floras of the USSR rapidly increased following World War II because of many new geological survices and research projects. During this period previously unknown Triassic deposits were discovered in Aktyubinsk Priuralye (BRICK, 1952), in the Pechora Basin (NEUBURG, 1959; DOBRUSKINA, 1969; CHRAMOVA, 1973, 1977), in the upper Volga region (NEUBURG, 1960), in the several parts of Middle Asia (SIXTEL, 1949–1968) and Kazakhstan (ORLOVSKAYA, 1960; MARKOVICH, 1961; KOVALCHUK, 1961; ALIEV & GENKINA, 1970), in Siberia (SCHVEDOV, 1963; TOLSTYCH, 1969; SADOVNIKOV, 1971 b; MOGUTCHEVA, 1973 and oth.) in Taymyr (SCHVEDOV, 1958, 1969 a, 1960 b). The age of the so-called Korvunchana flora of the Tunguska Basin caused much controversy because it could not be compared with any well identified flora. Neither could the including rocks be evaluated by direct correlation with marine sediments. But in the last years new discoveries of conifers made by MOGUCHEVA and new material published by chinese palaeobotanists permitted to consider the Korvunchana flora not so endemic as it was thought before (MOGUTCHEVA & DOBRUSKINA, 1985; DOBRUSKINA & MOGUTCHEVA, 1987).

SIXTEL was the first to publish data on the Madygen flora of Southern Fergana (SIXTEL, 1949, 1956, 1960, 1961, 1962 a, 1966; SIXTEL & KHUDAYBERDYEV, 1968) and the Keuper floras streching along the south of Eurasia from Western Europe to China and Japan. SIXTEL considered the Madygen flora to be Late Permian – Early Triassic in age. However, the conclusion about the relationship of this flora to the geographically adjacent ones and about the geographical zones in the Triassic are now considered to be wrong.

The work by NEUBURG (1960) on the genus *Pleuromeia* was of great botanical interest, as it demonstrated some new features in the structure of this lycopod. Excellent preservation and some new discoveries permitted the author of the present paper (DOBRUSKINA, 1974, 1985 a) to make some additional changes in the interpretation of the structure of this plant.

New, much more significant discoveries have been made in boreholes in the Eastern Urals. The fossils were described by VLADIMIROVICH (1958 a, 1958 b, 1959, 1960, 1965, 1968 a etc.) and by KIRICHKOVA (1962 a, 1962 b, 1969). Nevertheless there are still many uncertainties in the correlation of the sections from the different basins of the Eastern Urals due to the rather complex geology of this region.

Important investigations have been carried out on the Triassic plants of Primorye. KRYSHTOFOVICH (1921) who was the first to study the flora thought that it was of the same age as the Rhaetian flora of Tonkin. The existence of two Upper Triassic plant assemblages in Primorye was shown by SREBRODOLSKAJA (1961, 1968 a, 1968 b, 1968 c, 1968 d). The plant-bearing beds are underlain and overlain by marine sediments with fossils, which date the plant assemblages. SHOROCHOVA (1975 b) showed that these plants were more widely distributed within southern and northern Primorye. Their greater taxonomy variety was proved, as well.

The Soviet palaeobotanists SREBRODOLSKAJA and SADOVNIKOV investigated the Triassic flora of North Vietnam (Tinkin). The disagreement on the exact age of this flora (Norian or Rhaetian) was ended after a study of the Alpine stratotypes of the Norian and Rhaetian stages. This study (see part one of the present book) showed that the Rhaetian must be included in the Norian, either the whole stage or a part of it. Soviet palaeobotanist VASSILEVSKAYA (1972) monographed the Upper Triassic flora of Svalbard.

The Triassic floras of the north-western margins of the Donbas have been studied by STANISLAVSKY since 1953. He described the floras of Novorayskoye STANISLAVSKY, 1971), Garazhovka and Nikolaevka (STANISLAVSKY, 1976) and compared them with the floras of Western Europe and the Eastern Urals. The monography by GENKINA (1964, 1966) considered the Upper Triassic and the Lower Jurassic floras of the Issyk-Kul Lake.

Little has been described from the Triassic floras of Western Europe since World War II. Nevertheless, a lot of new data appeared on the composition and structure of some genera and species of the Triassic plants in Germany (ROSELT, 1952/1953, 1954, 1955/1956, 1957/1958, 1960; MÄGDEFRAU, 1953, 1960, 1963), France (GRAUVOGEL, 1967; SCHAARSCHMIDT & MOUBEUGE, 1969; RICOUR, 1951, 1968; LARSONNEUR, 1961/1962, 1963; MUIR ET AL., 1970; GRAUVOGEL-STAMM, 1969, 1972, 1978; GRAUVOGEL-STAMM & GRAUVOGEL, 1973, 1975), and in Sweden (LUNDBLAD, 1949 a, 1949 b, 1950 a, 1950 b, 1954, 1956, 1957, 1959 a, 1959 b). GRAUVOGEL gathered thousands of fossils, both plants and animals from the *Voltzia* sandstone of Vosges, "from Vasselone to the Saar frontier", and showed that marine beds occur within the *Voltzia* sandstone.

Recent investigations in Iran (KILPPER, 1964, 1971, 1975; BARNARD, 1965, 1967; SADOVNIKOV, 1967; CORSIN and STAMPFLI, 1977; SCHWEITZER, 1978) permit more accurate determination of the systematics and stratigraphic position of the fossil plants. SADOVNIKOV recognized three Upper Triassic plant assemblages in the Elburz Mountains.

Detailed studies by KON'NO (1961, 1962 a, 1962 b, 1972; KON'NO & NAITO 1960, 1978) have described the flora of Yamaguchi prefecture in Japan. As a result, it was shown that the flora more closely resembled the European and Middle Asian Keuper floras. The first evidence of Triassic floras in Thailand and Borneo are presented in some of KON'NO'S works (1972; KON'NO & ASAMA, 1973). Detailed description of the rich Yenchang flora of northern China by SZE (1956) proved its similarity to the Keuper floras of Western Europe and in the basin of the Ilek River in Western Kazakhstan.

For the first time in almost a hundred years many scientists are intensively investigating the Indian Triassic floras (LELE, 1953, 1955/1956, 1961/1962 et oth., RAO & LELE, 1962; SRIVASTAVA, 1969/1970, 1970/1971, 1970/1972, 1973 a, 1973 b et oth., BOSE & BANERJI, 1974/1976; PANT & BASU, 1973, 1977; SATSANGI 1973; SATSANGI & SHAH, 1970). These authors discussed the Lower Triassic or the Upper Permian age of the Panchet Series flora and the age of the Parsora Series which had been assigned to the Middle-Upper Triassic by some authors and to the Lower Triassic by others.

The Triassic floras are known now in great number of Eurasian localities but they are studied rather unevenly. In the Western Europe floras there are many plants which have been described in detail. However there are no summaries characterizing the floras, their correlation and geographical distribution and discussing the development of these floras. It is strange but it was the author of this book who first plotted on one map the distribution of the Triassic plants in the central part of the German Basin (DOBRUSKINA, 1980).

Complete summaries of the floras of Eastern Asia are available, but the preservation of the plants is worse than in Western Europe. Their cuticules are not preserved so they cannot be studied with precision and it is difficult to compare them with the European Triassic plants. The same can be said about the many Triassic floras of Middle Asia. Some of these floras are being restudied. A study of the huge collections from the Tunguska and the Pechora Basins, southern Priuralye, Armenia, the Pamirs has not been finished as yet. Some of the floras were described in unpublished dissertations but the main part of these collections are still being studied.

The stratigraphic relationships of the plant-bearing sections and marine strata in Eurasia can be directly observed only in western and eastern Eurasia. Elsewhere in Eurasia only the remains of *Pleuromeia* can be found within marine sediments. The majority of the Triassic floras are found in the continental rocks. In these cases the composition of the floras is used for the correlation, as well as the remains of the land animals (tetrapods mostly) and also the miospore assemblages. Tetrapods are of great importance for correlating Triassic strata in the East European platform, Priuralye, Central Europe, South Africa and partly in India.

In theory the possibilities of using palynological methods for the correlation are very good, but in practice the application of these methods usually run across many difficulties. First of all, there are few published works, where the spores and pollen are described in detail with good photographies. Second, there is no generally accepted classification of spores and pollen. Some palynologists use different names for the same forms. The counting technique of samples differs as well. As a result it is sometimes impossible to compare the results of various palynologists from different regions. Third, there are few described standard miospore assemblages derived from the standard sections. Fourth, the age of the including rocks is often determined inexactly if it is not related to the standard sections.

Consequently, the stratigraphical value of such descriptions is not high. The above mentioned facts show that the possibilities of reliable application of the palynological data is often low. Up to now they can be used only with great caution.

Similar difficulties may develop when ostracods, conchostracans, etc. are used for correlation. This does not mean that these fossils should not be used for correlation. Rather the data derived from these fossils must be cross checked in the same way as any other palaeontological data and the results should be analyzed carefully in each specific case.

The correlation of Triassic strata with fossil plants is also difficult. The primary problem concerns the question of how similar plant assemblages must be if they are to be considered coeval. In every case all available palaeobotanical data together with the palaeozoological and geological data must be considered. In practice difficulties arise because of (1) uneven knowledge of many floras, (2) the different mode of preservation of the floras which hampers comparisons, (3) uncertain systematics for many groups of Triassic plants, and (4) finally complete description of standard floral assemblages have not been prepared.

As it was mentioned above, there are many publications that concern floras of the German Basin and the Alps. Although some of them are excellent it is still difficult to understand the flora as a whole. It is impossible to systematically summarize the flora because the descriptions differ in detail, some of the specimens have been described repeatedly and whole groups have never been described (i. e., the ferns of the Alpine region). As a consequence some the aspects of the floras are misrepresented.

To determine the standard assemblages from the available data, the author was obliged to compile a card index system of the Western European and Eastern Asian Triassic plants using perforated cards with photos of the fossils. It is much easier with the help of such a system to retrieve information about the flora assemblages including data on the region as a whole, and all the floras of each stratigraphical level. Moreover, the plants can be classified according to any systematic or formal criteria such as the quality of description (morphological, anatomical, reprodutions), the time of collecting (to determine if we are dealing with a new plant or merely with a redescription), and the repository of the fossils (country, town, museum). Although this system was rather time consuming and tedious to develop it seems to have proved its value, as it gives one an opportunity to have an accurate view of that part of the European and Japanese collections which has been published. This part of the present paper contains corrected lists of the Triassic standard assemblage which were prepared from the index system decribed here. The lists constitute the basis for the correlation of the Triassic plant-bearing beds of Eurasia.

A direct comparison of the description and pictures of the Triassic plants appears necessary because the author's opinion about the scope of some genera and species can be different. Furthermore, the same fossils have been described under different names and vice versa. Thus, comparison with lists of plants can lead to wrong conclusions. So, it was necessary to revise all published data. For instance the revision of the so called gigantopterids found within the territory of the USSR by present author (DOBRUSKINA, 1966) proved that the taxa actually were not present in the USSR Triassic. The plants formerly referred to as the Gigantopteridaceae appear to represent the Peltaspermaceae (pteridosperms). This conclusion changes not only the opinion about the systematic position of the investigated plants, but also about their age and their relations to the corresponding floras (i. e., their connections with the Keuper of Europe, but not with the Permian of Cathaysia). The important role of the Peltaspermaceae in the Upper Perimian and the Triassic floras of the USSR was shown more recently by MEYEN (GOMANKOV & MEYEN, 1986) and by the author (DOBRUSKINA, 1975). This work caused a modification of the ideas of the relationships of the principal groups in the Triassic floras of the USSR.

Another example of the need for reevaluation of old determinations was given by DOBRUSKINA (1980) when she reported on her work with the so-called *Cordaites* leaves in the Triassic of the USSR. She showed that they have at least four different types of epidermis, and not one of them is similar to the epidermis of real *Cordaites*. Such plants had been considered to be Palaeozoic elements within the Triassic floras of Priuralye, the Pamirs etc. Thus, critical analysis of fossil lists and direct comparison with the fossils themselves are necessary for reliable conclusions.

In other words published materials do not always give a clear idea either of floral composition and correlation, or the history of the development of the Triassic floras and their biogeographical zonation. While compiling the Triassic part of "Palaeozoic and Mesozoic floras of Eurasia and the palaeofloristic provinces of that time" (Dobruskina, 1970 b, 1978) a preliminary attempt was made to gather and analyze all the available data on the Triassic floras of Eurasia. In the present paper the most complete data on the Triassic plants of Eurasia are compiled. Lists given in the third part contain all the described, figured and collected Triassic plant fossils that are in the accessable museums. This is the foundation of all conclusions by the present author. On the other hand, any palaeobotanist can also use them for his or her own conclusions and revision.

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With regard to the ideas on the phytogeographical zonation of Eurasia in the Triassic the bibliography on this question is not so voluminous compared with that on the zonation of the Palaeozoic, and especially of the Jurassic and the Cretaceous.

It was noticed by Harris (1937) that localities of the *Thaumatopteris*-flora type and the transitional type (given below as "mixed" ones) form a belt that passes from Greenland through Europe across Russia and Siberia to Japan. The territory of their distribution was called the "Northern province" by him, the northern boundary being vague due to the insufficiency of the data. The floras of Armenia, Iran, the Pamirs, southern China and Viet Nam were defined by him as the "Middle province". He mentioned that the southern German floras are related to some extent to the floras of the Middle province. The Gondwana flora composed the "Southern province".

Prynada (1944) has singled out the Siberian palaeofloristic area for the Siberian Mesozoic flora emphasizing the idea that this area was the largest at the end of the Triassic. It extended from the eastern slope of the Urals to Priumorye and Japan. The northern boundary passed north Spitzbergen and Franz-Joseph Land. The position of the southern boundary was uncertain but it passed somewhere through Fergana. Northern China was a part of the Siberian area. If one compares the Siberian area of Prynada and of Harris the former area turns out to be within the eastern part of the latter area. Prynada (1914) has emphasized the difference between the Eastern Ural and Primorye floras and the coeval European and Greenland ones. New data on the Primorye flora more clearly proves their transitional character and also shows more similarities with the floras of the south. With regard to the Japan and Middle Asia floras, they were closer in composition to the European than to the Eastern Urals ones.

Migatcheva (1964) discriminated (1) a zone of temperate warm climate for the Upper Triassic in the Urals, Siberia, Primorye, Kazakhstan, and northern China that corresponds to the Siberian area of Prynada, (2) a northern arid zone in the south of France, Germany, Poland, Sweden, Greenland, the Donbas, Ilek, Emba, Middle Asia and (3) a humid tropical zone (Basel, Lunz, Armenia, and the Elburz and the Pamirs mountains). But it appears wrong to consider the climate in the Upper Triassic for Western Europe and the European part of the USSR as arid. It is difficult to run the boundary of the climate zones through the middle of the German Basin with its uniform flora, isolating Basel from its other part and all the basin from the Alps. Moreover, the Lunz and Basel floras, on one hand, and the Armenia, Elburz and the Pamirs floras, on the other, belong to different stages of development and it is preferable to examine the phytogeography of these stages separately.

POMERANZEVA (1967) also examined the phytogeography of the Upper Triassic as a whole, but she dealt only with the territory of the USSR. She distinguished a special zone in Armenia and the Pamirs with the predominance of cycadophytes, uniting all other localities – the Donbas, the Urals, Middle Asia and Kazakhstan – in one zone. The boundary between these two zones corresponds to HARRIS's boundary between the Northern and Middle provinces and to the boundary between the northern area and southern arid zones of MIGATCHEVA. This means that the zones of the temperate warm climate and northern arid zone of MIGATCHEVA correspond to the single zone of Pomeranzeva. The boundary between MIGATCHEVA's zones differs from the southern boundary of PRYNADA's Siberian area as it is shifted further to the west, and includes the Donbas in one zone with the Urals and Primorye.

Phytogeographical divisions in the "Atlas of the Lithologic-Palaeogeographical Maps" (1968) and in the book "Stratigraphy of the USSR. Triassic system" (KIPARISOVA ET AL., 1973) were compiled by the same group of geologists of the All – Union Geological Institute in Leningrad (VSEGEI) and do not differ in essense from each other. The schemes of all the stages of the Lower and Upper Triassic and of the Middle Triassic on the whole are represented in the "Atlas of the lithologic-palaeogeographical maps". The three schemes are given in the "Triassic system": for the Induan, for the Olenekian with the Middle Triassic and for the Norian. These investigators divide the USSR territory into two areas: the Tunguska (adding "Siberian" to this name for the Upper Triassic time) and the Europen-Thien-Shan one (it is named Indo-European for the Upper Triassic time). The Tunguska area in the Lower Triassic time included the region of the Korvunchana flora and of its western boundary coincided with the Urals Range. The southern boundary remained in its place through all the Triassic. In contrast with PRYNADA's ideas the Middle Asia and Kazakhstan floras are placed south of this boundary.

In the Induan time the European-Tien-Shan area is divided into the European province (based on the presence of the European genus *Pleuromeia* in the upper Volga region), the Fergana province (based on the wrong evalution of the Lower Triassic age of the Madygen Formation) and the Kazakhstan province (based on the wrong evaluation of the Lower Triassic age of the Semeytau and Malaysary formations). The authors of the scheme are of the opinion that within the European-Tien-Shan area the Urals province was isolated from the Olenekian time untill the end of the Triassic. To be exact, this province should be called the Priuralye province because the eastern Urals floras are closely related to the Tunguska area. For the Olenekian time Fergana province is separated from the European province by the longitudinal boundary, but the reason for separating this province is not clear. Beginning with the Upper Triassic the

Mongugay province is distinguished in the eastern part of the European-Tien-Shan (Indo-European) area.

The odd configurations of the areas and provinces seem to be related to the initial ideas of the position of the North Pole and consequently of the palaeolatitudes as they are given in the scheme of the "Atlas of the Lithologic-Palaeogeographical Maps" for the first half of the Triassic. In these maps the parallels of the palaeoaltitudes are almost perpendicular to the present ones.

The present author gave a short review of palaeogeographical zonation of the European part of the USSR (DOBRUSKINA, 1967) and discussed the problem of meridional zonation. Palaeogeographical maps of Eurasia were also published by the author (DOBRUSKINA, 1970 b, 1978 a, 1982 b, 1987 a, 1987 c).

BARNARD's (1973) zonation of the Lower Triassic of Eurasia was based on DOBRUSKINA (1970 b) and zonation for the Rhaetian-Lias followed the division of VAKHRAMEEV (1970 a) as it is written in his paper.

KRASSILOV and SHOROCHOVA (1975) developed phytogeographic zonation on the basis of geofloras which are divisions of the ancient vegetation that preserve their texture for a considerable extent in space and time. These divisions according to KRASSILOV are phytoclimate zones. These authors found it possible to single out a geoflora for the Lower Triassic, as the typical genus of southern Eurasia, *Pleuromeia* is also present along the northern coast of Siberia (KRASSILOV & ZAKHAROV, 1975) proving the absence of the precise thermal zones within the Lower Triassic continents. For the second half of the Triassic period (the given map is for the Upper Triassic time) KRASSILOV and SHOROCHOVA have designated the Arcto-Triassic, the Medio-Triassic and the Noto-Triassic geofloras. The last one includes the Induan floras of the Gondwana type, whereas the boundary between the first ones is just another version of the HARRIS's (1937) boundary between the northern and middle provinces or PRYNADA's (1944) southern boundary of the Siberian area, etc. In the paper this boundary is very close to the southern boundary of the Siberian area as it goes along the Urals in the west and "somewhere in Fergana" in the south, being different only in shifting the northern China floras to the south. PRYNADA (1944) included the floras of northern China in the Siberian area.

The two principle genera – *Phoenicopsis* and *Lepidopteris* as well as *Goeppertella* – were taken into consideration by the authors while studying palaeozonation. The first taxon was supposed to belong to the Arcto-Triassic and the last two to the Medio-Triassic geofloras. But the presence of the genera *Phoenicopsis* and *Lepidopteris* in one locality, in Kenderlyk is proved by KOVALCHUK (1961, table 58, fig. 1 and table 57, fig. 3 and 4). On the other hand *Lepidopteris* is present within both the Anochino flora of the Eastern Urals and in the Priuralye region, i. e., in different geofloras. I think that the differences in the Priuralye and the Eastern Urals floras are primarily because of the existence of a barrier, the Urals and secondary with the difference in the age as well, and not with climate variations. It seems that the majority of the East Urals floras are younger than those of the Priuralye. So it seems that at least in the longitudinal part the boundary is not due to climate. As for its latitudinal part, in this case floras of different age are compared. For example, the Arkit flora which is of Early Triassic age is compared with the Upper Triassic floras.

Earlier the author of the present work carried out a palaeofloristic zonation of the Lower Triassic and could not find clear criteria for analogous zones in the second half of the Triassic (Dobruskina, 1970 b), although the essential distinctions of the floras of Europe, the Eastern Urals and the Far East were established. The Angara, Euramerican and Gondwana areas were recognized in the Lower Triassic, the boundary between the first two of them was settled by dividing the Korvunchana flora in the Tunguska Basin and the *Pleuromeia* flora. The discovery of *Pleuromeia* in the north of the Siberian platform (Krassilov & Zakharov, 1975) indicates that the difference between the European and the Siberian floras of that time is due more to variation in humidity than in temperature. But humidity is also a climate factor.

In connection with the discovery of *Pleuromeia* in the north of Siberia the author (Dobruskina, 1978 b) thought that the Korvunchana flora is older (the Uppermost Permian – the Induan) than the European *Pleuromeia* flora (the Olenekian-Anisian). Later the author (Dobruskina, 1980, 1982 b) came to the conclusion that both of these floras had to exist simultaneously in areas of different humidity (see chapter five of this book). It is evident that *Pleuromeia* could adapt to different climates because it is found in the deposits of sea coasts at different latitudes and in salt lakes deposits. Assuming these ideas the author gave the zonation for the Olenekian-Anisian time (Dobruskina, 1976 c), or, to be precise, for the first half of the Triassic (Dobruskina, 1978, 1982, 1987 c). The boundary in the maps coincides with the boundary in the first version but the interpretation is somewhat different.

The author also made an attempt to draw a climate boundary within Eurasia proper for the Ladinian-Karnian time (Dobruskina, 1976 c, 1978 b) having formulated more clearly the difference in the floras of the north and the south of Eurasia. But a better grounded decision for this boundary could be given only after studying the longitudinal zonation, sectorial differences of the consudered flora (Dobruskina, 1978 a, 1982 a, 1982 b).

Previously (Dobruskina, 1978) the maps of Norian and "Rhaetian" floras were given by the author separately, which obscured any regularities in the floral distribution of that time. Such regularities could be observed by plotting all the "*Dictyophyllum-Clathropteris*" floras (Sze, 1955) on one map. They correspond approximately to the Norian-Rhaetian flora of the present author (Dobruskina, 1976 a, 1978 b, 1980, 1982) and it was found that the areas and provinces of the Norian-Rhaetian time are similar to those of the Jurassic. This question is discussed in detail in chapter four of this book.

New investigations of the Triassic floras of China (see Kimura, 1984) suggest that *Dictyophyllum-Clathropteris*" flora is partly coeval with "*Danaeopsis-Bernoullia*" flora (= Ladinian-Karnian floras of the present paper) and is due to different palaeogeographical conditions. This data is not taken into consideration in this book because the published material is insufficient to revise the age of the floras.

As can be seen from this review of the different floral zonation schemes the ideas of the various authors have little in common. It seems that this is due to the different correlation of the Triassic sediments in the first place and of the choice of the time interval for which the division is made. The latter is of great importance, as the Triassic floras correspond to three different stages of development and in all these three cases the criteria for substandiating the palaeofloristic area boundaries are not the same. Moreover, differences from the points of view of fossil plant systematics naturally affect the accepted scheme of zonation. For instance, the attribution of certain fossils to either the gigantopterids or to the peltaspermous pteridosperms, or attributing certain leaves to either the cordaites or to the ancient ginkgophytes greatly change the pattern of plant distribution. Valid conclusions on phytogeographical zonation can only be drawn after an evaluation of the stratigraphic position of the plant-bearing beds and their correlation (Dobruskina, 1980), a taxonomic analysis of the Triassic floras and finally a determination of the stages of development of the Triassic floras of Eurasia.

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The opinions of certain investigators on the transitional character of the Triassic floras need to be mentioned. It was noticed long ago, that the development of the organic world in the geological history was uneven, that there were prolonged stages of relatively stable and homogeneous floras and faunas which alternated with short transitional periods. On the basis of volumnous materials on the fossil plants of the USSR Kryshtofovich (1940) proposed the doctrine of "polychronous floras", the theory that homogeneous plant societies existed for a prolonged time. This doctrine was developed further by Vakhrameev (1970 a) on the basis of more complete and detailed data.

The terms Palaeophytic and Mesophytic polychronous floras were introduced by Kryshtofovich (1940, 1957). He thought that the Palaeophytic in its typical form existed until the middle of the Permian whereas the Mesophytic continued until the Cretaceous. In the table showing the duration of the polychronous floras (Kryshtofovich, 1957) the boundary between the Palaeophytic and Mesophytic floras is placed in the middle of the Permian, but in the text the beginning of the Mesophytic is assigned to the Triassic. This contradiction itself implies the idea of a transitional type of Triassic and Upper Permian flora, because their resemblance to the preceding and the subsequent floras can be interpreted in a different way. This question is discussed in detail in chapter five.

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As to the place of the Triassic flora of Eurassia among the floras of the other continents Fontaine (1883), Stur (1888) and Krasser (1909 a) had recognized a great similarity between the floras of the Eastern United States and Western Europe which has a direct connection with the idea of the absence of the Atlantic ocean in the Triassic. This idea should be considered when taking into account the recent works on the floras of North America and Western Europe. On the other hand, the close similarity of the Triassic floras of India and those of the southern hemisphere together with the sharp distinction of these floras from the rest of Eurasia had been noticed long ago and had been taken into account by the adherents of the continental drift hypothesis.

Chapter ten

Comparative characteristics of plant assemblages of the Eurasian Triassic

As a result of the study of the stratigraphic position of the plant-bearing beds of Eurasian Triassic given in part one it is possible to correlate the Eurasian Triassic sediments by their plant remains (see fig. 46). All the sections with fossil plants in Eurasia were analysed. Special attention was given to the sections containing intercalation of layers bearing fossil plants and layers containing fossil invertebrates. The age of such plant-bearing beds was determined directly by the associated marine fauna and plant assemblages of such beds were considered as being **standard.**

It was determined that the plant assemblages from the western and eastern – most parts of Eurasia could be used as standards. The sections in the interior of Asia do not contain marine sediments and the plant assemblages they contain were used for age determination. Their age was established by comparing them with the **standard floras.**

Not only palaeobotanical, but, when possible, all geological and palaeozoological data were used for the correlation of the sections. Geological data were used for correlation of the sections of the regions with homogeneous structure and palaeozoological data was used for interregional correlations. The correlation value of palynological assemblages, tetrapods, ostracods, conchostracans, insects, freshwater molluscs is variable in different regions.

Four stratigraphic intervals with different plant assemblages were distinguished within the Eurasian Triassic sediments as a result of the correlation. One can never find all four assemblages in one stratigraphic section, but three of them often occur in the same section in the German Basin, Primorye, Japan and in the Taymyr. In addition several plant-bearing beds occur within one such interval in some regions. For example, in the German Basin three different plant-bearing horizons occur in the Ladinian-Karnian stratigraphical interval. They can be used to correlate between the Alps and the German Basin, but they are not valid for more wider correlation. Several stratigraphic levels with plants were distinguished by SADOVNIKOV (1977) in the floras of Iran and Vietnam and were correlated by him. However they cannot be used for correlation beyond these regions.

If Eurasia is taken as a whole the subdivisions based on plant remains are larger than biostratigraphic intervals based on fauna remains because the fossil plants were not studied to the same degree as the animal fossils. More thorough investigations of the Triassic plant fossils should allow one to distinguish outward by similar plant remains and, as a result, allow more detailed subdivision of the plant-bearing sediments and more accurate correlation.

In this chapter the following plant assemblages are examined: 1 – the first half of the Triassic, 2 – the Ladinian-Karnian, including perhaps the Lower Norian, and 3 – the Norian-Rhaetian.

The term "Norian-Rhaetian" is questionable, because the stratigraphic independence of the Rhaetian stage is still disputed. At present it seems in all probability that the plant-bearing Rhaetian-Keuper beds of the German Basin and the coeval zone of *Lepidopteris* of Greenland actually correspond to the Middle Norian of the Triassic of the Alps (Dobruskina, 1976 b, 1978 a).

First the characteristics of the standard plant assemblages are given for the time intervals here discussed. The age of these standard assemblages has been determined directly by their relations to marine sediments. Following this intercontinental assemblages are analysed and compared with the standard assemblages. The relations of these assemblages could not be traced into the inner parts of Eurasia however. In chart 8 the stratigraphic positions of the most important plant assemblages of the Eurasian Triassic are shown. The base for the age determinations of the intercontinental plant assemblages using all available geological and palaeontological evidences was given previously (Dobruskina; 1980, 1989 c). In the present chapter only the palaeobotanical data are analysed.

The relative proportion of the main plant groups in the plant assemblages of the Eurasian Triassic is shown in fig. 47. The percentage of the various groups of plants within the plant assemblages of the different areas can not be estimated in the same way for the following reasons.

In the Priuralye region, the Donbass, Middle Asia, and Kazakhstan it was possible to count all available fossils in the collections, including the dispersed phytoleims. In other floras only samples illustrated in the monographs could be counted. Although the illustrated samples in T. Harris's (1931–1937) monograph seem to reflect the qualitative relations in the Greenland flora and Oishi's monograph correctly describes the general relations of plants in the Japan flora, the same can not be said about the European Keuper flora which is depicted very unevenly. There are excellent detailed monographic descriptions of some fossils which usually include a revision of all previous works. For the others, however, no descriptions or illustrations are given at all. Thus, no illustrations and descriptions of the majority of Lunz and Raibl plants were published although they were known more than a century ago (list in Stur, 1885; diagnoses in Krasser, 1909 b). Most of the plants have not been revised since the middle of the last century. Illustrations of these fossils are often unavailable because of the general absence of the older works in most libraries.

Chart 8: Stratigraphic position of the most important Triassic plant assemblages of Eurasia (without India) and Northern America

Sequence of floras	Age	Alps	German Basin	Svalbard	Moscow syneclise	Donbass	Pechora Basin	Southern Priuralye	Prikaspiy	Eastern Predkavkazye	Mangyshlak	Eastern Urals	South-Western Asia	Middle Asia	Eastern Siberia			
															Kuzbass	Tunguska	Taymyr	Nort coa
Lepidopteris flora	Rhat U. Nor M. Nor	Seefeld	Rhatkeuper			Novorayskoe Kamenka				VI–VII beds		Fern-Ginkgo	Dzhermanis Shemshek Kokuybel	Aktash Turakavak Tologoy			Nemtsov Mamonov	
Scytophyllum flora	L. Nor			Kapp Toskana = +		Garazhovka						Horstail Fern Horstail		Madygen Kamyshbashi Koldzhat				
	U. Karn		Semionotus Ss			Nikolayevka												
	M. Karn	Lunz +	Schilfs =															
	L. Karn	Raibl +																
	U. Ladin		Lettenkohle =				Zalaznaya Perebor	Bukobay = Kurashasay				Anokhino					Kuldima	
	L. Ladin																	
	U. Anis																	
Voltzia and *Pleuromeia* floras	M. Anis	Recoaro +									Khozbulak				Maltsevo II–III	Korvunchana II–III	Olenek	
	L. Anis		Voltzia S Röt = +								Karaduan			Sokh-Isfara Yokunzh				
			Solling =								Karadzhatyk +							
			Hardegsen =					Petropavl. =	Bogdo = +					Alikagar +				Olen
					Rybinsk =					Kumansk +	Dolnapa = +							
Conifer-fern and *Pleuromeia* flora	Ind						Ust-Berezovka								Maltsevo I	Korvunchana I	E. Taymyr Keshin Tuffolava	Ul kha yury

+ Marine invertebrates collected together with plants
= Tetrapods collected together with plants

assemblages of Eurasia (without India) and Northern America

rn e	Prikaspiy	Eastern Predkavkazye	Mangyshlak	Eastern Urals	South-Western Asia	Middle Asia	Eastern Siberia					Zabaykalye and Mongolia	China	Southern Primorye	Japan	Vietnam	Northern America
							Kuzbass	Tunguska	Taymyr	Northern coast	Verkhoyanye						
		VI–VII beds		Fern-Ginkgo	Dzhermanis Shemshek Kokuybel	Aktash Turakavak Tologoy			Nemtsov Mamonov				S. China	Amba	Nariwa	Suoy Bang +	
				Horstail Fern Horstail		Madygen Kamyshbashi Koldzhat											Chinle Dockum = Newark
														Sad-Gorod	Mine +		
- = ia-				Anokhino					Kuldima		Khedalichen	Mongolia	Yenchang				
			Khozbulak				Maltsevo II–III	Korvunchana II–III	Olenek					M. Anis +			
			Karaduan			Sokh-Isfara Yokunzh							Voltzia	L. Anis +			
			Karadzhatyk +														
- =	Bogdo = +					Alikagar +				Olenek +	Sygynkan			Olenek +	U. Scyth +		
		Kumansk +	Dolnapa = +														
							Maltsevo I	Korvunchana I	E. Taymyr Keshin Tuffolava	Ulakhanyuryakh	Syurbelyakh Taganzhi Nedzheli		Pteridophytic complex				

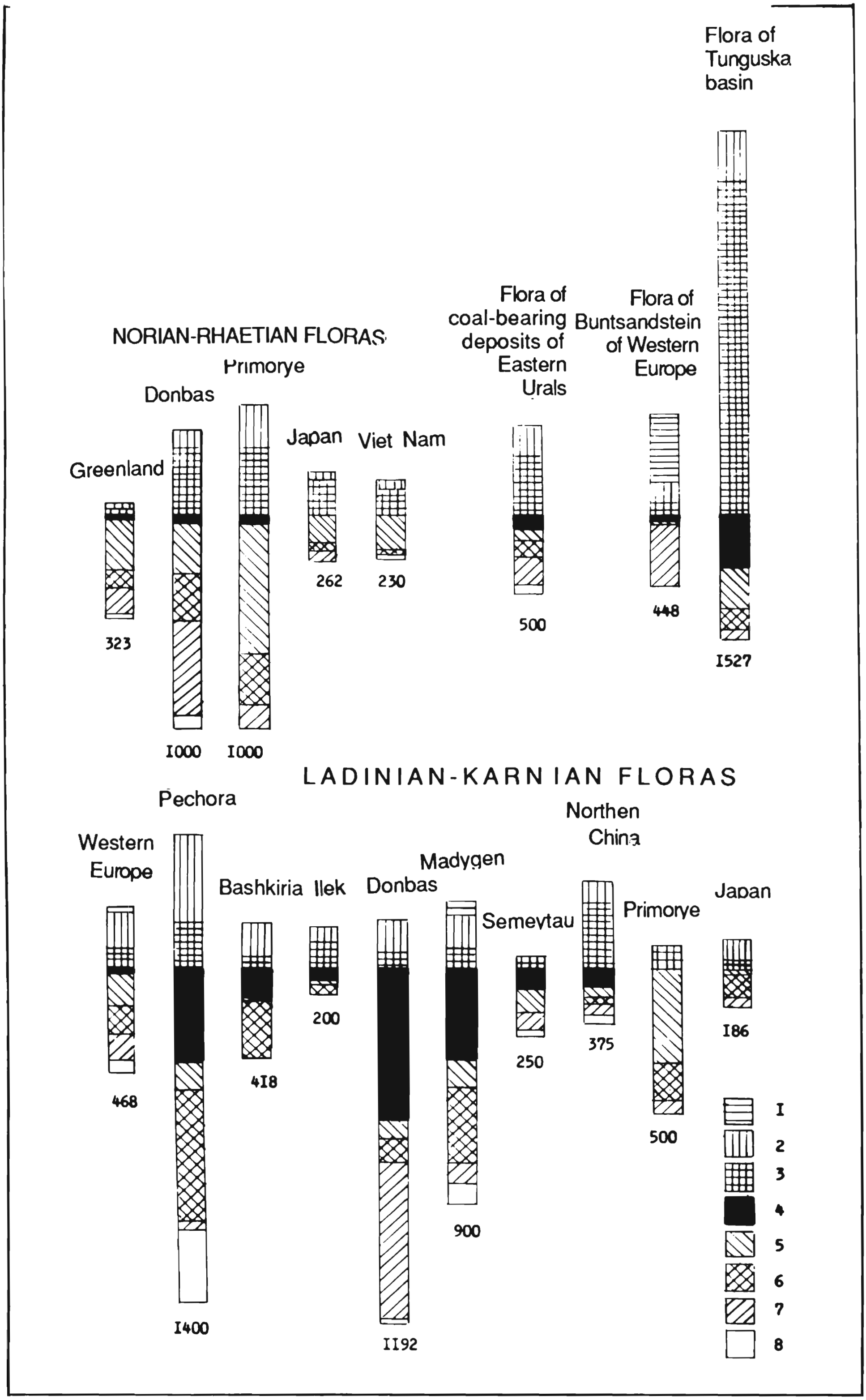

Fig. 47: Relative role of the main fossil plant groups in the Triassic floras of Eurasia: 1 – lycopods, 2 – sphenopsids, 3 – ferns, 4 – pteridosperms, 5 – cycadophytes, 6 – ginkgophytes, 7 – conifers, 8 – others. The number of accounted imprints is given under the columns.

Floras of the first half of the Triassic

The *Voltzia* and *Pleuromeia* floras

The standards for the first half of the Triassic are the plant assemblages of the Buntsandstein of Western Europe (Hardegsen, Solling, Röt). Close to them are the assemblages with *Pleuromeia* which are widely developed throughout all Eurasia. They date from the Olenekian and the lower part of Anisian stages (lists 1–3, 10, 13, 17, 20, 21, 25, 26 and chart 3 in the third part of this book).

The Buntsandstein flora consists mostly of the conifer *Voltzia* within the western part of its area, and the lycopod *Pleuromeia* within the eastern part. In some places they can be found together. In north-eastern France and further north along the left bank of the Rhine the *Voltzia* flora is represented most completely in the *Voltzia* sandstones and their analogues. *Voltzia* is represented by several species as well as the other conifer *Albertia,* which is also typical of this flora. Most probably *Yuccites* is coniferous as are the reproductive organs described recently (Grauvogel-Stamm, 1978) from the *Voltzia* sandstones. In second place are the Equisetales, which are represented by *Equisetites, Equisetostachys, Schizoneura-Echynostachys, Echinostachys.* The species *Equisetites mougeotii* is the most widerly distributed of these forms. The ferns take the third place, but only one species, *Anomopteris mougeotii* is at all widely distributed. The numbers of pteridosperms, cycadophytes and ginkgophytes in the floras are insignificant.

Voltzia and *Yuccites* are also the most distributed in the *Voltzia* flora of the Hessen Depression. In the South German Depression *Voltzia* flora is more diverse and contains all species known in this flora. In some localities in the Hessen and Thüringen depressions and everywhere in the Subherzynian depression only *Pleuromeia* is found. The fossils are abundant and well preserved. In other localities in Thüringia, Hessen, the South German Depression and in a few places along the left bank of the Rhine they are found together with other plants of the *Voltzia* flora.

According to Mägdefrau (1956) the *Voltzia* flora is mainly xeromorphic. Dense, mostly overlapping pinnae are characteristic of the ferns and the rare cycads in the flora, whereas leaves with large widely spaced pinnae are absent. The thick phytoleims found in the flora are evidence of coreaceous leaves. From the point of view of the palaeobotanist the extensive branching of conifers suggests the idea that they were shruby. The small number of Buntsandstein species, probably, not more than thirty, is now explained by the lack of vegetation in the arid and saline areas.

Until recently only two localities of the *Voltzia* flora were known outside Western Europe – in the southern Priuralye (list 34) and in southern Fergana (list 52). Recently, however, many localities containing the *Voltzia* flora were discovered in China. Besides, many poorly preserved Equisetalean stems (genus

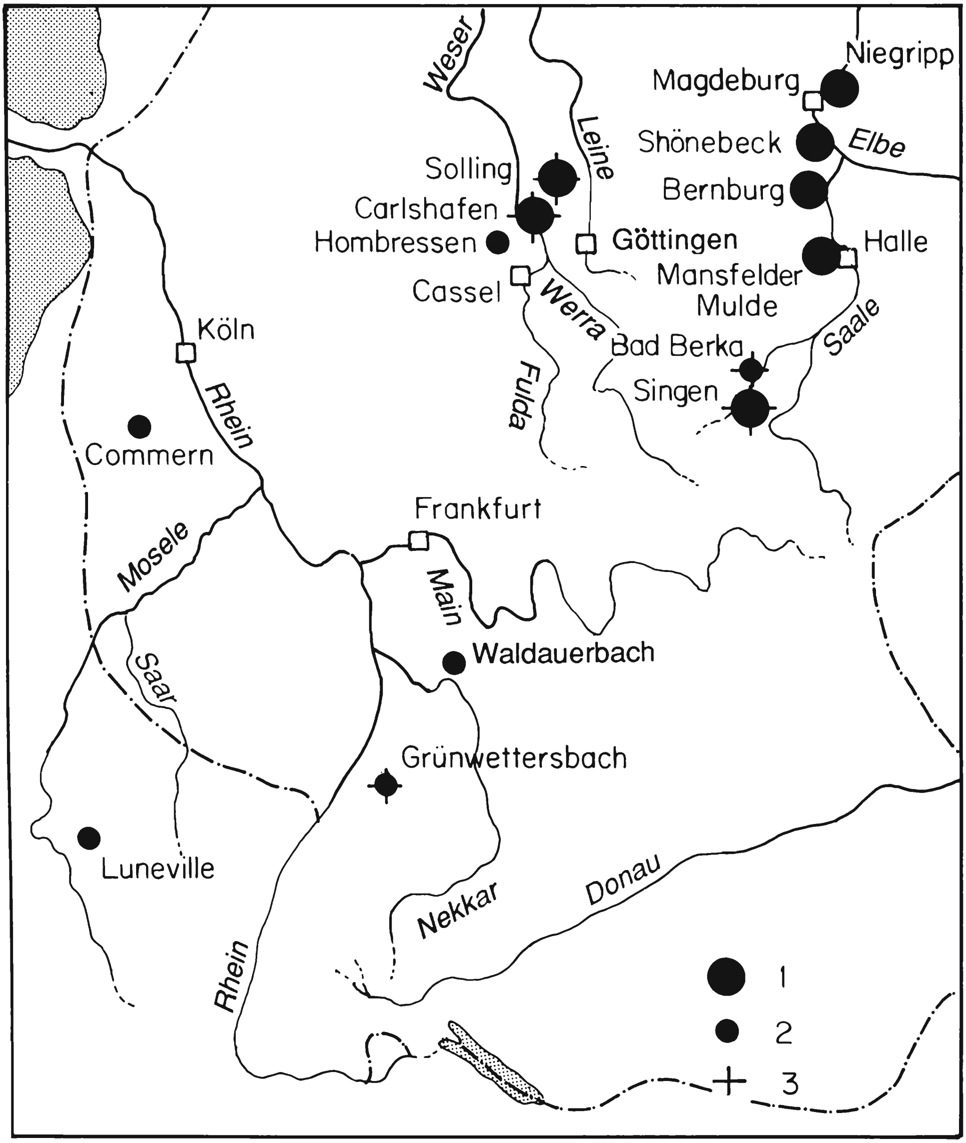

Fig. 48: The *Pleuromeia* localities in Buntsandstein of the German Basin (after MÄGDEFRAU, 1931 b, with additions):
1 – numerous findings, 2 – single findings, 3 – presence of other fossil plants.

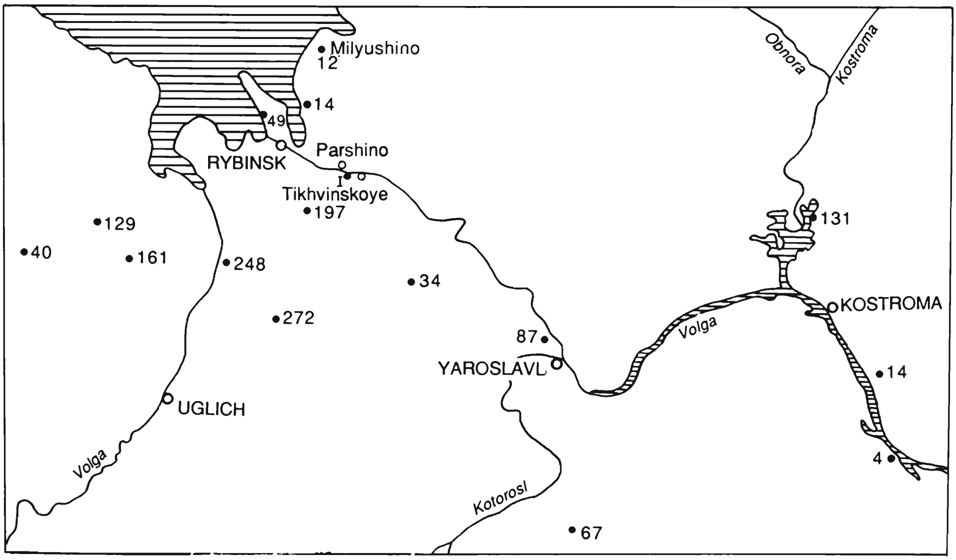

Fig. 49: The *Pleuromeia* localities in the upper reaches of the Volga River: 1 – the outcrop on the right bank of the Volga River between Tikhvinskoye and Parshino; other ciphers correspond to the numbers of boreholes.

and species undeterminable) are found nearly everywhere in the Lower Triassic sediments of Eastern Europe and Mangyshlak.

The remains of *Pleuromeia* are either directly associated with members of the *Voltzia* flora or not far from them in the same stratigraphic horizon in the central part of the German Basin (fig. 48), as well as in the marginal regions of the German Basin in Spain and in the Alps, where no other plant remains occur. Also without any other associated plants *Pleuromeia* is found in the upper Volga region (fig. 49), in the Prikaspian Depression, the Caucasus, the Predkavkazye, the Mangyshlak (fig. 50), in Darvaz and in Primorye (fig. 51), in Japan and Ust-Olenek district (lists 29, 37, 39, 40, 42, 51, 62, 69, 71). While a great number of *Pleuromeia* fossils were found (for instance several hundreds of them were collected in the upper Volga region) only a few poorly preserved ferns, ginkgophytes and conifers were discovered. These fossils show that somewhere away from the places of deposition there also existed Lower Triassic plant assemblages that are otherwise unknown to us.

If, in the central part of the German Basin *Pleuromeia* is included in the *Voltzia* flora, the same can not be done for other areas in Eurasia. The abundance of *Pleuromeia* suggest that it was the only inhabitant of sea and lake shore. Such plant assemblages can be considered a representative of an independent flora – the *Pleuromeia* flora.

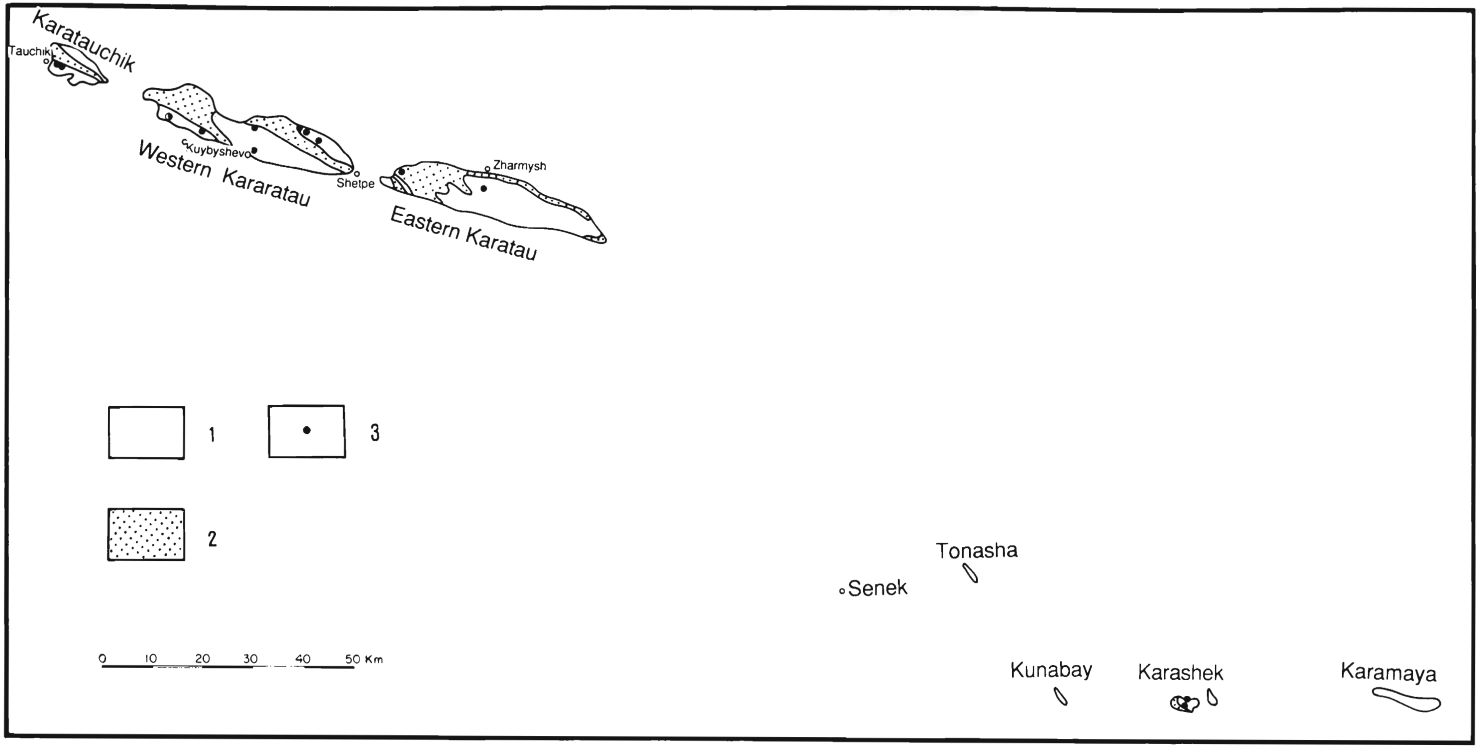

Fig. 50: The *Pleuromeia* localities in the Mountaneous Mangyshlak:
1 – the outcrops of Birkut, Otpan, Dolnapa, Tartali, Karadzhatyk and Karaduan formations,
2 – the same for the Khozbulak and Shair formations.

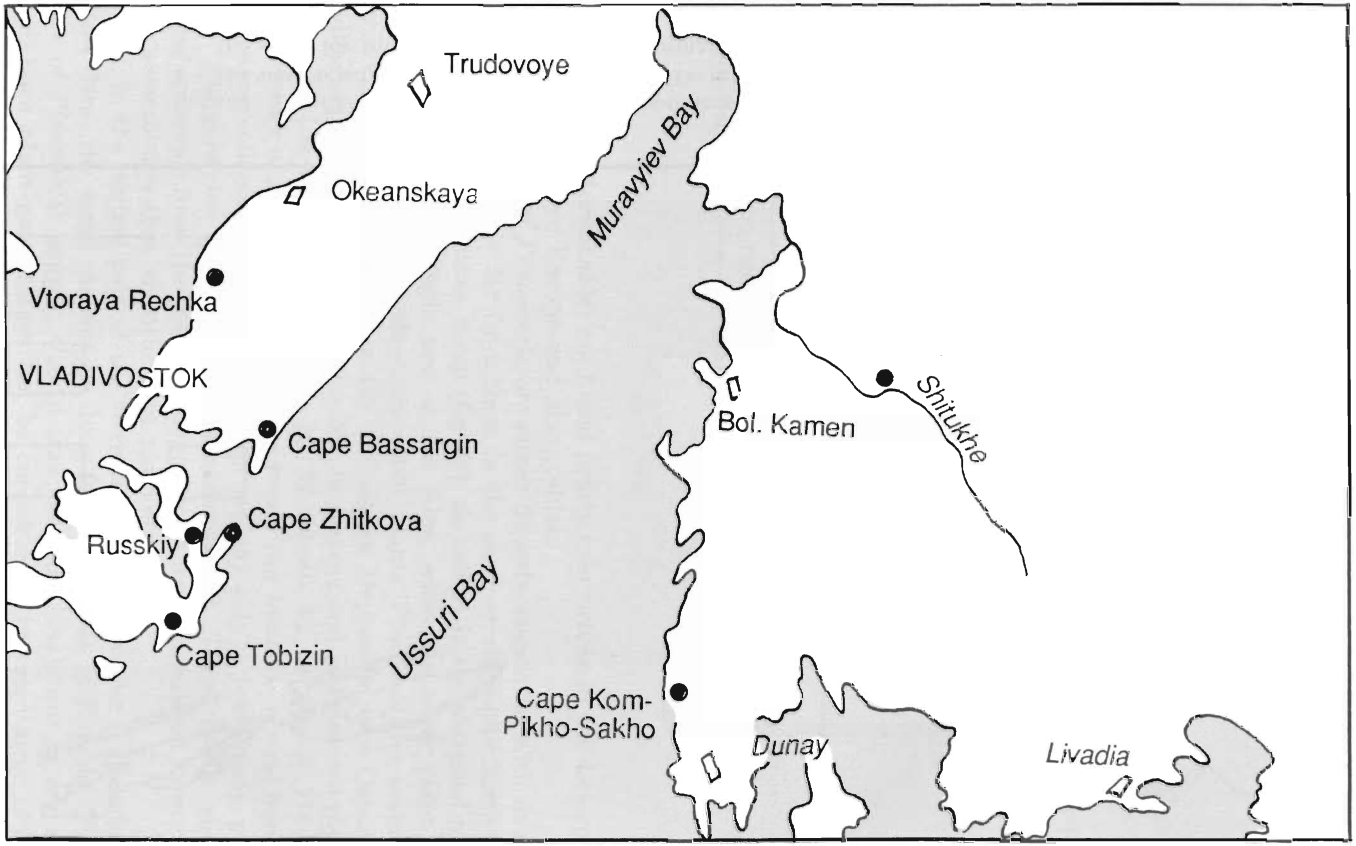

Fig. 51: The *Pleuromeia* localities in Southern Primorye.

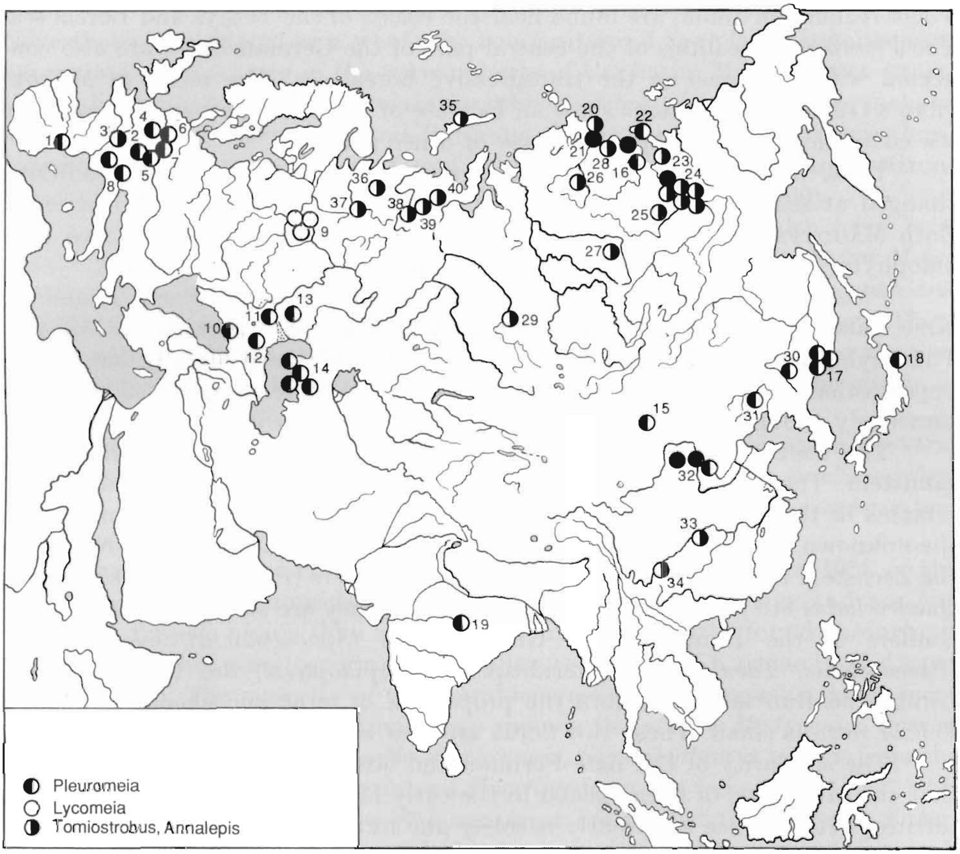

Fig. 52: Localities of Pleuromeiaceae in Eurasia:
1 – Spain, Molina-de-Aragon; 2 – France, Luneville; Germany: 3 – Commern, 4 – Schiesshaus, Carlshafen, Hombressen, 5 – Waldauerbach, Grunwettersbach, 6 – Bernburg, Schonebeck, Niegripp, 7 – Mansfelder Mulde, Bad Berka, Singen; 8 – Austria, Karnische Alpen; USSR: 9 – upper reaches of the Volga River, 10 – Northern Caucasus, 11 – Western Prikaspiy, 12 – Eastern Predkavkazye, 13 – Big Bogdo Mountain, 14 – Mangyshlak, 15 – Darvaz, 16 – lower reaches of the Olenek River, 17 – Southern Primorye; 18 – Japan: massif Kitakami; 19 – India; USSR: 20 – mys Tsvetkova, 21 – The Chernokhrebetnaya River, 22 – lower reaches of the Lena River, 23 – the Syncha River, 24 – Verkhoyanye, 25 – the Vilyuy syneclise, 26–27 – the Tunguska Basin, 28 – the Anabar Coast, 29 – the Kuznetsk Basin; 30–32 – Northern China, 33–34 – Southern China; USSR: 35 – Novaya Zemlya, 36 – Koslan at the Mezen River, 37 – Zheshard at the Vychegda River, 38 – Byzovaya village at the Pechora River, 39 – borehole 656, depth 490,5 m in the Pechora Basin, 40 – outcrop ch-25 at the Adzva River.

It is interesting that the *Pleuromeia* flora is known throughout most of Eurasia (fig. 52). Nearly all the *Pleuromeia* localities, except those in the upper Volga region and India, are found near the coasts of the Tethys and Boreal sea. The *Pleuromeia* localities of the central part of the German Basin are also connected with the coast of the transgressive boreal sea. The result of MÄGDEFRAU's (1956) investigations show an increase of *Pleuromeia* remains toward the sea coast along with a sharp decrease of other plants.

Thus, in the Early Triassic as severe aridisation developed conditions changed at sea coasts so that no other plants except *Pleuromeia* could exist. Both MÄGDEFRAU (1931 b) and NEUBURG (1960) considered the plant to be a halophyte, which could live in salt-ridden lands of sea and lake coasts.

Pleuromeia appeared suddenly during the middle of the Early Triassic in large numbers. It became extinct suddenly in the upper part of the Anisian. The phylogenetic relations of *Pleuromeia* can not be traced directly but it now appears that the *Pleuromeia* sporophyll structure is more complicated than was previously thought. So, the relationships of this plant should be re-examined.

The *Voltzia* flora is also known from the upper half of the Middle Buntsandstein. The strata correlated with the Induan stage do not contain plant remains in the areas where *Voltzia* and *Pleuromeia* floras occur. In contrast to the unknown origin of the *Pleuromeia* flora, the *Voltzia* flora is closely related to the Zechstein flora. In the Zechstein flora the conifers (*Pseudovoltzia, Ulmannia, Quadrocladus* etc.) were also well developed and they are strongly related to the conifers of the Buntsandstein. Ginkgophytes (*Sphenobaiera*), cycadophytes (*Pseudoctenis, Taeniopteris*), pteridosperms (*Lepidopteris*) are found as well. Unlike the Buntsandstein flora the proportion of ferns and shenopsids in the *Voltzia* flora is small. These two floras are also xeromorphic.

The similarity of the Late Permian and late Early Triassic floras suggest that the same type of flora existed in the early half of the Early Triassic in the territory. Its absence apparently is solely due to the incompleteness of the geological record.

The conifer-fern flora (Korvunchana flora)

In the lower half of the Triassic the so-called Korvunchana flora existed within the territory of Middle Siberia. It occurs in the volcanic sediments that overlap the coal-bearing beds in the Tunguska Basin. The latter contains the *Cordaites* floras. Jurassic terrestrial sediments overlie the volcanic rocks. PRYNADA (1970) considered the Korvunchana flora to be Early Triassic in age due to the absence of *Cordites* and the abundance of the ferns. This point of view was accepted by the majority of the palaeobotanists. However, SADOVNIKOV (1964) suggested that the Korvunchana flora originated near the end of the Permian. New data (MOGUTCHEVA, 1984; MOGUTCHEVA & DOBRUSKINA, 1986; DOBRUSKINA, 1984) confirms the Triassic age of the Korvunchana flora (most probably, from the Induan to the Anisian stage).

The composition of the Korvunchana flora varies greatly in the different localities of the Tunguska Basin: either monospecific assemblages can often be found, or diverse plant assemblages are met in the neighbouring localities. Nevertheless considered as a whole the composition of the plant assemblages is approximately the same in the various parts of the basin. MOGUTCHEVA ET AL. (1980) differentiated three phytostratigraphic horizons within the Korvunchana flora: Tutonchana, Dvurogyy and Putorana. Ferns occur within all three horizons and numerous conifers are found in the Dvurogyy and Putorana horizons but they are completely absent in the Tutonchana horizon (list 60).

The ferns comprise more than 60% of all imprints which have been examined from the Korvunchana flora (see fig. 46). The ferns include few Mesophytic forms, they most closely resemble the Palaeozoic ferns of Cataysian and Euramerian regions. A few common Keuper forms also exist in the flora. There is little resemblance to younger floras. The age of the flora is based on the presence in the flora of the form genus *Cladophlebis*. The species of this genus in the Korvunchana flora are rather peculiar.

There was no possibility to determine any essential differences in the stratigraphical distribution of the ferns in the Tunguska Basin using published descriptions and pictures except for the presence of the genera *Boreopteris* and *Eleganopteris* occuring only in the upper part of the section.

The sphenopsids and the pteridosperms constitute 10% of the assemblage. The sphenopsids have typical Palaeophytic features and are less similar to Triassic plants than any other group. They can be found throughout the section. The pteridosperms are similar to Ladinian-Karnian and Upper Tatarian ones. The majority of the pteridosperms of the Tunguska Basin occur in the middle part of the section. They include the genera *Madygenia, Comia, Protoblechnum, Edyndella, Tersiella, Pachipteris. Scytophyllum* is known from the upper formations and *Ctenopteris* and *Tatarina* from the lower ones.

Cycadophytes are few–8% and most are related to the genus *Yavorskyia* which is found throughout the section as well as in the underlying coal-bearing sediments. The genus *Taeniopteris* is also found throughout the section. *Parajacutiella* occurs in the middle part of the section.

Ginkgophytes represent only 35% of the described plants and are divided into two groups. The first group is related to the family Glossophyllaceae and includes genus *Kirjamkenia* and two species of *Sphenobaiera* (DOBRUSKINA, 1980). The majority of the fossils occur in the lower part of the section but one species occurs in the lower and the middle part. The genus *Rhipidopsis* belongs to the second group and is found throughout the section. It is also known from the coal-bearing deposits in the Kuzbass.

The conifers are less than 3% among all the described plants. In addition they are completely absent in the Lower Tutunchana bed, but they are known from higher parts of the section. According to MOGUTCHEVA every third locality in the Dvurogyy and Tutonchana horizons contains conifers, and though the ferns play the main role in this part of the section, the conifers constitute 10%. Until recently only two species of *Elatocladus* and *Retinospori-*

tes, one species of *Pityocladus*, one species of *Lutugina* and two species of *Yuccites* have been described from the volcanic sediments of Siberia. Except for *Retinosporites* all other genera including form genera are common in the Mesozoic. *Lutuginia* is known from the Triassic and Jurassic of Western Europe. Meyen (1981) has assigned *Retinosporites sibirica* from the Kuzbass to *Quadrocladus*, as well as *Elatocladus pachyphyllus* from the Tunguska Basin vegetative sprouts of conifers from the Dvurogyy horizon. At the same time he underlined that the species *Quadrocladus sibiricus* was very different from the Permian species of *Quadrocladus*. He did not exclude the possibility that these differences could be of generic value. Mogutcheva (1984 b) wrote that *Quadrocladus* from the Putorana horizon and *Voltzia* from the Dvurogyy horizon differ very much from the European species. Recently described Darneya and Willsiostrobus (Mogutcheva & Dobruskina, 1986) are similar to European ones.

The genus *Voltzia* is the main component of the Buntsandstein flora of Western Europe (*Voltzia* sandstone of the Anisian age), other species of *Voltzia* are known from the Upper Triassic of Western Europe. The strobils *Darneya* and *Willsiostrobus* are also common in *Voltzia* sandstone and Korvunchana beds. *Darneya* is found in the Vosges closely associated with the sprouts of *Yuccites*. The conifer roots determined as *Araucariorhizoxylon* have been described from the Dvurogyy Formation (Shilkina, 1984). Conifers, similar to those in the Korvunchana flora, occur in the flint-chalk pebbles (Gritsik & Meyen, 1975).

The lycopod *Tomiostrobus* is known from the north part of the Tunguska Basin, another lycopod *Takhtajanodoxa* occurs in the southern part. It is known from a single locality in the Lower Tunguska region. *Tomiostrobus* is widespread within the Siberian palaeofloristic area around the Tunguska Basin: in the Kuzbass, Vilyuy depression, Verkhoyanye, Olenek coast, Taymyr, Novaya Zemlya, Pechora Basin, Moscow syneclise (see fig. 29, lists 59, 63, 62, 31, 29). The lycopod *Pleuromeia* is also found in Taymyr, Olenek coast and Verkhoyanye.

The plant assemblage from the Maltsevo Formation of the Kuzbass (list 59) is very similar to the Korvunchana flora. It is much poorer and less studied but nearly all plant fossils known in the Maltsevo Formation are similar to those from the Tunguska Basin. No conifers are known from the lower part of Maltsevo Formation. Meyen (1981) has shown that the *Araucarites* scales and *Tomiostrobus* strobils are lycopods, not conifers as was thought before. On the basis of priority all of them must be called *Tomiostrobus* (not *Pseudoaracarites* as was done by the author before (Dobruskina, 1982). The conifers appear in the middle of the Maltsevo Formation and become dominant in the upper part.

The Korvunchana flora is also found in the only locality in Verkhoyanye at the Unguokhtakh River (list 63). Taking into consideration the absence of the conifers and the presence of some common species in the Korvunchana flora Mogutcheva (1984 c) correlates the sediments of Unguokhtakh River with the Tutonchana Formation of the Tunguska Basin. In the other localities of the Verkhoyanye and Olenek coast practically the only fossils found are lycopods

Tomiostrobus and *Pleuromeia* (the latter one more rare). SADOVNIKOV (1981 b) mentioned the presence of conifers without any description. In the wells of the Vilyy Depression in the Lower Triassic only *Tomiostrobus* was found (list 62 f).

The floras of the Keshin and Eastern Taymyr formations of the Eastern Taymyr (list 61) are very similar to the Korvunchana flora, though their dominants are different: *Tomiostrobus, Pleuromeia* and *Lepidopters*. A small number of ferns and sphenopsids in the flora are similar to the fossils in the Korvunchana flora. In Eastern and Central Taymyr (list 61) the Early Triassic flora includes ferns, pteridosperms and spenopsids. The only conifer is mentioned by SADOVNIKOV (1981 a) without any description from volcanic sediments of Kirjaka-Tas height.

VASSILEVSKAJA (1984) reported the discovery of *Tomiostrobus* in the Norther Island of Novaya Zemlya. The same genus was widely spread in the Pechora Basin (list 31) and in the North of the Moscow sineclyse (list 29). Only some poorly preserved sphenopsids and the genus *Glossophyllum* without cuticle are known in the two latter regions in addition to *Tomiostrobus*.

The name "conifer-fern flora" was accepted for the Korvunchana and similar floras of the Kuzbass, Verkhoyanye and Taymyr. Possibly the floras of the Russian platform and Verkhoyanye which do not contain typical Korvunchana ferns should be included in the flora. The differences of these floras, that is expressed in distinction of their dominants, are manifested by seperation of the facies in the centre of the Tunguska Basin and in its marginal parts. The conifers and the lycopods of the conifer-fern flora unite it with coeval floras of Western Europe and China. Nevertheless the percentage of the ferns and conifers in the conifer-fern flora is minor, the main part of them consists of endemic forms. As a whole it is most similar to Cathaysian Permian floras (of ferns and sphenopsids), but included also some elements of Upper Tatarian (*Tatarina* itself) and Ladinian-Karnian floras (some ferns, pteridosperms and *Glossophyllum*). The genera *Yavorskyia* and *Rhipidopsis* are inherited from the *Cordaites*-flora which existed in this area before.

Thus, the conifer-fern flora includes some elements of Late Permian as well as Late Triassic floras. In other words it is transitional from the Late Permian to Ladinian-Karnian floras.

The data suggests that the conifer-fern flora of the Korvunchana type appeared mainly as a result of the ferns and sphenopsid expansion from Cathaysia or adjacent regions of Angarida. This expansion and also the almost complete dying out of the *Cordaites* demonstrate the considerable climatic changes in the vast territories of that time. Only a few forms survived the changes of conditions in the Angarida and most of plants were immigrants from the southern regions. The new groups that developed in the Korvunchana flora were pteridospermous pteridosperms and *Glossophyllum*.

There is no geological evidence for its age but it is suggested that the conifer-fern flora existed up to the middle of the Triassic Period, when it was replaced by the flora of Western European Keuper type as indicated by some common families of fossil plants.

The *Dicroidium* flora

In the first half of the Triassic in India the flora was quite different from all other floras described above. The *Dicroidium* flora of the Parsora Formation consists mainly of Corystosperms (principally different species of *Dicroidium*). A few species of *Glossopteris* are known in the plant assemblages (list 80) but they are smaller in size than those of the older species of the genus and their role in the flora is limited. The Parsora formation also contains the lycopod *Pleuromeia*, the ferns *Sphenopteris, Cladophlebis, Danaeopsis, Asplenium*, the pteridosperms *Lepidopteris* and *Parsorophyllum*, the cycadophytes *Taeniopteris*, the ginkgophytes (?) *Baiera* and *Desmiophyllum*, and the conifers *Nidistrobus, Nidia, Satsangia, Araucarites* (= *Pleuromeia* ?), *Samaropsis*. The percentage of each taxa cannot be determined from the published works. The glossopterids also are present in the Parsora Formation though they play a minor role and are not found at all the localities. Their presence is very important because they are representives of Palaeozoic floras. The *Dicroidium* flora is thus connected with the Palaeozoic *Glossopteris* flora which it replaced at the very end of the Permian Period. Incomplete disappearance of glossopterids and relatively poor representation of variety of coristosperms seem to indicate that the Indian *Dicroidium* flora is older than the younger *Dicroidium* flora of South Africa and Australia. The presence of the genus *Pleuromeia* in the flora indicates that it is the same age as those European floras of the late Early and the early Middle Triassic described above.

Plant assemblages from the Nidpur beds (list 77) are similar to the plant assemblage of the Parsora Formation. The most important forms are the pteridosperms, in which *Dicroidium* with the double pinnate leaves prevails. *Glossopteris* is also well represented. A considerable amount of *Taeniopteris* is found in the flora but *Lepidopteris* is represented only by single imprint. *Noeggerathiopsis* is rare and fragmentary; a lot of fructifications described under new generic names also were encountered (list 77). This flora is correlated by SRIVASTAVA (1972/1974) with the upper part of the Lower Triassic because it is close to the Lower Triassic floras of the Narrabin Formation in eastern Australia and the upper Beaufort in South Africa. The palynological assemblages of the Nidpur flora and the Middle Triassic deposits of Australia are also similar.

The plant assemblages of the Panchet Formation have usually been correlated with the Triassic (list 81). However, there are no reliably Triassic forms in the assemblages. The *Pecopteris* and *Cyclopteris* reported by FEISTMANTEL (1880–1881) have not been re-identified there (MAHESWARI, 1974). Analysis of the stratigraphic data indicates that the Panchet Formation is more probable Late Permian in age (DOBRUSKINA, 1980).

The plant assemblages from the Kamthi and Almod beds were also thought to be Triassic in age, though most geologists referred the formation to the Permian. There are no typical Triassic forms in the flora, so the problem cannot be solved just by studying the plants themselves. However, MEYEN

(1969 b) noted that the Kamthi flora is closer to the Permian Panchet flora than to flora of the uppermost Raniganj.

The relative age of the Indian Triassic floras depends on the ratio of the *Dicroidium* and *Glossopteris*. SRIVASTAVA considers the Nidpur flora to be younger than the Panchet flora, but older than the Parsora flora. MAHESWARI (1974) correlated the Nidpur flora with the floras of the upper part of the Panchet (Auranga, Ramkola, Tatapani) and with the "mixed" floras of the Parsora. BOSE (1974) emphasizes the difference between the Nidpur and Parsora plant assemblages. There are no ferns in the Nidpur flora, whereas there are many of them in the Parsora flora. *Glossopteris* is common within the Nidpur assemblage and rare in the Parsora. *Dicroidium* is represented by quite different forms in these floras. Considering all of these facts BOSE (1974) concluded that the Nidpur flora is much older than the Parsora flora.

Floras of the second half of the Triassic

Ladinian-Karnian floras

The floras of Western Europe, Svalbard, Japan and Primorye are the standard for this time.

The Ladinian flora of Western Europe includes a small assemblage from the Upper Ladinian sediments of the Dolomiti, from the Zoldo and Grado valleys, and the plant assemblages of the Lettenkohle of the German Basin (chart 4 and list 4). The flora from the Upper Ladinian sediments consists of some poorly represented remains, which are impossible to identify to the specific level. They include only isolated pinnules of ferns, segments of cycadophytes, and leafy shoots and seeds of conifers.

The fossil plants of the Lettenkohle are known only in the center of the German Basin, especially in the northern part. No Lettenkohle flora has ever been described from the marginal parts of the basin.

According to MÄGDEFRAU (1956) the Equisetales dominate in the Lettenkohle. *Equisetites* is the most abundant genus with *E. arenaceus* being the most common species. As a rule, it is the only species of plant fossils found in the south of the German Basin. Then follows *Neocalamites* (usual species–*N. merianii*) and *Schizoneura*. There are many ferns, the most common of which is *Danaeopsis marantacea*. *Bernoullia* is present in Subherzynian Depression. Many ferns were described as *Pecopteris*, because their fructifications were not investigated. There also are many cycadophytes such as *Pterophyllum, Sphenozamites* and *Dioonitocarpidium* in the flora. BORNEMANN (1856) has given many illustrations of dispersed phytoleims of the Cycadales type from the Thüringian Depression. Pteridosperms (*Scytophyllum* and many dispersed phytoleims of the type), conifers (*Voltzia, Widdringtonites* and reproductive organs) were described for the first time from the Southern Thüringia. It is interesting to know that actually there is almost a complete absence of *Podozamites* and *Cycadocarpidium* in the flora. Only one doubtful imprint is related to each of the genera. The lycopods are exceptionally rare and are represented by just one poorly preserved imprint of *Bedheimia* from Southern Thüringia. Some solitary ginkgophytes from the family Glossophyllaceae were also described.

Although the Equisetales, ferns, conifers and cycadophytes are the main groops in both the Lettenkohle and Buntsandstein the general features of the two floras are quite different. Obvious xerophtes are absent in the Lettenkohle. The ferns have large and thin blades (mesophytic forms) and the pinna of the cycadophytes do not overlap but are separated from each other.

