Palynological study of the Kurosawa Swamp in Tokushima Prefecture.

Jun NAKAMURA and Mitsuo YAMANAKA
(Botanical Laboratory, Faculty of Literature and Science, Kochi University)

I. Preface

Palynological studies of the swamps in Shikoku are so far confined to those on the highland above Fagus zone or on the lowland of the warm temperate forest zone, and there is no investigation as to the transitional zone, so-called *Abies-Tsuga* zone, situated between the both zones.

So it is worthy to make clear the vegetational history in the transitional zone.

The study presented in this paper deals with the pollen analysis of the Kurosawa swamp situated in the trasitional zone in Tokushima Prefecture.

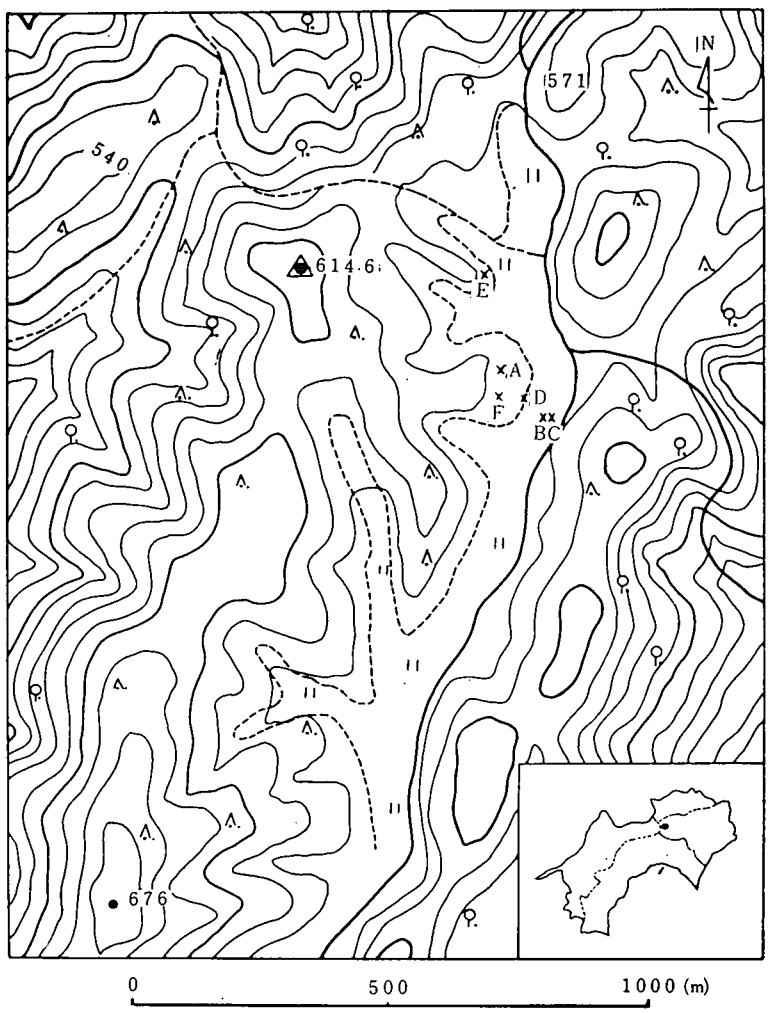

Fig. 1. Map showing the Kurosawa swamp

The author are indebted to Mr. Kiyoshige Imamura who helped in planning the borings, to Mr. Tsugio Yamanaka, Kochi Univ. and others for their kind assistance in collecting samples.

II. Locality and Configuration

The Kurosawa swamp (550−600 m. above sea level) which is surrounded by mountains less than 700 m., is located near the Matsuo River in the Iya district, Tokushima Prefecture, and it measures 0.5 km. wide and 2 km. length and slightly inclines to the south. At the eastern part of the swamp a stream flows through from the north to the south, and it makes a waterfall at the southern-most of the swamp. The greater part of the swamp turned to the rice field, but some small ponds and bogs remain in the middle part. Base rock is crystalline schist.

III. Vegetation

The climax vegetation of this region belongs to the upper limit of the warm temperate forest zone, but now secondary forests dominated by *Pinus densiflora* are developed extensively around the swamp, with some subordinating trees such as *Abies firma*, *Castanea crenata*, *Clethra barinervis*, *Prunus yamasakura*, *Quercus serrata*, *Hydrangea paniculata*, *Ilex serrata*, *I. crenata*, *Rhododendron Kaempferi*, *R. Weyrichii*, *Pieris japonica*, *Lyonia elliptica* and *Abelia serrata*. It shows that the climax vegetation was displaced to the present pine woods by human agency and such vegetations are frequently found from the areas of the warm temperate and temperate forest zones.

In the sunny margin of the swamp, there is semi-natural herbosa dominated by *Ligularia japonica*, *Cirsium Sieboldi*, *C. japonicum*, *Aster ovatum*, *A. semiamplexicauris*, *A. scaber*, *Solidago Virga-aurea* subsp. *asiatica*, *Eupatrium Lindleyanum*, *Gnaphalium affine*, *Serratula coronata* subsp. *insularia*, *Platycodon grandiflorus*, *Houtuynia cordata*, *Lysimachia clethroides*, *Gentiana scabra var. orientalis*, *Haloragis micranta*, *Prunella vulgaris* subsp. *asiatica*, *Cynanchum glabrum*, *Pertya scandens*, *Saussurea pulchella*, *Parnassia palustris* var. *multiseta*, *Ranunculus japonicus*, *Dimorpha Ganpi*, *Pogonia minor*, *Epipactis Thunbergii*, *Drosera peltata* var. *lunata*, *Pteridium aquilium* var. *latiusculum*. And a considerable numbers of sedge and grass such as *Miscanthus sinensis*, *Imperata cylindrica* var. *Koengii*, *Arundinella hirta*, *Scirpus Mitsukurianum*, *S. Wichurai* are found.

