OKLAHOMA GEOLOGICAL SURVEY

Carl C. Branson, *Director*

CIRCULAR 56

POLLEN AND SPORES FROM THE PERMIAN DEPOSITS OF THE CHERDYN' AND AKTYUBINSK AREAS, CIS-URALS

by

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Originally published in: *Paleobotanicheskii sbornik: Vsesoiuznyi nauchno-issledovatel'skii geologo-razvedochnyi institut, Leningrad, Trudy, new series, no. 75, p. 5-57, 1953.*

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March 1961

FOREWORD

Geologic literature in the Russian language is being printed in such volume that it will require the cooperation of all agencies able to provide translations to make significant Russian works available in English, French, or German. Several agencies are printing translations of certain journals and of some books. The Oklahoma Geological Survey needed the information in Samoilovich's paper for an investigation of Oklahoma Permian fossils and had it translated by Dr. Elias. The translation is printed in order that this useful paper will be available to all workers in the field and to libraries.

Carl C. Branson

PREFACE

This literal translation of S. R. Samoilovich's paper on the pollen and spores from the Permian deposits of the Cherdyn' and Aktyubinsk areas of the Cis-Urals of Russia was done by M. K. Elias as part of the palynological program of the Oklahoma Geological Survey.

The translation was edited by Alex. Nicholson and certain technical aspects were checked by L. R. Wilson. No attempt was made to alter several nomenclatural inconsistencies that occur in the original as they will be obvious to the reader. Several misspelled names in the text have been corrected without note. Where insertions have been found desirable or where paraphrasing has been substituted for literal translation, these have been inserted in brackets.

The boldface bracketed numbers (e.g. [**p. 10**]) which stand alone as center heads refer to the page of the original text on which the succeeding matter is found. Paragraphs and sentences correspond to the original. Where a sentence carries over to the next page in the original text it is broken as nearly as possible at the same place in the translation; however, because of differences in English and Russian sentence structure, it was not always possible to break a sentence exactly at the same point.

Author's footnotes are indicated by superior numbers ([1]). Editorial and other footnotes not found in the original are indicated by asterisks (*). Table 4, which appears on pages 22 and 23 of the original, has been rearranged for typographical convenience and for easier reading; the data are identical with those of the original. Numerous literature citations in the text were omitted from the original list of references and time has not permitted search for some of the difficult-to-find titles. A table of contents and an alphabetical list of figured specimens have been prepared by Alex. Nicholson.

L. R. Wilson
Professor of Geology
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POLLEN AND SPORES FROM THE PERMIAN DEPOSITS OF THE CHERDYN' AND AKTYUBINSK AREAS, CIS-URALS

S. R. SAMOILOVICH—1953

[Translated by M. K. ELIAS,* 1959]

INTRODUCTION

[Information derived from] the study of spores and pollen from the Permian deposits of the Soviet Union is now fairly abundant, but most of it has not yet been published. The published works belong largely to the pre-war period (S. N. Naumova, 1937; A. A. Luber, 1937, 1938, 1939; A. A. Luber and I. E. Val'ts (Waltz), 1938, 1941). Comparatively recent is only a brief note by S. N. Naumova and N. A. Bolkhovitina on the pollen from the Permian of the Pechora basin (1947).

The data accumulated to date testify well to the great stratigraphic significance of pollen and spores in the Permian deposits. Thus the investigations by A. A. Luber, S. N. Naumova, I. E. Val'ts, E. N. Kara-Murza, and others, conducted in various areas of the Soviet Union, support Professor A. N. Krishtofovich's thesis on the existence in the Upper Paleozoic of various paleofloristic regions, for instance: Euramerian or Westphalian, which includes, roughly, the territory of the SSSR on the west side of the Urals; Tunguskian, to which belongs the Asiatic part of the Union; and the region of the Pechora basin.

Numerous works by A. A. Luber on pollen and spores from the coal-bearing and coal-barren Permian deposits helped solve several stratigraphic problems, and in particular enabled a determination of the boundary between the Mesozoic and Paleozoic deposits of Karaganda with greater precision (1936) and differentiation of the Carboniferous and Permian in the Kuznetsk and Minusinsk basins (1937). In the Solikamsk area of the Molotov

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[now Perm] region, on the evidence of spore-pollen analysis, A. A. Luber succeeded in verifying, and, in part of the section, adding greater precision to a detailed stratigraphic division which had been previously established for the clayey-marly post-salt deposits on the basis of other geologic data (1940).

[This list of examples], far from being exhaustive, shows sufficiently well the need for study of pollen and spores of the Permian deposits and the effectiveness of the achieved results.

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The present work was initiated with a view to describing the characteristics of spores and pollen which occur in the Permian terrestrial deposits of the Cis-Urals, so that they can be used for stratigraphic subdivisions and correlations of the sediments. The materials investigated include personal samples from the cores of some bore holes in the vicinity of Cherdyn' City, as well as samples from the collections of V. P. Pneva from the Aktyubinsk area, and of E. M. Lyutkevich from the region of Solikamsk City and Udmurtsk, ASSR.

Unfortunately, important material from the Golyushurma coal deposits (coal-bearing and barren interlayers in the limestones faunistically determined to be Kazanian age) forwarded by E. M. Lyutkevich and other samples from Kazanian deposits of the Solikamsk area do not contain pollen or spores.

I have received some data from the Kungurian and Artinskian deposits on the material from the Aktyubinsk area. But it became possible to study most completely the section of the salt-bearing deposits of the Kungurian and the post-salt clayey-marly Solikamsk suite of the Kazanian stage in the Cherdyn' area of the Molotov [Perm] region, where a rich complex of pollen and spores has been discovered. This material became fundamental for the present work.

Altogether 148 slides have been investigated. Only a very few of these are from the Artinskian and Tatarian stages; the reason for this is that this material was used only for the purpose of comparative study in the investigation of the other stratigraphic horizons of the Permian deposits. As to the study of the Tatarian deposits, it had already been established that the red upper Permian deposits have an extremely poor pollen and spore content, as shown by the data of A. A. Luber, from the Belaya River basin and from

the Solikamsk area of the Molotov [Perm] region (1940), and by my own data from the Northern Kel'tma River basin (1948). Therefore the investigation of the rocks of this age has been conducted only as supplementary [to the main task]. An attempt at extraction of pollen and spores from the darker colored clayey interlayers of the multicolored rocks of the Tatarian stage in the Solikamsk region and the Uftyuga River area was unsuccessful. With the exception of solitary pollen grains, found in the core of one bore hole near Solikamsk City, the Tatarian deposits investigated by me proved to be barren.

In spite of the fact that a substantial percentage of the total number of samples analyzed did not contain pollen or spores, the discovered spore-pollen complexes, particularly rich in the Kungurian stage and in the Solikamsk suite from the vicinity of Cherdyn' City, have shown some characteristics which distinguish between the deposits of different ages.

The results of the study of the spores and pollen from different types of Permian deposits verified the known dependence between the lithologic

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character and color of rocks on one side, and the occurrence in them of spores on the other side (tables 1, 2).

As can be seen from the tables, the greatest saturation of pollen and spores is found in fine-grained rocks (clays, argillites, marls). A small number is encountered in sandy clays and sandstones. Pollen and spores have not been encountered at all in the limestones and dolomites, nor in the evaporites and carbonaceous rocks of the regions explored.

TABLE 1
RELATIONSHIP BETWEEN OCCURRENCE OF SPORES AND POLLEN, AND COLOR OF ROCK.

Color of rock	Number of studied samples	Number of samples with pollen and spores	Percent of samples containing pollen and spores
Dark-gray, black	65	28	43.1
Gray, greenish	62	24	30.0 [*sic*]
Red and multicolored	15	1	6.6

TABLE 2
RELATIONSHIP BETWEEN OCCURRENCE OF SPORES AND POLLEN, AND LITHOLOGY OF ROCKS.

Lithology of rocks	Number of studied samples	Number of samples with pollen and spores	Percent of samples containing pollen and spores
Clays, argillites	96	43	44.8
Clays, sandy	7	1	14.3
Sandstones	7	1	14.3
Marls	22	8	36.4
Limestones, dolomites	8	....	....
Carbonaceous rocks	5	....	....
Evaporites (anhydrites, anhydrites with clay interlayers)	5	....	....

As to the color of the rocks, there is a direct relationship between their saturation with pollen and spores and the darkness of deposits. Substantial, but lesser amounts of pollen and spores occur in greenish and gray rocks.

In the red Permian beds they are practically absent.

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SPORE-POLLEN COMPLEXES

ARTINSKIAN STAGE. As mentioned above, the material from the Artinskian deposits has been used for comparison and has been investigated in only a few samples. Therefore, one should regard the character of the Artinskian spore-pollen complex (given below) with some caution, as it needs further additions and verification. Nevertheless, the presently described characteristics of the pollen and spore content, which distinguish the deposits of this age from the deposits stratigraphically higher, should be noted.

In the Artinskian clays of the Cherdyn' area, the age of which has been determined by fauna, and which underlie the salt-bearing deposits of the Kungur, the pollen and spores of the following plants have been determined:

Cordaitina convallata (Lub.)	isolated	Pollen of Cordaitales
Ginkgocycadophytus erosus (Lub.)	8.0-18.8%	Pollen of
G. caperatus (Lub.)	3.0- 4.0%	Ginkgoales
G. caperatus var. *spinosus* var. n.	isolated	and
G. glaber (Lub.)	0.0- 2.5%	cycadophytes

Protopodocarpus alatus (Lub.)	isolated	Pollen
Protohaploxypinus prolixus (Lub.)	2.5- 8.0%	of
Coniferites nudus (Lub.)	1.2- 4.0%	conifers
Azonaletes irregulariplicatus sp. n.	2.4- 4.0%	
A. subreticulatus sp. n.	0.0-12.6%	Pollen of
A. pastillus sp. n.	8.8-32.0%	systematically
A. (Rigidella) bulbiferus Lub.	16.3-20.0%	undetermined
A. (Tenuella) levis Lub.	4.1- 4.9%	plants
Azonotriletes cf. *resistens* Lub.	isolated	
A. microspinosus (Ibr.) Lub.	isolated	Spores
A. punctatus Waltz	isolated	of
Azonomonoletes marattiiformis sp. n.	isolated	pteridophytes
Zonotriletes cf. *subdolus* Lub.	isolated	

In the Aktyubinsk area were encountered:

Cordaitina subrotata (Lub.)	0.0- 5.0%	Pollen
C. ragulifer [*sic*]* (Lub.)	0.0- 5.0%	of
C. limbata (Lub.)	0.0- 2.5%	Cordaitales
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Ginkgocycadophytus erosus (Lub.)	0.0-12.5%	Pollen
G. caperatus (Lub.)	0.0- 7.5%	of
G. caperatus var. *spinosus* var. n.	isolated	Ginkgoales
G. retroflexus (Lub.)	0.0- 3.3%	and
G. tunguskensis Lub.	0.0- 1.7%	cycadophytes
Protopodocarpus auritus (Lub.)	0.0- 5.8%	
Protohaploxypinus perfectus (Naum.)	0.0- 5.8%	Pollen
P. prolixus (Lub.)	isolated	of
P. tecturatus (Lub.)	isolated	conifers
Coniferites nudus (Lub.)	0.0-10.1%	
Azonaletes indefinitus sp. n.	isolated	
A. microdictyus (Lub.)	0.0- 1.7%	
A. irregulariplicatus sp. n.	0.0- 1.7%	Pollen
A. subreticulatus sp. n.	0.0- 4.2%	of
A. pustillus sp. n.	0.0- 7.5%	systematically
A. (Rigidella) bulbiferus Lub.	0.0-14.9%	undetermined
A. (Subreticosina) compactus Lub.	0.0- 5.0%	plants
Spores absent		

As can be observed in the two lists, many forms are common to both, such as: *Ginkgocycadophytus erosus* (Lub.), *G. caperatus* (Lub.), *G. caperatus* var. *spinosus* var. n., *Protohaploxypinus pro-*

* Spelled **rugulifer** in explanation of Plate II.

lixus (Lub.), *Coniferites nudus* (Lub.), *Azonaletes irregulariplicatus* sp. n., *A. subreticulatus* sp. n.

It is particularly important that in the Artinskian deposits of both regions are recorded pollen of *Azonaletes (Rigidella) bulbiferus* Lub. (maxima 14.9 and 20.0%) and *A. pastillus* sp. n. (maxima of 7.5 and 32.0%), which have not been encountered in the stratigraphically higher Permian.

Azonaletes (Rigidella) bulbiferus and *A. (Subreticosina) compactus* (the latter found by me only in the Aktyubinsk area) were described by A. A. Luber (1940) as species restricted to the Artinskian deposits of the Gur'yev area of the Kemerovo region in the area of Inder River, and in some regions of the western Cis-Urals.

Typical for the overlying Kungurian and Kazanian deposits is the pollen of Welwitschiaceae (genus *Vittatina* Lub.) which is absent in the Artinskian. Thus the Artinskian spore-pollen complex has some characteristics of its own.

Of interest is the presence of *Azonomonoletes marattiiformis* sp. n., with circular or oval outlines, single-ray and broad exine spores, similar in their morphologic characteristics

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to the spores of *Danaea dubia* Presl. of the family Marattiaceae described by M. A. Sedova (1950, pl. 17, figs. 5, 6).

Representatives of this family have a very ancient origin, and although none of the living genera has been found assuredly as fossils, nevertheless in the Paleozoic (Carboniferous and Permian) and in the Mesozoic deposits some remains have been found that are very similar to the plants *Danaea, Marattia,* and *Angiopteris.* As A. N. Krishtofovich writes, among the ferns of the European Permian flora, the "most prominent role has been played by the group of Pecopterideae, which by its sporangia shows its relationship to the Marattiaceae" (1945, p. 362).

[The Bardinsk stage of the Lower Permian of the Urals, which M. D. Zalessky differentiated as the lagoonal, near-shore facies of the Kungurian, contains *Pecopteris anthriscifolia* (Göppert). Zalessky pointed out its stratigraphic importance and expressed the opinion that the species had already appeared in the Artinskian stage (M. D. Zalessky, 1937).]

The presence in the Artinskian of the Cherdyn' area of spores

resembling the spores of the living Marattiaceae is an interesting fact which verifies the data based on vegetative imprints. It must be noted, however, that I have found the spores of *Azonomonoletes marattiiformis* only in limited quantity.

The following is a discussion of spore-pollen contents of the Artinskian deposits in their relationship to the systematic groups to which the spores and pollen belong. Because of the general resemblance of the two complexes of the Cherdyn' and Aktyubinsk areas, they are described together, with accompanying notes about characteristics which distinguish one spore-pollen assemblage from the other.

The Artinskian spore-pollen complex includes the spores of Pteridophyta, pollen of *Cordaites,* pollen of Cycadophyta and Ginkgoales[1], pollen of Coniferales, and pollen of undetermined systematic affinity.

It must be specially noted that, when dealing with pollen and spores from the Paleozoic and younger deposits, there are encountered side by side not only remains of plants having analogs in the living flora, but also pollen grains and spores of some extinct plants. In determining to what systematic plant groups they belong, one is greatly handicapped, because the only way to do so is to study the contents of the fossil

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sporangia and pollen sacs, which are rarely encountered. Thanks to some investigations conducted here and abroad, especially during the last two decades, pollen and spores of quite a few of the extinct plants have become known. Nevertheless, many remain unaffiliated, so that we must be content with the presence in our lists of a group of pollen of unknown affinity. It is natural to expect that, with a further advance of our knowledge, this group is apt to be gradually reduced.

In the Artinskian spore-pollen complex the group of unknown affinity is dominant, comprising 35.0% in that from the Aktyubinsk, and 65.0% in that from the Cherdyn' areas. A characteristic of the Artinskian complex is the presence of a large proportion of the pollen of Ginkgoales and cycadophytes (12.0-26.5%), with *Ginkgocycadophytus erosus* (Lub.) being particularly prolific. Con-

[1] Because of the close morphologic similarity of the pollen of Ginkgoales and Cycadophyta (which include Bennettitales and Cycadales), these, for the sake of elimination of possible errors, are all united in a common group.

ifer pollen are scarce in the Cherdyn' area (4.0-12.0%), but are much more common in the Aktyubinsk area (to 26.7%). Predominant among them are the forms with non-ribbed sculpture of the exine (*Protohaploxypinus prolixus* [Lub.] and some others). There are few pollen grains of Cordaitales: to 5.0% in Cherdyn' and to 12.0% in Aktyubinsk areas. *Welwitchia*-type pollen with ribbed sculpture of the exine (genus *Vittatina* Lub.), characteristic of the higher stratigraphic horizons, are absent. "Ribbed" pollen are found in small amounts only among the conifers. Spores are either absent or are found singly.

KUNGURIAN STAGE. The spore-pollen complex of the Kungurian stage has been studied on the most voluminous material (78 samples). Comparatively few spore-saturated horizons were encountered in the Aktyubinsk area. Much more complete data were obtained in the Cherdyn' area, where a 360-meter-thick salt-bearing Kungurian section has been investigated. Predominantly, the darkly stained clayey layers and interlayers were analyzed, whereas only control tests were made of the enclosing main thickness of anhydrite and gypsum, which showed absence of pollen and spores.

The diversified state of preservation of fossil forms must be pointed out. In the deposits of the Aktyubinsk and Solikamsk areas, the preservation of pollen is excellent, as it allows observation of the sculptural details of the exine, but in the sediments of the Cherdyn' area the pollen grains are much deformed, crushed, and not infrequently covered by a disorderly network, apparently of secondary nature.

In spite of poor preservation of the Kungurian pollen, its extraordinary diversification can nevertheless be observed.

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Among the more widely distributed species of the Cherdyn' region are the following:

**Cordaitina uralensis* (Lub.)[1]	6.0-24.0%	Pollen of Cordaitales
C. subrotata (Lub.)	1.2-10.0%	
C. rotata (Lub.)	2.4- 8.0%	
Ginkgocycadophytes erosus (Lub.)	0.4- 4.0% (in lower part of section)	Pollen of Ginkgoales and Cycadophyta
G. tunguskensis (Lub.)	0.4- 4.0%	
G. subrotatus (Lub.)	0.7- 1.3%	

**Protopodocarpus auritus* (Lub.)	0.4- 5.4%	
P. alatus (Lub.)	0.7- 7.5%	
Protohaploxypinus silvestritypus sp. n.	0.4- 4.0%	
**P. latissimus* (Lub.)	0.8-13.4%	Pollen
P. perfectus (Naum.)	0.5- 3.2%	of
P. striatus (Lub.)	0.5- 6.8%	conifers
P. prolixus (Lub.)	1.3-12.1%	
P. tecturatus (Lub.)	0.7- 3.6%	
**Coniferites nudus* (Lub.)	0.8-13.0%	
Florinites luberae sp. n.	0.7- 3.9%	
**Vittatina striata* Lub.	6.0-32.0%	Pollen of
**V. vittifer* Lub.	3.3-42.0%	*Welwitschia*
V. subsaccata Lub.	0.4- 4.0%	type
**Azonaletes indefinitus* sp. n.	2.0-19.3%	
A. microdictyus Lub.	0.4- 6.8%	
A. subreticulatus sp. n.	0.4-12.4%	
A. fabaginus sp. n.	1.2- 5.0%	Pollen of undetermined systematic affinity
A. (Tenuella) levis Lub.	3.2-18.8%	
Azonotriletes cf. *resistens* Lub.	0.7- 4.0%	
A. polypyrenus Lub.	0.8- 4.0%	
**Zonomonoletes turboreticulatus* sp. n.	0.4- 5.0%	

In the Kungurian deposits of the Aktyubinsk area the spore-pollen complex contains the pollen of the following of the most widely distributed plants:

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Cordaitina uralensis (Lub.)	3.3- 6.7%	Pollen of
C. subrotata (Lub.)	3.3- 6.7%	Cordaitales
Ginkgocycadophytus caperatus (Lub.)	1.1- 2.5%	Pollen of Ginkgoales and Cycadophyta
**Protohaploxypinus prolixus* (Lub.)	6.7-17.8%	
P. latissimus (Lub.)	3.3- 4.0%	Pollen
P. striatus (Lub.)	2.0- 3.3%	of
Protocedrus parviextensisaccus sp. n.	1.1- 3.3%	conifers
**Coniferites nudus* (Lub.)	6.7- 9.5%	
**Vittatina striata* Lub.	4.5-13.4%	Pollen
V. vittifer Lub.	3.3- 9.5%	of
V. vittifer var. *cribrata* var. n.	1.0- 3.3%	*Welwitschia*
V. cincinnata Lub.	3.5- 7.8%	type

1* indicates species common to Cherdyn' and Aktyubinsk regions

**Azonaletes indefinitus* sp. n.	1.1- 6.7%	Pollen of undetermined systematic affinity
A. fabaginus sp. n.	5.6-16.7%	
**Zonomonoletes turboreticulatus* sp. n.	7.8%	

As can be seen from the two lists shown above in which the common forms of the two are indicated by asterisks, the spore-pollen contents of the Kungurian in Cherdyn' and Aktyubinsk areas are fairly similar; specifically, there is only a certain impoverishment of the complex in the Aktyubinsk area, which, however, could be explained by the smaller amount of the material from the latter source.

The complex of pollen and spores from the Kungurian deposits of both areas studied has the following common characteristics: it consists of the spores of pteridophytes; pollen of Cordaitales, Cycadophyta, Ginkgoales and conifers; pollen of *Welwitschia* type; and pollen of undetermined systematic affinity.

Most abundant are the two latter groups, whose pollen count is rarely smaller than that of Cordaitales and conifers. In the Cherdyn' section an increase of the *Welwitschia* type of pollen is observed in the upper part (average 38.6%), and it decreases in the lower part (average 18.0%); but the amount of the pollen of undetermined systematic affinity has a reverse occurrence: in smaller amount in the upper (average 23.0%), and somewhat larger amount in the lower horizon (28.5%).

The presence of a larger amount of ribbed pollen of *Welwitschia* type, and the occurrence of forms with a ribbed sculpture

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of the body among the coniferous pollen render to the Kungurian spore-pollen complex a peculiar character.

In the Kungurian deposits a fairly large role is played by the pollen of Cordaitales and conifers.

In the Cherdyn' section each of these groups comprises, in average, about 20.0%. In some lower horizons, the pollen of Cordaitales predominates over all other groups, as it comprises from 32.0 to 38.0% of the whole amount [of spores and pollen]. For the upper horizons of the Cherdyn' Kungurian a reduction of Cordaitales pollen is characteristic.

In the Aktyubinsk area, Cordaitales takes second place to the conifers, whose pollen comprise from 23.3 to 43.0%.

Among the conifer pollen are observed some groups whose morphologic characteristics approach those of various extant conifers, such as the subgenera *Diploxylon* and *Haploxylon* of the genus *Pinus,* and the genera *Podocarpus* and *Cedrus.* Side by side with them are found pollen of archaic conifers, which possess either a pair of weakly developed air sacks (*Coniferites nudus* Lub.), or one sack, embracing the body [of the pollen grain] in ring-like fashion (genus *Florinites*). These less specialized pollen forms belong to some plants of a lower level of evolutionary development.

The pollen of Ginkgoales and Cycadophyta in the Kungurian deposits are found in small amounts, normally not exceeding 4.5%. In some horizons they are absent.

The amount of spores is small, in most cases not exceeding 7%, its maximum being 10%. Among them spores of the type of *Azonotriletes* predominate; the spores of *Zonotriletes* type are found singly or not at all.

Pollen of *Zonomonoletes turboreticulatus* sp. n. is characteristic of the described Kungurian complex, as it does not appear in either underlying or overlying Permian deposits (Artinskian and lower Kazanian).

Solikamsk Suite. In this work I give a description of the pollen and spore content of the Kazanian deposits according to the data obtained in the study of the Cherdyn' area. [Here clayey-marly deposits, encountered directly under the Quaternary, belong to the so-called Solikamsk suite, which overlies the salt-bearing deposits.]

The problem of the age of the Solikamsk suite, which in the western Cis-Urals is an important marker [datum] horizon, recently became a matter of considerable dispute. One group of investigators (E. I. Tikhvinskaya, N. P. Gerasimov, K. R. Chepikov, V. D. Nalivkin, and others) refers these deposits to the Kungurian, whereas the other group (E. N. Larionova, P. A. Sofronitsky, E. M. Lyutkevich, J. N. Skryl', and N. N. Rostovtsev) considers them of Kazanian age.

Without entering here into the substance of these disagreements, I accept the latter view on the evidence obtained by the

study of the spores and pollen from the Solikamsk suite and on the comparison

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of these data with the results of the spore-pollen analyses of the underlying and overlying deposits.

In the deposits of the Solikamsk suite of the Cherdyn' area, which overlie the salt-bearing Kungurian deposits, I have found a spore-pollen complex belonging to the same systematic groups found in the Kungurian deposits. Spores of pteridophytes; pollen of Cordaitales, Ginkgoales, Cycadophyta, and conifers; pollen of *Welwitschia* type; and pollen of undetermined systematic affinity have been found here.