The Karnian flora of Western Europe unlike the Ladinian ones is known only in the Southern German Basin, in the north-eastern part of the Paris Basin and in the more southern districts of France (Vanoise) and in the Alps (Lunz, Raibl). They include the plant assemblages of the Schilfsandstein and its analogues in the environs of Basel, the plant assemblages of the Semionotus sandstone, and the plant assemblages of Lunz, Raibl, and Mount Mecsek (charts 4, 5, 6, 7 and lists 5, 6, 7, 11, 22, 23). The Equisetales are the most numerous. The Schilfsandstein was named according the abundance of these plant remains. These are same *Equisetites* and *Neocalamites* as in the Ladinian flora but the number of species is larger. There are many ferns, cycadophytes and conifers as well. The changes in the fern group in comparison to the Ladinian flora are most noticeable. The Dipteridaceae appeared alongside with the Marattiaceae (*Danaeopsis, Bernoullia, Asterotheca*) known from the Ladinian sediments. The list of species is large but the specimens of each are not numerous and they are all the small-leaf type. Many reproductive organs of Bennettitales have been described from the flora. The conifers include the same genera (*Voltzia, Widdringtonites*) as in the Lettenkohle but the species are most numerous. The Semionotus sandstone flora consists only of the conifers except for a single imprint of the pteridosperm *Lepidopteris*. This flora is described from the single locality in Franken. *Podozamites* and *Cycadocarpidium* are absent here just as they are in the Ladinian flora. The pteridosperms are rare and include only one species of *Lepidopteris* in the Schilfsandstein and another one in the Semionotus sandstone. The lycopods are unknown.

Because the Karnian and Ladinian floras of Western Europe are very much alike only the ferns can be used for correlation purposes. Representatives of the Dipteridaceae occur only in the Karnian flora of Western Europe and are absent in the Ladinian floras. The occurence of reproductive organs of Bennettitales in the Karnian flora is significant because they are not found in the Ladinian flora. On the other hand the sterile leaves of the Bennettitales (*Pterophyllum*) are known in both floras, although their number and variety of species are larger among the Karnian plants. Species differences within other plant groups are of importance only for correlation within the German Basin.

The Karnian plant assemblages of Svalbardare very similar to the Karnian assemblages described above and are only slightly less representative (list 28). Sphenopsids, Marattiaceae, Dipteridaceae, cycadophytes (*Pterophyllum*) and ginkgophytes (*Glossophyllum*) are present in the Middle Keuper of Western Europe. The only genus which is met at Svalbard that is unknown in the German Basin and the Alps is *Paratatarina* which is similar in its external morphology and in its epidemic structure to the Upper Permian *Tatarina* (VASSILEVSKAJA, 1972).

The Ladinian flora of Japan occurs in the Tsubuta group. At present only a limited number of plants has been described from the unit (list 70 d): three species of *Equisetites, Dictyophyllum falcatum* (Dipteridaceae), one species of *Podozamites* and three species of *Cycadocarpidium,* as well as the endemic conifer *Nagatostrobus.* These forms are typically found in the Karnian flora of Japan showing that the Ladinian flora is very similar to the Karnian one.

The Karnian flora of Japan is found in the Yamanoi and Momonoki formations (lists 70 b, 70 c). The sphenopsids are most common here (up to 30%). The presence of *Annulariopsis* (*A. inopinata*) which is also known from the Norian and Rhaetian sediments of Vietnam is noteworthy besides the common Western European *Equisetites* and *Neocalamites* with the accompanying reproductive organs *Equisetostachys* and *Neocalamostachys.* Although *Equisetites* and *Neocalamites* occur in Western European floras of the same age these two genera are represented mainly by other species in Japan. The ginkgophytes are found in some beds in such big quantities that some layers consist exclusively of such plant remains. They include *Ginkgoites* (*G. sibirica*), *Baiera* and *Czekanowskia* (?). The ginkgophytes of Japan and Western Europe are quite different if the available determinations are correct but one cannot be confident because the epidermis is unknown. The difference consists of the presence of only one family of ginkgophytes, the Glossophyllaceae, among the Karnian plants of Western Europe. The conifers are in third place (15%) and have been studied in detail. They are mainly *Podozamites* and *Cycadocarpidium,* which are absent in coeval Western Europe floras. The conifers *Nagatostrobus* and *Minetaxites* are also unknown in Western Europe. The ferns include approximately 10% of all described plants. It is interesting to note that there are many Dipteridaceae (and also *Todites* and *Cladophlebis*) of same species that also existed during Norian-Rhaetian time in Japan. The floras of Japan also differ from those of Western Europe because of the absence of Marattiaceae in the Japanese floras. A relative small number of cycadophytes occur in the Japanese flora and they are represented both by genera common in Western Europe (*Pterophyllum, Taeniopteris*) and by others such as *Nilssonia.* The latter genus became well developed only during Norian-Rhaetian time in other regions. The species of cycadophtytes, as in the case of the ferns, is close to the species content of the younger flora. From this point of view the flora of Japan also differs from that of Western Europe. To other difference is the absence of the pteridosperms (except for *Sagenopteris*) in the flora of Japan.

The Karnian flora of Primorye occurs in the Sad-Gorod Formation (list 72). It is possible that the lower part of the Sad-Gorod Formation should be included in the Ladinian stage. The generic composition of the Primorye and Japanese floras is quite similar while the number of species in the Primorye Karnian flora is smaller than in the Japan flora of the same age. The sphenopsids are represented by *Equisetites* and *Neocalamites* which are common in all Karnian floras. The cycadophytes are the most numerous of fossils in the Karnian Primorye flora and represent about a half of all imprints. Most of the fossils represent *Taeniopteris. Otozamites* and *Pseudoctenis* are also known in the flora. Thus, the cycadophytes composition is quite different from both the Japanese and Western European Karnian floras. As in Japan the ginkgophytes are numerous (24%) and include *Baiera, Glossophyllum (?), Phoenicopsis* and *Czekanowskia.* In the Primorye flora many examples of Czekanowskiales (*Phoenicopsis* and *Czekanowskia*) are present. They, however, are unknown both in the Japanese and Western European floras of that age. The identifications of the genera *Baiera* and *Glossophyllum* in Primorye are unreliable because their cuticles are unknown and their relation with the European Glossophyllaceae is not substantuated. Ferns (16%) are represented by *Todites* and *Cladophlebis,* as well as by some limited numbers of the Dipteridaceae (*Clathropteris meniscoides, Hausmannia ussuriensis*) in the south west of Primorye. The conifers (8%) are similar to those of Japan and unlike those of Europe. They are almost exclusively *Podozamites* and *Cycadocarpidium.* As in Japan pteridosperms are unknown.

The lower part of the *Halobia* Series plant assemblage of Sarawak (list 76) is also standard Karnian assemblage. It is similar to that of Japan, only poorer in composition.

The following conclusions can be drawn about the standard Ladinian-Karnian floras:

1) The Ladinian floras of Western Europe are very close to the Karnian floras of the region . The difference is mainly in the ferns: Dipteridaceae are absent in the Ladinian floras. The reproductive organs of Bennettites are also not found in Ladinian Western European floras. The other differences are local and are not important for the correlation between the regions.

2) The Ladinian floras of Japan and Primorye are not sufficiently studied yet. They are not as rich as the Karnian floras of the same regions. The absence of Marattiaceae, the presence of Dipteridaceae and Cycadocarpidiaceae (conifers) are features that make them unlike the Ladinian floras of Western Europe.

3) The similarity of the Karnian floras of Western Europe and Far East consists of:

a) the same genus of Equisetales (whereas the species content is different),

b) the presence of Dipteridaceae and Osmundaceae (whereas the species content is also very different),

c) the presence of *Pterophyllum* and *Taeniopteris* (though with different species),

d) the presence of *Glossophyllum* (if the fossil from Primorye actually belongs to the genus).

4) The difference between the Karnian floras of Japan and Primorye on one hand, and of Western Europe, on the other, consists of:

a) the absence of Marattiaceae in the former,

b) the species of Dipteridiaceae and Osmundaceae, which in the Japanese floras are more similar to Norian-Rhaetian,

c) the absence of the pteridosperms,

d) the genera and species contents of the cycadophytes which in Far East are more similar to the Norian-Rhaetian representatives of this group,

e) the differences in the ginkgophytes: in the west the ginkgophytes are Glossophyllaceae, in the east Ginkgoaceae and Sphenobaieraceae, and in Primorye also *Czekanowskiales,*

f) the difference in the contents of conifers: in the west they are *Voltzia* and *Widdringtonites,* in the east *Podozamites* and *Cycadocarpidium.*

5) The Karnian floras of Primorye in spite of the general similarity differ from the Japanese coeval floras by the presence of Czekanowskiales, by fewer species and genera in the Dipteriadaceae and Cycadophytes.

*

I shall now proceed to an investigation of those plant assemblages of the intracontinental parts of Eurasia, the age of which was first determined by analysing the floras themselves. All of these assemblages differ considerably from each other, as well as from the standard assemblages (see chart 8). However in the same time they can be correlated with each other by using common species, genera and families. Each assemblage is similar to other assemblages, taking into consideration one plant group, and to still others, considering other plant groups. That is why in the following part I shall compare each of the plant assemblages with all the others independently of the previous analyses, whether the assemblages were compared or not.

The Nikolayevka flora of the north-western part of the Donbass. This flora consists of the plant assemblage from the middle part of the Protopivka Formation. In the assemblage (Stanislavsky, 1976: list 30 a in the third part of this book) the leaves of *Glossophyllum ?* is most common. They have no cuticle and their belonging to ginkgophytes is based on their morphology and the presence of two conductive bundles at the base of the leaf. The conifer *Podozamites guttiformis* is in second place. The third place belongs to *Desmiophyllum acuminatum.* The leaves *Lepidopteris, Furcula* (= *Vittaephyllum*), *Anomozamites, Taenioptris, Sphaenobaiera* and the leafy shoots of *Voltzia* are found approximately with about equal frequency. *Ptilozamites, Swedenborgia, Podozamites toretziensis* and *Ctenis acuminata* are rare. Other species are represented by single specimens. Ferns are absent.

Some species in the Nikolayevka flora are similar to certain Karnian forms of Western Europe: for example *Lepidopteris stuttgartiensis* is identical to the species from Schilfsandstein of the Stuttgart area, *Voltzia charkoviensis* is very close to *V. coburgensis* from the Schilfsandstein of the Coburg area, and a species of *Pterophyllum* with large fronds and narrow segments is similar to the representatives of the same genus in the Middle Keuper of Basel and the Middle Karnian of Lunz. The external morphology and the presence of two conductive bundles at the base of the leaf *Glossophyllum ?* suggests that it is the same as from Lunz. *Neocalamites* is a common form in the Ladinian and Karnian floras of Western Europe.

The Nikolayevka flora differs from the Karnian flora of Western Europe by lacking ferns, having an abundance of pteridosperms, *Podozamites* and *Cycadocarpidium.* The last two genera correlate the Nikolayevka and the Ladinian-Karnian floras of Japan.

Although the Nikolayevka flora and floras from Northern and Southern Priuralye do not contain a single common species the great number of peltasperms, similar cycadophytes and probably the genus *Glossophyllum* correlate these floras. The presence of ferns in the Priuralye floras together with an absence of *Podozamites* and *Cycadocarpidium* separate these two floras.

The similarity of the Nikolayevka and Eastern Urals Bogoslovsk floras is based on the larger number of *Podozamites* and *Cycadocarpidium* fossils in both floras. *Vittaephyllum* (*"Furcula"*) also is present in both of them. The differences are more obvious: sphenopsids and ferns are very common in the coal-bearing rocks of the Eastern Urals, the ginkgophytes are not the same as in the Nikolayevka flora and the cycadophytes (except *Taeniopteris*) are absent.

The Nikolayevka flora is very similar to the Madygen flora of southern Fergana with a great number of sphenopsids and peltasperms (*Furcula* of Nikolayevka is identical to *Vittaephyllum* of Madygen) as well as of *Glossophyllum ?*, cycadophytes, and *Swedenborgia. Podozamites* is known in the Madygen flora, but it is not as abundant as in Nikolayevka flora. *Cycadocarpidium* is absent in Madygen flora.

STANISLAVSKY (1976) considers the Nikolayevka flora to be Early Norian in age, but it seems more likely to be of Karnian age, as it is so similar to the Karnian floras of Western Europe, on one hand, and to the Ladinian-Karnian floras of Japan, on the other. The similarity of the Priuralye and Madygen floras does not contradict this statement, as will be shown later.

The Garazhovka flora of the north-western Donbass. This flora includes the plant assemblage from the upper part of the Protopivka Formation. According to STANISLAVSKY (1976; list 30 b, c) *Lepidopteris toretziensis* and representatives of *Podozamites, Cycadocarpidium* and *Borysthenia* are dominant in the Garazhovka plant assemblage. Other plants are less common. Some fragments of the sphenopsids are present as well as a few ferns (Dipteridaceae and Osmundaceae). Ginkgophytes are rare, and cycadophytes are completely absent. The Garazhovka flora has no single species in common with the Nikolayevka flora although the containing strata are lithologically similar. STANISLAVSKY (1976) explains the difference by the difference in age of these floras. They differ in the relative role of the main plant groups as well. There is by far more similarity with the Garazhovka and the younger Novorayskoye floras, the last one, however, being richer. Also "the well determined common species play quite opposite roles in the plant assemblages of Garazhovka and Novorayskoye.

Pityospermum ? scyticum and one species of *Masculostrobus* are an exception, as their occurence is approximately equal in the both floras. *Lepidopteris* and *Peltaspermum* are abundant in Garazhovka, being only fragmentary represented in Novorayskoye. The other dominant in the Garazhovka flora – *Podozamites trichocladus* – has been found in Novoraykoye only once, but *Samaropsis orbicularis* and *S. prynadae* which occur frequently in Novorayskoye, are each known by only two specimens in Garazhovka" (STANISLAVSKY, 1976, p. 19).

The presence of the Dipteridaceae is the only common feature connecting the Garazhovka and the Middle Keuper floras of Western Europe. The sphenopsids are by far more abundant in the Western Europe floras whereas the pteridosperms are abundant in the Garazhovka flora. Many cycadophytes occur in Western Europe, while they are completely absent in the Garazhovka flora. The conifers of Garazhovka represent different families than the conifers in the Middle Keuper of Western Europe. *Podozamites* and *Cycadocarpidium* of the Garazhovka and Nikolayevka floras are abundant in the West and in the Rhaetian and Liassic rocks of Eastern Greenland. On the other hand, there are many of them in Japan, starting in the Ladinian and Karnian.

The Garazhovka and the Priuralye floras also have little in common. In this case the peltasperms play the main role in the similarity of the floras. Through the courtesy of E. E. MIGATCHEVA the author had a chance to get acquainted with the Donbass Triassic plants in the collections of the Kharkov University. The epidermal structure of *Lepidopteris* and *Scytophyllum* from Sukhaya Kamenka and from boreholes # 61, 7601, 7615 (41 and 198 meters depth) is similar to the cuticle of *S. nerviconfluens* of Priuralye and with *S. apoldense* of Germany. The older samples were different: one from the borehole # 47 was similar to *Lepidopteris toretziensis* from the Eastern Predkavkazye (borehole Kolodeznaya 2), another sample (borehole # 76/6, depth 221 m) seemed to be of a new species. Thus, the epidermal structure proves the relationship of the peltasperms in the two floras. But the similarity of the Garazhovka and the Priuralye floras is limited in that there are neither Dipteridaceae, *Podozamites, Cycadocarpidium, Borysthenia* or any other Garazhovka conifers in the Priuralye flora.

The abundance of *Podozamites, Cycadocarpidium* with three seeds, *Tmematostrobus* as well as of the *Uralphyllum* both in Garazhovka nad Priuralye floras permitted STANISLAVSKY (1976) to acknowledge the similarity of these floras. Except *Taeniopteris* cycadophytes are absent in both floras. There are many sphenopsids and cycadophytes in the Priuralye flora, whereas the ferns are represented by another family.

The resemblance to the Madygen flora is suggested by the large amount of the peltasperms and of *Uralophyllum;* to the Ladinian-Karnian floras of Japan in the large role of the conifers (especially of *Podozamites*) and *Cycadocarpidium* with three seeds, in the presence of Dipteridaceae and in minor amount of the cycadophytes and ginkgophytes.

STANISLAVSKY considers the Garazhovka flora to be Late Norian in age because it directly underlies the Novorayskoye Formation which, according to him, is of Rhaetian age. He suggests also that the Garazhovka flora is younger than the Karnian floras of Western Europe. I accept both ideas concerning the Garazhovka flora, but new interpretations of the Norian and Rhaetian stratitype correlations should be taken into consideration. According to those correlations, the so-called Rhaetian floras had begun to develop during Middle Norian time (DOBRUSKINA, 1976 b). Thus, it is quite natural to suggest that the upper part of the Protopivka Formation with the Garazhovka flora (DOBRUSKINA, 1977 a) is of Early Norian to Late Karnian age.

STANISLAVSKY (1976) considers the Garazhovka flora to be the same age as the flora described by KILPPER (1964, 1975) from the lower plant-bearing ("Rhaetian") horizon with *Lepidopteris* from the Karmozd locality at the northern slope of Elburz. STANISLAVSKY (1976) correlates the overlying horizon with *Drepanozamites* with the flora of Sukhaya Kamenka. But the data on the Rhaetian Karmozd flora, given by KILPPER, can hardly permit such an exact correlation: KILPPER described only twelve species from all three horizons (list 47 g in present book). Consequently other correlations of the plant-bearing horizons of the Donbass and Karmozd are possible.

The upper horizon of Karmozd with *Drepanzamites* correspond to the "Rhaetian" floras as this genus is widely distributed within the Norian-Rhaetian floras. The next lower horizon, with *Keraiaphyllum* corresponds to the Novorayskoye Formation, because *Keraiaphyllum* is identical to *Sarmatiella* from the Novorayskoye Formation. The lowest horizon with *Lepidopteris* corresponds to the flora of Sukhaya Kamenka since *Lepidopteris toretziensis* from MIGATCHEVA's collection from Sukhaya Kamenka is the same as in the Garazhovka flora. As a result – the Garazhovka flora appears to be older than the Norian-Rhaetian floras of the Elburz.

The plant assemblage from the Dachrud and from the lower part of the Tokhradzekh formations (Norian-Rhaetian) of central Iran (coeval to the Garazhovka assemblage according STANISLAVSKY) is closer on the whole to the Novorayskoye Formation assemblage, in spite of the presence of *Cycadocarpidium* with three seeds. Thus, its correlation with the Garazhovka plant assemblage seems to be doubtful.

The Pechora flora includes the plant assemblages from the Perebor and Zalaznaya formations of the Big Synya Depression, Shapkino and Naryan Mar formations of the Pechora syneclise, Khey Yaga Formation of the Korotaikha Depression (lists 32, 33). All these plant assemblages can be examined together because the variations are insignificant.

The sphenopsids comprise 20% of all the plant fossils in the Pechora flora, but they are represented solely by barkless stems which indicate that they were transported a long distance from where they grew. They cannot be assigned to a species but the absence of identifiable sphenopsids in the Pechora flora differentiates it from all the close floras.

The ferns (10%) are represented principally by the Marattiaceae (*Danaeopsis, Asterotheca, Bernoullia*) and the Osmundaceae (two species of *Todites*), several species of *Cladophlebis*, and *Rhacophyllum pachyrhachys*. Some genera and species are known in the Southern Priuralye. The similarity of the Pechora and the European Keuper floras is shown by their fern content. Most resemblance can be noticed between the Keuper flora in which the Marattiaceae are associated with Palaeophytic ferns. The presence of the Dipteridaceae in the Middle Keuper floras discriminates them from the Pechora flora. The Middle Asian and the Northern Caucasus ferns are similar to the Pechora ferns. Absolutely different ferns are present within the Triassic flora of the Eastern Urals (mainly *Cladophlebis*) and Garazhovka (Dipteridaceae). The Korvunchana ferns are distinguished not only by their abundance, but by the genera present as well, though some of the species are similar. For instance, the genus *Bernoullia* from Pechora is characterized by the *Lobatopteris*-type nervation, similar to the Korvunchana form *Katasiopteris*.

Pteridosperms constitute 20% of the plants. They are equally abundant in Pechora, Madygen and Donbass floras. The same genera are known in Western Europe, but the group is of a minor importance both within the Lower and Middle Keuper of Western Europe. In Eastern Urals depressions *Scytophyllum* is present only at Bogoslovsk and was not found anywhere else. Only one species of *Scytophyllum* has been described from Korvunchana flora.

Cycadophytes are relatively rare in the Pechora Basin (6%). They include *Ptilozamites, Ctenozamites, Sagenopteris, Doratophyllum, Taeniopteris,* and *Aksarina*. The same genera (+ *Apoldia*) are present in Southern Priuralye. The Middle Asia, Northern China and Western Europe floras are characterized by less numbers of cycadophytes, but different genera are present in Nikolayevka flora and Korvunchana flora as well as in Pechora flora.

Ginkgophytes represent about 30% of all the plants, but this percentage includes the genus *Maria* and the plants tentatively assigned to *Pseudotorellia*. All ginkgophytes from the Pechora Basin also are known in Southern Priuralye, except *Kalantarium*. These two floras are very much alike and the absence of *Kalantarium* is especially striking in the South because they are so plentiful in the North. This plant is determined easily even in the form of dispersed phytoleim because of the distinctive structure of the epidermis. The genus *Kalantarium* correlates the Pechora, Western Europe and Korvunchana floras. A comparison of the Pechora ginkgophytes with Middle Asia, Northern China and Donbass ones is difficult because of their lacking cuticles.

Pechora plants of the same morphology but without the cuticles are included in the list under the name *Glossophyllum ?* and *Desmiophyllum* depending on their preservation. They represent 14% of the samples together with some other unidentified imprints.

Conifers (not more than 1% of all the plants) include *Swedenborgia, Ixostrobus, Araucarites,* and *Stachiotaxus*. They are also scarce in Southern Priuralye where they are reprensented by the same genera. It is interesting to note that *Podozamites* is represented by only a few imprints, *Cycadocarpidium* is absent just as is in the Ladinian-Karnian floras of Western Europe. These two genera are widely distributed in the Eastern Urals, Donbass and Middle Asia

(Kamyshbashi and Ketmen). In Madygen their role is smaller, and Madygen flora includes the same conifers as the Pechora flora.

There are practically no differences in the floras of the Pechora syneclize and the Big Synya Depression. Two species of *Todites,* one imprint of *"Thinnfeldia"* and two imprints of *Aksarina kipievica* are known in the Pechora syneclize but they are absent in the Big Synya Depression. Only one or two imprints of *Asterotheca, Madygenopteris* and *"Sphenocallipteris"* have been found in the Big Synya Depression.

The differences in the stratigraphical distribution are also not very convincing. The grey beds have richer plant assemblages. Only *Madygenopteris sp.* and *Aksarina kipievica* (three imprints) were found in the variegated rocks. The representatives of *Scytophyllum* and *Taeniopteris* are common in the grey beds together with *"Sphenocallipteris"* (a single imprint), *Ptilozamites* and *Ctenozamites.* Ginkgophytes conditionally placed in the genera *Sphenobaiera* and *Pseudotorellia* occur in abundance in the greybeds.

Rare plant fossils are found in the Korotaikha Depression. All the determined plants are from the Khey-Yaga River. They are similar to those in the Pechora depression except one new fern, tentatively called *Bernoullia* sp. nov.

The Pechora and South Priuralye floras are similar in general contents and in the number of common species. With all other floras the Pechora flora has few common species, such as the Marattiaceae and *Cladophlebis, Taeniopteris,* and *Swedenborgia.* However some close forms occur in other floras, but as can be seen from the foregoing one plant group of the Pechora flora is common in one flora, another plant group in a second flora, and the third group in a third flora.

Thus, the relation with the Western Europe floras is established on the occurence of Marattiaceae (but the Pechora flora differs from the Karnian ones with the Dipteridaceae) as well as ginkgophytes and conifers. The similarity with the Donbass floras consists of great role of peltasperms. In contrast to the Pechora flora the Dipteridaceae are also present in the Garazhovka flora, while cycadophytes are totally absent in the Garazhovka flora and *Podozamites* and *Cycadocarpidium* are present in a great abundance. The Eastern Urals floras have common forms (pteridosperms) with the Pechora flora only in Anokhino and Bogoslovsk.

In addittion to the floras of Southern Priuralye the floras of Middle Asia and Central China are the closest to the Pechora flora. Their similarity consists of the similar fern contents (Marrattiaceae and *Cladophlebis*), similar external morphology of the ginkgophytes, as well as of the great number of peltasperms. The absence of *Podozamites* and *Cycadocarpidium* is a common feature of the Pechora and Chinese floras.

There is very little similartity to the Korvunchana flora: only the ginkgophytes of the family Glossophyllaceae and genus *Scytophyllum* (with different species) are the same. There is no resemblance to the floras of Primorye, Japan and South Eastern Asia, either.

Thus, the Pechora flora is similar to the Ladinian-Karnian flora of Western Europe and it is very similar to the Norian-Rhaetian floras. As a result, the age of the Pechora flora lies somewhere within the Ladinian and the Karnian stages. The absence of the Dipteridaceae favours a Ladinian age.

The floras of the Southern Priuralye (the plant assemblages of the Kurashasay and Bukobai formations – lists 35, 36). As in the case of Northern Priuralye plant assemblages of different ages with dissimilar characteristics cannot be recognized in Southern Priuralye. Noticable changes in the plant assemblages cannot be recognized either vertically or laterally. Moreover, the assemblages from both Southern and Northern Priuralye are extremely similar. If you see imprints you cannot say with sure if they are from the Northern or from the Southern Priuralye. The ratio of the principal plant groups are also close to those in both regions.

Within the plant assemblages the following plants are present: ginkgophytes (30%), sphenopsids, ferns and pteridosperms (about 20% or slightly more each), cycadophytes (4%) and conifers (1%). There are more ferns than in Northern Priuralye and the sphenopsids are better preserved.

The abundance of ferns and the better preservation of the Equisetaceae (which distinguishes the Southern Priuralye flora from the Northern one) makes it closely related to the Yenchang flora of Northern China. In addition the sphenopsids and the ferns of Southern Priuralye are very similar to the fossils in the Northern China. Ferns are also similar to the Pechora ones, but the latter are richer in species.

Taking only the role and the species of the pteridosperms and the ginkgophytes and their epidermic texture into account, the Southern Priuralye and the Pechora floras should be undistinguishable. The difference is in a great abundance of the genus *Kalantarium* at Pechora and its absence in the Southern Priuralye. Number of pteridosperms distinguishes the flora of the Southern Priuralye from that of Northern China. Morphologically similar ginkgophytes are present in both floras. The cycadophytes and conifers are also close to the Pechora and Northern China forms, but in the latter case, the cycadophytes are plentiful and varied.

The flora of Southern Priuralye and the Pechora Basin are so similar that there can be no doubt about the similarity of their age. The same thing can also be said about the Northern China floras. The similarity of Ilek and Yenchang floras was noted by Brick (1952) and especially by Sze (1956). The resemblance of the Southern Priuralye floras and the Lower and Middle Keuper floras of Western Europe seems to prove their Ladinian age, taking into account the absence of Dipteridaceae in the floras of Priuralye and Northern China.

The Southern Priuralye and Madygen floras are similar in the number of peltasperms, the species of *Cladophlebis,* the number of sphenopsids, the morphology of ginkgophytes, and partly the species of conifers, although the Madygen conifers are more varied and include *Podozamites* (without *Cycadocarpidium*).

The flora of the volcanic-sedimentary rocks of the Eastern Urals (the plant assemblages of the Tura Series – list 43) is still unsufficiently studied. In the Anokhino locality only the pteridosperm, one imprint of *Pterophyllum* and one scale of *Lepeophyllum* were described (list 43). None of the published plants proves the Early Triassic age of the enclosing sediments. The genus *Sphenocallipteris* was incorrectly identified in the flora. Plants which are similar in morphology and epidermal structure were found in those Priuralye floras whose age is not older than Ladinian. Judging from the similarity of these remains and of *Lepidopteris* (oral communication, KIRITCHKOVA) the Anokhino flora is probably also Ladinian in age.

The flora of the coal-bearing rocks of the Eastern Urals (the plant assemblages of the Chelyabinsk Series – list 44). In this flora the ferns are most abundant (36%) with numerous *Cladophlebis* as well as representatives of the Osmundaceae (*Osmundopsis*). Marattiaceae are absent. *Danaeopsis rarinervis* from Bulanash (TURUTANOVA-KETOVA, 1958) actually belongs to *Taeniopteris*. Sphenopsids, prevailing in the lower part of the section, are in second place (20%). They are mainly *Neocalamites* as well as *Annulariopsis* and *Schizoneura*. The conifers are in the third place (15%), the majority of them are *Podozamites* and *Cycadocarpidium*. STANISLAVSKY (1976) draws attention to the fact that all the Eastern Urals *Cycadocarpidium* are the three seed forms. So he thinks the determinations of *C. erdmannii* in these floras are erroneous and should be assigned to another species. Ginkgophytes and pteridosperms are met in approximately aequal numbers (10% each). The ginkgophytes according KIRITCHKOVA are represented almost exclusively by Czekanowskiales in the lower part of the section and by numerous species of *Ginkgo* and *Sphenobaiera* with some species of Czekanowskiales in the upper part. Among the pteridosperms, various species of *Thinnfelldia* are found in two lower assemblages but al least some of them being *Scytophyllum* and *Vittaephyllum*. They are not mentioned in the upper assemblage, but *Uralophyllum* had appeared (the name *Miassia* is its synonym). Cycadophytes are less common, among which *Taeniopteris* is only of significance. Some single imprints of *Pterophyllum, Glossozamites* and *Ctenis* demonstrate the existence of this plant group in the Triassic time on the eastern side of the Urals.

With the geographically more closely located Pechora flora the floras of the Eastern Urals have nothing in common, except the peltasperms of the Bogoslovsk Depression.

The complete similarity only with Turgay Basin flora is observed, especially with the flora of the Burluk locality (oral communication, ORLOVSKAJA). Numerous *Cladophlebis* correlate the Eastern Urals flora with the Triassic flora of Primorye and with the Jurassic floras of the Siberian area although the Dipteridaceae are dominant among the ferns of the Primorye flora. The sphenopsids of these two floras are similar, but they are more varied in the Urals. the same is true of the ginkgophytes being more numerous and varied in the Urals. *Podozamites* and *Cycadocarpidium* are dominant among the conifers in both floras. A limited number of the cycadophytes correlates the Eastern Urals flora and the Karnian Primorye flora and sharply distinguishes it from the Nornian Primorye flora.

An essential similarity of this flora and the Garazhovka flora of the Donbass was emphasized by STANISLAVSKY (1976) when he noted the abundance of *Podozamites* and *Cycadocarpidium* as well as the presence of the genus *Uralophyllum*. The Eastern Urals floras differ greatly from all the floras of the second half of the Triassic period in Western Europe and from Middle Asia and Northern China ones (only *Neocalamites* and *Uralophyllum* are common elements there).

STANISLAVSKY (1976) thinks the floras of Middle Asia and Northern China to be older than Rhaetian (Upper Norian), correlating them with the Garazhovka flora of the Donbass. He bases this idea on the presence of the three-seed *Cycadocarpidium* and *Uralophyllum* in the Urals floras. I consider the Garazhovka flora to be Lower Norian or Upper Karnian and think it is justified to compare it with the horsetail and the horsetail-fern assemblages of the Urals. In my opinion, the fern-ginkgo assemblage is to be correlated with the Novorayskoye flora but not with the Garazhovka one, due to the abundance real Ginkgoaceae. The presence of the *Uralophyllum*, conifers indicate a Norian-Rhaetian age of this assemblage, as the same genus *("Thinnfeldia nordenskioldii")* is known from the Lower Liassic in Sweden. The presence of the three-seed *Cycadocarpidium* seems to contradict such correlation, so the exact age of the Eastern Urals floras has not yet been established.

The newly discovered Upper Triassic floras of Taymyr (MOGUTCHEVA, 1983) are very similar to the floras of the Eastern Urals. However, the exact correlation of these floras has not been yet determined. When it is, then the age of these floras will be established.

The abundance of the peltasperms in the "C" Formation of the Bogoslovsk Depression differentiates this flora from other floras of coal-bearing beds of the Urals and correlated it with the Priuralye floras.

The Madygen floras (Southern Fergana – list 53). The most abundant plants in these flora are the pteridosperms and ginkgophytes (about 55% of all the fossils), the other groups being approximately evenly divided.

The lycopods (4%) are represented by the endemic genus *Ferganodendron* whose leaves and bark have been described (DOBRUSKINA, 1982). Some trunks 20–30 cm in diameter, supposedly of this genus, were mentioned in the literature (SIXTEL, 1962 a). These plants are not known anywhere, except in the Madygen area. This genus has nothing in common with the genera *Pleuromeia* and *Sigillaria* with which it was previously compared by SIXTEL (DOBRUSKINA, 1974).

The sphenopsids (12%) except for some imprints belong to the species *Neocalamites hoerensis*. Some accompanying fructifications should be apparently singled out into a new species of the genus *Neocalamostachys*. The majority of Madygen *Neocalamites* are from the single outcrop in the Dzhaylau Cho. They were collected by SHAROV together with insects, fish and small exotic vertebrates. In some other outcrops *Neocalamites* are rather less common. Sometimes there are just isolated trunks of *Neocalamites hoerensis* or the closely related species *N. merianii* and *N. carrerei*, all of which are widely distributed in the floras of the second half of the Triassic (Western Europe, Donbass, the Eastern Urals, Middle Asia, Northern China, Priumorye and Japan; fructifications together with the vegetative twigs are described also from Western Europe and Japan).

The ferns (6%) are represented by the Marratiaceae (*Danaeopsis*), Osmundaceae ? (some species of the genus *Cladophlebis*, similar to the Pechora, Kamyshbashi, Yenchang and Japan forms) and by the endemic species of the genus *Chiropteris*.

Pteridosperms (31%) are the most numerous fossils in the Madygen flora. Very likely most of them belong to the family Peltaspermaceae (DOBRUSKINA, 1975). *Lepidopteris, Peltaspermum, Scytophyllum, Vittaephyllum, Madygenopteris, Madygenia* are the representatives of the family in this flora. *Ptilozamites, Uralophyllum, Rhaphidopteris ?, Edyndella* represent the second group of related forms. The third group consists of *"Thinnfeldia rhomboidales"*. Caytoniales are represented by *Sagenopteris* leaves. It is possible that some species of *Taeniopteris* from Madygen are related to the pteridosperms, as they have rachis with blisters, which is typical of Peltaspermaceae. A large number of peltasperms makes the Madygen flora similar to the Nikolayevka and Garazhovka floras of the Donbass and Southern and Northern Priuralye. Many representatives of *Vittaephyllum* (*Furcula* ?) unites the Madygen and Nikolayevka (Donbass) floras. Various *Taeniopteris*, two species of *Pterophyllum*, the genus *Leuthardtia* and the endemic *Taeniopteridium* are among the cycadophytes (9%). The similarity of the Madygen *Pterophyllum* (with narrow segments) and *Pterophyllum pschartense* from the Pamirs as well as *Pterophyllum filicoides* from European Keuper should be noted. The presence of the genera *Leuthardtia* and *Sagenopteris* correlates the Madygen and the Alpine floras. *Sagenopteris* is known also in Priuralye, Northern China and Japan. The presence of *Taeniopteris*like leaves (*Taeniopteris ? stankevichii*) is interesting. Such nervation was observed in some *Taeniopteris*like leaves from Pechora.

Ginkgophytes (24%) are numerous mainly due to some isolated leaves tentatively called *Glossophyllum ? sp.* (20%), although their systematic position is not clear. Some leaves, previousley determined as *Cordaites*, are related to this genus. The nerves usually do not reach the margins of these leaves, but are curved parallel to the margins coming together at the apex of the leaf, or reach the margin near the apex. Only a few specimens (three imprints out of 200) have a wider angle of nerve divergence and can be considered exeptional. Abundance of these leaves is another common feature of the Donbass, Priuralye, Ketmen floras and the Madygen flora. *Ginkgoites* and *Sphenobaiera* from Madygen are similar in the external morphology to the ginkgophytes (the genus *Kalantarium*) of Northern and Southern Priuralye, but the absence of cuticle in the Madygen flora prevents their exact identification.

The conifers (7%) are rare. They include *Podozamites distans, Swedenborgia cryptomerioides, Stachyotaxus* and numerous unstudied reproductive organs and seeds. *Podozamites* is rare and without *Cycadocarpidium*. The absence of these two genera is typical of the Madygen and Priutalye floras and differentiates them from the floras of the Eastern Urals, Donbass and Far East. Some peculiar leaves were attributed by SIXTEL (1962 b) to her genus *Mesenteriophyllum* (6%), whose systematic and stratigraphic positions are still uncertain.

The Madygen flora is very rich and varied, which is why to some extent, it is difficult to compare with any other flora (for example with Ketmen and Kamyshbashi floras). Taking into consideration different groups of plants in every case the Madygen flora compares closely with the Ladinian-Karnian floras of the Priuralye, Middle Asia, Northern China, and to a lesser extent with the floras of Western Europe, the Donbass and Japan. The resemblance of the Western European floras is in the contents of the spenopsids and to some extents of the ferns, of the sterile leaves of Bennettitales and Caytoniales. *Glossophyllum ?* of the Madygen flora might be related to the European floras. The similarity to the Nikolayevka flora of the Donbass is due to the sphenopsids and peltasperms and possibly to *Glossophyllum ?*. The presence of *Danaeopsis, Cladophlebis shensiensis, Lepidopteris, Scytophyllum, Ctenozamites, Sagenopteris, Glossophyllum, Swedenborgia* correlates the Madygen, Priuralye and northern China floras. There is little resemblance to the Primorye and Japan floras. Only *Neocalamites* and *Glossophyllum ?, Cladophlebis, Pterophyllum* with narrow segments and *Sagenopteris* are common to the floras. The age of the Madygen flora lies within the limits of the Ladinian and Karnian stages.

The Kamyshbashi flora (the plant assemblage from the Lower variegated Formation – list 55) and the Koldzhat flora (the Ketmen Range – list 55) are similar to Madygen flora but are not so varied from the systematic point of view. The presence of *Podozamites* and *Cycadocarpidium* within the first mentioned above correlates it with the Ladinian-Karnian floras of Japan and the Donbass.

The Yenchang flora from the Northern China (list 67). Ferns are most numerous and constitute about a half of all described imprints in this flora.

Sphenopsids (15%) are represented in the flora by numerous *Equisetites* and well preserved *Neocalamites* which are close to forms from Western Europe, Priuralye and Middle Asia. The ferns belong to *Danaeopsis, Bernoullia* and *Cladophlebis*. The number of the species of *Cladophlebis* reduced. The imprints described by SZE (1956) as *Thinnfeldia rigida* and *T. alethopteroides* probably are related to *Bernoullia*. The same probably might be said about *Phlebopteris ? linearifolia. Sphenopteris ? chowkiawanensis* is a peculiar form, similar to the fern of Darvaz. Most the ferns are identical with or very close to the ferns of Mongolia, Priuralye and Northern Vietnam.

Pteridosperms (about 10%) are not very numerous, a feature which distinguishes this flora from the western floras of the same age, but relates it to the floras farther to the east, where these groups are also esentially absent. The imprints previously described as "*Thinnfeldia nordenskioldii*", are attributed to the genus *Uralophyllum*.

The share of cycadophytes (8%) is even less although they are represented by four genera. The ginkgophytes constitute not more than 5% of the flora. They are devoid of cuticles and are similar in the external morphology to the ginkgophytes of Priuralye region and of Western Europe. The leaves described as *Glossophyllum* have no cuticles, but even in their external morphology (the leaves are thick and large) they differ from European *Glossophyllum* and from the leaves placed into this genus in Priuralye and East Urals, the Donbass and Madygen. Conifers (8%) are represented by the genera *Podozamites, Swedenborgia ?, Stenorachis* and *Taeniocladopsis. Podozamites* is not numerous and *Cycadocarpidium* is absent.

Just as the previously described floras, the Yenchang flora correlates with some of them by one group and to others by another group of plants. The abundance of well preserved sphenopsids is similar to the floras of Southern Priuralye and Japan; the species of the Marratiaceae to the floras of Western Europe, the Northern and Southern Priuralye. Abundance of cycadophytes is similar to the Madygen and Southern Priuralye floras; external morphology of the ginkgophytes to the floras of Madygen, Priuralye and Western Europe. Presence of genus *Swedenborgia* is similar to the floras located farther to the west; presence of genus *Podozamites* to the floras farther to the east.

As a whole the Yenchang flora is most similar to the floras of Southern Priuralye. However, an abundance of ferns distinguishes it from all other floras. The absence of the Dipteridaceae suggests a Ladinian age for the Yenchang flora. A great number of ferns correlates this flora with the Korvunchana flora of the Tunguska Basin, but their composition, as was previousley noted, is different. *Bernoullia* from Yenchang and *Katasiopteris* from Tunguska are similar in the nervation peculiarities, but the extent of their resemblance needs additional investigations. There is practically no similarity in all other plant groups.

The Mongolian flora (lists 65, 66) consists of a single assemblage. Conifers (40%) are the most widely distributed fossils but most of them were collected in adjacent localities in the Selenga River Basin.

Sphenopsids (23%) are common in all other regions. They are represented by *Equisetites arenaceus* and *Neocalamites carrerei.* Ferns (14%) are represented by the genera *Danaeopsis, Bernoullia* and *Cladophlebis*. The species of *Cladophlebis* are the same which are known in Northern China, Southern and Northern Priuralye. Two *Scytophyllum* imprints of a rather indifferent preservation and numerous *Uralophyllum* leaves represent the pteridosperms (3%). The *Uralophyllum* leaves are identical to those from the Yenchang Formation of Northern China where they have been called *"Thinnfeldia nordenskioldii"*. This genus is known in the Donbass (Garazhovka), in the Eastern Urals and Madygen floras. The cycadophytes (4%) are rare. They are represented by *Sphenozamites* sp., *Nilssonia* sp. and by several species of *Taeniopteris*. The ginkgophytes (6%) are not numerous, but are rather varied and include *Baiera, Sphenobaiera. Ginkgoites, Czekanowskia* and *Phoenicopsis. Glossophyllum ?* (10%) is also present. The conifers except the endemics from the Selenga River are represented by *Podozamites, Cycadocarpidium, Pityophyllum, Voltzia ?, Swedenborgia*.

The closest resemblance is with the Yenchang flora (Northern China), but the ferns are less varied. *Podozamites* is more abundant and in contrast to Yenchang flora *Cycadocarpidium* and *Czekanowskia* are present in the flora of Mongolia. The age of this flora is determined to be Ladinian because of its resemblance to the Northern China of Priuralye floras (in particular because of absence of the Dipteridaceae). The difference from the Northern China flora seems to be resulted with the climate.

In Verkhoyanye in the Aldan River Basin (Tumara River), the fern *Bernoullia* sp. (ABRAMOVA, 1960), a common member of the Ladinian-Karnian floras was found. It seems that the flora of the "Yollikhar" Formation (DAVYDOV, 1976) of Darvaz is of the same stratigraphic horizon. The fern that is close to *Sphenopteris ? chowkiwanensis* of Yenchang is the most important plant in this formation. The flora of the Semeytau Formation from the Semeytau mountains of Northern Kazakhstan is apparently of Ladinian-Karnian age as well. Here, the majority of imprints are most probably the reproductive organs of Bennettitales. *Lepidopteris, Peltaspermum* are also present (Coll. GIN 4252). A small plant assemblage from the Khorat group from Thailand (list 75) is apparently of the same age.

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Thus, the Ladinian-Karnian floras of the central regions of the Eurasia continent have some common elements: horsetails, Marattiaceae, a great number of peltasperms, ancient ginkgophytes of family Glossophyllaceae and small number of conifers. Different cycadophytes occur in each floras. The floras do not have many common species, as a rule. Common genera (except the most widespread ones) do not usually occur in all the floras, but only in a few: two – three adjancent ones. That is, every plant assemblage is correlated to another by certain common genera, while at the same time it is correlated with other ones by quite different genera.

For instance, the Nikolayevka flora of the Donbass includes *Lepidopteris* and *Voltzia,* typical of the European floras, together with *Podozamites* and *Cycadocarpidium* which are typical of the Japanese floras of the same age. Moreover, the first two genera, are unknown in the Ladinian-Karnian strata of Japan and the last two are not found in correlative strata in Western Europe. The same can be said about the flora of Mongolia, where the Marattiaceae (the western flora type) and the Cycadocarpidiaceae (the eastern flora type) are present. The Garazhovka flora of the Donbass is similar to the floras of the Eastern Urals by the conifers and *Uralophyllum* both of which are absent in coeval floras of Western Europe. On the other hand, the Garazhovka flora includes members of the Dipteridaceae which are known in the Karnian floras both in the west and the east, and in the Ladinian floras in the east.

One can say that all these floras are related to each other by some gradual transitions. They all are closely allied to each other in spite of a small number of common species in them. So, no boundaries can be traced in this continuous sequence of these floras, though the floras of the west and of the east of Eurasia, as was said above, are very much dissimilar. In other words, all the Ladinian-Karnian floras of Eurasia (except India) constitute one large flora, the differences within it being due to the provincial peculiarities. I suggest calling it the *Scytophyllum* flora.

Two groups of plant assemblages can be distinguished in the *Scytophyllum* flora: the older is approximately Ladinian in age and the younger is approximately Karnian in age (see chart 8). The first group apparently includes the floras absolutely devoid of the Dipteridaceae such as the floras of Northern and Southern Priuralye, the Tura Series of the Eastern Urals, the floras of Northern China and Mongolia. The occurence of the *Mastodonsaurus* fauna (tetrapods) confirms the Ladinian age of the Southern Priuralye floras. The second group consists of the Nikolayevka and Garazhovka floras of the Donbass, the horsetail and the horsetail-fern flora of the Eastern Urals and, with less assurance, the Madygen, Kamyshbashi and Koldzhat floras.

A rather small Maleri flora is known in India (list 82). It contains only conifers and does not include typical forms of either the *Dicroidium* flora, or the *Scytophyllum* flora. Its Karnian age is established by tetrapods.

If at least three large floras can be distinguished in the different parts of Eurasia (excluding India) in the first half of the Triassic, in the beginning of the second half only one flora is present in the region. The provincial peculiarities of that flora are given in chapter twelve and its general characteristics in chapter thirteen after the description of phytogeographical zonation of Eurasia in the Triassic.

Norian-Rhaetian floras

The standard floras of Norian-Rhaetian age are the *Lepidopteris* flora of Greenland and Western Europe (Middle Norian-Rhaetian) and the Norian (Middle Norian) flora of Japan, Primorye and of Northern Vietnam.

The *Lepidopteris* flora is very rich in number of species as well as in number of specimens. It was studied by Harris (1932–1937) most detailed and any comparison with other floras would be incomplete because of a less detailed characteristics of other floras. First of all the *Lepidopteris* flora (lists 8, 9, 12, 14, 15, 16, 19, 23d, 24, 27) is abundant in varied cycadophytes (fig. 47). They are represented by typical Mesophytic forms, such as *Ctenis*, *Pseudoctenis*, *Antrophyopsis*, *Nilssonia*, *Anomozamites*, *Pterophyllum*, *Wielandiella* etc. Numerous reproductive organs of cycads and bennettites are examined as well. The conifers occupy the second place: *Stachyotaxus*, *Elatocladus*, *Araucarites* and genera of the Cycadocarpidiaceae. They are very different from conifers of previous stages of the Triassic of Western Europe. For example they include *Podozamites* and *Cycadocarpidium* which have been known before mainly in the more eastern floras only.

The typical ginkgophytes (the Ginkgoaceae and Sphenobaieraceae) as well as czekanowsias are numerous: *Hartzia*, *Staphidiophora* etc.

Small numbers of the ferns, pteridosperms and sphenopsids occur approximately in equal amount. The ferns are the Dipteridaceae *(Dictyophyllum, Clathropteris, Camptopteris)*, Osmundaceae *(Todites)*, Matoniaceae *(Phlebopteris)*, Marattiaceae *(Marattiopsis, Danaeopsis, Rhinopteris)*. *Cladophlebis* also presents. The great number of Dipteridaceae and their large leaves differ the Norian-Rhaetian floras from the Ladinian-Karnian floras. The pteridosperms are a characteristic element of the flora, though their relative number is small. Nevertheless in some Swedish floras leaves of *Lepidopteris ottonis* constitute thin layers of rocks. *Lepidopteris ottonis* is a guide fossil for the *Lepidopteris* zone which distinguishes it from the upper *Thaumatopteris* zone. The sphenopsids are represented by the same genera of the Equisetaceae (*Equisetites* and *Neocalamites*) just as in the older Triassic floras but their number and variety now is less.

The different relations of the main plant groups distinguish the Norian-Rhaetian *Lepidopteris* flora from the Ladinian-Karnian floras of Western Europe. The number of the cycadophytes, ginkgophytes and czekanowskias has markedly risen and they are represented by another genera and species. The number of the pteridosperms and sphenopsids has markedly decreased. Among the ferns the Dipteridaceae, Osmundaceae and Matoniaceae have taken the first position.

The *Lepidopteris* flora is very close to a younger *Thaumatopteris* flora which is Lower Jurassic in age. The latter one is known in the same regions as the former flora and occur in the rocks which overlain beds with *Lepidopteris*. The genera and family composition of the *Thaumatopteris* flora is very similar to those of the *Lepidopteris* flora, though not a single common species is found. The difference is in greater variety of the Mesophytic fern families in the *Thaumatopteris* flora and different ratio between the ferns and cycadophytes.

The Norian flora of Japan (the plant assemblages of the Nariwa environs, the Hinabata Formation – list 70a). This flora is also rich and various but cannot be studied with the same details because there are no cuticules on the imprints.

The ferns (40%) are the most numerous. The Dipteridaceae are in the first position and they are followed by the Osmundaceae and Marattiaceae, i. e. the same families as in the west of Eurasia. In contrast to the west of Eurasia in Japanese Norian flora great number of *Thaumatopteris* species is present. Even *Thaumatopters shenkii*, the guide fossil for the *Thaumatopteris* zone in Europe and Greenland, is described from the Nariwa Triassic.

The cycadophytes (30%) are slightly less, but the variety is more than in ferns. Here are the same genera as in Europe and Greenland: *Ctenis, Otozamites, Nilssonia, Pterophyllum, Taeniopteris.*

The conifers (14%) are in the third position. *Podozamites* is less varied than in the Karnian flora of Yamaguti. *Cycadocarpidium* is not mentioned at all. The Cycadocarpidiaceae in the Norian-Rhaetian was more developed in the west of Eurasia (unlike the Ladinian-Karnian when it was more common in the east). *Stenorachis, Pityophyllum, Elatocladus, Nageiopsis, Storgaardia* are present.

The percentage of ginkgophytes (8%) in Japan is less than those in Greenlad and Sweden. These are various *Baiera, Ginkgoites, Czekanowskia, Phoenicopsis*, i. e. the Ginkgoaceae and Czekanowskiales.

The sphenopsids (8%) are similar to those from the Ladinian-Karnian floras, but they are less varied. Their share in in the Norian-Rhaetian floras is less than in the Ladinian-Karnian. It is true for the east of Eurasia as well as for the west of it. The main genera are (as before) *Equisetites* and *Neocalamites, Annulariopsis* is also found.

The pteridosperms are represented by the genera *Ptilozamites* and *Sagenopteris*.

Thus, the Norian flora of Japan is quite similar to the *Lepidopteris* flora though some elements of a younger *Thaumatopteris* flora are present. OISHI (1938) tried to find in Nariwa flora the analogues of the both European floras. He divided all localities of Nariwa flora into two groups, considering one of them as anology of *Lepidopteris* flora, the other as of *Thaumatopteris* flora. His interpretation was not accepted neither by stratigraphers nor by tectonists.

Recent investigations of KIMURA (1959) also suggest the existence of two floras in the Nariwa flora of Japan but this point of view differs from OISHI's. KIMURA following OISHI also considers the Triassic and Lower Jurassic floras of Japan to belong to the *Dictyophyllum* Series. According to KIMURA the older subseries includes all the Yamaguti and a part of the Nariwa floras, while the younger subseries includes another (bigger) part of the Nariwa flora and the Lower Jurassic floras of Japan. KIMURA indicates that in the younger flora there is a great deal of species in common with *Thaumatopteris* flora of Western Europe: *Dictyophyllum nilssonii, Todites princeps, Marattiopsis muensteri, Nilssonia brevis, N. muensteri, Swedenborgia cryptomerioides*. In the same time in the older Japanese flora only two species of *Cycadocarpidium* are common with the *Lepidopteris* flora. Moreover, some species found in one of two european floras occur in both Japanese floras.

KIMURA, indicating all these distinctions, thinks that Yamaguti flora resembles the *Lepidopteris* flora and Nariwa flora resembles the *Thaumatopteris* flora. In spite of this resemblance he considers that the boundary between Yamaguti flora (lower subseries of *Dictyophyllum* Series) and Nariwa Flora (upper subseries of *Dictyophyllum* Series) does not coincide in time with the boundary of *Lepidopteris* and *Thaumatopteris* floras. The last boundary in the west corresponds to the Triassic-Jurassic boundary while the boundary of two subseries of *Dictyophyllum* series in the east corresponds approximately the boundary between Lower and Middle Norian. It is traced inside the plant-bearing Hinabata Formation of Norian age.

It seems to me that the older (Yamaguti) flora of Japan which is mainly Karnian is more like the European floras of the same age than the yonger *Lepidopteris* flora. If we compare it with the Schilfsandstein flora we can see the similar relative quantities of representatives of the same Equisetaceae, Dipteridaceae and ginkgophytes. The difference is that such species as *Cycadocarpidium erdmannii, C. swabii, Sagenopteris nilssoniana* which occur in the Karnian of Japan appear in Europe only in the Norian-Rhaetian or in the Lower Jurassic. Thus, the younger, Norian flora of Japan is a "mixed" flora. It means that it includes forms which in Europe are present only in the *Lepidopteris* or only in the *Thaumatopteris* flora. The Liassic flora of Japan is similar only to coeval *Thaumatopteris* flora of Europe.

This suggests that some species appeared at first in the eastern part of Eurasia in the Upper Triassic. Later they migrated to the west and reached Western Europe and Greenland in the end of the Triassic or in the Early Jurassic (GOMOLITSKY & DOBRUSKINA, 1973).

The Norian flora of Primorye (the plant assemblage of the Amba Formation – list 72). The cycadophytes (40%) are the most abundant and varied plants: many species of *Pterophyllum* and *Taeniopteris* as well as *Ctenis, Tomia, Drepanozamites*. But their number and variety is less than in coeval flora of Japan. The ferns (more than 20%) take the second position. They also are less varied and abundant than in Japan. For example, such genera as *Thaumatopteris, Hausmannia, Goeppertella, Marattiopsis* which are known in Japan are absent in Primorye. Ferns in Primorye are represented by the Dipteridaceae *(Clathropteris, Dictyophyllum, Camptopteris)*, Osmundaceae *(Todites)* and by *Cladophlebis*.

The ginkgophytes (about 20%) are represented by *Baiera* and *Sphenobaiera* and by unimproved *Glossophyllum* (cuticles are absent). The sphenopsids (12%) are relatively numerous in comparison with the floras of Japan, Sweden and Greenland. They are represented by typical Triassic genera *Neocalamites* and *Equisetites*. The conifers (6%) are few but the relative number of *Podozamites* and *Cycadocarpidium* is much larger than in the coeval flora of Japan. *Swedenborgia, Pityophyllum* and *Elatocladus* are also found. The pteridosperms (3%) are represented only by the endemic genera *Imania* and *Tudovakia*.

The Amba assemblage differs from the Nariwa assemblage mainly by small variety of the cycadophytes and ferns, which can be connected with the geographical position of the flora – northward.

The Suoy-Bang and Hongay flora of Northern Viet Nam (the so-called Tonkin flora – list 73) is similar to the poorer Central Viet Nam flora – list 74. The cycadophytes (45%) are predominant in these floras as well as in other Norian-Rhaetian floras. They are rather varied and are represented by *Pterophyllum, Ptilophyllum, Otozamites, Zamites, Cycadites, Cycadolepis, Taeniopteris, Macrotaeniopteris, Sagenopteris*. The ferns (13,%) are on the second place. The Dipteridaceae *(Dityophyllum, Clathropteris)* and *Cladophlebis* are the most varied among them. The endemic genera are also present. The sphenopsids (10%) are *Neocalamites, Equisetites, Annulartiopsis*. The percentage of conifers (4%) *Yuccites, Podozamites, Araucarioxylon* is the same as of ginkgophytes (4%) *Baiera*. Pteridosperms (2%) are *Sagenopteris, Ctenozamites, "Danaeopsis" hughesii*.

SADOVNIKOV (1971 a) distinguished in the Triassic flora of Vietnam four flora horizons (from the bottom upward): 1) The horsetail horizon almost without any other plants, 2) The fern horizon with few *Pterophyllum* and *Taeniopteris*, 3) The cycadophytes horizon with few *Clathropteris*, and 4) The *Nilssonia* horizon with folded *Nilssonia*.

Due to the general composition and variety of species Viet Nam flora is similar to the Norian flora of Japan. Ginkgophytes and conifers are less in number because of more southern position of Viet Nam.

It is worth mentioning more similarity in floras of west and east of Eurasia in the Norian-Rhaetian time in comparison with the Ladinian-Karnian time.

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We shall now turn to examination of the plant assemblages of inner parts of Eurasia and to their comparison with each other and to the standard floras.

The Novorayskoye flora of Donbass (list 30c, 30f) is characterized by some common forms with the Garazhovka flora from the underlying beds but the relationships between main plant groups in these two assembleges are different. The number of the representatives of the family Dipteridaceae as well as of ginkgophytes is bigger in Novorayskoye flora and the Czekanowskiales appear. Pteridosperms completely decreased: *Uralophyllum* vanished, peltasperms are known by several specimens. Three-seed *Cycadocarpidium* also disappeared.

In the Novorayskoye flora there are some species similar to species of the *Lepidopteris* flora of Western Europe and Greenland: *Lepidopteris, Pelraspermum, Dictyophyllum exile, Drepanozamites nilssonii, Hydropterangium* etc. Moreover, there are some species and genera common with the *Thaumatopteris* flora: *Osmundopsis, Dictyophyllum* cf. *muesteri, Todites princeps, Coniopteris* sp. and oth.

It was a reason for PRYNADA and later for MIGATCHEVA and STERLIN (LAPKIN ET AL., 1975) to consider this flora to be the Lower Jurassic in age. STANISLAVSKY (1971) proved that the presence of *Lepidopteris* and *Peltaspermum* in Novorayskoye flora correlates it with the Upper Triassic *Lepidopteris* flora and that the "Liassic" elements of this flora turned out to be a new species. Anyway, even if we have "mixed" floras at this level they should be considered as Upper Triassic. It was shown (GOMOLITSKY & DOBRUSKINA, 1973) that moving from the west to the east of Eurasia we meet more and more "Liassic" species in the Norian-Rhaetian floras and they reach their maximum in the Nariwa flora of Japan.

The common feature of the Norian-Rhaetian floras of whole Eurasia is a great number of the Dipteridaceae, cycadophytes, ginkgophytes and czekanowskias.

The plant assemblage of the VII and VI beds from the Eastern Predkavkazye (list 38) also is a "mixed" assemblage. Species which are known only from the Triassic are dominant. But there are also species which were previously known only from the Jurassic.

The most important are the horsetails (*Neocalamites* sp.) and isolated *Podozamites* leaves. As in the Novorayskoye flora there are the Dipteridaceae, cycadophytes, ginkgos and czekanowskias. The assemblage is most similar to the Novorayskoye flora of the Donbass and to the Dahrud flora of Central Iran. This similarity allows to determine the age of the Predkavkazye flora as the Norian-Rhaetian.

The peculiar feature of this flora which differs it from coeval floras of the Donbass and Iran is the presence of *Asterotheca merianii* and *Bernoullia aktiubensis*. These two species are still unknown in the Norian-Rhaetian floras and are widely distributed in the Ladinian-Karnian floras. One cannot exclude that a part of enclosing sediments is older than the Norian, but when studying the distribution of fossil plants in boreholes you do not see that these forms belong to the lower part of the section. So, till now we cannot find an answer to this question.

In the previous collections from VII and VI beds of Predkavkazye the species with wide vertical distribution were dominant. It was a reason for an erroneous determination of their age in previous papers as Jurassic.

In Prikaspiy only *Clathropteris meniscoides* can be determined from the probable Norian-Rhatian sediments (list 41).

The Fern-Ginkgo assemblage of the Eastern Urals (list 44) is characterized by the abundance of *Cladophlebis*, the other fern genera being insignificant, by the absence of the cycadophytes except *Taeniopteris*, by the great number of ginkgophytes (Ginkgoaceae and Sphenobaieraceae) and czekanowskias, by the presence of *Podozamites* and absence of *Cycadocarpidium*, by the presence of *Uralophyllum*.

There were no typical Ginkgoaceae in the older Triassic plant assemblages of the Eastern Urals. Their appearance in the Fern-Ginkgo assemblage seems to prove its Norian-Rhatian age because in the Ladinian-Karnian we know only one ancient family of Ginkgoales – the Glossophyllaceae. *Uralophyllum* does not contradict this conclusion, this genus is known in the Lower Jurassic in Sweden (*"Thinnfeldia nordenskioldii"*). It means that it appeared in the Ladinian-Karnian floras (Donbass, Madygen, Northern China, Mongolia) and existed until Liassic.

Fern-Ginkgo flora was determined by KIRITCHKOVA (1962 b, 1969) and VLADIMIROVICH (1967) as a Lower Liassic one, while STANISLAVSKY (1976) considers all floras from coal-bearing beds of the Eastern Urals as pre-Rhaetian, being of the same age as the Garazhovka flora in Donbass.

The oldest plant assemblage of the Turgay Basin (list 45) is similar to the Fern-Ginkgo flora of the Eastern Urals.

The Dzhermanis plant assemblage (flora of coal-bearing deposits in Zakavkazye – list 46). KRYSHTOFOVICH and PRYNADA (1933 a) have described the Dipteridaceae, Matoniaceae and numerous cycadophytes (*Nilssoia, Anomozamites, Pterophyllum, Otozamites, Taeniopteris*). This plant assemblage is similar to the Norian-Rhaetian floras of Western Europe and Greenland on one hand and to Viet Nam, Japan and Primorye on the other. The most similar are the Norian-Rhaetian floras of Iran and the Pamirs which one to be discussed later. The very special genus *Hyrcanopteris* is known in Zakavkazye, Iran, Pamirs and Viet Nam.

The **Shemshak plant assemblage** (list 47 – flora from the lower part of coal-bearing deposits of Elburz: flora "A" of BARNARD, flora of basal member of KILPPER, the "first flora" of SADOVNIKOV). The new findings of SADOVNIKOV (1977) essentially enriched the list of the Triassic plants of the Elburz. The following typical Triassic forms belong to his "first flora":

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The **sphenopsids** in the Triassic Elburz floras are represented by genera *Equisetites* and *Neocalamites, N. hoerensis* being one of the most widespread species. The **ferns** are mainly the Dipteridaceae and Osmundaceae and also *Phlebopteris*. Endemic *Thainguynopteris pamirica* is one of dominant species. The presence of great number of the **pteridosperms** was shown by recent investigations of KILPPER and SADOVNIKOV. The **cycadophytes** are varied but not numerous. There are plenty only of *Taeniopteris*. The ginkgophytes are few: *Baiera muensteriana*. Maybe plants determined as *Yuccites uralensis* and *Y. vogesiacus* also belong to this group. The **conifers** are numerous *Podozamites,* especially *P. rigidus* and *Cycadocarpidium: C. erdmannii* and *C. swabii.*

SADOVNIKOV (1977) distinguishes three plant assemblages within his "first flora": 1) beds with *Podozamites rigidus* including also great number of *Neocalamites hoerensis* and *Thainguynopteris pamirica* (lower), 2) beds with *Hyrcanopteris leclerei,* 3) beds with *Pterophyllum bavieri* (upper). This author emphasises the similarity of the "first flora" of Iran and the flora of Northern Viet Nam and the similar sequence of the plant assemblages in two regions. He considers the lower "beds with *Podozamites rigidus*" to be an equivalent to horsetail and fern horizons of Viet Nam and two upper assemblages from Iran to be equivalents to cycadophyte and *Nilssonia* horizons from Viet Nam. He accepts the Rhaetian age for the "first flora" and Lower Liassic age for the "second flora" of Iran.

The plant assemblages of the Kerman Basin (Central Iran, Dahrud and Toghrajeh formations – list 48) are similar to the Elburz floras, but their description is not published, only several specimens were figured (POLIANSKY et al., 1974; SCHWEITZER, 1978). The sphenopsids are represented by *Neocalamites* and *Schizoneura*. Among ferns *Danaeopsis* and species of the Osmundaceae are present, the Dipteridaceae is represented by numerous and varied forms, the same as in the Elburz flora. The pteridosperms are *Scytophyllum* – and *Lepidopteris*. The cycadophytes are numerous and varied. The ginkgophytes are few, only *Yuccites* is given, but the systematic position of this plant is not clear. The conifers are represented by *Podozamites* and *Cycadocarpidium*.

STANISLAVSKY (1976) declares the similarity of three-seed *Cycadocarpidium* of Garazhovka and Nikolayevka (the Donbass), considering three-seed *Cycadocarpidium* typical for the pre-Rhaetian time only.

The floras of the Elburz and the Kerman Basin are very similar to standard Norian-Rhaetian floras by their composition as well as by the relationships of main plant groups in them. They also include some Liassic forms. The presence of peltasperms *Scytophyllum* and three-seed *Cycadocarpidium* seems to prove their Triassic age. As it was shown above, the presence of some "Liassic" forms is typical for the Norian-Rhaetian floras of Eurasia ("mixed" floras). They contain species of both *Lepidopteris* and *Thaumatopteris* zones of Greenland and Western Europe. The younger floras of Iran which are considered to be Jurassic in age contain common species only with the *Thaumatopteris* zone.

The plant assemblages of the Central Pamirs and Northern Afghanistan (lists 48, 49) occur in coeval sediments of the same structural zone and are represented by the same forms, the Afghanistan assemblage being poorer.

The most of plants are cycadophytes (70%), mainly *Pterophyllum* and *Nilssonia*. The second place (13%) belongs to large linear leaves with dense nervation which were determined by PRYNADA (1933) and SIXTEL (1960) as *Yuccites*. The ferns (8%), sphenopsids (4%), conifers (4%) and pteridosperms (1%) are not numerous.

The sphenopsids are usually represented by core casts of poor preservation and are identified as *Equisetites arenaceus* and *Neocalamites* sp. The Dipteridaceae dominates among the ferns, especially at the Bartang River, where *Thaumatopteris schenkii* were determined by PRYNADA. *Clathropteris meniscoides* with its large leaf and regular large-meshed nervation is very similar to the same species from Sweden. *Oligocarpia* identified by PRYNADA needs an additional investigation. PRYNADA also mentioned *Phlebopteris* and SIXTEL mentioned *Danaeopsis fecunda*.

The pteridosperms are represented by few *Scytophyllum pamiricum* and badly preseverd *Lepidopteris*. A new *Scytophyllum pamiricum* (determination of the author) was found by POLYANSKY together with *Sagenopteris* in the sediments 300 m above the base of Kokuybelsu Formation (Vomara Formation).

The cycadophytes are mainly *Pterophyllum*, and the majority of *Pterophyllum* are leaves with narrow segments. PRYNADA called them *P. pschartense*. BARNARD (1970) put this name in synonimy of *P. filicoides* after he studied two imprints from Afghanistan identical with those from the Pamirs. He also put in synonimy of the last species *P. longifolium*, *P. brevipenne* and *P. jaegeri* from the Middle Keuper of Western Europe. It shows a great similarity of this *Pterophyllum* from the Pamirs with those from the Middle Keuper.

HARRIS (1932) insisted – and he was right – that the reliable species determinations of *Pterophyllum* are impossible without epidermic investigations. Because *Pterophyllum* from the Pamirs does not have cuticules it is necessary to preserve for them the name given by PRYNADA in spite of great similarity with european plants. Moreover, I think that besides 50 specimens which PRYNADA included in *P. pschartense* some other imprints of *Pterophyllum* from the Pamirs should be also included in this species. They are leaves determinated by PRYNADA as *P. aequale*, *P. andreanum*, *P. propinguum*, *P. sassykense*, *P. angustifolium*. If we analyze this kind of leaves from the Pamirs, we can see that *P. pschartense* differs from *P. filicoides* by the presence of leaves with a higher ratio of length to width.

Pterophyllum from the Pamirs with wide segments were included by me in the species *P. braunsii* known in the Rhaetian and Liassic sediments of the Germain Basin. The most similar with the Pamirs composition and variety of *Pterophyllum* leaves is in the Lower Jurassic of Hor in Sweden. The species *P. bavieri* is the common species with the flora of Iran and Northern Viet Nam.

Folded *Nilssonia* of the *N. brevis* group is a very peculiar group of cycadophytes in the Pamirs. BARNARD (1970) considered this plant to be a species of *Taeniopteris* – *T. pseudobrevis* according to one specimen from Afghanistan which he had. Big collection of such leaves from the Pamirs shows that they are really *Nilssonia*. Maybe BARNARD had in his one specimen lower side of a leaf. CORSIN (CORSIN & STAMPFLI, 1977) came to the same conclusion and put BARNARD's specimen in the synonimy of *Nilssonis pseudobrevis*. The species *Nilssonia brevis* was known from the Jurassic sediments but similar forms are found in the Triassic of Northern Viet Nam *(Taeniopteris nilssonioides)* and Southern China *(Taeniopteris leclerei)*. SADOVNIKOV considers the last one to be a species of the genus *Hyrcanopteris* – *H. leclerei*. The genus *Hyrcanopteris* with folded leaves is known from the Triassic of Zakavkazye and the Pamirs. The genus *Tanymasia* from the Pamirs also belongs to the group of folded cycadophytes.

It is worth mentioning in the Pamirs flora *Taeniopteris* with large leaves *(Macrotaeniopteris ?)* and several *Otozamites* similar to the Jurassic ones.

The ginkgophytes are completely absent in the Pamirs, if the leaves determined as *Yuccites* are not of that group. Leaves from the Pamirs look very similar to *Yuccites vogesiacus* in shape and size but there are differences. Pamirs leaves are narrowing to the base, their texture is different, their consistence is finer, their nervation is thinner and denser. The widest leaf measured by me in the Kokuybelsu outcrop was 19 sm wide and 40 sm of incomplete length. It was characterized by a very dense nervation. So, the attribution of these leaves to *Yuccites* is rather questionable. Rare conifers are represented by *Podozamites lanceolatus, Pagiophyllum* and *Brachyphyllum.*

The Pamirs flora is similar to floras of Iran and Zakavkazye as well as to the flora of Viet Nam. The Pamirs flora seems to correspond to the "beds with *Pterophyllum bavieri*" in Elburz and "cycadophyte and *Nilssonia* horizons" in Northern Viet Nam. Assemblages similar to younger Lower Jurassic assemblages of Iran and Viet Nam are present in the Pamirs but they cannot be separated. Probably, the lower part of the Lower Kokuybelsu Formation (Lower Vomara Formation) corresponds to the uppermost part of sediments with flora "A" of BARNARD and "first flora" of SADOVNIKOV in part of the Lower Kokuybelsu Formation (Lower Vomara Formation) corresponds to the uppermost part of sediments with flora "A" of BARNARD and "first flora" of SADOVNIKOV in Iran. The upper part of the Lower Kokuybelsu Formation together with the Upper Kokuybelsu Formation probably corresponds to the sediments with "B" flora of BARNARD and "second flora" of SADOVNIKOV.

The Aktash, Turakavak and Tologoy floras (the plant assemblages of the lower part of the coal-bearing formations of the Issyk-Kul, Son-Kul and Kenderlyk depressions – lists 56, 57, 58). Among the sphenopsids *Neocalamites* is found in all three depressions. The most part of ferns is the Dipteridaceae in Aktash and Turakavak depressions, while in the northern Tologoy depression the Dipteridaceae is absent and the ferns are represented by a single poorly preserved species. The Marattiaceae few in number is known only in the Tologoy Depression. Also the pteridosperms are found only in the Tologoy Depression and the cycadophytes only in the Turakavak Depression (except a single species of *Taeniopteris* in the Kenderlyk Depression. The ginkgophytes mainly Czekanowskiales are known in the Aktash and Tologoy Depressions. As for the Turakavak Depression only the remains of *Yuccites* may be considered as ginkgophytes but the absence of cuticle leaves this question unsolved. The conifers are most numerous and varied in the Aktash Depression but *Podozamites* and *Cycadocarpidium* also present in other two depressions.

The difference between the Tologoy assemblage on one hand and Aktash and Turakavak on the other is the absence of the Dipteridaceae and cycadophytes in the northern depression. It can be explained by the geographical reasons. The difference between the Turakavak (absence of ginkgophytes) and Issyk-Kul (absence of cycadophytes) assemblages is due to the facies differences. The coal-bearing facies of the Turakavak Formation include cycadophytes and *Yuccites* and no ginkgophytes. The coalless sediments of the Aktash Formation contain ginkgophytes, varied conifers and do not have cycadophytes.

The composition of ferns, cycadophytes and gingkophytes (czekanowskias are at the first place), absence or small number of pteridosperms, abundance of of *Podozamites* and *Cycadocarpidium* differ these floras from Ladinian-Karnian floras of adjacent regions (Madygen, Kamyshbashi, Ketmen). They are similar to Norian-Rhatian floras of Europe, the Donbass, Iran, Afghanistan, the Pamirs, Viet Nam, Japan and Primorye.

The floras of Southern China (list 68) were partly described by ZEILLER (1902–1903) while describing Norian-Rhaetian floras of Northern Viet Nam, which is very similar. During last decade many new papers on Chinese Triassic floras appeared but it is very difficult to deal with them. KIMURA (1985, 1987) gave a short review of these floras.

The sphenopsids here are rare and nearly the same as in the Yenchang flora, whereas the varied ferns differ a great deal. The Dipteridaceae are in the first place, the genus *Cladophlebis* follows it, after them are genus *Rhinipteris* and numerous endemic genera. The quantative relationships are unclear. The pteridosperms are *Pachypteris, "Thinnfeldia", Lepidopteris, Ctenozamites, Sagenopteris.* Cycadophytes are numerous and varied: *Pterophyllum, Anomozamites, Sphenozamites, Otozamites, Ctenis, Ptilophyllum, Taeniopteris.* The ginkgophytes are hardly mentioned: *Phoenicopsis* in one locality and *Sphenobaiera* in another. The conifers are represented by *Podozamites* as well as by *Taxites latior* and *Araucarites prodromus* (determinations of SCHENK).

The age of these floras is Norian-Rhaetian due to the abundance and composition of the Dipteridaceae and cycadophytes.

All the Norian-Rhaetian floras all over Eurasia are very similar and some regularities in their composition can be traced. From the north to the south the number of ginkgos and czekanowskias decreases and the number of the Dipteridaceae and cycadophytes increases. Number of Ginkgoales and Czekanowskiales changes also from the west to the east. Maximum of them is in the central part of Eurasia, being less westward and eastward. The number of "Liassic elements" increases from the west to the east.

The similar character of all Norian-Rhaetian assemblages in Eurasia permits to consider them a single large flora. I suggest to name it *Lepidopteris* flora using the term of HARRIS for floras of Greenland and Western Europe. I suggest to use this term also more widely, for all floras of this stage all over Eurasia. Even for those of them in which *Lepidopteris* still is not found. I see that such extension of the term undoubtly suffers from shortcomings. Nevertheless the introduction of the new term for this purpose is even less desirable.

Chapter eleven

Taxonomic review of the Eurasian Triassic floras

The co-existence of Palaeophytic and Mesophytic plant groups is the most characteristic feature of the Eurasian Triassic floras. There occur, also, certain plants that existed only in this period or reached then their greatest abundance. Pteridopsperms, conifers of the family Voltziaceae, and certain sphenopsids and ferns are the Palaeophytic representatives. Cycads, bennettites, Czekanowiskiales, Ginkgoaceae, and ferns of the family Dipteridaceae are the Mesophytic representatives. Lycopsids of the family Pleuromeiaceae, Equisetaceae, pteridosperms of the family Peltaspermaceae, and early ginkgos of the family Glossophyllaceae are specifically Triassic plants. The mutual relations of these groups are constantly changing during the Triassic Period.