The surface of the swamp excepting the rice field, mainly preponderated by *Phragmites communis* var. *longivalvis* community which is subordinated by *Hololeion Krameri*, *Swertia Bimaculata*, *Sium Ninsi*, *Triadenum*, *japonicum*, *Lythrum salicaria* subsp. *anceps*, *Persicaria hastato-sagittata*, *P. conspicaua*, *P. sagittata* var. *Sieboldii*, *Viola vercunda*, *Drosera rotundifolia*, *Utricularia bifida*, *Spiranthes sinensis*, *Habenaria sagittifera*, *H. radiata*, *Rhyncospora chinensis*, *Sparganium japonicum*, *Scirpus juncoides*, *Carex Maximowiczii*, *Eriocaulon* sp. *Fimbristylis* sp. *Lastrea Thelypteris*, and *Osmunda cinamomea* var. *fokiensis*. In the ponds and the stream some hydrophytes such as *Potamogeton distinctus*, *Blyxa ceratosperma*, *B. japonica*, *Eleocharis mammilata* var. *cyclocarpa*, *E. Kuroguwai*, *Utricularia japonica*, *Nymphaea*

tetragona var. *angusta* and *Nitella* sp. are also found.

At the northern part of the swamp, there are small hummocks occupied by *Sphagnum* sp. In order to survey the plant composition of this area, two stations (1 m^2) were selected, one station in a wet part and the other in a somewhat drier part. Tab. 1 and 2 show the results of these surveies.

Tab, 1. Composition of the wet part in Sphagnum community

Species	Dominance	Species	Dominance
Phragmites comunis var. *longivalvis*	2	*Viola verecunda*	+
Juncus alatus	2	*Juncus effusus*	+
Utricularia bifida	1	*Lycopus lucidus*	+
Nymphaea tetragona	1	*Carex* sp.	2
Triadenum japonicum	+	*Eriocaulon* sp.	4
Isachne globosa	+	*Sphagnum* sp.	5
Hypericum iaxum	+		

Tab. 2. Composition of the dry part in Sphagnum community

Species	Dominance	Species	Dominance
Phragmites comunis var. *longivalvis*	3	*Pinns densiflora*	+
Rosa multiflora	2	*Viola verecunda*	+
Scirpus Wichurai	2	*Solidago japonica*	+
Hydrangea paniclata	1	*Cirsium Sieboldi*	+
Arundinella hirta	1	*Cynanchum nipponicum* var. *glabrum*	+
Isachne globosa	1	*Allium Thunbergii*	+
Liriope minor	1	*Rhynchospora chinensis*	+
Iastrea Thelypteris	1	*Juncus alatus*	+
Ilex crenata	+	*Sphagnum* sp.	5

IV. Materials and Methods

Borings were carried out at six stations; A, B, C, D, E, F, in the northern part of the swamp with Hiller type borer. In the southern part it was unable to take samples owing to tho occurrence of the gravels. Among these samples those of St. A and D were used for pollen analysis and their stratigraphic records are as follow.

Station A.

0 — 40 cm.	Clay with much *Sphagnum*, fragments of gramineous plant, gray brown.
40 — 75 cm.	Clay with a few organic matters, gray.
75 — 100 cm.	Silty clay with a few organic matters, white.
100 — 120 cm.	Clay with some organic matters, gray.
120 — 185 cm.	Clay with some fragments of gramineous plants, gray.

185 — 240 cm. Sandy clay with a few organic matters, white.

Station D.

0 — 15 cm. Water
15 — 30 cm. Clay with some organic matters, gray brown.
30 — 60 cm. Water
60 — 100 cm. Clay with some fragments of gramineous plants, gray.
100 — 115 cm. Peaty clay with much fragments of wood, black brown.
115 — 125 cm. Clay with a few organic matters, grayish white.
125 — 140 cm. Silty clay with a few organic matters, white.
140 — 215 cm. Clay, white.
215 — 220 cm. Peat, black.
220 — 290 cm. Clay with a few organic mattars, gray.
290 — 310 cm. Silty clay, grayish white.
310 — 320 cm. Silty clay with a few organic matters, grayish white.
320 — 330 cm. Silty clay, white.
330 — 360 cm. Clay, grayish white.

Each sample was taken at intervals of 10 — 20 cm. from the above profils and pollen analysis was made by HF-Acetolysis method. More than 200 tree pollen (TP) were counted for each samples as a basic number for calculation of percentage.

V. Results

Pollen detected throughout the layer amount to 32 genera (TP), 11 genera (non tree pollen; NTP) and 5 genera of fern spore, and these pollen sequences were shown in Tab. 3, 4 and Fig. 2.

At 90 cm. the detected grains were very scarce, so the actual number of pollen grains were shown.

The sequences of the main species are as follow.

Pinus which is most abundant at the surface decreases to 50 cm. and below this depth begins to increase but suddenly diminishes at the bottom. On the other hand, *Abies* is scarce at the surface, abruptly increases at 50 cm. and below this depth shows an irregular squence. *Tsuga* which is relatively abundant at the surface gradually declines downwards, excepting the sudden increase at the middle layer. Generally speaking, the both trees are more prosperous than *Pinus* throughout the layer except for the surface. *Picea* is not found at the surface but it occurs continuously in a small amount below 100 cm. and slightly tends to increase at the bottom. *Cyclobalanopsis* is relatively abundant in the middle layer but it decreases abruptly below this layer and becomes scarce at the bottom.

Quercus and *Carpinus* occur in all layers and amount to 10 % in maximum, but do not show remarkable fluctuations. *Alnus* is scarcely found in the upper layer and increases suddenly below 100 cm., reaching to 53 % in maximum. The other deciduous trees such as *Fagus*, *Corylus*, *Ulmus*, *Juglans*, *Pterocarya*, *Celtis* and *Tilia* are found discontinuously in small amount.

Concerning the non-tree pollen, Compositae and Gramineae are continuously found in the upper layer but the other herbs are sparsely found.

Fern spores are detected in considerable amounts, especially Polypodiaceae is abundant in the upper layer, though it decreases below the middle layer. Osmundaceae reaches to the maximum at 50—60 cm. *Lycopodium* and *Botrychium* occur continuously below

the middle layer.