The most widely distributed species are as follows:

Cordaitina uralensis (Lub.)	1.5- 6.5%	Pollen
C. subrotata (Lub.)	0.5- 8.0%	of
C. convallata (Lub.)	0.5- 2.0%	Cordaitales
Ginkgocycadophytus tunguskensis (Lub.)	2.0- 2.5%	Pollen of Ginkgoales and Cycadophyta
Protopodocarpus (Lub.)	1.0- 6.0%	
P. alatus (Lub.)	1.0- 2.5%	
Protodiploxypinus elongatus (Lub.)	1.0- 7.0%	
Protohaploxypinus latissimus (Lub.)	2.5- 5.3%	Pollen
P. perfectus (Naum.)	0.5- 4.0%	of
P. striatus (Lub.)	0.5- 2.0%	conifers
P. tractiferinus sp. n.	1.0- 8.0%	
P. prolixus (Lub.)	0.5- 7.0%	
Protocedrus parviextensisaccus sp. n.	0.7- 6.0%	
Coniferites nudus (Lub.)	2.0- 7.5%	
Vittatina striata Lub.	1.0-15.0%	Pollen
V. vittifer Lub.	8.0-22.5%	of
V. vittifer var. *cribrata* var. n.	0.5- 4.0%	*Welwitschia*
V. cincinnata Lub.	1.0- 9.0%	type
Azonaletes microdictyus Lub.	1.0-18.0%	Pollen of
A. irregulariplicatus sp. n.	4.0-13.0%	undetermined
A. (Tenuella) levis Lub.	1.0-11.0%	systematic
A. (Rugosina) tenuis Lub.	1.5%	affinity

Azonotriletes cf. *resistens* Lub.	0.5- 7.0%	
A. osmundae sp. n.	3.0- 8.0%	Unassigned
Zonotriletes (Effusina) procumbens Lub.	2.5-14.0%	fern spores
Z. (Effusina) graniferus Lub.	2.0- 4.5%	
Z. ornatus Lub.	1.0-13.0%	

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Although the spore-pollen complex from the Solikamsk suite belongs to the same systematic groups as that in the complex of the underlying Permian deposits, it possesses some peculiarities of the content and of the numerical relationships of separate groups.

The species content of the plants in the Solikamsk suite, as per the pollen and spores, is distinguished by somewhat lesser diversification and by the presence of several species which are absent or rare in the Kungurian.

Side by side with the species distributed widely in both Kazanian and Kungurian stages, some may be mentioned which are characteristic of only the lower Kazanian (Solikamsk) deposits. Here belong *Zonotriletes ornatus* Lub., *Zonotriletes (Effusina) procumbens* Lub., *Zonotriletes (Effusina) graniferus* Lub., *Azonotriletes osmundae* sp. n.

Protohaploxypinus tractiferinus sp. n. and *Protodiploxypinus elongatus* (Lub.) (pollen of conifers) and *Vittatina cincinnata* Lub. (pollen of *Welwitschia* type), amounting to 1.0 to 11.0% are encountered throughout the Solikamsk suite section whereas in the Kungurian deposits they are encountered sporadically, as single grains.

Of the species of spores and pollen listed, the spores of *Azonotriletes osmundae* sp. n., which are much like those of the extant ferns of the family Osmundaceae, are particularly interesting. The similarity of the fossil forms to the extant ones (most closely to the spores of *Osmunda cinnamomea* described by M. A. Sedova) consists of the presence in both of a circular outline, a long, three-rayed fissure of rupture, and finely tuberculate, distinctly expressed sculpture of the exine, which is reflected in the wavy line of the outer contour of the spores (see plate XVII, figs. 9, 10). The suggested parallelism is so much more possible because the "frequent occurrence of the remnants of stems, leaves, and sporan-

gia, which individually are fully similar to the Osmunda ferns, certainly points to an ancient age for this family" (A. N. Krishtofovich, 1945, p. 177).

Regarding the general characteristics of the spore-pollen complex of the post-salt deposits of the Kazanian stage, the following can be noted.

The larger proportion belongs [in nearly equal parts] to the conifer pollen (averaging 27.5% through the section) and the *Welwitschia*-type pollen (28.2%). The pollen of undetermined systematic affinity are fewer than in the stratigraphically lower horizons of the Permian (18.0%). The role of Cordaitales pollen is sharply diminished (averaging 7.0%). Pollen of Ginkgoales and Cycadophyta are present in minimal amount (0.5-8.0%). In some horizons they have not been found at all. The number of spores in the Solikamsk suite ranges widely. A characteristic peculiarity of this suite is the presence in it of some horizons well saturated with spores, where they comprise from 32.0 to 36.0%; whereas in the other parts of the section they are present in amounts of from 2.0 to 16.0%.

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In the general content of the spore assemblage, especially in the spore-saturated layers, the spores of *Zonotriletes* predominate. Characteristically in the Solikamsk suite, *Zonotriletes ornatus* Lub., *Zonotriletes (Effusina) procumbens* Lub., *Zonotriletes (Effusina) graniferus* Lub., *Azonotriletes osmundae* sp. n. are dominant in the spore-bearing horizons. The spores of these species are also encountered, though in smaller number, in the other parts of the Solikamsk section.

COMPARISON OF THE STUDIED SPORE-POLLEN COMPLEXES. CONCLUSIONS.

Before comparing the spore-pollen complexes with each other, and with other known complexes, it must be said that the material obtained by me, because of the limited number of the studied sections, certainly needs additional data. This pertains particularly to the conclusions regarding the areal persistence of the characteristics peculiar to each stratigraphic horizon. Nevertheless, the described spore-pollen complexes in the Artinskian, Kungurian, and lower Kazanian deposits have a sufficient value for differentiation of these deposits from each other in the studied areas.

When comparing the spore-pollen complex from the Artinskian deposits with the complexes from the overlying studied deposits it can be observed that, in spite of the common occurrence of the majority of the systematic groups characteristic for the whole section, the pollen and spore content of the Artinskian stage in the studied regions has a special aspect.

The highly characteristic and abundant ribbed pollen of *Welwitschia* type of the Kungurian and Kazanian stages are absent. The only forms with the ribbed sculpture of the exine encountered in the Artinskian are among the conifers, but among them they are rare.

The conifer pollen grains are a small part of the total content. Their proportion ranges from 4.0 to 12.0%. In the Kungurian deposits their proportion averages 20%, and in the Solikamsk suite it rises to 27.0%. (In the Artinskian stage of the Aktyubinsk area the proportion of the coniferous pollen is higher than in Cherdyn' area, and reaches 26.7%, but even here the amount is smaller than in the Aktyubinsk Kungurian in which the ratio of the conifers increases to 41.0-43.0%.)

The amount of the Cordaitales pollen in the Artinskian stage is much smaller than in the Kungurian, whereas pollen of Ginkgoales and Cycadophyta, on the contrary, are much more abundant; here they amount to from 12.0% to 26.5%, and in the Kungurian they do not exceed 12, and in the Solikamsk suite only 8%.

When comparing Kungurian and lower Kazanian (Solikamsk) spore-pollen complexes

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their greater resemblance to each other than to the Artinskian complex is noted. The uniting characteristic is the large amount of the coniferous and *Welwitschia*-type pollen, equally poor content of the Ginkgoales and Pteridophyte [fossils], and the proximity of the species content of the plants whose pollen are widely distributed in both Kungurian and Solikamsk rocks. The differences between the Kungurian and the lower Kazanian spore-pollen complexes are enumerated below. In the Solikamsk suite:

(1) The percentage of Cordaitales pollen is sharply reduced. Here it averages 7.0% throughout the section, whereas in the Kungurian it reaches 20.5%, and in some of its lower horizons in the Cherdyn' area it dominates all other spores.

(2) The percentage of coniferous pollen is increased; in the salt-bearing sediments it averages about 20.0%, and in the overlying Solikamsk sediments it averages 27.5%.

(3) Among the coniferous pollen the forms with ribbed sculpture of the exine invariably predominate; in the Kungurian, on the contrary, the non-ribbed pollen predominate in this group.

(4) Pollen of undetermined affinity comprise a smaller percentage (average 18.0%) than in the Kungurian (average 20.0-24.0%).

(5) An additional difference is the presence in it of some spore-saturated horizons; these are absent in the Kungurian deposits, where the spores are invariably present in a minimum amount, seldom exceeding 5.0-8.0% of the total spore-pollen content.

In the spore-saturated layers of the Solikamsk suite the spores of *Zonotriletes* are prolific, whereas these are seldom encountered in the Kungurian deposits.

(6) There are also some differences in the species. Some species are found only in the Solikamsk deposits: *Zonotriletes (Effusina) procumbens* Lub., *Azonotriletes osmundae* sp. n., and *Azonaletes (Rugosina) tenuis* Lub.; whereas the others are found only in the Kungurian: *Zonomonoletes turboreticulatus* sp. n., and *Azonaletes fabaginus* sp. n.

On the other hand, there are some species widely distributed in the salt-bearing deposits and found singly in the overlying deposits, and vice versa. Such species, characteristic of the Solikamsk deposits, are *Zonotriletes ornatus* Lub., *Protohaploxypinus tractiferinus* sp. n., *Vittatina cincinnata* Lub., *Zonotriletes (Effusina)*

graniferus Lub.; for the Kungurian—*Azonaletes indefinitus* sp. n.

Although there is a similarity between the most widely distributed species in the salt-bearing and the species in the overlying deposits, there is a difference in the percentage of the spores and pollen. Thus, in the Solikamsk deposits, compared with the Kungurian ones, there is a decrease of some pollen in the characteristic species complex, for example—*Protohaploxypinus prolixus* (Lub.), *Protopodocarpus alatus* (Lub.), *Cordaitina uralensis* (Lub.), and *Cordaitina subrotata* (Lub.).

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In the Solikamsk deposits there is some impoverishment of the species content at the expense of some forms of undetermined affinity, which are sporadically distributed in the Kungurian.

All such characteristics of the spore-pollen content, which are discovered in bed by bed investigation, clearly distinguish the deposits of the Solikamsk suite from the rocks of the Kungurian stage.

Interesting results are obtained from a comparison of the spore-pollen complexes from the Solikamsk area and the Kungurian deposits of the Cherdyn' area with complexes from the contemporaneous and similar deposits in facies of some other areas of western Cis-Urals and the southern approaches to Timan (the basin of Northern Kel'tma River).

Table 3 shows the relationship of the systematic groups of plants which were disclosed by the study of the pollen and spores from the Kungurian and Kazanian rocks in the areas of Molotov [Perm] region: Cherdyn' (my data), Nytva (materials of M. A. Sedova, 1944), Solikamsk (materials of A. A. Luber, 1940), and in the region of the Northern Kel'tma River basin (materials of V. V. Zauer, N. D. Mchedlishvili, S. R. Samoilovich, and M. A. Sedova, 1947). In all four areas the calcareous clayey-marly post-salt-bearing deposits have been investigated.[1]

In the same table are gathered the data obtained in the investigation of the Kungurian salt-bearing deposits of the Cherdyn' area, and of gypsum-clayey-dolomite rocks of Northern Kel'tma River correlated with them.

[1] A. A. Luber, who investigated the clayey-marly rocks of the post-salt-bearing deposits of Solikamsk area, subsequent to the work of the geologists of Solikamsk Gidrouzel, who turned over to her their materials, has regarded these rocks to be of the Kungurian stage.

Comparison of the spore-pollen complexes if the Solikamsk and Kungurian rocks in all four areas shows their almost complete identity (see table 3, p. 20-21).

The similarity of the Solikamsk spore-pollen spectra [to that of the Kungurian] is expressed by: [1] the fairly great similarity of the contents of the most widely distributed species, [2] the high percentage of the pollen of conifers and *Welwitschia* type, [3] sparse contents of the Cordaitales and Ginkgoales pollen, and [4] the presence in the sections—upon the background of the dominance of pollen over spores—of some spore-rich horizons in which occasionally the pollen are completely eliminated (the basin of Northern Kel'tma River).

The figures in table 3, which express the relationships of the groups in the different areas, are remarkably close to each other. The somewhat larger percentage is shown by only a few groups of pollen and spores in the basin of Northern Kel'tma River.

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The comparison of the spores and pollen of the Kungurian rocks of the Cherdyn' area with the spores and pollen of the Kungurian of the Kel'tma area, in spite of the great distance between these areas, also shows considerable similarity. In both places, together with the diminution (in comparison with the Solikamsk complex) of the amount of coniferous pollen, there is a sharp increase in the percentage of cordaitalean pollen. The spore-rich horizons are absent,

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whereas the number of spores in the correlated sections of the Kungurian also comprises an insignificant percentage. Difference is noted only in the unequal contents of the *Welwitschia*-type pollen, where the *Welwitschia*-type pollen in the Kungurian of Cherdyn' area are in somewhat smaller numbers than in the Solikamsk suite, they are, on the contrary, more numerous in the Kungurian of the Northern Kel'tma River basin.

A fairly similar situation is shown also by the comparison of my results with the data of S. N. Naumova (1950) in the investigation of the spores and pollen of the Permian in the Kuedin area and the area of the Chusovaya River of the Molotov [Perm] region. According to the data of S. N. Naumova the spores and pollen from the Solikamsk suite have the same characteristics,

TABLE 3. —DISTRIBUTION OF THE POLLEN OF CONIFERS, CORDAITES, WELWITSCHIA TYPE AND SPORES OF PTERIDOPHYTA IN KUNGURIAN AND KAZANIAN DEPOSITS OF CIS-URALS AND BASIN OF N. KEL'TMA RIVER (in percentages)[1]

Areas of Investigation	Authors of Investigations	Age of Deposits		Pollen of Gymnospermae						Spores of Pteridophyta			
				Coniferae		Cordaites		Welwitschia type		Spore-Saturated Horizon		Other Horizons of Section	
				range	aver.	range	aver.	range	aver.	range	aver.	range	aver.
Bashkiria	S. N. Naumova & N. A. Bolkhovitina	Kazanian stage P_2^{kz}		—	50.0	—	9.0	numerous[2]	—	—	30.0	—	—
Cherdyn'	S. R. Samoilovich		Solikamsk suite $P_2^{kz\,sol}$	14.0-32.4	27.5	1.0-14.0	7.1	12.5-44.5	28.2	32.0- 36.5	34.0	2.0-16.0	8.5
Nytva	M. A. Sedova			32.0-48.0	39.0	0.5-10.5	7.2	20.0-36.0	27.8	27.0	27.0	2.0-12.0	8.0
Solikamsk	A. A. Luber			10.0-57.0	31.0	2.0-15.0	7.0	10.0-67.0	27.0	20.0- 40.0	29.7	1.0-13.0	6.0
Northern Kel'tma River basin	V. V. Zauer, N. D. Mchedlishvili, S. R. Samoilovich & M. A. Sedova			15.2-59.5	42.7	1.0-26.8	8.6	7.3-80.0	49.0	35.0-100.0	82.3	0.5-20.0	5.1
Cherdyn'	S. R. Samoilovich	Kungurian stage P_1^{kg}		6.2-40.0	20.0	1.3-38.3	20.9	8.0-71.6	25.7	—	—	1.3- 9.9	5.3
Northern Kel'tma River basin	V. V. Zauer, N. D. Mchedlichvili, S. R. Samoilovich & M. A. Sedova			1.0-60.0	15.0	7.2-57.2	28.7	28.0-99.0	65.7	—	—	1.0- 6.0	5.4
Nytva	investigations not conducted												
Solikamsk													

[1] Compiled by S. R. Samoilovich.

[2] S. N. Naumova and N. A. Bolkhovitina note in the investigated deposits the presence of a large amount of ribbed pollen of Welwitschia type, but do not furnish numerical data (1945).

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that is, predominance of gymnospermic pollen, wide development of *Welwitschia*-type pollen, and small content of Cordaitales, Cycadophyta, and Ginkgoales pollen (according to Naumova of cycad and bennettit pollen).[1]

The quantities which characterize these pecularities, as well as comparative data on the species, are compiled by me in table 4.

As shown in the table, the spore-pollen complexes from the Solikamsk suite section in the Kuedin area and in the area of the Chusovaya River differ only in the absence of the richly spore-bearing horizons discovered in the corresponding areas of Cherdyn', and also Nytva, Solikamsk, and the Northern Kel'tma River basin. It must be pointed out, however, that, among the characteristic spores, S. N. Naumova notes the spores of *Hymenozonotriletes ornatus* Naum. (=*Zonotriletes ornatus* Lub.) and the spores of Osmundaceae, as in the area of my investigations.

Among the Coniferae a common species, *Protodiploxypinus elongatus* (Lub.), is characteristic of the Solikamsk suite of the Kuedin, Chusovaya, and Cherdyn' areas.

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All this indicates that at different places, even those substantially distant from each other, as are the southernmost part of the Molotov [Perm] region and the Komi ASSR, the spore-pollen spectra of the Solikamsk suite remains constant.

Data on investigation of the spores and pollen from undoubted Kazanian deposits, which could be used for comparison and were available to me are, unfortunately, few. The analyses made by me of the rocks from the Kazanian and Tatarian stages from the collections by E. M. Lyutkevich (Western Cis-Urals) have not given positive results: the material happens to be barren.

There are scant data on spores and pollen from the Kazanian deposits of Bashkiria investigated by S. N. Naumova and N. A. Bolkhovitina (1945). Besides, there are some known materials of S. N. Naumova from the *Spirifer* horizon of the Kazanian stage in the Sarapul' area (1950), and the data of 1940 by A. A. Luber on the Golyushurma coal deposits (Udmurtiya).

S. N. Naumova, when characterizing a spore-pollen complex

[1] The pollen of Cycadales, Ginkgoales, and Bennettitales are morphologically very similar and are difficult to distinguish one from another.

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TABLE 4.*—COMPARISON OF SPORE-POLLEN ANALYSES OF SOLIKAMSK SUITE OF MOLOTOV [PERM] REGION (in percentages)

	Kuedin area and heads of Chusovaya River *S. N. Naumova (1950)*	Cherdyn' *S. R. Samoilovich*
POLLEN OF GYMNOSPERMAE		
Total amount	85.0-90.0	50.0-78.0
Cordaitales	5.0-10.0	1.0-14.0
Cycadales, Bennettitales, and Ginkgoales	1.0- 8.0	0.5- 8.0
Welwitschia type	to 58.0	to 44.5
CHARACTERISTIC COMMON GENERA AND SPECIES OF POLLEN		
Coniferae		
Rhytisaccus elongatus (Lub.) Naum. =*Protodiploxypinus elongatus* (Lub.)	3.0- 5.0	0.5- 4.0
Platysaccus major Naum. =*Protopodocarpus major* (Lub.)	1.0	1.0
Cordaitales		
Perisaccus uralensis (Lub.) Naum. =*Cordaitina uralensis* (Lub.)	2.0- 8.0	1.5- 6.5
Perisaccus convallatus (Lub.) Naum. =*Cordaitina convallata* (Lub.)	1.0- 5.0	0.5- 2.0
Welwitschia type		
Genus *Vittatina* Lub.	30.0-50.0	40.0-74.0
SPORES OF PTERIDOPHYTA		
Average amount	5.0	8.5
Osmundaceae		
Azonotriletes osmundae Sam.	1.0- 5.0	3.0- 8.0
Hymenozonotriletes ornatus (Lub.) Naum. =*Zonotriletes ornatus* Lub.	1.0-10.0	0.7-13.0

* Table 4 is presented here in a format different from that of the original, for typographical convenience and readability; the data are unchanged.

from the studied rocks of the Kazanian stage of Bashkiria, is concerned only with the relationship of the separate systematic groups among themselves. In table 3, where these data are utilized, it can be seen that the relationships of the basic systematic groups in the Solikamsk suite of the Molotov [Perm] region and the Northern Kel'tma River and in the Kazanian

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stage of Bashkiria, are very close. Everywhere the pollen of conifers and *Welwitschia* type predominate, and there is a constant scarcity of cordaitalean pollen. The spore content approaches that of the characteristic richly spore-bearing horizons of the Solikamsk suite.

When comparing, in her 1950 work, the spore-pollen complexes from the *Spirifer* layers of the Kazanian stage of the Sarapul' area, Udmurt ASSR, with the complex of the Solikamsk suite of the Molotov [Perm] region, S. N. Naumova notes the similarity of their species content. She notes in each stratigraphic horizon predominance of the conifer pollen and of the ribbed *Welwitschia*-type pollen.

Comparing the pollen and spores which I have discovered in the Solikamsk suite of Cherdyn' with the pollen and spores described by A. A. Luber from several samples of the Kazanian coals of Golyushurma, several species common to both are noted: *Protopodocarpus major* (Lub.), *Zonotriletes (Effusina) graniferus* Lub., *Zonotriletes (Effusina) procumbens* Lub., *Azonaletes (Rugosina) tenuis* Lub.

In the Cherdyn' area the latter two species are exclusively Solikamsk suite forms, and are not encountered in the underlying deposits. On the evidence which I have obtained, the following brief conclusions can be made:

(1) Spore-pollen complexes of the studied Permian deposits in the Cherdyn' and Aktyubinsk areas are similar.

(2) The spore-pollen complex of the Artinskian rocks has several characteristics which distinguish it from spore-pollen complexes of the stratigraphically higher Permian deposits.

(3) The spore-pollen complexes of the salt-bearing Kungurian and post-salt-bearing Solikamsk suite of the Cherdyn' area, in spite of similar contents, have several differences which permit us

to distinguish one from the other when engaged in serial investigations.

(4) Taking into account the differences between the spore-pollen complexes of the Solikamsk suite and the Kungurian, the principal of which is the sharp reduction of the proportion of cordaitalean pollen and increase of the proportion of coniferous pollen (which is characteristic of the Upper Permian) in the first, and also taking into account the similarity of the basic characteristics of the spore-pollen complexes in the Solikamsk suite and the Kazanian stage, it is possible to refer the suite to the latter stage.

This thesis appears, to a certain degree, arbitrary, because a larger amount of comparative data on the spores and pollen from the rocks of undoubted Kazanian age is needed for its verification.

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(5) Comparison of spore-pollen complexes in the stages of the Cherdyn' area with the contemporaneous spectra of other areas of the Western Cis-Urals (Nytva and Solikamsk areas), as well as the complex from the Northern Kel'tma River basin, shows their almost complete identity.

This suggests the possibility of establishing, through the study of pollen and spores, correlation of the Permian deposits of some territories considerably remote from each other (Western Cis-Urals and southern approaches to Timan).

(6) Comparison of the morphological characteristics of the spores and pollen from the Permian with the morphology of the pollen and spores of the extant plants results in many cases in the establishment of some common features (it is discovered that some fossil pollen and spores resemble the pollen and spores of the extant plants of the families Pinaceae, Podocarpaceae, Welwitschiaceae, Osmundaceae, Marattiaceae and Selaginellaceae).

(7) Comparison of the Permian pollen with the pollen of some Paleozoic plants, which have been described from their pollen sacks, indicates similarity of some genera to the pollen of *Cordaites* and primitive conifers *(Lebachia, Walchia, Ernestiodendron).*

(8) Judging by the pollen and spore contents, there was a vegetation in the Permian period on the territory of the Cherdyn' and Aktyubinsk areas represented chiefly by conifers and cordaitaleans, with a slight addition of Ginkgoales and Cycadophyta, and also fern, *Calamites,* and lycopods.

PALEONTOLOGICAL SECTION

GENERAL REMARKS

In the descriptive part of this work I have attempted as fully as possible to utilize the materials available for comparison of the morphology of pollen and spores of the extant plants, and also of the fossils whose systematic relationships are well established.

When giving names to the newly described genera and species, and when changing artificial names previously given by other investigators, I have attempted to portray the similarity of the studied objects to the pollen and spores belonging to the plants whose classification and systematic relationships are known (for instance, the name *"Protodiploxypinus"* portrays the similarity of this genus to the pollen of the extant *Pinus* of the subgenus *Diploxylon;* the name *"Cordaitina"* indicates similarity to the pollen grains of *Cordaites; "Azonotriletes osmundae"*—similarity to the spores of the Osmundaceae ferns, and so on). In this fashion I have attempted to give some guidance for further work on the detection of systematic relationships of the spores and pollen grains encountered in the Permian deposits.

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However, for some genera, in spite of the similarity of their pollen to the pollen of some known plants, I have preserved the artificial generic names previously given to them by other authors; for instance—*Florinites* S. W. and B., and *Vittatina* Luber.

As to the pollen of the genus *Vittatina,* which is similar to that of Welwitschiaceae, and is referred by me to the *"Welwitschia* type," the artificial name has been retained for the following reasons.