During the first half of the Triassic the conifers and ferns, as well as pteridosperms and sphenopsids, were most abundant. Lycopods represented by the genera *Pleuromeia* and *Tomiostrobus* were present in some specific localities. In the Ladinian-Karnian floras the sphenopsids and pteridosperms gained the highest prominence (in the central part of Eurasia). Cycadophytes were abundant only in Western Europe, in the Semeytau mountains and in the Southern Primorye (*Taeniopteris,* only in the last mentioned region). A significant proportion of the leaves similar to those of the ginkgophytes' of Pechora and Madygen, seem to relate to the pteridosperms. Conifers are abundant only in the Donbass. The cycadophytes and ferns become prominent in the Norian-Rhaetian floras, while the pteridosperms become insignificant.

The lower plants attain marked importance only in the Middle Triassic sediments of the Tethys, where Algae (mainly whorled syphonacious forms) are the rockbuilding organisms. Fungi, on the leaves of higher plants, have been found in the Basel area *(Birsiomiccs pterophyllii),* in the Vosges, the Donbass and Ilek River *(Xylomites).*

Musci

The musci are insufficiently known in Triassic sediments in spite of their abundance in the Permian and Jurassic. In the Rhaetian sediments of England the liverwort *Naiadita lanceolata* was found – both sterile and fertile parts have been examined. *Thallites,* related to the liverworts are described as *Hepaticites* (Rhaetian in England), *Thallites* (Donbass, Eastern Urals, Kenderlyk, Primorye), and *Muscites* (Eastern Urals).

Lycopods

The lycopods ceased playing the important role in the vegetation of the Earth that they had in Carboniferous and Lower Permian times by the beginning of the Mesozoic Eras. Their numbers had decreased already in the Late Permian. Only some sporadical finds of herbal plants similar to present plants are known in post-Triassic times. It appears that the last time in the Earth's history that the lycopods were of considerable importance was during the Early Triassic. *Pleuromeia,* only 1–2 meters high, occupied vast coastal territories and the banks of salty lakes, especially in the South of Eurasia, from the Rhine to Japan (fig. 52), as well as along the northern coast of Eurasia at the Olenek River. Recently synthesized data show a wide distribution of the genus in the southern hemisphere as well (RETALLACK, 1975). The genus appeared in the beginning of the Early Triassic; its heyday was in the Olenek and Anisian. Described species include: *Pleuromeia rossica* (Upper Volga), *P. sternbergii* (German Basin, Alps, Caucasus, Prikaspiy, Mangyshlak), *P. jokunzhica* (Darvaz), *P. obrutschevii* (Primorye), *P. olenekensis* (Northern Siberia), *P. taymyrica* and *Pleuromeia* sp. (Taymyr and Olenek coast), *P. sternbergii, P. rossica* and four new species (China), *P. hataii* (Japan). In recent years it has been shown that *Tomiostrobus radiatus* and *Araucarites* from the Kuznetsk Basin and *Tomiostrobus* and *Pseudoaraucarites* from the Pechora Basin, Southern Priuralye, Novaya Zemlya, Taymyr Prianabarye, Olenek coast, Verkhoyanye, Vilyny synclise (MEYEN, 1981; SADOVNIKOV, 1981; DOBRUSKINA, 1985), as well as *Annalepsis* from the Vosges (GRAUVOGEL-STAMM, 1983) and China (WANG L. X., 1978) are lycopods and belong to the Pleuromeiaceae.

The *Selaginellites polaris* strobilus, considered to be related to the genus *Pleuromeia* (RETALLACK, 1975), was discovered in the Lower Triassic sediments of Greenland. Trunks casts with leaf scars (*Lepidodendrites, Lesangeana, Caulopteris* etc.) were found in the Lower Triassic sediments of the German Basin. Strobili from the same beds were considered as belonging to descendants, or related forms, of Palaeozoic lepidodendrons. But a recent study of *Lepidostrobus palaeotriassicus* attributes this plant to the conifers and the systematic position of the isolated trunks is unclear (GRAUVOGEL-STAMM, 1978).

Some roots of poorly preserved lycopod (?) *Bedheimia* were found in the Ladinian sediments of Thüringia. Approximately at the same time *Ferganodendron,* with large trunks 20–30 cm in diameter, existed in Southern Fergana (DOBRUSKINA, 1974). A spiral disposition of the leaf cushion and long narrow leaves with a single central vein show this genus to be a lycopod. Roots and fertile parts are unknown, so it is difficult to trace relationships with more ancient lycopods. *Ferganodendron* differs from *Pleuromeia* in the size, density and arrangement of the leaf scars and in the larger size of the plant.

From the Norian-Rhaetian interval only the genera *Lycopodites* and *Selaginella,* from southern Sweden, are known.

Sphenopsids

The sphenopsids of the Triassic sediments of Eurasia are numerous, but comparatively monotonous. Excluding the Korvunchana flora, the number of genera is limited: *Equisetites* (or *Equisetum*), *Neocalamites, Schizoneura, Lobatannularia, Annulariopsis* (the two latter being the less common). The fructifications *Equisetostachys* and *Neocalamostachys* associated with the first two genera. The fructification of *Aethophyllum* was for long associated with *Schizoneura paradoxa,* but recently GRAUVOGEL & GRAUVOGEL-STAMM (1975) and GRAUVOGEL-STAMM (1978) proved them to be coniferalian. It is the view of HARRIS (1931) that *Equisetites,* all morphological features considered, should be referred to the genus *Equisetum.*

The distinguishing of the genera *Neocalamites, Schizoneura, Lobatannularia* and *Phyllotheca* is artificial (HARRIS, 1931), *Neocalamites* is characterized by thick stems with thin leaf-bearing branches; its leaves are longer than the internodes and are free to the base. *Schizoneura* has a thin stem; its leaves are also longer than the internodes, but they are divided in two groups of fused leaves. *Phyllotheca* is notable for its thin stem; the leaves are shorter than the internodes and fuse proximally to form a collar which envelopes the trunk. The anisophylly is a characteristic feature of the genus *Lobatannularia.* Some plants exhibit the features of different genera. *Neocalamites carcinoides* from Greenland for instance, has free leaves, separating into two groups; the leaves being in one whole are of different length. For this reason some paleobotanists relate these species, well developed in Eurasia, to different genera *(Neocalamites, Lobatannularia, Neokoretrophyllites).* In this case it can scarcely be determined which features are more important and identification remains a formal issue.

In the Western European floras of the first half of the Triassic three species of *Equisetum (E. mougeotii, E. brongniartii* and *E. arenaceum)* are known together with a great quantity of indeterminable sphenopsid stems. The former two species existed only in the first half of the Triassic whilst the latter is widely developed in the second half beginning in the Ladinian. *Schizoneura paradoxa,* unknown outside the German Basin, was characteristic only in the first half of the Triassic. On the whole, the sphenopsids of the earlier and latter halves of the Triassic in Western Europe are very similar.

Only in the Lower Triassic of the Tunguska and Kuznetsk Basins are the sphenopsid genera different from elsewhere in Eurasia. The majority of the sphenopsids of the Korvunchana flora are attributed to Palaeozoic genera such as *Trizygia, Sphenophyllum, Gamophyllites* and *Tschernovia.* Some remains considered to belong to the genus *Paracalamites,* as well as *Prynadaia* and *Phyllo-*

theca (one imprint each), are of poor preservation and do not add much to the characteristics of the group. *Equisetes* and *Schizoneura* are absent from the Korvunchana flora.

Among the Indian sphenopsids. *Schizoneura gondwanensis* is a common Gondwana form, unknown outside the region. *Neocalamites foxii* is indeterminable according to evidence cited by Bose (1974). It consists of sphenopsid stem without any specific features. Thus for the sphenopsids in the first half of the Triassic the following regions can be distinguished: the Siberian palaeofloristic area, the European-Sinian area and the Gondwana kingdom; the first two being united in the Laurasian kingdom.

Most important are the spenopsids in the Ladinian-Karnian floras. An abundance of representatives of this plant group prompted the name Schilfsandstein for one of the stratigraphic divisions in the German Basin. Besides determinable remains a great amount of indeterminate stems, which suffered long distance transportation, are often met. The Ladinian-Karnian sphenopsids in Western Europe are represented exclusively by the genera *Equisetites* and *Neocalamites*. The floral difference between the Lettenkohle and Schilfsandstein exists only in the relative abundance of the fossil remains (the species present are the same). The Equisetales remain unkown in the Semionotus Sandstein.

The lower of the three plant assemblages in the coal-bearing beds of the Chelyabinsk Basin was named the Horsetail Assemblage by Kirichkova (1969) due to an especially great volume of this plant group. In the upper horizons the influence of this group is less. *Neocalamites* (with a terminal strobilus described by Vladimirovich, 1958 a), *Annulariopsis* and *Schizoneura* are prevalent here. Considering the species diversity within the sphenopsids, the plant assemblages in Bulanash-Elkino Depression are similar to the Horsetail Assemblage of the Chalyabinsk Basin.

The Equisetales in Japan are especially variable: European as well as Priuralye and Middle Asian species occur. The presence of *Neocalamites rugosus* in the majority of Southern Priuralye, Ketmen and North China localities is of interest. In Southern Priuralye it was groundlessly described as a new species *(N. squamulosus)*. Large accumulations of Equisetales remains of excellent preservation *(Equisetites arenaceus)* are characteristic in the Ilek River and Lysovo farm. The same can be said of various species of *Neocalamites* with associated strobili in Madygen, North China and Japan. The presence of *Schizoneura gondwanensis* in these sediments cannot be taken as proved, for only some poorly preserved remains were attributed to this species (Feistmantel, 1880–1881, Banerji & Bose 1975, 1977). Similar remains from the Madygen Formation are attributed to *Neocalamites hoerensis;* as are the majority of Madygen sphenopsids. The different parts of this plant are represented by a huge number of imprints – mostly gathered by A. G. Sharov in one layer (Northern area of Madygen). These imprints give a good idea of the plants appearance and make it possible to assemble the isolated imprints from the other outcrops of the Madygen Formation.

Neocalamites hoerensis is abundant also in the coeval sediments of Primorye, where other sphenopsids are absent. At the same time a variety of species of *Neocalamites, Equisetites, Annulariopsis* and their fructifications is again observed in Japan, Thailand and Indonesia. These can be compared only with species from North China and Western Europe.

The sphenopsids of Ladinian-Karnian times thus seem to be very similar all over Eurasia. It should be noticed that they are plentiful both in the northern (Chelyabinsk Basin) as well as in the southern zone (Western Europe, North China, Japan, Thailand, Sarawak). They are less plentiful and varied in the middle zone (Southern Priuralye, Madygen, Ketmen, Mongolia, Primorye).

The diversity and relative abundance of the sphenopsids decreased in Norian-Rhaetian times. The same species of *Neocalamites,* and *Annulariopsis (A. inopinata)* as well as some other species of Equisetales, known in the Ladinian-Karnian flora are found in Greenland, Sweden, Germany, Japan and Viet Nam. Similar but less varied material generally of poor preservation, occurs in Middle Asia and in South-Western Asia.

Ferns

The ferns were significant in the vegetation of Eurasia throughout the Triassic. It is possible, though, that their species diversity is to some extent exaggerated due to morphological variation and the fragmentary nature of the findings. The typical picture of the Triassic Period – the co-existance of Palaeozoic and Mesozoic families – is markedly noticeable for this group of plants. Palaeophytic forms prevail in the first half of the Triassic, whilst the development of the Mesophytic families (Dipteriaceae, Osmundaceae, Matoniaceae) began in the Middle Norian. The earliest representatives of the three families just mentioned appeared already in the Permian or in the beginning of the Triassic, flourished in the Jurassic and have survived up to the present in the tropics and subtropics. The Marattiaceae were important in the Middle Triassic although they were particularly abundant and characteristic of the later Palaeozoic.

The ferns are extremely important in the Korvunchana flora (more than 60%). As with all other Korvunchana plants, there is not a single species in common with the ferns from the underlying coal-bearing sediments of the Tunguska Basin. The Korvunchana ferns are very peculiar and most of them represent new genera. Sadovnikov (1965) relates some of them to Permian and Carboniferous genera (*Lobatopteris* for instance) and others to genera and species established in the Upper Triassic of North America and China *(Acrostichides, Mertensides, Cladophlebis shensiensis)*. Stur (1885) and Krasser (1909 a) have synonymised the genera *Acrostichides* and *Mertensides* with the European genera *Speirocarpus* and *Oligocarpia* respectively. They related them to the family Marattiaceae, mostly developed in the Palaeozoic. But neither the European, Virginian or Tunguska ferns are thoroughly enough studied to be reliably compared. The Korvunchana ferns have a lot of features in common with the

Palaeozoic (Permian, and even Carboniferous) ferns of the Euramerian and Cathaysian areas, especially with those from the *Lobatopteris* group. This resemblance seems to be more significant than with some imprints from Yenchang and Newark formations.

Probably the reason PRYNADA (inpublished reports 1930's, 40's) considered the Korvunchana flora to be of Triassic age was the presence of a great abundance of ferns (generally considered to suggest the Mesozoic character of a flora). The existance of an enormous quantity of cordaites (to 90%) is typical of the Permian & Carboniferous floras of the Angara (Siberia) palaeoflora. The minor fern element is usually lost among them. On the contrary the ferns are very characteristic of the Jurassic and Cretaceous floras of that region. The sudden disappearance of *Cordaites,* the presence of which is indispensable in suggesting Palaeophytic features of the Angara flora (*Cordaites*-like leaves related to the genus *Glossophyllum* are a minor element). The equally sudden appearance, in the place of *Cordaites,* of an enormous quantity of ferns (many belonging to the form-genus *Cladophlebis*) which since the early literature was connected with the concept of the Mesozoic floras of Siberia. These are the grounds on which the idea of the Mesophytic features of the Korvunchana flora was based – irrespective of the study of ferns systematics. It should be added that previously no clear view of the characteristic features of the Triassic floras was available and somehow the significance of the ferns in the Palaeophytic floras in the Euramerican and Cathaysian area was lost sight of.

We might ask which ferns of the Korvunchana flora may, in fact, be considered Mesophytic? The Osmundaceae *(Todites)*, Matoniaceae and Schizeaceae (if the genus *Schvedopteris* is really of this family) and also sterile leaves related to the genus *Cladophlebis* may apparently be noted. This latter genus usually is considered to show Mesozoic affinities whilst *Pecopteris* suggests Palaeozoic affinities. The representatives of the genus *Acrocarpus* and of the endemic genus *Elegenopteris* are also comparable with Mesozoic ferns, but ferns with Palaeozoic affinities are nevertheless predominant. These include leaves referred to as *Katasiopteris* or *Lobatopteris* (DURANTE & BITERMAN, 1978), *Lobifolia, Korvunchania, Prynadaeoopteris, Pecopteris* and at least some of *Kchonomakidium* (or *Acrostichides* sensu SADOVNIKOV 1965). It seems incorrect to identify the Tunguska ferns with *Cladophlebis schensiensis* from Yenchang (SADOVNIKOV included them in the genus *Acrostichides*) as the Yenchang leaves clearly exhibit a different range of variation. The similarity of the Korvunchana ferns to the American *Mertensides* also seems questionable.

There is nothing in common between the ferns of the Tunguska Basin and those of synchronous sediments in Western Europe (Buntsandstein) in which *Anomopteris mougeotii* and *Pecopteris sulziana* (with very small pinnules) are the most abundant and second most abundant species respectively. Three species of *Cladophlebis* are less characteristic. (It is possible that certain species of *Neuropteridium* should be referred to the ferns). Many worn transported stems, some probably of fern origin, occur in the Buntsandstein suggesting conditions of sedimentation unsuitable for the preservation of fern foliage.

From India (Parsora Formation) there have been described only a few (10) indeterminate fern imprints. The group is as yet unknown from the Nidpur locality.

In the Ladinian floras of Western Europe (Lettenkohle) the ferns are quite archaic. Included are *Anomopteris mougeotii*, *Pecopteris*, *Anotopteris* and *Cladophlobis gaillardotii*. In contrast to the *Voltzia*-flora, the Marattiaceae *(Asterotheca, Bernoullia, Danaeopsis)* are abundant. The same can be said of a very distinctive *Chiropteris* fern with anastomosing venation. In the Karnian floras of the same region archaic forms make up more than one third of all ferns. The Marattiaceae are practically the same as in the Lettenkohle. The Dipteridaceae and Matoniaceae appear for the first time in this flora.

In the Norian-Rhaetian floras there occur no archaic forms and few Marattiaceae. The Dipteridaceae (species distinct from earlier strata), Matoniaceae and Osmundaceae are prominent and various *Cladophlebis* appear.

The Marattiaceae are widely developed in the Ladinian-Karnian floras of Eurasia: German Basin, Alps, Svalbard, Pechora syneclise, Northern and Southern Priuralye, Eastern Predkavkazye, Middle Asia (Madygen, Kamyshbashi, Ketmen), North China, Mongolia, Primorye, Japan, Thailand and Sarawak and the family remains unkown in the Eastern Urals. Only one finding from Verkhoyanye (Aldan River) has been described. Isolated findings are also known in the Norian-Rhaetian floras of Viet Nam and South China, as well as of Greenland.

The relationships between the European *Bernoullia* and plants of the same genus from other Eurasia areas remain unclear. The type material was illustrated only by drawings with indistinct venation in the original publication (Heer, 1877) and has not been studied since. Both sporophylls and sterile leaves of the type material have petioles, but in Priuralye, Middle Asia, China and Mongolia the material referred to this genus shows decurrent and upcurrent pinnae. The venation of the sterile leaves is far more complex than in the type material from Switzerland and is similar to the *Lobapteris*-like venation of the Palaeozoic ferns and also of the Korvunchana *Katasiopteris*. This type of venation is also characteristic of the sterile leaves from the Ilek River Basin which were related to *Danaeopsis bipinnata* and *D. angustipinnata*. I agree with Sze (1956) that they are to be considered *Bernoullia* (fertile leaves are really related to *Danaeopsis*, as it was supposed by Sze). The type of venation also seems to show the relationship of *Thinnfeldia rigida* and *T.? alethopteroides* (North China) to the same genus *(Bernoullia)*. The former is very close to *Danaeopsis bipinnata*, from the Ilek River, which was related to the genus *Bernoullia* by Sze. It is possible that the leaf from the Yenchang Formation identified as *Phlebopteris ? linearifolia* also belongs to genus *Bernoullia*.

Thus *Bernoullia* of North China is represented by three species: *B. zeilleri* with non-decurrent pinnae with entire margins; *B. rigida* with larger decurrent pinnae, with slightly wavy margins and dense nervation; and *B. linearifolia,* with long narrow pinnae with entire margins and simpler nervation. It is interesting to note that the same three types of sterile leaves are found in the Kurashasay Formation of the Ilek River and also at the Khey-Yaga river in North

Priuralye. Fertile leaves from Western Verkhoyanye (Tumara River, a tributary of the Aldan River) and Mongolia are identical to those found in Priuralye and China. Some spores were extracted from fern sporangia from the Bukobay Formation of the Ilek River (BRICK ET AL., 1955). These spores are very similar to those extracted by NEUBURG from a sporangium of the same species from the Pechora Basin. Spores have also been studied from the genera *Asterotheca* and *Danaeopsis*. Some spores from the sporangia of *Asterotheca merianii* from the Pechora Basin were extracted by NAUMOVA (NEUBURG, 1959) and PAVLOV (CHRAMOVA & PAVLOV, 1971). The latter have also studied *Asterotheca* spores from Svalbard.

Danaeopsis fecunda and *D. marantacea* differ mainly in the size of the spores and sporangia. If data on spores and sporangia are absent the sterile leaves can only be uncertainly identified. To date, in-situ spores have been studied for *Danaeopsis* from South Priuralye (BRICK ET AL, 1955) and from the Pechora Basin (CHRAMOVA & PAVLOV, 1971). It appears possible to extract spores from the sporangia of *Danaeopsis* and *Asterotheca* from Eastern Predkavkazye.

KRASSER (1909 a) considered *Oligocarpia* and *Speirocarpus* from the Alpine Karnian sediments to belong to the Marattiaceae. In the synonymy of the former he included *Mertensides;* and in the synonymy of the latter he included *Acrostichides*. Taking into consideration the ideas of KRASSER it is interesting to investigate the systematic relationships of Korvunchana ferns in connection with the above mentioned American genera.

Maratticceae of the Norian-Rhaetian sediments have one or two representatives in almost every flora. They include *Rhinipteris concinna* (with similar sporophyll structure to *Bernoullia*) from Greenland; *Marattiopsis* and *Danaeopsis fecunda* from Sweden; *Bernoullia wahneri* from the Elburz; *Danaeopsis fecunda* from Kerman, the Pamirs and Kavak-Tau; *Rhinipteris concinna, Danaeopsis fecunda* and *Asterotheca? cottonii* from Southern China; *and A.? cottonii* and *Bernoullia* from Viet Nam.

A complete absence of this family in the Eastern Urals should be mentioned. At the same time it is widely evident along its western slope and also further to the north.

The Dipteriaceae are noted for the first time in the geological records from the Ladinian sediments of Japan (*Dictiophyllum falcatum* from Asa, Yamaguti Prefecture). They form not less than half of all the ferns in the Karnian sediments of Japan, Thailand and Sarawak. Their presence was proved recently by SHOROKHOVA (1975 b) in the Karnian sediments of Primorye. In Western Europe the Dipteriaceae first appeared in the Karnian sediments (they are absent in the Ladinian) – in small number and with notably small leaves. They are represented by six species in the genera *Clathropteris, Camptopteris, Dictyophyllum* and *Thaumatopteris* in the Schilfsandstein and Lunz Sandstones. They are common in the Svalbard sediments of the same age and are mentioned in the Protopivka Formation of the Donbass.

The Dipteridaceae are practically absent in the Priuralye (one doubtful specimen is noted by CHRAMOVA and PAVLOV (1971) and in the Eastern Urals (with only one species, *Dictyophyllum japonicum,* in the uppermost horizon coal-bearing strata). They are entirely absent in Siberia, and are unknown from the Ladinian-Karnian floras of Middle Asia, Mongolia and Northern China. Floras without Dipteridaceae are most likely Ladinian while those with Dipteridaceae are good indicators of the Karnian. This point of view on the age of the floras of the Ilek River and Northern China was previously expected by SIXTEL. We can now add to these two floras those of Middle Asia and Mongolia.

The Dipteridaceae were widely spread in Norian-Rhaetian times. The diversity of species in Europe and Greenland was larger than in the Ladinian-Karnian floras, but they were of different species with larger leaves and were relatively more numerous. There are many Dipteridaceae in the Novorayskoye Formation of the Donbass, in Eastern Predkavkazye, Middle Asia (Issyk-Kul and Kavak-Tau), Iran and especially in the Amba Formation of Primorye, Nariwa Formation in Japan, Viet Nam and Southern China.

In India the Dipteridaceae are unknown.

The Matoniaceae are represented by the genus *Phlebopteris* which was singled out already in the Korvunchana flora. A single species *(Laccopteris lunzensis)* was identified in the Karnian sediments of the Alps. The genus *Phlebopteris*first appears in the Norian-Rhaetian where it was widely developed (*P. angustiloba, P. polypodioides* in Sweden and Greenland, *P. muensteri* et al, in Iran, Afghanistan and in the Pamirs). This development continued into the Jurassic.

The Osmundaceae are represented by *Todites, Osmundopsis* and possibly by numerous *Cladophlebis,* but this is not as yet clear. The number of Osmundaceae found in Triassic floras increases with the degree of thorough study. Osmundaceae are known in all Triassic floras, beginning with the Korvunchana flora, and also in the Jurassic floras. Spores from *Todites* sporangia have been found in samples from the Ilek River Basin (BRICK ET AL., 1955) and the Pechora Basin (CHRAMOVA & PAVLOV, 1971); and the sporophyllys have been studied from Southern Primorye. It is possible that the widely distributed species *Cladophlebis shensiensis* in the Triassic sediments, as well as *C. szeiana,* are representatives of the genus *Todites.* No geographic or stratigraphic patterns in the distribution of this family can be noted.

A great number of sterile fern leaves without any connection to fertile leaves (mainly of the genus *Cladophlebis*) appear, as a rule, in Norian-Rhaetian sediments (Greenland, Sweden) and were specially widely distributed in the Jurassic. The majority are ferns with large pinnae which are scarcely distinguished from one to another due to the presence of the transitional forms. Being morphologically undistinguished, they are, on occasion, linked with fertile remains of different genera and families. It is supposed traditionally that an abundance of *Cladophlebis* gives a Mesophytic appearance to a flora. The Mesophytic *Cladophlebis* are especially numerous on the eastern slopes of the Urals, in Burluk and Turgay, in coal-bearing sections. Strangely, some quite different ferns are present in the coeval Priuralye sediments to the south and in other strata to the north. The picture is similar, no matter what part of the coal-bearing section of the Eastern Urals (Chelyabinsk) is correlated with the plant-bearing sediments of the Pechora Basin and the Ilek River. To consider the full coal-bearing sequence as being younger than the plant-bearing sediments of Priuralye is impossible in view of evidence from other plant groups. The only other possibility is to consider these differences as due to palaeogeographical conditions (the formation of coal-bearing sediments on the eastern slopes of the Urals and sediments without coal in the Pechora Basin) and to the presence of the high Ural Mountains, which were a barrier to the migrations of plants.

Cladophlebis is common also in Primorye, Japan and Viet Nam, beginning in the Karnian, but here it is present together with great quantities of Dipteridaceae and Osmundaceae, which are almost absent in the Eastern Urals. The representatives of the genus *Cladophlebis* in the Yenchang Formation of Northern China differ generally from the common "Jurassic" forms more like those from the Eastern Urals and from Primorye. The latter as a rule have large pinnae. Their venation is more regular with well developed midrib and divergent secondary veins. They dichotomise first near the midrib, then midway to the margin; only those veins near the base of the pinnae dichotomise three times. The venation of *Cladophlebis* from Yenchang is usually less regular; all intermediate transitions from a clearly distinct midrib to no midrib are seen; often catadrome veins emerge from the rachis and the pinnules are shorter and rounded. Both discussed representatives of the described genus are present in the Korvunchana flora.

It is interesting to mention the existence of the peculiar fern *Chiropteris* with anastomosing veins in Western Europe, the Donbass and Madygen. Without dwelling upon the examination of endemic genera of ferns it should be noted only that they are plentiful in Viet Nam and Southern China – which shows the distinctiveness of these floras in Norian-Rhaetian times. It is as well to point out some findings of the extraordinary forms *Acrostichopteris rara* (SHOROKHOVA, 1975 b) in the Southern Primorye and *Adiantopteris ishide* (KON'NO & NAITO 1978) in Japan.

Thus, considering the ferns as well as the sphenopsids three areas are clearly distinguished during the Early Triassic and Anisian interval: Western Europe, Eastern Siberia and India; the latter on the basis of a rather negative characteristic – the absence of ferns.

The most marked feature of fern distribution during the Ladinian-Karnian interval is the absence of the family Dipteridaceae in the intercontinental parts of Eurasia, while their role is great in the western and in the eastern areas of the landmass. This is most likely a reflection of the Ladinian age of the plant-bearing beds of Priuralye, Middle Asia, Mongolia and China and to the absence of Karnian floras there. The second important feature in fern distribution is the great significance of the Marattiaceae in Western Europe, Svalbard, Priuralye, Predkavkazye, Middle Asia, China, Mongolia, while they are completely absent in the Eastern Urals, Taymyr, Primorye, Japan and Indochina. This picture can be explained by the migration of the family from the West of

Eurasia, with some obstacles in its path. One of the obstacles could be the Urals, the other – some mountains in Eastern China.

Dipteridaceae of Ladinian-Karnian age are abundant in the southern zone, less abundant in the middle zone and are practically absent in the northern one.

Pteridosperms

The majority of pteridosperms in the Triassic sediments of Eurasia are representatives of the family Peltaspermaceae; *Lepidopteris, Peltaspermum, Antevsia, Scytophyllum, Vittaephyllum, Madygenia, Madygenopteris, Paratatarina, Maria* (Dobruskina, 1975, 1980). Leaves included in this family cover a wide range of morphology. They are united by association with the reproductive organs *Peltaspermum* and *Antevsia,* and also by very similar epidermal structure. Peltaspermous pteridosperms were widely distributed, especially in Eurasia, where their earliest representatives appear in the Lower Permian (Kungurian) and the latest in the Lower Triassic. In the Tatarian sediments of the Eastern European platform and Priuralye the plant assemblages consist sometimes exclusively of Peltaspermaceae; while in the Korvunchana flora they represent only about 6% of all plants. In the floral associations of the Priuralye, the Donbass Middle Asia and Northern Kazakhstan (Semeytau) in the Ladinian-Karnian floras the peltaspermous pteridosperms account for 20–30% of all fossil plants and in Northern China and Mongolia from 5 to 10%. Peltaspermaceae are absent in Primorye and Japan. Lundblad (1950b) recorded *Lepidopteris* (housed in the Paris Museum) from Tonkin. I have seen and studied these two specimen in Lyon in 1982. Recently Nhat Mai (1985 b) recorded new findings of *Lepidopteris* in Viet Nam.

According to the external appearance of the leaves the following three morphological series of Triassic peltaspermous pteridosperms can be distinguished: *Scytophyllum* series, characterized by fern-like fronds and *Scytophyllum*-type venation (fig. 53–55); *Tatarina-Paratatarina* series, with *Zamiopteris*-like leaves and *Maria* series with *Cordiates*-like leaves (Dobruskina, 1975, 1980).

The *Scytophyllum* series in the Korvunchana flora is represented by the genera *Lepidopteris, Scytophyllum, Madygenia* (one species each) in association with *Peltaspermum*. Representatives of the series are especially abundant in the Ladinian-Karnian floras of the internal areas of the Eurasian continent: the Donbass, Eastern Predkavkazye, Southern and Northern Priuralye, the Eastern Urals, Middle Asia and Kazakhstan. In these regions several species of each of the following genera were found: *Lepidopteris, Scytophyllum, Vittaephyllum, Madygenia, Madygenopteris* (all of which are associated with *Peltaspermum*). *Scytophyllum* and *Uralophyllum* are known in addition from Northern China and Mongolia. Two species of *Scytophyllum* and one species of *Lepidopteris* are known in the West of Eurasia in the Ladinian-Karnian floras; but it is quite possible that there really occur more representatives of the family among Lower

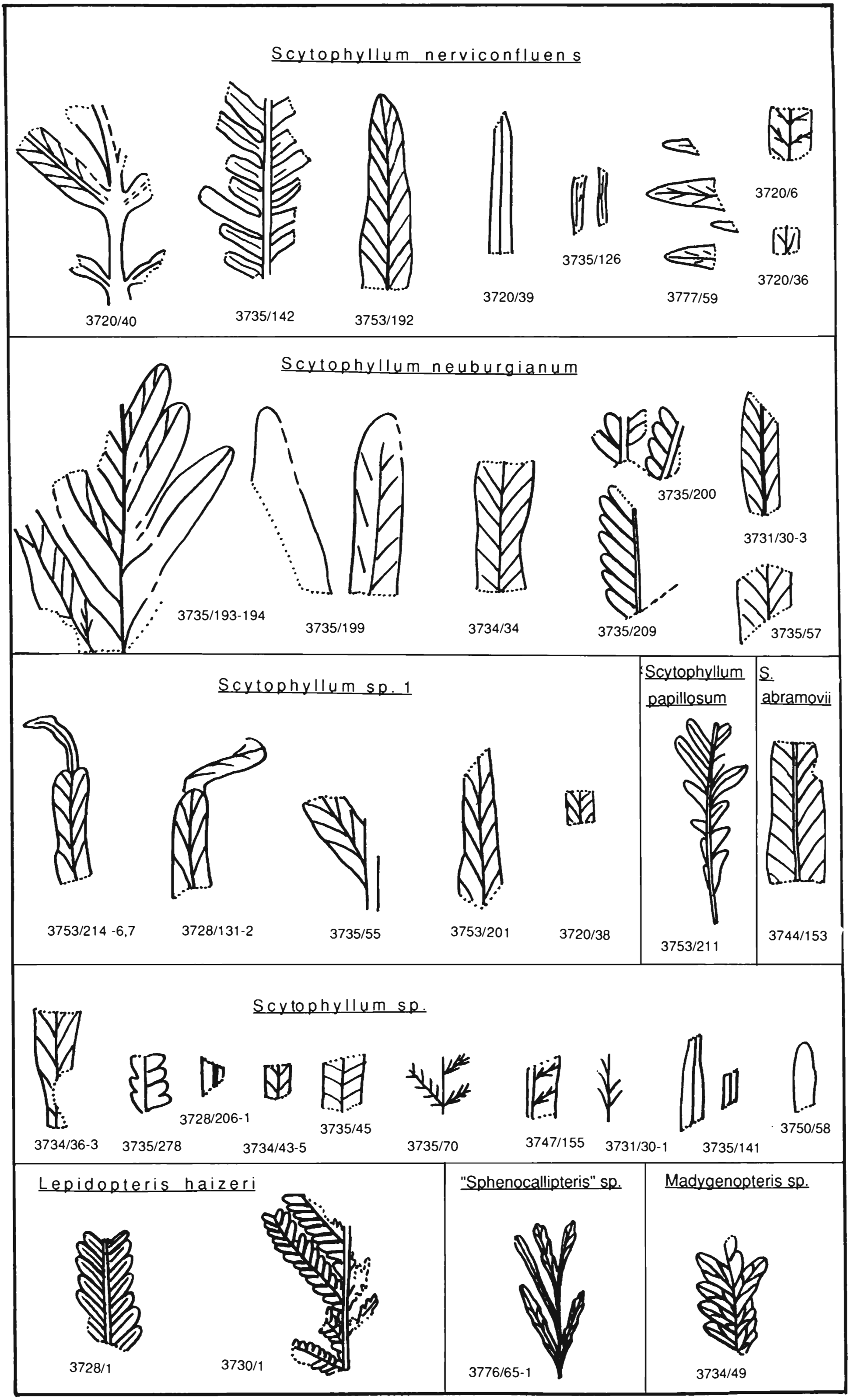


Fig. 53: The peltaspermous pteridosperms in the Triassic sediments of the Pechora Basin, x 0,5.

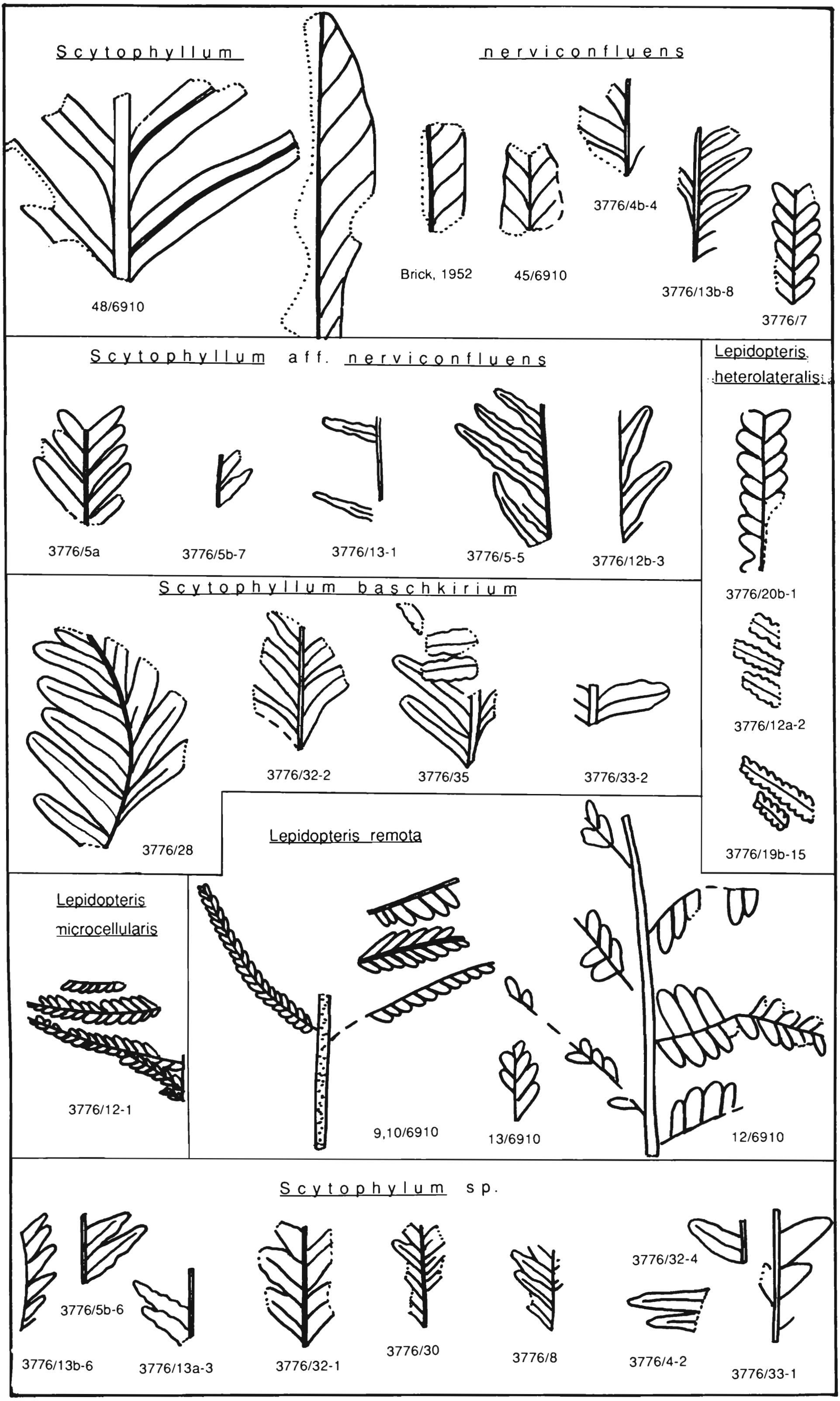


Fig. 54: The peltaspermous pteridosperms in the Triassic sediments of Southern Priuralye. x 0.5.

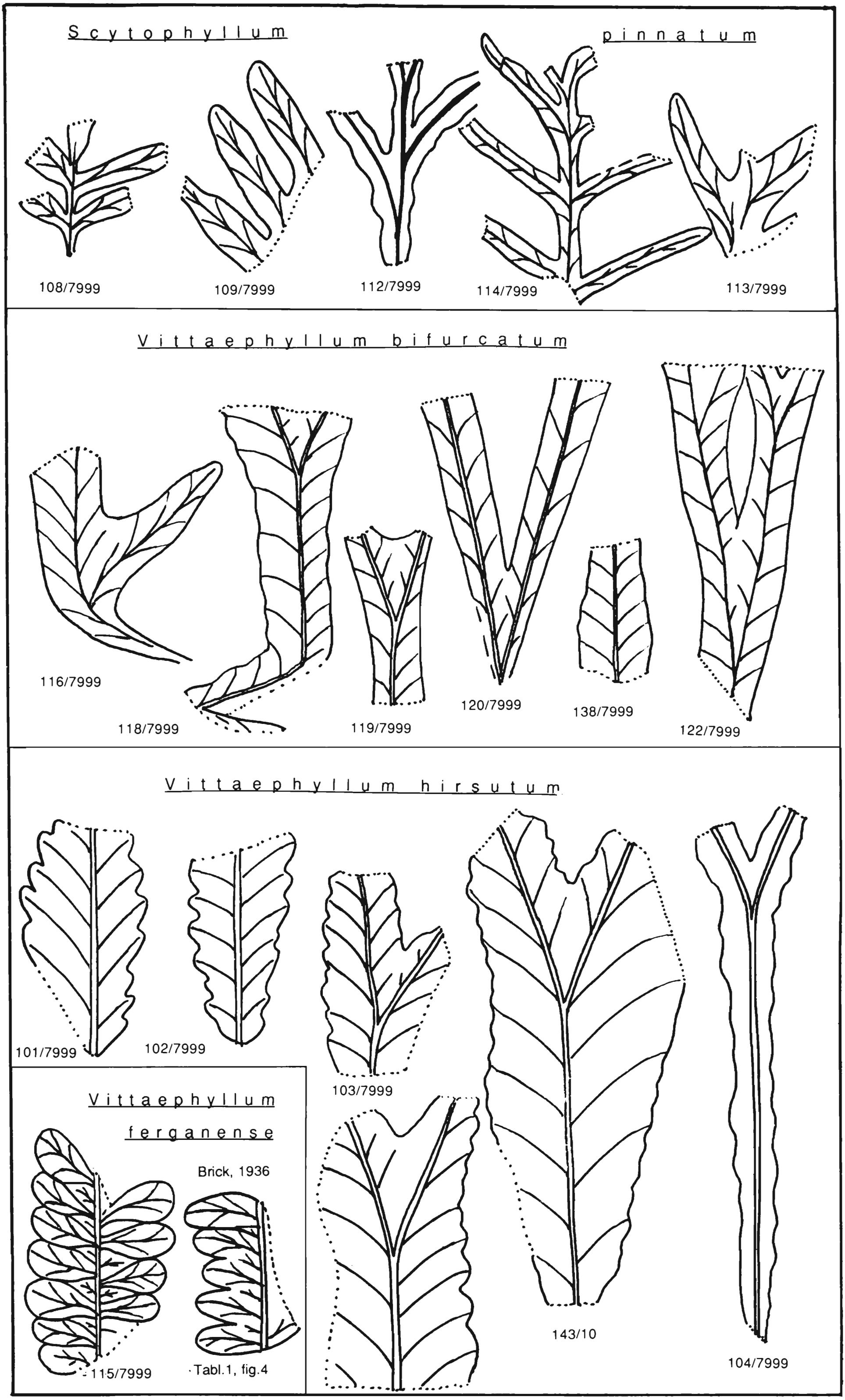


Fig. 55: The peltaspermous pteridosperms in the Triassic sediments of Southern Fergana (Madygen), x 0.5.

and Middle Keuper plants. Such conclusions are reached when examining the drawings in the old monographs (SCHENK, 1864) as well as the drawings of dispersed cuticle fragments (BORNEMANN, 1865). Peltaspermous pteridosperms are unknown in the East of Eurasia, in Primorye and Japan.

In the Norian-Rhaetian floras only one species of the genus *Lepidopteris* (*L. ottonis,* in association with *Peltaspermum* and *Antevsia*) from Germany, Greenland and Sweden is recorded and has been thoroughly studied. The species are known from many localities of these regions and in Sweden certain coaly layers are composed exclusively of it. *Lepidopteris* (with very small pinnules) was gathered in the Polar Urals (Lyulyino locality) – but this remains only a preliminary determination. *Lepidopteris* from the Norian-Rhaetian sediments of Viet Nam have been recorded (as noted above). The genus *Scytophyllum* is represented by many leaves in the Norian-Rhaetian floras of Kerman and the Elburz. In Middle Asia the Peltaspermaceae are unknown in Norian-Rhaetian floras.

It is interesting to mention that the plants of the *Scytophyllum* series in the Ladinian-Karnian floras are better developed in central Eurasia; while in the Norian-Rhaetian floras the findings are confined to the marginal parts of the continent, except a single imprint in the Novorayskoye Formation of the Donbass and some new discoveries in the Elburz. *Scytophyllum,* similar to those from the Priuralye, are known along from Zauralye (in the two lower plant assemblages from the coal-bearing sediments of the Chelyabinsk Basin and also in the Bogoslovsk and Bulanash-Ellkino depressions). Thus, the Urals were not such an insuperable obstacle for that group of plants, as it was for the ferns.

The relationship of leaves of the *Tatarina-Paratatarina* type to the family Peltaspermaceae is substantiated by the association of the former genus with *Peltaspermum* and by the rather similar texture of the epidermis of both with the peltasperms. Till now, epidermal studies have been carried out for representatives of these two genera only from the Tunguska Basin, Eastern European Platform (the Upper Permian sediments) and Svalbard. In addition it has been suggested that many other leaves of similar morphology might be related to the Peltaspermaceae. In the first place this is true of the leaves from the Kuzbas, the Pechora, Madygen, Mongolia and China, which are very similar in morphology to *Tatarina* and *Paratatarina* and were described under the names of *Thinnfeldia, Uralophyllum* and *Tersiella.* It is possible that the genus *Tersiella* is a synonym of *Pursongia* (MEYEN, 1969 a, 1971); the latter genus includes the leaves of *Zamiopteris*-type for which both the epidermal structure and mode of attachment remain unknown. Taking the genus *Uralophyllum* sensu lato, including the genus *Miassia* (STANISLAVSKY, 1976; MEYEN, 1969; KIRICHKOVA, 1969), I include with it not only the plants from the Urals and Madygen, described under this name but also (see list 53) *Tersiella radczenkoi* and *Hissarella ferganensis* (previously described as *Angaridium ? inflexum* and *A. ? dubitabilis*) from Madygen and *"Thinnfeldia nordenskioldii"* from Northern China and Mongolia.

The genus *Uralophyllum* is closely related in morphology to such genera as *Ptilozamites, Ctenozamites, Edyndella* (the division of the *Zamiopteris*-like leaf

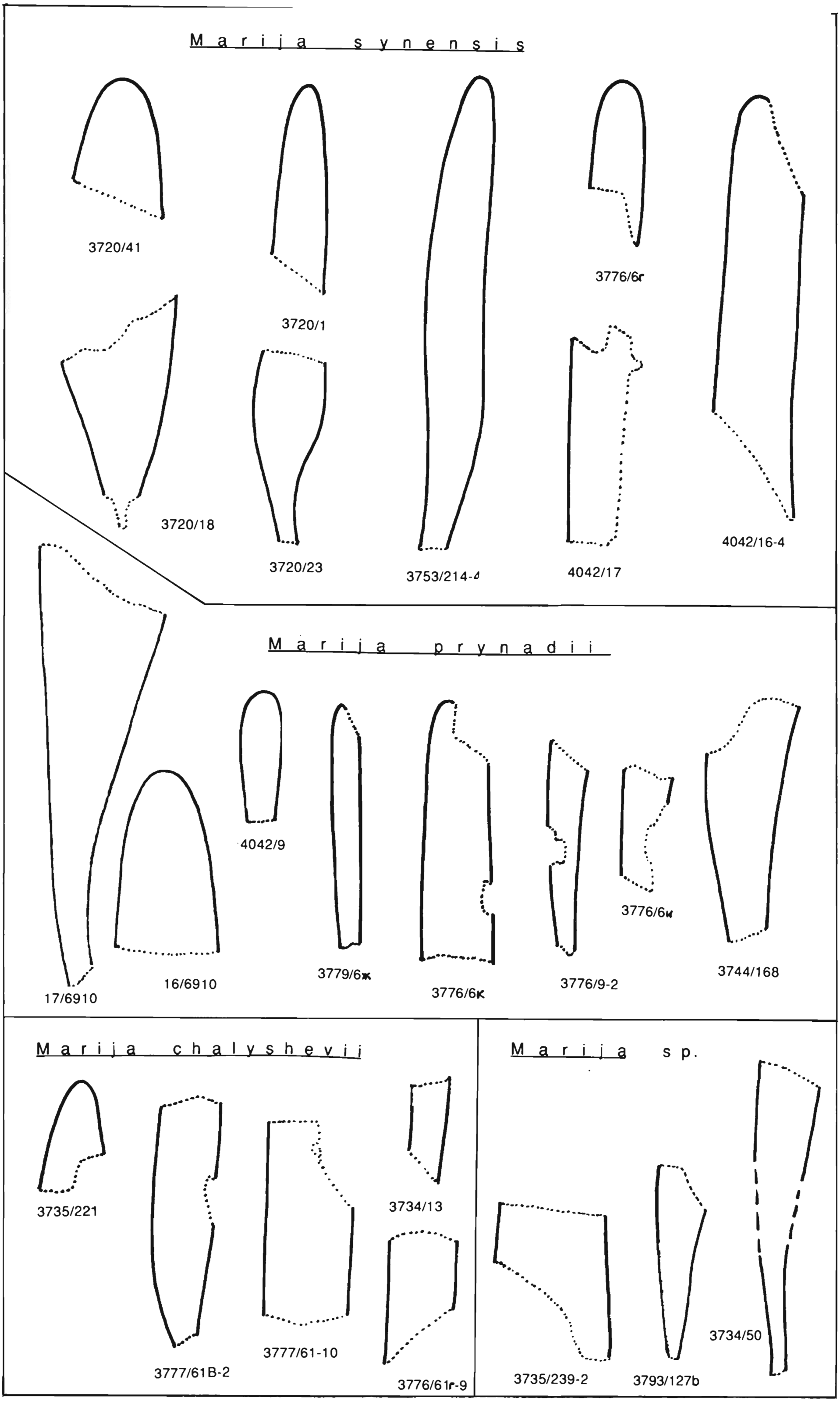


Fig. 56: The genus *Maria* in the Triassic sediments of Priuralye and Pechora syneclise, x 1.

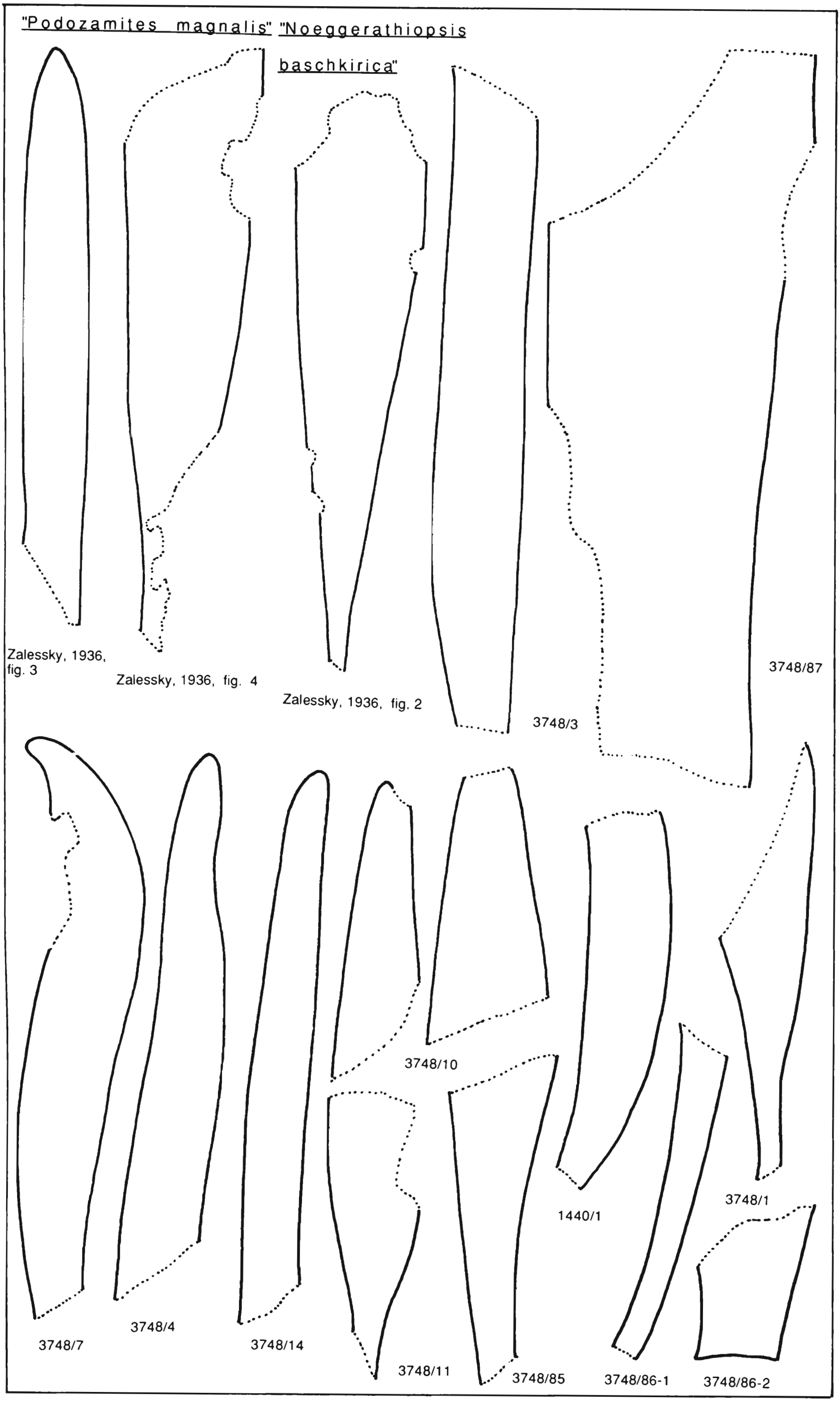


Fig. 57: The *Cordaites*-like leaves without cuticles in the Triassic sediments of Surakay, Southern Priuralye, x 1.

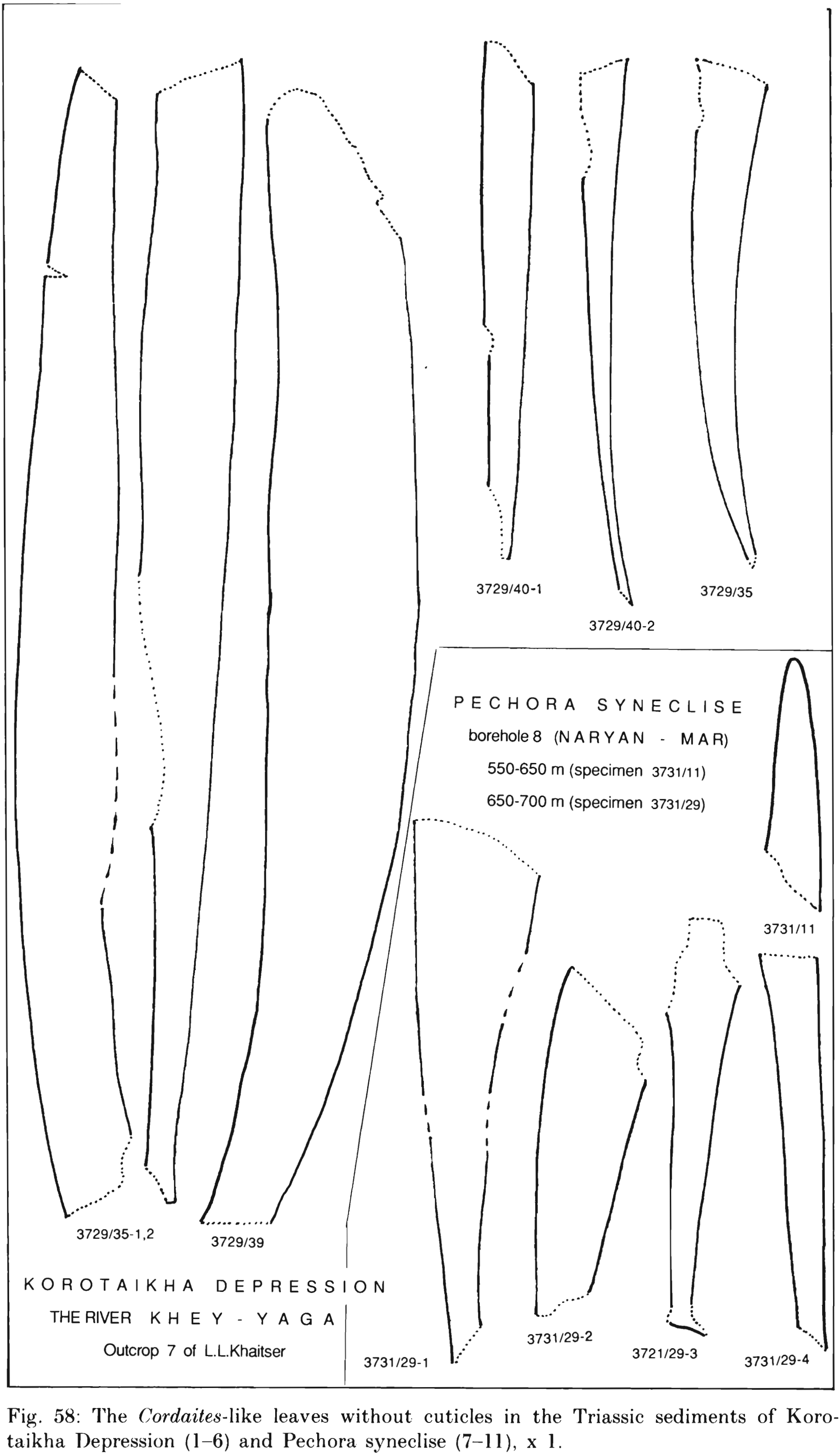


Fig. 58: The *Cordaites*-like leaves without cuticles in the Triassic sediments of Korotaikha Depression (1–6) and Pechora syneclise (7–11), x 1.

into wide segments) on one hand and on the other with the genus *Rhaphidopteris* (the division of the *Zamiopteris*-like leaf into narrow elongate segments with one – two nerves). Are all these plants closely related, or have similar leaves appeared independantly in different plant groups? The genera *Tatarina* and *Paratatarina*, as noted above, have peltaspermous cuticle and the former is found together with *Peltaspermum*. HARRIS (1937) pointed out the possible relationship of the genera *Ptilozamites, Ctenozamites, Stenopteris* (= *Rhaphidopteris:* BARALE, 1972) and *Thinnfeldia* – with the genus *Lepidopteris* on the basis of the similarity of stomatal structure. The epidermis of *Uralophyllym* from the Urals (KIRICHKOVA, 1969) is characterized by the same features, suggesting the relationship of this genus to the pteridosperms: rounded stomata (with 4–6 subsidiary cells, that differ from the epidermal cells only by their smaller size) that are variously oriented and scattered between the veins. In other words, classifying all the above mentioned plants in the pteridosperms is beyond doubt, but the relationships within the group remain uncertain.

The pteridosperms of the examined group are known in the Korvunchana flora, where their role in the vegetation is not great. Part of them have been proved to be related to Peltaspermaceae (genus *Tatarina*) (MEYEN, GOMANKOV, 1980), but nothing is known about the systematic position of the genus *Edyndella*. The pteridosperms of this type were widely distributed in the Ladinian-Karnian floras of Middle Asia, Northern China and Mongolia; they were less important in the Donbass and the Eastern Urals and extended into the Jurassic in Western Europe *("Thinnfeldia" nordenskioldii)*. The genera *Ctenozamites* and *Ptilozamites* appeared in the Ladinian-Karnian in the same regions (Donbass, Priuralye, Madygen, Northern China) and were widely distributed in the Norian-Rhaetian (Greenland, Sweden, Iran, the Pamirs, Viet Nam, Southern China, but absent in the Eastern Urals, Primorye and Japan). Thus, as with the true Peltaspermaceae, they were most widely spread in the central part of the continent.

It is possible that the leaves from northern and southern Priuralye included in the genus *Aksarina* (DOBRUSKINA, 1980) are of the *Tatarina-Paratatarina* series as well. They also have a *Zamiopteris*-like appearance, with distinct midvein and epidermis with cutinised guard cells. The degree of cutinisation of the guard cells resembles the bennettites but the straight walls of the cells, and the structure and position of the subsidiary cells are closer to the pteridosperms. If, after additional data is gathered, it should be found that the anastomoses are not accidental, but typical of the genus, then *Aksarina* could be compared with a peculiar plant from Madygen, identified by SIXTEL (1962) as *Taeniopteridium* (though the study of this epidermis is impossible).

The third morphological series (*Maria* series) of the family Peltaspermaceae consits of *Cordaites*-like leaves with peltaspermous cuticle (DOBRUSKINA, 1980). This type of leaf is distributed widely enough within the Triassic sediments of Eurasia (fig. 56–58), but the cuticles are studied only for a few of them. Till now only the leaves from Priuralye (see fig. 57) have been associated with *Peltaspermum*, but is is possible that *Yuccites* from the eastern slope of the

Urals are related to them. The name *Yuccites* should be given only to leaves with a wide amplexical base that can be seen in the typical representatives of this genus from the Buntsandstein of Western Europe, in *Y. vietnamensis* from the Norian-Rhaetian sediments of Vietnam and in some imprints from Surakay (see fig. 57). Nothing can be said about the systematic affinity of some other leaves from Surakay, of the leaves from the Pechora syneclise and the Korotaikha Depression (see fig. 58) or of all those leaves with unstudied epidermal structure (Madygen, Ketmen, Taymyr, Northern China, Mongolia and Primorye). No patterns are noticed in their geographical and stratigraphic position. *Cordaites*-like leaves with cuticle of *Glossophyllum* type are discussed below in the section "Ginkgophytes".

The leaves of pteridosperms described as related to the genera *Pachypteris, Thinnfeldia, Protoblechnum* are especially badly studied. This group can be characterized only in a negative manner: these plants are not *Pachypteris,* as there is no cuticle and they are not *Thinnfeldia* as the latter is the junior synonym of *Pachypteris.* In spite of all the fair reasons given by DOLUDENKO (1969), I consider it necessary to preserve for the time being the name *"Thinnfeldia"* (with inverted commas) in lists of plants for leaves of such appearance, but for which there are no data on systematic relationships and no other generic name has been proposed. Such plants in the Triassic sediments of Eurasia are not numerous: *Pachypteris, Protoblechnum* (scattered finds) are described in the Korvunchana flora; also some isolated finds of *"Thinnfeldia"* in the Ladinian-Karnian floras in the Pechora Basin, Ilek River, Bukobay, and Madygen; three species of *"Thinnfeldia"* in the Norian-Rhaetian floras of Sweden; a single scrap of cuticle in Greenland; one species in Kenderlyk; one species in Primorye, several species in Southern China; and *Pachypteris* in Iran.

Some peculiar pteridosperms *(Imania, Tudovakia)* stand apart in Primorye. SHOROCHOVA and KRASSILOV (1970) supposed the presence of the former also in Japan and North America.

The pteridosperms of India are represented by totally different genera: *Dicroidium, Angiopteridium, Parasorophyllum.* Besides, the importance of Glossopteridales is very great in the region. Taking this plant into consideration, India has nothing in common with all other parts of Eurasia. If one compares the representatives of the peltaspermous pteridosperms for the Ladinian-Karnian floras in the north and in the south of Eurasia (see fig. 53–57) the large leaves of Middle Asian floras are strikingly different from those in Priuralye: *Scytophyllum* leaves of Northern Priualye are smaller in size than those of Southern Priuralye. In the Donbass same small-leafed *Vittaephyllum* were encountered. The representatives of *Uralophyllum* are also far larger in Middle Asia than in the Eastern Urals and the Donbass. But the leaves of *Paratatarina* from Svalbard are quite comparable in size with those of *Uralophyllum* from Middle Asia.

In Norian-Rhaetian times *Ctenozamites* and *Ptilozamites* were absent in the Eastern Urals and Primorye. The genus *Lepidopteris* is known from the eastern slope of the Polar Urals.

Almost all the floras in which the representatives of the peltaspermous pteridosperms are known are connected with continental rocks, including the volcanic sediments of the Tunguska Syneclise and the Semeytau Mountains. They are not found where the intercalation of marine and continental sediments are known in the Triassic (Primorye and Japan). Only in the Pechora Basin are the peltaspermous pteridosperms probably connected with coastal-marine sediments (beds with *Gervillia*). It is quite possible that this type of distribution of the Peltaspermaceae has resulted in a nearly complete absence of its representatives in the floras of the first half of the Triassic. They are known in the Korvunchana flora. They are absent in the *Voltzia* and *Pleuromeia* floras which are connected with the coastal-marine deposits.

Caytoniales

Sagenopteris has been described from Western Europe, Northern Priuralye where CHRAMOVA studied their epidermal structure, Southern Priuralye, Madygen and Northern China.

Cycadophytes

Cycadophytes of the Triassic sediments of Eurasia are very irregularly distributed in time. They are rare in the first half of the Triassic: *Otozamites vogesiacus, Pterophyllum hogardii, Taeniopteris ambiqua* (a single find of each species) and a few species of cycadophyte including an endemic species *Yavorskyia* in the Tunguska syneclise. In the Ladinian-Karnian sediments they are important only in Western Europe, where they are most common together with Equisetales; possibly due to climatic conditions (and coastal situations as well?). The cycadophytes of Ladinian-Karnian times are also often found in Southern Primorye, where they are represented exclusively by the genus *Taeniopteris*. The end of the Triassic was the beginning of the hey day of the cycadophytes, which persisted through the Jurassic and Early Cretaceous. The percentage abundance of representatives of this group in Norian-Rhaetian floras is great – from 35 to 50%: figures that are far higher than earlier (7–10%).

Bennettites in the Ladinian-Karnian are known only in Western Europe and Svalbard. In Western Europe the numerous reproductive organs of the bennettites were studied together with the leaves of *Pterophyllum*. In Semeytau the reproductive organs of the bennettites were determined before as *Pleuromeiopsis semejtavica;* in Madygen the bennettites are represented by *Leuthardtia* and *Pterophyllum;* in Ketmen – by *Anomozamites*. Besides, the presence of the bennettites in Northern and especially in Southern Priuralye (genus *Askarina*) is quite possible.

The genus *Taeniopteris* is the most developed one among the cycadophytes. In the Pechora Basin the epidermal structure of some leaves of that type of morphology were described by CHRAMOVA (1977). The texture of the leaves was found to be similar to those of *Doratophyllum*. The presence of *Taeniopteris* without any other cycadophytes distinguishes the Eastern Urals and Southern Primorye from all other Ladinian-Karnian localities. The genus remains unknown only in Northern China; in other localities it occurs together with other cycads and bennettites. One of the questionable species of the genus from Madygen and Northern Priuralye has secondary veins with occasional loops, but no anatomoses (SIXTEL, 1962 b, fig. 33). Very typical of Ladinian-Karnian floras is the genus *Apoldia* (previously *Sphenozamites*); which is known in Western Europe, Southern Priuralye, Northern China and Mongolia. The genera *Ctenis, Pseudoctenis, Otozamites, Drepanozamites, Sinozamites, Parajacutiella, Dictyozamites* are also met. The genus *Nilssonia* is mentioned in Ladinian-Karnian sediments only from Japan and Indonesia; one from Mongolia is open to question. In general, though, the set of cycadophytes in all examined Ladinian-Karnian floras is not the same. Virtually no patterns in their distribution can be noticed: only the single genus *Taeniopteris* is present in Eastern Urals and Primorye; *Nilssonia* is found only in South-Western Asia; the other genera, in different combinations, are spread all over Eurasia.

In the Norian-Rhaetian a great variety of genera and species of cycadophytes is typical of all floras except that one of the Eastern Urals, where no other cycadophytes were added to the earlier existing *Taeniopteris*. The situation is quite different in Primorye: only *Taeniopteris* is known there in the Karnian floras, the same as in Zauralye, whilst in Norian-Rhaetian floras the additional genera *Pseudoctenis, Otozamites,* abundant *Pterophyllum, Ctenis, Nilssonia, Drepanozamites,* appeared. SHOROKHOVA (1975 b) supposed that in Primorye in the Norian-Rhaetian climatic conditions were more favourable than in the Ladinian-Karnian.

Only in Greenland and Sweden have the cycadophytes been revised in detail. There the epidermal structure of the leaves as well as associated reproductive organs are known. This level of investigation has not been achieved for the rest of Eurasia, and is partly impossible, because of the absence of cuticles. Hence the thorough correlation of the plants of this group between different Norian-Rhaetian localities is at present impossible.

In India the cycadophytes are of the same genera as in the rest of Eurasia: *Anthrophyopsis, Taeniopteris, Pterophyllum ?, Pseudoctenis.* It is true that these determinations are not proved through cuticular investigations, so one can not be certain of their identity.

Ginkgophytes

The Ginkgophytes from the Triassic sediments of Eurasia include not only the Ginkgoaceae, Sphenobaieriaceae, and Czekanowskiales, but, to a considerable extent, some peculiar groups with features reminiscent of both Ginkgoales and pteridosperms, and sometimes of conifers.

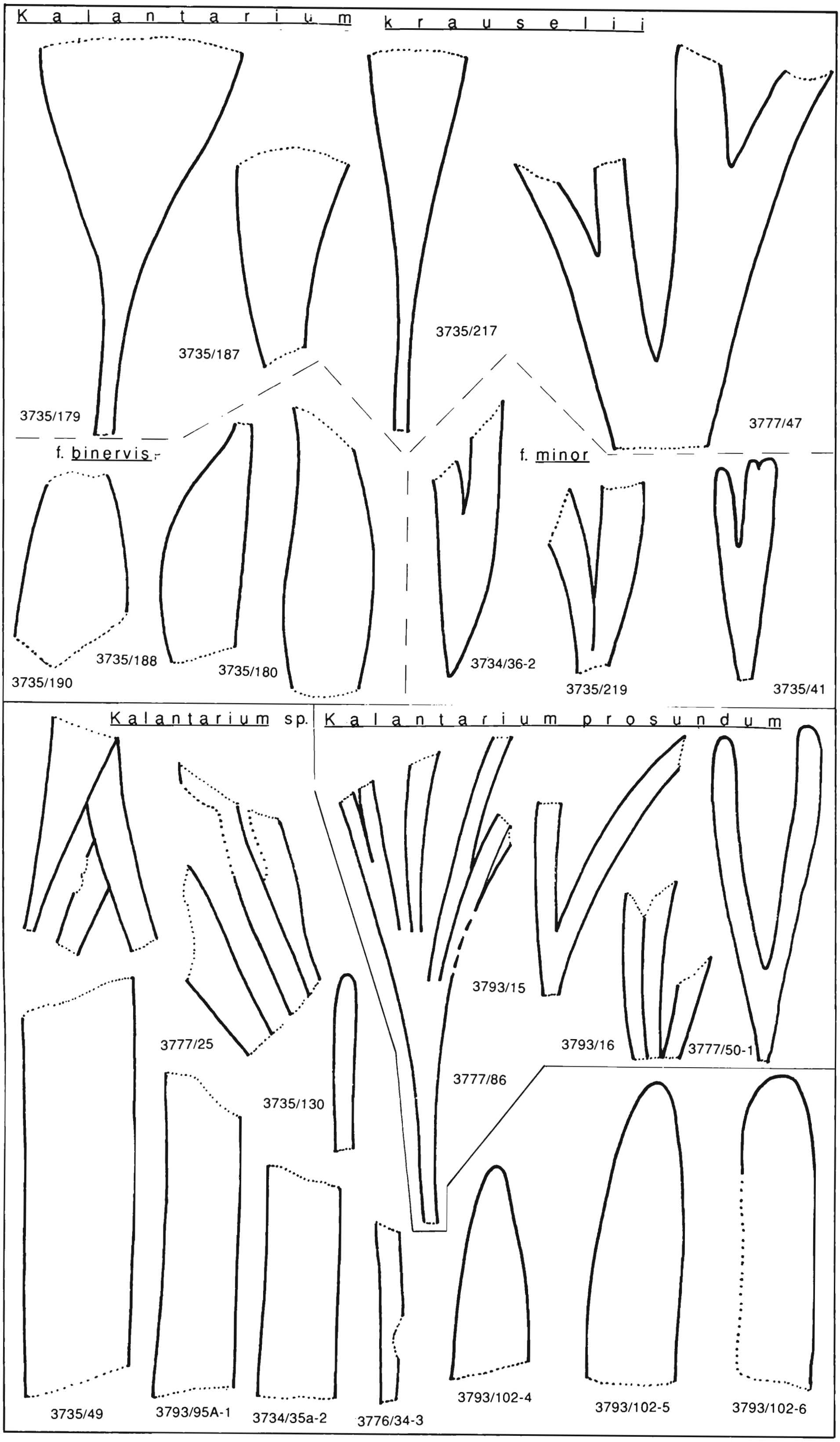


Fig. 59: The genus *Kalantarium* in the Triassic sediments of the Pechora Basin, x 1.

One of those groups, the family Glossophyllaceae, was thoroughly studied by the author (Dobruskina, 1980). It is distinguished by a typical epidermal structure, particularly the rounded to oval stomata with sunken guard cells. The subsidiary cells, 4–6 in number, are bracket shaped and surround the stomatal pit in a ring. They are much smaller in size than the epidermal cells, but have the same degree of cutinisation. The stomata are scattered quite irregularly within the stomatal bands; they are not orientated.

The described cuticles characterize several morphological representatives: the *Cordaites*-like leaves, described by Krausel (1943) as genus *Glossophyllum;* the wide lobed *Sphenobaiera lunzensis* and the narrow lobed *S. furcata* in Western Europe (Lunz and Basel); the *Cordaites*-like leaves of Svalbard *(Glossophyllum);* the *Cordaites*-like leaves together with the leaves of *Sphenobaiera* type referred to the genus *Kalantarium* in the Pechora Basin (fig. 59); the *Cordiates*-like leaves *(Glossophyllum claviforme)* and the leaves of *Sphenobaiera* type *(Kirjamkenia lobata, Sphenobaiera porrecta, S. vittaefolia)* in the Tunguska Basin. It is interesting to note that such an epidermis is unknown elsewhere and in each of the three widely scattered regions all three morphologic types with similar cuticle are met. These morphological types are separated better in Western Europe and the Tunguska Basin than in the Pechora Basin. This may be explained by the fact that I have at my disposal all the material from the Pechora Basin but only that published material from the other two regions that the authors considered necessary to confirm their point of view. In spite of the abundant cuticular material from both Northern and Southern Priuralye the genus *Kalantarium* is found only in Northern Priuralye and is absent in Southern Priuralye.

Prynada (1970) was the first to pay attention to the peculiarity of these plants before the description of the genus *Glossophyllum*. Unfortunately he dealt with very scant information, but this did not prevent him from expressing the supposition that the scraps of leaves of ginkgoalean appearance were more similar on the basis of their epidermis, to the pteridosperms than to the ginkgoales.

A careful study of the leaf morphology characterized by the described epidermal type, suggests that they could be plants with the fern-like frond of *Acrostichopteris* type, with segmented pinnae or with entire reverse-triangular segments. Leaves of such morphology, but of an unknown epidermal structure, are met in the Donbass, Madygen, Ketmen, Northern China, Mongolia and Primorye (Ladinian-Karnian floras). They are either absent or almost absent in younger floras. Related forms should be searched for in the palaeophytic floras. In any case they do represent some palaeophytic elements of the Triassic floras.

The second group of ginkgophytes, also including different morphologic types, consists of leaves with cuticles looking like common *Sphenobaiera* cuticles but having some different features. The group has not yet been studied in detail as has the first one, but its presence both in Northern and Southern Priuralye is obvious (fig. 60). One of the specimens has a distinct similarity in epidermal structure with Sphenobaiera spectabilis from the Lower Jurassic sediments of Sweden and some others differ from this species in variable degree.