Station D:

Detected pollen amount to 35 genera (TP), 12 genera (NTP) and 5 genera of fern spore and their details are shown in Tab. 5, 6 and Fig. 3.

According to these data, the sequcnces of the main species are similar to those of the above station.

Pinus which is most abundant at the surface decreases abruptly down to 100 cm. and after the repetition of increase and decrease it diminishes at the bottom.

Picea begins to appear at 100 cm, after this it is continuously found in a larger number than that of the Station A. *Cyclobalanopsis* increases rapidly down to 100 cm. amounting to some 43 %, but it suddenly decreases below the middle layer. On the other hand, *Quercus* inereases at the middle layer and *Alnus* luxuriates below the middle layer. An increase of heliophillous *Ilex* at the upper layer is worthy of attention.

Non-tree pollen and fern spores show the same sequence to the Station A and this fact suggests that the age of deposition at the Station A and D is the same.

VI. Discussion

As a result of pollen analysis three stages are distinguished from the diagram of the Station A. They are in the following order from the surface.

1. *Pinus*−*Tsuga*−*Cyclobalanopsis* stage 15−40 cm.
2. *Abies*−*Tsuga* stage 40−80 cm.
3. *Abies*−*Tsuga*−*Alnus* stage 100−180 cm.

In the 1st stage, *Pinus* dominates at the surface, while *Cyclobalanopsis* shows maximum at the lower layer. *Abies* and *Tsuga* play the important parts in this stage, however, it may be said that *Tsuga* more prevalent than *Abies* because the pollen production of *Tsuga* is less than that of *Abies*, so we used *Tsuga* for the stage name.

In the 2nd stage the codominance of *Pinus* and *Cyclobalanopsis* alternates with that of *Abies* and *Tsuga*. The occurrance of spores of Polypodiaceae and Osmundaceae is also note worthy.

In the 3rd stage, *Alnus* abundant next to *Abies* and *Tsuga*, *Picea* begins to appear continuously.

These three stages can be comparable with the results of the Station D as follow.

1. *Pinus*−*Tsuga*−*Cyclobalanopsis* stage 20−100 cm.
2. *Abies*−*Tsuga* stage 100−160 cm.
3. *Abies*−*Tsuga*−*Alnus* stage 160−360 cm.

1. *Pinus*−*Tsuga*−*Cyclobalanopsis* stage:

According to the observation of the present vegetation in this area, it clearly indicates that the detected *Pinus* pollen is derived from *P. densiflora*; *Abies*, *A. firma*; *Tsuga*, *T. Sieboldii*; *Quercns*, *Q. serrata*; *Cyclobalanopsis*, *C. glauca* and *C. salicina* var. *stenophylla* respectively. *Carpinus* may be derived from *C. Tschonoskii* because the majority of the detected grains have 4-pores. Also it can be said that *Ilex* consists of *I. crenata* and/or *I. serrata*; *Rhododendron*, *R. Kaempferi* and/or *R. Weyrichii*; Polypodiaceae, mainly *Lastrea Thelipteris*.

An abrupt increase of *Pinus* and a corresponding decrease of *Cyclobalanopsis* at the surface are due to human influence and it is indicated that ever-green oaks predominant in the early period of this stage were cut down and secondary woods consisting of *Pinus densiflora* and some heliophillus species were developed.

Tsuga seems to increase at the surface of the Station A, but such a tendency is not seen in the Station D and this irregularity seems to depend on the different sedimentation speed from these stations. *Tsuga* is not found in the neighbourhood of the swamp at present, though small numbers are found at the cliff near the Matsuo River, so *Tsuga* pollen on the surface may be derived from these trees.

Thus we reach to the conclusion that the changes of vegetation in this stage are mainly due to the human agencies.

2. *Abies*−*Tsuga* Stage:

Pinus and *Cyclobalanopsis* which were predominant in the previous stage decrease and *Abies* and *Tsuga* show rapid increase, especially a rise of *Abies* are remarkable in both stations, and also *Picea* begins to appear in this stage.

Apart from the pollen of the forest trees, the increase of *Ilex*, Polypodiaceae (*Lastrea Thelypteris*) and Osmundaceae (*O. japonica* and *O. cinnamomea* var. *fokiensis*) are note worthy. This indicates that the water table was lowered by the inflow of the eroded matters from the surrounding slope of the swamp, and the invasion of the sun-plants such *Ilex* and ferns became conspicuous.

At 90 cm. of the Station A, there is a layer which scarcely include the organic matters. From this layer *Tsuga* declines abruptly. On the other hand, at 100−120 cm. of the Station D, there is a layer containing litter in which *Abies* suddenly declines. These layers were made by the redeposition of the matters which inflowed in to these stations from the eroded forest floor near the swamp. From this fact it is considered that the erosion of the forest floor by the precipitation was promoted by the clearance of the usefull trees such as *Abies* and *Tsuga*.

Nakamura reported in his previous paper ('52) that *Tsuga*, *Chmaecyparis* and sometimes *Cryptomeria* increase for a time just prior to the gradual increase in *Pinus* in the various districts, and he made use of this fact as an indicator to divide the period between R 3 and R 2. Further, the edaphic demands of these trees are closely related to the precipitation; *Tsuga*, *Chamaecyparis* and *Scyadopitis* frequently occur on the unstable and steep incline from which the surface soil was eroded, while *Cryptomeria* is found on the thick and wet soil. Such soil conditions are frequently brought about by the increased precipitation. Considering these facts, it is not always irrational that this stage is comparable with the lower part of R 3. Consequently the 1st and 2nd stages should be placed in R 3.