Although having many morphologic characteristics in common with the pollen grains of *Welwitschia* (A. A. Chiguryaeva, 1949), the grains of *Vittatina* also resemble the bilateral spores of the Schizaeaceae, many species of which have bean-like shape and ribbed surface. It is true that the spores in some species of Schizaeales, for instance *Schizaea digitata* (L.) Sw., described by O. Selling (1946) and M. A. Sedova (1950), the exine is considerably more delicate and is covered by finer scars [ribs] than in the fossil

Vittatina; the spores of other species, *Schizaea melanesica* Selling and *S. penicillata* Kunth., which have a coarser ribbed sculpture (Selling, 1946) have greater resemblance to the fossil forms, and differ from them only in the greater width of the scars [ribs] and the furrows between them.

Greatest resemblance is between *Vittatina vittifer* var. *cribrata* and the spores of the extant *Schizaea laevigata* Mett., described by Selling from Melanesia (compare figs. 3 and 4 in plate XVII).

In connection with this it seems to be more prudent to speak about "*Welwitschia*-type pollen," thus not insisting that they belong to some kind of plant near the extant family Welwitschiaceae. Such caution seems so much more necessary, if we recall that, according to paleobotanical data, there is as yet no certain evidence of the existence in the Paleozoic of plants similar to *Welwitschia.* Occurrence of Gnetales, even in the Jurassic and Cretaceous sediments, is as yet not quite proved, according to Krishtofovich (1945).[1]

By preserving the artificial name *Vittatina* I wished to show that the systematic standing of the pollen of this genus cannot be considered firmly established as yet.

It is of some interest to point out that in the group of *Vittatina* pollen there are several gradual, imperceptible transitions of some morphological features, which connect it with the pollen of conifers. A gradual chain of changes from "sackless" forms to "almost sack-containing" (that is, with weak indications of air sacks)

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appears in the following order: *Vittatina vittifer* Lub. (longitudinally ribbed pollen without transverse ribbing on narrowed parts of body, plate VIII, figs. 4a-d); *Vittatina striata* (longitudinal ribbing with transverse ribbing on narrowed parts, plate IX, figs. 2a-c); *Vittatina subsaccata* (with network sculpture on narrowed parts of body, creating a semblance of a pair of undeveloped air sacks, plate IX, figs. 4a, b).

The artificial generic name *Florinites* S. W. and B., which embraces the pollen morphologically similar to the pollen of the three genera of the Permian conifers: *Walchia, Lebachia,* and *Ernestiodendron,* is also retained by me.

[1] The known occurrence of the seeds of **Samaropsis rotundata** Heer type demands a thorough investigation in view of their resemblance to the seeds (?) of Gnetales (remarks by A. N. Krishtofovich, made when reading the manuscript).

As to the naming of the pollen and spores, whose relationships are as yet quite obscure, I have used the artificial classification of A. A. Luber and I. E. Val'ts (1938). No description of the genera introduced by them is given in this work, which is limited only to the description of those genera which are understood by me in a different sense.

DESCRIPTION OF POLLEN AND SPORES

I. Pollen of Cordaitales

Genus Cordaitina gen. n.

1939. *Circella* A. A. Luber. Korrelyatsiya po sporam uglenosnykh otlozhenii verkhnego paleozoya, fig. 1, pl. A; P_1, P_2.
1939. *Libumella* A. A. Luber. *Ibid.*, fig. 1, pl. A; g_3, g_4.
1941. *Zonaletes* (pars) Luber. A. A. Luber i I. E. Val'ts. Atlas mikrospor i pyl'tsy paleozoya SSSR, pl. XIII, fig. 214, and pl. XV, figs. 248, 250.

Genotype. *Zonaletes (Latensina) uralensis* Luber. Permian.

Generic Description. Size: length of pollen grains 42.9 to 150.0μ; width 33.0-120.0μ.

Pollen grains, many of larger size, commonly are encountered in distal or proximal orientation, and have widely elliptical, less commonly rounded outline.

Pollen of *Cordaitina* are seldom encountered in lateral orientation, which apparently is explained by its polar compression (in the rare cases of lateral orientation a greater flattening on the distal side can be observed).

Pollen consists of a central part, a rounded or angular body; and a peripheral part, an embracing air sack, whose width in axial orientation of grains is usually even, and comprises about half the transverse diameter of body.

In lateral orientation there is notable diminution of the thickness of the air sack on the distal side as a result of the displacement of the body in this direction. Apparently this is

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explainable by the fact that the boundary between the air sack and the body is not in every case equally sharply observable: in the

distal side the body contour is seen clearly, but in the proximal part it is distinguished with greater difficulty.

Exine of the air sack normally fairly thick, and in optical section is bounded by two lines. Exine sculpture is mesh-like, less frequently granular; occasionally exine is crushed intensely into radially oriented folds *(Cordaitina rotata* (Lub.)*)*. The sculpture of body exine is generally finer than that of the sack; it is granular, occasionally mesh-like.

Comparison and Remarks. Pollen grains of *Cordaitina* are closely similar to the pollen of *Cordaites* described by Florin from the fossil flowers [fructification] of these plants, known as *Cordaianthus* (1936) (see pl. XVI, fig. 4—*Cordaianthus* sp.).

Pollen of *Cordaitina,* like the pollen of *Cordaianthus,* has a comparatively small rounded body, surrounded by the embracing wide air sack, which narrows only in the distal part. A characteristic of the pollen of *Cordaianthus* is a multicamerate body structure, not observed in the pollen grains of *Cordaitina.* This may possibly be explained as a result of maceration, which fossil pollen suffers when in the rocks.

The pollen grains of *Cordaitina* are also similar to the pollen of *Florinites* (of primitive conifer type) described by Schopf, Wilson, and Bentall; it also has a small rounded body, enclosed in an air sack, with the only difference that the latter is interrupted in the distal part of the pollen grains in *Florinites,* and makes a contact line with the body, which delimits on its surface a certain open area. In *Cordaitina* the pollen is fully embraced by the sack.

Age. Upper Paleozoic (Upper Carboniferous, Lower and Upper Permian), and Lower Mesozoic (Triassic).

1. Cordaitina ornata sp. n.
Pl. III, figs. 1a, b.

Holotype. Pl. III, fig. 1b. Slide No. 3(158[a])/17, preserved in the paleobotanical laboratory VNIGRI.

Locality of Holotype. Western Cis-Urals, Solikamsk City. Kungurian stage of Lower Permian.

Description of Species. Dimensions: length of pollen grains 63.0 to 66.0μ, width 56.0 to 60.0μ.

The described pollen grains are generally observed in lateral orientation, in which they have a broadly elliptical outline, flattened on the distal side. The central part of the grains,

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the body, is somewhat displaced toward the distal side; it has a trapezoidal outline and is sharply bordered by the contours, whose two lines determine the lesser thickness of the exine. The embracing air sack has a variable width: minimal, comprising less than half of the transverse body diameter in the distal part, and maximal, nearly equal to the width of the body on the sides. The outer contour of the air sack is outlined by a double line, which determines the thickness of its exine, slightly thicker than the body exine. The outer line of the contour is finely wavy, the inner [line is] entire.

The sculpture of the air-sack exine is an extraordinarily sharp, fine network; that of the body, poorly discernible, granular. Color of pollen is yellow; coloration of body is much lighter than that of the sack.

Number of specimens on which description is based—4. Preservation is very good.

Variability. In some pollen grains the body is sharply delimited from the air sack only on the sides, whereas the distal and proximal sides have obscure outlines.

Double contour of the air sack exine is occasionally poorly visible because of the density of its sculpture.

Comparison and Remarks. *C. ornata* differs from other species of the genus in its trapezoidal body outline and in an extraordinary sharpness and fineness of the sculptural network of its air sack.

Geographic Distribution and Age. Western Cis-Urals, Solikamsk area—Kungurian stage of Lower Permian.

2. Cordaitina uralensis (Lub.) f. striata f. n.
Pl. XIII, fig. 3.

Holotype. Pl. XIII, fig. 3. Slide No. 3(135)/17, preserved in paleobotanical laboratory VNIGRI.

Locailty of Holotype. Western Cis-Urals, Cherdyn' area, Pokcha River. Kungurian stage of Lower Permian.

DESCRIPTION OF FORM. Dimensions: length of pollen grains 60.0 to 73.0μ, width 41.0 to 60.0μ.

Outline of pollen grains irregularly elliptical. Air sack (frill) is of uneven width and colored darker than body.

Boundary between frill and body is not sharp.

Sculpture of exine is granular. A weak diagonal ribbing is indicated. Outer line of contour of pollen grains is uneven. Color is light yellow.

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Number of specimens on which description is based—29. Preservation is generally mediocre.

VARIABILITY. Variability in size is fairly great.

COMPARISONS AND REMARKS. Differs from the basic form of the species *C. uralensis* (Lub.) in ribbing of the exine.

GEOGRAPHIC DISTRIBUTION. Western Cis-Urals, Cherdyn' area —Kungurian stage of Lower Permian.

II. POLLEN OF GINKGOACEAE AND CYCADOPHYTA

Genus GINKGOCYCADOPHYTUS gen. n.

1937. *Entylissa* S. N. Naumova. Spory i pyl'tsy uglei SSSR, fig. 1.
1939. *Subsacculifer* A. A. Luber. Korrelyatsiya po sporam uglenosnykh otlozhenii verkhnego paleozoya, fig. 1, pl. A, sketch d_3 and fig. 2, pl. B, sketch d_3.
1941. *Azonaletes* (pars) Luber. A. A. Luber and I. E. Val'ts. Atlas microspor i pyl'tsy paleozoya SSSR. Pl. XVI, figs. 252-257.
1949. *Intorta* Naumova emend. Malavkina. V. S. Malyavkina, Opredelitel' spor i pyl'tsy. Yura-Mel. Pl. 44, figs. 1 to 20.

GENOTYPE. *Subscacculifer caperatus* Luber. Permian, Triassic.

GENERIC DESCRIPTION. Dimensions: length of pollen grains 33.0-85.0μ, width 20.0-40.0μ (extraordinary are the dimensions of the pollen grain described below as *Ginkgocycadophytus* sp., which attains a length of 117μ and a width of 56μ).

Pollen grains are unifurrowed, with outline from elongate-elliptical with acuminate ends to broadly oval, occasionally angular-oval, nearly tetragonal. Furrow on distal part of grain normally extends from one end to the other. Its edges are either in contact with each other along the entire length, or are parted in various

ways; the furrow may be open along the whole length, or at one of the ends, or at both ends, and edges elsewhere may be in contact or even overlapping. In many species of *Ginkgocycadophytus* there are wide dark thick lips along the furrow, widening in the central part of the grains and narrowing toward the ends. The membrane of the furrow usually has a lighter color and finer sculpture than the body.

In various species the pollen exine ranges from thin and delicate, uni-contoured, to thick and dense, outlined in optical section by two lines. Sculpture of the exine varies greatly. In some species the exine is almost smooth, in others it is granular, or has a fine network, and in a few species it is spiny.

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Comparisons and Remarks. In form and in the presence of one distal furrow the pollen has considerable morphologic resemblance to the pollen of three classes of gymnosperms: Bennettitales and Cycadales (united in a single group Cycadophyta), and the Ginkgoales. According to the investigations of various authors (Wieland, 1906; Nathorst, 1909; Erdtman, 1943; and V. Zauer, 1950), the unifurrowed ventricose pollen of these plants are slightly differentiated either by larger size (Bennettitales) or by variations of form—wider and rounded in Cycadales, and more elongate in Ginkgoales.

The pollen of *Ginkgocycadophytus* do not have adequately determined morphologic characteristics which would permit one to correlate them with the pollen grains of one or another of the mentioned classes (especially because even among them differentiation is difficult), and therefore the generic name here given to them reflects the similarity of the described pollen both to Ginkgoales and Cycadophyta.

Ginkgocycadophytus pollen differ in their somewhat larger size from the pollen of the extant Ginkgoales and Cycadophyta, whose pollen do not exceed 67μ in length and 32μ in width.

Age. Upper Paleozoic (Permian), Mesozoic (Jurassic, Lower Cretaceous).

3. GINKGOCYCADOPHYTUS CAPERATUS (Lub.) var. SPINOSUS var. n.
Pl. I, fig. 6

HOLOTYPE. Pl. I, fig. 6 (from temporary preparation).

LOCALITY OF HOLOTYPE. Western Cis-Urals, Cherdyn' area, village of Pokcha. Artinskian stage of Lower Permian.

DESCRIPTION OF VARIETY. Dimensions: length of pollen grains 63.0μ, width 26.0μ.

Grains are elongate-ellipsodal, ventricose; in outline they are elongate-oval, with acuminate ends. Edges of longitudinal furrow are almost in contact with each other in the middle part of the body, but spread out at its ends. Along the outer boundary of the body and along the edges of the furrow there is a double contour line, but it is not everywhere equally sharp.

Exine is densely covered by short spinelets, with more or less acuminate ends (nodo-spinose sculpture). Color of grains dark yellow, that of body darker than the color of the furrow membrane, through which is faintly visible the sculpture of the opposite wall of the envelope.

Number of specimens on which the description of variety is based—2. Preservation is good.

VARIABILITY. Edges of furrow separated from each other in various degrees.

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COMPARISONS AND REMARKS. Differs from the basic form of the species *Ginkgocycadophytus caperatus* (Lub.) (= *Azonaletes caperatus* Lub., 1941, pl. XVI, fig. 256a) by larger size and spinose sculpture of the exine, which in the basic form is network-shagreened or smooth.

By its elongate form, presence of a single longitudinal furrow, and particularly large size, the described variety is close to the pollen of Bennettitales described by Wieland (1936), but the exine in the latter is described as finely granular, not spinose.

GEOGRAPHIC DISTRIBUTION AND AGE. Western Cis-Urals Cherdyn' area—Artinskian stage of Lower Permian.

4. Ginkgocycadophytus sp.
Pl. III, fig. 4.

Location. Western Cis-Urals, Cherdyn' area, village of Pokcha. Kungurian stage of Lower Permian.

Description. Dimensions: length of pollen grain 117.0μ, width 56.0μ.

Pollen grain very large, ventricose in form, elongate-oval in outline. One of the ends is acuminate. Furrow extends along body and is slightly ajar at the ends. A narrow fold extends parallel to the furrow.

Sculpture of exine is finely, barely noticeably granulate. Membrane of the furrow, where it is observable (at the ends) is coarsely granulate. The color is bright yellow.

Only one specimen was encountered in the Kungurian deposits of the Cherdyn' area, and it is not determined specifically.

III. Pollen of Coniferales

Genus Protodiploxypinus gen. nov.

1914. *Pityosporites* Seward. Nat. Hist., Report British Antarctic (Terra Nova) Exped. 1910. Geology, vol. 1, no. 1, p. 23-24, pl. 8, fig. 45.
1919. *Pityosporites* Seward. Fossil Plants, vol. 4, p. 398.
1933. *Pityosporites* Seward. New Phyt., vol. 32, no. 4, p. 311-313, fig. 1.
1949. *Pinojella* Malyavkina, V. S. Opredelitel' spor i pyl'tsy. Yura-Mel. Pl. 25, fig. 12.
1949. *Rotundina* (pars.), Malyavkina, V. S. Ibid., pl. 22, figs. 1, 3, 5.

Genotype. *Pinojella bialinina* Mal., Lower Cretaceous.

Generic Description. Dimensions: length of pollen grains 36.0 to 172.0u, height of body 23.0 to 96.0u.

Pollen has widely ellipsoidal or rounded body and hemispherical or almost spherical air sacks. Hemispherical form of the latter is observed more frequently,

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and in this case the length of the line of attachment of the sacks to the body is shorter than their diameters, which, in turn, are usually less than the height of the body. Intersections of the outer

contours of all air sacks and the body produce clearly marked obtuse angles. General contour of pollen grains appears as three mutually intersecting circles: one in the middle, larger in size (body), and two of smaller size on the sides (air sacks). Exine sculpture of the latter is a network. Exine of body is granular or ribbed-granular.

Comparisons and Remarks. In its form and relationship of the size of the body and air sacks the pollen of the genus *Protodiploxypinus* is close to the pollen of the extant *Pinus,* subgenus *Diploxylon.* It is true that the latter has much greater stability in size, which ranges from 60.0 to 85.5μ, whereas the size of the pollen grains of *Protodiploxypinus* ranges widely, from 36.0μ to 172.0μ.[1]

Age. Upper Paleozoic and Mesozoic.

5. Protodiploxypinus bullaeformis sp. n.

Pl. IV, figs. 1a, b

Holotype. Pl. IV, fig. 1a. Slide No. 4(158[a])/13 preserved in paleobotanical laboratory VNIGRI.

Locality of Holotype. Western Cis-Urals, Solikamsk City. Kungurian stage, Lower Permian.

Description of Species. Dimensions: length of pollen grains 40.0-56.0μ, height of body 36.0-46.0μ.

Body of pollen grains rounded, almost spherical. Air sacks are hemispherical, small; their diameters are 1½-2 times smaller than the height of the body. Line of attachment of sacks equals their diameter.

A dark-colored scar extends across the body.

Exine of body is double layered. Judging by the even line of the inner contour, the endo-exine is smooth. Ecto-exine has a ribbed-granular sculpture, the uneveness of which results in a wavy outer contour of the grains; narrow longitudinal bands, which represent grooves, produce depressions along the line of the outer contour, whereas the wider prominences of the ribs produce elevations of the outer contour (fig. 1b).

[1] In spite of the close similarity of the described fossil pollen to the pollen of the extant **Pinus subgenus Diploxylon I** consider it necessary to introduce for them a separate generic name, **Protodiploxypinus,** because the origin of pines, according to the megascopic remains, is considerably more recent, and in Permian time apparently no real pines existed, but only some kinds of "ancestors."

Sculpture of exine of air sacks is a network, with wavy walls between the meshes. Color of pollen is yellow.

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Number of specimens on which description is based—17. Preservation is good.

VARIABILITY. Shape of body ranges from spherical to broadly ellipsoidal. Also variable are width and length of the transverse scar, which either encircles the body in ring-like fashion, or embraces only its ventral part.

COMPARISONS AND REMARKS. The presence of a transverse fold and ribbed sculpture makes the described pollen similar to the pollen of *Protohaploxypinus tractiferinus* sp. n. They differ in the shape of the body (spherical or almost spherical in *P. bullaeformis* and ellipsoidal in *P. tractiferinus)*, and also in the size and manner of attachment of air sacks: small and protruding in the species described, and larger, with diameter equal to the height of the body in the pollen of *P. tractiferinus.*

GEOGRAPHIC DISTRIBUTION AND AGE. Western and southern Cis-Urals. Solikamsk and Aktyubinsk areas—Kungurian stage of Lower Permian. Cherdyn' area—Kungurian stage and Solikamsk suite of Upper Permian.

6. PROTODIPLOXYPINUS SILVESTRITYPUS sp. n.
Pl. IV, figs. 2a, b

HOLOTYPE. Pl. IV, fig. 2b (from temporary preparation).

LOCALITY OF HOLOTYPE. Cis-Urals of Molotov [Perm] region, left shore of Kama River, below village of Bondyug. Tatarian stage of Upper Permian (lower part of cupriferous sandstones).

DESCRIPTION OF SPECIES. Dimensions: length of pollen grains 36.0-73.0μ, height of body 23.0-41.0μ.

Body widely ellipsoidal, almost round. Air sacks clearly expressed, almost spherical, smaller than body and attached to it on the sides, slightly below its longitudinal axis. Because of the nearly spherical shape of the air sacks, the lines of attachment to the body are shorter than their diameters. Intersection of the outer contours of body and sacks produces clearly observable obtuse angle.

Sculpture of body exine is granular on dorsal side (shield) and almost smooth on ventral side. Exine of air sacks is a coarse network, the meshes somewhat elongate parallel to the longitudinal axis of the grain. Color of grains is yellow.

Number of specimens on which the description is based—35. Preservation is mostly good.

Variability. Color of pollen varies from light yellow to brown. On the ventral sides of some of them

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a transverse groove can be observed. Air sacks occasionally have a finer network sculpture.

Comparisons and Remarks. In size and shape of body and air sacks, and in the manner of attachment of the latter the pollen of *P. silvestritypus* is similar to the pollen of the extant *Pinus silvestris*—the common pine, described by V. V. Zauer (1950), M. Kh. Monoszon-Smolina (1949), and by other foreign authors.

Geographic Distribution and Age. Western and southern Cis-Urals. Solikamsk and Aktyubinsk areas—Kungurian stage and Solikamsk suite of Kazanian stage, Upper Permian.

7. Protodiploxypinus giganteus sp. n.
Pl. IV, fig. 3; pl. V, fig. 1

Holotype. Pl. V, fig. 1. Slide No. 4(158[a])/13 preserved in paleobotanical laboratory VNIGRI.

Locality of Holotype. Western Cis-Urals, Solikamsk City. Kungurian stage of Lower Permian.

Description of Species. Dimensions: length of pollen grains 152.0-182.0μ, height of body 70.0-96.0μ.

Body ellipsoidal, angular-oval in outline. Air sacks almost spherical; lines of attachment to body are smaller than their diameters, which equal the height of body. Outer contours of body and air sacks intersect at an obtuse angle.

Body exine has an unequal thickness (from 4.0 to 10.0μ) and appears in optical section as a dark rim surrounding the body. There is no layer in the exine that can be observed continuously around the body—the whole rim appears as if it were made of separated, interwoven fascicles of longitudinally elongate fibers.

Exine sculpture is finely granular, not very sharply ribbed on body, and network on sacks; when elevating the tube of the microscope a coarse and sharply expressed network sculpture, with rounded-angular meshes, can be observed (pl. IV, fig. 3); and when lowering the microscope tube a finer, obscure network can be observed, the meshes of which are radially elongate near the line of attachment of the air sacks to the body (pl. V, fig. 1). Color of pollen is bright yellow.

Number of specimens on which the description is based—6. Preservation is good.

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VARIABILITY. In some grains the fascicles of fibers, which constitute the exine of the body, are locally disarranged, making some loops bend inside the pollen grain. In other specimens the exine is thin, double layered. Surface of body is occasionally fully devoid of ribbing.

GEOGRAPHIC DISTRIBUTION AND AGE. Western Cis-Urals, Solikamsk area—Kungurian stage of Lower Permian.

Genus PROTOHAPLOXYPINUS gen. nov.

1941. *Pemphygaletes* (pars.) Luber. A. A. Lyuber i I. E. Val'ts. Atlas mikrospori i pyl'tsy paleozoya SSSR, pl. XIII, fig. 221.
1949. *Orbicularia* (section *Tipica*). Malyavkina, V. S. Opredelitel' spor i pyl'tsy. Yura-Mel. Pl. 34, figs. 3, 8; pl. 35, figs. 1, 6, 7; and pl. 36, figs. 1, 4.
1949. *Dilaterella* Malyavkina, V. S. *Ibid.*, pl. 21, fig. 12.

GENOTYPE. *Pemphygaletes latissimus* Luber. Permian.

GENERIC DESCRIPTION. Dimensions: length of pollen grains from 36.3 to 82.5μ, height of body 23.1 to 52.8μ.

Pollen grains have ellipsoidal body, not infrequently elongate along transverse diameter, which in such cases is longer than longitudinal diameter. Air sacks are hemispherical, ocasionally of not quite regular, somewhat angular form; attached to sides of body. In the majority of species the air sacks embace the body deeply, leaving only a small area, about $\frac{1}{3}$ part of its surface, uncovered. Transition of the outer contours of sacks to body contours is gentle, without notable angles. Outlines of air sacks are elliptical in any projection; in the case of angular air sacks the pollen has an angular-oval outline in lateral orientation.

Sculpture of body exine in granular or granular-ribbed; of air sacks, reticulate.

Comparisions and Remarks. In form and manner of attachment of air sacks, and in the proportion of their size to the body size, the pollen of *Protohaploxypinus* is close to the pollen of the extant genus *Pinus* subgenus *Haploxylon*.

Age. Upper Paleozoic (Upper Carboniferous, Permian) and Mesozoic (Triassic, Jurassic, Cretaceous).

8. Protohaploxypinus tractiferinus sp. n.
Pl. XII, figs. 2a, b

Holotype. Pl. XII, fig. 2b. Slide No. 3(158[a])/17 preserved at paleobotanical laboratory VNIGRI.

Locality of Holotype. Western Cis-Urals, Solikamsk City—Kungurian stage of Lower Permian.

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Description of Species. Dimensions: length of pollen grains 60.0-82.0μ, height of body 33.0-41.0μ.

Body of pollen grain widely elliptical. Irregularly rounded form of air sacks produces certain angularity of the oval outlines of grains in lateral orientation. Lines of attachment of air sacks equal their diameters, which, in turn equal body height. Brown rope-like convex scar encircles body transversely across its middle.

Sculpture of body exine is ribbed-granular; on air sacks it is a dense, not very clear network. Color is yellow.

Number of specimens used for the description of the species—50. Preservation mostly good.

Variability. Transverse scar in some grains has considerable width (fig. 2a); in various specimens it is either wavy, or is straighter. Some pollen have a crest on the dorsal side that is not very wide, which connects proximal sides of air sacks.