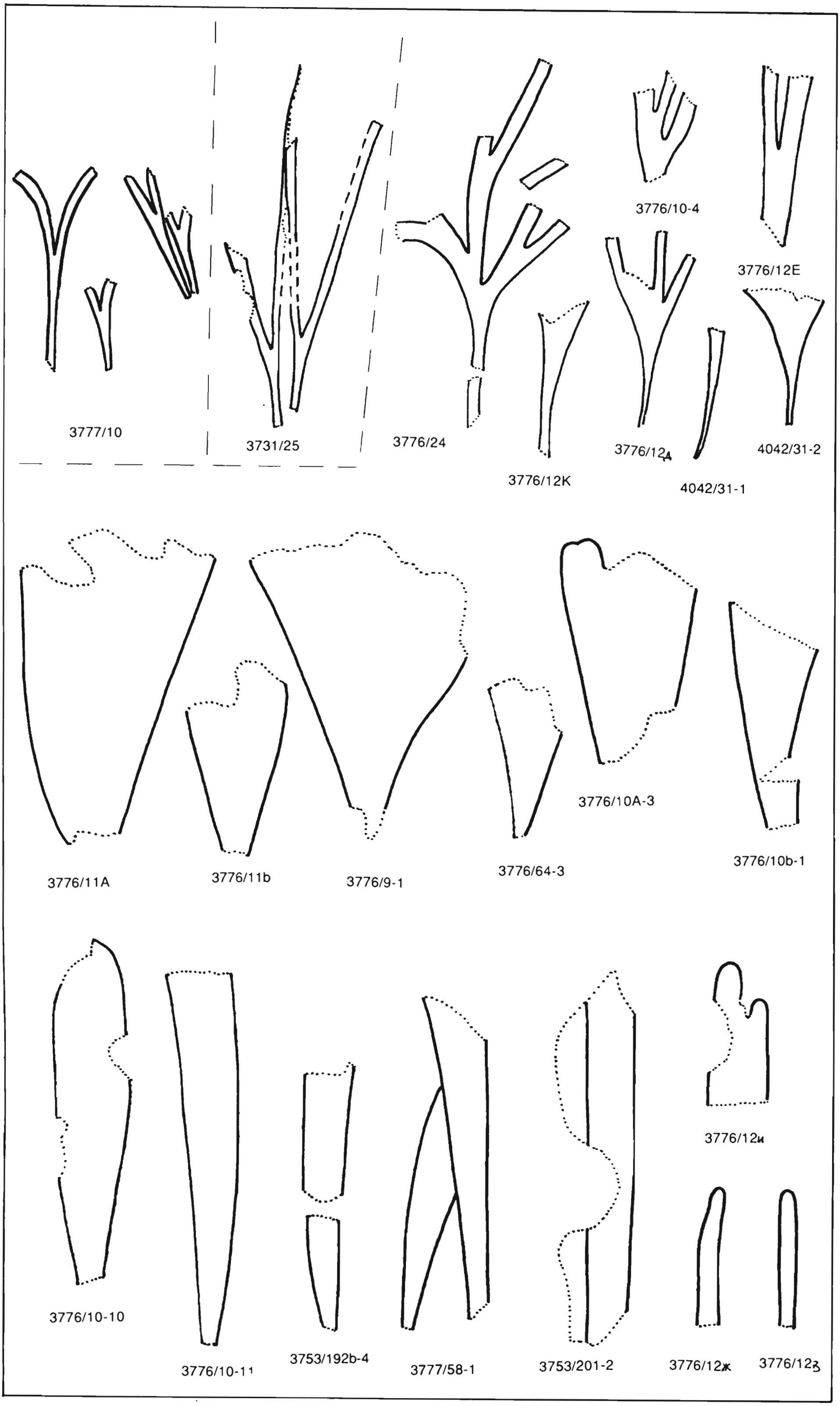


Fig. 60: Morphology of the leaves in the Triassic sediments of Priuralye and Pechora syneclise which have epidermal structure of *Sphenobaiera* type (1–23), x 1.

The third group is represented by leaves in which the morphology is as diverse as in the first and second groups (fig. 61) and in which the cuticle has some distinctive features: the stomata are set in regular rows; the epidermal cells are stretched and form rows; the polar cells are inserted in the rows of the elongated epidermal cells ("chains of stomata"). Such features together with the presence of the thickening of cuticles in the form of an interrupted crest in the centre of the epidermal cells is usually considered to be typical of conifers. But, on the other hand, the morphology of the leaves and some other epidermal features (such as the proximal thickening of the bracket shape, subsidiary cells, parallel to the stomal pit) make these plants similar to the genus *Pseudotorellia* as well as to the species *Desmiophyllum imhoffii* from Basel, the systematic position of which is not, as yet, settled.

The foregoing proves the following: 1) among the Triassic ginkgophytes (as well as those of the Jurassic and Cretaceous) leaves of different morphology (*Cordaites*-like on the one hand and of the *Sphenobaiera* type on the other) belong to each of the three epidermal types; 2) the genus *Sphenobaiera* is not a natural grouping: most likely the majority of its Triassic and Palaeozoic representatives are from families (or even orders) other than the Karkeniaceae KRASSILOV (1969/1970) or Sphenopbaieraceae SAMYLINA (1970); 3) the genus *Glossophyllum* should be singled out from the family Karkeniaceae as a separate family, as was suggested by TRALAU (1968) and SAMYLINA (1970); 4) the family Glossophyllaceae should be determined in a broadened sense (in comparison with the suggestion of Tralau): *Glossophyllum florinii, Sphenobaiera lunzensis, S. furcata, Antholites wettsteinii, Kirjamkenia lobata, Sphenobaiera porrecta, S. vittaepholia, Kalantarium kraeuselii, K. prosundum*. The attribution of the genus *Torellia* to this family is doubtful and needs further study. It seems quite possible that after future epidermal studies a lot of other Triassic, especially Ladinian-Karnian (and Permian?), ginkgophytes will be related to the family Glossophyllaceae. These ginkgophytes have been studied, till now, only morphologically; 5) it is not improbable that some of the Triassic ginkgophytes from the flora of the first half of the Triassic and from the floras of the Ladinian-Karnian are of the family Sphenobaieraceae (I prefer the name given by SAMYLINA, as there are no data on the reproductive organs of the examined plants as yet), though they are characterized by some peculiarities in epidermal texture; this question remains to be thoroughly investigated; 6) there is no evidence for the presence of the family Ginkgoaceae in the floras that are older than those of the Norian-Rhaetian.

So, the family Glossophyllaceae is known in the flora of the first half of the Triassic in the Korvunchana flora of the Tunguska Basin; it is possible that a single imprint of *Baiera* sp. from the Buntsandstein of Western Europe belongs to the same family.

The genus *Rhipidopsis* is present in the Tunguska and Kuznetsk Basins. It is usually related to the ginkgophytes, though there is no evidence for this opinion (SAMYLINA for instance, suggests that this plant more probably relates to the pteridosperms). The same genus *Rhipidopsis* is present in the Indian

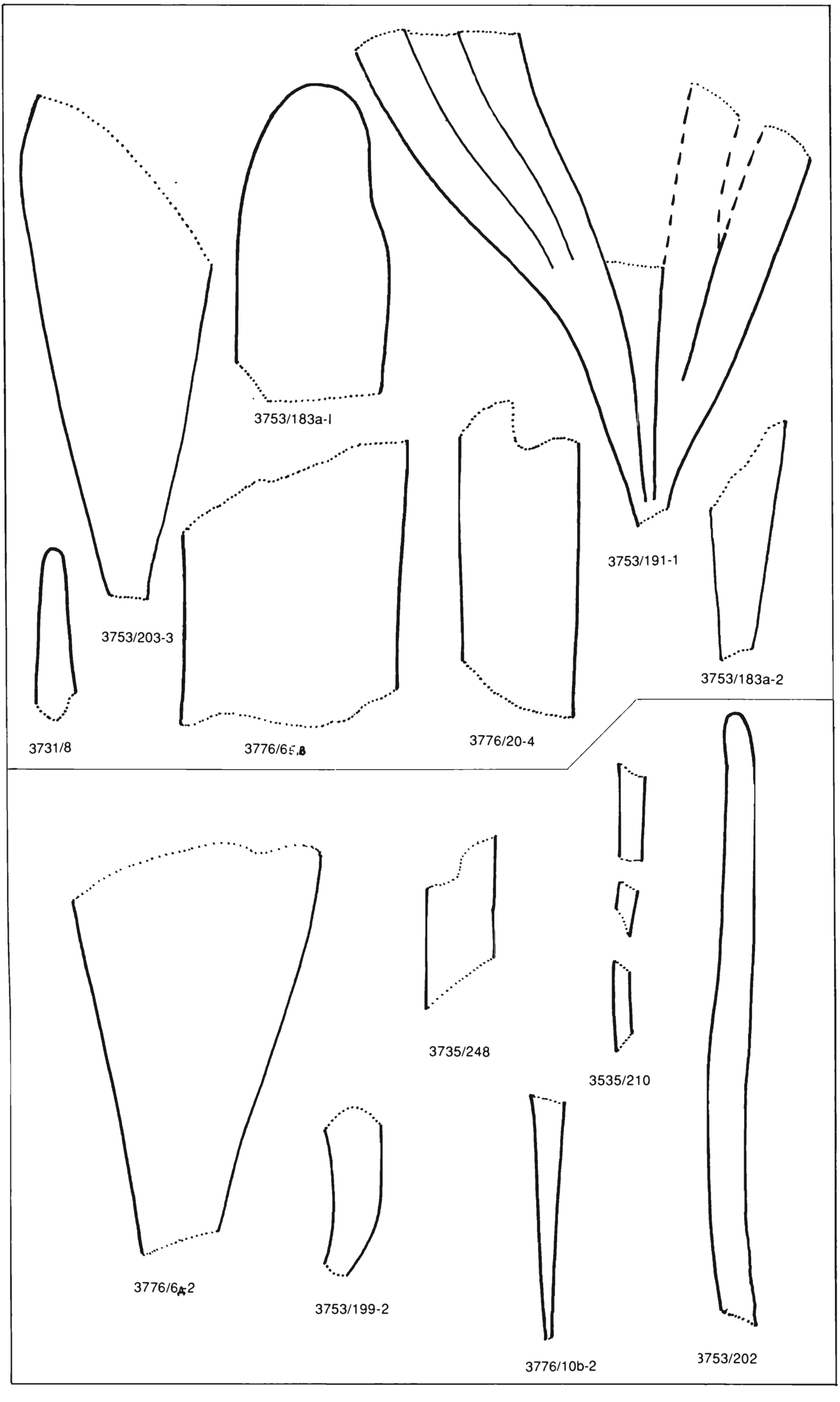


Fig. 61: Morphology of the leaves in the Triassic sediments of Priuralye and Pechora syneclise which have epidermal features of the conifers, x 1.

floras together with *Desmiophyllum taeniatum, D. indicum* and *Baiera indica*. As it can be judged from such brief data, the differences in the ginkgophytes of the first half of the Triassic all over Eurasia are less than in other plant groups.

The family Glossophyllaceae is more widely represented in Ladinian-Karnian floras: Western Europe (Northern Alps, northern Switzerland), Svalbard, Northern and Southern Priuralye. Coeval ginkgophytes from Middle Asia, Northern China and Mongolia, are of poor preservation. Thus, they cannot be epidermally studied, but morphologically they are very similar to ginkgophytes from Priuralye. Likewise, *Baiera minuta, Pseudotorellia* from Primorye and *Ginkgoites digitata* and *Baiera paucipartita* from Japan have no cuticles, and the external features alone do not enable one to draw any conclusions. Ginkgophytes are completely absent in Thailand and Sarawak.

In the Ladinian-Karnian floras of the Eastern Urals the epidermally studied ginkgophytes are from the Czekanowskiales (*Czekanowskia* and *Phoenicopsis*) and from the genus *Pseudotorellia*. The latter genus stands apart among the ginkgophytes and it is still unclear whether it represents a peculiar family in the order Ginkgoales (Krassilov, 1969, 1970, 1972) or is related to some peculiar order (Samylina, 1970). It is possible that this genus is a single link between the Ladinian-Karnian floras of Zauralye and Priuralye (if the attribution of the Priuralye plants to this genus should be proved). Besides there is nothing in common between the ginkgophytes of Priuralye and Zauralye in the Ladinian-Karnian, i. e. it is the same situation, as has already been mentioned, for the majority of other plant groups. Czekanowskiales are known in the Ladinian-Karnian floras also in Mongolia and Southern Primorye.

The first appearance of the Czekanowskiales is noted in the Ladinian-Karnian floras of the Eastern Urals, Mongolia and Primorye, i. e. only in the northern floras.

In the Norian-Rhaetian floras the Czekanowskiales are geographically widely distributed. Accompanying them are *Ginkgoites, Baiera, Sphenobaiera, Allicospermum, Pseudotorellia*. The attribution of this last genus to the Ginkgoales, as noted above, is open to question. They are epidermally studied only in Greenland, Sweden and the Eastern Urals (in the last region the genera *Ginkgoites* and *Sphenobaiera* have been described). In other floras, the plants are related to the listed genera only on the basis of their morphological resemblance. The composition of the genera of the Czekanowskiales *(Czekanowskia, Phoenicopsis, Hartzia, Staphidiophora)*, just as with the Ginkgoales, is monotonous all over Eurasia. *Phoenicopsis* is absent in the *Lepidopteris* flora of Greenland and Sweden but has been noted in the more southern floras (Southern China and Vietnam).

Conifers

Till recently it was thought that in the first half of the Triassic the conifers differed greatly between Western Europe, Siberia and India. From China

Triassic conifers remained unknown. Paleobotanical investigations of recent years have shown that the Buntsandstein flora, rich in conifers, was widely distributed all over the southern part of Eurasia – from Western Europe, through Southern Priuralye and Middle Asia to China. *Voltzia, Albertia, Yuccites, Elatocladus, Masculostrobus* were described from China (Zhou and Li, 1979; Huang and Zhou, 1980; Yao and Ouyang, 1980; Wang, 1983). New descriptions of Korvunchana plants (Meyen, 1981; Mogutcheva, 1984; Mogutcheva & Dobruskina, 1985) showed that *Voltzia, Quadrocladus, Darneya, Willsiostrobus* as well as *Yuccites, Elatocladus* and *Lutuginia* were present in Siberia in the first half of the Triassic. The Lower Triassic conifers of Siberia are very close to those of Western Europe and China, but they existed in association with very different plants.

It is worth mentioning that *Araucarites* and *Pseudoaraucarites* from Siberia (Meyen, 1981) as well as from India (Bose, 1974; Retallack, 1975) are now considered to be lycopods.

In the Ladinian-Karnian floras of Western Europe the conifers are obviously derived from those of the Buntsandstein; *Voltzia* (other species than in the Bundsandstein) being the most important representatives of this group, as well as *Widdringtonites*, unknown in floras of this age outside Western Europe. In the Ladinian-Karnian the genera *Pagiophyllum, Schizolepis, Pachylepis, Stachyotaxus* appeared and from that time became widely distributed all over Eurasia. Farther to the east *Swedenborgia* and *Araucarites*, as well as *Pityophyllum*, were added. The genera *Podozamites* and *Cycadocarpidium* probably spread from Japan all over Eurasia, for it is in Japan that many findings of various species have been made in the floras of that time. An earlier history of that family is now known through a recent finding of *Cycadocarpidium* in the *Voltzia* Sandstone of Western Europe. The endemic genera *Nagatostrobus* and *Minetaxites* have been described from Japan, and the genus *Taeniocladopsis* from Northern China. On the whole, some provincial features of the floras are obviously expressed in the distribution of Ladinian-Karnian conifer genera. This is apparent in the change of the dominating genera from the west to the east.

It is interesting to mention that the genus *Swedenborgia* in China, Middle Asia and Priuralye is known in the Ladinian-Karnian, and in Western Europe in the Norian-Rhaetian. The genus *Yuccites* in Western Europe is known only in the first half of the Triassic (not taking into account some doubtful determinations in the Jurassic sediments of France), in Priuralye in the Ladinian-Karnian and in Viet Nam in the Norian-Rhaetian.

In comparison with the previous periods a number of conifer genera, such as *Palissya, Palaeotaxus, Masculostrobus, Brachyphullum, Fraxinopsis, Storgaardia* etc., appeared in Eurasia during the Norian-Rhaetian. These genera co-existed with the forms that had appeared earlier. Changes in the content of the conifers are less significant than in the middle of the Triassic. Differences in the conifers are elusive in the regions where both Ladinian-Karnian and Norian-Rhaetian floras are met (Eastern Urals and Donbass). No pattern in the spread of conifers in Eurasia in the Norian-Rhaetian can be determined.

Chapter twelve

Phytogeographic zonation of Eurasia in the Triassic

There are great differences in the biogeographical zonation schemes of the continental Triassic sediments given by various authors (see chapter nine). This is related, as a rule, to different ideas on the correlation of the Triassic sediments that are used in these reconstructions and to the choice of time intervals for such zonations; rather than with differing evaluation of the palaeogeographical significance of the fossil plants (if such reason really exists). If a time interval is too great, the result can be as erroneous as in the case of a wrong correlation: we run the risk of tracing a boundary between plant assemblages of different ages.

While tracing the paleogeographical boundaries one should be sure of the equivalence in age of the floras under consideration. This means that the correlation of the sediments must be well-grounded. If the correlation is wrong it becomes necessary sometimes to construct very complicated paleogeographical systems. In these cases the zones often cannot be traced outside the regions where they were distinguished. For instance, until the Madygen flora of Southern Fergana was considered to be of Upper Permian-Early Triassic age a special Fergana province, represented only by the Madygen flora, had to be isolated for the Lower Triassic. This flora (and the corresponding province as well) had nothing in common with the very low diversity flora consisting almost solely of *Pleuromeia* of Southern Eurasia. (It was found, later, that the lycopsids of the Madygen flora had little in common with *Pleuromeia*). When the Keuper age of the Madygen flora was proved by the author (DOBRUSKINA, 1970 a, 1974, 1975, 1986 b) the flora took its proper place among the surrounding coeval floras of the Ilek River Basin and the Donbass to the west, and the Ketmen and Yenchang regions to the east. Besides, the delineation of paleofloral regions in the Early Triassic became more natural: one homogenous *Pleuromeia* flora extending across the whole southern extent of Eurasia, new localities of which were found recently in the Mountainous Mangyshlak, Eastern Predkavkazye, the northern Caucasus, Prikaspiy, Darvaz and Japan.

In case where phytogeographic zonation is based on only one or two genera, one of which e. g. *Phoenicopsis* is of wide stratigraphically extent (KRASSILOV & SHOROKHOVA, 1975), the boundary may turn out to fall within sediments of different age. Moreover, such a genus as *Phoenieopsis* may sometimes intrude into adjacent zones (e. g. in the Jurassic sediments of Middle Asia and Iran).

There is a further difficulty due to the fact that the dissimilarities in the compared floras are not always clear; either they depend on differences in age, or on geographical position. The problem is that only in a few places in Eurasia can we see two or three successive Triassic floras of different ages in one section or in one region. More common it is to meet one flora in one place, and another flora in another place. In the latter case the distinctions may be caused by differences in age, as well as by a position in different palaeofloral regions. The question is how to avoid the mistake of taking one characteristic feature for another, i. e. not to consider the presence of phytogeographical zonation where in fact floras of different ages are present. This is usually the problem when the content of the floras is the only criterion for age determination. In different cases these problems are to be solved in different ways.

One such task from this point of view, is the estimation of the significance of the Dipteridaceae in the Ladinian Karnian floras. This group existed both in the west (the Karnian sediments of Western Europe) and the east of Eurasia (the Ladinian and Karnian sediments of Japan and Primorye), while they are completely absent in the central part of Eurasia (except the Garazhovka flora in the Donbass, but this flora by a number of indications is considered to be somewhat younger). Their absence can be explained either by the Ladinian age of floras, without Dipteridaceae, which have not reached the central parts of Eurasia at that time, or by attributing these floras to zones with colder climates. This question is analysed when the phytogeographical zonation of the Ladinian-Karnian floras is discussed.

The phytogeographical zonation of Eurasia in the Triassic can be done separately for the first half of the Triassic (including the uppermost Permian), for the Ladinian-Karnian and for the Norian-Rhaetian.

The first half of the Triassic

At the boundary between the Palaeozoic and Mesozoic the phytochoria distribution system changed in essence and the phytogeographical zonation in Eurasia from the very beginning of the Mesozoic became close to that of the present day. At the very end of the Permian the isolation of the Palaeozoic palaeoflora kingdoms were disturbed: the barriers between them were broken, the migration of plants over great distances became possible. Investigations of recent years have showed that the *Voltzia* flora (determined in Western Europe at the beginning of the previous century) can be traced through to China in the south of Eurasia via Southern Priuralye and Middle Asia. Its uniform content in the west and in the east of Eurasia proves that the Atlantic and Cathaysian kingdoms of the Late Palaeozoic have united into one European-Sinian area. The differences in floras of that and of the previous Angara Kingdom decreased considerably: in the early Triassic the conifers of the *Voltzia* flora penetrated through Siberia. The Siberian area was disposed in the place of the Palaeozoic Angara kingdom. This Siberian area belonged in the Triassic to the single Laurasian kingdom together with the European-Sinian Area.

As is clear from the terminology used (palaeophytogeographical areas instead of kingdoms) the differences between the floras discussed for the Triassic are evaluated one to two ranks lower than for the Permian: the floras of the whole of Eurasia became more similar in the beginning of the Mesozoic.

As in the Palaeozoic, the palaeofloristic kingdom of Gondwana remained completely isolated; i. e. it has the same outline in the Triassic as it did in the Permian. Though, taking into consideration the spreading of the lycopods its limiting barriers became surmountable.

The wide expansion of the lycopods all over Eurasia and in the southern continents is the most distinctive feature of Early Triassic phytogeography. The wide spreading of the genus *Pleuromeia* in Eurasia was known long ago (see fig. 52). Recent investigations have added new localities in China (WANG, XIE & WANG, 1978; WANG & WANG, 1982; HUANG & ZHOE, 1980) and in Taymyr (SADOVNIKOV, 1981) and have permitted specimens from India to be related to this genus. They were previously mistakenly identified as *Araucarites* (BOSE, 1974; RETALLACK, 1975). Besides, the lycopods of the family Pleuromeiaceae turned out also to be widespread in the north of Siberia: *Tomiostrobus, Araucarites, Pseudoaraucarites* (MEYEN, 1981; SADOVNIKOV, 1982; DOBRUSKINA, 1985) and in Western Europe and China: *Annalepis* (GRAUVOGEL-STAMM and DURINGER, 1983; ZHOU and LI, 1979) which were before considered to be conifers. The expansion of the lycopods in the first half of the Triassic is found to be even more immense. Typical of *Pleuromeia* is its great abundance in every locality. These localities typically occur in clusters of 5 to 20 in number over a comparatively limited area (see fig. 48–51). In such localities the other plant remains are usually absent or are represented by single poorly preserved scraps. Thus, some other flora perhaps existed in the first half of the Triassic, but we have insufficient evidence thereof. But the character of preservation of the remains suggests that the other plants were growing at some distance from the *Pleuromeia* (which were buried in situ or almost so). According to MÄGDEFRAU (1931 b) in the German Basin *Pleuromeia* usually occurs apart from the other plants, even where they are noted from one locality. In the north of Siberia *Pleuromeia* and other plant remains are met in separate stratigraphical horizons.

The described peculiarities of *Pleuromeia* burial, which are usually found in marine or coastal-marine sediments, suggest that these plants formed brushwood of marsh type over great distances along coastlines and that these thickets consisted solely of *Pleuromeia*. In more rare cases (some localities of the German Basin and the Upper Volga) these thickets were along lake margins. The other plants were growing at substantial distances and under different conditions.

In contrast to the previously described *Voltzia*, conifer-fern (Korvunchana) and *Dicroidium* floras, confined to some what limited areas, the lycopod flora was spread all over Eurasia from its most western to its most eastern extremeties and from its most northerly limits to India; as well as through Australia and South America. The majority of localities are found along the northern coast of the Tethys or the Pacific Basin. It is possible that the absence of data on the floras other than *Pleuromeia,* in the eastern part of the Euramerican area can be explained by the presence mainly of marine or coastal-marine sediments of the first half of the Triassic, while continental sediments where other plants might be buried were hardly preserved within the territory. The findings of *Pleuromeia* in the Angara area are related to the coastline of the Boreal Basin area (fig. 62). Only in India are the assumed *Pleuromeia* probably from continental sediments.

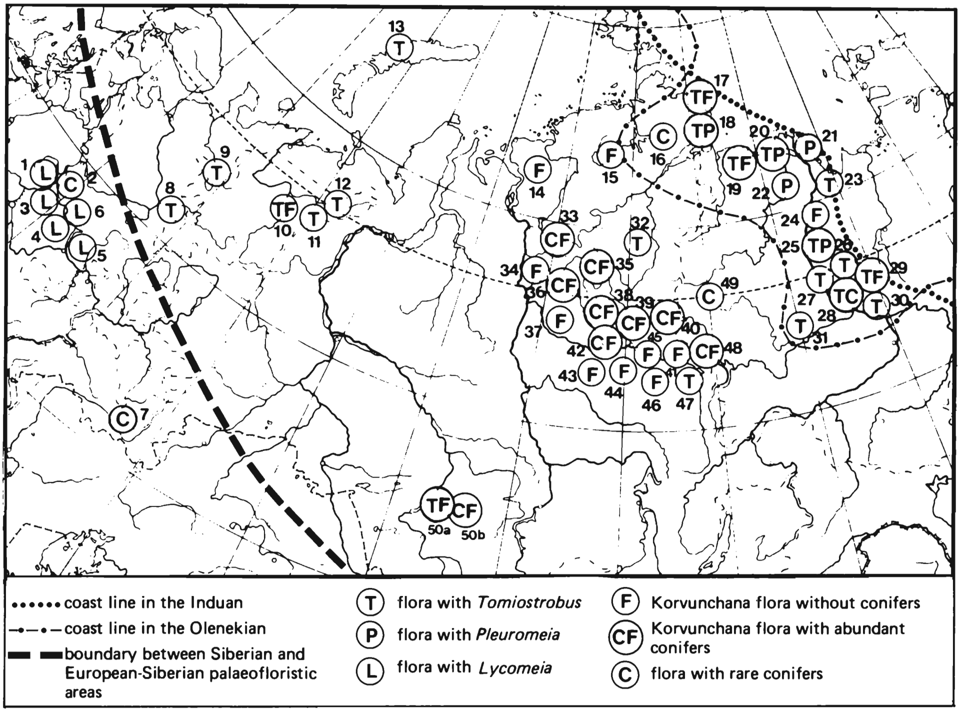


Fig. 62: Distribution of plant assemblages in the Lower Triassic of the northern part of Eurasia. Ciphers in the map:
1–6 – upper Volga, 7 – Petropavlovka village, 8 – Gam and Zheshard, 9 – Koslan, 10 – Byzovaya village and Yanyu River, 11 – Adzva River, 12 – borehole Kusshor 229, 13 – Novaya Zemlya, 14 – watershed of the rivers Uboynaya and Pura, 15 – Fadyu-Kuda River, 16 – Kiryaka-Tas Range, 17 – cape Tsvetkov, 18 – Chernokhrebetnaya River, 19 – Ystynaakh-Khocho, 20 – Olenek River mouth, 21 – Tasary, 22 – Kyra-Khos-Terryuteekh, 23 – Kharaulakh Mountains, 24 – Unguokhtakh River, 25 – Syncha and Sygynkan rivers, 26 – Sobopol River, 27 – Seymcheen River, 28 – Yulegiir River, 29 – Tokur-Yurekh River, 30 – Dolbuun River, 31 – Vilyuy River, 32 – Prianabarye, 33–49 – Tunguska Basin, 50 a,b – Kuznetsk Basin.

The distribution pattern of *Pleuromeia* most likely reflects ecological preferences (coastal areas of seas and lakes; warm climate) and does not have any phytogeographical significance.

The phytogeographical differences are more evidently traced when considering the ferns (fig. 63). The abundant (to 60%) diverse ferns of variable pinnae size all with thin leaf blades and often with large fronds as in the Korvunchana flora (Siberian area) differs sharply from the xerophytic floras with few ferns of the European-Sinian area. These latter include only the species *Anomopteris mougeotii*. If the even distribution of the lycopsids and conifers within the Eurasian territory seems to show approximately similar temperature conditions to north and south, the differences between the ferns in the *Voltzia* and Korvunchana floras testify to the significant variation in humidity between the European-Sinian and Siberian palaeogeographical areas.

The European-Sinian area seems to be related to the area of tropical arid climate. It is indicated by the low number of species and by the xerophytic features of the *Voltzia* plants as well as by the type of sediments with prevailing red and saline beds. The clay lenses with plant remains within the dominating sands in that part of the section which originated in the opinion of MÄGDEFRAU (1931 a, 1936) in oases containing stagnant water lakes.

The arid conditions of the European-Sinian area in the Early Triassic differ slightly from the conditions of the Late Permian. This is confirmed by the similarity both of the sediments and the content and appearance of the Zechstein and *Voltzia* floras. In the Early Triassic the climate became even more dry. The arid climate diffused to the eastern part of the area, where the hydrophytic Cathaysian flora existed in the Permian Period. The increase in aridity may have been due to continued regression, which reached its maximum in the Early Triassic Period. The appearance of a great number of the Cathaysian plants in the early of the Triassic (the ferns and the sphenopsids of the Korvunchana flora) within the territory of the Angara area also prove the change of conditions both in the Angara and Cathaysian areas.

The change of conditions outside the tropical regions, i. e. Siberia and Gondwana, was even greater. The floras of the temperate climate *(Cordaites* and *Glossopteris)* were replaced by those of tropical climates: the Cathaysian ferns appeared in Siberia and the Dipteridaceae ferns were known in the *Dicroidium* flora, not in India but in the other continents of Gondwana. Besides, some decrease in humidity occurred in these palaeofloristic regions as well. It seems to have resulted in the ceasing of coal formation. As a whole both Siberian and Gondwana areas do not show typical features of arid climates. The conditions for plant growth in Siberia and Gondwana differed from those in the European Sinian area in the humidity rather than in the temperature. It can be testified by the presence of tropical ferns in both northern and southern floras, as well as by the presence of such a distinctive plant as *Pleuromeia* in both areas, the maximum spread of which coincided with the tropical European-Sinian area.

The idea of the even temperature conditions all over Eurasia is in good agreement with the zoogeographical zonation of the Early Triassic seas. The

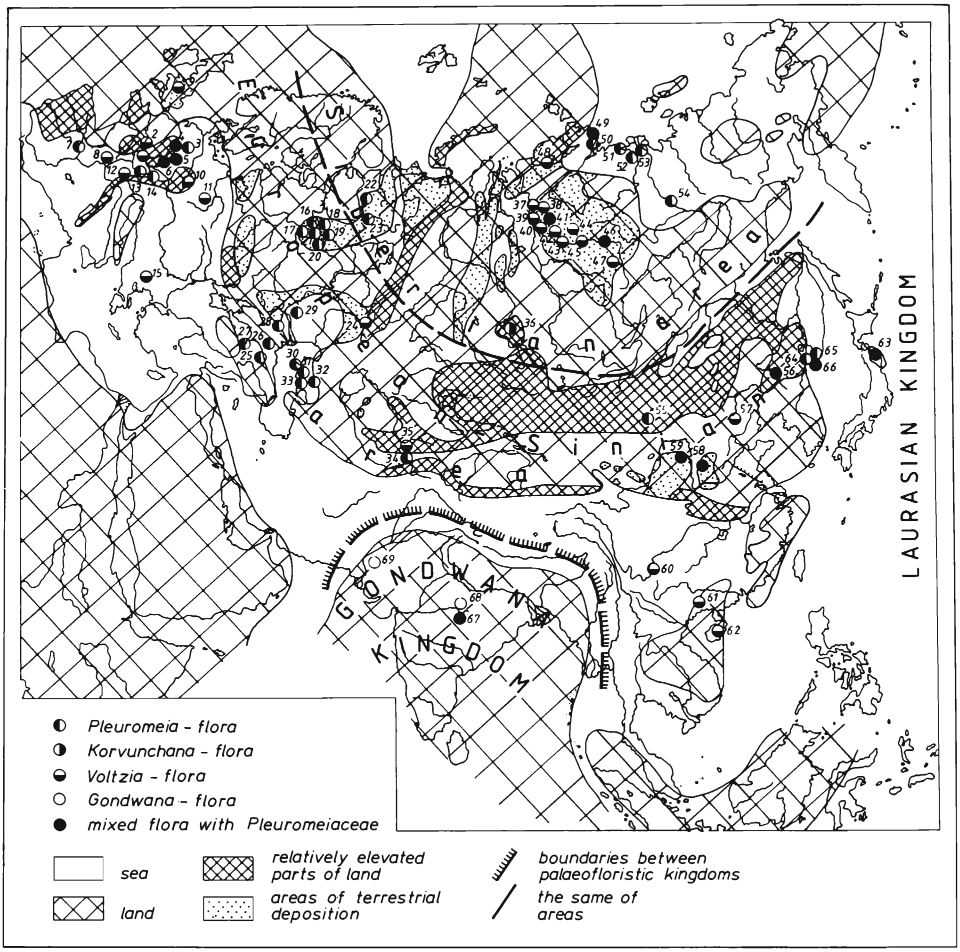


Fig. 63: Scheme of the palaeofloristic zonation of Eurasia in the Induan:
Localities (lists of plants are in the part three of the present book):
EUROPEAN PART OF THE USSR AND WESTERN KAZAKHSTAN: 1 – Novaya Zemlya, Northern Island, Admiralteystvo peninsula, cape Nivelir (list 31 e); 2–4 – the Pechora Basin: 2 – Byzovaya village (list 31 a) and the Yanyu River (list 31 d), 3 – the Adzva River (list 31 b), 4 – borehole Kusshor (list 31 c);
EASTERN SIBERIA AND NORTHERN KAZAKHSTAN: 5 – the Kuznetsk Basin (list 5, chart 8); 6–14 – the Tunguska Basin: 6 – Keta – Gorbiachin region, (list 60 a, Khakanchana Fm), 7–12 – Lower Tunguska region: 7–8 – the rivers Tutonchana, Vivi etc. (tributaries of the Lower Tunguska River), (list 60 c, Tutonchana Fm), 9–11 – central part of the Lower Tunguska River (with the tributaries Uchami, Taymura, Nydym etc.), (list 60 f, Tutonchana Fm), 12 – the Korvunchana River, (list 60 e, Tutonchana Fm), 13 – upper reaches of the Ilimpeya, Chunya, Taymura (list 60 g, Tutonchana Fm), 14 – watershed of the rivers Markha (tributary of the Vilyuy) and the Alakit (tributary of the Olenek)(list 60 h); 15 – Prianabarye (list 60 i, Kayalach Fm); 16–19 – Taymyr peninsula:

→

geographical differentiation of the marine fauna was very poorly expressed in the beginning of the Triassic Period. The tropical and boreal areas were evidently sufficient divided through to the end of the Early Triassic, but the main difference of the boreal fauna is in its low diversity and almost complete absence of endemic forms; at that time a great taxonomic diversity is characteristic only for the Tethys (KOZUR, 1973; DAGIS, 1976). In the Anisian the tropical fauna existed in Japan and Primorye. From the end of the Early Triassic the endemic forms appeared in the boreal faunas and their number gradually increased. That is to say, the differentiation of the temperature conditions is revealed somewhat earlier in the marine basins than in the continents. COLBERT (1968) considered that the decrease of temperature occurred in the beginning of the Early Triassic, as the tetrapods of that time (*Lystrosaurus* Zone and its correlates in the Eastern European platform) are small in size in comparison with those of the Late Permian. But the same features of the tetrapods can be explained equally well by the aridification and unfavourable drought conditions. The levelling of the temperatures all over the Eurasian territory is evident from the character and colonization of the plants and marine invertebrates and testifies to a general increase in temperature in the Early Triassic Period.

Ladinian-Karnian and possibly Early Norian time

An important change in plant distribution in the territory of Eurasia occurred in the middle of the Triassic. First of all, at that time only one large flora can be determined all over the territory (except India), though its content is variable to some extent in different parts of Eurasia. Individual floras of the different regions differ one from another, but at the same time they are closely related with each other. In addition, each flora has some features in common with those situated to the west or to the north and the other common features

←16 – wateshed of the rivers Uboynaya and Pura (list 61 a), 17 – the Range Kiryaka – Tas (list 61 c), 18 – cape Tsvetkov (list 61 d, Keshin and "Marininskiy" Fm), 19 – Chernokhrebetnaya River (list 61 e, "Mariniskiy" Fm); 20–21 – Northern Coast: 20 – village Ystanaakh-Khocho (list 62 b), 21 – the mouth of the Olenek River (list 62 c, the Induan); 22–29 – the Verkhoyansk Range, western and southern slopes: 22 – Kharaulakh Mountains (list 63 a), 23 – the Unguokhtakh River, the Orulgan Range (list 63 b), 24 – the Syncha River (list 63 c, 63 d, Taganzhinsk Fm), 25 – the Sobopol River (list 63 e), 26 – the Seymcheen River (list 63 f), 27 – the Tokur-Yurekh River (list 63 h), 28 – the Dolbuun River (list 63 i), 29 – the Yulegiir River (list 63 g); 30 – the Vilyuy syneclise, boreholes at the left bank of the Vilyuy River (list 62 f);
CENTRAL ASIA, SOUTH EASTERN ASIA AND THE FAR EAST: 31 – the Qinshui Basin of Shanxi in Northern China: Jiaocheng, Pingyao and Yushe (list 67 a, 67 d?, Luijiakou Fm), 32 – Fuyuan and Xuanwei, Eastern Yunnan in Southern China (list 68 a, Dongchuan Fm), 33 – Pan, Western Guizhou in Southern China (list 68 a, Dongchuan Fm).

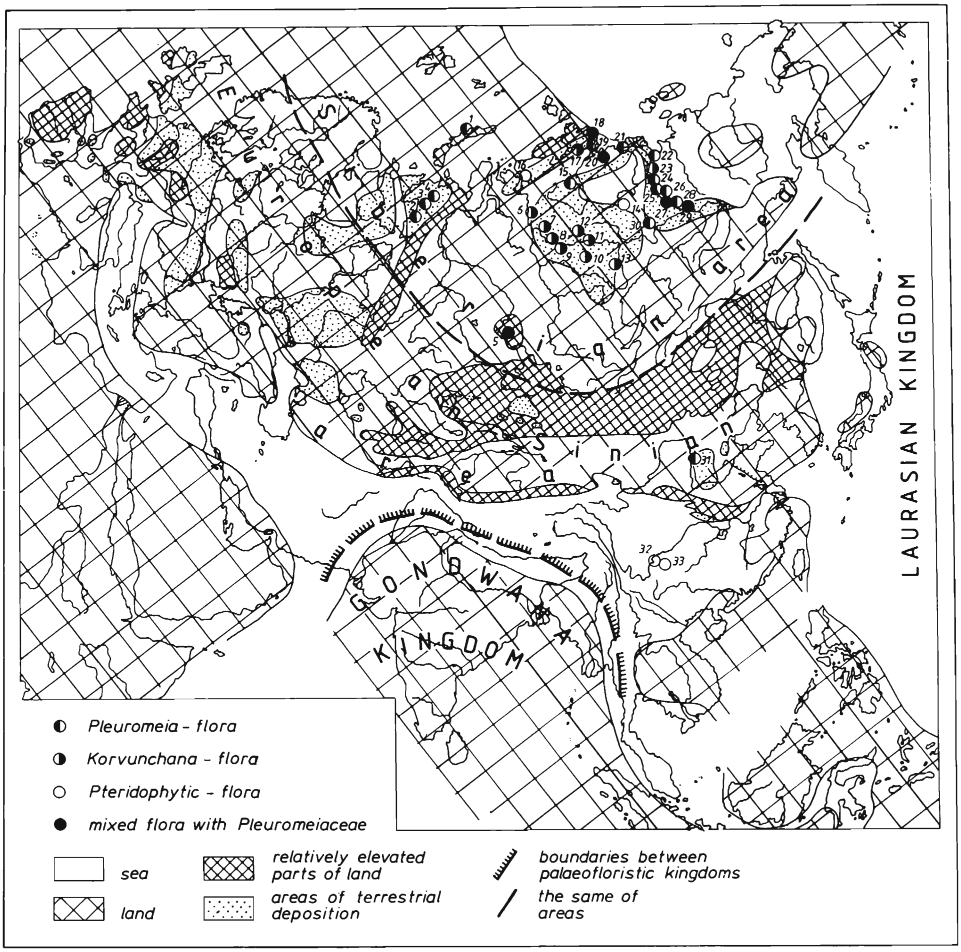


Fig. 64: Scheme of the palaeofloristic zonation of Eurasia in the Olenekian and Anisian: Localities (lists of plants are in the part three of the present book):
WESTERN EUROPE: 1–6 – central part of the German Basin: 1 – the Paris Basin (lists 2 a–2 d, 2 f, 2 g, 3 a), 2 – Eifel (lists 2 e, 2 h, 3 b), 3 – Subherzynische Senke (lists 1 m, 1 n), 4 – Hessische Senke (lists 1 d–1 i), 5 – Thüringer Senke (lists 1 j–1 l, 3 c), 6 – Süddeutsche Senke (Baden-Württemberg, Franken, Süd Thüringen - lists 1 a–1 c); 7–11 – marginal parts of the German Basin: 7 – Molina-de-Aragon, Spain (list 20 a), 8 – Lodeve and Creyseilles near Privas, southern France (list 10 a), 9 – Bromsgrove and Nottingham, Great Britain, English Midland (lists 13 a, 13 b),. 10 – Oberschlesien, Poland (list 18 a), 11 – borehole Radoszice 3, the Swiety Krzyz Mountains, Poland (list 17 a); 12–15 – the Alps, the Carpathians, the Balkans: 12 – Recoaro, Veneto, Italy (list 21 b), 13, 14 – the Karnischen Alpen, Austria (list 21 a), 15 – the Stara Planina Mountains, Yugoslavia and Bulgaria (lists 25 a, 25 b);
EUROPEAN PART OF THE USSR AND WESTERN KAZAKHSTAN: 16–21 – the upper Volga River in the southern part of Moscow syneclise (list 29 a, Rybinsk Fm), 22 – →

with floras placed to the east and to the south. Thus almost all floras of Eurasia are related to each other at that time. The Maleri flora of India, coeval with the *Scytophyllum* flora is of low diversity. It does not have any typical elements either of the *Scytophyllum* flora or of the *Dicroidium* flora of the southern continents. The position of India in the sytem of phytochoria of that time is thus still open to question.

← Koslan at the Mezen River in the northern part of Moscow syneclise (list 29 b), 23 – Zheshard at the Vychegda River in the northern part of Moscow syneclise (list 29 b), 24 – Petropavlovka village in Southern Priuralye (list 34 a, Petropavlovka Fm), 25–26 – Eastern Predkavkazye (list 37 a), 27 – gully Svinyachya in north western Caucasus (list 39 a), 28 – borehole Sadovaya 1 in Pricaspian Depression (list 40 b), 29 – Big Bogdo Mountain in Pricaspian Depression (list 40 a, Bogdo Fm), 30 – Western Karatau in the Mountaneous Mangyshlak (list 42 a), 31 – Eastern Karatau in the Mountaneous Mangyshlak (list 42 a), 32 – Karashek in the Mountaneous Mangyshlak (list 42 a), 33 – borehole Rakushechnaya in Southern Mangyshlak (list 42 b, c);
MIDDLE ASIA: 34 – the Yokunzh River, south western Darvaz (list 50 a), 35 – watershed of the rivers Isfara and Sokh, Southern Fergana, list 52 a);
EASTERN SIBERIA AND NORTHERN KAZAKHSTAN: 36 – the Kuznetsk Basin (list 59 and chart 8 partly), 37–47 – the Tunguska Basin: 37–38 – Keta – Gorbiachin region (list 60 a, Kutaramakan and Khonomakit Fm, 39–42 – Kureyka – Severnaya region (list 60 b, Kochechum, Nidym, Dvurogiy Fm), 43–46 – Lower Tunguska region: 43 – the Korvunchana River (list 60 d, Korvunchana Fm), 44–46 – central part of the Lower Tunguska River (list 60 f, Nidym, Bugarikta, Korvunchana ? Fm), 47 – the upper reaches of the rivers Ilimpea, Taymura, Chunya (list 60 g, Korvunchana and Nidym Fm); 48–50 – Taymyr peninsula: 48 – the Fadyu-Kuda River (list 61 b, the upper part of Mamonov Fm), 49 – cape Tsvetkov (lists 61 d, 61 e, Eastern Taymyr, Osipay, "Faduy-Kuda" Fm), 50 – the Chernokhrebetnaya River (list 61 b, "Fauy-Kuda" Fm); 51–53 – Northern Coast: 51 – mouth of the Olenek River (list 62, the Olenekian), 52 – Kira-Kos-Teeryuteekh village at the Buur River, tributary of the Olenek River (list 62 d), 53 – Tasary at the Lena River near its mouth (list 62 e); 54 – the Syncha River in the western slope of the Verkhoyansk Range (list 63 d, Sygynkan Fm);
CENTRAL ASIA, SOUTH EASTERN ASIA AND THE FAR EAST: 55 – Noyan Somon in southern Mongolia (list 66 f); 56–59 – Northern China: 56 – Linjia, Benxi city, Liaoning (list 57 g, Linjia Fm), 57 – Chengde, Xishan, Hebei (list 67 e), 58 – Pingyao and Yushe, Qinshui Basin of Shanxi (lists 67 b, 67 c, Heshankou Fm), 59 – Ordos, Shaan-Gan-Ning Basin (list 67 h, Ermaying Fm); 60–62 – Southern China: 60 – Fuyuan, Eastern Yunnan (list 68 a, Yunninjeng Formation), 61 – Yanshuitan (Kimura, 1984), 62 – Qionghai, Hainan island (list 68 b, Jiuqujing Fm); 63 – massif Kitakami in Japan (list 69 a); 64–66 – Southern Primorye (list 71): 64 – The Vtoraya Rechka and cape Basargin, 65 – The Shitukhe River and cape Kom-Pikho-Sakho, 66 – Island Russkiy; 67 – South Rewa in India (lists 80 a–g), 68 – Nidpur in India (lists 77, 78, 79); 69 – Sarai village in the Salt Range of Pakistan (list 85).

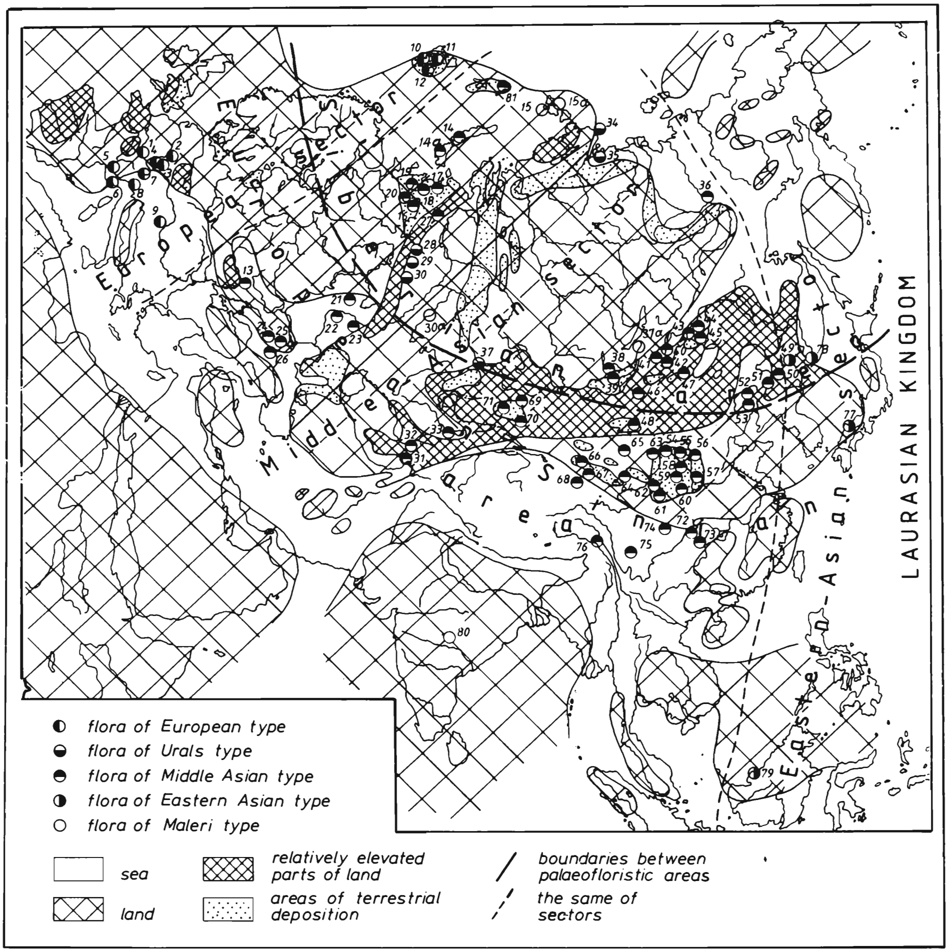


Fig. 65: Scheme of palaeofloristic zonation of Eurasia in the Ladinian and Karnian: Localities (lists of plants are in the part three of the present book):

WESTERN EUROPE: 1–4 – central part of the German Basin: 1 – Paris Basin (lists 4 f, 7 a), 2 – Subherzynische Senke (lists 4 e, 5 e), 3 – Thüringer Senke (list 4 d), 4 – Süddeutsche Senke (Baden-Württemberg, Franken, Süd Thüringen – lists 4 a–c, 5 a-d, 6 a; Basel environs in Switzerland – list in chart 5); 5–6 – marginal parts of the German Basin: 5 – Vanoise, dept. Savoie (list 11 a), 6 – Crocetta, Mont Charven, Lauce (lists 11 b–d); 7–9 – The Alps, Carpathians, Balkans: 7 – Lunz (list 22 b, chart 12), 8 – Raibl, Zoldo and Gardo; St. Cassian (list 22 a and chart 11; lists 22 c–d), 9 – Mecsek (lists 23 a–b);

SVALBARD: 10 – Spitzbergen, 11 – Barentz, 12 – Edge island;

EUROPEAN PART OF THE USSR AND WESTERN KAZAKHSTAN: 13 – villages Nikolayevka and Garazhovka in the Donets Basin (lists 30 a–c); 14 – bay Krestovaya in the Northern Island of Novaya Zemlya (list 32 b), 14 a – peninsula Britvin in the Southern Island of Novaya Zemlya (list 32 c); 15 – Island Zemlya Georga in Franz-Joseph Land (list 32 d); 15 a - Greem Bell Island in Franz-Joseph Land (list 32 e); 16 – Big ⟶

The most noticeable changes in the floras of that time can be traced from west to east (fig. 65). As a result the territory of Eurasia can be subdivided into the following three sectors: European, Middle Asian and Eastern Asian. The latitudinal differences in the floras can be observed when you analyse distribution of plants inside of a sector.

For the first time the phenomenon of the longtitudinal differentiation of the landscapes, i. e. the existence of the above mentioned sectors (sectoriality) is applied to the palaeofloral data (Dobruskina, 1982 a, 1982 b). However, this phenomenon was noticed long ago by specialists in physical geography and zoo-

← Synya Depression in the Pechora Basin (lists 32 a, 33 b), 17 – Korotaikha Depression in the Pechora Basin (lists 32 a, 33 c), 18–20 – Pechora syneclise in the Pechora Basin (lists 32 a, 33 a); 21 – watershed of the rivers Sakmara and Belaya in Southern Priuralye (lists 35 d–g, 36 c–i), 22 – gullies Bukobay and Burtya and village Lysov in Southern Priuralye (lists 35 b–c, 36 b), 23 – The Ilek River Basin in Southern Priuralye (lists 35 a, 36 a); 24–26 – Eastern Predkavkazye (list 38); 27–30 – The Eastern Urals: 27 – Lyulino Depression (list 44 j), 28 – Bogoslovsk and Veselovka depressions (lists 44 a, e, f, i), 29 – Bulanash-Elkino, Anokhino and Kvashnino depressions (lists 43 a, 44 h), 30 – Chelyabinsk Basin (lists 43 b, 44 c); 30 a – Burluk Depression (list 45 b);
MIDDLE ASIA: 31 – South-western Darvaz (list 51 a), 32 – Madygen (list 53 a–i) and Kamysh-Bashi (list 54 a), 33 – The Ketmen Range (list 55 a);
EASTERN SIBERIA AND NORTHERN KAZAKHSTAN: 34 – cape Tsvetkov in the Taymyr peninsula (list 61 d, Kuldima Fm); 35 – Anabar Coast (list 62 a); 36 – The Tumara River at the southern slope of the Verkhoyansk Range (list 64 b), 37 – Semeytau Mountains in Northern Kazakhstan (list 64 b); 37 a – Zabaykalye (list 64 c);
CENTRAL ASIA, SOUTH-EASTERN ASIA AND THE FAR EAST: 38–48 – Mongolia: 38 – The Selenga River (undetermined conifers), 39 – watershed of the rivers Orkhon and Tola (lists 65, 66 a), 40 – Dzhargalantuingol River (list 66 e), 41, 42 – Big bend of the Kerulen River: Murongol grabens and Dashibalbar (list 66 d), 43–45 – watershed of the rivers Uldza and Kerulen: Gertuin (44), Khutuinnur (45), Shaldza (43) depressions (list 66 f), 46 – Bayan – Zagan somon (list 66 b), 47 – mine Barun Zogto (list 66 c), 48 – Noyan somon (list 66 g); 49–71 – Northern China: 49 – Tuopankou (list 67 k), 50 – Beishan (list 67 l), 51 – Dajianggang, Shuangyang county (list 67 m), 52 – Laohugou, Lingyuan county, Jinlingsi, Yangshan Basin (list 67 n), 53* – Yancaogou, Beipiao, 54 – Ordos, Shaan-Gan-Ning Basin (list 67 h, Tongchuan Fm), 55–64 – The Hwang Ho River (lists 67 i, j: 55 – Shen-Mu, 56 – Hsinhsien, 57 – Wumen, 58 – Wu Pao, 59 – Suite, 60 – Yenchang, 61 – Huating, 62 – Kuyuan, 63 – Linyii, 64 – Wuwei), 65 – Alashan Mountains (list 67 q), 66* – Nanyinger, 67 – Mole (list 67 p), 68* – Babaoshan, 69* – Xiaoquangou, northern part : Junggar and Tulufan Basins, 70* – Xiaoquangou, southern part: Tarim Basin, 71 – Chinese Dzungaria (list 67 r); 72–76 – Southern China: 72 – Badong (Patung), Lichuan district, W. Hubei (list 68 c), 73* – Hongjiaguau, Sangzhi, Hunan, 74 – Tiechingshan, Jiangyou, N. Sichuan (lists 68 d, f, g) , 75* – Weishan and Jiangchuan (list 67 e), 76 – Qamdo, Eastern Xizang (list 68 i, Jiapila Fm); 77 – Yamaguti prefecture in Japan: Mine (list 70 b, Momonoki Fm), Asa (list 70 c, Yamanoi Fm), Asa (list 70 d, Tsubuta Fm); 78 – Southern Primorye (list 72 partly); 79 – Crusin in Sarawak (list 76); 80 – Naogaon, Bogapalmila, Tiki in India (lists 82 a–c, Maleri Fm).
Mark* shows that information about the locality was received from Kimura, 1984.

geography and was discussed in the corresponding literature (Isachenko, 1965; Chernov, 1975 etc.). It is enough to look at the map of the world with climatic belts and areas or geographic belts and natural "zones" to be convinced of the existence not only of latitudinal boundaries but also of some longtitudinal ones, crossing the former. On the map of the climatic belts and areas of the World together with the latitudinal boundaries of the climatic belts the longtitudinal boundaries of the areas are obvious and they are often crossing the boundaries of the belts. On the map of geographical belts and natural "zones" the belts are located approximately latitudinally, as well as climatic belts while the boundaries of the natural "zones" have any direction from latitudinal to longtitudinal. That is why the same natural "zone" happens to be situated within two, three or even four adjacent geographic belts. For instance, the "zone" of savanna and sparse growth of trees is located within the three belts: subtropical, tropical and subequatorial; the "zone" of variable-humidity forests – within the four belts: temperate, subtropical, tropical and subequatorial; the "zone" of mixed forest – within the two belts of North America: temperate and subtropical. In addition to that there are certainly some differences in flora and vegetation in the northern and southern parts of such "zones". This can be obviously seen in the corresponding maps of a larger scale.

In different kinds of zonation the following terms such as: longtitudinal differentiation of the landscapes, meridional zonation, provinciality or sectoriality etc. were used for phenomena not confined to the idea of latitudinal zonation. Isachenko (1965) in his book "The fundamentals of the study of landscapes and physicogeographical zonation" limited the term "zonation" to latitudinal zonation, depending mainly on the distribution of solar radiation on the surface of the Earth. He united in the one term, "azonation", the longitudinal differentiation of landscapes, the meridional zonation of Komarov, and provinciality sensu Dokuchaev, considering it to be a common geographical pattern. In contrast to latitudinal zonation which caused by external factors (solar radiation; distribution of aerial masses over the surface of the Earth), the causes of azonation are the internal processes such as development of the Earth, its geological history, tectonics and the evolution of the organic world. Azonation resulted in the differentiation into continents and oceans and in the generation of the major structural-morphological subdivisions of the continents; and in forming the relief of the Earth.

Thus, the azonal phenomenon of the first order is the division of the Earth into continents and oceans, and the azonal phenomena of the subsequent orders – the successive geographical changes on the continents which can be observed inside continents in direction from the ocean coast to the centre of the continent; the longitudinal (provincial) differentiation in top-soil characteristics within the same latitudinal zone etc. The longitudinal-climatic borderlines are usually related to orographical barriers. In the light of these ideas the term "natural zone" is unsuitable, as it is related to the azonation.

The zonal and azonal divisions do not coincide but cross one another and there is no direct relationship between them. The "focus" in which division of "zonation" and "azonation" meet is the **landscape.** Thus, the landscape is a unit of both zonal and azonal subdivision. For zonal subdivisions of different rank the following terms are used: **zone, subzone, belt;** for azonal subdivisions the terms are: **area, country, sector.** Such a subdivision of azonation as **country,** for instance, can include the parts of two or more belts or zones.

A SECTOR, being one of the subdivisions of azonation is not a member of the conventional hierarchy of phytochoria applied in palaeobotany: kingdom, area, subarea, province, count, for all of them are the terms of latitudinal zonation. A sector can have different relationships with the above listed phytochoria. It can be part of an area or of a subarea, can cross their boundaries and can include at the same time parts of two or three areas and subareas.

The azonation, to a certain extent, can be considered a main condition determining (by re-distribution of heat and moisture) specific local forms of zonal pattern. On the other hand, it may be said that zonal factors originate a definite background for the manifestation of azonal pattern (ISACHENKO, 1965, p. 106).

The development of the organic world, the origin of new groups, the forming of new floral and faunal associations are directly related to the geological history of the Earth; are some of the consequences of its internal processes. At the same time their propagation over the earth's surface is controlled by some external factors. That is why both azonal and zonal units are distinguished in the biogeographical division of the territory. Thus, CHERNOV (1975) who studied the natural zonation and animal kingdom of land thought that the zonal divisions had to correspond to the kinds of animals while the zoogeographical (i. e. azonal) divisions – to the faunal assemblages, that is the totality of forms of common origin. That is why he considers that "the greater or lesser lack of coincidence of the main geographic divisions with landscape-zonal divisions is inevitable and can be explained quite logically" (CHERNOV, 1975, p. 176). The configuration of azonal zoogeographic divisions is a result, as in our case, of the history of the Triassic floras, of the history of the development of the fauna, of the place of origin of its main components and of their migration routes.

In the case of zoogeography and phytogeography only after maps of zonation have been prepared, can we attempt to judge which communities of plants and animals originated together and where their centres of origin and migration roots might have been. The palaeontological data give witness to these phenomena. We do have an opportunity to draw a real picture of all these events, about which the zoogeographers and phytogeographers speak only hypothetically. Studying the sectoriality in the palaeofloral zonation of Eurasia in the middle of the Triassic we can see directly the very moment of origin, composition and beginning of migration of the Mesophytic flora that is reflected in the azonal divisions.

The existance of the sectors may be related to the migration of plants from their centres of origin (spreading centers); but not to climatic zonation, which was the most important cause determining the borders of palaeofloral areas and subareas during the Mesozoic. The degree of manifestation of different sectors depends on how far the migration had gone. This spreading only began in the Ladinian-Karnian. Later on the migration of plants led to the smoothing out of these differences; by the Jurassic they remained only in relic forms: in the existence of provinces within the European-Sinian area.

In the middle of the Triassic the Eastern-Asian sector differs most essentially from others. The first appearance in the geological record of the Dipteridaceae and Cycadocarpidiaceae in the Ladinian and their great diversity in the Karnian was noted in this sector. The Marratiaceae were absent there, but were widely spread all over the rest of Eurasia, except the Eastern Urals. As with the peltaspermous pteridosperms they were greatly abundant in the intercontinental parts of Eurasia. The Middle Asian sector is characterized by a very great number of peltaspermous pteridosperms, by the presence of Marratiaceae (connecting this sector with the European sector), by the absence of the Dipteridaceae and by minor amounts of the Cycadocarpidiaceae. In the European sector the abundance of peltaspermous pteridosperms is not great, the Dipteridaceae appeared only in the Karnian and the Cycadocarpidiaceae are practically absent. The Czekanowskiales are present only in the Eastern Urals, Mongolia and Primorye. The primitive ginkgophytes (Glossophyllaceae) are known in the European sector and in Priuralye; though their presence is supposed in other floras of the Middle Asian sector (Ginkgoaceae and Sphenobaieraceae are absent in the *Scytophyllum* flora). There occur neither cycadophytes (except *Taeniopteris*), Marratiaceae or Dipteridaceae in the Eastern Urals.

The *Scytophyllum* flora is characterized by the appearance of a great number of new plant groups in comparison with the floras of the first half of the Triassic. These include the Dipteridaceae, Bennettitales, Czekanowskiales, and Cycadocarpidiaceae. Peltaspermous pteridosperms and the Glossophyllaceae had the first appearance in the Permian; their spreading was proceeding meanwhile. The sharp phytogeographical differentiation of the Early Triassic floras also left its imprint on the spreading of those forms of the *Scytophyllum* flora which were inherited from both Korvunchana and Bundsandstein floras.

Thus, the discernable provinciality of that time was caused by the connection of some plant groups to their centres of origin, which was most intensive in the Middle Triassic. Their migration started because of the destruction of the largest barrier that existed in the Permian between the Angara and Euramerian kingdoms. These were the Urals-Tien Shan Hercynides (Meyen, 1969 b), the southern branch of which seems to have been fully eroded by the beginning of the Triassic. At that time the Urals, as well as the mountains on the border between the Middle Asian and Eastern Asian sectors in the north-eastern part of China continued to be a major barrier to plant migration.

The change in the content of the floras and their distribution in space in the middle of the Triassic was accompanied by significant changes in the character of sedimentation, by climatic changes and by increasing differentiation of the marine fauna. The transgression which had started in the Olenekian occupied large territories by the Middle Triassic. It led to a more humid climate, in the deposition of gray coloured terrestrial beds and in the beginning of coal formation, though on a limited scale (German Basin, Alps, Japan, Primorye, Eastern Urals, Middle Asia). The differentiation of the marine faunas in the beginning of the Late Triassic reached its maximum. The Tethyan faunas remained diverse whilst endemism at different taxonomic rank, was characteristic of the boreal faunas. Five regional faunal provinces are distinguished by Kozur (1973 b) in the Tethys. By the middle of the Triassic conditions favourable for the development and spreading of both marine fauna and land flora have arisen.

If one follows the changes in the floral content within each sector or even in some individual floras disposed approximately along the same meridian, some specific patterns related to climatic zonation can be traced. The climatic zonation was not recognized for a long time, as it was disguised by more expressed differences in the sectoriality of floras. Besides, there isn't a single criterion – either a group of plants in common, or even one or two genera in common, that could serve as an indicator for climatic zones. In each region different groups and different genera are more conspicuous. But as a whole they give a picture of the spreading of more heat-loving or cold-loving floras.

For instance, comparing very similar floras of northern and southern Priuralye the following differences can be traced: 1) an abundance of *Kalantharium* representatives in the Pechora Basin, whereas it is practically absent in the southern Priuralye; 2) the comparative macrophylly of the peltaspermous pteridosperms in southern in comparison with northern Priuralye (see fig. 53 & 54); 3) a larger amount of cycadophytes in southern Priuralye. Continuing with this comparison further to the south more diversity and more macrophylly of the peltaspermous pteridosperms in the floras of Middle Asia can be found (fig. 55), as well as the increasing in abundance of cycadophytes, the genus *Pterophyllum* especially. The greater macrophylly of the peltaspermous pteridoserms, particularly of the genus *Vittaephyllum,* distinguishes the Madygen flora from the floras of the Eastern Urals and the Donbass (Nikolayevka).

The floras of the Eastern Urals, except those of Anokhino and Bogoslovsk, differ very distinctly from the floras of Priuralye. This difference is due to some distinction in age of these floras (see chart 8), and is also accounted for by the significance of the Urals in the Late Triassic, being a barrier to plant migration (Kalantar, 1976). The same barrier explains the fact that the floras of the Pechora Basin, located approximately at the same latitude as the Eastern Urals floras or more to the north, are closer to the southern floras (of Southern Priuralye) than to those of the coal-bearing deposits of the Eastern Urals. The border, shown by Krassilov & Shorokhova (1975) between the floras of Priuralye and Zauralye, does not follow climatic zones. It reflects the peculiarity of the floras of the Eastern Urals, caused by the existence of the barrier. The latitidunal indicator of the border is the southern limit of the Czekanowskiales and, in contrast to the longtitudinal indicator, separates zones of different temperatures.

Comparing the floras of the Eastern Urals with the very close and obviously coeval flora of Garazhovka in the Donbas, the absence of Czekanowskiales in the Donbass and their abundance in the Eastern Urals is striking. The same difference is even more pronounced between the very close floras of Mongolia (with Czekanowskiales) and Northern China (without them).

The comparison of the coeval floras of Japan and Primorye also leads to a conclusion about the warmer climate of the more southern of these floras: the Czekanowskiales are present in Primorye, while the Dipteridaceae and cycadophytes prevail in the floras of Japan. According to palaeozoological evidence Japan and Primorye were within the same tropical zone of the Tethys in the Karnian, while the above noted data about the plants shows them to fall into two different zones. This apparent contradiction seems to be connected with a different time in the Karnian age, while studying the Karnian fauna and flora of Primorye. When analyzing the plants we have at our disposal material from Upper Ladinian and Lower Karnian sediments, whereas the palaeozoologists examining the marine invertebrates have the fossils from the upper part of the Karnian sediments. In other words, the position of Primorye near the border of the boreal and Tethys areas (SHOROKHOVA, 1975 b) led to the fact that minor changes in climate shifted this territory now to the northern zones (Upper Ladinian-Lower Karnian), now to the southern (Upper Karnian). Variations of such type continued into the Norian.

Now it is time to touch upon the differences in the floras of Western Europe and Svalbard, the similarity of which has already been mentioned. The flora of Svalbard is characterized by a lower diversity and by the presence of the genus *Paratatarina* which is absent in Western Europe. The significance of this genus in the evaluation of climatic conditions is still open to question.

Thus, the border between the more and less heat-loving floras in the Ladinian-Karnian can be traced between the floras of Svalbard and Western Europe, Northern and Southern Priuralye, Mongolia and Northern China, Primorye and Japan. In the Eastern Asian sector the floras of Thailand and Sarawak are also related to the more southern zone. The floras of India do not give enough information about their position.

The essential reconstruction of the plan of phytochoria distribution in the middle of the Triassic resulted in the appearance of a picture typical of the Mesozoic era (Mesophytic). That is why I take the names of the Jurassic and Cretaceous phytochoria (VAKHRAMEEV, 1957, 1966, 1975) for the phytochoria of the Triassic. The northern and southern phytocoria are named Siberian and European-Sinian respectively. The differences already noted make it possible to determine them as areas and not – subareas, as the author previously thought (DOBRUSKINA, 1978), of a single Laurasian Kingdom which also included the Northern American floras of the same age. These areas reflect the climatic differentiation of the Ladinian-Karnian floras, while the sectors (European, Middle Asian, and Eastern Asian, with names following the provinces of the Jurassic) reflect the centres of origin and spreading of the most important groups of Late Triassic plants.

The European-Sinian area most likely belonged to the zone of tropical climate. MÄGDEFRAU (1956) wrote about the floras of the German Basin belonging to the tropical zone, after analyzing both floral and lithological data. His results can be applied to the whole European-Sinian area, because everywhere the cycadophytes are abundant and annual rings (though unclear) often can be seen. Unlike the arid tropical zone of the first half of the Triassic, this is a humid tropical zone: ferns do not have xerophytic features; ferns and cycadophytes have mesomorphic blades; coals are present.

The Siberian area belonged to the non-tropical zone, as there were no cycadophytes or Dipteridaceae in the floras of the Eastern Urals. Nevertheless, the differences in climate between these two areas were probably not so great. Not withstanding the indicated differences, the northern floras are characterized by some features of warm climate: the Triassic wood of Svalbard shows the same indistinct annual rings as in Western Europe; the typical European fern *Bernoullia* is met far to the north (in the Aldan). On the whole, the Ladinian-Karnian floras of the Siberian area are not sufficiently known. The Ladinian *Neocalamites carcinoides* and *Podozamites* sp. from Taymyr do not add much to the characterization of the climate of that region.

The differentiation of marine faunas at the beginning of the second half of the Triassic is more evident than in the first half, and is more obvious than the differentiation of the floras. But the latter can be connected with our poor knowledge of the Ladinian-Karnian floras of the Siberian region.

Colbert (1968) links the Late Triassic with a rise in temperature, (as tetrapods of that time were represented by larger forms) and with a uniformity of climate, which he compares with a uniformity of the climate (?!) in the Late Permian. Aside from mentioning that the assertion about the uniformity of climate in the Late Permian arouses surprise (see Meyen, 1970), it is doubtful that the Late Triassic tetrapods permit such a conclusion: the information about tetrapods of the Late Triassic of Siberia is practically absent, so there is no possibility of comparing European & Siberian faunas. Colbert had the possibility of comparing only faunas of Western Europe and North America, but they belonged to the same climatic zone. Tetrapods of the southern continents are related to other groups.

Norian-Rhaetian time

Beginning from the Middle Norian, climatic differentiation is more evident and is approaching the conditions which existed in the territory of Eurasia in the Early Jurassic. More strongly pronounced climatic zones may be explained by the fact that the migration of plants at that time led to a sufficient levelling of plant assemblages within the climatic zones. It was the result of the elimination of barriers at least in the east of Asia. The significance of the Urals during this interval remains open to question due to the absence of floras from the Eastern European Platform and Priuralye.

The Norian-Rhaetian floras are scattered irregularly over the territory of Eurasia (fig. 66): they are uncommon in Siberia; abundant in Western Europe

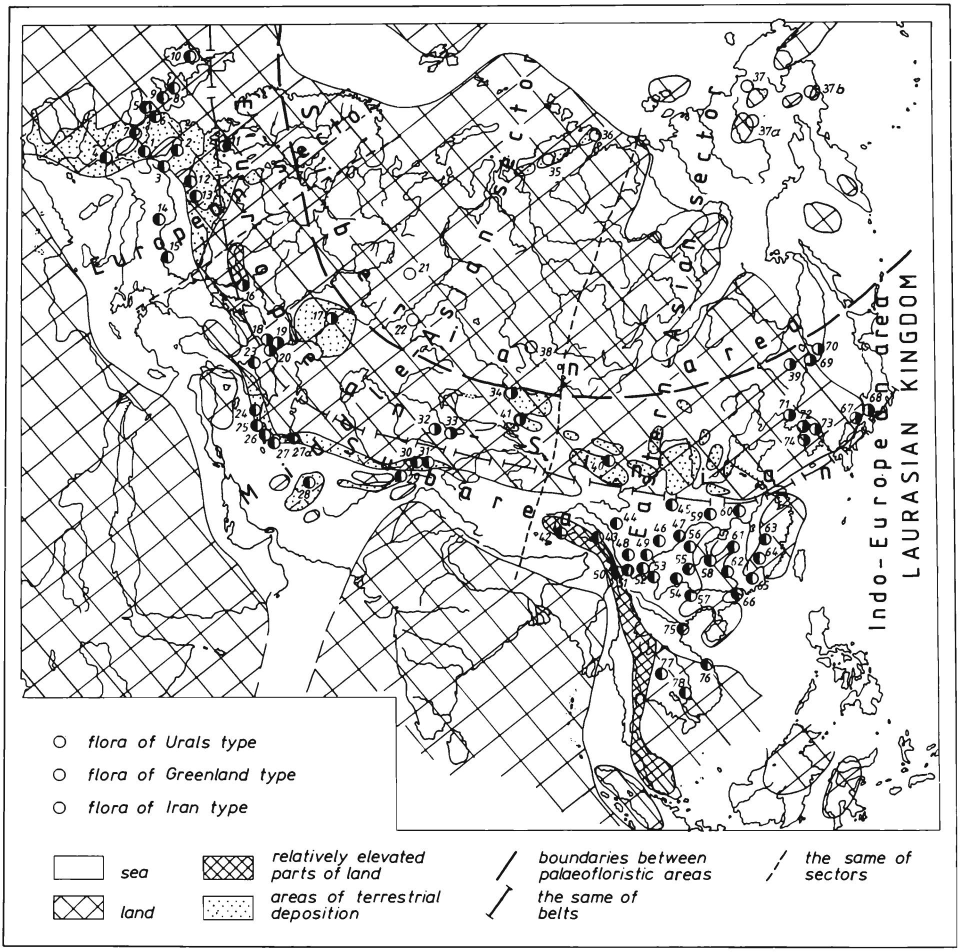


Fig. 66: Scheme of palaeofloristic zonation of Eurasia in the Norian and Rhaetian: Localities (lists of plants are in the part three of the present book):

WESTERN EUROPE: 1–3 – central part of the German Basin: 1 – Saint Etienne (list 9 a) and Luneville (list 9 b) in the Paris Basin, 2 – Seinstedt in Subherzynische Senke (list 8 b), 3 – Coburg in Süd Thüringen, Süddeutsche Senke (list 8 a); 4–13 – marginal parts of the German Basin: 4 – Lozere (list 12 a), 5 – Cherbourg, Cotentin (list 12 b), 6 – Boulonnais (list 12 c), 7 – Autin (list 12 d), 8 – English Midland (lists 14 a, b), 9 – Bridgend, Hensfield (list 15 a, b), 10 – Antrim, Ireland (list 14 c), 11 – Scania, southern Sweden (list 16 a), 12 – Velun, Poland (list 19 a), 13 – borehole Kolaczkowice near Rawicz, Poland (list 19 b); 14 – Mecsek Mountains, Hungary, in the Carpathians (list 23 c, d), 15 – Banat, Roumania, in the Carpathians (list 24 a);

EUROPEAN PART OF THE USSR AND WESTERN KAZAKHSTAN: 16 – village Novorayskoye (lists 30 e, f) and Sukhaya Kamenka (list 30 d) in the Donets Basin; 17 – Kusan-Kuduk in Pricaspian Depression (list 41 a); 18–20 – Eastern Predkavakazye (list 3B);

→

(and Greenland) and in the southern parts of Eurasia; and are unknown in India. The northern Siberian palaeofloral area is characterized by the abundance of ferns of the genus *Cladophlebis* (other ferns are insignificant), of ginkgophytes and Czekanowskiales, and by the absence of cycadophytes (except *Taeniopteris*).