3. *Abies*−*Tsuga*−*Alnus* stage:

The preponderance of *Abies* and *Tsuga* in the previous stage continues to this stage, and an increase of *Alnus* is very noticeable. Moreover, it is a characteristic feature of this stage that *Picea* occurs almost continuously through this stage. Here the pollen of *Picea* are either derived from *P. polita* or *P. jezoensis* var. *hondoensis*. *P. jezoensis* var. *hondoensis* is not indigeneous in Shikoku at present, if this species was distributed

to Shikoku at that time, some north temperate or subarctic species should be found from this stage. But such species are not found at all. *Fagus*, for example, shows rare occurrence in this stage, so it can be said that the area of Kurosawa did not belong to *Fagus* zone, but to *Abies—Tsuga* zone throughout this stage. On the other hand, *P. polita* is indigenous sporadically in the south-west Japan at present, so it is reasonable to maintain that *P. polita* was distributed in the neighbourhood of Kurosawa at that time and disappeared from this area at R 3. Concerening with this fact, Tsukada ('58) reported that *P. jezoensis* which is not indigenous in the north Alps at present, was distributed broadly to the north Alps until the middle part of R 3. This fact is similar to the above mentioned case. From these facts it may be inferred that *P. polita* which was distributed broadly in the south-western Japan, diminished at the end of R 2 or in the middle part of R 3.

With regard to *Alnus*, alder woods surrounded the swamp at this stage and were cleared up at the 2nd stage by human agencies.

At any rate this stage can be regarded as a part of R 2 and this area situated in *Abies—Tsuga* zone throughout this stage, so the vertical migration of the forest zone reflecting the climatic change was not recognized.

VII. Summary

The Kurosawa swamp lies in the Iya district (600 m. above sea level) in the north-western part of Tokushima Prefecture. This region belong to the upper limit of the warm temperate forest zone, but secondary woods dominated by *Pinus densiflora* are developed around the swamp. The greater part of the swamp turned to a rice field.

Samples were taken from five stations of the northern part of the swamp. Pollen analysis was made by HF-Acetolysis method and the results of the Station A and D were shown at Tab. 3, 4, 5 and 6, Fig. 2 and 3.

According to these results, three stages were distinguished in the following order from the surface;

1. *Pinus—Tsuga—Cyclobalanopsis* stage
2. *Abies—Tsuga* stage
3. *Abies—Tsuga—Alnus* stage.

The 1st and 2nd stages are comparable to R 3 in Nakamura's division of Japanese pollen records. The 3rd stage is thought to have been deposited during R 2.

VII. Literatures cited

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Tab. 3. Tree pollen frequencies of the Station A.

Depth (cm.) / Pollen type	15	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Pinus	18.8	15.1	2.6	1.8	5.5	5.5	2.4	—	12.7	14.6	14.6	10.7	8.7	7.4	9.0	14.2	0.7
Abies	15.1	20.2	18.9	64.8	38.7	34.7	28.0	(7)	21.7	21.4	28.8	30.7	23.9	33.6	41.5	34.3	14.1
Tsuga	23.8	19.3	10.6	8.4	9.4	13.4	10.6	(3)	40.8	22.8	21.0	20.2	13.2	22.0	19.6	14.2	13.1
Picea	—	—	—	—	—	—	—	—	1.9	0.8	—	—	0.6	2.5	2.3	1.0	2.0
Cryptomeria	1.8	1.4	0.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Torreya	0.5	0.5	0.8	—	—	0.5	1.6	(2)	—	—	—	—	—	—	—	—	—
Sciadopitys	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.4	—
Fagus	—	—	—	0.4	0.4	—	—	—	—	—	—	—	0.3	—	—	—	—
Cyclobalanopsis	13.5	13.8	21.1	4.4	7.7	9.4	11.0	(2)	—	0.3	0.8	0.6	0.3	—	—	0.7	—
Quercus	4.5	6.0	10.2	1.8	5.1	2.5	1.6	—	4.0	2.9	2.9	3.2	1.4	2.8	1.0	1.4	7.1
Betula	—	0.5	—	—	—	0.5	0.4	—	—	0.4	0.3	—	—	—	—	—	—
Alnus	2.2	0.5	4.5	—	1.3	6.9	2.8	(5)	13.7	25.3	22.5	25.8	43.3	23.0	20.0	23.8	53.0
Carpinus	3.1	4.6	8.7	1.3	3.0	4.0	11.4	(7)	1.0	3.0	3.5	3.7	4.5	2.8	1.3	4.0	5.1
Corylus	0.9	—	1.9	—	0.4	—	0.8	—	—	—	—	—	—	—	—	—	—
Ulmus	—	—	0.8	—	—	2.4	0.4	—	—	—	—	0.2	0.3	—	—	—	1.0
Juglans	—	—	0.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pterocarya	—	—	—	0.9	0.4	—	—	—	0.2	0.1	—	—	0.3	—	—	—	—
Tilia	—	—	—	—	—	0.5	—	—	0.2	0.2	—	—	0.6	0.2	—	—	—
Fraxinus	—	—	—	—	0.4	0.5	0.8	—	—	0.1	0.3	—	—	0.2	—	—	—
Celtia	—	—	1.5	0.9	2.6	—	—	—	—	—	—	—	—	—	—	—	—
Castanea	1.4	0.9	3.8	9.3	14.9	2.5	5.1	(1)	—	0.4	—	—	—	—	0.3	—	—
Rhus	—	—	0.8	—	—	0.5	—	—	—	1.6	0.7	—	0.3	—	0.3	—	—
Ilex	9.9	11.9	4.1	0.9	4.7	3.0	3.9	(1)	0.4	0.3	0.3	0.2	0.3	0.5	—	0.4	1.0
Zelkowa	0.5	—	5.7	4.0	3.8	4.5	1.6	(2)	—	—	—	—	0.3	0.2	—	0.4	—
Rhamus	—	—	—	—	—	—	1.6	—	—	—	—	0.2	—	0.2	0.6	—	—
Cornus	—	—	—	—	—	—	0.4	—	—	—	—	—	—	—	—	—	—
Deutzia	0.5	0.9	1.5	—	—	—	—	—	—	1.4	1.8	1.9	0.6	0.5	0.6	1.1	—
Eurya	—	—	—	0.4	—	—	8.3	(1)	—	0.4	—	—	0.5	—	—	1.4	1.4
Dicalix	—	—	0.8	—	0.4	—	0.4	—	—	—	—	—	—	—	—	—	—
Aesculus	0.9	1.4	—	0.4	0.9	2.0	2.4	(1)	—	—	0.5	0.4	—	0.5	—	—	1.4
Rhododendron	1.4	1.8	1.1	0.4	0.4	7.4	4.7	—	2.8	3.1	2.9	1.5	1.4	2.3	1.0	1.8	0.7
other Ericaceae	0.9	1.4	—	—	—	—	—	(6)	1.3	—	1.7	0.6	—	0.9	1.3	—	—

Tab. 4. Non tree pollen frequencies of the Station A.