Comparisons and Remarks. In the presence of a transverse scar and of ribbed sculpture of the body exine the pollen of *Protohaploxypinus tractiferinus* is similar to the pollen of *Protodiploxypinus bullaeformis*. Their distinction consists of difference in body form (ellipsoidal in *P. tractiferinus* and spherical in *P. bullaefor-*

mis), and also in size and manner of attachment of air sacks: larger, with diameter equal to the height of the body in the species described, and small, protruding in the pollen of *P. bullaeformis*.. Besides, the transverse scar in *P. tractiferinus* is generally wider than in *P. bullaeformis*.

Geographic Distribution and Age. Southern and western Cis-Urals. Aktyubinsk area—Kungurian stage of Lower Permian. Cherdyn' area—Kungurian stage and Solikamsk suite of Kazanian stage of Upper Permian.

Genus Protocedrus gen. n.

1949. *Sinuella* (pars.) Malyavkina, V. S. Opredelitel' spor i pyl' tsy. Yura-Mel. Pl. 23, figs. 1, 2.
1949. *Sacculina* (pars.) Malyavkina, V. S. *Ibid.*, pl. 24, figs. 1, 2, and 5.

Genotype. *Sacculina spongiosa* Mal. Lower Jurassic.

Description of Species. Deminsions: length of pollen grains 56.4-92.3μ, height of body 26.4-69.3μ.

Body ellipsoidal, much larger than air sacks. The latter are attached laterally, closer to distal (ventral) part of body, and have rounded or hemispherical shapes, or are somewhat acuminate and appear as if stretched from one side to another.

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Shield exine is usually thick, granular, and in addition is sculptured by narrow longitudinal scars ("ribs"), and occasionally by prominent thick ribs. Distal surface of grain is granular or smooth. Because of the contrast in the characters of the distal and proximal surfaces, the edge of the shield is well marked. In some pollen grains the shield exine forms a more or less wide crest, which connects the proximal parts of the air sacks, clearly observable in a lateral orientation. When the crest is present, the contours of the sacks and body fuse together, their boundary being imperceptibly smooth without noticeable angles. Sculpture of air-sack exines is reticulate.

Comparisons and Remarks. Pollen of *Protocedrus* is morphologically close to the pollen of the extant genus *Cedrus*, described by V. V. Zauer (1950). The features of similarity are: the same relationship of the sacks and body sizes, shape of bladders, and their manner of attachment to the ventral part of the body.

AGE. Upper Paleozoic (Lower and Upper Permian) and Mesozoic (Jurassic, Cretaceous).

9. PROTOCEDRUS PARVIEXTENSISACCUS sp. n.
Pl. VII, fig. 1a-d

HOLOTYPE. Pl. VII, fig. 1b. Slide No. 3(158[a])/13, preserved at paleobotanical laboratory VNIGRI.

PARATYPE. Pl. VII, fig. 1c. Slide No. 4(158[a])/13, preserved at paleobotanical laboratory VNIGRI.

LOCALITY OF HOLOTYPE. Western Cis-Urals. Solikamsk City—Kungurian stage of Lower Permian.

DESCRIPTION OF SPECIES. Dimensions: length of pollen grains 60.0-90.0μ, height of body 36.0 to 53.0μ.

Body ellipsoidal. Air sacks small, drawn out, and appear as if acuminate. They are attached close to the ventral side of body, being disposed below the longitudinal axis of the grains. Diameter of air sacks, 1½-2 times smaller than height of body.

Exine sculpture of proximal part of body (shield) is coarse, ribbed-granular. Rib-like wrinkles, oriented longitudinally, are substantially parrallel to each other, and at some places are pinched out. Exine of distal [ventral] side is almost smooth, but, in the majority of pollen grains, there is in it a wide, somewhat convex, transverse band of indefinite contour, darker color, and coarser granulation. Because of the different characters of the ventral and dorsal

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sides, the edge of the shield is sharply indicated. Sculpture of air-sack exines is densely reticulate. Color of grains is yellowish.

Number of specimens used for the description of species—76. Preservation is mostly good.

VARIABILITY. In some pollen grains, one shield, in addition to ribbing, is sculptured by longitudinally oriented, wide, convex, dark-colored folds (fig. 1c).

COMPARISONS AND REMARKS. A noticeable peculiarity in the pollen grains of *P. parviextensisaccus* is the presence in their ventral parts of a transverse band with an exine which is thicker than that of the rest of the distal surface. The central position of this band on

the ventral side, between air sacks, corresponds exactly to the disposition of the distal germinating furrow in the pollen of the extant conifers of Podocarpaceae and Pinaceae type (among which, as is known, belongs the extant genus *Cedrus*). It is possible that, in the described pollen of the ancient conifer, the outlet of the pollen tube was not located in the center of the ventral side, as is observed in the two sack-bearing pollen grains of the extant Coniferae.

GEOGRAPHIC DISTRIBUTION AND AGE. Western and southern Cis-Urals. Solikamsk and Atkyubinsk areas—Kungurian stage of Lower Permian. Cherdyn' area—Kungurian stage [Lower Permian] and Solikamsk suite of Kazanian stage, Upper Permian.

10. PROTOCEDRUS sp.
Pl. VII, fig. 2

LOCALITY. Western Cis-Urals, Cherdyn' area, village of Pokcha. Kungurian stage of Lower Permian.

DESCRIPTION. Dimensions: length of pollen grain 56.0μ, height of body is 26.0μ.

Body of pollen grain is ellipsoidal. Air sacks are hemispherical, brought very close together on the ventral side of the body.

Shield exine is fairly thick, forming a crest on the dorsal side, which preserves its width also at the proximal bases of the air sacks; because of this the line of the outer contour of the pollen grain is smooth, without angles. Exine sculpture on body is granular; on bladders, finely reticulate. Color of pollen is bright yellow.

A single pollen grain encountered in the Kungurian deposits of Cherdyn' area, and therefore not specifically determined.

Geographic distribution undetermined.

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Genus FLORINITES Schopf, Wilson, & Bentall, 1944

1940. *Pollenites* Potonié. Florin, R., Palaeontographica, vol. 85, pt. 13, book 5, p. 299, pl. 25-26; pt. 11-15, pl. 105-106; pt. 19-21, pl. 107-108; pt. 1, pl. 121-122; pt. 26, 27, pl. 123-124; pt. 4, pl. 155-156; pt. 18, 19, pl. 157-158; pt. 4, 5.

GENOTYPE. *Florinites antiquus* Schopf. Carboniferous.

GENERIC DESCRIPTION.[1] Dimensions: length of pollen grains 35.5 to 180.0μ, width 29.7-110.0μ.

Pollen grains are elliptical in outline, somewhat flattened on distal side and convex on the proximal side. Body irregularly rounded, slightly elongate in longitudinal direction, wholly embraced by air sack, which is interrupted on distal side, where a small surface ("contact area") remains uncovered; its contour is determined by the line of contact of the air sack and the body walls. Outline of "contact area" is observable only in the case of distal orientation of pollen grain, but even in this case it is very obscure.

The authors of the described genus identify the "contact area" with the germinating furrow.

Air sack attains its greatest width in the direction of the longitudinal axis, and, because of this, the pollen grains of *Florinites,* when in lateral orientation, resemble the double-sack pollen of more highly organized conifers (Pinaceae and Podocarpaceae).

In proximal and distal orientation the pollen has an oval outline, and the width of the air sack in this orientation is equal on the opposite sides—larger at the ends of the longitudinal axis, and smaller at the ends of the transverse axis.

Outer surface of air-sack exine is either smooth or, more frequently, sculptured-granular or wrinkled (rugose); inner surface of exine is usually reticulate. Body has a granular, thin or fairly thick exine, and in the periphery appears to be wrinkled. Radial folds are also formed in some air sacks.

COMPARISONS AND REMARKS. Pollen grains of the genus *Florinites* are morphologically identical with the pollen of the extinct Permian conifers *Walchia, Lebachia,* and *Ernestiodendron* described by Florin (1938-1940).

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The pollen have been extracted by Florin from the fossil sporophylls and investigated by him together with the other plant remains, to which they belong.

According to Florin, the pollen grains of *Walchia, Lebachia,* and *Ernestiodendron* are of the same type, in which the body is

[1] The original shapes of **Florinites** pollen and of the large size pollen of some other genera (**Cordaitina** gen. n., **Vittatina** Lub.), change considerably when they are buried in rocks, as they become crushed. Because of this it is impossible to consider their true form; and therefore I am forced in the description of such pollen grains to limit myself to the characteristics of their outlines only.

wholly embraced by the air sack, interrupted locally on the distal side, where the germinal furrow is located.

Because of the morphological similarity among the pollen grains of *Walchia, Lebachia,* and *Ernestiodendron,* Florin unified them into one genus under an artificial name *Pollenites* Potonié, borrowed from Potonié; and he described its characteristic peculiarities as belonging to one artificial species, named by him *Pollenites cordaitiformis* Florin. Such unification of pollen of several species of plants, the systematic affiliations of which are definitely known, into one artificial genus and species was justly criticized by Schopf, Wilson, and Bentall (1944). They censure Florin for lumping them into one generalized, artificially erected group of pollen, the systematic relationship of which he himself definitely and precisely established.

As a result of their own investigations of the pollen grains from the Carboniferous and Permian deposits of the state of Pennsylvania, Schopf, Wilson, and Bentall described a new genus *Florinites* S. W. & B., the pollen of which is quite similar to the pollen described by Florin as *Pollenites cordaitiformis.**

Rejecting the name suggested by Florin because it unites the pollen of different, systematically known plants, the authors gave a new name (*Florinites*) to the fossil pollen whose exact natural affiliation is not established, and concluded that on the evidence of their morphology it undoubtedly belonged to Paleozoic gymnosperms.

The authors of the genus *Florinites* point out the direct similarity of its pollen to that of *Lebachia, Ernestiodendron,* and *Walchianthus,* which were described under these names by Florin. It is necessary to add also that the morphology of *Florinites* pollen is extraordinarily close to that of the *Cordaites* pollen grains which Florin extracted from the fossil sporophylls and described under the name *Cordaianthus* sp.$_1$ and sp.$_2$ (1936), and also to the fossil pollen, apparently also belonging to *Cordaites,* and described here by me under the generic name *Cordaitina.* Pollen grains of *Cordaites,* like those of the primitive conifers, consist of a more or less rounded, comparatively small body, surrounded by an air sack. A sufficiently

* Pollen of **Florinites** described in Schopf, Wilson, and Bentall (1944) was secured from coal of Pennsylvanian age in Carbon County, Iowa, and not from the State of Pennsylvania. Permian **Florinites** was unknown in the United States until recently.—L.R.W.

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substantial difference between them is the complete embracement of the body from all sides in the cordaitalean pollen, whereas in the coniferous [*sic*] *(Florinites)* pollen a small part of the body remains uncovered on its distal part.

AGE. Upper Paleozoic (Upper Carboniferous, Lower and Upper Permian).

11. FLORINITES LUBERAE sp. n.
Pl. VIII, fig. 2a, b

HOLOTYPE. Pl. VIII, fig. 2a. Slide No. 1(158[a])/17, preserved at paleobotanical laboratory VNIGRI.

LOCALITY OF HOLOTYPE. Western Cis-Urals. Solikamsk City—Kungurian stage of Lower Permian.

DESCRIPTION OF SPECIES. Dimensions: length of pollen grains 39.6 to 66.0μ, width 29.7 to 49.5μ.

Pollen grains oval in outline, flattened on distal side and convex on proximal side. Centrally located body has irregularly rounded shape and fairly thick exine, which surrounds it by a wide, darker colored "rimlet" with uneven contours.

The embracing air sack is interrupted on the distal side and thins greatly in the proximal side. The greatest thickness is on the sides of the body in the direction of the longitudinal axis of the pollen grain.

The air sack exine is thin, bearing small folds, radially spreading out from the body. Sculpture of the whole pollen grain exine is finely granular, becoming denser and somewhat coarser on the "rimlet" that surrounds the body. Color of pollen is slightly yellowish or yellow.

Number of specimens used for the description—33. Preservation is mostly good.

COMPARISONS AND REMARKS. The described pollen, when in lateral orientation, is similar to the double-sack pollen of the Pinaceae- and Podocarpaceae-conifer types. In proximal and distal orientation it resembles the pollen of *Cordaites*.

GEOGRAPHIC DISTRIBUTION AND AGE. Southern and western Cis-Urals. Aktyubinsk area—Kungurian stage of Lower Permian. Cherdyn' and Solikamsk areas—Kungurian stage of Lower Permian and Solikamsk suite of Upper Permian.

12. Florinites luberae sp. n. var. striata var. n.
Pl. VIII, fig. 3

Holotype. Pl. VIII, fig. 3 (from temporary preparation).

Locality of Holotype. Western Cis-Urals, Cherdyn' area, village of Pokcha. Kungurian stage of Lower Permian.

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Description of Variety. Dimensions: length of pollen grains 63.0μ, width 41.0μ.

Pollen grains, compressed when buried in distal-proximal orientation, have irregularly rounded outline. Centrally located body has widely ellipsoidal shape, and is surrounded by wide "rim" (optical section of exine thickness), which has a poorly expressed inner contour.

Air sack has greatest width in direction of longitudinal axis of pollen, and smallest in transverse direction.

Exine sculpture is uniform over the whole surface of the pollen, granular-ribbed, the rib-like bands essentially parallel to each other, but locally they are interrupted and wedge out. Color of pollen is light yellow.

Number of specimens used for the description of variety—4. Preservation is satisfactory.

Geographic Distribution and Age. Western and southern Cis-Urals. Cherdyn' and Aktyubinsk areas—Kungurian stage of Lower Permian.

13. Florinites sp.
Pl. XII, fig. 6 [also pl. XV, fig. 3]

Locality. Western Cis-Urals, Cherdyn' area, village of Seregovo. Solikamsk suite of Kazanian stage, Upper Permian.

Description. Dimensions: length of pollen grain 148.5μ, width 109.0μ.

Pollen grain irregularly elliptical in outline, somewhat flattened on one side. The centrally located, quite rounded body does not have a very clear contour, seemingly because the proximal side of the grain faces upward. The air sack, which embraces the body, has least width in the direction of the transverse axis of the pollen

grain (equals about ½ diameter of body), and greatest [width] in the direction of the longitudinal axis, where it is ⅔ of the diameter of the body.

Exine sculpture is uniform over the whole surface of pollen grain—granular and fine, not quite distinct network. Color is yellow.

Single specimen encountered in the deposits of the Solikamsk suite of Cherdyn' area, and not specifically determined.

Comparisons and Remarks. Similar pollen grains, but of slightly smaller size, were noted by M. A. Sedova also in the rocks of the Solikamsk suite of the Nytva area, where they were recorded under an index W[20] (1944).

In its large size, elliptical contour, rounded body outline, and the relationship of the width of air sacks, elongate along the longitudinal

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axis of the grain, the described pollen closely resembles that of the extinct conifer *Lebachia* (see pl. XV, figs. 2, 3).

IV. Pollen of Welwitschiaceae type

Genus Vittatina Luber 1940

14. Vittatina subsaccata sp. n.
Pl. IX, fig. 4a, b

Holotype. Pl. IX, fig. 4a. Slide No. 4(158[a])/13, preserved at paleobotanical laboratory VNIGRI.

Locality of Holotype. Western Cis-Urals, Solikamsk City. Kungurian stage of Lower Permian.

Description of Species. Dimensions: length of pollen grains 50.0 to 66.0μ, width 36.0 to 40.0μ.

Pollen grains bean-like in outline. Surrounded by double contour, which determines exine thickness in optical section. Outer line of contour finely wavy, inner line even. Pollen exine finely mized ribbing. On the opposite narrowed ends of the body the exine sculpture is wavy and reticulate, the network portions having no granular, covered by dense longitudinally parallel, locally dichoto-

sharp boundaries, with the remaining ribbed part of the body (incipient air sacks?). Color is yellow.

Number of specimens used for the description of species—62. Preservation is good.

VARIABILITY. A coarse granulation is observed in the narrowed parts of the body in some pollen. Boundaries of such parts are fairly sharp, which increases their similarity to the air sacks of the conifers. In the pollen whose exine ribbing is weaker the outer contour is more nearly even.

COMPARISONS AND REMARKS. Pollen of *Vittatina subsaccata* is connected through gradual, frequently difficult to determine, morphologic transitions, on one side with pollen of the conifers, supplied with a well determined air sack, and on the other side with the pollen of *Vittatina striata* Lub., which is devoid of air sacks, but the narrowed parts of whose body are separated from the rest of the surface by transverse rib folds (pl. IX, fig. 2a-b).

GEOGRAPHIC DISTRIBUTION AND AGE. Western and southern Cis-Urals. Solikamsk and Aktyubinsk areas—Kungurian stage of Lower Permian. Cherdyn' area—Kungurian stage of Lower Permian and Solikamsk suite of Kazanian stage, Upper Permian.

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15. VITTATINA STRIATA Lub. var. CRIBRATA var. n.
Pl. IX, fig. 3

HOLOTYPE. Pl. IX, fig. 3 (from temporary preparation).

LOCALITY OF HOLOTYPE. Western Cis-Urals, Cherdyn' area, village of Pokcha. Kungurian stage of Lower Permian.

DESCRIPTION OF VARIETY. Dimensions: length of pollen grains 66.0-80.0μ, width 40.0-50.0μ.

Pollen grains have bean-like outline when viewed laterally, and oval outline in proximal-distal orientation. Body exine is covered by oblique ribbing in two directions, which mutually cross at an angle to the long axis of the pollen. Width of scars or "ribs" is wider than width of grooves between them. In addition to being ribbed the exine is completely covered by granulation. Ribbing is reflected in outer contour by its intensely wavy line. Color is bright yellow.

Number of specimens used for description of variety—42. Preservation is good.

Comparisons and Remarks. The described variety differs from the basic form of *Vittatina striata* described by A. A. Luber (1941) in obliquely intersecting ribbed sculpture of exine. In this peculiar character the pollen is similar to the spores of *Schizaea laevigata* Mett., described by Selling from Melanesia in 1944 (compare fig. 3 and 4 of pl. XVII).

Geographic Distribution and Age. Southern and western Cis-Urals. Aktyubinsk area—Kungurian stage of Lower Permian. Cherdyn' area—Kungurian stage of Lower Permian and Solikamsk suite of Kazanian stage, Upper Permian.

16. Vittatina vittifer Lub. f. minor f. n.
Pl. VIII, fig. 5

Holotype. Pl. VIII, fig. 5 (from temporary preparation).

Locality of Holotype. Western Cis-Urals, Cherdyn' area, village of Pokcha. Kungurian stage of Lower Permian.

Description of Form. Dimensions: length of pollen grains 27.0μ, width 20.0μ.

Pollen grains small, oval in outline. Exine is thick, appearing as narrow rim in optical section. Exine sculpture is granular-ribbed.

The form differs from the species described by A. A. Luber (1941) in its much smaller size and its less distinct ribbing. Color is light yellow.

Number of specimens used for description of form—12. Preservation is good.

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Geographic Distribution and Age. Western Cis-Urals. Cherdyn' area—Kungurian stage of Lower Permian.

17. Vittatina vittifer Lub. f. cinctutus f. n.
Pl. X, fig. 2a, b

Holotype. Pl. X, fig. 2a (from temporary preparation).

Locality of Holotype. Western Cis-Urals, Cherdyn' area, village of Pokcha. Kungurian stage of Lower Permian.

Description of Form. Dimensions: length of pollen grains 60.0-73.0μ, width 33.0-41.0μ.

Pollen grains oval or bean-like in outline. There is a thick brown wavy fold-scar that runs along the body parallel to its long axis, or diagonally. Exine sculpture is granular-ribbed. Color is yellow.

Number of specimens used for description of form—31. Preservation is mostly mediocre.

Variability. In some pollen grains, side by side with very clear-cut longitudinal ribbing, there is a noticeable coarse granulation on narrowed parts of the body (fig. 2b).

Comparisons and Remarks. The described form differs from the species described by A. A. Luber (1941) in the presence of a longitudinal fold.

Geographic Distribution and Age. Southern and western Cis-Urals. Aktyubinsk area—Kungurian stage of Lower Permian. Cherdyn' area—Kungurian stage of Lower Permian, and Solikamsk suite of Kazanian stage, Upper Permian.

V. Pollen of undetermined systematic relationship

Genus Azonaletes Luber, 1935

18. Azonaletes pastillus sp. n.
Pl. I, fig. 2a, b

Holotype. Pl. I, fig. 2b (from temporary preparation).

Locality of Holotype. Western Cis-Urals, Cherdyn' area, village of Pokcha. Artinskian stage of Lower Permian.

Description of Species. Dimensions: diameter of pollen grains 36.0-82.0μ.

Pollen grains appear quite flat (result of fossilization?). Outline is rounded, with irregularly wavy line of outer contour.

Exine is thin, with rare and short folds caused by crushing. Exine sculpture is uniformly finely granular (when

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microscope tube is raised there appears a slight impression of fine network). Color is yellow.

Number of specimens used for description of species—11. Preservation is mediocre to poor.

VARIABILITY. Some pollen encountered have smooth contour and particularly a fine-grained sculpture of the exine (fig. 2a).

COMPARISONS AND REMARKS. In the absence of furrows or any other kind of opening in the envelope, and also in thinness and crushed state of the latter, the pollen of *A. pastillus* has some resemblance to the pollen of *A. (Tenuella) levis* Lub. It differs in its larger size and the invariably regularly rounded shape of *A. pastillus* pollen. Folding of its exine is much less intense, and sculpture in all cases is granular, whereas many of the pollen of *A. (Tenuella) levis* Lub. are very crushed and smooth. *A. pastillus* pollen, covered unevenly by a coarse network with rounded-angular meshes, are encountered in some horizons of the Artinskian deposits. Such a meshwork gives an impression of being secondary, as it is superposed over the basic granular sculpture. Usually in these same horizons other species of pollen grains are encountered (for instance pollen belonging to conifers), and they have similar changes in their exine sculpture.

GEOGRAPHIC DISTRIBUTION AND AGE. Western Cis-Urals. Cherdyn' area—Artinskian stage of Lower Permian.

19. AZONALETES FABAGINUS sp. n.
Pl. X, fig. 5a-c

HOLOTYPE. Pl. X, fig. 5a. Slide No. 1(158[a])/17, preserved at paleobotanical laboratory of VNIGRI.

LOCALITY OF HOLOTYPE. Western Cis-Urals, Solikamsk City. Kungurian stage of Lower Permian.

DESCRIPTION OF SPECIES. Dimensions: length of pollen grains 41.0-73.0μ; width 33.0-53.0μ.

Outline of pollen grains bean-like in lateral projection, elliptical from ventral and dorsal sides. Outer contour even, usually sharply outlined. Exine is crushed into larger and smaller folds. Exine is thin and single-layered on the ventral, flattened part of the body, while around the rest of the body two layers of the envelope are visible. Color is yellow.

Exine sculpture is coarsely granular on dorsal side of the body,

and finely granular, in some cases almost smooth, on the ventral side.

Number of specimens which were used for the description of species—39. Preservation is variable, frequently poor.

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VARIABILITY. Character of the exine sculpture is variable; in some pollen grains it is finely spinose or finely reticulate.

COMPARISONS AND REMARKS. No pollen grains of other species of the genus known to me are like those of the species described.

GEOGRAPHIC DISTRIBUTION AND AGE. Western and southern Cis-Urals. Solikamsk, Cherdyn', and Aktyubinsk areas—Kungurian stage of Lower Permian.

20. AZONALETES SUBRETICULATUS sp. n.
Pl. II, fig. 6; pl. X, fig. 8

HOLOTYPE. Pl. X, fig. 8 (from temporary preparation).

LOCALITY OF HOLOTYPE. Western Cis-Urals, Cherdyn' area, village of Pokcha. Kungurian stage of Lower Permian.

DESCRIPTION OF SPECIES. Dimensions: length of pollen grains 50.0-70.0μ, width 30.0-36.0μ.

Outline of pollen grains bean-like in lateral projections, oval from dorsal and ventral sides. Furrow or fissure of rupture is absent. Exine is thin, granular, covered by indefinite network. Outer contour is ordinary, uneven. Color is yellow.

Number of specimens on which description of species is based. —86. Preservation is mostly poor.

VARIABILITY. Some pollen grains have a very thick exine, which is indicated by a double contour line (pl. II, fig. 6).

COMPARISONS AND REMARKS. Pollen of *A. subreticulatus* resembles the pollen of *A. indefinitus* (see below), but differs from it in reticulate sculpture, greater thickness of exine, and darker color.

GEOGRAPHIC DISTRIBUTION AND AGE. Western and southern Cis-Urals. Cherdyn' area—Artinskian and Kungurian stages of Lower Permian. Aktyubinsk area—Artinskian stage.

21. Azonaletes indefinitus sp. n.
Pl. X, fig. 7

Holotype. Pl. X, fig. 7 (from temporary preparation).