The great significance of the fern family Dipteridaceae is characteristic of the European-Sinian palaeofloral area – which occupies the remainder of

← THE EASTERN URALS AND TURGAY: 21 – Chalyabinsk Basin in the Eastern Urals (lists 43 c, 44 d), 22 – Turgay Basin in Western Kazakhstan (list 45 a);
SOUTH WESTERN ASIA: 23 – village Dzhermanis at the Vedi River in Zakavkazye (list 46 a); 24 – Hif (list 47 a) and Sapuin (list 47 d) in Elburz, 25 – Fechend (list 47 e), Laloun (list 47 f), Dorud (list 47 h), Shemshak (list 47 i), Ashtar (list 47 j) in Elburz, 26 – Zirab 5, Shirkola, Apun (list 47 g) in Elburz, 27 – Tash (list 47 b) and Asterabad (list 47 c) in Elburz, 27 a – Shah Pasand (list 47 k) in Elburz; 28 – the Kerman Basin in central Iran (list 47 m, Darbidkhun Fm); 29 – the Kalawch River (list 48 a) and the Pyandzh River (list 48 b) in north eastern Afghanistan; 30–31 – the Central Pamirs (lists 49 a–r);
MIDDLE ASIA: 32 – the Son-Kul Lake, the Range Kavak-Tau (list 56 a), 33 – the Issyk-kul Lake (list 57 a), 34 – the Kenderlyk mulda (list 58 a);
EASTERN SIBERIA AND NORTHERN KAZAKHSTAN: 35 – the Fadyu-Kuda River in Taymyr (list 61 b, the upper part of Mamonov Fm), 36 – cape Tsvetkova in Taymyr (list 61 d, Nemtsov Fm); North-East of the USSR: 37 – the Big Anyuy River Basin; 37 a – the Omolon River Basin; 37 b – the Anadyr River Basin (list 63 k); 38 – the Pyzha River in the Mountaneous Altay (list 64 a);
CENTRAL ASIA, SOUTH-EASTERN ASIA AND THE FAR EAST: 39–41 – northern China: 39 – Jilin (list 67 c, Malugou and Tuopangou Fm), 40* – Jieza, 41 – Xiaoquangou, southern part: Tarim Basin, Urumchi, Fuyan, Xijang (list 67 f); 42–66 – southern China: 42 – Amdo-Baquen area, N. Xizang (list 68 h, Tumaingela Fm), 43 – Qamdo, E. Xizang (list 63 i, Jiapila and Bagong Fm), 44 – Lamaya, W. Sichuan, east part of Qinghai-Xizang plateau (list 68 k, Lamaya Fm), 45 – Kwangyuan, N. Szechuan (list 68 l, Xujiache Fm), 46 – Yungjen, Yunnan (list 68 m, Daqiaode Fm), 47 – Yungjen, Yunnan (list 68 m, Dajing Fm), 48* – Baiguowan, Sichuan, 49 – Baoding, including Hueli, SW Sichuan (list 68 o, p), 50* – Yunnan, Baijizu Fm, 51* – Yunnan, Shizongshan Fm, 52* – Yunnan, Xiangyun Fm, 53 – Taipin Cnag (list 68 r, Yipinlang Fm), 54 – Kiang-Ti (list 68 s), 55 – Kueiyang and Anlung (list 68 t, u), 56* – Guizhou, Erqiao Fm, 57* – Fulongao and Pingdong, Guizhou, 58* – Hubei, Xiaojiangkou Fm, 59* – Hubei, Shazhenxi Fm, Hsiangchi Gr, 60* – Hubei and E. Hunan, Wuchang Fm, lower part, 61* – Hubei and E. Hunan, Anyuan Fm (including Pinghsiang and Lilin and Nan-hsiang coal mine, Hunan, Lui-yang-hsien = list 68 v), 62 – Hubei, Xiaoping Fm (including Kaomin?, Siaoping Ser - list 68 w), 63 – Fujian (list 68 x, Jiaokeng Fm), 64 – Fujan (list 68 x, Dakeng Fm), 65 – Fujan (list 68 x, Wenbinshan Fm), 66 – Kanton (list 68 y); 67 – Nariwa, Okayama pref., Japan (list 70 a), 68 – Maizuru, Kioto pref., Japan (list 70 e); 69 – southern Primorye (list 72), 70 – northern Primorye (list 72), 71–74 – Korea (list 73): 71 – Dadong coal-field, 72 – Gimpo and Yeoncheon coal-field, 73 – Dangyang and Mungueong coal field, 74 – Chingnam coal field; 75 – Northern Viet Nam (list 74 a), 76 – Central Viet Nam, Annam, Nong Son (list 74 b), 77 – Khorat, Thailand (list 75 a), 78 – Phum Laak, Cambodia (list 75 b).

Eurasia and is a part of the Indo-European palaeofloral area. As the picture of palaeofloral zonation is very similar to that of the Jurassic, I include India provisionally within the limits of the European-Sinian subarea, as was the case from the beginning of the Middle Jurassic.

In the European-Sinian palaeofloral area two belts are distinguished. They were recognized as far back as 40 years ago by HARRIS (1937). The northern Greenland-Japan belt is traced from Greenland through southern Sweden to Japan. It is characterized by the combined presence of the Dipteridaceae, Czekanowskiales and Ginkgophytes. The southern Iran – Viet Nam belt is traced from the central part of the German Basin through Iran, Afghanistan and the Pamirs to Southern China and Viet Nam. The ferns (mainly Dipteridaceae) and cycadophytes are dominant within this belt. Ginkgophytes and Czekanowskiales are practically absent.

As in the previous Ladinian-Karnian interval three sectors – in the west, in the centre and in the east of Eurasia – are distinguished, but their separation is now not so sharp. As before, the differences between the sectors are traced within the territory of both belts of the European-Sinian palaeofloral area. The borders of these sectors have not changed much, compared with the previous period, only the Eastern Asian sector has spread a little westward into the territory of central China, possibly due to the elimination of the barrier in the east of China. The provinces within the territory of Eurasia in the Early Jurassic coincide with the described sectors of the Norian-Rhaetian. As was noticed by VAKHRAMEEV (1970 b) the distribution of Ginkgoales and Czekanowskiales in the European-Sinian area in Early Jurassic was very irregular (the same was characteristic of the Greenland-Japan belt in the Norian-Rhaetian). The Middle Asian province has an abundance of these plants; the diversity of species as well as their role in the vegetation (judging from the amount of remains found) is not less than in the Siberian area.

Ginkgoales and especially Czekanowskiales in the European and Eastern Asian provinces are much poorer represented. Taking into consideration the floras of the Middle Jurassic, the ginkgos were very rare in the Indian province and the Czekanowskiales were completely absent.

Plant distributions suggest that the provinces in the Jurassic were the result of the residual relation of separate plant groups to their centres of origin or migration.

The Norian-Rhaetian plant-bearing sediments of the Siberian area embrace the variegated sediments underlying the coal-bearing strata of the Eastern Urals. The plant-bearing sediments of the Greenland-Japan belt are connected with the coal-bearing rocks in the west and east of Eurasia and with the coal-less sediments underlying the coal-bearing Jurassic strata, of the middle Asian sector. In the Iran – Viet Nam belt the fossil plants are related as a rule to the lower part of the coal-bearing beds.

According to the data of SHEVYREV & DAGIS (1976) the marine invertebrate fauna of Japan and Primorye in the Norian-Rhaetian relates the boreal faunas. This is not at variance with what has been said about the position of the Norian-Rhaetian floras of Japan and Primorye in the same palaeofloristic belt. Taking in consideration the above mentioned data of the palaeozoologists based on the benthonic fauna the belt should be considered as having had a rather cold climate; rare ammonoids are close to the Tethys type. Thus the conditions within that belt can be compared with the temperature conditions of the Siberian area in the LadinianKarnian, which is proved by the presence of the Czekanowskiales and the ginkgos in both palaeophytogeographic areas. In other words, a general fall of temperature can be noted for the territory of the Greenland – Japan belt in the Norian-Rhaetian in comparison with the Ladinian-Karnian.

These conclusions are at variance with the idea of a warmer climate in Primorye in Amba time (Norian-Rhaetian) in comparison with Sad-Gorod time (Ladinian-Karnian). It becomes clear when one compares corresponding floras: an abundance of cycadophytes and Dipteridaceae in the Amba floras and their insignificance in the Sad-Gorod flora; absence of the Czekanowskiales in the Amba flora and their abundance in the Sad-Gorod flora. That contradiction is apparently due to the following misunderstanding: speaking about floras we mean the Middle Norian, while speaking about faunas we mean the Lower and Upper Norian.

The climatic changes along the border of the biogeographic areas were probably more frequent. The temperature climate of Sad-Gorod time (late Ladinian-Early Krnian) changed and the temperature in the Late Karnian rose, when (according to SHEVYREV & DAGIS) the marine invertebrate fauna of the region was represented by tropical forms. This higher temperature continued in to the Amba time (Middle Norian) then fell again in the Upper Norian-Rhaetian due to a transgression from the Boreal Basin.

In the opinion of DAGIS (1976) the great taxonomic diversity of marine faunas at the end of the Norian declined and became, through a complete equalization of conditions in the Early Jurassic, a markedly monotonous fauna. The phytogeographic differentiation is also less in the Early Jurassic in comparison with that described for the end of the Triassic (no belts are distinguished in the European-Sinian area for instance), but the difference is not so great as is shown for the marine faunas.

On the whole, the distribution of phytochoria at the end of the Triassic is very similar to that observed in the Early Jurassic. The migration of plants that started in the Middle Triassic following the great reconstruction of the face of the Earth and of the organic world (the appearance of a great number of new plant forms) completed to the end of the Triassic. It remained relatively stable during the rest of Mesophytic. The variations in the phytochoria dimensions consisted only of a parallel shift of the border between the Siberian and Indo-European areas due to climatic changes.

Chapter thirteen

Stages in development of Eurasian Flora in the Triassic

As is evident from the previously offerred facts the history of the Triassic floras of Eurasia can be divided into three periods (DOBRUSKINA, 1978 a, 1987 a, 1988 a). The first includes the first half of the Triassic, when, in different parts of Eurasia, three coeval separate floras existed: the conifer-fern (Korvunchana) flora, *Voltzia* flora and *Dicroidium* flora. Each of them were accomponied by *Pleuromeia* flora. The second period includes the Ladinian-Karnian interval; which is characterized all over Eurasia by the *Scytophyllum* flora with strongly pronounced provincial (sectorial) differentiation. The third period consists of the Norian-Rhaetian *Lepidopteris* flora. In the very middle of the Triassic, approximately in the Upper Anisian and Lower Ladinian, there was a gap in the annals of the floral history.

The documented floras are so different in content that the three periods of geological history noted clearly characterize three different stages in the development of Triassic floras. Let us consider the relations between these floras from the historic point of view; whether these three stages are of equal worth; and how they are connected with the earlier and later phases in the evolution of the plant kingdom.

The first stage

The Voltzia flora. This flora is very similar in content and general appearance to the flora of the Zechstein (see chapter ten). In both floras the conifers of the same family are dominant; ferns and sphenopsids are present; pteridosperms, cycadophytes and ginkgophytes are rare. The difference exists in the greater proportion of Equisetales. The Zechstein flora differs so much from the typical Palaeophytic floras of the Carboniferous and Early Permian that many palaeobotanists considered it Mesophytic. MEYEN (1972) was the first to note that no new groups of plants appeared in the Zechstein flora and that the changes were reflected in the disappearance of dominants of the Palaeophytic and of the rise to prominence of plant groups previously in the background. They (pteridosperms, conifers, ferns) were not seen before because of the Palaeophytic dominants: arborescent lepidophytes, calamites, preferns. With the extinction of the latter the pteridosperms, conifers and ferns became dominants. Meyen (1970) proposed for the Zechstein flora the name "Postpalaeophytic", which I used before (Dobruskina, 1982). Now I prefer to consider it a final phase of the Palaeophytic (chart 9).

The *Voltzia* flora from this point of view belongs to the same phase of plant development. It constitutes the single flora with the Zechstein flora. Thus the Early Triassic floras of the European-Sinian area are referred to the single stage with the Late Permian floras of this area. New data of Chinese Late Permian and Early Triassic floras show that the floras of this stage (Zechstein-type floras and *Voltzia* flora) were widely distributed all over the south of Eurasia.

Direct connections between the *Voltzia* flora and the younger *Scytophyllum* flora consist of the close relationship of the Equisetales as well as some ferns and conifers. The other plant groups of the *Scytophyllum* flora are either new or migrants from other phytogeographic areas. That is to say that the *Voltzia* flora is more closely connected with the Zechstein flora than with the *Scytophyllum* flora.

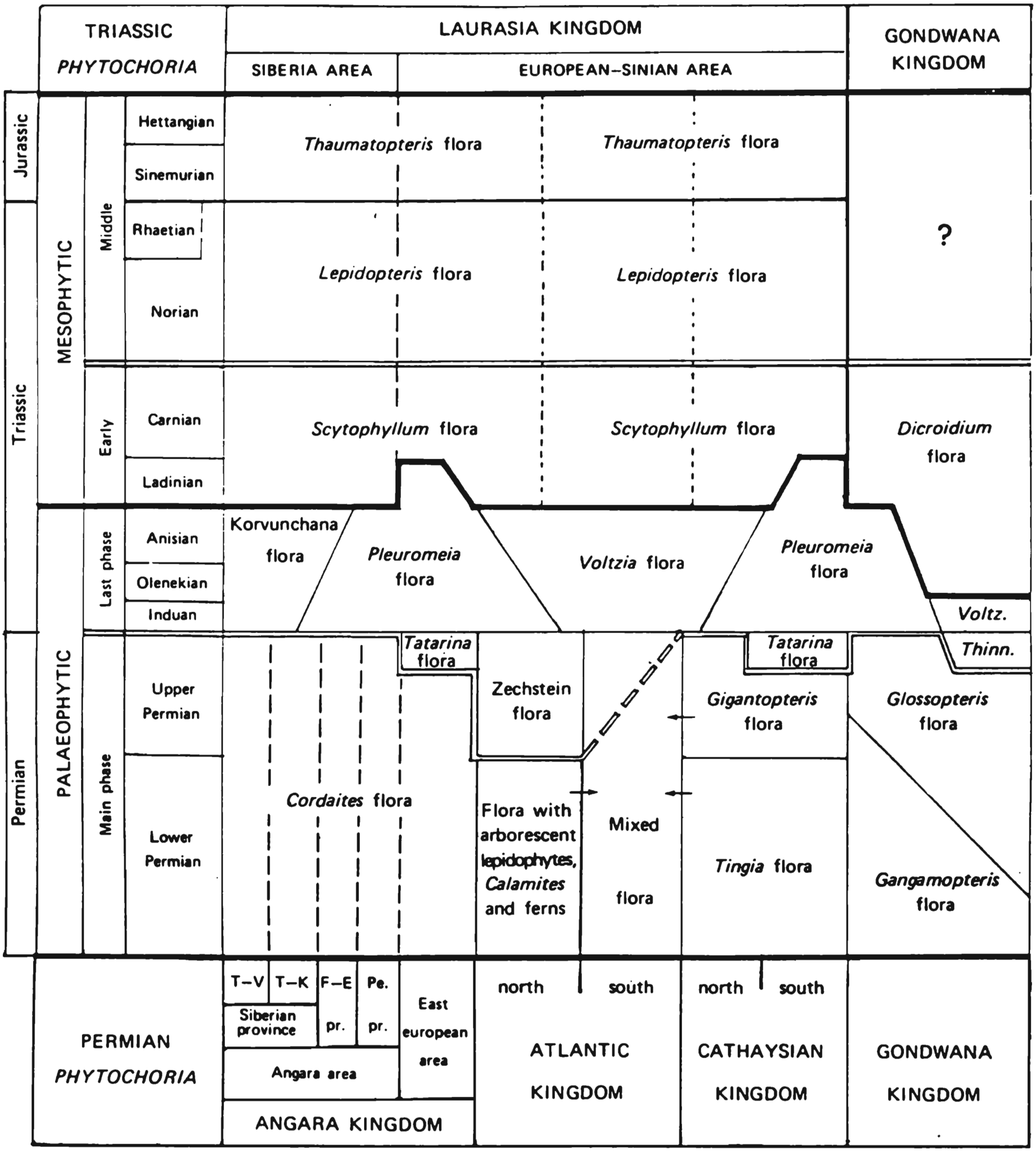
The Pleuromeia flora adds virtually nothing to the understanding of the phytogenetic connections between floras because neither the direct ancestors nor descendants are known.

The conifer-fern Korvunchana flora replaced the Permian *Cordaites* flora in the Early Triassic. These two floras have nearly nothing in common: only *Yavorskiya* and *Rhipidopsis* are inherited by the Korvunchana flora from the *Cordaites* flora.

But though unlike the Palaeophytic flora of the Angara area, the Korvunchana flora is Palaeophytic in composition. The majority of its representatives are similar to the palaeophytic plants of the Cathaysian and Euramerican areas. Sphenopsids and abundant ferns are more similar to corresponding groups of the Cathaysian flora than of any other flora. The conifers belong to the genera *Voltzia, Quadrocladus, Willsiostrobus, Darneva,* which show the close relationship to the *Voltzia* flora, and some relationship to the Zechstein flora, the Tatarina flora and the flora of zone "C" of the Nanshan Range in Northern China (Dobruskina, 1980). The peltaspermous pteridosperms similar to Korvunchana flora appeared in abundance in the Upper Tatarian deposits of the Eastern European Platform and zone "C" of Northern China (the earliest representatives of the Peltaspermaceae occur in earlier horizons of the Permian) and achieved maximum diversity and distribution in the *Scytophyllum* flora. In younger Mesophytic floras their role is diminished. That is why this group cannot be considered to be typical of the Mesophytic.

The conifer-fern Korvunchana flora being Lower Triassic in age, like the *Voltzia* flora, may also be referred to the last phase of the Palaeophytic. We can see here the same situation as in the Euro-American area: the dominant of the Palaeophytic kingdom, *Cordiates,* became extinct immediately before the appearance of the Korvunchana flora. But, in contrasts the Euramerican Palaeophytic floras which have a local origin, this flora in the Siberian area consists of Palaeophytic groups which are migrants from other palaeophytogeographical areas.

Chart 9: The stages of development of the flora at the Palaeophytic-Mesophytic transition. Phytochoria in the Permian, after Meyen (1970); Gondwana kingdom after Retallack (1977). Abbreviations: *T-V* = Taimyr-Verkhoyansk region; *T-K* = Taimyr-Kuznetsk region; *F-E* = Far-East province; *Pe.* = Pechora province; *Voltz.* = *Voltziopsis* flora; *Thinn.* = *"Thinnfeldia" callipteroides* flora



The Korvunchana flora is connected to the younger *Scytophyllum* flora by peltaspermous pteridosperms and primitive ginkgophytes as well as some ferns. But the majority of the ferns, sphenopsids and cycadophytes of the Korvunchana flora became extinct before the appearance of the *Scytophyllum* flora. The presence of the above mentioned connections of the Korvunchana flora with the *Scytophyllum* flora permits the suggestion that the Korvunchana flora continued its existence till the middle of the Triassic.

The second stage

The Scytophyllum flora. Only the characteristics of the individual plant assemblages of the given interval, as well as their comparisons, were described in the previous chapters. So it is appropriate here to present generalized characteristics of the *Scytophyllum* flora.

The spenopsids are represented almost solely by the genera *Equisetites* and *Neocalamites*. They are widely distributed in all individual floras and are very similar to each other all over the surveyed territory. There are no determined remains from the Pechora Basin, but an amount of poorly preserved fossils indicating great distances of transportation to the place of burial is large enough. The sphenopsids of the *Scytophyllum* flora are directly related to those of the Buntsandstein whereas there are no forms in common with the sphenopsids of the Korvunchana flora.

The ferns *Scytophyllum* flora are of comparatively minor significance (see fig. 47). Only in the Yenchang flora of Northern China do their remains represent more than half of all imprints. This feature draws the Yenchang and the Korvunchana floras together, though the composition of the fern genera of these floras is essentially different. The representatives of the Marattiaceae and Osmundaceae are most abundant among the ferns of the *Scytophyllum* flora. Such Marattiaceae as *Danaeopsis*, *Bernoullia* and *Asterotheca* are wide spread through Western Europe, Svalbard, northern and southern Priuralye, Predkavkazye, Middle Asia, Mongolia, Northern China and Verkhoyanye. They are unknown in the Donbass, Japan, Thailand and Sarawak. The Marattiaceae are unknown in the flora of the Buntsandstein, while the ferns of the genus *Katasiopteris* are abundant in the Korvunchana flora. According to the type of venation these ferns are similar to *Bernoullia* from the Keuper. Besides, the genus *Asterotheca* seems to be present in the Korvunchana flora. The Osmundaceae are known in all plant assemblages of the *Scytophyllum* flora. They also suggest links between the *Scytophyllum* and Korvunchana floras, whilst the family is absent in the *Voltzia* flora. Some resemblances can be traced in the type of venation of Keuper *Cladophlebis shensiensis* and Korvunchana *Acrostichides* or *Kchonomakidium*. Sadovnikov (1965) related them to the same genus and species. From my point of view it is wrong, because the similar forms from the two floras correspond to different monotopic series.

The Dipteridaceae are known in the Ladinian and Karnian floras of Japan and Primorye and in the Karnian floras of Western Europe, but have never been found in the floras of the Middle Asian sector (excepting the flora of

Garazhovka in the Donbass). As was already mentioned this peculiarity seems to be related to the absence of Karnian floras within that territory. The first appearance of the Dipteridaceae in the geological record was in the Ladinian in Japan. Their route to the west is not traced in the geological record.

The peltasperms in contrast to the Dipteridaceae, are most abundant in the floras of the internal parts of the continent. Many appeared in the Upper Tatarian deposits of the Eastern European Platform where they are sometimes the only plants found. They are abundant, as well, in the Korvunchana flora. The earliest appearance of the peltaspermous pteridosperms occurs in the Permian deposits of Western Europe, but their maximum abundance and diversity occurs from the Upper Permian to Middle Triassic on both sides of the Urals and over the whole Middle Asian sector. This group is considerably less represented in the *Scytophyllum* flora of Western Europe and it is completely absent in the older *Voltzia* flora. This group is more significant in the younger *Lepidopteris* flora of the European sector than in the *Scytophyllum* flora of the same sector, while in the Middle Asian sector the relationship is reversed. The peltaspermous pteridosperms are not mentioned in the *Scytophyllum* flora of the Eastern Asian sector.

The cycadophytes were not widely spread in the *Scytophyllum* flora, though there occur several genera in each individual flora. The genus *Taeniopteris* is everywhere most dominant and is, moreover, the only cycadophyte found in Primorye and the Eastern Urals. It is interesting to mention the earliest appearance of the Bennettitales which are well studied in the Karnian floras of Western Europe and are also present in the Pechora Basin, Southern Fergana and in the Semeytau Mountains. The Bennettitales reached their heyday and became widely spread in younger floras. Cycadophytes are uncommon both in the *Voltzia* and the conifer-fern Korvunchana floras. Their origin most probably is in the Cathaysian Permian flora. It is possible that the new data on the Chinese Lower Triassic floras will help us to find an intermediate link in the development of the bennettites.

Gingkgophytes. The family Glossophyllaceae is the most significant in the *Scytophyllum* flora (Western Europe, Svalbard, Priuralye). *Scytophyllum* flora was originated from the Korvunchana flora. It is possible that a high proportion of the ginkgophytes with unknown cuticle from Middle Asia, Primorye and Japan are also of this family. The presence of the family Sphenobaieriaceae in the *Scytophyllum* flora of Priuralye is not proved because *Sphenobaiera* from this flora have some peculiarities in their epidermic structure which make them different from the Jurassic and Cretaceous representatives of the family. There is no sure evidence of the Ginkgoaceae in the *Scytophyllum* flora. The genus *Pseudotorellia* is present (Eastern Urals and possibly Priuralye). For the first time the Czekanowskiales appeared in the geological record in the *Scytophyllum* flora. They are distributed only in the northern floras: Eastern Urals, Mongolia, Primorye.

The conifers of the *Scytophyllum* flora can be divided into two groups according to their relationship to the palaeofloristic sectors of that time. The first group includes the genera *Voltzia, Albertia, Widdringtonites* and *Swedenborgia*. A few representatives are known from the Middle Asian sector (e. g. *Swedenborgia* in Priuralye, Predkavkazye, Northern China and Madygen). The second group consists of *Podozamites* and *Cycadocarpidium*. They are practically absent in the European sector in the Ladinian-Karnian, though one species of *Cycadocarpidium* was described not long ago in the Anisian sediments of the Vosges. A considerable quantity of Cycadocarpidiaceae appeared in the European sector only in the *Lepidopteris* flora. They are abundant in the *Scytophyllum* flora in Japan and Primorye, in the Eastern Urals and in the Donbass, Nikolayevka (STANISLAVSKY, 1976); *Cycadocarpidium* is known in the floras of the Pechora and Madygen.

These two genera appeared in Japan in the Ladinian. They are already of a considerable variety in the Karnian sediments which suggests their first appearing in the Middle Triassic in the Eastern Asian sector. The origin of the plants of the first group (family Voltziaceae and its relatives) is in the flora of the Zechstein and Buntsandstein, from where they migrated in the east. Some representatives continued to exist in the European sector in the *Lepidopteris* flora.

Those elements of the *Scytophyllum* flora that originated in the *Voltzia* and the conifer-fern Korvunchana floras, were previously mentioned. A great number of new taxa is the most significant feature of the *Scytophyllum* flora: the Dipteridaceae, Bennettitales, Czekanowskiales, Cycadocarpidiaceae appeared for the first time. As was said before, a lot of Palaeophytic ferns and sphenopsids died out at that time. In other words, restructuring of floras took place in the middle of the Triassic.

This resulted in new geographical distributions. The majority of newly originated groups (unlike the new groups in the Korvunchana flora) became widely distributed not only in the *Scytophyllum* flora, but also in the younger Mesophytic floras of the Jurassic and the Lower Cretaceous.

Thus, the *Scytophyllum* flora can be seen as the earliest appearance of an essentially new stage of development in the plant kingdom, i. e. it can be seen as the beginning of the Mesophytic.

The third stage

The Lepidopteris flora. A most prominent feature of the flora is a tremendous amount of Cycadales, Bennettitales and Czekanowskiales and the appearance of Mesophytic ginkgoalean families (Ginkgoaceae, Sphenobaieraceae). Sphenopsids do not change in essence during the transition from the *Scytophyllum* to the *Lepidopteris* flora or during the transition from the *Lepidopteris* to the younger (Jurassic) *Thaumatopteris* flora. Only their relative amount in the latter two floras is much less than in the *Scytophyllum* flora. The systematic content of the ferns is seen to be gradually changing. The proportion of the Dipteridaceae increases – their fullest development commences in the Early

Jurassic. The role of the Osmundaceae remained unchanged: the role of this family increases if the majority of *Cladophlebis* leaves are considered to relate to it. The role of the Marratiaceae decreased rapidly (one species in Greenland, *Rhinipteris concinna,* and one in Sweden, *Danaeopsis fecunda*). The pteridosperms represent an insignificant part of the *Lepidopteris* flora (see fig. 46), although some thin beds in Sweden consist exclusively of *Lepidopteris* foliage. The species *L. ottonis* is a guide species for the *Lepidopteris* flora in Greenland and in the German Basin. In addition to this species, with its associated reproductive organs, the pteridosperms are represented by the genera *Thinnfeldia, Rhaphidopteris ?, Ptilozamites,* as well as by the Caytoniales. The genus *Scytophyllum* remains in great numbers in the *Lepidopteris* flora of Iran. For the first time in the geological record the Cycadales and Bennettitales attained a great diversity in genera and species. Judging by the amount of imprints they account for one half of all plants. They have been studied thoroughly in Greenland and Sweden. The ginkgos are represented by the genera *Ginkgoites, Sphenobaiera, Baiera, Allicoserpmum* and *Pseudotorellia.* The epidermal structure of the ginkgos of the third stage, besides material from Sweden and Greenland, has also been studied in the Eastern Urals. Primitive groups, such as the family Glossophyllaceae, are absent in the *Lepidopteris* flora. Great amounts of the Cczekanowskiales are known only in the Eastern Urals, where they already appeared in the *Scytophyllum* flora. They are also found in the floras of Greenland, Issyk-Kul, Kenderlyk, Japan and Primorye *(Czekanowskia, Phoenicopsis, Hartzia, Staphidiophora).* The Czekanowskiales (especially the genus *Phoenicopsis)* are widely distributed in Primorye in the older *Scytophyllum* and in the younger *Thaumatopteris* floras, but are absent in the *Lepidopteris* flora. SHOROKHOVA (1975 b) explains this fact by a rise in temperature in the Norian-Rhaetian. The ginkgos and the Czekanowskiales are insignificant in the floras of Zakavkazye, Iran, the Pamirs, Viet Nam and Southern China. Some conifers are present to the north of the just mentioned regions: *Stachyotaxus, Elatocladus, Ontheodendron, Podozamites, Cycadocarpidium, Pityophyllum, Araucarites* in Greenland and Sweden, *Stenorachis, Elatocladus, Storgaardia, Nageiopsis, Podozamites, Pityophyllum, Swedenborgia* in Japan and Primorye and nearly only *Podozamites* and *Cycadocarpidium* in the Eastern Urals, Kazakhastan and Kirgizia.

While passing from the *Lepidopteris* flora to the *Thaumatopteris* flora (which approximately corresponds to the Triassic-Jurassic boundary) the changes in the floras mainly consisted of changes of percentage of the most important plant groups as well as in the sharp differences in the range of species present (there are no species in common between these two floras of Greenland and Western Europe). There is an abrupt increase of ferns and conifers in the *Thaumatopteris* flora; the relative role of the Cycadales and Bennettitales as well as of the pteridosperms became smaller; and the relative amount of the Ginkgoales and Czekanowskiales remained the same.

The *Lepidopteris* flora is, in other words, most closely connected with the younger floras of the Lower and Middle Jurassic and they can all be taken together to constitute a united stage of development in the plant kingdom (see chart 9). Their similarity with the *Scytophyllum* flora is somewhat less; the difference is not only in the appearance of a new group of Mesophytic Ginkgoales, but also in the dying out or abrupt decrease in number of such specific groups as the peltaspermous pteridosperms, primitive Ginkgoales, Equisetaceae, which were of great importance in the transition floras (latest Palaeophytic to earliest Mesophytic).

Of the three stages of development of the Triassic flora, therefore, the first falls mainly within the Early Triassic but originated in the Middle of the Permian, whilst the third begins in the Late Triassic but continued through to the end of the Middle Jurassic.

The Carboniferous – Lower Permian floras of the Euramerian area, the *Cordaites* flora of the Angara area and the *Glossopteris* flora of the Gondwana area are typical Palaeophytic floras (see chart 9). Typical Mesophytic floras start with the *Lepidopteris* flora of the Norian-Rhaetian; this flora extends over all of Eurasia. The floras from the Middle Permian to the middle of the Late Triassic can be considered as transitional. In addition, the older among them (Zechstein flora, *Voltzia* flora, conifer-fern Korvunchana flora) are related more closely to the Palaeophytic floras; though they differ from them in the absence of the main plant groups of the Palaeophytic. The floras mentioned are considered to constitute the last stage of the Palaeophytic. The younger among the transitional floras, included in the *Scytophyllum* flora, are more closely connected with the Mesophytic floras and are considered here to constitute the earliest stage of the Mesophytic. These two transitional floras are characterized by the presence of the same plant groups which were not widely represented and distributed before or later. They have enough in common in spite of an essential reconstruction of the plant kingdom in the middle of the Triassic (the boundary of the Palaeophytic and the Mesophytic sensu stricto: DOBRUSKINA, 1976 a, 1976 b).

Chapter fourteen

Rise of Mesophytic Floras of Eurasia

In the history of the plant kingdom KRYSHTOFOVICH (1941, 1957) distinguished three long existing (polychronous) floras: the Palaeophytic, the Mesophytic and the Cainophytic – separated by shorter transitional floras. The polychronous floras only approximately correspond to the geological eras, but in each successive flora the start preceeded the beginning of the era. Thus, for example, when plotting the geological column (KRYSHTOFOVICH, 1941) the beginning of the Mesophytic is shown at the boundary between the Early and Late Permian and its close at the boundary of the Early and Late Permian.

At the same time in text KRYSHTOFOVICH described the Mesophytic flora as existing from the Rhaetian to the end of the Early Cretaceous. In this contradiction the specific features of the transitional flora (Late Palaeophytic and Early Mesophytic) were very well reflected. Their content appearance and the geographical distribution were affected by the process of one of the largest reconstructions of the plant kingdom in geological history.

It is natural to suggest that the dying out of the *Cordaites* flora in the Angara area and of the *Glossopteris* flora in the Gondwana area were approximately coeval. In both non-tropical areas it was effected by the same cause: the change of climate, which grew warmer (the Korvunchana and *Dicroidium* floras are more heat-loving than the *Cordaites* and *Glossopteris* floras); the large-scale regression at the end of the Permian and the increase in aridity (coal formation ceased together with dying out of typical Palaeophytic plant groups in both areas) etc. As concerns the extinction of the *Cordaites* flora in the Angara area it seems now that it coincided with the Permo-Triassic boundary (DOBRUSKINA, 1985 a). In the Angara (Siberian) area *Cordaites* is absent in the Triassic. In contrast the glossopterids represented by different smaller forms, continued to exist in the Gondwana area into the Early Triassic.

These above considerations, together with the analysis of the evolution of floras during the Triassic Period and their distribution in Eurasia suggest a new reconstruction of the floras of Eurasia during the transition from the Palaeophytic to the Mesophytic.

In the middle of the Permian in the Euramerican palaeofloristic area the arborescent lycopsids, calamites and ferns (the main representatives of the

Palaeophytic plant assemblages of the territory) were dying out. They were replaced by the xerophytic low diversity flora of the Zechstein and Buntsandstein, represented by those plant groups of the Palaeophytic flora that could adapt climate. The increasing aridity seems to be connected with widespread large-scale regression that began in the middle of the Permian.

At the beginning these changes did not affect the zones beyond the tropics, but the increasing regression resulted in climatic changes affecting the floras of nontropical Eurasia at the very end of the Late Permian. The continuing increase in aridity in the tropical Euramerican area led to the situation when at the very end of the Permian the xerophytic plants could not exist even in its eastern part, while the general increase of temperature led to the dying out of both the *Cordaites* and *Glossopteris* floras. This made it possible for the major elements of the Cathaysian flora (mainly the ferns and sphenopsids) to migrate to the territory of the Angara area. Only a few representatives of the *Cordaites* flora could adapt to the changed conditions *(Yavorskiya* and *Rhipidopsis).*

The migration of the peltaspermous pteridosperms, primitive ginkgos and conifers began on a massive scale at the very end of the Permian within the Middle Asian zone (Durante, 1983): the *Tatarina* flora of the east of the Eastern European Platform and the flora of zone "C" of Nanshan in Northern China. In the Early Triassic the Korvunchana flora penetrated to the Siberian palaeofloristic area.

As the climate everywhere became warmer and there were no great differences in temperature throughout the territory of Eurasia, it became possible for the lycopsid *Pleuromeia* to propagate far to the most northern parts of Siberia, while the majority of its localities were connected with the tropical Euramerican area. With the same causuality is connected the global uniformity of the Early Triassic marine invertebrate fauna; the absence of endemic forms at the beginning of the Triassic in the Boreal area; and a rather great variety of forms in the Tethys area. The Early Triassic tetrapods of the Euramerican region are smaller than their Permian counterparts. This can be explained by a very dry climate unfavourable to these animals.

The propagation of the Cathaysian and Euramerican elements in the Early Triassic in the Siberian area shows also, in addition to the climatic changes, a destruction of the barrier between the Euramerican and Angara areas. The eastern branch of the Urals-Tien Shan hercynides, still existed isolating as before the two mentioned palaeofloristic areas. The Gondwana region remained isolated as before.

Thus, all over the territory of Eurasia in the second half of the Permian and the first half of the Triassic (in spite of the different conditions in the different palaeofloristic areas) there was the same similar process: the dying out of the main representatives of the Palaeophytic floras and the rise or expansion from adjacent palaeofloristic areas of those Palaeophytic plant groups that were previously insignificant. These new plant groups, that appeared at that time, were not typically Mesophytic: such plants as the peltaspermous pteridosperms or the Glossophyllaceae lost their significance before the beginning of the typical Mesophytic. It means that the beginning of the reconstruction of the plant kingdom that led finally to the change from the Palaeophytic to the Mesophytic had begun already in the Permian within the same isolated palaeofloristic phytochoria. It can be considered as the first stage of the reconstruction.

The second stage of the reconstruction began in the middle of the Triassic. This stage is closely connected with the various global changes of that time, such as: an increasing transgression, that replaced at the end of the Early Triassic one of the largest regression in the Earth's history; the alteration in the type of sedimentation (the predominant red-beds in the first half of the Triassic gave way to grey-beds and coal formation in different parts of Eurasia); a change in the climate (increasing humidity and temperature differentiation, which affected the marine invertebrate fauna already towards the end of the Early Triassic and the land flora evidently only in the second half of the period); the orogenic processes on diverse scales in various parts of Eurasia (the Akiesi orogenesis in the Far East, in particular, was a very important one in plant history – some mountain chains appeared at that time. They could be the centres of origin of plants on one hand and also barriers preventing plants migration on the other).

To the number of great changes occurring at that time belong also the gradual disappearance of the barrier between the palaeofloristic phytochoria all over the territory of Eurasia and the weakening and vanishing of the differentiation of floras connected with the isolation of the palaeofloristic phytochoria. The mosaic of phytochoria within Eurasia changed radically from the Ladinian stage. Now distribution of plants depends first of all on the degree of migration of the new plant groups from their centres of origin and migration, and on the climatic differentiation as well.

An intensive evolution of new Mesophytic plant groups in different parts of Eurasia in the middle of the Triassic preceded the reconstruction. The Dipteridaceae most probably appeared in the Eastern Asia sector in the Ladinian: they were abundant in Japan and Primorye and were fairly diverse (species). Cycadocarpidiaceae (the genera *Podozamites* and *Cycadocarpidium*) were to all appearance distributed from the same regions. They were found in the Ladinian sediments of Japan*) and were abundant and variously there in the Karnian. The Czekanowskiales are known approximately from the same time. The mountains of the Urals-Tien Shan could have been the place of their origin. By the Ladinian and Karnian they had reached Primorye, Japan, Mongolia and by the Norian, the Eastern Urals.

As during the Ladinian-Karnian there was not sufficient time for the plants to migrate far from their place of origin and the provinciality (sectioriality) of the floras is obvious. The European, Middle Asian (central) and Eastern

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* The presence of *Cvcadocarpidium* in the Anisian sediments of Western Europe contradicts the suggestion. But the absence of this genus in the younger sediments of the same region makes the conifers relationships of western and eastern Eurasia questionable.

Asian sectors are thus very different in the composition of their plant assemblages. The barriers to their migration still existed. The Urals were high mountains at that time as was shown by the lithological-mineralogical studies of KALANTAR (1976). This explains the sharp differences in the floras of Priuralye and Zauralye but did not affect the distribution of the peltarspermous pteridosperms. The latter could have originated in the Urals and descended to the east and to the west from there. For the other plants the Urals were an unsurmountable barrier. The second barrier at that time was the mountain chain in the north-eastern part of China, that isolated the Eastern Asian sector especially in the Ladinian.

The Equisetales passed all barriers in their path. They spread from Western Europe all over Eurasia, including the Eastern Asian sector. The Marattiaceae also began their migration from the European sector, then scattered through the Middle Asian sector, but did not cross the Urals and did not reach the Eastern Asian sector in the Ladinian-Karnian. The Dipteridaceae in the Ladinian did not overstep the limits of the Eastern Asian sector and were already known in the European sector in the Karnian. But in the west of Eurasia they flourished only in the Norian-Rhaetian and especially in the Eearly Jurassic. In the geological record there is no evidence of their movement to the west within the Middle Asian sector. This may be connected with the almost complete absence of Karnian sediments in this part of Eurasia. But there may be another explanation: there was a barrier at the boundary between the Eastern Asian and Middle Asian sectors, so these ferns were moving west, crossing Indonesia, Australia and Southern Africa, where the Dipteridaceae in the Karnian sediments were more numerous and various than in Western Europe.

The peltaspermous pteridosperms descending from the Urals at the end of the Permian became very numerous and diverse in the Ladinian-Karnian only in the Middle Asian sector, especially in its western part, inclinated to the Urals. Some of their representatives reached the European sector, but did not penetrate into the Eastern Asian sector. The Glossophyllaceae having, to all appearances, the same history as the peltaspermous pteridosperms, migrated to the west with more success and reached Western Europe and Svalbard. The Czekanowskiales migrated from the eastern part of the Middle Asian sector to the west and to the east, but only within the Siberian sector, not propagating further to the south.

The origin and routes of migration of the Cycadales and Bennettitales are not so clear, but one can notice their distribution only to the European-Sinian area. The Cycadocaroidiaceae in the Ladinian are limited only by Eastern Asian sector, while in the Karnian and Lower Norian they had spread to within the Middle Asian sector but did not reach the European sector.

The climatic zonation in the Ladinian-Karnian was rather distinctly demarkated. This resulted in maximum diversification of marine invertebrates in the Karnian and in particular in an increasing amount of endemics in the boreal faunas. This zonation affected the spreading of floras as well, and even though they are marked by provinciality, the zonation within each sector can be clearly traced. The decrease of temperature out from the tropics can be readily traced in comparison with the situation in the first half of the Triassic.

As to the floras of the southern hemisphere, large numbers of Dipteridaceae and cycadophytes permit to think that there was the warm climate. But a complete absence of corystospermous pteridosperms in the tropical zone, seems to prove the difference in conditions between these two areas. Judging from the relationships between the Dipteridaceae and the cycadophytes in the tropical and non tropical zones there was a link between these two floras.

By the time of the spreading of the *Lepidopteris* flora in the territory of Eurasia in the middle of the Norian the migration of plants resulted in the smoothing out of the provincial (sectorial) differences between the floras. Differences related to climatic zonation came to the foreground. At that time the plant groups, that existed from the Palaeophytic or in the transitional floras, died out or lost their significance.

Typical Mesophytic plant groups became dominant. These included the Cycadales, Bennettitales, Ginkgoales (the latter appeared for the first time at that stage of floral development), and the Mesophytic families of ferns and the conifers. The real Mesophytic began in Eurasia from the middle of the Norian.

The spreading of the plants took place in such a way that their migration was controlled by climatic conditions. The migration occurred mainly along latitude within the limits of the climatic zones and led to the considerable smoothing of distinctions in the plant composition of the different sectors. Only the Middle Asian sector remained especially rich in the Czekanowskiales and Ginkgoales. This was the heritage, a weak echo, of the sharply demarkated provinciality (sectoriality) that existed in the previous stage. This trait of the Middle Asian sector still remained in the Early Jurassic.

The Siberian area, whose floras are less studied, is characterized by the abundance of the Czekanowskiales and Ginkgoales while the Dipteridaceae and cycadophyts (except *Taeniopteris*) are almost completely absent. The Dipteridaceae and Cycadophytes are extensively evolved in the European-Sinian area. They co-exist with the Ginkgoales and Czekanowskiales in the nothern part of this area (especially in the centre of Eurasia) and existed without them further in the south (Iranian-Viet Nam belt). The picture of the distribution of plants at the time of *Lepidopteris*-flora is very similar to the situation that held in the Early Jurassic. Only the boundary between Siberian and European-Sinian areas at the end of the Triassic was shifted to the north, i. e. it became somewhat colder in the Early Jurassic.

The climatic conditions of the Greenland-Japan belt and the Siberian area at the time of the *Scytophyllum* flora can be compared because of the significant presence of the Czekanowskiales and Ginkgoales. In other words, in spite of an approximately similar position of the southern boundary of the Siberian area during the second and third stages of the development of the Triassic floras, some decrease of temperature can be traced from the middle of the Triassic to its close and through to the beginning of the Early Jurassic.

The *Lepidopteris* flora is very similar to the floras of the Early and Middle Jurassic in pattern of the plants distribution and the composition of the floras. All these floras can thus be considered to form one united stage of development – the Middle Mesophytic, or the main phase of development of the Mesophytic. In the Late Jurassic the Mesophytic entered its next stage of development (Late Mesophytic), which was completed by the middle of the Cretaceous.

The forming of Mesophytic floras began, therefore, with the dying out of typical Palaeophytic groups (in the Middle Permian in the tropics and at the end of the Permian in the non-tropical zones); with the coming to the fore of those plant groups that played a secondary role in the Palaeophytic; and with the origin of some elements of the Eearly Mesophytic within the still isolated Palaeozoic palaeophytogeographic phytochoria. All these events began in the last phase of the Palaeophytic. The explosive radiation of new forms reached a climax in the middle of the Triassic and resulted in the most significant reconstruction: the migration of both new forms and the descendants of the Palaeozoic plants began. The migration was controlled by climatic zonation. This stage is named here the Early Mesophytic. A minor phase of radiation of new forms in the middle of the Late Triassic, the evolution and migration of new forms led to appearing of typical Mesophytic assemblages – those of the Middle Mesophytic (DOBRUSKINA, 1977 b).

The transition from the Palaeophytic to the Mesophytic was a long process (DOBRUSKINA, 1988 c, 1989). In Eurasia it occupied the time approximately from the middle of the Permian up to the middle of the Late Triassic, i. e. about 60 million years.

Chapter fifteen

Position of Triassic Eurasian floras among coeval floras of other continents

Northern America

In Northern America and in the continents of the southern hemisphere the Triassic floras are less spread than in Eurasia and their localities are concentrated in a limited number of regions.

In North America the fossil plants from the Triassic sediments are known in the Newark Formation of Virginia and North Carolina and in approximately coeval sediments of the Chinle and the Dockum formations of Arizona, New Mexico and Texas (fig. 67). The age of the enumerated formations is determined according to the remains of the tetrapods met there. These are very similar to the tetrapods from the Middle Keuper (Stubensandstein) of the German Basin. According to currently accepted correlations of the sections of the German Basin and the Alps the age of the Stubensandstein is determined as Lower Norian.

The Triassic flora of the Atlantic coast of the USA has been known since the end of the previous century from the works of EMMONS and FONTAINE (FONTAINE, 1883), who studied the Triassic plans of Virginia. Recently Triassic plants from different areas of development of the Newark Formation were published by BOCK (1969). He also gave a complete bibliography of papers concerning the Triassic floras of North America. In recent years a thorough study of the Triassic plants of North Carolina was begun (HOPE & PATTERSON, 1969, 1970; DELEVORYAS & HOPE, 1971, 1973, 1976, 1978).

In the opinion of STUR (1888), who studied the Triassic floras of Europe at the end of the last century, the floras of that age from the Alps and the Atlantic coast of the USA are extraordinarily similar. Stur reassessed many of FONTAINE's determinations and related the American plants to the same genera (often new ones) as occur in the Alpine Triassic. The diagnoses of ferns belonging to the Marrattiaceae (including the genera *Taeniopteris* and *Macrotaeniopteris*) made by STUR for the plants from the Alpine and North American Triassic, were subsequently published by KRASSER (1909 a).

The following species determined by FONTAINE were included by STUR

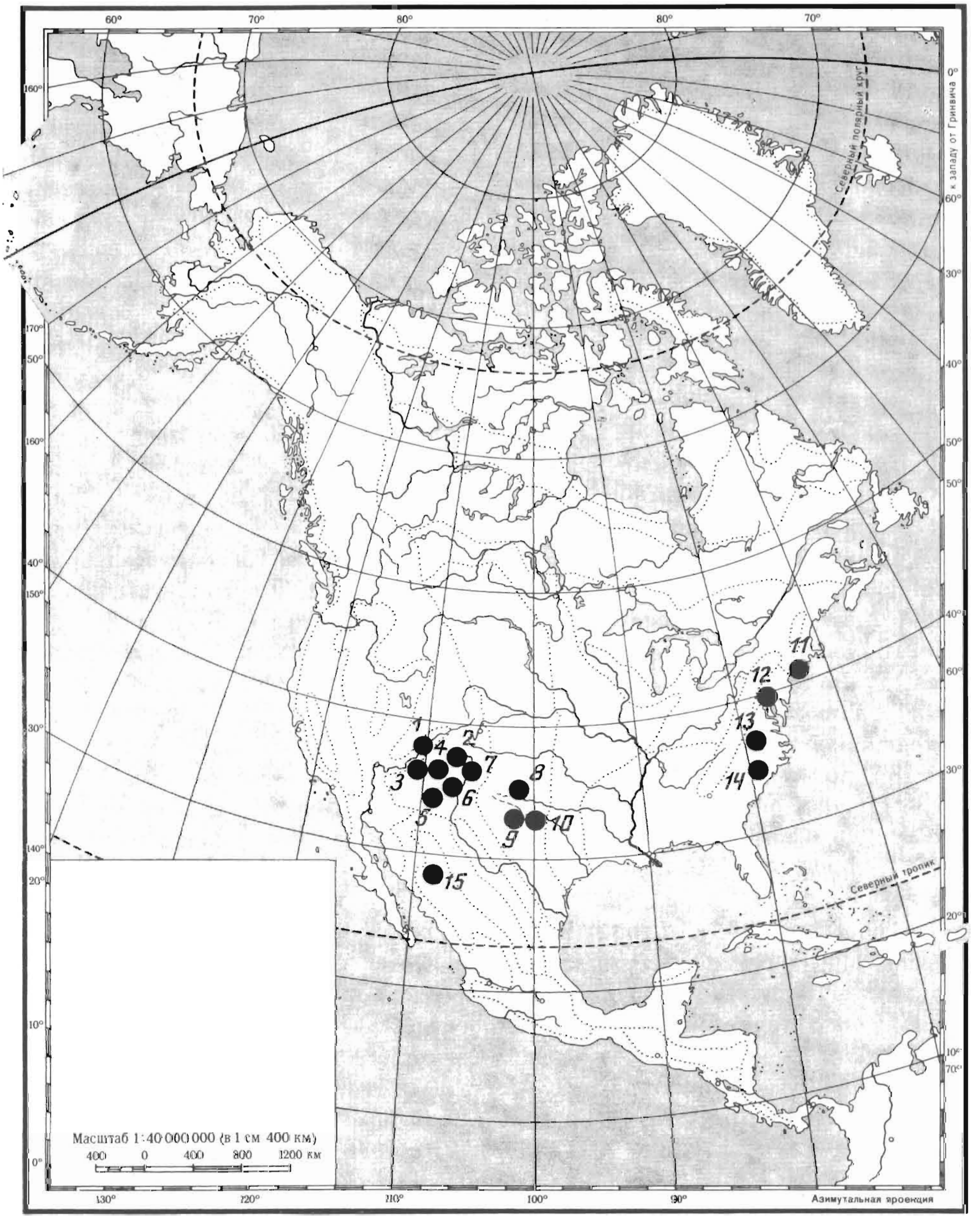

Fig. 67: Localities of the Triassic plants in North America:
1 – South-Eastern Utah, 2 – The San Miguel River, Colorado, Arizona, 3 – Gap, 4 – The Chinle wash, 5 – Petrified Forest National Park, New Mexico, 6 – Zuni mountains, 7 – Arroyo del Cobre, Texas, 8 – Amarillo, Panhandle area, 9 – Lubbocl environs, 10 – Crosbyton, Connecticut and Massachusets: 11 – Connecticut valley; 12 – New Jersey – Pennsylvania – Maryland, 13 – Richmond environs, Virginia, 14 – Deep River Basin, North Carolina, 15 – Sonora, Mexico.

and Krasser (1909 a) in synonymy with Alpine species and genera: 1) *Lonchopteris virginensis* was included in the genus *Speirocarpus*. 2) all species of the genus *Acrostichides* were also included in *Speirocarpus*. 3) the genus *Mertensides* was related to the genus *Oligocarpia*, 4) the genus *Asterocarpus* was related to the genus *Asterotheca*. Moreover, the genera *Pseudodanaeopsis* and *Macrotaenipteris* determined by Fontaine in the flora of North America, were also found by Stur and Krasser in the Alpine flora.

In other words Stur & Krasser considered the content of the ferns from Lunz and Virginia to be practically identical. As the ferns account for about 40% of all plants from the Newark Formation, as recorded by Fontaine (1883) and Bock (1969), the similarity should be considered as very significant. Moreover, they suggested that the representatives of the genera *Taeniopteris* and *Macrotaeniopteris* were also identical.

Fontaine himself compared the flora of Virginia with the younger European Rhaetian flora of the German Basin. He especially underlined its similarity with the flora of the Bayreuth vicinity in Bayern, that is now considered to be Liassic. It is impossible to form an opinion on the degree of resemblance between the floras of North America and the Liassic or Middle Keuper floras of Western Europe using only literary data. The ferns from Lunz were not figured at all (except *Asterotheca merianii*) and the monograph by Fontaine includes only very schematic pictures. The photos of Bock (1969) also need explanations and acquaintance with the imprints. Judging from the first descriptions of plants from the Newark given by Delevoryas and Hope (single ferns, cycadophytes, conifers), one finds them to be of endemic genera. The external similarity of representatives of the genus *Pterophyllum* from Virginia and Lunz is not proved by epidermal studies, while the ginkgos are absent in the American floras.

As for the flora of Arizona, Texas and adjacent states, it is now much better studied (Ash 1967, 1968, 1970 a,1970 b, 1970 c, 1972 a, 1972 b, 1972 c, 1972 d, 1973, 1974, 1975 a, 1975 b, 1976 a, 1976 b, 1977) but no detailed comparison was made either with the flora of the Atlantic shore or with the European flora. Insufficiently thorough investigations of the latter two floras prevents satisfactory comparison.

In the sediments of the Chinle Formation the conifer *Araucarioxylon* prevails. Its petrified trunks are met with throughout the section, but the leaves are known only in the lower part of the formation (the leaves of the conifers *Pagiophyllum* and *Brachyphyllum*). The endemic genus and species *Dinophyton spinosus* is second in abundance. In the opinion of Ash (1970 a) this plant is of a new group of Gymnosperms. *Otozomites powelii* and the sphenopsid *Neocalamites virginensis* are very characteristic, whilst the ferns *Phlebopteris smithii*, *Clathropteris walkeri*, *Cynopteris lasiophore* are also usually encountered. *Pelourdea paleonsis* and the problematical plant *Marcouia* are met in some localities. In addition are found: fungi, lycopods, *Equisetites*, *Cladophlebis*, some other representatives of the bennettites (for instance the species *Eoginkgoites davidsonii* thought to relate to the bennettites) and also the first supposed representative of the angiosperms – *Sanmiguelia*.

The majority of genera have either extensive stratigraphical distribution, or are endemics for the Chinle Formation, both of which hamper correlations. Ash (1972 c) mentioned a clear resemblance between the plant assemblages of the Chinle Formation and those of the Dockum Formation in Texas. At first his investigations denied the similarity of the China and Newark floras, but after the first description by Hope & Patterson (1969, 1970) and Delevoryas & Hope (1971, 1973, 1975, 1976, 1978) from the Atlantic coast he admitted the presence of a number of species common to both floras. He himself described two such species from several localities of the south-eastern and the north-western parts of the USA: *Zamites powelli* and *Eoginkgoites davidsonii*.

The greater part of the fossil plants of the Triassic in the south-east of the USA belongs to the lower part of the Chinle Formation and its analogues: the Shinarump Member, Monitor Butte and the lower part of the Petrified Forest beds beneath the Sonsela Sandstones. Some isolated plants were met in and above these Sonsela Sandstones. They proved the same as in the lower part of the section. All the published plants can thus be treated as one united complex; only *Eoginkgoites davidsonii* is confined to the Shinarump Member, the lowermost part of the Chinle Formation. In the Newark Formation this species was met also in the lower Pekin Formation.

The stratigraphic position of plants described from the Newark Formation is known for certain only for the Deep River Basin in North Carolina: all species, except *Neocalamites virginensis,* are from the Peking Formation. The last one was derived from the overlying Lumnock Formation. There is no possibility of receiving any such data from the earlier palaeobotanical papers.

The Late Triassic age of the described floras of North America is beyond any doubt for palaeobotanists, but they refrain from more exact conclusions. The correlation and determination of the age of the Chinle and the Newark formations are based principally on the tetrapods. Colbert and Gregory (in Reeside, 1957) indicated a great similarity between the tetrapod faunas of the south-west and the north-east of the USA and their similarity in turn with the Middle Keuper tetrapods of the German Basin. They outlined the existence of two horizons with the tetrapod faunas in the Chinle and the Newark formations. J. and H. Anderson (1970) distinguished three horizons. But the exact correlation of the fossiliferous rocks turned out to be impossible, even with the adjacent basins of the Atlantic coast.

The tetrapods of the German Basin which are compared by Colbert and Gregory with the North American representatives of this group, are met in the following subdivisions of the Middle Keuper: Knollenmergel, Stubensandstein, Lehrberg Schichten, Schilfsandstein and Gipskeuper of Württemberg, and the Blasensandstein and Gipskeuper of Franken. The correlation of all horizons of the European and American sections is impossible. One can speak in general about the similarity between the North American and Middle Keuper European faunas. The correlation of the lower part of the section with the Lettenkohle, as was done in the correlation table 8 a (Reeside, 1957), apparently was a misunderstanding. Nothing is said about the comparison with the Lettenkohle faunas in the text of Colbert and Gregory. Most probably, "Lower Keuper" in the table noted appeared instead of "lower part of the Middle Keuper", which would correspond to the text of Colbert and Gregory. This misunderstanding is eliminated in the work by J. and H. Anderson (1970, table 5), where the faunas of North America are compared with the faunas of the horizons younger than the Lettenkohle.

In this comparison the floras of North America turned out to be younger than the Lettenkohle and the Schilfsandstein floras and are of Lower Norian age. In my opinion, the correlations proposed by the Anderson's are probably indicative of an Upper Karnian-Lower Norian age for the lower part of the Chinle Formation (chart 10). The age of the plant-bearing beds can be placed in the Karnian-Lower Norian interval, if two tetrapod horizons are accepted or in the Upper Karnian-Lower Norian, if there are three. The plants themselves cannot be used for accurate correlations as the American floras are not identical to any of the similar floras of Western Europe, either of the Ladinian-Karnian or of the Norian-Rhaetian (Dobruskina, 1980, 1989 b). They are intermediate in composition between these European floras. This is in good agreement with supposed Karnian-Lower Norian age. The Lower Norian floras are unknown in Western Europe, and a rather poor assemblage (from the Semionotus Sandstone) corresponds to the Upper Karnian floras, so it is quite possible that some missing stage of the Mesozoic flora in Europe is represented by the North American floras.

Using palynological data Dunay and Fisher (1974) determined the age of the middle part of the Chinle Formation (the Petrified Forest Member and the Tekovas Member) and of the Newark Formation (Kumnock and Vichita members) as Middle-Upper Karnian and of the underlying Pekin Member as Lower Karnian. The palynological assemblages from the middle part show great similarity with assemblages from the Lunz beds in the Alps, from the Gipskeuper and the Schiftsandstein of the Swiss Jura and the Ardenne Sandstones of England. All are grouped in the "*Camerosporites* phase". The age of the "*Camerosporites* phase" is fixed by ammonoid-bearing sediments of the Karnian Stage in the Alps (Lunz, the environs of Salzburg, Bleiberg and Raibl in the Alps, the Palermo Mountains in Sicily and the Carpathians in Slovakia). But recently it was found out that many of the forms of this assemblage had appeared already in the Upper Ladinian (Reifling in the Alps), i. e. its lower boundary must include the Upper Ladinian Substage.

On the other hand, miospores from proven Norian sediments are unknown. That is why the upper limit of the "*Camerosporites* phase" is not known. Most likely it includes some possibly considerable part of the Norian stage. The analogues of the Norian Stage may be present in the following palynologically studied sections: the Swiss Jura, English Midlands, the North German Depression, Lower Saxonia, Poland. But even in the German Basin the Karnian-Norian boundary is not traced with certainty. The palynological data in other words, can not deny a Norian age for some part of the embedding sediments.

The North American floras belong to that stage of development of the Mesophytic floras when the longitudinal zonation was expressed sharply enough. On recent levels of knowledge it seems that the North American sector differs from the European Sector as much as the latter does from the Middle Asian and Eastern Asian sectors.

The flora of the coal-bearing sediments of the Newark Formation was always considered to be a humid one. New works of ASH, despite the opinion of L. DAUGHERTY (1941) showed that the flora of the Chinle Formation also belonged to the humid tropics. This is shown by many anatomic features of the leaves of different plant groups of this formation, and in particular by the texture of the fern stomata. Unclear annual rings in wood provide evidence of the formation belonging to the tropical zone. The reconstruction of the Chinle landscape, given by ASH, is very similar to the known reconstructions of the Keuper landscapes of Europe. Both North American floras were thus situated in the humid tropics.

Southern Hemisphere

It is customary to consider that during the Triassic Period in the Southern Hemisphere the *Glossopteris* flora still existed at the beginning of the period (Middle Beaufort Formation of South Africa and Panchet Formation in India) and that this was replaced by the *Dicroidium* flora later in the Triassic (Upper Beaufort and Molteno formations of South Africa; Parsora in India; Cacheuta and Ischigualasto in South America; Gosford Hawkesbury, Wiannamata, Ipswich, Esk in Australia). But it seems more probable to consider the Panchet and Upper Beaufort formations to belong to the uppermost Permian and that the dying out of the *Glossopteris* flora was complete before the start of the Triassic. In this case only some isolated finds of the glossopterids in India (Parsora Formation) happen to be from the Triassic sediments (in Australia similar leaves reidentified as *Anthrophyopsis*).

The appearance of the *Dicroidium* flora is indicated in the second half of the Early Triassic. In South America (fig. 68) and Africa (fig. 69) all known localities of the Triassic plants are disposed within the southern extremity of the continents. It is the Upper Beaufort Formation in Africa (= *Cynognathus)* zone, which is correlated with the *Parotosuchus* zone of the Olenek stage in the European part of the USSR. The following plants are known in these sediments in South Africa: *Neocalamites, Odontopteris, Danaeopsis, Dicroidium* (four species), *Lepidopteris, Taeniopteris, Nilssonia, Zamites, Ginkgoites*. In Australia the flora (fig. 70) appears in the Gosford Formation (the upper part of the Scythian stage) which contains: *Pleuromeia* (= *Cylomeia ?), Phyllotheca, Coniopteris ?, Todites, Cladophlebis, Sphenopteris, Dicroidium,* (four species), *Taeniopteris* (five species), *Rhipidopsis, Ginkgoites, Voltziopsis*. It appears in the Hawkesbury Formation (Anisian stage) and the Wiannamata Formation (Ladinian stage): *Phyllotheca, Asterotheca, Cladophlebis, Hymenophylites, Sphenopteris, Dicroidium* (four

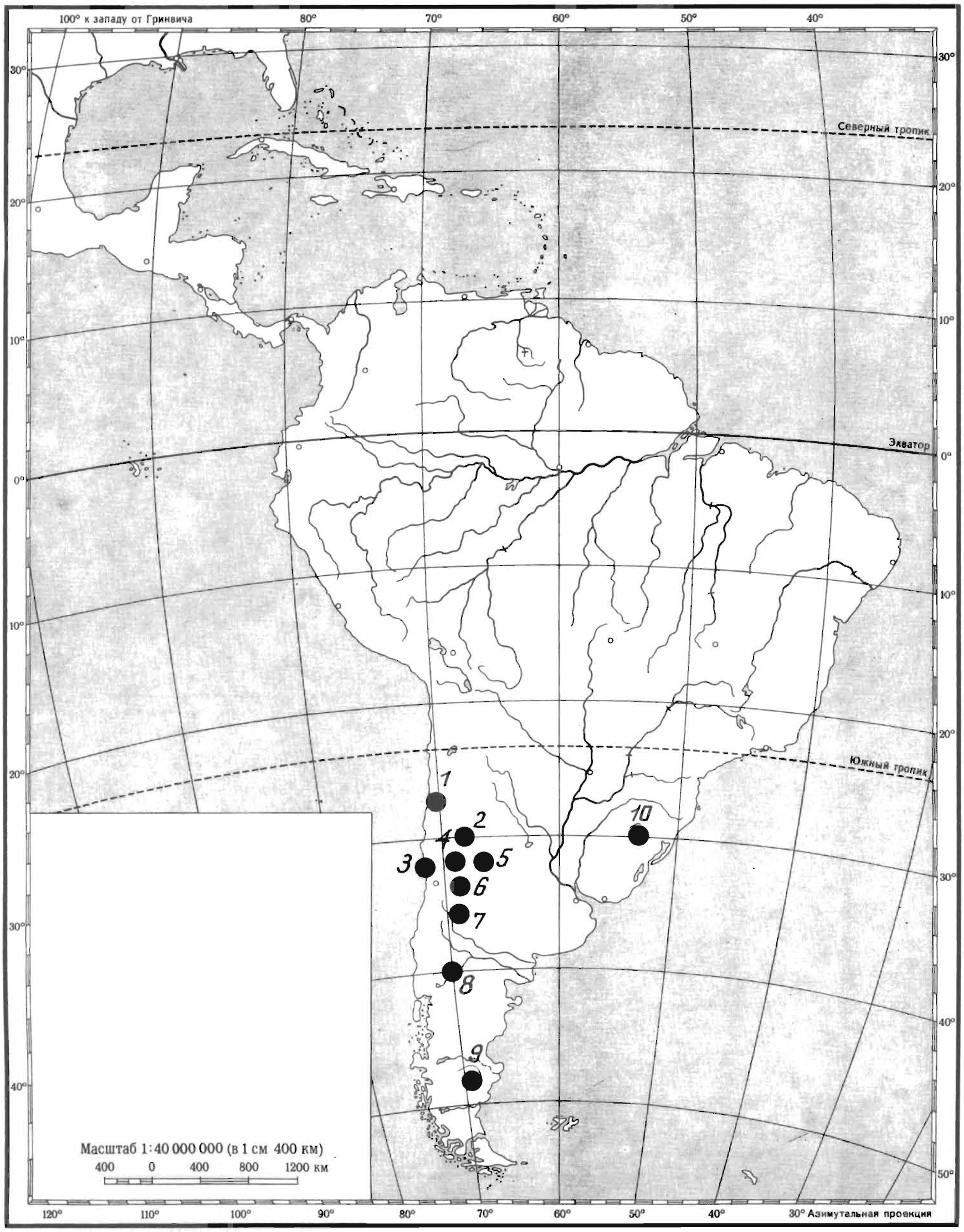

Fig. 68: Localities of the Triassic plants in South America (after **Arkhangelsky**, 1968): 1 – La Ternera, 2 – Ischigualasto, 3 – Los Vilos, 4 – Barreal-Hilario, 5 – Marayes, 6 – Cacheuta, 7 – Llantenis, 8 – Paso-Flores, 9 – El Tranquillo, 10 – Santa Maria.

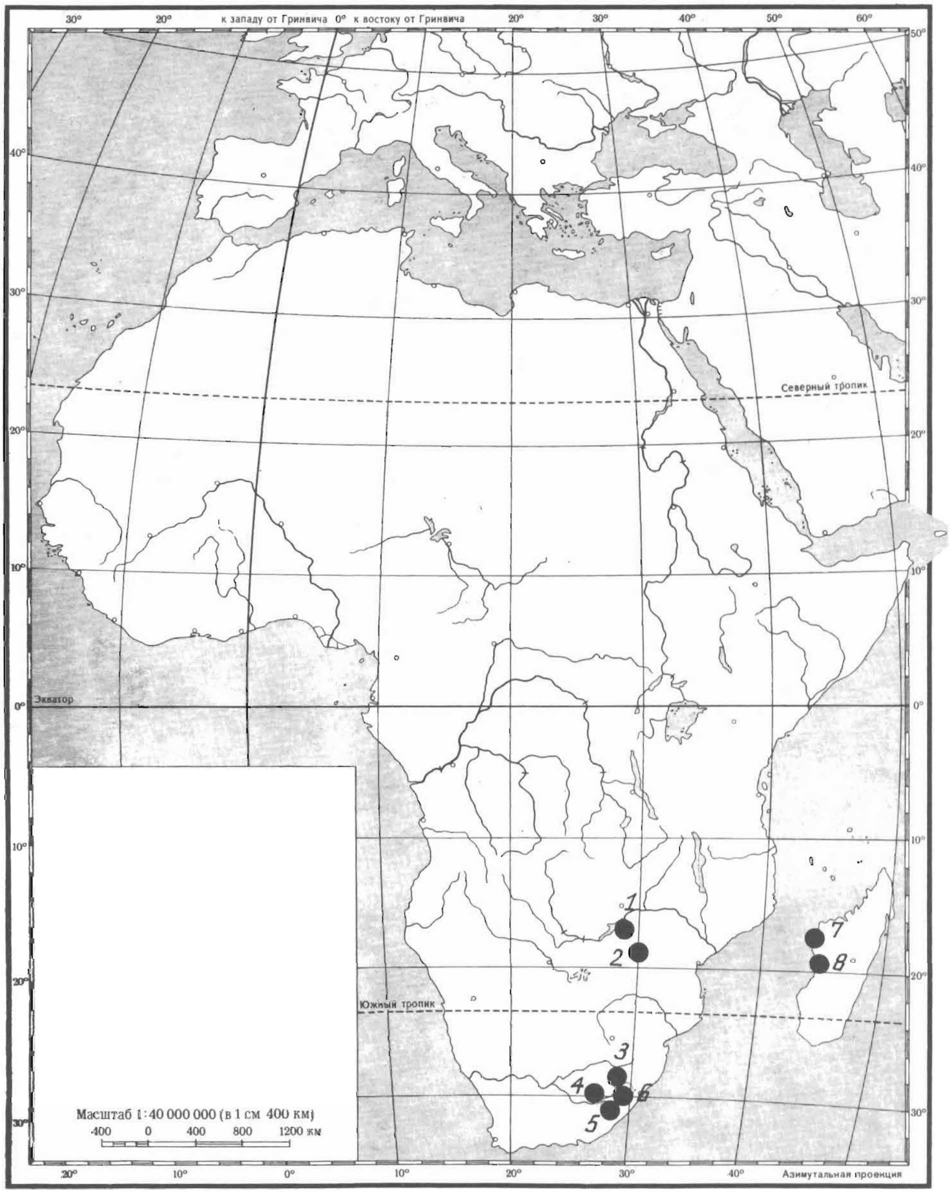

Fig. 69: Localities of the Triassic plants in Africa and Madagascar (after ANDERSON & ANDERSON, 1970):
1 – central part of the Zambezi valley, 2 – Somabula area, 3–6 – Karroo Basin, 7 – Amboriky, 8 – Tambohazo.

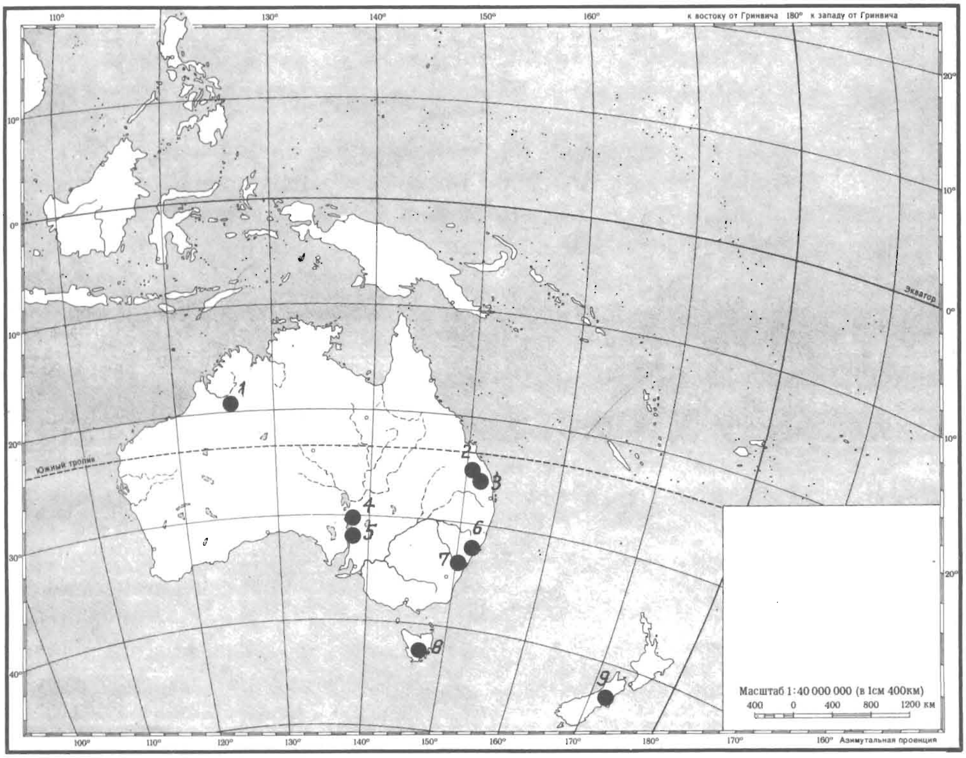

Fig. 70: Localities of the Triassic plants in Australia and New Zealand:
1 – Canning Basin, 2 – Esk, 3 – Ipswich, 4 – Leigh-Creek, 5 – Springfield, 6–7 – Sydney Basin, 8 – Tasmania, 9 – New Zealand.

species), *Lepidopteris, Rienitsia, Taeniopteris, Pterophyllum, Ginkgoites, Rissikia*. Mainly pteridosperms are described in the Triassic sediments of Antarctica (fig. 71): three species of *Dicroidium, Xylopteris*, cf. *Diplasiophyllum*, cf. *Johnstonia;* sphenopsids: *Schizoneura* sp. and *Neocalamites;* cycadophytes: *Zamites* sp., *Williamsonia, Nilssonia* sp. and the conifer *Rissikia* (PLUMSTEAD, 1962; TOWNROW, 1967).

The heyday of the *Dicroidium* flora is associated with the Ipswich, Esk, Molteno, Cacheuta and Ischingualasto formations. The age of the enumerated formations (mainly on the basis of fossil plants and tetrapods) is determined by different investigators in different ways. H. ANDERSON and J. ANDERSON (1970), studying the fossil plants and the palynological assemblages of the Molteno Formation in South Africa and gathering all available stratigraphic data on the described sediments of the Southern Hemisphere, consider the above mentioned formations coeval due to the resemblance of the plant remains. They show a Karnian age, on the basis of tetrapods, for the Molteno Formation. The

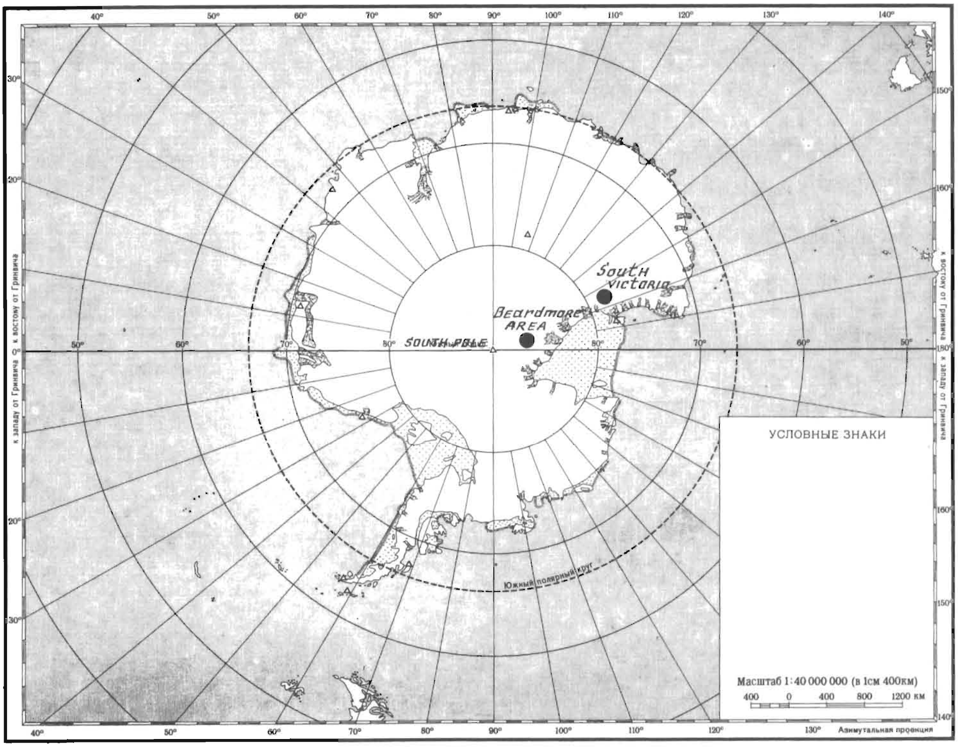

Fig. 71: Localities of the Triassic plants in Antarctica (after ANDERSON & ANDERSON, 1970).

greatest disagreements concern the age of the plant bearing sediments of South Africa – ranging from the middle of the Lower Triassic to the middle of the Upper Triassic.

The fossil plants of the enumerated formations of the southern continents are really very similar both in the systematic content and percentage abundances of the main plant groups. The corystospermous pteridosperms dominate. Their leaves are referred mainly to the genus *Dicroidium*. In the Molteno Formation this genus is represented by 24 species, that is 40% of all collected specimens. In Australia and South America 25 species of that genus are mentioned (no abundance data was given).

The ginkgophytes are second in abundance (20%) in the Molteno Formation, the cycadophytes third (more than 10%), the sphenopsids fourth (less than 10%), the ferns fifth (5%) and the conifers sixth (2%). There occur also, relatively small percentages of other pteridosperms *(Lepidopteris* and *Glossopteris ?)*. Mosses have also been identified.

In all four continents of the Southern Hemisphere the sphenopsids are represented by the genera *Neocalamites, Equisetites, Phyllotheca* and *Schizoneura,* i. e. the same genera occur in the Triassic of the Northern Hemisphere. The ferns are very diverse, fertile material of which shows the presence of the following genera: *Hausmannia, Dictyophyllum, Thaumatopteris, Chansitheca, Acrocarpus,* in South America; *Astherotheca* in South Africa; and *Astherotheca, Dictyopyllum, Todites* and *Coniopteris ?* in Australia. Infertile ferns include: *Cladophlebis* (endemic species) and other form genera, *Chiropteris* (also known in the Northern Hemisphere); and the genera *Kurtziana, Zeugophyllites, Harringtonia* unknown in the Northern Hemisphere.