Depth (cm.) / Pollen type	15	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Gramineae	8.0	4.6	0.4	0.4	1.7	1.0	0.8	(1)	—	—	—	—	0.2	—	0.6	—	5.7
Cyperaceae	0.9	0.5	1.5	—	—	—	0.8	—	—	0.2	—	0.4	—	—	—	—	—
Rumex	—	—	—	—	—	—	0.4	—	—	—	—	—	—	—	—	—	—
Persicaria	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.3	0.4	—
Sanguisorba	0.5	0.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Geranium	—	—	—	—	0.4	—	—	(7)	—	—	—	—	—	—	—	—	—
Myriophyllum	—	1.4	1.1	—	—	0.5	—	—	—	—	—	—	—	—	—	—	—
Violaceae	—	—	—	—	—	—	—	(2)	—	—	—	—	—	—	—	—	—
Umberiferae	—	—	—	—	—	0.5	—	—	0.6	0.1	—	—	—	—	—	—	—
Solanaceae	—	—	—	—	—	—	0.4	—	—	—	—	—	—	—	—	—	—
Compositae	0.5	1.4	1.1	0.9	1.3	1.5	—	(1)	0.4	1.8	0.6	—	0.6	0.5	0.6	0.4	0.7
Polypodiaceae	34.0	28.0	7.9	23.8	20.4	29.7	23.2	(38)	0.4	0.6	6.4	12.0	7.3	5.0	9.3	8.5	6.0
Osmundaceae	4.9	3.7	2.3	20.7	36.2	14.9	7.9	(63)	2.6	7.9	7.9	12.0	6.1	9.7	19.9	27.0	6.7
Lycopodium serratum	0.5	—	—	—	0.9	—	—	—	9.9	4.3	3.5	6.7	5.3	3.5	3.2	2.5	—
other *Lycopodium*	—	—	—	—	—	—	—	—	—	—	—	0.2	—	0.2	—	—	—
Botrychum	—	—	0.4	0.4	0.9	0.5	—	(28)	—	—	1.7	0.6	1.4	1.4	1.9	3.6	1.0

Tab. 5. Tree pollen frequencies of the Station D.

Depth (cm.) / Pollen type	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360
Pinus	52.3	—	36.6	10.0	1.2	2.0	5.1	9.8	2.7	13.8	1.0	11.3	7.8	13.4	10.8	7.6	5.0	3.7
Abies	5.1	—	8.1	8.5	4.6	46.0	23.0	30.0	26.4	39.3	20.0	29.5	46.1	19.9	14.0	14.8	25.2	27.4
Tsuga	7.2	—	8.5	15.2	8.9	26.2	45.3	38.8	22.6	26.7	10.3	13.4	12.0	16.9	12.4	14.8	16.2	18.7
Picea	—	—	—	—	0.3	1.0	0.4	2.5	8.1	6.9	14.0	6.7	7.4	2.0	3.6	1.9	4.1	9.0
Cryptomeria	5.5	—	—	—	—	—	—	—	—	—	—	—	—	0.5	0.4	—	—	—
Torreya	—	—	—	—	—	—	—	—	—	—	—	1.2	1.2	2.5	—	0.5	0.5	—
Sciadopitys	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.5	—	—
Fagus	0.4	—	—	0.7	0.3	—	0.9	—	—	—	1.0	0.3	0.8	0.5	—	3.3	—	0.3
Cyclobalanopsis	11.0	—	14.6	34.4	43.4	2.5	—	—	—	—	1.3	0.3	—	—	1.2	—	—	—
Quercus	3.4	—	11.4	—	0.3	4.5	1.7	3.0	5.4	0.6	17.8	8.2	8.5	14.4	12.0	7.6	4.1	6.7
Betula	—	—	—	0.4	—	—	—	—	—	—	0.8	0.3	—	0.5	0.4	1.0	0.9	0.7
Alnus	0.9	—	3.7	1.5	1.5	1.0	8.6	10.0	22.6	6.0	19.0	18.2	10.9	13.4	26.0	31.4	33.8	20.4
Carpinus	4.2	—	5.7	5.6	4.3	5.9	3.9	2.1	9.3	3.8	7.8	6.4	3.5	3.5	8.4	5.7	4.5	6.0
Corylus	—	—	—	—	—	—	—	0.3	—	—	—	1.2	0.4	—	0.8	0.5	—	—
Ulmus	0.9	—	—	1.1	1.2	1.5	0.4	—	0.4	0.9	2.0	0.9	0.4	1.0	1.2	1.4	—	1.0
Juglans	0.9	—	—	—	—	0.5	—	—	—	—	0.3	—	—	0.5	—	—	0.9	—
Pterocarya	1.2	—	0.8	—	0.3	—	—	0.3	—	0.6	0.8	0.3	—	—	0.4	—	—	1.0
Tilia	—	—	—	—	—	—	0.4	0.3	—	—	0.3	—	—	1.0	—	—	—	—
Fraxinus	—	—	—	—	—	—	1.7	—	0.4	—	1.0	—	—	—	—	—	—	—
Celtis	—	—	—	0.7	0.3	0.5	—	0.6	—	0.3	0.5	—	—	—	8.0	—	0.5	0.3
Castanea	0.4	—	—	1.5	1.8	1.0	—	—	—	0.6	—	—	—	2.5	1.6	—	—	1.0
Rhus	—	—	—	—	—	—	—	—	0.4	—	—	—	—	0.5	1.6	1.9	1.8	2.0
Ilex	2.1	—	6.1	13.0	27.2	4.5	0.4	—	—	—	—	0.3	—	3.0	0.4	1.9	0.5	0.3
Zelkowa	1.2	—	0.8	1.5	—	2.5	—	—	—	0.3	1.0	—	—	1.0	0.8	—	—	—
Rhamnus	—	—	—	—	—	—	—	—	—	—	—	0.3	—	—	0.8	—	—	—
Eurya	—	—	—	—	—	—	—	—	0.8	—	—	—	—	—	—	—	—	—
Stewartia	—	—	—	—	—	—	—	—	—	—	0.3	—	—	—	—	—	—	—
Buxus	—	—	—	—	—	—	—	—	—	—	0.3	—	—	—	—	—	—	—
Ligustrum	0.4	—	—	0.7	1.5	—	—	—	—	—	—	—	—	—	—	—	—	—
Callicarpa	—	—	—	—	—	0.5	—	—	—	—	0.5	—	0.4	—	0.4	0.5	—	—
Deutzia	1.2	—	0.4	—	—	—	—	—	—	—	0.3	—	—	—	—	—	—	—
Aesculus	—	—	—	—	—	—	—	—	—	—	—	1.2	—	—	—	—	—	—
Rosa	—	—	—	0.7	0.3	—	—	—	—	—	—	—	—	—	—	—	—	—
Rhododendron	0.9	—	1.6	3.0	1.2	—	7.3	0.9	0.4	—	1.3	—	0.8	2.5	0.8	—	2.3	0.7
other Ericaceae	0.4	—	1.2	1.5	1.2	—	0.9	1.2	0.8	—	—	—	—	0.5	1.2	4.8	—	—