Locality of Holotype. Aktyubinsk Cis-Urals, basin of Sintas River, section at village of Khazretovka. Kungurian stage of Lower Permian.

Description of Species. Dimensions: length of pollen grains 23.0-46.0μ, width 17.0-38.0μ.

Outline of pollen grains bean-like in lateral projection, in which position they are usually encountered in slides.

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Furrow or fissure of rupture is absent. Exine is very thin, in many cases torn on the pollen periphery, crushed into fine folds, which do not disturb, however, the regularity of the general bean-like outline. Exine sculpture is fine grained. Color is light yellow.

Number of specimens used for description of species—136. Preservation is mostly poor.

Variability. Color ranges from light yellow to pale greenish, almost colorless. Exine of some specimens is smooth.

Comparison. In extreme thinness of exine, light color, and small size, the pollen of *A. indefinitus* resembles that of *A. (Tenuella) levis* Lub. It differs in less intense exine folding, which is seemingly due to the greater strength of the latter, thanks to which *A. indefinitus* always preserves its regular bean-like shape, whereas the pollen of *A. (Tenuella) levis* Lub. frequently has a fanciful outline.

Distribution and Age. Western and southern Cis-Urals. Cherdyn' area—Kungurian stage of Lower Permian, and Solikamsk suite of Kazanian stage, Upper Permian. Aktyubinsk area—Kungurian stage.

22. Azonaletes irregulariplicatus sp. n.
Pl. I, fig. 9, pl. X, fig. 6

Holotype. Pl. I, fig. 9. (from temporary preparation).

Locality of Holotype. Western Cis-Urals, Cherdyn' area, village of Pokcha. Kungurian stage of Lower Permian.

Description of Species. Dimensions: length of pollen grain 41.0-56.0μ, width 33.0-36.0μ.

Pollen grains have oval outline from ventral and dorsal sides, and are bean-like laterally. Furrow or fissure of rupture is absent. Exine is covered by uneven, coarse-to-fine granulation. A characteristic peculiarity is the presence on the body of irregularly distributed, thick, gently waving, dark folds of variable width. In many cases the same folds are located on the dorsal side of the pollen grain, which in such cases appears much thickened (pl. X, fig. 6). Color is yellow.

Number of specimens used for description of species—98. Preservation is mostly mediocre.

Variability. Varied are the magnitude of exine granularity, and also thickness and number of folds, which are dispersed over the body surface.

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Comparisons and Remarks. The described pollen does not resemble the pollen of any other species of the genus.

Geographic Distribution and Age. Southern and western Cis-Urals. Aktyubinsk area—Artinskian stage of Lower Permian. Cherdyn' area—Artinskian and Kungurian stages of Lower Permian, and Solikamsk suite of Kazanian stage, Upper Permian.

Genus Pollenites Potonié, 1932

23. Pollenites sp.1
Pl. II, fig. 1

Locality. Western Cis-Urals, Cherdyn' area, village of Pokcha. Artinskian stage of Lower Permian.

Description. Dimensions: length of pollen grain 90.0μ, width 66.0μ.

The single pollen grain is fixed in lateral orientation, in which it has a bean-like outline. The dorsal side, the larger part of the body, with a convex line of the contour, is brown and has a coarser exine; exine is crushed into sparse folds and covered by not clearly observable coarse reticulation. The ventral, flattened

part of the body is light yellow in color. Its lighter shade is seemingly due to thinner exine, which is here also covered by a weak network. The boundary between the dorsal and ventral parts is expressed sharply. Color of pollen is brown.

One specimen of the pollen has been encountered in the Artinskian deposits of the Cherdyn' area, and was not specifically determined.

24. Pollenites sp.$_2$
Pl. I, fig. 10

Locality. Western Cis-Urals, Cherdyn' area, village of Pokcha. Artinskian stage of Lower Permian.

Description. Dimension: length of pollen grains 53.0-70μ width 36.0-41.0μ.

Pollen grains have oval outline. A poorly indicated furrow, in the form of an ordinary longitudinal line, occurs on the body. Exine sculpture is reticulate-granular. Meshes of the network are uniform, which gives the surface an excavated aspect. Outer contour is uneven. Color is bright yellow.

Encountered as isolated individuals in the Artinskian deposits of the Cherdyn' area and the species has not been determined.

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25. Pollenites sp.$_3$
Pl. II, fig. 2

Location. Western Cis-Urals, Cherdyn' area, village of Pokcha. Artinskian stage of Lower Permian.

Description. Dimensions: length of pollen grain 53.0μ, width 41.0μ.

Pollen grain of broadly oval outline, somewhat acuminate at ends. A noticeable longitudinal furrow, along which is developed a wide fold-like thickening, has a brown coloration. Exine sculpture is finely tuberculate. Color of pollen is yellow.

A single specimen of pollen has been encountered in the Artinskian deposits of the Cherdyn' area, and has not been determined.

VI. Spores of Pteridophyta

Genus Azonotriletes Luber, 1935

26. Azonotriletes (Spinosella) selaginelliformis sp. n.
Pl. XI, fig. 7

1939. *Spinosella obtusosetosa* Luber, A. A. Korrelyatsiya po sporam uglenosnykh otlozhenii verkhnego paleozoya, fig. 1, pl. A, f_1.

1941. *Azonotriletes obtusosetosus* Luber. A. A. Luber, i I. E. Val'ts. Atlas mikrospor i pyl'tsy paleozoya SSSR, pl. XIV, fig. 239a, c.

Holotype. Pl. XI, fig. 7 (from temporary preparation).

Locality of Holotype. Western Cis-Urals, Cherdyn' area, village of Pokcha. Kungurian stage of Lower Permian.

Description of Species. Dimensions: diameter of spores 20.0-26.0μ.

Outline of spores rounded-triangular. Length of fissure of rupture equals ⅔ of body radius, but because of the bold relief of the exine sculpture it is not clearly recognizable.

Spore surface is covered by irregularly scattered spines with blunt apices. Spines fairly long, some are somewhat bent; they project sharply beyond the line of the outer pollen contour. Color of spores is light yellow.

Number of specimens used for the description of species—2. Preservation is very good.

Variability. Only the length of the spines is somewhat variable.

Comparison and Remarks. In body outline, length and character of rupture fissure, and peculiarity of exine sculpture with blunt-ended spines, the spores of *Spinosella selaginelliformis* are very similar to the spores of *Selaginella polystachya* (Warb.) Hieron, illustrated in the work by E. Knox (1950, pl. XIV, fig. 147); compare pl. XVII, figs. 7 and 8.

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It is quite possible that the spinose spores of the genus *Azonotriletes (Spinosella)* described by A. A. Luber (1941) are analogous to the extant spores that belong to the lycopods of the family Sela-

ginellaceae, because (judging by the data of E. Knox, who investigated the spores of more than 200 species of *Selaginella*) among the latter there are many species morphologically similar to the spinose forms illustrated by A. A. Luber from the Permian deposits of the Tungusk paleofloristic province.

Geographic Distribution and Age. Western Cis-Urals, Cherdyn' area—Kungurian stage of Lower Permian. Tungusk and Kuznetsk coal basins. Vorkutin coal-bearing deposits of Pechora River, and Kenderlyk coal-bearing deposits of Kazakhstan—Permian deposits.

27. Azonotriletes osmundae sp. n.
Pl. XIV, fig. 5

Holotype. Pl. XIV, fig. 5 (from temporary preparation).

Locality of Holotype. Western Cis-Urals, Cherdyn' area, village of Seregovo. Solikamsk suite of Kazanian stage, Upper Permian.

Description of Species. Dimensions: diameter of spores 39.0-48.0μ.

Spores rounded in outline. Fissure of rupture generally unopen, long (¾ of radius). Exine sculpture is finely tuberculate, clear-cut. Tubercles not densely spaced, of varied size, and when viewed in plane have a round-angular outline. Outer contour of spores uneven, finely wavy. Color is yellow.

Number of specimens used for description of species—29. Preservation is good.

Variability. The length of the fissure and the density of tubercle spacing are variable.

Comparisons and Remarks. In shape, dimensions, length of rupture fissure, and sculpture, the described spores resemble closely the spores of *Osmunda* ferns (Osmundaceae), especially of the species *O. cinnamomea* L., described by M. A. Sedova (1950) (see pl. XVII, figs. 9 and 10).

Geographic Distribution and Age. Western Cis-Urals, Cherdyn' area, village of Seregovo, Solikamsk suite of Kazanian stage, Upper Permian.

Genus Azonomonoletes Luber, 1935

28. Azonomonoletes marattiiformis sp. n.
Pl. II, fig. 7

Holotype. Pl. II, fig. 7 (from temporary preparation).

Locality of Holotype. Western Cis-Urals, Cherdyn' area, village of Pokcha. Artinskian stage of Lower Permian.

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Description of Species. Dimensions of spores 30.0-33.0μ.

Spores rounded or elliptical in outline. Fissure of rupture is single-rayed, with simple, even edges, not always clearly discernible.

Exine sculpture is coarsely-spinose. Spines are fairly densely spaced, have broad bases, and acuminate ends. Because of unevenness of the exine the spore contour is extraordinarily wavy. Color is dark yellow.

Number of specimens on which description is based—6. Preservation is good.

Variability. Spores range in shape from rounded to ellipsoidal.

Comparisons and Remarks. In shape, single-rayed rupture fissure, and exine spinosity, the spores of *A. marattiiformis* are similar to the spores of *Danaea* of the family Marattiaceae (see pl. XVII, fig. 5) described by M. A. Sedova (1950). The latter possess somewhat thinner, more densely distributed spines.

Distribution and Age. Western Cis-Urals. Cherdyn' area—Artinskian stage of Lower Permian (in isolated specimens), and Solikamsk suite of Kazanian stage, Upper Permian.

[Genus Zonomonoletes Naumova, 1937]

29. Zonomonoletes turboreticulatus sp. n.
Pl. XI, fig. 13a, b

Holotype. Pl. XI, fig. 13a. Slide No. 3(158[a])/17 preserved at paleobotanical laboratory VNIGRI.

Locality of Holotype. Western Cis-Urals. Solikamsk City—Kungurian stage of Lower Permian.

DESCRIPTION OF SPECIES. Dimensions: length of spores 36.0-50.0μ, width 38.0-40.0μ.

Spores elliptical or rounded-elliptical in outline. The narrow and short single-rayed rupture fissure is longitudinally and centrally located. Rim is not wide, with wavy outer contour, and an even and double inner contour.

Exine sculpture of body and rim is densely reticulate, particularly dense on rim and in "narrowed" part of body at the ends of rupture fissure. On either side of the fissure the exine sculpture is very slightly developed—dotted or finely granular. Color is yellow.

Number of specimens used for description of species—47. Preservation is good.

VARIABILITY. Variability is fairly great, being expressed in the change of exine sculpture, now more and now less

[p. 54]

distinctly reticulate. Width of rim is also variable (from 3.0 to 7.0μ). Areas on narrowed parts, covered by particularly dense network, occasionally acquire fairly sharp bow [lunar] outline (fig. 13b). Length of rupture fissure also varies.

COMPARISONS AND REMARKS. There is some similarity to *Cordaitina subrotata* (Lub.), but *Z. turboreticulatus* differs in the presence of a rupture fissure and in possessing the areas of particularly dense network on narrowed parts of the body.

GEOGRAPHIC DISTRIBUTION AND AGE. Western and southern Cis-Urals. Solikamsk, Cherdyn', and Aktyubinsk areas—Kungurian stage of Lower Permian.

30. ZONOMONOLETES TURBORETICULATUS sp. n.
var. GRANULATUS var. n.
Pl. XI, fig. 14

HOLOTYPE. Pl. XI, fig. 14 (from temporary preparation).

LOCALITY OF HOLOTYPE. Western Cis-Urals, Cherdyn' area, village of Pokcha. Kungurian stage of Lower Permian.

DESCRIPTION OF VARIETY. Dimensions: length of spores 40.0μ, width 23.0μ.

Spores of the variety differ from basic spores of the species in

somewhat smaller size, and also in clear-cut finely granular exine sculpture over the whole body and rim. Color is bright yellow.

Number of specimens used for description of variety—4. Preservation is mediocre.

GEOGRAPHIC DISTRIBUTION AND AGE. Western Cis-Urals, Cherdyn' area, Kungurian stage of Lower Permian.

Genus ZONOTRILETES Waltz, 1935

31. ZONOTRILETES CONCORDIS sp. n.
Pl. XI, fig. 8

HOLOTYPE. Pl. XI, fig. 8 (from temporary preparation).

LOCALITY OF HOLOTYPE. Western Cis-Urals, Cherdyn' area, village of Pokcha. Kungurian stage.

DESCRIPTION OF SPECIES. Dimension of spores 26.0μ.

Outline of spores is triangular with rounded ends. Rupture fissure is very short (1/5 of radius), very poorly discernible. Width of rim is about ⅓ of radius, with even outer and inner contours.

Exine sculpture on body and rim is not clearly expressed, granular-fine network. Color is yellow.

[p. 55]

Number of specimens used for description of species—7. Preservation is good.

COMPARISONS AND REMARKS. In size and relationship of body diameter and rim width the described spores are close to the spores of *Z. tersus* Waltz. The latter differ in somewhat more rounded outline, longer rupture fissure, and smooth exine.

GEOGRAPHIC DISTRIBUTION AND AGE. Western Cis-Urals, Cherdyn' area, Kungurian stage of Lower Permian.

32. ZONOTRILETES ROTUNDUS sp. n.
Pl. XI, fig. 9

HOLOTYPE. Pl. XI, fig. 9 (from temporary preparation).

LOCALITY OF HOLOTYPE. Western Cis-Urals, Cherdyn' area, village of Pokcha. Kungurian stage of Lower Permian.

DESCRIPTION OF SPECIES. Dimensions: spore diameter 23.0μ.

Spore has a round outline. Rupture fissure is very short (¼ of

radius), barely perceptible. Rim is very broad (more than ½ of radius), with wavy outer and inner contours.

Exine sculpture is finely granular, denser on rim, which results in the rim having a slightly darker color. Color is dark yellow.

Number of specimens used for description of species—4. Preservation is mediocre.

Comparisons and Remarks. There are no similar spores of other species of the genus known to me.

Geographic Distribution and Age. Western Cis-Urals. Cherdyn' area—Kungurian stage of Lower Permian.

33. Zonotriletes rarus sp. n.
Pl. XIV, fig. 8

Holotype. Pl. XIV, fig 8 (from temporary preparation).

Locality of Holotype. Western Cis-Urals, Cherdyn' area, village of Seregovo. Solikamsk suite of Kazanian stage, Upper Permian.

Description of Species. Dimensions: length of spores 36.0μ, width 23.0μ.

Spore is bean-like in outline. Rupture fissure is very short (about 1/5 of radius). Rim (exine thickness?) is about ⅓ of radius. It is colored darker than the body, and covered by hachures parallel to outer contour of spore.

[p. 56]

Exine sculpture of body is hetero-granular. Color is yellowish brown.

Number of specimens used for description of species—5. Preservation is good.

Comparisons and Remarks. There are no similar spores of other species of the genus known to me.

Geographic Distribution and Age. Western Cis-Urals. Cherdyn' area—Solikamsk suite of Kazanian stage, Upper Permian.

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ALPHABETICAL LIST OF FIGURED SPECIMENS*

Name	Description page (original text)	Plate and figure
Azonaletes (Rigidella) bulbiferus Lub.		I, 1
Azonaletes (Subreticosina) compactus Lub.		I, 3
Azonaletes fabaginus sp. n.	47	X, 5
Azonaletes indefinitus sp. n.	48	X, 7
Azonaletes irregulariplicatus sp. n.	49	I, 9; X, 6
Azonaletes (Tenuella) levis Lub.		II, 3; X, 3; XIV, 2
Azonaletes microdictyus Lub.		X, 4
Azonaletes pastillus sp. n.	46	I, 2
Azonaletes subreticulatus sp. n.	48	II, 6; X, 8
Azonaletes (Rugosina) tenuis Lub.		XIV, 1
Azonomonoletes marattiiformis sp. n.	52	II, 7; XI, 6; XVII, 6
Azonotriletes cf. *gibbosus* (Ibr.)		II, 5
Azonotriletes cf. *notatus* Lub.		XIV, 4
Azonotriletes osmundae sp. n.	52	XIV, 5; XVII, 10
Azonotriletes cf. *perforatus* Lub.		XI, 3
Azonotriletes polypyrenus Lub.		XI, 2
Azonotriletes punctatus Waltz		II, 4
Azonotriletes (Spinosella) rectispina Lub.		XI, 5
Azonotriletes cf. *resistens* Lub.		XI, 4; XIV, 3
Azonotriletes (Spinosella) selaginelliformis sp. n.	51	XI, 7; XVII, 8
Calamospora hartungiana Schopf		XI, 1
Coniferites nudus (Lub.)		I, 12; VIII, 1; XII, 4
Cordaianthus sp. Florin		XVI, 4
Cordaitina convallata (Lub.)		I, 11; II, 9
Cordaitina ornata sp. n.	28	III, 1
Cordaitina rugulifer [*ragulifer?*] (Lub.)		II, 8
Cordaitina cf. *spongiosa* (Lub.)		III, 3; XIII, 1; XVI, 3
Cordaitina subrotata (Lub.)		II, 10
Cordaitina uralensis (Lub.)		II, 11; III, 2; XIII, 2
Cordaitina uralensis f. *striata* f. n.	29	XIII, 3
Danaea dubia Presl.		XVII, 5
Florinites sp.	43	XII, 6; XV, 3
Florinites sp. *S. W.* and *B.*		XVI, 2
Florinites luberae sp. n.	42	VIII, 2; XV, 1; XVI, 1
Florinites luberae sp. n. var. *striata* var. n.	42	VIII, 3
Ginkgocycadophytus sp.	32	III, 4

* This list does not appear in the original.

PLATE I

LOWER PERMIAN. ARTINSKIAN STAGE.

FIG. 1a, b. *Azonaletes (Rigidella) bulbiferus* Lub., x580.
Cherdyn' area, village of Pokcha.

FIG. 2a, b. *Azonaletes pastillus* sp. n., x580; p. 46.
Cherdyn' area, village of Pokcha.

FIG. 3. *Azonaletes (Subreticosina) compactus* Lub., x580.
Aktyubinsk area, Sintas River, Khazretovka section.

FIG. 4. *Ginkgocycadophytus retroflexus* (Lub.), x580.
Cherdyn' area, village of Pokcha.

FIG. 5. *Ginkgocycadophytus erosus* (Lub.), x580.
Aktyubinsk area, Sintas River, Khazretovka section.

FIG. 6. *Ginkgocycadophytus caperatus* var. *spinosus* var. n., x580; p. 31.
Cherdyn' area, village of Pokcha.

FIG. 7. *Ginkgocycadophytus caperatus* (Lub.), x580.
Cherdyn' area, village of Pokcha.

FIG. 8. *Protohaploxypinus prolixus* (Lub.) x580.
Cherdyn' area, village of Pokcha.

FIG. 9. *Azonaletes irregulariplicatus* sp. n., x580; p. 49.
Cherdyn' area, village of Pokcha.

FIG. 10. *Pollenites* sp.$_2$, x580; p. 50.
Cherdyn' area, village of Pokcha.

FIG. 11. *Cordaitina convallata* (Lub.), x580.
Cherdyn' area, village of Pokcha.

FIG. 12. *Coniferites nudus* (Lub.), x580.
Cherdyn' area, village of Pokcha.

PLATE I

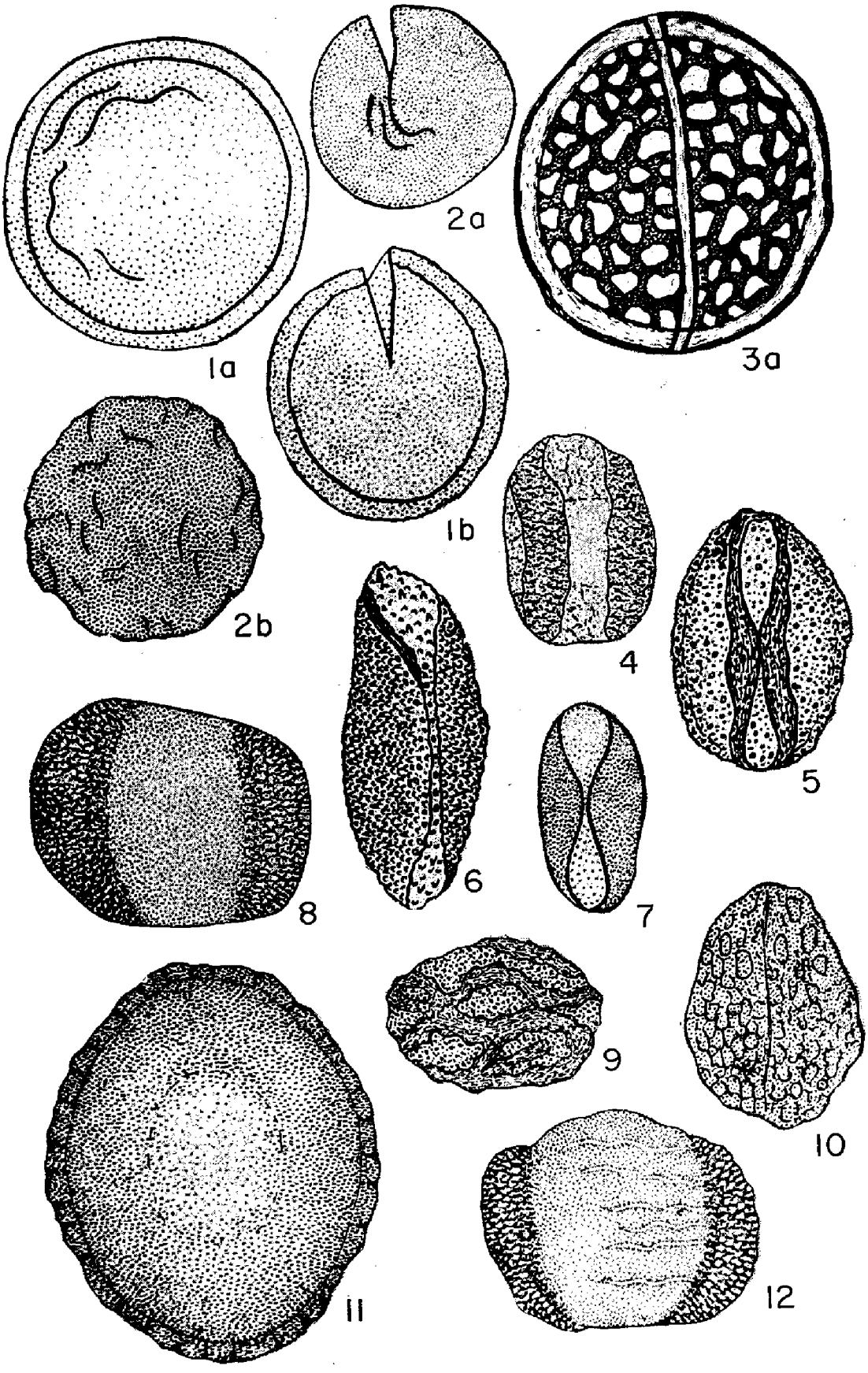


PLATE II

LOWER PERMIAN. ARTINSKIAN STAGE (CONTINUED).

FIG. 1. *Pollenites* sp.$_1$ x580; p. 50.
Cherdyn' area, village of Pokcha.

FIG. 2. *Pollenites* sp.$_3$ x580; p. 51.
Cherdyn' area, village of Pokcha.

FIG. 3a, b. *Azonaletes (Tenuella) levis* Lub., x580.
Cherdyn' area, village of Pokcha.

FIG. 4. *Azonotriletes punctatus* Waltz, x580.
Cherdyn' area, village of Pokcha.

Fig. 5. *Azonotriletes* cf. *gibbosus* (Ibr.) Lub., x580.
Cherdyn' area, village of Pokcha.

FIG. 6. *Azonaletes subreticulatus* sp. n., x580; p. 48.
Cherdyn' area, village of Pokcha.

FIG. 7. *Azonomonoletes marattiiformis* sp. n., x580; p. 52.
Cherdyn' area, village of Pokcha.

LOWER PERMIAN. KUNGURIAN STAGE.

FIG. 8. *Cordaitina rugulifer** (Lub.), x580.
Solikamsk City, salt-mine shaft.

FIG. 9. *Cordaitina convallata* (Lub.), x580.
Cherdyn' area, village of Pokcha.

FIG. 10. *Cordaitina subrotata* (Lub.), x580.
Solikamsk City, salt-mine shaft.

FIG. 11. *Cordaitina uralensis* (Lub.), x580.
Cherdyn' area, village of Pokcha.

* Spelled **ragulifer** on page 8 of original text.