The pteridosperms include the genus *Dicroidium,* unknown in the northern hemisphere, as well as the genera *Lepidopteris, Pachypteris* and *Thinnfeldia* which are universely spread. The cycadophytes *Nilssonia, Ctenis, Pseudoctenis, Zamites, Pterophyllum, Anomozamites, Ptilozamites, Taeniophteris* are all universely spread. In addition, the following genera are conditionally included in this group: the endemic genus *Moltenia* and the genera of unclear systematic position *Yabeiella, Rienitsia, Copiapaea, Linguifolium,* known only in the southern hemisphere. The ginkgophytes are related to the genera *Ginkgoites, Sphenobaiera, Baiera* and *Czekanowskia,* but their epidermal structure is unknown. The genera *Ripidopterus, Baierophyllites, Saportaea, Carpidiopteridium* have also been described. Everywhere in the southern hemisphere the conifers are not numerous and are placed in the three genera, *Elatocladus, Voltziopsis* and *Rissikia.*

Thus, the sphenopsids, Marattiaceae, Dipteridaceae and Osmundaceae (?), some pteridosperms, some cycadophytes and ginkgophytes are common to the floras of both the southern and northern hemisphere. As a result of the absence of cuticular examinations certain generic determinations remain uncertain. The presence of the Peltaspermaceae is shown in the southern hemisphere (TOWMROW, 1956, 1960) as well as of the mentioned ferns, from which fructifications were studied. The genus *Dicroidium,* dominant in the Southern Hemisphere and determining the appearance of the Triassic *Dicroidium* flora, is absent in the floras of the northern hemisphere.

Summary

Among the floras of the northern hemisphere only those from Parsora and Nidpur in India are decisively close to the described floras of the southern hemisphere. Because of its relative poorness and due to the absence of glossopterids this Indian flora is probably not to be compared with Karnian floras, but with the floras of the end of Early and Middle Triassic in Africa and Australia. Especially since recently in the Upper Scythian sediments of Australia and South America the presence of *Pleuromeia* (RETALLACK, 1975: re-examination of the genera *Lycostrobus, Caulopteris, Ourostrobus*) is shown. This genus is supposed to be present in the Parsora Formation in India. I think that we can speak now about the presence of the family Pleuromeiaceae in the southern

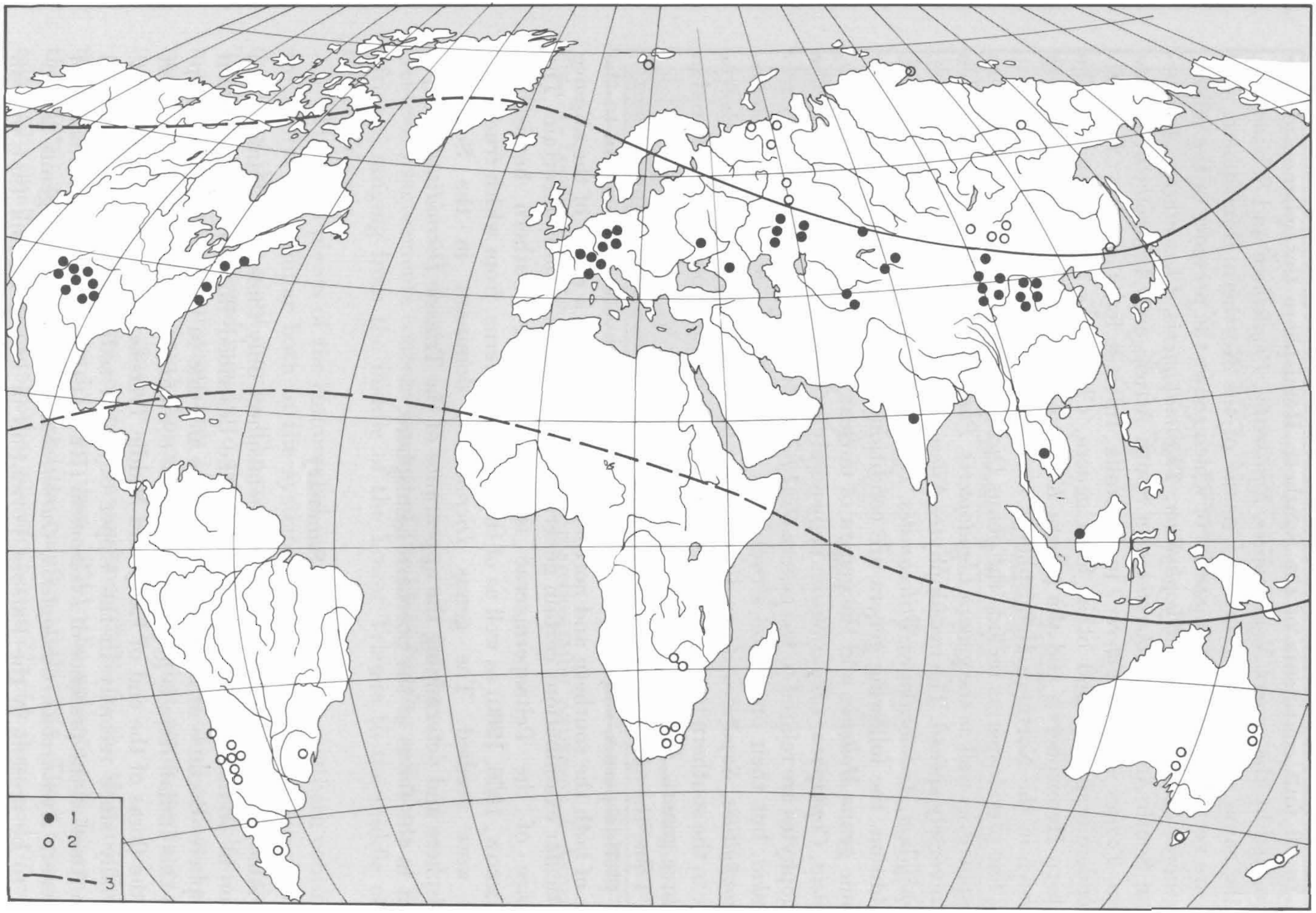

Fig. 72: Phytogeographical zonation in the middle of the Triassic:
1 – tropical floras. 2 – nontropical floras. 3 – boundaries of phytochoria.

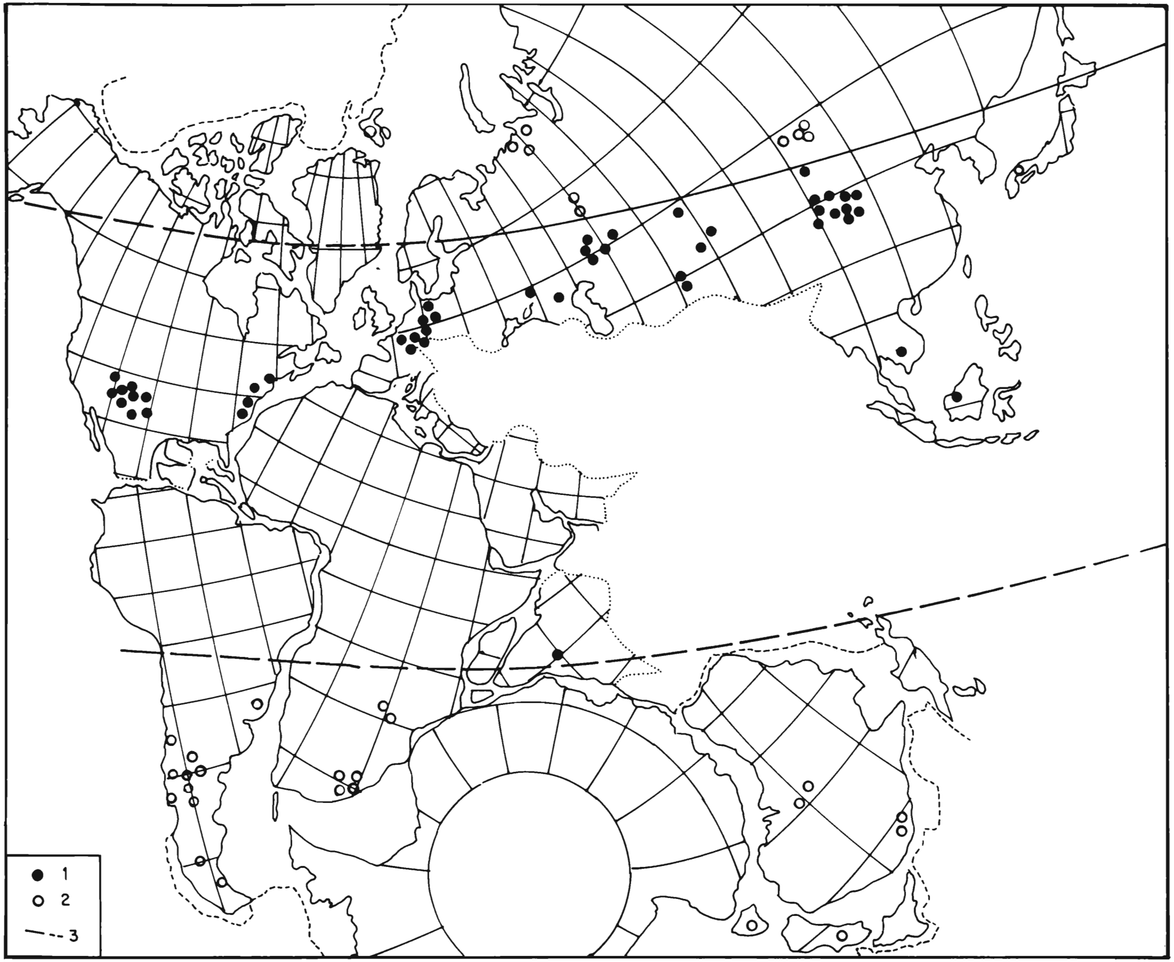

Fig. 73: Phytogeographical zonation in the middle of the Triassic:
1 – tropical floras, 2 – nontropical floras, 3 – boundaries of phytochoria.

hemisphere, but not about the same genera as in the northern hemisphere because their identity remains to be discussed (Dobruskina, 1985 b).

The Indian floras of the first half of the Triassic, as well as the Palaeozoic floras of India, are related to one united palaeobotanical area with all other floras of the continents of the southern hemisphere. The unity of the floras of Australia, Africa and South America remained in to the Late Triassic (Karnian). But there are no definite data on the Indian floras of that time (the Maleri flora is very uninformative) just as there are none for the floras of India in the Early Jurassic. Probably only in the Middle Jurassic do the Indian floras became part of a united European-Sinian palaeofloral area. Unfortunately, the absence of data on the floras of the Late Triassic and the Early Jurassic does not permit us to date closely the time interval when this unification occurred.

The abundance of the corystospermous pteridosperms especially *Dicroidium* leaves, obviously distinguishes the Triassic floras of the southern hemisphere (plus India) from those of the northern hemisphere.

Unfortunately, the almost complete absence of Triassic plants within the extant equatorial zone hampers the study of the history of colonisation of the Triassic floras. There are no Triassic plants either in the north of South America or in the north of Africa. Only the Triassic flora of Sarawak, with typical Eastern Asian features, is located near the equator. The floras of the northern and southern hemispheres thus turn out to be very widely separated (fig. 72). In particular the distribution of localities does not help us to understand the positions of the continents in the Triassic: the climatic zones are equally well situated on the recent map and in the reconstruction made according to palaeomagnetic data (fig. 72, 73).

So the floras of Eurasia (except India) are related to the tropical and to the northern non-tropical zones. In the first half of the Triassic the tropical zone is known only in Europe and Asia and in the second half is also well traced in North America. The data on the floras of the northern non-tropical zone are restricted to north-eastern Eurasia.

The southern non-tropical zone in the first half of the Triassic (the same as in the Palaeozoic), includes India. There are no certain data for the second half of the Triassic, though the relationship of the Maleri flora to certain Asian floras is most probable. In the case, in the second half of the Triassic the Indian floras occupied the same position as later in the Mesophytic. The position of the phytochoria given in fig. 72 assumes the location of the North Pole approximately in the region of New Siberian Islands.

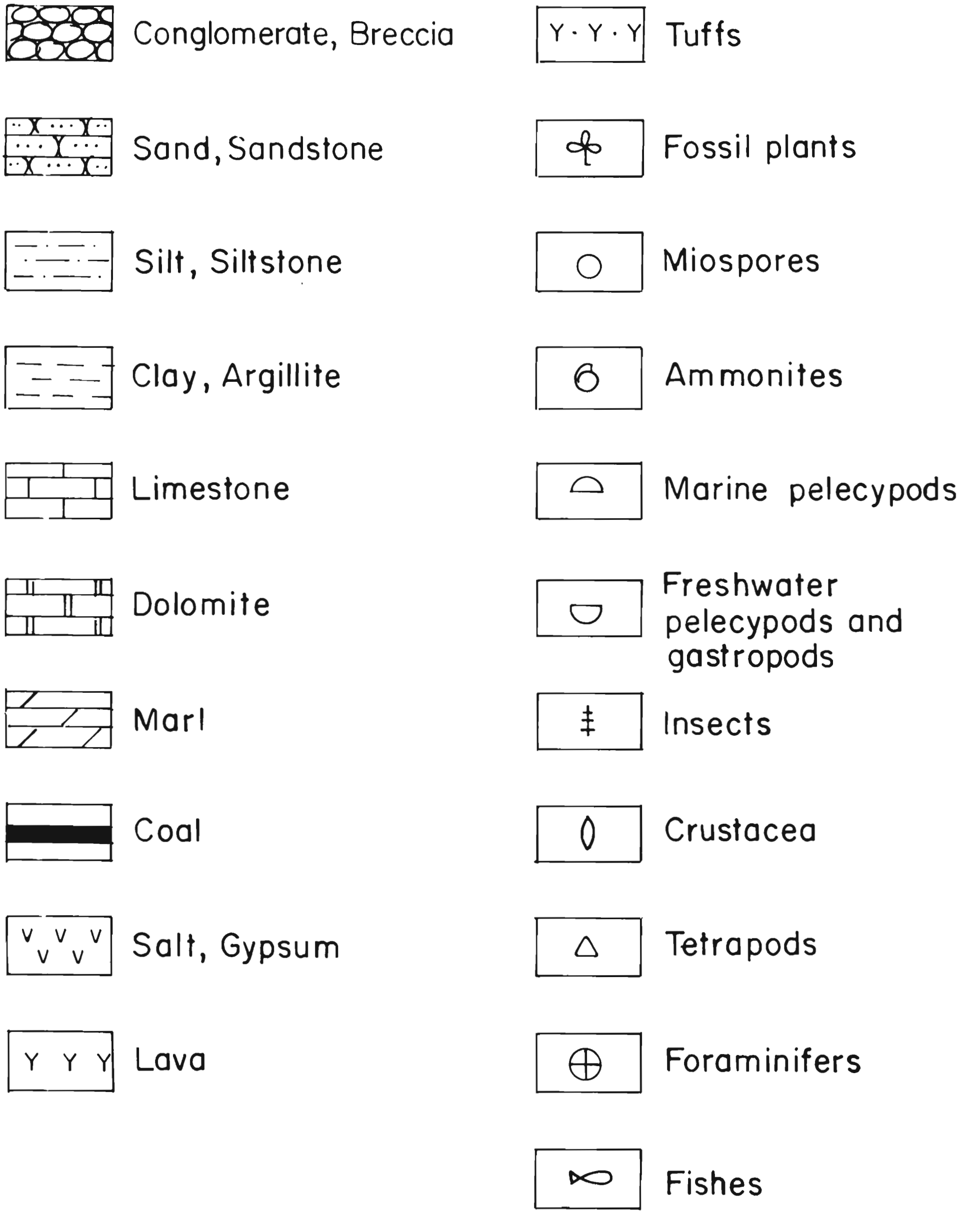

Fig. 74: Explanations to the symbols in the figures.

Part three

List of described and figured plant remains from the Triassic of Eurasia

The references are given to the published works or collections from the Geological Institute of the USSR Academy of Sciences in Moscow (GIN), Botanical Institute of the USSR Academy of Sciences in Leningrad (BIN), the Central Prospecting Research Geological F. N. CHERNYSHOV Museum in Leningrad (CPRG), Museum of the Geological Survey in Tashkent (GST), which were studied by the author of the present book.

If the list includes data presented by several authors the name of the species is followed, after a dash, by the first letter of the name of the author of description.

If the lists of several authors are combined from the same locality the redeterminations are given, as far as possible. In some cases, however, the same plants may be included in the lists under different names.

The Madygen, north Priuralye and south Priuralye floras were re-examined by the author or these determinations are based on the published data. The reference is given in the last case.

Indexes "ind", "ol-an", "lad-karn", "nor-rt" near the beginning of each list mean the Induan, Olenekian-Anisian, Ladinian-Karnian and Norian-Rhaetian age of the locality and reference to the maps in figs. 61, 62, 63 and 64 correspondingly. Numbers following such index mean a number of locality in the corresponding map.

I. Western Europe

The central part of the German Basin

1. Buntsandstein plants east of Rhine (for references see chart 1)

a) Grünwettersbach in Süd Deutsche Senke (ol-an, 6): *Pleuromeia sternbergii, Equisetum mougeotii, Schizoneura – Echynostachys paradoxa* (former *Schizoneura paradoxa*), *Anomopteris mougeotii, Carpolithes* sp., *Voltzia heterophylla, Willsiostrobus rhomboidalis* (former *Lepidostrobus palaeotriassicus*, strobil *Voltzia heterophylla* and *Masculostrobus rhomboidalis), Endolepis vogesiaca* (former *Knorria palaeotriassica*).

b) Wernfeld in Süddeutsche Senke (ol-an, 6): *Equisetum mougeotii, Voltzia heterophylla.*

c) Kissingen in Süddeutsche Senke (ol-an, 6): *Anomopteris mougeotii, Equisetum mougeotii, Voltzia heterophylla.*

d) Bodenwerder in Hessische Senke (ol-an, 4): *Anomopteris mougeotii.*

e) Bremke in Hessische Senke (ol-an, 4): *Equisetum arenaceum,* cf.*Pecopteris sulziana, Neuropteridium grandifolium, Yuccites vogesiacus, Willsiostrobus rhomboidalis* (former *Masculostrobus rhomboidalis* and "strobil *Yuccites*").

f) Fürstenberg in Hessische Senke (ol-an, 4): *Equisetum arenaceum, Neuropteridium* sp., *Yuccites vogesiacus, Voltzia heterophylla, Caulopteris* cf.*voltzii.*

g) Carlshafen in Hessische Senke (ol-an, 4): *Pleuropmeia sternbergii, Neuropteridium elegans, Voltzia heterophylla.*

h) Schishaus in Hessische Senke (ol-an, 4): *Pleuromeia sternbergii.*

i) Hombressen in Hessische Senke (ol-an, 4): *Pleuromeia sternbergii.*

j) Singen in Thüringer Senke (ol-an, 5): *Pleuromeia sternbergii, Schizoneura paradoxa, Neuropteridium elegans, Yuccitea vogesiacus.*

k) Bad Berka in Thüringer Senke (ol-an, 5): *Pleuromeia sternbergii, Equisetites mougeotii.*

l) Mansfelder Mulde in Thüringer Senke (ol-an, 5): *Pleuromeia sternbergii.*

m) Bernburg, Niegripp, Schönebeck in Subherzynische Senke – Solling Formation (ol-an, 3): *Pleuromeia sternbergii.*

n) Bernburg in Subherzynische Senke – Hardegsen Formation (ol-an, 3): *Pleuromeia sternbergii.*

2. Upper Buntsandstein plants to the west of Rhine

a) Vosges du Nord (ol-an, 1) (GRAUVOGEL-STAMM, 1978 revised BRONGNIART, 1828; SCHIMPER & MOUGEOT, 1844; ZEILLER, 1888; FLICHE, 1905–1910; FRENTZEN, 1931; FIRTION, 1936; GRAUVOGEL, DOUBINGER & GRAUVOGEL, 1967; GRAUVOGEL-STAMM, 1969; GRAUVOGEL-STAMM & GRAUVOGEL, 1973, 1975; SCHAARSCHMIDT & MAUBEUGE, 1969): *Pleuromeia sternbergii, Equisetites mougeotii* (former *Calamites mougeotii*), *Equisetostachvs verticulata, Schizoneura – Echinostachys paradoxa* (former *Convallarites erecta, C. nutans, Schizoneura paradoxa*), *Echynostachys oblonga, E. cylindrica, Anomopteris mougeotii, Pecopteris sulziana, Neuropteridium elegans, N.* cf. *intermedium, Crematopteris typica* (including *Filicitites scolopendroides*), *Zamites vogesiacus, Baiera* sp., *Aetophyllum stipulare* (including *A. speciosum*), *Cycadocarpidium pilosum, Albertia* sp., *Voltzia walchaeformis, Voltzia* sp., *Yuccites vogesiacus* (including *Cordaites vogesiacus*), *Willsiostrobus rhomboidalis* (former "Amentum coniferae", "Cone de *Voltzia*", *Masculostrobus rhomboidalis*), *W. ligulatus* (former *Masculostrobus ligulatus*), *W. cordiformis* (former *Masculostrobus cordiformis*), *W.* cf. *willsii* (former *Masculostrobus* cf. *willsii*), *W. denticulatus* (former *Masculostrobus denticulatus*), *W. acuminatus* (former "Amentum coniferae" in SCHIMPER & MOUGEOT, 1844; *Masculostrobus acuminatus,* cone d'*Aethophyllum* in GRAUVOGEL-STAMM & GRAUVOGEL, 1975), *Darneya peltata* (former "cone d'Albertia" in SCHIMPER & MOUGEOT, 1844; "cone de *Voltzia* sp., in GRAUVOGEL, DOUBINGER & GRAUVOGEL, 1967 and *Voltziostrobus schimperi*), *D. mougeotii* (former *Voltziostrobus mougeotii*), *D. dentata, Sertostrobus laxus, Lesangeana voltzii, Lepidodendrites tesselata* (including *Caulopteris tesselata, Cyatheopteris tesselata), Sphallopteris mougeotii* (including *Sphalmopteris mougeotii, Anomopteris mougeotii* in BRONGNIART, 1828: only plate 80; *Cottaea mougeotii*), *Endolepis vogesiaca* (including "tige de *Yuccites vogesiacus*" in SCHIMPER & MOUGEOT, 1844), *E. subvulgaris.*

b) Chauffontaine in the Paris Basin (ol-an, 1) (FLICHE, 1905–1910): *Anomopteris mougeotii, Chordites lebrunii, Algacites landsburgaeformis, Danaeopsis marantacea, Cladophlebis gaillardotii, Caulopteris parvisigillata, Cordaites mairii, Artisia triassica, Annalepis zeilleri, Pleuromeia* sp., *Clathrophyllum merianii.**

c) Saint-Anne in Paris Basin (ol-an, 1) (FLICHE, 1905–1910): *Algacites mougeotii, Cladophlebis gaillardotii, Caulopteris conchyliensis, Cordaites inhofii, C. mairii, Annalepis zelleri, Coniferomeylon conchylianum, Cystoseirites triassicus.**

d) Rehainviller in Paris Basin (ol-an, 1) (FLICHE, 1905–1910): *Cordaites inhofii.*

e) Duren in Eifel (ol-an, 2) (GOTHAN, 1938; GRAUVOGEL-STAMM, 1978): *Equisetites mougeotii ?, Schizoneura paradoxa, Neuropteridium elegans, Yuccites vogesiacus, Albertia latifolia, A. elliptica, Voltzia heterophylla, Wiilsiostrobus rhomboidalis* (former "strobilus of conifer").

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* P. FLICHE indicated the origin of these floral assemblages from the Lettenkohle beds, but MÄGDEFRAU (1930) considered them to be the upper part of Buntsandstein (not the upper part of Muschelkalk).

f) Bubenhausen near Zweibrucken in Paris Basin (ol-an, 1) (Ammon & Reis, 1903; Frentzen, 1931): *Lepidostrobus palaeotriassicus, Calamites arenaceus, Schizoneura paradoxa, Aetophyllum speciosum, Pecopteris sulziana, Neuropteridium elegans, N. intermedium, Otozamites vogesiacus, Pterophyllum hogardii, Albertia elliptica, Voltzia heterophylla, V. acutifolia, Carpolithes* sp.

g) Schafbrücke near Saarbrucken in Paris Basin (ol-an, 1) (Ch. E. Weiss, 1864): *Calamites arenaceus, Anomopteris mougeotii, Voltzia heterophylla* f. *brevifolia, V. heterophylla f. elegans.*

h) Commern in Eifel (ol-an ,2) (Blanckenhorn, 1886; Potonie, 1904): *Pleuromeia oculina, Equisetum mougeotii, Schizoneura paradoxa, Neuropteridium voltzii, N. intermedium, N. bergense, Taeniopteris ambiqua, Voltzia heterophylla, V. brevifolia, Pinites ramosus, Palissya ?* sp.

3. Muschelkalk plants

a) Alsace and Lorraine in Paris Basin (ol-an, 1) (Fliche, 1905–1910): *Anomopteris mougeotii, Cedroxylon* sp., *Coniferomeylon* sp., *Xenoxylon* sp.

b) Commern in Eifel (ol-an, 2) (Blanckenhorn, 1886): *Equisetum mougeotii, Neuropteridium* sp., *Voltzia heterophylla, Pagiophyllum* cf. *sandbergii, Pinites goeppertianus.*

c) Jena (ol-an, 5) (Schmidt, 1928): *Endolepis elegans, E. vulgaris.*

4. Lettenkohle plants, Lower Keuper (for references chart 4)

a) Baden-Württemberg (lad-karn, 4): *Equisetites arenaceus, Neocalamites merianii, Neuropteris schoenleiniana, N. remota, Sphenopteris schoenleiniana, Anotopteris distans, Danaeopsis marantacea, D. rumpfii* (in Frentzen, 1926 = *Bernoullia franconica*), *Clathropteris digitata, Pterophyllum jaegeri, P. longifolium, P. blumii, Schizostachium thyrsoedeum, V. coburgensis, Widdringtonites keuperianus, Dadoxylon implexum, D. keuperianum, D. gaildorfianum.*

b) Franken (lad-karn, 4): *Equisetites arenaceus, E. platyodon, E. latecostatus, Calamites merianii, Scizoneura paradoxa, Neuropteris schoenliana, N. remota, Danaeopsis marantacea, Chiropteris digitata, Schizopteris pachyrhachis, Scytophyllum bergeri, Cycadites rumpfii* (in Frentzen, 1926 = *Bernoullia franconica), Dioonites pennaeformis, Pterophyllum jaegeri, P. longifolium, Taeniopteris angustifolia, Voltzia coburgensis, Widdringtonites keuperianus, Carpolithes keuperiana, C. amygdalinus, C. minor, Chelepteris strongylopeltis, C. macropeltis.*

c) Süd Thüringen (lad-karn, 4): *Equisetites arenaceus, E. faveolatus, Neocalamites merianii, Chiropteris lacerata, Antholithes ruehlei, Ruehleostachys pseudoarticulatus, Bucklandiopsis ovalis, Tricranolepis monosperma, T. frischmanii, T. hoerensis, Androstrobus cycadiformis, Glossophyllum florinii, Ginkgoites lunzensis, Schizolepis liasokeuperianum, S. follinii.*

d) Thüringer Senke (lad-karn, 3): *Equisetites arenaceus, E. singularis, E. platyodon, E. latecostatus, Calamites mesozoicus, Neocalamites merianii, Schizoneura merianii, Danaeopsis marantacea, D. angustifolia, Anotopteris distans, Pecopteris merianii, P. ruetimeyeri, P. parvifolia, P. augusta, Neuropteris remota, Neuropteridium grandifolium, Scytophyllum apoldense* (former *Thinnfeldia apoldensis, Selenocarpidium gracillimum, Cycadites apoldensis* and *S. rumpfii*), *S. bergeri* (former

S. dentatum, S. dubium and *Cycadites pinnatilobatus*), *Cycadophyllum elegans, Cycadites pectinatus, Dioonites penneformis, Zamites angustiformis, Z. dichotomus, Z. tenniformis, Z. dilatatus, Pterophyllum longifolium, P. jaegeri, P. robustum, P. bronnii, P. spectabile, Taeniopteris angustifolia?, Apoldia tenera* (former *Sphenozamites tener*), *Cordaites keuperianus, Voltzia coburgensis, Widdringtonites keuperianus, Araucarites thueringicus, Podozamites praecursor, Cycadocarpidium thueringicum, Carpolithes keuperiana, C. amygdalinus, C. sphaericus.*

e) Subherzynische Senke (lad-karn, 2) (only species with sign* are described, others only mentioned): *Equisetites arenaceus, Pecopteris latepinnata, P. schoenleiniana, Cladophlebis remota, Bernoullia helvetica, Pseudodanaeopsis marantacea, Clathropteris reticulata, Chiroteris lacerata*, Neuropteridium* sp., *Theinnfeldia speciosa*, Scytophyllum apoldense*, S. bergeri*, Sphenozamites tener, Macrotaeniopteris* sp., *Pterophyllum jaegeri, Dioonitocarpidium pennaeforme.*

f) Paris Basin (lad-karn, 1) (GRAUVOGEL-STAMM & DOURINGER, 1983): *Annalepis zeilleri.*

5. Schilfsandstein plants and its analogues (for references see chart 4)

a) Basel environs, Northern Switzerland, in Süddeutsche Senke (lad-karn, 4) (see also chart 10): *Birsiomices pterophyllii, Equisetites arenaceus, E. conicus, E. glandulosus, E. elegans, Equisetites* sp. (possibly *E. platyodon*), *Equisetostachys pedunculatus, Neocalamites merianii, Camptopteris serrata, Clathropteris reticulata, Bernoullia franconica, Danaeopsis marantacea* (in KRASSER, 1909 a = *Pseudodanaeopsis marantacea*), *Asterotheca merianii, Pecopteris ruetimeyeri, P. triassica, P. gracilis, P. latepinnata, P. (Merianopteris) augusta, P. (Lonchopteris) reticulata* (in KRASSER, 1909 a = *Speirocarpus virginensis*), *Sphenopteris birsina, Rhacophyllum pachyrrachys, Pterophyllum longifolium, P. jaegeri, P. brevipenne, P. pulchellum, P. greppinii, Taeniopteris* sp., *Williamsonianthus keuperianus, Leuthardtia ovalis, Antholites leuthardtii, Leguminanthus siliquosus, Sphenobaiera furcata, Stachyotaxus sahnii, S. lipoldii, Voltzia heterophylla, V. novomundensis, Widdringtonites keuperianus, Carpolithes greppinii, Paradoxoxylon leuthardtii* and the plants of unclear systematic position.

b) Baden-Württemberg (lad-karn, 4): *Equisetites arenaceus, E. latecostatus, E. platyodon, Neocalamites merianii, Camptopteris quercifolia, Clathropteris reticulata, Dictyophyllum serratum, Gleichenites gracilis, Danaeopsis marantacea, Neuropteris schoenleiniana, N. remota, Pecopteris latepinnata, P. ruetimeyeri, P. triassica, P. quercifolia, Lepidopteris stuttgartiensis, Cyatheites rigida, Pterophyllum longifolium, P. jaegeri, Voltzia coburgensis, Pagiophyllum* sp. n., *Pachylepis quinquies, Dadoxylon graminovillae.*

c) Franken (lad-karn, 4): *Equisetites arenaceus, E. platyodon, Clathropteris meniscioides, Camptopteris quercifolia, Schizopteris pachyrrachys, Pterophyllum jaegeri, P. brevipenne, Pterophyllum* cf. *robustum, Voltzia coburgensis, Voltzia windsheimensis, V. fraasii, Willsiostrobus rhomboidalis* (former "strobilus *Voltzia coburgensis*" by SCHENK in SCHOENLEIN, 1865).

d) Süd Thüringen (lad-karn, 4): *Voltzia fraasii, V. coburgensis.*

e) Subherzynische Senke (lad-karn, 2): *Chiropteris lacerata.*

Chart 10: Revision of the determinations of fossil plants from environs of Basel, Northern Switzerland (see p. 289: 5a)

HEER, 1877	LEUTHARDT, 1903/1904	FRENTZEN, 1926 (Fr); FLORIN, 1936 (Fl), KRAUSEL, 1943, 1952, 1955, 1958, 1959, 1960; KRAUSEL & SCHAARSCHMIDT, 1966 (KS); SCHAARSCHMIDT, 1966 (S)
		Birsomices pterophyllii (S)
Equisetum arenaceum	Equisetum arenaceum	Equisetites arenaceus (K)
E. mytharum		
E. platyodon	E. platyodon	E. conicus (K)
E. mougeotii		E. glandulosus (K)
E. triphyllum		E. elegans (K)
E. trompianum		
E. schoenleinii		
Schizoneura merianii		Neocalamites merianii (K)
S. paradoxa	Schizoneura paradoxa	
Clathrophyllum merianii		Equisetites sp., possible E. platyodon (K)
Pterophyllum brevipenne (male fructification)		Equisetostachys pedunculatus (KS)
Camptopteris serrata	Camptopteris serrata	
Clathropteris reticulata	Clathropteris reticulata	
Bernoullia helvetica	Bernoullia helvetica	Bernoullia franconica (Fr)
Danaeopsis marantacea	Danaeopsis marantacea	
Asterocarpus merianii	Asterocarpus merianii	
Pecopteris ruetimeyeri	Pecopteris ruetimeyeri	
P. (Merianopteris) augusta	Merianopteris augusta	
P. steinmuelleri	Pecopteris steinmuelleri	Stachyotaxus sahnii (K)
P. triassica		
P. gracilis	Gleichenia gracilis	
Sphenopteris birsina	Pecopteris latepinnata	
Rhacophyllum pachyrrachis	R. (Lonchopteris) reticulata	
Pterophyllum longifolium	Pterophyllum longifolium	Pterophyllum longifolium (KS)
		Williamsonianthus keuperianus (KS)
		Leuthardtia ovalis (KS)
P. jaegeri	P. jaegeri	
P. brevipenne	P. brevipenne	P. brevipenne (KS)
P. merianii		Stachyotaxus sahnii (K)
		S. lipoldii (K 55)
P. pulchellum		
P. pulchellum (seed scales)		Voltzia novomundensis (K)
P. greppinii	Taeniopteris angustifolia f. siliquosa	Leguminanthus siliquosus (KS)
Taeniopteris angustifolia		
Baiera furcata	Baiera furcata	Taeniopteris sp. (KS)
Voltzia heterophylla	Voltzia heterophylla (partly)	Voltzia novomundensis (K)
Widdringtonites keuperianus	Widdringtonites keuperianus	Widdringtonites keuperianus (K)
Carpolithes greppinii		
		Paradoxoxylon leuthardtii (K)
Bambusium imhoffii	Bambusium imhoffii	Desmiophyllum imhoffii (Fl, K)
	„Baiera – Bluten“	Antholithes leuthardtii (K)

6. Semionotus Sandstein plants (for references see chart 4)

a) Hassfurt am Main, Franken (lad-karn, 4): *Lepidopteris brevipinnata, Voltzia coburgensis, V. divaricata, V. fraasii, Glyptolepis keuperiana, G. platysperma, Widdringtonites keuperianus, Podocarpites kehlii.*

7. Middle Keuper plants of Lorraine, Paris Basin

a) Gemmelaincourt, Norroy, Suriauville, Vic (lad-karn, 1) (FLICHE, 1905–1910; RICOUR, 1968): *Algacites areolatus, Xylomites clathrophylii, Equisetum mytharum* (with fructifications), *E. arenaceum* (with fructifications), *Clathrophyllum merianii, Pecopteris gracilis, Araucarioxylon keuperianum, Rhabdocaulon zeilleri, Cystoseirites triassicus.*

8. Rhaetian-Keuper plants of Germany (for references see chart 4)

a) Coburg in Süddeutsche Senke (nor-rt, 3): *Lepidopteris ottonis* (former *Asplenites ottonis*), *Laccopteris elegans, Dadoxylon brueckneri.*

b) Seinstedt in Subherzynische Senke (nor-rt, 2): *Clamites guembelii, C. hoerensis, Equisetites muensteri, Dictvophyllum acutilobum, Laccopteris alternifolia, Clathropteris platyphylla, C. meniscoides, Camptopteris exilis, C. fagifolia, C. planifolia, Lepidopteris ottonis* (former *Pecopteris grumbrechtii* and *Asplenites ottonis*), *Cyatheites asterocarpoides, Cyclopteris crenata, Odontopteris cycadea, O. laevis, Cycadites rectangularis, Nilssonia blasii, N. (Hisingera) linearis, N. elongata, Pterophyllum maximum, P. blasii, P. braunsii, Zamites* sp., *Taeniopteris tenuinervis, T. vittata, T. muensteri, Thuites schloenbachii, Arundites dubius, A. priscus.*

9. Rhaetian plants of France

a) Saint Etienne, Premontrey in Paris Basin (nor-rt, 1) (FLICHE, 1900): *Clathropteris platyphylla.*

b) Luneville (nor-rt, 1) (SAPORTA, 1873–1891): *Cylindropodium liasinum.*

II. Western Europe

The marginal parts of the German Basin

10. Early Triassic plants of France

a) Creyseilles, Lodeve near Privas, west of Montpellier (olan, 8) (DOUBINGER & CHEYLAN, 1964): *Equisetum mougeotii, Equisetum* cf. *brongniartii, Schizoneura* cf. *paradoxa, Aethophyllum* sp., *Voltzia heterophylla.*

11. Keuper plants of France and Italy

a) Vanoise, dept. Savoie (lad-karn, 5) (RICOUR, 1968): *Equisetum mytharum, Asterotheca ?* cf. *merianii, Pecopteris (Merianopteris)* cf. *augusta, Sphenopteris ? roessertiana ?, Pterophyllum brevipenne, P. jaegeri, P. longifolium, Taeniopteris* sp., *Voltzia* or *Brachyphyllum.*

b) Crochetta, Liguruan Maritime Alps (lad-karn, 6) (BLOCH, 1958): *Equisetites mytharus.*

c) Mont-Charven (lad-karn, 6) (BLOCH, 1958): *Equisetites mytharus.*

d) Lauce, sud-west from Gapa (lad-karn, 6) (BLOCH, 1958): *Equisetites mytharus.*

12. Rhaetian plants of France

a) Lozere (nor-rt, 4) (SAPORTA, 1873–1891; FLICHE, 1900): *Clathropteris platyphylla, Otozamites latior, Weltrichia faberi.*

b) Cherbourg, Cotentin Basin (nor-rt, 5) (RIOULT, 1964 without descriptions): *Equisetites* sp., *Pagiophyllum peregrinum, Brachyphyllum paprelii.*

c) Boulonnais (nor-rt, 6) (CORSIN, 1950): *Cladophlebis roessertii, Danaeopsis marantacea, Ctenopteris cycadea, Ctenopteris* sp. cf. *sarranii.*

d) Autin (nor-rt, 7) (SAPORTA, 1873–1891): *Equisetum arenaceum, E. muensteri, E. pellati, Clathropteris platyphylla, Danaeopsis marantacea, Taeniopteris angustodunensis, T. superba, T. tenuinervis, T. stenoneura, T. vittata.*

13. English "Keuper" plants

a) Bromsgrove, Worcestershire (ol-an, 9) (ARBER, 1907, 1909; WILLS, 1910; TOWNROW, 1962; GRAUVOGEL-STAMM, 1972, 1978): *Schizoneura – Echynostachys paradoxa* (former *Schizoneura paradoxa*), *Equisetites arenaceus ?, Yuccites vogesiacus, Willsiostrobus willsii* (former *Masculostrobus willsii* and *Voltzia heterophylla ?*), *W. bromsgrovensis* (former *Masculostrobus bromsgrovensis* and *Voltzia heterophylla*), *Endolepis subvulgaris.*

b) Nottingham (ol-an, 9) (Carpentier, 1923; Vernon, 1910): *Schizoneura paradoxa.*

14. Rhaetian plants of England

a) from Bristol to Birmingham (nor-rt, B) (Harris, 1938): *Naiadita lanceolata.*

b) Bristol (nor-rt, 8) (Harris, 1938): *Stenixys cosmarioides, Hepaticites solenotus, Otozamitrs* cf. *obtusus.*

c) Antrim, Ireland (nor-rt, 10) (Harris, 1961 b): *Otozamites bechei.*

15. Rhaetian-Liassic plants of England

a) Bridgend, near Cardiff (nor-rt, 9) (Harris, 1957; Lewarne & Pallot, 1957): *Doratophyllum* sp., *Ctenis* sp., *Pterophyllum* sp., Conifer sp., *Cycadolepis* sp. and pollen.

b) Henfield near Portsmouth (nor-rt, 9) (Chaloner, 1962): *Cheirolepis muensteri, Equisetites* cf. *grosphodon* and pollen *Classopolis.*

16. Rhaetian plants of Sweden

a) South Sweden (nor-rt, 11) (Nathorst, 1878 a, 1878 b, 1879, 1886, 1906 a, 1906 b, 1908, 1909; Halle, 1908 a, 1908 b, 1910; Antevs, 1914 a, 1914 b, 1914 c; Gothan, 1909; Johansson, 1922; Florin, 1933, 1936; Harris, 1937; Lundblad, 1949 a, 1950 a, 1950 b, 1954, 1956, 1957, 1959 a, 1959 b, 1959 c; Tralau, 1965; Barale, 1972; Lehman, 1983):

Selaginella hallei, Lycopodites scanicus, Lycostrobus scottii, Equisetites laevis, E. gracilis;

Danaeopsis fecunda, Dictyophyllum exile, Clathropteris meniscoides, Todites goeppertianus, Marrattiopsis crenulatus, Phlebopteris angustiloba, P. polypodioides, Camptopteris spiralis, Pecopteris aff. *acutifolia, Cladophlebis svedbergii, C. scoresbyensis, Cladophlebis* cf. *nebbensis, Cladophlebis* cf. *spectabilis, C. arguta, C. sublobata, C. sewardii, C. divaricata, Pterigopteris angelinii;*

Lepidopteris ottonis, Anteysia zeilleri, Peltaspermum rotula, Thinnfeldia polymorpha, T. major, T. rotundata, Rhaphidopteris ? sp. (former *Stenopteris* sp.), *Ptilozamites nilssonii* (according Lundblad, 1950 b includes *P. fallax*), *P. blasii, P. carlsonii, P. heeri, Sagenopteris undulata;*

Nilssonia pterophylloides, N. muensteri, N. polymorpha, Doratophyllum astartensis, D. nathorstii, D. scanicum, Pseudoctenis florinii, Desmiophyllum cyclostomum, Anomozamites minor, Nilssoniopteris sp., *Pterophyllum compressum, P. kochii, Pterophyllum* cf. *ptilum, P. aeguale, Pseudopterophyllum cteniforme, Ctenis nilssonii, C. minuta, C. latepinnata, C. laxa, Palaeocycas integer, Bjuvia simplex, Taeniopteris tenuinervis, Wielandiella angustifolia, W. punctata, Cycadocephallus sewardii, C. minor, Bennettistemon bursigerum, Bennetticarpus exiguus, Hydropterangium marsilioides, H. hyllingensis;*

Ginkgoites troedsonii, G. obovatus, G. marginatus (according LUNDBLAD, 1959 b includes *Ginkgoites* cf. *sibirica, Baiera taeniata* and *Baiera* cf. *longifolia*), *Sphenobaiera spectabilis, S. paucipartita, Sphenobaiera* cf. *angustifolia, Pseudotorellia minuta, Yuccites hadrocladus, Phyllotaenia ? hadroclada, Stachyotaxus septentrionalis, S. elegans, Palissya sphenolepis, Palaeotaxus angustifolium, Podozamites lanceolatus, Samaropsus zignoana.*

17. Early Triassic plants of Poland

a) Borehole Radoszice 3, the Sventokshisk mountains (ol-an, 11) (BOCHENSKI, 1957): *Glossopteridium J. Czarnockii.*

18. Middle Triassic plants of Poland

a) Oberschlesien (ol-an, 10) (SCHMIDT, 1928): *Voltzia krappitzensis.*

19. Rhaetian plants of Poland

a) The Velun environs – four localities (nor-rt, 12) (GOEPPERT, 1836; SCHENK, 1867; GOTHAN, 1909; ANTEVS, 1914 b): *Lepidopteris ottonis* (former *Alethopteris ottonis*), *Pterophyllum carnallianum, P. propinquum.*

b) Kolaczkowice well near Rawicz (nor-rt, 13) (PIWOCKI, 1970): *Lepidopteris ottonis.*

20. Early Triassic plants of Spain

a) Molina-de-Aragon (ol-an, 7) (SCHMIDT, 1937): *Pleuromeia sternbergii.*

III. The Alps, Carpathians, Balkans

21. Early and Middle Triassic plants of the Alps

a) Gaithaler Alps, Werfener Schichten (ol-an, 13, 14) (Chair & Thiedig, 1973; Amerom et al., 1976): *Pleuromeia* sp.

b) Recoaro, the Anisian (ol-an, 12) (Zigno, 1862; Schenk, 1868; Selli, 1938): *Voltzia recubariensis* (former *Araucarites recubariensis*).

22. Upper Triassic plants of the Alps

a) Raibl (lad-karn, 8) – see chart 11 for references, lists and redeterminations of Raibl plants.

b) Lunz (lad-karn, 7) – see chart 12 for references, lists and redeterminations of Lunz plants. One note else: Depape and Doubinger (1963) consider again *Cordaites*-like plants from Lunz to be *Noeggerathiopsis hislopi* (without explanations), although Krausel (1943) described these plants in special monograph studying their epidermal structure which resulted in distinquishing them in a new genus *Glossophyllum*. Epidermal structure of *Glossophyllum* differs very much from that of *Cordaites*.

c) Saint Cassian (lad-karn, 8) (Krasser, 1919): *Williamsonia alpina*.

d) Zoldo and Gardo, Dolomiti (lad-karn, 8) (Leonardi, 1953): *Equisetites* vel *Neocalamites ?*, *Neuropteridium* sp., cf. *Pecopteris sulzinensis*, *Pecopteris (Lonchopteris)* cf. *reticulata*, *Cladophlebis ruietimeyeri* var. *heeri*, cf. *Lomatopteris* sp., *? Thyrsopteris* sp., cf. *Taeniopteris* sp., *Pterophyllum jaegeri*, *Pterophyllum* sp., *Cycadeoidea ? moroderi*, sporofyles of Cycadea vel Bennettitae, *Yuccites vogesiacus*, *? Yuccites* sp., seeds, *Pagiophyllum ? massalongii*, *Pagiophyllum* cf. *foetterlei*, *Voltzia zoldana*, *Voltzia* sp.

23. Plants from the Triassic of the Mecsek mountains (after preliminary determinations given in: Nagy, 1969)

a) The Ladinian (lad-karn, 9): *Equisetites arenaceus*, *Equisetites* sp., *Schizoneura paradoxa*, *Clathropteris reticulata*, *Thaumatopteris muensteri*, *Phlebopteris angustiloba*, *Todites roessertii*, *Anotopteris distans*, *Norinbergia* sp., *Crossotheca* sp., *Macropterigium bronnii*, *Dioonitocarpidium* sp., *Baiera* sp., *Podozamites lanceolatus*, *Voltzia* sp., *Abies* sp.

Chart 11: Revision of the determinations of fossil plants from the Karnian of Raibl (see p. 298: 22a)

STUR, 1885	SCHENK, 1865/1866	SCHENK, 1864	BRONN, 1858	ARBER, 1907, 1909
Equisetum arenaceum	Calamites arenaceus	Equisetites arenaceus		
E. strigatum	C. raiblensis		Phylladelphia strigata	
Rhacopteris raiblensis	Equisetites sp.		P. strigata	
Speirocarpus cf. ruetimeyeri	Neuropteris ruetimeyeri			
Danaeopsis cf. marantacea	Taeniopteris marantacea		Taeniopteris marantacea	
Clathropteris sp.				
Dioonites pachyrhachis	Cyatheites pachyrhachis	Cyatheites pachyrhachis	Filices gen. indet	
Cycadites cuessii			Noeggerathia vogesiaca	Pterophyllum bronnii
Pterophyllum bronnii	Pterophyllum bronnii			Zamites grandis
P. giganteum	P. giganteum			(Yuccites vogesiacus)
P. longifolium			Pterophyllum minus	
P. sandbergeri	P. sandbergeri	Voltzia coburgensis	Voltzia heterophylla	
Voltzia raiblensis	Voltzia coburgensis			
V. haueri				
V. foetterlei				
Cephalotaxites raiblensis			undeterminable leaf	
Carpolithes sp.	Carpolithes			

b) The Karnian (lad-karn, 9): *Equisetites* sp., *Schizoneura* sp., *Clathropteris meniscoides, Clathropteris* sp., *Dictyophyllum* sp., *Todites roessertii, Todites* sp., *Pecopteris* sp., *Compsopteris* sp., *Taeniopteris tenuinervis, Cheirolepis* sp., *Samaropsis* sp.

c) The Norian (nor-rt, 14): *Equisetites* sp., *Czekanowskia rigida, Czekanowskia* sp., *Podozamites* sp.

d) The Rhaetian (nor-rt, 14): *Thaumatopteris braunianna, Zamites distans, Z. distanns* var. *longifolia, Palissya braunsii.*

24. Rhaeto-Liassic plants of Southern Carpathians

a) Banat, Roumania (nor-rt, 15) (Semaka & Givulescu, 1965): *Thinnfeldia* sp., *Pterophyllum* sp., *Taniopteris* sp., *Zamites* sp., *Podozamites mucronatus, Podozamites* sp., *Ginkgoites* sp., *Baiera lindleyana, Baiera* sp., *Phoenicopsis* sp., *Czekanowskia nathorstii, C. rigida, Czekanowskia* sp., *Palissya braunii.*

25. Lower Triassic plants of Balkans (Stara Planina)

a) Eastern Serbia, Yugoslavia (ol-an, 15) (Pantip, 1960): *Equisetites mougeotii, Schizoneura paradoxa, ? Neuropteridium intermedium, Yuccites* sp., *Voltzia heterophylla.*

b) North-western Bulgaria (ol-an, 15) (Kharkovska & Tenchov, 1963): *Equisetites mougeotii.*

Chart 12: Revision of the determinations of fossil plants from the Karnian of Lunz (see p. 298: 22b)

Stur, 1885	Krasser, 1909 a, 1909 b, 1918 Krausel, 1922, 1923 (K); Langer, 1943	Krausel, 1943, 1948, 1949, 1953; Krausel & Schaarschmidt, 1966 (KS); Bharadwaj & Singh, 1956 (BS); Roselt, 1954 (R)
Calamites merianii	Neocalamites merianii	Neocalamites merianii (R)
Equisetum arenaceum	Equisetites arenaceus	
E. lunzense		
E. gamingianum	E. gamingianus	
E. aratum		
E. majus	E. majus	
E. haidingeri	E. platyodon	
E. neuberi	E. (Equisetostachys) suecicus	
E. aequale		
E. constrictum		
Coniopteris lunzensis	Coniopteris lunzensis	
Speirocarpus pusillus	Speirocarpus auriculatus	
S. haberfelneri	S. virginensis	
S. neuberi	S. neuberi	
S. auriculatus		
S. lunzensis	S. tenuifolius	
S. dentiger		
Oligocarpia lunzensis	Oligocarpia distans	
O. robustior	O. bullata	
	O. coriacea	
Asterotheca merianii	Asterotheca merianii	Asterotheca merianii (BS)
A. lacera		
A. intermedia		
Bernoullia lunzensis	Bernoullia lunzensis	
Danaeopsis lunzensis	Pseudodanaeopsis plana	
L. marantacea	P. marantacea	
Laccopteria lunzensis	Laccopteris lunzensis	
Clathropteris lunzensis	Clathropteris lunzensis	
D. reticulata	C. reticulata	
C. repanda	C. repanda	
Thaumatopteris lunzensis	Thaumatopteris lunzensis	
Camptopteris lunzensis	Camptopteris lunzensis	
Taeniopteris simplex	Macrotaeniopteris simplex	Leguminanthus siliquosus (KS)
T. latior	M. latior	
T. angustior	M. angustior	
T. haidingeri	M. haidingeri	Tanaeniopteris haidingeri
T. lunzensis	M. lunzensis	
T. parvula		
Ctenis lunzensis	C. lunzensis	
C. angustior		
Dioonites cf. pennaeformis	"Dioonites cf. pennaeformis"	
	Dioonitocarpidium penneforme (L)	Dioonitocarpidium keuperianum
	Weltrichia keuperiana	
	Pseudoptilophyllum titzei	

Taeniopteris simplex	Macrotaeniopteris simplex	Leguminanthus siliquosus (KS)
T. latior	M. latior	
T. angustior	M. angustior	
T. haidingeri	M. haidingeri	Tanaeniopteris haidingeri
T. lunzensis	M. lunzensis	
T. parvula		
Ctenis lunzensis	C. lunzensis	
C. angustior		
Dioonites cf. pennaeformis	"Dioonites cf. pennaeformis"	
	Dioonitocarpidium penneforme (L)	Dioonitocarpidium keuperianum
	Weltrichia keuperiana	
	Pseudoptilophyllum titzei	
		D. liliensternii
	Lunzia austriaca	
	Haitingeria krasseri	
	Cycadospadix sp.	Haitingeria krasseri (K, KS)
	Pramelreuthia haberfelneri	Pramelreuthia haberfelneri
	Pramelreuthia II (L)	Sturiella langeri
	Discostrobus treitlii	
	Antholithes wettsteinii	Antholithes wettsteinii
	? Williamsonia juvenilis	Bennetticarpus sp.
	Williamsonia wettsteinii	
	Williamsonia sp.	Bennetticarpus wettsteinii
	? Williamsonia wettsteinii	Cycadolepsis wettsteinii
	Westersheimia pramelreuthensis	Westersheimia pramelreuthensis
	Androstrobus sp.	
	Beania sp.	
Pterophyllum pichleri	Pterophyllum pichleri	
P. lunzense	P. lunzense	
P. guembelii	P. guembelii	
P. haueri	P. haueri	
P. neuberi		
P. rectum		
P. cf. pulchellum	P. pulchellum	
P. cteniforme		
P. haberfelneri		
P. brevipenne	P. brevipenne	
P. longifolium	P. longifolium	Pterophyllum longifolium
P. macrophyllum		
P. pectiniforme		
P. riegeri	P. riegeri	
P. approximatum		
P. irregulare		
	P. jaegeri	
	P. grandifolium	
P. lipoldii	Palissya lipoldii	Stachyotaxus lipoldii
	Nilssonia sturi	
Clathrophyllum lunzense	Clathrophyllum lunzense	Ginkgoites lunzensis
	Baiera lunzensis (K, 1922)	
	Neoggerathiopsis sp.	Glossophyllum florinii
	Baiera lunzensis (K, 1923)	
		Desmiophyllum imhoffii

IV. Eastern Greenland

26. Lower Triassic plants of eastern Greenland

a) Peninsula Hold-with-Hope (ol-an, absent in the map) (LUNDBLAD, 1949 b): *Selaginellites polaris.*

b) Island Trail (ol-an, absent on the map) (LUNDBLAD, 1949 b): *Selaginellites polaris.*

27. Late Triassic plants of eastern Greenland, Scoresby Sound (nor-rt, absent on the map) (HARRIS, 1926, 1931–1937, 1961; LUNDBLAD, 1950 b, 1959 c):

a) *Lepidopteris* zone: *Equisetites muensteri, E. laevis, E. grosphodon, Neocalamites hoerensis, Todites goeppertianus, T. scoresbyensis, Cladophlebis scariosa, Rhinipteris concinna, Phlebopteris polypodioides, Dictyophyllum exile, Clathropteris meniscoides;*

Thinnfeldia sp., *Lepidopteris ottonis, Peltaspermum rotula., Antevsia zeilleri, Ptilozamites nilssonii, Harrisiothecium marsilioides* (formar *Hydropterangium marsilioides*), *Rhaphidopteris astartensis* (former *Stenopteris astartensis*), *Sagenopteris serrata, Amphorisperum rotundatum, A. ellipticum.*

Ctenis minuta, Ctenis nilssonii, Quervania spectabilis, Pseudoctenis spectabilis, Drepanozamites nilssonii, Macrotaeniopteris sp., *Anthrophyopsis crassinervis, Amdrupia stenodonta, Doratophyllum astartensis, Nilsonia fragilis, N. minor, Taeniopteris tenuinervis, Anomozamites minor, A. nitida, Nilssoniopteris groenlandica, N. jourdvi, N. ajorpokensis, Pterophyllum hannesianum, P. astartense, P. schenkii, P. rozenkrantzii, P. pinnatifidum, P. kochii, P. ptilum, P. zygotacticum, P. xiphipterum, Ptozamites* sp., *Wielandiella angustifolia, Bennettistemon amblum, B. bursigerum, B. ovatum, Bennetticarpus exiguus, B. crossospermus, Vardekloeftia conica, V. sulcata, Cycadolepis psila, Bennettitolepis dactylota;*

Ginkgoites obovatus, G. fimbriatus, G. acosimus, Baiera minuta, ? Sphenobaiera boeeggildiana, S. leptophylla, S. paucipartita (former *S. amaloidea* and *B. amaloidea*), *Hartzia tenuis, Staphidiophora secunda, S.? exilee, Alicospermum ? striatum, Stachyotaxus elegans, S. septeentrionalis, Elatocladus perforatus, E. stenostomus, E. lacinosus, E. punctatus, E. nitidus, E. molopicus, E. polystichus, E. physetus, E. euristomus, Onteodendron sternbergii, Podozamites stewartensis, P. astartensis, Podozamites* cf. *distans, Cycadocarpidium swabii, C. erdmanii, Araucarites charcoti.*

Furcula granulifer, *Desmiophyllum* sp., *Allicospermum obscurum*, *A. fragilis*, *A. hartzii*, *Brightonia arota*, *Sphaerostrobus clandestinus*, *Amydrostrobus groenlandicus*, *Chitospermum stereococcus*, *Bysmatospermum macrotrachelum*, *Samaropsis chalcor*, *S. nathorstiana*, *Tmematostrobus eremus*.

b) Transitional zone: *Lycostrobus scottii*, *Equisetites laevis*, *Neocalamites hoerensis*, *Todites princeps*, *T. goeppertianus*, *Phlebopteris angustiloba*, *Thaumatopteris schenkii*, *Clathropteris meniscoides*, *Dictyophyllum exile*, *Stenopteris dinosuarensis*, *Lepidopteris ottonis*, *Ptilozamites nilssonii*, *Anomozamites marginatus*, *Pterophyllum subaequale*, *P. schenkii*, *Czekanowskia nathorstii*, *Cycadocarpidium eerdmannii*, *Stachyotaxus elegans*, *Swedenborgia cryptomerioides*.

V. Svalbard

28. Late Triassic plants of Svalbard

a) Spitzbergen island (lad-karn, 10), Barentz island (lad-karn, 11), Edge island (lad-karn, 12) (VASSILEVSKAJA, 1972, 1983 b): *Neocalamites merianii, Neocalamites* cf. *merianii, Neocalamites* sp., *Equisetetis cf. glandulosus, Danaeopsis* cf. *marantacea, Asterotheca merianii, Clathropteris* sp., *Dictyophyllum* sp. 1, *Dictyophyllum* sp. 2, *Thaumatopteris brauniana, Cladophlebis* aff. *remota, Paratatarina ptchelinae, P. korchinskae, P. spetsbergensis, Paratatarina* sp., *Pterophyllum brevipenne, P. jaegeri, P. aff. jaegeri, P. longifolium, Pterophyllum* sp., *Taeniopteris* sp., *Glossophyllum ? spetsbergense, Glossophyllum* sp., *Podozamites protolanceolatus.*

VI. European part of the USSR and Western Kazakhstan

29. Early Triassic plants of Moscow syneclise

a) Upper Volga (ol-an, 16-21) (NEUBURG, 1960; DOBRUSKINA, 1974, 1982 b): *Pleuromeia rossica* in DOBRUSKINA, 1985 B = *Lycomeia rossica*), *Sphenobaiera* sp., *Elatocladus* sp., and undeterminable pinnule of fern.

b) Koslan, Basin of the Mezen River (ol-an, 22) and Zheshard, Basin of the Vychegda River (ol-an, 23) (determinations of DOBRUSKINA, COLL. GIN 3792/ 25-56): *Tomiostrobus* sp.

30. Late Triassic plants of Donbass

a) Nikolayevka (lad-karn, 13) (STANISLAVSKY, 1976): *Hepaticites konaschovii, Schizoneura ornata, Neocalamites merianii* (first described by STANISLAVSKY, 1965), pinna of fern, *Lepidopteris stittgartiensis, Peltaspermum* sp., *Furcula ? ucrainica, Ptilozamites semenovae, Sagenopteridium inaequale, Anomozamites variana, Pterophyllum* sp., *Cycadospadix* sp., *Ctenis ? acuminata, Taeniopteris* sp., *Sphenobaiera stenoloba, Glossophyllum angustifolium, Voltzia charkoviensis, Swedenborgia megasperma, S. tyttosperma, Podozamites toretziensis (Cycadocarpidium toretziensis), Podozamites guttiformis* (first described by MIGATSCHEVA, 1963 in "OSNOVY PALEONTOLOGII . . ., 1963" and repeated in 1968 as *Caveophyllum guttiformae* and *C. obtusum*), *Desmiophyllum acuminatum, Antholites* sp., *Carpolithes* sp.

b) Garazhovka (lad-karn, 13) (PRYNADA, coll. CPRG 6807): *Xylomites asteriformis, X. zamitae, Dictyophyllum* cf. *japonicum, Thaumatopteris* sp., *Cladophlebis donetziana, Callipteridium donetzianum, C. patens, Thinnfeldia rugosa, T. pannucea, Thinnfeldiella reticulata* (described in PRYNADA, 1956), *Peltaspermum incisum, Anteysia zeilleri, Miassia acutifolia, M. latifolia, Subzamites corrugatus, Feildenia* sp., *Podozamites angustifolius, Pityophyllum angustifolium, P. follinii, Pityocladus cobukensis, P. regularis, Cycadocarpidium erdmannii, C. tricarpum, C. elongantum, Tanaidocarpidium triphyllum, Pirocarpidium pendulus, Hyrgisiostachys dilatatus, Stenomiscus* sp., *Sorosaccus* sp., *Antholithes* sp., *Lungershausenia bicornuta, Carpolithes parvulus, C. protractus.*

c) Garazhovka (lad-karn, 13) (STANISLAVSKY, 1976): *Neocalamites* sp. (in STANISLAVSKY, 1965 = *N. baluchovskii*), *Equisetum* sp., *Todites berekensis, Clath-*

ropteris sp., *Dictyophyllum* sp., *Thaumatopteris mirabilis, Lepidopteris toretziensis, Peltaspermum incisum, Antevsia prynadea, Ctenozamites minor, Ptilozamites* cf. *nilssonii, Harrisiothecium laxum, Podozamites trichocladus, Podozamites* sp. 1, *Podozamites* sp. 2, *Cycadocarpidium tricarpum, C. exiguus, C. paulum, Cycadocarpidium* sp., *Borysthenia fascinata, Pityophyllum* sp., *Pityospermum ? scyticum, Uralophyllum prynadae, Desmiophyllum* sp. A, *Desmiophyllum* sp. B, *Desmiophyllum* sp. C, *Tmematostrobus spiciformis, Masculostrobus* sp. 1, *Masculostrobus* sp. 2, *Masculostrobus* sp. 3, *Samaropsis prynadae, S. orbicularis, Carpolithes* cf. *cinctus*, Problematicum A, Problematicum B.

d) Sukhaya Kamenka (nor-rt, 16) (PRYNADA, 1956): *Tanaidia mirabilis.*

e) Novorayskoye (nor-rt, 16) (PRYNADA, coll. CPRG 6807): *Equisetites* sp., *Osmundopsis plectrophora, Dictyophyllum japonicum, D. acutifolium, Chiropteris flabellata, Ptilozamites* sp., *Taeniopteris tenuinervis, Anomozamites minor, A. gracilis, A. minor* f. *irregularis, Pterophyllum equale, Sarmatiella brevifolia* (described in PRYNADA, 1956; in KILPPER, 1975 = *Keraiaphyllum brevifolium*), *Ginkgo concinna, Baiera donetziana, Ginkgodium iziumense, Czekanowskia rigida, Phoenicopsis angustifolia, P. elegans, Podozamites distans, P. angustifolius, Podozamites* ex gr. *kidstonii, P. concinnus, Cycadocarpidium erdmannii, Pityophyllum angustifolium, Pityophyllum nordenskioldii, Ropalostachys minor, Samaropsis* cf. *zignoana, S. orbicularis, Lepeophyllum subcirculare.*

f) Novorayskoye (nor-rt, 16) (STANISLAVSKY, 1971, 1973, 1976): *Thallites toretziensis, T. plicatus, Neocalamites lehmanianus* (in STANISLAVSKY, 1956 = *Neocalamites hoerensis*), *Annulariopsis* sp., *Equisetites* sp. 1, *Equisetites* sp. 2;

Osmundopsis scytica, Todites princeps ?, Coniopteris sp., *Clathropteris meniscoides, Dictyophyllum nervulosum, D.* cf. *muensteri, D. prynadae, Hausmannia* cf. *crenata, Chiropteris flabellata, Cladophlebis toretziensis, Rhizomopteris* sp. 1, *Rhizomopteris* sp. 2;

Lepidopteris toretziensis (former *Lepidopters* sp.), *Peltaspermum incisum* (former *Peltaspermum* sp.), *Sagenopteris* sp., *Ctenozamites ?* sp., *Sarmatiella brevifolia* (first described in PRYNADA, 1956), *Harrissiothecium* cf. *marsilioides* (former *Hydropterangium* cf. *marsilioides*);

Weltrichia sp., *Anomozamites* cf. *minor, Pterophyllum* cf. *ptilum, P. aeguale, Zamites corrugatus, Cycadolepis* sp. 1, *Cycadolepis* sp. 2, *Cycadolepis* sp. 3, *Cycadolepis* sp. 4, *Nilssonia* sp., *Taeniopteris* cf. *tenuinervis, Taeniopteris crassinervis*;

Baiera minuta, Sphenobaiera sp., *Toretzia angustifolia, T. longifolia, Czekanowskia* sp., *Phoenicopsis elegans, Pseudotorellia triplicata;*

Podozamites ex gr. *lanceolatus, P. rigidus, Podozamites* sp. 1, *Podozamites* sp. 2, *Podozamites* sp. 3, *Podozamites* sp. 4, *Cycadocarpidium erdmannii, C. swabii, Swedenborgia longiloba, Pityolepis ?* sp. 1, *Pityoplepis* sp. 2, *Pityospermum ? scythicum, Conites amadocensis, Masculostrobus* sp.;

Desmiophyllum sp. 1, *Desmiophyllum* sp. 2, *Ixostrobus* sp., *Rhopalostachys minor, Samaropsis orbicularis, S. prynadae, S. pumila, Antholithes* sp., *Carpolithes cinctus.*

31. Early Triassic plants of Pechora Basin and island Novaya Zemlya

a) Byzovaya village in Pechora Basin (ind, 2) (VLADIMIROVICH, 1967 IN: VLADIMIROVICH ET AL.,1967; FEFILOVA, 1983; determinations of DOBRUSKINA after coll. GIN 3705, 3748): *Tomiostrobus gorskii* (in FEFILOVA, 1983 = *Pseudoaracarites gorskii* and *Araucarites petschorensis*), *Glossophyllum* aff. *florinii, Glossophyllum* sp., *Peltaspermum* sp.

b) River Adzva in Pechora Basin, outcrop ch-25 (ind, 3) (determinations of DOBRUSKINA after coll. GIN 3739): *Tomiostrobus* sp.

c) Borehole Kushshor 656 in Pechora Basin, depth 490,5 m (ind, 4) (determinations of DOBRUSKINA after coll. GIN 3753): *Tomiostrobus* sp.

d) Yanyu River in Pechora Basin, 13,7 km from its mouth (ind, 2) (RADCZENKO & SREBRODOLSKAYA, 1960): *Tersiella belousovae.*

e) Novaya Zemlya, Northern Island, Admiralteistvo peninsula, south western coast of bay Nivelir (ind, 1) (VASSILEVSKAJA, 1984 a, 1984 b): *Tomiostrobus gorskii.*

32. Middle and Late Triassic plants of the Pechora Basin and of island Novaya Zemlya

a) Pechora River: Big Synya depression (lad-karn, 16) and Pechora syneclise (lad-karn, 18-20); Khey-Yaga River: Korotaikha depression (lad-karn, 17) (NEUBURG, 1959; DOBRUSKINA, 1969, 1980; CHRAMOVA & PAVLOV, 1971; CHRAMOVA, 1973, 1977): *Equisetites* sp. – N, *Paracalamites* sp. – N, *Danaeopsis* aff. *fecunda* – N, *D. petchorica* – C–P, *D. marantacea* – C, *Asterotheca merianii* – N, *A. viveia* – C–P, *Todites orbiculatus* – C–P, *T. goeppertianus* – C–P, *Dictyophyllum* sp. – C–P, *Cladophlebis szeiana* – C, *C. shensiensis* – C, *Cladophlebis* cf. *parvifolia* – N, *Cladophlebis* sp. – N, *Scytophyllum nerviconfluens* – D, C (in NEUBURG, 1959 = *Aipteris nerviconfluens*), *S. entsovae* – N, *S. neuburgianum* – D, *S. abramovii* – D, *S. papillosum* – D, *S. sorokini* – C, *S. sectum* – C, *S. flexuosum* – C, *S. geniculatum* – C, *S. kiritchkovae* – C, *S. lepidopteroides* – C, *S. multipapillatum* – C, *S. pilosiformis* – C, *Lepidopteris ? laevis* – C, *Lepidopteris* sp. – C (later in KIRITCHKOVA & CHRAMOVA, 1980 = *Lepidopteris evidens*), *Peltaspermum petchoricum* – C, *Antevsia kolvaensis* – C, *Maria synensis* – D, *M. prynadae* – D, *M. chalyshevii* – D, *Ptilozamites lanceolatus* – C, *P. linguliiformis* – C, *Aksarina kipievica* – D, *Sagenopteris angustifolius* – C, *S. variabilis* – C, *Doratophyllum acuminatum* – C, *D. multinervis* – C, *D. synensis* – C, *D. vjatkensis* – C, *Pseudoctenis* sp. – C, *Sphenobaiera petchorica* – C, *Ginkgo ?* sp. – C, *Glossophyllum synense* – N (in DOBRUSKINA, 1980 = *Maria synensis*), *Kalantarium kraeuselii* – D, *K. kraeselii* f. *binervis* – D. *K. kraeuseli* f. *minor* – D, *K. prosundum* – D, *Carpolithes oviformis* – N.

b) Novaya Zemlya, Northern Island, bay Krestovaya (lad-karn, 14) (VASSILEVSKAJA, 1983 a, 1985): *Neocalamites ?* sp., *Phlebopteris* sp., *Cladophlebis (Asterotheca ?)* sp., *Cladophlebis* cf. *yanschinii, Cladophlebis* sp., *Cycadolepis* sp., *Drepanozamites ? ambiguus, Taeniopteris* cf. *tenuinervis, Taeniopteris* ? sp., *Pityospermum* sp., *Yuccites novosemelicus, Yuccites* sp., *Desmiophyllum variabile, Desmiophyllum* sp., *Phyllites cordaiteformis.*

c) Novaya Zemlya, Southern Island, peninsula Britvin (lad-karn, 14 a) (VASSILEVSKAJA, 1985): *Equisetites tcherkesovii, Equisetites* sp., *Asterotheca* cf. *merianii, Scytophyllum* sp., *Taeniopteris* ex gr. *ensis.*

d) Franz-Joseph Land, island Zemlya Georga (lad-karn, 15) (NEWTON & TEAL, 1897): *Rhiptozamites* cf. *goeppertii, Zamiopteris* sp., *Phyllotheca (Equisetites)* cf. *columnarica, Asplenium* cf. *whitbiense.*

e) Franz-Joseph Land, island Greem Bell, peninsula Kholmistyy (lad-karn, 15 a) (VASSILEVSKAJA, 1985): *Equisetites tcherkesovii, Equisetites* sp., *Neocalamites* sp., Arthropsida gen. et sp. indet., *Asterotheca* aff. *merianii,* Dipteridaceae # 1 and # 2, *Strobilites* sp. (cf. *Voltzia novomundensis*), *Carpolithes* sp.

33. Middle and Late Triassic plants of Pechora Basin (determined and revised by DOBRUSKINA mainly after coll. GIN 3707, 3720, 3728, 2729, 3730, 3731, 3734, 3735, 3739, 3744, 3747, 3748, 3750, 3753, 3754, 3777, 3793; the mark * indicates species which are absent in the collections of GIN and were described before – see list 32)

a) Pechora syneclise (lad-karn, 18, 19, 20): *Equisetites* sp., *Paracalamites* sp., *Bernoullia aktjubensis, Danaeopsis fecunda, D. marantacea, Todites goeppertianus* *, T. orbiculatus *, *Cladophlebis shensiensis, C. paralobifolia, Rhacophyllum pachyrrachis, Lepidopteris haizeri, L. ? laevis* *, *Scytophyllum nerviconfluens, Scytophyllum* aff. *nerviconfluens, S. neuburgianum, S. papillosum, S. abramovii, S. baschkiricum, S. flexuosum* *, *Peltaspermum usensae, Peltaspermum* sp., *"Thinnfeldia"* sp., *Maria synensis, M. prynadae, Ptilozamites linguiformis* *, *Aksarina kipievica, Sagenopteris angustifolius* *, *S. variabilis, Doratophyllum acuminatum* *, *D. multinervis* *, *Taeniopteris spathulata, T. ? stankevichii. Kalantarium kraeuselii, K. prosundum, Sphenobaiera spectabilis, Sphenobaiera* spp., *Pseudotorellia*spp., *Glossophyllum ?* sp., *Swedenborgia crvptomerioides, Carpolithes* sp., *Radicites* sp.

b) Big Synya depression (lad-karn, 16): *Asterotheca merianii, Danaeopsis fecunda, D. marantacae, Polypodites cladophleboides, Cladophlebis shensiensis, C. szeiana* *, *Lepidopteris haizeri, L. heterolateralis, Lepidopteris* sp., *Scytophyllum nerviconfluens, S. neuburgianum, S. baschkiricum, S. flexuosum* *, *Peltaspermum usensae, Madygenopteris* sp., *"Sphenocallipteris"* sp., *Maria synensis, M. prynadae, M. chalyshevii, Ptilozamites lanceolatus* *, *Ctenopteris sarranii, Ctenopteris* sp., *Doratophyllum synense* *, *D. vjatkense* *, *Taeniopteris spathulata, T. ensis, Hyrcanopteris ?* sp., *Cycadolepis* sp., *Kalantarium kraeuselii, K. kraeuselii* f. *binervis, K. kraeuselii* f. *minor, Ginkgoites* sp. *, *Sphenobaiera petchorica* *, *Sphenobaiera* spp., *Glossophyllum ?* sp., *Pseudotorellia ?* spp., *Podozamites* sp., *Ixostrobus groenlandicus, Carpolithes* sp.

c) Korotaikha depression (lad-karn, 17): *Neocalamites* sp., *Asterotheca merianii, Bernoullia aktjubensis, Bernoullia ?* sp. nov., *Cladophlebis* sp., *Peltaspermum* sp. 1, *Ctenopteris sarranii, Taeniopteris spathulata, Glossophyllum ?* sp., *Araucarites* sp., *Carpolithes* sp.

34. Early Triassic plants of Southern Priuralye

a) Petropavlovka (ol-an, 24) (determinations of DOBRUSKINA after coll. GIN 3773, 3776): *Equisetites* sp., *Neocalamites* sp., *Voltzia heterophylla, Carpolithes* sp.