Tab. 6. Non tree pollen frequencies of the Station D.

Pollen type \ Depth (cm.)	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360
Gramineae	12.3	—	12.6	0.7	0.3	1.5	—	—	2.3	3.5	3.5	2.4	1.2	4.5	4.4	2.9	0.5	—
Cyperaceae	—	—	1.6	—	1.2	—	—	—	—	0.3	—	2.7	0.4	4.0	—	—	1.4	5.7
Persicaria	—	—	0.8	—	—	—	1.3	—	0.4	—	—	—	0.4	—	—	—	—	—
other Polygonaceae	—	—	—	—	—	—	—	—	0.4	—	—	—	—	—	—	—	—	—
Sanguisorba	—	—	0.4	—	—	—	—	—	6.9	1.9	0.3	—	—	—	—	—	—	—
Geranium	—	—	—	—	—	—	0.4	—	—	—	—	—	—	—	—	—	0.5	0.7
Potamogeton	—	—	—	—	—	0.5	—	—	—	—	—	—	—	—	—	—	—	—
Myriophyllum	0.9	—	0.8	—	—	—	—	—	0.4	0.3	—	—	—	0.5	—	—	—	—
Salvia	—	—	—	—	—	—	—	0.3	—	—	—	—	—	—	—	—	—	—
Patorinia	—	—	—	—	—	—	—	0.3	—	—	—	—	—	—	—	—	—	—
Alsinaceae	0.4	—	0.4	0.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Compiositae	1.2	—	4.1	1.1	—	9.9	0.9	0.3	0.4	—	1.5	1.8	1.2	1.0	0.4	7.1	0.5	1.3
Polypodiaceae	12.3	—	17.9	17.7	9.5	39.6	74.4	8.0	4.6	0.6	1.5	7.6	4.3	12.9	12.4	10.5	18.0	14.4
Osmundaceae	6.8	—	6.1	3.3	1.2	18.3	29.0	2.8	11.1	0.9	6.8	5.8	8.1	12.9	7.2	14.3	3.6	3.7
Lycopodium serratum	—	—	0.4	—	—	—	3.4	3.0	1.9	—	0.5	1.5	1.6	2.0	2.0	10.0	2.7	1.3
other *Lycopodium*	—	—	—	—	—	—	0.4	—	—	—	—	—	—	—	—	0.5	—	0.7
Botrychium	—	—	—	—	—	—	—	—	1.2	—	—	0.3	—	—	—	—	1.8	—

(Received September 30, 1961)