PLATE II

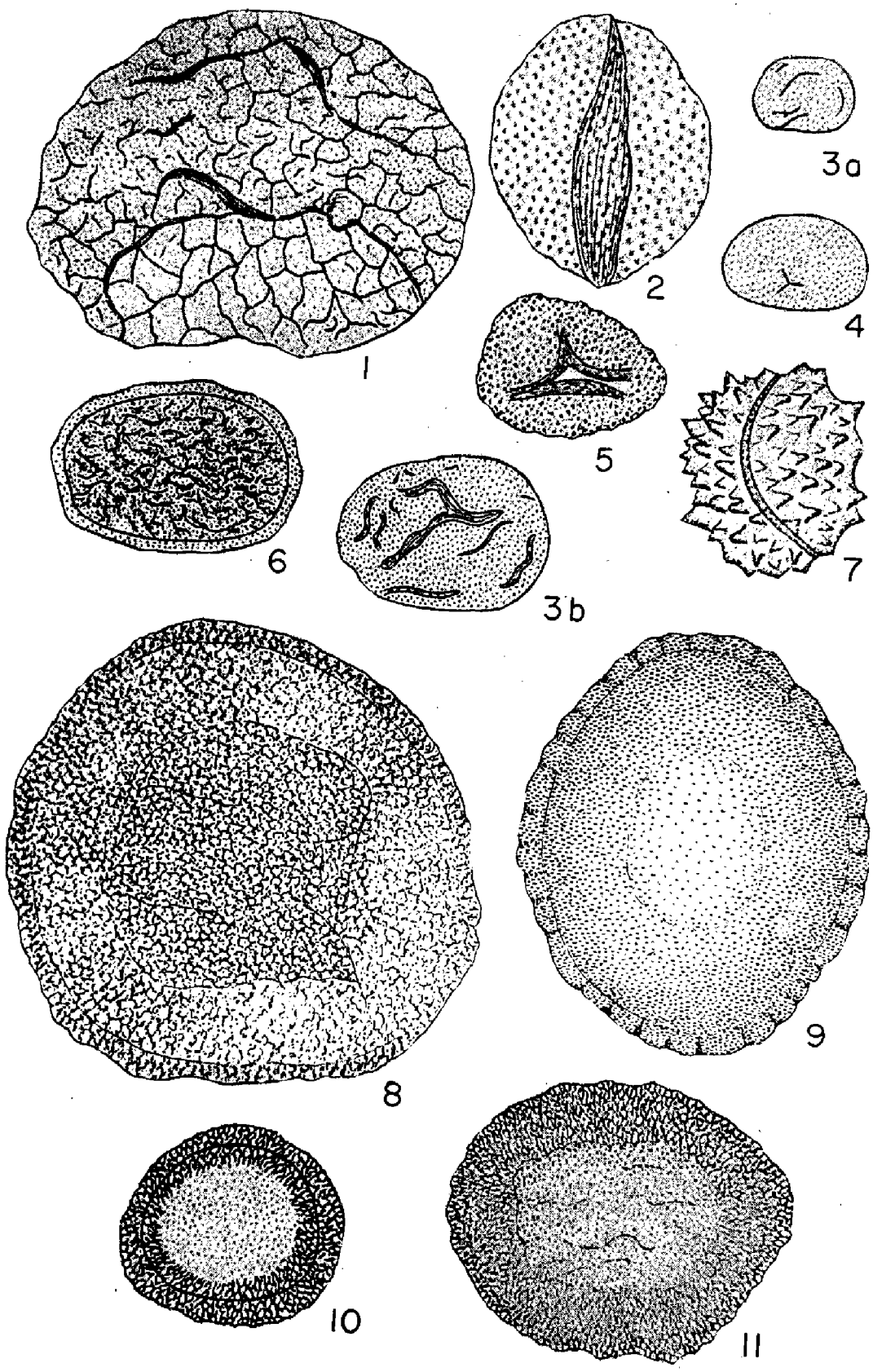


PLATE III

LOWER PERMIAN. KUNGURIAN STAGE.

FIG. 1a. *Cordaitina ornata* sp. n., x450; p. 28.
Solikamsk area (after A. A. Luber, Pl. III, fig. 9, 1940).

FIG. 1b. *Cordaitina ornata* sp. n., x580; p. 28.
Solikamsk City, salt-mine shaft.

FIG. 2. *Cordaitina uralensis* (Lub.), x750.
Cherdyn' area, village of Pokcha.

FIG. 3. *Cordaitina* cf. *spongiosa* (Lub.), x580.
Solikamsk City, salt-mine shaft.

Fig. 4. *Ginkgocycadophytus* sp., x580; p. 32.
Cherdyn' area, village of Pokcha.

FIG. 5. *Ginkgocycadophytus erosus* (Lub.), x580.
Solikamsk City, salt-mine shaft.

FIG. 6. *Ginkgocycadophytus subrotatus* (Lub.), x580.
Solikamsk City, salt-mine shaft.

FIG. 7a, b. *Ginkcocycadophytus retroflexus* Lub., x580.
Solikamsk City, salt-mine shaft.

FIG. 8. *Ginkgocycadophytus tunguskensis* (Lub.).
Cherdyn' area, village of Pokcha.

PLATE III

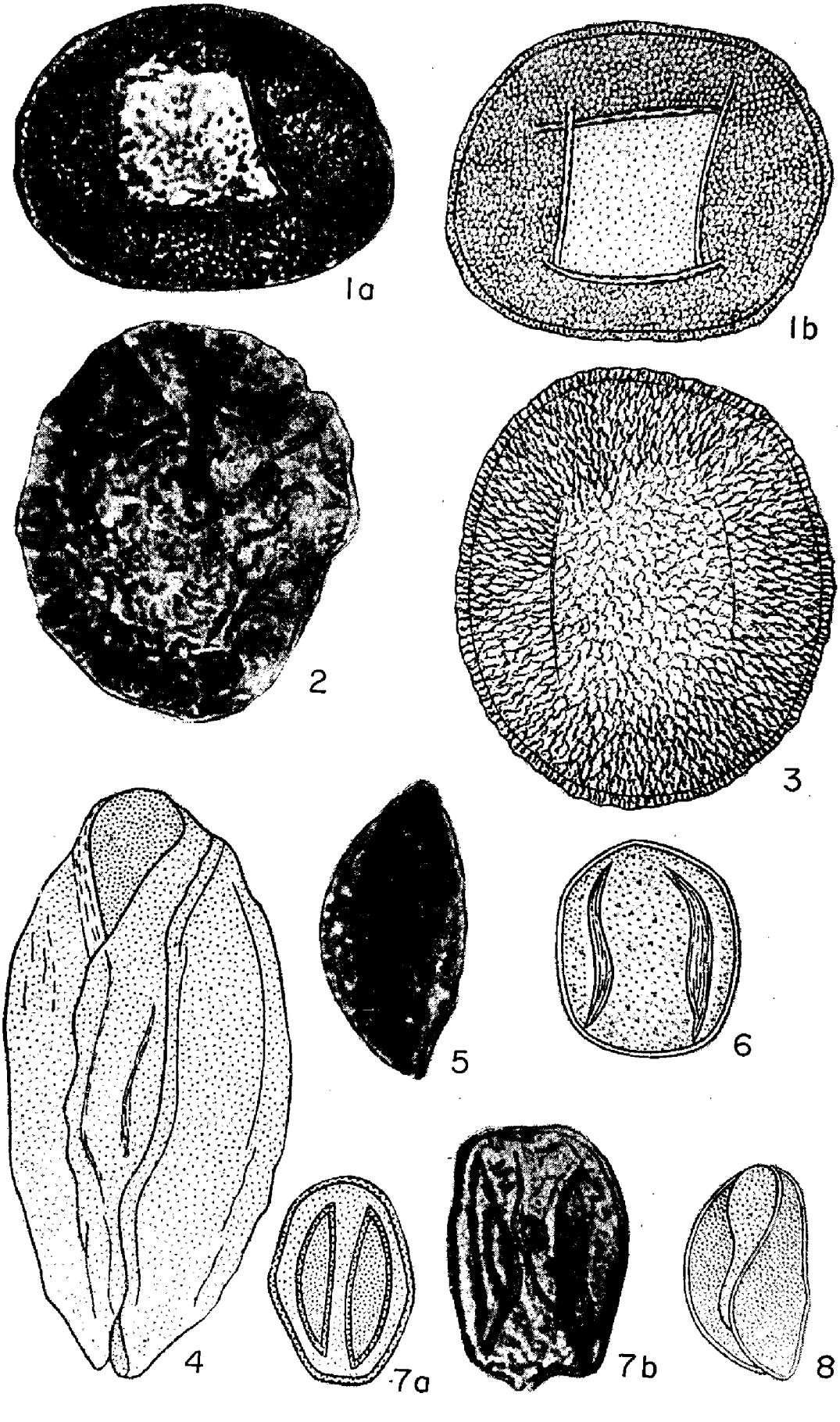


PLATE IV

LOWER PERMIAN. KUNGURIAN STAGE.

FIG. 1a, b. *Protodiploxypinus bullaeformis* sp. n.; p. 33.
Fig. 1a. x750, Solikamsk City, salt-mine shaft;
Fig. 1b. x580, Cherdyn' area, village of Pokcha.

FIG. 2a, b. *Protodiploxypinus silvestritypus* sp. n., x580; p. 34.
Fig. 2a. Cherdyn' area, village of Bondyug;
Fig. 2b. Cherdyn' area, village of Pokcha.

FIG. 3. *Protodiploxypinus giganteus* sp. n., x580; p. 35.
Solikamsk City, salt-mine shaft.

FIG. 4. *Protohaploxypinus latissimus* (Lub.), x580.
Solikamsk City, salt-mine shaft.

PLATE IV

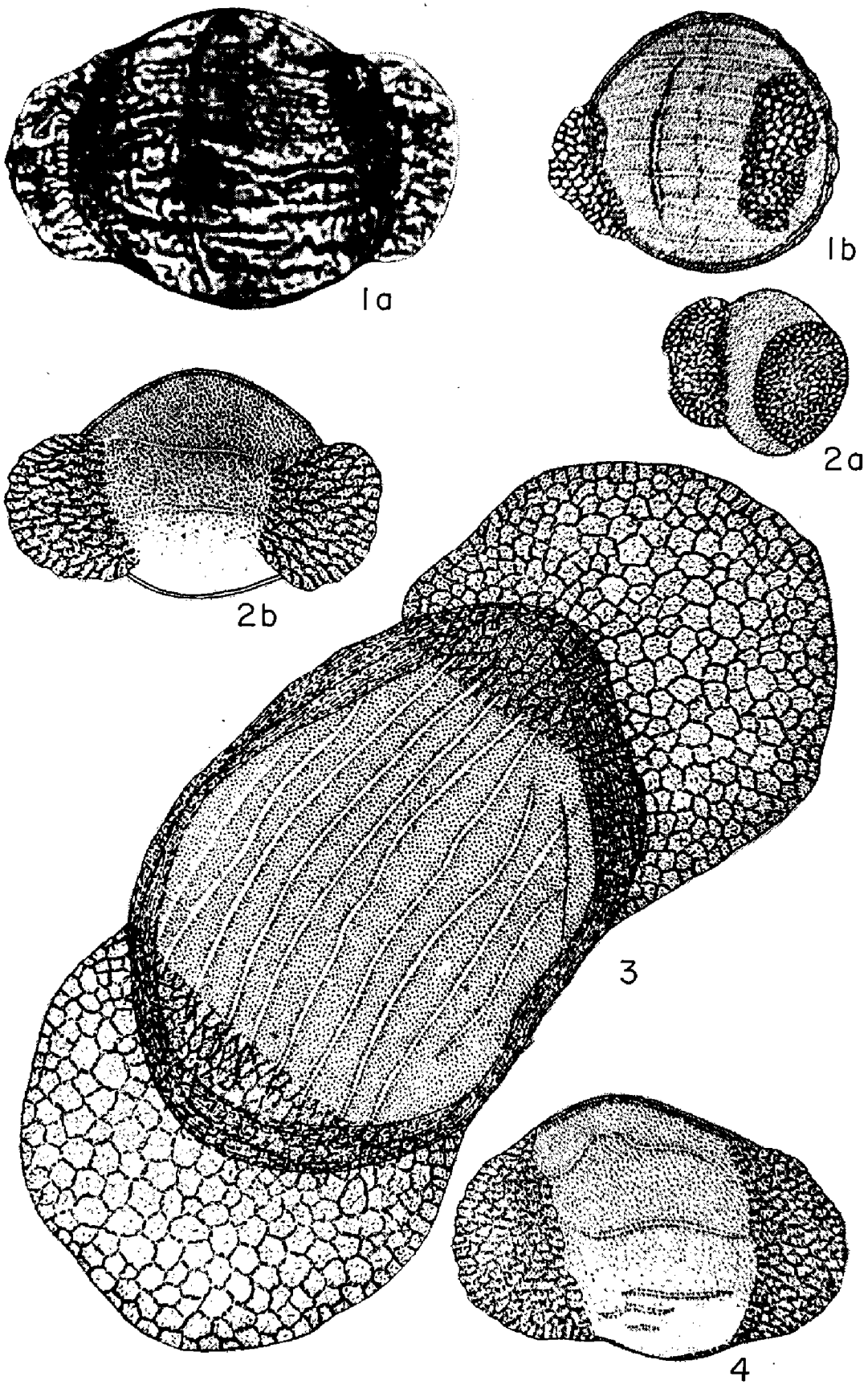


PLATE V

LOWER PERMIAN. KUNGURIAN STAGE.

FIG. 1. *Protodiploxypinus giganteus* sp. n., x750; p. 35.
Solikamsk City, salt-mine shaft.

PLATE V

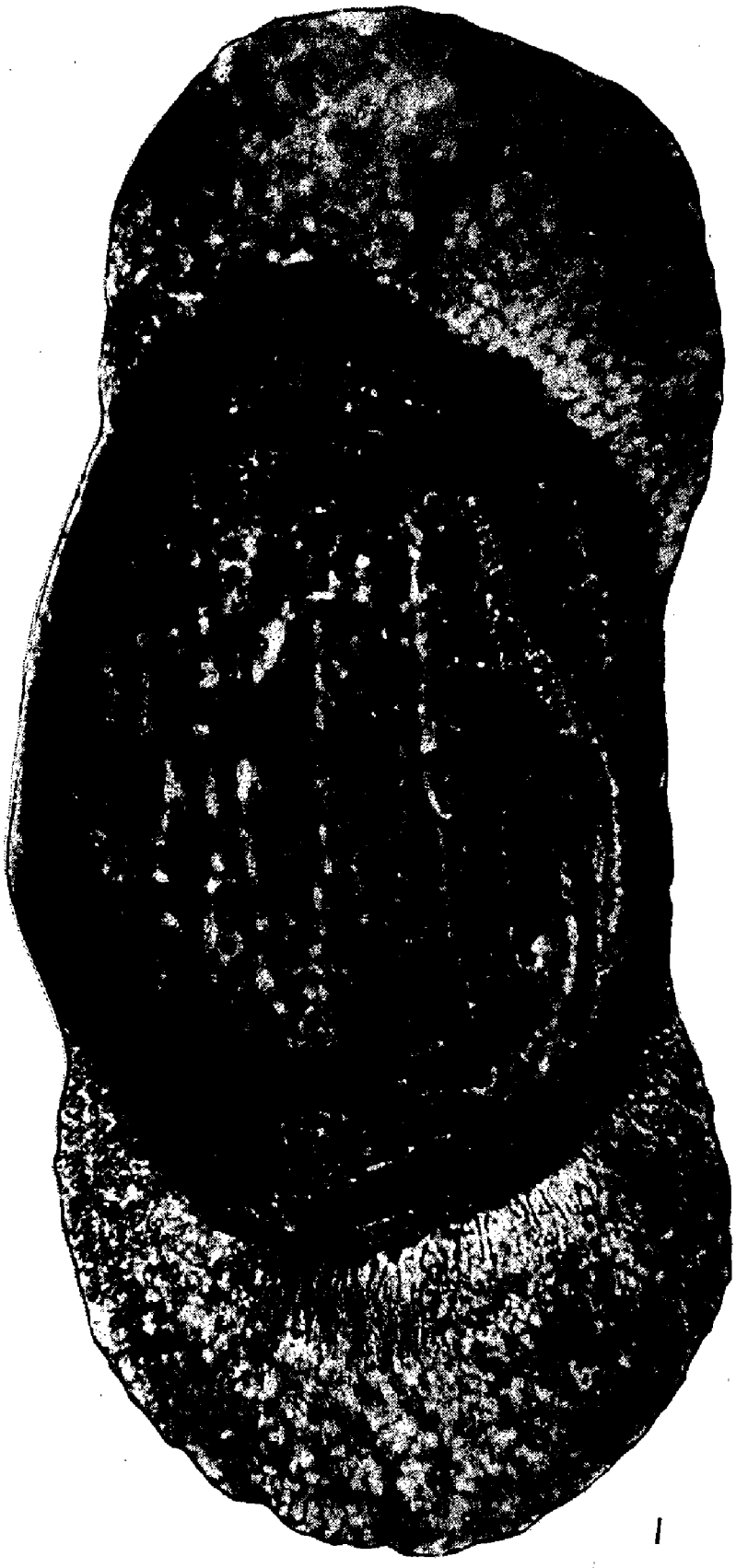


PLATE VI

LOWER PERMIAN. KUNGURIAN STAGE.

FIG. 1a-c.* *Protohaploxypinus perfectus* (Naum.).
Fig. 1a, b. x750, Solikamsk City, salt-mine shaft;
Fig. 1c. x580, Cherdyn' area, village of Pokcha.

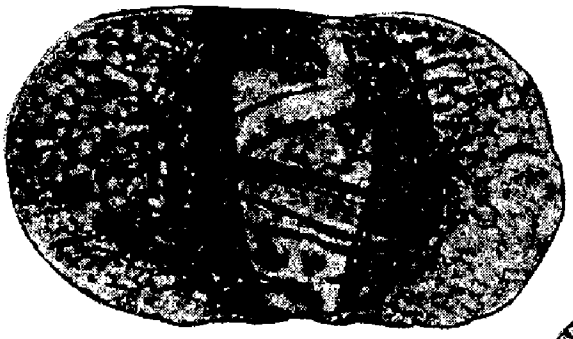
FIG. 2a, b. *Protohaploxypinus prolixus* (Lub.)
Fig. 2a. x750; Fig. 2b. x580;
Cherdyn' area, village of Pokcha.

FIG. 3a, b. *Protohaploxypinus tecturatus* (Lub.).
Fig. 3a. x580; Fig. 3b. x750;
Solikamsk City, salt-mine shaft.

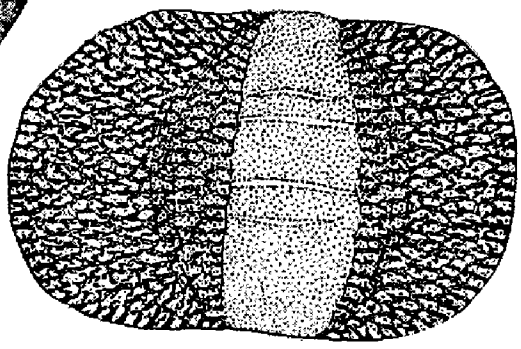
* Figure numbers have been modified to conform with the English alphabet. The first four letters of the Russian alphabet are transliterated as a, b, v, and g. In place of v and g the corresponding third and fourth letters of the English alphabet, c and d, are used here.

PLATE VI

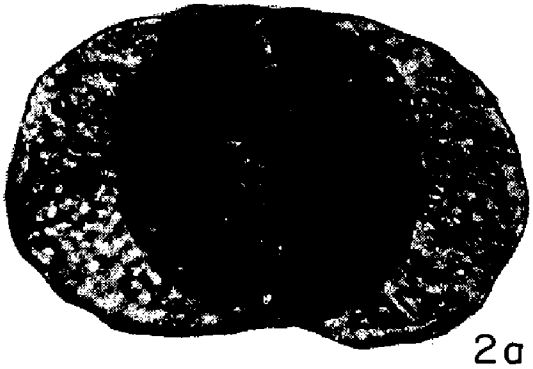
1a



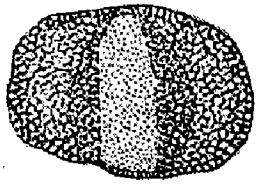
1b



1c

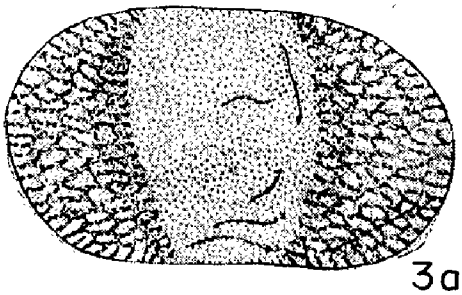


2a



2b

3b



3a

PLATE VII

LOWER PERMIAN. KUNGURIAN STAGE.

FIG. 1a-d.* *Protocedrus parviextensisaccus* sp. n., p. 38.
Fig. 1a, c, d. x580, Cherdyn' area, village of Pokcha.
Fig. 1b. x750, Solikamsk City, salt-mine shaft.

FIG. 2. *Protocedrus* sp., x580; p. 39.
Cherdyn' area, village of Pokcha.

FIG. 3a-c.* *Protopodocarpus alatus* (Lub.).
Fig. 3a, c. x750, Solikamsk City, salt-mine shaft.
Fig. 3b. x580, Cherdyn' area, village of Pokcha.

* See footnote, page 80.

PLATE VII

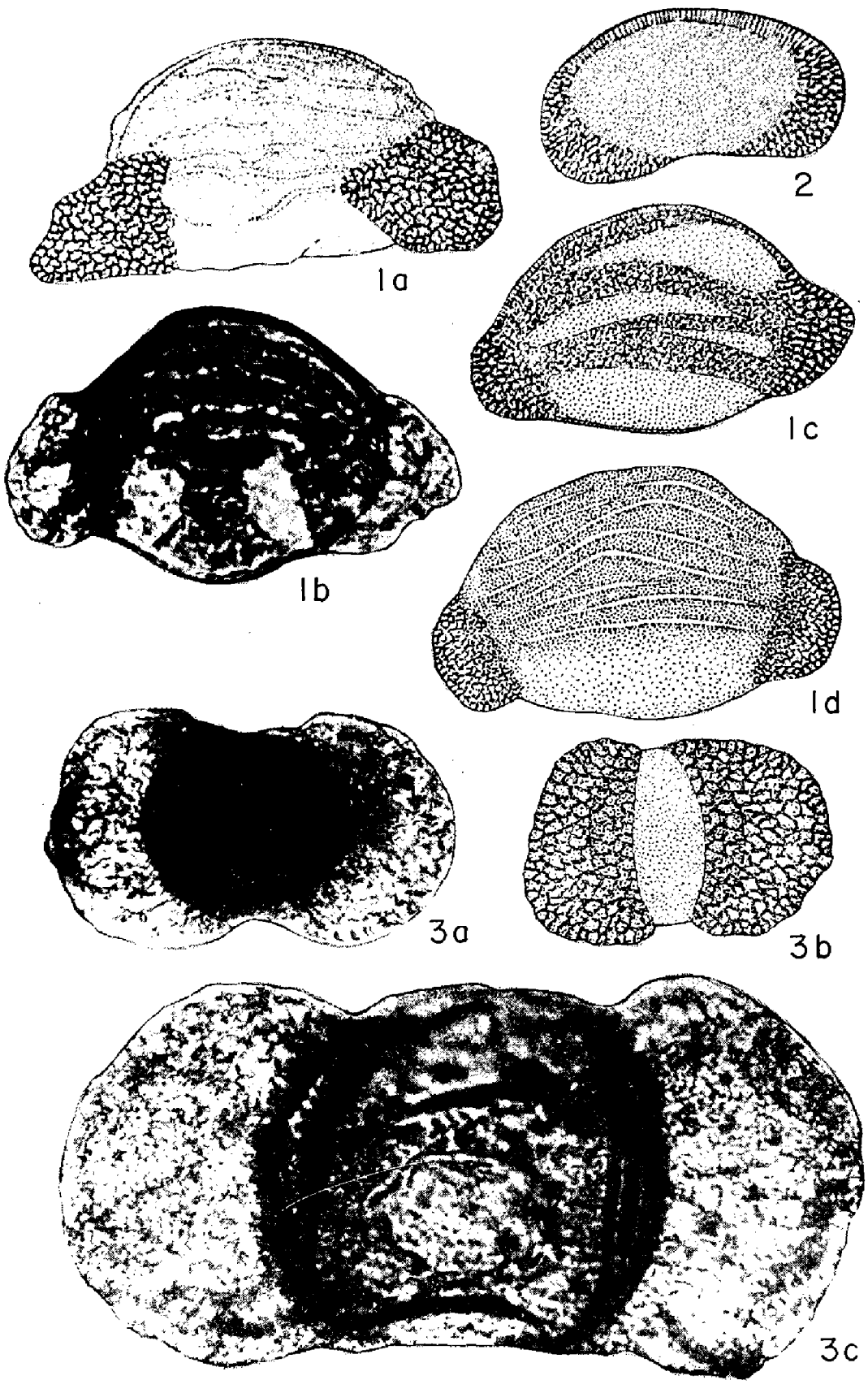


PLATE VIII

LOWER PERMIAN. KUNGURIAN STAGE.