35. Middle and Late Triassic plants of Southern Priuralye

a) Ilek River Basin (lad-karn, 23) (Brick, 1952; DOBRUSKINA, 1969, 1980): **Kurashasay Formation:** *Equisetites arenaceus, Danaeopsis marantacea, D. emarginata, D. bipinnata, D. angustipinnata, Bernoullia aktjubensis, Todites roessertii, Polypodites cladophleboides, C. adophlebis simplicinervis, C. tripinnata, Lepidopteris remota* (former *Lepidopteris ottonis* and *Callipteridium remotum*), *Scytophyllum nerviconfluens* (former *Aipteris nerviconfluens*), *Thinnfeldia* sp., *Taeniopteris angustifolia, Sphenozamites suracaicus, Maria prynadae* (former *Yuccites spathulatus* and *Y. uralensis*), *Araucarites convexus* (in SADOVNIKOV, 1982 a = *Tomiostrobus convexus*), *Sagenopteris ilekensis, Ixostrobus* cf. *groenlandicus, Swedenborgia cryptomerioides.* **Bukobay Formation:** *Xylomites zamitae, Bernoullia aktjubensis, Todites roessertii, Diplazites kazachstanicus, Cladophlebis szeiana, C. aktjubensis, Rhacophyllum pachyrrachis, Lepidopteris remota* (former *Lepidopteris ottonis*), *Taeniopteris ensis, Maria prynadae* (former *Yuccites uralensis*).

The Ilek River Basin (lad-karn, 23) (ORLOVSKAYA, 1977): *Equisetites arenaceus, E. sarranii, Equisetites* cf. *platyodon, Equisetites* ex gr. *conicus, Danaeopsis fecunda, Todites goeppertianus, Sagenopteris ilekensis, Dioonitocarpidium* cf. *keuperianum, Cycadolepis* sp., *Glossophyllum ?* sp., *Swedenborgia cryptomerioides.*

b) Burtya River Basin (lad-karn, 22) (BRICK, 1952): *Danaeopsis hughesii.*

c) Gully Bukobay (lad-karn, 22) (VLADIMIROVICH, 1972): *Phyllotheca* sp., *Danaeopsis bukobaica, Scytophyllum nerviconfluens, Protoblechnum tuzhykovae, Ketovia furcata, Tuzhikoviella elegans, Strobilites ?* sp.

d) Village Krivlya (lad-karn, 21) (PRYNADA & TURUTANOVA-KETOVA, 1962): *Neocalamites squamulosus, N. uralensis, Schizoneura altaica, Danaeopsis rarinervis.*

e) Village Staro-Mikhaylovka (lad-karn, 21) (PRYNADA & TURUTANOVA-KETOVA, 1962): *Neocalamites squamulosus, N. uralensis, Danaeopsis taeniopteroides.*

f) Gully Surakay (lad-karn, 21) (ZALESSKY, 1936; PRYNADA & TURUTANOVA-KETOVA, 1962; PRYNADA in "OSNOVY PALEONTOLOGII . . .", 1963): *Cladophlebis surakaica, C. yanshinii, C. curvifolia, Acozamites elegans, Sphenozamites surakaicus, Neoggerathiopsis baschkirica, Podozamites magnalis.*

g) Village Blagoveshchenka (lad-karn, 21) (DOBRUSKINA, 1969): *Scytophyllum nerviconfluens, S. baschkiricum.*

36. Middle and Late Triassic plants of Southern Priuralye (determined and revised by DOBRUSKINA)

a) The Ilek River Basin (lad-karn, 23) (coll. CPRG 6910, coll. GIN 4042): **Kurashasay Formation:** *Equisetites arenaceus, Danaeopsis marantacea, Bernoullia aktjubensis, B. zeilleri, B. rigida, Todites goeppertianus, Polypodites cladophleboi-*

des, Cladophlebis simplicinervis, Cladophlebis sp., *Lepidopteris remota, L. haizeri, L. heterolateralis, Scytophyllum nerviconfluens, "Thinnfeldia"* sp., *Maria prynadae, M. synensis, Sagenopteris ilekensis, Taeniopteris angustifolia, Apoldia surakaica, Sphenobaiera ?* spp., *Pseudotorellia* spp., *Tomiostrobus convexus, Ixostrobus* cf. *groenlandicus, Swedenborgia cryptomerioides.* **Bukobay Formation:** *Xylomites zamitae, Bernoullia aktjubensis, Todites goeppertianus, Diplazites kazachstanicus, Cladophlebis szeiana, C. aktjubensis, Rhacophyllum pachyrrachiys, Lepidopteris remota, ? Maria prynadae, Taeniopteris ensis.*

b) Gully Bukobay (lad-karn) (coll. CPRG 10180 and GIN 3776): *Bernoullia ?* sp., *Scytophyllum* cf. *nerviconfluens, Scytophyllum ?* sp., *"Thinnfeldia" rhomboidales, "Thinnfeldia"* sp.; *Carpolithes* sp.

c) Village Staro-Mikhaylovka (lad-karn, 21) (coll. GIN 1440, coll. BIN 803): *Neocalamites rugosus, N. uralensis ?, Danaeopsis marantacea, Taeniopteris ensis, Sphenobaiera angustiloba.*

d) Village Krivlya (lad-karn, 21) (coll. GIN 3776, coll. BIN 803): *Neocalamites rugosus, N. uralensis ?, Schizoneura* sp., *Danaeopsis marantacea.*

e) Gully Surakay (lad-karn, 21) (ZALESSKY, 1936; coll. CPRG 5556, coll. GIN 3748): *Danaeopsis marantacea, Cladophlebis surakaica, C. raciborskii, Cladophlebis* s., *Apoldia elegans, Taeniopteris ensis, Sphenobaiera angustifolia, Glossophyllum ? baschkiricum, Desmiophyllum magnalis, Yuccites ?* sp. n.

f) Village Blagoveshchenka, borehole 53 (lad-karn, 21) (coll. GIN 3776): *Equisetites arenaceus, Lepidopteris microcellularis, Scytophyllum nerviconfluens, Scytophyllum* aff. *nerviconfluens, Scytophyllum* sp., *"Sphenocallipteris"* sp., *Maria synensis, M. prynadae, Aksarina meridionalis, Kalantarium* aff. *prosundum, Sphenobaiera* spp., *Pseudotorellia ?* spp., *Glossophyllum ?* sp., *Desmiophyllum* sp.

g) Khutor Lysov (lad-karn, 21) (coll. GIN 3980): *Equisetites arenaceus, Danaeopsis marantacea, Cladophlebis shensiensis, Lepidopteris microcellularis, Apoldia surakaica, Sphenobaiera granulifer, Desmiophyllum* sp.

h) Village Aksarovo (lad-karn, 21) (coll. GIN 3776): many dispersed phytoleims including *Aksarina meridionalis.*

j) Yushatyr River in 2,8 km lower the farm Kuyurguzinsky (lad-karn, 21) (coll. GIN 3776): *Equisetites arenaceus, Taeniopteris* sp., *Glossophyllum* sp.

37. Early Triassic plants of Eastern Predkavkazye (ForeCaucasus)

a) Boreholes in Eastern Predkavkazye, Basin of Kuma River (ol-an, 25, 26) (DOBRUSKINA, 1977 c, 1982 b): *Pleuromeia sternbergii.*

38. Late Triassic plants of Eastern Predkavkazye (ForeCaucasus)

a) Boreholes in Eastern Predkavkazye, Basin of Kuma River (lad-karn, 24–26; nor-rt, 18–20) (determinations of DOBRUSKINA and VAKHRAMEEV in: VAKHRAMEEV ET AL., 1977. Mark * indicates species figured in: DOBRUSKINA, 1977 c): *Neocalamites* cf. *carrerei, Neocalamites hoerensis, Asterotheca merianii* *, *Bernoullia aktjubensis* *, *Danaeopsis fecunda* *, *Dictyophyllum exile, D. nilssonii, Clathropteris* cf. *meniscoides, Phlebopteris muensteri, Cladophlebis (Todites) shensiensis, C. donetziana, Lepidopteris toretziensis* *, *Anomozamites gracilis, A.*

minor, Pterophyllum ptilum *, *Pterophyllum brevipenne* *, *Nilssonia muensteri, Pseudoctenis* aff. *weberi, Taeniopteris* cf. *tenuinervis, Ginkgoites* sp. *, *Baiera minuta* *, *Sphenobaiera spectabilis, Phoenicopsis* sp., *Czekanowskia* sp., *Leptostrobus* sp., *Eretmophyllum* sp., *Ropalostachys* sp., *Podozamites lanceolatus, Podozamites* ex gr. *angustifolius, P. rigidus* *, *Palissya ? sphenolepis, Pityophyllum* ex gr. *nordenskioldii, Cycadocarpidium swabii, Swedenborgia minor, Stenorachis* sp., *Carpolithes* sp.

39. Early Triassic plants of Northern Caucasus

a) Gully Svinyachya, Belaya River Basin (ol-an, 27) (coll. GIN 4043, determinations of DOBRUSKINA): *Pleuromeia sternbergii.*

40. Early Triassic plants of Prikaspian Depression

a) Big Bogdo Mount (ol-an, 29) (DOBRUSKINA, 1974, 1982 b): *Pleuromeia sternbergii.*

b) Borehole Sadovaya 1 (ol-an, 28) (coll. GIN 4042, determinations of DOBRUSKINA): *Pleuromeia sternbergii.*

41. Late Triassic plants of Prikaspian Depression

a) Kusan-Kuduk, borehole II 35 (nor-rt, 17) (coll. GIN 4042, determinations of DOBRUSKINA): *Clathropteris meniscoides.*

42. Early Triassic plants of Mangyshlak

a) Mountaneous Mangyshlak (ol-an, 30, 31, 32) (DOBRUSKINA, 1974, 1982 b): *Pleuromeia sternbergii.*

b) Southern Mangyshlak, borehole Rakushechnaya, Khozbulak Formation (ol-an, 33) (coll. GIN 4053/209–212, determinations of DOBRUSKINA): *Pleuromeia sternbergii.*

c) Southern Mangyshlak, borehole Rakushechnaya, Birkut Formation (ol-an, 33) (coll. GIN 4053/213–217, determinations of DOBRUSKINA): *Pleuromeia sternbergii.*

VII. Eastern Urals and Western Kazakhstan

43. Plants from volcano-sedimentary deposits of Eastern Urals

a) Anokhino and Kvashnino depressions (lad-karn, 29) (Turutanova-Ketova, 1958; Kiritchkova, 1962 a): *Paracalamites* sp. – T–K, *Neocalamites* sp. – K, *Lepidopteris ottonis* – T–K, K (in Kiritchkova & Chramova, 1980 = *L. evidens*), *Sphenocallipteris uralica* – T–K, K (in Kiritchkova & Chramova, 1980 = *Raphidopteris uralica*), *S. anochensis* – T–K, K (in, Kiritchkova & Chramova 1980 = *Raphidopteris uralica*), *S. mesozoica* – K (in Kiritchkova & Chramova, 1980 = *Raphidopteris uralica)*, *S. ketovae* – K (in Kiritchkova & Chramova, 1980 = *Raphidopteris ketovae*), *Stenopteris* cf. *elongata* – T–K, *Pterophyllum braunianum* – K (in Kiritchkova & Chramova, 1980 = *Lepidopteris tuaevii*), *Lepeophyllum* sp. – K.

b) The Chelyabinsk Basin (lad-karn, 30) (Vladimirovich, 1968 b): *Madygenopteris triassica.*

44. Plants from coal-bearing deposits of Eastern Urals

a) Chelyabinsk Basin (Kryshtofovich, 1912): *Equisetacea* sp., *Todites willaimsonii, T. roessertii, Otozamites* sp. (in Kryshtofovich & Prynada, 1933 b = *Neocalamites nordenskioldii, Osmundites prigoroyskii, Cladophlebis haiburnensis*).

b) Chelyabinsk Basin (Kryshtofovich & Prynada, 1960*; Prynada 1960** – P): *Thallites uralensis, Thallites* sp., *Annulariopsis inopinnata, Neocalamites nordenskioldii* (in Kryshtofovich & Prynada, 1960 partly = *Schizoneura grandifolia*), *Osmundites prigorovskii* (in Harris, 1937 = *Osmundopsis prigorovskii*), *Cladophlebis haiburnensis, C. tchichatchevii, C. uralica* – P, *Taeniopteris ensis, Anomozamites lindleyanus, Otozamites* sp., *Ginkgo sibirica, Baiera taeniata, Erethmophyllum* cf. *saighanense, Phoenicopsis rarinervis, Czekanowskia rigida, Antholithes krasheninnikovii, Stenorhachis paradoxa, Stenorhachis* sp. cf. *Ixostrobus siemiradzkii, Uralophyllum krasheninnikovii, Podozamites angustifolius, P. distans, P. lanceolatus, Cycadocarpidium erdmannii.*

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* See Vladimirovich, Prynada & Radczenko, 1960

** See Vladimirovich, Prynada & Srebrodolskaya, 1960

c) Chelyabinsk Basin (lad-karn, 30) (Kiritchkova, 1962 b, 1969): **Horsetail assemblage:** *Schizoneura grandifolia, Annulariopsis inopinata, A. latissima, Neocalamites hoerensis, N. carcinoides, N. carrerei, N. nordenskioldii. Cladophlebis denticulata, C. sewardii, C. tuhaikulensis, C. jolkinensis, C. stenolopha, C. nebbensis, C. linneifolia, Raphaelia acutiloba, Thinnfeldia* aff. *gracilis* (in Kiritchkova & Chramova, 1980 = *Scytophyllum nerviconfluens*), *Taeniopteris* sp., *Phoenicopsis rarinervis, P. angustifolia, Pseudotorellia ensiformis, Podozamites lanceolatus, P. distans, P. mucronatus, Cycadocarpidium* sp., *Yuccites uralensis.*

Horsetail–fern assemblage (lad-karn, 30): *Neocalamites carrerei, N. hoerensis, Cladophlebis denticulata* var. *asiatica, C. whitbiensis, C. jolkinensis, C. haiburnensis, C. spectabilis, C. vaccensis, C. distans, C. magnifica, C. raciborskii, C. uralica, C. nebbensis, C. tuhaikulensis.*

Thinnfeldia vulgaris (in Kiritchkova & Chramova, 1980 = *Scytophyllum* sp.), *T. microphylla* (in Kiritchkova & Chramova, 1980 = *Raphidopteris microphylla*), *Taeniopteris ensis, T. stenophylla, Czekanowskia rigida, Phoenicopsis angustifolia, Carpolithes cinctus, Pityiophyllum nordenskioldii, Podozamites lanceolatus, Antholithes krasheninnikovii, Strobilites* sp.

Fern–ginkgo assemblage (nor-rt, 21): *Neocalamites carrerei, N. hoerensis, Osmundopsis* cf. *plectrophora, Dictyophyllum japonicum, Cladophlebis vaccensis, C. crenulata, C. jolkinensis, C. uralica, C. zauronica, C. tuhaikulensis, C. haiburnensis, C. spectabilis, C. nebbensis, C. stenolopha, C. raciborskii, C. sewardii, C. denticulata, C. denticulata* var. *asiatica, Raphaelia* cf. *diamensis;*

Taeniopteris ensis, Taeniopteris stenophylla, Miassia dentata (in Kiritchkova & Chramova, 1980 = *Uralophyllum*), *Uralophyllum krasheninnikovii, Ginkgo lepida, G. flabellata, G. lanceolata, Sphenobaiera longifolia, S. angustiloba, Czekanowskia rigida, C. setacea, Phoenicopsis rarinervis, P. angustifolia, Pityophyllum nordenskioldii, Podozamites distans, P. lanceolatus, P. lanceolatus* f. *ovalis, P. angustifolius.*

d) Chalyabinsk Basin (nor-rt, 21) (Vladimirovich, 1958 a, 1958 b, 1960 a, 1968 a, 1968 b, 1972*): *Neocalamites* aff. *carrerei, Osmundopsis ? bojakovae, Cladophlebis acuta, C. kushmurunica, C. korkinensis, Compsopteris kryshtofovichii, Stenopteris karashilikensis, Anthrophyopsis miassica.*

e) Bogoslovsk mine (lad-karn, 28) (Prynada, 1940, 1963**): *Thinnfeldia vulgaris* (in Kiritchkova & Chramova, 1980 = *Scytophyllum vulgaris*), *T. gracilis* (in Kiritchkova & Chramova, 1980 = *Raulia gracilis*), *Czekanowskia rigida, Cycadocarpidium erdmannii, C. tricarpum, Furcula uralica* (in Kiritchkova & Chramova, 1980 = *Vittaephyllum crenulatum*).

f) Bogosloysk mine (lad-karn, 28) (Vladimirovich, 1959, 1965): *Thinnfeldia rhomboidalis, T. vulgaris* (in Kiritchkova & Chramova, 1980 = *Scytophyllum vulgaris*), *T. distantifolia* (in Kiritchkova & Chramova, 1980 = *Raulia gracilis*), *T. gracilis* (in Kiritchkova & Chramova, 1980 = *Raulia gracilis*),

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* See Boyakova, Vladimirovich & Mogutcheva, 1972

** See OSNOVY PALEONTOLOGII . . ., 1963

T. irregularis, T. karpinskii, Phoenicopsis angustifolia, P. rarinervis, Czekanowskia rigida, C. setacea, Podozamites distans, Cycadocarpidium tricarpum, Furcula uralica (in KIRITCHKOVA & CHRAMOVA, 1980 = *Vittaephyllum crenulatum*).

g) Bogosloysk mine (lad-karn, 28) (KIRITCHKOVA, 1962 b): *Phyllotheca* sp., *Paracalamites* sp., *Cladophlebis whitbiensis, C. jolkinensis.*

h) Bulanash-Jolkino depression (lad-karn, 29) (TURUTANOVA-KETOVA, 1958; KIRITCHKOVA, 1962 b, 1969): **Bobrovka Formation:** *Annulariopsis inopinata, Neocalamites carrerei* – K, *N. hoerensis* – K, *Cladophlebis whitbiensis* – K, *Cladophlebis* cf. *tchichatchevii* – T–K, *Baiera concinna* – K, *Yuccites uralensis* – T–K, *Podozamites angustifolius.* **Bulanash Formation:** *Muscites uralensis* – T–K, *Thallites uralensis* – K, *Neocalamites hoerensis* – T–K, *N. carcinoides* – K, *N. carrerei, Cladophlebis argutula* – T–K, *C. nebbensis* – K, *C. tuhaikulensis* – K, *Cladophlebis* cf. *undulata* – K, *C. stenolopha* – K, *C. raciborskii* – K, *Todites kamyshbashensis* – K, *T. princeps* – K, *Danaeopsis rarinervis* – T–K, *Thinnfeldia* aff. *gracilis* – (in KIRITCHKOVA & CHRAMOVA, 1980 = *Scytophyllum nerviconfluens*), *Pterophyllum* cf. *schenkii* – T–K, *Taeniopteris kamyshbashensis* – K, *Glossozamites uralensis* – T–K, *Baiera concinna* – K, *Ferganiella bulanashensis* – K, *Yuccites nanus* – K, *Y. spatulatus* – K, T–K, *Y. uralensis* – K, *Podozamites lanceolatus* – K, *P. distans* – T–K, K, *P. angustifolius* – T–K. **Jolkino Formation:** *Neocalamites issykkulensis* – T–K, *Cladophlebis jolkinensis* – T–K, *C. tuhaikulensis* – T–K, *C. uralica* – T–K, *Conites* sp. – T–K. **Variegated Formation:** *Pityolepis cedriformis* – T–K.

i) Veselovka depression (lad-karn, 28) (KIRITCHKOVA, 1962 b, 1969): *Cladophlebis nebbensis, Thinnfeldia karevae* (in KIRITCHKOVA & CHRAMOVA, 1980 = *Scytophyllum karevae*), *Ginkgo donetziana, Sphenobaiera spectabilis, Podozamites lanceolatus, Pityophyllum nordenskioldii.*

j) Lyulino coal mine (lad-karn, 27) (determinations of DOBRUSKINA after coll. GIN 4353): *Lepidopteris* sp.

45. Plants from coal-bearing deposits of Turgay Basin and Burluk River Basin in Western Kazakhstan

a) Turgay Basin (nor-rt, 22) (VLADIMIROVICH, 1960 b, 1968; VLADIMIROVICH, PRYNADA & SREBRODOLSKAYA, 1960): *Cladophlebis kushmurunica, Stenopteris karashilikensis, Samaropsis ubagana, Tanaidocarpidium diphyllum.*

b) Burluk River Basin (lad-karn, 30 a) (ORLOVSKAJA, 1979): *Neocalamites lehmanianus, Dictyophyllum* sp., *Cladophlebis denticuloides, C. nebbensis, C. jolkinensis, C. raciborskii, C. stenolopha, C. tchihatchevii, C. undulata, C. vaccensis, Cladophlebis* sp., *Taeniopteris ensis, Taeniopteris* cf. *stenophylla, Ctenis ?* sp., *Ginkgoites burlukensis, Sphenobaiers ?* sp., *Podozamites lanceolatus, Podozamites distans, P. issykkulensis, Cycadocarpidium ?* sp., *Ferganiella buninae, Pityophpyllum* ex gr. *nordenskioldii, Uralophyllum krasheninnikovii, Uralophyllum* sp., *Antholithes krasheninnikovii, Yuccites ?* cf. *spathulatus, Carpolithes cinctus, Carpolithes* sp. 1, *Carpolithes* sp. 2, *Conites* sp.

VIII. South-Western Asia

46. Plants from Dzhermanis Formation of Transcaucasus

a) Vedi River near village Dzhermanis (nor-rt, 23) (Kryshtofovich & Prynada, 1933 a): *Clathropteris platyphylla* (in Harris, 1937 = *C. meniscoides*), *Dictyophyllum remaurvi* var. *expansa*, *Laccopteris daintrei*, *L. djulfensis*, *Cladophlebis* sp., *Taeniopteris eurychoron*, *Hyrcanopteris sevanensis*, *Anomozamites minor*, *Pterophyllum angustum*, *Pterophyllum* sp., *Otozamites obtusus*, *Nilssonia acuminata*, *N. polymorpha* var. *regularis*, *Strobilites* sp.

47. Early Mesozoic plants of Iran

a) Hif in Elburz (nor-rt, 24) (Schenk, 1887): *Schizoneura* sp., *Equisetum* sp., *Asplenium roessertii*, *Pecopteris persica* (after Kilpper = *Scytophyllum persicum*), *Adiantum tietzei*, *Oleandridium tenuinerve*, *C. spathulatum*, Gleicheniacea ?, *Ctenis asplenoides*, *Ctenozamits cycadea*, *Zamites* sp., *Pterophyllum aequale*, *P. muensteri*, *P. tietzei*, *P. braunianum*, *Dioonites affinis*, *Nilssonia polymorpha*, *N. compta*, *Anomozamites minor*, *Palissya braunii*, *P. sternbergii*, *Cyparissidium nilssonianum*, *Stachyotaxus septentrionalis*, *Schizolepis ?* sp.

b) Tasch in Elburz (nor-rt, 27) (Schenk, 1887): *Oleandridium tenuinerve*, *O. spathulatum*, *Ctenozamites cycadea*, *Podozamites lanceolatus*, *Pterophyllum aequale*, *Palyssia braunii*, *Cyparissidium nilssonianum*, *Ginkgo muensteriana*.

c) Asterabad in Elburz (nor-rt, 27) (Schenk, 1887): *Dictyophyllum acutilobum*.

d) Sapuhin in Elburz (nor-rt, 24) (Krasser, 1891): *Schizoneura hoerensis*, *Equisetum muensteri*, *Phyllotheca* sp., *(Phyllotheca sibirica ?)*, *Asplenium roessertii*, *Bernoullia wahneri*, *Macrotaeniopteris* sp., *Clathropteris muensteriana*, *Podozamites lanceolatus*, *P. reinii*, *P. peaeformis*, *Otozamits polakii*, *Pterophyllum braunianum* var. *persicum*, *P. imbricatum*, *P. tietzei*, *Nilssonia polymorpha*, *Anomozamites minor*, *A. angulatus*, *Palissya braunii*, *Baiera angustiloba*, *B. rodleri*, *Ginkgo muensteriana*, *G. minuta*.

e) Fechend in Elburz (nor-rt, 25) (Zeiller, 1905): *Cladophlebis nebbensis*, *Pecopteros persica*, *Pecopteris* aff. *merianii*, *Taeniopteris* sp., *Dictyophyllum* cf. *nathorstii*, *Podozamites schenkii*, *Zamites* sp., *Podozamites* sp., *Pterophyllum contiguum*, *P. bavieri*, *Baiera muensteriana*, *Cyparissidium nilssonianum*, *Taxites* sp.

f) Laloun in Elburz (nor-rt, 25) (ZEILLER, 1905): *Otozamites* sp., *Pterophyllum irregulare, Cyparissidium nilssonianum, Taxites* sp.

g) Zirab 5, Shirkola, Apun in Elburz (nor-rt, 26) (KILPPER, 1964, 1971, 1975; SCHWEITZER, 1977: only – *Irania* from Apun): *? Neocalamites hoerensis, Clathropteros meniscoides, Todites acutinervis, T. willamsonii, T. williamsonii* var. *goeppertiana, Todites* sp. A *(Todites nebbensis ?), Cladophlebis denticulata, C. nebbensis, Lepidopteris* sp., *Scytophyllum persicum* (former *Pecopteris persica*), *Keraiaphyllum brevifolium, Drepanozamites tietzei, Irania hermaphroditica.*

h) Dorud, Upper Djadjerud valley, in Elburz Shemshak Formation (nor-rt, 25) (BARNARD, 1965): *Neocalamites* sp. A, *Todites crenatus, Cladophlebis (Eboracea) doruda, Pachypteris shemshakensis, Nilssoniopteris shenkiana, N. musaefolia, Anomozamites* sp., *Pterophyllum tietzei, Dictyophyllum asseretoi, Podozamites* cf. *shenkii, Desmiophyllum* sp.

i) Shemshak in Elburz, Shemshak Formation (nor-rt, 25) (BARNARD, 1967): *Clathropteris* cf. *obovata, Sphenopteris* sp. A, *Cladophlebis* sp. B, *Pterophyllum bavieri, Zamites persica, Baiera muensteriana, Sphenobaiera* cf. *longifolia, Podozamites distans, Podozamites* cf. *shenkii, Elatocladus persica.*

j) Ashtar in Elburz, Shemshak Formation (nor-rt, 25) (BARNARD, 1967): *Equisetites muensteri, Dictyophyllum nathorstii, Phlebopteris* cf. *polypodioides, Cladophlebis* sp., *Spiropteris* sp., *Taeniopteris* sp. B, *Pterophyllum nathorstii, Otozamites ashtartensis, Baiera muensteriana, Podozamites* cf. *shenkii, Carpolithes* sp.

k) Shah Pasand in Elburz (nor-rt, 27a) (CORSIN & STAMPFLI, 1977):

Zone I: *Neocalamites* sp., *Dictyophyllum* cf. *falcatum,* axes Dipteridacees *(? Camptopteris), Clathropteris meniscoides, Lobifolia rotundifolia,* cf. *Nilssonia, Pterophyllum jaegeri, Otozamites brevifolius, Podozamites distans.*

Zone II: *Neocalamites merianii, Equisetites* cf. *muensteri, Equisetites* cf. *laevis, Equisetites* sp., *Dictyophyllum nathorstii, Phlebopteris polypodioides, Lobifolia* sp., *Marattia muensteri, Cladophlebis denticulata, Cladophlebis* sp., *Nilssonia orientalis, N. longifolia, N. pseudobrevis, Nilssonia* cf. *schaumburgensis, Pterophyllum bavieri, Pterophyllum* cf. *tietzei,* cf. *P. shenkii, P. (Anomozamites) inconstans, Zamites* sp. *(? Zamites boureau), Otozamites major, Otozamites* cf. *ashtartensis, Taeniopteris* sp., *Williamsonia* sp., cf. *Ginkgo digitata, Desmiophyllum* sp., *Elatocladus conferta, Podozamites* sp.

l) Geshlag Formation in Elburz (SADOVNIKOV, 1984; figures only): **Kalariz Formation:** *Leptofloios ?* sp., *Protosolanus ?* sp., *Lobatannularia* sp., *Neokoretrophyllites carcinoides, Radicites sulcatus, R. brevicellatus, Equisetum gracile, E. laterale, Equisetostachys ?* sp.;

Thainguenopteris parvipinnulata f. *parvipinnulata, Marattia suluctensis, Danaeopsis angustipinnata, D. emarginata, Cladophlebis scoresbiensis, Todites undulata, T. sewardii, Acrostichides princeps, A. acutinervis, Camptopteris* sp., *Clathropteris meniscoides, C. elegans, Thaumatopteris remaurii, Longcamia zeilleri, Dictyophyllum nervulosum, D. nathorstii, Phlebopteris longifolius, Phlebopteris* ex gr. *affinis, P. angustiloba;*

Scytophyllum persicum, Peltaspermum sp., *Amdrupia stenodonta, Pursongia ?* sp., *Compsopteris* sp., *Ptilozamites ctenoides, P. nilssonii* f. *nilssonii, Keraiaphyl-*

lum tazarense, K. intersulcatum, Hyrcanopteris leclerei, H. nilssonioides, Scoresbya dentata, cf. *Glossopteris ?* sp.;

Zamites persica, Zamites aff. *persica, Drepanozamites* sp., *Otozamites pamiricus, O. furonii, O. ashtartense, Dictyozamites asseretoi, Ptilophyllum minor, Cycadolepis* aff. *corrugatus, Vardecloeftia sulcata, Pterophyllum bavieri, P. muensteri, P. contiguum, Pterophyllum* ex gr. *schenkii, P. tietzei, P. braunianum, Nilssoniopteris vittata, N. schenkiana, Nilssonia acuminata, N. brevis, N. truncata, N. regularis, N. butrejaformis, N. simplex, Cycadolepis* sp., *Ctenis* sp., *Sinoctenis sulcicaulis, Cycadites tenuilobus, Pseudoctenis cteniformis, Ctenis constrictus, Ctenis* sp., *Taeniopteris* cf. *ferganensis, T. barnardii, T. densinervis, T. mikailovii, Taeniopteris* ex gr. *virgulata, Yuccites podozamitoides, Y. uralensis, Sphenobaiera longifolia, Gonkgo* sp., *Ginkgodium* sp., *Baiera muensteriana, Phoenicopsis astartensis, Ixostrobus trixigius, Leptostrobus* sp.;

Carpolithes aff. *cinctus, Piyiospermum ?* sp., *Swedenborgia* sp., *Drepanolepis* sp., *Araucarites* sp., *Pagiophyllum peregrinum, Stachiotaxus* sp., *Cycadocarpidium ?* sp., *Podozamites brevicellatus, Podozamites* ex gr. *lanceolatus, Podozamites* ex gr. *astartensis, Podozamites latissimus, Podozamites* ex gr. *eichwaldii, Podozamites* ex gr. *schenkii.*

Laleband Formation: *Calamoderma carcinoides, C. striata, C. heterocellata, Neokoretrophyllites carcinoides, Neocalamites hoerensis, Schizoneura ?* sp., *Radicites brevicellatus, R. sulcatus, R. cellulatus, Equisetum arenaceum, Thainguyenopteris parvipinnulata* f. *auriculata, Asterotheca cottonii, Danaeopsis emarginata, Osmundopsis ?* sp., *Cladophlebis haiburnensis, Acrostichides rotundifolius, A. princeps, Clathropterios meniscoides, Thaumatopteris fuchsii, T. kochibei, T. remaurii, Longcamia zeilleri, Dictyophyllum nathorstii;*

Lepidopteris sp., *Peltaspermum* sp., *Pursongia ?* sp., *Keraiaphyllum rarinervum, Ptilozamites* cf. *nilssonii, P. nilssonii* f. *confenensis, P. andreanum, P. braunianum, Nilssonia* sp., *Taeniopteris mikailovii, Czekanowskia* sp., *Sphenobaiera longifolia, Phoenicopsis astartensis, Ixostrobus* sp., *Araucarites* sp., *Voltzia elegans, Podozamites* ex gr. *angustifolius, P. rigidus, Podozamites* ex gr. *schenkii.*

Eckrasar Formation: *Equisetum arenaceum, Podozamites mucronatus.*

m) Darbidkhun in Kerman Basin (nor-rt, 28) (Schweitzer, 1978): *Thainguyenopteris pamirica, Lepidopteris toretziensis, Hyrcanopteris leclerei.*

48. Early Mesozoic Plants of northeastern Afghanistan

a) Kalawch River (nor-rt, 29) (Barnard, 1970): *Pterophyllum filicoides, P. kalavchiensis, Taeniopteris pseudobrevis* (in Corsin & Stampfli, 1977 = *Nilssonia pseudobrevis*), *Otozamites ashtartensis.*

b) left bank of Pyandzh River, 15–20 km lower the mouth of Bartang River (nor-rt, 29) (determinations of Dobruskina after coll. GIN 3778): *Neocalamites carcinoides, Dictyophyllum* sp., *Phlebopteris muensteri, Oligocarpia pamirica, Cladophlebis* sp., *Pterophyllum pschartense, P. bavieri, Nilssonia pseudobrevis, N. rajmahalensis, Nilssonia* sp., *Otozamites nalivkinii, Yuccites angustifolius.*

49. Early Mesozoic plants of Central Pamirs (nor-rt, 30, 31)

a) Bartang River (Prynada, 1934; coll. CPRG 4067, 6816): *Equisetites arenaceus, Equisetites* ex gr. *columnaris, Clathropteris meniscoides, Dictyophyllum remaurvi, D. acutilobum, Thaumatopteris schenkii, Cladophlebis denticulata, C. nebbensis, Pecopteris pamirica; Ptilozamites bartangensis*;

Pterophyllum angustilobum, P. longifolium, P. contiguum, P. bavieri, P. aequale, P. andreanum, P. propinquum, Taeniopteris cf. *jourdyi, Nilssonia brevis* f. *truncata, N. brevis* f. *sulcata, N. cycaditaeformis, N. polymorpha, N. acuminata, N. distantinervis, Otozamites nalivkinii, O. abbreviatus, O. indosinensis, Zamites* sp., *Pterophyllum* sp., *Ctenis* sp., *Yuccites angustifolius, Podozamites lanceolatus, Pagiophyllum* sp.

b) Bartang River (Sixtel, 1960, 1962 a; Sixtel & Khudayberdyev, 1968): *Clathropteris meniscoides, Phlebopteris daintrei, Aipteris pamirica (= Scytophyllum pamiricum), Lepidopteris elegans, Pterophyllum pschartense, Taeniopteris latecostata, Nilssonia rajmahalensis, Yuccites angustifolius, Uralophyllum kuschlinii.*

c) Bartang River (Vladimirovich, 1958 b; Iminov, 1976): *Anthrophyopsis crassinervis* – V, *Otozamites nalivkinii* – I, *Pterophyllum propinquum* – I, *P. pschartense* – I.

d) Bartang River (coll. GIN 3778): *Clathropteris meniscoides, Cladophlebis denticulata, Pterophyllum pschartense, Nilssonia* sp. A, *Yuccites ? angustifolius.*

e) Tanymas River (Prynada, 1934; coll. CPRG 4067): *Equisetites arenaceus, Cladophlebis* sp., *Pterophyllum bavieri, P. andreanum, P. braunianum, P. propinquum, P. angustilobum, Nilssonia brevis* f. *truncata, N. brevis* f. *sulcata, Otozamites pamiricus, Taeniopteris tenuinervis, Tanymasia pamirica, Baiera* sp., *Yuccites latifolius, Podozamites* sp., *Cupressinocladus* sp.

f) Tanymas River (Sixtel, 1960): *Pterophyllum andreanum.*

g) Tanymas River and Kysyl-Tukoy River (coll. GIN 4174, 4330): *Equisetites* sp., *Clathropteris meniscoides, Pterophyllum pschartense, P. propinquum, P. braunsii, P. bavieri, Hyrcanopteris tschuenkoi, Taeniopteris vittata, T. tenuinervis, Tanymasia pamirica, Sagenopteris rhoifolia, Yuccites ? angustifolius, Podozamites ?* sp.

h) Kokuybelsu River (Prynada, 1934; coll. CPRG 4067): *Cladophlebis* sp., *Pterophyllum braunsii, P.* cf. *princeps, P. aequale, P. andreanum, P. propinquum, P. rarinerve, Anomozamites* sp., *Nilssonia rarinervis, N. brevis* f. *sulcata, N. cycaditaeformis, Taeniopteris tenuinervis, T. reversa, Macrotaeniopteris lata, Hyrcanopteris chuenkoi, Yuccites latifolius, Y. angustifolius, Brachyphyllum* sp.

i) Kokuybelsu River (Sixtel, 1960): *Nilssonia rajmahalensis.*

j) Kokuybelsu River (coll. GIN 4171, 4330): *Neocalamites* sp., *Clathropteris meniscoides, C. obovata, Dictyophyllum muensteri, Phlebopteris angustiloba, P. muensteri, Cladophlebis haiburnensis, Scytophyllum persicum, Pterophyllum pshartense, P. propinquum, P. braunsii, Anomozamites* sp., *Nilssonia pseudobrevis, Taeniopteris vittata, Macrotaeniopteris virgulata, Pseudoctenis* sp., *Otozamites bucklandii, O. pamiricus, Tanymasia pamirica, Hyrcanopteris tchuenkoi, Sagenopteris ?* sp., *Pityophyllum* sp., *Carpolithes* sp., *Yuccites ? angustifolius, Yuccites ? latifolius.*

k) Western Pshart River (Prynada, 1934; coll. CPRG 4067): *Equisetites arenaceus, Oligocarpia pamirica, Clathropteris meniscoides, Pterophyllum longifolium, P. sassykense, Otozamites* cf. *obtusus, Macrotaeniopteris virgulata, Cycadites tenuilobus, Yuccites angustifolius.*

l) Western & Eastern Pshart Rivers (coll. GIN 3778, 4330): *Equisetites arenaceus, Clathropteris meniscoides, Phlebopteris muensteri, Pterophyllum pshartense, P. propinquum, P. bavieri, Nilssonia pseudobrevis, Cycadites* sp., *Tanymasia pamirica, Phoenicopsis ?* sp., *Yuccites ? latifolius.*

m) Sarez Lake (Sixtel, 1960; Sixtel & Khudayberdyev, 1968): *Uralophyllum kushlinii.*

n) Sarez Lake (Iminov, 1971, 1976): *Ctenis kushlinii, Otozamites nalivkinii, Pseudoctenis* ex gr. *ballii, Butefia ?* sp.

o) Rang-Kul Lake (Sixtel, 1960): *Danaeopsis fecunda, Lepidopteris elegans, Nilssonia mesentheriformis, Yuccites angustifolius.*

p) Chash-Tyube (Sixtel, 1960; Sixtel & Khudayberdyev, 1968): *Danaeopsis fecunda, Thaumatopteris elongata, Nilssonia mesentheriformis, N. rajmahalensis.*

q) Oksu River (coll. GIN 3778): *Pterophyllum pshartense, P. bavieri, Nilssonia rajmahalensis, N. pseudobrevis, Otozamites abbreviatus, Tanymasia pamirica, Hyrcanopteris tscuenkoi, Yuccites ? latifolius, Podozamites* sp.

r) Other regions of the Pamirs (Iminov, 1976): *Williamsonia haydenii, Otozamites nalivkinii* (Nunbist), *Otozamites* cf. *graphicus* (Vanch), *O. pamiricus* (Tashtyuba), *Pterophyllum aequale, P. propinquum* (Ramsunos, Badakhshan region), *P. pshartense* (Ramsunos, Vadinrov), *P. rarinerve* (Vovzib, Partysh), *Ptilophyllum acutifolium, Ctenis kushlinii, Nilssonia brevis* (Vadinrov), *N. princeps* (Varzob), *Taeniopteris virgulata* (Vadinrov).

IX. Middle Asia

50. Early and Middle Triassic plants of south-western Darvaz
a) Yokunzh River, **Alikagar** and **Yokunzh** Formations (ol-an, 34) (Dobruskina, 1985 c): *Pleuromeia jokunzhica.*

51. Middle – Late Triassic plants of south-western Darvaz
a) Zorbuz and Gring Rivers, Basin of Obipitoudu River, **"Yollikahar"** Formation (lad-karn, 31) (determinations of Dobruskina after coll. GIN 4055): *Schizoneura* sp., *Bernoullia* sp., *Pecopteris* sp., *Sphenopteris* ex gr. *chowkiawanensis, Macrotaeniopteris lata, Podozamites* ex gr. *schenkii.*

52. Early – Middle Triassic plants of southern Fergana
a) Watershed of rivers Sokh and Isfara (ol-an, 35) (determinations of Dobruskina after coll. GIN 4041): *Voltzia heterophylla* and undeterminable remains of sphenopsids.

53. Middle – Late Triassic plants of Madygen, Southern Fergana (lad-karn, 32) (in the right column the redeterminations of Dobruskina are given as a result of the study of coll. GIN 3795, Sixtel's coll. CPRG 7999 and CST 10; the location of Brick's collection is not known)

a) Brick, 1936

Pleuromeia oculina	*Ferganodendron sauktangensis*
Gigantopteris ferganensis	*Vittaephyllum ferganense*
Odontopteris ? sp.	undeterminable
Taeniopteris spathulata	*Taeniopteris spathulata*
Ptilophyllum sp. cf. *P. brevilatiphyllum*	*Ptilophyllum* ? sp.

b) Sixtel, 1949

Gigantopteris hirsuta	*Vittaephyllum hirsutum*

c) Sixtel, 1956

Prynadaia madygenica	*Prynadaia madygenica*
Madygenopteris irregularis	*Madygenopteris irregularis*
Madygenia asiatica	*Madygenia asiatica*
Kryshtofovichiella modica	?

d) Sixtel, 1961

Aipteris hirsuta	*Vittaephyllum hirsutum*
Aipteris bipinnata	*Scytophyllum pinnatum*
Furcula bifurcata	*Vittaephyllum bifurcatum*
Mesenteriophyllum kotscnevii	*Mesenteriophyllum kotschnevii*
M. serratum	*M. serratum*

e) Sixtel, 1962 b

Chara sp.	*Neocalamites hoerensis*
Thallites insolitus	*Thallites* sp.
Phyllotheca sp.	*Neocalamites hoerensis* exept one specimen which is *Equisetites* sp.
P. longifolia	*Neocalamites hoerensis*
Equisetites arenaceus	*Equisetites* sp.
Equisetostachys ? sp.	*Neocalamostachys sharovii*
Lobatannularia ensifolis	? (picture is absent)
Sphenophyllum aff. *sino-coreanum*	*Cladophlebis* sp. (Dobruskina, 1982)
Prynadaia madygenica	*Prynadaia madygenica*
Schizoneura ex gr. *gondwanensis*	*Neocalamites hoerensis*
Sigillaria sauktangensis	*Ferganodendron sauktangensis* (Dobruskina, 1974, 1982)
Sigillaria ? sp.	*Ferganodendron suktangennsis* (Dobruskina, 1974, 1982)
Pleuromeiopsis kryshtofovichii (holotype)	*Pleuromeiopsis kryshtofovichii* (Dobruskina, 1974)
Pleuromeiopsis kryshtofovichii (other specimens)	*Ferganodendron sauktagennsis* (Dobruskina, 1974, 1982) *Peltaspermum madygenicum* (Dobruskina, 1980) *Desmiophyllum* sp.
Pleuromeiopsis ? sp.	*Ferganodendron sauktangensis* (Dobruskina, 1982)
Danaeopsis ex gr. *fecunda*	*Danaeopsis fecunda*
Cladophlebis aff. *nystroemii*	*Cladophlebis* ex gr. *nebbensis*
Pecopteris filatovii	*"Pecopteris" filatovii* (fertile leaf)
Pecopteris sp.	*Pecopteris* sp.
Lepidopteris parvula	*Lepidopteris parvula* and *Peltaspermum madygenicum* (Dobruskina, 1980)
Aipteris hirsuta	*Vittaephyllum hirsutum* (Dobruskina, 1975, 1982)
Aipteris pinnata	*Scytophyllum pinnatum* (ibid.)
Gigantopteris ferganensis	*Vittaephyllum ferganense* (ib.)
Gigantopteris sp.	*Vittaephyllum bifurcatum* (ib.)
Furcula bifurcata	*Vittaephyllum bifurcatum* (ib.)

Callipteris ferganensis	*Lepidopteris ferganensis*
Callipteris sp.	*“Thinnfeldia” rhomboidales*
Callipteridium sp.	*Vittaephyllum* sp.
Madygenopteris irregularis	*Madygenopteris irregularis*
Sphenopteridium brickianae	*Rhaphidopteris ? brickianae*
Neuropteris sp.	undeterminable
Validopteris ? angustifolia	*Scytophyllum* sp.
Odontopteris ? laceratifolia	*Edyndella* sp. nov.
Odontopteris ? latiloba	undeterminable
Ptilozamites elegans	*Ptilozamites elegans*
Ptilozamites davidovii	*Ptilozamites davidovii*
Hydropterangium asiaticum	?
Dicroidium odontopteroides	*Ptilozamites davidovii* and *Ptilozamites elegans*
Tersiella radczenkoi	*Uralophyllum ? radczenkoi* and *Edyndella* sp. nov.
Thinnfeldia minima	*Lepidopteris ferganensis*
Dactylopteris exilifolia	*Uralophyllum petiolatum*
Protoblechnum wongii	*“Thinnfeldia” rhomboidalis*
P. kryshtofovichianum	*“Thinnfeldia” rhomboidalis*
Madygenia asiatica	*Madygenia asiatica*
Angaropteridium ? magnifolium	*Uralophyllum magnifolium*
Glottophyllum sp.	*Uralophyllum magnifolium ?*
Angaridium ? inflexum	*Uralophyllum* aff. *ramosum* and *Rhaphidopteris ? brickianae, Ginkgoites taeniatus*
Angaridium ? dubitabilis	*Uralophyllum ramosum* and *Ginkgoites taeniatus*
Neuropteridium ? ferganicum	*? Cladophlebis* ex gr. *shensiensis*
Neuropteridium ? sp.	*Scytophyllum ? pinnatum*
Ctenopteris punctata	*Ctenopteris punctata* and *Lepidopteris ferganennsis*
Taeniopteris multinervisrvis	*Taeniopteris multinervis*
Taeniopteris icrassata	*Taeniopteris latecostata*
Taeniopterislatecostata	*Taeniopteris latecostata*
T. ? laceratimarginale	*Pterophyllum pschartense ?*
Taeniopteris sp.	*Taeiopteris* sp.
Taeniopteris ? stannkevichii	*Taeniopteris ? stankevichii*
Taeniopteris ? plicata	*Taeniopteris spathulata*
Taeniopteridium glossopteroides	*Taeniopteridium glossopteroides*
Pterophyllum hanesianum	*Pterophyllum hanesianum*
Pterophyllum ketovae	*Pterophyllum pschartense*
Pterophyllum aff. *jaegeri*	*Pterophyllum pschartense*
Nilssonia lacinata	*Pterophyllum pschartense*

Baiera taeniata	*Ginkgoites taeniatus*
Baiera sp.	*Ginkgoites taeniatus*
Sphenobaiera granulifer	*Sphenobaiera granulifer* and *Ginkgoites taeniatus*
Sphenobaiera aff. *zalesskyi*	*Sphenobaiera* aff. *zalesskyi*
Ginkgophyllum ? triassicum	*Ginkgoites taeniatus*
Cordaites sp.	*Glossophyllum ? ereminae*
Cordaites ? ereminae	*Glossophyllum ? ereminae*
Antholithes (Cordaianthus) ? lepidus	
Glossophyllum ? oblanceolatum	*Podozamites distans* and *Glossophyllum ? ereminae*
Walchiostrobus sp.	*Voltzia* sp.
Walchia (Walchianthus) sp. A	*Voltzia* sp.
Walchia sp. B	*Voltzia* sp.
Pseudovoltzia liebeana	undeterminable
Albertia turkestanica	*Podozamites distans*
Albertia ? longifolia	undeterminable
Ulmannia bronnii	? (picture is absent)
Pityocladus angustifolius	*Borysthenia ?* sp.
Schizolepis brunsianae	?
Schizolepis ? sp.	?
"Coniferous" sp.	*Voltzia* sp.
Dicranophyllum kirghisicum	*Baiera* sp.
Dicranophyllum sp.	*Borysthenia ?* sp.
Conites gompholepis	?
Podozamites distans	*Podozamites distans*
Pentoxylon nodozum	undeterminable
Uralophyllum ramosum	*Uralophyllim ramosum*
Uralophyllum petiolatum	*Uralophyllum petiolatum*
Antholithes krasheninnikovii	*Leuthardtia* sp.
Chiropteris integella	? (picture is absent)
Mesentheriophyllum kotchnevii	*Mesentheriophyllum kotchevii*
Mesentheriophyllum serratum	*Mesentheriophyllum serratum*
Kryshtofovichiella modica	undeterminable
Ferganopteris sagulensis	undeterminable
Barakaria ? sp.	undeterminable
Potonie ? elegantiformis	undeterminable
Anthicocladus fimbricatus	*Peltaspermum madygenicum* (Dobruskina, 1980)
Polysaccus rarus	?
Rhopalostachys ex gr. *clavata*	?
Ixostrobus sp.	?
Virgalotasaccus exilis	?
Samaropsis fragosa	?

Bennettitathus ? sp.	?
Madygenoanthus inorantum	?
Calymatotheca ? pusilla	?

f) Sixtel, 1966

Phyllotheca longifolia	*Neocalamites hoerensis*
Schizoneura gondwanensis	*Neocalamites hoerensis*
Pecopteris sp.	*Pecopteris* sp.
Caytonanthus vachrameevii	*Leuthardtia ?* sp.
Sagenopteris vachrameevii	*Sagenopteris vachrameevii*
Hissarella ferganensis (based on *Angaridium ? dubitabilis* and A. *? inflexum* from Sixtel, 1962 b)	*Uralophyllum* aff. *ramosum* and *Edyndella* sp. and *Ginkgoites taeniatus*
Yuccites longifolium	*Glossophyllum ? ereminae*
Walchia sp. A	*Voltzia* sp.

g) Sixtel, 1968

Hissarella ferganensis	*Uralophyllum* aff. *ramosum*

i) Revision of the Madygen flora, made by Dobruskina (coll. GIN 3795; CPRG 7999; GST 10):

Species	Figure or number of specimen
Thallites sp.	Sixtel, 1962 b, tab. 1, fig. 4, 5.
Ferganodendron sauktangensis	Sixtel, 1962 b, tab. IV, fig. 1–9; tab. V, fig. 1, 3–5; tab. VI, fig. 1, 2; tab. VII, fig. 1–3; Dobruskina, 1974, tab. X, fig. 1–7; Dobruskina, 1982 b, tab. XV, fig. 1–7; tab. XVI, fig. 1–12; tab. XVII, fig. 1–6; tab. XVIII, fig. 4, 5, 6; tab. XIX, fig. 1–3; textfig. 28 a–d.
Neocalamites hoerensis	Sixtel, 1962 b, tab. I, fig. 6–9; tab. II; tab. III, fig. 5, 6, 8; Sixtel, 1966, tab. II; tab. III, fig. 1–2; tab. IV, fig. 1–3.
Neocalamostachys sharovii	Sixtel, 1962 b, tab. III, fig. 1 a, 1 b; Sixtel, 1966, tab. V, fig. 4–5.
Equisetites sp.	Sixtel, 1962 b, tab. III, f. 2.
Prynadaia madygenica	Sixtel, 1956, tab. XXXVII, fig. 5; Sixtel, 1962 b, tab. III, fig. 8.
Danaeopsis fecunda	Sixtel, 1962 b, tab. VIII, fig. 1–5.
"Pecopteris" filatovae	Sixtel, 1962 b, tab. VIII, fig. 6; tab. IX, fig. 1–2.
Cladophlebis raciborskii	Coll. CPRG # 82/7999, 85/7999, 86/7999.
Cladophlebis ex gr. *shensiensis*	Sixtel, 1962 b, tab. XVI, fig. 4–5; coll. GIN # 3795/376

Cladophlebis ex gr. *paralobifolia*	Coll. GIN # 3795/20, 3795/299, 3795/293a.
Cladophlebis ex gr. *nebbensis*	Sixtel, 1962 b, tab. VIII, fig. 8–9; tab. IX, fig. 3; coll. GIN # 3795/290, 3795/291.
Cladophlebis sp.	Sixtel, 1962 b, tab. III, fig. 9; textfig. 2.
Chiropteris integella	Sixtel, 1962 b, textfig. 45–46.
Lepidopteris parvula	Sixtel, 1962 b, tab. IX, fig. 4–6; Sixtel & Khudayberdyev, 1968, tab. XV, fig.5.
Lepidopteris ferganensis	Sixtel, 1962 b, tab. XIV, fig. 2–5; tab. XIX, fig. 5; tab. XX, fig. 6, 8.
Peltaspermum madygenicum	Sixtel, 1962 b, tab. VI, fig. 4–7; tab. IX, fig. 7–10; tab. XL, fig. 6; Dobruskina, 1982 b, tab. XVIII, f. 2–3; Sixtel & Khudayberdyev, 1968, tab. XV, fig. 4; Dobruskina, 1980, tab. XXII, fig. 1–11.
Scytophyllum pinnatum	Sixtel, 1962 b, tab. XII, fig. 1–4, 6, 7; textfig. 15, 16; Dobruskina, 1975, tab. XI, fig. 1, 3–5, 8; Dobruskina, 1982 b, tab. XIX, fig. 4–8; tab. XX, fig. 3–5; tab. XXI, fig. 4–5.
Scytophyllum sp.	Sixtel, 1962 b, tab. XVI, fig. 1; tab. XVII, fig. 5–6; Sixtel & Khudayberdyev, 1968, tab. XV, fig. 1; Dobruskina, 1982 b, tab. XX, fig. 1, 2.
Vittaephyllum hirsutum	Sixtel, 1962 b, tab. X, fig.1; tab. XI, fig. 1–5, textfig. 12; Dobruskina, 1975, tab. XII, f. 1, 2, 5; Dobruskina, 1982 b, tab. XX, fig. 6; tab. XXI, fig. 8; tab. XX, fig. 1–2, 5–6 tab. XXIV; textfig. 28e.
Vittaephyllum bifurcatum	Sixtel, 1962 b, tab. III, fig. 1–8; tab. XXIV, fig. 1; Dobruskina, 1975, tab. IX, fig. 2, 6, 7, 9, 10; tab. XII, fig. 6; Dobruskina, 1982 b, tab. XXI, fig. 1–3, 10; tab. XXII, fig. 3, 4, 7; tab. XXIII, fig. 1–7; tab. XXIV, fig. 2–4.
Vittaephyllum brickianum	Dobruskina, 1975, tab. XII, fig. 4; Dobruskina, 1982 b, tab. XXI, fig. 6, 7, 9.

Vittaephyllum ferganense	Brick, 1936, tab. I, fig. 4–5; Sixtel, 1968, tab. XII, fig. 8; textfig. 17; Dobruskina, 1975, tab. XII, fig. 11; Dobruskina, 1982 b, tab. XXI, fig. 11.
Madygenopteris irregularis	Sixtel, 1956, tab. XXXIII, fig. 4–5.
Madygenia asiatica	Sixtel, 1956, tab. XL, f. 1–3.
Uralophyllum radczenkoi	Sixtel, 1962 b, tab. XIX, fig. 7–13; tab. XX, fig. 2, 5; textfig. 25; Sixtel, 1968, tab. XXIV, fig. 4, 5.
Uralophyllum petiolatum	Sixtel, 1962 b, tab. XXXIX, fig. 3–7; textfig. 43–44; tab. XXVII, fig. 2.
Uralophyllum ramosum	Sixtel, 1962 b, tab. XXXIX, fig. 1–2, textfig. 42.
Uralophyllum aff. *ramosum*	Sixtel, 1962 b, tab. XXIII, fig. 1–7, 9, 10; Sixtel, 1966, tab. XI, fig. 4–10; Sixtel, 1968, tab. XXIV, fig. 1–3.
Uralophyllum magnifolium	Sixtel, 1962 b, tab. XXII, fig.1–6; Sixtel, 1968, tab. XXIV, fig. 6.
Rhaphidopteris ? brickianae	Sixtel, 1962 b, tab. XV, fig. 5–7; tab. XXIII, fig. 11.
Edyndella sp. nov.	Sixtel, 1962 b, tab. XVII, fig. 3–4; tab. XX, fig. 1; Sixtel, 1966, tab. XI, fig. 2, 3; Sixtel & Khudayberdyev, 1968, tab. XV, fig. 2.
Ptilozamites davidovae	Sixtel, 1962 b, tab. XVII, fig. 2; tab. XVIII, fig. 3; tab. XIX, fig. 1–4.
Ptilozamites elegans	Sixtel, 1962 b, tab. XVII, fig. 1; tab. XVIII, fig. 1–2; tab. XXI, fig. 8.
Ctenopteris punctata	Sixtel, 1962 b, tab. XIX, fig. 5, 6.
"Thinnfeldia" rhomboidalis	Sixtel, 1962 b, tab. XIV, fig. 1; tab. XXI, fig. 1–7, 9–10.
Sagenopteris vachrameevii	Sixtel, 1966, tab. VII, fig. 1–5.
Taeniopteridium glossopteroides	Sixtel, 1962 b, tab. XXVI, fig. 4–6; tab. XXVII, fig. 4, 5.
Pterophyllum hanesianum	Sixtel, 1962 b, tab. XXVII, fig. 6.
Pterophyllum pschartense	Sixtel, 1962 b, tab. XXVIII, fig.1–9.
Leuthardtia ? sp.	Sixtel, 1962 b, tab. XI, fig. 6; Sixtel, 1966, tab. VIII, fig. 1.
Taeniopteris multinervis	Sixtel, 1962 b, tab. XXIV, fig. 2–5.
Taeniopteris latecostata	Sixtel, 1962 b, tab. XXV, fig. 1, 2, 6.
Taeniopteris spathulata	Sixtel, 1962 b, tab. XXV, fig. 7.
Taeniopteris ? stankevichii	Sixtel, 1962 b, tab. XXV, fig. 3–5.

Ginkgoites taeniatus	SIXTEL, 1962 b, tab. XXX, fig. 1–4, 7, 8; tab. XXIII, fig. 8; tab. XXXI, fig. 3–6; SIXTEL, 1966, tab. XI, fig. 1; SIXTEL & KHUDAYBERDYEV, 1968, tab. XV, fig. 7.
Baiera sp.	SIXTEL, 1962 b, tab. XXXVIII, fig. 3–4.
Sphenobaiera granulifer	SIXTEL, 1962 b, tab. XXX, fig. 5–7.
Sphenobaiera aff. *zalesskyi*	SIXTEL, 1962 b, tab. XXXI, fig. 1–2.
Glossophyllum ? ereminae	SIXTEL, 1962 b, tab. XXXII, fig. 1–3; tab. XXXIII, fig. 1–3; tab. XXXIV, fig.1–6; SIXTEL, 1966, tab. XVI, fig. 7.
Podozamites distans	SIXTEL, 1962 b, tab. XXXV, fig. 1–5; tab. XXXVII, fig.1–2.
Voltzia sp.	SIXTEL, 1962 b, tab. XXXVI, fig. 1–6; tab. XXXVII, fig. 5–7; SIXTEL, 1966, tab. XIX, fig. 7.
Borysthenia ? sp.	SIXTEL, 1962 b, tab. III, fig. 5; tab. XXVII, fig. 8; tab. XXXVIII, fig. 2a, 2b.
Swedenborgia cryptomerioides	Coll. GIN # 3795/22, 3795/23, 3795/31, 3795/50, 3795/474.
Mesentheriophyllum kotchnevii	SIXTEL, 1962 b, tab. XXIX, fig. 1–8.
Mesentheriophyllum serratum	SIXTEL, 1962 b, tab. XXIX, fig. 9–10.
Reproductive organs and seeds	SIXTEL, 1962 b, tab. XXXI, fig. 8; tab. XXXIII, fig. 1; tab. XXXVI, fig. 7–9; tab. XXXIX, fig. 8; tab. XL, fig. 1–12; tab. XVIII, fig. 4–5; textfig. 24.

54. Middle – Late Triassic plants of Kamyshbashi, Southern Fergana

a) **Lower Variegated Formation** (lad-karn,32) (BRICK, 1941; SIXTEL, 1960*)*: *Neocalamites carrerei* – B, *N. nordenskioldii* – B, S, *Schizoneura gondwanensis* – B, *Danaeopsis* cf. *marantacea* – B, *Todites kamyshbashensis* – B, *Diplazites dentatus* – S, *Lonchopteris ?* sp. – S, *Cladophlebis haiburnensis* – B, S, *Cladophlebidium elegans* – B (in SIXTEL, 1960 = *Lepidopteris elegans*), *Odontopteris triassica* – B, *Lepidopteris triassica* – S, *Taeniopteris kamyshbashensis* – B, S, *Taeniopteris* cf. *nystroemii* – B, *Tanaidia ferganensis* – B, *Otozamites* sp. – B, *Pseudoctenis* sp. – B, *Yuccites turkestanicus* – S, *Podozamites isfarensis* – B, *P. isfarensis* var. *rotundata* – B, *Cycadocarpidium erdmannii* – B, *C. ferganensis* – S.

55. Middle – Late Triassic plants of Ketmen Range

a) **Koldzhat Formation** (lad-karn, 33) (ORLOVSKAJA, 1968): *Phyllotheca* cf. *deliguiscens, Schizoneura* sp., *Paracalamites* sp., *Neocalamites rugosus, Neocalamites* sp., *Danaeopsis marantacea, Callipteridium* sp., *Todites roessertii, T.*

kamyshbashensis, Cladophlebis sp., *Taeniopteris stenophylla, Taeniopteris* sp., *Anomozamites lindleyanus, Anomozamites* sp., *Glossophyllum ?* sp.

56. Late Triassic plants of Kavak-Tau Range

a) Son-Kul Lake, Kavak-Tau Range, **Turukavak Formation** (nor-rt, 32) (SIXTEL; 1960; TURUTANOVA-KETOVA, 1960, 1968 a, 1968 b; GENKINA, 1970*): *Thallites undulatus* – T, *Neocalamites issykkulensis* – T, *Danaeopsis* sp. – G, *Dictyophyllum exile* – S, *Clathropteris obovata* – G, S, *Clathropteris elegans* – G, S, *C. elegans* f. *magna* – G, *Haussmania kirgisica* – G, *Cladophlebis suniana* – G, *Anomozamites kirgisicus* – G, *A. dongurmensis* – G, *Pterophyllum* cf. *ctenoides* – G, *Otozamites kirgisicus* – G, *O. asiaticus* – G, *Ctenis* Sp. – G, *Taeniopteris kamyshbashensis* – G, *T. dongurmensis* – G, *Yuccites angustifolius* – G, *Y. latifolius* – G, *Y. spathulatus* – G, *Podozamites isfarensis* – G, *P. dongurmensis* – G, P. *minutus* – T, *Cycadocarpidium dongurmensis* – G, *Samaropsis zignoana* – G.

57. Late Triassic plants of Issyk – Kul Lake

a) **Aktash Formation** (nor-rt, 33) (TURUTANOVA-KETOVA, 1931; SIXTEL, 1960; GENKINA, 1964, 1966): *Neocalamites carrerei* – S, *Lobatannularia heianensis* – S, *Clathropteris obovata* – G, *Dictyophyllum exile* – G, *D. nilssonii* – G, *Rhizomopteris* sp. – G, *Spiropteris* sp. – G, *Cladophlebis shensiensis* – G, *Cladophlebis*cf. *szeiana* – G, *Baiera* aff. *leptophylla* – G, *Sphenobaiera spectabilis* – G, *Phoenicopsis* aff. *rarinervis* – G, *P. angustifolia* – T, G, *Leptostrobus* sp. – G.

Yuccites sp. – G, *Podozamites issykkulensis* – G, *P. angustifolius* – G, *P. lanceolatus* var. *longifolia* – G, *P. schenkii* – G, *P. distans* – G, *Cycadocarpidium issykkulensis* – G, *C. sogutensis* – G, *C. insignis* – G, *C. swabii* – G, *C. ferganensis* – G, *C. minor* – G, *Fraxinopsis vachrameevii* – G, *Ferganiella kirgisica* – S, G, *Stachyotaxus elegans* – G, *Pityophyllum nordenskioldii* – G, *P. angustifolium* – G.

58. Late Triassic plants of Kenderlyk Mulda

a) **Akzhaltay Formation**(nor-rt, 34) (TURUTANOVA-KETOVA, 1968 b, 1968 c): *Thallites undulatus, Parasorocaulus corticalis.*

b) **Tologoy Formation** (nor-rt, 34) (KOVALCHUK, 1961; TURUTANOVA-KETOVA, 1962, 1963**, 1968 b, 1968 d; unmarked species were figured by KOVALCHUK without descriptions): *Pseudophyllotheca torosa* – T, *Parasorocaulus corticalis* – T, *Equisetites* sp., *Neocalamites carrerei, Kenderlykia gracilis* – T, *Cladophlebis* cf. *whitbiensis, Thinnfeldia distantifolia, Lepidopteris ottonis, Taeniopteris spathulata, Feildenia* sp., *Phoenicopsis rarinervis, Czekanowskia latifolia, Carpolithes cinctus, Cycadocarpidium* sp., *Podozamites angustifolius, Conites* sp.

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* See ALIEV & GENKINA, 1970 (ALIEV had nothing to do with this work, but he was the head of the Institute in Moscow where GENKINA worked).

** See "OSNOVY PALEONTOLOGII . . .", 1963.

X. Eastern Siberia and Northern Kazakhstan

59. Plants of Kuznetsk Basin
    a) **Maltsevo Formation** (ol-an, 36) – see chart 13.

60. Plants from volcanics of Tunguska syneclise
    a) Keta-Gorbiachin region (SREBRODOLSKAYA, 1960 a, 1960 b; VLADIMIROVICH, 1960 b; SCHVEDOV, 1963; VLADIMIROVICH, 1967*; PRYNADA & RADCZENKO, 1967*; RADCZENKO, 1967*; MOGUTCHEVA, 1972**, 1973, 1983; MOGUTCHEVA & KURBATOVA, 1980; unmarked species were described by MOGUTCHEVA):

Khonomakit Formation (ol-an, 37–38): *Trizygia borealis, Boreopteris evenkensis, B. triangularis, Todites kirjamkensis, Lobifolia taymurensis, L. putoranensis, Eboracia ? evenkensis* – M & K, *Cladophlebis ? khonomakensis, C. chantaykensis, Pecopteris polkinii, P. jaktalicum, Sphenopteris trisecta, Khonnomakidium srebrodolskae* – Sv, M, *Korvunchania tunguscana, Katasiopteris polymorpha, Eleganopteris tripinnata, Scytophyllum tenuinerve, Yavorskyia radczenkoi* – Sv, M, *Y. serrata, Rhipidopsis triassica* – Sr, *Yuccites angaridens, Lutuginia furcata* – P & R, M.

Kutaramakan Formation (ol-an, 37–38): *Koretrophyllites chantaica, Todites korvunchanica* – V, *Sphenopteris kirjamkensis, Khonnomakidium srebrodolskae, Katasiopteris lebedevii, K. polymorpha* (in DURANTE, 1978 = *Lobatopteris polymorpha*), *Madygenia borealis* f. *typica, Protoblechnum* sp., *Edyndella dentata, Tersiella jurakchensis* – Sv, *Sphenobaiera vittaefolia.*

Khakanchana Formation (ind, 6): *Neokoretrophyllites linearis, Paracalamites triassica* – R, *Pecopteris ? pseudotchichatchevii* – V, *Tungussopteris sphenopteroides* – V, *Cladophlebis gorbiachiana, C. ? dogaldensis, Taeniopteris prynadae, T. ? gorbiachinii.*

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* See VLADIMIROVICH ET AL., 1967.

** See BOYAKOVA ET AL., 1972 and VASSILEVSKAJA ET AL., 1972.

Chart 13: The plants from the Maltsevo Formation of the Kuzbass (see p. 328: 59a)

1. Phyllotheca oligophylla	Babiy Kamen	Vladimirovich, 1980 a
2. Neocalamites primoris	Babiy Kamen, Ostashkiny Gory	Vladimirovich, 1980 a
3. Paracalamites triassica	Babiy Kamen	Vladimirovich, 1967*
4. P. taradanica	Tom (lower Azhendarovo)	Vladimirovich, 1980 b
5. P. sp.	Kyrgay, Ostashkiny Gory	Radczenko, 1936
6. Schiozoneura altaica	Babiy Kamen, Middle Ters	Vladimirovich & Radczenko, 1960**
7. Neokoretrophyllites annularioides	Babiy Kamen, Middle Ters	Radczenko, 1960
8. Todites korvunchanica	Naryk	Vladimirovich, 1960 b
9. Pecopteris pseudotchichatchevii	Babiy Kamen	Vladimirovich, 1967*
10. Tungussopteris cladophleboides	Ostashkiny Gory	Vladimirovich, 1967*
11. Prynadaeopteris schvedovii	Babiy Kamen	Vladimirovich, 1980 c
12. Cladophlebis augusta	Kyrgay, Ostashkiny Gory, Babiy Kamen, Ters, Naryk	Neuburg, 1936; Radczenko, 1936; Vladimirovich, 1980 c
13. C. pygmea	Babiy Kamen	Neuburg, 1936
14. C. lobifera	Babiy Kamen	Prynada, 1960***
15. C. ex gr. concinna	Ostashkiny Gory	Radczenko, 1936
16. C. pusilla	Babiy Kamen, Ostashkiny Gory	Vladimirovich, 1980 c
17. C. platyphylla	Babiy Kamen, Middle Ters	Vladimirovich, 1980 c
18. C. tomiensis	Babiy Kamen	Vladimirovich, 1980 c
19. D. densinervis	Babiy Kamen	Vladimirovich, 1980 c
20. C. (Aurifolia) lobifera	Babiy Kamen	Vladimirovich, 1980 c
21. C. (Diversiofolia) mutnaensis	Middle Ters, Kyrgay	Vladimirovich, 1980 c
22. Madygenia borealis f. typica	Middle Ters	Vladimirovich, 1967*
23. Tersiella belloussovae	Babiy Kamen, Middle Ters, Azhendarovo	Radczenko, 1960****
24. T. serrata +	Babiy Kamen	Srebrodolskaya, 1960
25. Glossozamites kryshtofovichii	Babiy Kamen, Azhendarovo	Prynada & Radczenko, 1960
26. Taeniopteris sp.	Babiy Kamen	Radczenko, 1936
27. Tomia radczenkoi	Babiy Kamen	Srebrodolskaya, 1960 b
28. T. malzevskiana	Babiy Kamen	Srebrodolskaya, 1960 b
29. Rhipidopsis triassica	Babiy Kamen	Srebrodolskaya, 1960 a
30. Baiera sp.	Babiy Kamen	Neuburg, 1936
31. Retinosporites sibirica + +	Babiy Kamen	Neuburg, 1936
32. Araucarites tomiensis + + +	Babiy Kamen	Neuburg, 1936; Sadovnikov, 1982 a; Dobruskina, 1985
33. Tomiostrobus radiatus + + +	Babiy Kamen	Neuburg, 1936; Sadovnikov, 1982 a, Dobruskina, 1985
34. Elatocladus linearis	Babiy Kamen	Vladimirovich, 1967*
35. Lituginia furcata	Babiy Kamen	Vladimirovich, 1967*
36. Quadrocladus sibiricus	Babiy Kamen	Meyen, 1981

* See Vladimirovich et al., 1967
** See Vladimirovich, Prynada & Radczenko, 1960
*** See Vladimirovich, Prynada & Srebrodolskaya, 1960
**** See Radczenko & Srebrodolskaya, 1960
***** See Radczenko, 1960
\+ After Meyen, 1971 it is Pursongia serrata
\+ + After Meyen, 1981 it is Quadrocladus sibiricus
\+ + + After Meyen, 1981 they are lycopsids of the family Pleuromeiaceae

b) Kureyka-Severnaya region (Vladimirovich, 1967*; Radczenko, 1967*; Mogutcheva, 1972, 1973, 1983, 1984 b, 1984 c; Mogutcheva & Dobruskina, 1986; SCHILKINA, 1984; unmarked species described by Mogutcheva):

Kochechum Formation (ol-an, 39–41): *Annularia ? epeclissensis, Boreopteris evenkensis, B. triangularis, Mertensides lingulatus, M. concinnus, Cladophlebis grandifolia, C. angustipinnula, Khonnomakidium srebrodolskae* f. *grande, Katasiopteris lata, K. polymorpha* (in Durante, 1978 = *Lobatopteris polymorpha), Elegantopteris tripinnata, Scytophyllum tenuinerve, Williamsoniella* sp., *Yuccites angaridens.*

Nidym Formation (ol-an, 39–41): *Lobifolia paucinervis, Diplazites sibiricus, Quadrocladus pilosus, Q. lebedevii.*

Dvurogiy Formation (ol-an, 39–41): *Paracalamites triassica* – R, *Mertensides concinnus, Tungussopteris cladophleboides* – V, *T. sphenopterioides* – V, *Cladophlebis grandifolia, Khonnomakidium srebrodolskae, Katasiopteris lebedevii* – R, V, M, *K. polymorpha* (in Durante, 1978 = *Lobatopteris polymorpha*), *Eleganopteris tripinnata, Madygenia borealis* f. *typica* – R, M, *Edyndella dentata, Tersiella leptophylla, Parajacutiella angusta, Sphenobaiera vittaefolia, Rhipidopsis triassica, Voltzia angusta, Voltzia ? avamica, Darneya inornata* – M & D, *Wilssiostrobus cylindricus* – M & D, *Elatocladus linearis* – P, *Araucariorhizoxylon kryshtofovichii* – S.

c–f – Lower Tunguska region (ind, 7–12; ol-an, 43–46):

c) Tutonchana River, **Tutonchana Formation** (ind, 7–8) (Mogutcheva, 1973, 1974): *Tschernovia imbricata, Gammophyllites ruminatus, Cladophlebis gorbiachina, Yavorskyia radczenkoi, Rhipidopsis tutonchanica.*

d) Korvunchana River, **Korvunchana Formation** (ol-an, 43) (Vladimirovich, 1960 b; Radczenko, 1960 b): *Neokoretrophyllites annularioides* – R, *Todites korvunchanica* – V.

e) Korvunchana River, **Tutonchana Formation** (ind, 12) (Prynada, 1960**, 1970; Vladimirovich, 1967***; Mogutcheva, 1972****, 1973): *Neokoretrophyllites linearis* – M, *Lobatannularia linearis* – P, *Cladophlebis curviplumulis* M, *C. lobifolia* – P, *Pecopteris* sp., *Tungussopteris cladophleboides* – P, *Neuropteridium tunguscanum* – P (in Schvedov, 1963 = *Khonomakidium tunguscanum*), *Khonomakidium tunguscaum* – M, *Ctenopteris angustiloba* – P, *Rhizomopteris* sp. A–P, *Rhizomopteris* sp. B–P.

f) Lower Tunguska River (ind, 9–11; ol-an, 44–46) (Prynada, 1960**, 1967**, 1970; Schvedov, 1963; Vladimirovich, 1967***; Sadovnikov, 1971 b, 1983 b; Mogutcheva, 1972****, 1973, 1980 a, 1983, 1984 c; coll. GIN 3769, Snigirevskaja, 1980 a, 1980 b; Meyen & Gomankov, 1980; Meyen, 1981):

Nidym Formation (ol-an, 44–46): *Lobatannularia evenkorum* – P, *Todites ? simplicinervis* – P, *T. kirjamkensis* – M, *Cladophlebis kirjamkensis* – P, *Cla-*

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* See Vladimirovich et al., 1967

** See Vladimirovich, Prynada & Srebrodolskaja, 1960.

*** See Vladimirovich et al., 1967.

**** See Boyakova et al., 1972.

dophlebis lobifera – P, M, *C. eniseica* – P, *Cladoplebis* cf. *concinna* – P, *C. disjuncta* – P, *Sphenopteris rangiferina* – P, *S. ? kirjamkensis* – P, *S. simplicinervis* – P, *Lobifolia taimurensis* – M, *Khonomakidium srebrodolskae* – M, *Korvunchania dentata* – P, *K. tunguscana* – P, M, *Eleganopteris tripinnata* – M, *Ixostrobus tunguscanus* – P, *Radicites* sp. – P, *Rhizomopteris* sp. – V, P.