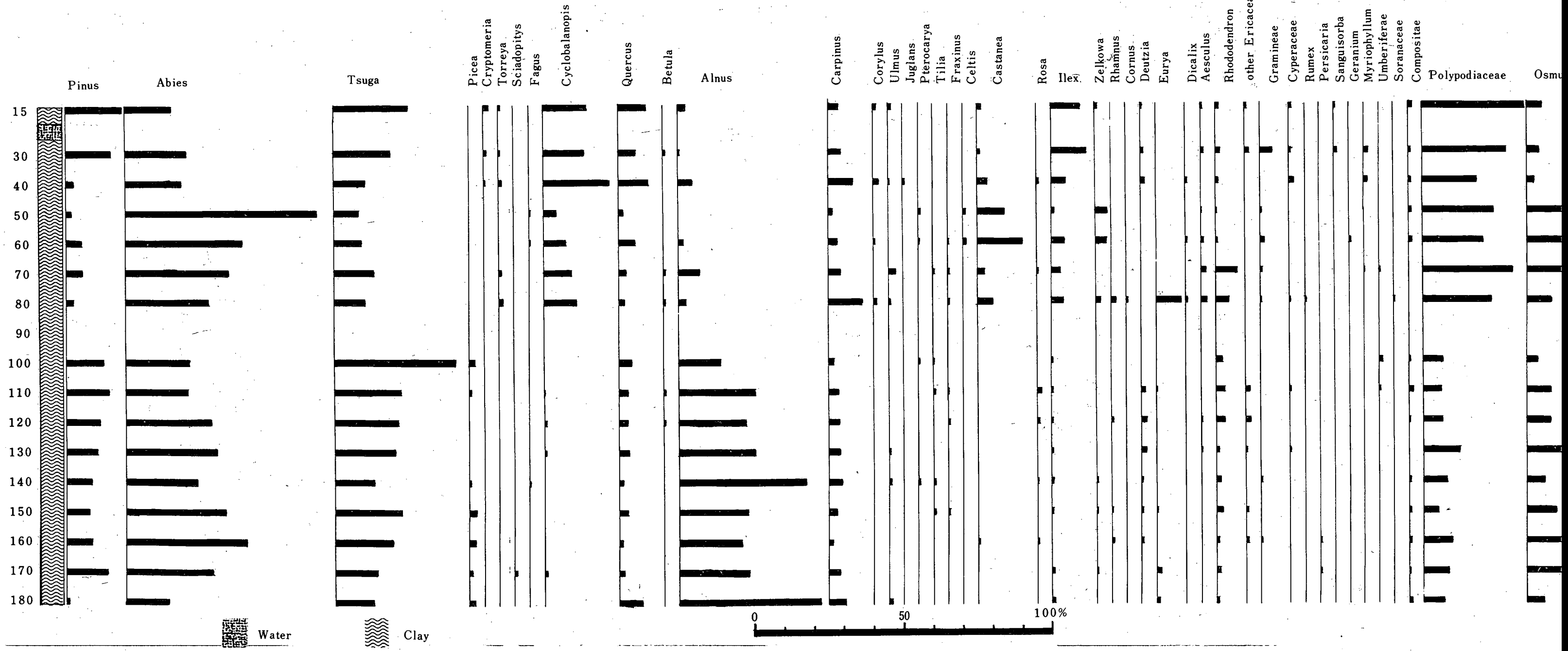

Fig. 2. Pollen diagram of the Station A.

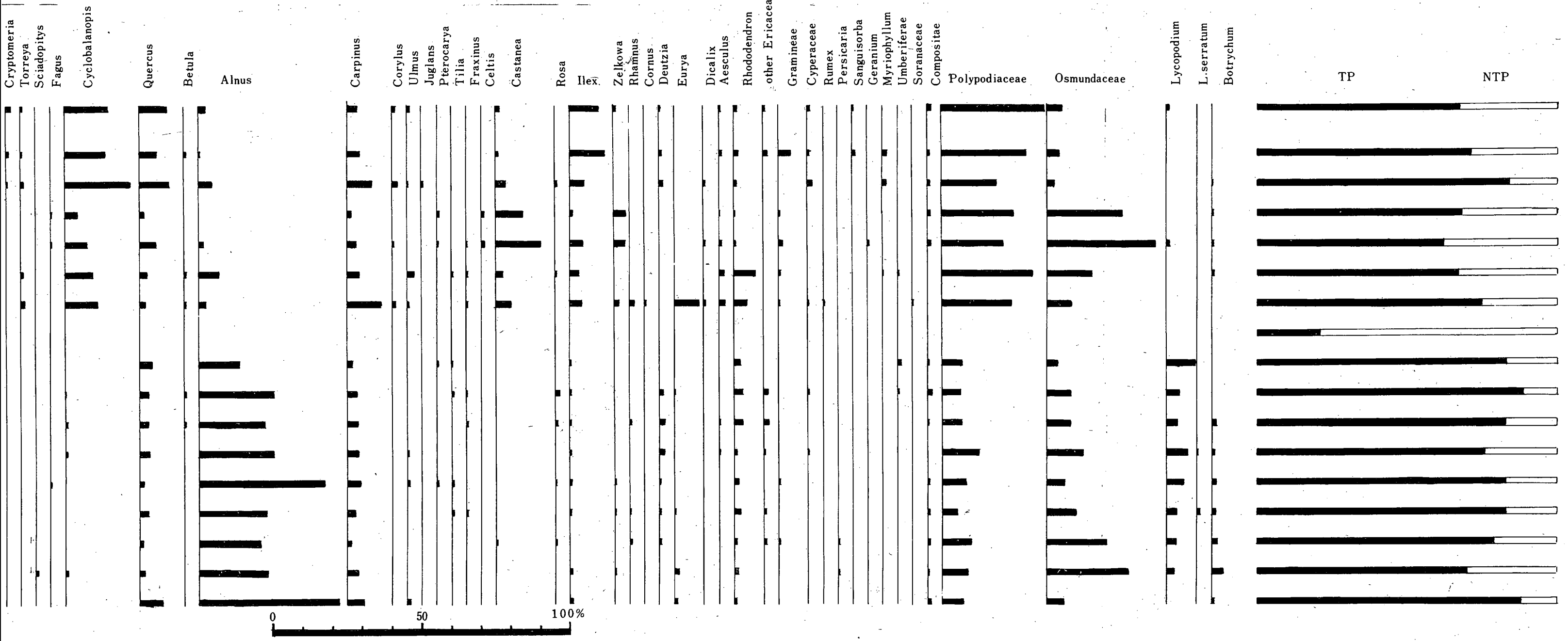

Fig. 2. Pollen diagram of the Station A.