FIG. 1a, b. *Coniferites nudus* (Lub.), x580.
Fig. 1a. Aktyubinsk area, Sintas River, Khazretovka section;
Fig. 1b. Cherdyn' area, village of Pokcha.

FIG. 2a, b. *Florinites luberae* sp. n.; p. 42.
Fig. 2a. x750—proximal orientation; Fig. 2b. x580—lateral orientation.
Solikamsk City, salt-mine shaft.

FIG. 3. *Florinites luberae* sp. n. var. *striata* var. n., x580; p. 42.
Cherdyn' area. village of Pokcha.

FIG. 4a-d.* *Vittatina vittifer* Lub., x580.
Fig. 4a. Proximal orientation, Solikamsk City, salt-mine shaft.
Fig. 4b, d. Lateral orientation.
Fig. 4c. Proximal orientation. Cherdyn' area, village of Pokcha.

FIG. 5. *Vittatina vittifer* f. *minor* f. n., x580; p. 45.
Cherdyn' area, village of Pokcha.

FIG. 6. *Vittatina striata* Lub., x750.
Solikamsk City, salt-mine shaft.

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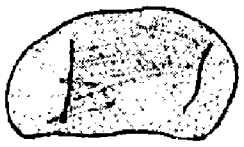
* See footnote, page 80.

PLATE VIII



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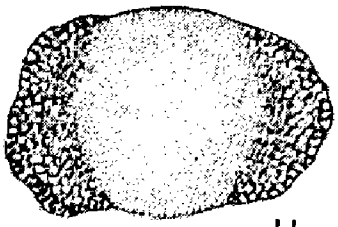
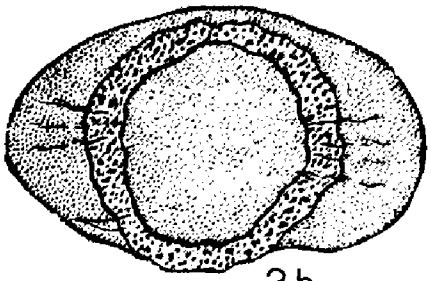


1b

2a



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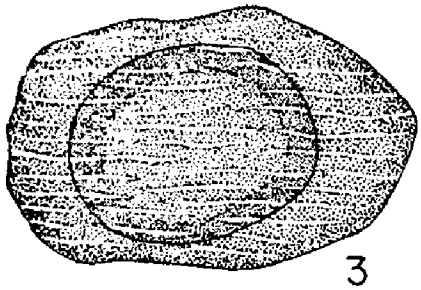

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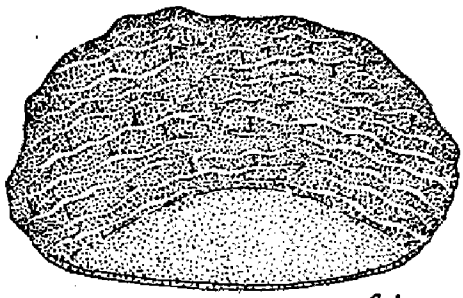

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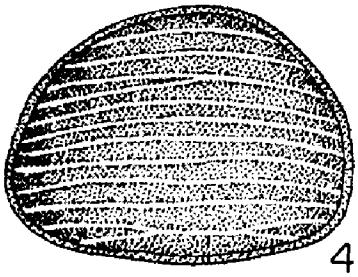

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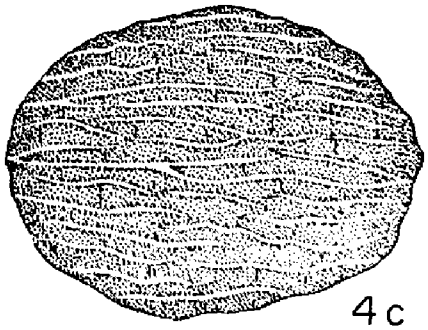

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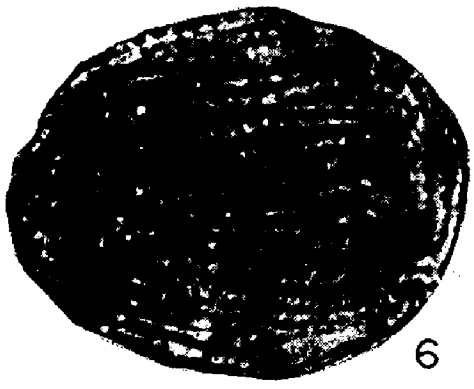

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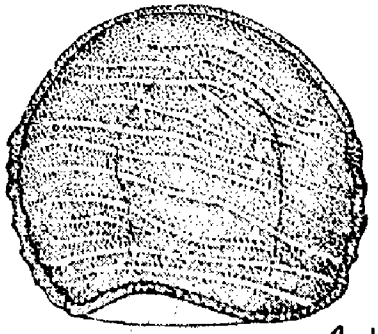

4d

PLATE IX

LOWER PERMIAN. KUNGURIAN STAGE.

FIG. 1. *Vittatina vittifer* Lub., x750.
Cherdyn' area, village of Pokcha.

FIG. 2a-c.* *Vittatina striata* Lub., x580.
Fig. 2a, b. Proximal orientation;
Fig. 2c. Lateral orientation;
Solikamsk City, salt-mine shaft.

FIG. 3. *Vittatina striata* Lub. var. *cribrata* var. n.; p. 45.
Cherdyn' area, village of Pokcha.

FIG. 4a, b. *Vittatina subsaccata* sp. n.; p. 44.
Fig. 4a. x750, Cherdyn' area, village of Pokcha;
Fig. 4b. x580, Solikamsk City, salt-mine shaft.

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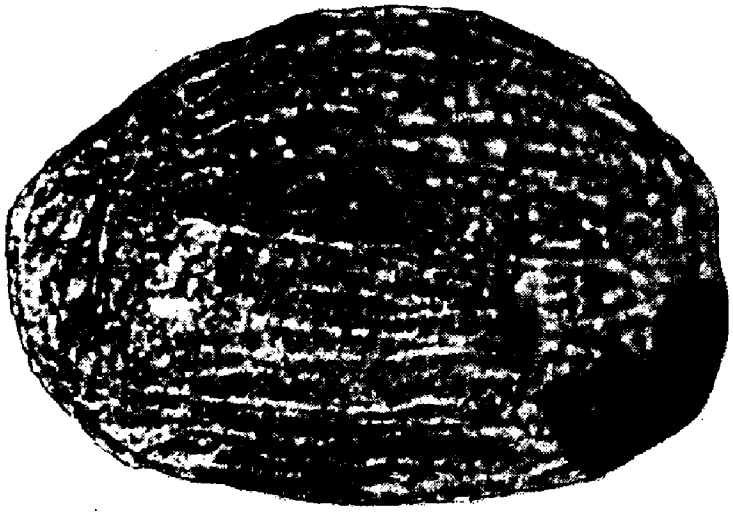
* See footnote, page 80.

PLATE IX



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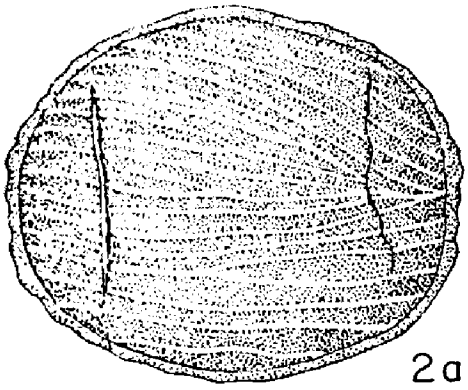

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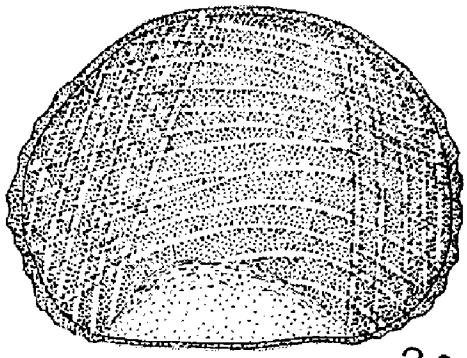

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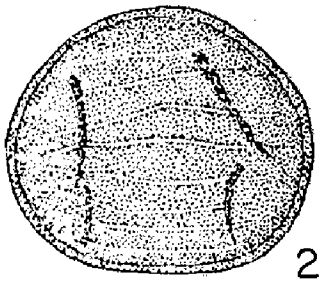

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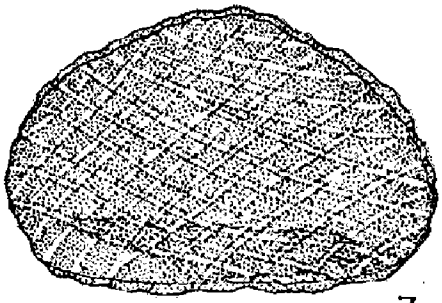

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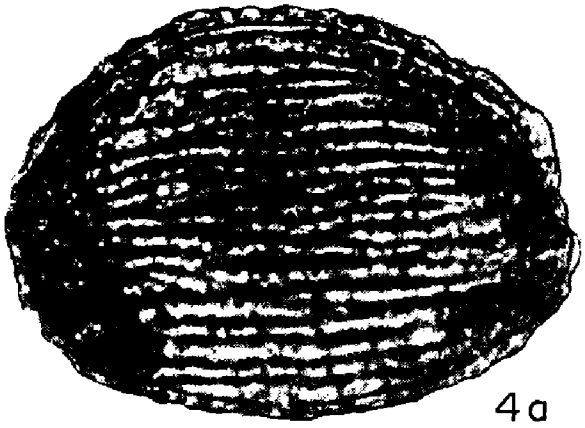

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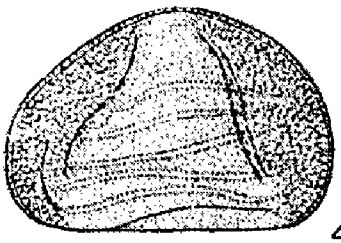

4b

PLATE X

LOWER PERMIAN. KUNGURIAN STAGE.

FIG. 1. *Vittatina cincinnata* Lub., x750.
Solikamsk City, salt-mine shaft.

FIG. 2a, b. *Vittatina vittifer* Lub. f. *cinctutus* f. n., x580; p. 46.
Cherdyn' area. village of Pokcha.

FIG. 3a-c.* *Azonaletes (Tenuella) levis* Lub.
Fig. 3a. x750; Fig. 3b. x580, Cherdyn' area, village of Pokcha;
Fig. 3c. x580, Aktyubinsk area, Sintas River, Khazretovka section.

FIG. 4. *Azonaletes microdictyus* Lub., x580.
Cherdyn' area, village of Pokcha.

FIG. 5a-c.* *Azonaletes fabaginus* sp. n.; p. 47.
Fig. 5a, x750—lateral orientation, Solikamsk City, salt-mine shaft.
Fig. 5b, x750; Fig. 5c. x580—proximal orientation, Cherdyn' area, village of Pokcha.

FIG 6. *Azonaletes irregulariplicatus* sp. n., x580; p. 49.
Cherdyn' area, village of Pokcha.

FIG. 7. *Azonaletes indefinitus* sp. n., x580; p. 48.
Aktyubinsk area, Sintas River, Khazretovka section.

FIG. 8. *Azonaletes subreticulatus* sp. n., x580; p. 48.
Cherdyn' area, village of Pokcha.

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* See footnote, page 80.

PLATE X

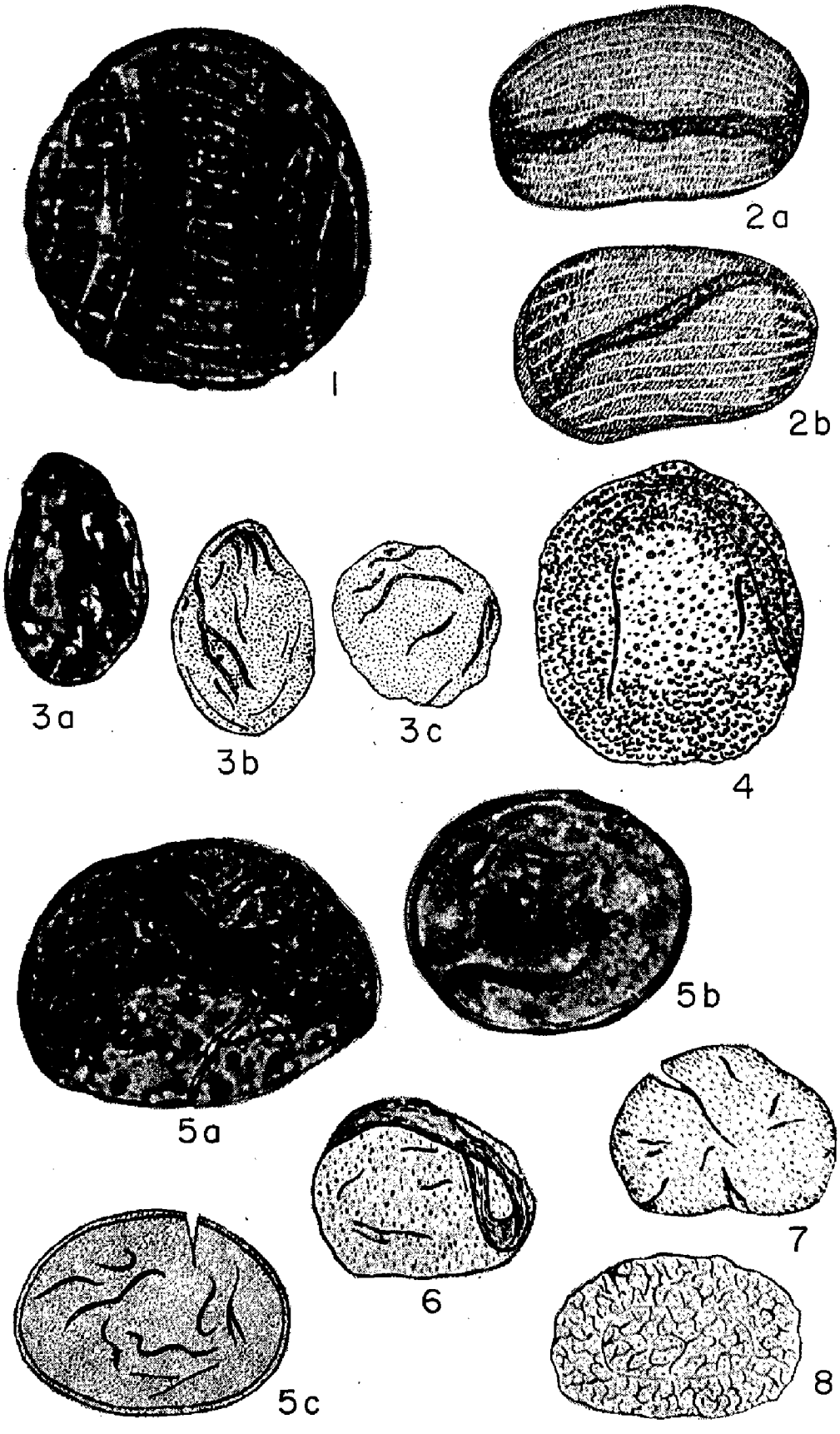

Plate XI

Lower Permian. Kungurian stage.

Fig. 1a-c.* *Calamospora hartungiana* Schopf.
Fig. 1a. x580, Aktyubinsk area, Sintas River, Khazretovka section.
Fig. 1b, c. x580. Cherdyn' area, village of Pokcha.

Fig. 2. *Azonotriletes polypyrenus* Lub., x580.
Cherdyn' area, village of Pokcha.

Fig. 3. *Azonotriletes* cf. *perforatus* Lub., x580.
Cherdyn' area, village of Pokcha.

Fig. 4. *Azonotriletes* cf. *resistens* Lub., x580.
Cherdyn' area, village of Pokcha.

Fig. 5. *Azonotriletes (Spinosella) rectispina* Lub., x580.
Cherdyn' area, village of Pokcha.

Fig. 6. *Azonomonoletes marattiiformis* sp. n., x580; p. 52.
Cherdyn' area, village of Pokcha.

Fig. 7. *Azonotriletes (Spinosella) selaginelliformis* sp. n., x580; p. 51.
Cherdyn' area, village of Pokcha.

Fig. 8. *Zonotriletes concordis* sp. n., x580; p. 54.
Cherdyn' area, village of Pokcha.

Fig. 9. *Zonotriletes rotundus* sp. n., x580; p. 55.
Cherdyn' area, village of Pokcha.

Fig. 10. *Zonotriletes* cf. *varians* Sadk., x580.
Cherdyn' area, village of Pokcha.

Fig. 11. *Zonotriletes (Effusina) graniferus* Lub.. x580.
Cherdyn' area, village of Pokcha.

Fig. 12. *Zonotriletes praetextus* Lub. x580.
Cherdyn' area, village of Pokcha.

Fig. 13a, b. *Zonomonoletes turboreticulatus* sp. n., x580; p. 53.
Cherdyn' area, village of Pokcha.

Fig. 14. *Zonomonoletes turboreticulatus* sp. n., var. *granulatus* var. n., x580; p. 54.
Cherdyn' area, village of Pokcha.

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* See footnote, page 80.

PLATE XI

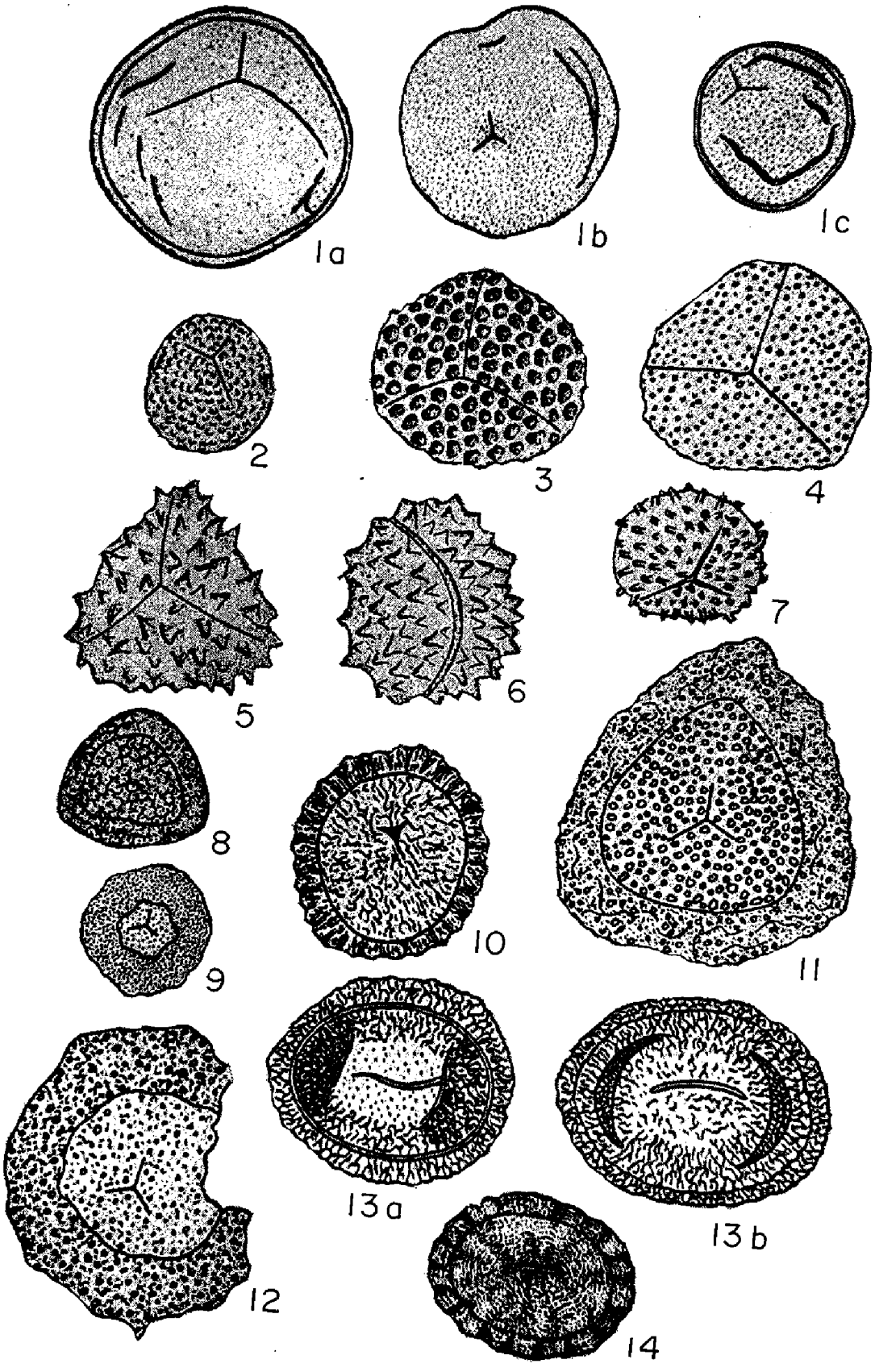


PLATE. XII

UPPER PERMIAN. KAZANIAN STAGE, SOLIKAMSK SUITE.

FIG. 1a, b. *Protohaploxypinus perfectus* (Naum.), x750.
Solikamsk City, salt-mine shaft.

FIG. 2a, b. *Protohaploxypinus tractiferinus* sp. n.; p. 36.
Fig. 2a, x580; Fig. 2b, x750.
Cherdyn' area, village of Pokcha.

FIG. 3. *Protopodocarpus alatus* (Lub.), x580.
Cherdyn' area, village of Pokcha.

FIG. 4. *Coniferites nudus* (Lub.), x580.
Cherdyn' area, village of Pokcha.

FIG. 5. *Protodiploxypinus elongatus* (Lub.), x580.
Cherdyn' area, village of Pokcha.

FIG. 6. *Florinites* sp., x580; p. 43.
Cherdyn' area, village of Pokcha.

PLATE XII

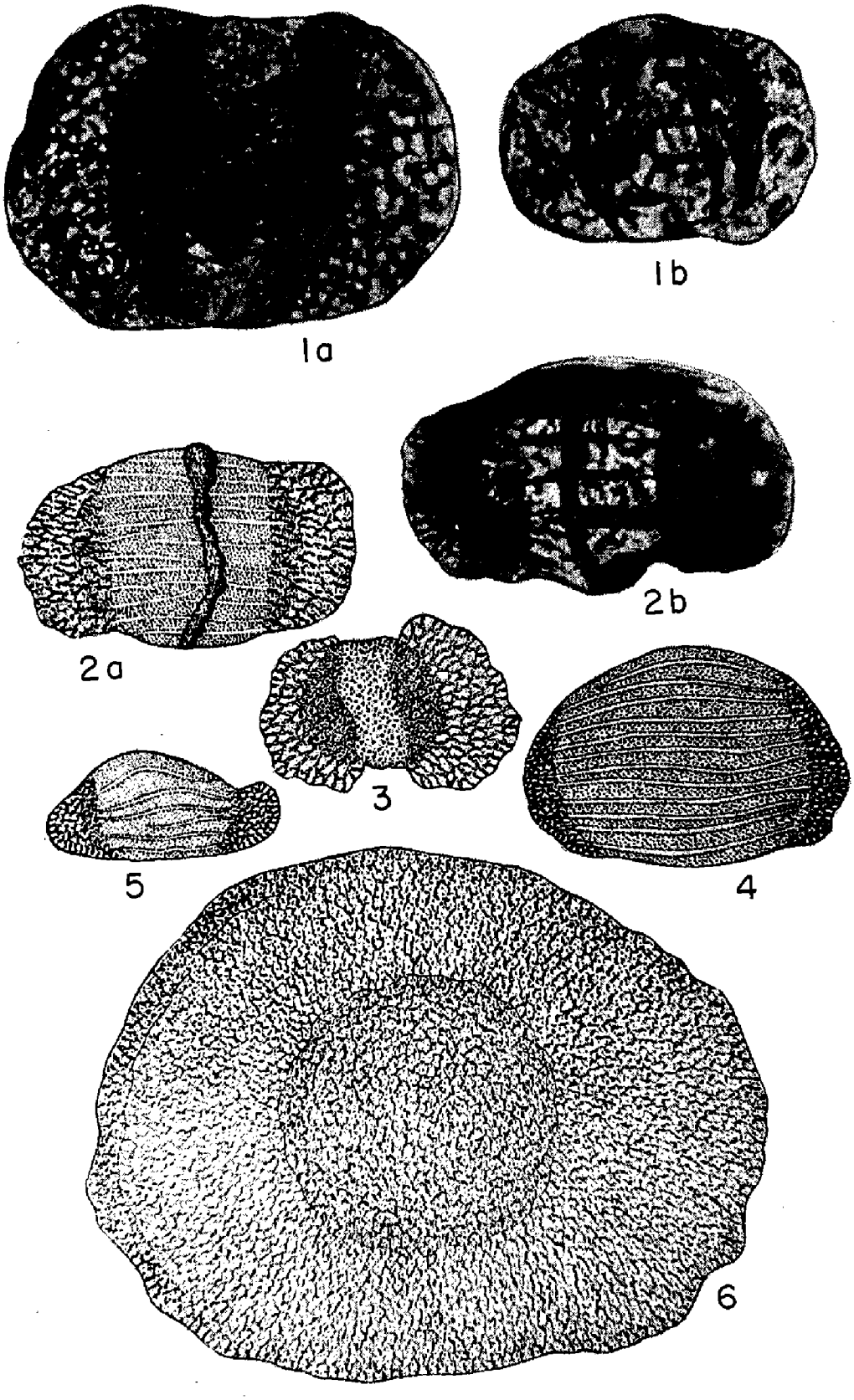


PLATE XIII

UPPER PERMIAN. KAZANIAN STAGE, SOLIKAMSK SUITE.