Bugarikta Formation (ol-an, 44–46): *? Osmundopsis* sp. – P, *Coniopteris* sp. – P, *Cladophlebis lobifera* – P, *Pecopteris crenata* – P, *Pachypteris ?* sp. – P, *Taeniopteris ensis* – P, *Taeniopteris prinadae* – M, *"Czekanowskia setacea"* – P, *Quadrocladus sibiricus* – Me (former *Elatocladus pachyphyllus* in PRYNADA, 1970).

Tutonchana Formation (ind, 9–11): *Takhtajanodoxa mirabilis* – Sn, *Arthropitys prynadae* – Sa, *A. tunguscana* – Sa, *Lobatannularia linearis* – P, *Paracalamites doliaris* – M, *Paracalamites* sp. – P, *Cladophlebis borealis* P, M, *Cladophlebus* cf. *concinna* – P, *Osmundopsis angusta* – M, *Lobifolia paucinervis* – M, *Neuropteridium tunguscanum* – P, *Khonomakidium tunguscanum* – M, *Tungussopteris cladophleboides* – V, *Korvuntchania tunguscana* – M, *Ctenopteris angustiloba* – P, *Kirjamkenia lobata* – P, Sa, *Leuthardtia crassa* – M (in MEYEN, 1983 = *Stiphorus crassus*), *Taeniopteris ensis* – P, *T. prynadae* M, *? Glossophyllum* sp. – P (in SCHVEDOV, 1963 = *Yavorskyia radczenkoi*), *Ginkgo* sp. A–P, *Gingko* sp. B–P, *Sphenobaiera vittaefolia* – M, *S. porrecta* – M, *S. tunguscana* – M, *Sphenobaiera* sp. – P, *Glossophyllum claviforme* – M, *Antholithes cylindricus* – P, *Elatocladus linearis* – P, *Carpolithes* sp. – P, *Rhizomopteris* sp. – P, Sa.

Korvunchana Formation (ol-an, 44–46): *Tomiostrobus* sp. (determination of DOBRUSKINA after coll. GIN 3769), *Acrocarpus dacatensis* – M, *Tatarina lobata* – M & G, *T. sadovnikovii* – M & G, *Taeniopteris prynadae* – M.

Nidym Formation (ol-an, 44–46): *Lobifolia paucinervis* – M, *Trichomanes ? pussilum* – M, *Todites orulganensis* – M.

g) Headwaters of rivers Ilimpeya, Taymura and Chunya (ind, 13; ol-an, 47) (MOGUTCHEVA, 1973):

Nidym Formation (ol-an, 47): *Phylloptheca* sp., *Lobifolia taymurensis, Prynadaeopteris* sp., *Korvunchania tunguscana, Rhipidopsis triassica.*

Korvunchana Formation (ol-an, 47): *Parajacutiella parva, P. angusta.*

Tutonchana Formation (ind, 13): *Neokoretrophyllites linearis, Prynadaia* sp., *Schvedopteris lobata, Cladophlebis borealis.*

h) Watershed of rivers Marcha (tributary of Vilyuy River) and Alakit (tributary of Olenek River) (ind, 14) (TOLSTYCH, 1968 a, 1968 b, 1969): *Marchajella kaschirzewii, M. angusta, Yuccites jacutensis, Noeggerathiopsis pseudominutifolia, Crassinervia acuminata.*

i) Prianabarye, **Kayalach Formation** (ind, 15?) (SADOVNIKOV, 1982 a): *Tomiostrobus migayi, T. beloserovii* (in DOBRUSKINA, 1985 b = *T. radiatus*), *T. bulbosus* (in DOBRUSKINA, 1985 c = *T. radiatus*).

61. Plants from Taymyr peninsula

a) Watershed of rivers Uboynaya and Pura, **Tuffo-lava Formation** (ind, 16) (SCHVEDOV, 1960 a): *Cladophlebis tajmyrensis, Sphenopteris trisecta, Sphenobaiera tajmyrensis.*

b) Fadyu – Kuda River, **Mamonov Formation** (ol-an, 48; nor-rt, 35) (Schvedov, 1958, 1960 b): *Neocalamites carcinoides, Neocalamites* sp. 2, *Paracalamites* sp., *Thinnfeldia* sp., *Protoblechnum ?* sp., *Taeniopteris* sp.

c) Kiryaka – Tas Range (ind, 17) (Sadovnikov, 1981 b): *Ouadrocladus sibiricus* (name only).

d) Cape Tsvetkov (Schvedov, 1958; Mogutcheva, 1980 b, 1982 a, 1984 a):

Nemtsov Formation (nor-rt, 36): *Neocalamites* aff. *hoerensis* – S, *N. carrerei* – M, *Annulariopsis inopinata* – M, *Cladophlebis zwetkoviensis* – S, *C. jolkinensis* – M, *C. uralica* – M, *C. crenulata* – M, *Glossophyllum ? spathulatum* – S,. *Podozamites zwetkowii* – S, *Lepeophyllum pumile* – M.

Kuldima Formation (previously **Tsvetkov Formation**) (lad-karn, 34): *Neocalamites carcinoides* – S, *N. carrerei* – M, *Schizoneura grandifolia* – M, *Podozamites guttiformis* – M, *P. issykkulensis* – M, *Podozamites* sp. – S.

Osipay Formation (ol-an, 49): *Schizoneura grandifolia* – M.

Eastern Taymyr Formation (previously **Terrigeneous Formation**) (ol-an, 49): *Tomiostrobus migayi* (former *Araucarites migayi)* – S, *Pityospermum* sp. – S, *Carpolithes* sp. – S.

Keshin Formation (previously **Lower Terrigeneous Member** of **Effusive – Tuffite Formation**) (ind, 18): *Tomiostrobus migayi* (former *Araucarites migayi*) – S, *Equisetites sixtelae* – M, *Cladophlebis parvulus* – M, *Lepidopteris arctica* – M, *Taeniopteris tajmyrica* – M, *Carpolithes tsvetkoviensis* – M.

"Mariniskiy Formation (Sadovnikov, 1982 a): *Tomiostrobus beloserovii, T. fusiformis, T. bulbosus* (in Dobruskina, 1985 b the three species = *T. radiatus*), *T. migayi*.

"Fadyu – Kuda Formation" (Sadovnikov, 1982 a): *Tomiostrobus fusiformis, T. bulbosus* (in Dobruskina, 1985 b the both = *T. radiatus*), *T. migayi*.

e) Chernokhrebetnaya River (Sadovnikov, 1982 a, 1982 b):

"Marininsky Formation (ind, 19 ?): *Tomiostrobus beloserovii* (in Dobruskina, 1985 b = *T. radiatus*), *T. migayi, Pleuromeia taymirica* (in Dobruskina, 1985 c = *Pleuromeia* sp.).

"Fadyu – Kuda Formation" (ol-an, 50 ?): *Tomiostrobus migayi, Pleuromeia taymyrica* (in Dobruskina, 1985 c = *Pleuromeia* sp.).

62. Plants of Northern Coast and Vilyuy syneclise

a) Anabar coast (lad-karn, 35) (Mogutcheva, 1981): *Cladophlebis* aff. *chantajkensis, Cladophlebis* sp., *Sphenopteris* sp., *Vittaephyllum anabarense, Anomozamites parvifolius, Macrotaeniopteris* sp.

b) Ystynaach-Khocho, **Ulakhanyuryakh Formation** (ind, 20) (Mogutcheva, 1982 a): *Cladophlebis parvulus, Tomiostrobus* sp. (former *Araucarites* sp.).

c) Mouth of Olenek River

The Induan (ind, 21) (Popov, 1973): *Araucarites migayi* (now *Tomiostrobus migayi*) – only mentioned.

The Olenekian (ol-an, 51) (Krassilov & Zakharov, 1975 a, 1975 b): *Pleuromeia olenekensis*.

d) Buur River, tributary of Olenek River, Kyra – Kos – Terryuteekh village (ol-an, 52) (determinations of DOBRUSKINA after coll. GIN 3769): *Pleuromeia* sp.

e) Lena River near its mouth, Tasary (ol-an, 53) (determinations of DOBRUSKINA after coll. GIN 3769): *Pleuromeia* sp.

f) Vilyuy syneclise, boreholes at the left bank of Vilyuy River, **Nedzhelinsk** and **Taganzhinsk Formation** (ind, 30) (determinations of MOGUTCHEVA): *Tomiostrobus* sp.

63. Plants of Western Verkhoyanye and North East

a) Kharaulakh mountains (ind, 22) (TUCHKOV & POPOV, 1973): *Pseudoaraucarites migayi* (now *Tomiostrobus migayi*) – name only.

b) Unguokhtakh River, Orulgan Range, **Syurbelyakh Formation** (ind, 23) (DURANTE & BITERMAN, 1978; MOGUTCHEVA, 1984 c): *Phyllotheca kryshtofovichii* – M, *Equisetites sixtelae* – M, *Asterotheca ? radczenkoi* – M, *Todites korvunchanica* – M, *T. orulanganensis* – M, *Lobifolia paucinervis* – M, *Lobatopteris polymorpha* – D, *Khonnomakidium srebrodolskae* – D.

c) Syncha River, **Nedzhelinsk Formation** (ind, 24) (SADOVNIKOV, 1982 a): *Tomiostrobus migayi, T. beloserovii* (in DOBRUSKINA, 1985 b = *T. radiatus*).

d) Syncha River, **Taganzhinsk** and **Sygynkan Formation** (ind, 24, ol-an, 54) (coll. of MOGUTCHEVA): *Pleuromeia* sp.

e) Sobopol River (ind, 25) (SADOVNIKOV, 1982 a; coll. GIN 3769): *Tomiostrobus migayi, T. bulbosus* (in DOBRUSKINA, 1985 = *T. radiatus*), *Tomiostrobus* sp.

f) Seymchan River, **Nedzhelinsk** and **Taganzhinsk Formations** (ind, 26) (SADOVNIKOV, 1982 a): *Tomiostrobus migayi.*

g) Ylegiir River, **Nedzhelinsk Formation** (ind, 29) (SADOVNIKOV, 1981 b, 1982 a): *Tomiostrobus migayi* (1982 a), *Quadrocladus sibiricus* (1981 b – name only).

h) Tokur-Yurekh River, **Kelter Formation** (ind, 27) (coll. GIN 3769): *Tomiostrobus* sp., *Neocalamites* sp.

i) Dolbuun River, **Nedzhelinsk Formation** (ind, 28) (SADOVNIKOV, 1982 a): *Tomiostrobus migayi, T. radiatus, T. beloserovii* (in DOBRUSKINA, 1985 b = *T. radiatus*).

j) Tumara River, **Khedvalichensk Formation** (lad-karn, 36) (ABRAMOVA, 1960); *Bernoullia* sp.

k) Anadyr, Big Anyuy, Omolon rivers (nor-rt, 37) (EFIMOVA, 1976): *Sagenopteris* ex gr. *rhoifolia ?, Sagenopteris* sp.

64. Plants from Mountaneous Altay, Semeytau Mountains and Zabaykalye

a) Mountaneous Altay, Pyzha River (nor-rt, 38) (MOGUTCHEVA, 1987): a list of undescribed Upper Triassic plants: *Tomiostrobus* cf. *conflexus, Lycopodites* ex gr. *trichiatus, Schizoneura grandifolia, Neocalamites carrerei, N. carcinoides, Phyllotheca* ex gr. *sibirica, Equisetites* cf. *macrocoleon, E.* ex gr. *arenaceus, Radicites* sp., *Cladophlebis (Todites) roessertii, C. raciborskii, C. stenolopha, C. haiburnen-*

sis, C. aff. *haiburnensis, C. crenulata, C. undulata, C..* cf. *grabauiana, C.* cf. *gigantea, C.* cf. *zwetkovensis, C.* cf. *sublobata, C.* sp. cf. *Todites princeps, C.* cf. *parvifolia, Kugartenia* sp., *Bernoullia* ? sp., *Thinnfeldia* sp. nov., *Scytophyllum* cf. *S. toretziensis, Williamsonia* ex gr. *subtillis, Dictyozamites* sp., *Eretmophyllum* sp., *Glossophyllum ?* sp., *Pseudotorellia nordenskioldii, P.* cf. *rarinervis, P.* ? ex gr. *ephela, Toretzia* sp., *Phoenicopsis* ex gr. *angustifolia, Yuccites uralensis, Y. spathulatus, Yuccites* cf. *angustifolius, Yuccites* sp., *Podozamites distans, P. guttiformis, P. lanceolatus, Borysthenia* sp., *? Swedenborgia* sp., *Pityospermum* sp., ? *Pityophyllum* sp.

b) Semeytau Mountains (lad-karn, 37) (coll. GIN 4252, determinations of DOBRUSKINA): *Paracalamites* sp., *Cladophlebis* sp., *Sphenopteris* sp., *Lepidopteris* sp., *Peltaspermum* sp. (figured in DOBRUSKINA, 1980), bennettites, *Taeniopteris* sp., *Voltzia* sp., *Podozamites* sp., scales, seeds, ginkgophytes.

c) Zabaykalye, Tamir River (lad-karn, 37 a, coll. GIN 3732, determinations of NEUBURG): *Asterotheca* sp., *Cladophlebis szeiana, Cladophlebis* cf. *ichunensis, Cladophlebis* ex gr. *kaoiana.*

XI. Central Asia, South Eastern Asia, and the Far East

65. Plants of Mongolia

a) Watershed of rivers Orkhon and Tola (lad-karn, 39) (VLADIMIROVICH, 1970*):

The "Lower" Triassic: *Nilssoniopteris undulata, Tologoella abzogensis, Tychtopteris ? ovalis.*

The Middle – Late Triassic: *Taeniopteris toiensis, Amantovia setacea, Elatocladus angustifolia, Mongolophyllum amantovii, M. linearis, Pseudotychtopteris angustilobata.*

66. Plants of Mongolia determined and revised by DOBRUSKINA (coll. GIN 3794; collected by Soviet geologists in 1967–1974)

a) Watershed of rivers Orkhon and Tola (lad-karn, 39): *Equisetites arenaceus, Neocalamites carrerei, Danaeopsis* sp., *Cladophlebis shensiensis, Scytophyllum ?* sp., *Uralophyllum* sp. nov. *("Thinnfeldia" nordenskioldii), Sphenozamites* sp., *Nilssonia* sp., *Taeniopteris ensis, Sphenobaiera* sp., *Glossophyllum ?* sp., *Podozamites* sp., *Cycadocarpidium* sp., *Pityophyllum latifolium, Carpolithes* sp.

b) Environs of Bayan-Zagan Somon (lad-karn, 46): *Equisetites arenaceus, Neocalamites carrerei, Bernoullia aktjubensis, Cladophlebis roessertii, C. ichunensis, Scytophyllum* sp., *Nilssonia* sp., *Taeniopteris* sp., *Sphenobaiera* sp., *Phoenicopsis* sp., *Glossophyllum ?* sp., *Podozamites* sp., *Pityophyllum* sp., *Conites* sp.

c) Mine Barun-Zogto (lad-karn, 47): undeterminable sphenopsids, *Cladophlebis ?* sp., *Sphenobaiera* sp. A, *Sphenobaiera* sp. B, *Czekanowskia* sp., *Pityophyllum latifolium, Podozamites ?* sp., *Carpolithes* sp., Squama sp.

d) Big bend of Kerulen River : Murongol grabens and Dashibalbar (lad-karn, 41): *Equisetites* sp., *Neocalamites hoerensis, Danaeopsis* sp., *Cladophlebis* sp., *Uralophyllum* sp. nov. *("Thinnfeldia" nordenskioldii), Taeniopteris spathulata, Taeniopteris* cf. *macclelandii, Taeniopteris* cf. *ambabirensis, Baiera ? gracilis, Glossophyllum ?* sp., *Pityophyllum latifolium, Voltzia ?* sp., *Swedenborgia cryptomerioides, Carpolithes* sp.

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* See AMANTOV ET AL., 1970.

e) Dzhargantuingol River (lad-karn, 40): undeterminable sphenopsids, *Cladophlebis raciborskii, C. roessertii, Uralophyllum* sp. nov. *("Thinnfeldia" nordenskioldii), Ginkgoites taeniatus, Phoenicopsis angustifolia, Glossophyllum ?* sp., *Podozamites lanceolatus, P. reinii, Pityophyllum latifoloium, Carpolithes* sp.

f) Watershed of rivers Uldza and Kerulen: Gertuin (lad-karn, 44), Khutuinnur (lad-karn, 45), and Shaldza (lad-karn, 43) mulds: *Equisetites* sp., *Neocalamites* sp., *Cladophlebis* sp., *Uralophyllum* sp. nov. *("Thinnfeldia" nordenskioldii), Taeniopteris spathulata, Sphenobaiera angustiloba, S. longifolia, Czekanowskia rigida, Phoenicopsis angustifolia, Glossophyllum ?* sp., *Podozamites lanceolatus, Pityophyllum latifolium, Carpolithes* sp.

g) South Gobi, Somon Noyan (lad-karn, 48): *Equisetites* sp., *Neocalamites carrerei, Cladophlebis* sp., *Glossophyllum ?* sp., *Podozamites lanceolatus, Pityophyllum latifolium.*

h) South Gobi, Somon Noyan (ol-an, 5): *Pleuromeia ?* sp.

67. Triassic plants of Northern China

Early Triassic plants

a) Jiaocheng district, Shanxi province, the Hwang Ho River (ind, 31) (WANG Z. Q. & WANG L. X., 1982): **Luijiakou Formation, Shischienfeng Series:** *Pleuromeia jiaochensis*;

(WANG Z. Q., 1985): *Crematopteris brevipinnata, C. circinales.*

b) Yushe district, Shanxi province, the Hwang Ho River (ol-an, 58) (WANG L. X., XIE Z. M. & WANG Z. Q., 1978): **Heshankou Formation, Shischienfeng Series:** *Pleuromeia sternbergii, P. rossica, Yuccites ?* sp., *Voltzia* sp. (male cone), *Neocalamites* sp., *Equisetites* sp.;

(WANG Z. Q., 1985): *Schizoneura* sp., *Neocalamites shanxiensis, Willsiostrobus hongyantouensis.*

c) Pingyao district, Shanxi province, the Hwang Ho River (ol-an, 58) (WANG L. X., XIE Z. M. & WANG Z. Q, 1978): **Heshankou Formation, Shischenfeng Series:** *Pleuromeia sternbergii, Neocalamites* sp., cf. *Anomopteris mougeotii* (= *Crematopteris* sp. according written communication of WANG Z. Q.), *Samaropsis* sp.;

(WANG Z. Q., 1985): *Crematopteris* cf. *typica.*

d) Central Shansi (ind, 31) (WANG Z. Q., 1984): *Phyllotheca ? yushenensis, Schizoneura megaphylla,* cf. *Sphenopteris (Neomariopteris) polymorpha, Bothrychiopsis* cf. *validus,* the cone of Equisetales, *Neoglossopteris shanxiensis, Gangamopteris ? qinshuensis, C. ? tuncuensis,* cf. *Dicroidium odontopteroides,* cf. *Eretmonia* sp., cf. *Glossotheca* sp., cf. *Palaeovittaria* sp., cf. *Euryphyllum* sp., *Samaropsis milleri.*

e) Hsishan (Xishan) or Western Hills of Peiping , **Shuangtsuan Series** (ol-an, 57) (VAKHRAMEEV, 1964 after CHI Y. S. & P'AN C. H., 1933): *Danaeopsis hughesii, Lobatannularia heianensis* = Chengde in KIMURA, 1984 = the Chaitang

Basin west of Peking (NEWBERRY, 1866): *Pecopteris ? whitbiensis, Sphenopteris orientalis, Hymenophyllites tenellus, Pterozamites sinensis, Taxites spathulatus.*

f) Sinkang province: Urumchi, Fuyuan (nor-rt, 41) (SZE, 1933 a): *Thinnfeldia svenhedina.*

Middle Triassic plants

g) Benxi, Liaoning province, **Lingjia Formation** (ol-an, 56) (ZHANG W., ZHENG S. L. & CHANG S. Q., 1983): *Hepacitites minutus, Neocalamites merianii, Schizoneura ornata, Asterotheca* sp., *Symopteris* cf. *densinervis, S. zeilleri,* cf. *S. helvetica, Symopteris* sp., *Todites* cf. *shensiensis, Spiropteris* sp., *Cladophlebis* cf. *ichunensis, C. tenerus, Cladophlebis* spp., *Sphenopteris digitata, S. lobifolia, Chiropteris* spp., *"Aipteris"* cf. *wuziwanensis, Thinnfeldia major, Dicroidium ? allophyllum, Benxiopteris acuta, B. partita, Benxiopteris* sp., *Pterophyllum* s., *Sinozamites myrionervus, Ginkgoites* spp., *Sphenobaiera qiandianziensis, Sphenobaiera* spp., *Psygmophyllum* cf. *multipartitum, Pityophyllum* sp., *Podozamites lanceolatus, Podozamites ?* sp., *Albertia* sp., *Swedenborgia linjanensis, Araucarites* sp., *Yabeiella multinervis, Yabeilella* cf. *mareyesiaca, Taeniopteris* spp., *Desmiophyllum* sp., *Samaropsis rhombicus, Samaropsis* sp., *Carpolithus* spp.

(ZHANG W., CHANG C. C. & ZHENG S. L., 1980): *Pleuromeia ?* sp., *Lobatannularia* cf. *heianensis, Gleichenites benxiensis, Chiropteris taizihoensis, Benxiopteris acuta, B. densinervis, B. partita, B. polymorpha, Sinozamites magnus, Albertia* cf. *latifolia.*

h) Shaan-Gan-Ning Basin (HUANG Z. G. & ZHOU H. G., 1980):

Ermayang Formation (ol-an, 59): *Pleuromeia wuziwanensis, Bernoullia zeilleri, Todites shensiensis, Cladophlebis* cf. *roessertii, C. raciborskii, Protoblechnum wongii, Pachypteris* sp., *Aipteris wusiwanensis, Nilssonia grandifolia, Nilssonia* sp. 1, *Nilssonia* sp. 2, *Ctenozamites sarranii, Sinozamites ?* sp., *Ginkgo* cf. *marginatus, Baiera* sp. cf. *Baiera gracilis, Sphenobaiera* sp. 1, *Sphenobaiera* sp. 2, *Sphenobaiera* cf. *crassinervis, Glossophyllum ? shensiense, Stenorachis lepida, Araucarites* sp., *Podozamites lanceolatus, Voltzia* cf. *walchaeformis, Pagiophyllum ?* sp..*Carpolithes* sp. 1, *Carpolithes* sp. 2, *Carpolithes* sp. 3, *Taeniopteris abnormis.*

Tongchuan Formation (lad-karn, 54): *Pleuromeia labiata, P. tungchuanensis, Equisetites brevipinnatus, E. stenodon, Equisetites* sp., *Neocalamites carrerei, N. carcinoides, N. hoerensis, Taeniocladopsis rhizomoides, Danaeopsis magnifolia, Danaeopsis* cf. *marantacea, D. plana, Bernoullia zeilleri, Todites shensiensis, Cladophlebis* cf. *roessertii, Glossopteris* cf. *angustifolia, G. chinensis, Tungchuanophyllum trigonum, T. concinum, T. shensiense, Glossophyllum shensiense, Stenorachis lepida, Araucarites* sp.

i) Hwang Ho River Basin, **Yenchang Formation** (lad-karn, 55–64) (P'AN, 1936; SZE, 1956; WANG Z. Q., 1985): *Annalepis* cf. *zelleri* – W, *Equisetites sarranii* – S, *E. brevipinnatus* – S, *E. sthenodon* – S, *E. acanthodon* – S, .*E. deltodon* – S, *E. ? rogersii* – S, *Equisetites* sp. (strobili of *Equisetites*) – S, *Neocalamites carrerei* – S, *N. carcinoides* – S, (in P'AN, 1936 = *Schizoneura gondwanensis*), *N. brevifolius* – S, *N. rugosus* – S.

Danaeopsis fecunda – S (in P'AN, 1936 = *D. hallei*), *Bernoullia zeilleri* – P, S, *Phlebopteris ? linnearifolia* – S, *Cladophlebis (Todites) shensiensis* – P, S (in SZE, 1956 *Cladophlebis* cf. *roessertii* of P'AN, 1936 is also included inthis species), *Cladophlebis (Asterotheca) szeiana* – P, S, *C. grabauiana* – P, *Cladophlebis* cf. *gigantea* – P, S, *C. kaoiana* – S, *C. gracilis* – S, *C. ichunenesis* – S, *C. stenophylla* – S, *C. paralobifolia* – S, *C. suniana* – S, *C. raciborskii* – S, *Sphenopteris* cf. *arizonica* – S, *Sphenopteris ? chowkianensis* – S.

? Thinnfeldia nordenskioldii – P, S (according author's opinion = *Uralophyllum*), *T. rhomboidalis* – P, S, *T. major* – S, *T. rigida* – S (according author's opinion = *Bernoullia rigida*), *T. alethopteroides* – S, *T. laxusa* – S, *Ctenopteris sarranii* – S, *? Protoblechnum hughesii* – S (in P'AN, 1936 = *"Danaeopsis" hughesii*), *Sagenopteris spathulata* – S, *Sphenozamites changii* – S, *Drepanozamites planii* – S, *Sinozamites leeana* – S.

Glossophyllum ? shensiense – S (in P'AN, 1936 = *Noeggerathiopsis hislopii*), *Desmiophyllum* sp. – S, *Ginkgoites chowii* – S, *G. magnifolia* – S (in P'AN, 1936 = *Ginkgo magnifolia*), *Sphenobaiera crassinervis* – S, *? S. furcata* – S, *Psygmophyllum ?* sp. – S.

Podozamites lanceolatus – P, *Swedenborgia cryptomerioides* – S, *? Stenorachis (Ixostrobus konianus)* – S, *Taeniocladopsis rhizomoides* – S, *Carpolithes* spp. – S.

j) Shanxi, Gansu, Ningxia (lad-karn, 55–64) (HUANG Z. G. & ZHOU H. G., 1980):

Yenchang Formation: *Equisetites brevidentatus, E. deltodon, Neocalamites carrerei, N. carcinoides, Neocalamites* cf. *hoerensis, Annulariopsis annularioides, Annulariopsis lobatannularioides, Annulariopsis* sp. 1, *Annulariopsis* sp. 2, *Danaeopsis fecunda, Danaeopsis ?* sp., *Asterotheca ? szeiana, Bernoullia zeilleri, Todites shensiensis, Cladophlebis ichunensis, C. gigantea, C. gracilis, C. grabauiana, C. fuxianensis, C. kaoiana, C. raciborskii, C. undulata, Sphenopteris chowkiawanensis, Sphenopteris* sp. 1, *Sphenopteris* sp. 2, *Sphenopteris* sp. 3, cf. *Lepidopteris ottonis, Thinnfeldia nordenskioldii, T. alethopteroides, T. rhomboidalis, Ptilozamites* sp., *? Protoblechnum hughesii, Aipteris nerviconfluens, A. obovata, Pterophyllum crassinervum, Pterophyllum* sp., *Anomozamites loczyi, Otozamites* sp., *Nilssonia orientalis, N. pterophylloides, Ctenozamites sarranii, Sphenozamites changii, Ginkgo* cf. *digitata, G. magnifolia, Baiera* cf. *gracilis, Ginkgodium longifolium, G. erethmophylloidium, G. truncatum, Glossophyllum shensiense, Stenorhachis lepida, Podozamites lanceolatus, Carpolithes* sp. 4, *Sagenopteris ginkgoides, S. lanceolatus.*

k) North-east China, **Topankou Formation** (lad-karn, 49) (ZHANG W., CHANG C. C. & ZHENG S. L., 1980): *Todites denticulata*.

l) Jilin province, **Beishan Formation** (lad-karn, 50) (ZHANG W., CHANG C. C. & ZHENG S. L., 1980): *Neocalamites carcinoides, N. rugosus, Todites shensiensis, Cladophlebis kaoiana, Thinnfeldia nordenskioldii, Glossophyllum shensiense, Swedenborgia minor*.

m) Dajianggang, Shuangyang county, central Jilin, **Dajianggang Formation** (lad-karn, 51) (SUN GE, ZHAO Y. H. & LI C. T., 1983): *Equisetites shuangyangensis, Neocalamites carrerei, N. hoerensis, Schizoneura ?* sp., *Todites williamsonii, Thaumatopteris ?* sp., *Cladophlebis scariosa, Drapanozamites incisus, Nilssonia* cf. *incisoserrata, Nilssonia* sp., *Phoenicopsis angustifolia,* cf. *Glossophyllum florinii, Glossophyllum* sp., *Storgaardia ?* sp., *Pityophyllum* sp., *Podozamites* cf. *distans, P. lanceolatus, Podozamites ?* sp., *Taeniopteris* cf. *leclerei, T. tenuinervis, Taeniopteris* sp.

n) Jinlingsi-Yangshan Basin, Western Liaoning province, **Laohugou Formation** (lad-karn, 52) (ZHANG W. & ZHENG S. L., 1984): *Neoannularia confertifolia, Gleichenites chaovangensis, Cladophlebis nobilis, C. sublobata, Lepidopteris toretziensis, Scytophyllum chaoyanense, Podozamites astartensis, Borysthenia opulenta, Nanpiaophyllum cordatum*.

(ZHANG W., CHANG C. C. & ZHENG C. L., 1980): *Sinoctenis minor, Glossophyllum shensiense*.

o) Yangcagou, Beipiao, Liaoning (lad-karn, 53) (ZHOU H. Q., 1981): *Thallites* sp., *Annulariopsis vancaogouensis* (described), *Ginkgoites papilionaceus* (described), *Neocalamites carcinoides, N. rugosus, Dictyophyllum nathorstii, Todites goeppertianus, Danaeopsis* sp., *Cladophlebis gracilis, C. kaoiana, Nilssonia furcata, N. polymorpha, Taeniopteris oblique, Ginkgoites papilionaceus, Baiera* cf. *multipartita, B. muensteriana, B. guilhaumatii, B. hallei, Baiera* sp., *Sphenobaiera crassinervis, Glossophyllum shensiense, Glossophyllum* sp., *Podozamites lanceolatus, P. schenkii, Cycadocarpidium erdmannii, Stenorachis* cf. *lepida*.

p) South Qilian Mountains, **Atasi** and **Galedesi Formations** (lad-karn, 67) (HE X. L., 1984): *Danaeopsis* cf. *fecunda, D. marantacea, Acitheca singhaiensis, Dictyophyllum ?* sp., *Pseudodanaeopsis sinensis, Pseudodanaeopsis* sp., *Poterophyllum* sp., *Ctenis* sp., *Sphenobaiera crassinervis, Glossophyllum ? shensiense, Taeniopteris* sp.

q) Alashan region, Inner Mongolia, **Yenchang Formation** (lad-karn, 65) (CHOW T. N. & CHANG, 1956): pictures without descriptions: *Equisetites* sp. cf. *E. sarranii, ? Neocalamites (? Equisetites)* sp., *N. carcinoides, Cladophlebis raciborskii*.

r) Heiyushan, Kara-mai (Black Oil Hills) of the Dzungaria Basin, **Yenchang Formation** (lad-karn, 71) (SZE, 1956): *Neocalamites carcinoides, Chiropteris yuanii, Sphenobaiera* sp. cf. *S. spectabilis*.

Late Triassic plants
Dictyophyllum-Clathropteris Flora

s) Tianqiaolin in Wangaing of eastern Jilin (nor-rt, 39) (SUN GE, 1979, 1981): *Dictyophyllum exquisitum, Dictyophyllum* sp. 1, *Dictyophyllum* sp. 2, *Clathropteris elegans, Hausmannia (Protorhipis) ussuriensis, H. (Protorhipis)* cf. *emejensis, H. (Protorhipis)* sp., *Cycadocarpidium giganteum, C. elegans, C. tricarpum, C. swabii, C. erdmannii, Cycadocarpidium* cf. *parvum, Cycadocarpidium* sp. 1, *Cycadocarpidium* sp. 2.

t) Sinkiang province, Urumchi, Fuyuan (nor-rt, 41) (SZE, 1953): cf. *Lepidopteris ottonis.*

68. Plants of Southern China

Early Triassic plants

a) Fuyuan and Xuanwei, Eastern Yunnan; Pan, Western Guizhou (YAO Z. Q. & OUYANG S., 1980 following YAO Z. Q., 1978):

Dongchuan Formation, lower part (ind, 32, 33): *Annularia, Lobatannularia, Cladophlebis, Lepidopteris, Gigantopteris.*

Dongchuan Formation, upper part (ol-an, 60): *Elatocladus.*

Yunningzhen Formation (ol-an, 60): *Annalepis* sp., *Equisetites* sp. etc.

b) Qionghai district, Hainan island, Guandong province, Jiuqu River, **Lingwen Group** (ol-an, 62) (ZHOU Z. Y. & LI B. X., 1979): *Equisetites* sp., *Phyllotheca* sp., *Neocalamites* sp., cf. *Asterotheca szeiana, Caulopteris* sp., *Neuropteridium marginatum* sp. nov., *Taeniopteris heianensis, Weltrichia* sp., *Albertia latifolia, A. elliptica, Voltzia heterophylla, Voltzia* spp., cf. *Glyptolepis longibracteata, Pagiophyllum* sp., *Brachyiphyllum* sp., *Aetophyllum ?* sp., *Oionghaica carnosa, Masculostrobus ? prolatus, Strobilites* sp., *Carpolithus* sp.

Middle Triassic plants

c) Western Hupeh, **Patung Formation** (lad-karn, 72) (YE M. N., 1979): *Annalepis zeilleri, Annalepius* sp., *Neocalamites merianii, Neocalamites* sp., *Radicites* s., *Cladophlebis* sp., *Desmiophyllum* sp. (*Glossophyllum ?* sp.), *Samaropsis* sp., Problematicum.

d) Szechuan, **Tienchingshan Formation** (lad-karn, 74) (YE M. N., 1979): *Sinoctenis pulchella.*

e) Weishan and Jiangcghuan (lad-karn, 75) (KIMURA, 1984 following LI ET AL., 1976): *Neocalamites* sp. in Weishan, *Equisetites longidens, Nilssonia ?* sp., *Glyptolepis* in Jiangchuan.

Late Triassic plants
Danaeopsis-Symopteris Flora

f) Sichuan-Shanxi area (lad-karn, 74) (WANG X. F., 1977): *Neoannularia shanxiensis, N. chuandianensis, Neostachya shanxiensis.*

g) Hongni, Yanbin district, Sichuan (lad-karn, 74): (CHEN Y. & DUAN S. Y., 1981): *Danaeopsis marantacea, Asterotheca cottonii, Todites yanbianensis, Marattia antiqua, Lureticopteris megaphylla, Hicropteris triassica, Kylipteris simplex, Lesleya triassica, Sagenopteris stenopholia, S. glossopteroides.*

Late Triassic plants
Dictyophyllum-Clathropteris Flora

h) Amdo-Baquen area, Northern Xizang, **Tumaingela Formation** (nor-rt, 42) (WU X. W., 1982 a): *Equisetites arenaceus, E. longidens, E. sarranii, Equisetites* sp. 1, E. (Equisetostachvs) sp. 2, *Neocalamites carrerei, Neocalamites ?* sp., *Radicites* sp., *Taeniocladopsis rhizomoides, Danaeopsis* cf. *marantacea.* cf. *Todites crenatum, Thaumatopteris fuchsii, Thaumatopteris* sp., *Clathropteris meniscoides, C. tenuinervis, Cladophlebis* sp., *Sphenopteris* sp., *Allophyton denggenensis, Hyrcanopteris sevanensis, Pterophyllum hanesianum, P. minutum, P. schenkii, Pterophyllum* cf. *zygotacticum, Dictyozamites bagenensis, Otozamites* cf. *indosinensis, Nilssoniopteris jourdyii, Baiera* cf. *elegans,* cf. *Hirmerella muensteri.*

i) Eastern Xizang, **Jiapila Formation** (lad-karn, 76; nor-rt, 43) (WU X. W., 1982 b): *Equisetites arenaceus, Neocalamites* cf. *hoerensis, Weltrichia ?* sp.

j) Eastern Xizang, **Bagong Formation** (nor-rt, 43) (WU X. W., 1982 b): *Hysterites fraasii, Equisetites platyodon, E. rogersii, Equisetites* sp. 1, *Neocalamites* cf. *hoerensis, Neocalamites* sp., *Danaeopsis fecunda, Marattia asiatica, M. muensteri, Asterotheca szeiana, Todites shensiensis, Reteophlebis simplex, Phlebopteris gonojoensis, Gleichenites yipinglangensis, Thaumatopteris contracta, Thaumatopteris* cf. *remauryii, Thaumatopteris* cf. *dunkeri, Thaumatopteris* sp., *Dictyophyllum nathorstii, Dictyophyllum* sp. (sp. nov.), *Clathropteris meniscoides, Clathropteris* cf. *mongugaica, C. platyphylla, Goeppertella* cf. *kwangyunensis, G. microloba, Goeppertella* sp., *Cladophlebis grabauiana, C. tibetica, Cladophlebis* cf. *ruetimeyeri, Cladophlebis* sp. 1, *Cladophlebis* sp. 2, *Cladophlebis* sp. 3, *Hyrcanopteris sevanensis, Ctenozamites ?* sp., *Sagenopteris* sp., *Pterophyllum* cf. *aequale, Pterophyllum* cf. *astartense, Pterophyllum* cf. *magnificum, P. minutum,* cf. *P. nathorstii, P. shenkii, Pterophyllum* sp., *Anomozamites qamdoensis,* cf. *A. marginatus, A. paucinervis, A. orientalis, Otozamites* cf. *indosinensis, Otozamites* sp., *Sinoctenis calophylla, Sinoctenis ?* sp., *Nilssoniopteris jordyi, Nilssonia brevis, Nilssonia* cf. *polymorpha, Nilssonia* cf. *muensteri, Nilssonia* sp., cf. *Ctenis anomozamoides, Drepanozamites nilssonii, D. densinervis, Baiera* sp., *Stenorachis* sp. (cf. *Ixostrobus groenlandicus*), *Podozamites lanceolatus, Podozamites* sp., *Cycadocarpidium* sp., cf. *Elatides williamsonii,* cf. *Hirmerella muensteri, Taeniopteris* sp.

k) Lamaya, Western Sichuan, east part of Qinghai-Xizang plateau, **Lamaya**

Formation (nor-rt, 44) (Li P. J. & Wu X. W., 1982): *Selaginellites yunnanesis, Equisetites* cf. *multidentatus, Equisetites* cf. *takahashii, Equisetites* sp. 1, *Equisetites* sp. 2, *Neocalamites tuberculatus, Neocalamites* sp., *Marattia asiatica, M. hoerensis, Marattia* sp., *Todites denticulatus, T. goeppertianus, T. recurvatus,* cf. *T. shensiensis, Gleichenites yipinglangensis, Thaumatopteris* sp., *Dictyophyllum nathrostii, D. muensteri, Clathropteris meniscoides, Clathropteris* cf. *mongugaica, Clathropteris* sp. (sp. nov.?), *Clathropteris* sp., *Goeppertella xiangchengensis, Cladophlebis gamboensis, C. scariosa, Cladophlebis* cf. *raciborskii, Ctenozamites cycadea, Ctenozamites ?* sp., *Hyrcanopteris magnifolia, H. synensis, Pterophyllum aequale, P. jaegeri, P. ptilum, P. sinense, Anomozamites* cf. *loczyi, Nilssoniopteris jourdyi, Otozamites ?* sp., *Sinoctenis calophylla, Nilssonia* cf. *muensteri, Nilssonia ?* sp., *Pseudoctenis* sp. 1, *Pseudoctenis* sp. 2, *Ginkgoites gamdoensis,* cf. *Glossophyllum shensiense,* cf. *Ptilophyllum longifolium, Cycadocarpidium* sp., *Podozamites lanceolatus, P. shenkii, Conites* sp., *Carpolithes* sp., *Taeniopteris* cf. *tenuinervis.*

l) Kwangyuan, Hsuchiaho (nor-rt, 45) (Schenk, 1883, 1884; Krasser, 1901; Sze, 1933 b): *Phyllotheca ?* sp. – Sch, *Asplenites petruschinense* – Sch, *A. whitbiense* – Sch, *Adiantum szechenyi* – Sch, *Clathropteris* sp. – Sch, *? Dictyophyllum* sp. – Sze, *Macrotaeniopteris richthofenii* – Sze, *Oleandridium eurychoron* – Sch, *Anamozamites minor ?* – Sch, *A. loczyi* – Sch, *Ctenis chaoi* – Sze, *Phoenicopsis* sp. – Sch, *Podozamites lanceolatus* – Sch, K, Sze, *Taxites latior* – Sch, *Araucaria prodromus* – Sch.

m) Yungjen (nor-rt, 46, 47) (Hsu Y. & Chu C. N., 1974, 1975): *Angiopteris antiqua, A. yunngienensis, Pecopteris callipteroides, Rirecopteris microphylla, Lureticopteris megaphylla, Mixopteris intercelensis, Thaumatopteris nodosa, Cladophlebis yungjenensis, C. calciformis, C. imbricata, Pacypteris chinennsis* (in 1975 = *Ctenopteris chinensis*), *P. yungjengensis, Sagenopteris glossopteroides, G. stenopholia, Spenozamites yungjenensis, Otozamites megaphyllus, O. racurvus, Ctenis yunjenensis, C. multinervis, Pseudoctenis gigantea, Pterophyllum yunannensis, Anomozamites alternus, A. ptilus, A. pachylomus, Tichingia pinniformis, Stenopteris chinensis, Sphenobaiera bifurcata, Yungjenophyllum grandifolium.*

n) Fujuan province (nor-rt, 63, 64, 65) (Zhou T. S., 1978): *Thallites* sp., *Selaginellites ?* sp., *Equisetites ferganensis, Neocalamites carrerei, Danaeopsis fecunda, Danaeopsis* cf. *marantacea, Pecopteris (Asterotheca) cottonii, Todites goeppertianus, Coniopteris hymenophylloides, C. tatukensis, Clathropteris meniscoidees, C. platyphylla, Dictyophyllum exile, Thaumatopteris fujianensis, Goeppertella* sp., *Spiropteris* sp., *Cladophlebis shensiensis, C. heterophylla, Lepidopteris ottonis, Ptilozamites chinensis, P. nilssonii, Pterophyllum aequale, P. ptilum, P. bavieri, P. exhibens, P. sinense, P. ctenoides, P. pinnatifidum, Anomozamites loczyi, A. giganteus, Zamites truncatus, Sinoctenis calophylla, Nilssonia gigantea, Mironeura dakengensis, Anthrophyopsis crassinervis, Ctenozamites sarranii, C. ptilozamoides, Drepanozamites nilssonii, Baiera elegans, B. minuta, Glossophyllum ? shensiense, Stachyotaxus elegans, Cycadocarpidium erdmannii.*

o) South-western Sichuan, **Baoding Flora** (nor-rt, 49) (Xu R. et al., 1979): *Neocalamites hoerensis, N. carcinoides, N. carrerei, Equisetum arenaceum, Equisetum* cf. *sarranii, Asterotheca cottonii, A. latepinnata, Danaeopsis marantacea, D.*

fecunda, Symopteris densinervis, Angiopteris antiqua, A. yungjenensis, Marattia asiatica, M. muensteri, Todites shensiensis, Clathropteris meiscoides, Dictyophyllum exile, D. serratum, D. gracilis, D. nathorstii, Thaumatopteris expansa, T. fuchsii, T. nodosa, T. remauryi, T. viellardii, Thaumatopteris sp., *Goeppertella microloba, Pecopteris callipteroides, Cladophlebis caloriformis, C. gracilis, C. ichunensis, C. imbricata, C. raciborskii, C. scariosa, C. yungjenensis, Cladophlebis* sp. 1, *Cladophlebis* sp. 2, *Mixopteris intercalaris, Rireticopteris microphylla, Lureticopteris megaphylla, Thinnfeldia rhomboidalis, Pachypteris yungjenensis, Ctenozamites chinensis, Stenopteris bifurcata, Sagenopteris glossopteroides, S. stenofolia, Sagenopteris* sp., *Nilssonia stenophylla, Nilssonia* sp. 1, *Nilssonia* sp. 2, *Nilssonia* sp. 3, *Nilssonia* sp. 4, *Nilssonia* sp. 5, *Nilssonia* sp. 6, *Nilssonia* sp. 6, *Nilssonia* sp. 7, *Ctenis multinervis, C. nilssonii, C. yungjenensis, Ctenis* sp. 1, *Ctenis* sp. 2, *Pseudoctenis gigantea, Pseudoctenis* sp., *Androstrobus pagodiformis, Pterophyllum aequale, P. angustum, Pterophyllum* cf. *astartense, P. bavieri, P. contiguum, P. jaegeri, Pterophyllum* cf. *multilineatum, P. nathorstii, P. otofoliolatum, P. subaequale, P. tietzei, P. yunnanense, P. Pterophyllum* sp. 1, *Pterophyllum* sp. 2, *Pterophyllum* sp. 3, *Anomozamites alternans, Anomozamites* cf. *hartzii, A. inconstans, A. minor, A. pachylomus, A. ptilus, Anomozamites* sp. 1, *Otozamites hsiangchianensis, O. indosinensis, O. megaphylla, O. nalajingensis, O. pamiricus, O. recurvatus, Otozamites* sp. 1, *Otozamites* sp. 2, *Nilssoniopteris jourdyi, Sphenozamites yungjenensis, Glossophyllum shensiense, G. zeilleri, Podozamites distans, Cycadocarpidium erdmannii, Stachyotaxus saladinii, Taeniopteris* cf. *gigantea, T. immersa, T. lecklerei, T. magnifolia, T. richthofenii, Taeniopteris* sp. 1, *Taeniopteris* sp. 2, *Yungjenophyllum grandifolium, Tacingia pinniformis, Carpolithe* sp., *Lepidopteris stutgartiensis, Ctenozamites baodingensis, Scleropteris junncta.*

p) Hueili (nor-rt, 49) (HALLE, 1927): *Clathropteris meniscoides, Cladophlebis* cf. *nebbensis, Ctenopteris sarranii, Pterophyllum multilineatum, Taeniopteris leclerei, Podozamites lanceolatus, Samaropsis* sp.

r) Taipin-Tchang (nor-rt, 53) (ZEILLER, 1902–1903): *? Schizoneura carrerei, Dictyophyllum nathorstii, Clathropteris platyphylla, Cladophlebis (Todea) roessertii, Ctenopteris sarranii, Glossopteris indica, G. angustiloba, Ptilophyllum acutifolium, Pterophyllum (Acozamites) inconstans, P. multilineatum, Taeniopteris* cf. *immersa, T. leclerei.*

s) Kiang-Ti (nor-rt, 54) (ZEILLER, 1902–1903): *? Schizoneura carrerei, Clathropteris platyphylla, Cladophlebis (Todites) roessertii, Glossopteris indica (Sagenopteris ?).*

t) Kueiyang (nor-rt, 55) (SZE, 1933 b): *Lepidopteris ottonis,* cf. *Podozamites* sp., cf. *Pterophyllum* sp.

u) Anlung (nor-rt, 55) (WU S. C., 1966): *Equisetites* sp., *Neocalamites* sp. 1, *Neocalamites* sp. 2, *Rhinipteris* cf. *concinna, Asterotheca ?* sp., cf. *Pecopteris (Asterotheca) cottonii, Taeniopteris leclerei, Pterophyllum multilineatum, P. portalii, Otozamites ? anlungensis, Sinoctenis venulosa, Anomozamites ?* sp.

v) Hunnan (nor-rt, 61) (ZHOU Z. Y., 1981): *Ptilozamites chinensis.*

Nan-hsiang coal-field of Hunan (YABE & OISHI, 1929): *Pterophyllum jaegeri, P. angustifolium, P. (Anomozamites) inconstans.*

w) Kaomin (nor-rt, 62) (TSAO C. Y., 1965): *Equisetites kaomingensis, Neocalamites carrerei, Danaeopsis fecunda, Phlebopteris angustiloba, Dictyophyllum* cf. *nathorstii, Thaumatopteris brauniana, Clathropteris meniscoides, Gleichenites ?* sp., *Cladophlebis roessertiana, ? Protoblechnum hughesii, Thinnfeldia ?* sp., *Ptilozamites chinensis, P. nilssonii, Pterophyllum bavieri, P. subaequale, P. schenkii, ? Anomozamites major, Nilssonia* sp., *Ctenis chaoi, C. gracilis, Taeniopteris* sp., *Podozamites lanceolatus* f. *ovalis, P. schenkii, Carpolithes* sp. 1, *Carpolithes* sp. 2.

x) Kanton, Kwantung (nor-rt, 66) (LO C. P., 1956: from Refertivnyy zhurnal 10639): *Neocalamites carrerei, Cladophlebis* cf. *gigantea, Cladophlebis* sp., *Dictyophyllum nathorstii, Clathropteris meniscoidees, Thaumatopteris shenkii, Hausmannia* sp., *Goeppertella* sp. (sp. nov. ?), *Nilssonia* cf. *princeps, Pterophyllum aequale, P. inconstans, Pterophyllum* sp., *Anomozamites minor, Podozamites lanceolatus, P. schenkii, Hexaphyllum sinensis, ? Ginkgoites* sp.

69. Early Triassic plants of Japan

a) Kitakami Massif (ol-an, 63) (KON'NO, 1973): *Pleuromeia hatai, Neocalamites muratae.*

70. Middle – Late Triassic plants of Japan

a) Nariwa, Okayama province (nor-rt, 67) (YOKOYAMA, 1905; OISHI, 1930, 1931, 1932 c, 1940; OISHI & HUZIOKA, 1938; KON'NO, 1962 a; HUZIOKA, 1970): *Annulariopsis inopinata, Phyllotheca* sp., *Equisetites nariwensis, E. multidentatus, Neocalamites hoerensis, N. carrerei, Hausmannia nariwaense, H. dentata, H. crenata, Clathropteris meniscoides, C. meniscoidees* var. *elegans, C. obovata, Dictyophyllum muensteri, D. nilssonii, D. spectabile, Thaumatopteris brauniana, T. kochibei, T. nipponica, T. schenkii* (in HARRIS, 1937 = *T. brauniana*), *T. pusilla, Goeppertella varida, Marattiopsis muensteri, Todites princeps, T. williamsonii, T. roessertii* (in HARRIS, 1937 = *T. goeppertiana*), *Cladophlebis (Osmundopsis) subplectrophora, C. nariwaensis, C. tenue, C. pseudodelicatula, C. denticulata, C. raciborskii, C. gigantea, C. bitchuensis, C. haiburnensis, C. nebbensis, Sphenopteris gracilis, Cladophlebidium ? okayamensis;*

Ctenis takamiana, C. japonica, C. yabei, Otozamites indosinensis, O. huzisawae, O. lancifolius, Ptilozamites tenuis, P. nilssonii, Nilssonia brevis, N. muensteri, N. acuminata, N. orientalis, N. simplex, Pterophyllum serratum, P. angustum, P. jaegeri, P. distans, P. ctenoides, P. schenkii, P. aequale, Pterophyllum sp. cf. *Nilssonia tenuicaulis, Taeniopteris carruthersii, Taeniopteris* cf. *leclerei, T. lanceolata, Taeniopteris* cf. *stenophylla, T. nabbaensis, Sagenopteris nariwaensis, Baiera guilhaumatii, B. paucipartita, B. elegans, B. taeniata, B. filiformis, B. furcata, B. muensteriana, Ginkgoites sibirica, Czekanowskia rigida, Phoenicopsis* sp., *Stenorachis (Ixostrobus ?) konnianus, S. bitchuensis, S. elegans, Pityophyllum (Pityocladus) longifolium, Elatocladus plana, E. tenerrima, Campilophyllum hoermannii, Nageiopsis rhaetica,* cf. *Storgaardia spectabilis, Podozamites concinnus, P. schenkii, P. lanceolatus.*

b) Mine, Yamaguti province, **Momonoki Formation** (lad-karn, 77) (YABE, 1922; OISHI, 1932 b, 1940; OISHI & TAKAHASI, 1936; TAKAHASI, 1950, 1951;

Kon'no & Naito, 1960, 1978; Kon'no, 1961, 1962 a, 1962 b; Asama & Naito, 1978): *Annulariopsis inopinata, Equisetites takahasii, E. minensis, E. nagatoensis, E. (Equisetostachys) bracteosus, Equisetostachys (Neocalamites ?) pedunculatus* (in Kon'no, 1972 = *Neocalamostachys takahasii*), *Neocalamites carrerei, Neocalamites minensis, N. hoerensis, Trizygia ominensis, Dictyophyllum falcatum, Clathropteris meniscoides, Cladophlebis raciborskii, Todites recurvatus, T. goeppertianus, Sphenopteris gracilis, Adiantopteris ishidae*;

Plagiozamites minensis, cf. *Nilssonia polymorpha, Taeniopteris minensis, Ginkgo digitata* var. *huttonii, Baiera paucipartita, Podozamites agarhiaus* var. *acuminatus, P. schenkii, P. distans, P. distans* var. *nagatoensis, P. distans* var. *osawae, P. concinnus, P. minensis, P. atsuensis, P. oishii, P. nagatoensis, Cycadocarpidium swabii, C. ovatum, C. nagatoense, C. naitoi, Stenorachis elegans, Sorosaccus naitoi, Nagatostrobus stenomishoides, N. naitoi, N. linearis, N. minor, Minetaxites ushioi.*

(Kimura & Ohana, 1980; Kimura, Naito & Ohana, 1983): *Asterotheca okafujii, Todites fukutomii, T. yamanoiensis, Cladophlebis bitchuensis, Baiera* cf. *furcata.*

c) Asa, Yamaguti province, **Yamanoi Formation** (lad-karn, 77) (Yokoyama, 1891, 1905; Yabe, 1922; Oishi, 1932 b; Oishi & Takahasi, 1936; Takahasi, 1951): *Equisetites* sp., *Phyllotheca* sp., *Neocalamites carrerei, Clathropteris obovata, Dictyophyllum nathorstii, D. japonica* (in Kon'no, 1968 = *Camptopteris japonica*), *D. kochbei, Cladophlebis denticulata, C. nebbensis, C. haiburnensis, C. raciborskii, C. raciborskii* var. *integra;*

Pterophyllum longifolium, P. yamanoensis, Nilssonia innoyei, N. simplex, Ctenis ? sp., *Taeniopteris minensis, T. nabaensis, Sagenopteris nilssoniana, Baiera paucipartita, Czekanowskia ?* sp., *Leptostrobus laxiflorus, Podozamites nagatoensis, P. lanceolatus, Cycadocarpidium* sp., *Pityophyllum longifolium, Elatocladus* sp.

d) Asa, Yamaguti province, **Tsubuta Group** (lad-karn, 77) (Kon'no, 1961, 1962 a, 1962 b): *Equisetites asaensis, E. naitoi, E. takaianus, Dictyophyllum falcatum, Podozamites* cf. *astartensis, Cycadocarpidium ovatum, Cycadocarpidium* cf. *naitoi, C. asaense, Nagatostrobus* cf. *linearis.*

e) Maizuru coal-field, Kyoto province, Shitaka Group (nor-rt, 68) (Yabe, 1922; Oishi, 1932 a, 1940): *Neocalamites carrerei, Cladophlebis argutula, C. denticulata, C. haiburnensis, C. raciborskii* f. *integra, Otozamites klipstenii*, cf. *Zamites megaphyllus, Taeniopteris shitakensis, T. stenophylla, Czekanowskia* sp., *Podozamites griesbachii, P. lanceolatus.*

71. Early Triassic plants of Soviet Primorye

a) Southern Primorye (ol-an, 64–66) (Kryshtofovich, 1924; Krassilov & Zakharov, 1975 a, 1975 b; coll. GIN 4054/1-411): *Pleuromeia obrutchevii* (in Kryshtofovich, 1924 = *P. sternbergii*), *Lepidopteris* sp.

72. Middle – Late Triassic plants of Soviet Primorye

a) Southern Primorye (lad-karn, 78; nor-rt, 69–70) (Kryshtofovich, 1910, 1921, 1954*; Srebrodolskaya, 1960 c, 1961, 1968 a, 1968 b, 1968 c, 1968 d, 1980; Krassilov & Shorochova, 1970; Shorochova, 1975 a; Shorochova & Srebrodolskaja, 1979) (mark + means the occurence from the **Sad-Gorod Formation,** former the Lower Mongugay, mark + + – from the **Amba Formation,** former the Upper Mongugay): *Equisetites* sp. – K, *Neocalamites carrerei* – K, *Camptopteris spiralis* – K, *Dictyophyllum japonicum* – K, *D. nathorstii* + + – S, *D. mongugaicum* + + – S, *D. kryshtofovichii* + + – S, *Clathropteris meniscoides* – K, *C. mongugaica* + + – S, *Hausmannia ussuriensis* – K, *Todites* sp. – K, *Cladophlebis pseudoraciborskii* + + – S, *C. pseudodelicatula* + + – Sh & S, *Cladophlebis* cf. *haiburnensis* – K, *C. denticulata* – K, *C. whitbiensis* – K, *C. vaccensis* – K, *C. ussuriensis* + + – Sh & S, *C. macrophylla* + + – Sh & S, *Sphenopteris* sp. – K, *Acrostichtopteris ? rara* + + – Sh & S, *Imania heterophylla* + + – K & Sh, Sh & S, *Tudovakia papilosa* + + – K, *Thinnfeldia ambabiraensis* + + – Sh & S;

Pterophyllum mongugaicum + + – S, *P. ambabiraensis* + + – Sh, *P. innae* + + – Sh, *Nilssonia schmidtiana* – K, *N. orientalis* – K, *Parajacutiella mongugaica* + – S, *P. mongugaica* var. *rarinervis* + – S, *Taeniopteris spathulata* – K, *T. ensis* – K, *T. stenophylla* var. *mongugaica* + – S, *T. ambabiraennsis* + + – S, *T. minuscula* + – S, *T. lingulata* + – S, *Macrotaeniopteris* cf. *richthofenii* – K, *Noeggerathiopsis triassica* + + – S;

Feildenia minima + + – S, *Ginkgo digitata* – K, *G. sibirica* – K, *Sphenobaiera paucipartita* + + – S, *Czekanowskia rigida* – K, *C. setacea* – K, *Phoenicopsis angustifolia* – K, *P. speciosa* – K, *Yuccites angustifolius* – K, *Podozamites lanceolatus* – K, *P. kiparisovkensis* + + – Sh & S, *Podozamites* ex gr. *schenkii* – Sh & S, *Ferganiella mongugaica* + + – S, *Pityophyllum lindstroemii* – K, *Pinus nordenskioldii* – K, *Elatocladus subzamioides* – K, *Stachyotaxus ? gracilis* = = – S, *Drepanolepis squamulosa* + + – S, *Conites ambabirensis* + + – S, *Carpolithes mongugaicus* + – S.

73. Late Triassic plants of Korea

a) Daedong, Gimpo, Chungnam, Yeoncheon, Danyang, Mungyeong coalfields and scattered areas in the north-east (nor-rt, 71–74) (Kawasaki, 1925, 1926, 1939; Kimura & Kim, 1982, 1984; Kimura, Kim & Ochana, 1982): *Annulariopsis bunkeiensis, Lobatannularia nampoensis, Neocalamites carrerei, N. koraiensis, Neocalamites* sp. A, *Equisetites* cf. *ferganensis, E. koreanicus, Marattia asiatica, Coniopteris* cf. *neiridanensis, Plebopteris* ex gr. *polypodioides, Clathropteris obovata, Dictyophyllum exile, Hausmannia ussuriensis,* cf. *Asterotheca okafujii,* cf. *Todites denticulatus,* cf. *T. princeps,* cf. *T. yamanoensis,* cf. *Eboracia lobifolia, Cladophlebis* cf. *aktashensis,* C. mungyeongensis, C. nampoensis, Cladophlebis cf. *pseudodelicatula, C. raciborskii;*

Ctenozamites sp. A, *Chiropteris coreanica, Anomozamites mungyeonensis, Coreanophyllum varisegmentum, Otozamites micraurilus, Pterophyllum cheondae-*

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* See Kiparisova, 1954.

riense, Pterophyllum cf. *dcurrrens, P. microaequale, Pterophyllum* cf. *ptilum, P. tietzei, Pterophyllum* sp. A, *Pterophyllum* sp. B, *Weltricia* sp., *Ctenis yamanarii, Anthrophyopsis decurrens, Nilssonia* cf. *muensteri, Nilssonia* sp. A, *Nilssonia* sp. B, *Pseudoctenis ?* sp., *Drepanozamites* sp.;

Baiera cf. *furcata, Sphenobaiera* cf. *spectabilis, Erethmophyllum* ? sp., *Czekanowskia* sp. A, *Czekanowskia* sp. B, *Phoenicopsis* ex gr. *angustifolia, Stenorachis ?* sp., *Desmiophyllum* sp. A, *Desmiophyllum* sp. B, *Desmiophyllum* sp. C, *Elatocladus* cf. *manchurica, Equisetites* spp., *Pityophyllum ?* spp., *Podozamites* ex gr. *distans, Podozamitees* ex gr. *schenkii, Podozamites* sp. A, *Cycadocarpidium* cf. *asaense, Cycadocarpidium* cf. *nagatoense, Cycadocarpidium* sp. A, *Cycadocarpidium ?* sp. B, *Swedenborgia* spp., *Xenoxylon phyllocladoides, X. latiporosum, Phyllocladoxylon lilizoense, Taeniopteris cheundaensis, Taeniopteris* cf. *lanceolata, T. mungyeonensis, T. richthofenii, Taeniopteris* cf. *stenophylla, Taeniopteris* sp. A.

74. Late Triassic plants of Viet Nam

a) Northern Viet Nam, Hongay coal-field (nor-rt, 75) (ZEILLER, 1902–1903; PELOURDE, 1913; COLLANI, 1915; AKAGI, 1954; SREBRODOLSKAJA, 1969; NHAT MAI, 1985 a; DOBRUSKINA, 1987): *Annulariopsis inopinata* – Z, *Schizoneura carrerei* – Z, *Equisetum sarranii* – Z, *Clathropteris platyphylla* – Z, *Dictophyllum fuchsii, Dictyophyllum remaurii* – Z, *D. sarranii* – Z, *D. nathorstii* – Z, A, *D. golionii* – P, *D. viellardii* – P, *Woodwardites microlobus* – Z, A, *Palaeovittaria kurtzii* – Z, *Maokheopteris vietnamica* – S, *Thaiguenopteris paevipinnulata* – S, *Longcamia zeilleri* – S, *Protoblechnum hongaicum* – S, Bongamia vietnamica – N; *Cladophlebis* cf. *lobifolia* – Z, *C. (Todea) roessertii* – Z (in HARRIS, 1937 = *Todites goeppertianus*), C. nebbensis – Z, *C. raciborskii* – Z, *C. denticulata* – A, *Pecopteris (Asterotheca) cottonii* – Z, *P. adumbrata* – Z, *P. tonquinensis* – Z, *P. (Bernoullia)* sp. – Z, *Sphenopteris* cf. *princeps* – Z, *Ctenopteris sarranii* – Z, A, *Danaeopsis* cf. *hughesii* – Z, *Lepidopteris ottonis* – D;

Pterophyllum (Anomozamites) inconstans – Z, *P. (Anomozamites) schenkii* – Z, *P. muensteri* – Z, *P. portalii* – Z, A, *P. tietzei* – Z, *P. contiguum* – Z, *P. aequale* – Z, A, *P. bavieri* – Z, A, *P. halinense* – C, *Ptilophyllum acutifolium* – Z, *Otozamites indosinensis* – Z, *O. rarinervis* – Z, *Zamites truncatus* – Z, *Cycadites saladinii* – Z, *Cycadolepis corrugata* – Z, *C. granulata* – Z, *Cycadolepis* cf. *villosa* – Z, *Taeniopteris ensis* – Z, *T. macclelandii* – Z, *T. (Marattia) muensteri* – Z, *T. jourdyi* – Z, *T. virgulata* – Z, *Z. spathulata* – Z, *T. nilssoniana* – Z, *Macrotaeniopteris hongaica* – C, *Glossopteris indica* – Z, *Baiera guilhaumatii* – Z, *Noeggerathiopsis hislopii* – Z;

Yuccites vietnamicus – S, *Podozamites distans* – Z, A, P. schenkii – Z, *Trioolepis leclerei* – Z, *Conites charpentieri* – Z, *Araucarioxylon zeilleri* – Z, A, *Araucarioxylon* sp., *Carpolithes* sp. A–A.

b) Central Viet Nam, Quang Nam, Annam (nor-rt,76) (ZEILLER, 1902–1903; COUNILLON, 1914): *Equisetum sarranii* – Z, *Schizoneura carrerei* – Z, *Clathropteris platyphylla* – Z, *Cladophlebis (Todea) roessertii* – Z, *C. raciborskii* – Z, C, *C. lobifolia* – C, *C. nebbensis* – Z, C, *Pecopteris (Asterotheca) cottonii* Z, *P. adumbrata* – Z, *Sphenozamites marionii* – C, *Pterophyllum tietzei* – Z, C, *P. carterianum* C, *Baiera guilhaumatii* – Z, C, *Podozamites distans* – C, *P. schenkii* – Z, C, *P. rarinervis* – C, *Cycadocarpidium erdmannii* – C, *Palissya braunii* – C, cf. *Brachyphyllum* sp. – C.

75. Plants of Thailand and Cambodia

a) Khorat, Thailand (nor-rt, 77) (Kon'no & Asama, 1973): *Equisetites arenaceus, E. naitoi, Neocalamites* cf. *hoerensis, Clathropteris meniscoides, Todites goeppertianus, Sphenopteris (Ruffordia) goeppertii, Nilssonia thailandica, Anomozamites minor, Brachyphyllum* sp., *Elatocladus* sp. *Frenelopsis ?* sp.

b) Phum Laak, Cambodia (lad-karn,78) (Kimura, 1985 after Vosenin-Serra & Laroche and Corsin & Dasreumaux): list without descriptions.

76. Plants of Sarawak

a) Crusin (lad-karn, 79) (Kon'no, 1972): *Annulariopsis hashimotoi, Neocalamites carrerei, Neocalamostachys takahashii, Equisetum* sp. A, *Equisetum* sp. B, *Clathropteris meniscoides, Dictiophyllum* cf. *nilssonii* var. *genuinum, Cladophlebis haiburnensis, Cladophlebis* cf. *haiburnensis, C. ishiiana, Todites katoi, T. sarawakensis, T. tamurae, Sphenopteris (Todites ?)* sp., *Dictyozamites krusinensis, Otozamites* sp.

XII. Indostan

77. Early Triassic plants from Nidpur beds

a) Environs of Nidpur village (Bose, Srivastava, 1969/1970, 1970/1971, 1970/1972, 1973a, 1973b; Srivastava, 1969, 1973/1975, 1974/1976, 1974/1977; Srivastava, Maheshwari, 1973; Pant, Basu, 1973, 1977): *Glossopteris senii, G. papillosa, G. nidpurensis, G.* cf. *linearis, Rhabdotaenia* sp., *Noeggerathiopsis* sp., *Lepidopteris indica, Dicroidium nidpurensis, D. papillosum, D. gopadensis, Taeniopteris glandulata, Glottolepis rugosa, G. glabrosa, G. tuberculata, G. sidhiensis, G. ovata, Conites* sp., *Nidistrobus harrisianus, Nidia ovalis, Satsangia campanulata, Pteruchus indicus, Bosea indica, Gopadia coriacea, G. papillata, Charkea papillosa, Rugaspermum insigne, R. media, R. obscura, Rugatheca nidpurensis, Rugapites spherica, Equitatilepis elongatus.*

78. Early Triassic plants older Nidpur beds

a) Environs of Nidpur village, outcrop 3 (ol-an, 68) (Banerji, Maheshwari & Bose, 1974/1976): *Glossopteris gopadensis, Glossopteris* cf. *senii, G. taeniopteroides, Dicroidium* sp., *Taeniopteris* cf. *glandulata,* seeds.

79. Early Triassic plants older than outcrop 3 (list 78 a)

a) Environs of Nidpur village, outcrop 2 (ol-an, 68) (Banerji, Maheshwari & Bose, 1974/1976): *? Sphenopteris* sp., *Glossopteris browniana, G. communis, Glossopteris* cf. *damudica, Scutum* sp., *Dicroidium* sp. A, scales, seeds.

80. Plants from Parsora Formation

a) Chicharia, South Rewa (ol-an, 67) (Seward, 1932; Lele, 1961/1962, 1962/1963; Rao & Lele, 1962/1963): *Thinnfeldia sahni* – S, *Dicroidium sahni* – R & L, *D. odontopteroides* – L, *Dicroidium* cf. *feistmantelii* – L, *Cordaicarpus chichariensis* – L, *Cordaicarpus* sp. – L.

b) Bhaursen, South Rewa (ol-an, 67) (Lele, 1961/1962): *Dicroidium* sp. cf. *D. festmantelii.*

c) Barnauda, South Rewa (ol-an, 67) (Lele, 1961/1962): *Dicroidium hughesii.*

d) Beli, South Rewa (ol-an, 67) (Lele, 1961/1962, 1962/1963): *Lycopodites sahnii, Sphenopteris* sp. C, *Cladophlebis* cf. *denticulata* (in Bose, 1974 it is not

Cladophlebis denticulata), *Danaeopsis gracilis, Glossopteris* sp., *Taeniopteris* cf. *feddenii, Baiera indica* (in BOSE, 1974 it is not *Baiera*), leaves of ginkgophytes, *Araucarites indica* (in BOSE, 1974 it is not conifer, but lycopsid; in RETALLACK, 1975 = *Pleuromeia*), *Araucarites* sp. (in BOSE, 1974 and RETALLACK, 1975 = lycopsid), *Desmiophyllum indicum* (in BOSE, 1974 it is not conifer, but ginkgophyte or *Noeggerathiopsis*), *D. taeniatum, Samaropsis* sp. cf. *S. srivastavai.*

e) Parsora, South Rewa (ol-an, 67) (FEISTMANTEL, 1882; SEWARD & SAHNI, 1920; LELE, 1953, 1955/1956, 1961/1962, 1962/1963, 1969): *Neocalamites foxii* – L (in BOSE, 1974 it is an undeterminable stem of sphenopsid), *Asplenium whitbiense* – F, *Danaeopsis hughesii* – F, S & L, *Thinnfeldia (Danaeopsis) hughesii* – L, 1955/1956 (in LELE, 1961/1962 = *Dicroidium hughesii*), *Thinnfeldia odontopteroides* – F, *Dicroidium odontopteroides* – L, *Parsorophyllum indicum* – L, *Pterophyllum ? sahni* – L, *Taeniopteris ? spathulata* – L (in BOSE, 1974 = *Pterophyllum sahni*), *Glossopteris ? browniana* – L, *Noeggerathiopsis hislopi* – F, L, *Araucarites parsorensis* – L (in BOSE, 1974 = *Samaropsis* sp.), *Samaropsis* sp. cf. *S. srivastavai.*

f) Kamtadand, South Rewa (ol-an, 67) (LELE, 1961/1962; SAKSENA, 1961/1962): stem of Equisetaceae – S, *Sphenopteris* sp. – L, *Cladophlebis* sp., (? cf. *C. shensiensis*) – L, *Marattiopsis* sp. – L, *Dicroidium highesii* – S, *Glossopteris ? indica* – S.

g) Daigaon, South Rewa (ol-an, 67) (FEISTMANTEL, 1882; LELE, 1961/1962): *Vertebraria indica* – F, diaphragm of Equisetaceae, *Sphenopteris* sp. A–L, *Cladophlebis* cf. *denticulata* – L, *Glossopteris communis* – F, *G. indica* – F, *Dicroidium* sp. – L, *Pterophyllum ? sahni* – L, *Noeggerathiopsis hislopii* – L.

h) Goira, Madhya Pradesh (MAHESHWARI & BANERJI, 1976/1978): *Ginkgoites goiraensis.*

81. Plants from Panchet Formation

a) Maitur-Asansol, Raniganj (ind ?, 34) (FEISTMANTEL, 1880–1881; SATSANGI & SHAH, 1970; SATSANGI, 1973; BANERJI & BOSE, 1975/1977): *Schizoneura gondwanensis* – F, B, S, *Pecopteris concinna* – F, B, *Cyclopteris pachyrhachis* – F, B, *? Dicroidium/Lepidopteris* – B (*Dicroidium* from SATSANGI, 1973 is included in synonimics list), cuticle of *? Lepidopteris* type – B, *Taeniopteris (Oleandridium) stenoneuron* – F, *Taeniopteris* cf. *stenoneuron* – B, *Macrotaeniopteris ?* sp. – B, *Glossopteris indica* – F, *G. communis* – F, B, *G. browniana* – B, *G. angustifolia* – B, *G. conspiqua* – B, *G. retifera* – B, *Glossopteris* cf. *intermedia* – B, *Podozamites* cf. *lanceolatus* – B (*Podozamites* sp. from SATSANGII, 1973 is included in synonimics list), *Samaropsis ? parvula* – F, *Cordaicarpus* sp. – B, cf. *Kendostrobus* sp. (*Schizoneura gondwanensis* from SATSANGI & SHAH, 1970 is included in synonimics list).

b) Coal-mine Auranga (ind ? 35) (FEISTMANTEL, 1880–1881, 1886): *Vertebraria indica, Schizoneura gondwanensis, Pecopteris* sp., *Cyclopteris* sp., *Glossopteris communis, G. indica, G. damidica, Gangamopteris* sp., *Samaropsis parvula.*

c) Deobar, valley of the Auranga River (ind ? 35) (BOSE & BANERJI, 1974/1976): *Trizygia speciosa, Schizoneura gondwanensis, Glossopteris indica, G. angu-*

stifolia, G. communis, Dicroidium sp., stem with ribs and furrows, *Vertebraria indica, ? Noeggerathiopsis* sp.

d) Tubed, valley of the Auranga River (ind ? 35) (BOSE & BANERJI, 1974/1976): *Lepidopteris ?* sp.

e) Ramkola and Tatapani (ind ? 35) (FEISTMANTEL, 1880–1881): *Glossopteris communis, G. indica, Thinnfeldia* cf. *odontopteroides.*

82. Plants of Maleri Formation

a) Naogaon, Basin of the Godawari River (lad-karn, 80) (SAHNI, 1931): *Elatocladus jabalpurensis, Athrotaxites feistmantelii, Araucarites cutchensis.*

b) Bogapalmila, Godawari River Basin (lad-karn, 80) (SAHNI, 1931): *Mesembrioxylon godaverianum.*

c) Tiki, South Rewa (lad-karn, 80) (SAHNI, 1931; GOSWAMI, 1973): *Mesembrioxylon malerianum* – S, *Dadoxylon (Araucarioxylon)* sp. – S, *Tikioxylon hughesii* – G, *T. spirallii* – G.

83. Plants from Kamthi beds

a) Nagpur, Pranhita-Godawari rivers Basin (the Permian ?) (FEISTMANTEL, 1880–1881): *Phyllotheca indica, Vertebraria indica, Pecopteris* sp., *Cladophlebis* sp., *Glossopteris communis, G. indica, G. browniana, G. damudica, G. stricta, G. musaefolia, G leptoneura, Gangamopteris highesii, Angiopteridium* cf. *macclellandii, Macrotaeniopteris danaeoides, M. feddenii, Noeggerathiopsis hislopii.*

b) Chanda, Pranhita-Godawari rivers Basin (the Permian ?) (FEISTMANTEL, 1880–1881): *Vertebraria indica, Alethopteris* sp., *Glossopteris communis, G. angustifolia, G. browniana, Sagenopteris* sp., *Anthrophyopsis* sp., *Rhipidopsis* sp., *Pterophyllum* sp.

84. Plants from Almod beds

a) Rorighat, Satpura River Basin (the Permian ?) (FEISTMANTEL, 1880–1881): *Schizoneura gondwanensis, Vertebraria indica, Glossopteris angustifolia.*

85. Plants from Middle Triassic deposits of Salt Range

a) Left bank of Indus River, east of Sarai village (ol-an, 69) (SITHOLEY, 1943): *Equisetites* sp., *Sphenopteris* sp., *Cladophlebis* sp., *Indotheca sakesarensis.*

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