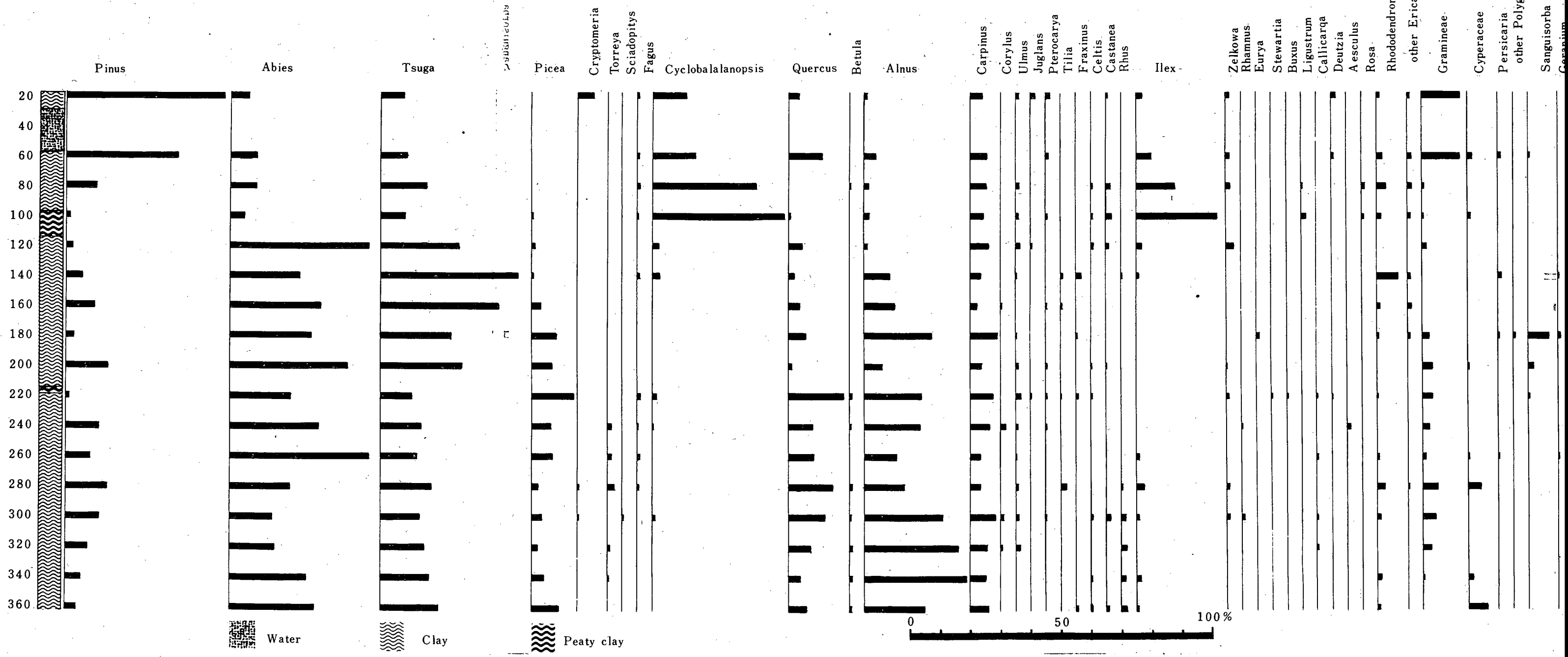

Fig. 3. Pollen diagram of the Station D.

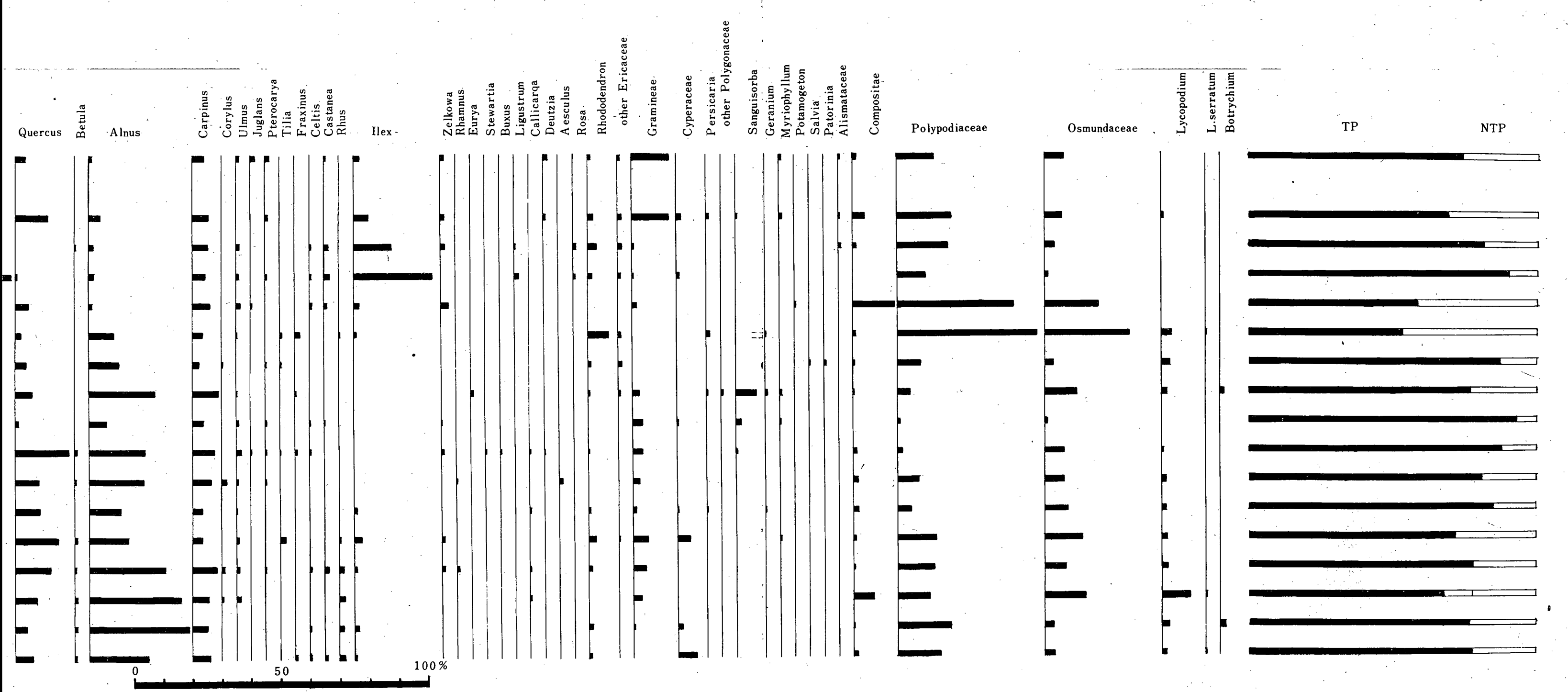

Fig. 3. Pollen diagram of the Station D.