FIG. 1. *Cordaitina* cf. *spongiosa* (Lub.), x750.
Cherdyn' area, village of Seregovo.

FIG. 2. *Cordaitina uralensis* (Lub.), x580.
Solikamsk City.

FIG. 3. *Cordaitina uralensis* f. *striata* f. n., x580; p. 29.
Cherdyn' area, village of Seregovo.

FIG. 4. *Ginkgocycadophytus tunguskensis* (Lub.), x580.
Cherdyn' area, village of Seregovo.

FIG. 5a, b. *Vittatina striata* Lub.
Fig. 5a. x750, Solikamsk City.
Fig. 5b. x580, Cherdyn' area, village of Seregovo.

FIG. 6. *Vittatina vittifer* Lub., x750.
Cherdyn' area, village of Seregovo.

FIG. 7. *Vittatina cincinnata* Lub., x580.
Solikamsk City.

PLATE XIII

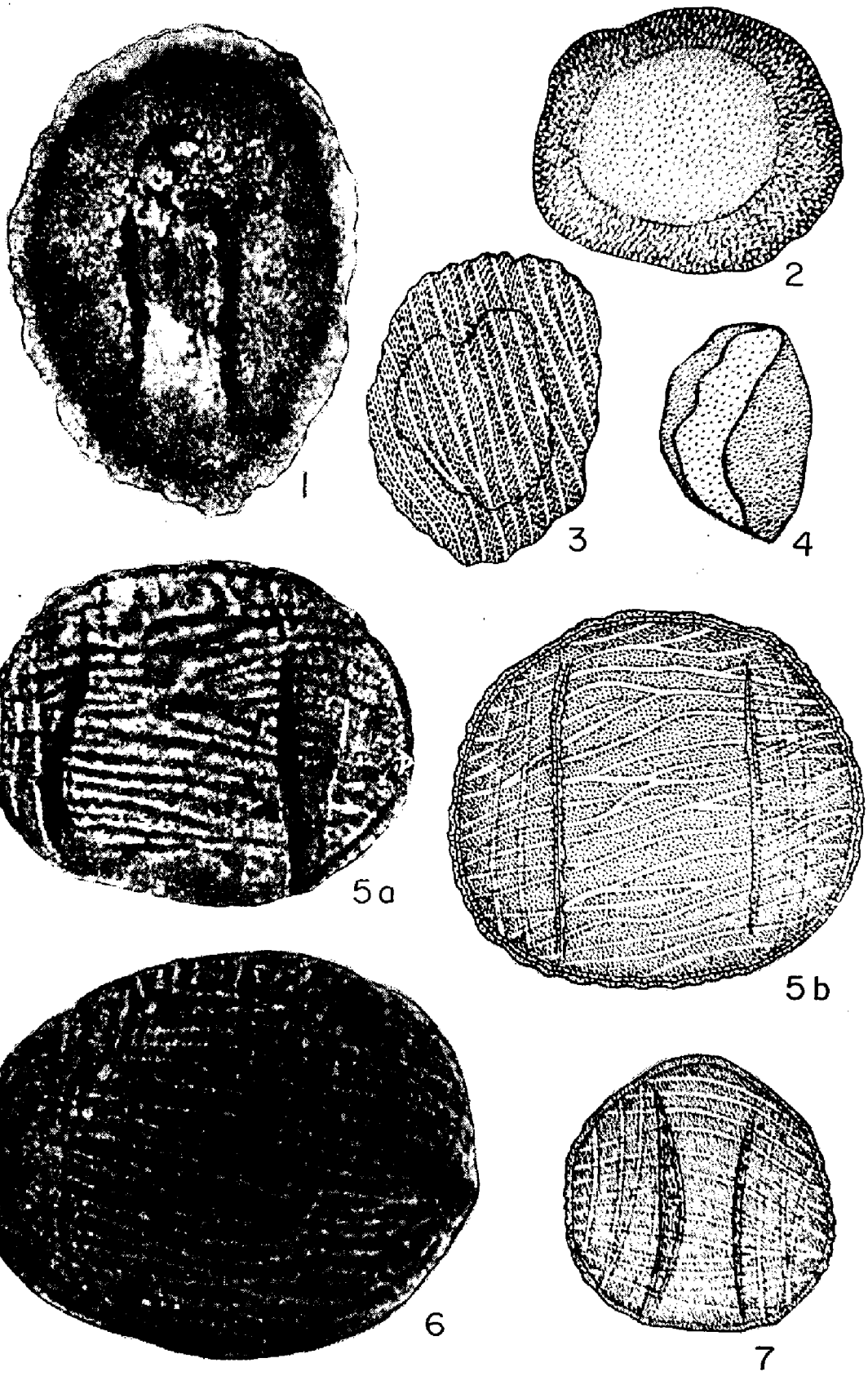


PLATE XIV

UPPER PERMIAN. KAZANIAN STAGE, SOLIKAMSK SUITE.

FIG. 1. *Azonaletes (Rugosina) tenuis* Lub., x580.
Cherdyn' area, right shore of Kama River, "Tikhie Gory."

FIG. 2. *Azonaletes (Tenuella) levis* Lub., x750.
Cherdyn' area, village of Pokcha.

FIG. 3. *Azonotriletes* cf. *resistens* Lub., x580.
Cherdyn' area, village of Seregovo.

FIG. 4. *Azonotriletes* cf. *notatus* Lub., x580.
Cherdyn' area, village of Seregovo.

FIG. 5. *Azonotriletes osmundae* sp. n., x580; p. 52.
Cherdyn' area, village of Seregovo.

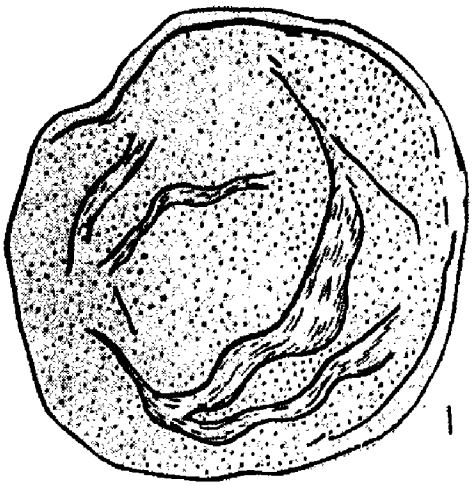
FIG. 8. *Zonotriletes (Effusina) graniferus* Lub., x580.
Cherdyn' area, village of Seregovo.

FIG. 7. *Zonotriletes ornatus* Lub., x580.
Cherdyn' area, village of Seregovo.

FIG. 8. *Zonotriletes rarus* sp. n., x580; p. 55.
Cherdyn' area, village of Seregovo.

FIG. 9. *Zonotriletes (Effusina) procumbens* Lub., x580.
Cherdyn' area, village of Seregovo.

PLATE XIV



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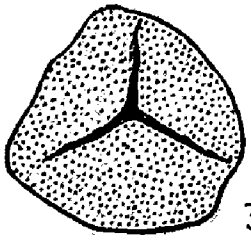

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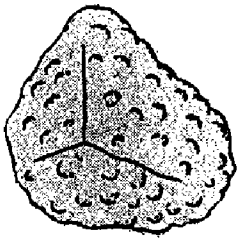

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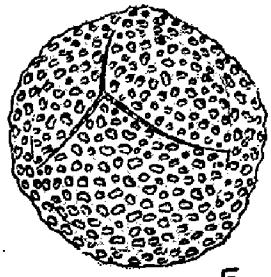

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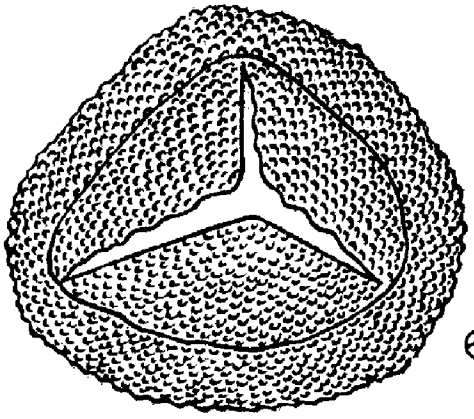

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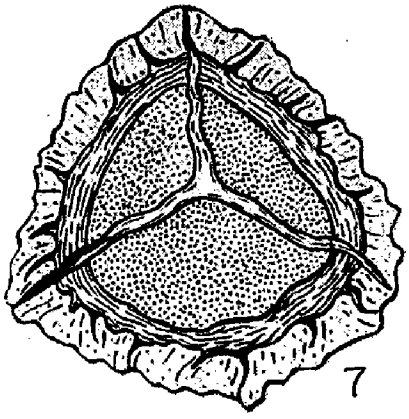

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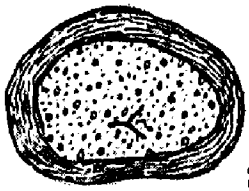

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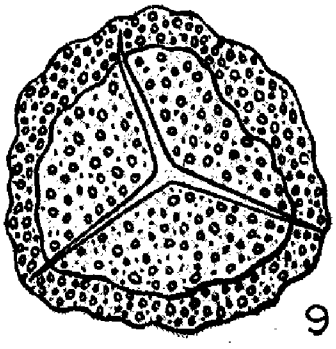


9

PLATE XV

COMPARISON OF FOSSIL POLLEN OF KNOWN AND UNKNOWN SYSTEMATIC RELATIONSHIPS.

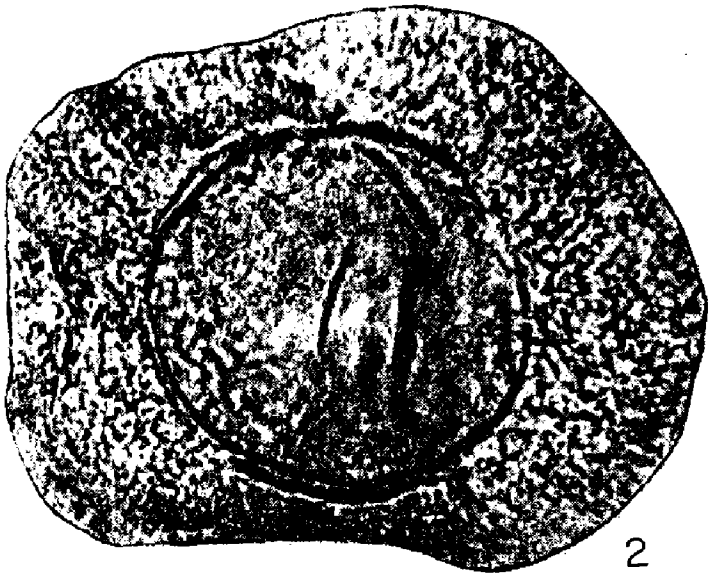
FIG. 1. *Florinites luberae* sp. n., x750; p. 42.
Solikamsk City, salt-mine shaft, Kungurian stage of Lower Permian.

FIG. 2. *Lebachia hypnoides* (Brongn.) Florin, x800. Pollen grain extracted from sporophyll of Permian conifer of same name (after Florin, pl. 107-108, fig. 1, 1939).

FIG. 3. *Florinites* sp., x580; p. 43.
Cherdyn' area, village of Seregovo; Solikamsk suite of Kazanian stage.

PLATE XV

1



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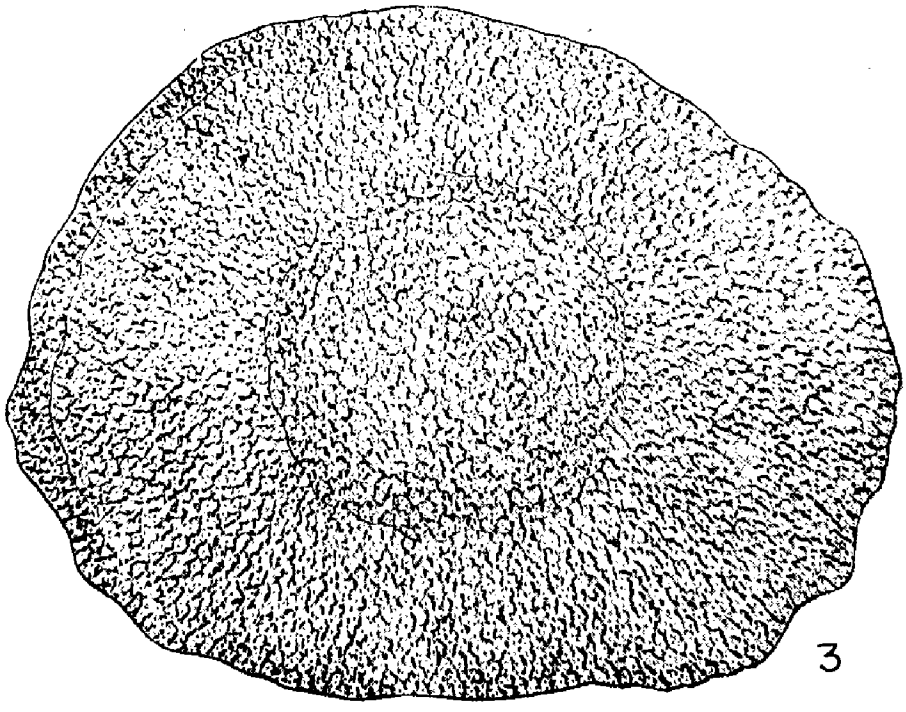


3

PLATE XVI

COMPARISON OF FOSSIL POLLEN OF KNOWN AND UNKNOWN SYSTEMATIC RELATIONSHIPS.

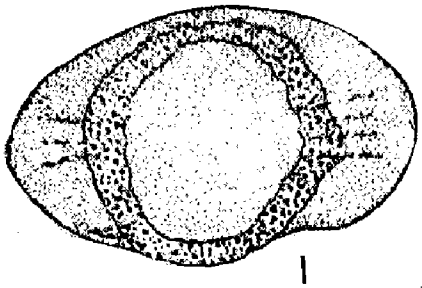
FIG. 1. *Florinites luberae* sp. n., x580, lateral orientation; p. 42.
Solikamsk City, salt-mine shaft; Kungurian stage, Lower Permian.

FIG. 2. *Florinites* sp. S. W. and B., lateral orientation.
Type of Permian conifer pollen of *Walchia, Lebachia,* and *Ernestiodendron* (after Schopf, Wilson, and Bentall, pl. 2, fig. 13, 1944).

FIG. 3a, b. *Cordaitina* cf. *spongiosa* (Lub.).
Fig. 3a. x750—distal orientation; Fig. 3b. x580—proximal orientation.
Solikamsk City, Kungurian stage of Lower Permian.

FIG. 4. *Cordaianthus* sp. Florin, x740—distal orientation.
Pollen from sporophyll of fossil cordaites (after Florin, pl. VII, fig. 1, 1936).

PLATE XVI



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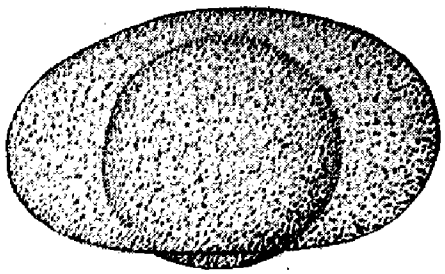

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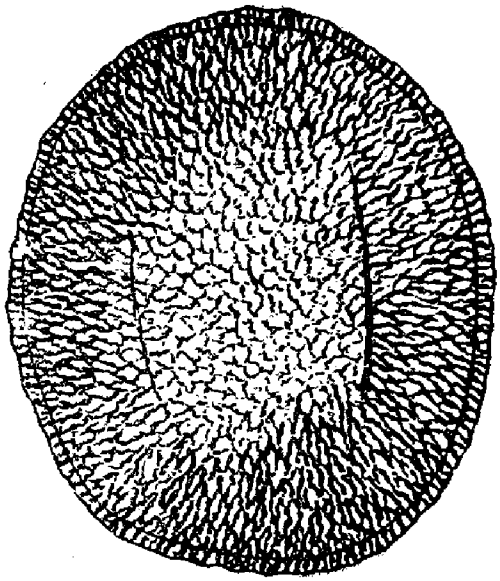
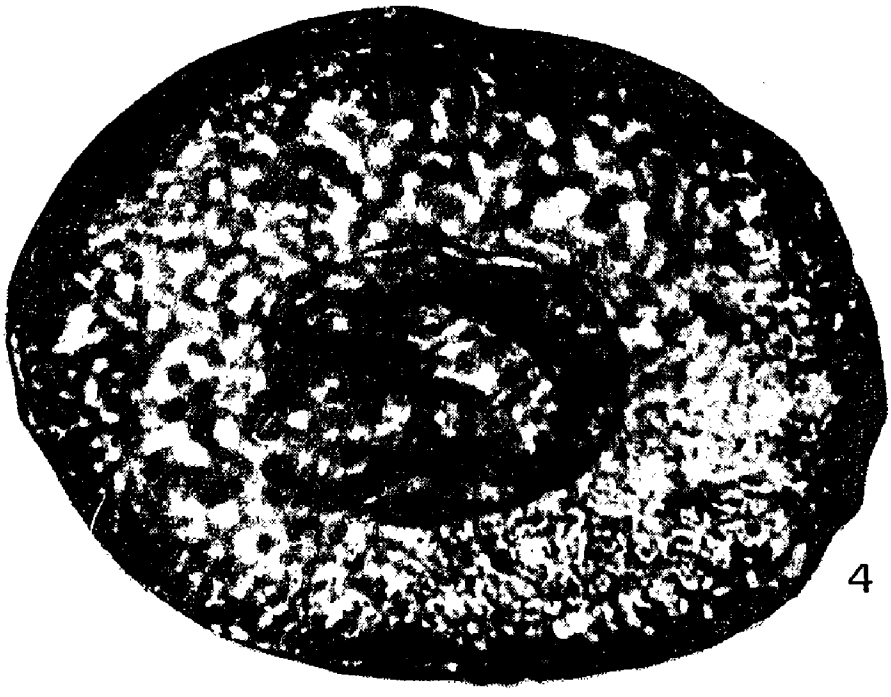


3b



4

PLATE VII

COMPARISON OF FOSSIL AND EXTANT POLLEN AND SPORES.

FIG. 1a, b. *Welwitschia mirabilis* Hook., x645.
Fig. 1a. Proximal orientation; fig. 1b. Distal orientation (after Erdtman, pl. XXVI, figs. 448 and 449, 1943).

FIG. 2a, b. *Vittatina vittifer* Lub. x580.
Fig. 2a. Proximal orientation. Cherdyn' area, village of Pokcha, Kungurian stage of Lower Permian; fig. 2b. Lateral orientation, Solikamsk City, salt-mine shaft.

FIG. 3. *Schizaea laevigata* Mett., x400—lateral orientation (after Selling, pl. III, fig. 25, 1944).

FIG. 4. *Vittatina striata* var. *cribrata*, x580—lateral orientation, Cherdyn' area, village of Pokcha; Kungurian stage of Lower Permian.

FIG. 5. *Danaea dubia* Presl., x400—proximal orientation (after M. A. Sedova, pl. 10, fig. 5a, 1950).

FIG. 6. *Azonomonoletes marattiiformis* sp. n., x580—proximal orientation. Cherdyn' area, village of Pokcha; Artinskian stage of Lower Permian.

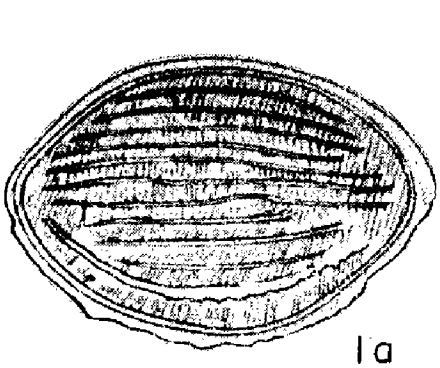
FIG. 7. *Selaginella polystachys* (Warb.) Hieron., x500—proximal orientation (afer Knox, fig. 147, 1950).

FIG. 8. *Azonotriletes (Spinosella) selaginelliformis* sp. n., x580—proximal orientation. Cherdyn' area, village of Pokcha; Kungurian stage of Lower Permian.

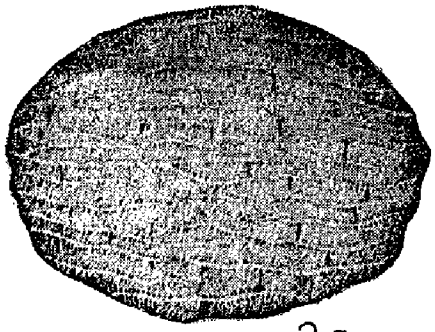
FIG. 9. *Osmunda cinnamomea* L., x400—proximal orientation (after M. A. Sedova, pl. 9, fig. 2a, 1950).

FIG. 10. *Azonotriletes osmundae* sp. n., x580—proximal orientation. Cherdyn' area, village of Seregovo, Solikamsk suite of Kazanian stage, Upper Permian.

PLATE XVII



1a



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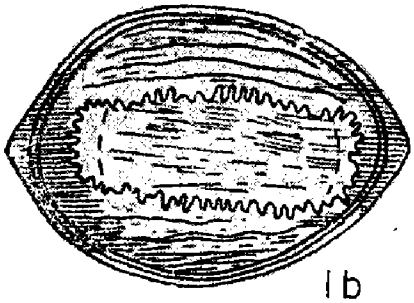
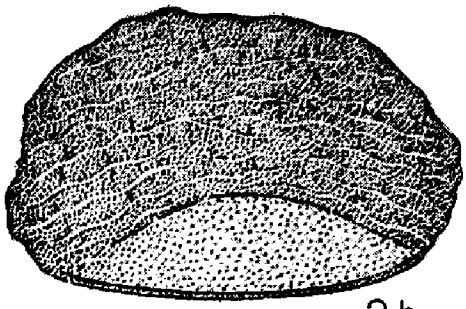


1b



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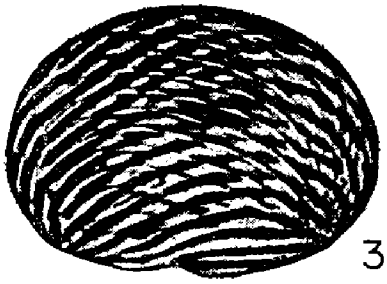

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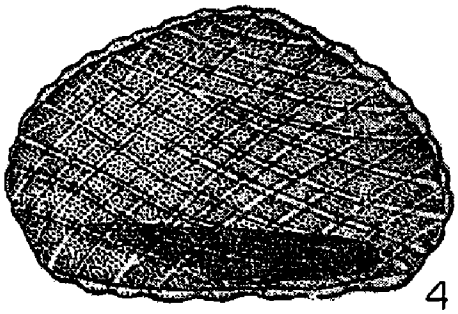

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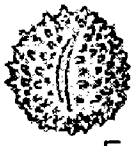
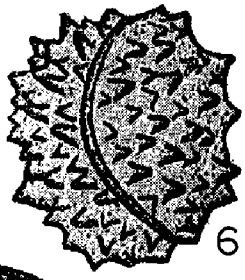
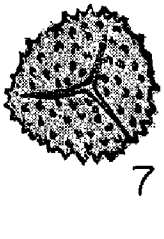


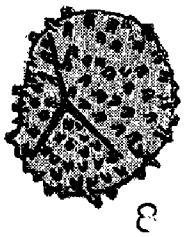
5



6



7



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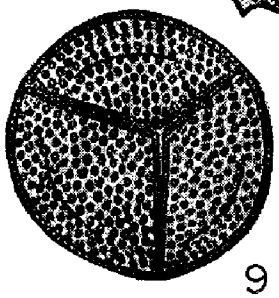
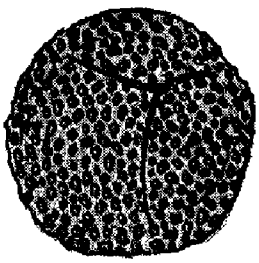


9



10